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Material, Materialists.

MATERIAL, denotes ſomething compoſed of *matter*. In which ſenſe the word ſtands oppoſed to *immaterial* See MATTER and METAPHYSICS.

MATERIALISTS, a ſect in the ancient church, compoſed of perſons who, being prepoſſeſſed with that maxim in the ancient philoſophy, *Ex nihilo nihil fit*, "Out of nothing nothing can ariſe," had recourſe to an internal matter, on which they ſuppoſed God wrought in the creation; inſtead of admitting God alone as the ſole cauſe of the exiſtence of all things. Tertullian vigorouſly oppoſes the doctrine of the materialiſts in his treatiſe againſt Hermogenes, who was one of their number.

Materialiſts.

MATERIALISTS is alſo a name given to thoſe who maintain that the ſoul of man is material; or that the principle of perception and thought is not a ſubſtance diſtinct from the body, but the reſult of corporeal organization: See METAPHYSICS. There are others, called by this name, who have maintained that there is nothing but matter in the univerſe; and that the Deity himſelf is material. See SPINOZA.

MATHEMATICS.

Definition of mathematics.

MATHEMATICS is divided into two kinds, *pure* and *mixed*. In *pure mathematics* magnitude is conſidered in the abſtract; and as they are founded on the ſimpleſt notions of quantity, the concluſions to which they lead have the ſame evidence and certainty as the elementary principles from which theſe concluſions are deduced. This branch of mathematics comprehends, 1. *Arithmetic*, which treats of the properties of numbers. 2. *Geometry*, which treats of extenſion as endowed with three dimenſions, length, breadth, and thickneſs, without conſidering the phyſical qualities inſeparable from bodies in their natural ſtate. 3. *Algebra*, ſometimes called univerſal arithmetic, which compares together all kinds of quantities, whatever be their value. 4. The *direct and inverſe method of Fluxions*, (called on the continent, the *differential* and *integral calculi*), which conſider magnitudes as divided into two kinds, conſtant and variable, the variable magnitudes being generated by motion; and which determines the value of quantities from the velocities of the motions with which they are generated. *Mixed Mathematics* is the application of pure mathematics to certain eſtabliſhed phyſical principles, and comprehends all the phyſico-mathematical ſciences, namely, 1. *Mechanics*; 2. *Hydrodynamics*; 3. *Optics*; 4. *Aſtronomy*; 5. *Acouſtics*; 6. *Electricity*; and, 7. *Magnetiſm*. The hiſtory of theſe various branches of ſcience having been given at full length, we ſhall at preſent direct the attention of the reader to the origin and progreſs of pure mathematics.

2. In attempting to diſcover the origin of arithmetic and geometry, it would be a fruitleſs taſk to conduct the reader into thoſe ages of fable which preceded the records of authentic hiſtory. Our means of information upon this ſubject are extremely limited and imperfect; and it would but ill accord with the dignity of a ſcience whoſe principles and concluſions are alike irreſiſtible, to found its hiſtory upon conjecture and fable. But notwithſtanding this obſcurity in which the early hiſtory of the ſciences is enveloped, one thing appears certain, that arithmetic and geometry, and ſome of the phyſical ſciences, had made conſiderable progreſs in Egypt, when the myſteries and the theology of that favoured kingdom were tranſplanted into Greece. It is highly probable that much natural and moral knowledge was taught in the Eleuſinian and Dionyſian myſteries, which the Greeks borrowed from the Egyptians, and that ſeveral of the Grecian philoſophers were induced by this circumſtance to travel into Egypt, in ſearch of thoſe higher degrees of knowledge, which an acquaintance with the Egyptian myſteries had taught them to anticipate. We accordingly find Thales and Pythagoras ſucceſſively under the tuition of the Egyptian prieſts, and returning into Greece loaded with the intellectual treaſures of Egypt. By the eſtabliſhment of the Ionian ſchool at Miletus, Thales inſtructed his countrymen in the knowledge which he had received, and gave birth to that ſpirit of inveſtigation and diſcovery with which his followers were inſpired. He taught them the method of aſcertaining the height of the pyramids of Memphis by the length of their ſhadows; and there is reaſon to believe that he was the

The ſciences originated in Egypt.

A. C. 640.

A. C. 590.

Diſcoveries of Thales.

firſt who employed the circumference of a circle for the menſuration of angles. That he was the author of greater diſcoveries, which have been either loſt or aſcribed to others, there can be little doubt; but theſe are the only facts in the hiſtory of Thales which time has ſpared.

Diſcoveries of Pythagoras.

3. The ſcience of arithmetic was one of the chief branches of the Pythagorean diſcipline. Pythagoras attached ſeveral myſterious virtues to certain combinations of numbers. He ſwore by *four*, which he regarded as the chief of numbers. In the number *three* he ſuppoſed many wonderful properties to exiſt; and he regarded a knowledge of arithmetic as the chief good. But of all Pythagoras's diſcoveries in arithmetic, none have reached our times but his multiplication table. In geometry, however, the philoſopher of Samos ſeems to have been more ſucceſsful. The diſcovery of the celebrated propoſition which forms the 47th of the firſt book of Euclid's Elements, that in every right-angled triangle the ſquare of the ſide ſubtending the right angle is equal to the ſum of the ſquares of the other two ſides, has immortalized his name; and whether we conſider the inherent beauty of the propoſition, or the extent of its application in the mathematical ſciences, we cannot fail to claſs it among the moſt important truths in geometry. From this propoſition its author concluded that the diagonal of a ſquare is incommenſurate to its ſide; and thus gave occaſion to the diſcovery of ſeveral general properties of other incommenſurate lines and numbers.

4. In the time which elapſed between the birth of Pythagoras and the deſtruction of the Alexandrian ſchool, the mathematical ſciences were cultivated with great ardour and ſucceſs. Many of the elementary propoſitions of geometry were diſcovered during this period; but hiſtory does not enable us to refer each diſcovery to its proper author. The method of letting fall a perpendicular upon a right line from a given point (Euclid, B. I. prop. xi.);—of dividing an angle into two equal parts, (Euclid, B. I. prop. ix.); and of making an angle equal to a given angle, (Euclid B. I. prop. xxiii.) were invented by Oenopidus of Chios. About the ſame time Zenodorus, ſome of whoſe writings have been preſerved by Theon in his commentary on Ptolemy, demonſtrated, in oppoſition to the opinion then entertained, that iſoperimetrical figures have equal areas. Coeval with this diſcovery was the theory of regular bodies, for which we are indebted to the Pythagorean ſchool.

Diſcoveries of Oenopidus and Zenodorus.

The celebrated problem of the duplication of the cube propoſed and inveſtigated.

5. About this time the celebrated problem of the duplication of the cube began to occupy the attention of the Greek geometers. In this problem it was required to conſtruct a cube whoſe ſolid content ſhould be double that of a given cube; and the aſſiſtance of no other inſtrument but the rule and compaſſes was to be employed. The origin of this problem has been aſcribed by tradition to a demand of one of the Grecian deities. The Athenians having offered ſome affront to Apollo, were afflicted with a dreadful peſtilence; and upon conſulting the oracle at Delos, received for anſwer, *Double the altar of Apollo*. The altar alluded to happened to be cubical; and the problem, ſuppoſed to be of divine origin, was inveſtigated with ardour by the Greek geometers, though it afterwards baffled all their acuteneſs. The ſolution of this difficulty was attempted by Hippocrates of Chios. He diſcovered, that if

A. C. 450.

two mean proportionals could be found between the ſide of the given cube, and the double of that ſide, the firſt of theſe proportionals would be the ſide of the cube ſought. In order to effect this, Plato invented an inſtrument compoſed of two rules, one of which moved in grooves cut in two arms at right angles to the other, ſo as always to continue parallel with it; but as this method was mechanical, and likewiſe ſuppoſed the deſcription of a curve of the third order, it did not ſatisfy the ancient geometers. The doctrine of conic ſections, which was at this time introduced into geometry by Plato, and which was ſo widely extended as to receive the name of the *higher geometry*, was ſucceſsfully employed in the problem of doubling the cube. Menechmus found that the two mean proportionals mentioned by Hippocrates, might be conſidered as the ordinates of two conic ſections, which being conſtructed according to the conditions of the problem, would interſect one another in two points proper for the ſolution of the problem. The queſtion having aſſumed this form, gave riſe to the theory of geometrical loci, of which ſo many important applications have been made. In doubling the cube, therefore, we have only to employ the inſtruments which have been invented for deſcribing the conic ſections by one continued motion. It was afterwards found, that inſtead of employing two conic ſections, the problem could be ſolved by the interſection of the circle of the parabola. Succeeding geometers employed other curves for this purpoſe, ſuch as the conchoid of Nicomedes and the ciſſoid of Diocles, &c. An ingenious method of finding the two mean proportionals, without the aid of the conic ſections, was afterwards given by Pappus in his mathematical collections.

Conic-ſections diſcovered by Plato. A. C. 390.

A. C. 250.

A. C. 460.

A. D. 400.

6. Another celebrated problem, to triſect an angle, was agitated in the ſchool of Plato. It was found that this problem depended upon principles analogous to thoſe of the duplication of the cube, and that it could be conſtructed either by the interſection of two conic ſections, or by the interſection of a circle with a parabola. Without the aid of the conic ſections, it was reduced to this ſimple propoſition:—To draw a line to a ſemicircle from a given point, which line ſhall cut its circumference, and the prolongation of the diameter that forms its baſe, ſo that the part of the line comprehended between the two points of interſection ſhall be equal to the radius. From this propoſition ſeveral eaſy conſtructions may be derived. Dinoſtratus of the Platonic ſchool, and the cotemporary of Menechmus, invented a curve by which the preceding problem might be ſolved. It had the advantage alſo of giving the multiplication of an angle, and the quadrature of the circle, from which it derived the name of quadratrix.

The triſection of an angle.

Hippocrates's lunula. A. C. 450.

7. While Hippocrates of Chios was paving the way for the method of doubling the cube, which was afterwards given by Pappus, he diſtinguiſhed himſelf by the quadrature of the lunulæ of the circle; and had from this circumſtance the honour of being the firſt who found a curvilineal area equal to a ſpace bounded by right lines. He was likewiſe the author of Elements of Geometry, a work, which, though highly approved of by his cotemporaries, has ſhared the ſame fate with ſome of the moſt valuable productions of antiquity.

8. After the conic ſections had been introduced into geometry by Plato, they received many important additions from Euxodus, Menechmus, and Ariſteus. The

latter

A. C. 380.

latter of theſe philoſophers wrote *five* books on conic ſections, which, unfortunately for ſcience, have not reached our times.

A. C. 300.

Elements of Euclid.

9. About this time appeared Euclid's Elements of Geometry, a work which has been employed for 2000 years in teaching the principles of mathematics, and which is ſtill reckoned the moſt complete work upon the ſubject. Peter Ramus has aſcribed to Theon both the propoſitions and the demonſtrations in Euclid. It has been the opinion of others that the propoſitions belong to Euclid, and the demonſtrations to Theon, while others have given to Euclid the honour of both. It ſeems moſt probable, however, that Euclid merely collected and arranged the geometrical knowledge of the ancients, and that he ſupplied many new propoſitions in order to form that chain of reaſoning which runs through his elements. This great work of the Greek geometer conſiſts of fifteen books: the eleven firſt books contain the elements of pure geometry, and the reſt contain the general theory of ratios, and the leading properties of commenſurate and incommenſurate numbers.

Diſcoveries of Archimedes.
A. C. 250.

10. Archimedes, the greateſt geometer among the ancients, flouriſhed about half a century after Euclid. He was the firſt who found the ratio between the diameter of a circle and its circumference; and, by a method of approximation, he determined this ratio to be as 7 to 22. This reſult was obtained by taking an arithmetical mean between the perimeters of the inſcribed and circumſcribed polygon, and is ſufficiently accurate for every practical purpoſe. Many attempts have ſince been made to aſſign the preciſe ratio of the circumference of a circle to its diameter; but in the preſent ſtate of geometry this problem does not ſeem to admit of a ſolution. The limits of this article will not permit us to enlarge upon the diſcoveries of the philoſopher of Syracuſe. We can only ſtate, that he diſcovered the ſuperficies of a ſphere to be equal to the convex ſurface of the circumſcribed cylinder, or to the area of four of its great circles, and that the ſolidity of the ſphere is to that of the cylinder as 3 to 2. He diſcovered that the ſolidity of the paraboloid is one half that of the circumſcribed cylinder, and that the area of the parabola is two thirds that of the circumſcribed rectangle; and he was the firſt who pointed out the method of drawing tangents and forming ſpirals. Theſe diſcoveries are contained in his works on the dimenſion of the circle, on the ſphere and cylinder, on conoids and ſpheroids, and on ſpiral lines. Archimedes was ſo fond of his diſcovery of the proportion between the ſolidity of the ſphere and that of the cylinder, that he ordered to be placed upon his tomb a ſphere inſcribed in a cylinder, and likewiſe the numbers which expreſs the ratio of theſe ſolids.

Diſcoveries of Apollonius.
A. C. 200.

11. While geometry was thus advancing with ſuch rapid ſteps, Apollonius Pergæus, ſo called from being born at Perga in Pamphylia, followed in the ſteps of Archimedes, and widely extended the boundaries of the ſcience. In addition to ſeveral mathematical works, which are now loſt, Apollonius wrote a treatiſe on the theory of the conic ſections, which contains all their properties with relation to their axes, their diameters, and their tangents. He demonſtrated the celebrated theorem, that the parallelogram deſcribed about the two conjugate diameters of an ellipſe or hyperbola is equal to the rectangle deſcribed round the two axes, and that the ſum or difference of the ſquares of the two conjugate diameters are equal to the ſum or difference of the ſquares of the two axes. In his fifth book he determines the greateſt and the leaſt lines that can be drawn to the circumferences of the conic ſections from a given point, whether this point is ſituated in or out of the axis. This work, which contains every where the deepeſt marks of an inventive genius, procured for its author the appellation of the *Great Geometer*.

Menelaus writes on ſpherical triangles.
A. D. 55.

12. There is ſome reaſon to believe, that the Egyptians were a little acquainted with plane trigonometry; and there can be no doubt that it was known to the Greeks. Spherical trigonometry, which is a more difficult part of geometry, does not ſeem to have made any progreſs till the time of Menelaus, an excellent geometrician and aſtronomer. In his work on ſpherical triangles, he gives the method of conſtructing them, and of reſolving moſt of the caſes which were neceſſary in the ancient aſtronomy. An introduction to ſpherical trigonometry had already been given to the world by Theodoſius in his Treatiſe on Spherics, where he examines the relative properties of different circles formed by cutting a ſphere in all directions.

Theodoſius's ſpherics.
A. C. 60.

Progreſs of analyſis.

13. Though the Greeks had made great progreſs in the ſcience of geometry, they do not ſeem to have hitherto conſidered quantity in its general or abſtract ſtate. In the writings of Plato we can diſcover ſomething like traces of geometrical analyſis; and in the ſeventh propoſition of Archimedes's work on the ſphere and the cylinder, theſe traces are more diſtinctly marked. He reaſons about unknown magnitudes as if they were known, and he finally arrives at an analogy, which, when put into the language of algebra, gives an equation of the third degree, which leads to the ſolution of the problem.

The analyſis of indeterminate problems invented by Diophantus.
A. D. 350.

14. It was reſerved, however, for Diophantus to lay the foundation of the modern analyſis, by his invention of the analyſis of indeterminate problems; for the method which he employed in the reſolution of theſe problems has a ſtriking analogy to the preſent mode of reſolving equations of the 1ſt and 2d degrees. He was likewiſe the author of thirteen books on arithmetic, ſeveral of which are now loſt. The works of Diophantus were honoured with a commentary by the beautiful and learned Hypatia, the daughter of Theon. The ſame fanaticiſm which led to the murder of this accompliſhed female was probably the cauſe that her works have not deſcended to poſterity.

A. D. 410.

Mathematical collections of Pappus.
A. D. 400.

15. Near the end of the fourth century of the Chriſtian era, Pappus of Alexandria publiſhed his mathematical collections, a work which, beſides many new propoſitions of his own, contains the moſt valuable productions of ancient geometry. Out of the eight books of which this work conſiſted, two have been loſt; the reſt are occupied with queſtions in geometry, aſtronomy, and mechanics.

Diſcoveries of Diocles,

16. Diocles, whom we have already had occaſion to mention as the inventor of the ciſſoid, diſcovered the ſolution of a problem propoſed by Archimedes, viz. to cut a ſphere by a plane in a given ratio. The ſolution of Diocles has been conveyed to us by Eutocius, who wrote commentaries on ſome of the works of Archimedes and Apollonius, A. D. 520. About the time of

and Serenus.

of Diocles flouriſhed Serenus, who wrote two books on the cylinder and cone, which have been publiſhed at the end of Halley's edition of Apollonius.

Labours of Proclus. A. D. 500.

17. Geometry was likewiſe indebted to Proclus, the head of the Platonic ſchool at Athens, not only for his patronage of men of ſcience, but his commentary on the firſt book of Euclid. Mathematics were alſo cultivated by Marinus, the author of the Introduction to Euclid's Data;—by Iſidorus of Miletus, who was a diſciple of Proclus, and by Hero the younger, whoſe work, entitled Geodeſia, contains the method of determining the area of a triangle from its three ſides.

Deſtruction of the Alexandrian library.

18. While the mathematical ſciences were thus flouriſhing in Greece, and were ſo ſucceſsfully cultivated by the philoſophers of the Alexandrian ſchool, their very exiſtence was threatened by one of thoſe great revolutions with which the world has been convulſed. The dreadful ravages which were committed by the ſucceſſors of Mahomet in Egypt, Perſia, and Syria, the deſtruction of the Alexandrian library by the caliph Omar, and the diſperſion of a number of thoſe illuſtrious men who had flocked to Alexandria as the cultivators of ſcience, gave a deadly blow to the progreſs of geometry. When the fanaticiſm of the Mahometan religion, however, had ſubſided, and the termination of war had turned the minds of the Arabs to the purſuits of peace, the arts and ſciences engaged their affection, and they began to kindle thoſe very intellectual lights which they had ſo aſſiduouſly endeavoured to extinguiſh. The works of the Greek geometers were ſtudied with care; and the arts and ſciences reviving under the auſpices of the Arabs, were communicated in a more advanced condition to the other nations of the world.

Revival of ſcience.

19. The ſyſtem of arithmetical notation at preſent adopted in every civilized country, had its origin among the Arabs. Their ſyſtem of arithmetic was made known to Europe by the famous Gerbert, afterwards Pope Sylveſter II. who travelled into Spain when it was under the dominion of that nation.

A. D. 960.

20. The invention of algebra has been aſcribed to the Arabs by Cardan and Wallis, from the circumſtance of their uſing the words *ſquare*, *cube*, *quadrato-quadratum*, &c. inſtead of the 2d, 3d, 4th, &c. powers as employed by Diophantus. But whatever truth there may be in this ſuppoſition, it appears that they were able to reſolve cubic, and even biquadratic equations, as there is in the Leyden library, an Arabic MS. entitled "The Algebra of Cubic Equations, or the Solution of Solid Problems."

Progreſs of the Arabs in geometry.

21. The various works of the Greek geometers were tranſlated by the Arabs, and it is through the medium of an Arabic verſion, that the fifth and ſixth books of Apollonius have deſcended to our times. Mahomet Ben Muſa, the author of a work on Plane and Spherical Figures, and Geber Ben Aphla, who wrote a commentary on Plato, gave a new form to the plane and ſpherical trigonometry of the ancients. By reducing the theory of triangles to a few propoſitions, and by ſubſtituting, inſtead of the chords of double arcs, the ſines of the arcs themſelves, they ſimplified this important branch of geometry, and contributed greatly to the abridgement of aſtronomical calculation. A treatiſe on the art of ſurveying was likewiſe written by Mahomet of Bagdad.

22. After the deſtruction of the Alexandrian ſchool founded by Lagus, one of the ſucceſſors of Alexander, the diſperſed Greeks continued for a while to cultivate their favourite ſciences, and exhibited ſome marks of that genius which had inſpired their forefathers. The *magic ſquares* were invented by Moſchopulos, a diſcovery more remarkable for its ingenuity than for its practical uſe. The ſame ſubject was afterwards treated by Cornelius Agrippa in his work on occult philoſophy; by Bachet de Meziriac, a learned algebraiſt, about the beginning of the 17th century, and in later times by Frenicle de Beſſi, M. Poignard of Bruſſels, De la Hire, and Sauveur.

Moſchopulos's diſcovery of the magic ſquares.

Algebra introduced into Italy by Leonard of Piſa 1202, 1228.

23. The ſcience of pure mathematics advanced with a doubtful pace during the 13th, 14th, and 15th centuries. The algebra of the Arabians was introduced into Italy by Leonard of Piſa, who, in the courſe of his commercial ſpeculations in the eaſt, had conſiderable intercourſe with the Arabs. A work on the Planiſphere, and ten books on arithmetic, were written by Jordanus Nemorarius. The Elements of Euclid were tranſlated by Campanus of Novara. A work on algebra, entitled *Summa de Arithmetica, Geometria, Proportione et Proportionalitate*, was publiſhed by Lucas Paccioli; and about the ſame time appeared Regiomontanus's treatiſe on trigonometry, which contains the method of reſolving ſpherical triangles in general, when the three angles or three ſides are known.

A. D. 1230. A. D. 1250. A. D. 1494.

24. During the 16th century, algebra and geometry advanced with rapidity, and received many new diſcoveries from the Italian philoſophers. The formula for the ſolution of equations of the third degree was diſcovered by Scipio Ferrei profeſſor of mathematics at Bologna, and perhaps by Nicholas Tartalea of Breſcia; and equations of the fourth order were reſolved by Lewis Ferrari, the diſciple of Hieronymus Cardan of Bononia. This laſt mathematician publiſhed nine books of arithmetic in 1539; and in 1545 he added a tenth, containing the doctrine of cubic equations which he had received in ſecrecy from Tartalea, but which he had ſo improved as to render them in ſome meaſure his own. The common rule for ſolving cubic equations ſtill goes by the name of Cardan's Rule.

A. D. 1505. A. D. 1535.

Diſcoveries of Bombelli. A. D. 1579.

25. The irreducible caſe in cubic equations was ſucceſsfully illuſtrated by Raphael Bombelli of Bologna. He has ſhown in his algebra, what was then conſidered as a paradox, that the parts of the formula which repreſents each root in the irreducible caſe, form, when taken together, a real reſult; but the paradox vaniſhed when it was ſeen from the demonſtration of Bombelli that the imaginary quantities contained in the two numbers of the formula neceſſarily deſtroyed each other by their oppoſite ſigns. About this time Maurolycus, a Sicilian mathematician, diſcovered the method of ſumming up ſeveral ſerieſes of numbers, ſuch as the ſeries 1, 2, 3, 4, &c.; 1, 4, 9, 16, &c. and the ſeries of triangular numbers, 1, 3, 6, 10, 15, 21, &c.

Labours of Maurolycus. Born 1494. Died 1579.

Diſcoveries of Vieta. Born 1540. Died 1603.

26. The ſcience of analyſis is under great obligations to Francis Vieta, a native of France. He introduced the preſent mode of notation, called *literal*, by employing the letters of the alphabet to repreſent indefinite given quantities; and we are alſo indebted to him for the method of transforming one equation into another, whoſe roots are greater or leſs than thoſe of the original equation by a given quantity; for the method of multiplying or dividing their roots by any given number,

ber, of depriving equations of the ſecond term, and of freeing them from fractional coefficients. The method which he has given for reſolving equations of the third and fourth degree is alſo new and ingenious, and his mode of obtaining an approximate ſolution of equations of every order is entitled to ſtill higher praiſe. We are alſo indebted to Vieta for the theory of angular ſections, the object of which is to find the general expreſſions of the chords or ſines for a ſeries of arcs that are multiples of each other.

Logarithms invented by Baron Napier. Born 1550. Died 1617.

27. While analyſis was making ſuch progreſs on the continent, Baron Napier of Merchiſton in Scotland was bringing to perfection his illuſtrious diſcovery of the *logarithms*, a ſet of artificial numbers, by which the moſt tedious operations in multiplication and diviſion may be performed merely by addition and ſubtraction. This diſcovery was publiſhed at Edinburgh in 1614 in his work entitled *Logarithmorum Canonis Deſcriptio, ſeu Arithmetica Supputationum Mirabilis Abbreviatio.* It is well known that there is ſuch a correſpondence between every arithmetical and geometrical progreſſion, viz. $\left\{\begin{matrix} 0, & 1, & 2, & 3, & 4, & 5, & 6, \\ 1, & 2, & 4, & 8, & 16, & 32, & 64, \end{matrix}\right\}$ that any terms of the geometrical progreſſion may be multiplied or divided by merely adding or ſubtracting the correſponding terms of the arithmetical progreſſion; thus the product of four and eight may be found by taking the ſum of the correſponding terms in the arithmetical progreſſion, viz. 2 and 3, for their ſum 5 points out 32 as the product of 4 and 8. The numbers 0, 1, 2, 3, &c. are therefore the logarithms of 1, 2, 4, 8, &c. The choice of the two progreſſions being altogether arbitrary, Baron Napier took the arithmetical progreſſion which we have given above, and made the term 0 correſpond with the unit of the geometrical progreſſion, which he regulated in ſuch a manner that when its terms are repreſented by the abſciſſæ of an equilateral hyperbola in which the firſt abſciſs and the firſt ordinate are each equal to 1, the logarithms are repreſented by the hyperbolic ſpaces. In conſequence, however, of the inconvenience of this geometrical progreſſion, Baron Napier, after conſulting upon the ſubject with Henry Briggs of Greſham College, ſubſtituted the decuple progreſſion 1, 10, 100, 1000, of which 0, 1, 2, 3, 4, &c. are the logarithms. Nothing now remained but to conſtruct tables of logarithms, by finding the logarithms of the intermediate numbers between the terms of the decuple progreſſion. Napier, however, died before he was able to calculate theſe tables; but his loſs was in ſome meaſure ſupplied by Mr Briggs, who applied himſelf with zeal to this arduous taſk, and publiſhed in 1618 a table of the logarithms of all numbers from 1 to 1000. In 1624 he publiſhed another table containing the logarithms from 1000 to 20,000, and from 90,000 to 100,000. The defects in Briggs's tables were filled up by his friends Gellibrand and Hadrian Vlacq, who alſo publiſhed new tables containing the logarithms of ſines, tangents, &c. for 90 degrees.

Tables of logarithms computed by Mr Briggs.

A.D. 1618.

Diſcoveries of Harriot Born 1560. Died 1621.

28. During the time when Napier and Briggs were doing honour to their country by completing the ſyſtem of logarithms, algebra was making great progreſs in the hands of our countryman Harriot. His *Artis analyticæ Praxis*, which appeared in 1620, contains along with the diſcoveries of its author, a complete view of the ſtate of algebra. He ſimplified the notation by ſubſtituting ſmall letters inſtead of the capitals introduced by Vieta; and he was the firſt who ſhowed that every equation beyond the firſt degree may be conſidered as produced by the multiplication of as many ſimple equations as there are units in the exponent of the higheſt power of the unknown quantity. From this he deduced the relation which exiſts between the roots of any equation, and the coefficients of the terms of which it conſiſts.

29. About the ſame time, a foreign author named Fernel, phyſician to King Henry II. of France, had the merit of being the firſt who gave the meaſure of the earth. By reckoning the number of turns made by a coach wheel from Amiens to Paris, till the altitude of the pole ſtar was increaſed one degree, he eſtimated the length of a degree of the meridian to be 56,746 toiſes, which is wonderfully near the truth. He alſo wrote a work on mathematics, entitled *De Proportionibus.*—About this time it was ſhown by Peter Metius, a German mathematician, that if the diameter of a circle be 113, its circumference will be 355. This reſult, ſo very near the truth, and expreſſed in ſo few figures, has preſerved the name of its author.

Fernel firſt gives the meaſure of the earth.

Metius finds more correct numbers for the diameter and circumference of a circle.

30. The next author, whoſe labours claim our attention, is the illuſtrious Deſcartes. We do not allude to thoſe wild and ingenious ſpeculations by which this philoſopher endeavoured to explain the celeſtial phenomena; but to theſe great diſcoveries with which he enriched the kindred ſciences of algebra and geometry. He introduced the preſent method of marking the powers of any quantity by numerical exponents. He firſt explained the uſe of negative roots in equations, and ſhowed that they are as real and uſeful as poſitive roots, the only difference between them being founded on the different manner in which the correſponding quantities are conſidered. He pointed out the method of finding the number of poſitive and negative roots in any equation where the roots are real; and developed the method of indeterminates which Vieta had obſcurely hinted at.

Diſcoveries of Deſcartes in algebra. Born 1596. Died 1650.

31. Though Regiomontanus, Tartalea, and Bombelli, had reſolved ſeveral geometrical problems by means of algebra, yet the general method of applying geometry to algebra was firſt given by Vieta. It is to Deſcartes, however, that we are indebted for the beautiful and extenſive uſe which he made of his diſcovery. His method of repreſenting the nature of curve lines by equations, and of arranging them in different orders according to the equations which diſtinguiſhed them, opened a vaſt field of inquiry to ſubſequent mathematicians; and his methods of conſtructing curves of double curvature, and of drawing tangents to curve lines, have contributed much to the progreſs of geometry. The inverſe method of tangents, which it was reſerved for the fluxionary calculus to bring to perfection, originated at this time in a problem which Florimundus de Beaune propoſed to Deſcartes. It was required to conſtruct a curve in which the ratio of the ordinate and ſubtangent ſhould be the ſame as that of a given line to the portion of the ordinate included between the curve and a line inclined at a given angle. The curve was conſtructed by Deſcartes, and ſeveral of its properties detected, but he was unable to accompliſh the complete ſolution of the problem. Theſe diſcoveries of Deſcartes were ſtudied and improved by his ſucceſſors, among whom

He extends the application of algebra to geometry.

A. D. 1647.

A. D. 1658.

whom we may number the celebrated Hudde, who publiſhed in Schooten's commentary on the geometry of Deſcartes, an excellent method of determining if an equation of any order contains ſeveral equal roots, and of diſcovering the roots which it contains.

Diſcoveries of Paſcal. Born 1623. Died 1662.

32. The celebrated Paſcal, who was equally diſtinguiſhed by his literary and his ſcientific acquirements, extended the boundaries of analyſis by the invention of his arithmetical triangle. By means of arbitrary numbers placed at the vertex of the triangle, he forms all the figurate numbers in ſucceſſion, and determines the ratio between the numbers of any two caſes, and the various ſums reſulting from the addition of all the numbers of one rank taken in any poſſible direction. This ingenious invention gave riſe to the calculation of probabilities in the theory of games of chance, and formed the foundation of an excellent treatiſe of Huygens, entitled *De Ratiociniis in Ludo Aleæ*, publiſhed in 1657.

Diſcoveries of Fermat. Born 1590. Died 1663.

33. Several curious properties of numbers were at the ſame time diſcovered by Fermat at Toulouſe. In the theory of prime numbers, particularly, which had firſt been conſidered by Eratoſthenes, Fermat made great diſcoveries; and in the doctrine of indeterminate problems, he ſeems to have been deeply verſed, having republiſhed the arithmetic of Diophantus, and enriched it with many valuable notes of his own. He invented the method of diſcovering the *maxima* and *minima* of variable quantities, which ſerves to determine the tangents of geometrical curves, and paved the way for the invention of the fluxionary calculus.

Cavaleri's method of indiviſibles. 1635.

34. Another ſtep towards the diſcovery of fluxions was at this time made by Cavaleri in his geometry of indiviſibles. In this work, which was publiſhed in 1635, its author ſuppoſes every plane ſurface to conſiſt of an infinite number of planes; and he lays it down as an axiom, that theſe infinite ſums of lines and ſurfaces have the ſame ratio when compared with the unit in each caſe as the ſuperficies and ſolids to be meaſured. This ingenious method was employed by Cavaleri in the quadrature of the conic ſections, and in the curvature of ſolids generated by their revolution; and in order to prove the accuracy of his theory, he deduced the ſame reſults from different principles.

The ſame ſubject diſcuſſed by Roberval. 1634.

35. Problems of a ſimilar kind had been ſolved by Fermat and Deſcartes, and now occupied the attention of Roberval. The latter of theſe mathematicians began his inveſtigation of this ſubject about a year before the publication of Cavaleri's work, and the methods which both of them employed were ſo far the ſame as to be founded on the principles of indiviſibles. In the mode, however, which Roberval adopted, planes and ſolids were conſidered as compoſed of an infinite number of rectangles, whoſe altitudes and the thickneſs of their ſections were infinitely ſmall.—By means of this method, Roberval determined the area of the cycloid, the centre of gravity of this area, and the ſolids formed by its revolution on its axis and baſe. He alſo invented a general method for tangents, ſimilar in metaphyſical principles to that of fluxions, and applicable both to mechanical and geometrical curves. By means of this, he determined the tangents of the cycloid; but there were ſome curves which reſiſted its application. Conſidering every curve to be generated by the motion of a point, Roberval regarded this point as acted upon at every inſtance with two velocities aſcertained from the nature of the curve. He conſtructed a parallelogram having its ſides in the ſame ratio as the two velocities; and he aſſumes as a principle, that the direction of the tangent muſt fall on the diagonal, the poſition of which being aſcertained, gives the poſition of the tangent.

Labours of Torricelli. 1644.

36. In 1644, ſolutions of the cycloidal problems formerly reſolved by Roberval were publiſhed by Torricelli as invented by himſelf. The demonſtrations of Roberval had been tranſmitted to Galileo the preceptor of Torricelli, and had alſo been publiſhed in 1637 in Merſennus's Univerſal Harmony. The Italian philoſopher was conſequently accuſed of plagiariſm by Roberval, and the charge ſo deeply affected his mind as to bring him prematurely to the grave. It is obvious, however, from the demonſtrations of Torricelli, that he had never ſeen thoſe of Roberval, and that he was far from meriting that cruel accuſation which deprived ſcience of one of its brighteſt ornaments.

Farther diſcoveries of Paſcal. 1658.

37. The cycloid having attracted the notice of geometers from the number and ſingularity of its properties, the celebrated Paſcal propoſed to them a variety of new problems relative to this curve, and offered prizes for their ſolution. Theſe problems required the area of any cycloidal ſegment, the centre of gravity of that ſegment, the ſolids, and the centres of gravity of the ſolids, which are generated either by a whole revolution, a half or a quarter of a revolution of this ſegment round an abſciſſa or an ordinate. The reſolution of theſe problems was attempted by Huygens, Sluze, Sir Chriſtopher Wren, Fermat, and Roberval. Sluze diſcovered an ingenious method of finding the area of the curve. Huygens ſquared the ſegment compriſed between the vertex, and as far as a fourth of the diameter of the generating circle; and Sir Chriſtopher Wren aſcertained the length of the cycloidal arc included between the vertex and the ordinate, the centre of gravity of this arc, and the ſurfaces of the ſolids generated during its revolution. Theſe attempts were not conſidered by their authors as ſolutions of Paſcal's problems, and therefore they did not lay claim to his prize. Our countryman Wallis, however, and Lallouere a Jeſuit, gave in a ſolution of all the problems, and thought themſelves entitled to the proffered reward. In the methods employed by theſe mathematicians, Paſcal detected ſeveral ſources of error; and it was reſerved for that great genius to furniſh a complete ſolution of his own problems. Extending his inveſtigations to curtate and prolate cycloids, he proved that the length of theſe curves depends on the rectification of the ellipſe, and aſſigned in each caſe the axis of the ellipſe. From this method he deduced this curious theorem, that if two cycloids, the one curtate and the other prolate, be ſuch, that the baſe of the one is equal to the circumference of the circle by which the other is generated, the length of theſe two cycloids will be equal.

Labours of Wallis. 1655.

38. While theſe diſcoveries were making on the continent, the friends of ſcience in Britain were actively employed in promoting its advancement. In 1655, Wallis publiſhed his *Arithmetica Infinitorum*, a work of great genius. He attempted to determine by the ſummation of infinite ſeries, the quadrature of curves, and the curvature of ſolids, ſubjects which were afterwards inveſtigated in a different manner by Iſhmael Bullialdus. By Wallis's method, curves were ſquared when their ordinates are expreſſed by one term, and when 1682.

their

their ordinates were complex quantities raiſed to entire and poſitive powers, theſe ordinates were reſolved into ſeries, of which each term is a monomial. Wallis attempted to extend his theory to curves whoſe ordinates were complex and radical, by attempting to interpolate the ſeries of the former kind with a new ſeries; but he was unſucceſsful.

Diſcoveries of Newton.

39. It was left to Newton to remove this difficulty. He ſolved the problem in a more direct and ſimple manner by the aid of his new formula for expanding into an infinite ſeries any power of a binomial, whether its exponent was poſitive or negative, an integer or a fraction. Algebra is alſo indebted to this illuſtrious mathematician for a ſimple and extenſive method of reſolving an equation into commenſurable factors; for a method of ſumming up the powers of the roots of an equation, of extracting the roots of quantities partly commenſurable, and partly incommenſurable, and of finding by approximation the roots of literal and numerical equations of all orders.

Lord Brouncker diſcovers continued fractions. Born 1620. Died 1684.

40. About this time, William Lord Brouncker, in attempting to demonſtrate an expreſſion of Wallis on the magnitude of the circle, diſcovered the theory of continued fractions. When an irreducible fraction is expreſſed by numbers too great and complicated to be eaſily employed by the analyſt, the method of Lord Brouncker enables us to ſubſtitute an expreſſion much more ſimple and nearly equivalent. This theory, which enables us to find a very accurate relation between the diameter and circumference of the circle, was employed by Huygens * in the calculation of his planetary automaton, for repreſenting the motions of the ſolar ſyſtem, and was enlarged and improved by other celebrated geometers. Lord Brouncker had likewiſe the merit of diſcovering an infinite ſeries to repreſent the area of the hyperbola. The ſame diſcovery was made by Nicholas Mercator, who publiſhed it in his *Logarithmotechnia* in 1668.

* *Opera Poſthuma*, tom. ii. *ſub finem.*

Labours of James Gregory.

41. The ſubject of infinite ſeries received conſiderable addition from Mr James Gregory. He was the firſt who gave the tangent and ſecant in terms of the arc, and, inverſely, the arc in terms of the tangent and ſecant. He conſtructed ſeries for finding directly the logarithm of the tangent and ſecant from the value of the arc, and the logarithm of the arc from that of the tangent and ſecant; and he applied this theory of infinite ſeries to the rectification of the ellipſis and hyperbola.

Labours of Dr Barrow.

42. The differential triangle invented by the learned Dr Barrow, for drawing tangents to curves, may be regarded as another contribution towards the invention of fluxions. This triangle has for its ſides the element of the curve and thoſe of the abſciſs and ordinate, and thoſe ſides are treated as quantities infinitely ſmall.

Theory of evolutes diſcovered by Huygens, 1673.

43. The doctrine of evolutes had been ſlightly touched upon by Apollonius. It remained, however, for the illuſtrious Huygens to bring it to perfection. His theory of evolutes is contained in his *Horologium Oſcillatorium*, publiſhed in 1673, and may be regarded as one of the fineſt diſcoveries in geometry. When any curve is given, Huygens has pointed out the method of conſtructing a ſecond curve, by drawing a ſeries of perpendiculars to the firſt, which are tangents to the ſecond; and of finding the firſt curve from the ſecond. From this principle he deduces ſeveral theorems on the rectification of curves; and that remarkable property of the cycloid, in which an equal and ſimilar cycloid is produced by evolution.

Hiſtory of the diſcovery of fluxions.

44. In contemplating the progreſs of analyſis from the beginning of the 17th century, to the invention of fluxions, we cannot fail to perceive the principles of that calculus gradually unfolding themſelves to view. The human mind ſeemed to advance with rapidity towards that great diſcovery; and it is by no means unlikely that it would ſoon have arrived at the doctrine of fluxions, even if the ſuperior genius of Newton had not accelerated its progreſs. In Cavalerius's *Geometria Indiviſibilium*, we perceive the germ of the infiniteſimal calculus; and the method of Roberval for finding the tangents of curves, bears a ſtriking analogy to the metaphyſics of the fluxionary calculus. It was the glory of Newton, however, to invent and illuſtrate the method of fluxions; and the obſcure hints which he received from preceding mathematicians, do not in the leaſt detract from the merit of our illuſtrious countryman.

General remarks on the diſpute between Newton and Leibnitz.

45. On the claims of Leibnitz as a ſecond inventor of fluxions, and the illiberal violence with which they have been urged by foreign mathematicians, we would wiſh to ſpeak with delicacy and moderation. Who that can appreciate the diſcoveries of that celebrated mathematician, or is acquainted with that penetrating genius which threw light on every department of human knowledge, would willingly ſtain his memory with an ungracious imputation? The accuſation of plagiariſm is one of thoſe charges which it is difficult either to ſubſtantiate or repel, and when directed againſt a great man, ought never, without the cleareſt evidence, to be wantonly preferred or willingly received. If charitable ſentiments are ever to be entertained towards others,—to what claſs of beings ſhould they be more cheerfully extended than to thoſe who have been the ornaments of human nature? If ſociety has agreed to regard as ſacred the failings and excentricities of genius,—when ought that reverence to be more ſtrongly excited than when we are paſſing judgment on its mightieſt efforts? Inquiries into the motives and actions of the learned ought never to be wantonly indulged. When the honour of our country, or the character of an individual, requires ſuch an inveſtigation, a regard to truth, and a contempt of national prejudice, ſhould guide the inquiry.—We ſhould proceed with delicacy and forbearance.—We ſhould tread lightly even on the aſhes of genius. It is not uncommon to witneſs the indulgence of malicious pleaſure, in detracting from the merits of a diſtinguiſhed character. The aſſailant raiſes himſelf for a while to the level of his enemy, and acquires glory by his fall. But let him remember that the laurels thus won cannot flouriſh long. The ſame public opinion which conferred them will tear them from his brow, and conſign the accuſer to that infamy from which the brighteſt abilities will be inſufficient to raiſe him. The conſequences of ſuch conduct have been ſeen in the fall of Torricelli. It was the charges of plagiariſm, preferred by Roberval, that hurried this young and accompliſhed philoſopher to an early grave.

46. We have been led into theſe obſervations by ſtudying the diſpute between the followers of Newton and Leibnitz. The claims of the Britiſh, as well as thoſe of the

the foreign mathematicians, have undoubtedly been too high; and victory rather than truth ſeems to have been the object of conteſt. Even the name of Newton has not eſcaped from ſerious imputations. The immenſity of the ſtake for which the different parties contended, may perhaps juſtify the commencement of the diſpute; and the brilliancy of the talents that were called into action, may leave us no cauſe to regret its continuance: But nothing can reconcile us to thoſe perſonal animoſities in which the good ſenſe and temper of philoſophy are loſt, and that violence of literary warfare where ſcience can gain nothing in the combat.—In giving an account, therefore, of that intereſting diſpute, we ſhall merely give a brief view of the facts that relate to the diſcovery of the higher calculus, and make a few obſervations on the concluſions to which they lead.

Newton publiſhes a tract containing the principles of fluxions.

47. In the year 1669, a paper of Sir Iſaac Newton's, entitled *De analyſi per equationes numero terminorum infinitas*, was communicated by Dr Barrow to Mr Collins, one of the ſecretaries of the Royal Society. In this paper the author points out a new method of ſquaring curves, both when the expreſſion of the ordinate is a rational quantity, and when it contains complex radicals, by evolving the expreſſion of the ordinate into an infinite number of ſimple terms by means of the binomial theorem. In a letter from Newton to Collins, dated December 10. 1672, there is contained a method of drawing tangents to curve lines, without being obſtructed by radicals; and in both theſe works, an account of which was circulated on the continent by the ſecretaries of the Royal Society, the principles of the fluxional calculus are plainly exhibited; and it is the opinion of all the diſputants, that thoſe works at leaſt prove, that Newton muſt have been acquainted with the method of fluxions when he compoſed them.

48. Leibnitz came to London in 1673, and though there is no direct evidence that he ſaw Newton's paper *De Analyſi per Equationes*, &c. yet it is certain that he had ſeen Sir Iſaac's letter to Collins of 1672; and it is highly improbable that ſuch a man as Leibnitz ſhould have been ignorant of a paper of Newton's which had been four years in the poſſeſſion of the public, and which contained diſcuſſions at that time intereſting to every mathematician.

Correſpondence between Leibnitz and Oldenburg.

49. A letter from Newton to Oldenburg, one of the ſecretaries of the Royal Society, dated October 24. 1676, was communicated to Leibnitz. This letter contains ſeveral theorems without the demonſtrations, which are founded on the method of fluxions, and merely ſtates that they reſult from the ſolution of a general problem. The enunciation of this problem he expreſſes in a cypher, the meaning of which was, An equation containing any number of flowing quantities being given, to find the fluxions, and inverſely. In reply to this communication, Leibnitz tranſmitted a letter to Oldenburg, dated June 21. 1677, where he explains the nature of the differential calculus, and affirms, that he had long employed it for drawing tangents to curve lines.

Leibnitz publiſhes an account of the differential calculus.

50. The correſpondence between Leibnitz and Oldenburg having been broken off by the death of the latter, Leibnitz publiſhed in the *Acta Erudit. Lipſ.* for October 1684, the principles of the new analyſis, under the title of *Nova Methodus pro maximis et minimis, itemque tangentibus, quæ nec fractas, nec irrationales quantitates moratur, et ſingulare pro illis calculus*. This paper contains the method of differencing ſimple, fractional, and radical quantities, and the application of the calculus to the ſolution of ſome phyſical and geometrical problems. In 1685, he likewiſe publiſhed two ſmall pamphlets on the quadrature of curves, containing the principles of the *Calculus Summatorius*, or the *Inverſe Method of Fluxions*; and in 1686 there appeared another tract by the ſame author, *On the Recondite Geometry, and the Analyſis of Indiviſibles and Infinites*, containing the fundamental rule of the integral calculus.

Newton publiſhes his Principia.

51. Towards the cloſe of the year 1686, Sir Iſaac Newton gave to the world his illuſtrious work entitled *Philoſophiæ Naturalis Principia Mathematica.* Some of the moſt difficult problems in this work are founded on the fluxional calculus; and it is allowed by Boſſut, one of the defenders of Leibnitz, "that mathematicians did Newton the juſtice to acknowledge, that at the period when his *Principia* was publiſhed, he was maſter of the method of fluxions to a high degree, at leaſt with reſpect to that part which concerns the quadrature of curves." The claim of Leibnitz, as a ſeparate inventor of the differential calculus, is evidently allowed by Newton himſelf, when he obſerves, that Leibnitz had communicated to him a method ſimilar to his own for drawing tangents, &c. and differing from it only in the enunciation and notation.

Leibnitz propoſes the problem of the iſochronous curve;

52. About this time, it became faſhionable among geometers to perplex each other by the propoſal of new and difficult problems, a practice which powerfully contributed to the progreſs of mathematics. The diſpute in which Leibnitz was engaged with the Carteſians reſpecting the meaſure of active forces, which the former ſuppoſed to be as the ſimple velocity, while the latter aſſerted, that they were as the ſquare of the velocity, led him to propoſe the problem of the iſochronous curve, or "to find the curve which a heavy body muſt deſcribe equally, in order to approach or recede from a horizontal plane in equal times." This curve was found by Huygens to be the ſecond cubic parabola; but he gave only its properties and conſtruction without the demonſtrations. The ſame ſolution, along with the demonſtration, was given by Leibnitz in 1689, who, at the ſame time, propoſed to geometers to find the *paracentric iſochronal curve*, or the curve in which a body would equally approach or recede from a given point in equal times.

which is ſolved by Huygens in 1687.

James Bernouilli alſo finds the iſochronous curve.

53. It was at this time that the two brothers, James and John Bernouilli, began to diſplay thoſe talents from which the phyſical and mathematical ſciences received ſuch immenſe improvements. James was born in 1654, and died in 1705; and John, who was his pupil, was born in 1667, and lived to the advanced age of 68 years. In 1690, James Bernouilli gave the ſame ſolution of the iſochronous curve that had been given by Huygens and Leibnitz; and propoſed the celebrated problem of the catenary curve, which had formerly perplexed the ingenuity of Galileo. In two memoirs, publiſhed in 1691, he determined, by means of the inverſe method of fluxions, the tangents of the parabolic ſpiral, the logarithmic ſpiral, and the loxodromic curve, and likewiſe the quadratures of their areas.

1691. Solution of the problem of the catenarian curve, and other analogous problems.

54. The problem of the catenary curve having occupied the attention of geometers, was reſolved by Huygens, Leibnitz,

Leibnitz, and John Bernouilli. In these solutions, however, the gravity of the catenary curve was supposed to be uniform; but James Bernouilli extended the solution to cases where the weight of the curve varies from one point to another, according to a given law. From this problem he was also conducted to the determination of the curvature of a bended bow, and that of an elastic bar fixed at one extremity, and loaded at the other with a given weight. In the hopes of contributing to the progress of navigation, the same mathematician considered the form of a sail swoln with the wind. When the wind after striking the sail, is not prevented from escaping, the curvature of the sail is that of the common catenarian curve; but when the sail is supposed perfectly flexible, and filled with a fluid pressing downwards on itself, as water presses on the sides of a vessel, the curve which it forms is one of those denominated *lintearia*, which is expressed by the same equation as the common elastic curve, where the extensions are reckoned proportional to the forces applied at each point. —The same problem was solved in the *Journal des Sçavans* for 1692, by John Bernouilli; but there is satisfactory evidence that it was chiefly borrowed from his brother James.

Labours of James Bernouilli. 1692.

55. The attention of James Bernouilli was now directed to the theory of curves produced by the revolution of one curve upon another. He considers one curve rolling upon a given curve, equal to the first, and immoveable, He determines the evolute and the caustic of the epicycloid, described by a point of the moving circle, and he deduces from it other two curves, denominated the *antievolute* and *pericaustic*. He found also that the logarithmic spiral was its own evolute, caustic, antievolute, and pericaustic; and that an analogous property belonged to the cycloid.

1692. Problem of Viviani solved.

56. About this time Viviani, an Italian geometer, distinguished as the restorer of Aristeus's conic sections, required the solution of the following problem, that there existed a temple of a hemispherical form, pierced with four equal windows, with such skill that the remainder of the hemisphere might be perfectly squared. With the aid of the new analysis, Leibnitz and James Bernouilli immediately found a solution, while that of Viviani was founded on the ancient geometry. He proved that the problem might be solved, by placing, parallel to the base of the hemisphere, two right cylinders, the axes of which should pass through the centres of two radii, forming a diameter of the circle of the base, and piercing the dome each way.

Tschirnhausen on caustic curves.

57. Prior to some of these discussions, the curves called *caustic*, and sometimes *Tschirnhausenian*, were discovered by Tschirnhausen. These curves are formed by the crossing of the rays of light, when reflected from a curved surface, or refracted through a lens so as not to meet in a single point. With the assistance of the common geometry, Tschirnhausen discovered, that they are equal to straight lines when they are formed by geometrical curves, and found out several other curious properties. By the aid of the higher calculus, James Bernouilli extended these researches, and added greatly to the theory of caustics produced by refraction.

James Bernouilli attends to the same subject, 1693.

and solves the problem of the paracentric isochronal curve.

58. The problem of the paracentric isochronal curve, proposed by Leibnitz in 1689, was solved by James Bernouilli, who took for ordinates parallel straight lines, and for abscissas the chords of an infinite number of concentric circles described about the given point. In this way he obtained a separate equation, constructed at first by the rectification of the elastic curve, and afterwards by the rectification of an algebraic curve. The same problem was solved by John Bernouilli and Leibnitz. 1689.

The exponential calculus invented by Leibnitz and John Bernouilli.

59. In 1694, a branch of the new analysis, called the *exponential calculus*, was invented separately by John Bernouilli and Leibnitz. It consists in differencing and integrating exponential quantities or powers with variable exponents. To Leibnitz, the priority in point of invention certainly belongs; but John Bernouilli was the first who published the rules and uses of the calculus.

The Marquis l'Hospital publishes his analysis of infinites.

60. The marquis l'Hospital, who, in 1695, had solved the problem about the curve of equilibration in draw-bridges, and shewn it to be an epicycloid, published in the following year his *Analysis of Infinites for the understanding of curve lines*. In this celebrated work, the differential calculus, or the direct method of fluxions, was fully explained and illustrated; and as the knowledge of the higher geometry had been hitherto confined to a few, it was now destined to enlighten the different nations of Europe.

Newton finds the solid of least resistance.

61. The methods which were employed by Descartes, Fermat, &c. for finding the maxima and minima of quantities, yielded in point of simplicity and generality to that which was derived from the doctrine of fluxions. Another class of problems, however, of the same kind, but more complicated, from their requiring the inverse method of fluxions, began now to exercise the ingenuity of mathematicians. A problem of this class for finding the solid of least resistance, was solved by Newton in the 34th proposition of the 2d book of his *Principia*. After having determined the truncated right cone, which being moved in a fluid by the smallest base (which is unknown), experiences the least resistance, he gave without any demonstration the ratio from which might be derived the differential equation of the curve that generates by a revolution of its axis the solid of least resistance. A general solution, however, was still wanting, till the attention of geometers was directed to the subject by John Bernouilli, who proposed, in 1697, the celebrated problem of the *Brachystochronon*, or the curve along the concave side of which if a heavy body descend, it will pass in the least time possible from one point to another, the two points not being in the same vertical line. This problem was resolved by Leibnitz, Newton, the marquis de l'Hospital, and James Bernouilli, who demonstrated that the curve of quickest descent is a cycloid reversed. This result will appear at first surprising, when we consider a line to be the shortest distance between two points; but the surprise will cease when we reflect, that in a concave curve lying between the two given points the moving body descends at first in a more vertical direction, and therefore acquires a greater velocity than when it rolls down an inclined plane. This addition to its velocity, consequently, at the commencement of its path may balance the increase of space through which it has to move.

Dispute between James and John Bernouilli on isoperimetrical figures.

62. At the close of this discussion, commenced that celebrated dispute about isoperimetrical problems, between James and John Bernouilli, in which the qualities of the head were more conspicuous than those of the heart.

heart. These illustrious characters, connected by the strongest ties of affinity, were, at the commencement of their distinguished career, united by the warmest affection. John was initiated by his elder brother into the mathematical sciences; and a generous emulation, softened by friendship in the one, and gratitude in the other, continued for some years to direct their studies, and accelerate their progress. There are few men, however, who can support at the same time the character of a rival and a friend. The success of the one party is apt to awaken the envy of the other, and success itself is often the parent of presumption. A foundation is thus laid for future dissension; and it is a melancholy fact in the history of learning, that the most ardent friendships have been sacrificed on the altar of literary ambition. Such was the case between the two
1695. Bernouillis. As soon as John was settled as professor of mathematics at Groningen, all friendly intercourse between the two brothers was at an end. Regarding John as the aggressor, and provoked at the ingratitude which he exhibited, his brother James challenged him by name to solve the following problems: 1. "To find, among all the isoperimetrical curves between given limits, such a curve, that, constructing a second curve, the ordinates of which shall be the functions of the ordinates or arcs of the former, the area of the second curve shall be a maximum or a minimum.—2. "To find among all the cycloids which a heavy body may describe in its descent from a point to a line, the position of which is given, that cycloid which is described in the least possible time."—A prize of 50 florins was promised to John Bernouilli, if, within three months, he engaged to solve these problems, and publish within a year legitimate solutions of them.

Problems proposed by James to John Bernouilli.

63. In a short time John Bernouilli produced his solution and demanded the prize. He succeeded in constructing the problem of swiftest descent; but his solution of the other problem was radically defective. This failure mortified that vanity with which he gloried in his apparent success. He acknowledged the mistake in his solution, and, with the same imperious tone, transmitted a new result, and redemanded the prize. This new solution, which was still defective, drew down the wit and ridicule of James Bernouilli, which his brother attempted to repel by a torrent of coarse invective.

1700. 64. Leibnitz, Newton, and the marquis l'Hospital, being appointed arbiters in this dispute, James Bernouilli published, in 1700, the formulæ of the isoperimetrical problem, without any demonstration; and John transmitted his solution to the French academy in February 1701, on condition that it should not be opened till his brother's demonstrations were published. In consequence of this, James Bernouilli published his solution in May 1701, in the *Acta Eruditorum*, under the following title, *Analysis magni Problematis Isoperimetrici*, and gained great honour from the skill which it displayed. For five years John Bernouilli was silent upon the subject; but his brother dying in 1705, he published his solution in the Memoirs of the Academy for 1706. About 13 years afterwards, John Bernouilli having perceived the source of his error, confessed his mistake, and published a new solution, not very different from that of his brother, in the Memoirs of the Academy for 1718.

65. In the problem relative to the cycloid of swiftest descent, John Bernouilli obtained a result similar to that of his brother, by a very ingenious method, which extended the bounds of the new analysis. In his investigations he employed the synchronous curve, or that which cuts a series of similar curves placed in similar positions, so that the arcs of the latter included between a given point and the synchronous curve, shall be described by a heavy body in equal times. He demonstrated, that of all the cycloids thus intersected, that which is cut perpendicularly is described in less time than any other terminating equally at the synchronous curve. But being unable to give a general solution of the problem, he applied to Leibnitz, who easily resolved it, and at that time invented the method of differencing *de curva in curvam*.

John Bernouilli's solution of the second problem.

1704.

66. About a month after the death of the marquis de l'Hospital, John Bernouilli declared himself the author of a rule given by the marquis in his Analysis of Infinites, for finding the value of a fraction, whose numerator and denominator should vanish at the same instant, when the variable quantity that enters into it has a certain given value. The defence made by the marquis's friends only induced John Bernouilli to make greater demands, till he claimed as his own the most important parts of the Analysis of Infinites: But it does not appear, from an examination of the subject, that there is any foundation for his claims.

67. Towards the close of 1704, Sir Isaac Newton published, at the end of his Optics, his *Enumeratio linearum tertiæ ordinis*, and his treatise *De Quadratura Curvarum*. The first of these papers displays great ability; but is founded only on the common algebra, and the doctrine of series which Newton had brought to such perfection. His treatise, *De Quadratura Curvarum*, contains the resolution of fluxional formulæ, with one variable quantity which leads to the quadrature of curves. By means of certain series he obtains the resolution of several complicated formulæ, by referring them to such as are more simple; and these series being interrupted in particular cases, give the fluents in finite terms. From this several interesting propositions are deduced, among which is the method of resolving rational fractions. In 1711 Newton published his *Method of Fluxions*. The object of this work is 1711.
to determine, by simple algebra, the linear coefficients of an equation that satisfies as many conditions as there are coefficients, and to construct a curve of the parabolic kind passing through any number of given points. Hence arises a simple method of finding the approximate quadrature of curves, in which a certain number of ordinates are determinable. It has been the opinion of some able mathematicians, that this treatise contains the first principles of the integral calculus with finite differences, afterwards invented by Dr Taylor. A posthumous work of Newton's, entitled *The Method of* 1736.
Fluxions, and of Infinite Series, was published by Dr Pemberton about nine years after the death of its author; but it does not contain any new investigations which accelerated the progress of the new analysis.

Labours of Newton. 1704.

68. The mathematical sciences were at this time indebted to the labours of Manfredi, Parent, and Saurin. The former of these geometers published a very able work, *De Constructione Equationum differentialium primi gradus*. To Parent we are indebted for the problem by which

Labours of Manfredi, Parent, and Saurin, 1707.

which we obtain the ratio between the velocity of the power, and the weight for finding the *maximum* effect of machines; but his reputation was much injured by the obscurity of his writings. Saurin was celebrated for his theoretical and practical knowledge of watchmaking, and was the first who elucidated the theory of tangents to the multiple points of curves.

Account of the dispute between Newton and Leibnitz.

69. While the science of analysis was thus advancing with rapidity, the dispute between Newton and Leibnitz began to be agitated among the mathematicians of Europe. These illustrious rivals seemed to have been hitherto contented with sharing the honour of having invented the fluxional calculus. But as soon as the priority of invention was attributed to Newton, the friends of Leibnitz came forward with eagerness to support the claims of their master.

Facio de Duillier commences the dispute in favour of Newton.

70. In a small work on the curve of swiftest descent, and the solid of least resistance, published in 1699, Nicholas Facio de Duillier, an eminent Genoese, attributed to Newton the first invention of Fluxions, and hinted, that Leibnitz, as the second inventor, had borrowed from the English philosopher. Exasperated at this improper insinuation, Leibnitz came forward in his own defence, and appeals to the admission of Newton in his *Principia*, that neither had borrowed from the other. He expressed his conviction, that Facio de Duillier was not authorised by Sir Isaac, to prefer such a charge, and threw himself upon the testimony and candour of the English geometer.

Leibnitz defends himself.

Dr Keill makes the same charge against Leibnitz. 1708.

71. The discussion rested in this situation for several years, till our celebrated countryman, Dr Keill, instigated by an attack upon Newton in the Leipsic Journal, repeated the same charge against Leibnitz. The German philosopher made the same reply as he did to his former opponent, and treated Dr Keill as a young man incapable of judging upon the subject. In 1711,
1711. Dr Keill addressed a letter to Sir Hans Sloane, secretary to the Royal Society, and accused Leibnitz of having adopted the differential notation, in order to have it believed, that he did not borrow his calculus from the writings of Newton.

Leibnitz appeals to the Royal Society.

72. Leibnitz was with reason irritated at this accusation, and called upon the Royal Society to interfere in his behalf. A committee of that learned body was accordingly appointed to investigate the subject, and their report was published in 1712, under the title of *Commercium Epistolicum de Analysi promota*. In this report the committee maintain that Leibnitz was not the first inventor, and absolve Dr Keill from all blame in giving the priority of invention to Newton. They were cautious, however, in stating their opinion upon that part of the charge in which Leibnitz was accused of plagiarism.

1712.

Who appoint a committee to examine and report.

John Bernouilli replies to their report given in the *Commercium Epistolicum*.

73. In answer to the arguments advanced in the *Commercium Epistolicum*, John Bernouilli, the particular friend of Leibnitz, published a letter, in which he has the assurance to state, that the method of fluxions did not precede the differential calculus, but that it might have taken its rise from it. The reason which he assigns for this strange assertion is, that the differential calculus was published before Newton had introduced an uniform algorithm into the method of fluxions. But it may as well be maintained that Newton did not discover the theory of universal gravitation, because the attractive force of mountains and of smaller portions of matter was not ascertained till the time of Maskelyne and Cavendish. The principles of fluxions are allowed to have been discovered before those of the differential calculus, and yet the former originated from the latter, because the fluxional notation was not given at the same time!

Remarks on the controversy.

74. Notwithstanding the ridiculous assertion of John Bernouilli, it has been admitted by all the foreign mathematicians that Newton was the first inventor of the method of fluxions. The point at issue therefore is merely this:—did Leibnitz see any of the writings of Newton that contained the principles of fluxions before he published in 1684 his *Nova Methodus pro maximis et minimis?* The friends of Leibnitz have adduced some presumptive proofs that he had never seen the treatise of Newton, *de Analysi*, nor the letter to Collins, in both of which the principles of the new calculus were to be found; and in order to strengthen their argument, they have not scrupled to assert, that the writings already mentioned contained but a vague and obscure indication of the method of fluxions, and that Leibnitz might have perused them without having discovered it. This subsidiary argument, however, rests upon the opinion of individuals; and the only way of repelling it is to give the opinion of an impartial judge. M. Montucla, the celebrated historian of the mathematics, who being a Frenchman, cannot be suspected of partiality to the English, has admitted that Newton in his treatise *de Analysi* "has disclosed in a very concise and obscure manner his principles of fluxions," and "that the suspicion of Leibnitz having seen this work is not destitute of probability, for Leibnitz admitted, that in his interview with Collins he had seen a part of the epistolary correspondence between Newton and that gentleman." It is evident therefore that Leibnitz had opportunities of being acquainted with the doctrine of fluxions, before he had thought of the differential calculus; and as he was in London, where Newton's treatise was published, and in company with the very men to whom the new analysis had been communicated, it is very likely that he then acquired some knowledge of the subject. In favour of Leibnitz, however, it is but justice to say, that the transition from the method of tangents by Dr Barrow to the differential calculus is so simple, that Leibnitz might very easily have perceived it; and that the notation of his analysis, the numerous applications which he made of it, and the perfection to which he carried the integral calculus, are considerable proofs that he was innocent of the charge which the English have attempted to fix upon his memory.

Works on the doctrine of chance. 1708.

75. In 1708, Remond de Montmort published a curious work, entitled the Analysis of Games of Chance, in which the common algebra was applied to the computation of probabilities, and the estimation of chances. Though this work did not contain any great discovery, yet it gave extent to the theory of series, and admirably illustrated the doctrine of combinations. The same subject was afterwards discussed by M. de Moivre, a French protestant residing in England, in a small treatise entitled *Mensura Sortis*, in which are given the 1711.
elements of the theory of recurrent series, and some very ingenious applications of it. Another edition was published in English in 1738, under the title of the *Doctrine of Chances*.

Leibnitz propoſes to the Engliſh the problem of orthogonal trajectories.

76. A ſhort time before his death, Leibnitz propoſed to the Engliſh geometers the celebrated problem of orthogonal trajectories, which was to find the curve that cuts a ſeries of given curves at a conſtant angle, or at an angle varying according to a given law. This problem was put into the hands of Sir Iſaac Newton when he returned to dinner greatly fatigued, and he brought it to an equation before he went to reſt. Leibnitz being recently dead, John Bernouilli aſſumed his place, and maintained, that nothing was eaſier than to bring the problem to an equation, and that the ſolution of the problem was not complete till the differential equation of the trajectory was reſolved. Nicholas Bernouilli, the ſon of John reſolved the particular caſe in which the interſected curves are hyperbolas with the ſame centre and the ſame vertex. James Hermann and Nicholas Bernouilli, the nephew of John, treated the ſubject by more general methods, which applied to the caſes in which the interſected curves were geometrical. The moſt complete ſolution, however, was given by Dr
1717. Taylor in the Philoſophical Tranſactions for 1717, though it was not ſufficiently general, and could not apply to ſome caſes capable of reſolution. This defect was ſupplied by John Bernouilli, who in the Leipſic
1718. Tranſactions for 1718, publiſhed a very ſimple ſolution, embracing all the geometrical curves, and a great number of the mechanical ones.

Integration of rational fractions. 1719.

77. During theſe diſcuſſions, ſeveral difficult problems on the integration of rational fractions were propoſed by Dr Taylor, and ſolved by John Bernouilli. This ſubject, however, had been firſt diſcuſſed by Roger Cotes, profeſſor of mathematics at Cambridge, who died in 1710. In his poſthumous work entitled *Harmonia Menſurarum*, publiſhed in 1716, he gave general and convenient formulæ for the integration of rational fractions; and we are indebted to this young geometer for his method of eſtimating errors in mixed mathematics, for his remarks on the differential method of Newton, and for his celebrated theorem for reſolving certain equations.

Labours of Roger Cotes, born 1676.

Dr Taylor invents the integral calculus of finite differences.

78. In 1715, Dr Taylor publiſhed his learned work entitled *Methodus incrementorum directa et inverſa*. In this work the doctor gives the name of increments or decrements of variable quantities to the differences, whether finite or infinitely ſmall, of two conſecutive terms in a ſeries formed after a given law. When the differences are infinitely ſmall, their calculus belongs to fluxions; but when they are finite, the method of finding their relation to the quantities by which they are produced forms a new calculus, called the integral calculus of finite differences. In conſequence of this work, Dr Taylor was attacked anonymouſly by John Bernouilli, who laviſhed upon the Engliſh geometer all that dull abuſe, and angry ridicule, which he had formerly heaped upon his brother.

Problem of reciprocal trajectories. 1716.

79. The problem of reciprocal trajectories was at this time propoſed by the Bernouillis. This problem required the curves which, being conſtructed in two oppoſite directions in one axis, given in poſition, and then moving parallel to one another with unequal velocities, ſhould perpetually interſect each other at a given angle. It was long diſcuſſed between John Bernouilli and an anonymous writer, who proved to be Dr Pemberton. It was by an elegant ſolution of this problem that the celebrated Euler began to be diſtinguiſhed among mathematicians. He was the pupil of John Bernouilli, and continued through the whole of his life, the friend and rival of his ſon Daniel. The great object of his labours was to extend the boundaries of analyſis; and before he had reached his 21ſt year, he publiſhed a new and general method of reſolving differential equations of the ſecond order, ſubjected to certain conditions.

Reſolved by Euler, born 1707, died 1783. 1728.

Labours of Count Fagnani.

80. The common algebra had been applied by Leibnitz and John Bernouilli to determine arcs of the parabola, the difference of which is an algebraic quantity, imagining that ſuch problems in the caſe of the ellipſe and hyperbola reſiſted the application of the new analyſis. The Count de Fagnani, however, applied the integral calculus to the arcs of the ellipſis and hyperbola, and had the honour of explaining this new branch of geometry.

Problem of Count Riccati. 1725.

81. In the various problems depending on the analyſis of infinites, the great difficulty is to reſolve the differential equation to which the problems are reduced. Count James Riccati having been puzzled with a differential equation of the firſt order, with two variable quantities, propoſed it to mathematicians in the Leipſic Acts for 1725. This queſtion baffled the ſkill of the moſt celebrated analyſts, who were merely able to point out a number of caſes in which the indeterminate can be ſeparated, and the equation reſolved by the quadrature of curves.

Problem of Offenburg.

82. Another problem ſuggeſted by that of Viviani was propoſed in 1718 by Erneſt von Offenburg. It was required to pierce a hemiſpherical vault with any number of elliptical windows, ſo that their circumferences ſhould be expreſſed by algebraic quantities;—or in other words, to determine on the ſurface of a ſphere, curves algebraically rectifiable. In a paper on the rectification of ſpherical epicycloids, Herman * imagined that theſe curves were algebraically rectifiable, and therefore ſatisfied the queſtion of Offenburg; but John Bernouilli (Mem. Acad. Par. 1732) demonſtrated, that as the rectification of theſe curves depended on the quadrature of the hyperbola, they were only rectifiable in certain caſes, and gave the general method of determining the curves that are algebraically rectifiable on the ſurface of a ſphere.

* *Peterſburgh Tranſactions.* 1726.

Reſolved by John Bernouilli.

Labours of Clairaut.

83. The ſame ſubject was alſo diſcuſſed by Nicole and Clairaut, (Mem. Acad. 1734). The latter of theſe mathematicians had already acquired fame by his *Recherches ſur les Courbes à double Courbure*, publiſhed in 1730, before he was 21 years of age; but his reputation was extended by a method of finding curves whoſe property conſiſts in a certain relation between theſe branches expreſſed by a given equation. In this reſearch, Clairaut pointed out a ſpecies of paradox in the integral calculus, which led to the celebrated theory of particular integrals which was afterwards fully illuſtrated by Euler and other geometers.

Problem of iſochronous curves.

84. The celebrated problem of iſochronous curves began at this time to be reagitated among mathematicians. The object of this problem is to find ſuch a curve that a heavy body deſcending along its concavity ſhall always reach the loweſt point in the ſame time, from whatever point of the curve it begins to deſcend. Huygens had already ſhewn that the cycloid was the iſochronous curve *in vacuo*. Newton had demonſtrated the ſame curve to be iſochronous when the deſcending body experiences from the air a reſiſtance proportional to its velocity;

* Memoirs of Petersburgh, 1729, and † Mem. Par. 1730.

locity; and Euler * and John Bernouilli †, had separately found the isochronous curve when the resistance was as the square of the velocity. These three cases, and even a fourth in which the resistance was as the square of the velocity added to the product of the velocity by a constant coefficient, were all resolved by Fontaine, by means of an ingenious and original method; and it is very remarkable that the isochronous curve is the same in the third and fourth cases.—The method of Fontaine was illustrated by Euler, who solved a fifth case, including all the other four, when the resistance is composed of three terms, the square of the velocity, the product of the velocity by a given coefficient, and a constant quantity. He found also an expression of the time which the body employs to descend through any arc of the curve.

Solved by Fontaine.

Algebra of sines and cosines.

85. The application of analytical formulæ to the physico-mathematical sciences was much facilitated by the algebra of sines and cosines with which Frederick Christian Mayer, and Euler, enriched geometry. By the combination of arcs, sines, and cosines, formulæ are obtained which frequently yield to the method of resolution, and enable us to solve a number of problems which the ordinary use of arcs, sines, and cosines, would render tedious and complicated.

Improvement in the resolution of differential equations.

86. About this time a great discovery in the theory of differential equations of the first order was made separately by Euler, Fontaine, and Clairaut. Hitherto geometers had no direct method of ascertaining if any differential equation were resolvable in the state in which it was presented, or if it required some preparation prior to its resolution. For every differential equation a particular method was employed, and their resolution was often effected by a kind of tentative process, which displayed the ingenuity of its author, without being applicable to other equations. The conditions under which differential equations of the first order are resolvable were discovered by the three mathematicians whom we have mentioned. Euler made the discovery in 1736, but did not publish it till 1740. Fontaine and Clairaut lighted upon it in 1739. Euler afterwards extended the discovery to equations of higher orders.

Discovery of the integral calculus with partial differences.

87. The first traces of the integral calculus with partial differences appeared in a paper of Euler's in the Petersburgh Transactions for 1734; but d'Alembert, in his work *Sur les Vents*, has given clearer notions of it, and was the first who employed it in solution of the problem of vibrating cords proposed by Dr Taylor, and investigated by Euler and Daniel Bernouilli. The object of this calculus is to find a function of several variable quantities, when we have the relation of the coefficients which affect the differentials of the variable quantities of which this function is composed. Euler exhibited it in various points of view, and shewed its application to a number of physical problems; and he afterwards, in his paper entitled *Investigatio Functionum ex data Differentialium conditione* ‡, completely explained the nature, and gave the algorithm of the calculus.

‡ Petersburgh Transactions, 1762.

The principles of fluxions attacked by Dr Berkeley, 1734.

88. While the analysis of infinites was making such rapid progress on the continent, it was attacked in England by the celebrated Dr Berkeley, bishop of Cloyne, in a work called the *Analyst, or a discourse addressed to an Infidel Mathematician, wherein it is examined whether the object, principles, and inferences of the modern analysis, are more distinctly conceived than Religious Mysteries and Points of Faith.* In this work the doctor admits the truth of the conclusions, but maintains that the principles of fluxions are not founded upon reasoning strictly logical and conclusive. This attack called forth Robins and Maclaurin. The former proved that the principles of fluxions were consistent with the strictest reasoning, while Maclaurin, in his *Treatise of Fluxions*, gave a synthetical demonstration of the principles of the calculus after the manner of the ancient geometricians, and establishes it with such clearness and satisfaction that no intelligent man could refuse his assent. The differential calculus had been attacked at an earlier period by *Nieuwentiet* and *Rolle*, but the weapons wielded by these adversaries were contemptible when compared with the ingenuity of Dr Berkeley.

Works of Thomas Simpson.

89. Notwithstanding this attack upon the principles of the new analysis, the science of geometry made rapid advances in England in the hands of Thomas Simpson, Landen, and Waring. In 1740, Mr Simpson published his *Treatise on Fluxions*, which, besides many original researches, contains a convenient method of resolving differential equations by approximation, and various means of hastening the convergency of slowly converging series. We are indebted to the same geometer for several general theorems for summing different series, whether they are susceptible of an absolute or an approximate summation. His *Mathematical Dissertations*, published in 1743, his *Essays on several Subjects in Mathematics*, published in 1740, and his *Select Exercises for Young Proficients in the Mathematics*, published in 1752, contain ingenious and original researches which contributed to the progress of geometry.

1740.

1743.

The residual analysis invented by Landen, Died in 1777.

90. In his *Mathematical Lucubrations*, published in 1755, Mr Landen has given several ingenious theorems for the summation of series; and the Philosophical Transactions for 1775 contain his curious discovery of the rectification of a hyperbolic arc, by means of two arcs of an ellipsis, which was afterwards more simply demonstrated by Legendre. His invention of a new calculus, called the *residual analysis*, and in some respects subsidiary to the method of fluxions, has immortalized his name. It was announced and explained in a small pamphlet published in 1715, entitled a *Discourse concerning the Residual Analysis*.

Labours of Waring. Phil. Trans. 1784, and 1791, p. 146.

91. The progress of geometry in England was accelerated by the labours of Mr Edward Waring, professor of mathematics at Cambridge. His two works entitled *Meditationes Analyticæ*, published in 1769, and *Meditationes Algebraicæ*, and his papers in the Philosophical Transactions on the summation of forces, are filled with original and profound researches into various branches of the common algebra, and the higher analysis.

Discoveries of Lagrange.

92. It was from the genius of Lagrange, however, that the higher calculus has received the most brilliant improvements. This great man was born in Piedmont. He afterwards removed to Berlin, and hence to Paris, where he still resides. In addition to many improvements upon the integral analysis, he has enriched geometry with a new calculus called the *method of variations*. The object of this calculus is, when there is given an expression or function of two or more variable quantities whose relation is expressed by a certain law, to find what this function becomes when that law suffers any variation infinitely small,

His method of variations.

ſmall, occaſioned by the variation of one or more of the terms which expreſs it. This calculus is as much ſuperior to the integral calculus, as the integral calculus is above the common algebra. It is the only means by which we can reſolve an immenſe number of problems *de maximis et minimis*, and is neceſſary for the ſolution of the moſt intereſting problems in mechanics. His theory of analytical functions is one of the moſt brilliant ſpecimens of human genius. In the Memoirs of Berlin for 1772 he had touched upon this intereſting ſubject, but the theory was completely developed in 1797 in his work entitled *Theorie des fonctions analytiques, contenant les principes du calcul differentiel, degageès de toute conſideration d'infiniments petits, ou evanouiſſements, ou des limites, ou des fluxions ; et reduit à l'analyſe algebrique des quantites finies.* In a great number of memoirs which are to be found in the Memoirs of the Academy of Paris, in thoſe of the Academy of Berlin, and in thoſe of the French Academy, Lagrange has thrown light on every branch both of the common algebra and the new analyſis.

His theory of analytical functions.

93. The new geometry has likewiſe been much indebted to the celebrated Laplace. His various papers in the *Memoires des Sçavans Etrangers* *, and the Memoirs of the French Academy, have added greatly to the higher calculi, while his application of analyſis to the celeſtial phenomena, as exhibited in the *Mechanique Celeſte*, and his various diſcoveries in phyſical aſtronomy, entitle him to a high rank among the promoters of ſcience.

Labours of La Place.

* *Tom.* 6. 7.

94. Among the celebrated French mathematicians of the laſt and preſent century, we cannot omit the names of Couſin, Lacroix, and Boſſut ; all of whom have written large works on the differential and integral calculi, and illuſtrated the new analyſis by their diſcoveries. The *Elemens de Geometrie* by Legendre is one of the beſt and moſt original works upon elementary geometry, and his papers in the Memoirs of the Academy contain ſeveral improvements upon the new analyſis.

Works of Couſin, Lacroix, Boſſut, and Legendre.

95. In Italy the mathematical ſciences were deſtined to be improved and explained by a celebrated female. Donna Maria Gaetana Agneſi was profeſſor of mathematics in the univerſity of Bologna, and publiſhed a learned work entitled *Analytical Inſtitutions*, containing the common analyſis, and the differential and integral calculi. It has been tranſlated into Engliſh by Profeſſor Colſon, and was publiſhed at the expence of Baron Maſeres. A few years ago ſeveral curious properties of the circle have been diſcovered by Maſcheroni, another Italian mathematician, who has publiſhed them in his intereſting work *ſur le Geometrie du Compas.*

Agneſi's analytical inſtitutions. 1784.

Maſcheroni on the circle.

96. In England the mathematical ſciences have been ſucceſsfully cultivated by Emerſon, Baron Maſeres, Dr M. Young, Dr Hutton, Profeſſor Vince, and Profeſſor Robertſon of Oxford. The *Doctrine of Fluxions* by Emerſon, and his *Method of Increments*, are good introductions to the higher geometry. The *Scriptores Logarithmici* of Baron Maſeres ; his *Tracts on the Reſolution of Equations ;* his *Principles of Life Annuities*, and his other mathematical papers, do the higheſt honour to his talents as a mathematician ; while his zeal for the promotion of the mathematical ſciences, and his generous attention to thoſe who cultivate them, entitle him to the noble appellation of the friend and patron of genius. Dr Matthew Young, biſhop of Clonfert, has given a ſynthetical demonſtration of Newton's rule for the quadrature of ſimple curves ; and has written on the extraction of cubic and other roots. Dr Hutton and Dr Vince have each publiſhed ſeveral elementary treatiſes on mathematics, and have invented ingenious methods for the ſummation of ſeries. Mr Robertſon of Oxford is the author of an excellent treatiſe on conic ſections.

Engliſh mathematicians.

Emerſon.

Baron Maſeres.

Dr M. Young.

Dr Hutton and Dr Vince.

Mr Robertſon.

97. The ancient geometry was aſſiduouſly cultivated in Scotland by Dr Robert Simpſon and Dr Matthew Stewart. Dr Simpſon's edition of Euclid and his treatiſe on conic ſections have been much admired. The *Tracts Phyſical and Mathematical* of Dr Matthew Stewart, and his *Propoſitiones Geometricæ more veterum demonſtratæ*, contain fine ſpecimens of mathematical genius. In the preſent day the names of Profeſſor Playfair and Profeſſor Leſlie of the univerſity of Edinburgh, Mr Wallace and Mr Ivory now of the Royal Military College at Great Marlow, are well known to mathematicians. Mr Playfair's Elements of Geometry, and his papers on *the Arithmetic of Impoſſible Quantities* and on *Poriſms*, are proofs of his great talents as a mathematician and a philoſopher. Mr Leſlie, well known for his great diſcoveries on heat, has found a very ſimple principle, capable of extenſive application, by which the complicated expreſſions in the ſolution of indeterminate problems may be eaſily reſolved. Mr Wallace's papers on *Geometrical Poriſms* in the 4th vol. of the Edinburgh Tranſactions, diſplay much genius ; and Mr Ivory's Treatiſes in the laſt vol. of Baron Maſeres's *Scriptores Logarithmici*, and his paper on *A New Series for the Rectification of the Ellipſis*, Edin. Tranſ. vol. 4th. entitle him to a high rank among modern mathematicians.

Scottiſh mathematicians.

Dr Simpſon.

Dr M. Stewart.

Mr Playfair.

Mr Leſlie.

Mr Wallace.

Mr Ivory.

Mathematical, Matlock.

MATHEMATICAL, any thing belonging to the ſcience of mathematics.

MATHEMATICAL Inſtruments, ſuch inſtruments as are uſually employed by mathematicians, as compaſſes, ſcales, quadrants, &c.

Machine for dividing MATHEMATICAL Inſtruments. See RAMSDEN's *Machine*.

MATLOCK, a town or village of Derbyſhire, near Wickſworth, ſituated on the very edge of the Derwent ; noted for its bath, the water of which is milkwarm ; and remarkable for the huge rocks in its environs, particularly thoſe called the *Torr*, which is 140 yards high. It is an extenſive ſtraggling village, built in a very romantic ſtyle, on the ſteep ſide of a mountain, and containing, in 1801, above 2000 inhabitants. Near the bath are ſeveral ſmall houſes, whoſe ſituation is

Matlock.

is on the little natural horizontal parts of the mountain, a few yards above the road, and in ſome places the roofs of ſome almoſt touch the floors of others. There are excellent accommodations for company who reſort to the bath; and the poorer inhabitants are ſupported by the ſale of petrifactions, cryſtals, &c. and notwithſtanding the rockineſs of the ſoil, the cliffs produce an immenſe number of trees, whoſe foliage adds greatly to the beauty of the place.

MATRASS, Cucurbit, or Bolthead, among chemiſts. See Chemistry, Explanation of Plates.

MATRICARIA, Feverfew; a genus of plants, belonging to the ſyngeneſia claſs; and in the natural method ranking under the 49th order, *Compoſitæ*. See Botany *Index*.

MATRICE, or Matrix. See Matrix.

Matrice, or matrix, in *Dyeing*, is applied to the five ſimple colours, whence all the reſt are derived or compoſed. Theſe are, the black, white, blue, red, and yellow or root colour.

Matrice, or matrices, uſed by the letter-founders, are thoſe little pieces of copper or braſs, at one end whereof are engraven, dentwiſe, or *en creux*, the ſeveral characters uſed in the compoſing of books. Each character, virgula, and even each point in a diſcourſe, has its ſeveral matrix; and of conſequence its ſeveral puncheon to ſtrike it. They are the engravers on metal that cut or grave the matrices.

When types are to be caſt, the matrice is faſtened to the end of a mould, ſo diſpoſed, as that when the metal is poured on it, it may fall into the creux or cavity of the matrice, and take the figure and impreſſion thereof. See *Letter FOUNDERY*.

Matrices, uſed in coining, are pieces of ſteel in form of dies, whereon are engraven the ſeveral figures, arms, characters, legends, &c. wherewith the ſpecies are to be ſtamped. The engraving is performed with ſeveral puncheons, which being formed in relievo, or prominent, when ſtruck on the metal, make an indented impreſſion, which the French call *en creux*.

MATRICULA, a regiſter kept of the admiſſion of officers and perſons entered into any body or ſociety whereof a liſt is made. Hence thoſe who are admitted into our univerſities are ſaid to be matriculated. Among eccleſiaſtical authors, we find mention made of two kinds of matricule; the one containing a liſt of the eccleſiaſtics, called *matricula clericorum*: the other of the poor ſubſiſted at the expence of the church, called *matricula pauperum*.

Matricula was alſo applied to a kind of almſhouſe, where the poor were provided for. It had certain revenues appropriated to it, and was uſually built near the church, whence the name was alſo frequently given to the church itſelf.

MATRIMONY. See Marriage.

MATRIX, in *Anatomy*, the womb, or that part of the female of any kind, wherein the fœtus is conceived and nouriſhed till the time of its delivery. See Anatomy, N° 108.

Matrix is alſo applied to places proper for the generation of vegetables, minerals, and metals. Thus the earth is the matrix wherein ſeeds ſprout; and marcaſites are by many conſidered as the matrices of metals.

The matrix of ores is the earthy and ſtony ſubſtances in which theſe metallic matters are enveloped: theſe are various, as lime and heavy ſpar, quartz, fluors, &c.

MATRON, an elderly married woman.

Jury of MATRONS. When a widow feigns herſelf with child in order to exclude the next heir, and a ſuppoſititious birth is ſuſpected to be intended, then, upon the writ *de ventre inſpiciendo*, a jury of women is to be impannelled to try the queſtion whether the woman is with child or not. So, if a woman is convicted of a capital offence, and, being condemned to ſuffer death, pleads in ſtay of execution, that ſhe is pregnant, a jury of matrons is impannelled to inquire into the truth of the allegation; and, if they find it true, the convict is reſpited till after her delivery.

MATRONA, in *Ancient Geography*, a river ſeparating Gallia Celtica from the Belgica (Ceſar). Now the Marne; which, riſing in Champagne near Langres, runs north-weſt, and then weſt, and paſſing by Meaux falls into the Seine at Charenton, two leagues to the eaſt of Paris.

MATRONALIA, a Roman feſtival inſtituted by Romulus, and celebrated on the kalends of March, in honour of Mars. It was kept by matrons in particular, and bachelors were entirely excluded from any ſhare in the ſolemnity. The men during this feaſt ſent preſents to the women, for which a return was made by them at the Saturnalia: And the women gave the ſame indulgence to their ſervants now which the men gave to theirs at the feaſt of Saturn, ſerving them at table, and treating them as ſuperiors.

MATROSSES, are ſoldiers in the train of artillery, who are next to the gunners, and aſſiſt them in loading, firing, and ſpunging the great guns. They carry firelocks, and march along with the ſtore waggons, both as a guard, and to give their aſſiſtance in caſe a waggon ſhould break down.

MATSYS, Quintin, painter of hiſtory and portraits, was born at Antwerp in 1460, and for ſeveral years followed the trade of a blackſmith or farrier, at leaſt till he was in his 20th year. Authors vary in their accounts of the cauſe of his quitting his firſt occupation, and attaching himſelf to the art of painting. Some affirm, that the firſt unfolding of his genius was occaſioned by the ſight of a print which accidentally was ſhown to him by a friend who came to pay him a viſit while he was in a declining ſtate of health from the labour of his former employment, and that by his copying the print with ſome degree of ſucceſs, he was animated with a deſire to learn the art of painting. Others ſay, he fell in love with a young woman of great beauty, the daughter of a painter, and they allege that love alone wrought the miracle, as he could have no proſpect of obtaining her except by a diſtinguiſhed merit in the profeſſion of painting: for which reaſon he applied himſelf with inceſſant labour to ſtudy and practiſe the art, till he became ſo eminent as to be entitled to demand her in marriage, and he ſucceeded. Whatever truth may be in either of theſe accounts, it is certain that he appeared to have an uncommon genius; his manner was ſingular, not reſembling the manner of any other maſter; and his pictures were ſtrongly coloured and carefully finiſhed, but yet they are ſomewhat dry and hard. By many competent

tent judges it was believed, when they obferved the ftrength of expreffion in fome of his compofitions, that if he had ftudied in Italy to acquire fome knowledge of the antiques and the great mafters of the Roman fchool, he would have proved one of the moft eminent painters of the Low Countries. But he only imitated ordinary life; and feemed more inclined, or at leaft more qualified, to imitate the defects than the beauties of nature. Some hiftorical compofitions of this mafter deferve commendation; particularly a Defcent from the Crofs, which is in the cathedral at Antwerp; and it is juftly admired for the fpirit, fkill, and delicacy of the whole. But the moft remarkable and beft known picture of Matfys, is that of the Two Mifers in the gallery at Windfor. He died in 1529.

MATT, in a fhip, is a name given to rope-yarn, junk, &c. beat flat and interwoven; ufed in order to preferve the yards from galling or rubbing, in hoifting or lowering them.

MATTER, in common language, is a word of the fame import with *body*, and denotes that which is tangible, vifible, and extended; but among philofophers it fignifies that fubftance of which all bodies are compofed; and in this fenfe it is fynonymous with the word ELEMENT.

It is only by the fenfes that we have any communication with the external world; but the immediate objects of fenfe, philofophers have in general agreed to term *qualities*, which they conceive as inhering in fomething which is called their *fubject* or *fubftratum*. It is this fubftratum of fenfible qualities which, in the language of philofophy, is denominated *matter;* fo that *matter* is *not* that which we immediately fee or handle, but the *concealed fubject* or *fupport* of vifible and tangible qualities. What the moderns term *qualities*, was by Ariftotle and his followers called *form;* but fo far as the two doctrines are intelligible, there appears to be no effential difference between them. From the moderns we learn, that body confifts of *matter* and *qualities;* and the Peripatetics taught the fame thing, when they faid that body is compofed of *matter* and *form*.

How philofophers were led to analyze body into matter and form, or, to ufe modern language, into matter and qualities; what kind of exiftence they attribute to each; and whether *matter* muft be conceived as felf-exiftent or created—are queftions which fhall be confidered afterwards (See METAPHYSICS). It is fufficient here to have defined the term.

MATTHEW, or *Gofpel of St MATTHEW*, a canonical book of the New Teftament.

St MATTHEW wrote his gofpel in Judea, at the requeft of thofe he had converted; and it is thought he began in the year 41, eight years after Chrift's refurrection. It was written, according to the teftimony of all the ancients, in the Hebrew or Syriac language; but the Greek verfion, which now paffes for the original, is as old as the apoftolical times.

St MATTHEW the Evangelift's Day, a feftival of the Chriftian church, obferved on September 21ft.

St MATTHEW, the fon of Alpheus, was alfo called *Levi*. He was of a Jewifh original, as both his names difcover, and probably Galilean. Before his call to the apoftolate, he was a publican or toll-gatherer to the Romans; an office of bad repute among the Jews, on account of the covetoufnefs and exaction of thofe who managed it; St Matthew's office particularly confifting in gathering the cuftoms of all merchandife that came by the fea of Galilee, and the tribute that paffengers were to pay who went by water. And here it was that Matthew fat at the receipt of cuftoms, when our Saviour called him to be a difciple. It is probable, that, living at Capernaum, the place of Chrift's ufual refidence, he might have fome knowledge of him before he was called. Matthew immediately expreffed his fatisfaction in being called to this high dignity, by entertaining our Saviour and his difciples at a great dinner at his own houfe, whither he invited all his friends, efpecially thofe of his own profeffion, hoping, probably, that they might be influenced by the company and converfation of Chrift. St Matthew continued with the reft of the apoftles till after our Lord's afcenfion. For the firft eight years afterwards, he preached in Judea. Then he betook himfelf to propagating the gofpel among the Gentiles, and chofe Ethiopia as the fcene of his apoftolical miniftry; where it is faid he fuffered martyrdom, but by what kind of death is altogether uncertain. It is pretended, but without any foundation, that Hyrtaeus, king of Ethiopia, defiring to marry Iphigenia, the daughter of his brother and predeceffor Æglippus, and the apoftle having reprefented to him that he could not lawfully do it, the enraged prince ordered his head immediately to be cut off. Baronius tells us, the body of St Matthew was tranfported from Ethiopia to Bithynia, and from thence was carried to Salernum in the kingdom of Naples in the year 954, where it was found in 1080, and where Duke Robert built a church bearing his name.

St MATTHEW, a town of Spain, in the kingdom of Arragon, feated in a pleafant plain, and in a very fertive country watered with many fprings. W. Long. 0. 15. N. Lat. 40. 22.

MATTHEW of Paris. See PARIS.

MATTHEW of Weftminfter, a Benedictine monk and accomplifhed fcholar, who wrote a hiftory from the beginning of the world to the end of the reign of Edward I. under the title of *Flores Hiftoriarum;* which was afterwards continued by other hands. He died in 1380.

St MATTHIAS, an apoftle, was chofen inftead of Judas. He preached in Judea and part of Ethiopia, and fuffered martyrdom. See the *Acts of the Apoftles*, chap. i. There was a gofpel publifhed under Matthias's name, but rejected as fpurious; as likewife fome traditions, which met with the fame fate.

St MATTHIAS's Day, a feftival of the Chriftian church, obferved on the 24th of February. St Matthias was an apoftle of Jefus Chrift, but not of the number of the twelve chofen by Chrift himfelf. He obtained this high honour upon a vacancy made in the college of the apoftles by the treafon and death of Judas Ifcariot. The choice fell on Matthias by lot; his competitor being Jofeph called *Barfabas*, and furnamed *Juftus*. Matthias was qualified for the apoftlefhip, by having been a conftant attendant upon our Saviour all the time of his miniftry. He was, probably, one of the 70 difciples. After our Lord's refurrection, he preached the gofpel firft in Judea.

Afterwards

Afterwards it is probable he travelled eaſtwards, his reſidence being principally near the irruption of the river Apſarus and the haven Hyſſus. The barbarous people treated him with great rudeneſs and inhumanity; and, after many labours and ſufferings in converting great numbers to Chriſtianity, he obtained the crown of martyrdom; but by what kind of death, is uncertain.—They pretend to ſhow the relics of St Matthias at Rome; and the famous abbey of St Matthias near Treves boaſts of the ſame advantage: but doubtleſs both without any foundation. There was a goſpel aſcribed to St Matthias; but it was univerſally rejected as ſpurious.

MATTIACÆ Aquæ, or Mattiaci Fontes, in *Ancient Geography*, now Wiſbaden, oppoſite to Mentz, in Wetcravia. E. Long. 8. N. Lat. 50. 6.

MATTIACUM, or Mattium, in *Ancient Geography*, a town of the Mattiaci, a branch of the Catti in Germany. Now Marpurg in Heſſe. E. Long. 8. 40. N. Lat. 50. 40.

MATTINS, the firſt canonical hour, or the firſt part of the daily ſervice in the Romiſh church.

MATTHIOLUS, Peter Andrew, an eminent phyſician in the 16th century, born at Sienna, was well ſkilled in the Greek and Latin tongues. He wrote learned commentaries on Dioſcorides, and other works which are eſteemed; and died in 1577.

MATURANTS, in *Pharmacy*, medicines which promote the ſuppuration of tumors.

MATY, Matthew, M. D. an eminent phyſician and polite writer, was born in Holland in the year 1718. He was the ſon of a clergyman, and was originally intended for the church; but in conſequence of ſome mortifications his father met with from the ſynod, on account of the peculiar ſentiments he entertained about the doctrine of the Trinity, turned his thoughts to phyſic. He took his degree of M. D. at Leyden; and in 1740 came to ſettle in England, his father having determined to quit Holland for ever. In order to make himſelf known, he began in 1749 to publiſh in French an account of the productions of the Engliſh preſs, printed at the Hague under the name of the *Journal Britannique*. This journal, which continues to hold its rank amongſt the beſt of thoſe which have appeared ſince the time of Bayle, anſwered the chief end he intended by it, and introduced him to the acquaintance of ſome of the moſt reſpectable literary characters of the country he had made his own. It was to their active and uninterrupted friendſhip he owed the places he afterwards poſſeſſed. In 1758 he was choſen fellow, and in 1765, on the reſignation of Dr Birch, who died a few months after, and had made him his executor, ſecretary to the Royal Society. He had been appointed one of the under librarians of the Britiſh muſeum at its firſt inſtitution in 1753, and became principal librarian at the death of Dr Knight in 1772. Uſeful in all theſe ſituations, he promiſed to be eminently ſo in the laſt, when he was ſeized with a languiſhing diſorder, which in 1776 put an end to a life which had been uniformly devoted to the purſuit of ſcience and the offices of humanity. He was an early and active advocate for inoculation; and when there was a doubt entertained that one might have the ſmallpox this way a ſecond time, tried it upon himſelf unknown to his family. He was a member of the medical club (with the Drs Parſons, Templeman, Fothergill, Watſon and others), which met every fortnight in St Paul's Churchyard. He was twice married, viz. the firſt time to Mrs Elizabeth Boiſragon; and the ſecond to Mrs Mary Deners. He left a ſon and three daughters. He had nearly finiſhed the Memoirs of the earl of Cheſterfield; which were completed by his ſon-in-law Mr Juſtamond, and prefixed to that nobleman's Miſcellaneous Works, 1777, 2 vols. 4to.

Maty, *Paul Herry*, M. A. F. R. S. ſon of the former, was born in 1745, and was educated at Weſtminſter and Trinity college, Cambridge, and had their travelling fellowſhip for three years. He was afterwards chaplain to Lord Stormont at Paris, and ſoon after vacated his next fellowſhip by marrying one of the three daughters of Joſeph Clerk, Eſq. and ſiſter of Captain Charles Clerk (who ſucceeded to the command on the death of Captain Cook). On his father's death in 1776, he was appointed to the office of one of the under librarians of the Britiſh Muſeum, and was afterwards preferred to a ſuperior department, having the care of the antiquities, for which he was eminently qualified. In 1776 he alſo ſucceeded his father in the office of ſecretary to the Royal Society. On the diſputes reſpecting the reinſtatement of Dr Hutton in the department of ſecretary for foreign correſpondence in 1784, Mr Maty took a warm and diſtinguiſhed part, and reſigned the office of ſecretary; after which he undertook to aſſiſt gentlemen or ladies in perfecting their knowledge of the Greek, Latin, French, and Italian claſſics. Mr Maty was a thinking conſcientious man; and having conceived ſome doubts about the articles he had ſubſcribed in early life, he never could be prevailed upon to place himſelf in the way of eccleſiaſtical preferment, though his connexions were amongſt thoſe who could have ſerved him eſſentially in this point; and ſoon after his father's death he withdrew himſelf from miniſtering in the eſtabliſhed church, his reaſons for which he publiſhed in the 47th volume of the Gent. Magazine, p. 466. His whole life was thenceforwards taken up in literary purſuits. He received 100l. from the duke of Marlborough, with a copy of that beautiful work, the *Gemmæ Marlburienſes*, of which only 100 copies were worked off for preſents; and of which Mr Maty wrote the French account, as Mr Bryant did the Latin. In January 1782 he ſet on foot a Review of publications, principally foreign, which he carried on, with great credit to himſelf and ſatisfaction to the public, for near five years, when he was obliged to diſcontinue it from ill health. He had long laboured under an aſthmatic complaint, which at times made great ravages in his conſtitution, and at laſt put a period to his life in Jan. 1787, at the age of 42; leaving behind him one ſon.—Mr Maty was eminently acquainted with ancient and modern literature, and particularly converſant in critical reſearches. The purity and probity of his nature were unqueſtionable; and his humanity was as exquiſite as it would have been extenſive, had it been ſeconded by his fortune.

MAUBEUGE, a town of the Netherlands, in Hainault, with an illuſtrious abbey of canoneſſes, who muſt be noble both by the father and mother's ſide. This place was ceded to France in 1678; and fortified after the manner of Vauban. In September 1793, the Auſtrians

Auftrians formed the blockade of this place, but were driven from their pofition in the following month. It is feated on the river Sambre, in E. Long. 4. 2. N. Lat. 50. 16.

MAUCAUCO, Macaco, or *Maki*, a genus of quadrupeds belonging to the order *Primates*. See Mammalia *Index*.

MAVIS, a fpecies of turdus. See Ornithology *Index*.

MAUNCH, in *Heraldry*, the figure of an ancient coat fleeve, born in many gentlemen's efcutcheons.

MAUNDY thursday, is the Thurfday in paffion week; which was called *Maunday* or *Mandate Thurfday*, from the command which our Saviour gave his apoftles to commemorate him in the Lord's fupper, which he this day inftituted; or from the new commandment which he gave them to love one another, after he had wafhed their feet as a token of his love to them.

MAUPERTUIS, Peter Louis Morceau de, a celebrated French academician, was born at St Malo in 1698; and was there privately educated till he arrived at his 16th year, when he was placed under the celebrated profeffor of philofophy M. le Blond, in the college of La Marche, at Paris. He foon difcovered a paffion for mathematical ftudies, and particularly for geometry. He likewife practifed inftrumental mufic in his early years with great fuccefs, but fixed on no profeffion till he was 20, when he entered into the army. He firft ferved in the Grey mufqueteers; but in the year 1720, his father purchafed for him a company of cavalry in the regiment of La Rocheguyon. He remained but five years in the army, during which time he purfued his mathematical ftudies with great vigour; and it was foon remarked by M. Freret and other academicians, that nothing but geometry could fatisfy his active foul and unbounded thirft for knowledge. In the year 1723, he was received into the Royal Academy of Sciences, and read his firft performance, which was a memoir upon the conftruction and form of mufical inftruments, November 15. 1724. During the firft years of his admiffion, he did not wholly confine his attention to mathematics; he dipt into natural philofophy, and difcovered great knowledge and dexterity in obfervations and experiments upon animals. If the cuftom of travelling into remote climates, like the fages of antiquity, in order to be initiated into the learned myfteries of thofe times, had ftill fubfifted, no one would have conformed to it with greater eagernefs than M. de Maupertuis. His firft gratification of this paffion was to vifit the country which had given birth to Newton: and during his refidence at London he became as zealous an admirer and follower of that philofopher as any one of his own countrymen. His next excurfion was to Bafil in Switzerland, where he formed a friendfhip with the famous John Bernouilli and his family, which continued to his death. At his return to Paris, he applied himfelf to his favourite ftudies with greater zeal than ever: —And how well he fulfilled the duties of an academician, may be gathered by running over the memoirs of the academy from the year 1724 to 1736; where it appears that he was neither idle nor occupied by objects of fmall importance. The moft fublime queftions in geometry and the relative fciences received from his hands that elegance, clearnefs, and precifion, fo remarkable in all his writings. In the year 1736, he was fent by the king of France to the polar circle, to meafure a degree, in order to afcertain the figure of the earth, accompanied by Meffrs Clairault, Camus, Le Monnier, l'Abbe Outhier, and Celfius the celebrated profeffor of aftronomy at Upfal. This diftinction rendered him fo famous, that at his return he was admitted a member of almoft every academy in Europe.

In the year 1740 Maupertuis had an invitation from the king of Pruffia to go to Berlin; which was too flattering to be refufed. His rank among men of letters had not wholly effaced his love for his firft profeffion, namely, that of arms. He followed his Pruffian majefty into the field, and was a witnefs of the difpofitions and operations that preceded the battle of Molwitz; but was deprived of the glory of being prefent, when victory declared in favour of his royal patron, by a fingular kind of adventure. His horfe, during the heat of the action, running away with him, he fell into the hands of the enemy; and was at firft but roughly treated by the Auftrian foldiers, to whom he could not make himfelf known for want of language; but being carried prifoner to Vienna, he received fuch honours from their Imperial majefties as were never effaced from his memory. From Vienna he returned to Berlin; but as the reform of the academy which the king of Pruffia then meditated was not yet mature, he went again to Paris, where his affairs called him, and was chofen in 1742 director of the Academy of Sciences. In 1743 he was received into the French academy; which was the firft inftance of the fame perfon being a member of both the academies at Paris at the fame time. M. de Maupertuis again affumed the foldier at the fiege of Fribourg, and was pitched upon by Marfhal Cogny and the Count d'Argenfon to carry the news to the French king of the furrender of that citadel.

He returned to Berlin in the year 1744, when a marriage was negotiated and brought about by the good offices of the queen-mother, between our author and Mademoifelle de Borck, a lady of great beauty and merit, and nearly related to M. de Borck, at that time minifter of ftate. This determined him to fettle at Berlin, as he was extremely attached to his new fpoufe, and regarded this alliance as the moft fortunate circumftance of his life.

In the year 1746, M. de Maupertuis was declared by his Pruffian majefty prefident of the Royal Academy of Sciences at Berlin, and foon after by the fame prince was honoured with the order of Merit: However, all thefe accumulated honours and advantages, fo far from leffening his ardour for the fciences, feemed to furnifh new allurements to labour and application. Not a day paffed but he produced fome new project or effay for the advancement of knowledge. Nor did he confine himfelf to mathematical ftudies only: metaphyfics, chemiftry, botany, polite literature, all fhared his attention, and contributed to his fame. At the fame time, he had, it feems, a ftrange inquietude of fpirit, with a morofe temper, which rendered him miferable amidft honours and pleafures.—Such a temperament did not promife a very pacific life, and he was engaged in feveral quarrels. He had a quarrel with Koenig the profeſſor of philoſophy at Franeker, and another more terrible with Voltaire. Maupertuis had inſerted into the volume of Memoirs of the Academy of Berlin for 1746, a diſcourſe upon the laws of motion; which Koenig was not content with attacking, but attributed to Leibnitz. Maupertuis, ſtung with the imputation of plagiariſm, engaged the academy of Berlin to call upon him for his proof; which Koenig failing to produce, he was ſtruck out of the academy, of which he was a member. Several pamphlets were the conſequence of this; and Voltaire, for ſome reaſon or other, engaged againſt Maupertuis. We ſay, for ſome reaſon or other; becauſe Maupertuis and Voltaire were apparently upon the moſt amicable terms; and the latter reſpected the former as his maſter in the mathematics. Voltaire, however, exerted all his wit and ſatire againſt him; and on the whole was ſo much tranſported beyond what was thought right, that he found it expedient in 1753 to quit the court of Pruſſia.

Our philoſopher's conſtitution had long been conſiderably impaired by the great fatigues of various kinds in which his active mind had involved him; though from the amazing hardſhips he had undergone in his northern expedition, moſt of his future bodily ſufferings may be traced. The intenſe ſharpneſs of the air could only be ſupported by means of ſtrong liquors, which ſerved to increaſe his diſorder, and bring on a ſpitting of blood, which began at leaſt 12 years before he died. Yet ſtill his mind ſeemed to enjoy the greateſt vigour; for the beſt of his writings were produced, and moſt ſublime ideas developed, during the time of his confinement by ſickneſs, when he was unable to occupy his preſidial chair at the academy. He took ſeveral journeys to St Malo, during the laſt years of his life, for the recovery of his health: And though he always received benefit by breathing his native air, yet ſtill, upon his return to Berlin, his diſorder likewiſe returned with greater violence.—His laſt journey into France was undertaken in the year 1757; when he was obliged, ſoon after his arrival there, to quit his favourite retreat at St Malo, on account of the danger and confuſion which that town was thrown into by the arrival of the Engliſh in its neighbourhood. From thence he went to Bourdeaux, hoping there to meet with a neutral ſhip to carry him to Hamburgh, in his way back to Berlin; but being diſappointed in that hope, he went to Thoulouſe, where he remained ſeven months. He had then thoughts of going to Italy, in hopes a milder climate would reſtore him to health: but finding himſelf grow worſe, he rather inclined towards Germany, and went to Neufchatel, where for three months he enjoyed the converſation of Lord Mariſchal, with whom he had formerly been much connected. At length he arrived at Baſil, October 16. 1758, where he was received by his friend Bernouilli and his family with the utmoſt tenderneſs and affection. He at firſt found himſelf much better here than he had been at Neufchatel: but this amendment was of ſhort duration; for as the winter approached, his diſorder returned, accompanied by new and more alarming ſymptoms. He languiſhed here many months, during which he was attended by M. de la Condamine; and died in 1759.

He wrote in French, 1. The figure of the earth determined. 2. The meaſure of a degree of the meridian. 3. A diſcourſe on the paralax of the moon. 4. A diſcourſe on the figure of the ſtars. 5. The elements of geography. 6. Nautical aſtronomy. 7. Elements of aſtronomy. 8. A phyſical diſſertation on a white inhabitant of Africa. 9. An eſſay on coſmography. 10. Reflections on the origin of languages. 11. An eſſay on moral philoſophy. 12. A letter on the progreſs of the ſciences. . 13. An eſſay on the formation of bodies. 14. An eulogium on M. de Monteſquieu. 15. Letters, and other works.

MAUR, St, was a celebrated diſciple of St Benedict. If we can believe a life of St Maur aſcribed to Fauſtus his companion, he was ſent by Benedict on a miſſion to France. But this life is conſidered as apocryphal. In rejecting it, however, as well as the circumſtances of the miſſion, we muſt beware of denying the miſſion itſelf. It is certain that it was believed in France as early as the 9th century; and notwithſtanding the ſilence of Bede, Gregory of Tours, and others, there are ſeveral documents which prove this, or at leaſt render it extremely probable. A celebrated ſociety of Benedictines, took the name of *St Maur* in the beginning of the laſt century, and received the ſanction of Pope Gregory XV. in 1621. This ſociety was early diſtinguiſhed by the virtue and the knowledge of its members, and it ſtill ſupports the character. There are, perhaps, fewer eminent men in it than formerly; but this may be aſcribed to the levity of the age, and partly to the little encouragement for the reſearches of learned men. The chief perſons of ingenuity which this ſociety has produced are, the Fathers Menard, d'Acheri, Mabillon, Ruinart, Germain, Lami, Montfaucon, Martin, Vaiſſette, le Nourri, Martianay, Martenne, Maſſuet, &c. &c. See *L'Hiſtoire Litteraire de la Congregation de St Maur*, publiſhed at Paris under the title of *Bruſſels*, in 4to, 1770, by Dom. Taſſin.

MAURICEAU, Francis, a French ſurgeon, who applied himſelf with great ſucceſs and reputation to the theory and practice of his art for ſeveral years at Paris. Afterwards he confined himſelf to the diſorders of pregnant and lying-in-women, and was at the head of all the operators in this way. His *Obſervations ſur la groſſeſſe* and *ſur l'accouchement des femmes*, *ſur leurs maladies*, *et celles des enfans nouveaux*, 1694, in 4to, is reckoned an excellent work, and has been tranſlated into ſeveral languages, German, Flemiſh, Italian, Engliſh: and the author himſelf tranſlated it into Latin. It is illuſtrated with cuts. He publiſhed another piece or two, by way of ſupplement, on the ſame ſubject; and died at Paris in 1709.

MAURICE, St, commander of the Theban legion, was a Chriſtian, together with the officers and ſoldiers of that legion, amounting to 6600 men.—This legion received its name from the city Thebes in Egypt, where it was raiſed. It was ſent by Diocleſian to check the Bagaudæ, who had excited ſome diſturbances in Gaul. Maurice having carried his troops over the Alps, the emperor Maximinian commanded him to employ his utmoſt exertions to extirpate Chriſtianity. This propoſal was received with horror both by the commander and by the ſoldiers. The emperor, enraged at their oppoſition, commanded the legion to be decimated; and when they ſtill

Maurice. declared that they would sooner die than do any thing prejudicial to the Christian faith, every tenth man of those who remained was put to death. Their perseverance excited the emperor to still greater cruelty; for when he saw that nothing could make them relinquish their religion, he commanded his troops to surround them, and cut them to pieces. Mauriee, the commander of these Christian heroes, and Exuperus and Candidus, officers of the legion, who had chiefly instigated the soldiers to this noble resistance, signalized themselves by their patience and their attachment to the doctrines of the Christian religion. They were massacred, it is believed, at Agaune, in Chablais, the 22d of September 286.—Notwithstanding many proofs which support this transaction, Dubordier, Hottinger, Moyle, Burnet, and Mosheim, are disposed to deny the fact. It is defended, on the other hand, by Hickes an English writer, and by Dom Joseph de Lisle a Benedictine monk *de la congregation de Saint Vannes*, in a work of his, entitled *Defence de la Verité du Martyre de la Legion Thebenne*, 1737. In defence of the same fact, the reader may consult *Historia de S. Mauritie*, by P. Rossignole a Jesuit, and the *Acta Sanctorum* for the month of September. The martyrdom of this legion, written by St Eucherius bishop of Lyons, was transmitted to posterity in a very imperfect manner by Surius. P. Chifflet a Jesuit, discovered, and gave to the public, an exact copy of this work. Don Ruinart maintains, that it has every mark of authenticity. St Maurice is the patron of a celebrated order in the king of Sardinia's dominions, created by Emanuel Philibert duke of Savoy, to reward military merit, and approved by Gregory XIII. in 1572. The commander of the Theban legion must not be confounded with another *St Maurice*, mentioned by Theodoret, who suffered martyrdom at Apamea in Syria.

MAURICE, (*Mauritius Tiberius*), was born at Arabissus in Cappadocia, A. D. 539. He was descended from an ancient and honourable Roman family.—After he had filled several offices in the court of Tiberius Constantine, he obtained the command of his armies against the Persians. His gallantry was so conspicuous that the emperor gave him his daughter Constantina in marriage, and invested him with the purple the 13th August 582. The Persians still continued to make inroads on the Roman territories, and Maurice sent Philippicus, his brother-in-law, against them. This general conducted the war with various success. At first he gained several splendid victories, but he did not continue to have a decided superiority. As there was a great use for soldiers in these unfortunate times, the emperor issued a mandate in 592, forbidding any soldier to become a monk till he had accomplished the term of his military service. Maurice acquired much glory in restoring Chosroes II. king of Persia, to the throne, after he had been deposed by his subjects. The empire was in his reign harassed by the frequent inroads of the Arabian tribes. He purchased peace from them, by granting them a pension nearly equal to 100,000 crowns; but these barbarians took frequent opportunities to renew the war. In different engagements the Romans destroyed 50,000, and took 17,000 prisoners. These were restored, on condition that the king of the Abari should return all the Roman captives in his dominions. Maurice. Regardless of his promise, he demanded a ransom of 10,000 crowns. Maurice, full of indignation, refused the sum: and the barbarian, equally enraged, put the captives to the sword. While the emperor, to revenge this cruelty, was making preparations against the Abari, Phocas, who from the rank of centurion had attained the highest military preferment, assumed the purple, and was declared emperor. He pursued Maurice to Chalcedon, took him prisoner, and condemned him to die. The five sons of this unfortunate prince were massacred before his eyes, and Maurice, humbling himself under the hand of God, was heard to exclaim, *Thou art just, O Lord, and thy judgments are without partiality*. He was beheaded on the 26th November 602, in the 63d year of his age and 20th of his reign. Many writers have estimated the character of this prince by his misfortunes instead of his actions. They believed him guilty without evidence, and condemned him without reason. It cannot be denied, however, that he allowed Italy to be harassed; but he was a father to the rest of the empire. He restored the military discipline, humbled the pride of his enemies, supported the Christian religion by his laws, and piety by his example. He loved the sciences, and was the patron of learned men.

MAURICE, elector of Saxony, son of Henry le Pieux, was born A. D. 1521. He was early remarkable for his courage, and during his whole life he was engaged in warlike pursuits. He served under the emperor Charles V. in the campaign of 1544 against France; and in the year following against the league of Smalkalde; with which, although a Protestant, he would have no manner of connexion. The emperor, as a reward for his services, in the year 1547, made him elector of Saxony, having deprived his cousin John Frederick of that electorate. Ambition had led him to second the views of Charles, in the hope of being elector, and ambition again detached him from that prince. In 1551 he entered into a league against the emperor, together with the elector of Brandenburgh, the Count Palatine, the duke of Wirtemburg, and many other princes. This league, encouraged by the young and enterprising Henry II. of France, was more dangerous than that of Smalkalde. The pretext for the association was the deliverance of the landgrave of Hesse, whom the emperor kept prisoner. Maurice and the confederates marched, in 1552, to the defiles of Tyrol, and put to flight the Imperial troops who guarded them. The emperor and his brother Ferdinand narrowly escaped, and fled from the conquerors in great disorder. Charles having retired into Passau, where he had collected an army, brought the princes of the league to terms of accommodation. By the famous peace of Passau, which was finally ratified the 12th of August 1552, the emperor granted an amnesty without exception to all those who had carried arms against him from the year 1546. The Protestants not only obtained the free exercise of their religion, but they were admitted into the imperial chamber, from which they had been excluded since the victory of Mulberg.—Maurice soon after united himself with the emperor against the margrave of Brandenburg, who laid waste the German provinces. He engaged him in 1553, gained

Maurice.

ed the battle of Siverſhauſen, and died of the wounds he had received in the engagement two days after. He was one of the greateſt protectors of the Lutherans in Germany, and a prince equally brave and politic. After he had profited by the ſpoils of John Frederick, the chief of the Proteſtants, he became himſelf the leader of the party, and by theſe means maintained the balance of power againſt the emperor in Germany.

MAURICE de Naſſau, prince of Orange, ſucceeded to the government of the Low Countries after the death of his father William, who was killed in 1584 by the fanatic Gerard. The young prince was then only eighteen years of age, but his courage and abilities were above his years. He was appointed captain general of the United Provinces, and he reared that edifice of liberty of which his father had laid the foundation. Breda ſubmitted to him in 1590; Zutphen, Deventer, Hulſt, Nimeguen, in 1591. He gained ſeveral important advantages in 1592, and in the year following he made himſelf maſter of Gertrudenburg. When he had performed theſe ſplendid ſervices, he returned to the Low Countries by the way of Zealand. His fleet was attacked by a dreadful tempeſt, in which he loſt forty veſſels, and he himſelf had very nearly periſhed. His death would have been conſidered by the Hollanders as a much greater calamity than the loſs of their veſſels. They watched over his ſafety with exceeding care. In 1594, one of his guards was accuſed of an intention to take away his life; and it was generally believed that he was bribed to this ſervice by the enemies of the republic. He fell a ſacrifice at Bruges, either to his own fanaticiſm or to the jealous anxiety of the friends of Maurice. The prince of Orange, increaſing in reputation, defeated the troops of the archduke Albert in 1597, and drove the Spaniards entirely out of Holland. In 1600 he was obliged to raiſe the ſiege of Dunkirk; but he took ample vengeance on Albert, whom he again defeated in a pitched battle near Nieuport. Before the action, this great general ſent back the ſhips which had brought his troops into Flanders: *My brethren* (ſaid he to his army), *we muſt conquer the enemy or drink up the waters of the ſea. Determine for yourſelves; I have determined I ſhall either conquer by your bravery, or I ſhall never ſurvive the diſgrace of being conquered by men in every reſpect our inferiors.* This ſpeech elevated the ſoldiers to the higheſt pitch of enthuſiaſm, and the victory was complete. Rhinberg, Grave, and Ecluſe, cities in Flanders, ſubmitted to the conqueror the following year. Maurice, however, not only laboured for the commonwealth, but alſo for himſelf. He coveted the ſovereignty of Holland, and was oppoſed in the proſecution of his deſign by the penſioner Barneveldt. The zeal and activity of this wiſe republican coſt him his life. He was an Arminian; and at this time Maurice defended Gomar againſt Arminius.—Taking advantage of the general odium under which the Arminians lay, he found means to get Barneveldt condemned in 1619. His death, wholly owing to the cruel ambition of the prince of Orange, made a deep impreſſion on the minds of the Hollanders. The truce with Spain being expired, Spinola laid ſiege to Breda in 1624, and in ſix months, by the proper direction of his great talents, though with great ſlaughter of his troops, he took the place. The prince of Orange, unſucceſsful in every attempt to raiſe the ſiege, died of vexation in 1625, aged 55 years, with the reputation of the greateſt warrior of his time.—"The life of this ſtadtholder (ſays the abbe Raynal) was almoſt an uninterrupted ſeries of battles, of ſieges, and of victories. Of moderate abilities in every thing elſe, he ſhone conſpicuous in his military capacity. His camp was the ſchool of Europe; and thoſe who received their military education in his armies augmented, perhaps, the glory of their maſter.—Like Montecuculi, he diſcovered inimitable ſkill in his marches and encampments; like Vauban, he poſſeſſed the talent of fortifying places, and of rendering them impregnable; like Eugene, the addreſs of finding ſubſiſtence for great armies in countries barren by nature, or ravaged by war; like Vendome, the happy talent of calling forth, in the moment they became neceſſary, greater exertions from his ſoldiers than could reaſonably be expected; like Condé, that infallible quickneſs of eye which decides the fortune of battles; like Charles XII. the art of rendering his troops almoſt invincible to cold, hunger, and fatigue; like Turenne, the ſecret of making war with the leaſt poſſible expence of human blood." The Chevalier Folard maintains, that Maurice was the greateſt commander of infantry ſince the time of the Romans. He ſtudied the military art of the ancients, and applied their rules with great exactneſs in the various occurrences of war. He not only took advantage of the inventions of others, but he enriched the ſcience of war with ſeveral improvements. Teleſcopes were firſt uſed by him for a military purpoſe; and, beſides a kind of gallery in conducting a ſiege, and the plan of blockading a ſtrong place, which were of his invention, he greatly improved the whole art by his method of puſhing an attack with great vigour, and of defending, for the greateſt length of time, and in the beſt manner, a place beſieged. In ſhort, the many uſeful things which he practiſed or invented, placed him in the higheſt rank among men of a military character. On one occaſion, a lady of quality aſked him, *Who was the firſt general of the age? Spinola* (replied he) *is the ſecond.* It was his conſtant practice, during ſleep, to have two guards placed by his bedſide, not only to defend him in caſe of danger, but to awake him if there ſhould be the leaſt occaſion. The war betwixt Spain and Holland was never carried on with greater keenneſs and animoſity than during his adminiſtration.—The Grand Signior, hearing of the vaſt torrents of blood ſhed in this conteſt, thought that a great empire muſt depend on the deciſion. The object of ſo many battles was pointed out to him on a map, and he ſaid coldly, *If it were my buſineſs, I would ſend my pioneers, and order them to caſt this little corner of earth into the ſea.* Maurice, like many great men, was impatient under contradiction, and too much devoted to women. He was ſucceeded by Frederick Henry his brother.

Maurice, Mauritania.

MAURITANIA, an ancient kingdom of Africa, bounded on the weſt by the Atlantic ocean, on the ſouth by Getulia or Libya Interior, and on the north by the Mediterranean; comprehending the greater part of the kingdoms of Fez and Morocco.—Its ancient limits are not exactly mentioned by any hiſtorian; neither

neither can they now be aſcertained by any modern obſervations, theſe kingdoms being but little known to Europeans.

This country was originally inhabited by a people called *Mauri*, concerning the etymology of which name authors are not agreed. It is probable, however, that this country, or at leaſt a great part of it, was firſt called *Phut*, ſince it appears from Pliny, Ptolemy, and St Jerome, that a river and territory not far from Mount Atlas went by that name. From the Jeruſalem Targum it likewiſe appears, that part of the Mauri may be deemed the offspring of Lud the ſon of Miſraim, ſince his deſcendants, mentioned Geneſis x. are there called מרוטאי, *Mauri*, or *Mauritani*. It is certain, that this region, as well as the others to the eaſtward of it, had many colonies planted in it by the Phœnicians. Procopius tells us, that in his time two pillars of white ſtone were to be ſeen there, with the following inſcription in the Phœnician language and character upon them: "We are the *Canaanites*, that fled from *Joſhua* the ſon of Nun, that notorious robber." *Ibnu Rachic*, or *Ibnu Raquig*, an African writer cited by Leo, together with Evagrius and Nicephorus Calliſtus, aſſert the ſame thing.

The Mauritanians, according to Ptolemy, were divided into ſeveral cantons or tribes. The *Metagonitæ* were ſeated near the ſtraits of Hercules, now thoſe of Gibraltar. The *Saccoſii*, or *Cocoſii*, occupied the coaſt of the Iberian ſea. Under theſe two petty nations the *Maſices*, *Verues*, and *Verbicæ* or *Vervicæ*, were ſettled. The *Saliſæ* or *Salinſæ*, were ſituated lower, towards the ocean; and, ſtill more to the ſouth, the *Volubiliani*. The *Maurenſii* and *Herpiditani* poſſeſſed the eaſtern part of this country, which was terminated by the *Mulucha*. The *Angaucani*, or *Jangacaucani*, *Nectiberes*, *Zagrenſii*, *Baniubæ*, and *Vacuntæ*, extended themſelves from the ſouthern foot of Ptolemy's Atlas Minor to his Atlas Major. Pliny mentions the *Baniuræ*, whom Father Hardouin takes to be Ptolemy's Baniubæ; and Mela the Atlantes, whom he repreſents as poſſeſſed of the weſtern parts of this diſtrict.

The earlieſt prince of Mauritania mentioned in hiſtory is Neptune; and next to him were Atlas and Antæus his two ſons, both famous in the Grecian fables on account of their wars with Hercules. Antæus, in his contention with that hero, ſeems to have behaved with great bravery and reſolution. Having received large reinforcements of Libyan troops, he cut off great numbers of Hercules's men. But that celebrated commander, having at laſt intercepted a ſtrong body of Libyans ſent to the relief of Antæus, gave him a total overthrow, wherein both he and the beſt part of his forces were put to the ſword. This deciſive action put Hercules in poſſeſſion of Libya and Mauritania, and conſequently of the riches of all theſe kingdoms. Hence came the fable, that Hercules, finding Antæus, a giant of an enormous ſize with whom he was engaged in ſingle combat, to receive freſh ſtrength as often as he touched his mother earth when thrown upon her, at laſt lifted him up in the air and ſqueezed him to death. Hence likewiſe may be deduced the fable intimating that Hercules took the globe from Atlas upon his own ſhoulders, overcame the dragon that guarded the orchards of the Heſperides, and made himſelf maſter of all the golden fruit there. Bochart thinks that the fable alluded chiefly to naval engagements, wherein Hercules, for the moſt part, was victorious; though Antæus from time to time received ſuccours by ſea. But at laſt Hercules, coming up with one of his ſquadrons which had a ſtrong reinforcement on board, made himſelf maſter of it, and thus rendered Antæus incapable for the future of making head againſt him. The ſame author likewiſe inſinuates, that the notion of Antæus's gigantic ſtature prevailing for ſo many centuries amongſt the Tingitanians, pointed out the ſize of the veſſels of which his fleets and ſquadrons were compoſed. As for the golden apples ſo frequently mentioned by the old mythologiſts, they were the treaſures that fell into Hercules's hands upon the defeat of Antæus; the Greeks giving the oriental word מאל, *riches*, the ſignification affixed to their own term *μηλα*, *apples*.

With regard to the age in which Atlas and Antæus lived, the moſt probable ſuppoſition ſeems to be that of Sir Iſaac Newton. According to that illuſtrious author, Ammon the father of Seſac was the firſt king of Libya, or that vaſt tract extending from the borders of Egypt to the Atlantic ocean; the conqueſt of which country was effected by Seſac in his father's lifetime. Neptune afterwards excited the Libyans to a rebellion againſt Seſac, and ſlew him; and then invaded Egypt under the command of Atlas or Antæus, the ſon of Neptune, Seſac's brother and admiral. Not long after, Hercules, the general of Thebais and Ethiopia for the gods or great men of Egypt, reduced a ſecond time the whole continent of Libya, having overthrown and ſlain Antæus near a town in Thebais, from that event called *Antæa* or *Antæopolis*: this, we ſay, is the notion advanced by Sir Iſaac Newton, who endeavours to prove, that the firſt reduction of Libya, by Seſac, happened a little above a thouſand years before the birth of Chriſt, as the laſt, by Hercules, did ſome few years after. Now, though we do not pretend to adopt every particular circumſtance of Sir Iſaac Newton's ſyſtem, yet we cannot forbear obſerving, that it appears undeniably plain from Scripture, that neither the weſtern extremity of Libya, nor even the other parts of that region, could poſſibly have been ſo well peopled before the time of David or Solomon, as to have ſent a numerous army to invade Egypt. For Egypt and Phœnicia, from whence the greateſt part of the anceſtors of the Libyans came, and which were much nearer the place from whence the firſt diſperſion of mankind was made, could not themſelves have been greatly overſtocked with inhabitants any conſiderable time before the reign of Saul. And that ſuch an invaſion happened in the reign of Neptune, or at leaſt of his ſon Antæus, has been moſt fully evinced by this moſt excellent chronologer.

From the defeat of Antæus, nothing remarkable occurs in the hiſtory of Mauritania till the times of the Romans, who at laſt brought the whole kingdom under their juriſdiction; for which ſee the article ROME. 1. With regard to the cuſtoms, &c. of this people, it would ſeem, from what Hyginus inſinuates, that they fought only with clubs, till one Belus, the ſon of Neptune, as that author calls him, taught them the uſe of the ſword. Sir Iſaac Newton makes this Belus to have been the ſame perſon with Seſoſtris king of Egypt, who overran a great part of the then known world. 2. All perſons of diſtinction in Mauritania went richly attired, wearing much gold and ſilver in their clothes. They took great pains in cleanſing their teeth, and curled their hair in a curious and elegant manner. They combed their beards, which were very long, and always had their nails pared extremely cloſe. When they walked out in any numbers, they never touched one another, for fear of diſconcerting the curls into which their hair had been formed. 3. The Mauritanian infantry, in time of action, uſed ſhields made of elephants ſkins, being clad in thoſe of lions, leopards, and bears, which they kept on both night and day. 4. The cavalry of this nation was armed with broad ſhort lances, and carried targets or bucklers, made likewiſe of the ſkins of wild beaſts. They uſed no ſaddles. Their horſes were ſmall and ſwift, had wooden collars about their necks, and were ſo much under the command of their riders, that they would follow them like dogs. The habit of theſe horſemen was not much different from that of the foot above mentioned, they conſtantly wearing a large tunic of the ſkins of wild beaſts. The Phutæi, of whom the Mauritanians were a branch, were eminent for their ſhields, and the excellent uſe they made of them, as we learn from Homer, Xenophon, Herodotus, and Scripture. Nay, Herodotus ſeems to intimate, that the ſhield and helmet came from them to the Greeks. 5. Notwithſtanding the fertility of their ſoil, the poorer ſort of the Mauritanians never took care to manure the ground, being ſtrangers to the art of huſbandry; but roved about the country in a wild ſavage manner, like the ancient Scythians or Arabes Scenitæ. They had tents, or *mapalia*, ſo extremely ſmall, that they could ſcarce breathe in them. Their food was corn, herbage, &c. which they frequently did eat green, without any manner of preparation, being deſtitute of wine, oil, and all the elegancies as well as many neceſſaries of life. Their habit was the ſame both in ſummer and winter, conſiſting chiefly of an old tattered, though thick garment, and over it a coarſe rough tunic; which anſwered probably to that of their neighbours the Numidians. Moſt of them lay every night upon the bare ground; though ſome of them ſtrewed their garments thereon, not unlike the preſent African Kabyles and Arabs, who, according to Dr Shaw, uſe their hykes for a bed and covering in the night. 6. If the moſt approved reading of Horace may be admitted, the Mauritanians ſhot poiſoned arrows; which clearly intimates, that they had ſome ſkill in the art of preparing poiſons, and were excellent dartmen. This laſt obſervation is countenanced by Herodian and Ælian, who entirely come into it, affirming them to have been in ſuch continual danger of being devoured by wild beaſts, that they durſt not ſtir out of their tents or mapalia without their darts. Such perpetual exerciſe muſt render them exceedingly ſkilful in hurling that weapon. 7. The Mauritanians ſacrificed human victims to their deities, as the Phœnicians, Carthaginians, &c. did.

The country people were extremely rude and barbarous; but thoſe inhabiting cities muſt undoubtedly have had at leaſt ſome ſmattering in the literature of the ſeveral nations they deduced their origin from. That the Mauritanians had ſome knowledge in naval affairs, ſeems probable, not only from the intercourſe they had with the Phœnicians and Carthaginians, as well as the ſituation of their country; but likewiſe from Orpheus, or Onomacritus, who aſſerts them to have made a ſettlement at the entrance into Colchis, to which place they came by ſea. Magic, ſorcery, divination, &c. they appear to have applied themſelves to in very early times. Cicero and Pliny ſay, that Atlas was the inventor of aſtrology, and the doctrine of the ſphere, i. e. he firſt introduced them into Mauritania. This, according to Diodorus Siculus, gave riſe to the fable of Atlas's bearing the heavens upon his ſhoulders. The ſame author relates, that Atlas inſtructed Hercules in the doctrine of the ſphere and aſtrology, or rather aſtronomy, who afterwards brought thoſe ſciences into Greece.

MAURITIA, the Ginkgo, or *Maidenhair Tree;* a genus of plants belonging to the natural order of palmæ. See Botany *Index*.

MAURITIUS, or Maurice, an iſland of Africa, about 400 miles eaſt of Madagaſcar, lying in the latitude of 20 and 21 degrees ſouth. It is about 150 miles in circumference. In the beginning of the 16th century it was diſcovered by the Portugueſe, who knowing that Pliny and other ancient writers had mentioned the iſland of Cerne in theſe ſeas, took it for granted that this muſt be it; and accordingly we find it ſtyled *Cerne* or *Sirne*, in their maps: but, notwithſtanding this, they did not think fit to ſettle it; and indeed their force was ſo ſmall, in compariſon of the vaſt dominions they graſped, that it was very excuſable. However, according to their laudable cuſtom, they put ſome hogs, goats, and other cattle, upon it, that in caſe any of their ſhips either going to the Indies or returning to Portugal ſhould be obliged to touch there, they might meet with refreſhments. The Dutch, in the ſecond voyage they made to the Eaſt Indies under their admiral James Cornelius Vanneck, came together with five ſhips on the 15th of September 1568; anchored in a commodious port, to which they gave the name of *Warwick Haven;* and gave a very good account of the place in their journals. Captain Samuel Caſtleton, in the Pearl, an Engliſh Eaſt India ſhip, arrived there on the 27th of March 1612; and taking it to be an iſland undiſcovered before, beſtowed upon it the name of *England's Foreſt*, though others of his crew called it *Pearl Iſland;* and in the account of their voyage, written by John Tatton the maſter of the ſhip, celebrated it as a place very convenient for ſhipping, either outward or homeward bound, to refreſh at. This they ſometimes accordingly did, and brought ſome cargoes of ebony, and rich wood from thence, but without fixing any ſettlement.

At length, in 1638, the Dutch ſeated themſelves here: and it is highly remarkable, that at the very time they were employed in making their firſt ſettlement, the French ſent a veſſel to take poſſeſſion of it, who found the Dutch beforehand with them, and refuſed the aſſiſtance of an Engliſh Indiaman, wooding and watering in another port of the iſland, who very frankly offered it, to drive the Dutch from their half-ſettled poſts. They continued for ſome time in quiet poſſeſſion

Mauritius. possession of the places they fortified in this island, to which they gave the name of *Mauritius*, in honour of Prince Maurice their stadtholder. But having engaged the French, who were settled on Madagascar, to steal 50 of the natives, and sell them for slaves, for the improvement of the Dutch settlements here, this proved the ruin of both colonies; for the negroes surprised and massacred the French in Madagascar; and the slaves in Mauritius fled into the centre of the island; from whence they so much and so incessantly molested those who had been formerly their masters, that they chose to quit a country where they could no longer remain in any tolerable degree of safety. The East India Company, however, from motives of conveniency, and a very imperfect notion of its value, disapproved this measure, and therefore ordered it to be resettled; which was accordingly done, and three forts erected at the principal havens. Things now went on somewhat better than they did before; but they were still very much disturbed by the revolted negroes in the heart of the isle, whom they could never subdue. One principal use that the company made of this place, was to send thither state prisoners, who, as they were not men of the best morals, quickly corrupted the rest of the inhabitants, and rendered them such a race of outrageous smugglers, the situation of the place concurring with their bad disposition, that, after various ineffectual attempts made to reform them, orders were at length given to abandon Mauritius a second time, which, after some delays, were put in execution in the year 1710.

Two years after this, the French took possession of it, and named it the *isle de France*. This name has obtained among themselves, but the Europeans in general continue to call it Mauritius. It lies in S. Lat. 20. 15. E. Long. 6. 15. The inconveniences arising from the want of a port at the island of Bourbon, induced the French to take possession of Mauritius, it having two very good harbours, to fortify which no expence has been spared. That on the north-west is called *Port Louis*, that on the south-east side of the island is called *Port Bourbon*. The trade-wind from the south-east in these latitudes blows all the year round, excepting for a few days at the summer solstice, when it is interrupted by hard gales and hurricanes from the north. The ease with which this wind enables ships to enter the port of Bourbon, caused the French, when they first took possession of this spot, to esteem it the best port in the island; but experience pointing out to them, that the same wind often rendered the passage out of the harbour so difficult, that a ship was sometimes obliged to wait a considerable time before the weather admitted of her putting to sea, this harbour is in a great measure abandoned, and the principal town and seat of government is now fixed at Port Louis, which is nearly in the middle of the north side of the island, and its entrance is through a channel formed by two shoals, which advance about two miles into the sea. When a ship arrives opposite to this channel, the south-east wind hinders her from entering the port under sail, and she must either warp in with cables or be towed in with boats. The necessity of this operation, joined to the extreme narrowness of the channel, which does not admit of two ships abreast of each other entering at the same time, is one of the best defences the harbour has against an attack by sea; for, from these obstacles, an enemy would find it a matter of the greatest difficulty to force the port; and in addition to this natural strength, they have built two forts and as many batteries, which are mounted with heavy cannon, and entirely command the approach to the harbour, should ships presume to force an entry under sail. This port is capable of containing 100 sail of ships, and is well provided with every requisite for repairing and even building of ships. This port has proved of the greatest advantage to France in the several wars which have been carried on between Great Britain and her; and has proved of great utility to the French East India Company's commerce; for here their ships and crews were sure to meet with all necessary refreshment after a long voyage. The port of Bourbon is also fortified; and an army landed here would find it an extremely difficult task to pass the mountains to the different parts of the island. There are several places between the north-east extremity and Port Louis where boats may land, but all these are defended by batteries; and the country behind them is a continued thicket: The rest of the coast is inaccessible. In the north-eastern quarter is a plain extending about 10 miles from east to west, and in some places five miles inland from the northern coast. All the rest of the island is full of high and steep mountains, lying so near to one another, and the intervals between them so narrow, that, instead of valleys, they rather resemble the beds of torrents; and these are choked with huge fragments of rocks which have fallen from the steep sides of the impending mountains. On the summits of the mountains ice is frequently to be found, and they are covered with forests of ebony and other large trees. The ground they shade produces herbage, shrubs, and plants of various sorts, from the common grass to the strongest thorn, and that in such profusion, that they form a thicket so closely interwoven, that no progress can be made but by means of a hatchet. Notwithstanding these difficulties, plantations have been formed on these mountains, and very considerable progress has been made in the plains; but the productions, although mostly of the same kind, are not only in less quantity, but of an inferior quality to those produced at Bourbon island.

In a course of years, however, the settlement cost so much, and was considered in every light worth so little, that it had been more than once under deliberation, whether, after the example of the Dutch, they should not leave it again to its old negro inhabitants; which sooner or later in all likelihood would have been its fate, if, in 1735, the famous M. de la Bourdonnais had not been sent thither with the title of *governor-general of the French islands*.

He found this isle in the worst state possible, thinly inhabited by a set of lazy people, who equally hated industry and peace, and who were continually flattering this man to his face, and belying him wherever and as far as they durst. He gave himself no trouble about this, having once found the means to make himself obeyed; he saw the vast importance of the island; he conceived that it might be settled to great advantage; and, without so much as expecting the thanks of those for whom he laboured, he began to execute this great design. His first step was to bring over black

Mauritius.

black boys from Madagascar, whom he carefully trained up in good principles, and in continual exercise; by which he rendered them so good soldiers, that he very quickly obliged the Marones, or wild negroes, either to submit or to quit the island: he taught the planters to cultivate their lands to advantage; he, by an aqueduct, brought fresh water to the sea side; and whereas they had not so much as a boat at his coming thither, he made a very fine dock, where he not only built sloops and large vessels, but even a ship of the burden of 500 tons. However incredible it may seem, yet it is certainly fact, that in the space of five years he converted this country into a paradise, that had been a mere wilderness for 5000; and this in spite of the inhabitants, and of the company, who being originally prejudiced by them, behaved ill to him at his return. He soon made the cardinal de Fleury, however, sensible of the true state of things; and compelled the company to acknowledge, though they did not reward, his services. He afterwards returned into the Indies, and perfected the work he had begun, and to him it is owing that the isle of France was rendered one of the finest and most important spots upon the globe. Here no coffee is raised; but by the indefatigable industry of M. de Bourdonnais, sugar, indigo, pepper, and cotton (which are not at Bourbon), came to be cultivated with success. Since the departure of that most excellent governor, the plantations have been neglected, and are fallen off; but if a proper spirit of activity was raised among the inhabitants, they might soon be made to resume their flourishing appearance. Mines of iron have been discovered in the mountains near the great plain, in the north-east part of the island; and these mountains affording in great abundance the necessary fuel, forges have been erected: but the iron produced is of a very inferior quality, it being brittle, and only fit for making cannon-balls and bomb-shells. Black cattle, sheep, and goats, are preserved with difficulty; the first generally die before they have been a year in the island, and this occasions frequent importations of them from Madagascar and other parts. Common domestic poultry breed in great plenty; and, with fish and turtle, furnish a great part of the food of the European inhabitants.

The approach to the island is extremely dangerous, it being surrounded with ledges of rocks, and many of them covered by the sea. The shore abounds with coral and shells. This island is said to contain 60 rivers: some are considerable streams, and most of them have their sources from lakes, of which there are several in the middle part of the island. The rivers afford plenty of various kinds of fish, particularly eels. These are of an enormous size, some having been found that were six feet long, and six inches in circumference, and so extremely voracious, that it is dangerous to bathe in those parts of the river where they lie, as they will seize a man without fear, and have strength sufficient to keep him under water till he is drowned. Here is a great variety of birds, and bats as large as a young kitten: the inhabitants esteem them a delicate morsel. The air is both hot and moist, but not unwholesome. The place abounds with insects, which are very troublesome; but there are no serpents. It has been discovered, that off Port Louis the south-east wind generally blows with least strength about sunrise; and it also happens, on four or five days, at intervals, in the course of a month, that early in the morning the wind ceases in the northern part of the island for an hour or two, when a breeze rises, although but faintly, from the north-west; during which, a ship stationed at the entrance of the channel to avail herself of this breeze, may enter the harbour and attack the forts.

Mauritius ‖ Maxentius.

This island, during the period of the French revolution, did not entirely escape from the storm which then agitated the parent country. In the year 1799, a conspiracy was formed, and broke out, for the purpose of resisting the government which had been established under the authority of the republic. It was, however, soon suppressed by the activity of the municipality and governor-general, supported by the majority of the inhabitants, and order and tranquillity were again restored.

The population of this island in 1799 amounted to 65,000, viz. 55,000 slaves, and 10,000 whites and mulattoes. The following is a state of the produce of this island in 1800: viz. coffee, 6000 bales, of 100lbs. French; indigo, 300,000lbs. from 2s. to 8s. per lb.; cotton, 2000 bales, of 250 lbs.; raw sugar, 20,000,000 lbs.; cloves, 20,000 lbs. The island of Mauritius, as well as the other French islands in the Indian ocean, were taken by the British in 1811.

MAURUA, one of the Society islands in the South sea. It is a small island, entirely surrounded with a ridge of rocks, and without any harbour for shipping. It is inhabited; and its productions are the same with those of the neighbouring islands. A high round hill rises in the middle of it, which may be seen at the distance of 10 or 12 leagues. W. Long. 152. 32. S. Lat. 16. 25.

MAUSOLEUM, a magnificent tomb or sepulchral monument. The word is derived from Mausolus king of Caria, to whom Artemisia his widow erected a most stately monument, esteemed one of the wonders of the world, and called it, from his own name, *Mausoleum*.

St MAWES, a town of Cornwall, in England, seated on the east side of Falmouth haven, in W. Long. 4. 56. N. Lat. 50. 6. Though but a hamlet of the parish of St Just, two miles off, without a minister, or either church, chapel, or meeting-house, it has sent members to parliament ever since 1562, who are returned by its mayor or portreve. It consists but of one street, under a hill, and fronting the sea, and its inhabitants subsist purely by fishing. K. Henry VIII. built a castle here, opposite to Pendennis, for the better security of Falmouth haven. It has a governor, a deputy, and two gunners, with a platform of guns. Here is a fair the Friday after St Luke's day.

MAXENTIUS, Marcus Aurelius Valerius, a son of the emperor Maximianus Hercules, was, by the voluntary abdication of Dioclesian, and of his father, raised to the empire A. D. 306. He afterwards incited his father to reassume his imperial authority; and in a perfidious manner destroyed Severus, who had delivered himself into his hands, and relied upon his honour for the safety of his life. His victories and successes were impeded by Galerius Maximianus, who opposed him with a powerful force. The defeat and

and voluntary death of Galerius soon restored peace to Italy; and Maxentius passed into Africa, where he rendered himself odious by his cruelty and oppression. He soon after returned to Rome, and was informed that Constantine was come to dethrone him. He gave his adversary battle near Rome, and, after he had lost the victory, he fled back to the city. The bridge over which he crossed the Tiber was in a decayed situation, and he fell into the river, and was drowned, A. D. 312. The cowardice and luxuries of Maxentius were as conspicuous as his cruelties. He oppressed his subjects with heavy taxes, to gratify the cravings of his pleasures, or the avarice of his favourites. He was debauched in his manners, and neither virtue nor innocence were safe whenever he was inclined to voluptuous pursuits. His body was deformed and unwieldy. To visit a pleasure ground, or to exercise himself under a marble portico, or walk on a shady terrace, was to him a Herculean labour, which required the greatest exertions of strength and resolution.

MAXILLA, the JAW. See ANATOMY, N° 20—26.

MAXIM, an established proposition or principle; in which sense it denotes much the same with axiom.

MAXIMILIAN I. emperor of Germany, signalized himself against the French while he was king of the Romans, and after he was emperor entered into the army of Henry VIII. of England as a volunteer against that nation: he was a protector of learned men, and abolished an iniquitous tribunal, styled *Judicium occultum Westphaliæ;* he composed some poems, and the memoirs of his own life. He died in 1519, aged 60.

MAXIMUM, in *Mathematics*, denotes the greatest quantity attainable in any given case.

If a quantity conceived to be generated by motion increases or decreases till it arrives at a certain magnitude or position, and then, on the contrary, grows greater or lesser, and it be required to determine the said magnitude or position, the question is called a *problem de maximis et minimis.*

MAXIMUS, a celebrated Cynic philosopher, and magician, of Ephesus. He instructed the emperor Julian in magic; and, according to the opinion of some historians, it was in the conversation and company of Maximus that the apostasy of Julian originated. The emperor not only visited the philosopher, but he even submitted his writings to his inspection and censure. Maximus refused to live in the court of Julian; and the emperor, not dissatisfied with the refusal, appointed him high pontiff in the province of Lydia, an office which he discharged with the greatest moderation and justice. When Julian went into the east, the philosopher promised him success, and even said that his conquests would be more numerous and extensive than those of the son of Philip. He persuaded his imperial pupil, that, according to the doctrine of metempsychosis, his body was animated by the soul which once animated the hero whose greatness and victories he was going to eclipse. After the death of Julian, Maximus was almost sacrificed to the fury of the soldiers; but the interposition of his friends saved his life, and he retired to Constantinople. He was soon after accused of magical practices, before the emperor Valens, and beheaded at Ephesus, A. D. 366. He wrote some philosophical and rhetorical treatises, some of which were dedicated to Julian. They are all now lost.

MAXIMUS of Tyre, a Platonic philosopher, went to Rome in 146, and acquired such reputation there, that the emperor Marcus Aurelius became his scholar, and gave him frequent proofs of his esteem. This philosopher is thought to have lived till the reign of the emperor Commodus. There are still extant 41 of his dissertations; a good edition of which was printed by Daniel Heinsius, in 1624, in Greek and Latin, with notes.

MAXIMUS MARIUS. See *MARIUS.*

MAY, the fifth month in the year, reckoning from our first, or January; and the third, counting the year to begin with March, as the Romans anciently did. It was called Maius by Romulus, in respect to the senators and nobles of his city, who were named *majores;* as the following month was called *Junius*, in honour of the youth of Rome, *in honorem juniorum*, who served him in the war; though some will have it to have been thus called from *Maia*, the mother of Mercury, to whom they offered sacrifice on the first day of it; and Papius derives it from *Madius, eo quod tunc terra madeat.* In this month the sun enters Gemini, and the plants of the earth in general begin to flower.—The month of May has ever been esteemed favourable to love; and yet the ancients, as well as many of the moderns, look on it as an unhappy month for marriage. The original reason may perhaps be referred to the feast of the Lemures, which was held in it. Ovid alludes to this in the fifth of his Fasti, when he says,

Nec viduæ tædis eadem, nec virginis apta
Tempora; quæ nupsit, non diuturna fuit;
Hac quoque de causa, si te proverbia tangunt,
Mense malum Maio *nubere vulgus ait.*

MAY-dew. See DEW.

MAY-duke, a species of cherry. See PRUNUS, BOTANY *Index.*

MAY, *Isle of*, a small island at the mouth of the frith of Forth, in Scotland, about a mile and a half in circumference, and seven miles from the coast of Fife, almost opposite to the rock called the *Bass.* It formerly belonged to the priory of Pittenweem; and was dedicated to St Adrian, supposed to have been martyred in this place by the Danes; and hither, in times of Popish superstition, barren women used to come and worship at his shrine, in hopes of being cured of their sterility. Here is a tower and lighthouse built by Mr Cunningham of Barns, to whom King Charles I. granted the island in fee, with power to exact twopence per ton from every ship that passes, for the maintenance of a lighthouse. In the middle of it there is a fresh-water spring, and a small lake.—The soil produces pasturage for 100 sheep and 20 black cattle. On the west side the steep rocks render it inaccessible; but to the east there are four landing places and good riding. It was here that the French squadron, having the chevalier de St George on board, anchored in the year 1708, when the vigilance of Sir George Byng obliged him to relinquish his design, and bear away for Dunkirk. The shores all round

round the island abound with fish, and the cliffs with water fowl.

MAY, *Thomas*, an eminent English poet and historian in the 17th century, was born of an ancient but decayed family in Sussex, educated at Cambridge, and afterwards removed to London, where he contracted a friendship with several eminent persons, and particularly with Endymion Porter, Esq. one of the gentlemen of the bedchamber to King Charles I. While he resided at court, he wrote the five plays now extant under his name. In 1622, he published a translation of Virgil's Georgics, with annotations; and in 1635 a poem on King Edward III. and a translation of Lucan's Pharsalia; which poem he continued down to the death of Julius Cæsar, both in Latin and English verse. Upon the breaking out of the civil wars he adhered to the parliament; and in 1647, he published, "The history of the parliament of England, which began November the third, MDCXL. With a short and accessary view of some precedent years." In 1649, he published, *Historiæ Parliamenti Angliæ Breviarium*, in three parts; which he afterwards translated into English. He wrote the History of Henry II. in English verse. He died in 1642. He went well to rest over night, after a cheerful bottle as usual, and died in his sleep before morning: upon which his death was imputed to his tying his nightcap too close under his fat cheeks and chin, which caused his suffocation; but the facetious Andrew Marvel has written a poem of 100 lines, to make him a martyr of Bacchus, and die by the force of good wine. He was interred near Camden in Westminster Abbey; which caused Dr Fuller to say, that "if he were a biassed and partial writer, yet he lieth buried near a good and true historian indeed." Soon after the restoration, his body, with those of several others, was dug up, and buried in a pit in St Margaret's churchyard; and his monument, which was erected by the appointment of parliament, was taken down and thrown aside.

MAYER, Tobias, one of the greatest astronomers and mechanics the 18th century produced, was born at Maspach, in the duchy of Wirtemberg 1723. He taught himself mathematics, and at the age of fourteen designed machines and instruments with the greatest dexterity and justness. These pursuits did not hinder him from cultivating the belles lettres. He acquired the Latin tongue, and wrote it with elegance. In 1750, the university of Gottingen chose him for their mathematical professor; and every year of his short life was thenceforward marked with some considerable discoveries in geometry and astronomy. He published several works in this way, which are all reckoned excellent; and some are inserted in the second volume of the "Memoirs of the university of Gottingen." His labours seem to have exhausted him; for he died worn out in 1762.

MAYERNE, Sir Theodore de, baron of Aulbone, was the son of Lewis de Mayerne, the celebrated author of the General History of Spain, and of the *Monarchie aristo-democratique*, dedicated to the states-general. He was born in 1573, and had for his godfather Theodore Beza. He studied physic at Montpelier, and was made physician in ordinary to Henry IV. who promised to do great things for him, provided he would change his religion. James I. of England invited him over, and made him first physician to himself and his queen, in which office he served the whole royal family to the time of his death in 1655. His works were printed at London in 1700, and make a large folio, divided into two books; the first containing his *Consilia, Epistolæ, et Observationes*; the second his *Pharmacopœia variæque medicamentorum formulæ*.

MAYHEM. See Maim.

MAYNE, Jasper, an eminent English poet and divine in the 17th century, who was bred at Oxford, and entered into holy orders. While his majesty resided at Oxford, he was one of the divines appointed to preach before him. He published in 1647 a piece entitled ΟΧΛΟΜΑΧΙΑ, or *The people's war examined according to the principles of reason and scripture, by Jasper Mayne*. In 1648 he was deprived of his studentship at Christ church, and two livings he had; but was restored with the king, who made him his chaplain and archdeacon of Chichester; all which he held till he died. Dr Mayne was held in very high esteem both for his natural parts and his acquired accomplishments. He was an orthodox preacher, and a man of severe virtue and exemplary behaviour; yet of a ready and facetious wit, and a very singular turn of humour. From some stories that are related of him, he seems to have borne some degree of resemblance in his manner to the celebrated Dr Swift; but if he did not possess those very brilliant parts that distinguished the Dean, he probably was less subject to that capricious and those unaccountable whimsies which at times so greatly eclipsed the abilities of the latter. Yet there is one anecdote related of him, which, although it reflects no great honour on his memory, as it seems to carry some degree of cruelty with it, yet it is a strong mark of his resemblance to the Dean, and a proof that his propensity for drollery and joke did not quit him even in his latest moments. The story is this: The Doctor had an old servant, who had lived with him some years, to whom he had bequeathed an old trunk, in which he told him he would find *something that would make him drink after his death*. The servant, full of expectation that his master, under this familiar expression, had left him somewhat that would be a reward for the assiduity of his past services, as soon as decency would permit, flew to the trunk; when, behold, to his great disappointment, the boasted legacy proved to be a red herring. The doctor, however, bequeathed many legacies by will to pious uses; particularly 50 pounds towards the rebuilding of St Paul's cathedral, and 200 pounds to be distributed to the poor of the parishes of Cassington and Pyrton, near Wattington, of both which places he had been vicar. In his younger years he had an attachment to poetry; and wrote two plays, the latter of which may be seen in the tenth volume of Dodsley's Collection, viz. 1. Amorous war, a tragicomedy. 2. The city-match, a comedy. He published a poem upon the naval victory by the duke of York over the Dutch, printed in 1665. He also translated into English from the Greek, part of Lucian's Dialogues.

Maynooth || Mayo.

MAYNOOTH, or MANOOTH a poſt town in the county of Kildare, and province of Leinſter, in Ireland, near 12 miles from Dublin. Though not very large, it is regularly laid out, and conſiſts of good houſes. Here is a charter ſchool, which was opened 27th July 1759.

MAYNWARING, ARTHUR, an eminent political writer in the beginning of the 18th century, ſtaid ſeveral years at Oxford, and then went to Cheſhire, where he lived ſome time with his uncle Mr Francis Cholmondeley, a very honeſt gentleman, but extremely averſe to the government of King William III. to whom he refuſed the oaths. Here he proſecuted his ſtudies in polite literature with great vigour; and coming up to London, applied to the ſtudy of the law. He was hitherto very zealous in anti-revolutional principles, and wrote ſeveral pieces in favour of King James II.; but upon being introduced to the duke of Somerſet and the earls of Dorſet and Burlington, began to entertain very different notions in politics. His father left him an eſtate of near 800l. a-year, but ſo encumbered, that the intereſt money amounted to almoſt as much as the revenue. Upon the concluſion of the peace he went to Paris, where he became acquainted with Mr Boileau. After his return he was made one of the commiſſioners of the cuſtoms, in which poſt he diſtinguiſhed himſelf by his ſkill and induſtry. He was a member of the Kit-cat club, and was looked upon as one of the chief ſupports of it by his pleaſantry and wit. In the beginning of Queen Anne's reign, the lord treaſurer Godolphin engaged Mr Donne to quit the office of auditor of the impreſts, and made Maynwaring a preſent of a patent for that office worth about 2000l. a-year in a time of buſineſs. He had a conſiderable ſhare in the Medley, and was author of ſeveral other pieces. The Examiner, his antagoniſt in politics, allowed that he wrote with tolerable ſpirit, and in a maſterly ſtyle. Sir Richard Steele dedicated the firſt volume of the Tatler to him.

MAYO, one of the Cape de Verd iſlands, lying in the Atlantic ocean, near 300 miles from Cape Verd in Africa, about 17 miles in circumference. The ſoil in general is very barren, and water ſcarce; however, they have ſome corn, yams, potatoes, and plantains, with plenty of beeves, goats, and aſſes. What trees there are, grow on the ſides of the hills, and they have ſome figs and water melons. The ſea round about the iſland abounds with fiſh. The chief commodity is ſalt, with which many Engliſh ſhips are loaded in the ſummer time. The principal town is Pinoſa, inhabited by negroes, who ſpeak the Portugueſe language, and are ſtout, luſty, and fleſhy. They are not above 200 in number, and many of them go quite naked. W. Long. 23. 5. N. Lat. 15. 10.

MAYO, a county of Ireland, in the province of Connaught, having Sligo and the ſea on the north, Roſcommon on the ſouth, Leitrim and Roſcommon on the eaſt, and the Atlantic ocean on the weſt. It contains 724,640 Iriſh plantation acres, 68 pariſhes, and 140,000 inhabitants. It gives title of earl to the family of Bourke. This county takes its name from an ancient city, built in 664; the ruins of the cathedral, and ſome traces of the ſtone walls which encompaſſed the city, yet remain on the plains of Mayo. It was a univerſity, founded for the education of ſuch of the Saxon youths as were converted to the Chriſtian faith: it was ſituated a little to the ſouth of Lough Conn; and is to this day frequently called *Mayo of the Saxons*, being celebrated for giving education to Alfred the Great, king of England. As this town has gone to decay, Balinroke is reckoned the chief town. The county by the ſea is mountainous; but inland has good paſtures, lakes, and rivers. It is about 62 miles long, and 52 broad. Caſtlebar is the aſſizes town.—Mayo was formerly a biſhop's ſee, which is now united to TUAM.

Mayo, Mayor.

MAYOR, the chief magiſtrate of a city or town, choſen annually out of the aldermen. The word, anciently wrote *meyr*, comes from the Britiſh *miret*, i. e. *cuſtodire*, or from the old Engliſh *maier*, viz. *poteſtas*, and not from the Latin *major*. King Richard I. in 1189, changed the bailiff of London into a mayor, and from that example King John made the bailiff of King's Lynn a mayor anno 1204: Though the famous city of Norwich obtained not this title for its chief magiſtrates till the ſeventh year of King Henry V. anno 1419; ſince which there are few towns of note but have had a mayor appointed for government.

Mayors of corporations are juſtices of peace *pro tempore*, and they are mentioned in ſeveral ſtatutes; but no perſon ſhall bear any office of magiſtracy concerning the government of any town, corporation, &c. who hath not received the ſacrament according to the church of England within one year before his election, and who ſhall not take the oaths of ſupremacy, &c.

If any perſon intrudes into the office of mayor, a *quo warranto* lies againſt him, upon which he ſhall not only be ouſted, but fined. And no mayor, or perſon holding an annual office in a corporation for one year, is to be elected into the ſame office for the next; in this caſe, perſons obſtructing the choice of a ſucceſſor are ſubject to 100l. penalty. Where the mayor of a corporation is not choſen on the day appointed by charter, the next officer in place ſhall the day after hold a court and elect one; and if there be a default or omiſſion that way, the electors may be compelled to chooſe a mayor, by a writ of mandamus out of the king's bench. Mayors, or other magiſtrates of a corporation, who ſhall voluntarily abſent themſelves on the day of election, are liable to be impriſoned, and diſqualified from holding any office in the corporation.

MAYOR'S Courts. To the lord mayor and city of London belong ſeveral courts of judicature. The higheſt and moſt ancient is that called the *huſtings*, deſtined to ſecure the laws, rights, franchiſes, and cuſtoms of the city. The ſecond is a court of *requeſt*, or of *conſcience*; of which before. The third is the court of the lord mayor and aldermen, where alſo the ſheriffs ſit; to which may be added two courts of ſheriffs, and the court of the city orphans, whereof the lord mayor and aldermen have the cuſtody. Alſo the court of common council, which is a court or aſſembly, wherein are made all by-laws which bind the citizens of London. It conſiſts, like the parliament, of two houſes: an upper, conſiſting of the lord mayor and aldermen; and a lower, of a number of common council men, choſe by the ſeveral wards as repreſentatives

tatives of the body of the citizens. In the court of common council are made laws for the advancement of trade, and committees yearly appointed, &c. But acts made by them are to have the assent of the lord mayor and aldermen, by stat. 11 Geo. I. Also the chamberlain's court, where every thing relating to the rents and revenues of the city, as also the affairs of servants, &c. are transacted. Lastly, To the lord mayor belong the courts of coroner and of escheator; another court for the conservation of the river Thames; another of gaol-delivery, held usually eight times a year, at the Old Bailey, for the trial of criminals, whereof the lord mayor is himself the chief judge. There are other courts called *wardmotes* or meetings of the wards; and courts of halymote or assemblies of the several guilds and fraternities.

MAZA, among the Athenians, was a sort of cake made of flour boiled with water and oil, and set as the common fare, before such as were entertained at the public expence in the common hall or *Prytaneum*.

MAZAGAN, a strong place of Africa in the kingdom of Morocco, and on the frontiers of the province of Duguela. It was fortified by the Portuguese, and besieged by the king of Morocco with 200,000 men in 1562, but to no purpose. It is situated near the sea. W. Long. 8. 15. N. Lat 33. 12.

MAZARA. an ancient town of Sicily, and capital of a considerable valley of the same name, which is very fertile, and watered with several rivers. The town is a bishop's see, and has a good harbour; is seated on the sea coast, in E. Long. 12. 30. N. Lat. 37. 53.

MAZARINE, Julius, a famous cardinal and prime minister of France, was born at Piscina in the province of Abruzzo, in Naples, in 1602. After having finished his studies in Italy and Spain, he entered into the service of Cardinal Sachetts, and became well skilled in politics, and in the interests of the princes at war in Italy; by which means he was enabled to bring affairs to an accommodation, and the peace of Queiras was shortly concluded. Cardinal Richlieu being taken with his conduct, did from thenceforward highly esteem him; as did also Cardinal Antonio, and Louis XIII. who procured him a cardinal's hat in 1641. Richlieu made him one of the executors of his will; and during the minority of Louis XIV. he had the charge of affairs. At last he became the envy of the nobility, which occasioned a civil war; whereupon Mazarine was forced to retire, a price was set on his head, and his library sold. Notwithstanding, he afterwards returned to the court in more glory than ever; concluded a peace with Spain, and a marriage treaty betwixt the king and the infanta. This treaty of peace passes for the masterpiece of Cardinal de Mazarine's politics, and procured him the French king's most intimate confidence: but at last his continual application to business threw him into a disease, of which he died at Vinciennes in 1661.—Cardinal Mazarine was of a mild and affable temper. One of his greatest talents was his knowing mankind, and his being able to adapt himself, and to assume a character conformable to the circumstances of affairs. He possessed at one and the same time the bishopric of Metz, and the abbeys of St Arnauld, St Clement, and St Vincent, in the same city; that of St Dennis, Clugny, and Victor, of Marseilles; of St Michel at Soissons, and a great number of others. He founded Mazarine college at Paris; which is also called the *college of the four nations*. There has been published a collection of his letters, the most copious edition of which is that of 1745, in 2 vols. duodecimo.

MAZZUOLI. See Parmigiano.

MEAD, a wholesome, agreeable liquor, prepared with honey and water.

One of the best methods of preparing mead is as follows: Into twelve gallons of water put the whites of six eggs; mixing these well together, and to the mixture adding twenty pounds of honey. Let the liquor boil an hour, and when boiled, add cinnamon, ginger, cloves, mace, and rosemary. As soon as it is cold, put a spoonful of yest to it, and turn it up, keeping the vessel filled as it works; when it has done working, stop it up close; and, when fine, bottle it off for use.

Thorley says, that mead not inferior to the best of foreign wines may be made in the following manner: Put three pounds of the finest honey to one gallon of water, and two lemon peels to each gallon; boil it half an hour, well scummed; then put in, while boiling, lemon peel: work it with yest; then put it in your vessel with the peel, to stand five or six months, and bottle it off for use. If it is to be kept for several years, put four pounds to a gallon of water.

The author of the Dictionary of Chemistry directs to choose the whitest, purest, and best tasted honey, and to put it into a kettle with more than its weight of water: a part of this liquor must be evaporated by boiling, and the liquor scummed, till its consistence is such, that a fresh egg shall be supported on its surface without sinking more than half its thickness into the liquor; then the liquor is to be strained, and poured through a funnel into a barrel; this barrel, which ought to be nearly full, must be exposed to a heat as equable as possible, from 20 to 27 or 28 degrees of Mr Reaumur's thermometer, taking care that the bung-hole be slightly covered, but not closed. The phenomena of the spirituous fermentation will appear in this liquor, and will subsist during two or three months, according to the degree of heat; after which they will diminish and cease. During this fermentation, the barrel must be filled up occasionally with more of the same kind of liquor of honey, some of which ought to be kept apart, on purpose to replace the liquor which flows out of the barrel in froth. When the fermentation ceases, and the liquor has become very vinous, the barrel is then to be put into a cellar, and well closed; a year afterwards the mead will be fit to be put into bottles.

Mead is a liquor of very ancient use in Britain. See Feast.

Mead, *Dr Richard*, a celebrated English physician, was born at Stepney near London, where his father, the Reverend Mr Matthew Mead, had been one of the two ministers of that parish; but in 1662 was ejected for nonconformity, but continued to preach at Stepney till his death. As Mr Mead had a handsome fortune, he bestowed a liberal education upon 13 children, of whom Richard was the eleventh; and for that purpose kept a private tutor in his house, who

Mead.

who taught him the Latin tongue. At 16 years of age Richard was ſent to Utrecht, where he ſtudied three years under the famous Grævius; and then chooſing the profeſſion of phyſic, he went to Leyden, where he attended the lectures of the famous Pitcairn on the theory and practice of medicine, and Herman's botanical courſes. Having alſo ſpent three years in theſe ſtudies, he went with his brother and two other gentlemen to viſit Italy, and at Padua took his degree of doctor of philoſophy and phyſic in 1695. Afterwards he ſpent ſome time at Naples and at Rome; and returning home the next year, ſettled at Stepney, where he married, and practiſed phyſic, with a ſucceſs that laid the foundation of his future greatneſs.

In 1703, Dr Mead having communicated to the Royal Society an analyſis of Dr Bonomo's diſcoveries relating to the cutaneous worms that generate the itch, which they inſerted in the Philoſophical Tranſactions; this, with his account of poiſons, procured him a place in the Royal Society, of which Sir Iſaac Newton was then preſident. The ſame year he was elected phyſician of St Thomas's hoſpital, and was alſo employed by the ſurgeons to read anatomical lectures in their hall, which obliged him to remove into the city. In 1707 his Paduan diploma for doctor of phyſic was confirmed by the univerſity of Oxford; and being patronized by Dr Radcliffe, on the death of that famous phyſician he ſucceeded him in his houſe at Bloomſbury-ſquare, and in the greateſt part of his buſineſs. In 1727 he was made phyſician to King George II. whom he had alſo ſerved in that capacity while he was prince of Wales; and he had afterwards the pleaſure of ſeeing his two ſons-in-law, Dr Nichols and Dr Wilmot, his coadjutors in that eminent ſtation.

Dr Mead was not more to be admired for the qualities of the head than he was to be loved for thoſe of his heart. Though he was himſelf a hearty whig, yet, uninfluenced by party principles, he was a friend to all men of merit, by whatever denomination they might happen to be diſtinguiſhed. Thus he was intimate with Garth, with Arbuthnot, and with Freind; and long kept up a conſtant correſpondence with the great Boerhaave, who had been his fellow ſtudent at Leyden: they communicated to each other their obſervations and projects, and never loved each other the leſs for being of different ſentiments. In the mean time, intent as Dr Mead was on the duties of his profeſſion, he had a greatneſs of mind that extended itſelf to all kinds of literature, which he ſpared neither pains nor money to promote. He cauſed the beautiful and ſplendid edition of Thuanus's hiſtory to be publiſhed in 1713, in ſeven volumes folio: and by his interpoſition and aſſiduity, Mr Sutton's invention of drawing foul air from ſhips and other cloſe places was carried into execution, and all the ſhips in his majeſty's navy provided with this uſeful machine. Nothing pleaſed him more than to call hidden talents into light; to give encouragement to the greateſt projects, and to ſee them executed under his own eye. During almoſt half a century he was at the head of his buſineſs, which brought him one year above ſeven thouſand pounds, and for ſeveral years between five and ſix thouſand; yet clergymen, and in general all men of learning, were welcome to his advice. His library conſiſted of 10,000 volumes, of which his Latin, Greek, and oriental manuſcripts, made no inconſiderable part. He had a gallery for his pictures and antiquities, which coſt him great ſums. His reputation, not only as a phyſician, but as a ſcholar, was ſo univerſally eſtabliſhed, that he correſponded with all the principal literati in Europe: even the king of Naples ſent to deſire a complete collection of his works; and in return made him a preſent of the two firſt volumes of Signior Bajardi, which may be conſidered as an introduction to the collection of the antiquities of Herculaneum. At the ſame time that prince invited him to his palace, that he might have an opportunity of ſhowing him thoſe valuable monuments of antiquity; and nothing but his great age prevented his undertaking a journey ſo ſuited to his taſte. No foreigner of learning ever came to London without being introduced to Dr Mead; and on theſe occaſions his table was always open, and the magnificence of princes was united with the pleaſures of philoſophers. It was principally to him that the ſeveral counties of England and our colonies abroad applied for the choice of their phyſicians, and he was likewiſe conſulted by foreign phyſicians from Ruſſia, Pruſſia, Denmark, &c. He wrote, beſides the above works, 1. A Treatiſe on the Scurvy. 2. *De variolis et morbillis diſſertatio.* 3. *Medica ſacra: ſive de Morbis inſignioribus, qui in Bibliis memorantur, Commentarius.* 4. *Monita et Præcepta medica.* 5. A Diſcourſe concerning peſtilential contagion, and the methods to be uſed to prevent it. The works he wrote and publiſhed in Latin were tranſlated into Engliſh, under the Doctor's inſpection, by Thomas Stack, M. D. and F. R. S. This great phyſician, naturaliſt, and antiquarian, died on the 16th of February 1754.

Mead || Meal.

MEADOW, in its general ſignification, means paſture or graſs lands, annually mown for hay: but it is more particularly applied to lands that are ſo low as to be too moiſt for cattle to graze upon them in winter without ſpoiling the ſward. For the management and watering of meadows, ſee AGRICULTURE, p. 435.

MEAL, the flour of grain. The meal or flour of Britain is the fineſt and whiteſt in the world. The French is uſually browner, and the German browner than that. Our flour keeps well with us; but in carrying abroad it often contracts damp, and becomes bad. All flour is ſubject to breed worms; theſe are white in the white flour, and brown in that which is brown; they are therefore not always diſtinguiſhable to the eye: but when the flour feels damp, and ſmells rank and muſty, it may be conjectured that they are there in great abundance.

The colour and the weight are the two things which denote the value of meal or flour; the whiter and the heavier it is, other things being alike, the better it always is. Pliny mentions theſe two characters as the marks of good flour; and tells us, that Italy in his time produced the fineſt in the world. This country indeed was famous before his time for this produce; and the Greeks have celebrated it; and Sophocles in particular ſays, that no flour is ſo white or ſo good as that of Italy. The corn of this country has, however, loſt much of its reputation ſince that time;

time; and the reaſon of this ſeems to be, that the whole country being full of ſulphur, alum, vitriol, marcaſites, and bitumens, the air may have in time affected them ſo far as to make them diffuſe themſelves through the earth, and render it leſs fit for vegetation; and the taking fire of ſome of theſe inflammable minerals, as has ſometimes happened, is alone ſufficient to alter the nature of all the land about the places where they are.

The flour of Britain, though it pleaſes by its whiteneſs, yet wants ſome of the other qualities valuable in flour; the bread that is made of it is brittle and does not hold together, but after keeping a few days becomes hard and dry as if made of chalk, and is full of cracks in all parts; and this muſt be a great diſadvantage in it when intended for the ſervice of an army, or the like occaſions, where there is no baking every day, but the bread of one making muſt neceſſarily be kept a long time.

The flour of Picardy is very like that of Britain; and after it has been kept ſome time, is found improper for making into paſte or dough. The French are forced either to uſe it immediately on the grinding, or elſe to mix it with an equal quantity of the flour of Brittany, which is coarſer, but more unctuous and fatty; but neither of theſe kinds of flour keep well.

The flour of almoſt any country will do for the home conſumption of the place, as it may be always freſh ground; but the great care to be uſed in ſelecting it, is in order to the ſending it abroad, or furniſhing ſhips for their own uſe. The ſaline humidity of the ſea air ruſts metals, and fouls every thing on board, if great care be not taken in the preſerving them. This alſo makes the flour damp and mouldy, and is often the occaſion of its breeding inſects, and being wholly ſpoiled.

The flour of ſome places is conſtantly found to keep better at ſea than that of others; and when that is once found out, the whole caution needs only be to carry the flour of thoſe places. Thus the French find that the flour of Poitou, Normandy, and Guienne, all bear the ſea carriage extremely well; and they make a conſiderable advantage by carrying them to their American colonies.

The choice of flour for exportation being thus made, the next care is to preſerve it in the ſhips; the keeping it dry is the grand conſideration in regard to this; the barrels in which it is put up ought to be made of dry and well ſeaſoned oak, and not to be larger than to hold two hundred weight at the moſt. If the wood of the barrels have any ſap remaining in it, it will moiſten and ſpoil the flour; and no wood is ſo proper as oak for this purpoſe, or for making the bins and other veſſels for keeping flour in at home, ſince when once well dried and ſeaſoned it will not contract humidity afterwards. The beech wood, of which ſome make their bins for flour, is never thoroughly dry, but always retains ſome ſap. The fir will give the flour a taſte of turpentine; and the aſh is always ſubject to be eaten by worms. The oak is preferable, becauſe of its being free from theſe faults; and when the ſeveral kinds of wood have been examined in a proper manner, there may be others found as fit, or poſſibly more ſo, than this for the purpoſe. The great teſt is their having more or leſs ſap. See FLOUR and WOOD.

MEAN, in general, denotes the middle between two extremes: thus we ſay the mean diſtance, mean proportion, &c.

MEAN, Arithmetical, is half the ſum of the two extremes, as 4 is the arithmetical mean between 2 and 6; for $\frac{2+6}{2}=4$.

MEAN, Geometrical, is the ſquare root of the rectangle, or product of the two extremes: thus,

$$\sqrt{1\times 9}={}^{2}\sqrt{9}=3.$$

To find two mean proportionals between two extremes: multiply each extreme by the ſquare of the other, then extract the cube root out of each product, and the two roots will be the mean proportionals required.

Required two proportionals between 2 and 16,

$$\overline{2\times 2}\times 16=64, \text{ and } \sqrt[3]{64}=4. \text{ Again,}$$

$\sqrt[3]{2\times 16^2}=\sqrt[3]{512}=8$. 4 and 8 therefore are the two proportionals ſought.

MEARNSSHIRE, a county of Scotland. See KINCARDINESHIRE.

MEASLES, a cutaneous diſeaſe attended with a fever, in which there is an appearance of eruptions that do not tend to a ſuppuration. See MEDICINE *Index*.

MEASURE *of an angle*, is an arch deſcribed from the vertex in any place between its legs. Hence angles are diſtinguiſhed by the ratio of the arches, deſcribed from the vertex between the legs to the peripheries. Angles then are diſtinguiſhed by thoſe arches; and the arches are diſtinguiſhed by their ratio to the periphery. Thus an angle is ſaid to be ſo many degrees as there are in the ſaid arch.

MEASURE of a ſolid, is a cube whoſe ſide is an inch, a foot, or a yard, or any other determinate length. In geometry it is a cubic perch, divided into cubic feet, digits, &c.

MEASURE of velocity, in *Mechanics*, is the ſpace paſſed over by a moving body in a given time. To meaſure a velocity, therefore, the ſpace muſt be divided into as many equal parts as the time is conceived to be divided into; the quantity of ſpace anſwering to ſuch a part of time is the meaſure of the velocity.

MEASURE, in *Geometry*, denotes any quantity aſſumed as one, or unity, to which the ratio of the other homogeneous or ſimilar quantities is expreſſed.

MEASURE, in a legal and commercial ſenſe, denotes a certain quantity or proportion of any thing bought, ſold, valued, or the like.

It is neceſſary, for the convenience of commerce, that an uniformity ſhould be obſerved in weights and meaſures, and regulated by proper ſtandards. A foot-rule may be uſed as a ſtandard for meaſures of length, a buſhel for meaſures of capacity, and a pound for weights. There ſhould be only one authentic ſtandard of each kind, formed of the moſt durable materials, and kept with all poſſible care. A ſufficient number of copies, exactly correſponding to the principal ſtandard, may be diſtributed for adjuſting the weights and meaſures that are made for common uſe. There are ſeveral ſtandards of this kind both in England

Measure.

England and Scotland. See the article *WEIGHTS and Measures*.

If any one of the standards above mentioned be justly preserved, it will serve as a foundation for the others, by which they may be corrected if inaccurate, or restored if entirely lost. For instance, if we have a standard foot, we can easily obtain an inch, and can make a box which shall contain a cubical inch, and may serve as a standard for measures of capacity. If it be known that a pint contains 100 cubical inches, we may make a vessel five inches square, and four inches deep, which will contain a pint. If the standard be required in any other form, we may fill this vessel with water, and regulate another to contain an equal quantity. Standards for weights may be obtained from the same foundation; for if we know how many inches of water it takes to weigh a pound, we have only to measure that quantity, and the weight which balances it may be assumed as the standard of a pound.

Again, If the standard of a pound be given, the measure of an inch may be obtained from it; for we may weigh a cubical inch of water, and pour it into a regular vessel; and having noticed how far it is filled, we may make another vessel of like capacity in the form of a cube. The side of this vessel may be assumed as the standard for an inch; and standards for a foot, a pint, or a bushel, may be obtained from it. Water is the most proper substance for regulating standards; for all other bodies differ in weight from others of the same kind; whereas it is found by experience that spring and river water, rain, and melted snow, and all other kinds, have the same weight; and this uniformly holds in all countries when the water is pure, alike warm, and free from salt and minerals.

Thus, any one standard is sufficient for restoring all the rest. It may further be desired to hit on some expedient, if possible, for restoring the standards, in case that all of them should ever fall into disorder, or should be forgotten, through the length of time, and the vicissitudes of human affairs. This seems difficult, as no words can convey a precise idea of a foot-rule, or a pound weight. Measures, assumed from the dimensions of the human body, as a foot, a hand-breadth, or a pace, must nearly be the same in all ages, unless the size of the human race undergo some change; and therefore, if we know how many square feet a Roman acre contained, we may form some judgment of the nature of the law which restricted the property of a Roman citizen to seven acres; and this is sufficient to render history intelligible; but it is too inaccurate to regulate measures for commercial purposes. The same may be said of standards, deduced from the measure of a barley-corn, or the weight of a grain of wheat. If the distance of two mountains be accurately measured and recorded, the nature of the measure used will be preserved in a more permanent manner than by any standard; for if ever that measure fall into disuse, and another be substituted in its place, the distance may be measured again, and the proportion of the standards may be ascertained by comparing the new and ancient distances.

But the most accurate and unchangeable manner of establishing standards is, by comparing them with the length of pendulums. The longer a pendulum is, it vibrates the slower; and it must have one precise length in order to vibrate in a second. The slightest difference in length will occasion a difference in the time; which will become abundantly sensible after a number of vibrations, and will be easily observed if the pendulum be applied to regulate the motion of a clock. The length of a pendulum which vibrates seconds in London is about $39\frac{1}{5}$ inches, is constantly the same at the same place, but it varies a little with the latitude of the place, being shorter as the latitude is less. Therefore, though all standards of weights and measures were lost, the length of a second pendulum might be found by repeated trials: and if the pendulum be properly divided, the just measure of an inch will be obtained; and from this all other standards may be restored. See *Whitehurst on Invariable MEASURES*.

Measures are various, according to the various kinds and dimensions of the things measured.—Hence arise lineal or longitudinal measures, for lines or lengths; square measures, for areas or superfices; and solid or cubic measures, for bodies and their capacities; all which again are very different in different countries and in different ages, and even many of them for different commodities. Whence arise other divisions of ancient and modern measures, domestic and foreign ones, dry measures, liquid measures, &c.

I. *LONG Measures, or Measures of Application.*

1.] The *English* and *Scotch* Standards.

The English lineal standard is the yard, containing 3 English feet; equal to 3 Paris feet 1 inch and $\frac{3}{12}$ of an inch, or $\frac{7}{9}$ of a Paris ell. The use of this measure was established by Henry I. of England, and the standard taken from the length of his own arm. It is divided into 36 inches, and each inch is supposed equal to 3 barleycorns. When used for measuring cloth, it is divided into four quarters, and each quarter subdivided into 4 nails. The English ell is equal to a yard and a quarter, or 45 inches, and is used in measuring linens imported from Germany and the Low Countries.

The Scots *elwand* was established by King David I. and divided into 37 inches. The standard is kept in the council chamber of Edinburgh, and being compared with the English yard, is found to measure $37\frac{1}{5}$ inches; and therefore the Scots inch and foot are larger than the English, in the proportion of 180 to 185; but this difference being so inconsiderable, is seldom attended to in practice. The Scots ell, though forbidden by law, is still used for measuring some coarse commodities, and is the foundation of the land measure of Scotland.

Itinerary measure is the same both in England and Scotland. The length of the chain is four poles, or 22 yards; 80 chains make a mile. The old Scots computed miles were generally about a mile and a half each.

The reel for yarn is $2\frac{1}{2}$ yards, or 10 quarters, in circuit; 120 threads make a cut, 12 cuts make a hasp or hank, and 4 hanks make a spindle.

2.] The *French* standard was formerly the aune or ell, containing 3 Paris feet 7 inches 8 lines, or 1 yard $\frac{3}{4}$ English; the Paris foot royal exceeding the English by $\frac{68}{1000}$ parts, as in one of the following tables. This ell

Meafure. ell is divided two ways; viz. into halves, thirds, fixths, and twelfths; and into quarters, half-quarters, and fixteenths.

The French, however, have alfo formed an entirely new fyftem of weights and meafures, according to the following table. Meafure.

Proportions of the meafures of each fpecies to its principal meafure or unity.	Firft part of the name which indicates the proportion to the principal meafure or unity.	Length.	Capacity.	Weight.	Agrarian.	For firewood.
10,000 1,000 100 10 0 0.1 0.01 0.001	Myria Kilo Hecto Deca —— Deci Centi Milli	Metre.	Litre.	Gramme.	Are.	Stere.
Proportion of the principal meafures between themfelves and the length of the meridian.		10,000,000th part of the diftance from the pole to the equator.	A decimetre cube.	Weight of a centimetre cube of diftilled water.	100 fquare metres.	One cubic metre.
Value of the principal meafures in the ancient French meafures.		3 feet 11 lines and $\frac{1}{2}$ nearly.	1 pint and $\frac{1}{10}$ or 1 litron and $\frac{1}{4}$ nearly.	18 grains and 841,000 parts.	Two fquare perches des eaux et forêt.	1 demi-voie, or $\frac{1}{4}$ of a cord des eaux et forêt.
Value in Englifh meafures.		Inches 39.383.	61.083 inches, which is more than the wine, and lefs than the beer quart.	22,966 grains.	11.968 fquare yards.	

The Englifh avoirdupois pound weighs troy grains 7004; whence the avoirdupois ounce, whereof 16 make a pound, is found equal to 437.75 troy grains. —And it follows that the troy pound is to the avoirdupois pound as 88 to 107 nearly; for as 88 to 107, fo is 5760 to 7003.636: that the troy ounce is to the avoirdupois ounce, as 80 to 73 nearly; for as 80 to 73, fo is 480 to 438. And, laftly, That the avoirdupois pound and ounce is to the Paris two marc weight and ounce, as 63 to 68 nearly; for as 63 to 68, fo is 7004 to 7559.873. See WEIGHT. The Paris foot, expreffed in decimals, is equal to 1.0654 of the Englifh foot, or contains 12.785 Englifh inches. See FOOT.

3.] The ftandard in *Holland*, *Flanders*, *Sweden*, a good part of *Germany*, many of what were formerly called the *Hans-towns*, as *Dantzick* and *Hamburgh*, and at *Geneva*, *Franckfort*, &c. is likewife the ell: but the ell in all thefe places differs from the Paris ell. In Holland it contains one Paris foot eleven lines, or four-fevenths of the Paris ell. The Flanders ell contains two feet one inch five lines and half a line; or feven-twelfths of the Paris ell. The ell of Germany, Brabant, &c. is equal to that of Flanders.

4.] The *Italian* meafure is the branchio, brace, or fathom. This obtains in the ftates of Modena, Venice, Florence, Lucca, Milan, Mantua, Bologna, &c. but is of different lengths. At Venice, it contains one Paris foot eleven inches three lines, or eight-fifteenths of the Paris ell. At Bologna, Modena, and Mantua, the brace is the fame as at Venice. At Lucca it contains one Paris foot nine inches ten lines, or half a Paris ell. At Florence, it contains one foot nine inches four lines, or forty-nine hundredths of a Paris ell. At Milan, the brace for meafuring of filks is one Paris foot feven inches four lines, or four-ninths of a Paris ell: that for woollen cloths is the fame with the ell of Holland. Laftly, at Bergama, the brace is one foot feven inches fix lines, or five-ninths of a Paris ell. The ufual meafure at Naples, however, is the canna, containing fix feet ten inches and two lines, or one Paris ell and fifteen feventeenths.

5.] The *Spanifh* meafure is the vara or yard, in fome places called the bara; containing feventeen twenty-fourths of the Paris ell. But the meafure in Caftile and Valencia is the pan, fpan, or palm; which is ufed, together with the canna, at Genoa. In Arragon, the vara is equal to a Paris ell and a half, or five feet five inches fix lines.

6.] The *Portuguefe* meafure is the cavedos, containing two feet eleven lines, or four-fevenths of a Paris ell; and the vara, an hundred and fix whereof make an hundred Paris ells.

7.] The *Piedmontefe* meafure is the ras, containing one

Measure. one Paris foot nine inches ten lines, or half a Paris ell. In Sicily, their measure is the canna, the same with that of Naples.

8.] The *Muscovy* measures are the cubit, equal to one Paris foot four inches two lines; and the arcin, two whereof are equal to three cubits.

9.] The *Turkish* and *Levant* measures are the picq, containing two feet two inches and two lines, or three-fifths of the Paris ell. The Chinese measure, the cobre; ten whereof are equal to three Paris ells. In Persia, and some parts of the Indies, the gueze, whereof there are two kinds; the royal gueze, called also the *gueze monkelser*, containing two Paris feet ten inches eleven lines, or four-fifths of the Paris ell; and the shorter gueze, called simply *gueze*, only two-thirds of the former. At Goa and Ormuz, the measure is the vara, the same with that of the Portuguese, having been introduced by them. In Pegu, and some other parts of the Indies, the cando or candi, equal to the ell of Venice. At Goa, and other parts, they use a larger cando, equal to seventeen Dutch ells; exceeding that of Babel and Balsora by $\frac{7}{8}$ per cent. and the vara by $6\frac{1}{2}$. In Siam, they use the ken, short of three Paris feet by one inch. The ken contains two soks, the sok two keubs, the keub twelve nious or inches, the niou to be equal to eight grains of rice, i. e. to about nine lines. At Camboia, they use the hafter; in Japan, the tatam; and the span on some of the coasts of Guinea.

TABLES of Long Measure.

1. English.

Barley-corn											
3	Inch										
9	3	Palm									
27	9	3	Span								
36	12	4	$1\frac{1}{3}$	Foot							
54	18	6	2	$1\frac{1}{2}$	Cubit						
108	36	12	4	3	2	Yard					
180	60	20	$6\frac{2}{3}$	5	$3\frac{1}{3}$	$1\frac{2}{3}$	Pace				
216	72	24	8	6	4	2	$1\frac{1}{5}$	Fathom			
594	198	66	22	$16\frac{1}{2}$	11	$5\frac{1}{2}$	$3\frac{3}{10}$	$2\frac{3}{4}$	Pole		
23760	7920	2640	880	660	440	220	132	110	40	Furlong	
190080	63360	21120	7040	5280	3520	1760	1056	880	320	8	Mile.

2. Scripture *Measures reduced into English.*

								Eng. feet.	Inch Dec.
Digit								0	0.912
4	Palm							0	3.648
12	3	Span						0	10.944
24	6	2	Cubit					1	9.888
96	24	8	4	Fathom				7	3.552
144	36	12	6	$1\frac{1}{2}$	Ezekiel's reed			10	11.328
192	48	16	8	2	$1\frac{1}{3}$	Arabian pole		14	7.104
1920	480	160	80	20	$13\frac{1}{3}$	10	Schœnus, or measuring line	145	11.04

3. The

3. *The* SCRIPTURE *Itinerary Meaſures.*

						Eng. Miles.	Paces.	Feet.
					Cubit	0	0	1.824
400					Stadium	0	145	4.6
2000	5				Sabbath day's journey	0	729	3.000
4000	10	2			Eaſtern mile	1	403	1.000
12000	30	6	3		Paraſan	4	153	3.000
96000	240	48	24	8	A day's journey	33	172	4.000

4. GRECIAN

												Paces.	Feet.	Dec.
											Dactylus, digit	0	0	0.7554 $\frac{11}{16}$
4											Doron, dochme	0	0	3.0218 $\frac{3}{4}$
10	$2\frac{1}{2}$										Lichas	0	0	7.5546 $\frac{7}{8}$
11	$2\frac{3}{4}$	$1\frac{1}{10}$									Orthodoron	0	0	8.3101 $\frac{9}{16}$
12	3	$1\frac{1}{5}$	$1\frac{1}{11}$								Spithame	0	0	9.0656 $\frac{1}{4}$
16	4	$1\frac{6}{10}$	$1\frac{5}{11}$	$1\frac{1}{3}$							Foot	0	1	0.0875
18	$4\frac{1}{2}$	$1\frac{4}{5}$	$1\frac{7}{11}$	$1\frac{1}{2}$	$1\frac{1}{8}$						Cubit	0	1	1.5984 $\frac{3}{8}$
20	5	2	$1\frac{9}{11}$	$1\frac{2}{3}$	$1\frac{1}{4}$	$1\frac{1}{9}$					Pygon	0	1	3.109 $\frac{3}{8}$
24	6	$2\frac{2}{5}$	$2\frac{2}{11}$	2	$1\frac{1}{2}$	$1\frac{1}{3}$	$1\frac{1}{5}$				Cubic larger	0	1	6.13125
96	24	$9\frac{3}{5}$	$8\frac{8}{11}$	8	6	$5\frac{1}{3}$	$4\frac{4}{5}$	4			Pace	0	6	0525
9600	2400	960	$872\frac{8}{11}$	800	600	$533\frac{1}{3}$	480	400	100		Furlong	100	4	4.5
76800	19200	7680	$6981\frac{9}{11}$	6400	6800	$4266\frac{2}{3}$	3840	3200	800	8	Mile	805	5	0

5. ROMAN.

									Paces.	Feet.	Dec.
								Digitus tranſverſus	0	0	0.725 $\frac{1}{4}$
$1\frac{1}{3}$								Uncia	0	0	0.967
4	3							Palmus minor	0	0	2.901
16	12	4						Pes	0	0	11.604
20	15	5	$1\frac{1}{4}$					Palmipes	0	1	2.505
24	18	6	$1\frac{1}{2}$	$1\frac{1}{5}$				Cubitus	0	1	5.406
40	40	10	$2\frac{1}{2}$	2	$1\frac{2}{3}$			Gradus	0	2	5.01
80	60	20	5	4	$3\frac{1}{3}$	2		Paſſus	0	4	10.02
10000	7500	2500	625	500	$416\frac{2}{3}$	250	125	Stadium	120	4	4.5
80000	60000	20000	5000	4000	$3333\frac{1}{3}$	2000	1000	8 Milliare	967	0	0.

6. *Proportion of several Long Measures to each other, by M. Picard.*

The Rhinland or Leyden foot (12 whereof make the Rhinland perch) supposed	696
The English foot - -	$675\frac{1}{2}$
The Paris foot - -	720
The Amsterdam foot, from that of Leyden, by Snellius - -	629
The Danish foot (two whereof make the Danish ell) - - -	$701\frac{8}{10}$
The Swedish foot - -	$658\frac{1}{4}$
The Brussels foot - -	$609\frac{3}{5}$
The Dantzick foot, from Hevelius's Selenographia - - -	636
The Lyons foot, by M. Auzout -	$757\frac{2}{5}$
The Bologna foot, by the same -	843
The braccio of Florence, by the same, and Father Marsenne - -	1290
The palm of the architects at Rome, according to the observations of Messrs Picard and Auzout - - -	$494\frac{1}{4}$
The Roman foot in the Capitol, examined by Messrs Picard and Auzout - 653 or	$653\frac{1}{2}$
The same from the Greek foot -	652
From the vineyard Mattei -	$657\frac{1}{2}$
From the palm - - -	$658\frac{1}{4}$
From the pavement of the Pantheon, supposed to contain 10 Roman feet - -	653
From a slip of marble in the same pavement, supposed to contain three Roman feet	650
From the pyramid of Cestius, supposed to contain 95 Roman feet - -	$653\frac{1}{2}$
From the diameters of the columns in the arch of Septimius Severus - -	$653\frac{1}{3}$
From a slip of porphyry in the pavement of the Pantheon - - -	$653\frac{1}{3}$

See on this subject Phil. Trans. vol. iv. art. 69. p. 774.

7. *Proportions of the Long Measures of several nations to the English foot, taken from Messrs Greaves, Auzout, Picard, and Eisenchmid.* See FOOT.

The English standard foot being divided into 1000 equal parts, the other measures will have the proportions to it, which follow.

	Feet.	Inches.
English foot - -	1000	12
Paris foot - -	1068	12.816
Venetian foot - -	1161	13.944
Rhinland foot - -	1033	12.396
Strasburgh foot -	952	14.424
Norimberg foot - -	1000	12
Dantzick foot - -	944	11.328
Danish foot - -	1042	12.504
Swedish foot - -	$977\frac{1}{4}$	11.733
Derahor cubit of Cairo -	1824	12.888
Persian arish - -	3197	38.364
Greater Turkish pike -	2200	26.4
Lesser Turkish pike -	2131	25.572
Braccio at Florence -	1913	22.956
Braccio for woollen at Sienna -	1242	14.904
Braccio for linen at Sienna -	1974	23.688
Canna at Naples - -	6880	82.56
Vera at Almaria and Gibraltar -	2760	33.12
Palmo di Archtetti at Rome -	732	87.84
Canna di Archtetti - -	7320	87.84
Palmo di braccio di mercantia -	$695\frac{1}{2}$	83.46
Genoa palm - -	815	9.78
Bolognian foot - -	1250	15
Antwerp ell - -	2283	27.396
Amsterdam ell - -	2268	27.216
Leyden ell - -	2260	27.12
Paris draper's ell - -	3929	47.148
Paris mercer's ell - -	3939	47.244

8. *Different Itinerary Measures.*

A French league is about	$2\frac{3}{4}$	English miles
A German mile	4	ditto
A Dutch mile	$3\frac{1}{4}$	ditto
An Italian mile	$\frac{11}{12}$	ditto
A Spanish league	$3\frac{2}{3}$	ditto
A Russian verst	$\frac{3}{4}$	ditto

II. *SQUARE, SUPERFICIAL, or LAND Measure.*

1. *English* square measures are raised from the yard of 36 inches multiplied into itself, and thus producing 1296 square inches in the square yard; the divisions of this are square feet and inches; and the multiples, poles, roods, and acres. Because the length of a pole is $5\frac{1}{2}$ yards, the square of the same contains $30\frac{1}{4}$ square yards. A square mile contains 640 square acres. In measuring fens and woodlands, 18 feet are generally allowed to the pole, and 21 feet in forest lands.

A hide of land, frequently mentioned in the earlier part of the English history, contained about 100 arable acres; and 5 hides were esteemed a knight's fee. At the time of the Norman conquest, there were 243,600 hides in England.

2. *Scotch* square or land measure is regulated by the Scotch ell: 36 square ells = 1 fall, 40 falls = 1 rood, 4 roods = 1 acre.—The proportion between the Scotch and English acre, supposing the feet in both measures alike, is as 1369 to 1089, or nearly as 5 to 4. If the difference of the feet be regarded, the proportion is as 10,000 to 7869. The length of the chain for measuring land in Scotland is 24 ells, or 74 feet.—A husband-land contains 6 acres of sock and scythe land, that is, of land that may be tilled with a plough or mown with a scythe; 13 acres of arable land make one ox-gang, and four ox-gangs make a pound-land of old extent.

3. *French* square measures are regulated by 12 square lines in the inch square; 12 inches in the foot, 22 feet in the perch, and 100 perches in the arpent or acre.

TABLES

TABLES of SQUARE Measure.

1. ENGLISH.

Inches						
144	Feet					
1296	9	Yards				
3600	25	$2\frac{7}{9}$	Paces			
39204	$272\frac{1}{4}$	$30\frac{1}{4}$	10.89	Poles		
1568160	10890	1210	435.6	40	Rood	
6272640	43560	4840	1743.6	160	4	Acre

2. *Grecian* ſquare meaſures were the plethron or acre, by ſome ſaid to contain 1444, by others 10,000 ſquare feet; and aroura, the half of the plethron. The aroura of the Egyptians was the ſquare 100 cubits.

3. *Roman* ſquare meaſure reduced to Engliſh. The integer was the jugerum or acre, which the Romans divided like the libra or as: thus the jugerum contained

	Square feet.	Scruples.	Engliſh roots.	Sq. poles.	Square feet.
As	28800	288	2	18	250.05
Deunx	26400	264	2	10	183.85
Dextans	24000	240	2	2	117.64
Dodrans	21600	216	1	34	51.42
Bes	19200	192	1	25	257.46
Septunx	16800	168	1	17	191.25
Semis	14400	144	1	9	125.03
Quincunx	12000	120	1	1	58.82
Triens	9600	96	0	32	264.85
Quadrans	7200	72	0	24	198.64
Sextans	4800	48	0	16	132.43
Uncia	2400	24	0	8	66.21

Note, Actus major was 14,400 ſquare feet, equal to a ſemis; clima, 3600 ſquare feet, equal to ſeſcuncia; and actus minimus equal to a ſextans.

III. *CUBICAL Meaſures*, or Meaſures of Capacity, for LIQUIDS.

1. The *Engliſh* meaſures were originally raiſed from troy weight: it being enacted by ſeveral ſtatutes, that eight pounds troy of wheat, gathered from the middle of the ear, and well dried, ſhould weigh a gallon of wine meaſure, the diviſions and multiples whereof were to form the other meaſures; at the ſame time it was alſo ordered, that there ſhould be but one liquid meaſure in the kingdom: yet cuſtom has prevailed; and there having been introduced a new weight, viz. the avoirdupois, we have now a ſecond ſtandard gallon adjuſted thereto, and therefore exceeding the former in the proportion of the avoirdupois weight to troy weight. From this latter ſtandard are raiſed two ſeveral meaſures, the one for ale, the other for beer. The ſealed gallon at Guildhall, which is the ſtandard for wines, ſpirits, oils, &c. is ſuppoſed to contain 231 cubic inches; and on this ſuppoſition the other meaſures raiſed therefrom will contain as in the table underneath: yet, by actual experiment, made in 1688, before the lord mayor and the commiſſioners of exciſe, this gallon was found to contain only 224 cubic inches: it was, however, agreed to continue the common ſuppoſed contents of 231 cubic inches: ſo that all computations ſtand on their old footing. Hence, as 12 is to 231, ſo is $14\frac{1}{2}\frac{2}{0}$ to $281\frac{1}{2}$ the cubic inches in the ale gallon: but in effect the ale quart contains $70\frac{1}{2}$ cubic inches, on which principle the ale and beer gallon will be 282 cubic inches. The ſeveral diviſions and multiples of theſe meaſures, and their proportions, are exhibited in the tables underneath.

The barrel for ale in London is 32 gallons, and the barrel for beer 36 gallons. In all other places of England, the barrel, both for ale and beer, is 34 gallons.

2. *Scotch* liquid meaſure is founded on the pint. The Scotch pint was formerly regulated by a ſtandard jug of caſt metal, the cuſtody of which was committed to the borough of Stirling. This jug was ſuppoſed to contain 105 cubic inches; and though, after ſeveral careful trials, it has been found to contain only about $103\frac{1}{2}$ inches; yet, in compliance with eſtabliſhed cuſtom, founded on that opinion, the pint *ſtoups* are ſtill regulated to contain 105 inches, and the cuſtomary ale meaſures are about $\frac{1}{18}$ above that ſtandard. It was enacted by James I. of Scotland, that the pint ſhould contain 41 ounces trone weight of the clear water of Tay, and by James VI. that it ſhould contain 55 Scots troy ounces of the clear water of Leith. This affords another method of regulating the pint, and alſo aſcertains the ancient ſtandard of the trone weight. As the water of Tay and Leith are alike, the trone weight muſt have been to the Scots troy weight as 55 to 41; and therefore the pound trone muſt have contained about $21\frac{1}{2}$ ounces Scots troy.

4 gills	=	1 mutchkin.
2 mutchkins	=	1 chopin.
2 chopins	=	1 pint.
2 pints	=	1 quart.
4 quarts	=	1 gallon.

The Scotch quart contains 210 inches; and is, therefore, about $\frac{1}{10}$ leſs than the Engliſh wine gallon, and about $\frac{1}{4}$ leſs than the ale gallon.

3. As to the liquid meaſures of foreign nations, it is to be obſerved, that their ſeveral veſſels for wine, vinegar, &c. have alſo various denominations according to their different ſizes and the places wherein they are uſed. The woeders of Germany, for holding Rheniſh and Moſelle wines, are different in their gauges; ſome containing 14 aumes of Amſterdam meaſure, and others more or leſs. The aume is reckoned at Amſterdam for 8 ſteckans, or 20 verges, or for $\frac{1}{6}$ of a tun of 2 pipes, or 4 barrels, of French or Bourdeaux, which $\frac{1}{6}$ at this latter place is called *tierçon*; becauſe

Meafure.

becaufe 3 of them make a pipe or 2 barrels, and 6 the faid tun. The fteckan is 16 mingles, or 32 pints; and the verge is, in refpect of the faid Rhenifh and Mofelle, and fome other forts of wine, 6 mingles; but, in meafuring brandy it confifts of $6\frac{1}{8}$ mingles. The aume is divided into 4 anckers, and the ancker into 2 fteckans, or 32 mingles. The ancker is taken fometimes for $\frac{1}{24}$ of a tun, or 4 barrels; on which footing the Bourdeaux barrel ought to contain at Amfterdam (when the cafk is made according to the juft gauge) $12\frac{1}{2}$ fteckans, or 200 mingles, wine and lees; or 12 fteckans, or 192 mingles, racked wine; fo that the Bourdeaux tun of wine contains 50 fteckans, or 800 mingles, wine and lees; and 48 fteckans, or 768 mingles, of pure wine. The barrels or poinçons of Nantes and other places on the river Loire, contain only 12 fteckans, Amfterdam meafure. The wine tun of Rochelle, Cognіac, Charente, and the ifle of Rhé, differs very little from the tun of Bourdeaux, and confequently from the barrels and pipes. A tun of wine of Chaloffe, Bayonne, and the neighbouring places, is reckoned 60 fteckans, and the barrel 15, Amfterdam meafure.

The muid of Paris contains 150 quarts or 300 pints, wine and lees; or 280 pints clear wine; of which muids 3 make a tun, and the fractions are,

The muid	containing	36 fetiers
The fetier		4 quarts
The quart		2 pints
The pint		2 chopins
The chopin		2 demi-fetiers
The demi-fetier		2 poiffons

The muid is alfo compofed of pipes or poinçons, quarteaux, queves, and demiqueves; thofe poinçons of Paris and Orleans contain about 15 fteckans Amfterdam meafure, and ought to weigh with the cafk 666lb. a little more or lefs. In Provence they reckon by milleroles, and the millerole of Toulon contains 66 Paris pints, or 100 pints of Amfterdam, nearly, and the Paris pint is nearly equal to the Englifh wine quart (A).

The butts or pipes from Cadiz, Malaga, Alicant, Benecarlo, Saloe, and Mataro, and from the Canaries, from Lifbon, Oporto, and Fayal, are very different in their gauges, though in affreightments they are all reckoned two to the tun.

Vinegar is meafured in the fame manner as wine; but the meafures for brandies are different: thefe fpirits from France, Spain, Portugal, &c. are generally fhipped in large cafks called *pipes*, *butts*, and *pieces*, according to the places from whence they are imported, &c. In France, brandy is fhipped in cafks called *pieces* at Bourdeaux, and *pipes* at Rochelle, Cognіac, the ifle of Rhé, and other neighbouring places, which contain fome more and fome lefs, even from 60 to 90 Amfterdam verges or veertels, according to the capacity of the veffels, and the places they come from, which, being reduced into barrels, will ftand as follows, viz.

At Rochelle, Cognіac, the ifle of Rhé, and the country of Aunis, -	27 Veertels	per barrel.
At Nantes, and feveral places of Bretagne and Anjou - -	29 Veertels	
At Bourdeaux, and different parts of Guienne - -	32 Verges	
At Amfterdam, and other cities of Holland - -	30 Veertels	
At Hamburgh and Lubeck -	30 Verges	
At Embden - - -	27 Verges	

In Provence and Languedoc, brandy is fold by the quintal, the cafks included; and at Bruges in Flanders, the verges are called *fefters* of 16 ftops each, and the fpirits is fold at fo much per ftop.

Olive oil is alfo fhipped in cafks of various fizes, according to the cuftom of the places where it is embarked, and the convenieney of ftowage. In England it is fold by the tun of 236 gallons; and at Amfterdam by the tun of 717 mingles, or 1434 pints. In Provence it is fold by milleroles of 66 Paris pints; from Spain and Portugal it is brought in pipes or butts, of different gauges; at the firft place it is fold by roves, where 40 go to the butt; and at the latter place by almoudas, whereof 26 make a pipe. Train oil is fold in England by the tun, at Amfterdam by the barrel.

TABLES of LIQUID Meafure.

1. ENGLISH.

[*Wine.*]

Solid inches									
$28\frac{7}{8}$	Pint								
231	8	Gallon							
4158	144	18	Rundlet						
$7276\frac{1}{2}$	252	$31\frac{1}{2}$	$1\frac{3}{4}$	Barrel					
9702	336	42	$2\frac{1}{3}$	$1\frac{1}{3}$	Tierce				
14553	504	63	$3\frac{1}{2}$	2	$1\frac{1}{2}$	Hogfhead			
19279	672	84	$4\frac{2}{3}$	$2\frac{2}{3}$	2	$1\frac{1}{3}$	Puncheon		
29106	1008	126	7	4	3	2	$1\frac{1}{2}$	Butt or pipe	
58212	2016	252	14	8	6	4	3	2	Tun.

[*Ale*]

Pints					
8	Gallon				
64	8	Firkin			
128	16	2	Kilderkin		
256	32	4	2	Barrel	
512	64	8	4	2	Hogfh.

[*Beer.*]

Pints					
8	Gallon				
72	9	Firkin			
144	18	2	Kilderkin		
288	36	4	2	Barrel	
576	72	8	4	2	Hogfh.

2. JEWISH

(A) Thefe are the old meafures of France, the account of which, for the fake of comparifon, is here retained.

Measure. Measure.

2. JEWISH reduced to English Wine Measure.

							Gall.	Pints	Solid inches.
Caph							0	0 5/8	0.177
1 1/3	Log						0	0 5/8	0.211
5 1/3	4	Cab					0	3 1/3	0.844
16	12	3	Hin				1	2	2.533
32	24	6	2	Seah			2	4	5.067
96	72	18	6	3	Bath, or Epha		7	4	15.2
960	720	180	60	30	10	Coron, or Chomer	75	5	7.625

3. ATTIC reduced to English Wine Measure.

										Gal.	Pints.	Sol. inch. .Dec.
Cochliarion										0	1/120	0.0356 5/12
2	Cheme									0	1/60	0.0712 5/6
2 1/2	1 1/4	Mystrone								0	1/48	0.089 11/48
5	2 1/2	2	Conche							0	1/24	0.178 11/24
10	5	4	2	Cyathos						0	1/12	0.356 11/12
15	7 1/2	6	3	1 1/2	Oxybaphon					0	1/8	0.535 3/8
60	30	24	12	6	4	Cotyle				0	1/2	2.141 1/2
120	60	48	24	12	8	2	Xestes			0	1	4.283
720	360	288	144	72	48	12	6	Chous		0	6	25.698
8640	4320	3456	1728	864	576	144	72	12	Metretes	10	2	19.629

4. ROMAN reduced to English Wine Measure.

										Gal.	Pints.	Sol. inch. .Dec.
Ligula										0	0 1/48	0.117 5/12
4	Cyathus									0	0 1/12	0.469 2/3
6	1 1/2	Acetabulum								0	0 1/8	0.704 1/2
12	3	2	Quartarius							0	0 1/4	1.40
24	6	4	2	Hemina						0	0 1/2	2.818
48	12	8	4	2	Sextarius					0	1	5.636
288	72	48	24	12	6	Congius				0	7	4.942
1152	288	192	96	48	24	4	Urna			3	4 1/2	5.33
2304	576	384	192	96	48	8	2	Amphora		7	1	10.66
46080	11520	7680	3840	1920	960	160	40	20	Culeus	143	3	11.095

IV. *Measures*

Measure.

IV. *Measures of Capacity for things* DRY.

1.] *English* dry or corn measure. The standard for measuring corn, salt, coals, and other dry goods, in England, is the Winchester gallon, which contains $272\frac{1}{4}$ cubic inches. The bushel contains 8 gallons, or 2178 inches. A cylindrical vessel, $18\frac{1}{2}$ inches diameter, and 8 inches deep, is appointed to be used as a bushel in levying the malt tax. A vessel of these dimensions is rather less than the Winchester bushel of 8 gallons, for it contains only 2150 inches; though probably there was no difference intended. The denominations of dry measure commonly used, are given in the first of the subjoined tables. Four quarters corn make a chaldron, 5 quarters make a wey or load, and 10 quarters make a ton. In measuring sea coal, 5 pecks make a bushel, 9 bushels make a quarter or vatt, 4 quarters make a chaldron, and 21 chaldrons make a score.

40 feet hewn timber make a load.
50 feet unhewn timber make a load.
32 gallons make a herring barrel.
42 gallons make a salmon barrel.
1 cwt. gunpowder makes a barrel.
256 lbs. soap make a barrel.
10 dozen candles make a barrel.
12 barrels make a last.

2.] *Scotch* dry measure. There was formerly only one measure of capacity in Scotland; and some commodities were heaped, others *straiked*, or measured exactly to the capacity of the standard. The method of heaping was afterwards forbidden as unequal, and a larger measure appointed for such commodities as that custom had been extended to.

The wheat firlot, used also for rye, pease, beans, salt, and grass seeds, contains 21 pints 1 mutchkin, measured by the Stirling jug. The barley firlot, used also for oats, fruit, and potatoes, contains 31 pints. A different method of regulating the firlot was appointed from the dimensions of a cylindrical vessel. The diameter for both measures was fixed at $19\frac{1}{8}$ inches, the depth $7\frac{1}{4}$ inches for the wheat firlot, and $10\frac{1}{2}$ for the barley firlot. A standard constructed by these measures is rather less than when regulated by the pint; and as it is difficult to make vessels exactly cylindrical, the regulation by the pint has prevailed, and the other method gone into disuse.

If the Stirling jug contains $103\frac{1}{2}$ inches, the wheat firlot will contain 2199 inches; which is more than 2 per cent. larger than the legal malt bushel of England, and about 1 per cent. larger than the Winchester bushel: and the barley firlot will contain 3208 inches. The barley boll is nearly equal to six legal malt bushels.

In Stirlingshire, 17 pecks are reckoned to the boll: in Invernesshire, 18 pecks: in Ayrshire the boll is the same as the English quarter. And the firlots, in many places, are larger than the Linlithgow standard.

3.] *French dry*, are, the litron, bushel, minot, mine, septier, muid, and tun. The litron is divided into two demilitrons, and four quarter litrons, and contains 36 cubic inches of Paris. By ordonnance, the litron is to be three inches and a half high, and three inches 10 lines broad. The litron for salt is larger, and is divided into two halves, four quarters, eight demi-quarters, and 16 mesurettes. The French bushel is different in different jurisdictions. At Paris it is divided into demibushels; each demibushel into two quarts; the quart into two half quarts; and the half quart into two litrons: so that the bushel contains 16 litrons. By ordonnance the Paris bushel is to be eight inches two lines and a half high, and ten inches broad, or in diameter within-side. The minot consists of three bushels, the mine of two minots or six bushels, the septier of two mines or 12 bushels, and the muid of 12 septiers or 144 bushels. The bushel of oats is estimated double that of any other grain; so that there go 24 bushels to make the septier, and 288 to make the muid. It is divided into four picotins, the picotin containing two quarts, or four litrons. The bushel for salt is divided into two half bushels, four quarters, eight half quarters, and 16 litrons; four bushels make a minot, 16 a septier, and 192 a muid. The bushel for wood is divided into halves, quarters, and half quarters. Eight bushels make the minot, 16 a mine; 20 mines or 320 bushels, the muid. For plaster, 12 bushels make a sack, and 36 sacks a muid. For lime, three bushels make a minot, and 48 minots a muid. The minot is by ordonnance to be 11 inches 9 lines high, and 14 inches 8 lines in diameter. The minot is composed of three bushels, or 16 litrons; four minots make a septier, and 48 a muid. The French mine is no real vessel, but an estimation of several others. At Paris the mine contains six bushels, and 24 make the muid; at Rouen the mine is four bushels; and at Dieppe 18 mines make a Paris muid. The septier differs in different places: at Paris it contains two mines, or eight bushels, and 12 septiers the muid. At Rouen the septier contains two mines or 12 bushels. Twelve septiers make a muid at Rouen as well as at Paris; but 12 of the latter are equal to 14 of the former. At Toulon the septier contains a mine and a half; three of which mines make the septier of Paris. The muid or muy of Paris consists of 12 septiers; and is divided into mines, minots, bushels, &c. That for oats is double that for other grain, i. e. contains twice the number of bushels. At Orleans the muid is divided into mines, but those mines only contain two Paris septiers and a half. In some places they use the tun in lieu of the muid; particularly at Nantes, where it contains 10 septiers of 16 bushels each, and weighs between 2200 and 2250 pounds. Three of these tuns make 28 Paris septiers. At Rochelle, &c. the tun contains 42 bushels, and weighs two per cent. less than that of Nantes. At Brest it contains 20 bushels, is equal to 10 Paris septiers, and weighs about 2240 pounds. See TUN.

4.] *Dutch*, *Swedish*, *Polish*, *Prussian*, and *Muscovite*. In these places, they estimate their dry things on the foot of the *last*, *lest*, *leth*, or *lecht*; so called according to the various pronunciations of the people who use it. In Holland, the last is equal to 19 Paris septiers, or 38 Bourdeaux bushels, and weighs about 4560 pounds; the last they divide into 27 mudes, and the mude into four scheples. In Poland, the last is 40 Bourdeaux bushels, and weighs about 4800 Paris pounds. In Prussia, the last is 133 Paris septiers. In Sweden and Muscovy they measure by the great and little last; the first containing 12 barrels, and the second half as many. See LAST.

Last. In Muscovy, they likewise use the chefford, which is different in various places: that of Archangel is equal to three Rouen bushels.

5.] *Italian.* At Venice, Leghorn, and Lucca, they estimate their dry things on the foot of the staro or staio; the staro of Leghorn weighs 54 pounds: 112 staros and seven-eighths are equal to the Amsterdam last. At Lucca, 119 staros make the last of Amsterdam. The Venetian staro weighs 128 Paris pounds: the staro is divided into four quarters. Thirty-five staros and one-fifth, or 140 quarters and four-fifths, make the last of Amsterdam. At Naples and other parts, they use the tomolo or tomalo, equal to one-third of the Paris septier. Thirty-six tomoli and a half make the carro, and a carro and a half, or 54 tomoli, make the last of Amsterdam. At Palermo, 16 tomoli make the salma, and four mondili the tomolo. Ten salmas and three-sevenths, or 171 tomoli and three-sevenths, make the last of Amsterdam.

6.] *Flemish.* At Antwerp, &c. they measure by the viertel; 32 and one-half whereof make 19 Paris septiers. At Hamburgh, the schepel; 90 whereof make 19 Paris septiers.

7.] *Spanish* and *Portuguese.* At Cadiz, Bilboa, and St Sebastian, they use the fanega; 23 whereof make the Nantes or Rochelle tun, or nine Paris septiers and a half: though the Bilboa fanega is somewhat larger, insomuch that 21 fanegas make a Nantes tun. At Seville, &c. they use the anagoras, containing a little more than the Paris mine; 36 anagoras make 19 Paris septiers. At Bayonne, &c. the concha; 30 whereof are equal to nine Paris septiers and a half. At Lisbon, the alquiver, a very small measure, 240 whereof make 19 Paris septiers, 60 the Lisbon muid.

Tables of Dry Measure.

1. English.

Solid inches					
33.6	Pint				
268.8	8	Gallon			
537.6	16	2	Peck		
2150.4	64	8	4	Bushel	
17203.2	512	64	32	8	Quarter.

2. Scripture Dry, reduced to English.

							Peck.	Gall.	Pint.	Dec. Sol. inch.
Gachal							0	0	$0\frac{17}{120}$	0.031
20	Cab						0	0	$2\frac{5}{6}$	0.073
36	$1\frac{4}{5}$	Gomor					0	0	$5\frac{1}{10}$	1.211
120	6	$3\frac{1}{3}$	Seah				1	0	1	4.036
360	18	10	3	Epha			3	0	3	12.107
1800	90	50	15	5	Leteeh		16	0	0	26.500
3600	180	100	30	10	2	Chomer, or coron	32	0	1	18.969

3. Attic Meaſures of Capacity for Things dry, reduced to Engliſh Corn Meaſure.

							Peck.	Gal.	Pint.	Dec. Sol. inch
Cochliarion							0	0	0	0.276 $\frac{7}{20}$
10	Cyathos						0	0	0	2.763 $\frac{1}{2}$
15	$1\frac{1}{2}$	Oxybaphon					0	0	0	4.144 $\frac{3}{4}$
60	6	4	Cotyle				0	0	0	16.579
120	12	8	2	Xeſtes			0	0	0	33.158
180	18	12	3	$1\frac{1}{2}$	Choenix		0	0	1	15.705 $\frac{1}{4}$
8640	864	576	144	72	48	Medimnos	4	0	6	3.501

4. Roman Meaſures of Capacity for Things dry, reduced to Engliſh Corn Meaſure.

							Peck.	Gall.	Pint.	Dec. Sol. inch
Ligula							0	0	0 $\frac{1}{48}$	0.01
4	Cyathus						0	0	0 $\frac{1}{12}$	0.04
6	$1\frac{1}{2}$	Acetabulum					0	0	0 $\frac{1}{8}$	0.06
24	6	4	Hemina				0	0	8 $\frac{1}{2}$	0.24
48	12	8	2	Sextarius			0	0	1	0.48
384	96	64	16	8	Semimodius		0	1	0	3.84
768	192	128	32	16	2	Modius	1	0	0	7.68

Measure of Wood for Firing, is uſually the cord four feet high, and as many broad, and eight long; this is divided into two half cords, called *ways*, and by the French *membrures*, from the pieces ſtuck upright to bound them; or *voyes*, as being ſuppoſed half a waggon load.

Measure for Horſes, is the hand, which by ſtatute contains four inches.

Measure, among *Botaniſts*. In deſcribing the parts of plants, Tournefort introduced a geometrical ſcale, which many of his followers have retained. They meaſured every part of the plant; and the eſſence of the deſcription conſiſted in an accurate menſuration of the whole.

As the parts of plants, however, are liable to variation in no circumſtance ſo much as that of dimenſion, Linnæus very rarely admits any other menſuration than that ariſing from the reſpective length and breadth of the parts compared together. In caſes that require actual menſuration, the ſame author recommends, in lieu of Tournefort's artificial ſcale, the following natural ſcale of the human body, which he thinks is much more convenient, and equally accurate.

The ſcale in queſtion conſiſts of 11 degrees, which are as follow: 1. A hair'sbreadth, or the diameter of a hair, (*capillus*). 2. A line, (*linea*), the breadth of the creſcent or white appearance at the root of the finger (not thumb, meaſured from the ſkin towards the body of the nail; a line is equal to 12 hairbreadths, and is the 12th part of a Pariſian inch. 3. A nail (*unguis*), the length of a finger nail; equal to ſix lines, or half a Pariſian inch. 4. A thumb (*polex*), the length of the firſt or outermoſt joint of the thumb; equal to a Pariſian inch. 5. A palm (*palmus*), the breadth of the palm excluſive of the thumb; equal to three Pariſian inches. 6. A ſpan (*ſpithama*), the diſtance between the extremity of the thumb and that of the firſt finger when extended; equal to ſeven Pariſian inches. 7. A great ſpan (*dodrans*), the diſtance between the extremity of the thumb and that of the little finger, when extended; equal to nine inches. 8. A foot (*pes*), meaſuring from the elbow to the baſis of the thumb; equal to 12 Pariſian inches. 9. A cubit (*cubitus*), from the elbow to the extremity of the middle finger; equal to 17 inches. 10. An arm length (*brachium*), from the armpit to the extremity of the middle finger; equal to 24 Pariſian inches, or two feet. 11. A fathom (*orgya*), the meaſure of the human ſtature; the diſtance between the extremities of the two middle fingers, when the arms are extended; equal, where greateſt, to ſix feet.

Measure is alſo uſed to ſignify the cadence and time obſerved in poetry, dancing, and muſic, to render them regular and agreeable.

The different meaſures or metres in poetry, are the different

different manners of ordering and combining the quantities, or the long and ſhort ſyllables. Thus, hexameter, pentameter, iambic, ſapphic verſes, &c. conſiſt of different meaſures.

In Engliſh verſes, the meaſures are extremely various and arbitrary, every poet being at liberty to introduce any new form that he pleaſes. The moſt uſual are the heroic, generally conſiſting of five long and five ſhort ſyllables; and verſes of four feet; and of three feet and a cæſura, or ſingle ſyllable.

The ancients, by variouſly combining and tranſpoſing their quantities, made a vaſt variety of different meaſures. Of words, or rather feet of two ſyllables, they formed a ſpondee, conſiſting of two long ſyllables; a pyrrhic, of two ſhort ſyllables; a trochee, of a long and a ſhort ſyllable; and an iambic, of a ſhort and a long ſyllable.

Of their feet of three ſyllables they formed a moloſſus, conſiſting of three long ſyllables; a tribrach, of three ſhort ſyllables; a dactyl, of one long and two ſhort ſyllables; and an anepæſt, of two ſhort and one long ſyllable. The Greek poets contrived 124 different combinations or meaſures, under as many different names, from feet of two ſyllables to thoſe of ſix.

MEASURE, in *Muſic*, the interval or ſpace of time which the perſon who beats time takes between the riſing and falling of his hand or foot, in order to conduct the movement, ſometimes quicker, and ſometimes ſlower, according to the kind of muſic, or the ſubject that is ſung or played.

The meaſure is that which regulates the time we are to dwell on each note. See TIME.

The ordinary or common meaſure is one ſecond, or 60th part of a minute, which is nearly the ſpace between the beats of the pulſe or heart; the ſyſtole, or contraction of the heart, anſwering to the elevation of the hand; and its diaſtole, or dilatation, to the letting it fall. The meaſure uſually takes up the ſpace that a pendulum of two feet and a half long employs in making a ſwing or vibration. The meaſure is regulated according to the different quality or value of the notes in the piece; by which the time that each note is to take up is expreſſed. The ſemibreve, for inſtance, holds one riſe and one fall; and this is called the *meaſure* or *whole meaſure*, ſometimes the *meaſure note*, or *time note*; the minim, one riſe, or one fall; and the crotchet, half a riſe, or half a fall, there being four crotchets in a full meaſure.

MEASURE Binary, or *Double*, is that wherein the riſe and fall of the hand are equal.

MEASURE Ternary, or *Triple*, is that wherein the fall is double to the riſe; or where two minims are played during a fall, and but one in the riſe. To this purpoſe, the number 3 is placed at the beginning of the lines, when the meaſure is intended to be triple; and a C, when the meaſure is to be common or double. This riſing and falling of the hands was called by the Greeks *αρσις* and *θεσις*. St Auguſtine calls it *plauſus*, and the Spaniards *compas*. See ARSIS and THESIS.

Powder MEASURES in Artillery, are made of copper, and contain from an ounce to 12 pounds: theſe are very convenient in a ſiege, when guns or mortars are loaded with looſe powder, eſpecially in ricochet firing, &c.

MEASURING, or MENSURATION, is the uſing a certain known meaſure, and determining thereby the preciſe extent, quantity, or capacity of any thing.

MEASURING, in general, includes the practical part of geometry. From the various ſubjects on which it is employed, it acquires various names, and conſtitutes various arts. See GEOMETRY, LEVELLING, MENSURATION, TRIGONOMETRY, &c.

MEAT. See FOOD, DIET, DRINK, &c.

Amongſt the Jews, ſeveral kinds of animals were forbidden to be uſed as food. The fleſh with the blood, and the blood without the fleſh, were prohibited; the fat alſo of ſacrificed animals was not to be eaten. Roaſt meat, boiled meat, and ragouts, were in uſe among the Hebrews, but we meet with no kind of ſeaſoning except ſalt, bitter herbs, and honey.—They never mingled milk in any ragout or haſh, and never ate at the ſame meal both meat and milk, butter, or cheeſe. The daily proviſion for Solomon's table was 30 meaſures of fine wheat flour, 60 of common flour, 10 fat oxen, 20 paſture oxen, 100 ſheep, beſides veniſon and wildfowl. See LUXURY.

The principal and moſt neceſſary food among the ancient Greeks, was bread, which they called *αρτος* and produced in a wicker baſket called *κανεον*. Their loaves were ſometimes baked under the aſhes, and ſometimes in an oven. They alſo uſed a ſort of bread called *maza*. Barley meal was uſed amongſt the Greeks, which they called *αλφιτον*. They had a frequent diſh called *θριον*, which was a compoſition of rice, cheeſe, eggs, and honey, wrapped in fig-leaves. The *μυττωτον* was made of cheeſe, garlic, and eggs, beaten and mixed together. Their bread and other ſubſtitutes for bread, were baked in the form of hollow plates, into which they poured a ſauce. Garlic, onions, and figs, ſeem to have been a very common food amongſt the poorer Athenians. The Greeks, eſpecially in the heroical times, ate fleſh roaſted; boiled meat ſeldom was uſed. Fiſh ſeems not to have been uſed for food in the early ages of Greece. The young people only, amongſt the Lacedæmonians, ate animal food; the men and the old men were ſupported by a black ſoup called *μεγα ζυμος*, which to people of other nations was always a diſagreeable meſs. Graſshoppers and the extremities or tender ſhoots of trees were requently eaten by the poor among the Greeks. Eels dreſſed with beet root were eſteemed a delicate diſh, and they were fond of the jowl and belly of ſaltfiſh. Neither were they without their ſweet-meats; the deſſert conſiſted frequently of fruits, almonds, nuts, figs, peaches, &c. In every kind of food we find ſalt to have been uſed.

The diet of the firſt Romans conſiſted wholly of milk, herbs, and roots, which they cultivated and dreſſed with their own hands; they alſo had a kind of gruel, or coarſe groſs pap, compoſed of meal and boiling water; this ſerved for bread: And when they began to uſe bread, they had none for a great while but of unmixed rye. Barley-meal was eaten by them, which they called *polenta*. When they began to eat animal food, it was eſteemed a piece of luxury, and an indulgence not to be juſtified but by ſome particular occasion. After animal food had grown into common use, the meat which they most frequently produced upon their tables was pork.

Method of Preserving Flesh-MEAT without spices, and with very little salt. Jones, in his *Miscellanea Curiosa*, gives us the following description of the Moorish *Elcholle*, which is made of beef, mutton, or camel's flesh, but chiefly beef, which is cut in long slices, and laid for 24 hours in a pickle. They then remove it out of those jars or tubs into others with water; and when it has lain a night, they take it out, and put it on ropes in the sun and air to dry. When it is thoroughly dried and hard, they cut it into pieces of two or three inches long, and throw it into a pan or caldron, which is ready with boiling oil and suet sufficient to hold it, where it boils till it be very clear and red when cut. After this they take it out, and set it to drain; and when all is thus done it stands to cool, and jars are prepared to put it up in, pouring upon it the liquor in which it was fried; and as soon as it is thoroughly cold, they stop it up close. It will keep two years; will be hard, and the hardest they look upon to be the best done. This they dish up cold, sometimes fried with eggs and garlic, sometimes stewed, and lemon squeezed on it. It is very good any way, either hot or cold.

MEATH, commonly so called, or otherwise *East* Meath, to distinguish it from the county called *West* Meath: A county of Ireland, in the province of Leinster, bounded by the counties of Cavan and Louth on the north, the Irish channel on the east, Kildare and Dublin on the south, and West Meath and Longford on the west. It is a fine champaign country, abounding with corn, and well inhabited. It returns 14 members to parliament; and gives title of earl to the family of Brabazan. It contains 326,480 Irish plantation acres, 139 parishes, and 112,000 inhabitants. The chief town is Trim. This district being the most ancient settlement of the Belgians in Ireland, the inhabitants were esteemed the eldest and most honourable tribe: from which seniority their chieftains were elected monarchs of all the Belgæ; a dignity that was continued in the Hy-n-Faillian without intermission, until the arrival of the Caledonian colonies, under the name of Tuath de Danan, when Conor-Mor, chieftain of these people, obtained, or rather usurped, the monarchial throne, obliged Eochy Failloch, with several of his people, to cross the Shannon, and establish themselves in the present county of Roscommon, where Crothar founded the palace of Atha or Croghan, a circumstance which brought on a long and bloody war between the Belgian and Caledonian races, which was not finally terminated until the close of the 4th century, when the Belgian line was restored in the person of O'Nial the Great, and continued until Briam Boromh usurped the monarchial dignity, by deposing Malachy O'Malachlin, about the year 1001. Tuathal Tetcthomar, by a decree of the Tarah assembly, separated certain large tracts of land from each of the four provinces, where the borders joined together; whence, under the notion of adopting this spot for demesne lands to support the royal household, he formed the county or kingdom of Meath, which afterwards became the peculiar inheritance of the monarchs of Ireland. In each of the portions thus separated from the four provinces, Tuathal caused palaces to be erected, which might adorn them, and commemorate the name in which they had been added to the royal domain. In the tract taken out of Munster, he built the palace called Flachtaga, where the sacred fire, so called, was kindled, and where all the priests and druids annually met on the last day of October; on the evening of which day it was enacted, that no other fire should be used throughout the kingdom, in order that all the fires might be derived from this, which being lighted up as a fire of sacrifice, their superstition led them to believe would render all the rest propitious and holy; and for this privilege every family was to pay threepence, by way of acknowledgment to the king of Munster. The second royal palace was erected in the proportion taken out of Connaught, and was built for the assembly called the convocation of Visneach, at which all the inhabitants were summoned to appear on the 1st day of May, to offer sacrifice to *Beal*, or *Bel*, the god of fire, in whose honour two large fires being kindled, the natives used to drive their cattle between them, which was supposed to be a preservative for them against accidents and distempers, and this was called *Beal-Tinne*, or *Bel-Tine*, or the festival of the god of fire. The king of Connaught at this meeting claimed a horse and arms from every lord of a manor or chieftain, as an acknowledgement for the lands taken from that province, to add to the territory of Meath. The third was that which Tailtean erected in the part taken from Ulster, where the fair of that name was held, which was remarkable for this particular circumstance, that the inhabitants brought their children thither, males and females, and contracted them in marriage, where the parents having agreed upon articles, the young people were joined accordingly; every couple contracted at this meeting paid the king of Ulster an ounce of silver by way of acknowledgement. The royal mansion of Tarah, formerly destroyed by fire, being rebuilt by Tuathal, on the lands originally belonging to the king of Leinster, was reckoned as the fourth of these palaces; but as a fabric of that name had stood there before, we do not find that any acknowledgement was made for it to the king of Leinster.

Meath, with *Clonmacnois*, is a bishop's see, valued in the king's books at 373l. 7s. $0\frac{1}{2}$d. sterling, by an extent returned anno 28th Elizabeth; but, by a former extent taken anno 30th Henry VIII. the valuation amounts to 373l. 12s. which being the largest and most profitable for the king, is the measure of the first fruits at this day. This see is reputed to be worth annually 3400l. There were formerly many episcopal sees in Meath, as Clonard, Duleek, Kells, Trim, Ardbraccan, Donshaghlin, Slaine, and Foure, besides others of less note; all these, except Duleek and Kells, were consolidated, and their common see was fixed at Clonard, before the year 1152; at which time the divisions of the bishoprics in Ireland were made by John Paparo, cardinal priest, entitled Cardinal of St Lawrence in Damaso, then legate from Pope Eugene III. to the Irish. This division was made in a synod held on the 6th of March in the abbey of Mellifont, or, as some say, at Kells: and the two sees of Duleek and Kells afterwards submitted to the same fate. The constitution of this diocese is singular, having

ing no dean nor chapter, cathedral, or economy.—Under the bishop, the archdeacon is the head officer, to whom, and to the clergy in general, the *congé d'elire* issued while bishops were elective. The affairs of the diocese are transacted by a synod, in the nature of a chapter, who have a common seal, which is annually lodged in the hands of one of the body, by the appointment and vote of the majority. The diocese is divided into twelve rural deaneries.

Of CLONMACNOIS, now annexed to Meath: There is no valuation of this see in the king's books; but it is supposed to be included in the extent of the see of Meath, taken anno 30th Henry VIII. The chapter of this see consisted anciently of dean, chanter, chancellor, treasurer, archdeacon, and twelve prebendaries, but most of their possessions have fallen into lay hands. At present the deanery is the only part of the chapter which subsists, to which the prebend of Cloghran is annexed, and he hath a seal of office, which appears to have been the ancient episcopal seal of this see. This see was founded by St Kiaran, or Ciaran, the younger, in 548 or 549; and Dermod, the son of Ceronill, king of Ireland, granted the site on which the church was built.

West MEATH. See WESTMEITH.

MEATUS AUDITORIUS. See ANATOMY, N° 144.

MEAUX, an ancient town of France, in the department of the Seine and Marne, with a bishop's see, seated in a place abounding in corn and cattle, on the river Marne, which divides it into two parts; and its trade consists in corn, wool, and cheese. It sustained a siege of three months against the English in 1421. E. Long. 2. 58. N. Lat. 48. 58.

MECÆNAS, or MECOENAS, C. CILNIUS, a celebrated Roman knight, descended from the kings of Etruria. He has rendered himself immortal by his liberal patronage of learned men and of letters; and to his prudence and advice Augustus acknowledged himself indebted for the security he enjoyed. His fondness for pleasure removed him from the reach of ambition; and he preferred dying, as he was born, a Roman knight, to all the honours and dignities which either the friendship of Augustus or his own popularity could heap upon him. To the interference of Mecænas, Virgil owed the retribution of his lands; and Horace was proud to boast that his learned friend had obtained his forgiveness from the emperor, for joining the cause of Brutus at the battle of Philippi. Mecænas was himself fond of literature: and, according to the most received opinion, he wrote a history of animals, a journal of the life of Augustus, a treatise on the different natures and kinds of precious stones, besides the two tragedies of Octavia and Prometheus, and other things, all now lost. He died eight years before Christ; and on his deathbed he particularly recommended his poetical friend Horace to the care and confidence of Augustus. Seneca, who has liberally commended the genius and abilities of Mecænas, has not withheld his censure from his dissipation, indolence, and effeminate luxury. From the patronage and encouragement which the princes of heroic and lyric poetry among the Latins received from the favourite of Augustus, all patrons of literature have ever since been called *Mecænates*. Virgil dedicated to him his Georgics, and Horace his Odes.

MECCA, an ancient and very famous town of Asia, in Arabia Felix; seated on a barren spot, in a valley surrounded with little hills, about a day's journey from the Red sea. It is a place of no strength, having neither walls nor gates; and the buildings are very mean. That which supports it is the resort of a great many thousand pilgrims annually, for the shops are scarcely open all the year besides. The inhabitants are poor, very thin, lean, and swarthy. The hills about the town are very numerous; and consist of a blackish rock, some of them half a mile in circumference. On the top of one of them is a cave, where they pretend Mahomet usually retired to perform his devotions, and hither they affirm the greatest part of the Alcoran was brought him by the angel Gabriel. The town has plenty of water, and yet little garden-stuff; but there are several sorts of good fruits to be had, such as grapes, melons, water melons, and cucumbers. There are also plenty of sheep brought thither to be sold to the pilgrims. It stands in a very hot climate; and the inhabitants usually sleep on the tops of their houses for the sake of coolness. In order to protect themselves from the heat through the day, they carefully shut the windows, and water the streets to refresh the air. There have been instances of persons suffocated in the middle of the town by the burning wind called *Simoom*.

As a great number of the people of distinction in the province of Hedsjas stay in the city, it is better built than any other in Arabia. Amongst the beautiful edifices it contains, the most remarkable is the famous *Kaba* or *Caaba*, "The house of God," which was held in great veneration by the Arabs even before Mahomet's time.

No Christian dares go to Mecca; not that the approach to it is prohibited by any express law, or that the sensible part of the Mahometans have any thing to object to it; but on account of the prejudices of the people, who regarding this ground as sacred, think Christians unworthy of setting their foot on it; it would be profaned in the opinion of the superstitious, if it was trod upon by infidels. The people even believe, that Christians are prevented from approaching by some supernatural power; and they tell the story of an infidel, who having got so far as the hills that surround Mecca, all the dogs of the city came out, and fell upon him; and who, being struck with this miracle, and the august appearance of the Kaba, immediately became a mussulman. It is therefore to be presumed that all the Europeans who describe Mecca as eye-witnesses, have been renegadoes escaped from Turkey. A recent example confirms this supposition. On the promise of being allowed to preserve his religion, a French surgeon was prevailed on to accompany the Emir Hadsji to Mecca, in quality of physician; but at the very first station, he was forced to submit to circumcision, and then he was permitted to continue his journey.

Although the Mahometans do not allow Europeans to go to Mecca, they do not refuse to give them descriptions of the Kaba, and information with regard to that building; and there are persons who gain their bread by making designs and little pictures of the Kaba, and selling them to pilgrims. See CAABA.

The Mahometans have so high an opinion of the sanctity

Mecca.

sanctity of Mecca, that they extend it to the places in the neighbourhood. The territory of that city is held sacred to certain distances, which are indicated by particular marks. Every caravan finds in its road a similar mark, which gives notice to the pilgrims when they are to put on the modest garb in which they must appear in those sacred regions. Every mussulman is obliged to go once in his life at least to Mecca, to perform his devotions there. If that law was rigourously enforced, the concourse of pilgrims would be prodigious, and the city would never be able to contain the multitudes from all the countries where the Mahometan religion prevails. We must therefore, suppose, that devotees alone perform this duty, and that the others can easily dispense with it. Those whose circumstances do not permit a long absence, have the liberty of going to Mecca by a substitute.—A hired pilgrim, however, cannot go for more than one person at a time; and he must, to prevent frauds, bring an attestation in proper form, from an Imam of Mecca, that he has performed the requisite devotions on behalf of such a person, either alive or dead; for, after the decease of a person who has not obeyed the law during his life, he is still obliged to perform the journey by proxy.

The caravans, which are not numerous, when we consider the immense multitude of the faithful, are composed of many people who do not make the journey from purposes of devotion. These are merchants, who think they can transport their merchandises with more safety, and dispose of them more easily; and contractors of every kind, who furnish the pilgrims and the soldiers who escort the caravans, with necessaries. Thus it happens, that many people have gone often to Mecca, solely from views of interest. The most considerable of those caravans is that of Syria, commanded by the pacha of Damascus. It joins at some distance the second from Egypt, which is conducted by a bey, who takes the title of Emir Hadsji. One comes from Yemen, and another, less numerous, from the country of Lachsa. Some scattered pilgrims arrived by the Red sea from the Indies, and from the Arabian establishments on the coasts of Africa. The Persians come in that which departs from Bagdad; the place of conductor to this last is bestowed by the pacha, and is very lucrative, for he receives the ransoms of the heretical Persians.

It is of consequence to a pilgrim to arrive early at the holy places. Without having been present from the beginning at all the ceremonies, and without having performed every particular act of devotion, a man cannot acquire the title of Hadsji: this is an honour very much coveted by the Turks, for it confers real advantages, and makes those who attain it to be much respected. Its infrequency, however, in the Mahometan dominions, shows how much the observation of the law commanding pilgrimages is neglected. A similar custom prevails among the Oriental Christians, who are also exceedingly emulous of the title of Hadsji, or Mokdasi, which is given to pilgrims of their communion. In order to acquire this title, it is not sufficient that the person has made the journey to Jerusalem; he must also have kept the passover in that city, and have assisted at all the ceremonies of the holy weeks.

Mecca, Mechanical.

After all the essential ceremonies are over, the pilgrims next morning move to a place where they say Abraham went to offer up his son Isaac, which is about two or three miles from Mecca: here they pitch their tents, and then throw seven small stones against a little square stone building. This, as they affirm, is performed in defiance of the devil. Every one then purchases a sheep, which is brought for that purpose, eating some of it themselves, and giving the rest to the poor people who attend upon that occasion. Indeed these are miserable objects, and such starved creatures, that they seem ready to devour each other. After all, one would imagine that this was a very sanctified place; and yet a renegado who went in pilgrimage thither, affirms there is as much debauchery practised here as in any part of the Turkish dominions. It is 25 miles from Jodda, the sea port town of Mecca, and 220 south-east of Medina. E. Long. 40. 55. N. Lat. 21. 45.

MECHANICAL, an epithet applied to whatever relates to mechanics: Thus we say, mechanical powers, causes, &c. See the articles POWER, CAUSE, &c.

The mechanical philosophy is the same with what is otherwise called *corpuscular philosophy*, which explains the phenomena of nature, and the operations of corporeal things, on the principles of mechanics; viz. the motion, gravity, arrangement, disposition, greatness or smallness, of the parts which compose natural bodies. See CORPUSCULAR.

This manner of reasoning is much used in medicine; and, according to Dr Quincy, is the result of a thorough acquaintance with the structure of animal bodies: for considering an animal body as a composition out of the same matter from which all other bodies are formed, and to have all those properties which concern a physician's regard, only by virtue of its peculiar construction; it naturally leads a person to consider the several parts, according to their figures, contexture, and use, either as wheels, pulleys, wedges, levers, screws, cords, canals, strainers, &c. For which purpose, continues he, it is frequently found helpful to design in diagrams, whatsoever of that kind is under consideration, as is customary in geometrical demonstrations.

For the application of this doctrine to the human body, see the article MEDICINE.

MECHANICAL, in mathematics, denotes a construction of some problem, by the assistance of instruments, as the duplicature of the cube and quadrature of the circle, in contradistinction to that which is done in an accurate and geometrical manner.

Mechanical Curve, is a curve, according to Descartes, which cannot be defined by any algebraic equation; and so stands contradistinguished from algebraic or geometrical curves.

Leibnitz and others call these mechanical curves *transcendental*, and diffent from Descartes, in excluding them out of geometry. Leibnitz found a new kind of transcendental equations, whereby these curves are defined: but they do not continue constantly the same in all points of the curve, as algebraic ones do. See the article TRANSCENDENTAL.

Mechanical Solution of a problem is either when the thing is done by repeated trials, or when lines used in

Mechanical

in the solution are not truly geometrical, or by organical construction.

Mechanical Powers, are certain simple machines, which are used for raising greater weights, or overcoming greater resistances, than could be effected by the natural strength without them. See MECHANICS.

MECHANICS.

Definition. 1. MECHANICS is the science which enquires into the laws of the equilibrium and motion of solid bodies; into the forces by which bodies, whether animate or inanimate, may be made to act upon one another; and into the means by which these may be increased so as to overcome such as are more powerful.—The term *mechanics* was originally applied to the doctrine of equilibrium. It has by some late writers been extended to the motion and equilibrium of all bodies, whether solid, fluid, or aeriform; and has been employed to comprehend the sciences of hydrodynamics and pneumatics.

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Progress of practical mechanics among the ancients.

2. As the science of mechanics is intimately connected with the arts of life, and particularly with those which exist even in the rudest ages of society, the construction of machines must have arrived at considerable perfection before the theory of equilibrium, or the simplest properties of the mechanical powers, had engaged the attention of philosophers. We accordingly find that the lever, the pulley, the crane, the capstan, and other simple machines, were employed by the ancient architects in elevating the materials of their buildings, long before the dawn of mechanical science; and the military engines of the Greeks and Romans, such as the catapultæ and balistæ, exhibit an extensive acquaintance with the construction of compound machinery. In the splendid remains of Egyptian architecture, which in every age have excited the admiration of the world, we perceive the most surprising marks of mechanical genius. The elevation of immense masses of stone to the tops of their stupendous fabrics, must have required an accumulation of mechanical power which is not in the possession of modern architects.

Aristotle the first who attended to the theory of mechanics. B. C. 320.

3. The earliest traces of any thing like the theory of mechanics are to be found in the writings of Aristotle. In some of his works we discover a few erroneous and obscure opinions, respecting the doctrine of motion, and the nature of equilibrium; and in his 28th mechanical question he has given some vague observations on the force of impulse, tending to point out the difference between impulse and pressure. He maintained that there cannot be two circular motions opposite to one another; that heavy bodies descended to the centre of the universe, and that the velocities of their descent were proportional to their weights.

Archimedes lays the foundation of theoretical mechanics. B. C. 250.

4. The notions of Aristotle, however, were so confused and erroneous, that the honour of laying the foundation of theoretical mechanics is exclusively due to the celebrated Archimedes, who, in addition to his inventions in geometry, discovered the general principles of hydrostatics. In his two books, *De Equiponderantibus*, he has demonstrated that when a balance with unequal arms, is in equilibrio, by means of two weights in its opposite scales, these weights must be reciprocally proportional to the arms of the balance. From this general principle, all the other properties of the lever, and of machines referable to the lever, might have been deduced as corollaries; but Archimedes did not follow the discovery through all its consequences. In demonstrating the leading property of the lever, he lays it down as an axiom, that if the two arms of the balance are equal, the two weights must also be equal when an equilibrium takes place; and then shows that if one of the arms be increased, and the equilibrium still continue, the weight appended to that arm must be proportionally diminished. This important discovery conducted the Syracusan philosopher to another equally useful in mechanics. Reflecting on the construction of his balance, which moved upon a fulcrum, he perceived that the two weights exerted the same pressure on the fulcrum as if they had both rested upon it. He then considered the sum of these two weights as combined with a third, and the sum of these three as combined with a fourth; and saw that in every such combination the fulcrum must support their united weight, and therefore that there is in every combination of bodies, and in every single body which may be conceived as made up of a number of lesser bodies, *a centre of pressure or gravity*. This discovery Archimedes applied to particular cases, and pointed out the method of finding the centre of gravity of plane surfaces, whether bounded by a parallelogram, a triangle, a trapezium, or a parabola. The theory of the inclined plane, the pulley, the axis in peritrochio, the screw, and the wedge, which was first published in the eighth book of Pappus's mathematical collections, is generally attributed to Archimedes. It appears also from Plutarch and other ancient authors, that a greater number of machines which have not reached our times was invented by this philosopher. The military engines which he employed in the siege of Syracuse against those of the Roman engineer Appius, are said to have displayed the greatest mechanical genius, and to have retarded the capture of his native city.

Invention of water-mills and wind-mills.

5. Among the various inventions which we have received from antiquity, that of water mills is entitled to the highest place, whether we consider the ingenuity which they display, or the useful purposes to which they are subservient. In the infancy of the Roman republic the corn was ground by hand-mills consisting of two millstones, one of which was moveable, and the other at rest. The upper millstone was made to revolve either by the hand applied directly to a winch, or by means of a rope winding round a capstan. The precise time when the impulse or the weight of water was substituted in the place of animal labour, is not exactly known. From an epigram in the *Anthologia Græca* there is reason to believe that water-mills were invented during the reign of Augustus; but it is strange that in the

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the description given of them by Vitruvius, who lived under that emperor, they are not mentioned as of recent origin. The invention of wind-mills is of a later date. According to some authors, they were first used in France in the sixth century; while others maintain that they were brought to Europe in the time of the crusades, and that they had long been employed in the east, where the scarcity of water precluded the application of that agent to machinery.

Stevinus discovers the parallelogram of forces. Died in 1635.

6. The science of mechanics seems to have been stationary till the end of the 16th century. In 1577 a treatise on mechanics was published by Guidus Ubaldus, but it contained merely the discoveries of Archimedes. Simon Stevinus, however, a Dutch mathematician, contributed greatly to the progress of the science. He discovered the parallelogram of forces; and has demonstrated in his Statics, published in 1586, that if a body is urged by two forces in the direction of the sides of a parallelogram and proportional to these sides, the combined action of these two forces is equivalent to a third force acting in the direction of the diagonal of the parallelogram, and having its intensity proportional to that diagonal. This important discovery, which has been of such service in the different departments of physics, should have conferred upon its author a greater degree of celebrity than he has actually enjoyed. His name has scarcely been enrolled in the temple of fame, but justice may yet be done to the memory of such an ingenious man. He had likewise the merit of illustrating other parts of statics; and he appears to have been the first who, without the aid of the properties of the lever, discovered the laws of equilibrium in bodies placed on an inclined plane. His works were reprinted in the Dutch language in 1605. They were translated into Latin in 1608, and into French in 1634; and in these editions of his works his Statics were enlarged by an appendix, in which he treats of the rope machine, and on pulleys acting obliquely.

Lucas Valerius writes on the centre of gravity of solids. 1661.

7. The doctrine of the centre of gravity, which had been applied by Archimedes only to plane surfaces, was now extended by Lucas Valerius to solid bodies. In his work entitled *De Centro Gravitatis Solidorum Liber*, published at Bologna in 1661, he has discussed this subject with such ability, as to receive from Galileo the honourable appellation of the *Novus nostræ ætatis Archimedes*.

Discoveries of Galileo. Born 1564. Died 1642.

8. In the hands of Galileo the science of mechanics assumed a new form. In 1572 he wrote a small treatise on statics, which he reduced to this principle, that it requires an equal power to raise two different bodies to altitudes in the inverse ratio of their weights, or that the same power is requisite to raise 10 pounds to the height of 100 feet, and 20 pounds to the height of 50 feet. This fertile principle was not pursued by Galileo to its different consequences. It was left to Descartes to apply it to the determination of the equilibrium of machines, which he did in his explanation of machines and engines, without acknowledging his obligations to the Tuscan philosopher. In addition to this new principle, Galileo enriched mechanics with his theory of local motion. This great discovery has immortalized its author; and whether we consider its intrinsic value, or the change which it produced on the physical sciences, we are led to regard it as nearly of equal importance with the theory of universal gravitation, to which it paved the way. The first hints of this new theory were given in his SYSTEMA COSMICUM, *Dialogus* II. The subject was afterwards fully discussed in another, entitled *Discursus et Demonstrationes Mathematicæ circa duas novas Scientias pertinentes ad Mechanicam et Motum Localem*, and published in 1638. This work is divided into four dialogues; the first of which treats of the resistance of solid bodies before they are broken: The second points out the cause of the cohesion of solids. In the third he discusses his theory of local motions, comprehending those which are equable, and those which are uniformly accelerated. In the fourth he treats of violent motion, or the motion of projectiles; and in an appendix to the work he demonstrates several propositions relative to the centre of gravity of solid bodies. In the first of these dialogues he has founded his reasoning on principles which are far from being correct, but he has been more successful in the other three. In the third dialogue, which contains his celebrated theory, he discusses the doctrine of equable motions in six theorems, containing the different relations between the velocity of the moving body, the space which it describes, and the time employed in its description. In the second part of the dialogue, which treats of accelerated motion, he considers all bodies as heavy, and composed of a number of parts which are also heavy. Hence he concludes that the total weight of the body is proportional to the number of the material particles of which it is composed, and then reasons in the following manner. As the weight of a body is a power always the same in quantity, and as it constantly acts without interruption, the body must be continually receiving from it equal impulses in equal and successive instants of time. When the body is prevented from falling by being placed on a table, its weight is incessantly impelling it downwards, but these impulses are incessantly destroyed by the resistance of the table which prevents it from yielding to them. But where the body falls freely, the impulses which it perpetually receives are perpetually accumulating, and remain in the body unchanged in every respect excepting the diminution which they experience from the resistance of air. It therefore follows, that a body falling freely is uniformly accelerated, or receives equal increments of velocity in equal times. Having established this as a definition, he then demonstrates, that the time in which any space is described by a motion uniformly accelerated from rest, is equal to the time in which the same space would be described by an uniform equable motion with half the final velocity of the accelerated motion; and that in every motion uniformly accelerated from rest, the spaces described are in the duplicate ratio of the times of description. After having proved these theorems, he applies the doctrine with great success to the ascent and descent of bodies on inclined planes.

History. 1638.

Labours of Torricelli. 1644.

9. The theory of Galileo was embraced by his pupil Torricelli, who illustrated and extended it in his excellent work entitled *De motu gravium naturaliter accelerato*, published in 1644. In his treatise *De motu projectorum*, published in the Florentine edition of his works, in 1664, he has added several new and important propositions to those which were given by his master on the motion of projectiles.

Invention of the steam engine.

10. It was about this time that steam began to be employed

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employed as the firſt mover of machinery. This great diſcovery has been aſcribed by the Engliſh to the marquis of Worceſter, and to Papin by the French; but it is almoſt certain, that about 34 years before the date of the marquis's invention, and about 61 years before the conſtruction of Papin's digeſter, ſteam was employed as the impelling power of a ſtamping engine by one Brancas an Italian, who publiſhed an account of his invention in 1629. It is extremely probable, however, that the marquis of Worceſter had never ſeen the work of Brancas, and that the fire-engine which he mentions in his Century of Inventions was the reſult of his own ingenuity. The advantages of ſteam as an impelling power being thus known, the ingenious Captain Savary invented an engine which raiſed water by the expanſion and condenſation of ſteam. Several engines of this conſtruction were actually erected in England and France, but they were incapable of raiſing water from depths which exceeded 35 feet. The ſteam-engine received great improvements from our countrymen Newcomen, Brighton, and Blakey; but it was brought to its preſent ſtate of perfection by Mr Watt of Birmingham, one of the moſt accompliſhed engineers of the preſent age. Hitherto it had been employed merely as a hydraulic machine for draining mines or raiſing water, but in conſequence of Mr Watt's improvements it has long been uſed as the impelling power of almoſt every ſpecies of machinery. It is a curious circumſtance, that the ſteam-engine was not only invented, but has received all its improvements, in our own country.

Diſcoveries of Huygens. 1673.

11. The ſucceſs of Galileo in inveſtigating the doctrine of rectilineal motion, induced the illuſtrious Huygens to turn his attention to curvilineal motion. In his celebrated work *De Horologio Oſcillatorio*, publiſhed in 1673, he has ſhown that the velocity of a heavy body deſcending along any curve, is the ſame at every inſtant in the direction of the tangent, as it would have been if it had fallen through a height equal to the correſponding vertical abſciſs; and from the application of this principle to the reverſed cycloid with its axis vertical, he diſcovered the iſochroniſm of the cycloid, or that a heavy body, from whatever part of the cycloid it begins to fall, always arrives at the lower point of the curve in the ſame ſpace of time. By theſe diſcuſſions, Huygens was gradually led to his beautiful theory of central forces in the circle. This theory may be applied to the motion of a body in any curve, by conſidering all curves as compoſed of an infinite number of ſmall arcs of circles of different radii, which Huygens had already done in his theory of evolutes. The theorems of Huygens concerning the centrifugal force and circular motions, were publiſhed without demonſtrations.

1700.

They were firſt demonſtrated by Dr Keill at the end of his Introduction to Natural Philoſophy. The demonſtrations of Huygens, however, which were more prolix than thoſe of the Engliſh philoſopher, were afterwards given in his poſthumous works.

The laws of colliſion diſcovered by Wallis, Huygens, and Wren. 1661.

12. About this time the true laws of colliſion or percuſſion were ſeparately diſcovered by Wallis, Huygens, and Sir Chriſtopher Wren in 1661, without having the leaſt communication with each other. They were tranſmitted to the Royal Society of London in 1688, and appeared in the 43d and 46th numbers of their Tranſactions. The rules given by Wallis and Wren are publiſhed in N° 43, pp. 864 and 867, and thoſe of Huygens in N° 46, p. 927. The foundation of all their ſolutions is, that in the mutual colliſion of bodies, the abſolute quantity of motion of the centre of gravity is the ſame after impact as before it, and that when the bodies are elaſtic, the reſpective velocity is the ſame after as before the ſhock.—We are indebted likewiſe to Sir Chriſtopher Wren for an ingenious method of demonſtrating the laws of impulſion by experiment. He ſuſpended the impinging bodies by threads of equal length, ſo that they might touch each other when at reſt. When the two bodies were ſeparated from one another, and then allowed to approach by their own gravity, they impinged againſt each other when they arrived at the poſitions which they had when at reſt, and their velocities were proportional to the chords of the arches through which they had fallen. Their velocities after impact were alſo meaſured by the chords of the arches through which the ſtroke had forced them to aſcend, and the reſults of the experiments coincided exactly with the deductions of theory. The laws of percuſſion were afterwards more fully inveſtigated by Huygens, in his poſthumous work *De Motu Corporum ex Percuſſione*, and by Wallis in his *Mechanica*, publiſhed in 1670.

Mechanical problems propoſed by Merſennus. 1635.

13. The attention of philoſophers was at this time directed to the two mechanical problems propoſed by Merſennus in 1635. The firſt of theſe problems was to determine the centre of oſcillation in a compound pendulum, and the ſecond to find the centre of percuſſion of a ſingle body, or a ſyſtem of bodies turning round a fixed axis. The centre of oſcillation is that point in a compound pendulum, or a ſyſtem of bodies moving round a centre, in which, if a ſmall body were placed and made to move round the ſame centre, it would perform its oſcillations in the ſame time as the ſyſtem of bodies. The centre of percuſſion, which is ſituated in the ſame point of the ſyſtem as the centre of oſcillation, is that point of a body revolving or vibrating about an axis, which being ſtruck by an immoveable obſtacle, the whole of its motion is deſtroyed.

Huygens ſolves the problem of the centre of oſcillation.

Theſe two problems were at firſt diſcuſſed by Deſcartes and Roberval, but the methods which they employed were far from being correct. The firſt ſolution of the problem on the centre of oſcillation was given by Huygens. He aſſumed as a principle, that if ſeveral weights attached to a pendulum deſcended by the force of gravity, and if at any inſtant the bodies were detached from one another, and each aſcended with the velocity it had acquired by its fall, they would riſe to ſuch a height that the centre of gravity of the ſyſtem in that ſtate would deſcend to the ſame height as that from which the centre of gravity of the pendulum had deſcended. The ſolution founded on this principle, which was not derived from the fundamental laws of mechanics, did not at firſt meet with the approbation of philoſophers; but it was afterwards demonſtrated in the cleareſt manner, and now forms the principle of the conſervation of active forces.—The problem of the centre of percuſſion was not attended with ſuch difficulties. Several incomplete ſolutions of it were given by different geometers; but it was at laſt reſolved in an accurate and general manner by James Bernouilli by the principle of the lever.

Works of Borelli. 1666.

14. In 1666, a treatiſe *De Vi Percuſſionis*, was publiſhed

History. 1686. lished by J. Alphonso Borelli, and in 1686, another work, *De Motionibus Naturalibus à Gravitate Pendentibus;* but he added nothing to the science of mechanics. His ingenious work, *De Motu Animalium*, however, is entitled to great praise, for the beautiful application which it contains of the laws of statics to explain the various motions of living agents.

Labours of Varignon. 15. The application of statics to the equilibrium of machines, was first made by Varignon in his Project of a new System of Mechanics, published in 1687. The subject was afterwards completely discussed in his *Nouvelle Mecanique*, a posthumous work published in 1725. In this work are given the first notions of the celebrated principle of virtual velocities, from a letter of John Bernouilli's to Varignon in 1717. The virtual velocity of a body is the infinitely small space, through which the body excited to move has a tendency to describe in one instant of time. This principle has been successfully applied by Varignon to the equilibrium of all the simple machines. The resistance of solids, which was first treated by Galileo, was discussed more correctly by Leibnitz in the *Acta Eruditorum* for 1687. In the Memoirs of the Academy for 1702, Varignon has taken up the subject, and rendered the theory much more universal.

Parent on the maximum effect of machines. 16. An important step in the construction of machinery was about this time made by Parent. He remarked in general that if the parts of a machine are so arranged, that the velocity of the impelling power becomes greater or less according as the weight put in motion becomes greater or less, there is a certain proportion between the velocity of the impelling power, and that of the weight to be moved, which renders the effect of the machine a *maximum* or a *minimum* *. He then applies this principle to undershot wheels, and shows that a maximum effect will be produced when the velocity of the stream is equal to *thrice* the velocity of the wheel. In obtaining this conclusion, Parent supposed that the force of the current upon the wheel is in the duplicate ratio of the relative velocity, which is true only when a single floatboard is impelled by the water. But when more floatboards than one are acted upon at the same time, it is obvious that the momentum of the water is directly as the relative velocity; and by making this substitution in Parent's demonstration, it will be found that a maximum effect is produced when the velocity of the current is double that of the wheel. This result was first obtained by the Chevalier Borda, and has been amply confirmed by the experiments of Smeaton. (See HYDRODYNAMICS, § 279, 280, 281). The principle of Parent was also applied by him to the construction of windmills. It had been generally supposed that the most efficacious angle of weather was 45°; but it was demonstrated by the French philosopher that a maximum effect is produced when the sails are inclined $54\frac{2}{7}$ degrees to the axis of rotation, or, when the angle of weather is $35\frac{5}{7}$ degrees. This conclusion, however, is subject to modifications which will be pointed out in a subsequent part of this article.

* Mem. de l'Acad. 1704.

De la Hire writes on the teeth of wheels. 17. The *Traite de Mecanique* of De la Hire, published separately in 1695, and in the 9th volume of the Memoirs of the French Academy from 1666 to 1699, contains the general properties of the mechanical powers, and the description of several ingenious and useful machines. But it is chiefly remarkable for the *Traite des Epicycloides*, which is added to the edition published in the Memoirs of the Academy. In his interesting treatise, De la Hire considers the genesis and properties of exterior and interior epicycloids, and demonstrates, that when one wheel is employed to drive another, the one will move sometimes with greater and sometimes with less force, and the other will move sometimes with greater and sometimes with less velocity, unless the teeth of one or both of the wheels be parts of a curve generated like an epicycloid. The same truth is applicable to the formation of the teeth of rackwork, the arms of levers, the wipers of stampers, and the lifting cogs of forge hammers; and as the epicycloidal teeth when properly formed roll upon one another without much friction, the motion of the machine will be uniform and pleasant, its communicating parts will be prevented from wearing, and there will be no unnecessary waste of the impelling power. Although De la Hire was the first who published this important discovery, yet the honour of it is certainly due to Olaus Roemer, the celebrated Danish astronomer, who discovered the successive propagation of light. It is expressly stated by Leibnitz *, in his letters to John Bernouilli, that Roemer communicated to him the discovery 20 years before the publication of De la Hire's work; but still we have no ground for believing that De la Hire was guilty of plagiarism. Roemer's researches were not published; and from the complete discussion which the subject has received from the French philosopher, it is not unlikely that he had the merit of being the second inventor. Even Camus †, who about 40 years afterwards gave a complete and accurate theory of the teeth of wheels, was unacquainted with the pretensions of Roemer, and ascribes the discovery to De la Hire.

The discovery of epicycloidal teeth first made by Roemer.

* *Miscellan. Berolinens.* 1710. p. 315.

† *Cours de Mathematique*, Liv. x. et xi.

Discoveries of Newton. 18. The publication of Newton's Principia contributed greatly to the progress of mechanics. His discoveries concerning the curvilineal motion of bodies, combined with the theory of universal gravitation, enabled philosophers to apply the science of mechanics to the phenomena of the heavens, to ascertain the law of the force by which the planets are held in their orbits, and to compute the various irregularities in the solar system, which arise from the mutual action of the bodies which compose it. The *Mecanique Celeste* of La Place will be a standing monument of the extension which mechanics has received from the theory of gravity. The important mechanical principle of the conservation of the motion of the centre of gravity is also due to Newton. He has demonstrated in his Principia, that the state of the centre of gravity of several bodies, whether in a state of rest or motion, is not affected by the reciprocal action of these bodies, whatever it may be, so that the centre of gravity of the bodies which act upon one another, either by the intervention of levers, or by the laws of attraction, will either remain at rest, or move uniformly in a right line.

Principle of the conservation of active forces first discovered by Huygens. 19. We have already seen that the principle of the conservation of active forces was discovered by Huygens when he solved the problem of the centre of oscillation. The principle alluded to consists in this, that in all the actions of bodies upon each other, whether that action consists in the percussion of elastic bodies, or is communicated from one body to another by threads or inflexible rods, the sums of the masses multiplied by the squares of the absolute velocities remain always the same. This

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This important law is easily deducible from two simpler laws admitted in mechanics. 1. That in the collision of elastic bodies, their respective velocities remain the same after impact as they were before it; and, 2. That the quantity of action, or the product of the masses of the impinging bodies, multiplied by the velocity of their centre of gravity, is the same after as before impact. The principle of the conservation of active forces, was regarded by its inventor only as a simple mechanical theorem. John Bernouilli, however, considered it as a general law of nature, and applied it to the solution of several problems which could not be resolved by direct methods; but his son Daniel deduced from it the laws of the motion of fluids from vessels, a subject which had been formerly treated in a very vague manner. He afterwards rendered the principle more general *, and showed how it could be applied to the motion of bodies influenced by their mutual attractions, or solicited towards fixed centres by forces proportional to any function of the distance.

Rendered general by Daniel Bernouilli.

* Mem. de l'Acad. Berlin, 1748.

20. After the parallelogram of forces had been introduced into statics by Stevinus, it was generally admitted upon the same demonstration which was given for the composition of motion. The first complete demonstration was given by Daniel Bernouilli in the Commentaries of Petersburgh for 1726, independent of the consideration of compound motion. This demonstration, which was both long and abstruse, was greatly simplified by D'Alembert in the Memoirs of the Academy for 1769. Fonseneix and Riccati have given a very ingenious one in the Memoirs of the Academy of Turin for 1761. This was also improved by D'Alembert, who gave another in the same Memoirs, and a third in his *Traite de Dynamique*, published in 1743. Dr Robison † has combined the demonstrations of Bernouilli and D'Alembert with one by Frisi, and produced one that is more expeditious and simple. La Place has likewise given a demonstration of the parallelogram of forces in his *Mecanique Celeste*.

Daniel Bernouilli and other philosophers demonstrate the parallelogram of forces.

† Sup. Encycl. § Dynamics.

21. About the beginning of the 18th century, the celebrated dispute about the measure of active forces was keenly agitated among philosophers. The first spark of this war, which for 40 years England maintained single-handed against all the genius of the continent, was excited by Leibnitz. In the Leipsic acts for 1686, he asserted that Descartes was mistaken in making the force of bodies proportional to their simple velocity, and maintained that it followed the ratio of the square of the velocity. He shewed, that a body, with a velocity of two feet, acquires the power of raising itself to a height four times as great as that to which a body could rise with a velocity of only one foot; and hence he concludes, that the force of that body is as the square of its velocity. The abbé de Cotilon, a zealous Cartesian, allowed the premises of Leibnitz, but denied his conclusion. The body, said he, which moves with a velocity of two feet, will certainly rise to quadruple the height of another body that has only the velocity of one foot; but it will take *twice the time* to rise to that height, and a quadruple effect, in a double time, is not a quadruple force, but only a double one. The theory of Leibnitz was supported by John Bernouilli, Herman, Gravesende, Muschenbroeck, Poleni, Wolff, and Bulfinger; and the opinion of Descartes by Maclaurin, Stirling, Clarke, Desaguliers, and other English philosophers. The question was at last involved in metaphysical reasoning; and if the dispute did terminate in favour of either party, the English philosophers were certainly victorious. It appears, in the clearest manner, that the force of a moving body, indicated by the space which it describes, is as the simple velocity, if we consider the space as described in a determinate time; but it is as the square of the velocity, if we do not consider the time in which the space is described. The question, therefore, comes to be this: In estimating the forces of bodies in motion, ought we to take time into consideration? If, with the followers of Leibnitz, we reject this element, then we may maintain that the force of a child is equal to that of a man carrying a load, because the child is also capable of carrying the same load, though in small parts and in a greater length of time.

Dispute about the measure of active forces.

22. In 1743, D'Alembert published his *Traité de Dynamique*, founded upon a new principle in mechanics. This principle was first employed by James Bernouilli in his solution of the problem of the centre of oscillation; but D'Alembert had the honour of generalising it, and giving it all that simplicity and fertility of which it was susceptible. He showed, that in whatever manner the bodies of one system act upon another, their motions may always be decomposed into two others at every instant, those of the one being destroyed the instant following, and those of the other retained, and that the motions retained are necessarily known from the conditions of equilibrium between those which are destroyed. This principle is evidently a consequence of the laws of motion and equilibrium, and has the advantage of reducing all the problems of dynamics to pure geometry and the principles of statics. By means of it D'Alembert has resolved a number of beautiful problems which had escaped his predecessors, and particularly that of the precession of the equinoxes, which had occupied the attention of Newton. In his *Traité de Dynamique*, D'Alembert has likewise reduced the whole of mechanics to three principles, the force of inertia, compound motion, and equilibrium; and has illustrated his views on this subject by that profound and luminous reasoning which characterises all his writings.

D'Alembert's principle of dynamics.

23. Another general principle in dynamics was about this time discovered separately by Euler, Daniel Bernouilli, and the chevalier D'Arcy, and received the name of *the conservation of the momentum of rotatory motion*. According to the two first philosophers, the principle may be thus defined: In the motion of several bodies round a fixed centre, the sum of the products of the mass of each body multiplied by the velocity of its motion round the centre, and by its distance from that centre, is always independent of the mutual action which the bodies may exert upon each other, and always preserves itself the same, provided the bodies are not influenced by any external cause. This principle was given by Daniel Bernouilli in the Memoirs of the Academy of Berlin for 1746; and in the same year by Euler in the first volume of his works. They were both led to the discovery, while investigating the motion of several bodies in a tube of a given form, and which can only turn round a fixed point. The principle discovered by the chevalier D'Arcy was given in a memoir dated 1746, and published in the Memoirs of the

Euler, Daniel Bernouilli, and d'Arcy, discover the conservation of the momentum of rotatory motion.

1746.

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the Academy for 1747. He shewed, that the sum of the products of the mass of each body by the area which its radius vector describes round a fixed point, is always proportional to the times. The identity of this principle, which is a generalisation of Newton's theorem about the areas described by the planetary bodies, with that of Euler and Bernouilli, will be easily perceived, if we consider that the element of the circular arc, divided by the element of the time, expresses the velocity of circulation, and that the element of the circular arc, multiplied by the distance from the centre, gives the element of the area described round that centre; so that the principle of Euler is only a differential expression of the principle of D'Arcy, which he afterwards expressed in this form, that the sum of the products of the masses of each body by their velocities, and by the perpendiculars drawn from the centre to their lines of direction, is a constant quantity.

The principle of least action proposed by Maupertuis.

24. The principle of least action, which was first proposed by Maupertuis in 1744, consists in this, that when several bodies, acting upon one another, experience any change in their motion, this change is always such, that the quantity of action (or the product of the mass by the space and the velocity) employed by nature to produce it, is the least possible. From this principle Maupertuis deduced the laws of the reflection and refraction of light, and those of the collision of bodies *. He afterwards extended its application to the laws of motion, and made the principle so general as to comprehend the laws of equilibrium, the uniform motion of the centre of gravity in the percussion of bodies, and the conservation of active forces. This celebrated principle was attacked by Koenig, professor of mathematics at the Hague, in the Leipsic acts for 1751, who not only attempted to shew its falsity, but asserted that Leibnitz had first described it in 1707 in a letter to Herman. The paper of Koenig gave rise to a long and violent dispute about the accuracy of the principle, and the authenticity of the letter of Leibnitz. The academy of Berlin interfered in behalf of their president, and gave importance to a controversy which was too personal to merit the attention which it received.

* *Mem. Acad. Paris* 1744, and *Mem. Acad. Berlin* 1746.

Euler and Lagrange generalise the principle of Maupertuis.

25. In his *Traité des Isoperimetries*, printed at Lausanne in 1744, Euler extended the principle of least action, and shewed, "that in the trajectories described by means of central forces, the integral of the velocity, multiplied by the element of the curve, is either a *maximum* or a *minimum*." This remarkable property, which Euler recognised only in the case of insulated bodies, was generalised by Lagrange into this new principle, "that the sum of the products of the masses by the integrals of the velocities, multiplied by the elements of the spaces described, is always a maximum or a minimum." In the memoirs of Turin, Lagrange has employed this principle to resolve several difficult problems in dynamics; and he has shewn †, that when it is combined with the conservation of active forces, and developed according to the rules of his method of variations, it furnishes directly all the equations necessary for the solution of each problem, and gives rise to a simple and general method of treating the various problems concerning the motion of bodies.

† *Mecanique Analytique*, p. 189, 1788.

Labours of Segner, 1765.

26. An important discovery in rotatory motion, was at this time made by Professor Segner. In a paper, entitled *Specimen Theoriæ Turbinum*, he demonstrated, that if a body of any form or magnitude, after it has received rotatory motions in all directions, be left entirely to itself, it will always have three principal axes of rotation; or, in other words, all the rotatory motions with which it is affected, may be reduced to three, which are performed round three axes, perpendicular to each, passing through the centre of gravity of the revolving body, and preserving the same position in absolute space, while the centre of gravity is either at rest or moving uniformly in a straight line.

Coulomb inquires into the force of torsion,

27. The force of torsion began at this time to be investigated by Coulomb, who published two ingenious papers on the subject, in the Memoirs of the French Academy. He has successfully employed this principle in several physical researches, but particularly in determining the law of magnetic action, and in finding the laws of the resistance of fluids when the motions are extremely slow *. It was by means of an elegant experiment on the principle of torsion that Mr Cavendish determined the mutual attraction of two masses of lead, and thence deduced the mean density of the earth.—We are also indebted to Coulomb for a complete set of experiments on the nature and effects of friction. By employing large bodies and ponderous weights, and conducting his experiments on a large scale, he has corrected errors which necessarily arose from the limited experiments of preceding writers; he has brought to light many new and interesting facts, and confirmed others which had hitherto been partially established. The most curious result of these experiments is the effect of time in increasing the friction between two surfaces. In some cases the friction reaches its maximum after the rubbing surfaces have remained in contact for one minute; and in other cases five or six days were necessary before this effect was produced. The increase of friction, which is generated by prolonging the time of contact, is so great, that a body, weighing 1650 pounds, was moved with a force of 64 pounds when first laid upon the corresponding surface. After remaining in contact for the space of three seconds, 100 pounds were necessary to put it in motion; and when the time was prolonged to six days, it could scarcely be moved with a power of 622 pounds †.

and into the subject of friction.

* *Memoirs de l'Instit. Nat.* tom. iii. p. 246.

† *Memoires Presentées* tom. ix.

Works on mechanics.

28. One of the most important treatises on the science of motion is the Mechanics of the celebrated Euler, published in 1736. It contains the whole theory of rectilineal and curvilineal motion in an insulated body, affected by any accelerating forces, either in vacuo or in a resisting medium. He uniformly uses the analytical method, and has employed the principle of the *vis inertiæ*, and that of compound motion, for putting his problems into equations. By the *vis inertiæ*, motion is at every moment of time rectilineal and uniform; and by the principle of compound motion, a body, exposed to the action of any number of forces, tending to alter the quantity and the direction of its motion, will move in such a direction as to reach the very point at which it would have arrived, had it obeyed successively each of the forces which act upon it.—In the *Mecanique Analytique* of Lagrange, published in 1788, all the mechanical problems are reduced to general formulæ, which, being developed, furnish us with the equations that are necessary for the solution of each problem; and the different principles which

Euler's mechanics.

Lagrange's Mecanique Analytique.

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which have been discovered for facilitating the solutions of mechanical questions, are brought under one point of view, and their connection and dependence clearly pointed out. The *Architecture Hydraulique*, by M. Prony, published in 1790, and the *Mecanique Philosophique*, of the same author, published in 1799, contains all the late improvements in mechanics, and a complete view both of the theory and application of that science. The first of these works is intended chiefly for the use of the engineer, though an extensive acquaintance with the higher geometry is necessary for perusing it with advantage. His *Mecanique Philosophique* is a profound work, in which, without the aid of a single diagram, he gives all the formulæ, and the various theorems and problems which belong to the sciences of mechanics and hydrodynamics. Every alternate page contains a methodical table of the results obtained in the preceding page, the description of the symbols, and the theorems, problems, and formulæ which may have been obtained.—The *Traité de Mecanique Elementaire*, by M. Franceur, published in 1802 in one volume octavo, is an excellent abridgement of the works of Prony, and is intended as an introduction to the *Mecanique Philosophique* of that author, to the *Mecanique Analytique* of Lagrange, and to the *Mecanique Celeste* of Laplace.—None of these works have been translated into English; but their place is well supplied by a *Treatise on Mechanics Theoretical, Practical*, and *Descriptive*, by Olinthus Gregory, A. M. published in 1806, and containing a complete view of the latest improvements, both in the theory and practice of mechanics.

Prony's *Architecture Hydraulique* and *Mecanique Philosophique*.

PART I. THEORY OF MECHANICS.

Objects of theoretical mechanics.

29. THE theory of mechanics properly comprehends, 1. Dynamics. 2. The motion of projectiles. 3. The theory of simple machines, or the mechanical powers. 4. The theory of compound machines, and their maximum effects. 5. The doctrine of the centre of gravity. 6. The centre of oscillation, gyration, &c. 7. The collision of bodies. 8. The theory of rotation. 9. The theory of torsion. 10. The strength of materials; and, 11. The equilibrium of arches, domes.—The subjects of DYNAMICS, PROJECTILES, ROTATION, and STRENGTH of MATERIALS having been already ably treated by Dr Robison, under their respective heads, we shall now direct the attention of the reader to the other branches of theoretical mechanics.

CHAP. I. *On Simple Machines*, or the *Mechanical Powers*.

Division of machines into simple and compound.

30. THE simple machines have been generally reckoned six in number. 1. The lever; 2. The wheel and axle, or *axis in peritrochio;* 3. The pulley; 4. The inclined plane; 5. The wedge; and, 6. The screw: to which some writers on mechanics have added the *balance*, and others the *rope-machine.* It is evident, however, that all these machines may be reduced to three, the *lever*, the *inclined plane*, and the *rope-machine.* The *pulley*, and the *wheel* and *axle*, are obviously composed of an assemblage of levers; the *balance* is a lever with equal arms; the *wedge* is composed of two inclined planes, with their bases in contact; and the *screw* is either a wedge or an inclined plane, wrapped round a cylinder.—Under the head of simple machines, therefore, we cannot, in strict propriety, include any of the mechanical powers, excepting the lever, the inclined plane, and the rope-machine.

DEFINITIONS.

Definitions.

31. DEF. 1. When two forces act against each other by the intervention of a machine, the one force is called the *power*, and the other the *weight.* The *weight* is the resistance to be overcome, or the effect to be produced. The *power* is the force, whether animate or inanimate, which is employed to overcome that resistance, or to produce the required effect.

32. DEF. 2. The power and weight are said to balance each other, or to be in equilibrio, when the effort of the one to produce motion in one direction, is equal to the effort of the other to produce motion in the opposite direction;—or when the weight opposes that degree of resistance which is precisely required to destroy the action of the power.

SECT. I. *On the Lever.*

33. DEFINITIONS. A *lever* is an inflexible bar or rod moving freely round a point, called its *fulcrum*, or *centre of motion.*

Levers divided into three kinds.

Levers have been generally divided into *three* kinds. In levers of the first kind the fulcrum is situated between the power and the weight, as in steelyards, scissars, pincers, &c. Levers of the second kind have the weight between the power and the fulcrum, as in cutting knives fastened at the point of the blade, and in the oars of a boat where the water is regarded as the fulcrum. In levers of the third kind, the power is between the weight and the fulcrum, as in tongs, sheers for sheep, &c. The bones of animals are generally considered as levers of the third kind, for the muscles, by the contraction of which the power or moving force is generated, are fixed much nearer to the joints or centres of motion than the centre of gravity of the weight to be raised. On this subject, see Paley's Natural Theology, chap. 7. & 8. and *Borelli de Motu Animalium.*

AXIOMS.

Axioms.

34. AXIOM 1. *Equal weights acting at the extremities of equal arms of a straight lever, and having the lines of the direction in which they act at equal angles to these arms, will exert the same effort to turn the lever round its fulcrum* This axiom has been generally restricted to the particular case when the weights act perpendicularly to the arms of the lever; but no reason can be assigned for such limitation. The truth in the axiom is as self-evident when the angles formed by the arms of the lever and the direction of the forces are 80°, as when they are 90°, for in each case the two weights exert

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exert their influence upon the lever in precisely the same circumstances.

35. AXIOM 2. *If two equal weights are placed at the extremities of a lever supported by two fulcra; and if these fulcra are at equal distances from the weights, or the extremities of the lever; the pressure upon the fulcra will be equal to the sum of the weights, and the pressure upon each fulcrum will be equal to one of the weights.* The lever being supposed devoid of weight, it is obvious, that as each fulcrum is similarly situated with respect to both the weights, the pressure upon each must be equal; and as the fulcra support both the equal weights, the pressure upon each must be equal to one of the weights.

PROPOSITION I.

36. If two weights or forces acting at equal angles upon a straight lever, devoid of weight, are in equilibrio, they are reciprocally proportional to their distances from the fulcrum.

37. CASE 1. When the weights act on contrary sides of the fulcrum.

Plate CCCXVI. fig. 1.

Let AB be a lever devoid of weight, and let it be supported upon the two fulcra, fF, situated in such a manner that $Af = f\text{F} = \text{FB}$. Then if two equal weights C, D of one pound each are suspended at the extremities A, B, so as to act in the directions AC, BD, making the angles CAB, DBA equal, these weights will be in equilibrio, for since $Af = \text{FB}$ (Axiom 1.) the effort of the weight D to turn the lever round the fulcrum F, will be equal to the effort of the weight C to turn it round the fulcrum f. Now (Axiom 2.) the pressure upon the fulcrum f is equal to one pound, therefore if that fulcrum be removed, and a weight E of one pound be made to act upward at the point F, the weights C and D will continue in equilibrio. Then it is obvious that since $\text{FB} = \text{F}f$, the weight E of one pound acting upwards at the point f, so that the angle $\text{D}f\text{F} = \text{DBA}$, will have the same effect as an equal weight acting downwards at B. By removing the weight E, therefore, and suspending its equal C at the extremity B, the equilibrium will still be preserved. But the weights D, C, suspended at B, are equal to two pounds, and the weight C is only one pound; and as FA is double of FB, it follows that a weight of two pounds, placed at the end of one arm of a lever, will be in equilibrio with a weight of one pound placed at twice the distance of the former from the fulcrum. But $2 : 1 = 2\ \text{FB}$ or $\text{AF} : \text{FB}$, that is, when the distances are as 2 to 1, an equilibrium takes place if the weights are reciprocally proportional to these distances.

38. CASE 2. When weights act on the same side of the fulcrum.

Fig. 2.

Let AB be a lever in equilibrio upon the fulcrum F, and let FA be equal to FB, consequently (case 1.) we must have $\text{C} = \text{D} = 1$ pound. Now as the fulcrum F supports a weight equal to $\text{C} + \text{D} = 2$ pounds, the equilibrium will continue if a weight E of two pounds is made to act upwards at the point F, for in this case it supplies the place of the fulcrum. It is obvious also that a fulcrum placed at A or B will supply the place of the weights at these parts without affecting the equilibrium. Let, therefore, the weight D be removed, and let the extremity B rest upon a fulcrum; then since the lever is in equilibrio, we have a weight $\text{E} = \text{C} + \text{D} = 2$ pounds acting at F, and balancing a weight C of one pound acting at A. But $2 : 1 = \text{AB} : \text{FB}$, consequently when there is an equilibrium between two weights C, D acting at the distances 2 and 1 from the fulcrum, and on the same side of the fulcrum, the weights are reciprocally proportional to these distances.

39. Again, let AB be the same lever supported by the fulcra f, F, and let $Af = \text{FB}$ and $f\text{F} = 2\text{FB}$. Then if two weights C, D of one pound each be suspended at the extremities A, B, they will be in equilibrio as before. But since the fulcrum f supports a pressure of one pound (Axiom 2.), the equilibrium will still continue when that fulcrum is removed and a weight of one pound made to act in a contrary direction fP at the point f, so that the angle PfF may be equal to DBA. Now, (Axiom 1.) a weight E of one pound acting upward at f will be in equilibrio with a weight E′ of one pound acting downwards at f'; Ff being equal to Ff', and therefore by removing E from the point f and substituting E at the point f', an equilibrium will still obtain. But since $\text{F}f' = 2\text{FB}$ a weight of one pound suspended from f will have the same influence in turning the lever round F as a weight of two pounds suspended at B (Case 2.). Let us remove, therefore, the weight E′ from f', and substitute a weight $\text{G} = 2\text{E}'$, so as to act at B. Then since the equilibrium is not destroyed, we have a weight C of one pound acting at the distance FA, and the weights $\text{D} + \text{G} = 3$ pounds acting at the distance FB. But $\text{FA} = 3\text{FB}$ and $\text{D} + \text{G} = 3\text{C}$, consequently $\text{C} : \text{D} + \text{G} = \text{FB} : \text{FA}$: That is, when the distances from the fulcrum are as 3 to 1, and when an equilibrium exists, the weights are reciprocally proportional to these distances. Fig. 3.

40. By making FA in fig. 2. equal to 2FB it may be shewn, as in Case 2. that the weights are reciprocally proportional to their distances from the fulcrum, when they act on the same side of the fulcrum, and when the distances are as 3 to 1. Fig. 2.

41. In the same way the demonstration may be extended to any commensurable proportion of the arms, by making EA to FB in that proportion, and keeping fA always equal to FB. Hence we may conclude in general, that when two weights acting at equal angles upon a straight lever devoid of weight, are in equilibrio, they are reciprocally proportional to their distances from the centre of motion. Q. E. D. Fig. 3.

Corollaries.

42. COR. 1. If two weights acting at equal angles upon the arms of a straight lever devoid of weight are reciprocally proportional to their distances from the fulcrum, they will be in equilibrio.

For if an equilibrium does not take place, the proportion of the weights must be altered to procure an equilibrium, and then, contrary to the proposition, the weights would balance each other when they were not reciprocally proportional to their distances from the fulcrum.

43. COR. 2. If a weight W be supported by a horizontal lever resting on the fulcra A, B, the pressure upon A is to the pressure upon B in the inverse ratio of their distances from the point where the weight is suspended, that is, as BF to FA. Fig. 4.

For if we suppose B to be the fulcrum, and if removing the

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the fulcrum A, we support the extremity A of the lever by a weight E equivalent to the weight sustained by the fulcrum A, and acting upwards over the pulley P, then the weight E or that sustained by A : W=BF : BA (Prop. 1.); and if we conceive A to be the fulcrum, and support the extremity B by a weight F equal to that which was supported by the fulcrum B, we shall have the weight F or the weight sustained by B : W=AF : AB. Hence *ex æquo* the weight sustained by A is to the weight sustained by B as BF is to FA.

Fig. 5. 44. Cor. 3. We may now call the two weights P and W, the power and the weight, as in fig. 5, and since P : W=FB : FA, we have (Geometry, Sect. iv. Theor. 8.) $P\times FA=W\times FB$, when an equilibrium takes place,

consequently $P=\frac{W\times FB}{FA}$; $W=\frac{P\times FA}{FB}$

$$FA=\frac{W\times FB}{P}$$

$$FB=\frac{P\times FA}{W}.$$

45. Cor. 4. We have already seen (Axiom 2.) that when the power and the weight are on contrary sides of the fulcrum, the pressure upon the fulcrum is equal to P+W or the sum of the weights; but it is obvious that when they act on the same side of the fulcrum, the pressure which it supports will be P—W, or the difference of their weights.

46. Cor. 5. If a weight P be shifted along the arm of a lever AD, the weight W, which it is capable of balancing at A, will be proportional to FA.

When the weights are in equilibrio (Cor. 3.) W : P=FA : FB, or by alternation W : FA=P : FB, and if w be another value of W and fa another value of FA, we shall also have w : P=fa : FB or w : fa= P : FB, consequently (Euclid, Book v. Prop. xi. and xvi.) W : w=FA : fa, that is, W varies as FA.

Fig. 6. Cor. 6. It is obvious that the truths in the preceding proposition and corollaries, also hold when the lever has the form represented in figure 6. only the straight lines AF, FB are in that case the length of the arm.

Description of the steelyard or statera. 47. Cor. 7. Since by the last corollary FA : fa= W : w, it follows that in the *Roman statera* or *steelyard*, which is merely a lever with a long and short arm, having a weight moveable upon the long one, the distances at which the constant weight must be hung are as the weights suspended from the shorter arm. The steelyard is represented in fig. 7. where AB is the lever with unequal arms AF, FB, and F the centre of motion. The body W, whose weight is to be found, is suspended at the extremity B of the lever, and the constant weight P is moved along the divided arm FB till an equilibrium takes place. As soon as this happens, the number placed at the point of suspension D, indicates the weight of the body. If the lever is devoid of weight, it is obvious that the scale EB will be a scale of equal parts of which EB is the unit, and that the weight of the body W will be always equal to the constant weight P multiplied by the number of divisions between P and F. Thus if the equilibrium takes place when P is pulled out to the 12 division, we shall have W=12 P, and if P=1 pound, W=12 pounds. But when the gravity

Fig. 7.

of the lever is considered, which must be done in the real steelyard, its arms are generally of unequal weight, and therefore the divisions of the scale must be ascertained by experiment. In order to do this, remove the weight P, and find the point C, at which a weight P′ equal to P being suspended, will keep the unequal arms in equilibrio, C will then be the point at which the equal divisions must commence. For when W and P are placed upon the steelyard and are in equilibrio, W balances P along with a weight which, placed at D, would support P placed at C: Therefore $W\times BF=P\times DF+P\times CF$; but $P\times DF+P\times CF=P\times DC$, consequently $W\times BF=P\times DC$, and (Geometry, Sect. iv. Theor. 8.) W : DC=P : BF. By taking different values of the variable quantities W and DC as w and dc, we shall have w : dc=P : BF, consequently (Euclid, B. V. Prop. xi. and xvi.) W : w=DC : ds, that is, the weight of W varies as DC, and therefore the divisions must commence at C. If the arm BF had been heavier than FA, which, however, can scarcely happen in practice, the point C would have been on the other side of F. In constructing steelyards, it might be advisable to make the unequal arms balance each other by placing a weight M at the extremity of the lighter arm, in which case the scale will begin at F. In the Danish and Swedish steelyard the body to be weighed and the constant weight are fixed at the extremities of the steelyard, but the point of suspension or centre of motion F moves along the lever till the equilibrium takes place. The point F then indicates the weight of the body required. —There are some steelyards in which the constant weight is fixed to the shorter arm, while the body to be weighed moves upon the longer arm. The method of dividing this and the preceding steelyard may be seen in De la Hire's *Traite de Mecanique*, Prop. 36, 37, 38.

Danish and Swedish steelyard.

Prop. II.

48. To find the condition of equilibrium on a straight lever when its gravity is taken into the account.

49. Let us suppose the lever to be of uniform thickness and density, as AB, fig. 7. and let it be suspended by the points c, d to another lever ab, considered as without weight, so that $ac=cf=fd=db$. Then if f be the centre of motion or point of suspension, the cylinder A B will be in equilibrio; for the weight AB may be regarded as composed of a number of pairs of equal weights, equally distant from the centre of motion. For the same reason, if we conceive the cylinder to be cut through at F the equilibrium will continue, c, d being now the points at which the weights AF, FB act, and their distances cf, df from the centre of motion being equal. Consequently the arms AF, FB have the same energy in turning the lever round f as if weights equal to AF, FB were suspended at the distance of their middle points c, d from the fulcrum. Fig. 8.

Let P therefore, in fig. 5. be the power, W the weight, m the weight of the arm AF, and n the weight of FB. Then when there is an equilibrium we shall have (Prop. I. Cor. 3.) $P\times AF+m\times\frac{1}{2}AF=W\times FB+n\times\frac{1}{2}FB$; and since the weight m acting at half the distance AF is the same as half the weight m, acting at the Fig. 5.

Theory. the whole diftance AF, we may fubftitute $\frac{1}{2}m \times AF$ inftead of $m \times \frac{1}{2}AF$, and the equation becomes $\overline{P+\frac{1}{2}m} \times AF = \overline{W+\frac{1}{2}n} \times FB$. Hence

$$P = \frac{\overline{W+\frac{1}{2}n} \times FB}{AF} - \frac{1}{2}m$$

$$W = \frac{\overline{P+\frac{1}{2}n} \times AF}{FB} - \frac{1}{2}n$$

$$m = \frac{\overline{W+\frac{1}{2}n} \times 2FB}{AF} - 2P$$

$$n = \frac{\overline{P+\frac{1}{2}n} \times 2AF}{FB} - 2W$$

$$AF = \frac{\overline{W+\frac{1}{2}n} \times FB}{P+\frac{1}{2}m}$$

$$FB = \frac{\overline{P+\frac{1}{2}m} \times AF}{W+\frac{1}{2}m}.$$

50. Cor. If the arms of the lever are not of uniform denfity and thicknefs, inftead of the diftance of their middle points, we muft take the diftance of their centre of gravity from the fulcrum.

Prop. III.

51. If two forces acting in any direction, and in the fame plane, upon a lever of any form, are in equilibrio, they will be reciprocally proportional to the perpendiculars let fall from the fulcrum upon the directions in which they act.

Plate CCCXVII. Fig. 1. & 2. 52. Let AFB be a lever of any form, F its fulcrum, A, B the points to which the forces, or the power P and weight W, are applied, and AE, BK the directions in which thefe forces act. Make AE to PK as P is to W, and they will therefore reprefent the forces applied at A and B. Draw AC perpendicular to AF and EC parallel to it, and complete the parallelogram ADEC. In the fame way form the parallelogram BGKH. Produce EA and KB towards m and n if neceffary, and let fall F m, F n perpendicular to AE, BK produced. Then P fhall be to W as F n is to F m. By the refolution of forces (Dynamics, § 140.) the force AE is equivalent to forces reprefented by AD and AC, and acting in thefe directions. But as AD acts in the direction of the arm AF, it can have no influence in turning the lever round F, and therefore AC reprefents the portion of the force AD which contributes to produce an angular motion round F. In the fame way it may be fhewn that BG is the part of the force BK which tends to move the lever round F. Now fuppofe AF produced to B, FB being made equal to FB and B′G′=BG. Then by Prop. I. AC : B′G′ =FB′ : FA; but by Axiom 1. the effort of BG to turn the lever round F is equal to the effort of the equal force B′G′ to turn the lever round F; therefore AC : BG=FB : FA and AC × FA=BG × FB. Now the triangles ACE, AE m are fimilar, becaufe the angles at F and M are both right, and on account of the parallels DF, AC, MAC=ADF; therefore AC : AE=F m : FA, and AC × FA=AE × F m. For the fame reafon in the fimilar triangles BGK, BF n we have BG : BK=F n : FB, and BK × F n=BG × FB. Hence AE × F m=BK × F n, and AE : BK or P : W =F n : F m. Q. E. D. Theory.

53. Cor. 1. The forces P and W are reciprocally proportional to the fines of the angles which their directions make with the arms of the lever, for F m is evidently the fine of the angle FA m, and F n the fine of the angle FB n, FA, FB being made the radii;—therefore P : W=Sin. FB n : Sin. FA m, or P : W $=\frac{1}{\text{Sin. FA}m} : \frac{1}{\text{Sin. FB}n}$. Since FA : F m=Rad. : Sin. FA m, we have F $m=\frac{\text{FA} \times \text{Sin. FA}m}{\text{Rad.}}$; and fince FB : F n=Rad. : Sin. FB n, we have F $m=\frac{\text{FB} \times \text{Sin.FB}n}{\text{Rad.}}$, but in the cafe of an equilibrium P : W=F n : F m, confequently P : W $=\frac{\text{FE} \times \text{Sin. FB}n}{\text{Rad.}} : \frac{\text{FA} \times \text{Sin.FA}m}{\text{Rad.}}$; and fince magnitudes have the fame ratio as their equimultiples, P : W=EB × Sin. EB n : FA × Sin. FA m. Corollaries. Fig. 1 & 2.

54. Cor. 2. The energies of the forces P, W to turn the lever round the fulcrum F is the fame at whatever point in the directions m E, n K they are applied, for the perpendiculars to which thefe energies are proportional remain the fame.—The truth of this corollary has been affumed as an axiom by fome writers on mechanics, who have very readily deduced from it the preceding propofition. But it is very obvious that the truth affumed as felf-evident is nearly equivalent to the truth which it is employed to prove. Thofe who have adopted this mode of demonftration illuftrate their axiom by the cafe of a folid body that is either pufhed in one direction with a ftraight rod, or drawn by a cord; in both of which cafes it is manifeft that the effect of the force employed is the fame, at whatever part of the rod or ftring it is applied: But thefe cafes are completely different from that of a body moving round a fixed centre.

55. Cor. 3. If AE and BK the directions in which the forces P, W are exerted be produced till they meet at L; and if from the fulcrum E the line FS be drawn parallel to the direction AL of one force till it meets BL, the direction of the other; then LS, SF will reprefent the two forces. For as the fides of any triangle are as the fines of the oppofite angles LS : SF=fin. LFS : fin. FLS; but on account of the parallels FS, AL the angle LFS=FLA, and FL being radius F m is the fine of FLA or LFS, and F n the fine of FLS, therefore by fubftitution LS : SF=F m : F n, that is as the force W : P.

56. Cor. 4. If feveral forces act upon a lever, and keep it in equilibrio, the fum of the products of the forces and the perpendiculars from the fulcrum to the direction of the different forces on one fide is equal to the fum of the products on the other. For fince the energy of each force to turn the lever is equal to the product of the force and the perpendicular from the fulcrum on the line of its direction; and fince in the cafe of an equilibrium, the energy of all the forces on one fide of the fulcrum muft be equal to the energy of all the forces on the other fide, the products proportional to their energies muft alfo be equal.

57. Cor. 5. If two forces act in a parallel direction upon an angular lever whofe fulcrum is its angular point,

Theory.

point, these forces will be in equilibrio when a line drawn from the fulcrum upon the line which joins the two points where the forces are applied, and parallel to the direction of the forces, cuts it in such a manner that the two parts are reciprocally proportional to the forces applied.

Fig. 3. Let AFB be the angular lever, whose fulcrum is F, and let the forces P, W be applied at A and B in the parallel directions P m, W n; then if the line FD, parallel to P m or W n, cut AB in such a manner that DB : DA=P : W, the forces will be in equilibrio. Draw F m perpendicular to P m, and produce it to n; then since A m, B n are parallel, $m\,n$ will also be perpendicular to B n, and by the proposition (Art. 51.) F n : F m = P : W. Now, if through F, there be drawn $m'\,n'$ parallel to AB, the triangles F $m\,m'$, F $n\,n'$ will be similar, and we shall have F n : F m=F n' : F m', but on account of the parallels AB, $m'\,n'$; F n' : F m' =DB : DA, therefore DB : DA=P : W.

Fig. 4. 58. Cor. 6. Let CB be a body moveable round its centre of gravity F, and let two forces P, W act upon it at the points A, B in the plane AFB, in the directions AP, BW; then since this body may be regarded as a lever whose fulcrum is F, the forces will be in equilibrio when P : W=F n : F m the perpendiculars on the directions in which the forces act.

Fig 5. 59. Cor. 7. If AB be an inflexible rod moveable round F as a fulcrum, and acted upon by two forces P, W in the directions A m, A n, these forces will be in equilibrio when they are to one another as the perpendiculars F n, F m.—For by cor. 2. the forces may be considered as applied at m and n, and m F n may be regarded as the lever; but by the proposition (Art. 51.) P : W=F n : F m; F m, F n being perpendiculars upon A m, A n.

Fig. 6. 60. Cor. 8. Let DE be a heavy wheel, and FG an obstacle over which it is to be moved, by a force P, acting in the direction AH. Join AF, and draw F m, F n perpendicular to CA and AH. The weight of the wheel is evidently the weight to be raised, and may be represented by W acting at the point A in the vertical direction AC. We may now consider AF as a lever whose fulcrum is F, and by cor. 7. there will be an equilibrium when P : W=F n : F m. Since F m represents the mechanical energy of the power P to turn the wheel round F, it is obvious that when FG is equal to the radius of the wheel, the weight P, however great, has no power to move it over the obstacle; for when FG=AC, F m=o, and F $m\times$P=o.

Fig. 7. 61. Cor. 9. If a man be placed in a pair of scales hung at the extremities of a lever, and is in equilibrio with a weight in the opposite scale, then if he presses against any point in the lever, except that point from which the scale is suspended, the equilibrium will be destroyed. Let CB be the lever in equilibrio, F its fulcrum, and let the scales be suspended from A and B, AP being the scale in which the man is placed. Then if he presses with his hand or with a rod against D, a point nearer the centre than A, the scale will take the position AP′, and the same effect will be produced as if AD were a solid mass acting upon the lever in the direction of gravity. Consequently if P′ p be drawn perpendicular from the point P′ to FC, F p will be the lever with which the man in the scale tends to turn the lever round the fulcrum; and as F p is greater than FA, the man will preponderate. In the same way it may be shown, that if the man in the scale AP presses upwards against a point C, more remote from the fulcrum than A, he will diminish his relative weight, and the scale W will preponderate, for in this case the scale assumes the position AP″, and F p' becomes the lever by which it acts.

Theory.

62. Cor. 10. If a weight W be supported by an inclined lever resting on the fulcra A, B, the pressure upon A is to that upon B inversely, as A f is to f b, the sections of a horizontal line by the vertical direction of the weight W. Fig. 8.

Remove the fulcrum A, and support the extremity A by a weight P, equal to the pressure upon A; then B being the centre of motion, and $m\,n$ being drawn through F perpendicular to the direction of the forces A m, E f, and consequently parallel to A b, we have (Art. 51.) P : W=F n : F m=$f\,b$: f A, that is, the pressure upon A is to the pressure upon B inversely as A f is to f b.

Scholium.

63. Various attempts have been made by different writers on mechanics to give a complete and satisfactory demonstration of the fundamental property of the lever. The first of these attempts was made by Archimedes, who assumes as an axiom, that if two equal bodies be placed upon a lever, they will have the same influence in giving it a rotatory motion as if they were both placed in the middle part between them. This truth, however, is far from being self evident, and on this account Mr Vince * has completed the demonstration by making this axiom a preliminary proposition. The demonstration of Galileo † is both simple and elegant, and does not seem to have attracted much notice, though in principle it is exactly the same as that of Archimedes completed by Mr Vince. Galileo suspends a solid cylinder or prism from a lever by several threads. When the lever is hung by its centre, the whole is in equilibrio. He then supposes the cylinder to be cut into two unequal parts, which from their mode of suspension still retain their position, and then imagines each part of the cylinder to be suspended by its centre from the lever. Here then we have two unequal weights hanging at unequal distances from the centre of suspension, and it follows from the construction, that these weights are in the reciprocal ratio of their distances from that centre. Mr Vince, on the other hand, employs a cylinder balanced on a fulcrum. He supposes this cylinder divided into unequal parts, and thus concludes from his preliminary proposition, that these unequal parts have the same effect in turning the lever as if the weight of these parts was placed in their centres; which is done by Galileo by suspending them from their centres. From this the fundamental property of the lever is easily deduced.—The next demonstration was given by Huygens, who assumes as an axiom, that if any weight placed upon a lever is removed to a greater distance from the fulcrum, its effort to turn the lever will be increased. This axiom he might have demonstrated thus, and his demonstration would have been completely satisfactory, though it applies only to cases where the arms of the lever are commensurable. Let AB be a lever with equal weights C, D, supported on the fulcra f, F, so that A f=

Plate CCXVI. Fig. 1.

* *Phil. Transf.* 1794. p. 33

† *Discursus et Demonstrationes Mathemat.* Dial. ii. p. 98.

Theory.

$Af=FB$; then, as was shown in Prop. I. the weights will be in equilibrio, and each fulcrum will support a weight equal to C or D. By removing the fulcrum *f*, the weight C must descend, as the equilibrium is destroyed by a weight equal to C acting at *f*; therefore the weight C, at the distance AF, has a greater effect in turning the lever than an equal weight D placed at a less distance FB.—In Sir Isaac Newton's demonstration, it is supposed that if a given weight act in any direction, and if several radii be drawn from the fulcrum to the line of direction, the effort of that weight to turn the lever will be the same to whatever of these radii it is applied. It appears, however, from Art. 54. that this principle is far from being self-evident, and therefore the demonstration which is founded upon it cannot be admitted as satisfactory. The demonstration given by Maclaurin * is simple and convincing, and has been highly approved of by Dr T. Young, and other writers on mechanics, though it extends only to any commensurable proportion of the arms. He supposes the lever AB with equal arms to be in equilibrio upon the fulcrum F, by means of the equal forces P, W, in which case the fulcrum F will evidently be pressed down with a weight equal to $2\,P=P+W$. He then substitutes, instead of the weight P, a fixed obstacle O, which will not destroy the equilibrium, and *considers the fulcrum as still loaded with a weight equal to* $P+W$. The pressure on F being therefore equal to 2 P or $P+W$, a weight E equal to 2 P, and acting upwards, is substituted in the room of that pressure, so that the equilibrium will still continue. Here then we have a lever AB of the second kind, influenced by two forces E and W acting at different distances from the fulcrum A; and since $E=2\,P=2\,W$, and $AB=2\,AF$, we have $E:W=AB:AF$, which expresses the fundamental property of the lever. Without objecting to the circumstance that this demonstration applies only to the lever of the second kind, we may be allowed to observe, that it involves an axiom which cannot be called self-evident. It is certainly manifest that when P and W are in equilibrio, the pressure upon the fulcrum is $=2\,P=P+W$; but it by no means follows that this pressure remains the same when the fixed obstacle O is substituted in the room of P. On the contrary, the axiom assumed is a result of the proposition which it is employed to prove, or rather it is the proposition itself. For if, when the extremity A bears against the obstacle O, the pressure upon F is equal to 2 W, the force W obviously produces a pressure $=2\,W$ at half the distance AB, which is the property to be demonstrated. —The demonstrations given by Mr Landen and Dr Hamilton, the former in his Memoirs, and the latter in his Essays †, though in a great measure satisfactory, are long and tedious. In the demonstration of Dr Hamilton, he employs the following proposition; that when a body is at rest, and acted upon by three forces, they will be to one another as the three sides of a triangle parallel to the direction in which the forces act. When the three forces act on one point of a body, the proposition is true, but it is not applicable to the case of a lever where the forces are applied to three different points, and at all events the demonstratiion does not hold when any two of the forces act in parallel directions. The demonstration which we have given in Prop. I. is new, and different from any that have been noticed. The truths on which it is founded are perfectly axiomatic; and the only objection to which it seems liable is, that the demonstration extends only to a commensurate proportion of the arms of the lever.—An analytical demonstration of the fundamental property of the lever was given by Fonceneix in the Miscellan. Jour. tom. ii. p. 321. which was afterwards improved by D'Alembert in the Mem. de l'Acad. 1769. p. 283.

* *Account of Newton's Discoveries.*

Plate CCCXVII. Fig. 9.

† See also *Phil. Trans.* vol. xciii. p. 113.

Theory.

Prop. IV.

64. When several levers AB, ab, $\alpha\beta$, whose fulcra are F, f, φ, are so combined as to act perpendicularly upon each other, or at equal angles; and if the directions in which the power and weight are applied, be also perpendicular to the arms, or at the same angles with them as those at which the levers act upon each other, there is an equilibrium when $P:W=\overline{BF\times bf\times\beta\varphi}:\overline{AF\times af\times\alpha\varphi}$.

Plate CCCXVIII. Fig. 1.

Let M be the force which is exerted by the first lever AB upon the second ab, and N the force which is exerted by the second lever ab upon the third $\alpha\beta$, then by Prop. I.

$$P:M=BF:AF$$
$$M:N=bf:af$$
$$N:W=\beta\varphi:\alpha\varphi.$$

Consequently by composition

$$P:W=\overline{BF\times bf\times\beta\varphi}:\overline{AF\times af\times\alpha\varphi}.$$

Prop. V.

65. To explain the new property of the lever discovered by M. Æpinus, and extended by Van Swinden.

Let AFB be any lever whose fulcrum is F, and to whose extremities A, B are applied the forces P, W in the directions AY, BO. Join AB, and produce it on both sides towards E and I. Produce also the lines YA, VB till they meet in H, and from H, through the fulcrum F, draw HFf, dividing AB into two parts Af, Bf. Let UM be a line given in position, and let α, β represent the angles which the direction of the forces YA, VB make with that line. Let YA and VB likewise represent the intensity of the forces P, W, and let VA be resolved into AE and YF; and the force VB into BI and VI.—Then the lever cannot be in equilibrium till

Fig. 2.

I. $\overline{EA\times fA}+\overline{IB\times fB}$ is a maximum.

II. Or putting φ for the angles formed by the lines AB, UT, which the lever, when in equilibrio, makes with the line UM given in position, there cannot be an equilibrium till

$$\overline{\text{Tang.}\,\varphi\times P\times Af\times \text{Cos.}\,\alpha}+\overline{\text{Tang.}\,\varphi\times W\times Bf\times\text{Cos.}\,\beta}=\overline{W\times Bf\times\text{Sin.}\,\beta}-\overline{P\times Af\times\text{Sin.}\,\alpha}.$$

III. And

Theory. III. And putting a, b for the arms AF, BF, and m, n for the angles EAB, EBA, there cannot be an equilibrium unless Theory.

$$\text{Tang. } \varphi = \frac{W.\,b\,(\text{Sin. }\beta \times \text{Cos. } n - \text{Sin. } n \times \text{Cos. } \beta) - P.\,a\,(\text{Sin. } \alpha \times \text{Cos. } m - \text{Sin. } m \times \text{Cos. } \alpha)}{P.\,a\,(\text{Cos. } \alpha \times \text{Cos. } m + \text{Sin. } \alpha \times \text{Sin. } m) + W.\,b\,(\text{Cos. } \beta \times \text{Cos. } n + \text{Sin. } \beta \times \text{Sin. } n)}.$$

As the demonstrations of these different cases are far from being elementary, we shall only refer the reader to the memoir upon this subject given by Æpinus in the *Nov. Comment. Petropol.* tom. viii. p. 271.

Scholium.

66. This property of the lever was only considered by Æpinus in the case of a rectilineal lever with equal arms; but was extended by J. H. Van Swinden. When the lever is rectilineal and with equal arms, we have $AF = FB = Af = Bf$, and also $m = n = 0$, so that, if the last formula is suited to these conditions, we shall have the formula of Æpinus.

Prop. VI.

67. If a power and weight acting upon the arms of any lever be in equilibrio, and if the whole be put in motion, the velocity of the power is to the velocity of the weight as the weight is to the power.

Fig. 3. Let AFB be any lever whose fulcrum is F, and let the power P and weight W be applied to its extremities A, B, so as to be in equilibrio. Draw Fm, Fn perpendicular to AD, BE the direction of the forces P, W. Then suppose an uniform angular motion to be given to the lever, so as to make it describe the small angle AFA′, the position of the lever will now be A′FB′, and the directions of the forces, P, W will be A′D′, B′E, parallel to AD, BE respectively, since the angle AEF is exceedingly small. Join AA′, BB′, and from A′ and B′ draw A′x, B′z perpendicular to AD and BE. Now it is obvious, that though the point A has moved through the space AA′ in the same time that the point B has described the space BB′, yet Ax is the space described by A in the direction AD, and Bz the space described by B in the direction BE. For if we suppose a plane passing through A at right angles to AD, and another through P parallel to the former plane, it is manifest that Ax measures the approach of the point A to the plane passing through P; and for the same reason Bz measures the approach of the point B to a plane passing through W at right angles to WB. Therefore Ax, Bz represent the spaces uniformly and simultaneously described by the points A, B, and may therefore be taken to denote the velocities of these points (Dynamics, § 14.); consequently the velocity of A : the velocity of B = Ax : Bz. Now, in the triangles AxA′, FmA, the exterior angle xAF = AmF + mF, A (Euclid, B. I. Prop. 32.) and A′AF = AmF, because AFA′ is so exceedingly small that A′A is sensibly perpendicular to AF; consequently xAA′ = AEm: and as the angles at x and m are right, the triangles AxA′, AmF are similar (Geometry, Theor. XX. Sect. IV.).

Therefore, Ax : AA′ = Fm : FA, and in the similar triangles AFA′, BFB′ AA′ : BB′ = FA : FB, and in the similar triangles BB′z, BFn, BB′ : Bz = FB : Fn, therefore by composition we have Ax : Bz = Fm : Fn. But by Proposition II. P : W = Fn : Fm, consequently Ax : Bz = W : P, that is, the velocity of the power is to the velocity of the weight as the weight is to the power. Q. E. D.

68. Cor. Since Ax : Bz = W : P we have Ax × P = Bz × W, that is, the momenta of the power and weight are equal.

Sect. II. *On the Inclined Plane.*

69. Definition. An *inclined plane* is a plane surface AB, supported at any angle ABC formed with the horizontal plane BC. The *inclination of the plane* is the angle which one line in the plane AB forms with another in the horizontal plane BC, both these lines being at right angles to the common intersection of the two planes.—The line BA is called the *length of the plane*, AC its *height*, and BC the *length of its base*. Plate CCCXVIII fig. 4.

70. In order to understand how the inclined plane acts as a mechanical power, let us suppose it necessary to elevate the weight D from C to A. If this weight is lifted by the arms of a man to the point A, he must support the whole of the load; but when it is rolled up the inclined plane, a considerable part of its weight is supported upon the plane, and therefore a much smaller force is capable of raising it to A.

Prop. I.

71. When any weight W is kept in equilibrio upon an inclined plane by a power P, the power is to the weight as the sine of the plane's inclination is to the sine of the angle which the direction of the power makes with a line at right angles to the plane.

Let MN be the inclined plane, NO a horizontal line, and MNO the inclination of the plane, and let the weight W be sustained upon MN by means of the power P acting in the direction AE. From the point A, the centre of gravity of the weight, draw AB perpendicular to the horizontal plane ND, and AF perpendicular to MN; produce EA till it meets the plane in C, and from the point F where the body touches the plane draw Fm at right angles to AC, and Fn at right angles to AB. Then, since the whole body may be considered as collected in the centre of gravity A, AB will be the direction in which it tends to fall, or the direction of the weight, and EA is the direction of the power; but AF is a lever whose fulcrum is F, and since it is acted upon by two forces which are in equilibrio, we shall have (Art. 59.) P : W = Fn : Fm, that is, as the perpendiculars drawn from the fulcrum to the direction in which the forces act. Now FA being radius, Fn is the sine of the angle FAB, and Fm is the sine of the angle FAC; but FAB is equal to MNO the angle of the plane's inclination, on account of the right angles at F and B and the vertical angles at D; and FAC is the angle which the direction of the power makes with a line perpendicular to the plane; therefore P : W Fig. 5.

Theory.

as the fine of the plane's inclination, is to the fine of the angle formed by the direction of the power with a line at right angles to the plane.

72. Cor. 1. When the power acts parallel to the plane in the direction AE′, P is to W as EA to E n, that is, as radius is to the fine of the plane's inclination, or on account of the fimilar triangles FA n, MNO, as the length of the plane is to its height. In this cafe the power acts to the greateft advantage.

73. Cor. 2. When the power acts in a vertical line A ε, F m becomes equal to or coincides with F n, and we have P : W=F n : F n, that is, the power in this cafe fuftains the whole weight.

74. Cor. 3. When the power acts parallel to the bafe of the plane in the direction A e, P : W=F n : F f =F n : A n.

75. Cor. 4. When the power acts in the direction AF e' perpendicular to the plane, it has no power to refift the gravity of the weight; for the perpendicular from the fulcrum F, to which its energy is proportional, vanifhes.

76. Cor. 5. Since the body W acts upon the plane in a direction AF perpendicular to the plane's furface, (for its force downwards may be refolved into two, one parallel to the plane, and the other perpendicular to it), and fince the reaction of the plane muft alfo be perpendicular to its furface (Dynamics, § 149.), that is, in the direction FA, then, when the direction of the power is A e parallel to the horizon, the power, the weight, and the preffure upon the plane, will be refpectively as the height, the bafe, and the length of the plane. The weight W is acted upon by three forces; by its own gravity in the direction A n, by the reaction of the plane in the direction AF, and by the power P in the direction AF. Therefore, fince thefe forces are in equilibrio, and fince A f is parallel to n F, and F f to A n, the three fides AF, A f, F f, will reprefent the three forces (Dynamics, § 144.). But the triangle AF f is fimilar to A n F, that is, to MNO, for it was already fhewn that the angle n AF is equal to MNO, therefore, fince in the triangle AF f, AF reprefents the preffure on the plane, A f the weight of the body, and F f the energy of the power, thefe magnitudes will alfo be reprefented in the fimilar triangle MNO by the fides MN, MO, NO.

Fig. 6.

77. Cor. 6. If a power P and weight W are in equilibrio upon two inclined planes AB, AC; P : W= AB : AC. Let p be the power, which acting on the weight W in a direction parallel to the plane would keep it in equilibrio, then we have p : W=AD : AC; but fince the ftring is equally ftretched at every point, the fame power p will alfo fuftain the power P, confequently P : p=AB : AD, and by compofition P : W =AB : AC.

Prop. II.

78. If a fpherical body is fupported upon two inclined planes, the preffures upon thefe planes will be inverfely as the fines of their inclination, while the abfolute weight of the body is reprefented by the fine of the angle formed by the two planes.

Fig. 7.

Let AC, BC be the two inclined planes, and F the fpherical body which they fupport. The whole of its matter being fuppofed to be collected in its centre of gravity F, its tendency downwards will be in the vertical line FO. The reaction of the planes upon F is evidently in the direction MF, NF perpendicular to the furface of thefe planes, and therefore we may confider the body F as influenced by three forces acting in the directions FC, FM, FN; but thefe forces are reprefented by the fides of the triangle ABC perpendicular to their directions, (Dynamics, § 144.), confequently the abfolute weight of the body F, the preffure upon the plane AC, and the preffure upon the plane BC, are refpectively as AB, AC, and BC, that is, as the fines of the angles ACD, ABC, BAC, for in every triangle the fides are as the fines of the oppofite angles, or, to exprefs it in fymbols, W being the abfolute weight of the body, w the preffure on AC, and w' the preffure on BC,

$$W : w : w' = AB : AC : BC, \text{ or}$$
$$W : w : w' = \text{fin. } ACB : \text{fin. } ABC : \text{fin. } BAC.$$

But on account of the parallels AB, DF, the angle ABC=BCF, and BAC=ACD, therefore the preffures upon the planes are inverfely as the fines of their inclination, the abfolute weight of the body being reprefented by the fine of the angle formed by the furfaces of the two planes.

Corollaries.

79. Cor. 1. Since the two fides of a triangle are greater than the third, the fum of the relative weights fupported by the two planes is greater than the abfolute weight of the body.

80. Cor. 2. If the inclination of each plane is 60°, then ACB muft alfo be 60°, and the triangle ABC equilateral, confequently the preffure upon each plane is equal to the abfolute weight of the body.

81. Cor. 3. When the inclination of each plane increafes, the preffure which each fuftains is alfo increafed; and when their inclination diminifhes till it almoft vanifhes, the preffure upon each plane is one half of the abfolute weight of the body F.

Prop. III.

82. If a body is raifed with an uniform motion along an inclined plane, the velocity of the power is to the velocity of the weight as the weight is to the power.

Let the weight W be drawn uniformly up the inclined plane AB, from B to D, by a power whofe direction is parallel to DH. Upon DB defcribe the circle BFEDN, cutting BC in E, and having produced HD to F, join FP, FB, FE, and draw DC perpendicular to BD. Now the angles BFD, BED are right (Geometry, Sect. II. Theor. 17.), and therefore, though the power moves through a fpace equal to BD, yet its velocity in the direction DH is meafured by the fpace FD uniformly defcribed; and for the fame reafon, though the weight W defcribes the fpace BD, yet its velocity in the direction in which it acts, that is, in a vertical direction, is evidently meafured by the fpace DE uniformly defcribed. Then becaufe the triangle DBE is equal to DFE, (Geometry, Sect. II. Theor. 15.) and DBE=DCH, (Geometry, Sect. IV. Theor. 23.) and FDE=DHC, (Geometry, Sect. I. Theor. 21.)

Fig. 8.

Theory. 21.) the triangles DFE, DHC are similar, and (GEOMETRY, Sect. IV. Theor. 20.) DF : DE=DH : HC. But DH : HC=sin. DCH : sin. HDC, that is, (art. 71.) DF : DE, or the velocity of the power to the velocity of the weight, as W : P. Q. E. D.

SCHOLIUM.

83. The inclined plane, when combined with other machinery, is often of great use in the elevation of weights. It has been the opinion of some writers, that the huge masses of stone which are found at great altitudes in the splendid remains of Egyptian architecture, were raised upon inclined planes of earth, with the aid of other mechanical powers. This supposition, however, is not probable, as the immense blocks of granite which compose the pyramids of Egypt could not possibly have been raised into their present situation by any combination of the mechanical powers with which we are acquainted.—The inclined plane has been very advantageously employed in the duke of Bridgewater's canal. After this canal has extended 40 miles on the same level, it is joined to a subterraneous navigation about 12 miles long by means of an inclined plane, and this subterraneous portion is again connected by an inclined plane with another subterraneous portion about 106 feet above it. This inclined plane is a stratum of stone which slopes one foot in four, and is about 453 feet long. The boats are conveyed from one portion of the canal to another by means of a windlass, so that a loaded boat descending along the plane turns the axis of the windlass, and raises an empty boat.—A pair of stairs, and a road that is not level, may be regarded as inclined planes; and hence it is a matter of great importance in carrying a road to the top of a hill, to choose such a line that the declivity may be the least possible. The additional length, which, in order to effect this purpose must sometimes be given to the line of road is a trifling inconvenience, when compared with the advantages of a gentle declivity.

SECT. III. *On the Rope Machine.*

84. DEFINITION. When a body suspended by two or more ropes, is sustained by powers which act by the assistance of these ropes, this assemblage of ropes is called a *rope machine.*

PROP. I.

85. If a weight is in equilibrium with two powers acting on a rope machine, these powers are inversely as the sines of the angles which the ropes form with the direction of the weight.

Fig. 9. Let the weight W be suspended from the point B, where the ropes AB, BC are joined, and let the powers P, p acting at the other extremities of the ropes which pass over the pulleys A, C, keep this weight in equilibrio, we shall have P : p=sin. CBD : sin. ABD. Produce WB to F, and let BD represent the force exerted by W; then by drawing DE parallel to AB, the sides of the triangle BDE will represent the three forces by which the point B is solicited (DYNAMICS, § 144.), for AB, CB are the directions of the forces P and p. We have therefore P : p=DE : BE; but DE : BE=sin. DBE : sin. BDE, and on account of the parallels DE, AB, the angle BDE=ABD, consequently P : p=sin. DBE : sin. BDE. Theory.

86. COR. 1. When the line joining the pulleys is horizontal, as AC, then P : p=FC : FA, for FC and FA are evidently the sines of the angles DBE, BDE.

87. COR. 2. Any of the powers is to the weight, as the sine of the angle which the other makes with the direction of the weight, is to the sine of the angles which the power makes with one another. For since DB represents the weight, and BE the power P, we have BE : BD=sin. BDE : sin. BED; but on account of the parallels DE, AB, the angle DEB=ABC, the angle made by the direction of the powers, consequently BE : BD, that is, p : W=sin. ABF : sin. ABC. In the same way it may be shown that P : W=sin. CBF : sin. ABC. Hence we have P+p : W= $\overline{\text{sin. CBF+sin. ABF}}$: sin. ABC, that is, the sum of the powers is to the weight, as the sum of the sines of the angles which the powers make with the direction of the weight is to the sine of the angle which the powers make with one another.

88. COR. 3. The two powers P, p, are also directly proportional to the cosecants of the angles formed by the direction of the powers with the direction of the weight. For since P : p=sin. DBE : sin. BDE, and by the principles of trigonometry, sin. DBE : sin. DBE =cosec. BDE : cosec. DBE, we have P : p=cosec. ABF : cosec. CBF. It is also obvious that P : p as the secants of the angles which these powers form with the horizon, since the angles which they make with the horizon are the complements of the angles which they form with the direction of the weight, and the cosecant of any angle is just the secant of its complement, therefore P : p=sec. BAF : sec. BCF.

CHAP. II. *On Compound Machines.*

89. DEFINITION. Compound machines are those which are composed of two or more simple machines, either of the same or of different kinds. The number of compound machines is unlimited, but those which properly belong to this chapter, are, 1. The wheel and axle; 2. The pulley; 3. The wedge; 4. The screw; and, 5. The balance.

SECT. I. *On the Weeel and Axle.*

90. The *wheel and axle*, or the axis in peritrochio, is represented in fig. 9. and consists of a wheel AB, and cylinder CD having the same axis, and moving upon pivots E, F, placed at the extremity of the cylinder. The power P is most commonly applied to the circumference of the wheel, and acts in the direction of the tangent, while the weight W is elevated by a rope which coils round the cylinder CD in a plane perpendicular to its axis.—In this machine a winch or handle EH is sometimes substituted instead of the wheel, and sometimes the power is applied to the levers S, S fixed in the periphery of the wheel; but in all these forms the principle of the machine remains unaltered.—That the wheel and axle is an assemblage of levers will be obvious, by considering that the very same effect would be produced if a number of levers were to radiate Fig. 10.

Theory. diate from the centre C, and if a rope carrying the power P were to paſs over their extremities, and extricate itſelf from the deſcending levers when they come into a horizontal poſition.

91. Axiom. The effect of the power to turn the cylinder round its axis, is the ſame at whatever point in the axle it is fixed.

Prop. I.

92. In the wheel and axle the power and weight will be in equilibrium, when they are to one another reciprocally as the radii of the circles to which they are applied, or when the power is to the weight as the radius of the axle is to the radius of the wheel.

Fig. 11. Let AD be a ſection of the wheel, and BE a ſection of the axle or cylinder, and let the power P and weight W act in the directions AP, WP, tangents to the circumferences of the axle and wheel in the points A, B, by means of ropes winding round theſe circumferences. As the effect is the ſame according to the *axiom*, let the power and weight act in the ſame plane as they appear to do in the figure, then it is obvious that the effort of the power P and weight W will be the ſame as if they were ſuſpended at the points A, B; conſequently the machine may be regarded as a lever AFB, whoſe centre of motion is F. But ſince the directions of the power and weight make equal angles with the arms of the lever, we have (Art. 36.) $P : W = FB : FA$, that is, the power is to the weight as the radius of the axle is to the radius of the wheel.

Corollaries. 93. Cor. 1. If the power and weight act obliquely to the arms of the lever in the directions $A p$, $B w$, draw $F m$ $F n$ perpendicular to $A p$ and $B w$, and as in the caſe of the lever (Art. 51.) there will be an equilibrium when $P : W = F n : F m$. Hence the tangential direction is the moſt advantageous one in which the power can be applied, for FA is always greater than $F m$, and the leaſt advantageous direction in which the weight can be applied, for it then oppoſes the greateſt reſiſtance to the power.

94. Cor. 2. If the plane of the wheel is inclined to the axle at any angle x, there will be an equilibrium when $P : W =$ ſemidiameter of the axle : ſin. x.

95. Cor. 3. When the thickneſs of the rope is of a ſenſible magnitude, there will be an equilibrium when the power is to the weight as the ſum of the radius of the axle, and half the thickneſs of its rope, is to the ſum of the radius of the wheel and half the thickneſs of its rope; that is, if T be the thickneſs of the rope of the wheel, and t the thickneſs of the rope of the axle, there will be an equilibrium when $P : W = \overline{FB+\frac{1}{2}t} : \overline{FA+\frac{1}{2}T}$.

96. Cor. 4. If a number of wheels and axles are ſo combined that the periphery of the firſt axle may act on the periphery of the ſecond wheel, either by means of a ſtring or by teeth fixed in the peripheries of each, and the periphery of the ſecond axle on the periphery of the third wheel, there will be an equilibrium when the power is to the weight as the product of the radii of all the axles is to the product of the radii of all the wheels. This corollary may be demonſtrated by the ſame reaſoning which is uſed in Art. 63. for the combination of Levers. Theory.

97. Cor. 5. In a combination of wheels, where the motion is communicated by means of teeth, the axle is called the *pinion*. Since the teeth therefore muſt be nearly of the ſame ſize, both in the wheel and pinion, the number of teeth in each will be as their circumferences, or as their radii; and conſequently in the combination mentioned in the preceding corollary, the power will be to the weight, in the caſe of an equilibrium, as the product of the number of teeth in all the pinions is to the product of the number of teeth in all the wheels.

Prop. II.

98. In the wheel and axle the velocity of the weight is to the velocity of the power as the power is to the weight.

If the power is made to riſe through a ſpace equal to the circumference of the wheel, the weight will evidently deſcribe a ſpace equal to the circumference of the axle. Hence, calling V the velocity of the power, v that of the weight, C the circumference of the wheel, and c that of the axle, we have $V : v = C : c$. But by the propoſition $P : W = c : C$, therefore $P : W = v : V$.

Scholium.

99. The conſtruction of the main-ſpring box of the fuſee of a watch round which the chain is coiled, is a beautiful illuſtration of the principle of the wheel and axle. The ſpring-box may be conſidered as the wheel, and the fuſee the axle or pinion to which the chain communicates the motion of the box. The power reſides in the ſpring wound round an axis in the centre of the box, and the weight is applied to the lower circumference of the fuſee. As the force of the ſpring is greateſt when it is newly wound up, and gradually decreaſes as it unwinds itſelf, it is neceſſary that the fuſee ſhould have different radii, ſo that the chain may act upon the ſmalleſt part of the fuſee when its force is greateſt, and upon the largeſt part of the fuſee when its force is leaſt, for the equable motion of the watch requires that the inequality in the action of the ſpring ſhould be counteracted ſo as to produce an uniform effect. In order to accompliſh this, the general outline of the ſurface of the fuſee muſt be an Apollonian hyperbola in which the ordinates are inverſely as their reſpective abſciſſæ. For further information on this ſubject, ſee *Recherches des Mathemat. par M. Parent.* tom. ii. p. 678.; *Traitè d'Horlogerie, par M. Berthoud*, tom. i. chap. 26.; and *Traitè de Mecanique, par M. de la Hire*, prop. 72. On the fuſee of a watch.

Sect. II. *On the Pulley.*

100. Definition.—The pulley is a machine compoſed of a wheel with a groove in its circumference, and a rope which paſſes round this groove. The wheel moves on an axis whoſe extremities are ſupported on a kind of frame called the block, to which is generally ſuſpended the weight to be raiſed. A ſyſtem of pulleys is called a *muffle*, which is either fixed or moveable according as the block which contains the pulleys is fixed or moveable. On the pulley.

Theory.

Prop. I.

101. In a ſingle pulley, or ſyſtem of pulleys where the different portions of the rope are parallel to each other, and where one extremity of it is fixed, there is an equilibrium when the power is to the weight as unity is to the number of the portions of the rope which ſupport the weight.

Fig. 12. 102. Case 1. In the ſingle fixed pulley AA let the power P and weight W be equal, and act againſt each other by means of the rope PBAW, paſſing over the pulley AA; then it is obvious that whatever force is exerted by P in the direction PBA, the ſame force muſt be exerted in the oppoſite direction WBA, conſequently theſe equal and oppoſite forces muſt be in equilibrio; and as the weight is ſupported only by one rope, the propoſition is demonſtrated, for $P : W = 1 : 1$.

Fig. 13. 103. Case 2. In the ſingle moveable pulley, where the rope, faſtened at H, goes beneath the moveable pulley D and over the fixed pulley C, the weight to be raiſed is ſuſpended from the centre of the pulley D by the block p, and the power is applied at P in the direction PE. Now it is evident that the portions CFp, HGD of the rope ſuſtain the weight W, and as they are equally ſtretched in every point, each muſt ſuſtain one half of W; but (Caſe 1.) in the ſingle pulley C the rope CEP ſuſtains a weight equal to what the rope CFp ſuſtains; that is, it ſuſtains one-half of W. Conſequently $P = \frac{1}{2}W$, or $W = 2P$, when there is an equilibrium; and ſince the weight W is ſupported by *two* ſtrings, we have $P : W = 1 : 2$.

Fig. 14. 15. 16. 104. Case 3. When the ſame rope paſſes round a number of pulleys, the ropes which ſupport the weight W are evidently equally ſtretched in every part, and therefore each of them ſuſtains the ſame weight. Conſequently if there be *ten* ropes ſupporting the weight, each ſuſtains $\frac{1}{10}$th part of the weight, and therefore $P = \frac{1}{10}W$, or $W = 10P$, which gives us $P : W = 1 : 10$. —The pulley in fig. 15. is the patent pulley invented by Mr White, in which the lateral friction and ſhaking motion is conſiderably removed.

Prop. II.

105. In a ſyſtem of n moveable pulleys ſuſpended by ſeparate and parallel ropes, there is an equilibrium when $P : W = 1 : 2^n$; that is, if there are 4 pulleys $n = 4$, and $P : W = 1 : 2 \times 2 \times 2 \times 2$, or $P : W = 1 : 16$.

Fig. 17. This ſyſtem is repreſented in fig. 17. where the rope which carries the power P paſſes over the fixed pulley M, and beneath the moveable pulley A, to the hook E where it is fixed. Another rope fixed at A paſſes over B and is fixed at F, and ſo on with the reſt. Then by Art. 103.

P : the weight at $A = 1 : 2$
The weight at A : the weight at $B = 1 : 2$
The weight at B : the weight at $C = 1 : 2$
The weight at C : the weight at D or $W = 1 : 2$; and therefore by compoſition

$P : W = 1 : \overline{2 \times 2 \times 2 \times 2}$ or $P : W = 1 : 16$. Q. E. D.

Prop. III.

106. In a ſyſtem of moveable pulleys whoſe number is n, ſuſpended by ſeparate and parallel ropes, whoſe extremities are fixed to the weight W, there is an equilibrium when $P : W : 1 : 2^n - 1$.

In this ſyſtem of pulleys, the rope which ſuſtains the power P paſſes over the pulley C, and is fixed to the weight at D. Another rope attached to the pulley C paſſes over the pulley B and is fixed to the weight at E, and a third rope faſtened to B paſſes over A and is fixed at F. Then it is manifeſt that the rope CD ſuſtains a weight equal to P; and ſince the pulley C is pulled downward with a weight equal to 2P, the rope BC muſt ſupport a weight equal to 2P, and the rope B the ſame weight; conſequently the rope AB ſuſtains 4P. The whole weight therefore is $P + 2P + 4P$, and hence $P : W = P : P + 2P + 4P$, or $P : W = 1 : 1 + 2 + 4$ &c. to n terms, ſo that $P : W = 1 : 2_n - 1$. Fig. 18.

Prop. IV.

107. In the ſyſtem of pulleys repreſented in fig. 19. and called a Spaniſh barton, in which two pulleys are ſupported by one rope, there is an equilibrium when $P : W = 1 : 4$. Fig. 19.

In this combination of pulleys, the rope AB which ſupports the power P paſſes over the moveable pulley A, and beneath C towards H, where it is fixed. Another rope, attached to the pulley A, paſſes over the fixed pulley B, and is faſtened at E to the pulley C, which ſupports the weight W. Then, ſince the rope AP ſupports 1 pound, the rope AC alſo ſupports 1 pound, and therefore the pulley A, or the rope BA, is pulled down with a force of 2 pounds. But the rope BDE is equally ſtretched with BA, conſequently the pulley C, to which DE is attached, is pulled upwards with a force of 2 pounds. Now the rope AC ſupporting 1 pound, the rope GH muſt likewiſe ſupport 1 pound, conſequently, ſince DE ſuſtains 2 pounds, AC 1 pound, and HG 1 pound, they will together ſuſtain $W = 4$ pounds, and therefore $P : W = 1 : 4$.

Prop. V.

108. In the ſyſtem of pulleys repreſented in fig. 20. called a Spaniſh barton, where two pulleys are ſupported by one rope, there is an equilibrium when $P : W = 1 : 5$. Fig 20.

In this ſyſtem the rope PB paſſes over B round C, and is fixed at E. Another rope attached to B paſſes round AF and is fixed at I to the pulley CD, which carries the weight W. Now the rope BP being ſtretched with a force of 1 pound, the ropes BGC, CDE are alſo ſtretched with a force of 1 pound each, and the pulley CD is pulled upwards with a force of 2 pounds. But ſince the three ropes BP, ED, and GC, are each ſtretched with a force of 1 pound, the pulley B and the rope BA, upon which they all act in one direction, muſt be pulled down with a force of 3 pounds. Now the rope FI is equally ſtretched with BA, conſequently it will draw the pulley CD upwards with a force of 3 pounds,

Theory.

pounds, and ſince it is drawn upwards by the ropes CG, DF, with a force of two pounds, the whole force will ſuſtain W=5 pounds; but this force of 5 pounds is by the hypotheſis in equilibrio with P or 1 pound, conſequently P : W=1 : 5.

PROP. VI.

Plate CCCXIX. fig. 1.

109. When the ropes are not parallel, and when two powers are in equilibrio with a weight by means of a pulley, and have their directions at equal angles to the direction of the weight, each of theſe powers is to the weight as the radius of the pulley is to the chord of that portion of the pulley's circumference with which the rope is in contact.

Let the weight W ſuſpended from C be ſuſtained in equilibrio by two powers P, p, which act by a rope PCFEp paſſing over the pulley CHEF, and touching the arch CFE of its circumference. Then ſince the angles PWD, pWD are equal, and the powers P, p in equilibrio, P muſt be equal to p; and making WA =WB, and drawing AI parallel to PW, and BI parallel to pW; WB, BI, WI will reſpectively repreſent the forces P, p, W or P : p : W=WB : BI : WI, DYNAMICS, Art. 144. Now the triangles WBI, CDE having their reſpective ſides at right angles to each other, are ſimilar; conſequently WB : BI : WI=CD : DE : EC, that is, P : p : W=CD : DE : EC; but CD, DE are equal to radius, and EC is obviouſly the chord of the arch CFE, therefore P : W or p : W as radius is to the chord of the arch with which the rope is in contact.

110. COR. 1. Any of the powers is alſo to the weight as radius is to twice the coſine of the angle which either rope makes with the direction of the weight. For ſince CG is the coſine of DCG, and ſince CE is double of CG, CE is equal to 2 coſine DCG =2 Coſ. PWD; but P : W=CD : CE, hence we have by ſubſtituting the preceding value of CE, P : W=CD or radius : 2 Coſ. PWD.

SCHOLIUM.

111. By means of this propoſition and corollary, the proportion between the powers and the weight in the various ſyſtems of pulleys, repreſented in fig. 12, 13, 14, 15, 16, 17, 18, 19, 20. when the ropes are not parallel, may be eaſily found.

PROP. VII.

112. In a ſyſtem of moveable pulleys, where each has a ſeparate rope, and where the ropes are not parallel, there is an equilibrium when the power is to the weight as radius is to the coſines of half the angles made by the rope of each pulley, multiplied into that power of 2 whoſe exponent is the number of pulleys.

Fig. 2

Let the power P ſuſtain the weight W by means of the pulleys A, B, C; let P, p, π be the different powers which ſupport the pulleys A, B, C, and let MAP, NBA, RCB be the angles formed by the ropes. Then, by the laſt propoſition,

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$$P : p = \text{rad.} : 2\,\text{coſ. } MAP$$
$$p : \pi = \text{rad.} : 2\,\text{coſ. } NBA$$
$$\pi : W = \text{rad.} : 2\,\text{coſ. } RCB, \text{ conſequently}$$
$$P : W = \text{rad.} : \overline{2\,\text{coſ. } MAP} \times \overline{2\,\text{coſ. } NBA} \times \overline{2\,\text{coſ. } RCB},$$

or, which is the ſame thing,

$$P : W = \text{rad.} : \overline{2 \times 2 \times 2} \times \text{coſ. } MAP \times \text{coſ. } NBA \times \text{coſ. } RCB.$$

PROP. VIII.

113. In a ſingle pulley, or in a combination of pulleys, the velocity of the power is to the velocity of the weight as the weight is to the power.

114. CASE 1. In the ſingle fixed pulley, it is obvious, that if the weight W is raiſed uniformly one inch, the power D will alſo deſcribe one inch, conſequently velocity of P : velocity of W=W : P. Fig. 12.

115. CASE 2. In the ſingle moveable pulley, when the weight W is raiſed one inch, the ropes become one inch ſhorter; and ſince the rope has always the ſame weight, the power muſt deſcribe two inches, therefore velocity P : velocity W=W : P. Fig. 13.

116. CASE 3. In the combination of pulleys, in figs. 14, 15, 16, when the weight riſes one inch, each of the four ſtrings becomes an inch ſhorter, ſo that P muſt deſcribe four inches, as the length of the rope is invariable; conſequently velocity P : velocity W= W : P. Figs 14, 15, 16.

117. CASE 4. In the ſyſtem exhibited in fig. 17. it is evident, that when the weight W riſes one inch, the rope DC is lengthened two inches, the rope CB four inches, the rope BA eight inches, and the rope AFP, to which the power is ſuſpended, 16 inches; ſo that ſince the power of this pulley is as 16 to 1, we have velocity P : velocity W=W : P. Fig. 17.

118. CASE 5. In the combination of pulleys, repreſented in fig. 18. when the weight W riſes one inch, all the three ropes CD, BE, AF are each ſhortened one inch. But while CD ſhortens one inch, CP becomes *one inch longer*; while BE ſhortens one inch, BC becomes one inch longer, and CP *two inches* longer (art. 110.); and while AF ſhortens one inch, AB becomes one inch longer, BC two inches longer, and CP *four inches* longer; therefore CP is lengthened altogether ſeven inches, and as the power of the pulley is as 7 to 1, we have, as before, velocity P : velocity W=W : P. Fig. 18.

119. CASE 6. In the ſyſtem of pulleys, called the Spaniſh barton, fig. 19. when the weight W riſes one inch, the three ropes AC, DE, HG are each ſhortened one inch. By the ſhortening of HG, CA one inch each, the rope AP is lengthened *two inches*; and by the ſhortening of DE one inch, BA is lengthened one inch, and AP *two inches* (art. 115.); conſequently, ſince AP is lengthened in all four inches, and ſince the power of the pulleys is four, we have velocity P : velocity W=W : P. Fig. 19.

120. CASE 7. In the other Spaniſh barton, in fig. 20. when the weight is elevated one inch, the three ropes DE, IF, CG are each one inch ſhorter. While ED, and CG ſhorten one inch each, BP is lengthened *two inches*, Fig. 20.

Theory. *inches*, and while IF becomes one inch ſhorter, AB becomes one inch longer; but when AB is lengthened one inch, BP becomes one inch longer, and ED, CG one inch ſhorter each, and by this ſhortening of ED, CG, the rope B is lengthened two inches, therefore, ſince the rope BP is lengthened altogether five inches, and ſince the pulleys have a power of five, we have, as formerly, velocity P : velocity W=W : P.

Sect. III. *On the Wedge.*

121. Definition. A wedge is a machine compoſed of two inclined planes with their baſes in contact; or, more properly, it is a triangular priſm, generated by the motion of a triangle, parallel to itſelf, along a ſtraight line paſſing through the vertex of one of its angles. The wedge is called *iſoſceles*, *rectangular*, or *ſcalene*, according as the triangle ABC by which the wedge is generated, is an iſoſceles, a rectangular or a ſcalene triangle. The part AB is called the head or back of the wedge, DC its altitude, and AC, BC its faces.—The wedge is generally employed for cleaving wood, or for quarrying ſtones; but all cutting inſtruments, ſuch as knives, ſwords, chiſels, teeth, &c. properly belong to this mechanical power, when they act in a direction at right angles to the cutting ſurface; for when they act obliquely, in which caſe their power is increaſed, their operation reſembles more the action of a ſaw.

Plate CCXIX fig. 3.

Prop. I.

122. If each of the faces of an iſoſceles wedge, which are perfectly ſmooth, meet with an equal reſiſtance from forces acting at equal angles of inclination to their faces, and if a power act perpendicularly upon the back, theſe forces will be in equilibrio, when the power upon the back is to the ſum of the reſiſtances upon the ſides, as the ſine of half the angle of the wedge, multiplied by the ſine of the angle at which the reſiſting forces act upon its faces, is to the ſquare of radius.

Fig. 3. Let ABC be the wedge, AC, BC its acting faces, and MD, ND the directions in which the reſiſting forces act upon theſe faces, forming with them the equal angles DMA, DNB. Draw CD, DF, DE at right angles to three ſides of the wedge, and join F, E meeting CD in G. On account of the equal triangles CAD, CDB (Euclid, Book i. Prop. 26.) AD=DB; and in the equal triangles ADM, BDN, MD=ND. In the ſame way DF=DE and AF=BE, therefore CF=CE. But in the triangles CFG, CEG there are two ſides FC, CG equal to EC, CG, and the angle FCG=ECG, conſequently FG=GE, and FGC, ABC are both right angles, therefore FE is parallel to AB.—Now the force MD is reſolvable into DF, FM, of which FM has no effect upon the wedge. But, as the effective force FD is not in direct oppoſition to the perpendicular force exerted on the back of the wedge, we may reſolve it into the two forces FG, GD, of which GD acts in direct oppoſition to the power, while FG acts in a direction parallel to the back of the wedge. In the ſame way it may be ſhewn that EG, GD are the only effective forces which reſult from the force ND. But the forces FG, EG being equal and oppoſite, deſtroy each other; conſequently 2GD is the force which oppoſes that which is exerted upon the back of the wedge, and the wedge will be kept at reſt if the force upon the back is equal to 2GD, that is, when the force upon the back is to the ſum of the reſiſtances upon the faces as 2GD is to MD+ND, or as 2GD : 2DM, or as GD is to DM. Now

DG : DF = ſin. DFG : radius, or as (Euclid, vi. 8.) ſin. DCF : radius, and

DF : MD=ſin. DMF : radius; therefore by compoſition,

DG : MD= ſin. DCF × ſin. DMF : rad. × rad. or $\overline{\text{rad.}}|^2$. But, DG : MD as the force upon the back is to the ſum of the reſiſtances, therefore the force upon the back is to the ſum of the reſiſtances as ſin. DCF × ſin. DMF is to the ſquare of the radius.

Corollaries. 123. Cor. 1. If the direction of the reſiſting forces is perpendicular to the faces of the wedge, DMF becomes a right angle, and therefore its ſine is equal to radius. Conſequently we have, in this caſe, the force upon the back to the ſum of the reſiſtances, as ſin. DCF × rad. is to $\overline{\text{radius}}|^2$, that is, as ſin. DCF is to radius, or as AD half the back of the wedge is to AC the length of the wedge.

124. Cor. 2. In the particular caſe in the propoſition, it is obvious that the forces MF, NE are not oppoſed by any other forces, and therefore the force upon the back will not ſuſtain the reſiſting forces; but in the caſe in cor. 2. the forces MF, NE vaniſh, and therefore the other forces will ſuſtain each other.

125. Cor 3. If the reſiſting forces act in a direction perpendicular to AB, the angle DMF becomes equal to ACD, and therefore the force upon the back is to the ſum of the reſiſtances as ſin. $\overline{\text{ACD}}|^2$ is to $\overline{\text{radius}}|^2$, that is, as the ſquare of AD half the back of the wedge is to the ſquare of AC the length of the wedge.

126. Cor. 4. When the direction of the reſiſtances is parallel to the back of the wedge, the angle of inclination DMC becomes the complement of the ſemiangle of the wedge, and therefore the force upon the back is to the ſum of the reſiſtanees as the ſin. ACD × coſ. ACD is to the ſquare of the radius, that is, as DA × DC is to $\overline{AC}^2$. But in the ſimilar triangles DAF, DAC, we have DF : DA=DC : AC, and DF × AC=DA × DC, conſequently the force upon the back of the wedge is to the ſum of the reſiſtances as DF × AC is to $\overline{AC}^2$, that is, as DF : AC.

Prop. II.

127. If, on account of the friction of the wedge, or any other cauſe, the reſiſtances are wholly effective, that is, if the reſiſting ſurfaces adhere to the places to which they are applied without ſliding, there will be an equilibrium, when the force upon the back is to the ſum of the reſiſtances, as the ſine of the acute angle which the direction of the reſiſting forces makes with the back of the wedge is to radius. Fig.

Join MN, which will cut DC perpendicularly at the point

Theory.

point H. Then, since the forces MD, ND are resolvable into MH, HD and into NH, HD, and since MH, HN destroy each other, the force upon the back is sustained by 2 HD. Consequently, the force upon the back is to the sum of the resistances as 2 HD is to 2 MD, or as HD is to MD. But the angle ADM, which the direction of the forces makes with the back of the wedge, is equal to DMN, and HD is the sine of that angle, MD being radius, therefore the force upon the back is to the sum of the resistances as sin. ADM : radius. Q. E. D.

Corollaries. 128. Cor. 1. Since the angle $AMD=MDC+MCD$, the angle MDC is the difference between MCD the semiangle of the wedge, and AMD the angle which the direction of the resisting forces makes with the face of the wedge, and since HD is the cosine of that angle, MD being radius, we have the force upon the back to the sum of the resistances, as the cosine of the difference between the semiangle of the wedge and the angle which the direction of the resisting forces makes with the face of the wedge, is to radius.

Prop. III.

129. When there is an equilibrium between three forces acting perpendicularly upon the sides of a wedge of any form, the forces are to one another as the sides of the wedge.

This is obvious from Dynamics, § 144. Cor. 2. where it is shewn that when three forces are in equilibrio, they are proportional to the sides of a triangle, which are respectively perpendicular to their directions.

Prop. IV.

130. When the power acting upon the back of a wedge is in equlibrio with the resistances opposed to it, the velocity of the power is to the velocity of the resistance as the resistance is to the power.

Fig. 3. Produce DM to K, and draw CK perpendicular to DK. Then, by Art. 122. the power is to the resistance as MD : DH. Let the wedge be moved uniformly from D to C, and DK is the space uniformly described by the resisting force in the direction in which it acts; therefore, the velocity of the power is to the velocity of the resistance as DC : DK; that is, on account of the equiangular triangles DHM, DKC, as MD : DH; that is, as the resistance is to the power.

Sect. IV. *On the Screw.*

131. Definition. A screw is a cylinder with an inclined plane wrapped round it, in such a manner, that the surface of the plane is oblique to the axis of the cylinder, and forms the same angle with it in every part of the cylindrical surface. When the inclined plane winds round the exterior surface of a solid cylinder, it is called a male screw; but when it is fixed on the interior circumference of a cylindrical tube, it is called a female screw. In the female screw, the spiral grooves formed by the inclined plane on the surface of the cylindrical tube, must be equal in breadth to the inclined

plane in the male screw, in order that the one may move freely in the other. By attending to the mode in which the spiral threads are formed by the circumvolution of the inclined plane, it will appear, that if one complete revolution of the inclined plane is developed, its altitude will be to its base as the distance between the threads is to the circumference of the screw. Thus, let *a b c* (fig. 4.) be the inclined plane, whose base is *a c* and altitude *b c*, and let it be wrapped round the cylinder MN (fig. 5.) of such a size that the points *a*, *c* may coincide. The surface *ab* of the plane (fig. 4.) will evidently form the spiral thread *a d e b* (fig. 5.), and *ab* the distance between the threads will be equal to *bc* (fig. 4.) the altitude of the plane, and the circumference of the screw MN will be equal to *ac* the base of the plane. If any body, therefore, is made to rise along the plane *adeb* in fig. 5. or along the spiral thread of the screw, by a force acting in a direction parallel to *adcb*, there will be the same proportion between the power and the resistance as if the body ascended the plane *abc* (fig. 4.). Fig. 4.

132. A male screw with triangular threads is represented by AB (fig. 6.), and its corresponding female screw by AB (fig. 7.). A male screw with quadrangular threads is exhibited in fig. 8. and the female screw in which it works in fig. 9. The friction is considerably less in quadrangular than in triangular threads, though, when the screw is made of wood, the triangular threads should be preferred. When the screws are metallic and large, the threads should be quadrangular; but the triangular form is preferable in small screws. When the screw is employed in practice, the power is always applied to the extremity of a lever fixed in its head. This is shewn in fig. 10. where AB is the lever acting upon the screw BC, which works in a female screw in the block F, and exerts its force in bending the spring CD. Fig. 6, 7. Fig. 8, 9. Fig. 10.

Prop. I.

133. If the screw is employed to overcome any resistance, there will be an equilibrium when the power is to the resistance as the distance between two adjacent threads is to the circumference described by the power.

Let FAK be a section of the screw represented in fig. 8. perpendicular to its axis; CD a portion of the inclined plane which forms the spiral thread, and P the power, which, when applied at C in the plane ACF, will be in equilibrium with a weight upon the inclined plane CD. Then, in the inclined plane, when the direction of the power is parallel to the base, we have (Art. 72.) P : W, as the altitude of the plane is to the base, or (Art. 131.) as the distance between two threads is to the whole circumference FKCF. If we suppose another power P′ to act at the end of the lever AB, and describe the arch HBG, and that this power produces the same effect at B as the power P did at C, then (Art. 36.), we have $P' : P=CA : BA$, that is, as FKCF is to the circumference HBG; but it was shewn before, that $P : W=$ as the distance between two contiguous threads is to FKCF; therefore, by composition, P′ : W as the distance between two threads is to HBG or the circumference of a circle whose radius is AB. Q. E. D. Fig. 11.

134. Cor. 1. It is evident from the proposition that the

Theory. the power does not in the leaſt depend upon the ſize of the cylinder FCK, but that it increaſes with the diſtance of that point from the centre A, to which the power is applied, and alſo with the ſhortneſs of the diſtance between the threads. Therefore, if P, p be the powers applied to two different ſcrews, D, d the diſtances of theſe powers from the axis, and T, t the diſtances between the threads; their energy in overcoming a given reſiſtance will be directly as their diſtances from the axis, and inverſely as the diſtances of their threads, that is, $P : p = \frac{D}{T} : \frac{d}{t}$, or P varies as $\frac{D}{T}$.

Prop. II.

135. **In the endleſs ſcrew, there will be an equilibrium when the power is to the weight, as the diſtance of the threads multiplied by the radius of the axle, is to the diſtance of the power from the axis of the ſcrew multiplied by the radius of the wheel.**

Fig. 12. The endleſs ſcrew, which is repreſented in fig. 12. conſiſts of a ſcrew EF, ſo combined with the wheel and axle ABC, that the threads of the ſcrew may work in teeth fixed in the periphery of the wheel, and thus communicate the power exerted at the handles or winches P, p. Let W′ repreſent the power produced by the ſcrew at the circumference of the wheel; then, by the laſt propoſition, P : W′ as the diſtance between the threads is to the diſtance of P from the axis of the ſcrew; but (Art. 92.) in the wheel and axle W′ : W as the radius of the axle is to the radius of the wheel; therefore, by compoſition, P : W as the diſtances of the threads multiplied by the radius of the axle C, is to the diſtance of the power P from the axis multiplied by the radius of the wheel AB.

Prop. III.

136. **When there is an equilibrium in the ſcrew, the velocity of the weight is to the velocity of the power, as the power is to the weight.**

Fig. 11. It is obvious from fig. 11. that while the power deſcribes the circumference of the circle HBG uniformly, the weight uniformly riſes through a ſpace equal to the diſtance between two adjacent threads; therefore, the velocity of the power is to the velocity of the weight as the diſtance between the threads is to the arch deſcribed by the power, that is, (by Art. 133.), as the weight is to the power.

Prop. IV.

137. **To explain the conſtruction and advantages of Mr Hunter's double ſcrew *.**

* See *Phil. Tranſ.* vol. lxxi. p. 58.

Fig. 13. Let the ſcrew CD work in the plate of metal BA, and have n threads in an inch: the cylinder CD, of which this ſcrew is formed, is a hollow tube, which is alſo formed into a ſcrew, having $\overline{n+1}$ threads in an inch, and into this female ſcrew is introduced a male ſcrew DE, having, of courſe, $\overline{n+1}$ threads in an inch. The ſcrew DE is prevented from moving round with CD by the frame ABGF and the croſs bar $a\,b$, but is permitted to aſcend and deſcend without a motion of rotation. Then, by a revolution of the ſcrew CD, the other ſcrew DE will riſe through a ſpace equal to $\frac{1}{\overline{n+1}\times n}$, and if the circumference deſcribed by the lever CK be m inches, we ſhall have $P : W = \frac{1}{\overline{n+1}\times n} : m$; or $P : W = 1 : m\,n\times\overline{n+1}$. Theory.

138. This reaſoning will be more perſpicuous by ſuppoſing n, or the number of threads in CD, to be 12, and $\overline{n+1}$, or the number of threads in DE, will conſequently be 13. Let us ſuppoſe that the handle CK is turned round 12 times, the ſcrew CD will evidently aſcend through the ſpace of an inch, and if the ſcrew DE is permitted to have a motion of rotation along with CD, it will alſo advance an inch. Let the ſcrew DE be now moved backwards by 12 revolutions, it will evidently deſcribe a ſpace of $\frac{12}{13}$ of an inch, and the conſequence of both theſe motions will be that the point E is advanced $\frac{1}{13}$ of an inch. But, ſince DE is prevented from moving round with CD, the ſame effect will be produced as if it had moved 12 times round with CD, and had been turned 12 times backwards; that is, it will in both caſes have advanced $\frac{1}{13}$ of an inch. Since, therefore, it has advanced $\frac{1}{13}$ of an inch in 12 turns, it will deſcribe only $\frac{1}{12}$ of $\frac{1}{13}$, or $\frac{1}{156}$ of an inch uniformly at one turn; but if the length of the lever CK is 8 inches, its extremity K will deſcribe, in the ſame time, a ſpace equal to $16\times 3.1416 = 50.2656$ inches, the circumference of the circle deſcribed by K; therefore the velocity of the weight is to the velocity of the power, as $\frac{1}{156}$ of an inch is to 50.2656 inches, or as 1 is to 7841.4336, that is, (Art. 136.) P : W = 1 : 7841.4336. Hence the force of this double ſcrew is much greater than that of the common ſcrew, for a common one with a lever 8 inches long muſt have 156 threads in an inch to give the ſame power, which would render it too weak to overcome any conſiderable reſiſtance.

139. Mr Hunter propoſes * to connect with his double ſcrews, a wheel and a lantern, which are put in motion by a winch or handle. The power of this compound machine is ſo great, that a man, by exerting a force of 32 pounds at the winch, will produce an effect of 172100 pounds; and if we ſuppoſe $\frac{2}{3}$ of this effect to be deſtroyed by friction, there will remain an effect of 57600 pounds.—In ſome ſcrews it would be advantageous, inſtead of perforating the male ſcrew CD, to have two cylindrical ſcrews of different kinds at different parts of the ſame axis.

* *Phil. Tranſ.* vol. lxxi. p. 65.

Scholium.

140. The ſcrew is of extenſive uſe as a mechanical power, when a very great preſſure is required, and is very ſucceſsfully employed in the printing preſs. In the preſs which is uſed for coining money, the power of the ſcrew is advantageouſly combined with an impulſive force, which is conveyed to the ſcrew by the intervention of a lever. The ſcrew is alſo employed for raiſing water, in which form it is called the ſcrew of Archimedes (Hydrodynamics, § 328); and it has been lately employed in the flour mills in America for puſhing the flour which comes from the millſtones, to the end of a long trough, from which it is conveyed to other parts of

Theory.

of the machinery, in order to undergo the remaining proceffes. In this cafe, the fpiral threads are very large in proportion to the cylinder on which they are fixed.

141. As the lever attached to the extremity of the fcrew moves through a very great fpace when compared with the velocity of its other extremity, or of any body which it puts in motion; the fcrew is of immenfe ufe in fubdividing any fpace into a great number of minute parts. Hence it is employed in the engines for dividing mathematical inftruments, and in thofe which have been recently ufed in the art of engraving. It is likewife of great ufe in the common wire micrometer, and in the divided object-glafs micrometer, inftruments to which the fcience of aftronomy has been under great obligations. See MICROMETER.

SECT. V. *On the Balance.*

Plate CCCXX. Fig. 1.

142. DEFINITION. The balance, in a mathematical fenfe, is a lever of equal arms, for determining the weights of bodies.—The phyfical balance is reprefented in fig. 1. where FA, FB are the equal arms of the balance, F its centre of motion fituated a little above the centre of gravity of the arms, FD the handle which always retains a vertical pofition, P, W the fcales fufpended from the points A, B, and CF the tongue or index of the balance, which is exactly perpendicular to the beam AB, and is continued below the centre of motion, fo that the momentum of the part below F is equal and oppofite to the momentum of that part which is above it. Since the handle FD, fufpended by the hook H, muft hang in a vertical line, the tongue CF will alfo be vertical when its pofition coincides with that of FD, and confequently the beam AB, which is perpendicular to CF, muft be horizontal. When this happens, the weights in the fcale are evidently equal.

Theory.

PROP. I.

143. To determine the conditions of equilibrium in a phyfical balance. Fig. 2.

Let AOB be the beam, whofe weight is S, and let P, Q be equal weights expreffed by the letter p, and placed in the fcales, whofe weights are L and l. Let O be the centre of motion, and g the centre of gravity of the whole beam, when unloaded; we fhall have in the cafe of an equilibrium,

I. $\overline{p+L}\times AC=\overline{p+l}\times BC+\overline{S\times Cc}$; for fince S is the weight of the beam and g its centre of gravity, its mechanical energy in acting againft the weights $p+L$ is $=S\times Cc$, the diftance of its centre of gravity from the vertical line paffing through the centre of motion O.

II. But fince $AC=BC$; $\overline{p\times AC}-p\times BC=0$. Then, after tranfpofition, take this from the equation in N° I. and we fhall have,

III. $l\times BC-L\times AC+S\times Cc$; or $L-l=\dfrac{S\times Cc}{AC}$.

Let us now fuppofe that a fmall weight w is placed in the fcale L, the line AB which joins the points of fufpenfion will be no longer horizontal, but will affume an inclined pofition. Let $BA\lambda=\varphi$ be the angle which the beam makes with the direction of gravity. Then by refolving the weight of the beam which acts in the direction Oz, the parts $\dfrac{OG}{Og}$ and $\dfrac{Gg}{Og}$ will be in equilibrio, and we fhall have,

$$\text{IV. } \overline{p+L}\times AO\times \text{Sin.}\lambda AO+S\times OG\times \text{Sin.}\varphi=\overline{p+l+w}\times BO\times \text{Sin. }ABO+S\times Cc\times \text{Cof.}\varphi.$$

But fince the fines and cofines of any angles, are the fame as the fines and cofines of their fupplement, we have,

$$\text{V. } \overline{p+L}\times \overline{AC\times\text{Cof.}\varphi-Oc\times\text{Sin.}\varphi}+S\times OG\times\text{Sin.}\varphi=\overline{p+l+w}\times\overline{AC\times\text{Cof.}\varphi+OC\times\text{Sin.}\varphi}+S\times Cc\times\text{Cof.}\varphi.$$

Hence by N° III. we have,

$$\text{VI. Tang. }\varphi=\frac{w\times AC}{\overline{2p+L+l+w}\times OC+S\times OG}$$

But the force v, with which the balance attempts to recover its horizontal fituation, is the excefs of momenta with which one arm is moved, above the momenta with which the other arm is moved, therefore

$$v=\overline{2p+L+l}\times OC\times\text{Sin. }\varphi+S\times OG\times\text{Sin }\varphi.$$

144. A more extended illuftration of thefe conditions of equilibrium will be found in an excellent paper by Euler, publifhed in the *Comment. Petropol.* tom. x. p. 1. and in another memoir upon the fame fubject by Kuhne in the *Verfuche der naturforchende gefellchhaft* in Dantzig, tom. i. p. 1.—See alfo Hennert's *Curfus Mathefeos applicatæ*, tom. i. § 123. From the preceding formulæ, the following practical corollaries may be deduced.

145. COR. 1. The arms of the balance muft be exactly equal in length, which is known by changing the weights in the fcales; for if the equilibrium continues, the arms muft be equal.

146. COR. 2. The fenfibility of the balance increafes with the length of the arms.

147. COR. 3. If the centre of motion coincides with the point C and the centre of gravity, the balance will be in equilibrio in any pofition, and the fmalleft weight added to one of the fcales will bring the beam into a horizontal pofition. The centre of motion, therefore, fhould not coincide with the centre of gravity.

148. COR. 4. If the centre of motion is in the line which joins the points of fufpenfion, the accuracy of the balance will be increafed. The excefs of the weights may be eafily determined by the inclination of the beam, pointed out by the tongue or index upon a circular arch fixed to the handle, or more accurately by means of two divided arches fixed near the points of fufpenfion, on a ftand independent of the balance. When the value of one of thefe divifions is determined experimentally, the reft are eafily found, being proportional to the tangents of the inclination of the beam.

Theory.

149. Cor. 5. The ſenſibility of the balance will increaſe, the nearer that the centre of gravity approaches to the centre of motion.

150. Cor. 6. If the centre of gravity is above the centre of motion, the balance is uſeleſs.

Scholium.

151. A balance with all the properties mentioned in the preceding corollaries, has been invented by M. Kuhne, and deſcribed in the work already quoted (Art. 144.). It is ſo contrived that the points of ſuſpenſion may be placed either above the centre of motion or below it, or in the line of its axis: the beam is furniſhed with an index, which points out the proportion of the weights upon a divided ſcale, and the friction of the axis is diminiſhed by the application of friction wheels.

Kuhne's balance.

152. In order to get rid of the difficulties which attend the conſtruction of the tongue, the handle, and the arms of the balance, M. Magellan invented a very accurate and moveable one, in which there is no handle, and where one of the arms acts as a tongue. The body to be weighed and the counterpoiſe are placed in the ſame ſcale, ſo that it is of little conſequence whether the arms of the balance are equal or not. In this balance the centre of motion can be moved to the ſmalleſt diſtance from the centre of gravity. See *Journal de Phyſique*, Jan. 1781. tom. xvii. p. 43.

Magellan's balance.

Ludlam's balance. Plate CCCXVIII fig. 3.

153. The balance invented by Ludlam, and deſcribed in the Philoſophical Tranſactions for 1765, N° 55. depends upon Æpinus's property of the lever, which we have explained in Art. 65. The angular lever AFB, in which AF=FB, is moveable round *f*, which is equidiſtant from A and B. The weight P is ſuſpended by a thread from A, and the body W, which is to be weighed, is ſuſpended by a thread from B. Hence it is obvious, that with different bodies the lever AFB will have different degrees of inclination, and the index or tongue LF*f*, which is perpendicular to AB, will form different angles ZFL, *b* F *f* with the line of direction ZF *b*. Now, by Art. 57. and by ſubſtituting for *b* B, *b* A the ſines of the angles F *b* B, F *b* A, to which they are proportional, and alſo by taking inſtead of F *b* B the difference of the angles *f* FB, *f* F *b*, and inſtead of AF *b*, the ſum of theſe angles, we ſhall have

$$\text{Tang.}\, fFb = \frac{P-W}{P+W} \times \text{Tang.}\,\frac{AFB}{2},$$

whence, by tranſpoſition, and by Geometry, Theor. VIII. Sect. IV.

$$\overline{P+W} : \overline{P-W} = \text{Tang.}\,\frac{AFB}{2} : \text{Tang.}\, fFb.$$

Hence, when the angle formed by the arms of the balance, and the angle of aberration *f* F *b* or ZFL, are known, the weights may be found, and *vice verſa*.

Chap. IV. *On the Centre of Inertia, or Gravity.*

154. Definition.—The centre of inertia, or the centre of gravity, of any body or ſyſtem of bodies, is that point upon which the body or ſyſtem of bodies, when influenced only by the force of gravity, will be in equilibrio in every poſition. The centre of inertia of plane ſurfaces bounded by right lines, and alſo of ſome ſolids may be eaſily determined by the common geometry. The application of the method of fluxions, however, to this branch of mechanics is ſo ſimple and beautiful, that we ſhall alſo avail ourſelves of its aſſiſtance. The centre of gravity has been called, by ſome writers, the centre of poſition, and by others, the centre of mean diſtances.

Theory.

Prop. I.

155. To find the centre of inertia of any number of bodies, whatever be their poſition.

Let ABCD be any number of bodies influenced by the force of gravity. Suppoſe the bodies A, B connected by the inflexible line AB conſidered as devoid of weight, then find a point F, ſo that the weight of A : the weight of B=BF : FA. The bodies A, B will therefore be in equilibrio about the point F in every poſition (Art. 36.), and the preſſure upon F will be equal to A+B. Join FC, and find the point *f*, ſo that A+B : C=C*f* : *f*F; the bodies A, B, C, will conſequently be in equilibrio upon the point *f*, which will ſuſtain a preſſure equal to A+B+C. Join D*f*, and take the point φ, ſo that A+B+C : D=φD : φf; the bodies A, B, C, D will therefore be in equilibrio about the point φ, which will be their common centre of inertia, and which ſupports a weight equal to A+B+C+D. In the ſame manner we may find the centre of inertia of any ſyſtem of bodies, by merely connecting the laſt fulcrum with the next body by an inflexible right line, and finding a new fulcrum from the magnitude of the oppoſite weights which it is to ſuſtain. Fig. 4.

156. Cor. 1. If the weights of the bodies A, B, C, D be increaſed or diminiſhed in a given ratio, the centre of inertia of the ſyſtem will not be changed, for the poſitions of the points F, *f*, φ are determined by the relative and not by the abſolute weights of the bodies.

157. Cor. 2. A motion of rotation cannot be communicated to a body by means of a force acting upon its centre of inertia; for the reſiſtances which the inertia of each particle oppoſes to the communication of motion act in parallel directions, and as they are proportional to the weights of the particles, they will be in equilibrio about the centre of gravity.

Prop. II.

158. To find the centre of inertia of any number of bodies placed in a ſtraight line.

Let A, B, C, D, E be any number of bodies whoſe common centre of gravity is φ. In the ſtraight line AE take any point X. Then ſince all the bodies are in equilibrio about their common centre of gravity φ, we have by the property of the lever (Art 36.) $\overline{A \times A\varphi} + \overline{B \times B\varphi} = C \times C\varphi + \overline{D + D\varphi} + \overline{E \times E\varphi}$; but ſince $X\varphi - XA = A\varphi$, and $X\varphi - XB = B\varphi$, and ſo on with the reſt, we have by ſubſtitution $A \times \overline{X\varphi - XA} + B \times \overline{X\varphi - XB} = C \times \overline{X\varphi - XC} + D \times \overline{X\varphi - XD} + E \times \overline{X\varphi - XE}$. Hence by multiplying and tranſpoſing, we obtain $\overline{A \times X\varphi} + \overline{B \times X\varphi} + \overline{C \times X\varphi} + \overline{D \times X\varphi} + E \times X\varphi = \overline{A \times XA} + \overline{B \times XB} + \overline{C \times XC} + \overline{D \times XD} + E \times XE$, then dividing by A+B+C+D+E, we have Fig. 5.

$X\varphi$

$$X\varphi=\frac{\overline{A\times XA}+\overline{B\times XB}+\overline{C\times XC}+\overline{D\times XD}+\overline{E\times XE}}{A+B+C+D+E}.$$

Now $A\times XA$; $B\times XB$, &c. are evidently the momenta of the bodies A, B, &c. and the divisor $A+B+C+D+E$ is the sum of the weights of all the bodies; therefore the distance of the point X from the centre of gravity φ is equal to the sum of the momenta of all the weights divided by the sum of the weights.

159. Cor. 1. If the point X had been taken between A and E, at x for example, then the quantity $A\times XA$ would have been reckoned negative, as lying on a different side of the point X.

160. Cor. 2. From this proposition we may deduce a general rule for finding the centre of gravity in any body or system of bodies. Let any point be assumed at the extremity of the system, then the product of the momenta of all the bodies, (or the product arising from the continual multiplication of each body by its distance from the point), divided by the sum of the weights of all the bodies, will be a quotient which expresses the distance of the centre of gravity from the point assumed.

Prop. III.

161. **If, in a system of bodies, a perpendicular be let fall from each upon a given plane, the sum of the products of each body multiplied by its perpendicular distance from the plane, is equal to the sum of all the bodies multiplied by the perpendicular distance of their common centre of inertia from the given plane.**

Fig. 6. Let A, B, C be the bodies which compose the system, and MN the given plane; by Art. 155. find F the centre of inertia of A and B, and G the centre of gravity of the three bodies; and from A, F, B, G, C draw Aa, Ff Bb, Gg, Cc perpendicular to the plane MN. Through F draw xFy, meeting Aa produced in x, and Bb in, y, then in the similar triangles AxF, ByF, we have $Ax : By = AF : BF$, that is, (Art. 155.) as $B : A$, hence $A\times Ax = B\times By$, that is, $A\times \overline{xa-Aa} = B\times \overline{Bb-yb}$, or on account of the equality of the lines xa, Ff, Bb; $A\times \overline{Ff-Aa} = B\times \overline{Bb-Ff}$, therefore, by multiplying and transposing, we have $\overline{A+B}\times Ff = \overline{A\times Aa}+\overline{B\times Bb}$. In the very same way, by drawing wGz parallel to the plane, it may be shewn that $\overline{A+B+C}\times Gg = A\times Aa + B\times Bb + C\times Cc$. Q. E. D.

162. Cor. By dividing by $A+B+C$ we have

$$G=\frac{\overline{A\times Aa}+\overline{B\times Bb}+\overline{C\times Cc}}{A+B+C}.$$

Prop. IV.

163. **To find the centre of inertia of a straight line, composed of material particles.**

If we consider the straight line as composed of a number of material particles of the same size and density, it is evident that its centre of inertia will be a point in the line equidistant from its extremities. For if we regard the line as a lever supported upon its middle point as a fulcrum, it will evidently be in equilibrio, in every position, as the number of particles or weights on each side of the fulcrum is equal.

Prop. V.

164. **To find the centre of inertia of a parallelogram.**

Let ABCD be a parallelogram of uniform density, bisect AB in F, and having drawn Ff parallel to AC or BD, bisect it in φ; the point φ will be the centre of inertia of the parallelogram. The parallelogram may be regarded as composed of lines AB, ab parallel to one another, and consisting of material particles of the same size and density. Now, by Art. 155. the centre of inertia of AB is F, and the centre of inertia of ab is c; and in the same way it may be shewn that the centre of inertia, of every line of which the surface is composed, lies in the line Ff. But Ff may be considered as composed of a number of material particles of uniform density, each being equal in weight to the particles in the line AB, therefore, by Art. 165. its centre of inertia will be in φ, its middle point. Fig. 7.

Prop. VI.

165. **To find the centre of inertia of a triangle.**

Let ABC be a triangle of uniform density, and let AB, BC be bisected in the points E, D. Join CE, AD, and the point of intersection F shall be the centre of inertia of the triangle ABC. The triangle may be considered as composed of a number of parallel lines of material particles BC, bc, $\beta\varkappa$; but in the similar triangles ADC, Aec; $AD : DC = Ae : ec$, and in the triangles ADC, ADB, Aeb; $BD : DA = be : eA$; hence by composition $BD : DC = be : ec$; but BD and DC are equal; therefore, $be = ec$; and the line bc, supposed to consist of material particles, will be in equilibrio about e. In the same way it may be shewn that every other line $\beta\varkappa$ will be in equilibrio about a point situated in the line AD; consequently the centre of gravity is in that line. For the same reason it follows, that the centre of gravity is in the line CE, that is, it will be in F, the point of intersection of these two lines. In order to determine the relation between FA and FD, join ED; then, since $BE = EA$, and $BD = DC$, $BE : EA = BD : DC$, and consequently, (Geometry, Sect. IV. Theor. 18.) ED is parallel to AC, and the triangles BED, BAC similar. We have, therefore, $CA : CB = DE : DB$, and by alternation $CA : DE = CB : DB$, that is, $CA : DE = 2 : 1$. In the similar triangles CFA, DFE, $AF : AC = DF : DE$, and by alternation $AF : DF = AC : DE$, that is, $AF : DF = 2 : 1$, or $AF = \frac{2}{3}AD$. Fig. 2.

166. Cor. 1. By Geometry, Theor. 16. Sect. IV. we have

$$AB^2+AC^2=2BD^2+2AB^2(=\tfrac{1}{2}BC^2+\tfrac{9}{2}\overline{AF}^2$$
$$AB^2+BC^2=2CC^2+2BG^2\ =\tfrac{1}{2}AC^2+\tfrac{9}{2}\overline{CF}^2$$
$$AC^2+BC^2=2AE^2+2EC^2\ =\tfrac{1}{2}AB^2+\tfrac{9}{2}\overline{BF}^2.$$

By

Theory. By adding theſe three equations, and removing the fractions, we have $AB^2+BC^2+AC^2=3\,AF^2+3\,CF^2+3\,BF^2$, or in any plane triangle, the ſum of the ſquares of the three ſides is equal to thrice the ſum of the ſquares of the diſtances of the centre of gravity from each of the angular points.

167. Cor. 2. By reſolving the three quadratic equations in the preceding corollary, we obtain $AF=\frac{1}{3}\sqrt{2\,AB^2+2\,AC^2-BC^2}$; $CF=\frac{1}{3}\sqrt{2\,BA^2+2\,BC^2-AC^2}$; and $BF=\frac{1}{3}\sqrt{2\,BC^2+2\,AC^2-AB^2}$, formulæ which expreſs the diſtances of the centre of gravity from each of the angular points.

Prop. VII.

168. To find the centre of inertia of a trapezium or any rectilineal figure.

Fig. 9. Let ABCDE be the trapezium, and let it be divided into the triangles ABC, ACE, ECD by the lines AC, EC. By the laſt propoſition find m, n, o, the centres of gravity of the triangles, and take the point F in the line $m\,n$, ſo that $F\,n : F\,m=$ triangle ABC : triangle ACE, then F will be the centre of gravity of theſe triangles. Join $F\,o$, and find a point f, ſo that $f\,o : F\,f=$ triangle ABC + triangle ACE : triangle CED, then all the triangles will be in equilibrio about f, that is, f is the centre of gravity of the rectilineal figure ABCDE. The ſame method may be employed in finding the centre of gravity of a trapezium, whatever be the number of its ſides.

Prop. VIII.

169. To find the centre of inertia of a pyramid with a polygonal baſe.

Fig. 10. Let the pyramid be triangular, as ABCD, fig. 10. Biſect BD in F, and join CF and FA. Make $F\,f=\frac{1}{3}$ of FC, and $F\,\varphi=\frac{1}{3}$ of FA, and draw $f\,\varphi$. It is evident, from Art. 159. that f is the centre of gravity of the triangular baſe BCD, and that the line AF, which joins the vertex and the point f, will paſs through the centre of gravity of all the triangular laminæ or ſections of the pyramid parallel to its baſe ABC; for, by taking any ſection $b\,c\,d$, and joining $c\,m$, it may be eaſily ſhewn, that $b\,m=m\,d$, and $m\,n=\frac{1}{3}m\,c$, ſo that n is the centre of gravity of the ſection $b\,c\,d$. It follows, therefore, that $A\,f$ will paſs through the centre of gravity of the pyramid. In the ſame way it may be ſhewn, by conſidering ABD as the baſe, and D the vertex, and making $F\,\varphi=\frac{1}{3}FA$, that the centre of gravity lies in the line $\varphi\,C$. But, as the lines $A\,f$, $\varphi\,C$ lie in the plane of the triangle AFC, they muſt interſect each other; and therefore the point of interſection H will be the centre of inertia of the triangular pyramid. Now, ſince $F\,f=\frac{1}{3}FC$, and $F\,\varphi=\frac{1}{3}FA$, we have $F\,\varphi : FA=F\,f : FC$, therefore (Geometry, Theor. 8. Sect. IV.) $\varphi\,f$ is parallel to AC. The triangle $\varphi\,f\,H$ will conſequently be ſimilar to AHC, and $H\,\varphi : HC=H\,f : HA=f\,\varphi : AC=1 : 3$; therefore $H\,\varphi=\frac{1}{3}HC=\frac{1}{4}\varphi\,C$, and $f\,H=\frac{1}{3}AH=\frac{1}{4}A\,f$.

170. When the pyramid has a polygonal baſe, it may be conceived to be formed of a number of triangular pyramids, whoſe centres of inertia will be in one plane parallel to the baſe. Their common centre of gravity will therefore be in the ſame plane, and in the line drawn from the vertex to the centre of gravity of all the triangles which compoſe the baſe; the diſtance of the centre of gravity, therefore, from the vertex, will be equal to three-fourths of the altitude of the pyramid.

171. Cor. 1. Hence it is obvious, that the centre of gravity of a right cone is a point in its axis, whoſe diſtance from the vertex is equal to three-fourths of the length of the axis; for as this may be demonſtrated of a pyramid whoſe baſe is a polygon, with an infinite number of ſides, it muſt hold alſo of a right cone which may be conſidered as a pyramid of this deſcription.

172. Cor. 2. By proceeding as in Art. 160. it will be found, that in a triangular pyramid, the diſtance of any of the vertices from its centre of inertia, is equal to one-fourth of the ſquare root of the difference of thrice the ſum of the ſquares of the three edges which meet at that vertex, and the ſum of the ſquares of the other three edges;—and likewiſe, that the ſum of the ſquares of the diſtances of the centre of inertia from the vertices of any triangular pyramid, is equal to one-fourth of the ſum of the ſquares of the ſix edges of the pyramids. A demonſtration of theſe theorems may be ſeen in Gregory's Mechanics, vol. i. p. 59, 60.

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173. In order to ſhew the application of the doctrine of fluxions to the determination of the centre of inertia of curve lines, areas, ſolids, and the ſurfaces of ſolids, let ABC be any curve line whoſe axis is BR. Fig. 11.
Then, ſince the axis biſects all the ordinates DG, AC, each of the ordinates, conſidered as compoſed of material particles, will be in equilibrio about their points of biſection E, R; and therefore the centre of inertia of the body will lie in the axis. But, if we conſider the body as compoſed of a number of ſmall weights $D\,d\,g\,G$, we ſhall find its centre of inertia by multiplying each weight by its diſtance from any line $m\,n$ parallel to the ordinates, and dividing the ſum of all theſe products by the ſum of all the particles, Art. 158. Thus, let x denote the diſtance EB, then its fluxion $\dot{x}$ will be the breadth of the element or ſmall weight $D\,d\,g\,G$, and $\dot{x}\times DG$ will repreſent the weight, and the fluent of this quantity will be the ſum of all the weights. Again, if we multiply the weight $\dot{x}\times DG$ by $x=EB$ its diſtance from the point B, we ſhall have the momentum of that weight $=x\times\dot{x}\times DG$, and the fluent of this quantity will expreſs the ſum of the momenta of all the weights into which the body is divided. But, by Art. 158. the diſtance of the centre of gravity from a given point B is equal to the ſum of all the momenta divided by the ſum of all the weights or bodies, that is, if F be the centre of gravity of the body ABC, we have $FB=\frac{\text{fluent of } x\times\dot{x}\,DG}{\text{fluent of } \dot{x}\times DG}$, or calling y the ordinate DE, we have $DG=2\,y$, and $FB=\frac{\text{fluent of } x\,2\,y\,\dot{x}}{\text{fluent of } 2\,y\,\dot{x}}$, or $FB=\frac{\text{fluent of } x\,y\,\dot{x}}{\text{fluent } y\,\dot{x}}$ in the caſe of areas.

174. In the caſe of ſolids generated by rotation, the element or ſmall weight $F\,\dot{x}\times DG$ will be a circular ſection,

Theory.

ſection, whoſe diameter is $2\,DE = 2y$, and ſince the area of a circle is equal to its circumference multiplied by its diameter, we have (making $\pi = 3.1416$) $2\pi y^2 \dot{x}$, $=$ the circular ſection whoſe diameter is DG; and ſince $x \times 2\pi y^2 \dot{x}$, or $2\pi x y^2 \dot{x}$, will repreſent the momentum of the weight, we ſhall have $FB = \frac{\text{fluent of } 2\pi x y^2 \dot{x}}{\text{fluent of } 2\pi y^2 \dot{x}}$, and dividing by $2\pi y$, we have $FB = \frac{\text{fluent of } y x \dot{x}}{\text{fluent of } y \dot{x}}$.

175. In finding the centre of inertia of the ſurfaces of ſolids, the elements or ſmall weights are the circumferences of circles, whoſe radii are the ordinates of the curve by whoſe revolution the ſolid is generated. Now, the ſurface of the ſolid may be conceived to be generated by the circumference of a circle increaſing gradually from B towards A and C; making z therefore equal to BD, its fluxion $\dot{z}$ multiplied into the periphery of the circle whoſe diameter is DG, that is, $2\pi y \dot{z}$ will expreſs the elementary ſurface or ſmall weight whoſe diameter is DG. Then, ſince $x \times 2\pi y \dot{z}$, or $2\pi x y \dot{z}$, will be the momentum of the elementary weight, we ſhall have $FB = \frac{\text{fluent of } 2\pi x y \dot{z}}{\text{fluent of } 2\pi y \dot{z}}$, and dividing by 2π we obtain $FB = \frac{\text{fluent of } x y \dot{z}}{\text{fluent of } y \dot{z}}$.

176. If the body, whoſe centre of inertia is to be found, be a curve line, as GBD, then it is manifeſt that the ſmall weights will be expreſſed by the fluxion of

Fig. 11. GBD, that is, by $2\dot{z}$, ſinee $GBD = 2\,BD = 2\dot{z}$; conſequently their momenta will be $2x\dot{z}$, and we ſhall have $FB = \frac{\text{fluent } 2x\dot{z}}{\text{fluent } 2\dot{z}} = \frac{\text{fluent } x\dot{z}}{\text{fluent } \dot{z}} = \frac{\text{fluent } x\dot{z}}{z}$.

Prop. IX.

177. To find the centre of inertia of a circular ſegment.

Fig. 12. Let $AE = x$, $FC = y$, and AD the radius of the circle $= R$, conſequently $ME = 2R - EA$. Then, ſince by the property of the circle (Geometry, Theor. 28. Sect. IV.) $ME \times EA = BE^2$, we have, by ſubſtitution, $BE^2 = 2R \times EA - EA \times EA$, or $y^2 = 2Rx - x^2$; hence $y = \sqrt{2Rx - x^2}$. Now, by Art. 174. we have the diſtance of the centre of gravity from A, that is, $AG = \frac{\text{fluent } x y \dot{x}}{\text{fluent } y \dot{x}}$; but the fluent of $y\dot{x}$ or the ſum of all the weights, is equal to the area of half the ſegment ABEC; therefore $AG = \frac{\text{fluent } x y \dot{x}}{\frac{1}{2}ABEC}$. Then, by ſubſtituting inſtead of y, in this equation, the value of it deduced from the property of the circle, we have $AG = \frac{\text{fluent of } x\dot{x}\sqrt{2Rx - x^2}}{ABEC}$; or, in order to find GD the diſtance of the centre of gravity from the centre, we muſt ſubſtitute inſtead of x (without the vinculum) its value $R - x$, and we have $GD = \text{fluent } \frac{(R-x)\dot{x}(2Rx - x^2)}{\frac{1}{2}ABEC}$. Now, in order to find the fluxion of the numerator of the preceding fraction, aſſume $z = 2Rx - x^2$, and $z^{\frac{1}{2}} = \sqrt{2Rx - x^2}$, and by taking the fluxion, we have $\dot{z} = 2R\dot{x} - 2x\dot{x} = \overline{2R - 2x} \times \dot{x}$; but this quantity is double of the firſt term of the numerator, therefore $\frac{\dot{z}}{2} = \overline{R - x} \times \dot{x}$. By ſubſtituting theſe values in the fractional formula, we obtain $GD = \text{fluent } \frac{z^{\frac{1}{2}}}{2} \times \frac{1}{2}\dot{z} = \frac{z^{\frac{2}{3}}}{3} = \frac{\sqrt{2Rx - xx}|^{\frac{3}{2}}}{3}$; but ſince $y = \overline{2Rx - xx}|^{\frac{1}{2}}$ we have, by raiſing both ſides to the third power, $y^3 = \overline{2Rx - xx}|^{\frac{3}{2}}$; therefore $GD = \frac{\frac{1}{3}y^3}{\frac{1}{2}ABEC} = \frac{\frac{1}{24} \times 8y^3}{\frac{1}{2}ABEC} = \frac{\frac{1}{12}(2y)^3}{ABEC}$, that is, the diſtance of the centre of gravity of a circular ſegment from the centre of the circle, is equal to the twelfth part of the cube of twice the ordinate, (or the chord of the ſegment) divided by the area of the ſegment.

Theory.

178. Cor. When the ſegment becomes a ſemicircle we have $2y = 2r$; and therefore $= GD = \frac{\frac{1}{12}(2r)^3}{ABEC} = \frac{(2r)^3}{12\,ABEC} = \frac{8 \times r^3}{12\,ABEC} = \frac{r^3}{1\frac{1}{2}ABEC}$, that is, the diſtance of the centre of gravity of a ſemicircle from the centre of the ſemicircle, is equal to the cube of the radius, divided by one and a half times the area of the ſegment.

Prop. X.

179. To find the centre of inertia of the ſector of a circle.

Let ABDC be the ſector of the circle. By Art. 157. find m the centre of inertia of the triangle BCD, and by the laſt propoſition find G the centre of inertia of the ſegment; then take a point n ſo ſituated between G and m, that $ABEC : BCB = m n : G n$, then the point n will be the centre of gravity of the ſector.—By proceeding in this way, it will be found that D n, or the diſtance of the centre of gravity of the ſector from the centre of the circle, is a fourth proportional to the ſemiarc, to the ſemichord, and to two-thirds of the radius.

Prop. XI.

180 To find the centre of inertia of a plane ſurface bounded by a parabola whoſe equation is $y = a x^n$.

Since $y = a x^n$, multiply both terms by $x\dot{x}$, and $\dot{x}$ ſeparately, and we have $y x \dot{x} = a x^{n+1}\dot{x}$, and $y\dot{x} = a x^n \dot{x}$. But, by Art. 174. we have $FB = \frac{\text{fluent of } x y \dot{x}}{\text{fluent } y \dot{x}}$, therefore, by ſubſtituting the preceding values of $x y \dot{x}$ and $y\dot{x}$ in the formula, we obtain $FB = \frac{\text{fluent of } a x^{n+1}\dot{x}}{\text{fluent of } a x^n \dot{x}}$, and

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and by taking the fluents it becomes

$$FB=\frac{\dfrac{a x^{n+2}}{n+2}}{\dfrac{a x^{n+1}}{n+1}}=\frac{n+1}{n+2}\times x.$$

If n, therefore, be equal to $\frac{1}{2}$, then $y=a x^{\frac{1}{2}}$, and, ſquaring both ſides, $y^2=a^2 x$, which is the equation of the common or Apollonian parabola. Hence, $FB=\frac{3}{5}x$, that is, the diſtance of the centre of gravity from the vertex is $\frac{3}{5}$ths of the axis.

When n is equal to 1, then $y=a x$, and the parabola degenerates into a triangle, in which caſe $FB=\frac{2}{3}x$, as in Art. 165.

Prop. XII.

181. To find the centre of inertia of a ſolid, generated by the revolution of the preceding curve round its axis.

Since $y=a x^n$, ſquare both ſides, and we have $y^2=a^2 x^{2n}$; then multiply both ſides by $x\dot{x}$, and $\dot{x}$ ſeparately, we obtain $y^2 x\dot{x}=a^2 x^{2n+1}\dot{x}$, and $y^2\dot{x}=a^2 x^{2n}\dot{x}$. But, by Art. 174. we have $FB=\frac{\text{fluent of } y^2 x\dot{x}}{\text{fluent of } y^2\dot{x}}$; therefore, by ſubſtituting the preceding values of $y^2 x\dot{x}$, and $y^2\dot{x}$ in that formula, we obtain $FB=\frac{\text{fluent of } a^2x^{2n+1}\dot{x}}{\text{fluent of } a^2x^{2n}\dot{x}}$, and by taking the fluents we ſhall have

$$FB=\frac{\dfrac{a^2 x^{2n+2}}{2n+2}}{\dfrac{a^2 x^{2n+1}}{2n+1}}=\frac{2n+1}{2n+2}\times x.$$

When $n=\frac{1}{2}$, the ſolid becomes a common paraboloid, and we obtain $FB=\frac{2}{3}x$.

When $n=1$, the ſolid becomes a cone, and $FB=\frac{3}{4}x$, as in Art. 171.

Prop. XIII.

182. To find the centre of gravity of a ſpherical ſurface or zone, comprehended between two parallel planes, or of the ſpherical ſurface of any ſpherical ſegment.

Fig. 12. Let BMNC be a ſection of the ſpherical ſurface comprehended between the planes BC, MN, and let $EP=x$, $EC=y$, $DC=R$, and $z=$ the arc CN. Suppoſe the abſciſſa EP to increaſe by the ſmall quantity E o, draw $o\,r$ parallel to EC, C s parallel to E o, and C r perpendicular to DC; then it is evident, that in the ſimilar triangles CDE, C s r, EC : DC = C s : C r, that is, $y : R = C s : C r$; but C r is the fluxion of the arc NC, and C s the fluxion of the abſciſſa PE; therefore $y : R=\dot{x} : \dot{z}$, and $\dot{z}y=R\dot{x}$, and $\dot{z}=\frac{R\dot{x}}{y}$. Now, by Art. 175. $FB=\frac{\text{fluent of } x y\dot{z}}{\text{fluent of } x y\dot{z}}$, therefore, by ſubſtituting the preceding value of $\dot{z}$ in this formula, we obtain $FB=\frac{\text{fluent of } R x\dot{x}}{\text{fluent of } R\dot{x}}$, for

$$\frac{\dfrac{R x\dot{x}\dot{z}}{y}}{\dfrac{R\dot{x}z}{y}}=\frac{R y x\dot{x}\dot{z}}{R y\dot{x}\dot{z}}\ \text{(and dividing by } y\dot{z})=\frac{R x\dot{x}}{R\dot{x}}.$$

By taking the fluents we obtain $FB=\frac{1}{2}\frac{R x^2}{R x}=\frac{1}{2}x$, a fluent which requires no correction, as the other quantities vaniſh at the ſame time with x.

183. When DP is equal to DC, the ſolid becomes a ſpherical ſegment, and EA becomes the altitude of the ſegment, ſo that univerſally the centre of gravity of the ſpherical ſurface of a ſpherical ſegment is in the middle of the line which is the altitude of the ſegment, or in the middle of the line which joins the centres of the two circles that bound the ſpherical ſegment.

184. When the ſpherical ſegment is a hemiſpheroid, the centre of gravity of its hemiſpherical ſurface is obviouſly at the diſtance of one-half the radius from its centre.

Prop. XIV.

185. To find the centre of gravity of a circular arc.

Let BAC be the circular arc, it is required to find its centre of inertia, or the diſtance of the centre of inertia of the half arc AC from the diameter HG; for it is evident, that the line which joins the centres of gravity of each of the ſemiarcs AB, AC muſt be parallel to HG, and therefore the diſtance of their common centre of gravity, which muſt be in that line, from the line HG, will be equal to the diſtance of the centre of gravity of the ſemiarc from the ſame line. Make $PC=DE=x$; $EC=y$; $DC=DA=R$, and $AC=z$, then it may be ſhewn, as in the laſt propoſition, that $y : R=\dot{x} : \dot{z}$; hence $\dot{z}y=R\dot{x}$. But, by Art. 176. we have $FB=\frac{\text{fluent of } y\dot{z}}{z}$, y being in this caſe equal to x in the formula in Art. 176. and ſubſtituting the preceding value of $y\dot{z}$, it becomes $FB=\frac{\text{fluent of } R\dot{x}}{z}$, Fig. 13.

and, taking the fluent, we have $FB=\frac{R x}{z}$, which requires no correction, as the fluent of $y\dot{z}$ vaniſhes at the ſame time with x. Calling d, therefore, the diſtance of the centre of inertia of the arc BAC from the centre D, we have $d=\frac{R x}{z}$, and $d z=R x$; hence $z : x = R : d$, or $2Z : 2x=R : d$, that is, the diſtance of the centre of inertia of a circular arc from the centre of the circle is a fourth proportional to the arc, the chord of the arc, and radius.

186. When the arc BAC becomes a ſemicircle, PC or x is equal to DG or radius, ſo that we have $2z : 2R=R : d$, or $4Z : 4R=R : d$; but $4z$ is equal to the whole circumference of the circle, and 4 R is

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is equal to twice the diameter; therefore, 3.141593 : 2 $=$ R : d; hence $d=\frac{2\,R}{3.141593}=.63662$ R.

187. When y is equal to 2R, or when the arc ABC becomes equal to the whole circumference of the circle, x vanishes, and is $=0$, and therefore $\frac{Rx}{z}=0$, which shews, that the centre of inertia coincides with the centre of the circle.

Scholium I.

188. From the specimens which the preceding propositions contain of the application of the formulæ in Articles 173, 174, 175, 176, the reader will find no difficulty in determining the centre of inertia of other surfaces and solids, when he is acquainted with the equation of the curves by which the surfaces are bounded, and by whose revolution the solids are generated.

A knowledge of the nature of these curves, however, is not absolutely necessary for the determination of the centres of inertia of surfaces and solids. A method of finding the centre of gravity, without employing the equation of the bounding curves, was discovered by our countryman, Mr Thomas Simson*. It was afterwards more fully illustrated by Mr Chapman, in his work on the Construction of Ships; by M. Leveque, in his translation of Don George Juan's Treatise on the Construction and Management of Vessels; and by M. Prony, in his *Architecture Hydraulique*, tom. i. p. 93. to which we must refer such readers as wish to prosecute the subject.

* *Mathematical Differtations*, p. 109.

Scholium II.

Position of the centre of inertia in bodies of various forms.

189. As it is frequently of great use to know the position of the centre of inertia in bodies of all forms, we shall collect all the leading results which might have been obtained, by the method given in the preceding propositions.

1. The centre of inertia of a straight line is in its middle point.

2. The centre of inertia of a parallelogram is in the intersection of its diagonals.

3. The centre of inertia of a triangle is distant from its vertex two-thirds of a line drawn from the vertex to the middle of the opposite side.

4. The centre of inertia of a circle, and of a regular polygon, coincides with the centres of these figures.

5. The centre of inertia of a parallelopiped is in the intersection of the diagonals joining its opposite angles.

6. The centre of inertia of a pyramid is distant from its vertex three-fourths of the axis.

7. The centre of inertia of a right cone is in a point in its axis whose distance from the vertex is three-fourths of the axis.

8. In the segment of a circle, the centre of inertia is distant from the centre of the circle a twelfth part of the cube of the chord of the segment divided by the area of the segment, or $d=\frac{\frac{1}{2}C^3}{A}$, where $d=$ the distance of the centre of inertia from the centre of the circle, C $=$ the chord of the segment, and A its axis.

9. In the sector of a circle, the centre of inertia is distant from the centre of the circle, by a quantity which is a fourth proportional to the semiarc, the semichord, and two-thirds of the radius.

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10. In a spherical surface or zone, comprehended between two planes, the centre of inertia is in the middle of the line which joins the centres of the two circular planes by which it is bounded. When one of the circular planes vanishes, the spherical zone becomes the spherical surface of a spherical segment; therefore,

11. In a spherical surface of a spherical segment, the centre of inertia is in the middle of its altitude or versed sine; consequently,

12. The centre of inertia of the surface of a complete sphere coincides with the centre of the sphere.

13. In a spherical segment, the centre of inertia is distant from the vertex by a quantity equal to $\frac{4a-3x}{6a-4x}\times x$, where a is the diameter of the sphere, and x the altitude or versed sine of the segment. Hence,

14. The centre of inertia of a hemisphere is distant from its vertex by a quantity equal to five-eighths of the radius, or it is three-eighths of the radius distant from the hemisphere; and,

15. The centre of inertia of a complete sphere coincides with the centre of the sphere.

16. In a circular arc the centre of inertia is distant from its centre by a quantity equal to $\frac{Rx}{z}$, where R is the radius, x the semichord, and z the semiarc. Hence,

17. In a semicircular arc the centre of inertia is distant from its centre .63662 R, and,

18. The centre of inertia of the circumference of a circle coincides with the centre of the circle.

19. In a circular sector the centre of inertia is distant from the centre of the circle $\frac{2\,c\,R}{3\,a}$, where R is the radius, a the arc, and c its chord.

20. In a spherical sector, composed of a cone and a spherical segment, the centre of inertia is distant from the vertex of the segment by a quantity equal to $\frac{2\,R+3\,x}{8}$, where R is radius, and x the altitude or versed sine of the segment.

21. In an ellipsis the centre of inertia coincides with the centre of the figure.

22. The centre of inertia of an oblate and prolate spheroid, solids generated by the revolution of an ellipse round its lesser and its greater axis respectively, coincides with the centres of the figures.

23. In the segment of an oblate spheroid the centre of inertia is distant from its vertex by a quantity equal to $\frac{4m-3x}{6m-4x}\times x$, where m is the lesser axis, or axis of rotation, and x the altitude of the segment. Hence,

24. In a hemispheroid the centre of inertia is distant from its vertex five-eighths of the radius.

25. The centre of inertia of the segment of a prolate spheroid

Theory. spheroid is distant from its vertex by a quantity equal to $\frac{4n-3x}{6m-4x} \times x$, where n is the greater axis, or axis of rotation.

26. In the common or Apollonian parabola, the distance of the centre of inertia from its vertex is three-fifths of the axis.

27. In the cubical parabola the distance of the centre of inertia from its vertex is four-sevenths of the axis, in the biquadratic parabola five-ninths of the axis, and in the sursolid parabola six-elevenths of the axis.

28. In the common semiparabola, the distance of its centre of gravity from the centre of gravity of the whole parabola, in the direction of the ordinate passing through that centre, is $\frac{3}{8}$ of the greatest ordinate.

29. In the common paraboloid, the distance of the centre of inertia from its axis, is equal to $\frac{2}{3}$ of the axis.

30. In the common hyperboloid, the distance of the centre of inertia from the vertex is equal $\frac{4a+3x}{6a+4x} \times x$, where a is the transverse axis of the generating hyperbola, and x the altitude of the solid.

31. In the frustum of a paraboloid, the distance of the centre of inertia from the centre of the smallest circular end is $\frac{2R^2+r^2}{R^2+r^2} \times \frac{h}{4}$, where h is the distance between the centres of the circles which contain the paraboloidal frustum, R the radius of the greater circle, and r the radius of the lesser circle.

32. In a conic frustum or truncated cone, the distance of the centre of inertia from the centre of the smallest circular end is $\frac{3R^2+2Rr+r^2}{R^2+Rr+r^2} \times \frac{h}{4}$ which represents the distance between the centres of the circles which contain the frustum, and R, r the radii of the circles.

33. The same formula is applicable to any regular pyramid, R and r representing the sides of the two polygons by which it is contained.

Prop. XIV.

190. If a quantity of motion be communicated to a system of bodies, the centre of gravity of the system will move in the same direction, and with the same velocity, as if all the bodies were collected in that centre, and received the same quantity of motion in the same direction.

Fig. 14. Let A, B, C be the bodies which compose the system, and let F be the centre of gravity of the bodies B, C, and f the centre of gravity of the whole system, as determined by Art. 155. Then if the body A receives such a momentum as to make it move to a in a second, join Fa, and take a point φ so that Fφ : φa = Ff : fa, φ will now be the centre of gravity of the system, $f\varphi$ the path of that centre will be parallel to Aa, and $f\varphi$ will be to Aa as B is to A+B+C. Let the same quantity of motion be now communicated to B, so as to make it describe the space Bb in a second; and having drawn φG parallel to Bb, take a point G, so that φG : Bb=B : A+B+C, and G will be the centre of gravity of the bodies after B has moved to b. In the same it may be found, that H will be the common centre of gravity of the bodies after the same quantity of motion has been communicated to C in the direction Cc. Now if the quantity of motion which was communicated to A, B, C separately had been communicated to them at the same instant, they would have been found at the end of a second in the points a, b, c, and their centre of gravity would have been the point H. Let us now suppose the three bodies collected in their common centre of gravity f, the body at F will be equal to A+B+C, and if the same quantity of motion which made A move to a in a second be communicated to the body at f and in the same direction, it will be found somewhere in the line $f\varphi$ at the end of a second. But as the quantity of motion is equal to the product of the velocity of the body multiplied by its quantity of matter, the velocities are inversely as the quantities of matter, and consequently the velocity of the body at f is to A's velocity as A is to A+B+C, that is, as $f\varphi$ is to Aa; therefore Aa and $f\varphi$ are described by A and by the body at f in equal times, and the body at f will be found at φ at the end of a second. In the same way it may be shewn, that the body at f will be found at G if it receives the same momentum that was given to B, and in the same direction, and that it will be found at H after it has received the momentum that was communicated to C, consequently if it received all these momenta at the same instant, it would have described fH in a second. Q. E. D.

191. Cor. 1. If the bodies of a system move uniformly in right lines, their common centre of gravity will either be at rest, or move uniformly in a right line. For if the momenta communicated to the bodies A, B, C were communicated to a body at f=A+B+C, it will either remain at rest or move uniformly in a straight line. See *Newton's Principia*, I. Sect. III. Cor. 1.

192. Cor. 2. The centre of gravity of any system is not affected by the mutual action of the bodies which compose it. For let B and C be two bodies whose common centre of gravity is F; and let the points β, $\varkappa$, be taken, so that Bβ : C$\varkappa$=C : B, the spaces Bβ, C$\varkappa$ will represent the mutual action of the bodies B, C, that is, Bβ will represent the action of C upon B, or the motion which is the result of that action, and C$\varkappa$ the action of B upon C, or the motion which results from it. Then, since F is the common centre of gravity of B and C, we have (Art. 155.) B : C=FC : FB, but B : C=C$\varkappa$: Bβ, therefore FC : FB=C$\varkappa$: Bβ; but C$\varkappa$ is a magnitude taken from FC, and Bβ is a magnitude taken from FB, consequently (Playfair's Euclid, Book V. Prop. 19.) the remainder $\varkappa$F : βF =FC : FB, that is, $\varkappa$F : βF=B : C, that is, (Art. 155.) the point F continues to be the centre of gravity notwithstanding the action of the bodies B, C. If the system is composed of several bodies, the same thing may be proved of every two of the bodies, and consequently of the whole system. See *D'Alembert's Dynamique*, Art. 76. and *Newton's Principia*, I. Sect. III. Cor. 4. Fig. 14.

Prop. XV.

193. If a body is placed upon a horizontal plane, or suspended by two threads, it cannot be in equilibrio

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equilibrio unless a perpendicular drawn from the centre of gravity to the horizontal plane, or to a horizontal line passing through the two threads, fall within the base of the body, or upon that part of the horizontal line which lies between the threads.

Fig. 15. 194. 1. Let ABCD be a body placed in the horizontal plane CD, G its centre of gravity, and GE a perpendicular drawn to the horizontal line DE. Then the whole matter of the body ABCD may be conceived as united in its centre of gravity G, and as its tendency downwards is in the vertical line GE, it can descend only by turning round the point C as a centre. Here then we have a body G placed at the end of a lever GC whose fulcrum is C, and its power to turn round C is represented by the quantity of matter in G multiplied by the perpendicular CE, let fall from the fulcrum upon its line of direction; and as there is no force to counterbalance this, the body G, and consequently the body ABCD, will fall by turning round C. When the vertical line GE coincides with GC, EC vanishes, and the weight of the body concentrated at G has no power to turn the lever round C, but is supported upon the fulcrum C. When the vertical line GE, (by some writers called the *line of direction*), falls within the base CD, it is obvious that the weight at G has no influence in producing a motion round C or D, but is employed in pressing the body upon the horizontal plane ED.

Fig. 16. 195. 2. Let the body ACBD be suspended at the points f, φ by the threads hf, $h'\varphi$, and let G be the centre of gravity of the body. Join Gφ, Gf, draw $f\varphi$ parallel to the horizon, and through G draw no parallel to $f\varphi$. Continue hf, $h'\varphi$ to o and n, and draw Gi perpendicular to $f\varphi$, the body AB cannot be in equilibrio unless the point i falls upon the horizontal line $f\varphi$ which passes through the threads. It is obvious that the centre of gravity can never change its distance from the fixed points of suspension f, φ; if therefore the body is not in equilibrio, its centre of gravity must descend either towards m or n; let it descend towards m till it rests at the point γ then $\gamma f = f$G; but $\gamma\varphi$ is greater than G φ (Euclid, Book I. Prop. 7.) which is absurd, therefore the point G cannot descend, that is, the body is in equilibrio. It may be shewn in the same way, that it will be in equilibrio when G is any where between n and o, that is, when the perpendicular let fall from G cuts the horizontal line $f\varphi$ that lies between the threads. If the body be suspended by the two threads HE, hf, so that the perpendicular G i falls without the line fF, the body is not in equilibrio, for the centre of gravity G acting at the end of the lever GF tends to turn round F with a power equal to G$\times$Gm, it will therefore descend, and as its distance from f cannot change, the point f will rise, and the thread fh will be relaxed. When G arrives at m the perpendicular G m vanishes, and G has no power to turn round F. The body AB therefore cannot be in equilibrio till the perpendicular G i falls within fF, which it does as soon as it arrives at m.

196. Cor. 1. If a body is placed upon an inclined plane, supposed without friction, it will slide down the plane when the line of direction falls within its base, and will roll down when this line falls without the base. This is the reason why a sphere or cylinder rolls down an inclined plane; for as they touch the plane only in one point or line, the line of direction must always fall without the base.

197. Cor. 2. The higher the centre of gravity of a body is, the more easily will it be overturned. For if ABCD be the body whose centre of gravity is F, and if any force be employed to move it round C as a fulcrum, the power with which it will resist this force is inversely as FC; then, if the centre of gravity is raised to f, fC will be greater than FC, and the power with which it resists being overturned is diminished, that is, the body is the more easily overturned the higher that its centre of gravity is placed. Fig. 17.

198. Cor. 3. If a body be suspended by one thread, it will not be at rest unless its centre of gravity is in the direction of the thread produced, for when the two threads hf', $h'\varphi$ approach so near each other as to coincide with the single thread HE, the point i must in the case of an equilibrium fall upon F, and the lines G i, GF must coincide with m F; but HF and m F are both perpendicular to the horizontal line $f\varphi$, therefore the centre of gravity G is in the direction of the thread HF.

199. Cor. 4. If the bodies A, B, C, fig. 18. be suspended by any point F from the hook H, they will not be in equilibrio unless their common centre of gravity G is in the vertical line FG passing through the point of suspension; and in fig. 19. the bodies A, B connected by the bent rod AFB will not be in equilibrio unless their common centre of gravity G is in a vertical line passing through F, the point in which the system rests upon the plane CD. Fig. 18. Fig. 19.

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200. We have seen in the preceding proposition and corollaries, the position which must be given to the centre of gravity in order to procure an equilibrium. It is evident, however, that though the bodies are necessarily at rest, yet they have different degrees of stability, depending on the position of the centre of gravity with regard to the centre of motion. Hence bodies are said to have a stable equilibrium when their centre of gravity cannot move without ascending, or when the path described by their centre of gravity has its concavity upwards;—a tottering equilibrium when the centre of gravity cannot move without descending, or when the path which it describes has its concavity downwards,—and a neutral equilibrium when the body will rest in any position. Thus in fig. 20. if the vessels A, B have their handles so placed that in the one the handle A is fixed above the centre of gravity g, and in the other the handle B is fixed below the centre of gravity g, then the equilibrium of A will be stable, and that of B tottering; for if A is held by the handle it will require a considerable force to make its centre of gravity describe the path $m\,n$, whereas the smallest force will destroy the equilibrium of B. The vessel A, too, has a constant tendency to recover its equilibrium, and always recovers it as soon as the disturbing force is removed, but the vessel B has no tendency to do this even when its equilibrium is affected in the smallest degree. For the same reason the elliptical body A, when resting on the extremity of its conjugate axis, has a stable equilibrium, but when resting on its transverse axis as at B, its equilibrium

Different kinds of equilibrium. Fig. 20. Fig. 21.

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um is tottering. The equilibrium of a circle or sphere is always neutral, for when it is disturbed, the body has neither a tendency to fall nor to resume its former situation.—A flat body A supported by a sphere B will have its equilibrium stable when its centre of gravity is nearer the point of contact than the centre of the sphere is, and the equilibrium of C will be tottering when its centre of gravity is farther distant from the surface of the sphere D than the centre of the sphere is. (Fig. 22.)

Prop. XVI.

1. To find the centre of inertia mechanically.

Mechanical method of finding the centre of gravity.

201. If the body whose centre of inertia is to be found can be suspended by a thread, then when the body is in equilibrio, the centre of gravity will be somewhere in the line, prolonged if necessary, that is formed by the thread upon the surface of the body. Let a body be again suspended from another part of its surface, so that the direction of the thread may be nearly at right angles to its former direction, then as the centre of gravity must also be in the new direction of the thread prolonged, it will be in the point where these two lines intersect each other.

202. 2. If the body is of such a kind that it cannot be conveniently suspended, balance it upon two sharp points, and its centre of motion will be somewhere in the line which joins these points. Balance it a second time upon the sharp points, so that the line which joins the points may be nearly at right angles to the former line. The intersection of these two lines will be the centre of inertia of the body.

203. 3. If the body is so flexible that it can neither be suspended by a thread nor balance upon points, then let a thin board be balanced upon the points as before, and let the body be so placed upon this board when balanced, that the equilibrium may still continue; then, having found the centre of gravity of the board when loaded with the body, the centre of gravity of the body will be a point on its surface exactly opposite to that centre.

204. The preceding method, however, only gives us the centre of gravity when the body has no sensible thickness, for when it is of three dimensions, the centre of gravity must be somewhere between the two opposite surfaces.

205. *Definition.*—The centro-baryc method is the method of determining the areas of surfaces, and the contents of solids, by considering them as generated by motion, and by employing the laws of the centre of gravity.

Prop. XVII.

Centro-baryc method of Guldinus.

206 If any straight or curve line, or any plane surface bounded by straight or curve lines revolve round an axis situated in the same plane with the lines or surfaces, the surface or solid thus generated will be respectively equal to a surface or solid whose base is equal to the given line or surface, and whose height is equal to the arc described by the centre of gravity of the generating line or surface.

Fig. 23. Let ABCD be the plane surface by whose revolution round the axis MPN is generated the solid aD, contained by the parallelograms ABCD, $a\,b\,c\,d$, and by the areas a AC c, b BD d, and a AB b, c CD d; let G be the centre of gravity of ABCD, then the solid aD shall be equal to a solid whose base is ABCD, and whose altitude is a line equal to Gg, the space described by its centre of gravity G. It is evident from Art. 161. that the sum of the products of all the particles of the surface ABCD, multiplied by their respective distances from any given point P, is equal to the sum of all the particles multiplied by the distance of their common centre of gravity G from the same point P. Now every particle of the surface ABCD, during its revolution round the point P, will obviously describe the arch of a circle proportional to the distance of that particle from the point P, which is the centre of all the arches; therefore the sum of the product of all the particles multiplied by the arch described by each of them, will be equal to the sum of the particles multiplied by the arch which their common centre of gravity describes; that is, the solid aD will be equal to the area of the surface multiplied by the path of its centre of gravity. In order to have a clearer illustration of this reasoning, let P, p, π, &c. be the particles of the surface ABCD; D, d, δ their distance from the centre of rotation P, and A, a, α, the arches which they describe, while GP is the distance of the centre of gravity of the surface ABCD from the centre P, and Gg the arch descrbed by it. Then by Art. 161. $\overline{P\times D}+\overline{p\times d}+\overline{\pi+\delta}=\overline{P+p+\pi}\times GP$, but $D:d:\delta:GP=A:a:\alpha:Gg$, therefore $\overline{P\times A}+\overline{p\times a}+\overline{\pi\times\alpha}=\overline{P+p+\pi}\times Gg$. But $\overline{P\times A}+\overline{p\times a}+\overline{\pi\times\alpha}$ &c. make up the whole solid aD, and $\overline{P+p+\pi}$, &c. make up the whole surface ABCD; therefore the solid aD is equal to the generating surface ABCD multiplied by the path of its centre of gravity. Q. E. D.

207. Cor. 1. Let us suppose the circle BACO to be generated by the revolution of the line DA round the point D; then since the centre of gravity of the line DA is in its middle point G, the path of this centre will be a circumference whose radius is DG, or a line equal to half the circumference BONAB, therefore, by the theorem, the area of the circle BONB will be equal to the radius DA multiplied by the semicircumference, which coincides with the result obtained from the principles of geometry. See Playfair's Geometry, Supp. B. I. Prop. 5. In the same way, by means of the preceding theorem, we may readily determine the area of any surface, or the content of any solid that is generated by motion. (Fig. 12.)

Scholium.

208. The centro-baryc method, which is one of the finest inventions of geometry, was first noticed by Pappus in the preface to the seventh book of his mathematical collections, but it is to Father Guldinus that we are indebted for a more complete discussion of the subject. He published an account of his discovery partly in 1635, and partly in 1640, in his work entitled *De Centro Gravitatis*, lib. ii. cap. 8. prop. 3. and gave an indirect demonstration of the theorem, by showing the conformity of its results with those which were obtained by other means. Leibnitz demonstrated the theorem in the case of superficies generated by the revolution of curves, but concealed his demonstration (Act. Leips. 1695, p. 493.

Theory.

493. The theorem of Leibnitz, however, as well as that of Guldinus, was demonſtrated by Varignon in the Memoirs of the Academy for 1714, p. 78. Leibnitz obſerves that the method will ſtill hold, even if the centre round which the revolution is performed be continually changed during the generating motion. For further information on this ſubject, the reader is referred to Dr Wallis's work, *De Calculo Centri Gravitatis*, Hutton's Menſuration, Prony's Architecture Hydraulique, vol. i. p. 88. and Gregory's Mechanics, vol. i. p. 64.

Prop. XVIII.

209. To ſhow the uſe of the doctrine of the centre of gravity in the explanation of ſome mechanical phenomena.

On the motion of animals.

In the equilibrium and motion of animals, we perceive many phenomena deducible from the properties of the centre of gravity. When we endeavour to riſe from a chair, we naturally draw our feet inwards, and reſt upon their extremities, in order to bring the centre of gravity directly below our feet, and we put the body into that poſition in which its equilibrium is tottering, a poſition which renders the ſmalleſt force capable of producing motion, or of overturning the body. In this ſituation, in order to prevent ourſelves from falling backwards, we thruſt forward the upper part of the body for the purpoſe of throwing the centre of gravity beyond our feet: and when the equilibrium is thus deſtroyed, we throw out one of our feet, and gradually raiſe the centre of gravity till the poſition of the body is erect.—When we walk, the body is thrown into the poſition of tottering equilibrium by reſting it on one foot; this equilibrium is deſtroyed by puſhing forward the centre of gravity, and the body again aſſumes the poſition of tottering equilibrium by reſting it on the other foot. During this alternate proceſs of creating and deſtroying a tottering equilibrium, the one foot is placed upon the ground, and the other is raiſed from it; but in running, which is performed in exactly the ſame way, both the feet are never on the ground at the ſame time: At every ſtep there is a ſhort interval, during which the runner does not touch the ground at all.

210. When we aſcend an inclined plane the body is thrown farther forward than when we walk on a horizontal one, in order that the line of direction may fall without our feet; and in deſcending an inclined plane, the body is thrown backward, in order to prevent the line of direction from falling too ſuddenly without the baſe. In carrying a burden, the centre of gravity is brought nearer to the burden, ſo that the line of direction would fall without our feet if we did not naturally lean towards the ſide oppoſite to the burden, in order to keep the line of direction within our feet. When the burden is therefore carried on the back, we lean forward; when it is carried in the right arm, we lean towards the left; when it is carried in the left arm, we lean towards the right; and when it is carried before the body, we throw the head backwards.

211. When a horſe walks, he firſt ſets out one of his fore feet and one of his hind feet, ſuppoſe the right foot; then at the ſame inſtant he throws out his left fore foot and his left hind foot, ſo as to be ſupported only by the two right feet. His two right feet are then brought up at the ſame inſtant, and he is ſupported only by his two left feet.—When a horſe pulls at a load which he can ſcarcely overcome, he raiſes both his fore feet, his hind feet become the fulcrum of a lever, and the weight of the horſe collected in his centre of gravity acts as a weight upon this lever, and enables him to ſurmount the obſtacle. (See Appendix to Ferguſon's Lectures, vol. ii.).

Theory.

Method in which a rope-dancer keeps his equilibrium.

212. When a rope-dancer balances himſelf upon the fore part of one foot, he preſerves his equilibrium in two ways, either by throwing one of his arms or his elevated foot, or his balancing pole, to the ſide oppoſite to that towards which he is beginning to fall, or by ſhifting the point of his foot, on which he reſts, to the ſame ſide towards which he is apt to fall; for it amounts to the ſame thing whether he brings the centre of gravity directly above the point of ſupport, or brings the point of ſupport directly below the centre of gravity. For this purpoſe the convex form of the foot is of great uſe, for if it had been perfectly flat, the point of ſupport could not have admitted of ſmall variations in its poſition *.

* See Dr *T. Young's Natural Philoſophy*, vol. i. p. 64.

213. We have already ſeen (Art. 197.) that any body is more eaſily overturned in proportion to the height of its centre of gravity. Hence it is a matter of great importance that the centre of gravity of all carriages ſhould be placed as low as poſſible. This may often be effected by a judicious diſpoſition of the load, of which the heavieſt materials ſhould always have the loweſt place. The preſent conſtruction of our mail and poſt coaches is therefore adverſe to every principle of ſcience, and the cauſe of many of thoſe accidents in which the lives of individuals have been loſt. The elevated poſition of the guard, the driver, and the outſide paſſengers, and the two boots which contain the baggage, raiſes the centre of gravity of the loaded vehicle to a very great height, and renders it much more eaſily overturned than it would otherwiſe have been. When any accident of this kind is likely to happen, the paſſengers ſhould bend as low as poſſible, and endeavour to throw themſelves to the elevated ſide of the carriage.—In two wheeled carriages where the horſe bears part of the load upon its back, the elevation of the centre of gravity renders the draught more difficult, by throwing a greater proportion of the load upon the horſe's back when he is going down hill, and when he has the leaſt occaſion for it; and taking the load from the back of the horſe when he is going up hill, and requires to be preſſed to the ground.

The conſtruction of mail coaches erroneous.

Fig. 24.

214. A knowledge of the laws of the centre of gravity enables us to explain the experiment repreſented in fig. 24. where the veſſel of water CG is ſuſpended on a rod AB, paſſing below its handle, and reſting on the end E of the beam DE. The extremity B of the rod AB is ſupported by another rod BF, which bears againſt the bottom of the veſſel; ſo that the veſſel and the two rods become, as it were, one body, which, by Art. 199. will be in equilibrio when their common centre of gravity C is in the ſame vertical line with the point of ſupport E.

A loaded cylinder may be made to aſcend an inclined plane by its own weight.

215. The cylinder G may be made to aſcend the inclined plane ABC by putting a piece of lead or any heavy ſubſtance on one ſide of its axis, ſo that the centre of gravity may be moved from G towards *g*. Hence it

Theory

it is obvious, that the centre of gravity g will defcend, and by its defcent the body will rife towards A. The inclination of the plane, however, muft be fuch, that before the motion commences, the angles formed by a vertical line drawn from g with a line drawn from G perpendicularly to AB, muft be lefs than the angle of inclination ABC, or, which is the fame thing, when the vertical line drawn from g does not cut the line which lies between the point of contact and the centre of the cylinder. When the vertical line, let fall from g, meets the perpendicular line drawn from G to the plane in the point of contact, the cylinder will be in equilibrio on the inclined plane.

A double cone may be made to afcend an inclined plane by its own weight. Fig. 26.

216. Upon the fame principle, a double fcalene cone may be made to afcend an inclined plane without being loaded with a weight. In fig. 26. let ABC be the fection of a double inclined plane, AB, BC being fections of its furfaces perpendicular to the line in which the double fcalene cone ADEFC moves. Then, fince the centre of gravity of a cone is in the line joining the vertex and the centre of its bafe, and fince the axis of a fcalene cone is not perpendicular to its bafe, the line which joins the centres of both the cones, when in the pofition reprefented in the figure, will be above the line which joins the centres of their bafes. If the circle, therefore, in fig 27. reprefents the bafe of one of the cones, and C its centre, the line which joins the centres of gravity of the two cones will terminate in fome point G at a diftance from the centre, and therefore the double cone will afcend the plane upon the fame principles, and under the fame conditions, as thofe mentioned in the laft paragraph.

Fig. 27.

CHAP. V. *On the Motion of Bodies along inclined Planes and Curves, on the Curve of fwifteft defcent, and on the Ofcillations of Pendulums.*

PROP. I.

Plate CCCXXI. fig. 1.

217. When a body moves along an inclined plane, the force which accelerates or retards its motion, is to the whole force of gravity as the height of the plane is to its length, or as the fine of its inclination is to radius.

Let ABC be the inclined plane, A the place of the body, and let AB reprefent the whole force of gravity. The force AB is equivalent to the two forces AD, DB or AE, AD, of which AD is the force that accelerates the motion of the body down the plane, while AE is deftroyed by the refiftance or re-action of the plane. The part of the force of gravity, therefore, which makes the body arrive at C is reprefented by AD, while the whole force of gravity is reprefented by AB; but the triangle ABD is equiangular to ABC, and AD : AB=AB : AC, that is, the accelerating force which makes the body defcend the inclined plane, is to the whole force of gravity as the height of the plane is to its length, or as the fine of the plane's inclination is to radius; for when AC is radius, AB becomes the fine of the angle ACB.

218. COR. 1. Since the force of gravity, which is uniform, has a given ratio to the accelerating force, the accelerating force is alfo uniform; confequently the laws of accelerated and retarded motions, as exhibited in the article DYNAMICS, are alfo true when the bodies move along inclined planes. If H, therefore, reprefent the height AB of the plane, L its length AC, g the force of gravity, and A the accelerating force, we fhall have, by the propofition, L : H$=g$: A, hence A$=g\times\frac{\text{H}}{\text{L}}$, or, fince g : A=radius : fin. ACB, and A $=g\times$ fin. ACB. Now, from the principles of DYNAMICS, $s=\frac{1}{2}g\,t^2$, $v=gt=\sqrt{2gs}$, and $t=\frac{v}{g}=\sqrt{\frac{2s}{g}}$, where s is the fpace defcribed, g the force of gravity, or $32\frac{1}{4}$ feet, v the velocity, and t the time. Making φ, therefore, equal to ACB, and fubftituting the value of A inftead of g in the preceding equation, we fhall have $s'=$fin. $\varphi\times\frac{1}{2}t'^2$; $v'=g$ fin. $\varphi t=\sqrt{2gs'\,\text{fin.}\,\varphi}$, and $t=\frac{v'}{g.\ \text{fin.}\ \varphi}=\sqrt{\frac{2s'}{g.\ \text{fin.}\ \varphi}}$.

219. COR. 2. If one body begins to defcend through the vertical AB at the fame time that another body defcends along the plane AC, when the one is at any point m, the pofition of the other will be n, which is determined by drawing $m\,n$ perpendicular to AC. The forces by which the two bodies are actuated, are as AB : to AD, that is, as A m to A n; but forces are meafured by the fpaces defcribed in the fame time; therefore, the fpaces defcribed in the fame time, are as A m, A n, that is, as the length of the plane is to its height; for A m : A n=AC : AB; confequently, when the body that defcends along the vertical line AB is at m, the other body will be at n.—Through the three points A, m, n defcribe the femicircle A $m\,n$; then, fince A $n\,m$ is a right angle, the centre of the femicircle will be in the line A m (Playfair's Euclid, Book iv. Prop. 5.); confequently, *if two bodies defcend from the point* A *at the fame time, the one through the diameter of a circle* A m, *and the other through any chord* A n, *they will arrive at the points* m n, *the extremities of the diameter and of the chord at the fame inftant.* It alfo follows from this corollary, that if from the point A there be drawn any number of lines making different angles with the diameter A m, and if bodies be let fall from A, fo as to move along thefe lines, they will, at the end of any given time, be found in the circumferences of circles which touch one another in the point A. If the lines are not in the fame plane, the bodies will be in the circumferences of fpheres which touch each other in the point A.

220. COR. 3. If any number of bodies defcend from the fame point A along any number of inclined planes AC, AF, their velocities at the points C, F will be equal. By Cor. 1. the velocity of a body defcending the plane AC, is $v=\sqrt{2gs\ \text{fin.}\ \varphi}$, and the velocity of a body falling in the vertical line AB is $v'=\sqrt{2gs'}$. But, fince $v=v'$, we have $\sqrt{2\,g\,s\ \text{fin.}\ \varphi}=\sqrt{2gs'}$ or $2gs$ fin. $\varphi=2gs'$, and dividing by $2g$; s fin. $\varphi=o$, confequently $s:s'=$fin. φ : 1, or AB : AC=fin. DAB : radius. Therefore, when $v=v'$, that is, when the velocities of the two bodies are equal, the fpaces defcribed are as fin. DAB : radius, which can only happen when BC is perpendicular to AB. In the fame way it may be fhewn that the velocity at F is equal to the velocity at C, therefore the velocity at C is equal to the velocity at F.

221. COR. 4. The time of defcending along AC is to

5

Theory.

to the time of defcending along AB, as AC is to AB. From the values of s, s' in Cor. 1. we obtain $t^2 : t'^2 = \frac{s}{\text{fin. } \varphi} : s' = \frac{AC}{\text{fin. } \varphi} : AB$. But $\frac{AB}{AC} = \text{fin. } \varphi$; therefore, $t^2 : t'^2 = \frac{AC^2}{AB} : AB$, and taking equal multiples of thefe two laft terms, that is, multiplying them by AB, we have $t^2 : t'^2 = AC^2 : AB^2$, or $t : t' = AC : AB$. Hence the times of defcending along AF and AC, are as AF and AC.

222. Cor. 5. The velocities acquired by defcending any planes AC, AF, are as the fquare roots of their altitudes AB. The velocity acquired by falling through AB is, by the principles of Dynamics, as the fquare root of AB; and as the velocities at F, C are equal to that at B, they will alfo be as the fquare root of AB.

Prop. II.

223. If a body defcend from any point along a number of inclined planes to a horizontal line, its velocity, when it reaches the horizontal line, will be equal to that which it would have acquired by falling in a vertical direction from the given point to the horizontal line.

Fig. 2. Let AB, BC, CD, be a number of planes differently inclined to a horizontal line DN, and let the body be let fall from the point A, fo as to move along thefe planes, without lofing any of its velocity at the angular points; it will have the fame velocity when it reaches the horizontal plane at D, which it would have acquired by falling freely from A to F. It is manifeft from Art. 220. that the velocity of the body when at B will be the fame as that of another body which had fallen freely from A to c in a vertical line. The two bodies fet out from B and c with the fame velocity, and will therefore continue to have the fame velocity when they reach the points C, G, becaufe $c\,G = B\,d$. The two bodies again fet off from the points C, G with the fame celerity, and fince $GF = Ce$, their refpective velocities will be equal when they arrive at the points D, F in the horizontal plane. The velocity, therefore, acquired by the body falling along the planes AB, BC, CD is equal to that which is acquired by the fame body falling through the vertical line AF.

224. Cor. 1. As the preceding propofition holds true, whatever be the number of inclined planes which lie between the point A and the horizontal line, it will hold true alfo of any curve line which may be confidered as made up of an infinite number of ftraight lines. And, fince the fmall planes are diminifhed without limit, the radius is diminifhed without limit, and therefore the verfed fine, or the velocity loft in paffing from one plane to another, is diminifhed without limit (A), confequently, abftracting from friction, a body will afcend or defcend a curve furface without lofing any of its velocity from the curvature of the furface.

225. Cor. 2. If a body be made to afcend a curve furface, or a fyftem of inclined planes, the vertical height to which it will rife, is equal to that through which it muft fall in order to acquire the velocity with which it afcended, abftracting from the effects of friction, and the velocity which is loft in paffing from one plane to another. This is obvious, from Dynamics, § 26, 51.; for the body experiences the fame decrements of velocity in its afcent, as it received increments in its defcent.

226. Cor. 3. The fame thing will hold if the body is kept in the curve by a ftring perpendicular to the curve, for the ftring fuftains that part of the weight which was fuftained by the curve, fince the reaction of the curve furface is in a line perpendicular to the curve.

Scholium.

227. It is obvious, that the body which moves along the fyftem of inclined planes muft lofe a part of its velocity in paffing from one plane to another. By the refolution of motion it will be found that the velocity acquired by falling through any of the planes, is to the velocity loft in paffing to the fucceeding one, as radius is to the verfed fine of the angle formed by the two planes. Or the velocity with which the body enters upon one plane is as the cofine of the angle made by the contiguous planes, divided by the velocity which the body had when it left the preceding plane.

Prop. III.

228. The times of defcending two fyftems of inclined planes fimilar and fimilarly fituated, are in the fubduplicate ratio of their lengths.

Let AB, BC, CD, and $a\,b$, $b\,c$, $c\,d$ be the fimilar fyftems of inclined planes, and let T be the time of defcending ABCD, and t the time of defcending $a\,b\,c\,d$. Fig. 2.

Theory.

By Cor. 4. Prop. 1. we have

$$\text{Time along AB} : \text{Time along A}c = \text{AB} : \text{A}c,$$
$$\text{Time along } ab : \text{Time along } \alpha\beta = ab : \alpha\beta,$$

But, on account of the fimilar triangles AB c, $a\,b\,\beta$, we have,

$$\text{AB} : \text{A}c = ab : \alpha\beta.$$

Hence (Euclid, Book v. Prop. 11. 16.)

$$\text{Time along AB} : \text{Time along } ab = \text{Time along A}c : \text{Time along } \alpha\beta.$$

In

(A) See Wood's Principles of Mechanics, p. 58. note; and alfo Gregory's Mechanics, vol. i. p. 112. where this corollary is demonftrated by the method of fluxions.

Theory. In the same way it may be shewn, that Theory.

$$\text{Time along BC : Time along } bc = \text{Time along } cG : \text{Time along } \beta\kappa,$$
$$\text{Time along CD : Time along } cd = \text{Time along GF : Time along } \kappa f.$$

Then, by GEOMETRY, Sect. III. Theorem VIII.

Time along AB+BC+CD : Time along $\overline{ab+bc+cd}$ = Time along $\overline{Ac+cG+GF}$: Time along $\overline{a\beta+\beta\kappa+\kappa f}$, that is,

$$\text{Time along } \overline{AB+BC+CD} : \text{Time along } \overline{ab+bc+cd} = \text{Time along AF : Time along } af.$$

But by DYNAMICS § 37, 2.

$$\text{Time along AF : Time along } af = \sqrt{AF} : \sqrt{af},$$

Therefore, EUCLID, B. V. Prop. 11.

$$\text{Time along } \overline{AB+BC+CD} : \text{Time along } \overline{ab+bc+cd} = \sqrt{AF} : \sqrt{af}. \quad \text{Q. E. D.}$$

But by similar triangles, &c.

$$\sqrt{AF} : \sqrt{af} = \sqrt{AB+BC+CD} : \sqrt{ab+bc+cd}.$$

Therefore,

$$\text{Time along } \overline{AB+BC+CD} : \text{Time along } \overline{ab+bc+cd} = \sqrt{AB+BC+CD} : \sqrt{ab+bc+cd}. \quad \text{Q. E. D.}$$

229. COR. 1. This proposition holds true of curves, for the reasons mentioned in Prop. 2. Cor. 1.

230. COR. 2. The times of descent along similar arcs of a circle are as their radii; for by the preceding corollary the times are as the arcs, and the arcs are as the radii, therefore the times are as the radii.

PROP. IV.

231. An inverted semicycloid is the curve of quickest descent, or the curve along which a body must descend in order to move between two points not in a vertical line, in the least time possible.

Fig. 4. Let q FZ be a semicycloid, and A′D′, C′F′ two parallel and vertical ordinates at an infinitely small distance. Draw the ordinate B′E′ an arithmetical mean between the ordinates A′D′ and C′F′, and from F′,E′ draw F′v, E′u perpendicular to B′F, C′E′. Make C′F′$=a$, B′E′$=b$, E′$v=c$, C′B′$=m$, B′A′$=n$. Then since F′E′ may be considered as a straight line, and since B′C′=F′v, we have (Euclid, B. I. Prop. 47.) F′E′$=\sqrt{m^2+c^2}$, and since F′v=E′u, E′D′$=\sqrt{n^2+c^2}$. Now the velocities at F′ and E′ vary as $\sqrt{a}$ and $\sqrt{b}$, and F′E′, E′D′ are the elementary spaces described with these velocities; but the times are directly as the square root of the spaces, and inversely as the velocities, therefore the time of describing F′E′ is $\frac{\sqrt{m^2+c^2}}{\sqrt{a}}$, and the time of describing E′D′ is $\frac{\sqrt{n^2+c^2}}{\sqrt{b}}$, consequently, the time of describing FD must be $\frac{\overline{m^2+c^2}|^{\frac{1}{2}}}{a^{\frac{1}{2}}}+\frac{\overline{n^2+c^2}|^{\frac{1}{2}}}{b^{\frac{1}{2}}}$. But the proposition requires that this time should be the least possible or a minimum, therefore taking its fluxion and making it equal to 0, we have

$$\frac{2m\dot{m}}{2\sqrt{a\times mm+c^2}}+\frac{2n\dot{n}}{2\sqrt{b\times nn\times c^2}}=0.$$

But since CA is invariable $m+n$ is invariable, and therefore its fluxion $\dot{m}+\dot{n}=0$, or $\dot{m}=-\dot{n}$ and $\dot{n}=-\dot{m}$, therefore by transposing the second member of the preceding equation, and substituting these values of $\dot{m}$ and $\dot{n}$, it becomes $\frac{m}{\sqrt{a\times m^2+c^2}}=\frac{n}{\sqrt{b\times n^2+c^2}}$. Let us now call the variable abscis qC′$=x$, the ordinate C′F′$=y$, and the arc q F′$=z$, then m and n are fluxions of x, and F′E′ is the increment of q F or z, when y is equal to a, and E′D′ the increment of q F or z, when y is equal to b, therefore by substituting these values in the preceding equation, we obtain $\frac{x'}{\sqrt{yz'}}=\frac{x'}{\sqrt{yz'}}$, which shews that this quantity is constant, and gives us the following analogy, $z' : x' = 1 : \sqrt{y}$. Now in the cycloid $\sqrt{y}$ is always the chord of the generating circle when the diameter is y (for by Euclid, Book. I. Prop. 47, Book. II. Fig. 5. Prop. 8. and Book III. Prop. 35.) AF$=\sqrt{\overline{AD\times AO}}$, and since AO$=1$ and AD$=y$, we have AF$=\sqrt{y}$. But since the arc of the cycloid at F is perpendicular to the chord AF, the elementary triangle FEv is similar to FDO, (for BE is parallel to AO) and consequently to AFO (Euclid. B. VI. Prop. 8.), therefore, we have FE : E′z'=AO : AF; but FE$=x'$, E$v=v$, AO$=1$ and AF$=\sqrt{y}$, consequently $z' : x' = 1 : \sqrt{y}$, which coincides with the analogy already obtained, and being the property of the cycloid shews that the curve of quickest descent is an inverted cycloidal arc.

Properties of the Cycloid.

Fig. 3. Properties of the cycloid.

DEFINITION.—If a circle NOP be so placed as to be in contact with the line AD, and be made to roll along that line from D towards A, till the same point D of the circle touches the other extremity A, the point D will describe a curve DBA, called a cycloid.

The line AD is called the *base of the cycloid;* the line CB, which bisects AD at right angles and meets the curve in B, is called the *axis*, and B the *vertex*.

The circle NOP is called the generating circle.

232. 1. The

Theory.

232\. 1. The base AD is equal to the circumference of the generating circle, and AC is equal to half that circumference.

2\. The axis CB is equal to the diameter of the generating circle.

3\. If from any point G of the cycloid, there be drawn a straight line GM parallel to AD, and meeting the circle BLC in L, the circular arc BL is equal to the line GL.

4\. If the points L, B be joined, and a tangent drawn to the cycloid at the point G, the tangent will be parallel to the chord LB, and the tangent is found by joining G, E, for GE is parallel to LB.

5\. The arc BG of the cycloid is double of the chord BL, and the arc BA or BD is equal to twice the axis BC.

6\. If the two portions AB, DB of the cycloid in fig. 3. be placed in the inverted position AB, DB (fig. 4.), and if a string BP equal in length to BA be made to coincide with BA, and then be evolved from it, its extremity P will describe a semicycloid AF, similar and equal to BA. In the same way the semicycloid DF, produced by the evolution of the string BP from the semicycloid BD, is equal and similar to BD and to AF. Therefore, if BP be a pendulum or weight attached to the extremity of a flexible line BP, which vibrates between the cycloidal cheeks BA, BD, its extremity D will describe a cycloid AFD, equal to that which is composed of the two halves BA, BD. Fig. 4.

7\. The chord CN is parallel to MP, and MP is perpendicular to the cycloid AFD, at the point P.

8\. If Pp be an infinitely small arc, the perpendicular to the curve drawn from the points Pp will meet at M, and Pp may be regarded as a circular arc, whose radius is MP. An infinitely small cycloidal arc at F may likewise be considered as a circular arc whose radius is BF.

As these properties of the cycloid are demonstrated in almost every treatise on mechanics, and as their demonstrations more properly belong to geometry than to mechanics, they are purposely omitted to make room for more important matter.

233\. Definition.—If a body descend from any point of a curve, and ascend in the same curve till its velocity is destroyed, the body is said to oscillate in that curve, and the time in which this descent and ascent are performed is called the time of an oscillation or vibration.

234\. Definition.—A cycloidal pendulum is a pendulum which oscillates or vibrates in the arch of a cycloid.

235\. Definition.—Oscillations which are performed in equal times are said to be isochronous.

Prop. V.

Fig. 4. 236. The velocity of a cycloidal pendulum BP at the point F, varies as the arch which it describes.

The velocity of the pendulum at F is that which it would have acquired by falling through EF (Prop. 2. and Cor. 3. Prop. 2.), and the velocity of a falling body is as the square root of the space which it describes (Dynamics, § 37.), therefore the velocity of the pendulum P, when it reaches F, varies as $\sqrt{EF}$. But (Geometry, Sect. IV. Theor. 23. and 8.) FE varies as $\frac{FN^2}{FC}$, and since FC is a constant quantity, FE will vary as FN^2 varies, or, to adopt the notation used in the article Dynamics, $FE \doteq \overline{FN}^2$, or $\sqrt{FE} \doteq FN$, but the velocity acquired by falling through EF varies as $\sqrt{FE}$, therefore the velocity of the pendulum at F varies as FN, that is, as FP, for (Art. 232. N° 5.) FN is equal to half FP. Q. E. D. Theory.

Prop. VI.

237\. If the pendulum begins its oscillation from the point P, the velocity of the pendulum at any point R varies as the sine of a circular arc whose radius is FP, and whose versed sine is PR.

Through F draw p F q parallel to AD, and with a radius equal to the cycloidal arc FP, describe the semicircle $p o q$. Make $p r$ equal to the arc PR of the cycloid, and through r draw $r m$ perpendicular to p F. Through the points P, R draw PE, RT parallel to AD, and cutting the generating circle CNF in the points N, S.—By Prop. 4. the velocity at R varies as $\sqrt{ET}$, that is, as $\sqrt{EF-TF}$, or since CF is constant, as $\sqrt{CF\times EF-CF\times TF}$, that is, as $\sqrt{FN^2-FS^2}$. For, (Playfair's Euclid, Book I. Prop. 47, Book II. Prop. 7. and Book III. Prop. 35.) $FN^2 = CF\times EF$, and $FS = CF\times TF$), that is, as $\sqrt{4\,FN^2-4\,FS^2}$, that is (Art. 232. N° 5.) as $\sqrt{FP^2-FR^2}$. But Fp or Fm was made equal to FP, and, $p r$ being made equal to PR, the remainder Fr must be equal to FR, therefore the velocity at R varies as $\sqrt{Fm^2-Fr^2}$, but (Euclid, 47. 1.) $rm=\sqrt{Fm^2-Fr^2}$, and rm is by construction equal to the sine of a circular arc, whose radius is FP, and versed sine PR, consequently, the velocity at R varies as the sine of that arc. Q. E. D. Fig. 4.

238\. Corollary. The velocity of the pendulum at F is to the velocity of the pendulum at R, as Fm : $r m$, for the versed sine is in this case equal to radius, and therefore the corresponding arc must be a quadrant whose sine is also equal to radius or Fm.

Prop. VII.

239\. The time in which the pendulum performs one complete oscillation from P to O, is equal to the time in which a body would describe the semicircle $p o q$, uniformly with the velocity which the pendulum acquires at the point F. Fig. 4.

Take any infinitely small arc RV, and making $r v$ equal to it, draw $v o$ parallel to $r m$, and $m n$ to $r v$. Now, by the last proposition, and by Dynamics, Art. 28.; the velocity with which RV is described is to the velocity with which $m o$ is described as $r m$ is to Fm, that

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that is as $\frac{RV}{rm} : \frac{mo}{Fm}$, or as $\frac{mn}{rm} : \frac{mo}{Fm}$, for $mn=rv=RV$. But in the similar triangles Fmr, mno, $Fm : rm = mo : mn$, consequently $\frac{mn}{rm} = \frac{mo}{Fm}$, therefore the velocity with which RV is described is equal to the velocity with which mo is described, and the times in which these equal spaces are described must likewise be equal. The same thing may be demonstrated of all the other corresponding arcs of the cycloid and circle, and therefore it follows that the time in which the pendulum performs one complete oscillation is equal to the time in which the semicircle poq is uniformly described with the velocity acquired at F.

Prop. VIII.

240. The time in which a cycloidal pendulum performs a complete oscillation is to the time in which a body would fall freely through the axis of the cycloid, as the circumference of a circle is to its diameter.

Fig. 4. Since FP=2FN, and since the velocity acquired by falling down NF is equal to the velocity acquired by falling down PF, the body, if it continued to move uniformly with this velocity, would describe a space equal to 2PF (Dynamics, § 37. N° 6.) in the same time that it would descend NF or CF (Art. 219.). Calling T therefore the time of an oscillation, and t the time of descent along the axis, we have, by the preceding proposition,

T= time along poq, with the velocity at F,

and by the preceding paragraph,

t=time along Fp, with the same velocity; therefore

T :: t=time along poq with velocity at V : time along Fp with the same velocity; that is, T : t=poq : Fp =2poq : 2Fp= the circumference of a circle : its diameter.

241. Cor. 1. The oscillations in a cycloid are isochronous, that is, they are performed in equal times whatever be the size of the arc which the pendulum describes. For the time of an oscillation has a constant ratio to the time of descent along the axis, and is therefore an invariable quantity.

242. Cor. 2. The oscillations in a small circular arc whose radius is BF, and in an equal arc of the cycloid, being isochronous (Art. 232. N° 8.), the time of an oscillation in a small circular arc will also be to the time of descent along the axis, as the circumference of a circle is to its diameter.

243. Cor. 3. Since the length BF of the pendulum is double of the axis CF, the time of an oscillation in a cycloid or small circular arc varies as the time of descending along CF, half the length of the pendulum, the force of gravity being constant. But the time of descent along CF varies as $\sqrt{CF}$, therefore the time of an oscillation in a small circular or cycloidal arc varies as the square root of half the length of the pendulum, or as the square root of its whole length. If T, t therefore be the times of oscillations of two pendulums, and L, l their respective lengths, we have by this corollary $T : t = \sqrt{L} : \sqrt{l}$, and $T \times \sqrt{l} = t \times \sqrt{L}$; hence $T = \frac{t \times \sqrt{L}}{\sqrt{l}}$; $t = \frac{T \times \sqrt{l}}{\sqrt{L}}$; $l = \sqrt{\frac{t \times \sqrt{L}}{T}}$, and $L = \sqrt{\frac{T \times \sqrt{l}}{t}}$, from which we may find the time in which a pendulum of any length will vibrate; a pendulum of 39.2 inches vibrating in one second.

244. Cor. 4. When the force of gravity varies, which it does in going from the poles to the equator, the time of an oscillation is directly as the square root of the length of the pendulum, and inversely as the square root of the force of gravity. The time of an oscillation varies as the time of descent along half the length of the pendulum, and the time of descent through any space varies as $\frac{\sqrt{s}}{\sqrt{g}}$, where s is the space described and g the force of gravity; but in the present case $s = \frac{L}{2}$; therefore, by substitution, the time of descent along half the length of the pendulum, or the time of an oscillation, varies as $\frac{\sqrt{\frac{1}{2}L}}{\sqrt{g}}$, or as $\frac{\sqrt{L}}{\sqrt{g}}$. Hence $T : t = \frac{\sqrt{L}}{\sqrt{g}} : \frac{\sqrt{l}}{\sqrt{g}}$, from which it is easy to deduce equations similar to those given in the preceding corollary.

245. Cor. 5. Since $T \doteqdot \frac{\sqrt{L}}{\sqrt{g}}$, $\sqrt{g} \times T \doteqdot \sqrt{L}$; and if the time of oscillation is 1 second, we have $\sqrt{g} \doteqdot \sqrt{L}$, or $g \doteqdot L$, that is, the force of gravity in different latitudes varies as the length of a pendulum that vibrates seconds.

246. Cor. 6. The number of oscillations which a pendulum makes in a given time, and in a given latitude, are in the inverse subduplicate ratio of its length. The number of oscillations n made in a given time are evidently in the inverse ratio of t, the time of each oscillation; that is $n \doteqdot \frac{1}{t}$; but by Corollary 3. $t \doteqdot \sqrt{l}$, therefore $n \doteqdot \frac{1}{\sqrt{l}}$, and $l \doteqdot \frac{1}{n^2}$, from which it is easy to find the length of a pendulum which will vibrate any number of times in a given time, or the number of vibrations which a pendulum of a given length will perform in a given time.

Prop. IX.

247. To find the space through which a heavy body will fall in one second by the force of gravity.

Since by Proposition 8. the time of an oscillation is to the time along half the length of the pendulum as 3.14159 is to 1, and since the spaces are as the squares of the times, the spaces described by a heavy body in the time of an oscillation will be to half the length of the pendulum as $\overline{3.14159}^2$ is to 1. Now it appears from the experiments of Mr Whitehurst, that the length of a pendulum which vibrates seconds at London at 113 feet above the level of the sea, in a temperature of 60°

Theory. 60° of Fahrenheit, and when the barometer is 30 inches, is 39.1196 inches; hence $1^2 : \overline{3.14159}|^2 = \frac{39.1196}{2} : 19.5598 \times \overline{3.14159}|^2 = 16.087$ feet the fpace required.

The methods of determining the centre of ofcillation, gyration, and percuffion, properly belong to this chapter, but they have been already given in the article ROTATION, to which we muft refer the reader who wifhes to profecute the fubject.

CHAP. VI. *On the Collifion or Impulfion of Bodies.*

248. DEF. 1. When a body moving with a certain velocity ftrikes another body, either at reft or in motion, the one is faid to impinge againft, or to impell the other. This effect has been diftinguifhed by the names collifion, impulfion or impulfe, percuffion, and impact.

249. DEF. 2. The collifion or impulfion of two bodies is faid to be *direct* when the bodies move in the fame ftraight line, or when the point in which they ftrike each other is in the ftraight line which joins their centres of gravity. When this is not the cafe, the impulfe is faid to be oblique.

250. DEF. 3. A *hard* body is one which is not fufceptible of compreffion by any finite force An *elaftic* body is one fufceptible of compreffion, which recovers its figure with a force equal to that which compreffes it. A *foft* body is one which does not recover its form after compreffion. There does not exift in nature any body which is either perfectly hard, perfectly elaftic or perfectly foft. Every body with which we are acquainted poffeffes elafticity in fome degree or other. Diamond, cryftal, agate, &c. though among the hardeft bodies, are highly elaftic; and even clay itfelf will in fome degree recover its figure after compreffion. It is neceffary, however, to confider bodies as hard, foft or elaftic, in order to obtain the limits between which the required refults muft be contained.

251. DEF. 4. The mafs of a body is the fum of the material particles of which it is compofed; and the *momentum*, or *moving force*, or *quantity of motion* of any body, is the product arifing from multiplying its mafs by its velocity.

PROP. I.

252. Two hard bodies B, B′ with velocities V, V′ ftriking each other perpendicularly, will be at reft after impulfe, if their velocities are inverfely as their maffes.

1. When the two bodies are equal, their velocities muft be equal in the cafe of an equilibrium after impulfe, and therefore $B : B' = V' : V$, or $BV = B'V'$; for if they are not at reft after impulfe, the one muft carry the other along with it: But as their maffes and velocities are equal, there can be no reafon why the one fhould carry the other along with it.

2. If the one body is double of the other, or $B = 2B'$, we fhould have $V' = 2V'$. Now inftead of B we may fubftitute two bodies equal to B′, and inftead of V′ we may fubftitute two velocities equal to V, with which the bodies B′ may be conceived to move; confequently we have $2B' \times V = B' \times 2V$, or $B' : 2B' = V : 2V$; but 2 V is the velocity of B′, and V is the velocity of 2 B′, therefore when one body is double of the other, they will remain at reft when the maffes of the bodies are inverfely as their velocities. Theory.

In the fame way the propofition may be demonftrated when the bodies are to one another in any commenfurable proportion.

PROP. II.

253. To find the common velocity v of two hard bodies B, B′ whofe velocities are V, V′, after ftriking each other perpendicularly.

If the bodies have not equal quantities of motion they cannot be in equilibrio after impulfe. The one will carry the other along with it, and in confequence of their hardnefs, they will remain in contact, and move with a common velocity v.

1. In order to find this, let us firft fuppofe B′ to be at reft and to be ftruck by B in motion. The quantity of motion which exifts in B before impulfe is BV, and as this is divided between the two bodies after impulfe, it muft be equal to the quantity of motion after impulfe. But $v \times \overline{B+B'}$ is the quantity of motion after impulfe, therefore $v \times \overline{B+B'} = BV$, and $v = \frac{BV}{B+B'}$.

2. Let us now fuppofe that both the bodies are in motion in the fame direction that B follows B′. In order that B may impel B′, we muft have V greater than V′. Now we may conceive both the bodies placed upon a plane moving with the velocity V′. The body B′, therefore, whofe velocity is V′ equal to that of the plane, will be at reft upon the plane, while the velocity of B with regard to B′ or the plane, will be $V - V'$; confequently, the bodies are in the fame circumftances as if B′ were at reft, and B moving with the velocity $V - V'$. Therefore, by the laft cafe, we have the common velocity of the bodies in the moveable plane $\frac{BV - BV'}{B+B'}$; and by adding to this V′, the velocity of the plane, we fhall have v, or the abfolute velocity of the bodies after impulfe, $v = \frac{BV + B'V'}{B+B'}$

Hence the quantity of motion, after impact, is equal to the fum of the quantities of motion before impact.

3. If the impinging bodies mutually approach each other, we may conceive, as before, that the body B′ is at reft upon a plane which moves with a velocity V′ in an oppofite direction to V, and that B moves on this plane with the velocity $V + V'$. Then, by Cafe 1. $\frac{BV + BV'}{B+B'}$ will be the common velocity upon the plane after impulfe; and adding to this V′, or the velocity of the plane, we fhall have v, or the abfolute velocity of the bodies after impact, $v = \frac{BV - B'V'}{B+B'}$. Hence the quantity of motion after impact is equal to the difference of the quantities of motion before impact. It is obvious that v is pofitive or negative, according as BV is greater or lefs than B′V′, fo that when BV is greater than B′V′, the bodies will move in the direction of B's

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B's motion; and when BV is lefs than B′V′, the bodies will move in the direction of A's motion.

254. All the three formulæ which we have given, may be comprehended in the following general formula, $v=\frac{BV\pm B'V'}{B+B'}$; for when B′ is at reft, V′=0, and the formula affumes the form which it has in Cafe 1.

255. Cor. 1. If B=B′, and the bodies mutually approach each other, the equation in Cafe 3. becomes $v=\frac{V-V'}{2}$, or the bodies will move in the direction of the quickeft body, with a velocity equal to one half of the difference of their velocities.

256. Cor. 2. If V=V′, and the bodies move in the fame direction, the laft formula will become $v=V\times\frac{B+B'}{B+B'}$, or $v=V$; for in this cafe there can be no impulfion, the one body merely following the other in contact with it. When the bodies mutually approach each other, and when V=V′, we have $v=V\times\frac{B-B'}{B+B}$.

257. Cor. 3. When the bodies move in the fame direction, we have, by Cafe 2. $v=\frac{BV+BV'}{B+B'}$. Now the velocity gained by B′ is evidently $v-V'$, or $\frac{BV+B'V'}{B+B'}-V=\frac{BV-BV'}{B+B'}$; hence $B+B' : B = V-V' : \frac{BV-BV'}{B+B'}$, but this laft term is the velocity gained by B, and V—V′ is the relative velocity of the two bodies. Therefore, *in the impact of two hard bodies moving in the fame direction*, B+B′ : B *as the relative velocity of the two bodies is to the velocity gained by* B′. It is obvious alfo that the velocity loft by B is $V-v=V-\frac{BV+B'V'}{B+B'}$ or $\frac{B'V-B'V'}{B+B'}$; hence $B+B' : B' = V-V' : \frac{B'V-B'V'}{B+B}$; but this laft term is the velocity loft by B, and V—V′ is the relative velocity of the bodies, therefore *in the impact of two hard bodies* B+B′ : B′ *as their relative velocity is to the velocity loft by* B. The fame thing may be fhewn when the bodies move in oppofite directions, in which cafe their relative velocity is V+V′.

Prop. III.

258. To determine the velocities of two elaftic bodies after impulfe.

If an elaftic body ftrikes a hard and immoveable plane, it will, at the inftant of collifion, be compreffed at the place of contact. But as the elaftic body inftantaneoufly endeavours to recover its figure, and as this force of reftitution is equal and oppofite to the force of compreffion, it will move backwards from the plane in the fame direction in which it advanced.—If two elaftic bodies, with equal momenta, impinge againft each other, the effect of their mutual compreffion is to deftroy their relative velocity, and make them move with a common velocity, as in the cafe of hard bodies. But by the force of reftitution, equal to that of compreffion, the bodies begin to recover their figure,—the parts in contact ferve mutually as points of fupport, and the bodies recede from each other. Now, before the force of reftitution began to exert itfelf, the bodies had a tendency to move in one direction with a common momentum; therefore, the body whofe effort to recover its figure was in the fame direction with that of the common momentum, will move on in that direction, with a momentum or moving force equal to the fum of the force of reftitution and the common momentum; while the other body, whofe effort to recover from compreffion is in a direction oppofite to that of the common momentum, will move with a momentum equal to the difference between its force of reftitution and the common momentum, and in the direction of the greateft of thefe momenta: After impulfe, therefore, it either moves in the direction oppofite to that of the common momentum, or its motion in the fame direction as that of the common momentum is diminifhed, or it is ftopped altogether, according as the force of reftitution is greater, lefs, or equal to the common momentum.

259. In order to apply thefe preliminary obfervations, let us adopt the notation in the two preceding propofitions, and let v be the common velocity which the bodies would have received after impulfe, if they had been hard, and v', v'' the velocities which the elaftic bodies B, B′ receive after impact.

260. 1. If B follows B′, then V is greater than V′, and when B has reached B′, they are both compreffed at the point of impact. Hence, fince v is the common velocity with which they would advance if the force of reftitution were not exerted, we have $V-v$= the velocity loft by B, and $v-V'$= the velocity gained by B′ in confequence of compreffion.—But, when the bodies ftrive to recover their form by the force of reftitution, the body B will move backwards in confequence of this force, while B′ will move onward in its former direction with an accelerated velocity. Hence, from the force of reftitution, B will again lofe the velocity $V-v$, and B′ will, a fecond time, gain the velocity $v-V'$; confequently, the whole velocity loft by B is $2V-2v$, and the whole velocity gained by B′ is $2v-2V'$. Now, fubtracting this lofs from the original velocity of B, we have $V-\overline{2V-2v}$, for the velocity of B after impact, and adding the velocity gained by B to its original velocity, we have $V'+\overline{2v-2V'}$ for the velocity of B′ after impact; hence we have

$$v'=V-\overline{2V-2v}=2v-V$$
$$v''=V'+\overline{2v-2V'}=2v-V.$$

Now, fubftituting in thefe equations, the value of v as found in Cafe 2. Prop. 2. we obtain

$$v'=\frac{BV-B'V+2B'V'}{B+B'}$$
$$v''=\frac{BV'-B'V'+2BV}{B+B'}.$$

261. 2. When the bodies move in oppofite directions or mutually approach each other, the body B is in precifely the fame circumftances as in the preceding cafe; but

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but the body B′ loses a part of its velocity equal to $\overline{2v+2V'}-V'$. Hence we have, by the same reasoning that was employed in the preceding case,

$$v'=2v-V'$$
$$v''=2v+V',$$

and by substituting instead of v its value, as determined in Case 3. Prop. 2. or by merely changing the sign of V′ in the two last equations in the preceding corollary, we obtain the two following equations, which will answer for both cases, by using the upper sign when the bodies move in the same direction, and the under sign when they move in opposite directions.

$$v'=\frac{BV-B'V\pm 2B'V'}{B'+B'}$$
$$v''=\frac{\pm BV'\pm B'V'+2BV}{B+B'}.$$

From the preceding equation the following corollaries may be deduced.

262. Cor. 1. The velocity gained by the body that is struck, and the velocity lost by the impinging body, are twice as great in elastic as they are in hard bodies; for in hard bodies the velocities gained and lost were $v-V'$, and $V-v$; whereas in elastic bodies the velocities gained and lost were $2v-2V'$, and $2V-2v$.

263. Cor. *If one of the bodies, suppose* B′, *is at rest*, its velocity $V'=0$, and the preceding equation becomes

$$v'=\frac{VB-VB'}{B+B'};\ v''=\frac{2VB}{B+B'}.$$

264. Cor. 3. If one of the bodies B′ is at rest, and their masses equal, we have $B=B'$ and $V'=o$, by substituting which in the preceding formulæ, we obtain $v'=o$, and $v''=V$; that is, the impinging body B remains at rest after impact, and the body B′ that is struck when at rest moves on with the velocity of the body B that struck it, so that there is a complete transfer of B's velocity to B′.

265. Cor. 4. If B′ is at rest and B greater than B′, both the bodies will move forward in the direction of B's motion; for it is obvious from the equations in Cor. 2. that when B is greater than B′, v', and v'' are both positive.

266. Cor. 5. If B′ is at rest, and B less than B′, the impinging body B will return backwards, and the body B′ which is struck will move forward in the direction in which B moved before the stroke. For it is evident that when B is less than B′, v' is negative, and v'' positive.

267. Cor. 6. *If both the bodies move in the same direction*, the body B′ that is struck will after impact move with greater velocity than it had before it. This is obvious from the formula in Case 1. of this proposition.

268. Cor. 7. *If the bodies move in the same direction*, and if $B=B'$, there will at the moment of impact be a mutual transfer of velocities, that is, B will move on with B′'s velocity, and B′ will move on with B's velocity. For in the formulæ in Case 1. when $B=B$, we have $v'=V'$ and $v''=V$.

269. Cor. 8. *When the bodies move in opposite directions*, or mutually approach other, and when $B=B'$ and $V=V'$, both the bodies will recoil or move backwards after impact with the same velocities which they had before impact. For in the formulæ in Case 2. with the inferior signs, when $B=B'$ and $V=V'$, we have $v'=-V$ and $v''=V'$.

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270. Cor. 9. If the bodies move in opposite directions, and $V=V'$, we have $v'=V\times\frac{B-3B'}{B+B'}$, and $v''=V\times\frac{3B-B'}{B+B'}$. Hence it is obvious, that if $B=3B'$, or if one of the impinging bodies is thrice as great as the other, the greatest will be stopped, and the smallest will recoil with a velocity double of that which it had before impact. For since $B=3B'$, by substituting this value of B in the preceding equations, we obtain $v'=o$, and $v''=2V$.

271. Cor. 10. If the impinging bodies move in opposite directions, and if $B=B'$, they will both recoil after a mutual exchange of velocities. For when $B=B'$, we have $v'=-V'$, and $v'=V$.

272. Cor. 11. When the bodies move in opposite directions, the body which is struck, and the body which strikes it, will stop, continue their motion, or return backwards, according as $BV-B'V$ is equal to, or greater or less than $2B'V'$.

273. Cor. 12. The relative velocity of the bodies after impact, is equal to their relative velocity before impact, or, which is the same thing, at equal instants before and after impact, the distance of the bodies from each other is the same. For in the different cases we have $v'=2v-V$; $v''=2v\mp V'$. But the relative velocity before impact is in the different cases $V\mp V'$, and the relative velocity after impact is $v'-v'=V\mp V'$.

274. Cor. 13. By reasoning similar to that which was employed in Prop. 2. Cor. 3. it may be shewn that $B+B':2B$ as their relative velocity before impact is to the velocity gained by B′ in the direction of B's motion; and $B+B':2B'$ as their relative velocity before impact is to the velocity lost by B in the direction of A's motion.

275. Cor. 14. The *vis viva*, or the sum of the products of each body multiplied by the square of its velocity, is the same before and after impact, that is, $Bv'^2+B'v''^2=BV^2+B'V'^2$. From the formulæ at the end of Case 2. we obtain

$$Bv^2=\frac{\overline{B-B'}|^2\times\overline{BV^2+B'V'^2}}{\overline{B+B'}|^2}\text{ and}$$

$$B'v'^2=\frac{4BB'\times\overline{BV^2+B'V'^2}}{\overline{B+B'}|^2},\text{ hence their sum }Bv'^2\times B'v''^2$$

$$=\frac{\overline{B-B'}|^2\times\overline{BV^2+B'V'^2}+4BB'\times\overline{BV^2+B'V'^2}}{\overline{B+B'}|^2}=$$

$$\frac{\overline{BV^2+B'V'^2}\times\overline{B-B'^2+4BB'}}{\overline{B+B'^2}}=BV^2+B'V'^2.$$

276. Cor. 14. If several equal elastic bodies B, B″, B‴, B⁗, &c. are in contact, and placed in the same straight line, and if another elastic body β of the same magnitude impinges against B, they will remain at rest, except the last body B⁗, which will move on with the velocity of β. By Art. 264. B will transfer to

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to B'' all its velocity, and therefore B will be at reſt, in the ſame way B'' will transfer to B''' all its velocity, and B'' will remain at reſt, and ſo on with the reſt; but when the laſt body B'''' is ſet in motion, there is no other body to which its velocity can be transferred, and therefore it will move on with the velocity which it received from B''', that is, with the velocity of β.

277. COR. 15. If the bodies decreaſe in ſize from B to B'''', they will all move in the direction of the impinging body β, and the velocity communicated to each body will be greater than that which is communicated to the preceding body.

278. COR. 16. If the bodies increaſe in magnitude, they will all recoil, or move in a direction oppoſite to that of β, excepting the laſt, and the velocity communicated to each body will be leſs than that which is communicated to the preceding body.

PROP. IV.

279. To determine the velocities of two imperfectly elaſtic bodies after impulſe, the force of compreſſion being in a given ratio to the force of reſtitution or elaſticity.

Let B, B' be the two bodies, V, V' their velocities before impact, v', v'' their velocities after impact, and $1:n$ as the force of compreſſion is to that of reſtitution. It is evident from Caſe 1. Prop. 8. that in conſequence of the force of compreſſion alone we have,

$$\left.\begin{array}{l} V-v=\text{velocity loſt by B} \\ v-V'=\text{velocity gained by B}' \end{array}\right\}\text{from compreſſion.}$$

But the velocity which B loſes and B' gains by the force of compreſſion will be to the velocity which B loſes and B' gains by the force of reſtitution or elaſticity as $1:n$; hence

$$\left.\begin{array}{l} 1:n=V-v:nV-nv,\text{ the velocity loſt by B} \\ 1:n=v-V':nv-nV'\text{ the velocity gained by B} \end{array}\right\}\text{from elaſticity.}$$

therefore by adding together the two portions of velocity loſt by B, and alſo thoſe gained by B', we obtain

$\overline{1+n}\,V-\overline{1+n}\,v$, the whole velocity loſt by B,
$\overline{1+n}\,v-\overline{1+n}\,V'$, the whole velocity gained by B.

Hence by ſubtracting the velocity loſt by B in conſequence of colliſion from its velocity before impact, we ſhall have v' or the velocity of B after impact, and by adding the velocity gained by B' after colliſion to its velocity before impact, we ſhall find v'' or the velocity of B' after impact, thus

$v'=V-\overline{\overline{1+n}\,V-\overline{1+n}\,v}$ the velocity of B after impact.
$v''=V'+\overline{1+n}\,v-\overline{1-n}\,V'$ the velocity of B after impact.

Now by ſubſtituting in the place of v its value as determined in Caſe 2. Prop. 2. we obtain

$$v'=V-\frac{\overline{1+n}\times\overline{B'V-B'V'}}{B+B'}.$$

$$v''=V'+\frac{\overline{1+n}\times\overline{BV-BV'}}{B+B}.$$

280. COR. 1. Hence by converting the preceding equation into analogies, $B+B:\overline{1+n}\times B$ as the relative velocity of the bodies before impact is to the velocity gained by B' in the direction of B's motion; and $B+B':\overline{1+n}\times B'$ as the relative velocity of the bodies before impact is to the velocity loſt by B.

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281. COR. 2. The relative velocity before impact is to the relative velocity after impact as the force of compreſſion is to the force of reſtitution, or as $1:n$.

The relative velocity after impact is $v''-v'$, or taking the preceding values of theſe quantities $v''-v'=V'+\frac{\overline{1+n}\times\overline{BV-BV'}}{B+B'}-V-\frac{\overline{1+n}\times\overline{B'V-B'V'}}{B+B'}=V'-V+\frac{\overline{1+n}\times\overline{B+B'}\times\overline{V-V'}}{B+B'}$, dividing by $B+B'$ we have $v''-v'=V'-V+V-V'+\overline{n\times\overline{V-V'}}=n\times\overline{V-V'}$ = the relative velocity after impact. But the relative velocity before impact is $V-V'$, and $V-V':n\times\overline{V-V'}=1:n$. Q. E. D. The quantity V' has evidently the negative ſign when the bodies move in oppoſite directions.

282. COR. 3. Hence from the velocities before and after impact we may determine the force of reſtitution or elaſticity.

PROP. V.

283. To find the velocity of a body, and the direction in which it moves after impinging upon a hard and immoveable plane.

When the body is perfectly hard. Fig. 6.

284. CASE 1. *When the impinging body is perfectly hard.* Let AB be the hard and immoveable plane, and let the impinging body move towards AB in the direction CD, and with a velocity repreſented by CD. Then the velocity CD may be reſolved into the two velocities CM, MD, or MD, FD; CM DF being a parallelogram. But the part of the velocity FD, which carries the body in a line perpendicular to the plane, is completely deſtroyed by impact, while the other part of the velocity MD, which carries the body in a line parallel to the plane, will not be affected by the colliſion, therefore the body will, after impact, move along the plane with the velocity MD. Now, CD : MD = radius : coſ. $\angle$CDM, therefore ſince MD = CF the ſine of the angle of incidence CDF, the *velocity before impact is to the velocity after impact, as radius is to the ſine of the angle of incidence;* and ſince AM = CD—MD, *the velocity before impact is to the velocity loſt by impact, as radius is to the verſed ſine of the complement of the angle of incidence.*

When the body is perfectly elaſtic.

285. CASE 2. *When the impinging body is perfectly elaſtic.* Let the body move in the direction CD with a velocity repreſented by CD, which, as formerly, may be reſolved to MD, FD. The part of the velocity MD remains after impact, and tends to carry the body parallel to the plane. The other part of the velocity FD is deſtroyed by compreſſion; but the force of reſtitution or elaſticity will generate a velocity equal to FD, but in the oppoſite direction DF. Conſequently the impinging body after impact is ſolicited by two velocities, one of which would carry it uniformly from D to F in the ſame time that the other would carry it uniformly from M to D, or from D to N; the body will, therefore

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therefore, move along DE, the diagonal of the parallelogram DFEN, which is equal to the parallelogram DFCM. Hence the angle CDF is equal to the angle EDF, therefore, when *an elastic body impinges obliquely against an immoveable plane, it will be reflected from the plane, so that the angle of reflexion is equal to the angle of incidence.* Since CD, DE are equal spaces described in equal times, the velocity of the body after impact will be equal to its velocity before impact.

When the body is imperfectly elastic.

286. Case 3. *When the impinging body is imperfectly elastic.* In DF take a point *m*, so that DF is to D *m* as the force of compression is to the force of restitution or elasticity, and having drawn *m e* parallel to DB, and meeting NE in *e*, join D *e*; then, if the impinging body approach the plane in the direction CD, with a velocity represented by CD, D *e* will be the direction in which it will move after impact. Immediately after compression, the velocity DF is destroyed as in the last case, while the velocity MD tends to carry the body parallel to the plane. But, by the force of restitution, the body would be carried uniformly along D *m*, perpendicular to the plane, while, by the velocity MD=DN=*m e*, it would be carried in the same time along *m e*, consequently, by means of these two velocities, the body will describe D *e*, the diagonal of the parallelogram D *m e* N. The velocity, therefore, before impact is to the velocity after impact as DC : D *e*, or as DE : D *e*, or as sin. D *e* E, sin. DE *e*, or as sin. D *e m* : sin. DE *e*, or as sin. FD *e* : sin. FDE. Now, by produing D *e* so as to meet the line CE produced in G, we have, on account of the parallels FE, *m e*, D *m* : DF =*m e* : FG ; but, FD being radius, FE is the tangent of FDE, or FDG the angle of incidence, and FDG is the tangent of the angle of reflexion FDG : Therefore D *m* : DF=tang. ∠CDF : tang. ∠FDG. Consequently, *when an imperfectly elastic body impinges against a plane*, it will be reflected in such a manner *that the tangent of the angle of reflexion is to the tangent of the angle of incidence, as the force of compression is to the force of restitution or elasticity; and the velocity before incidence will be to the velocity after reflexion, as the sine of the angle of reflexion is to the sine of the angle of incidence.*

Scholium.

287. When the surface against which the body impinges is curved, we must conceive a plane touching the surface at the place of incidence, and then apply the rules in the preceding proposition. The doctrine of the oblique collision of bodies is of great use both in acoustics and optics, where the material particles which suffer reflexion, are regarded as perfectly elastic bodies.

Prop. VI.

288. To find the point of an immoveable plane which an elastic body moving from a given place must strike, in order that it may, after reflexion, either from one or two planes, impinge against another body whose position is given.

Fig. 7.

289. Case 1. *When there is only one reflexion.* Let C be the place from which the impinging body is to move, and let E be the body which is to be struck after reflexion from the plane AB. From C let fall CH perpendicular to AB, continue it towards C till HG=CH, and join G,E by the line GDE; the point D where this line cuts the plane, is the place against which the body at C must impinge in order that, after reflexion, it may strike the body at E. The triangles CDH, HDG are equiangular, because two sides and one angle of each are respectively equal, therefore the angles DCH, DGH are equal. But on account of the parallels FD, CG the angle EDF=DGC=DCH, and DCH=FDC, therefore the angle of incidence FDC=FDE the angle of reflexion; consequently by Prop. 4. a body moving from C and impinging on the plane at D will, after reflexion, move in the line DE, and strike the body at E.

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290. Case 2. *When there are two reflexions.* Let AB, BL, be the two immoveable planes, C the place from which the impinging body is to move, and F the body which it is to strike after reflexion from the two planes, it is required to find the point of impact D. Draw CHG perpendicular to AB, so that HG=CH. Through G draw GMN parallel to AB, cutting LB produced in M, and make GM=MN. Join N, F, and from the point E, where NF cuts the plane BL, draw EG, joining the points EG : the point D will be the point of the plane, against which the body at C must impinge, in order to strike the body at F. By reasoning as in the preceding case, it may be shewn that the angle CDH=EDB, therefore DE will be the path of the body after the first reflexion. Now, the triangles GEM, EMN are equiangular, because GM=MN, and the angles at M right, therefore DEB=FEL, that is, the body after reflexion at E will strike the body placed at F. Fig. 8.

Prop. VII.

291. To determine the motions of two spherical bodies which impinge obliquely upon each other, when their motion, quantities of matter, and radii, are given.

Let A, B be the two bodies, and let CA, DB be the directions in which they move before impact, and let these lines represent their respective velocities. Join A, B the centres of the bodies, and produce it both ways to K and I. Draw LM perpendicular to IK, and it will touch the bodies at the point of impact. Now, the velocity CA may be resolved into the two velocities CI, IA, and the velocity DB into the velocities DK, KB, but CA and DB are given, and also the angles CAI, DBK, consequently CI and IA, and DK and KB may be found. The velocities CI, DK, which are parallel to the plane, will not be altered by collision, therefore IA, KB are the velocities with which the bodies directly impinge upon each other, consequently their effects or the velocities after impact may be found from Prop 3.; let these velocities be represented by AN, BP. Take AF=CI and BH=DM, and having completed the parallelograms AFON, BPQH, draw the diagonals AO, BQ. Then, since the body A is carried parallel to the line LM with a velocity CI=AF, and from the line LM by the velocity AN, it will describe AO, the diagonal of the parallelogram Fig. 9.

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rallelogram NF; and for the same reason the body B will describe the diagonal BQ of the parallelogram PH.

292. COROLLARY. If A=B, and if the body which is struck moves in a given direction and with a given velocity after impact, the direction of the impinging body, and the velocity of its motion, may be easily found. Let the body D impinge against the equal body C, and let CB be the direction in which C moves after impact, it is required to find the direction in which D will move. Draw D *c*, touching the ball C at *c*, the place where the ball D impinges; produce BC to E, and through *c* draw A *c* F perpendicular to EB, and complete the rectangle FE. The force D *c* may be resolved into the forces E *c*, *c* F, of which E *c* is employed to move the ball C in the direction CB and with the velocity E *c*; but the force *c* F has no share in the impulse, and is wholly employed in making the body D move in the direction CA, and with the velocity CF.

Fig. 10.

SCHOLIUM.

The phenomena of impulsion owing to repulsive forces which prevent bodies from coming into mathematical contact.

293. In the preceding proposition, we have endeavoured to give a short and perspicuous view of the common theory of impulsion. The limits of this article will not permit us to enter upon those interesting speculations to which this subject has given rise; but those who are anxious to pursue them will find ample assistance in the article IMPULSION, in the Supplement to the last edition of this work, where Dr Robison has treated the subject with his usual ability. It may be proper however to remark, that all the phenomena of impulse as well as pressure, are owing to the existence of forces which prevent the particles of matter from coming into mathematical contact. The body which is struck, in the case of collision, is put in motion by the mutual repulsion of the material particles at the point of impact, while the velocity of the impinging body is diminished by the same cause. Hence we see the absurdity of referring all motion to impulse, or of attempting to account for the phenomena of gravitation, electricity, and magnetism by the intervention of any invisible fluid. Even if the supposition that such a medium exists were not gratuitous, it would be impossible to shew that its particles, by means of which the impulse is conveyed, are in contact with the particles of the body to which that impulse is communicated.

Don Georges Juan's physico-mathematical theory of percussion.

294. A physico-mathematical theory of percussion, in which the impinging bodies are considered as imperfectly elastic, has been lately given by Don Georges Juan, in his *Examen Maritimo*, a Spanish work which has been translated with additions by M. L'Eveque, under the title of *Examen maritime, theorique et pratique, ou Traite de mecanique, appliquè a la construction, et a la manœuvre des vaisseaux et autres batimens*. This theory has been embraced by many eminent French philosophers, and may be seen in Prony's *Architecture Hydraulique*, vol. i. p. 208, and in Gregory's Mechanics, vol. i. p. 291. We shall endeavour, under the article PERCUSSION, to give a short account of this interesting theory, which has been found to accord with the most accurate experiments.

295. In some cases of collision the results of experiments are rather at variance with those of theory, in consequence of the communication of motion not being exactly instantaneous. "If an ivory ball (says Mr Leslie) strikes against another of equal weight, there should, according to the common theory, be an exact transfer of motion. But if the velocity of the impinging ball be very considerable, so far from stopping suddenly, it will recoil back again with the same force, while the ball which is struck will remain at rest; the reason is, that the shock is so momentary, as not to permit the communication of impulse to the whole mass of the second ball, a small spot only is affected, and the consequence is therefore the same as if the ball had impinged against an immoveable wall. On a perfect acquaintance with such facts depends, in a great measure, the skill of the billiard player. It is on a similar principle that a bullet fired against a door which hangs freely on its hinges will perforate without agitating it in the least. Nay, a pellet of clay, a bit of tallow, or even a small bag of water, discharged from a pistol will produce the same effect. In all these instances the impression of the stroke is confined to a single spot, and no sufficient time is allowed for diffusing its action over the extent of the door. If a large stone be thrown with equal momentum, and consequently with smaller velocity, the effect will be totally reversed, the door will turn on its hinges, and yet scarcely a dent will be made on its surface. Hence likewise the theory of most of the tools, and their mode of application in the mechanical arts: the chisel, the saw, the file, the scythe, the hedge bill, &c.—In the process of cutting, the object is to concentrate the force in a very narrow space, and this is effected by giving the instrument a rapid motion. Hence, too, the reason why only a small hammer is used in rivetting, and why a mallet is preferred for driving wedges." *Enquiry into the Nature of Heat*, p. 127,8.

Successive propagation of motion illustrated.

Fig. 11.

296. The successive propagation of motion may be illustrated by a very simple experiment. Take two balls A, B, of which B is very large when compared with A, and connect them by a string S passing over the pulley P. If the ball B is lifted up towards S and allowed to fall by its own weight, instead of bringing the little ball A along with it, as might have been expected, the string will break at P. Here it is evident that the motion is not propagated instantaneously, for the string is broken before the motion is communicated to the portion of the string between P and A.

Apparatus for experiments on collision.

Fig. 12.

297. An apparatus for making experiments on the collision of bodies is represented in fig. 12. The impinging bodies are suspended by threads like pendulums, and as the velocities acquired by descending through the arches of circles are in the ratio of their chords, the velocities of the impinging bodies may be easily ascertained. The apparatus is therefore furnished with a graduated arch MN which is generally divided into equal parts, though it would be more convenient to place the divisions at the extremities of arcs whose chords are expressed by the corresponding numbers. The balls that are not used may be placed behind the arc as at *m* and *n*; and in order to give variety to the experiments, the balls may be of different sizes. Sometimes a dish like G is attached to the extremities of the strings, for the purpose of holding argillaceous balls, and balls of wax softened with a quantity of oil equal to one-fourth part of their weight.—See *Smeaton's Experiments on the Collision of Bodies*.

CHAP.

Chap. VII. *On the Maximum Effects of Machines.*

298. We have already ſeen in ſome of the preceding chapters, that when two bodies act upon each other by the intervention either of a ſimple or compound machine, there is an equilibrium when the velocity of the power is to the velocity of the weight as the weight is to the power. In this ſituation of equilibrium, therefore, the velocity of the weight is nothing, and the power has no effect in raiſing the weight, or, in other words, the machine performs no work. When the weight to be raiſed is infinitely ſmall, the velocity is the greateſt poſſible; but in this caſe likewiſe, the machine performs no work. In every other caſe, however, between theſe two extremes, ſome work will be performed.—In order to illuſtrate this more clearly, let us ſuppoſe a man employed in raiſing a weight by means of a lever with equal arms; and that he exerts a force upon the extremity of the lever, equivalent to 50 pounds. If the weight to be raiſed is alſo 50 pounds, there will be an equilibrium between the force of the man and the weight to be raiſed, the machine will remain at reſt, and no work will be performed. If the man exert an additional force of one pound, or if his whole force is 51 pounds, the equilibrium will be deſtroyed, the weight will riſe with a very ſlow motion, and the machine will therefore perform ſome work. When the motion of the machine therefore is $=0$ the work performed is alſo nothing, and when the machine is in ſuch a ſtate that the power preponderates, the work performed increaſes. Let us now ſuppoſe that the weight ſuſpended from the lever is infinitely ſmall, the motion of the machine will then be the greateſt poſſible; but no work will be performed. If the weight however is increaſed, the motion of the machine will be diminiſhed, and work will be performed. Here then it is evident that the work performed increaſes from nothing when the velocity is a maximum, and decreaſes to nothing when the velocity is a minimum. There muſt therefore be a particular velocity when the work performed is a *maximum*, and this particular velocity it is our preſent object to determine. Sometimes, indeed, the velocities of the machine are determined by its ſtructure, and therefore it is out of the power of the mechanic to obtain a maximum effect by properly proportioning them. The ſame object however may be obtained, by making the work to be performed, or the reſiſtance to be overcome, in a certain proportion to the power which is employed to perform the work or overcome the reſiſtance.

299. Def. 1.—In a machine performing work, the powers employed to begin and continue the motion of the machine, are called the *firſt movers*, *the movers of powers*; and thoſe powers which oppoſe the production and continuance of motion are called *reſiſtances*. The friction of the machine, the inertia of its parts, and the work to be performed, all oppoſe the production and continuance of motion, and are therefore the reſiſtances to be overcome. When various powers act at the ſame time, and in different directions, the equivalent force which reſults from their combined action is called the *moving force*, and the force reſulting from all the reſiſting forces, the *reſiſtance*. If the machine, for example, is a lever AB moving round the centre F, by means of which, two men raiſe water out of two pump barrels by the chains A*u*, C*w* attached to the piſtons, and paſſing over the arched heads or circular ſectors M, N, for the purpoſe of giving the piſtons and chains a vertical motion. Let the force of the man at B, ſix feet from F, be equal to 50 pounds, or π, his mechanical energy to turn the lever is $6\times 50=300$. Let the force of the other man applied at E, four feet from F, be alſo equal to 50 pounds, or p. His mechanical energy will be $4\times 50=200$, ſo that the whole moving power is equal to $300+200=500$. But if the two forces of 50 pounds, inſtead of being applied at two different diſtances from F, had been applied at the ſame point G, 5 feet from F, their energy to turn the lever would have been the ſame, for $5\times\overline{50+50}=500$. In the preſent caſe, therefore, the *moving force* is equivalent to $P\times GF$, or a force of 100 pounds acting at a diſtance of five feet from the centre of motion. Now let us ſuppoſe that each piſton A *u*, C *w* raiſes 60 pounds of water equivalent to the weights *u*, *w*, and that $CF=2$ feet, and $AF=3$ feet, then the mechanical energy of theſe weights will be reſpectively $2\times 60=120$, and $3\times 60=180$, and the ſum of their energies $=300$. But two forces of 60 pounds each, acting at the diſtances two feet and three feet from F, are equivalent to their ſum $=120$ pounds, acting at a diſtance of two feet and a half from F, for $2\frac{1}{2}\times 120=300$; therefore, the reſiſtance ariſing from the work to be performed, or from the water raiſed in the pump barrels, is equal to a weight P of 120 pounds acting at the diſtance $DF=2\frac{1}{2}$ feet. But in addition to the reſiſtance ariſing from the work to be performed, the two men have to overcome the reſiſtance ariſing from the friction of the piſton in the barrels, which we may ſuppoſe equivalent to f, φ, each equal to 10 pounds, acting at the points A, C; but theſe forces are equivalent to 20 pounds, or $f+\varphi$ acting at D, therefore the reſiſtance ariſing from the work and from friction is equal to 140 pounds, acting at the diſtance $DF=2$ feet and a half. While the two men are employed in overcoming theſe reſiſtances, they have alſo to contend againſt the inertia of the beam AF, and that of the chains and piſtons, which we may ſuppoſe equal to 20 pounds when collected in their centre of gravity *g*, whoſe diſtance from F is 2.2 feet; but a weight of 20 pounds acting at the diſtance of 2.2 feet is equivalent to a weight of $19\frac{1}{2}$ pounds, acting at the diſtance of 2.5 feet, or DF, conſequently the ſum of all the reſiſtances when reduced to the ſame point D of the lever is equal to $159\frac{1}{2}$ pounds acting at the diſtance of 2.5 feet from F. The mechanical energy, therefore, of the ſum of all the reſiſtances will be $=2.5\times 159\frac{1}{2}=398.75$, while the energy of the moving force, or the ſum of all the moving powers, is equal to 500.

300. Def. 2.—The *impelled point* of a machine is that point to which the moving power is applied, if there is only one power, or that point to which all the moving powers are reduced, or at which the moving force is ſuppoſed to act. The *working point* of a machine is that point at which the reſiſtance acts if it is ſingle, or that point to which all the reſiſtances are reduced, and at which they are ſuppoſed to act when combined. Thus in fig. 1. G is the impelled point of the machine, and D the working point. Had a ſingle force π been applied at the point B to raiſe a ſingle weight *u*, acting at

Plate CCCXXII. fig. 1.

Fig. 1.

Theory.

at the point A, then B would have been the impelled point, and A the working point of the machine. In the wheel and axle, the point of the wheel at which the rope touches its circumference is the impelled point, while the working point is that point in the circumference of the axle where the rope which carries the weight is in contact with it.

301. Def. 3.—The velocity of the moving power, and the velocity of the resistance, are respectively the same as the velocity of the impelled point, and the velocity of the working point.

302. Def. 4.—The *effect* of a machine, or the *work performed*, is equal to the resistance multiplied by the velocity of the working point; for when any machine raises a mass of matter to a given height in a certain time, the effect produced is measured by the product of the mass, and the height through which it rises, that is, by the product of the mass by the velocity with which it moves.

303. Def. 5.—The *momentum of impulse* is equal to the moving force multiplied by the velocity of the impelled point.

Explanation of symbols.

304. In any machine that has a motion of rotation, let x be the velocity of the impelled point, and y the velocity of the working point. When the machine is a lever, x, y will express the perpendiculars let fall from the centre of motion upon the line of direction in which the forces act; and if the machine is a wheel and axle, x, y will represent the diameters of the wheel and the axle respectively. In compound machines, which may be regarded as composed of levers, (Art. 90.) x will represent the sum of all the levers by which the power acts, and y the sum of all the levers by which the resistance acts.

305. Let P be the real pressure which the moving power exerts at the impelled point of the machine, and R the actual pressure which the mere resistance of the work to be performed exerts at the working point, or which it directly opposes to the exertion of the power. Let a be the inertia of the power P, or the mass of matter which the power P must move with the velocity of the impelled point, in order that P may exert its pressure at the impelled point; and let b be the inertia of the resistance R, or the mass of matter which must be moved with the velocity of the working point in the performance of the work.

306. Since the resistance arising from the friction of the communicating parts is an uniformly retarding force, it may be measured by a weight φ acting at the working point of the machine, which will oppose the same resistance to the moving power as the friction of the parts.

307. Let m be the inertia of the machine, or rather that quantity of matter, which acting at the working point of the machine will require the same part of the moving force to give it an angular motion, then since y represents the arm of the lever by which the resistance acts, or the distance of the working point from the centre of motion; and since the momentum of inertia, or the momentum with which any mass revolving round a centre resists being put in motion, is equal to its quantity of matter multiplied by the square of its distance from its centre of motion (see article Rotation), we have $m\,y^2$ for the momentum of inertia of the machine. It is obvious that every machine opposes a certain resistance to any force that endeavours to give it an angular motion, and that this resistance will increase with the inertia of its parts. It is easy, therefore, to find a quantity of matter, which, when placed at any part of the machine, will oppose the same resistance to an angular motion, as the combined inertia of the various parts of the machine. This is the quantity of matter which we have called m, and which we have supposed to act at the working point, because to that point all the other resistances have been reduced. Collecting the symbols, therefore, we have

x = the velocity of the impelled point or the radius of the wheel, or the length of the lever by which the power acts.

y = the velocity of the working point, or the radius of the axle, or the length of the lever by which the resistance acts against the power.

P = the pressure exerted by the power at the impelled point of the machine.

R = the pressure which the resistance arising from the work to be performed exerts at the working point of the machine.

a = the inertia of the power P, or the quantity of matter to which it must communicate the velocity of the impelled point.

b = the inertia of the resistance R, or the quantity of matter which it must move with the velocity of the working point before any work is performed.

φ = a quantity of matter which, if placed at the working point of the machine, would oppose the same resistance to the moving power as that which arises from the friction of the communicating parts.

m = the quantity of matter which, if placed at the working point of the machine, would oppose the same resistance to the production of an angular motion, that is opposed by the inertia of the various parts of which the machine is composed. Hence, by the principles of rotation, we have

$m\,y^2$ = the momentum of inertia of the machine.

We are now prepared for determining the conditions of construction, which will enable any machine to produce a maximum effect.

Prop. I.

308. To determine the velocities which must be given to the impelled and working points of a machine, or the ratio of the levers by which the power and resistance ought to act, in order to obtain a maximum effect.

Let AB be a lever, whose fulcrum is F, and to whose extremity B is applied the power P to overcome the resistance R, and let $FB = x$, and $FA = y$. Then, by Art. 36. we shall have, from the following analogy, the weight which, placed at B, would be in equilibrio with R; $x : y = R : \frac{Ry}{x}$, the weight which will keep R in equilibrio, or the weight which is equal to Fig. 2.

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to that part of the power P which balances the resistance R. Hence, $P-\frac{Ry}{x}$ will be the effective force exerted by the power P, which, multiplied by x, its distance from the centre of motion, gives $Px-Ry$ for the force which is exerted in giving an angular motion to the power and resistance. But the resistance of friction was supposed equal to the weight φ acting at the working point or at the distance FA or y; consequently, φy will be the resistance which friction opposes to the force $Px-Ry$, and therefore $Px-Ry-\varphi y$ is the motive force exerted by P. Now, the momentum of the inertia of the power P, or the force with which it resists being put in motion, is ax^2, and the momentum of inertia of the resistance R is by^2, while the momentum of inertia of the machine is my^2. Therefore, the sum of these momenta, viz. $ax^2+by^2+my^2$ is the mass to be put in motion by the power P. But, by Dynamics, § 167. the velocity generated in a given time is directly as the motive force, and inversely as the quantity of matter to which that force is applied. Hence the angular velocity, or the number of turns which the machine will make in a given time, is $\frac{Px-Ry-\varphi y}{ax^2+by^2+my^2}$. But in every rotatory machine the velocities of its different parts are as their distance from the axis; hence, we shall have the velocities of the impelled and working points of the machine, by multiplying the angular velocity by x, y the distances of the impelled and working points of the machine from the centre of motion. Therefore,

$\frac{Px^2-Rxy-\varphi xy}{ax^2+by^2+my^2}$ = the velocity of the impelled point,

and

$\frac{Pxy-Ry^2-\varphi y^2}{ax^2+by^2+my^2}$ = the velocity of the working point of the machine; and multiplying by R, we have from

Def. 4. $\frac{PxyR-R^2y^2-\varphi Ry^2}{ax^2+vy^2+my^2}$ = the work performed.

309. But as forces are proportional to the velocities generated by them in equal times (Dynamics, § 153. Cor. 4. § 159.), the preceding quantities will represent the accelerating forces. Now, the velocities are as the forces and times jointly (Dynamics, § 153.), that is, $v=Ft$, or is $=gtF$; but F, the accelerating force, which generates the velocity of the impelled point, is represented by the formula $\frac{Px^2-Rxy-\varphi xy}{ax^2+by^2+my^2}$. Therefore, v, or the absolute velocity of the impelled point, is $\frac{Px^2-Rxy-\varphi xy}{ax^2+by^2+my^2}\times gt$, and the absolute velocity of the working point $\frac{Pxy-Ry^2-\varphi y^2}{ax^2+by^2+my^2}\times gt$. Again, by Def. 4. the effect of a machine, or the work performed, is equal to the resistance of the work multiplied by the velocity; consequently, since R is the work, we have, for the performance of the machine,

$$\frac{PxyR-R^2y^2-\varphi Ry^2}{ax^2+by^2+my^2}\times gt.$$

Now, considering y as the variable quantity, and making the fluxion of the preceding formula $=0$, we shall find that the performance of the machine is a maximum, when

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$$y=\frac{\overline{a^2\times\overline{R+\varphi}|^2+P^2a\times\overline{m+b}}|^{\frac{1}{2}}-aR-a\varphi}{Pm+Pb}\times x.$$

When $R=0$, we have

$$y=\frac{\overline{a^2\varphi^2+P^2a\times\overline{m+b}}|^{\frac{1}{2}}-a\varphi}{Pm+Pb}\times x.$$

When $\varphi=0$, the first formula becomes

$$y=\frac{\overline{a^2R^2+P^2a\times\overline{m+b}}|^{\frac{1}{2}}-aR}{Pm+Pb}\times x.$$

When both R and $\varphi=0$, we have, after reduction,

$$y=\frac{\sqrt{a}}{\sqrt{m+b}}\times x.$$

When $b=0$, the first formula becomes

$$y=\frac{\overline{a^2\times\overline{R+\varphi}|^2+P^2am}|^{\frac{1}{2}}-aR-a\varphi}{Pm}\times x.$$

When R, φ and $b=0$, we have

$$y=\frac{\sqrt{a}}{\sqrt{m}}\times x.$$

When $a:b=P:R$, we have, by substituting P and R instead of a and b,

$$y=\frac{\overline{P^2\times\overline{R+\varphi}|^2+P^3\times\overline{m+R}}|^{\frac{1}{2}}-PR-P\varphi}{Pm+PR}\times x.$$

When Pm and $\varphi=0$, the last formula becomes

$$y=\frac{\overline{P^2R^2+P^3R}|^{\frac{1}{2}}-PR}{PR}\times x=\sqrt{\frac{P^2R^2+P^3R}{P^2R^2}}-\frac{PR}{PR}\times x$$

$$x=\sqrt{\frac{P}{R}+1}\,\Big|-1,$$

and when $x=1$, and $R=1$, we have

$$y=\sqrt{P+1}\,\Big|-1,$$

and when $P=1$, and $x=1$, we obtain

$$y=\sqrt{\frac{1}{R}+1}\,\Big|-1.$$

When $x=1$,

$$y=\sqrt{\frac{P}{R}+1}\,\Big|-1.$$

These various formulæ, the application of which to particular cases shall be shown in the practical part of this article, give us values of y for almost every species of machinery; so that the mechanic may easily determine the velocities which must be given to the impelled and working points of the machine in order to produce a maximum effect.

310. When the machine, however, is already constructed, the velocities of the impelled and working points cannot be changed, without altering the structure of the machine; and therefore we must find the ratio between the power and resistance, which will enable

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Prop. II.

311. To determine the ratio between the power and the refiftance of a machine when its performance is a maximum.

Since the ftructure of the machine is given, the values of x, y are known, and therefore we have to determine the relative values of P and R, when the effect of the machine is a maximum. This would be eafily done, by making R variable in the formula which expreffes the performance of the machine, and making its fluxion equal to o, if none of the other quantities varied along with R. It often happens, however, that while R varies, the mafs b fuffers a confiderable change, though in other cafes the change induced upon b is too unimportant to merit notice. This propofition, therefore, admits of two cafes, 1. When the change upon b is fo fmall that it may be fafely omitted in the inveftigation; and, 2. When the change upon b is fufficiently great to require attention.

312. Case 1. When R is the only quantity which is variable, the fluxion of the formula

$$\frac{P\,x\,y\,R - R^2\,y^2 - \varphi\,R\,y^2}{a\,x^2 + b\,y^2 + m\,y^2},$$

which reprefents the work performed, is equal to the fluxion of the numerator, becaufe the denominator is conftant, that is, $P\,x\,y\,\dot{R} - 2\,R\dot{R}\,y^2 - \varphi\,\dot{R}\,y^2 = 0$, and, dividing by $\dot{R}$; $Pxy - 2\,R\,y^2 - \varphi\,y^2 = 0$, hence $2Ry^2 = P\,x\,y - \varphi\,y^2$, and $R = \frac{P\,x\,y - \varphi\,y^2}{2\,y^2}$, which, divided by y, gives $R = \frac{P\,x - \varphi\,y}{2\,y}$. Now, according to the experiments of Coulomb, the friction is, in general, proportional to the refifting preffure, or a certain part of that preffure, for example, $\frac{1}{15}R$; and calling $Z = \frac{1}{15}$, and omitting $\varphi\,y$, we have for the refiftance $R + \frac{1}{15}R$, or $\frac{16}{15}R = \frac{P\,x - \varphi}{2\,y}$, or $R = \left(\frac{P\,x}{2\,y}\right) \div \frac{16}{15}$, and making $P = 1$, and $x = 1$, we have $R = \left(\frac{1}{2\,y}\right) \div \frac{16}{15}$, fo that, abftracting from the quotient $\frac{16}{15}$, which being little greater than 1, will not alter the refult, the refiftance fhould be one-half of the force which would keep the impelling power in equilibrio.

313. Case 2. When b varies at the fame time with R, it will in moft cafes vary in the fame prroportions, and therefore may be reprefented by any multiple of R, as d R, where d may be either an integer or a fraction. In order to fimplify the inveftigation, we may confider the fraction φ as a refiftance diminifhing the impelling power, inftead of regarding it as a refiftance to be added to the other refifting forces. Thus the impelling power P will become $P - \varphi$. In the fame way we may confider the momentum of the machine's inertia applied to the impelled point, that is, inftead of my^2 it may be made $m\,x^2$. Now making $P - \varphi$, or the impelling power $= 1$, and making $x = 1$, we fhall have by thefe fubftitutions in the formula which expreffes the effect of the machine, $\frac{R\,y - R^2\,y^2}{a + m + d\,R\,y^2}$, or, for the fake of fimplicity, making $a + m = q$, we have for the performance of the machine $\frac{R\,y - R^2\,y^2}{q + d\,r\,y^2}$; then fince R is the variable quantity, we fhall find, after making the fluxion of this formula $= 0$, that the performance is a maximum when $R = \frac{\overline{q^2 + q\,d\,y}|^{\frac{1}{2}} - q}{d\,y^2}$.

When $b = R$ then $d - 1$, and we fhall have

$$R = \frac{\overline{q^2 + q\,y}|^{\frac{1}{2}} - q}{y^2}.$$

When $a = P$ and $P = 1$, and when m, the inertia of the machine, $= 0$, we fhall have $a + m = 1 = q$, and then the formula becomes

$$R = \frac{\overline{y + 1}|^{\frac{1}{2}} - 1}{y^2}.$$

When $y = x$, then $y = 1$, and

$$R = \frac{\overline{1 + 1}|^{\frac{1}{2}} - 1}{1} = 0.4142.$$

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314. Thofe who wifh to profecute this interefting fubject may confult the different papers of Euler in the *Comment. Petropol.* vol. x. p. 80, 1743, and in the *Comment. Nov. Petropol.* vol. iii. and viii. In the article Machinery in the Supplement to the laft edition of this Work, the fubject has been treated with great ability by Dr Robifon, though he has omitted the various fteps in the inveftigation which conduct to the leading formulæ. The fubject has been alfo ably difcuffed by Profeffor Leflie in a paper publifhed in the Appendix to Fergufon's Lectures, vol. ii. p. 353; and as the refults of his inveftigations may be of great ufe in practice, we fhall here prefent the reader with a fhort abftract of them.

If the refiftance is equal to the power, is double, triple, or quadruple, &c. a maximum effect will be produced when the velocity of the power, or its diftance from the centre of motion, is $1 + \sqrt{2}$; $2 + \sqrt{6}$; $3 + \sqrt{12}$; $4 - \sqrt{20}$; $5 + \sqrt{30}$; $6 + \sqrt{42}$, that of the weight being 1, &c. If the refiftance is very great, compared with the power, the velocity fhould at leaft be double of that which would procure an equilibrium, in order that the machine will produce a maximum effect.

315. If the velocity of the power, or its diftance from the centre of motion, be equal to, double, triple, quadruple, &c. &c. of the velocity of the weight or refiftance, a maximum effect will be produced when the power P is equal to $R \times \overline{1 + \sqrt{2}}$; $R \times \overline{\frac{1}{2} + \sqrt{\frac{3}{8}}}$; $R \times \overline{\frac{1}{3} + \sqrt{\frac{4}{27}}}$; $R \times \frac{1}{4} + \sqrt{\frac{5}{64}}$, $R \times \frac{1}{5} + \sqrt{\frac{6}{125}}$, &c. where R is the refiftance or weight to be raifed. If the velocity of the power be very large, a maximum effect will be produced when the power P is, at leaft, double of that which would procure an equilibrium. It appears alfo from Mr Leflie's paper, that in whatever way the maximum be procured, the force which impells the

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the weight can never amount to one-fourth part of the direct action of the power; and that in machines where the velocity of the power is great, we may disregard the momenta of the connecting parts, and consider the force which ought to be employed as double of what is barely able to maintain the equilibrium.

CHAP. VIII. *On the Equilibrium of Arches, Piers, and Domes.*

Fig. 3. 316. DEF. 1. An arch is represented in fig. 3. by the assemblage of stones *a b*, *c d*, *e f*, &c. forming the mass ABMN, whose inferior surface is the portion of a curve. The parts A, B are called the *spring of the arch*, the line AB the *span of the arch*, C *b* its *altitude*, *b* its crown, *a b* the *keystone*, the curve or lower surface A *b* B the *intrados*, and the roadway TUV the *extrados*; PQ, RS, the *piers* when they stand between two arches, and the *abutments* when they are at the extremities of the bridge.

Fig. 4. 317. DEF. 2. A catenarian curve is the curve formed by any line or cord perfectly flexible, and suspended by its extremities. Thus if the chain ACB be suspended by its extremities A, B, it will by the action of gravity upon all its parts assume the form ACB, which is called the catenary or catenarian curve.

318. There are three modes of determining the construction of arches; the first of which is to consider the arch as an inverted catenary; the second is to establish an equilibrium betweeen the vertical pressures of all the materials between the intrados and extrados; and the third is to regard the different arch-stones as portions of wedges without friction, which endeavour by their own weight to force their way through the arch. The first of these methods was given by the ingenious Dr Hook, and is contained in the following proposition.

PROP. I.

319. To determine the form of an arch by considering it as an inverted catenary, when its span, its altitude, and the form of the roadway or extrados are given.

Fig. 5. Let *a*, *b*, *c*, *d* be a number of spheres or beads connected by a string, and suspended by their extremities A, B; they will form a catenarian curve A *a b c* B, and be in equilibrio by the action of gravity. Each sphere is acted upon by two forces; at its lower point by the weight of the spheres immediately below it, and at its upper point by the weight of the same spheres added to that of the sphere itself; that is, any sphere *c* is in equilibrio from the result of two forces, one of which is produced by the weights of *c d e* acting at the lower point of *b*, while the other force arises from the weight of *b c d e* acting at its upper point. The equilibrium of this chain of spheres is evidently of the stable kind, as it will immediately recover its position when the equilibrium is disturbed. Let us now suppose this arch inverted, so as to stand in a vertical plane as in

Fig. 6. fig. 6. It will still preserve its equilibrium. For the relative positions of the lines which mark the directions remain unchanged by inverting the curve, the force of gravity continues the same, and therefore the result of these forces will be the same, and the arch will be in equilibrio. The equilibrium, however, which the arch now possesses is of the tottering kind, so that the least disturbing force will destroy it, and it will consequently be unable to support any other weight but its own.

320. Let us now suppose that it is required to form an equilibrated arch, whose span is AB, whose altitude is D *k*, and which will support the materials of a roadway, whose form TUV is given. It is obvious, that if the spheres *a*, *b*, *c*, *d* increase in density from *k* towards *a*, the catenarian curve will grow less concave at its vertex *e*, and more concave towards its extremities A, B. Let us then suppose that the densities of the spheres *a*, *b*, *c*, *d*, *e*, &c. are respectively as *a m*, *b n*, *c o*, *d p*, *e q*, &c. the vertical distances of their respective centres from the roadway TUV, the arch will have a form different from that which it would have assumed if the spheres were of equal density, and will be in equilibrio when inverted as in fig. 6. Now, in place of the Fig. 6. spheres *a*, *b*, *c*, *d*, *e*, &c. of different densities, let us substitute spheres of the same density, and having the same position as those of different densities; let us then load the sphere *a* with a weight which, when combined with the weight of *a*, will be equal to the weight of the corresponding sphere *a*, that had a greater density; and let us load the other spheres *b*, *c*, *d*, &c. with weights proportional to *b n*, *c o*, *d p*, &c. Then it is obvious that the pressure of each sphere when thus loaded upon that which is contiguous to it, is precisely equal to the pressure of the spheres of different densities upon each other, because the density of these spheres varied as their distances from the roadway. But the arch composed of spheres of different densities was in equilibrio when inverted, therefore since the loaded spheres of the same density have the same position and exert the same pressures, the arch composed of these spheres and supporting TUVB *k* A composed of homogeneous materials, will be in equilibrio. *Hence a roadway of a given form, and composed of homogeneous materials, will be supported by an arch whose form is that of a catenary, each of whose points varies in density as their distance from the surface of the roadway*; or, which is the same thing, *A roadway of a given form, and composed of homogeneous materials, will be supported by an arch whose form is that of a catenary, each of whose points is acted upon by forces proportional to the distances of these points from the surface of the roadway*.

321. Hence we have the following practical method of ascertaining the form of an equilibrated arch, whose span is AB, and altitude D *k*, and which is to support a roadway of the form T′U′V′. Let a chain Fig. 7. A *a b c k* B, of uniform density, be suspended from the points A, B, so that it forms a catenary whose altitude is D *k*, the required height of the arch. Divide AB into any number of equal parts, suppose eight, and let the vertical lines 1 *m*, 2 *n*, 3 *o*, drawn from these points, intersect the catenary in the points *a*, *b*, *c*. From the points *a*, *b*, *c*, *k*, *r*, *s*, *t*, suspend pieces of chain of uniform density, and form them of such a length, that when the whole is in equilibrio, the extremities of the chains may lie in the line T′U′V′; then the form which the catenary A *k* B now assumes, will be the form of an equilibrated arch, which, when inverted like AKB, will support the roadway TUV, similar to T′U′V′.

This

Theory. This is obvious from the last paragraph, for the pieces of chain am, bn, co, kU, &c. are forces acting upon the points a, b, c, k of the catenary, and are proportional to am, bn, co, &c. the distances of the points a, b, c, k, &c. from the roadway.

322. An arch of this construction will evidently answer for a bridge, in which the weight of the materials between the roadway and the arch stones is to the weight of the arch stones, as the weight of all the pieces of chain suspended from a, b, c, &c. is to the weight of the chain AkB. As the ratio, however, of the weight of the arch stones to the weight of the superincumbent materials is not known, we may assume a convenient thickness for the arch stones, and if from this assumed thickness their weight be computed, and be found to have the required ratio to the weight of the incumbent mass, the curve already found will be a proper form for the arch. But if the ratio is different from that of the weight of the whole chain to the weight of the suspended chains; it may be easily computed how much must be added to or subtracted from the pieces of chain, in order to make the ratios equal. The new curve which the catenary then assumes, in consequence of the change upon the length of the suspended chains, will be the form of an equilibrated arch, the weight of whose arch stones is equal to that which we assumed.

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323. In most cases the catenarian curve thus determined will approach very near to a circular arc equal to 120 degrees, which springs from the piers so as to form an angle of 60 degrees with the horizon. The form of the arch, however, as determined in the preceding proposition, is suited only to those cases in which the superincumbent materials exert a vertical pressure. A quantity of loose earth and gravel exerts a pressure in almost every direction, and therefore tends to destroy the equilibrium of a catenarian arch. This tendency, however, may be removed by giving the arch a greater curvature towards the piers. This will make it approach to the form of an ellipsis, and make it spring more vertically from the piers or abutments.

324. We shall now proceed to deduce the form of an arch and its roadway, by establishing an equilibrium among the weights of all the materials between the arch and the roadway. This method was given by Emerson in his Fluxions, published in 1742, and afterwards by Dr Hutton in his excellent work on bridges.

Prop. II.

325. To determine the form of the roadway or extrados, when the form of the arch or intrados is given.

Fig. 8. Let the lines AD, DE, EB, BF, FG, GH lie in the same plane, and let them be placed perpendicular to the horizon. From the points D, E, B, &c. draw the vertical lines Dd, Ee, Bb, &c. and taking Dp of any length, make Er equal to Dp, &c. and complete the parallelograms pc, qr. Again, make Bs=qe, and complete the parallelogram ts; in like manner make Fk=sb, and complete the parallelogram Ff; and so on with all the other lines, making the side of each parallelogram equal to that side of the preceding parallelogram which is parallel to it. Let us now suppose that the lines CD, DE, EB, &c. can move round the angular points D, E, B, F, &c. the extremities A, C being immoveable; and that forces proportional to Dd, Ee, Bb, &c. are exerted upon the points D, E, B, F, &c. and in the direction Dd, Ee, &c. Now, by the resolution of forces, the force Dd may be resolved into the forces Dc, Dp, the force Ee into the forces Eq, Er, and the force Bb into the forces Bs, Bt, and so on with the rest. The force Dc produces no other effect than to press the point A on the plane on which it rests, and is therefore destroyed by the resistance of that plane; but the remaining force Dp tends to bring the point D towards E, and to enlarge the angle ADE; this force, however, is destroyed by the equal and opposite force Eq, and in the same way the forces Er, Bt, Fx are destroyed by the equal and opposite forces Bs, Fk, Gv, while the remaining force Gw is destroyed by the resistance of the plane which supports the point C. When the lines AD, DE, &c. therefore are acted upon by vertical forces proportional to Dd, Ee, Bb, &c. these forces are all destroyed by equal and opposite ones, and the lines will remain in equilibrio.

326. Now the force Dc : Dp or Eq=sin. cdD or dDp : sin. ADd, that is, by taking the reciprocals

$$\mathrm{D}c:\mathrm{E}q=\frac{1}{\text{sin. AD}d}:\frac{1}{\text{sin. }d\mathrm{D}p},$$

and for the same reason

$$\mathrm{E}q:\mathrm{B}s=\frac{1}{\text{sin. E}eq}:\frac{1}{\text{sin. }b\mathrm{B}s}.$$

Hence

$$\mathrm{E}q \doteq \frac{1}{\text{sin. E}eq},$$

Now, since Eq : Ee=sin. Eeq : sin. Eqe, we have $\mathrm{E}e=\dfrac{\mathrm{E}q\times\text{sin. E}qe}{\text{sin. E}eq}$, that is, since DE$m$=E$qe$, and eEB=Eeq; $\mathrm{E}e=\dfrac{\mathrm{E}q\times\text{sin. DE}m}{\text{sin. }e\mathrm{EB}}$. But $\mathrm{E}q\doteq\dfrac{1}{\text{sin. E}eq}$ therefore, by substitution, we obtain

$$\mathrm{E}e \doteq \frac{\text{sin. DE}m}{\text{sin. E}eq\times\text{sin. }e\mathrm{EB}}.$$

Now, as the same reasoning may be employed to find Dd, Bb, &c. we have obtained expressions of the forces which, when acting at the angular points D, E, B, &c. keep the whole in equilibrio, and these expressions are in terms of the angles which the lines DE, EB, &c. form with the direction of the forces. If the lines AD, DE, &c. be increased in number so that they may form a polygon with an infinite number of sides, which will not differ from a curve line, then the forces will act at every point of the curve, and the line mE will be a tangent to the curve at the point E, and DEm will be the angle of contact. The line Eq being now infinitely small will coincide with Em, and therefore the angles eEq and eEB or Eeq will be equal to the angle eEm, and consequently their sines will be equal. Therefore by making these substitutions in the last formula, we have an expression of the force at every point of the curve, thus

$$\mathrm{E}e \doteq \frac{\text{sin. DE}m}{\text{sin. }e\mathrm{E}m\times\text{sin. }e\mathrm{E}m} \doteq \frac{\text{sin. DE}m}{|\text{sin. }e\mathrm{E}m|^2}.$$

But

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But the angle of contact DEm varies with the curvature at the point E, and the curvature varies as the reciprocal of the radius of curvature, therefore the angle of contact varies as the reciprocal of the radius of curvature; hence by substitution,

$$Ee \doteq \frac{1}{\text{radius of curvature} \times \overline{\text{sin. } eEm}^2}.$$

Fig. 9. In order to get rid of the confusion in fig. 8. where the arch is a polygon, let us suppose ABC, fig. 9. to be the curve, mn a tangent to any point E, and Ee a vertical line; *then the pressure at any point of the arch is reciprocally as the radius of curvature at that point, and the square of the sine of the angle which the tangent to that point of the curve forms with a vertical line.*

327. COROLLARY. Let us now suppose that the arch ABC supports a mass of homogeneous materials lying between the roadway TUV and the arch AEBC; and the whole being supposed in equilibrio, let us determine the weight which presses on the point E. The weight of the superincumbent column $Ecbd$ varies as $Ec \times gd$, but $gd = Ed \times \text{sin. } dEg$, Ed being radius, and $dEg = EnB$, on account of the parallels Ec, UB, therefore the weight of the column $Ecbd$ varies as $Ec \times Ed \times \text{sin. } EnB$, that is, as $Ec \times \text{sin. } EnB$, because Ed is a constant quantity; but the pressure at E was proved to vary as $\frac{1}{\text{radius curvature} \times \overline{\text{sin. } eEm}^2}$, therefore the weight of the column $Ecbd$ or $Ec \times \text{sin. } EnB$ varies also as this quantity, that is,

$$Ec \times \text{sin. } EnB \doteq \frac{1}{\text{radius curvature} \times \overline{\text{sin. } eEm}^2}.$$

But as the angle EnB is equal to the angle eEm, we shall have, by substitution and division,

$$Ec \doteq \frac{1}{\text{radius curvature} \times \overline{\text{sin. } eEm}^3}, \text{ that is,}$$

When an arch supports a roadway, the pressure exerted upon any point of it, is reciprocally as the radius of curvature, and the cube of the sine of the angle which the tangent to that point forms with a vertical line.

328. Having thus obtained an expression for Ec, we shall proceed to shew the application of the formula to the case when the arch is a portion of a circle.

Fig. 10. Let EB be the arch of a circle whose centre is F. Let the radius $= R$, $BD =$ versed sine, $BE = x$, $DF = \text{cos. } BE = b$, $BU = m$. Draw the tangent GE, and through E the vertical line ce, which will be parallel to BE. Then since GEF is a right angle, and $eEF = EFB$, the angle GEe is the complement of EFB, therefore, $\text{sin. } GEe = \text{cos. } EFB = FD$. But, in the present case, the radius of curvature is the radius of the arch, or R, therefore, $Ec \doteq \frac{1}{R \times \overline{\text{sin. } GEe}^3}$, or by substitution, $Ec \doteq \frac{1}{Rb^3}$, that is, since R is constant, $Ec \doteq \frac{1}{b^3}$. But when the point E coincides with B, the cosine b becomes equal to radius; therefore, in that case $Ec \doteq \frac{1}{R^3}$, and Ec becomes $BU = m$, hence $\frac{1}{R^3} : \frac{1}{b^3} = m : Ec$, and by GEOMETRY, Theor. 8. Sect. IV. and Division, we have $Ec = \frac{mb^3}{b^3}$. Now, by the notation $R : b = BF : DF$; therefore $R^3 : b^3 = \overline{BF}^3 : DF^3$, hence $\frac{R^3}{b^3} = \frac{\overline{BF}^3}{DF^3}$, and multiplying each side by m, we have $\frac{mR^3}{b^3} = \frac{m\overline{BF}^3}{DF^3}$; but $\frac{mR^3}{b^3} = Ec$, therefore the vertical distance of the surface of the roadway from the point F, or $Ec = \frac{m\overline{BF}^3}{DF^3} = \frac{BU \times \overline{BF}^3}{DF^3}$. When the point E coincides with B, $BF = DF$, and $Ee = BU$. When E coincides with A, the cosine DF vanishes, and therefore Ec, or the distance of the point A from the extrados or roadway, is infinite. The curve $VUcT$, therefore, will run up to an infinite height, approaching continually to a vertical line, drawn from A, which will be its asymptote. Such a form of the extrados, however, is inadmissible in practice; and therefore a semicircular arch is not an arch of equilibration. When the arch is less than a semicircle, as PBR, the curve terminates in the point p; and as it does not rise very much above a horizontal line, passing through U when the arch is small, we might produce a perfect equilibrium, by making the roadway horizontal as tUv, and making the density of the superincumbent columns Pn, Eo, which press upon the points P, E respectively, in the ratio of Pp, Ec, the distances of these points from the curvilineal roadway.

329. The inconvenience, however, arising from the inflexion of the extrados, may be considerably removed by throwing the point of contrary flexure to a greater distance, which may be done by diminishing BU, the thickness of the incumbent mass above the keystone. Thus, if BU is diminished to Bd, and if points a, b are taken in the lines Pp, Ec, so that $Pa : Pp = Eb : Ec = Bd : BU$, and so on with all the points in the arch; and if a new roadway $vdbat$ be drawn through these points, the equilibrium of the arch will still continue, for the various pressures which it sustained, though they are diminished, preserve the same proportion.

330. Let us suppose it necessary to have the extrados a horizontal line, and let it be required to find $BU = m$ when there is an equilibrium. In this case the point H coincides with U; or rather, when the curve UcT cuts the horizontal line tUv, the point H coincides with U. By substituting BF—BD instead of DF in the value of Ec, formerly determined, and by putting $BD = y$, we have $Ec = \frac{mR^3}{\overline{R-y}|^3}$. But when H coincides with U, c coincides with o, and therefore $Eo = Ec = BD + BU = y + m$, consequently, $\frac{mR^3}{\overline{R-y}|^3} = y + m$, and multiplying by $\overline{R-y}|^3$, we have $mR^3 = y \times \overline{R-y}|^3 + m \times \overline{R-y}|^3$, or $mR^3 + m \times \overline{R-y}|^3 = y \times \overline{R-y}|^3$, and, dividing by the coefficients of m, we have

$$m = \frac{y \times \overline{R-y}|^3}{R^3 - \overline{R-y}|^3}, \text{ that is,}$$

The thickness of the roadway above the keystone, when the extrados is a straight line, is equal to the quotient arising

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arising from multiplying the versed sine of half the arch by the cube of its cosine, and dividing this product by the difference between the cube of the radius, and the cube of the cosine; or, to change the expressions, *the thickness of the roadway above the keystone, when the roadway is a straight line, is equal to the quotient arising from multiplying the height of the arch, by the cube of the difference between the radius of the arch and its height, and dividing this product by the difference between the cube of the radius, and the cube of the difference between the radius and the height of the arch.*

331. When the arch is a semicircle $R-y$ vanishes, and m becomes equal 0, so that the semicircular arch is evidently inadmissible. But when the arch is less than a semicircle, the value of m will be finite. Thus, if the arches are respectively

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60°, we have $m=\frac{1}{4}$ the span,
90°, we have $m=\frac{1}{2}$ of the span, or
110°, we have $m=\frac{1}{11}$ of the span nearly.

The two first arches of 60° and 90°, manifestly give too great a thickness to the part BU or m. In the third arch of 110°, the thickness of BD is nearly what is given to it by good architects, and is therefore the best in practice; for if the arch were made greater than 110°, the thickness of BU or m would be too small. It is obvious, however, that an arch of 110° is not an arch of *perfect* equilibration, for this can be the case only when the roadway has the form U$z$$r$. When the roadway, therefore, is horizontal, as Ur, there is an unbalanced pressure on both sides of the keystone, produced by the weight of the materials in the mixtilinear space $r\,z$ U. It is indeed very small, and might be counteracted, by making the materials below Z lighter than those below U: but the unbalanced pressure is so trifling, that it may be safely neglected. We may, therefore, conclude, *that when the arch is to be circular with a horizontal roadway, an arch of 110 degrees approaches nearest to an arch of equilibration.*

Elliptical arches superior to circular arches when their transverse axis is horizontal.

332. When the arch is elliptical, it will be found, as in the circle, that $m=\frac{y\times\overline{R-y}|^3}{R^3-\overline{R-y}^3}$. An elliptical arch, however, has the advantage of a circular one, when the transverse axis is horizontal; for as it is much flatter, the point of contrary flexure in the extrados is thrown at a greater distance, and therefore it will, with less inconvenience, admit of a horizontal roadway. Elliptical arches have also the advantage of being more elegant, and likewise require less labour and materials.

333. The cycloidal arch is likewise superior to a circular one, but inferior to those which are elliptical. Parabolic, hyperbolic, and catenarian arches, may be employed when the bridge has only one arch, and is to rise high; but in other cases they are inadmissible. The method of determining the roadway for all these forms of arches will be found in Dr Hutton's excellent work on the Principles of Bridges, p. 3. See also Emerson's Miscellanies, p. 156.; and his work on Fluxions, published in 1742.

On the mechanical curve of equilibration.

334. When the form of the roadway is given, the shape of the intrados for an arch of equilibration may be determined. As the investigation is very difficult, unless when the roadway is a horizontal line, we shall merely give the formula, which will enable any person to construct the curve. In all other curves the equilibrium of the arch is imperfect; but the curve described by the following formula is an arch of perfect equilibration, and has been called *the mechanical curve of equilibration.*

$$ED=AF\times\frac{\text{Hyperbol. log. }\dfrac{BU+BD+\sqrt{2\,BU\times BD+\overline{BD}^2}}{BU}}{\text{Hyperbol. log. }\dfrac{BU+BF+\sqrt{2\,BU\times BF+\overline{BF}^2}}{BU}}$$

From this formula, which corresponds with figure 11. Dr Hutton has computed the following table, containing the values of cU and cE, for an arch whose span AC is 100, whose height BF is 40, and whose thickness at the crown or BU is 6. The table will answer for any other arch whose span and thickness are as the numbers 100, 40, 6; only the values of cU and cE must be increased or diminished in the same ratio as these numbers.

TABLE for constructing the Curve of Equilibration, when the span, height, and thickness at the crown, are as the numbers 100, 40, *and* 6.

Value of cU.	Value of cE.	Value of cU.	Value of cE.	Value of cU.	Value of cE.	Value of cU.	Value of cE.	Value of cU.	Value of cE.
0	6.000	15	8.120	24	11.911	33	18.627	42	29.919
2	6.035	16	8.430	25	12.489	34	19.617	43	31.563
4	6.144	17	8.766	26	13.106	35	20.665	44	33.299
6	6.324	18	9.168	27	13.761	36	21.774	45	35.135
8	6.580	19	9.517	28	14.457	37	22.948	46	37.075
10	6.914	20	9.934	29	15.196	38	24.190	47	39.126
12	7.330	21	10.381	30	15.980	39	25.505	48	41.293
13	7.571	22	10.858	31	16.811	40	26.894	49	43.581
14	7.834	23	11.368	32	17.693	41	28.364	50	46.000

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335. The construction of arches has also been deduced from considering the arch-stones as frustums of polished wedges without friction, which endeavour to force their way through the arch. This principle has been adopted by Belidor, Parent, Bossut, Prony, and other French philosophers, and likewise by our ingenious countryman, the late Mr Atwood. This theory, however, is more plausible than useful. So far from the arch-stones having liberty to slide between those which are contiguous to them, without friction, they are bound together by the strongest cement, and sometimes connected by iron pins or wedges. The theory likewise requires, that the weight of the arch must regularly increase as the portion of the vertical tangent cut off by lines drawn from a given point in a direction parallel to that of the joints, and therefore either the density or the magnitude of the arch-stones must be very great at the spring of the arch, where the portion of the vertical tangent is a maximum. Those who wish to be acquainted with the mode of investigation, by which the equilibrium of arches is established in this theory, may consult Prony's *Architecture Hydraulique*, tom. i. p. 152.

On the Construction of Piers and Abutments.

336. In the construction of piers and abutments, there are two circumstances which claim our attention. 1. The strength that must be given to them, in order to resist the lateral thrust which they sustain from the adjacent semiarches, and which tend either to overset them, or make them slide upon their base. 2. The form which must be given to their extremities, so that the force of the current may be a minimum.—The adhesion of the pier to the place on which it rests is always much greater than one-third of the pressure; and as the lateral thrust of the arch which this adhesion resists, is oblique to the horizon, and may be resolved into two forces, one of which is horizontal, and the other vertical, we have the vertical portion of the lateral thrust, the weight of the pier, and the friction on its base, combined in resisting the horizontal portion of the lateral thrust, which tends to make the pier slide upon its base, so that there is no danger of the pier yielding to such a pressure.—We do not here consider, that the lateral thrust which tends to give a horizontal motion to the pier, is completely counteracted by the lateral thrust of the opposite semiarch, because it is necessary that the pier should have sufficient stability to resist the lateral thrust of one semiarch, in case of the failure of the opposite one. Let us therefore consider the strength of the pier which will prevent it from being overset.

337. For this purpose, let ABC be an arch, MHTO the pier, and BUHA the loaded semiarch, whose pressure tends to overturn the pier. Let G be the centre of gravity of the mass BUHA: Join GA, and from G draw GK perpendicular to AC. Then, since the whole pressure of the arch is exerted at its spring A; and since this pressure is the same as if the whole weight of the arch were collected into the point G, GA will be the direction in which the weight of the arch and the superincumbent mass acts upon the point A. Now, by DYNAMICS, the force GA may be resolved into the two forces GK, KA, one of which KA endeavours to give the pier a motion of rotation about the point O, while the other GK denotes the weight of the loaded arch in the direction GK. Putting W, therefore, for the weight or area of the superincumbent mass, we have $GK : KA = W : \frac{W \times KA}{GK}$, the pressure upon A. Now, as this force tends to turn the pier round O by means of the lever OA, and as ON = AM is the perpendicular from the centre of motion upon the line of direction, we have $AM \times \frac{W \times KA}{GK}$ for the force which tends to overturn the pier. Now, the force which is opposed to this is the weight of the pier MHTO collected in its centre of gravity g, which acts by the vertical lever $Om = \frac{1}{2}OM$, because g is in the centre of the rectangle TM (Art. 164.). But the weight or area of the pier may be represented by $OM \times MH$; therefore, the force which resists the lateral thrust of the loaded arch is $OM \times MH \times \frac{1}{2}OM$, or $\frac{1}{2}MH \times OM$. Now, in the case of an equilibrium between these opposing forces, we have $AM \times \frac{W \times KA}{GK} = \frac{1}{2}MH \times OM^2$, which, by reduction, becomes $OM = \sqrt{\frac{2\,AM \times W \times KA}{MH \times GK}}$. This formula gives us the breadth of the pier which is capable of balancing the lateral thrust; and therefore OM must be taken a little greater than the preceding value. In practice, OM is generally between one-fifth and one-seventh of AC, the span of the arch. The method of finding the centre of gravity G of the loaded arch, whether the arch is in perfect equilibrium or not, may be seen in Dr Hutton's work already quoted, p. 49. A very simple method of doing this is to form the part BVHA of a piece of card, and to find its centre of gravity G by the rules given in Articles 201, 202, 203. This indeed supposes all the materials to be homogeneous; but if they are of various kinds, we can load the arch made of card in a similar manner, and determine its centre of gravity as before.

338. The limits of this article will not permit us to apply the method of fluxions to the determination of the form which should be given to the ends of the pier, in order that the impulse of the current may be the least possible. The theory of the resistance of fluids, indeed, differs so widely from experiment, that such an investigation would, in this place, be of little practical utility. It may be sufficient merely to remark, that the pier should have an angular form, and that the impulse of the current will be diminished as the angle is more acute. When the ends are semicircular, the impulse of the stream is reduced to one half; and though a triangular termination of the piers reduces the impulse still more, yet semicircular ends are more pleasing to the eye, and are particularly advantageous when small vessels have occasion to pass the arch. When those vessels happen to impinge against the piers, the semicircular ends are more able to bear the shock, and do less injury to the vessel, while the additional quantity of masonry will give greater stability to the pier.

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On the Conſtruction of Domes.

339. Definition. A dome, cupola, or vault, is an arched roof, either of a ſpherical, conoidal, or ſpheroidal form.

The following propoſition, taken from Dr Robiſon's article upon this ſubject, in the Supplement to the late edition of the Encyclopædia Britannica, contains a very brief view of the theory of domes.

Proposition.

340. "To determine the thickneſs of a dome vaulting when the curve is given, or the curve when the thickneſs is given.

Plate CCCXXIII. fig. 1. "Let B b A, figure 1. be the curve which produces the dome by revolving round the vertical axis AD. We ſhall ſuppoſe this curve to be drawn through the middle of all the arch-ſtones, and that the courſing or horizontal joints are every where perpendicular to the curve. We ſhall ſuppoſe (as is always the caſe) that the thickneſs KL, HI, &c. of the arch-ſtones is very ſmall, in compariſon with the dimenſions of the arch. If we conſider any portion HA h of the dome, it is plain that it preſſes on the courſe, of which HL is an arch-ſtone, in a direction b C perpendicular to the joint HI, or in the direction of the next ſuperior element βb of the curve. As we proceed downwards, courſe after courſe, we ſee plainly that this direction muſt change, becauſe the weight of each courſe is ſuperadded to that of the portion above it, to complete the preſſure on the courſe below. Through B draw the vertical line BCG, meeting βb, produced in C. We may take bc to expreſs the preſſure of all that is above it, propagated in this direction to the joint KL. We may alſo ſuppoſe the weight of the courſe HL united in b, and acting on the vertical. Let it be repreſented by b F. If we form the parallelogram b FGC, the diagonal b G will repreſent the direction and intenſity of the whole preſſure on the joint KL. Thus it appears that this preſſure is continually changing its direction, and that the line, which will always coincide with it, muſt be a curve concave downward. If this be preciſely the curve of the dome, it will be an equilibrated vaulting; but ſo far from being the ſtrongeſt form, it is the weakeſt, and it is the limit to an infinity of others, which are all ſtronger than it. This will appear evident, if we ſuppoſe that b G does not coincide with the curve A b B, but paſſes without it. As we ſuppoſe the arch-ſtones to be exceedingly thin from inſide to outſide, it is plain that this dome cannot ſtand, and that the weight of the upper part will preſs it down, and ſpring the vaulting outwards at the joint KL. But let us ſuppoſe, on the other hand, that b G falls within the curvilineal element b B. This evidently tends to puſh the arch-ſtone inward, toward the axis, and would cauſe it to ſlide in, ſince the joints are ſuppoſed perfectly ſmooth and ſlipping. But ſince this takes place equally in every ſtone of this courſe, they muſt all abut on each other in the vertical joints, ſqueezing them firmly together. Therefore, reſolving the thruſt b G into two, one of which is perpendicular to the joint KL, and the other parallel to it, we ſee that this laſt thruſt is withſtood by the vertical joints all around, and there remains only the thruſt in the direction of the curve. Such a dome muſt therefore be firmer than an equilibrated dome, and cannot be ſo eaſily broken by overloading the upper part. When the curve is concave upwards, as in the lower part of the figure, the line b C always falls below B b, and the point C below B. When the curve is concave downwards, as in the upper part of the figure, $'b$ C$'$ paſſes above, or without b B. The curvature may be ſo abrupt, that even b' G$'$ ſhall paſs without $'b$ B$'$, and the point G$'$ is above B$'$. It is alſo evident that the force which thus binds the ſtones of a horizontal courſe together, by puſhing them towards the axis, will be greater in flat domes than in thoſe that are more convex; that it will be ſtill greater in a cone; and greater ſtill in a curve whoſe convexity is turned inwards: for in this laſt caſe the line b G will deviate moſt remarkably from the curve. Such a dome will ſtand (having poliſhed joints) if the curve ſprings from the baſe with any elevation, however ſmall; nay, ſince the friction of two pieces of ſtone is not leſs than half of their mutual preſſure, ſuch a dome will ſtand, although the tangent to the curve at the bottom ſhould be horizontal, provided that the horizontal thruſt be double the weight of the dome, which may eaſily be the caſe if it do not riſe high.

"Thus we ſee that the ſtability of a dome depends on very different principles from that of a common arch, and is in general much greater. It differs alſo in another very important circumſtance, viz. that it may be open in the middle: for the uppermoſt courſe, by tending equally in every part to ſlide in toward the axis, preſſes all together in the vertical joints, and acts on the next courſe like the key-ſtone of a common arch. Therefore an arch of equilibration, which is the weakeſt of all, may be open in the middle, and carry at top another building, ſuch as a lantern, if its weight do not exceed that of the circular ſegment of the dome that is omitted. A greater load than this would indeed break the dome, by cauſing it to ſpring up in ſome of the lower courſes; but this load may be increaſed if the curve is flatter than the curve of equilibration: and any load whatever, which will not cruſh the ſtones to powder, may be ſet on a truncate cone, or on a dome formed by a curve that is convex toward the axis; provided always that the foundation be effectually prevented from flying out, either by a hoop or by a ſufficient maſs of ſolid pier on which it is ſet.

"We have ſeen that if b G, the thruſt compounded of the thruſt b C, exerted by all the courſes above HILK, and if the force b F, or the weight of that courſe, be everywhere coincident with b B, the element of the curve, we ſhall have an equilibrated dome; if it falls within it, we have a dome which will bear a greater load; and if it falls without it, the dome will break at the joint. We muſt endeavour to get analytical expreſſions of theſe conditions. Therefore draw the ordinates $b\,\delta\,b''$, BDB$''$, C d C$''$. Let the tangents at b and b'' meet the axis in M, and make MO, MP, each equal to bc, and complete the parallelogram MONP, and draw OQ perpendicular to the axis, and produce b F, cutting the ordinates in E and e. It is plain that MN is

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is to MO as the weight of the arch HAh to the thrust bc which it exerts on the joint KL (this thrust being propagated through the course of HILK); and that MQ, or its equal be, or δd, may represent the weight of the half AH.

"Let AD be called x, and DB be called y. Then $be=\dot{x}$, and eC$=\dot{y}$ (because bc is in the direction of the element βb). It is also plain, that if we make $\dot{y}$ constant, BC is the second fluxion of x, or BC$=\ddot{x}$, and be and BE may be considered as equal, and taken indiscriminately for $\dot{x}$. We have also bC$=\sqrt{\dot{x}^2+\dot{y}^2}$. Let d be the depth or thickness HI of the arch-stones. Then $d\sqrt{\dot{x}^2+\dot{y}^2}$ will represent the trapezium HL; and since the circumference of each course increases in the proportion of the radius y, $dy\sqrt{\dot{x}^2+\dot{y}^2}$ will express the whole course. If $\int$ be taken to represent the sum or aggregate of the quantities annexed to it, the formula will be analogous to the fluent of a fluxion, and $\int dy\sqrt{\dot{x}^2+\dot{y}^2}$ will represent the whole mass, and also the weight of the vaulting, down to the joint HI. Therefore we have this proportion, $\int dy\sqrt{\dot{x}^2+\dot{y}^2} : dy\sqrt{\dot{x}^2+\dot{y}^2}=be : b\mathrm{F}, =be : \mathrm{CG}, =\delta d : \mathrm{CG}, =\dot{x} : \mathrm{CG}$. Therefore $\mathrm{CG}=\frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}$.

"If the curvature of the dome be precisely such as puts it in equilibrium, but without any mutual pressure in the vertical joints, this value of OG must be equal to CB, or to $\ddot{x}$, the point G coinciding with B. This condition will be expressed by the equation $\frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}=\ddot{x}$, or, more conveniently, by $\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}=\frac{\ddot{x}}{\dot{x}}$. But this form gives only a tottering equilibrium, independent of the friction of the joints and the cohesion of the cement. An equilibrium, accompanied by some firm stability, produced by the mutual pressure of the vertical joints, may be expressed by the formula $\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}>\frac{\ddot{x}}{\dot{x}}$, or by $\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}=\frac{\ddot{x}}{\dot{x}}+\frac{\dot{t}}{t}$, where t is some variable positive quantity, which increases when x increases. This last equation will also express the equilibrated dome, if t be a constant quantity, because in this case $\frac{\dot{t}}{t}$ is $=o$.

"Since a firm stability requires that $\frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2=\dot{y}^2}}$ shall be greater than $\ddot{x}$, and CG must be greater than CB: Hence we learn, that figures of too great curvature, whose sides descend too rapidly, are improper. Also, since stability requires that we have $\frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}^2}}{\ddot{x}}$ greater than $\int dy\sqrt{\dot{x}^2+\dot{y}^2}$, we learn that the upper part of the dome must not be made very heavy. This, by diminishing the proportion of bF to bC, diminishes the angle cbG, and may set the point G above B, which will infallibly spring the dome in that place. We see here also, that the algebraic analysis expresses that peculiarity of dome-vaulting, that the weight of the upper part may even be suppressed.

"The fluent of the equation $\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}=\frac{\ddot{x}}{\dot{x}}+\frac{\dot{t}}{t}$ is most easily found. It is $\mathrm{L}\int dy\sqrt{\dot{x}^2+\dot{y}^2}=\mathrm{L}\dot{x}+\mathrm{L}t$, where L is the hyperbolic logarithm of the quantity annexed to it. If we consider $\dot{y}$ as constant, and correct the fluent so as to make it nothing at the vertex, it may be expressed thus, $\mathrm{L}\int dy\sqrt{\dot{x}^2+\dot{y}^2}-\mathrm{L}a=\mathrm{L}\dot{x}-\mathrm{L}\dot{y}+\mathrm{L}t$. This gives us $\mathrm{L}\frac{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}{a}=\mathrm{L}\frac{\dot{x}}{\dot{y}}t$, and therefore $\frac{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}{a}=t\frac{\dot{x}}{\dot{y}}$.

"This last equation will easily give us the depth of vaulting, or thickness d of the arch, when the curve is given. For its fluxion is $\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{a}=\frac{\dot{t}\dot{x}+t\ddot{x}}{\dot{y}}$, and $d=\frac{a\dot{t}\dot{x}+at\ddot{x}}{y\dot{y}\sqrt{\dot{x}^2+\dot{y}^2}}$, which is all expressed in known quantities; for we may put in place of t any power or function of x or of y, and thus convert the expression into another, which will still be applicable to all sorts of curves.

"Instead of the second member $\frac{\ddot{x}}{\dot{x}}+\frac{\dot{t}}{t}$, we might employ $\frac{p\ddot{x}}{\dot{x}}$, where p is some number greater than unity. This will evidently give a dome having stability; because the original formula $\frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}$ will then be greater than $\ddot{x}$. This will give $d=\frac{pa\dot{x}^{p-1}\ddot{x}}{y\dot{y}^p\sqrt{\dot{x}^2+\dot{y}^2}}$. Each of these forms has its advantages when applied to particular cases. Each of them also gives $d=\frac{a\ddot{x}}{y\dot{y}\sqrt{\dot{x}^2+\dot{y}^2}}$ when the curvature is such as is in precise equilibrium. And, lastly, if d be constant, that is, if the vaulting be of uniform thickness, we obtain the form of the curve, because then the relation of $\dot{x}$ to x and to $\dot{y}$ is given.

"The chief use of this analysis is to discover what curves are improper for domes, or what portions of given curves may be employed with safety. Domes are

Theory. are generally built for ornament; and we see that there is great room for indulging our fancy in the choice. All curves which are concave outwards will give domes of great firmness: they are also beautiful. The Gothic dome, whose outline is an undulated curve, may be made abundantly firm, especially if the upper part be convex and the lower concave outwards.

"The chief difficulty in the case of this analysis arises from the necessity of expressing the weight of the incumbent part, or $\int dy\sqrt{\dot{x}^2+\dot{y}^2}$. This requires the measurement of the conoidal surface, which, in most cases, can be had only by approximation by means of infinite serieses.

"The surface of any circular portion of a sphere is very easily had, being equal to the circle described with a radius equal to the chord of half the arch. This radius is evidently $=\sqrt{\dot{x}^2+\dot{y}^2}$.

"In order to discover what portion of a hemisphere may be employed (for it is evident we cannot employ the whole) when the thickness of the vaulting is uniform, we may recur to the equation or formula $\frac{dy\dot{x}\sqrt{\dot{x}^2-\dot{y}^2}}{\ddot{x}}=\int dy\sqrt{\dot{x}^2+\dot{y}^2}$. Let a be the radius of the hemisphere. We have $\dot{x}=\frac{ay\dot{y}}{\sqrt{a^2-y^2}}$, and $\ddot{x}=\frac{a^2\dot{y}^2}{\overline{a^2-y^2}|^{\frac{3}{2}}}$. Substituting these values in the formula, we obtain the equation $y^2\sqrt{a^2-y^2}=\int\frac{a^2y\dot{y}}{\sqrt{a^2-y^2}}$. We easily obtain the fluent of the second member $=a^3-a^2\sqrt{a^2-y^2}$, and $y=a\sqrt{-\frac{1}{2}+\sqrt{\frac{5}{4}}}$. Therefore if the radius of the sphere be 1, the half breadth of the dome must not exceed $\sqrt{-\frac{1}{2}\times\sqrt{\frac{5}{4}}}$, or 0.786, and the height will be .618. The arch from the vertex is about 51° 49′. Much more of the hemisphere cannot stand, even though aided by the cement, and by the friction of the coursing joints. This last circumstance, by giving connection to the upper parts, causes the whole to press more vertically on the course below, and thus diminishes the outward thrust; but it at the same time diminishes the mutual abutment of the vertical joints, which is a great cause of firmness in the vaulting. A Gothic dome, of which the upper part is a portion of a sphere not exceeding 45° from the vertex, and the lower part is concave outwards, will be very strong, and not ungraceful.

"341. Persuaded that what has been said on the subject convinces the reader that a vaulting perfectly equilibrated throughout is by no means the best form, provided that the base is secured from separating, we think it unnecessary to give the investigation of that form, which has a considerable intricacy, and shall merely give its dimensions. The thickness is supposed uniform. The numbers in the first column of the table express the portion of the axis counted from the vertex, and those of the second column are the length of the ordinates.

AD	DB	AD	DB	AD	DB
0.4	100	610.4	1080	2990	1560
3.4	200	744	1140	3442	1600
11.4	300	904	1200	3972	1640
26.6	400	1100	1260	4432	1670
52.4	500	1336	1320	4952	1700
91.4	600	1522	1360	5336	1720
146.8	700	1738	1400	5756	1740
223.4	800	1984	1440	6214	1760
326.6	900	2270	1480	6714	1780
475.4	1000	2602	1520	7260	1800

"The curve formed according to these dimensions will not appear very graceful, because there is an abrupt change in its curvature at a small distance from its vertex; if, however, the middle be occupied by a lantern of equal or of smaller weight than the part whose place it supplies, the whole will be elegant, and free from this defect.

"The connexion of the parts arising from cement and from friction has a great effect on dome-vaulting. In the same way as in common arches and cylindrical vaulting, it enables an overload on one place to break the dome in a distant place. But the resistance to this effect is much greater in dome-vaulting, because it operates all round the overloaded part. Hence it happens that domes are much less shattered by partial violence, such as the falling of a bomb, or the like. Large holes may be broken in them without much affecting the rest; but, on the other hand, it greatly diminishes the strength which should be derived from the mutual pressure in the vertical joints. Friction prevents the sliding in of the arch-stones which produces this mutual pressure in the vertical joints, except in the very highest courses, and even there it greatly diminishes it. These causes make a great change in the form which gives the greatest strength; and as their laws of action are but very imperfectly understood as yet, it is perhaps impossible, in the present state of our knowledge, to determine this form with tolerable precision. We see plainly, however, that it allows a greater deviation from the best form than the other kind of vaulting; and domes may be made to rise perpendicular to the horizon at the base, although of no great thickness; a thing which must not be attempted in a plane arch. The immense addition of strength which may be derived from hooping largely compensates for all defects; and there is hardly any bounds to the extent to which a very thin dome-vaulting may be carried, when it is hooped or framed in the direction of the horizontal courses. The roof of the Halle du Bled at Paris is but a foot thick, and its diameter is more than 200, yet it appears to have abundant strength."

Scholium.

342. The section of the dome of St Paul's cathedral is part of an ellipse whose conjugate diameter is parallel to the horizon. It is built of wood, and confined by strong iron chains; and is supported by carpentry resting on a cone of brick work.

Theory.

CHAP. IX. *On the Force of Torsion.*

Fig. 2.

343. DEFINITION. Let $g\,a$ be a metallic wire firmly fixed in the pincers g by means of the screw s; let the cylindrical weight P, furnished with an index $e\,o$, be suspended at the lower extremity of the wire; and let the axis of the cylinder, or the wire $g\,a$ produced, terminate in the centre of the divided circle MNO. Then, if the cylinder P is made to move round its axis so that the index $e\,o$ may describe the arch ON, the wire $g\,a$ will be twisted. If the cylinder be now left to itself, the wire will, in consequence of its elasticity, endeavour to recover its form; the index $e\,o$ will therefore move backwards from N, and oscillate round the axis of the cylinder. The force which produces these oscillations is called the *force of torsion*, and the angle measured by the arch ON is called the *angle of torsion*.

PROP. I.

344. To deduce formulæ for the oscillatory motion of the cylinder, on the supposition that the reaction of the force of torsion is proportional to the angle of torsion, or nearly proportional to it.

Fig. 3.

Let PQ be a section of the cylinder P in fig. 2. and let all the elements of the cylinder be projected upon this circular section in d, d', d''. Let ACB, the primitive angle of torsion, be called A, and let this angle, after the time t, become ACb, so that it has been diminished by the angle BCb=M; then ACb=A—M= the angle of torsion after the time t.

Since the force of torsion is supposed to be proportional to the angle of torsion, the momentum of the force of torsion must be some multiple of that angle, or $n\times\overline{A-M}$, n being a constant coefficient, whose value depends on the nature, length, and thickness of the metallic wire. If, therefore, we call v the velocity of any point d at the end of the time t, when the angle of torsion becomes ACb, and r=Cd the distance of the point d from the axis of rotation C, we shall have, by the principles of Dynamics,

$$n\times\overline{A-M}\times\dot t=\int d\,r\,\dot v.$$

But if CD, the radius of the cylinder, be equal a, and if u be the velocity of the point D after the time t, we have evidently $v:u=r:a$, and $v=\frac{r\,u}{a}$. Now by substituting the fluxion of this value of v in the place of $\dot v$ in the preceding formula, we have

$$n\times\overline{A-M}\times\dot t=\dot u\int\frac{d\,r^2}{a};$$

and since $\dot t=\frac{a\,\dot M}{u}$, we have by substitution

$$n\times\overline{A-M}\times\frac{a\dot M}{u}=\dot u\int\frac{d\,r^2}{a},$$

whose fluent is

$$n\times\overline{2AM-M^2}=u^2\int\frac{d\,r^2}{a^2}.$$

Taking the square root of both sides of the equation, we have

Theory.

$$\sqrt{n}\times\sqrt{2AM-M^2}=u\times\overline{\int\frac{d\,r^2}{a^2}}\Big|^{\frac{1}{2}}.$$

Multiplying both sides by $\frac{a\dot M}{u}$, and dividing by $\sqrt{n}\times\sqrt{2AM-M^2}$, the equation becomes

$$\frac{a\dot M}{u}=\frac{\frac{a\dot M}{u}\times u\times\overline{\int\frac{d\,r^2}{a^2}}\Big|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2AM-M^2}}=\frac{a\dot M\times\frac{1}{a}\times\overline{\int d\,r^2}\Big|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2AM-M^2}}$$

$$=\frac{\dot M\times\overline{\int d\,r^2}\Big|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2AM-M^2}}.$$

Therefore, since $\dot t=\frac{a\dot M}{u}$, we shall have

$$\dot t=\frac{\dot M\times\overline{\int d\,r^2}\Big|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2AM-M^2}},\text{ or}$$

$$\dot t=\frac{\dot M}{\sqrt{2AM-M^2}}\times\overline{\int\frac{d\,r^2}{n}}\Big|^{\frac{1}{2}}.$$

But $\frac{\dot M}{\sqrt{2AM-M^2}}$ represents an arch or angle whose radius is A and whose versed sine is M, which arch vanishes when M=0, and which becomes equal to 90° when M=A. Therefore the time of a complete oscillation will be

$$T=\overline{\int\frac{p\,r^2}{n}}\Big|^{\frac{1}{2}}\times180^\circ.$$

345. In order to compare the force of torsion with the force of gravity in a pendulum, we have for the time of a complete oscillation of a pendulum whose length is l, g being the force of gravity,

$$T=\overline{\frac{l}{g}}\Big|^{\frac{1}{2}}\,180^\circ.$$

Therefore, since the time in which the cylinder oscillates must be equal to the time in which the pendulum oscillates, we have

$$\overline{\int\frac{p\,r^2}{n}}\Big|^{\frac{1}{2}}180^\circ=\overline{\frac{l}{g}}\Big|^{\frac{1}{2}}\times180^\circ.$$

Hence dividing by 180°, and squaring both sides, we obtain

$$\overline{\int\frac{p\,r^2}{n}}\Big|=\frac{l}{g}.$$

We must therefore find for a cylinder the value of $\int p\,r^2$, or the sum of all the particles multiplied by the squares of their distances from the axis. Now, if we make π=6.28318 the ratio of the circumference of a circle to its radius, a= radius of the cylinder, λ= its length, d= its density; then we shall have for the area of its base $\frac{a^2\pi}{2}$, which multiplied by λ gives the solid content of the cylinder $=\frac{a^2\pi\lambda}{2}$, and this multiplied by

d

Theory.

d gives $\frac{a^2\pi\lambda d}{2}$ for the fum of all its particles. But as this is to be multiplied by the fum of the fquares of all the diftances of the particles from the centre C, we fhall have $\int p r^2 = \frac{a^4\pi^2\lambda d}{4}$. But the number of particles in the cylinder, or the mafs μ of the cylinder, is $\frac{a^2\pi\lambda d}{2}$, therefore fubftituting μ, inftead of this value of it in the preceding equation, we have $\int p r^2 = \frac{\mu a^2}{2}$, and, dividing both fides by n, we have $\frac{\int p r^2}{n} = \frac{\mu a^2}{2n}$, and, extracting the fquare root and multiplying by 180, it becomes

$$\overline{\frac{\int p r^2}{n}}\Big|^{\frac{1}{2}} \times 180° = \overline{\frac{a^2}{2n}}\Big|^{\frac{1}{2}} \times 180°. \text{ Therefore}$$

$$T = \overline{\frac{\mu a^2}{2n}}\Big|^{\frac{1}{2}} \times 180, \text{ and fince } \int \frac{p r^2}{r} = \frac{l}{g},$$

$\frac{\mu a^2}{2n} = \frac{l}{g}$, and by reduction $n = \frac{g\mu a^2}{2l}$. But $g\mu$ is the weight W of the cylinder, therefore, by fubftituting W inftead of $g\mu$, we obtain $n = \frac{P a^2}{2l}$, a very fimple formula for determining the value of n from experiments.

If it were required to find a weight Q, which, acting at the extremity of a lever L, would have a momentum equal to the momentum of the force of torfion when the angle of torfion is A—M, we muft make $Q \times L = n \times \overline{A-M}$.

346. In the preceding inveftigation we have fuppofed, what is conformable to experiment, that the force of torfion is proportional to the angle of torfion, which gives us $n \times \overline{A-M}$ for the momentum of that force. Let us now fuppofe that this momentum is altered by any quantity S, then the momentum of the force of torfion will become $n \times \overline{A-M} - S'$, and the general equation will affume this form

$$n \times \overline{A-M} - S \times \dot{t} = \dot{u}\int\frac{p r^2}{a};$$

and by multiplying in place of $\dot{t}$ its value $\frac{a\dot{M}}{u}$, and taking the fluent, we have

$$\overline{n \times 2AM - M^2} - 2\int S\dot{M} = u^2\int\frac{d r^2}{a^2}.$$

Now, in order to find the value of T or a complete ofcillation, we muft divide the ofcillation into two parts, the firft from B to A, where the force of torfion accelerates the velocity u, while the retarding force, arifing from the refiftance of the air and the imperfection of elafticity, diminifhes the velocity u; and the fecond from A to B', where the force of torfion, as well as the other forces, concur in diminifhing u or retarding the motion.

Theory.

347. *Ex.* 1. If $S = m \times \overline{A-M}^{\nu}$, we fhall have for the ftate of motion in the firft portion BA

$$n \times \overline{2AM - M^2} + \frac{2m \times \overline{A-M}|^{\nu+1}}{\nu+1} - \frac{2mA^{\nu+1}}{\nu+1} = u^2\int\frac{pr^2}{a^2}$$

Hence, when the angle of torfion becomes equal to nothing, or A—M=0, we have

$$nA^2 - \frac{2mA^{\nu+1}}{\nu+1} = UU\int\frac{pr^2}{a^2},$$

which dividing by $\int\frac{pr^2}{a^2}$, becomes

$$U^2 = \frac{nA^2 - \frac{2mA^{\nu+1}}{\nu+1}}{\int\frac{pr^2}{a^2}}.$$

Let us now confider the other part of the motion from A to B', and fuppofe the angle $ACb' = M'$, we fhall find, by calling U the velocity of the point A,

$$\frac{nM'^2}{2} + \frac{mM'^{\nu+1}}{\nu+1} = \frac{U^2 - u^2}{2} \times \int\frac{pr^2}{a^2}.$$

Then, by fubftituting inftead of U its value as lately found, and taking the fluents, we fhall have, when the velocity vanifhes, or when the ofcillation is finifhed,

$$A - M' = \frac{2m}{n \times \overline{\nu+2}} \times \frac{A^{\nu+1} + M'^{\nu+1}}{A + M'},$$

and if the retarding forces are fuch, that at each ofcillation, the amplitude is a little diminifhed, we fhall have for the approximate value of A—M'

$$A - M' = \frac{2mA^{\nu}}{n \times \overline{\nu+1}},$$

and if the angle A—M' is fo fmall that it may be treated as a common fluxional quantity, we fhall then have for any number of ofcillations

$$N \times \frac{2m}{n \times \overline{\nu+1}} = \frac{1}{\nu-1} \times \frac{1}{M^{\nu-1}} - \frac{1}{A^{\nu-1}},$$

where M reprefents the angle to which A becomes equal after any number of ofcillations N. Hence we obtain

$$M = \frac{1}{\left(N \times \frac{2m \times \overline{\nu+1}}{n \times \nu+1} + \frac{1}{A^{\nu-1}}\right) \times \frac{1}{\nu-1}},$$

which determines the value of M after any number of ofcillations N.

348. *Ex.* 2. If $S = m \times \overline{A-M}|^{\nu} + m' \times \overline{A-M}^{\nu'}$, m' and ν' being different values of m and ν, we fhall obtain by following the mode of inveftigation in the laft example,

$$n \times A - M = \frac{2m}{\nu+1} \times \frac{A^{\nu+1} + M^{\nu+1}}{A+M} + \frac{2m'}{\nu'+1} \times \frac{A^{\nu'+1} \times M^{\nu'+1}}{A+M}:$$

and if the retarding force is much lefs than the force of torfion, we fhall have for an approximate value of

$n \times \overline{A-M}$

Theory.

$$n \times \overline{A-M} = \frac{2mA^{\nu}}{\nu+1} + \frac{2m'A^{\nu'}}{\nu'+1}.$$

349. *Ex.* 3. In general, if $S = m \times \overline{A-M}|^{\nu} + m' \times \overline{A-M}|^{\nu'} + m'' \times \overline{A-M}|^{\nu''} + m''' \times \overline{A-M}|^{\nu'''}$, &c. we ſhall always have for an oſcillation when S is ſmaller than the force of torſion.

$$n \times \overline{A-M} = \frac{2mA^{\nu}}{\nu+1} + \frac{2m'A^{\nu'}}{\nu'+1} + \frac{2m''A^{\nu''}}{\nu''+1} + \frac{2m'''A^{\nu'''}}{\nu'''+1}, \text{ \&c.}$$

350. Having thus given after Coulomb, the mode of deducing formulæ for the oſcillatory motion of the cylinder, we ſhall proceed to give an account of the reſults of his experiments.

Torſion balance. Fig. 2.

In theſe experiments M. Coulomb employed the torſion balance repreſented in fig. 2. in which he ſuſpended cylinders of different weights from iron and braſs wires of different lengths and thickneſſes; and by obſerving carefully the duration of a certain number of oſcillations, he was enabled to determine, by means of the preceding formulæ, the laws of the force of torſion relative to the length, the thickneſs, and the nature of the wires employed. If the elaſticity of the metallic wires had been perfect, and if the air oppoſed no reſiſtance to the oſcillating cylinder, it would continue to oſcillate till its motion was ſtopped. The diminution of the amplitudes of the oſcillations, therefore, being produced ſolely by the imperfection of elaſticity, and by the reſiſtance of the air, M. Coulomb was enabled, by obſerving the ſucceſſive diminution of the amplitude of the oſcillation, and by ſubſtracting the part of the change which was due to the reſiſtance of the air, to aſcertain, with the aſſiſtance of the preceding formulæ, according to what laws this elaſtic force of torſion was changed.

351. From a great number of experiments it appeared, that when the angle of torſion was not very great, the oſcillations were ſenſibly iſochronous; and therefore it may be regarded as a fundamental law, *That for all metallic wires, when the angles of torſion are not very great, the force of torſion is ſenſibly proportional to the angle of torſion.* Hence, as the preceding formulæ are founded on this ſuppoſition, they may be ſafely applied to the experiments.

352. In all the experiments, a cylinder of two pounds weight oſcillated in twice the time employed by a cylinder which weighed only half a pound; and therefore *the duration of the oſcillations is as the ſquare root of the weights of the oſcillating cylinders.* Conſequently the tenſion of the wires has no ſenſible influence upon the force of torſion. If the tenſions however be very great relative to the ſtrength of the metal, the force of torſion does ſuffer a change; for when the weight of the cylinder, and conſequently the tenſion of the wire, is increaſed, the wire is lengthened, and as this diminiſhes the diameter of the wire, the duration of the oſcillation muſt evidently be affected.

353. When the lengths of the wires are varied without changing their diameters or the weights of the cylinders, *the times of the ſame number of oſcillations are as the ſquare roots of the lengths of the wires*, a reſult alſo deducible from theory.

Theory.

354. When the diameters of the wires are varied without changing their lengths, or the weight of the cylinders, the momentum of the force of torſion varied as the fourth power of the diameters of the wires. Now this reſult is perfectly conformable to theory; for if we ſuppoſe two wires of the ſame ſubſtance, and of the ſame length, but having their diameters as one to two, it is obvious that in the wire whoſe diameter is double of the other, there are four times as many parts extended by torſion, as in the ſmaller wire, and that the mean extenſion of all theſe parts will be proportional to the diameter of a wire, the ſame as the mean arm of a lever is, relative to the axis of rotation. Hence it appears that, according to theory, the force of torſion of two wires of the ſame nature and of the ſame length, but of different diameters, is proportional to the fourth power of their diameter.

355. From this it follows in general, that in metallic wires the momentum of torſion is directly in the compound ratio of the angle of torſion and the fourth power of their diameter, and inverſely as the length of the wires. If a therefore be the angle of torſion, λ the length of the thread, δ its diameter, and F the force of torſion, we ſhall have

$$F = \frac{ma\delta^4}{l},$$

where m is a conſtant coefficient for wires of the ſame metal, depending on the tenacity of the metal, and deducible from experiment.

356. When the angle of torſion is not great, relative to the length of the wire, the index of the cylinder returns to the poſition which it had before the torſion took place, or, in other words, the wire untwiſts itſelf by the ſame quantity by which it had been twiſted. But when the angle of torſion is very great, the wire does not completely untwiſt itſelf, and therefore the centre of torſion will have advanced by a quantity equal to that which it has not untwiſted.—When the angle of torſion was below 45°, the decrements of the amplitudes of the oſcillations were nearly proportional to the amplitudes of the angle of torſion; but when the angle exceeded 45°, the decrements increaſed in a much greater ratio.—The centre of torſion did not begin to advance or be diſplaced till the angle of torſion was nearly a ſemicircle: its diſplacement was very irregular till the angle was one circle and 10 degrees, but beyond this angle the torſion remained nearly the ſame for all angles.

357. The theory of torſion is particularly uſeful in delicate reſearches, where ſmall forces are to be aſcertained with a preciſion which cannot be obtained by ordinary means. It has been ſucceſsfully employed by Coulomb in diſcovering the laws of the forces of electricity and magnetiſm, and in determining the reſiſtance of fluids when the velocities are very ſmall.

PART

PART II. ON THE CONSTRUCTION OF MACHINERY.

358. WE have already seen, when considering the maximum effects of machines, the various causes which affect their performance. It appeared from that investigation, that there must be a certain relation between the velocities of the impelled and working points of a machine, or between the power and the resistance to be overcome, before it can produce a maximum effect, and therefore it must be the first object of the engineer to ascertain that velocity, and to employ it in the construction of this machine. The performance of the machine is also influenced by the friction and inertia of its various parts; and as both these act as resistances, and therefore destroy a considerable portion of the impelling power, it becomes an object of great importance to attend to the simplification of the machinery, and to ascertain the nature of friction so as to diminish its effect, either by the application of unguents or by mechanical contrivances. Since the impelled and working points of a machine are generally connected by means of toothed wheels, the teeth must be formed in such a manner, that the wheels may always act upon each other with the same force, otherwise the velocity of the machine will be variable, and its structure soon injured by the irregularity of its motion. The irregular motion of machines sometimes arises from the nature of the machinery, from an inequality in the resistance to be overcome, and from the nature of the impelling power. In large machines, the momenta of their parts are generally sufficient to equalize these irregularities; but in machines of a small size, and in those where the irregularities are considerable, we must employ fly-wheels for regulating and rendering uniform their variable movements. These various subjects, and others intimately connected with them, we shall now proceed to discuss in their order.

CHAP. I. *On the Proportion between the Velocity of the Impelled and Working points of Machines, and between the Power and Resistance, in order that they may perform the greatest work.*

359. IN the chapter on the maximum effect of machines we have deduced formulæ containing x and y, the velocities of the impelled and working points of the machines, and including every circumstance which can affect their motion. The formula which exhibits the value of y, or the velocity of the working point, assumes various forms, according as we neglect one or more of the elements of which it is composed.—When the work to be performed resists only by its inertia, which is the case in urging round a millstone or heavy fly, the quantity R may be neglected, and the second formula, (Page 92. col. 2.) should be employed. In small machines, and particularly in those where the motion is conveyed by wheels with epicycloidal teeth, the friction is very trifling, and the element φ may be safely omitted. In corn and saw mills, the quantity b or the inertia of the resistance may be left out of the formula, as the motion communicated to the flour or to the saw dust is too small to be subjected to computation. In machines where one heavy body is employed to raise another merely by its weight, the inertia of the power and the resistance, viz. a, b, are proportional to P, R, the powers and resistances themselves, and consequently P, R may be substituted in the formula, in the place of a, b.—The engineer therefore must consider, before he construct his machine, what elements should enter into the formula, and what should be omitted, in order that he may adapt it to the circumstances of the case, and obtain from his machine the greatest possible effect.

360. When the inertia of the power and that of the resistance are proportional to the power and resistance themselves; and when the inertia and friction of the machine may be omitted, the formula becomes $y=\sqrt{\frac{P}{R}+1}-1$ from which the following table is computed, which contains the values of y for different values of P; R being supposed $=10$, and $m=1$. To find the relation between the velocities of the impelled and working points of a machine.

TABLE containing the best Proportions between the Velocities of the Impelled and Working Points of a Machine, or between the Levers by which the Power and Resistance act.

Proportional value of the impelling power, or P.	Value of the velocities of the working point or y; or of the lever by which the resistance acts, that of x being 1.	Proportional value of the impelling power, or P.	Value of the velocities of the working point or y; or of the lever by which the resistance acts, that of x being 1.
1	0.048809	20	0.732051
2	0.095445	21	0.760682
3	0.140175	22	0.788854
4	0.183216	23	0.816590
5	0.224745	24	0.843900
6	0.264911	25	0.870800
7	0.303841	26	0.897300
8	0.341641	27	0.923500
9	0.378405	28	0.949400
10	0.414214	29	0.974800
11	0.449138	30	1.000000
12	0.483240	40	1.236200
13	0.516575	50	1.449500
14	0.549193	60	1.645700
15	0.581139	70	1.828400
16	0.612451	80	2.000000
17	0.643168	90	2.162300
18	0.673320	100	2.316600
19	0.702938		

In order to explain the use of this table, let us suppose that it is required to raise one cubic foot of water in a second, by means of a stream which discharges three cubic feet of water in a second; and let it be required to find the construction of a wheel and axle for performing this work; that is, the diameter of the axle, that of the wheel being 6. Here the power is evidently 3 cubic feet, while the resistance is only one cubic foot, therefore P=3 R; but in the preceding table

$R=10$, consequently $P=3\times 10=30$. But it appears from the table that when $P=30$, y or the diameter of the axle is 1, upon the supposition that the diameter x of the wheel is 1; but as x must be $=6$, we shall have $y=6$.

361. Instead of using the preceding table, we might find the best proportion between x and y by a kind of tentative process, from the formula $\frac{PxRy-R^2y^2}{Px^2+Ry^2}$, which expresses the work performed. This method is indeed tedious; and we mention it only for the sake of showing the conformity of the results, and of proving that there is a certain proportion between x and y which gives a maximum effect. Let $x=6$, as in the preceding paragraph, and let us suppose y to be successively 5, 6, and 7, in order to see which of these values is the best. Since $P=3$, $R=1$, and $x=6$, we have

$$\text{When } y=5 \quad \frac{PxRy-R^2y^2}{Px^2+Ry^2}=\frac{3\times6\times1\times5-1\times5\times5}{3\times6\times6+1\times5\times5}=\frac{65}{133}=0.488$$

$$\text{When } y=6 \quad \frac{PxRy-R^2y^2}{Px^2+Ry^2}=\frac{3\times6\times1\times6-1\times6\times6}{3\times6\times6+1\times6\times6}=\frac{72}{144}=0.500$$

$$\text{When } y=7 \quad \frac{PxRy-R^2y^2}{Px^2+Ry^2}=\frac{3\times6\times1\times7-1\times7\times7}{3\times6\times6+1\times7\times7}=\frac{77}{157}=0.49045$$

It appears therefore that when $y=5, 6, 7$, the work performed is 0.488; 0.5000; 0.49045; so that the effect is a maximum when $y=6$, a result similar to what was obtained from the table.

To find the best proportion between the power and the resistance.

362. When the machine is already constructed, x and y cannot be varied so as to obtain a maximum effect. The same object however will be gained by properly adjusting the power to the work when the work cannot be altered, or the work to the power when the power is determinate. The formulæ in Prop. 2. Chap. 7. exhibit the values of R under many circumstances, and it depends on the judgment of the engineer to select such of them as are adapted to all the conditions of the case.

363. The following table is founded on the formula $R=\frac{\sqrt{y+1}-1}{y^2}$, which answers to the case where the inertia of the impelling power is the same with its pressure, and where the inertia and the friction of the machine may be safely neglected. The second column contains the different values of R corresponding to the values of y in the first column. The numbers in the third column shew the ratio of y to R, or they have the same proportion to 1, which R has to the resistance which will balance P. In the table it is supposed that $P=1$ and $x=1$.

TABLE containing the best proportions between the Power *and the* Resistance, *the inertia of the impelling power being the same with its pressure, and the friction and inertia of the Machine being omitted.*

Values of y, or the velocity of the working point; x being equal to 1.	Values of R, or the resistance to be overcome, P being $=1$.	Ratio of R to the resistance which would balance P.	Values of y, or the velocity of the working point; x being equal to 1.	Values of R, or the resistance to be overcome, P being $=1$.	Ratio of R to the resistance which would balance P.
$\frac{1}{4}$	1.8885	0.4724 to 1	7	0.03731	0.26117 to 1
$\frac{1}{3}$	1.3928	0.4639 ——	8	0.03125	0.25000 ——
$\frac{1}{2}$	0.8986	0.4493 ——	9	0.02669	0.24021 ——
1	0.4142	0.4142 ——	10	0.02317	0.23170 ——
2	0.1830	0.3660 ——	11	0.02037	0.22407 ——
3	0.1111	0.3333 ——	12	0.01809	0.21708 ——
4	0.0772	0.3088 ——	13	0.01622	0.21086 ——
5	0.0580	0.2900 ——	14	0.01466	0.20524 ——
6	0.0457	0.2742 ——	15	0.01333	0.19995 ——

364. To exemplify the use of the preceding table, let us suppose that we are to raise water by means of a simple pulley and bucket, with a power $=10$, and that it is required to find the resistance R, or the quantity of water which must be put into the bucket, in order that the work performed may be a maximum. In the simple pulley, x, y, the arms of the vertical levers or the velocities of the impelled and working points are equal; and since x is supposed in the table to be $=1$, we have $y=1$, which corresponds in the table with 0.4142, the value of R, P being $=1$ in the table: But in the present case $P=10$. Therefore, $10:1=0.4142:4.142$, the value of R when $P=10$.

365. The same result might be obtained in a more circuitous method by means of the formula $\frac{PxRy-R^2y^2}{Px^2+Ry^2}$, which expresses the performance of the machine. Thus, let $x=1$; $y=1$; $P=10$, and let us suppose R successively equal to 3; 4; 4.142; 5; so that we may determine which of these values gives the greatest performance.

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When R=3, the preceding formula becomes $\frac{\overline{10\times3}-\overline{3\times3}}{10+3}=\frac{21}{13}=1.6154$.

When R=4, the formula becomes $\frac{\overline{10\times4}-\overline{4\times4}}{10+4}=\frac{24}{14}=1.7143$.

When R=4.142, the formula becomes $\frac{\overline{10\times4.142}-\overline{4.142}|^2}{10+4.142}=\frac{24.26384}{14.142}=1.7157$.

When R=5, the formula becomes $\frac{10\times5-5\times5}{10+5}=\frac{25}{15}=1.6666$.

Hence it appears, that when R=3; 4; 4.142; 5; the work performed is respectively = 1.6154; 1.7143; 1.7157; 1.6666; so that the work performed is a maximum when R is =4.142, the same result which was obtained from the table.

Chap. II. *On the Simplification of Machinery.*

366. As the inertia of every machine adds greatly to the resistance to be overcome, and as the friction of the communicating parts is proportional to the pressure, it becomes a matter of great practical importance, that the different parts of a machine should be proportioned to the strains to which they are exposed. If the beam of a steam-engine, for example, is larger than what is necessary, an immense portion of the impelling power must be destroyed at every stroke of the piston, by dragging the superfluous mass from a state of rest into motion; the pressure upon the gudgeons will also be increased, and their friction in their sockets proportionally enlarged. The engineer, therefore, should be well acquainted with the strength of the materials of which the machine is to be constructed, and should frame its different parts in such a manner that they may not be heavier than what is necessary for resisting the forces with which they are urged.—When the motions of the machine are necessarily irregular, and when the machine may be exposed to accidental strains, the parts must be made considerably stronger than what is necessary for resisting its ordinary strains; but it is not often that such a precaution should be observed. The gudgeons of water-wheels, and of the beams of steam-engines, ought to be made as short and small as possible, as the friction increases with the rubbing surfaces. This is very seldom attended to in the construction of water-wheels. The diameter of the gudgeons is frequently thrice as large as what is necessary for supporting the weight of the wheel.

367. In the construction of machinery we must not only attend to the simplification of the parts, but also to the number of these parts, and the mode of connecting them. From the nature and quantity of the work to be performed, it is easy to ascertain the velocity of the working point which is most proper for performing it. Now this velocity may be procured in a variety of ways, either by a perplexing multiplicity of wheels, or by more simple combinations. The choice of these combinations must be left solely to the judgement of the engineer, as no general rules can be laid down to direct him. It may be useful, however, to remark, that the power should always be applied as near as possible to the working point of the machine, and that when one wheel drives another, the diameter of the one should never be great, when the diameter of the other is very small. The size of wheels is often determined from the strains to which they are exposed. If, for example, we are obliged to give a certain velocity to an axle by means of a wheel with 120 teeth, and if the force with which this wheel is urged, requires the teeth to be at least one inch thick in order to prevent them from breaking, we shall be obliged to make its diameter at least seven feet; for supposing the spaces between the teeth to be equal to the thickness of the teeth, the circumference of the wheel must at least be equal to 120+120=240 inches, the sum of the teeth and their intervals, which gives a diameter of six feet eight inches. There are some cases where our choice of combination must be directed by the nature of the machinery. If the work to be performed is a load raised with a certain velocity by means of a rope winding round a hollow drum, and if the simplest combination of mechanical powers for producing this velocity should give a small diameter to the drum, then this combination must give way to another which corresponds with a larger size of the drum, for, on account of the inflexibility of the ropes, a great portion of the impelling power would be wasted in winding them about the circumference of a small drum.

368. The advantages of simplifying machinery are well exemplified in the following capstane, which unites great strength and simplicity. It is represented in fig. 4. where AD is a compound barrel composed of two cylinders of different radii. The rope DEC is fixed at the extremity of the cylinder D; and after passing over the pulley E, which is attached to the load by means of the hook F, it is coiled round the other cylinder D, and fixed at its upper end. The capstane bar AB urges the compound barrel CD about its axis, so that while the rope coils round the cylinder D it unwinds itself from the cylinder C. Let us suppose that the diameter of the part D of the barrel is 21 inches, while the diameter of the part C is only 20 inches, and let the pulley E be 20 inches in diameter. When the barrel AD, therefore, has performed one complete revolution by the pressure exerted at B, 63 inches of rope, equal to the circumference of the cylinder, will be gathered upon the cylinder D, and 60 inches will be unwinded from the cylinder C. The quantity of wound rope, therefore, exceeds the quantity that is unwound by 63—60=3 inches, the difference of their respective perimeters; and the half of this quantity, or $1\frac{1}{2}$ inches, will be the space through which the load or pulley E moves by one turn of the bar. If a simple capstane of the same dimensions had been employed, the length of rope coiled round the barrel would have been 60 inches;

Description of a powerful capstane. Plate CCCXXIII. fig. 4.

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inches; and the ſpace deſcribed by the pulley, or load to be overcome, would have been 30 inches. Now, as the power is to the weight as the velocity of the weight is to the velocity of the power, and as the velocity of the power is the ſame in both capſtanes, the weights which they will raiſe will be as $1\frac{1}{2}$ to 30. If it is wiſhed to double the power of the machine, we have only to cover the cylinder C with lathes a quarter of an inch thick, ſo that the difference between the radii of each cylinder may be half as little as before; for it is obvious that the power of the capſtane increaſes as the difference between the radii of the cylinders is diminiſhed. As we increaſe the power, therefore, we increaſe the ſtrength of our machine, while all other engines are proportionably enfeebled by an augmentation of power. Were we for example to increaſe the power of the common capſtane, we muſt diminiſh the barrel in the ſame proportion, ſuppoſing the bar AB not to admit of being lengthened, which will not only diminiſh its ſtrength, but deſtroy much of its power by the additional flexure of the rope.—This capſtane may be eaſily converted into a crane by giving the compound barrel a horizontal poſition, and ſubſtituting a winch inſtead of the bar AB. The ſuperiority of ſuch a crane above the common ones does not require to be pointed out; but it has this additional advantage, that it allows the weight to ſtop at any part of its progreſs, without the aid of a ratchet wheel and catch, becauſe the two parts of the rope pull on the contrary ſides of the barrel. The rope indeed which coils round the larger part of the barrel acts with a larger lever, and conſequently with greater force than the other; but as this exceſs of force is not ſufficient to overcome the friction of the machine, the weight will remain ſtationary in any part of its path. (*Appendix to Ferguſon's Lectures*, vol. ii.).

Compound double machine on the ſame principle.

369. The principle on which the preceding capſtane is conſtructed, might be applied with great advantage when two ſeparate axles AC, BD are driven by means of the winch H and the wheels B and A. It is evident that when the winch is turned round in one direction, the rope R is unwinded from the axle BD; the wheel B drives the wheel A, ſo that the axle AC moves in a direction oppoſite to that of BD, and the rope is coiled round the axle AC. If the wheels A, B are of the ſame diameter and the ſame number of teeth, the weight W will be ſtationary, as the rope winded about one axle will be always equal to what is unwinded from the other. If the wheels have different diameters, or different numbers of teeth, the quantity of rope wound round the one axle will exceed what is unwound from the other, and the weight will be raiſed.

Fig. 5.

Chap. III. *On the Nature of Friction and the Method of diminiſhing its effects in Machinery; and on the Rigidity of Ropes.*

370. The friction generated in the communicating parts of machinery, oppoſes ſuch a reſiſtance to the impelling power, and is ſo injurious to the machine itſelf, that an acquaintance with the nature and effects of this retarding force, and with the method of diminiſhing its effects on machinery, is of infinite importance to the practical mechanic.

371. The ſubject of friction has been examined at great length by Amontons, Bulfinger, Parent, Euler, and Boſſut, and has lately occupied the attention of our ingenious countryman Mr Vince of Cambridge.

Reſult of Vince's experiments.

He found that the friction of hard bodies in motion is an uniformly retarding force, and that the quantity of friction conſidered as equivalent to a weight drawing the body backwards is equal to $M\,\frac{\overline{M+W}\times S}{g\,t^2}$, where M is the moving force expreſſed by its weight, W the weight of the body upon the horizontal plane, S the ſpace through which the moving force or weight deſcended in the time t, and $g=16.087$ feet, the force of gravity. Mr Vince alſo found that the quantity of friction increaſes in a leſs ratio than the quantity of matter or weight of the body, and that the friction of a body does not continue the ſame when it has different ſurfaces applied to the plane on which it moves, but that the ſmalleſt ſurfaces will have the leaſt friction.

Experiments of Coulomb.

372. Notwithſtanding the attempts of preceding philoſophers to unfold the nature of friction, it was reſerved for the celebrated Coulomb to ſurmount the difficulties which are inſeparable from ſuch an inveſtigation, and to give an accurate and ſatisfactory view of this difficult branch of mechanical philoſophy. By employing large bodies and conducting his experiments on a large ſcale, he has corrected ſeveral errors which aroſe from the limited experiments of others; he has brought to light many new and ſtriking phenomena, and confirmed others which were hitherto but partially eſtabliſhed. As it would be foreign to the nature of this work to follow this ingenious philoſopher through his numerous and varied experiments, we ſhall only preſent the reader with the intereſting reſults to which they led.

1. The friction of homogeneous bodies, or bodies of the ſame kind, moving upon one another, is generally ſuppoſed to be greater than that of heterogeneous bodies; but Coulomb has ſhewn that there are exceptions to this rule. He found, for example, that the friction of oak upon oak was equal to $\frac{1}{2.34}$ of the force of preſſion; the friction of pine againſt pine $\frac{1}{1.78}$, and that of oak againſt pine $\frac{1}{1.5}$. The friction of oak againſt copper was $\frac{1}{5.5}$, and that of oak againſt iron nearly the ſame.

2. It was generally ſuppoſed, that in the caſe of wood, the friction is greateſt when the bodies are dragged contrary to the courſe of their fibres; but Coulomb has ſhewn that the friction is in this caſe ſometimes the ſmalleſt. When the bodies moved in the direction of their fibres, the friction was $\frac{1}{2.34}$ of the force with which they were preſſed together; but when the motion was contrary to the courſes of the fibres, the friction was only $\frac{1}{3.76}$.

3. *The longer the rubbing ſurfaces remain in contact, the greater is their friction.*—When wood was moved upon

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upon wood, according to the direction of the fibres, the friction was increased by keeping the surfaces in contact for a few seconds; and when the time was prolonged to a minute, the friction seemed to have reached its farthest limit. But when the motion was contrary to the course of the fibres, a greater time was necessary before the friction arrived at its maximum. When wood was moved upon metal, the friction did not attain its maximum till the surfaces continued in contact for five or six days; and it is very remarkable, that when wooden surfaces were anointed with tallow, the time requisite for producing the greatest quantity of friction is increased. The increase of friction which is generated by prolonging the time of contact is so great, that a body weighing 1650 pounds was moved with a force of 64 pounds when first laid upon its corresponding surface. After having remained in contact for the space of three seconds, it required 160 pounds to put it in motion; and, when the time was prolonged to six days, it could scarcely be moved with a force of 622 pounds. When the surfaces of metallic bodies were moved upon one another, the time of producing a maximum of friction was not changed by the interposition of olive oil; it was increased, however, by employing swine's grease as an unguent, and was prolonged to five or six days by besmearing the surfaces with tallow.

4. *Friction is in general proportional to the force with which the rubbing surfaces are pressed together; and is, for the most part, equal to between $\frac{1}{2}$ and $\frac{1}{4}$ of that force.*—In order to prove the first part of this proposition. Coulomb employed a large piece of wood, whose surface contained three square feet, and loaded it successively with 74 pounds, 874 pounds, and 2474 pounds. In these cases the friction was successively $\frac{1}{2.46}$, $\frac{1}{2.16}$, $\frac{1}{2.21}$ of the force of pression; and when a less surface and other weights were used, the friction was $\frac{1}{2.36}$, $\frac{1}{2.42}$, $\frac{1}{2.40}$. Similar results were obtained in all Coulomb's experiments, even when metallic surfaces were employed. The second part of the proposition has also been established by Coulomb. He found that the greatest friction is engendered when oak moves upon pine, and that it amounts to $\frac{1}{1.78}$ of the force of pression; on the contrary, when iron moves upon brass, the least friction is produced, and it amounts to $\frac{1}{4}$ of the force of pression.

5. *Friction is in general not increased by augmenting the rubbing surfaces.*—When a superficies of three feet square was employed, the friction, with different weights, was $\frac{1}{2.28}$ at a medium; but when a small surface was used, the friction instead of being greater, as might have been expected, was only $\frac{1}{2.39}$.

Friction diminished by increasing the velocity.

6. *Friction for the most part is not augmented by an increase of velocity.* In some cases, *it is diminished by an augmentation of celerity.*—M. Coulomb found, that when wood moved upon wood in the direction of the fibres, the friction was a constant quantity, however much the velocity was varied; but that when the surfaces were very small in respect to the force with which they were pressed, *the friction was diminished by augmenting the rapidity:* the friction, on the contrary, was increased when the surfaces were very large when compared with the force of pression. When the wood was moved contrary to the direction of its fibres, the friction in every case remained the same. If wood be moved upon metals, the friction is greatly increased by an increase of velocity; and when metals move upon wood besmeared with tallow, the friction is still augmented by adding to the velocity. When metals move upon metals, the friction is always a constant quantity; but when heterogeneous substances are employed which are not bedaubed with tallow, the friction is so increased with the velocity, as to form an arithmetical progression when the velocities form a geometrical one.

7. *The friction of loaded cylinders rolling upon a horizontal plane, is in the direct ratio of their weights, and the inverse ratio of their diameters.* In Coulomb's experiments, the friction of cylinders of guaiacum wood, which were two inches in diameter, and were loaded with 1000 pounds, was 18 pounds or $\frac{1}{58}$ of the force of pression. In cylinders of elm, the friction was greater by $\frac{2}{5}$, and was scarcely diminished by the interposition of tallow.

373. From a variety of experiments on the friction of the axes of pulleys, Coulomb obtained the following results.—When an iron axle moved in a brass bush the friction was $\frac{1}{6}$ of the pression; but when the bush was besmeared with very clean tallow, the friction was only $\frac{1}{11}$; when swine's grease was interposed, the friction amounted to $\frac{1}{8.5}$; and when olive oil was employed as an unguent, the friction was never less than $\frac{1}{7}$ or $\frac{1}{7.5}$. When the axis was of green oak, and the bush of guaiacum wood, the friction was $\frac{1}{26}$ when tallow was interposed; but when the tallow was removed, so that a small quantity only covered the surface, the friction was increased to $\frac{1}{17}$. When the bush was made of elm, the friction was in similar circumstances $\frac{1}{33}$ and $\frac{1}{20}$, which is the least of all. If the axis be made of box, and the bush of guaiacum wood, the friction will be $\frac{1}{23}$ and $\frac{1}{14}$, circumstances being the same as before. If the axle be of boxwood, and the bush of elm, the friction will be $\frac{1}{29}$ and $\frac{1}{16}$; and if the axle be of iron and the bush of elm, the friction will be $\frac{1}{20}$ of the force of pression.

Method of diminishing the effects of friction.

374. Having thus considered the nature and effects of friction, we shall now attend to the method of lessening the resistance which it opposes to the motion of machines. The most efficacious mode of accomplishing this is to convert that species of friction which arises from one body being dragged over another, into that which is occasioned by one body rolling upon another. As this will always diminish the resistance, it may be easily effected by applying wheels or rollers to the sockets or bushes which sustain the gudgeons of large wheels, and the axles of wheel carriages. Casatus seems to have been the first who recommended this apparatus. It was afterwards mentioned by Sturmius and Wolfius; but was not used in practice till Sully applied it to clocks in the year 1716, and Mondran to cranes in 1725. Notwithstanding these solitary attempts to introduce friction wheels, they seem to have attracted little notice till the celebrated Euler examined and

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and explained, with his usual accuracy, their nature and advantages. The diameter of the gudgeons and pivots should be made as small as the weight of the wheel and the impelling force will permit. The gudgeons should rest upon wheels as large as circumstances will allow, having their axes as near each other as possible, but no thicker than what is absolutely necessary to sustain the superincumbent weight. When these precautions are properly attended to, the resistance which arises from the friction of the gudgeon, &c. will be extremely trifling.

Friction may be diminished by a judicious application of the impelling power.

375. The effects of friction may likewise in some measure be removed by a judicious application of the impelling power, and by proportioning the size of the friction wheels to the pressure which they severally sustain. If we suppose, for example, that the weight of a wheel, whose iron gudgeons move in bushes of brass, is 100 pounds; then the friction arising from both its gudgeons will be equivalent to 25 pounds. If we suppose, also, that a force equal to 40 pounds is employed to impel the wheel, and acts in the direction of gravity, as in the cases of overshot wheels, the pressure of the gudgeons upon their supports will then be 140 pounds and the friction 35 pounds. But if the force of 40 pounds could be applied in such a manner as to act in direct opposition to the wheel's weight, the pressure of the gudgeons upon their supports would be 100—40, or 60 pounds, and the friction only 15 pounds. It is impossible, indeed, to make the moving force act in direct opposition to the gravity of the wheel, in the case of water mills; and it is often impracticable for the engineer to apply the impelling power but in a given way: but there are many cases in which the moving force may be so exerted, as at least not to increase the friction which arises from the wheel's weight.

376. When the moving force is not exerted in a perpendicular direction, but obliquely as in undershot wheels, the gudgeon will press with greater force on one part of the socket than on any other part. This point will evidently be on the side of the bush opposite to that where the power is applied; and its distance from the lowest point of the socket, which is supposed circular and concentric with the gudgeon, being called x, we shall have Tang. $x = \frac{H}{V}$, that is, the tangent of the arch contained between the point of greatest pressure and the lowest point of the bush, is equal to the sum of all the horizontal forces, divided by the sum of all the vertical forces and the weight of the wheel, H representing the former, and V the latter quantities. The point of greatest pressure being thus determined, the gudgeon must be supported at that part by the largest friction wheel, in order to equalize the friction upon their axles.

The application of these general principles to particular cases is so simple as not to require any illustration. To aid the conceptions, however, of the practical mechanic, we may mention two cases in which friction wheels have been successfully employed.

Plate CCCXXIII. fig. 6.

377. Mr Gottlieb, the constructor of a new crane, has received a patent for what he calls an anti-attrition axle-tree, the beneficial effects of which he has ascertained by a variety of trials. It consists of a steel roller R about four or six inches long, which turns within a groove cut in the inferior part of the axle-tree C which runs in the nave AB of the wheel. When the wheel-carriages are at rest, Mr Gottlieb has given the friction wheel its proper position; but it is evident that the point of greatest pressure will change when they are put in motion, and will be nearer the front of the carriage. This point, however, will vary with the weight of the load; but it is sufficiently obvious that the friction roller should be at a little distance from the lowest point of the axle-tree.

378. Mr Gamett of Bristol has applied friction rollers in a different manner, which does not, like the preceding method, weaken the axle-tree. Instead of fixing them in the iron part of the axle, he leaves a space between the nave and the axis to be filled with equal rollers almost touching each other. A section of this apparatus is represented in fig. 7. where ABCD is the metallic ring inserted in the nave of the wheel. The axle-tree is represented at E, placed between the friction rollers I, I, I, made of metal, and having their axes inserted into a circle of brass which passes through their centres. The circles are rivetted together by means of bolts passing between the rollers, in order to keep them separate and parallel. Fig. 7.

379. As it appears from the experiments of Coulomb, that the least friction is generated when polished iron moves upon brass, the gudgeons and pivots of wheels, and the axles of friction rollers, should all be made of polished iron; and the bushes in which these gudgeons move, and the friction wheels, should be formed of polished brass.

Friction diminished by unguents.

380. When every mechanical contrivance has been adopted for diminishing the obstruction which arises from the attrition of the communicating parts, it may be still farther removed by the judicious application of unguents. The most proper for this purpose are swine's grease and tallow when the surfaces are made of wood, and oil when they are of metal. When the force with which the surfaces are pressed together is very great, tallow will diminish the friction more than swine's grease. When the wooden surfaces are very small, unguents will lessen their friction a little, but it will be greatly diminished if wood moves upon metal greased with tallow. If the velocities, however, are increased, or the unguent not often enough renewed, in both these cases, but particularly in the last, the unguent will be more injurious than useful. The best mode of applying it, is to cover the rubbing surfaces with as thin a stratum as possible, for the friction will then be a constant quantity, and will not be increased by an augmentation of velocity.

381. In small works of wood, the interposition of the powder of black lead has been found very useful in relieving the motion. The ropes of pulleys should be rubbed with tallow, and whenever the screw is used, the square threads should be preferred." *Appendix to Ferguson's Lectures*, vol. ii.

On the rigidity of ropes.

382. When ropes pass over cylinders or pulleys, a considerable force is necessary to bend them into the form of the circumference round which they are coiled. The force which is necessary to overcome this resistance is called the *stiffness* or *rigidity* of the ropes. This important subject was first examined by Amontons,* who contrived an ingenious apparatus for ascertaining the rigidity of ropes. His experiments were repeated and confirmed in part by subsequent philosophers, but particularly by M. Coulomb, who has investigated the subject

* *Mem. Acad.* 1699, p. 217.

ject with more care and ſucceſs than any of his predeceſſors. His experiments were made both with the apparatus of Amontons, and with one of his own invention; and as there was no great diſcrepancy in the reſults, he was authoriſed to place more confidence in his experiments. The limits of this article will not permit us to give an account of the manner in which the experiments were conducted, or even to give a detailed view of the various concluſions which were obtained. We can only preſent the reader with ſome of thoſe leading reſults which may be uſeful in the conſtruction of machinery.

1. The rigidity of ropes increaſes, the more that the fibres of which they are compoſed are twiſted.

2. The rigidity of ropes increaſes in the duplicate ratio of their diameters. According to Amontons and Deſaguliers, the rigidity increaſes in the ſimple ratio of the diameters of the ropes; but this probably aroſe from the flexibility of the ropes which they employed: for Deſaguliers remarks, that when he uſed a rope whoſe diameter was half an inch, its rigidity was increaſed in a greater proportion; ſo that it is probable that if they had employed ropes from two to four inches in diameter, like thoſe uſed by Coulomb, they would have obtained ſimilar reſults. (See N° 9.)

3. The rigidity of ropes is in the ſimple and direct ratio of their tenſion.

4. The rigidity of ropes is in the inverſe ratio of the diameters of the cylinders round which they are coiled.

5. In general, the rigidity of ropes is directly as their tenſions and the ſquares of their diameters, and inverſely as the diameters of the cylinders round which they are wound.

6. The rigidity of ropes increaſes ſo little with the velocity of the machine, that it need not be taken into the account when computing the effects of machines.

7. The rigidity of ſmall ropes is diminiſhed when penetrated with moiſture; but when the ropes are thick, their rigidity is increaſed.

8. The rigidity of ropes is increaſed and their ſtrength diminiſhed when they are covered with pitch; but when ropes of this kind are alternately immerſed in the ſea and expoſed to the air, they laſt longer than when they are not pitched.—This increaſe of rigidity, however, is not ſo perceptible in ſmall ropes as in thoſe which are pretty thick.

9. The rigidity of ropes covered with pitch is a ſixth part greater during froſt than in the middle of ſummer, but this increaſe of rigidity does not follow the ratio of their tenſions.

10. The reſiſtance to be overcome in bending a rope over a pulley or cylinder may be repreſented by a formula compoſed of two terms. The firſt term $\frac{a\,D^n}{r}$ is a conſtant quantity independent of the tenſion, a being a conſtant quantity determined by experiment, D^n a power of the diameter D of the rope, and r the radius of the pulley or cylinder round which the rope is coiled. The ſecond term of the formula is $T \times \frac{b\,D^n}{r}$, where T is the tenſion of the rope, b a conſtant quantity, and D^n and r the ſame as before. Hence the complete formula is $\frac{a\,D^n}{r} + T \times \frac{b\,D^n}{r} = \frac{D^n}{r} \times a + T\,b$. The exponent n of the quantity D diminiſhes with the flexibility of the rope, but is generally equal to 1.7 or 1.8; or, as in N° 2. the rigidity is nearly in the duplicate ratio of the diameter of the rope. When the cord is much uſed, its flexibility is increaſed, and n becomes equal to 1.5 or 1.4.

Chap. IV. *On the Nature and Advantages of Fly Wheels.*

383. A fly, in mechanics, is a heavy wheel or cylinder which moves rapidly upon its axis, and is applied to machines for the purpoſe of rendering uniform a deſultory or reciprocating motion, ariſing either from the nature of the machinery, from an inequality in the reſiſtance to be overcome, or from an irregular application of the impelling power. When the firſt mover is inanimate, as wind, water, and ſteam, an inequality of force obviouſly ariſes from a variation in the velocity of the wind, from an increaſe or decreaſe of water occaſioned by ſudden rains, or from an augmentation or diminution of the ſteam in the boiler, produced by a variation in the heat of the furnace; and accordingly various methods have been adopted for regulating the action of theſe variable powers. The ſame inequality of force obtains when machines are moved by horſes or men. Every animal exerts its greateſt ſtrength when firſt ſet to work. After pulling for ſome time, its ſtrength will be impaired; and when the reſiſtance is great, it will take frequent though ſhort relaxations, and then commence its labour with renovated vigour. Theſe intervals of reſt and vigorous exertion muſt always produce a variation in the velocity of the machine, which ought particularly to be avoided, as being detrimental to the communicating parts as well as the performance of the machine, and injurious to the animal which is employed to draw it. But if a fly, conſiſting either of croſs bars, or a maſſy circular rim, be connected with the machinery, all theſe inconveniences will be removed. As every fly wheel muſt revolve with great rapidity, the momentum of its circumference muſt be very conſiderable, and will conſequently reſiſt every attempt either to accelerate or retard its motion. When the machine therefore has been put in motion, the fly wheel will be whirling with an uniform celerity, and with a force capable of continuing that celerity when there is any relaxation in the impelling power. After a ſhort reſt the animal renews his efforts; but the machine is now moving with its former velocity, and theſe freſh efforts will have a tendency to increaſe that velocity. The fly, however, now acts as a reſiſting power, receives the greateſt part of the ſuperfluous motion, and cauſes the machinery to preſerve its original celerity. In this way the fly ſecures to the engine an uniform motion, whether the animal takes occaſional relaxations or exerts his force with redoubled ardour.

384. We have already obſerved that a deſultory or variable motion frequently ariſes from the inequality of the reſiſtance, or work to be performed. This is particularly manifeſt in thraſhing mills, on a ſmall ſcale, which are driven by water. When the corn is laid unequally on

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on the feeding board, so that too much is taken in by the fluted rollers, this increase of resistance instantly affects the machinery, and communicates a desultory or irregular motion even to the water wheel or first mover. This variation in the velocity of the impelling power may be distinctly perceived by the ear in a calm evening when the machine is at work. The best method of correcting these irregularities is to employ a fly wheel, which will regulate the motion of the machine when the resistance is either augmented or diminished. In machines built upon a large scale there is no necessity for the interposition of a fly, as the *inertia* of the machinery supplies its place, and resists every change of motion that may be generated by an unequal admission of the corn.

385. A variation in the velocity of engines arises also from the nature of the machinery. Let us suppose that a weight of 1000 pounds is to be raised from the bottom of a well 50 feet, by means of a bucket attached to an iron chain which winds rounds a barrel or cylinder, and that every foot length of this chain weighs two pounds. It is evident that the resistance to be overcome in the first moment is 1000 pounds added to 50 pounds the weight of this chain, and that this resistance diminishes gradually as the chain coils round the cylinder, till it is only 1000 pounds when the chain is completely wound up. The resistance therefore decreases from 1050 to 1000 pounds; and if the impelling power is inanimate, the velocity of the bucket will gradually increase; but if an animal is employed, it will generally proportion its action to the resisting load, and must therefore pull with a greater or less force according as the bucket is near the bottom or top of the well. In this case, however, the assistance of a fly may be dispensed with, because the resistance diminishes uniformly, and may be rendered constant by making the barrel conical, so that the chain may wind upon the part nearest the vertex at the commencement of the motion, the diameter of the barrel gradually increasing as the weight diminishes. In this way the variable resistance will be equalized much better than by the application of a fly wheel, for the fly having no motion of its own must necessarily waste the impelling power.

386. Having thus pointed out the chief causes of variation in the velocity of machines, and the method of rendering it uniform by the intervention of fly wheels, the utility, and in some instances the necessity, of this piece of mechanism, may be more obviously illustrated by shewing the propriety of their application in particular cases.

* See Part III. Plate CCCXXIX fig. 1.

387. In the description of Vaulone's pile engine *, the reader will observe a striking instance of the utility of fly wheels. The ram Q is raised between the guides *bb* by means of horses acting against the levers S, S; but as soon as the ram is elevated to the top of the guides, and discharged from the follower G, the resistance against which the horses have been exerting their force is suddenly removed, and they would instantaneously tumble down, were it not for the fly O. This fly is connected with the drum B by means of the trundle X, and as it is moving with a very great force, it opposes a sufficient resistance to the action of the horses, till the ram is again taken up by the follower.

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388. When machinery is driven by a single-stroke steam engine, there is such an inequality in the impelling power, that for two or three seconds it does not act at all. During this interval of inactivity the machinery would necessarily stop, were it not impelled by a massy fly wheel of a great diameter, revolving with rapidity, till the moving power again resumes its energy.

389. If the moving power is a man acting with a handle or winch, it is subject to great inequalities. The greatest force is exerted when the man pulls the handle upwards from the height of his knee, and he acts with the least force when the handle being in a vertical position is thrust from him in a horizontal direction. The force is again increased when the handle is pushed downwards by the man's weight, and it is diminished when the handle being at its lowest point is pulled towards him horizontally. But when a fly is properly connected with the machinery, these irregular exertions are equalized, the velocity becomes uniform, and the load is raised with an equable and steady motion.

390. In many cases, where the impelling force is alternately augmented and diminished, the performance of the machine may be increased by rendering the resistance unequal, and accommodating it to the inequalities of the moving power. Dr Robison observes that "there are some beautiful specimens of this kind of adjustment in the mechanism of animal bodies."

Besides the utility of fly wheels as regulators of machinery, they have been employed for accumulating or collecting power. If motion is communicated to a fly wheel by means of a small force, and if this force is continued till the wheel has acquired a great velocity, such a quantity of motion will be accumulated in its circumference, as to overcome resistances and produce effects which could never have been accomplished by the original force. So great is this accumulation of power; that a force equivalent to 20 pounds applied for the space of 37 seconds to the circumference of a cylinder 20 feet diameter, which weighs 4713 pounds, would, at the distance of one foot from the centre, give an impulse to a musket ball equal to what it receives from a full charge of gunpowder. In the space of six minutes and 10 seconds, the same effect would be produced if the cylinder was driven by a man who constantly exerted a force of 20 pounds at a winch one foot long (D).

391. This accumulation of power is finely exemplified in the *sling*. When the thong which contains the stone is swung round the head of the slinger, the force of the hand is continually accumulating in the revolving stone, till it is discharged with a degree of rapidity which it could never have received from the force of the hand alone. When a stone is projected from the hand itself, there is even then a certain degree of force accumulated, though the stone only moves through the arch of a circle. If we fix the stone in an opening at the

(D) This has been demonstrated by Mr Atwood. See his Treatise on Rectilineal and Rotatory Motion.

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extremity of a piece of wood two feet long, and discharge it in the usual way, there will be more force accumulated than with the hand alone, for the stone describes a larger arch in the same time, and must therefore be projected with greater force.

392. When coins or medals are struck, a very considerable accumulation of power is necessary, and this is effected by means of a fly. The force is first accumulated in weights fixed in the end of the fly. This force is communicated to two levers, by which it is farther condensed; and from these levers it is transmitted to a screw, by which it suffers a second condensation. The stamp is then impressed on the coin or medal by means of this force, which was first accumulated by the fly, and afterwards augmented by the intervention of two mechanical powers.

393. Notwithstanding the great advantage of fly wheels, both as regulators of machines and collectors of power, their utility wholly depends upon the position which is assigned them relative to the impelled and working points of the engine. For this purpose no particular rules can be laid down, as their positions depend altogether on the nature of the machinery. We may observe however, in general, that when fly wheels are employed to regulate machinery, they should be near the impelling power; and when used to accumulate force in the working point they should not be far distant from it. In hand mills for grinding corn, the fly is for the most part very injudiciously fixed on the axis to which the winch is attached; whereas it should always be fastened to the upper millstone so as to revolve with the same rapidity. In the first position indeed it must equalize the varying efforts of the power which moves the winch; but when it is attached to the turning millstone, it not only does this, but contributes very effectually to the grinding of the corn.

Description of the conical pendulum. Fig. 8.

394. A new kind of fly, called a conical pendulum has been ingeniously employed by Mr Watt for procuring a determinate velocity at the working point of his steam-engine. It is represented in fig. 8. where AB is a vertical axis moving upon pivots, and driven by means of a rope passing from the axis of the large fly over the sheave EF. The large balls M, N are fixed to the rods NG, MH, which have an angular motion round P, and are connected by joints at G and H, with the rods GK, HK attached to the extremity of the lever KL whose centre of motion is L, and whose other extremity is connected with the cock which admits the steam into the cylinder. The frames CD and QR prevent the balls from receding too far from the axis, or from approaching too near it. Now when this conical pendulum is put in motion, the centrifugal force of the balls M, N makes them recede from the axis AB. In consequence of this recess, the points C, H, K are depressed, and the other extremity of the lever is raised; and the cock admits a certain quantity of steam into the cylinder. When the velocity of the fly is by any means increased, the balls recede still farther from the axis, the extremity of the lever is raised higher, and the cock closes a little and diminishes the supply of steam. From this diminution in the impelling power, the velocity of the fly and the conical pendulum decreases, and the balls resume their former position. In this way, when there is any increase or diminution in the velocity of the fly, the corresponding increase or diminution in the centrifugal force of the balls raises or depresses the arm of the lever, admits a greater or a less quantity of steam into the cylinder, and restores to the engine its former velocity.

Chap. V. *On the Teeth of Wheels, and the Wipers of Stampers.*

395. In the construction of machines, we must not only attend to the form and number of their parts, but also to the mode by which they are to be connected. It would be easy to shew, did the limits of this article permit it, that, when one wheel impels another, the impelling power will sometimes act with greater and sometimes with less force, unless the teeth of one or both of the wheels be parts of a curve generated after the manner of an epicycloid by the revolution of one circle along the convex or concave side of another. It may be sufficient to shew, that, when one wheel impels another by the action of epicycloidal teeth, their motion will be uniform. Let the wheel CD drive the wheel AB by means of the epicycloidal teeth mp, nq, or, acting upon the infinitely small pins or spindles a, b, c; and let the epicycloids mp, nq, &c. be generated by the circumference of the wheel AB, rolling upon the convex circumference of the wheel CD. From the formation of the epicycloid it is obvious that the arch ab is equal to mn, and the arch ac to mo; for during the formation of the part nb of the epicycloid nq, every point of the arch ab is applied to every point of the arch mn, and the same happens during the formation of the part co of the epicycloid or. Let us now suppose that the tooth mp begins to act on the pin a, and that b, c are successive positions of the pin a after a certain time; then, nq, or will be the positions of the tooth mp after the same time; but $ab=mn$ and $ac=mo$, therefore the wheels AB, CD, when the arch is driven by epicycloidal teeth, move through equal spaces in equal times, that is, the force of the wheel CD, and the velocity of the wheel AB, are always uniform. Fig. 9.

396. In illustrating the application of this property of the epicycloid, which was discovered by Olaus Roemer the celebrated Danish astronomer, we shall call the small wheel the *pinion*, and its teeth the *leaves* of the pinion. The line which joins the centre of the wheel and pinion is called the *line of centres*. There are three different ways in which the teeth of one wheel may drive another, and each of these modes of action requires a different form for the teeth.

1. When the action is begun and completed after the teeth have passed the line of centres.

2. When the action is begun and completed before they reach the line of centres.

3. When the action is carried on, on both sides of the line of centres.

First mode of action. Plate CCCXXIV fig. 1.

397. 1. The first of these modes of action is represented in fig. 1. where B is the centre of the wheel (D), A that of the pinion, and AB the line of centres. It is evident from the figure, that the part b of the tooth ab of the wheel, does not act on the leaf m of the pinion till they arrive at the line of centres AB; and that all the action is carried on after they have passed this line, and is completed when the leaf m comes into the situation n. When this mode of action is adopted, the acting faces of

(D) In figs. 1, 2, 3, 4, the letter B is supposed to be placed at the centre of the wheels.

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of the leaves of the pinion ſhould be parts of an *interior epicycloid*, generated by a circle of any diameter rolling upon the concave ſuperficies of the pinion, or within the circle *a d h*; and the faces *a b* of the teeth of the wheel ſhould be portions of an *exterior epicycloid* formed by the *ſame* generating circle rolling upon the convex ſuperficies *o d p* of the wheel.

398. But when one circle rolls within another whoſe diameter is double that of the rolling circle, the line generated by any point of the latter is a *ſtraight line*, tending to the centre of the larger circle. Therefore, if the generating circle above mentioned ſhould be taken with its diameter equal to the radius of the pinion, and be made to roll upon the concave ſuperficies *a d h* of the pinion, it will generate a ſtraight line tending to the pinion's centre, which will be the form of the faces of its leaves; and the teeth of the wheel will be exterior epicycloids, formed by a generating circle, whoſe diameter is equal to the radius of the pinion, rolling upon the convex ſuperficies *o d p* of the wheel. This rectilineal form of the teeth is exhibited in fig. 2. and is perhaps the moſt advantageous, as it requires leſs trouble, and may be executed with greater accuracy, than if the epicycloidal form had been employed, though the teeth are evidently weaker than thoſe in fig. 1.; it is recommended both by De la Hire and Camus as particularly advantageous in clock and watch work.

Fig. 2.

Fig. 1.

399. The attentive reader will perceive from fig. 1. that in order to prevent the teeth of the wheel from acting upon the leaves of the pinion before they reach the line of centres AB; and that one tooth of the wheel may not quit the leaf of the pinion till the ſucceeding tooth begins to act upon the ſucceeding leaf, there muſt be a certain proportion between the number of leaves in the pinion and the number of teeth in the wheel, or between the radius of the pinion and the radius of the wheel, when the diſtance of the leaves AB is given. But in machinery the number of leaves and teeth is always known from the velocity which is required at the working point of the machine: It becomes a matter therefore of great importance to determine with accuracy the relative radii of the wheel and pinion.

Relative ſize of the wheel and pinion.

400. For this purpoſe, let A, fig. 2. be the pinion having the acting faces of its leaves ſtraight lines tending to the centre, and B the centre of the wheel. AB will be the diſtance of their centres. Then as the tooth C is ſuppoſed not to act upon the leaf A*m* till it arrives at the line AB, it ought not to quit A*m* till the following tooth F has reached the line AB. But ſince the tooth always acts in the direction of a line drawn perpendicular to the face of the leaf A*m* from the point of contact, the line CH, drawn at right angles to the face of the leaf A*m*, will determine the extremity of the tooth CD, or the laſt part of it which ſhould act upon the leaf A*m*, and will alſo mark out CD for the depth of the tooth. Now, in order to find AH, HB, and CD, put *a* for the number of teeth in the wheel, *b* for the number of leaves in the pinion, *c* for the diſtance of the pivots A and B, and let x be the radius of the wheel, and y that of the pinion. Then, ſince the circumference of the wheel is to the circumference of the pinion, as the number of teeth in the one to the number of leaves in the other, and as the circumferences of circles are proportional to their radii, we ſhall have $a : b = x : y$, then by compoſition (Eucl. v. 18.) $a+b : b = c : y$ (c being equal to $x+y$), and conſequently the radius of the pinion, viz. $y = \frac{cb}{a+b}$; then by inverting the firſt analogy, we have $b : a = y : x$, and conſequently the radius of the wheel, viz. $x = \frac{ay}{b}$; y being now a known number.

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Now, in the triangle AHC, right-angled at C, the ſide AH is known, and likewiſe all the angles (HAC being equal to $\frac{360}{b}$); the ſide AC, therefore, may be found by plain trigonometry. Then, in the triangle ACB, the $\angle$CAB, equal to HAC, is known, and alſo the ſides AB, AC, which contain it; the third ſide, therefore, viz. CB, may be determined; from which DB, equal to HB, already found, being ſubſtracted, there will remain CD for the depth of the teeth. When the action is carried on after the line of centres, it often happens that the teeth will not work in the hollows of the leaves. In order to prevent this, the $\angle$ CBH muſt always be greater than half the $\angle$ HBP. The $\angle$ HBP is equal to 360 degrees, divided by the number of teeth in the wheel, and CBH is eaſily found by plane trigonometry.

401. If the teeth of wheels and the leaves of pinions be formed according to the directions already given, they will act upon each other, not only with uniform force, but nearly without friction. The one tooth rolls upon the other, and neither ſlides nor rubs to ſuch a degree as to retard the wheels, or wear their teeth. But as it is impoſſible in practice to give that perfect curvature to the faces of the teeth which theory requires, a quantity of friction will remain after every precaution has been taken in the formation of the communicating parts.

402. 2. The ſecond mode of action is not ſo advantageous as that which we have been conſidering, and ſhould, if poſſible, always be avoided. It is repreſented in fig. 3. where A is the centre of the pinion, B that of the wheel, and AB the line of centres. It is evident from the figure that the tooth C of the wheel acts upon the leaf D of the pinion before they arrive at the line BA; that it quits the leaf when they reach this line, and have aſſumed the poſition of E and F; and that the tooth *c* works deeper and deeper between the leaves of the pinion, the nearer it comes to the line of centres. From this laſt circumſtance a conſiderable quantity of friction ariſes, becauſe the tooth C does not, as before, roll upon the leaf D, but ſlides upon it; and from the ſame cauſe the pinion ſoon becomes foul, as the duſt which lies upon the acting faces of the leaves is puſhed into the interjacent hollows. One advantage, however, attends this mode of action: It allows us to make the teeth of the large wheel rectilineal, and thus renders the labour of the mechanic leſs, and the accuracy of his work greater, than if they had been of a curvilineal form. If the teeth C, E, therefore of the wheel BC are made rectilineal, having their ſurfaces directed to the wheel's centre, the acting faces of the leaves D, F, &c. muſt be epicycloids formed by a generating circle, whoſe diameter is equal to the radius B *o* of the circle *o p*, rolling upon the circumference *m n* of the pinion A. But if the teeth of the wheel and the leaves of the pinion are made curvilineal as in the figure, the faces of the teeth of the wheel muſt be portions of an interior epicycloid formed by any generating

Second mode of action.

Fig. 3.

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rating circle rolling within the concave ſuperficies of the circle $o\,p$, and the faces of the pinion's leaves muſt be portions of an exterior epicycloid produced by rolling the ſame generating circle upon the convex circumference $m\,n$ of the pinion.

Third mode of action. Fig. 4.

403. 3. The third mode of action, which is repreſented in fig. 4. is a combination of the two firſt modes, and conſequently partakes of the advantages and diſadvantages of each. It is evident from the figure that the portion $e\,b$ of the tooth acts upon the part $b\,c$ of the leaf till they reach the line of centres AB, and that the part $e\,d$ of the tooth acts upon the portion $b\,a$ of the leaf after they have paſſed this line. Hence the acting parts $e\,h$ and $b\,c$ muſt be formed according to the directions given for the firſt mode of action, and the remaining parts $e\,d$, $b\,a$, muſt have that curvature which the ſecond mode of action requires; conſequently $e\,h$ ſhould be part of an interior epicycloid formed by any generating circle rolling on the concave circumference $m\,n$ of the wheel, and the correſponding part $b\,c$ of the leaf ſhould be part of an exterior epicycloid formed by the ſame generating circle rolling upon b EO, the convex circumference of the pinion: the remaining part $c\,d$ of the tooth ſhould be a portion of an exterior epicycloid, engendered by any generating circle rolling upon e L, the concave ſuperficies of the wheel: and the correſponding part $b\,a$ of the leaf ſhould be part of an interior epicycloid deſcribed by the ſame generating circle, rolling along the concave ſide b EO of the pinion. As it would be extremely troubleſome, however, to give this double curvature to the acting faces of the teeth, it will be proper to uſe a generating circle, whoſe diameter is equal to the radius of the wheel BC, for deſcribing the interior epicycloid $e\,h$ and the exterior one $b\,c$, and a generating circle, whoſe diameter is equal to AC, the radius of the pinion, for deſcribing the interior epicycloid $b\,a$, and the exterior one $e\,d$. In this caſe the two interior epicycloids $e\,h$, $b\,a$, will be ſtraight lines tending to the centres B and A, and the labour of the mechanic will by this means be greatly abridged.

Relative diameters of the wheel and pinion

404. In order to find the relative diameters of the wheel and pinion, when the number of teeth in the one and the number of leaves in the other are given, and when the diſtance of their centres is alſo given, and the ratio of ES to CS, let a be the number of teeth in the wheel, b the number of leaves in the pinion, c the diſtance of the pivots A, B, and let m be to n as ES to CS, then the arch ES, or $\angle$ SAE, will be equal to $\frac{360^\circ}{b}$, and LD, or $\angle$ LBD, will be equal to $\frac{360^\circ}{a}$. But ES : CS$=m:n$; conſequently LD : LC$=m:n$, therefore (Eucl. vi. 16.) LC$\times m=$LD$\times n$, and LC$=\frac{\text{LD}\times n}{m}$; but LD is equal to $\frac{360}{a}$, therefore by ſubſtitution LC$=\frac{360\times n}{am}$.

Now, in the triangle APB, AB is known, and alſo PB, which is the coſine of the angle ABD, PC being perpendicular to DB; AP or the radius of the pinion therefore may be found by plane trigonometry. The reader will obſerve that the point P marks out the parts of the tooth D and the leaf SP where they commence their action; and the point I marks out the parts where their mutual action ceaſes (E); AP therefore is the proper radius of the pinion, and BI the proper radius of the wheel, the parts of the tooth L without the point I, and of the leaf SP without the point P, being ſuperfluous. Now, to find BI, we have ES : CS$=m:n$, and CS$=\frac{\text{ES}\times n}{m}$; but ES was ſhewn to be $=\frac{360}{b}$, therefore, by ſubſtitution, CS$=\frac{360\times n}{bm}$. Now the arch ES, or $\angle$EAS, being equal to $\frac{360}{b}$, and CS, or $\angle$ CAS, being equal to $\frac{360\times n}{bm}$, their difference EC, or the angle EAC, will be equal to $\frac{360}{b}-\frac{360\times n}{bm}$, or $\frac{360^\circ\times\overline{m-n}}{bm}$. The $\angle$ EAC being thus found, the triangle EAB, or IAB, which is almoſt equal to it, is known, becauſe AB is given, and likewiſe AI, which is equal to the coſine of the angle IAB, AC being radius, and AIC being a right angle, conſequently IB the radius of the wheel may be found by trigonometry. It was formerly ſhewn that AC, the radius of what is called the primitive pinion, was equal to $\frac{c\,b}{a+b}$, and that BC the radius of the primitive wheel was equal to $\frac{\text{AC}\times a}{b}$. If then we ſubſtract AC or AS from AP, we ſhall have the quantity SP which muſt be added to the radius of the primitive pinion, and if we take the difference of BC (or BL) and DE, the quantity LE will be found, which muſt be added to the radius of the primitive wheel. We have all along ſuppoſed that the wheel drives the pinion, and have given the proper form of the teeth upon this ſuppoſition. But when the pinion drives the wheel, the form which was given to the teeth of the wheel in the firſt caſe, muſt in this be given to the leaves of the pinion; and the ſhape which was formerly given to the leaves of the pinion muſt now be transferred to the teeth of the wheel.

Form of the teeth according to Dr Robiſon.

405. Another form for the teeth of wheels, different from any which we have mentioned, has been recommended by Dr Robiſon. He ſhews that a perfect uniformity of action may be ſecured, by making the acting faces of the teeth involutes of the wheel's circumference, which are nothing more than epicycloids, the centres of whoſe generating circles are infinitely diſtant. Thus, in fig. 1. let AB be a portion of the wheel on which

(E) The letter L marks the interſection of the line BL with the arch $e\,m$, and the letter E the interſection of the arch b O with the upper ſurface of the leaf m. The letters D and S correſpond with L and E reſpectively, and P with I.

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Fig. 5.

which the tooth is to be fixed, and let A*pa* be a thread lapped round its circumference, having a loop hole at its extremity *a*. In this loop hole fix the pin *a*, and with it deſcribe the curve or *involute a b c d e h*, by unlapping the thread gradually from the circumference A*pm*. This curve will be the proper ſhape for the teeth of a wheel whoſe diameter is AB. Dr Robiſon obſerves, that as this form admits of ſeveral teeth to be acting at the ſame time (twice the number that can be admitted in M. de la Hire's method), the preſſure is divided among ſeveral teeth, and the quantity upon any one of them is ſo diminiſhed, that thoſe dents and impreſſions which they unavoidably make upon each other are partly prevented. He candidly allows, however, that the teeth thus formed are not completely free from ſliding and friction, though this ſlide is only $\frac{1}{60}$th of an inch, when a tooth three inches long fixed on a wheel ten feet in diameter drives another wheel whoſe diameter is two feet. *Append. to Ferguſon's Lectures.*

406. *On the Formation of Exterior and Interior Epicycloids, and on the Diſpoſition of the Teeth on the Wheel's Circumference.*

Mechanical method of forming epicycloids.

Nothing can be of greater importance to the practical mechanic, than to have a method of drawing epicycloids with facility and accuracy; the following, we truſt, is the moſt ſimple mechanical method that can be employed.—Take a piece of plain wood GH, fig. 6. and fix upon it another piece of wood E, having its circumference *mb* of the ſame curvature as the circular baſe upon which the generating circle AB is to roll. When the generating circle is large, the ſegment B will be ſufficient: in any part of the circumference of this ſegment, fix a ſharp pointed nail *a*, ſloping in ſuch a manner that the diſtance of its point from the centre of the circle may be exactly equal to its radius; and faſten to the board GH a piece of thin braſs, or copper, or tinplate, *a b*, diſtinguiſhed by the dotted lines. Place the ſegment B in ſuch a poſition that the point of the nail *a* may be upon the point *b*, and roll the ſegment towards G, ſo that the nail *a* may riſe gradually, and the point of contact between the two circular ſegments may advance towards *m*; the curve *a b* deſcribed upon the braſs plate will be an accurate exterior epicycloid. In order to prevent the ſegments from ſliding, their peripheries ſhould be rubbed with roſin or chalk, or a number of ſmall iron points may be fixed on the circumference of the generating ſegment. Remove, with a file, the part of the braſs on the left hand of the epicycloid, and the remaining concave arch or gage *a b* will be a pattern tooth, by means of which all the reſt may be eaſily formed. When an *interior epicycloid* is wanted, the concave ſide of its circular baſe muſt be uſed. The method of deſcribing it is repreſented in fig. 7. where CD is the generating circle, F the concave circular baſe, MN the piece of wood on which this baſe is fixed, and *c d* the interior epicycloid formed upon the plate of braſs, by rolling the generating circle C, or the generating ſegment D, towards the right hand. The *cycloid*, which is uſeful in forming the teeth of *rack-work*, is generated preciſely in the ſame manner, with this difference only, that the baſe on which the generating circle rolls muſt be a ſtraight line.

Fig. 6.

Fig. 7.

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Diſpoſition of the teeth.

In order that the teeth may not embarraſs one another before their action commences, and that one tooth may begin to act upon its correſponding leaf of the pinion, before the preceding tooth has ceaſed to act upon the preceding leaf, the height, breadth, and diſtance of the teeth muſt be properly proportioned. For this purpoſe the pitch-line or circumference of the wheel, which is repreſented in fig. 2. and 3. by the dotted arches, muſt be divided into as many equal ſpaces as the number of teeth which the wheel is to carry. Divide each of theſe ſpaces into 16 equal parts; allow 7 of theſe for the greateſt breadth of the teeth, and 9 for the diſtance between each; or the diſtance of the teeth may be made equal to their breadth. If the wheel drive a trundle, each ſpace ſhould be divided into 7 equal parts, and 3 of theſe allotted for the thickneſs of the tooth, and $3\frac{2}{7}$ for the diameter of the cylindrical ſtave of the trundle. If each of the ſpaces already mentioned, or if the diſtance between the centres of each tooth, be divided into three equal parts, the height of the teeth muſt be equal to two of theſe. Theſe diſtances and heights, however, vary according to the mode of action which is employed. The teeth ſhould be rounded off at the extremities, and the radius of the wheel made a little larger than that which is deduced from the rules in Art. 400, 404. But when the pinion drives the wheel, a ſmall addition ſhould be made to the radius of the pinion.

On the Nature of Bevelled Wheels, and the method of giving an epicycloidal form to their Teeth.

407. The principle of bevelled wheels was pointed out by De la Hire, ſo long ago as the end of the 17th century. It conſiſts in one fluted or toothed cone acting upon another, as is repreſented in fig. 8. where the cone OD drives the cone OC, conveying its motion in the direction OC. If theſe cones be cut parallel to their baſes as at A and B, and if the two ſmall cones between AB and O be removed, the remaining parts AC and BD may be conſidered as two bevelled wheels, and BD will act upon AC in the very ſame manner, and with the ſame effect, that the whole cone OD acted upon the whole cone OC. If the ſection be made nearer the baſes of the cones, the ſame effect will be produced: this is the caſe in fig. 9. where CD and DE are but very ſmall portions of the imaginary cones ACD and ADE.

Bevelled wheels.

Fig. 8.

Fig. 9.

408. In order to convey motion in any given direction, and determine the relative ſize and ſituation of the wheels for this purpoſe, let AB, fig. 10. be the axis of a wheel, and CD the given direction in which it is required to convey the motion by means of a wheel fixed upon the axis AB, and acting upon another wheel fixed on the axis CD, and let us ſuppoſe that the axis CD muſt have four times the velocity of AB, or muſt perform four revolutions while AB performs one. Then the number of teeth in the wheel fixed upon AB muſt be four times greater than the number of teeth in the wheel fixed upon CD, and their radii muſt have the ſame proportion. Draw *c d* parallel to CD at any convenient diſtance, and draw *a b* parallel to AB at four times that diſtance, then the lines *i m* and *i n* drawn perpendicular to AB and CD reſpectively, will mark the ſituation and ſize of the wheels required. In this

Fig. 10.

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this case the cones are O *n i* and O *m i*, and *s r n i*, *r p m i*, are the portions of them that are employed.

On the formation of their teeth.

The formation of the teeth of bevelled wheels is more difficult than one would at first imagine. The teeth of such wheels, indeed, must be formed by the same rules which have been given for other wheels; but since different parts of the same tooth are at different distances from the axis, these parts must have the curvature of their acting surfaces proportioned to that distance. Thus, in fig. 10. the part of the tooth at *r* must be more incurvated than the part at *i*, as is evident from the inspection of fig. 9.; and the epicycloid for the part *i* must be formed by means of circles whose diameters are *i m* and F *f*, while the epicycloid for the part *r* must be generated by circles whose diameters are C *n* and D *d*.

409. Let us suppose a plane to pass through the points O, A, D; the lines AB, AO, will evidently be in this plane, which may be called the *plane of centres*. Now, when the teeth of the wheel DE, which is supposed to drive CD the smallest of the two, commence their action on the teeth of CD, when they arrive at the plane of centres, and continue their action after they have passed this plane, the curve given to the teeth of CD at C, should be a portion of an interior epicycloid formed by any generating circle rolling on the concave superficies of a circle whose diameter is twice C *n* perpendicular to CA, and the curvature of the teeth at *i* should be part of a similar epicycloid, formed upon a circle, whose diameter is twice *i m*. The curvature of the teeth of the wheel DE at D, should be part of an exterior epicycloid formed by the same generating circle rolling upon the concave circumference of a circle whose diameter is twice D *d* perpendicular to DA; and the epicycloid for the teeth at F is formed in the same way, only instead of twice D *d*, the diameter of the circle must be twice F *f*. When any other mode of action is adopted, the teeth are to be formed in the same manner that we have pointed out for common wheels, with this difference only, that different epicycloids are necessary for the parts F and D. It may be sufficient, however, to find the form of the teeth at F, as the remaining part of the tooth may be shaped by directing a straight ruler from different points of the epicycloid at F to the centre A, and filing the tooth till every part of its acting surface coincide with the side of the ruler. The reason of this operation will be obvious by attending to the shape of the tooth in fig. 8. When the small wheel CD impels the large one DE, the epicycloids which were formerly given to CD must be given to DE, and those which were given to DE must be transferred to CD.

Fig. 8.

On crown wheels.

410. The wheel represented in fig. 11. is sometimes called a crown wheel, though it is evident from the figure that it belongs to that species of wheels which we have just been considering; for the acting surfaces of the teeth both of the wheel MB and of the pinion EDG are directed to C the common vertex of the two cones CMB, CEG. In this case the rules for bevelled wheels must be adopted, in which AS is to be considered as the radius of the wheel for the profile of the tooth at A, and MN as its radius for the profile of the tooth at M; and the epicycloids thus formed will be the sections or profiles of the teeth in the direction MP, at right angles to MC the surfaces of the cone. When the vertex C of the cone MCG approaches to N till it be in the same plane with the points M, G, some of the curves will be cycloids and others involutes, as in the case of rack-work, for then the cone CEG will revolve upon a plane surface. *Appendix to Ferguson's Lectures.*

Fig. 11.

Sect. II. *On the Wipers of Stampers, &c. the Teeth of Rack-work, &c. &c.*

411. In fig. 12. let AB be the wheel which is employed to elevate the rack C, and let their mutual action not commence till the acting teeth have reached the line of centres AC. In this case C becomes as it were the pinion or wheel driven, and the acting faces of its teeth must be *interior epicycloids* formed by any generating circle rolling within the circumference *p q*; but as *p q* is a straight line, these interior epicycloids will be *cycloids*, or curves generated by a point in the circumference of a circle, rolling upon a straight line or plane surface. The acting face *o p*, therefore, will be part of a *cycloid* formed by any generating circle, and *m n*, the acting face of the teeth of the wheel, must be an *exterior* epicycloid produced by the same generating circle rolling on *m r* the convex surface of the wheel. If it is required to make *o p* a straight line, as in the figure, them *m n* must be an *involute* of the circle *m r* formed in the manner represented in fig. 5.

Fig. 12.

412. Fig. 12. likewise represents a wheel depressing the rack *c* when the third mode of action is used. In this case also *c* becomes the pinion, and DE the wheel; *e h* therefore must be part of an interior epicycloid formed by any generating circle rolling on the concave side *e x* of the wheel, and *b c* must be an exterior epicycloid produced by the same generating circle rolling upon the circumference of the rack. The remaining part *c d* of the teeth of the wheel must be an exterior epicycloid described by any generating circle moving upon the convex side *e x*, and *b a* must be an interior epicycloid engendered by the same generating circle rolling within the circumference of the rack. But as the circumference of the rack is in this case a straight line, the exterior epicycloid *b c* and the interior one *b a* will be cycloids formed by the same generating circles which are employed in describing the other epicycloids. Since it would be difficult, however, as has already been remarked, to give this compound curvature to the teeth of the wheel and rack, we may use a generating circle whose diameter is equal to D *x* the radius of the wheel, for describing the interior epicycloid *e h*, and the exterior one *b c*; and a generating circle whose diameter is equal to the radius of the rack, for describing the interior epicycloid *a b*, and the exterior one *d e*; *a b* and *e h*, therefore, will be straight lines, and *b c* will be a cycloid, and *d e* an involute of the circle *e x*, the radius of the rack being infinitely great.

413. In the same manner may the form of the teeth of rack-work be determined, when the second mode of action is employed, and when the teeth of the wheel or rack are circular or rectilineal. But if the rack be part of a circle, it must have the same form for its teeth as that of a wheel of the same diameter with the circle of which it is a part.

In

Proper form of wipers.

In machinery, where large weights are to be raised, such as fulling-mills, mills for pounding ore, &c. or where large pistons are to be elevated by the arms of levers, it is of the greatest consequence that the power should raise the weight with an uniform force and velocity; and this can be effected only by giving a proper former to the wiper.

Now there are two cases in which this uniformity of motion may be required, and each of these demands a different form for the communicating parts. 1. When the weight is to be raised vertically, as the piston of a pump, &c. 2. When the weight to be raised or depressed moves upon a centre, and rises or falls in the arch of a circle, such as the sledge hammer in a forge, &c.

Fig. 13.

414. 1. Let AH be a wheel moved by any power which is sufficient to raise the weight MN by its extremity O, from O to *e*, in the same time that the wheel moves round one-fourth of its circumference, it is required to fix upon its rim a wing OBCDEH which shall produce this effect with an uniform effort. Divide the quadrant OH into any number of equal parts O *m*, *m n*, &c. the more the better, and *o e* into the same number *o b*, *b c*, *c d*, &c. and through the points *m*, *n*, *p*, H draw the indefinite lines AB, AC, AD, AE, and make AB equal to A*b*, AC to A*c*, AD to A*d*, and AE to A*e*; then through the points O, B, C, D, E, draw the curve OBCDE, which is a portion of the spiral of Archimedes, and will be the proper form for the wiper or wing OHE. It is evident that when the point *m* has arrived at O, the extremity of the weight will have arrived at *b*; because AB is equal to A*b*, and for the same reason, when the points *n*, *p*, H have successively arrived at O, the extremity of the weight will have arrived at the corresponding points *c*, *d*, *e*. The motion therefore will be uniform, because the space described by the weight is proportional to the space described by the moving power, O*b* being to O*c* as O*m* to O*n*. If it be required to raise the weight MN with an accelerated or retarded motion, we have only to divide the line O*e* according to the law of acceleration or retardation, and divide the curve OBCDE as before.

When the weight rises in the arch of a circle. Fig. 14.

415. 2. When the lever moves upon a centre, the weight will rise in the arch of a circle, and consequently a new form must be given to the wipers or wings. Let AB, fig. 14. be a lever lying horizontally, which it is required to raise uniformly through the arch BC into the position AC, by means of the wheel BFH furnished with the wing BNOP, which acts upon the extremity C of the lever; and let it be required to raise it through BC in the same time that the wheel BFH moves through one-half of its circumference; that is, while the point M moves to B in the direction MFB. Divide the chord CB into any number of equal parts, the more the better, in the points 1, 2, 3, and draw the lines 1 *a* 2 *b* 3 *c* parallel to AB, or a horizontal line passing through the point B, and meeting the arch CB in the points *a*, *b*, *c*. Draw the lines CD, *a* D, *b* D, *c* D, and BD cutting the circle BFH in the points *m*, *n*, *o*, *p*.

Having drawn the diameter BM, divide the semicircle BFM into as many equal parts as the chord CB, in the points *q*, *s*, *u*. Take B *m*, and set it from *q* to *r*: Take B *n* and set it from *s* to *t*: Take B *o* and set it from *u* to *v*, and lastly set B*p* from M to E. Through the points *r*, *t*, *v*, E, draw the indefinite lines DN, DO, DP, DQ, and make DN equal to D*c*; DO equal to D*b*; DP equal to D*a*; and DQ equal to DC. Then through the points Q, P, O, N, B, draw the spiral B, N, O, P, Q, which will be the proper form for the wing of the wheel when it moves in the direction EMB.

That the spiral BNO will raise the lever AC, with an uniform motion, by acting upon its extremity *c*, will appear from the slightest attention to the construction of the figure. It is evident, that when the point *q* arrives at B, the point *r* will be in *m*, because B*m* is equal to *q r*, and the point N will be at *c*, because DN is equal to D *c*; the extremity of the lever, therefore, will be found in the point *c*, having moved through B *c*. In like manner, when the point *s* has arrived at B, the point *t* will be at *n*, and the point O, in *b*, where the extremity of the lever will now be found; and so on with the rest, till the point M has arrived at B. The point E will then be in *p*, and the point Q in C; so that the lever will now have the position AC, having moved through the equal heights B*c*, *c b*, *b a*, *a c*, (F) in the same time that the power has moved through the equal spaces *q* B, *s q*, *u s*, M *u*. The lever, therefore, has been raised uniformly, the ratio between the velocity of the power, and that of the weight, remaining always the same.

416. If the wheel D turn in a contrary direction, according to the letters MHB, we must divide the semicircle BH EM, into as many equal parts as the chord *c* B, viz. in the points *e*, *g*, *h*. Then, having set the arch B *m* from *e* to *d*, the arch B *n* from *g* to *f*, and the rest in a similar manner, draw through the points *d*, *f*, *h*, E, the indefinite lines DR, DS, DT, DQ: make DR equal to D*c*; DS equal to D*b*; DT equal to D*a*, and DQ equal to DC; and through the points B, R, S, T, Q, describe the spiral BRSTQ, which will be the proper form for the wing, when the wheel turns in the direction MEB. For, when the point *e* arrives at B, the point *d* will be in *m*, and R in *c*, where the extremity of the lever will now be found, having moved through B *c* in the same time that the power, or wheel, has moved through the division *e* B. In the same manner it may be shewn, that the lever will rise through the equal heights *c b*, *b a*, *a* C, in the same time that the power moves through the corresponding spaces *e g*, *g i*, *i* M. The motion of the lever, therefore, and also that of the power, are always uniform. Of all the positions that can be given to the point B, the most disadvantageous are those which are nearest the points F, H; and the most advantageous position is when the chord B *c* is vertical, and passes, when prolonged, through D, the centre

(F) The arches B *c*, *c b*, &c. are not equal; but the perpendiculars let fall from the points *c*, *a*, *b*, &c. upon the horizontal lines, passing through *a b*, &c. are equal, being proportional to the equal lines *c* 1, 1, 2. Eucl. VI. 2.

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centre of the circle (G). In this particular case the two curves have equal bases, though they differ a little in point of curvature. The farther that the centre A is distant, the nearer do these curves resemble each other; and if it were infinitely distant, they would be exactly similar, and would be the spirals of Archimedes, as the extremity c would in this case rise perpendicularly.

It will be easily perceived that 4, 6, or 8 wings may be placed upon the circumference of the circle, and may be formed by dividing into the same number of equal parts as the chord BC, $\frac{1}{4}$, $\frac{1}{6}$, or $\frac{1}{8}$ of the circumference, instead of the semicircle BFM.

That the wing BNO may not act upon any part of the lever between A and C, the arm AC should be bent; and that the friction may be diminished as much as possible, a roller should be fixed upon its extremity C. When a roller is used, however, a curve must always be drawn parallel to the spiral described according to the preceding method, the distance between it and the spiral being everywhere equal to the radius of the roller.

If it should be required to raise the lever with an accelerated or retarded motion, we have only to divide the chord BC, according to the degree of retardation or acceleration required, and the circle into the same number of equal parts as before.

417. As it is frequently more convenient to raise or depress weights by the extremity of a constant radius, furnished with a roller, instead of wings fixed upon the periphery of a wheel; we shall now proceed to determine the curve which must be given to the arm of the lever which is to be raised and depressed, in order that this elevation or depression may be effected with an uniform motion.

Let AB be a lever, which it is required to raise uniformly through the arch BC, into the position AC, by means of the arm or constant radius DE, moving upon D as a centre, in the same time that the extremity E describes the arch EeF. From the point C draw CH at right angles to AB, and divide it into any number of equal parts, suppose three, in the points 1, 2; and through the points 1, 2, draw 1 a 2 b, parallel to the horizontal line AB, cutting the arch CB in the points a, b, through which draw a A, b A. Upon D as a centre, with the distance DE, describe the arch E$i$$e$F, and upon A as a centre, with the distance AD, describe the arch eOD, cutting the arch E$i$$e$F in the point e. Divide the arches E$i$$e$, and F$s$$e$, each into the same number of equal parts as the perpendicular cH, in the points k, i, s, m, and through these points about the centre A, describe the arches k z, i g, q r, m n. Take z x and set it from k to l, and take g f, and set it from i to h. Take r q also, and set it from s to t, and set n m from o to p, and d c from e to O. Then through the points E, l, h, O, and O, t, p, F, draw the two curves E l h O, and O t p F, which will be the proper form that must be given to the arm of the lever. If the handle DE moves from E towards F, the curve EO must be used, but if in the contrary direction, we must employ the curve OF.

It is evident, that when the extremity E of the handle DE, has run through the arch Ek, or rather El, the point l will be in k, and the point z in x, because xz is equal to kl, and the lever will have the position Ab. For the same reason, when the extremity E of the handle has arrived at i, the point h will be in i, and the point g in f, and the lever will be raised to the position Aa. Thus it appears, that the motion of the power and the weight are always proportional. When a roller is fixed at E, a curve parallel to EO, or OF, must be drawn as formerly. See *Appendix to Ferguson's Lectures*.

Chap. VI. *On the First Movers of Machinery.*

418. The powers which are generally employed as the first movers of machines are water, wind, steam, and animal exertion. The mode of employing water as an impelling power has already been given at great length in the article Hydrodynamics. The application of wind to turn machinery will be discussed in the chapter on Windmills; and what regards steam will be more properly introduced into the article *Steam-Engine*. At present, therefore, we shall only make a few general remarks on the strength of men and horses; and conclude with a general view of the relative powers of the first movers of machinery. The following table contains the weight which a man is able to raise through a certain height in a certain time, according to different authors.

Table *of the Strength of Men, according to different authors.*

Number of pounds raised.	Height to which the weight is raised.	Time in which it is raised.	Duration of the Work.	Names of the authors.
1000	180	60 minutes		Euler
60 } French.	1 } French.	1 second	8 hours	Bernouilli
25 } French.	220 } French.	145 seconds		Amontons
170 } French.	1 } French.	1 second	half an hour	Coulomb
1000	330	60 minutes		Desaguliers
1000	225	60 minutes		Smeaton
30	$3\frac{1}{2}$	1 second	10 hours	Emerson
29 or 30	2.45 feet	1 second		Schulze

419.

(G) In the figure we have taken the point B in a disadvantageous position, because the intersections are in this case more distinct.

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Force of men according to Amontons.

419. According to Amontons, a man weighing 133 pounds French, ascended 62 feet French by steps in 34 seconds, but was completely exhausted. The same author informs us that a sawer made 200 strokes of 18 inches French each, with a force of 25 pounds, in 145 seconds; but that he could not have continued the exertion above three minutes.

According to Desaguliers.

420. It appears from the observations of Desaguliers, that an ordinary man can, for the space of ten hours, turn a winch with a force of 30 pounds, and with a velocity of two feet and a half per second; and that two men working at a windlass with handles at right angles to each other can raise 70 pounds more easily than one man can raise 30. The reason of this is, that when there is only one man, he exerts variable efforts at different positions of the handle, and therefore the motion of the windlass is irregular; whereas in the case of two men, with handles at right angles, the effect of the one man is greatest when the effect of the other is least, and therefore the motion of the machine is more uniform, and will perform more work. Desaguliers also found, that a man may exert a force of 80 pounds with a fly when the motion is pretty quick, and that by means of a good common pump, he may raise a hogshead of water 10 feet high in a minute, and continue the exertion during a whole day.

Results of Coulomb's experiments.

421. A variety of interesting experiments upon the force of men were made by the learned M. Coulomb. He found that the quantity of action of a man who ascended stairs with nothing but his own weight, was double that of a man loaded with 223 pounds avoirdupois, both of them continuing the exertion for a day. In this case the total or *absolute effect* of the unloaded man is the greatest possible; but the *useful effect* which he produces is nothing. In the same way, if he were loaded to such a degree that he was almost incapable of moving, the useful effect would be nothing. Hence there is a certain load with which the man will produce the greatest useful effect. This load M. Coulomb found to be 173.8 pounds avoirdupois, upon the supposition that the man is to ascend stairs, and continue the exertion during a whole day. When thus loaded, the quantity of action exerted by the labourer is equivalent to 183.66 pounds avoirdupois raised through 3282 feet. This method of working is however attended with a loss of three-fourths of the total action of the workman.—It appears also from Coulomb's experiments, that a man going up stairs for a day raises 205 chiliogrammes (a chiliogramme is equal to three ounces five drams avoirdupois) to the height of a chiliometre (a chiliometre is equal to 39571 English inches); that a man carrying wood up stairs raises, together with his own weight, 109 chiliogrammes to one chiliometre;—that a man weighing 150 pounds French, can ascend by stairs three feet French in a second, for the space of 15 or 20 seconds;—that a man cultivating the ground performs $\frac{12}{20}$ as much labour as a man ascending stairs, and that his quantity of action is equal to 328 pounds avoirdupois raised through the space of 3282 feet;—that a man with a winch does $\frac{6}{8}$ as much as by ascending stairs;—and that in a pile-engine, a man by means of a rope drawn horizontally, raised for the space of five hours $55\frac{1}{7}$ pounds French through one foot French in a second.—When men walk on a horizontal road, Coulomb found that the quantity of action was a maximum when they were loaded, and that this maximum quantity of action is to that which is exerted by a man loaded with 190.25 pounds avoirdupois as 7 to 4.—The weight which a man ought to carry in order that the *useful effect* may be a maximum, is 165.3 pounds avoirdupois. When the workman, however, returns unloaded for a new burden, he must carry 200.7 pounds avoirdupois.

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422. According to Dr Robison a feeble old man raised seven cubic feet of water=437.5 pounds avoirdupois, $11\frac{1}{2}$ feet high, in one minute, for eight or ten hours a day, by walking backwards and forwards on a lever;—and a young man weighing 135 pounds, and carrying 30 pounds, raised $9\frac{1}{4}$ cubic feet of water =578.1 pounds avoirdupois, $11\frac{1}{2}$ feet high, for 10 hours a day, without being fatigued.

423. From the experiments of Mr Buchanan, it appears that the forces exerted by a man pumping, acting at a winch, ringing and rowing, are as the numbers 1742, 2856, 3883, 4095.

On the strength of horses.

424. According to Desaguliers and Smeaton, the power of one horse is equal to the power of five men. Several French authors suppose a horse equal to seven men, while M. Schulze considers one horse as equivalent to 14 men.—Two horses, according to the experiment of Amontons, exerted a force of 150 pounds French, when yoked in a plough. According to Desaguliers, a horse is capable of drawing, with a force of 200 pounds, two miles and a half an hour, and of continuing this action eight hours in the day. When the force is 240 pounds he can work only six hours. It appears from Smeaton's reports, that by means of pumps a horse can raise 250 hogsheads of water, 10 feet high, in an hour.—The most disadvantageous way of employing the power of a horse is to make him carry a load up an inclined plane, for it was observed by De la Hire, that *three* men, with 100 pounds each, will go faster up the inclined plane than a horse with 300 pounds. When the horse walks on a good road, and is loaded with about two hundred weight, he may easily travel 25 miles in the space of seven or eight hours.

425. When a horse is employed in raising coals by means of a wheel and axle, and moves at the rate of about two miles an hour, Mr Fenwick found that he could continue at work 12 hours each day, two and a half of which were spent in short intervals of rest, when he raised a load of 1000 pounds avoirdupois, with a velocity of 13 feet per minute;—and that he will exert a force of 75 pounds for nine hours and a half, when moving with the same velocity. Mr Fenwick also found that 230 ale gallons of water delivered every minute on an overshot water wheel, 10 feet in diameter; that a common steam-engine, with a cylinder eight inches in diameter, and an improved engine with a cylinder 6.12 inches in diameter, will do the work of one horse, that is, will raise a weight of 1000 pounds avoirdupois, through the height of 13 feet in a minute. It appears from Mr Smeaton's experiments, that Dutch sails in their common position with a radius of nine feet and a half,—that Dutch sails in their best position with a radius of eight feet, and that his enlarged sails with a radius of seven feet, perform the same work as one man; or perform one-

one-fifth part of the work of a horſe. Upon theſe facts we have conſtructed the following table, the four firſt columns of which are taken from Mr Fenwick's Eſſays on Practical Mechanics.

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TABLE ſhewing the relative ſtrength of Overſhot Wheels, Steam Engines, Horſes, Men, and Wind-mills of different kinds.

Number of ale gallons delivered on an overſhot wheel, 10 feet in diameter, every minute.	Diameter of the cylinder in the common ſteam-engine, in inches.	Diameter of the cylinder of the improved ſteam-engine, in inches.	Number of horſes working 12 hours per day, and moving at the rate of two miles per hour.	Number of men working 12 hours a-day.	Radius of Dutch ſails in their common poſition in feet.	Radius of Dutch ſails in their beſt poſition, in feet.	Radius of Mr Smeaton's enlarged ſails, in feet.	Height to which theſe different powers will raiſe 1000 pounds avoirdupois in a minute.
230	8.	6.12	1	5	21.24	17.89	15.65	13
390	9.5	7.8	2	10	30.04	25.30	22.13	26
528	10.5	8.2	3	15	36.80	30.98	27.11	39
660	11.5	8.8	4	20	42.48	35.78	31.30	52
790	12.5	9.35	5	25	47.50	40.00	35.00	65
970	14.	10.55	6	30	52.03	43.82	38.34	78
1170	15.4	11.75	7	35	56.90	47.33	41.41	90
1350	16.8	12.8	8	40	60.09	50.60	44.27	104
1445	17.3	13.6	9	45	63.73	53.66	46.96	117
1584	18.5	14.2	10	50	67.17	56.57	49.50	130
1740	19.4	14.8	11	55	70.46	59.33	51.91	143
1900	20.2	15.2	12	60	73.59	61.97	54.22	156
2100	21.	16.2	13	65	76.59	64.5	56.43	169
2300	22.	17.	14	70	79.49	66.94	58.57	182
2500	23.1	17.8	15	75	82.27	69.28	60.62	195
2686	23.9	18.3	16	80	84.97	71.55	62.61	208
2870	24.7	19.	17	85	87.07	73.32	64.16	221
3055	25.5	19.6	18	90	90.13	75.90	67.41	234
3240	26.25	20.1	19	95	92.60	77.98	68.23	247
3420	27.	20.7	20	100	95.00	80.00	70.00	260
3750	28.5	22.2	22	110	99.64	83.90	73.42	286
4000	29.8	23.	24	120	104.06	87.63	76.68	312
4460	31.1	23.9	26	130	108.32	91.22	79.81	338
4850	32.4	24.7	28	140	112.20	94.66	82.82	364
5250	33.6	25.5	30	150	116.35	97.98	85.73	390

426. Dutch ſails are always conſtructed ſo that the angle of weather may diminiſh from the centre to the extremity of the ſail. They are concave to the wind, and are in their *common poſition* when their extremities are parallel to the plane in which they move, or perpendicular to the direction of the wind. Dutch ſails are in their *beſt poſition* when their extremities make an angle of ſeven degrees with the plane of their motion. Mr Smeaton's enlarged ſails are Dutch ſails in their beſt poſition, but enlarged at their extremities.

427. It appears from M. Coulomb's experiments on Dutch wind-mills, with rectangular ſails, that when the diſtance between the extremities of two oppoſite ſails is 66 feet French, and the breadth of each ſail ſix feet, a wind moving at the rate of 20 feet per ſecond will produce an effect equivalent to 1000 pounds raiſed through the ſpace of 218 feet in a minute.

According to Watt and Boulton, one of their ſteam-engines, with a cylinder 31 inches in diameter, and which makes 17 double ſtrokes per minute, is equivalent to 40 horſes working day and night; that is, to 101 horſes working nine hours and a half, the time of conſtant exertion in the preceding table. When the cylinder is 19 inches in diameter, and the engine makes 25 ſtrokes of four feet each per minute, its power is equivalent to twelve horſes working conſtantly, or thirty horſes working nine hours and a half;—and when the cylinder is 24 inches in diameter, and the engine makes 22 ſtrokes, of five feet each, in a minute, its power is equal to that of 20 horſes working conſtantly, or 50 horſes working nine hours and a half.

Chap VII. *On the Conſtruction of Wind-mills.*

428. A WIND-MILL is repreſented in fig. 1. where MN is the circular building that contains the machinery, E the extremity of the windſhaft, or principal axis, which is generally inclined from 8 to 15 degrees to the horizon; and EA, EB, EC, ED four rectangular frames upon which ſails of cloth of the ſame form are ſtretched. At the lower extremity G of the ſails their ſurface is inclined to the axis 72°; and at their fartheſt extremities A, D, &c. the inclination of the ſail is about 83°. Now, when the ſails are adjuſted to the wind, which happens when the wind blows in the direction of the windſhaft E, the impulſe of the wind upon Plate CCCXXV. fig. 1.

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upon the oblique sails may be resolved into two forces, one of which acts at right angles to the windshaft, and is therefore employed solely in giving a motion of rotation to the sails and the axis upon which they are fixed. When the mill is used for grinding corn, a crown wheel, fixed to the principal axis E, gives motion to a lantern or trundle, whose axis carries the moveable millstone.

Methods of turning the sails to the wind.

429. That the wind may act with the greatest efficacy upon the sails, the windshaft must have the same direction as the wind. But as this direction is perpetually changing, some apparatus is necessary for bringing the windshaft and sails into their proper position. This is sometimes effected by supporting the machinery on a strong vertical axis, whose pivot moves in a brass socket firmly fixed into the ground, so that the whole machine, by means of a lever, may be made to revolve upon this axis, and be properly adjusted to the direction of the wind. Most wind-mills, however, are furnished with a moveable roof which revolves upon friction rollers inserted in the fixed kerb of the mill; and the adjustment is effected by the assistance of a simple lever. As both these methods of adjustment require the assistance of men, it would be very desirable that the same effect should be produced solely by the action of the wind. This may be done by fixing a large wooden vane or weather-cock at the extremity of a long horizontal arm which lies in the same vertical plane with the windshaft. By this means when the surface of the vane, and its distance from the centre of motion, are sufficiently great, a very gentle breeze will exert a sufficient force upon the vane to turn the machinery, and will always bring the sails and windshaft to their proper position. This weather-cock, it is evident, may be applied either to machines which have a moveable roof, or which revolve upon a vertical arbor.

On the Form and Position of Wind-mill Sails.

The inclination assigned by Parent, erroneous.

430. It appears from the investigations of Parent, that a maximum effect will be produced when the sails are inclined $54\frac{3}{7}$ degrees to the axis of rotation, or when the angle of weather is $35\frac{4}{7}$ (G) degrees. In obtaining this conclusion, however, M. Parent has assumed data which are inadmissible, and has neglected several circumstances which must materially affect the result of his investigations. The angle of inclination assigned by Parent is certainly the most efficacious for giving motion to the sails from a state of rest, and for preventing them from stopping when in motion; but he has not considered that the action of the wind upon a sail at rest is different from its action upon a sail in motion: for since the extremities of the sails move with greater rapidity than the parts nearer the centre, the angle of weather should be greater towards the centre than at the extremity, and should vary with the velocity of each part of the sail. The reason of this is very obvious. It has been demonstrated by Bossut, and established by experience, that when any fluid acts upon a plain surface, the force of impulsion is always exerted most advantageously when the impelled surface is in a state of rest, and that this force diminishes as the velocity of the surface increases. Now, let us suppose with Parent, that the most advantageous angle of weather for the sails of wind-mills is $35\frac{4}{7}$ degrees for that part of the sail which is nearest the centre of rotation, and that the sail has every where this angle of weather; then, since the extremity of the sail moves with the greatest velocity, it will in a manner withdraw itself from the action of the wind, or, to speak more properly, it will not receive the impulse of the wind so advantageously as those parts of the sail which have a less degree of velocity. In order therefore to counteract this diminution of force, we must make the wind act more perpendicularly upon the sail, by diminishing its obliquity or its angle of weather. But since the velocity of every part of the sail is proportional to its distance from the centre of motion, every elementary portion of it must have a different angle of weather diminishing from the centre to the extremity of the sail. The law or rate of diminution, however, is still to be discovered, and we are fortunately in possession of a theorem of Euler's, afterwards given by Maclaurin, which determines this law of variation. Let a represent the velocity of the wind, and c the velocity of any given part of the sail; then the effort of the wind upon that part of the sail will be greatest when the tangent of the angle of the wind's incidence, or of the sail's inclination to the axis, is to radius, as $\sqrt{2+\frac{9cc}{4aa}}+\frac{3c}{2a}$ to 1.

Euler's theorem.

Fig. 2. Explanation and application of this theorem.

431. In order to apply this theorem, let us suppose that the radius or whip ED of the sail $\alpha\beta\delta\gamma$, is divided into six equal parts; that the point n is equidistant from E and D, and is the point of the sail which has the same velocity as the wind; then, in the preceding theorem, we shall have $c=a$, when the sail is loaded to a maximum; and therefore the tangent of the angle, which the surface of the sail at n makes with the axis, when $a=1$, will be $\sqrt{2+\frac{9}{4}}+\frac{3}{2}=3.561=$ tangent of $74°$ $19'$, which gives $15°\ 41'$ for the angle of weather at the point n. Since, at $\frac{1}{2}$ of the radius $c=a$, and since c is proportional to the distance of the corresponding part of the sail from the centre, we will have, at $\frac{1}{6}$ of the radius sm, $c=\frac{a}{3}$, at $\frac{2}{6}$ of the radius, $c=\frac{2a}{3}$; at $\frac{4}{6}$, $c=\frac{4a}{3}$, at $\frac{5}{6}$, $c=\frac{5a}{3}$; and at the extremity of the radius, $c=2a$. By substituting these different values of c, instead of c in the theorem, and by making $a=1$, the following table will be obtained, which exhibits the angles of inclination and weather which must be given to different parts of the sails.

Parts

(G) The *weather* of the sails is the angle which the surface forms with the plane in which they move, and is equal to the complement of the angle which that surface forms with the axis.

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Parts of the radius from the centre of motion at E.	Velocity of the ſail at theſe diſtances—or values of c.	Angle made with the axis.		Angle of weather.	
		Deg.	Min.	Deg.	Min.
$\frac{1}{6}$	$\frac{a}{3}$	63	26	26	34
$\frac{2}{6}$	$\frac{2a}{3}$	69	54	20	6
$\frac{3}{6}$ or $\frac{1}{2}$	a	74	19	15	4
$\frac{4}{6}$ or $\frac{2}{3}$	$\frac{4a}{3}$	77	20	12	40
$\frac{5}{6}$	$\frac{5a}{3}$	79	27	10	33
1	$2a$	81	0	9	0

Reſults of Smeaton's experiments.

432. Mr Smeaton found, from a variety of experiments, that the common practice of inclining plane ſails from 72° to 75° to the axis, was much more efficacious than the angle aſſigned by Parent, the effect being as 45 to 31. When the ſails were weathered in the Dutch manner, that is, when their ſurfaces were concave to the wind, and when the angle of inclination increaſed towards their extremities, they produced a greater effect than when they were weathered either in the common way, or according to Euler's theorem. But when the ſails were enlarged at their extremities, as repreſented at $\alpha\,\beta$, in fig. 2. ſo that $\alpha\,\beta$ was one-third of the radius ED, and α D to D β as 5 to 3, their power was greateſt of all, though the ſurface acted upon by the wind remained the ſame. If the ſails be farther enlarged, the effect is not increaſed in proportion to the ſurface; and beſides, when the quantity of cloth is great, the machine is much expoſed to injury by ſudden ſqualls of wind. In Mr Smeaton's experiments, the angle of weather varied with the diſtance from the axis; and it appeared from ſeveral trials, that the moſt efficacious angles were thoſe in the following table.

Fig. 2.

Parts of the radius EA, which is divided into 6 parts.	Angle with the axis.	Angle of weather.
1	72	18
2	71	19
3	72	18 middle
4	74	16
5	$77\frac{1}{2}$	$12\frac{1}{2}$
6	83	7

If the radius ED of the ſail be 30 feet, then the ſail will commence at $\frac{1}{6}$ ED, or 5 feet from the axis, where the angle of inclination will be 72°. At $\frac{2}{6}$ ED, or 10 feet from the axis, the angle will be 71°, and ſo on.

On the Effect of Wind-mill Sails.

433. The following maxims deduced by Mr Smeaton from his experiments, contain the moſt accurate information upon this ſubject.

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Effects of wind-mill ſails, according to Smeaton.

Maxim 1. The velocity of wind-mill ſails, whether unloaded or loaded, ſo as to produce a maximum effect, is nearly as the velocity of the wind, their ſhape and poſition being the ſame.

Maxim 2. The load at the maximum is nearly, but ſomewhat leſs than, as the ſquare of the velocity of the wind, the ſhape and poſition of the ſails being the ſame.

Maxim 3. The effects of the ſame ſails at a maximum, are nearly, but ſomewhat leſs than, as the cubes of the velocity of the wind.

Maxim 4. The load of the ſame ſails at the maximum is nearly as the ſquares, and their effects as the cubes of their number of turns in a given time.

Maxim 5. When ſails are loaded, ſo as to produce a maximum at a given velocity, and the velocity of the wind increaſes, the load continuing the ſame: 1ſt, The increaſe of effect, when the increaſe of the velocity of the wind is ſmall, will be nearly as the ſquares of thoſe velocities: 2dly, When the velocity of the wind is double, the effects will be nearly as 10 : $27\frac{1}{2}$: But, 3dly, When the velocities compared are more than double of that where the given load produces a maximum, the effects increaſe nearly in the ſimple ratio of the velocity of the wind.

Maxim 6. In ſails where the figure and poſitions are ſimilar, and the velocity of the wind the ſame, the number of turns in a given time will be reciprocally as the radius or length of the ſail.

Maxim 7. The load at a maximum that ſails of a ſimilar figure and poſition will overcome at a given diſtance from the centre of motion, will be as the cube of the radius.

Maxim 8. The effects of ſails of ſimilar figure and poſition are as the ſquare of the radius.

Maxim 9. The velocity of the extremities of Dutch ſails, as well as of the enlarged ſails, in all their uſual poſitions when unloaded, or even loaded to a maximum, are conſiderably quicker than the velocity of the wind.

434. A new mode of conſtructing the ſails of wind-mills has been recently given by Mr Sutton, and fully deſcribed by Mr Heſleden of Barton, in a work excluſively devoted to the ſubject.

The limits of this article will not permit us to enter into any diſcuſſion reſpecting the principles upon which Mr Sutton's gravitated ſails are conſtructed; but the ſubject ſhall be reſumed under the article WINDMILL. It may be proper however to remark that Mr Sutton gives his ſails the form repreſented in fig. 4. and makes the angle of weather at the point M, equidiſtant from A and B, equal to 22° 30′. The inclination of the ſail at any other point N of the ſail, is an angle whoſe ſine is the diſtance of that point from the centre of motion A, the radius being the breadth of the ſail at that point. Fig. 3. ſhews the angles at the different points of the ſail; and the apparent and abſolute breadths of the ſail at theſe points. Mr Sutton's mode of regulating the velocity of the ſails, and of bringing them to a ſtate of reſt is particularly ingenious.

Fig. 3.

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On Horizontal Wind-mills.

Horizontal wind-mills.

435. Various opinions have been entertained respecting the relative advantages of horizontal and vertical wind-mills. Mr Smeaton, with great justice, gives a decided preference to the latter; but when he asserts that horizontal wind-mills have only $\frac{1}{8}$ or $\frac{1}{10}$ of the power of vertical ones, he certainly forms too low an estimate of their power. Mr Beatson, on the contrary, who has received a patent for the construction of a new horizontal wind-mill, seems to be prejudiced in their favour, and greatly exaggerates their comparative value. From an impartial investigation, it will probably appear, that the truth lies between these two opposite opinions; but before entering on this discussion, we must first consider the nature and form of horizontal wind-mills.

Fig. 4.

436. In fig. 4. CK is the windshaft, which moves upon pivots. Four cross bars, CA, CD, IB, FG, are fixed to this arbor, which carry the frames APIB, DEFG. The sails AI, EG, are stretched upon these frames, and are carried round the axis CK, by the perpendicular impulse of the wind. Upon the axis CK, a toothed wheel is fixed, which gives motion to the particular machinery that is employed. In the figure, only two sails are represented; but there are always other two placed at right angles to these. Now, let the sails be exposed to the wind, and it will be evident that no motion will ensue; for the force of the wind upon the sail AI, is counteracted by an equal and opposite force upon the sail EG. In order then, that the wind may communicate motion to the machine, the force upon the returning sail EG must either be removed by screening it from the wind, or diminished by making it present a less surface when returning against the wind. The first of these methods is adopted in Tartary, and in some provinces of Spain; but is objected to by Mr Beatson, from the inconvenience and expence of the machinery and attendance requisite for turning the screens into their proper positions. Notwithstanding this objection, however, I am disposed to think that this is the best method of diminishing the action of the wind upon the returning sails, for the moveable screen may easily be made to follow the direction of the wind, and assume its proper position, by means of a large wooden weathercock, without the aid either of men or machinery. It is true, indeed, that the resistance of the air in the returning sails is not completely removed; but it is at least as much diminished as it can be by any method hitherto proposed. Besides, when this plan is resorted to, there is no occasion for any moveable flaps and hinges, which must add greatly to the expence of every other method.

Common method of bringing back the sails against the wind.

Beatson's method.

437. The mode of bringing the sails back against the wind, which Mr Beatson invented, is, perhaps, the simplest and best of the kind. He makes each sail AI to consist of six or eight flaps or vanes, AP b 1, b 1 c 2, &c. moving upon hinges represented by the dark lines, AP, b 1, c 2, &c. so that the lower side b 1, of the first flap overlaps the hinge or higher side of the second flap, and so on. When the wind, therefore, acts upon the sail AI, each flap will press upon the hinge of the one immediately below it, and the whole surface of the sail will be exposed to its action. But when the sail AI returns against the wind, the flaps will revolve round upon their hinges, and present only their edges to the wind, as is represented at EG, so that the resistance occasioned by the return of the sail must be greatly diminished, and the motion will be continued by the great superiority of force exerted upon the sails in the position AI. In computing the force of the wind upon the sail AI, and the resistance opposed to it by the edges of the flaps in EG, Mr Beatson finds, that when the pressure upon the former is 1872 pounds, the resistance opposed by the latter is only about 36 pounds, or $\frac{1}{52}$ part of the whole force; but he neglects the action of the wind upon the arms CA, &c. and the frames which carry the sails, because they expose the same surface in the position AI, as in the position EG. This omission, however, has a tendency to mislead us in the present case, as we shall now see, for we ought to compare the whole force exerted upon the arms, as well as the sail, with the whole resistance which these arms and the edges of the flaps oppose to the motion of the windmill. By inspecting fig. 4. it will appear, that if the force upon the edges of the flaps, which Mr Beatson supposed to be 12 in number, amounts to 36 pounds, the force spent upon the bars CD, DG, GF, FE, &c. cannot be less than 60 pounds. Now, since these bars are acted upon with an equal force, when the sails have the position AI, $1872+60=1932$ will be the force exerted upon the sail AI, and its appendages, while the opposite force upon the bars and edges of the flaps when returning against the wind will be $36+60=96$ pounds, which is nearly $\frac{1}{20}$ of 1932, instead of $\frac{1}{52}$ as computed by Mr Beatson. Hence we may see the probable advantages of a screen over moveable flaps, as it will preserve not only the sails, but the arms and the frame which support it, from the action of the wind.

Comparisons between vertical and horizontal wind-mills.

438. We shall now conclude this chapter with a comparison of the power of horizontal and vertical wind-mills. It was already stated, that Mr Smeaton rather underrated the former, while he maintained that they have only $\frac{1}{8}$ or $\frac{1}{10}$ the power of the latter. He observes, that when the vanes of a horizontal and a vertical mill are of the same dimensions, the power of the latter is four times that of the former, because, in the first case, only one sail is acted upon at once, while, in the second case, all the four receive the impulse of the wind. This, however, is not strictly true, since the vertical sails are all oblique to the direction of the wind. Let us suppose that the area of each sail is 100 square feet; then the power of the horizontal sail will be 100, and the power of a vertical sail may be called $100\times\overline{\text{sine }70^{\circ}}^{2}$ (70° being the common angle of inclination) $=88$ nearly; but since there are four vertical sails, the power of them all will be $4\times 88=352$; so that the power of the horizontal sail is to that of the four vertical ones as 1 to 3.52, and not as 1 to 4, according to Mr Smeaton. But Mr Smeaton also observes, that if we consider the farther disadvantage which arises from the difficulty of getting the sails back against the wind, we need not wonder if horizontal wind-mills have only about $\frac{1}{8}$ or $\frac{1}{10}$ the power of the common sort. We have already seen, that the resistance occasioned by the return of the sails, amounts to $\frac{1}{20}$ of the whole force which they receive; by subtracting $\frac{1}{20}$, therefore, from $\frac{1}{3.52}$, we shall find that the

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the power of horizontal wind-mills is only $\frac{1.03}{4.40}$, or little more than $\frac{1}{4}$ that of vertical ones. This calculation proceeds upon a ſuppoſition, that the whole force exerted upon vertical ſails is employed in turning them round the axis of motion; whereas a conſiderable part of this force is loſt in preſſing the pivot of the axis or windſhaft againſt its gudgeon. Mr Smeaton has overlooked this circumſtance, otherwiſe he could never have maintained that the power of four vertical ſails was quadruple the power of one horizontal ſail, the dimenſions of each being the ſame. Taking this circumſtance into the account, we cannot be far wrong in ſaying, that in theory at leaſt, if not in practice, the power of a horizontal wind-mill is about $\frac{1}{5}$ or $\frac{1}{4}$ of the power of a vertical one, when the quantity of ſurface and the form of the ſails is the ſame, and when every part of the horizontal ſails has the ſame diſtance from the axis of motion as the correſponding parts of the vertical ſails. But if the horizontal ſails have the poſition AI, EG, in fig. 4. inſtead of the poſition CA *d m*, CD *o n*, their power will be greatly increaſed, though the quantity of ſurface is the ſame, becauſe the part CP 3 *m* being transferred to BI 3 *d*, has much more power to turn the ſails.

Chap. VIII. *On the Conſtruction of Wheel Carriages.*

On the ſize of carriage wheels. Plate CCCXXV. fig. 6.

439. It is evident from Art. 60. that when a wheel ſurmounts an obſtacle, it acts as a lever of the firſt kind, and that its power to overcome ſuch reſiſtances increaſes with its diameter. The power of the force P, for example, to raiſe the wheel NB over the eminence C, is proportional to the vertical lever FC, which increaſes with the diameter of the wheel, while the lever of reſiſtance FA, by which the weight of the wheel acts, remains unchanged; hence we ſee the advantages of large wheels for overcoming ſuch obſtacles as generally reſiſt the motion of wheel carriages. There are ſome circumſtances, however, which, independent of the additional weight and expence of large wheels, preſcribe limits to their ſize. If the radius AC of the wheel exceeds the height of that part of the horſe to which the traces are attached, the line of traction DA will be oblique to the horizon, and part of the power P will be employed in preſſing the wheel upon the ground. A wheel exceeding four and a half feet radius, which is the general diſtance from the ground of that part of the horſe to which the traces are attached, has ſtill the advantage of a ſmaller wheel; but when we conſider that the traces or poles of the cart will, in this caſe, rub againſt the flanks of the horſes, ſo that the power of the wheel is diminiſhed by the increaſe of its weight, we ſhall be convinced that no power is gained by making the radius of the wheels greater than four and a half feet. Even this ſize is too great, as ſhall be afterwards ſhown, when we treat of the line of traction, ſo that we may ſafely aſſert, that the diameter of wheels ſhould never be greater than ſix feet. The fore wheels of our carriages are ſtill unaccountably ſmall, and it is not uncommon to ſee carts moving upon wheels ſcarcely 14 inches in diameter. The convenience of turning is urged as the reaſon for diminiſhing the fore wheels of carriages, and the facility of loading the cart is conſidered as a ſufficient reaſon for uſing wheels ſo ſmall as 14 inches. The firſt of theſe advantages, however, may be obtained by going to the end of a ſtreet, or to a proper place for turning the carriage; and a few additional turns of a windlaſs will be ſufficient to convey the heavieſt loads into carts mounted on high wheels.

440. The next thing to be determined is the ſhape of the wheels. Now it is certainly a matter of ſurpriſe how the unnatural ſhape which is at preſent given to them could ever have been brought into uſe. A cylindrical wheel, with the ſpokes perpendicular to the naves, is undoubtedly the form which every mechanic would give to his wheels, before he had heard of the pretended advantages of concave or diſhing wheels, or thoſe which have inclined ſpokes and conical rims. It has been alleged, indeed, that the form repreſented in fig. 5. when A *r*, B *s* is the conical rim, and *o* A, *p* B the inclined ſpokes, renders the wheel ſtronger than it would otherwiſe be; that by extending the baſe of the carriage it prevents it from being overturned; that it hinders the fellies from rubbing againſt the load or the ſides of the cart; and that when one wheel falls into a rut, and therefore ſupports more than one half of the load, the ſpokes are brought into a vertical poſition, which renders them more capable of ſuſtaining the additional weight. Now it is evident that the ſecond of theſe advantages is very trifling, and may be obtained, when required, by interpoſing a piece of board between the wheel and the load. Plate CCCXXV. fig. 5.

441. The other two advantages exiſt only in very bad roads; and if they are neceſſary, which we much queſtion, in a country like this, where the roads are ſo excellently made and ſo regularly repaired, they can eaſily be procured, by making the axle-tree a few inches longer, and increaſing the ſtrength of the ſpokes. But it is allowed on all hands that perpendicular ſpokes are preferable on level ground. The inclination of the ſpokes, therefore, which renders concave wheels advantageous in rugged and unequal roads, renders them diſadvantageous when the roads are in good order; and where the good roads are more numerous than the bad ones, as they certainly are in this country, the diſadvantages of concave wheels muſt overbalance their advantages. It is true indeed that in concave wheels, the ſpokes are in their ſtrongeſt poſition, when they are expoſed to the ſevereſt ſtrains, that is, when one wheel is in a deep rut, and ſuſtains more than one half of the load: but it is equally true that on level ground, where the ſpokes are in their weakeſt poſition, a leſs ſevere ſtrain, by continuing for a much longer time, may be equally if not more detrimental to the wheel.

Upon theſe obſervations we might reſt the opinion which we have been maintaining, and appeal for its truth to the judgment of every intelligent and unbiaſſed mind; but we ſhall go a ſtep farther, and endeavour to ſhow that concave diſhing wheels are more expenſive, more injurious to the roads, more liable to be broken by accidents, and leſs durable in general, than thoſe wheels in which the ſpokes are perpendicular to the naves. By inſpecting fig. 5. it will appear that the whole of the preſſure which the wheel AB ſuſtains is exerted along the inclined ſpoke *p s*, and therefore acts obliquely upon the level ground *n* D, whether the rims are conical or cylindrical. This oblique action muſt neceſſarily

necessarily injure the roads, by loosening the stones more between B and D than between B and n, and if the load were sufficiently great, the stones would start up between s and D. The texture of the roads, indeed, is sufficiently firm to prevent this from taking place; but in consequence of the oblique pressure, the stones between s and D will at least be loosened, and by admitting the rain the whole of the road will be materially damaged. But when the spokes are perpendicular to the nave as pn, and when the rims mA, nB are cylindrical, or parallel to the ground, the weight sustained by the wheel will act perpendicularly upon the road; and however much that weight is increased, its action can have no tendency to derange the materials of which it is composed, but is rather calculated to consolidate them, and render the road more firm and durable.

442. It was observed that concave wheels are more expensive than plane ones. This additional expence arises from the greater quantity of wood and workmanship which the former require; for in order that dishing wheels may be of the same perpendicular height as plane ones, the spokes of the former must exceed in length those of the latter, as much as the hypothenuse oA of the triangle oAn exceeds the side om; and therefore the weight and the resistance of such wheels must be proportionably great. The inclined spokes, too, cannot be formed nor inserted with such facility as perpendicular ones. The extremity of the spoke which is fixed into the nave is inserted at right angles to it, in the direction $o\,p$, and if the rims are cylindrical, the other spoke should be inserted in a similar manner; while the intermediate portion has an inclined position. There are therefore two flexures or bendings in the spokes of concave wheels, which requires them to be formed out of a larger piece of wood than if they had no such flexures, and renders them liable to be broken by any sudden strain at the points of flexure.

443. We shall now dismiss the subject of concave wheels with one observation more, and we beg the reader's attention to it, because it appears to be decisive of the question. The obstacles which carriages have to encounter, are almost never spherical protuberances that permit the elevated wheel to resume by degrees its horizontal position. They are generally of such a nature, that the wheel is instantaneously precipitated from their top to the level ground. Now the momentum with which the wheel strikes the ground is very great, arising from a successive accumulation of force. The velocity of the elevated wheel is considerable when it reaches the top of the eminence, and while it is tumbling into the level ground, it is receiving gradually that proportion of the load which was transferred to the other wheel, till having recovered the whole, it impinges against the ground with great velocity and force. But in concave wheels the spoke which then strikes the ground is in its weakest position, and therefore much more liable to be broken by the impetus of the fall, than the spokes of the lowest wheel by the mere transference of additional weight. Whereas, if the spokes be perpendicular to the nave, they receive this sudden shock in their strongest position, and are in no danger of giving way to the strain.

444. In the preceding observations we have supposed the rims of the wheels to be cylindrical. In concave wheels, however, the rims are uniformly made of a conical form, as A r, B s, fig. 5. which not only increases the disadvantages which we have ascribed to them, but adds many more to the number. Mr Cumming, in a late Treatise on Wheel Carriages, solely devoted to the consideration of this single point, has shewn with great ability the disadvantages of conical rims, and the propriety of making them cylindrical; but we are of opinion that he has ascribed to conical rims several disadvantages which arise chiefly from an inclination of the spokes. He insists much upon the injury done to the roads by the use of conical rims; yet though we are convinced that they are more injurious to pavements and highways than cylindrical rims, we are equally convinced, that this injury is occasioned chiefly by the oblique pressure of the inclined spokes. The defects of conical rims are so numerous and palpable, that it is wonderful how they should have been so long overlooked. Every cone that is put in motion upon a plane surface will revolve round its vertex, and if force is employed to confine it to a straight line, the smaller parts of the cone will be dragged along the ground and the friction greatly increased. Now when a carriage moves upon conical wheels, one part of the cone rolls while the other is dragged along, and though confined to a rectilineal direction by external force, their natural tendency to revolve round their vertex occasions a great and continued friction upon the linch pin, the shoulder of the axle-tree, and the sides of deep ruts.

445. The shape of the wheels being thus determined, we must now attend to some particular parts of their construction. The iron plates of which the rims are composed should never be less than three inches in breadth, as narrow rims sink deep into the ground, and therefore injure the roads and fatigue the horses. Mr Walker, indeed, attempts to throw ridicule upon the act of parliament which enjoined the use of broad wheels; but he does not assign any sufficient reason for his opinion, and ought to have known that several excellent and well devised experiments were lately instituted by Boulard and Margueron, which evince in the most satisfactory manner the great utility of broad wheels. Upon this subject an observation occurs to us, which has not been generally attended to, and which appears to remove all the objections which can be urged against broad rims. When any load is supported upon two points, each point supports one half of the weight; if the points are increased to four, each will sustain one-fourth of the load, and so on; the pressure upon each point of support diminishing as the number of points increases. If a weight therefore is supported by a broad surface, the points of support are infinite in number, and each of them will bear an infinitely small portion of the load; and, in the same way, every finite portion of this surface will sustain a part of the weight inversely proportional to the number of similar portions which the surface contains. Let us now suppose that a cart carrying a load of sixteen hundred weight is supported upon wheels whose rims are four inches in breadth, and that one of the wheels passes over four stones, each of them an inch broad and equally high, and capable of being pulverized only by a pressure of four hundred pounds weight. Then as each wheel sustains one half of the load, and as the wheel which passes over

over the ſtones has four points of ſupport, each ſtone will bear a weight of two hundred weight, and therefore will not be broken. But if the ſame cart, with rims only two inches in breadth, ſhould paſs the ſame way, it will cover only two of the ſtones; and the wheel having now only two points of ſupport, each ſtone will be preſſed with a weight of four hundred weight, and will therefore be reduced to powder. Hence we may infer that narrow wheels are in another point of view injurious to the roads, by pulverizing the materials of which they are compoſed.

446. As the rims of wheels wear ſooneſt at their edges they ſhould be made thinner in the middle, and ought to be faſtened to the fellies with nails of ſuch a kind that their heads may not riſe above the ſurface of the rims. In ſome military waggons we have ſeen the heads of theſe nails riſing an inch above the rims, which not only deſtroys the pavements of ſtreets, but oppoſes a continual reſiſtance to the motion of the wheel. If theſe nails were eight in number, the wheel would experience the ſame reſiſtance, as if it had to ſurmount eight obſtacles, one inch high, during every revolution. The fellies on which the rims are fixed ſhould in carriages be three inches and a fourth deep, and in waggons four inches. The naves ſhould be thickeſt at the place where the ſpokes are inſerted; and the holes in which the ſpokes are placed ſhould not be bored quite through, as the greaſe upon the axle-tree would inſinuate itſelf between the ſpoke and the naves, and prevent that cloſe adheſion which is neceſſary to the ſtrength of the wheel.

On the Poſition of the Wheels.

447. It muſt naturally occur to every perſon reflecting upon this ſubject, that the axle-trees ſhould be ſtraight and the wheels perfectly parallel, ſo that they may not be wider at their higheſt than at their loweſt point, whether they are of a conical or a cylindrical form. In this country, however, the wheels are always made concave, and the ends of the axle-trees are univerſally bent downwards, in order to make them ſpread at the top and approach nearer below. In ſome carriages which we have examined, where the wheels were only four feet ſix inches in diameter, the diſtance of the wheels at top was fully ſix feet, and their diſtance below only four feet eight inches. By this fooliſh practice the very advantages which may be derived from the concavity of the wheels are completely taken away, while many of the diſadvantages remain; more room is taken up in the coach-houſe, and the carriage is more liable to be overturned by the contraction of its baſe.

448. With ſome mechanics it is a practice to bend the ends of the axle-trees forwards, and thus make the wheels wider behind than before. This blunder has been ſtrenuouſly defended by Mr Henry Beighton, who maintains that wheels in this poſition are more favourable for turning, ſince, when the wheels are parallel, the outermoſt when turning would preſs againſt the linch pin, and the innermoſt would reſt againſt the ſhoulder of the axle-tree. In rectilineal motions, however, theſe converging wheels engender a great deal of friction both on the axle and the ground, and muſt therefore be more diſadvantageous than parallel ones.

On the Line of Traction, and the Method by which Horſes exert their ſtrength.

449. M. Camus attempted to ſhew that the line of traction ſhould always be parallel to the ground on which the carriage is moving, both becauſe the horſe can exert his greateſt ſtrength in this direction, and becauſe the line of draught being perpendicular to the vertical ſpoke of the wheel, acts with the largeſt poſſible lever. M. Couplet, however, conſidering that the roads are never perfectly level, and that the wheels are conſtantly ſurmounting ſmall eminences even in the beſt of roads, recommends the line of traction to be oblique to the horizon. By this means the line of draught HA, (which is by far too much inclined in the figure) Fig. 6. will in general be perpendicular to the lever AC which mounts the eminence, and will therefore act with the longeſt lever when there is the greateſt neceſſity for it. We ought to conſider alſo, that when a horſe pulls hard againſt any load, he always brings his breaſt nearer the ground, and therefore it follows, that if a horizontal line of traction is preferable to all others, the direction of the traces ſhould be inclined to the horizon when the horſe is at reſt, in order that it may be horizontal when he lowers his breaſt and exerts his utmoſt force. The particular manner, however, in which living agents exert their ſtrength againſt great loads, ſeems to have been unknown both to Camus and Couplet, and to many ſucceeding writers upon this ſubject. It is to M. Deparcieux, an excellent philoſopher and ingenious mechanic, that we are indebted for the only accurate information with which we are furniſhed; and we are ſorry to ſee that philoſophers who flouriſhed after him have overlooked his important inſtructions. In his memoir on the draught of horſes he has ſhewn in the moſt ſatisfactory manner, that animals draw by their weight, and not by the force of their muſcles. In four-footed animals, the hinder feet is the fulcrum of the lever by which their weight acts againſt the load, and when the animal pulls hard, it depreſſes its cheſt and thus increaſes the lever of its weight, and diminiſhes the lever by which the load reſiſts its efforts. Thus, in fig. 6. let P be the load, AD the line of traction, and let us ſuppoſe FC to be the hinder leg of the horſe, and AE part of its body, A its cheſt or centre of gravity, and CE the level road. Then AFC will repreſent the crooked lever by which the horſe acts, which is equivalent to the ſtraight one AC. But when the horſe's weight acts downwards at A, ſo as to drag forward the rope AD and raiſe the load P, CE will repreſent the power of the lever in this poſition, or the lever of the horſe's weight, and CF the lever by which it is reſiſted by the load, or the lever of reſiſtance. Now if the horſe lowers its centre of gravity A, which it always does when it pulls hard, it is evident that CE, the lever of its weight, will be increaſed, while CF the lever of its reſiſtance will be diminiſhed, for the line of traction AD will approach nearer to CE. Hence we ſee the great benefit which may be derived from large horſes; for the lever AC neceſſarily increaſes with their ſize, and their power is always proportioned to the length of this lever, their weight remaining the ſame. Large horſes, therefore, and other animals, will draw more than ſmall ones, even though they have leſs muſcular force,

force, and are unable to carry such a heavy burden. The force of the muscles tends only to make the horse carry continually forward his centre of gravity, or, in other words, the weight of the animal produces the draught, and the play and force of its muscles serve to continue it.

450. From these remarks, then, we may deduce the proper position of the line of traction. When the line of traction is horizontal, as AD, the lever of resistance is CF; but if this line is oblique to the horizon, as A d, the lever of resistance is diminished to C f, while the lever of the horse's weight always remains the same. Hence it appears, that inclined traces are much more advantageous than horizontal ones, as they uniformly diminish the resistance to be overcome. Deparcieux, however, has investigated experimentally the most favourable angle of inclination, and found, that when the angle DAF made by the trace A d and a horizontal line is fourteen or fifteen degrees, the horses pulled with the greatest facility and force. This value of the angle of draught will require the weight of the spring-tree bar, to which the traces are attached in four-wheeled carriages, to be *one-half* of the height of that part of the horse's breast to which the fore end of the traces is connected.

Fig. 7. 451. When several horses are yoked in the same carriage as represented in fig. 7. and when the declivity changes, the length of the traces has a considerable influence upon the draught. From the point E where the traces are fastened to the horse next the load, draw ER to the same point in the second horse R, and let R′ be another position of the second horse; it is required to find the difference of effect that will be produced by placing the second horse at R or at R′, or the comparative advantages of short and long traces. From R′, the point where the traces are fixed, draw R′F′E; and from E draw E mn parallel to the declivity DA. Take EF=EF′ to represent the power of the horse in the direction of the traces, which will be the same whether he is yoked at R or at R′; draw EA perpendicular to DA, F n, F′ m parallel to EA, and F φ, F′ f parallel to E n. Then since the second horse when at R pulls with a force represented by FE, in the direction FE, we may resolve this force into the two forces E n, E φ, one of which E n is solely employed in dragging the cart up the inclined plane DA, while the other E φ is solely employed in pressing the first horse E to the ground. Let the horse be now removed from R to R′, the direction of the traces becomes RF′E, and F′E=FE is the power exerted by the horse at R′ and the direction in which it it exerted. But this force is equivalent to the forces E m, E f, the first of which acts directly against the load, while the other presses the horse against the ground. Hence we see the disadvantages of long traces, for the force which draws the load when the horse is at R′ is to the force when the horse is at R, as E m to E n, and the forces which press the horse upon the ground as E f to E φ, or as F′ m to F n. Now $E\varphi = Fn = FE \times \text{sin. } nEF$; hence $F\varphi = FE \times \text{sin. } \overline{(nEg' - FEg')}$ (g' E being parallel to AB′) and $En = EF \times \text{cos. } (nEg' - FEg')$. In like manner we have $Ef = FE \times \text{sin. } (nEg' - F'Eg')$, and $Em = EF \times \text{cos. } (nEg' - F'Eg')$. Now $\text{sin. } FEg' = \text{sin. } FEg = \frac{Rg}{ER}$, and $\text{sin. } FEg' = \frac{R'g'}{ER'} = \frac{Rg}{ER'}$; but $Rg = R'g' = BR - EQ = BR - BR \times \text{cos. } nEg' = BR \times (1 - \text{cos. } nEg)$. By substituting this value in the equations which contain the values of E φ, E n, E f, E m, and considering that the angles FE g', F′E g' are always so small that their arcs differ very little from their sines, we have $FEg = \frac{BR \times \overline{1 - \text{cos. } nEg}}{ER}$, and

$$F'Eg' = \frac{BR \times \overline{1 - \text{cos. } nEg}}{ER'}.$$

By substituting these values in the preceding equations, we have

$$E\varphi = EF \times \text{sin. } (nEg - \frac{BR \times \overline{1 - \text{cos. } nEg}}{ER},$$

$$Efn = EF \times \text{sin. } (nEg - \frac{BR \times \overline{1 - \text{cos. } nEg}}{ER'},$$

$$En = EF \times \text{cos. } (nEg - \frac{BR \times \overline{1 - \text{cos. } nEg}}{ER},$$

$$Em = EF \times \text{cos. } (nEg - \frac{BR \times \overline{1 - \text{cos. } nEg}}{ER'}.$$

If AB is horizontal, and the declivity AD $=\frac{1}{6}$, we shall have $nEg = 9° 28'$, or in parts of the radius=0.16522, and cos. nEg=0.98638. Then, if EF=200 pounds, BR=$3\frac{1}{2}$ feet, ER=8 feet, ER′=12 feet, then we shall have from the preceding formulæ, E φ=31.716 pounds, E f=32.350 pounds, E n=197.470 pounds, and E m=197.404. Hence an additional length of four feet to traces eight feet long, presses the horse E to the ground with an additional force of 32.250—31.716 =0.534 pounds, and diminishes the effect of the other horse by 0.066 pounds.

On the Position of the Centre of Gravity, and the manner of disposing the load.

452. If the axle-tree of a two-wheeled carriage pass through the centre of gravity of the load, the carriage will be in equilibrio in every position in which it can be placed with respect to the axle-tree; and in going up and down hill the whole load will be sustained by the wheels, and will have no tendency either to press the horse to the ground or to raise him from it. But if the centre of gravity is above the axle-tree, as it must necessarily be, according to the present construction of wheel-carriages, a great part of the load will be thrown on the back of the horses from the wheels when going down a steep road, and thus tend to accelerate the motion of the carriage which the animal is striving to prevent; while, in ascending steep roads, a part of the load will be thrown behind the wheels, and tend to raise the horse from the ground, when there is the greatest necessity for some weight on his back to enable him to fix his feet in the earth, and overcome the great resistance which is occasioned by the steepness of the road. On the contrary, if the centre of gravity is below the axle, the horse will be pressed to the ground in going up hill, and lifted from it when going down. In all these cases, therefore, where the centre of gravity is either on the axle-tree or directly above it or below, the

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the horse will bear no part of the load in level ground. In some situations the animal will be lifted from the ground when there is the greatest necessity for his being pressed to it, and he will sometimes bear a great proportion of the load when he should rather be relieved of it.

453. The only way of remedying these evils, is to assign such a position to the centre of gravity, that the horse may bear some portion of the weight when he must exert great force against the load, that is, in level ground, and when he is ascending steep roads; for no animal can pull with its greatest effort unless it is pressed to the ground.—Now this may be in some measure effected in the following manner. Let BCN be the wheel of a cart, AD one of the shafts, D that part of it where the cart is suspended on the back of the horse, and A the axle-tree; then, if the centre of gravity of the load is placed at *m*, a point equidistant from the two wheels, but below the line DA, and before the axle-tree,—the horse will bear a certain weight on level ground,—a greater weight when he is going up hill and has more occasion for it, and less weight when he is going down hill, and does not require to be pressed to the ground: All this will be evident from the figure.—When we recollect that the shaft DA is horizontal, the centre of gravity will press more upon the point of suspension D the nearer it comes to it; or the pressure upon D, or the horse's back, will be proportional to the distance of the centre of gravity from A. If *m*, therefore, be the centre of gravity, *b* A will represent its pressure upon D, when the shaft DA is horizontal. When the cart is ascending a steep road, AH will be the position of the shaft, the centre of gravity will be raised to *a*, and *a* A will be the pressure upon D. But if the cart is going down hill, AC will be the position of the shaft, the centre of gravity will be depressed to *n*, and *c* A will represent the pressure upon the horse's back. The weight sustained by the horse, therefore, is properly regulated by placing the centre of gravity at *m*. We have still, however, to determine the proper length of *b a* and *b m*, the distance of the centre of gravity from the axle, and from the horizontal line DA; but as these depend upon the nature and inclination of the roads, upon the length of the shaft DA, which depends on the size of the horse, on the magnitude of the load, and on other variable circumstances, it would be impossible to fix their value.—If the load, along with the cart, weighs 400 pounds; if the distance DA be eight feet, and if the horse should bear 50 pounds of the weight, then *b* A should be one foot, which, being one-eighth of DA, will make the pressure upon D exactly 50 pounds. If the road slopes four inches in a foot, *b m* must be four inches, or the angle *b* A *m* should be equal to the inclination of the road; for then the point *m* will rise to *a* when ascending such a road, and will press with its greatest force on the back of the horse.

Plate CCCXXV. fig. 5.

454. When carts are not made in this manner, we may, in some degree, obtain the same end by judiciously disposing the load. Let us suppose that the centre of gravity is at O when the cart is loaded with homogeneous materials, such as sand, lime, &c. then if the load is to consist of heterogeneous substances, or bodies of different weights, we should place the heaviest at the bottom and nearest the front, which will not only lower the point *o*, but will bring it forward, and nearer the proper position *m*. Part of the load, too, might be suspended below the fore part of the carriage in dry weather, and the centre of gravity would approach still nearer the point *m*. When the point *m* is thus depressed, the weight on the horse is not only judiciously regulated, but the cart would be prevented from overturning; and in rugged roads the weight sustained by each wheel would be in a great degree equalised.

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Description of different Carriages.

Carriages that move without horses. Fig. 8.

455. In figure 8. is represented a carriage invented by Mr Richard, a physician in Rochelle, which moves without horses, merely by the exertion of the passengers. The machinery by which this is effected is placed in a box behind the carriage, and is shewn in figure 9. where AA is a small axis fixed into the box, and B a pulley over which a rope passes whose two extremities are tied to the ends of the levers or treddles C, D: the other ends of the levers are fixed by joints to the cross beam MN. The cranks FF are fixed to the axle KL, and move upon it as a centre. Each of them has a detent tooth at F which catches in the teeth of the wheels H, H, so that they can move from F to H without moving the wheel, but the detent tooth catches in the teeth of the wheels when the cranks are brought backward, and therefore bring the wheel along with them. When the foot of the passenger, therefore, is placed upon the treddle D, it brings down the crank F and along with it the wheel H, so that the large wheels fixed on the same axis perform part of a revolution; but when D is depressed, the rope DA descends, the extremity C of the other treddle rises, and the crank F rising along with it, takes into the teeth of the wheel H, so that when the elevated treddle C is depressed, the wheels H, H, and consequently the wheels I, I, perform another part of a revolution. In this way, by continuing to work at the treddles, the machine advances with a regular pace.

Fig. 9.

456. A carriage of this kind, where the mechanism is much more simple and beautiful than that which we have described, has been lately invented and constructed by Mr Nasmyth of Edinburgh, a gentleman whose mechanical genius is scarcely inferior to his talents as a painter. The pulley B and axle AA, are rendered unnecessary; leather straps are substituted in place of the cranks F, F, and the whole mechanism is contained in two small cyclindrical boxes about six inches in diameter, and one and a half broad.

475. A carriage driven by the action of the wind is exhibited in fig. 10. It is fixed on four wheels, and moved by the impulse of the wind upon the sails C, D, being guided by the rudder E. Carriages of this kind will answer very well in a level country where the roads are good and the wind fair; and are said to be much used in China. In Holland they sometimes use similar vehicles for travelling upon the ice; but they have a sledge instead of wheels, so that if the ice should happen to break, there will be no danger of sinking. Stephinus, a Dutchman, is said to have constructed one of these carriages with wheels, which travelled at the rate of 21 miles an hour with a very strong wind. Fig. 10.

458. The carriage represented in fig. 11. is made so as to sail against the wind by means of the spiral sails Fig. 11.

Deſcription of Machines.

E, F, G, H, one of which F, is expanded by the wind. The impulſe of the wind upon the ſails gives a rotatory motion to the axle M, furniſhed with a cog-wheel K, whoſe trundles act upon teeth placed on the inſide of the fore-wheels.

Fig. 12. 459. A carriage which cannot be overturned is repreſented in figure 12. where AB is the body of the carriage, conſiſting of a hollow globe, made of leather or wood, at the bottom of which is placed an immoveable weight proportioned to the load which the carriage is to bear. Two horizontal circles of iron D, E, connected with bars HI, and two vertical circles F, G, ſurround the globe; and the wheels are faſtened by a handle K to the perpendicular bars HI. Then ſince the body of the carriage moves freely in every direction within the iron circles, the centre of gravity will always be near C, and the carriage will preſerve an upright poſition even if the wheels and frame were overturned. Fig. 12.

PART III. DESCRIPTION OF MACHINES.

Chap. I. *Machines which illuſtrate the doctrines of Mechanics, or are connected with them.*

1. *Atwood's Machine.*

Atwood's machine, Plate CCCXXVI Fig. 1. 2. 3. &c.

460. THE ingenious machine invented by Mr Atwood for illuſtrating the doctrines of accelerated and retarded motion, is repreſented in figs. 1, 2, 3, 4, 5, 6, and enables us to diſcover, 1. The quantity of matter moved. 2. The moving force. 3. The ſpace deſcribed. 4. The time of deſcription; and, 5. The velocity acquired at the end of that time.

461. 1. *Of the quantity of matter moved.*—In order to obſerve the effects of the moving force, which is the object of any experiment, the interference of all other forces ſhould be prevented: the quantity of matter moved, therefore, conſidering it before any impelling force has been applied, ſhould be without weight; for though it be impoſſible to abſtract weight from any ſubſtance whatever, yet it may be ſo counteracted as to produce no ſenſible effect. Thus in the machine

Fig. 1. fig. 1. A, B repreſent two equal weights affixed to the extremities of a very fine ſilk thread: this thread is ſtretched over a wheel or fixed pulley *a b c d*, moveable round a horizontal axis: the two weights A, B being equal, and acting againſt each other, remain in equilibrio; and when the leaſt weight is ſuperadded to either (ſetting aſide the effects of friction), it will preponderate. When A, B are ſet in motion by the action of any weight *m*, the ſum $A+B+m$, would conſtitute the whole maſs moved, but for the inertia of the materials which muſt neceſſarily be uſed in the communication of motion. Theſe materials conſiſt of, 1. The wheel *a b c d*, over which the thread ſuſtaining A and B paſſes. 2. The four friction wheels on which the axle of the wheel *a b c d* reſts. 3. The thread by which the bodies A and B are connected, ſo as when ſet in motion to move with equal velocities. The weight and inertia of the thread are too ſmall to have any ſenſible effect on the experiments; but the inertia of the other materials conſtitute a conſiderable proportion of the maſs moved, and muſt therefore be taken into account. Since when A and B are put in motion, they muſt move with a velocity equal to that of the circumference of the wheel *a b c d* to which the thread is applied; it follows, that if the whole maſs of the wheels were accumulated in this circumference, its inertia would be truly eſtimated by the quantity of matter moved; but ſince the parts of the wheels move with different velocities, their effects in reſiſting the communication of motion to A and B by their inertia will be different; thoſe parts which are furtheſt from the axis reſiſting more than thoſe which revolve nearer in a duplicate proportion of thoſe diſtances, (ſee Rotation). If the figures of the wheels were regular, the diſtances of their centres of gyration from their axes of motion would be given, and conſequently an equivalent weight, which being accumulated uniformly in the circumference *a b c d*, would exert an inertia equal to that of the wheels in their conſtructed form, would alſo be given. But as the figures are irregular, recourſe muſt be had to experiment, to aſſign that quantity of matter, which being accumulated uniformly in the circumference of the wheel *a b c d*, would reſiſt the communication of motion to A in the ſame manner as the wheels.

In order to aſcertain the inertia of the wheel *a b c d*, with that of the friction wheels, the weights AB being removed, the following experiment was made.

A weight of 30 grains was affixed to a ſilk thread of inconſiderable weight; this thread being wound round the wheel *a b c d*, the weight 30 grains by deſcending from reſt communicated motion to the wheel, and by many trials was obſerved to deſcribe a ſpace of about $38\frac{1}{2}$ inches in 3 ſeconds. From theſe data the equivalent maſs or inertia of the wheels will be known from this rule.

Let a weight P, fig. 2. be applied to communicate motion to a ſyſtem of bodies by means of a very ſlender and flexible thread going round the wheel SLDIM, through the centre of which the axis paſſes (G being the common centre of gravity, R the centre of gravity of the matter contained in this line, and O the centre of oſcillation). Let this weight deſcend from reſt through any convenient ſpace *s* inches, and let the obſerved time of its deſcent be *t* ſeconds; then if *l* be the ſpace through which bodies deſcend freely by gravity in one ſecond, the equivalent weight ſought $=$ Fig. 2.

$$\frac{W\times SR\times SO}{SD^2}=\frac{P\times t^2 l}{s}-P.$$

Here we have $p=30$ grains, $t=3$ ſeconds, $l=193$ inches, $s=38.5$ inches; and $\frac{P\times t^2 l}{s}-P=\frac{30\times 9\times 193}{385}$ $30=1323$ grains, or $2\frac{3}{4}$ ounces.

This is the inertia equivalent to that of the wheel *a b c d*, and the friction wheels together: for the rule extends to the eſtimation of the inertia of the maſs contained in all the wheels.

The reſiſtance to motion therefore ariſing from the wheel's inertia, will be the ſame as if they were abſolutely Fig. 1.

lutely removed, and a mafs of $2\frac{3}{4}$ ounces uniformly accumulated in the circumference of the wheel *a b c d*. This being premifed, let the boxes A and B be replaced, being fufpended by the filk thread over the wheel or pulley *a b c d*, and balancing each other: fuppofe that any weight *m* be added to A fo that it fhall defcend, the exact quantity of matter moved, during the defcent of the weight A, will be afcertained, for the whole mafs will be $A+B+m+2\frac{3}{4}$ oz.

In order to avoid troublefome computations in adjufting the quantities of matter moved and the moving forces, fome determinate weight of convenient magnitude may be affumed as a ftandard, to which all the others are referred. This ftandard weight in the fubfequent experiments is $\frac{1}{4}$ of an ounce, and is reprefented by the letter *m*. The inertia of the wheels being therefore $=2\frac{3}{4}$ ounces, will be denoted by 11 *m*. A and B are two boxes conftructed fo as to contain different quantities of matter, according as the experiment may require them to be varied: the weight of each box, including the hook to which it is fufpended, $=1\frac{1}{2}$ oz. or, according to the preceding eftimation, the weight of each box will be denoted by 6 *m*; thefe
Fig. 3. boxes contain fuch weights as are reprefented by fig. 3. each of which weighs an ounce, fo as to be equivalent to 4 *m*; other weights of $\frac{1}{2}$ oz.$=2\,m$, $\frac{1}{4}=m$, and aliquot parts of *m*, fuch as $\frac{1}{2}m$, $\frac{1}{4}m$, may be alfo included in the boxes, according to the conditions of the different experiments hereafter defcribed.

If $4\frac{3}{4}$ oz. or 19 *m*, be included in either box, this with the weight of the box itfelf will be 25 *m*; fo that when the weights A and B, each being 25 *m*, are balanced in the manner above reprefented, their whole mafs will be 50 *m*, which being added to the inertia of the wheels 11 *m*, the fum will be 61 *m*. Moreover, three circular weights, fuch as that which is reprefented at fig. 4. are conftructed; each of which $=\frac{1}{4}$ oz. or *m*: if one of thefe be added to A and one to B, the whole mafs will now become 63 *m*, perfectly in equilibrio, and moveable by the leaft weight added to either (fetting afide the effects of friction), in the fame manner precifely as if the fame weight or force were applied to communicate motion to the mafs 63 *m*, exifting in free fpace and without gravity.

462. 2. *The moving force.* Since the weight of any fubftance is conftant, and the exact quantity of it eafily eftimated, it will be convenient here to apply a weight to the mafs A as a moving force: thus, when the fyftem confifts of a mafs $=63\,m$, according to the preceding defcription, the whole being perfectly balanced, let
Fig. 5. a weight $\frac{1}{4}$ oz. or *m*, fuch as is reprefented in fig. 5. be applied on the mafs A; this will communicate motion to the whole fyftem; by adding a quantity of matter *m* to the former mafs 63 *m*, the whole quantity of matter moved will now become 64 *m*; and the moving force being $=m$, this will give the force which accelerates the defcent of $A=\frac{m}{64\,m}$, or $\frac{1}{64}$ part of the accelerating force of gravity.

By the preceding conftruction, the moving force may be altered without altering the mafs moved; for fuppofe the three weights *m*, two of which are placed on A and one on B, to be removed, then will A balance B. If the weights 3 *m* be all placed on A, the moving force will become 3 *m*, and the mafs moved 64 *m* as before, and the force which accelerates the defcent of $A=\frac{3\,m}{64\,m}=\frac{3}{64}$ parts of the force by which gravity accelerates falling bodies.

Suppofe it were required to make the moving force 2 *m*, the mafs moved continuing the fame. Let the three weights, each of which $=m$, be removed; A and B will balance each other; and the whole mafs will be 61 *m*: let $\frac{1}{2}\,m$, fig. 5. be added to A, and $\frac{1}{2}\,m$ Fig. 5.
to B, the equilibrium will be preferved, and the mafs moved will be 62 *m*; now let 2 *m* be added to A, the moving force will be 2 *m*, and the mafs moved 64 *m* as before; wherefore the force of acceleration $=\frac{1}{32}$ part of the acceleration of gravity. Thefe alterations in the moving force may be eafily made in the more elementary experiments, there being no neceffity for altering the contents of the boxes A and B: but the proportion and abfolute quantities of the moving force and mafs moved, may be of any affigned magnitude, according to the conditions of the propofition to be illuftrated.

463. 3. *Of the fpace defcribed.* The body A, fig. 1. Fig. 1.
defcends in a vertical line; and a fcale about 64 inches in length divided into inches and tenths of an inch is adjufted vertical, and fo placed that the defcending weight A may fall in the middle of a fquare ftage, fixed to receive it at the end of the defcent: the beginning of the defcent is eftimated from o on the fcale, when the bottom of the box A is on a level with o. The defcent of A is terminated when the bottom of the box ftrikes the ftage, which may be fixed at different diftances from the point o; fo that by altering the pofition of the ftage, the fpace defcribed from reft may be of any given magnitude lefs than 64 inches.

464. 4. *The time of defcription* is obferved by a pendulum, vibrating feconds; and the experiments intended to illuftrate the elementary propofitions, may eafily be fo conftructed that the time of motion fhall be a whole number of feconds. The eftimation of the time, therefore, admits of confiderable exactnefs, provided the obferver takes care to let the bottom of the box A begin its defcent precifely at any beat of the pendulum; then the coincidence of the ftroke of the box againft the ftage, and the beat of the pendulum at the end of the time of motion, will fhow how nearly the experiment and the theory agree. There might be various devices for letting the weight A begin its defcent at the inftant of a beat of the pendulum W; for inftance, let the bottom of the box A, when at o on the fcale, reft on a flat rod, held in the hand horizontally; its extremity being coincident with o, by attending to the beats of the pendulum; and with a little practice, the rod which fupports the box A may be removed at the moment the pendulum beats, fo that the defcent of A fhall commence at the fame inftant.

465. 5. *Of the velocity acquired.* It remains only to defcribe in what manner the velocity acquired by the defcending weight A, at any given point of its path is made evident to the fenfes. The velocity of A's defcent being continually accelerated will be the fame in two points of the fpace defcribed. This is occafioned by the conftant action of the moving force; and fince the velocity of A at any inftant is meafured by the fpace which

which would be deſcribed by it moving uniformly for a given time with the velocity it had acquired at that inſtant, this meaſure cannot be experimentally obtained, except by removing the force by which the deſcending body's acceleration was cauſed.

In order to ſhow in what manner this is effected particularly, let us again ſuppoſe the boxes A and B $=25m$ each, ſo as together to be $=50m$; this with the wheel's inertia $11m$ will make $61m$; now let m be added to A, and an equal weight m to B, theſe bodies will balance each other, and the whole maſs will be $63m$. If a weight m be added to A, motion will be communicated, the moving force being m, and the maſs moved $64m$. In eſtimating the moving force, the circular weight $=m$ was made uſe of as a moving force: but for the preſent purpoſe of ſhowing the velocity acquired, it will be convenient to uſe a flat rod, the weight of which is alſo $=m$. Let the bottom of the box A be placed on a level with o on the ſcale, the whole maſs being as deſcribed above $=63m$, perfectly balanced. Now let the rod, the weight of which $=m$, be placed on the upper ſurface of A; this body will deſcend along the ſcale in the ſame manner as when the moving force was applied in the form of a circular weight. Suppoſe the maſs A, fig. 6. to have deſcended by conſtant acceleration of the force of m, for any given time, or through a given ſpace: let a circular frame be ſo affixed to the ſcale, contiguous to which the weight deſcends, that A may paſs centrally through it, and that this circular frame may intercept the rod m by which the body A has been accelerated from reſt. After the moving force m has been intercepted at the end of the given ſpace or time, there will be no force operating on any part of the ſyſtem which can accelerate or retard its motion: this being the caſe, the weight A, the inſtant after m has been removed, muſt proceed uniformly with the velocity which it had acquired that inſtant: in the ſubſequent part of its deſcent, the velocity being uniform will be meaſured by ſpace deſcribed in any convenient number of ſeconds.

Fig. 6.

466. Mr Atwood's machine is alſo uſeful for eſtimating experimentally the velocities communicated by the impact of bodies elaſtic and nonelaſtic; the quantity of reſiſtance oppoſed by fluids, as well as for various other purpoſes. Theſe uſes we ſhall not inſiſt on; but the properties of retarded motion being a part of the preſent ſubject, it may be neceſſary to ſhow in what manner the motion of bodies reſiſted by conſtant forces are reduced to experiment by means of the inſtrument above deſcribed, with as great eaſe and preciſion as the properties of bodies uniformly accelerated. A ſingle inſtance will be ſufficient: Thus, ſuppoſe the maſs contained in the weights A and B, fig. 6. and the wheels to be $61m$, when perfectly in equilibrio; let a circular weight m be applied to B, and let two long weights or rods, each $=m$, be applied to A, then will A deſcend by the action of the moving force m, the maſs moved being $64m$: ſuppoſe that when it has deſcribed any given ſpace by conſtant acceleration, the two rods m are intercepted by the circular frame above deſcribed, while A is deſcending through it, the velocity acquired by that deſcent is known; and when the two rods are intercepted, the weight A will begin to move on with the velocity acquired, being now retarded by the conſtant force m; and ſince the maſs moved is $62m$, the force of retardation will be $\frac{1}{62}$ part of that force whereby gravity retards bodies thrown perpendicularly upwards. The weight A will therefore proceed along the graduated ſcale in its deſcent, with an uniformly retarded motion, and the ſpaces deſcribed, times of motion, and velocities deſtroyed by the reſiſting force, will be ſubject to the ſame meaſures as in the examples of accelerated motion already deſcribed.

In the preceding deſcriptions, two ſuppoſitions have been aſſumed, neither of which is mathematically true: but it might be eaſily ſhown that they are ſo in a phyſical ſenſe; the errors occaſioned by them being inſenſible in practice.

2. *Machine for illuſtrating the Theory of the Wedge.*

467. This machine is repreſented in fig. 7. where KILM and LMNO are two flat pieces of wood joined together by a hinge at LM; P is a graduated arch on which theſe pieces of wood can be moved ſo as to ſubtend any angle not greater than 60°, and *a*, *b* two ſcrews for fixing them at the required angle. The back of the wedge will therefore be repreſented by IKNO, its ſharp edge by LM, and its two ſides by KILM, LMNO. The weight *p* ſuſpended to the wedge by the hook M, and the weight of the wedge itſelf, may be conſidered as the force employed to drive the wedge. The wooden cylinders AB, CD, have their extremities made like two flat circular plates to prevent the wedge from ſlipping off at one ſide. To the pivots of theſe cylinders, two of which are repreſented at *e* and *f*, are faſtened the cords *e*W, *f*U, CV, AX, which paſſing over the pulleys U, V, X, W are faſtened to the two bars *uv*, *xw*, on which any equal weights Y, Z may be hung at pleaſure. The tendency of theſe weights is evidently to draw the cylinders towards each other, and they may therefore be regarded as the reſiſtance of the wood acting againſt the ſides of the wedge. The cylinders themſelves are ſuſpended by their pivots to the threads E, F, G, H, which may be fixed to the ceiling of the room, or to the horizontal beam of a frame made on purpoſe.—By placing various equal weights at Y and Z, it may be eaſy to determine the proportion between the power and the reſiſtance when the wedge is in equilibrio.—In this machine the impelling power is the preſſure of the weight *p*, whereas, in the real wedge, the impelling power is always an impulſive force which is infinitely more powerful.

Plate CCCXXVI. fig. 7.

3. *Machine for illuſtrating the effects of the centrifugal force in flattening the poles of the Earth.*

468. Fig. 8. repreſents this machine, which conſiſts of two flexible circular hoops, AB and CD, croſſing one another at right angles, and fixed to the vertical axis EF at its lower extremity, but left looſe at the pole or interſection *e*. If this axis be made to revolve rapidly by means of the winch *m*, and the wheel and pinion *n*, *o*, the middle parts A, B, C, D will, by their centrifugal force, ſwell out and ſtrike againſt the frame at F and G; if the pole *e*, when ſinking, is not ſtopped by means of a pin E fixed in the vertical axis. The hoops, therefore, will have a ſpheroidal form; the equatoreal being larger than the polar diameter.

Fig. 8.

4. *Machine for trying the Strength of Materials.*

Machine for trying the ſtrength of materials.

469. The piece of wood, whoſe ſtrength is to be tried,

Description of Machines. Plate CCCXXVII. Fig. 1. tried, is represented by EF, and the force is applied to it by means of the winch A, which winds up the rope BC, passing over the pulley n, and below the pulley m, and attached to the point D of the beam EF. The pulleys slide on two parallel bars fixed in a frame, held down by a projecting point, at G, of the lever GR, which is graduated like a steelyard, and measures the force employed. The beam EF is held by a double vice IK with four screws, two of which are invisible. When a wire is to be torn it is fixed to the cross bar LM; and when any body is to be crushed, it must be placed beneath the lever NO, the rope BC being fixed to the hook N, and the end O being held down by the click which acts on the double ratchet OP.—The lever is double from O to Q, and acts on the body by a loop fixed to it by a pin. See *Young's Nat. Philos.* vol. i. p. 768. from which this drawing and description are taken.

5. Machine in which all the Mechanical powers are combined.

Combination of all the mechanical powers. Fig. 2. 470. The lever AB, whose centre of motion is C, is fixed to the endless screw DE, which drives the wheel and axle FHG. Round the axle G is coiled a rope GHI, which passes round the four pulleys K, L, m, n, and is fixed to a hook at m on the lower block, which carries the weight W. When equal weights are suspended on the lever at equal distances from the fulcrum C, the lever becomes a balance, and the wedge and inclined plane are evidently included in the endless screw DE. If the wheel F has 30 teeth, if the lever AB is equal to twice the diameter of the wheel FH, and if the diameter of the axle G is one-tenth of the diameter of the wheel, a power of 1 exerted at P will raise a weight of 2400 suspended at the lower block of the four pulleys.

6. Fidler's Balance.

Fidler's balance. Fig. 3. 471. The balance represented in fig. 3. was made by Fidler for the Royal Institution, and does not differ much from those which have been constructed by Ramsden and Troughton. The middle column A can be raised at pleasure by the nut B, and supports the round ends of the axis in the forks at its upper extremity, in order to remove the pressure on the sharp edges of the axis within the forks. C and D are pillars which occasionally support the scales, and may be elevated or depressed by turning the nut E. The screw F raises or depresses a weight within the conical beam, for the purpose of regulating the position of the centre of gravity. The graduated are G measures the extent of the vibrations. See *Young's Nat. Philos.* vol. i. p. 765.

7. Improvement on the Balance.

Improvement on the balance. Fig. 5. 472. An improvement on the balance is represented in fig. 4. where DC is a micrometer screw fixed to the arm FA, so that when it is turned round by the nut D, it neither approaches to, nor recedes from, the centre of motion F. The screw DC works in a female screw in the small weight n, and by revolving in one direction, carries this weight from S to R, and thus gives the preponderance to the scale G. The recession of the weight n from the centre F is measured as in the common micrometer, and a weight x placed in the scale suspended at A, will be in equilibrio with n placed at any distance S n, when $x = \frac{Sn \times n}{FA}$.—*Appendix to Ferguson's Lectures.*

8. Machine for shewing the Composition of Forces.

473. The part BEFC is made to draw other parts into the wooden square ABCD. The pulley H is joined to BEFC so as to turn on an axis which will be at H when the square BEFC is pushed in, and at p when it is drawn out. A ball G is made to slide on the wire k which is fixed to BEFC, and the thread m attached to the ball goes over the pulley to I, where it is fixed. Now, when the piece BEFC is pulled out, the pulley, wire, and ball, move along with it, in the direction DCF, and it is evident that the ball G will slide gradually up the wire k. It is therefore acted upon by two forces; one in the direction GH, and the other in the direction GC, and will be found at the end of the motion at g, having moved in the direction G g, the diagonal of a parallelogram whose sides are GH, GC. Machine for the composition of forces. Fig. 4.

8. Smeaton's Machine for experiments on Windmill Sails.

474. In the experiments with this machine, the sails were carried round in the circumference of a circle, so that the same effect was produced as if the wind had struck the sails at rest with the velocity which was then given them. In the pyramidal frame ABC is fixed to the axis DE, which carries the arm FG with the sails GI. By pulling the rope Z, which coils round the barrel H, a motion of rotation is given to the sails, so that they revolve in the circumference of a circle, whose radius is DI. At L is fixed a cord which passes round the pulleys M, N, O, and coils round a small cylinder on the axis of the sails and raises the scale C, in which different weights are placed for trying the power of the sails, and which, being in the direction of the axis DE, is not affected by the circular motion of the arm DG. The scale C is kept steady by the pillars Q, R, and prevented from swinging by the chains S, T, which hang loosely round the pillars. VX is a pendulum composed of two leaden balls moveable upon a wooden rod, so that they can be adjusted to vibrate in any given time. The pendulum hangs upon a cylindrical wire, on which it vibrates as on a rolling axis. Apparatus for windmills. Fig. 6.

9. Smeaton's Machine for experiments on Rotatory Motion.

475. This machine is exhibited in fig. 1. where the vertical axis NB is turned by the rope M passing over the pulley R, and carrying the scale S. The axis NB carries two equal leaden weights K, D, moveable at pleasure on the horizontal bar HI. The upper part N of the axis is one half the diameter of the part M, so that when the rope is made to wind round N, it acts at half the distance from the axis, at which it acts when coiled round M.—When the rope is wound round N, the same force will produce in the same time but half the velocity which is produced when the rope coils round M, the situation of the leaden weights being the same: But when the weights K, L are removed to a double distance from the axis, a quadruple force will be required in order to produce an equal angular velocity in a given time. Apparatus for rotatory motion. Plate CCCXXVIII. Fig. 1.

CHAP.

Description of Machines.

Chap. II. *Machines for various purposes.*

1. *Prony's Condenser of Forces.*

Prony's condenser of forces. Plate CCCXXVIII. fig. 2, 3.

476. The object of this machine is to obtain a maximum effect from an impelling power which is subject to variation in its intensity. Let us suppose that wind is the first mover, and that O, O is the vertical axis of a windmill; *e, e, e, e,* are several radii issuing from this axis, and carrying a wiper *b d*, which acts upon the corresponding wipers *a f*, and gives a motion of rotation to the axis *a, a, a, a* to which they are attached. The wipers *b d, a f* must be so constructed that when *b d* ceases to press on one wiper *a f*, it shall at the same moment begin to act upon the next wiper. Each of the axes *a, a, a, a,* carries a drum *t t r r*, round which is coiled a cord *t p* F, passing over the pulley *p*, and supporting a weight Q which can be placed at different distances from G on the lever FG. The axes *a, a, a, a* also pass through the pinions *q q*, to which they are not fixed; but these pinions carry ratchet wheels that bear against the teeth *r r*, so that when the weight Q rises, the rope merely coils round the drum without moving the pinion *q q*. But when the wiper *b d* ceases to act upon *a f*, the weight Q descends, and then the toothed wheel *r r* acts against the ratchet, so that Q cannot descend without turning the pinion *q q* along with the drum. The pinion *q q* drives the wheel *a b*, which again drives the wheel CE by means of the bevelled teeth CD, and elevates the load at P. Hence, when the axis OO is put in motion by the wind acting on the sails, it will first raise a number of weights Q sufficient to put the machine in motion, and will continue to raise new weights while those before raised are fallen, so that the motion once impressed will be continued.

2. *Portable Stone Crane, for loading and unloading Carts.*

Portable stone crane. Fig. 4.

477. This crane is mounted on a wooden stage, and is so constructed that it may be taken to pieces. The frame A, A, A, A is about ten feet high, nine feet long and nine feet wide. The wheels B, B are of iron, and about three feet in diameter. The pinion D that is fixed to the axis of the first wheel B is eight inches diameter, and the other pinion C is about the same diameter. When the stones are suspended to the rope that coils round the barrel, the workman turns a winch on the axis of the wheel C, and raises or lowers the weight according to the direction in which he turns it.

3. *Portable Cellar Crane.*

Portable cellar crane. Fig. 5.

478. This crane is represented in fig. 5. where A, A are two wooden supports about six feet high, which are jointed at E, and connected by the iron cylinder C and the wooden bar D. The supports A, A are fastened to the edge of the cellar by the iron prongs E, E, and the two ropes which support the barrel and pass round it are fixed to the iron clamp G, G. These ropes coil round the cylindrical bar F, which is put in motion by the winch K, driving the pinion I about four inches diameter, which gives motion to the wheel H, about three feet in diameter. The barrel, therefore, will rise or fall according to the direction in which the winch is moved.

4. *Weighing Crane.*

Plate CCCXXX. fig. 6. Andrews's weighing crane.

479. This crane represented in fig. 6. was invented by Mr Andrews, and weighs the body at the time that it is raising it. The weight W is elevated by means of the levers M, N, O, P which coil the rope HR round the barrel H. The jib ED stands on a horizontal beam moveable in a vertical plane round the centre FA, and the distance of the upright beam E from the centre of motion A is $\frac{1}{20}$ of BF. The weight of the body W is then ascertained by the weight at B, which keeps it in equilibrio. The piece of wood C projects from the vertical beam CT, in order to prevent the beam from rising too high.

5. *Gilpin's Crane.*

Gilpin's crane. Plate CCCXXIX. fig. 1, 2, 3, 4. 5.

480. In fig. 1. where this machine is represented, AB is the perpendicular stand, formed of two oaken planks let into cast iron mortises C, D: Between these planks is fixed the barrel E with spiral grooves on its surface, on which the chain RL winds. When the winch N is put in motion it drives the pinion O, which again drives the wheel P, on whose axis is fixed the barrel F, so that the chain is coiled round the barrel and the weight raised. A section of this part of the machinery is shewn in fig. 2. Figure 3. shews an enlarged view of part of the barrel, and part of the chain lying in its proper position in the spiral grooves or channels. In order to prevent the chain from twisting when it is wound upon the barrel, the lower edge of one link lies in the groove, and the next link upon the surface of the barrel. This will be better understood from fig. 4. which is a section of the barrel F, and shews the manner in which one link lies within it, and the other link on its outside. The old method of working chains is exhibited in fig. 5. For a full account of this useful invention, see Nicholson's Journal, vol. xv. p. 126.

6. *Bramah's Jib for Cranes.*

Bramah's jib. Fig. 6.

481. The nature of this invention, for which we are indebted to the ingenious Mr Bramah, may be easily understood from a bare inspection of fig. 6. which represents a jib attached to the wall of a warehouse. The jib turns on a perforated axis or pillar. The rope by which the weight is raised after passing over two pulleys, goes through the perforated axis, and is conducted over another pulley to the barrel of the crane, which is not represented in the figure. In jibs of the common construction which turn in two solid gudgeons, the rope passes over the upper gudgeon, and is confined between two vertical rollers; but the bending of the rope occasions a great deal of friction, and produces a constant effort to bring the arm of the jib into a position parallel to the inner part of the rope.

7. *Gottlieb's Carriage Crane.*

Plate CCCXXIX. fig. 7. Carriage crane.

482. This machine, which is useful for carrying large stones where carts and horses cannot be easily obtained, consists of two sorts of crane wheels applied to the two sets of wheels belonging to the carriage, so that two men, one acting at each winch A, A give motion to the loaded carriage. The pinion B, six inches in diameter turns the wheel C, three feet in diameter. The wheel C gives motion to the pinion D one foot in diameter,

Description of Machines. meter, which works into two wheels E, E three feet six inches diameter, and are fixed on the wheels of the carriage.

8. *Common Jack.*

Common jack. Fig. 8. 483. The common worm jack is represented in fig. 8. and is impelled by the weight W, which is suspended to a rope passing through the pulleys V, R, and rolling round the barrel Q. When the barrel is put in motion by the action of the weight, it drives the wheel KL of 60 teeth, by means of a catch fixed to AB, which lays hold of the cross bars in KL. The wheel KL drives the pinion M of 15 teeth, fixed on the axis of the wheel N of 30 teeth, which gives motion to the endless screw O, and the fly-wheel P. On the axis of the wheel KL is fixed the pulley DG, which, by means of a rope, gives motion to the spit. The axis ET is fixed in the barrel AC; and as this axis is hollow, both it and the barrel turn round upon the axis FD, so that the rope may be coiled round the barrel by the winch H without moving the wheel K.

9. *Loading and Unloading Machine.*

Loading and unloading machine. Fig. 9. 484. This portable machine, invented by Mr Davis of Windsor, is put in motion by the winch A, which drives the two endless screws C, C. These screws move the wheels E, E, and consequently the barrels connected with them, so that the ropes F, F passing over the pulleys G, G are coiled round the barrels, and the load H which these ropes support is raised into the frame R, R, which shews a part of the cart. The barrels and wheels are contained in an iron box L, the sides of which are removed in the figure.

10. *Vauloue's Pile Engine.*

Vauloue's pile engine. Plate CCCXXX. fig. 1. 485. The horses which work this engine are yoked at S, S, and by moving the wheel B and drum C, which are locked together, raise the follower GH, (carrying the ram Q by the handle R), by means of the rope HH which coils round the drum. When the follower G reaches the top of the frame, the upper legs of the tongs H are closed by pressing against the adjacent beams; and their lower legs are opened, so that they drop the ram Q, which falls and strikes the pile.
Fig. 2. When G is at the top of the frame, the crooked handle 6, of the follower G, presses against the cords *a*, *a*, which raise the end of the lever L (see fig. 2.) round *m* as a centre, and by depressing the extremity N, and consequently the bar S, S, unlock the drum C and the wheel B, so that the follower G falls by its weight and seizes the ram R. As soon as the follower drops, the horses would tumble down, having no resistance to overcome, were not this prevented by the fly O, which is moved by the wheel B and trundle X, and opposes a sufficient resistance to the horses till the follower again seizes the ram. When the follower falls, the weight L (fig. 2.) pushes up the bolt Y into the drum C, and locks the wheel and the drum;—and the same operation is afterwards repeated. See *Ferguson's Lect.* vol. i. p. 118.

11. *Bunce's Pile Engine.*

486. A side view of this engine is shewn in fig. 3, 4. Bunce's pile engine. Fig. 3, 4.
It consists of two endless ropes or chains A, connected by cross pieces of iron B, B, &c. (fig. 4.) which pass round the wheel C, the cross pieces falling into corresponding cross grooves, cut in the periphery of the wheel. When the man at S, therefore, drives the wheel *m* by means of the pinion *p*, he moves also the wheel C fixed on the axis of *m*, and makes the double ropes revolve upon the wheels, C, D. The wheel D is fixed at the end of a lever DHK, whose centre of motion is H, a fixed point in the beam FT. Now, when the ram L (fig. 3, 5.) is fixed to one of the cross pieces B by the hook M, the weight of the ram, acting by the rope, moves the lever DK round H, and brings the wheel D to G, so that, by turning the winch, the ram L (fig. 3.) is raised in the vertical line LRG. But when it reaches R, the projecting piece R disengages the ram from the cross piece B, by striking the bar Q; and as the weight is removed from the extremity D of the lever, the counterpoise I brings it back from G to its old position at F, and the ram falls without interfering with the chain. When the hook is descending, it is prevented from catching the rope by means of the piece of wood N suspended from the hook M at O; for being specifically lighter than the iron weight L, and moving with less velocity, it does not come in contact with L till the ram is stopped at the end of its path. When N, therefore, falls upon L, it depresses the extremity M of the hook, and therefore brings the hook over one of the cross pieces B, by which the ram is again raised.

487. For the description of a great variety of useful machines, the reader is referred to the second volume of Mr Gregory's Mechanics, and to Dr Young's Natural Philosophy, a work of great merit, which would have been more particularly noticed if it had reached us before the historical part of this article was printed off.—See also HYDRODYNAMICS, MARLY, *Machine at*, MILL, RAMSDEN, and *WATER-Works*.

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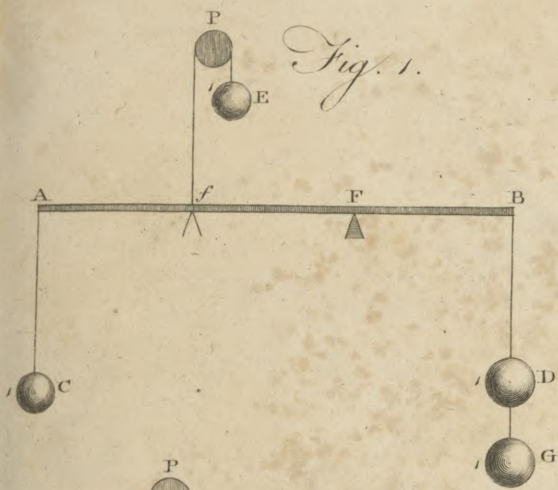
Conical

Fig. 1.



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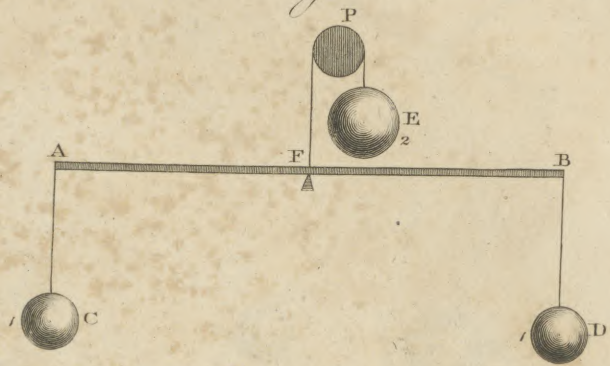

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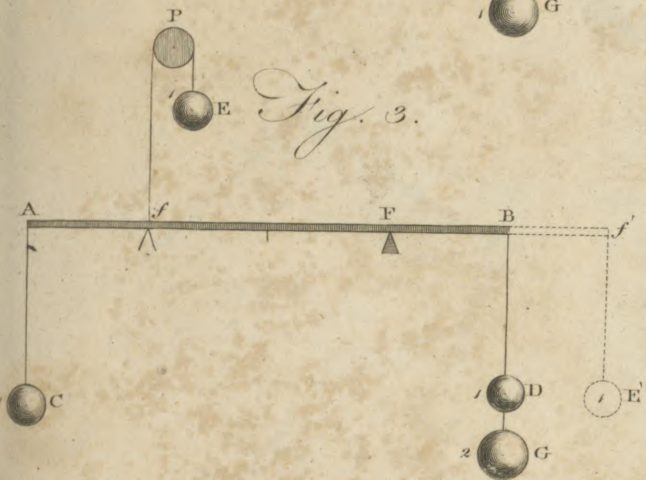

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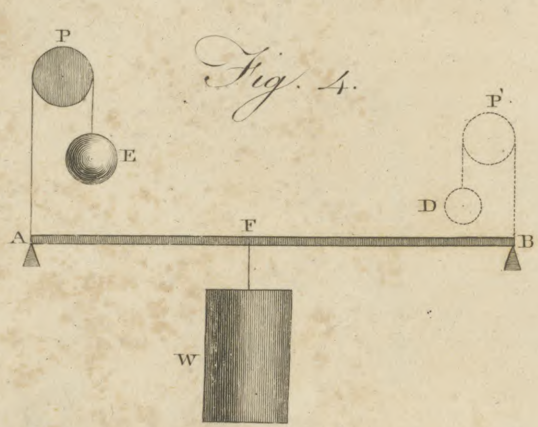

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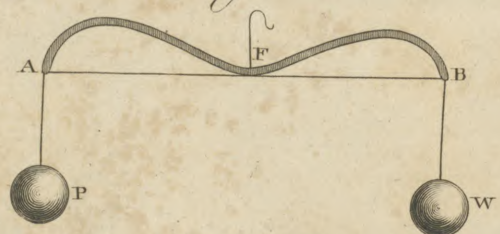

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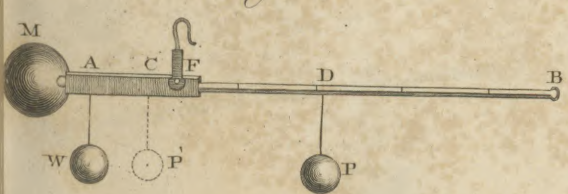

Fig. 8.

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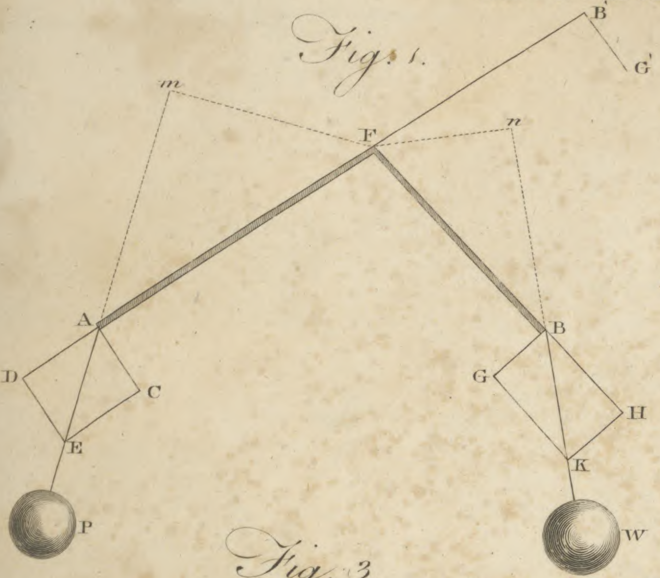

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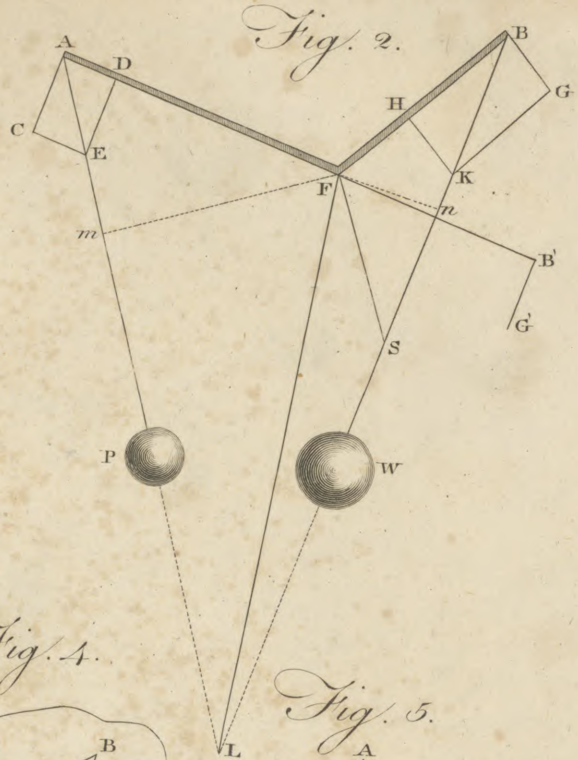

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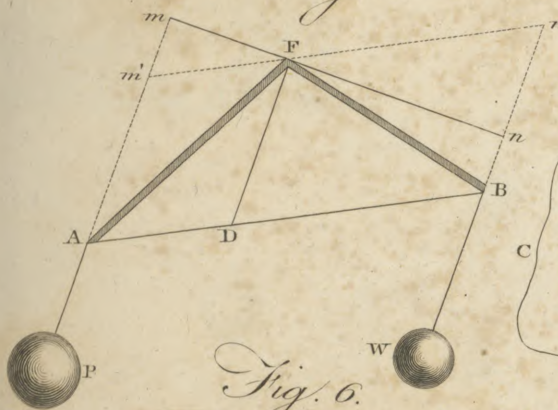

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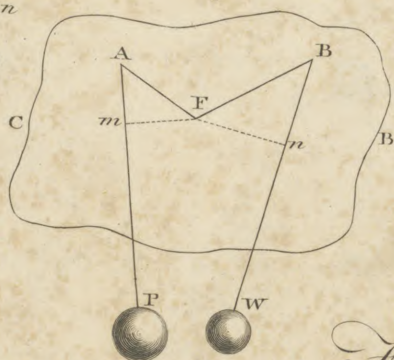

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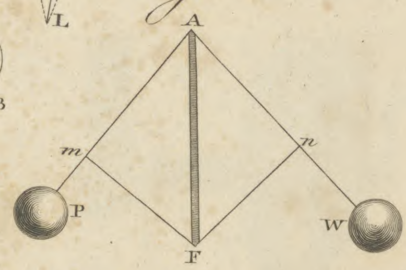

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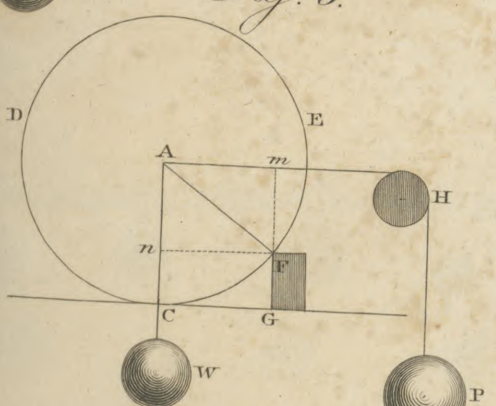

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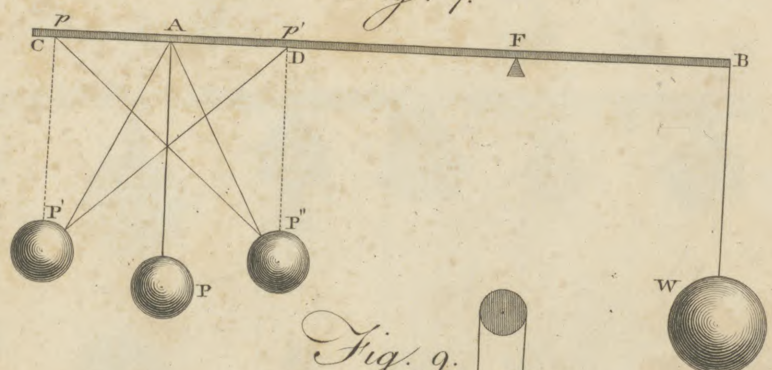

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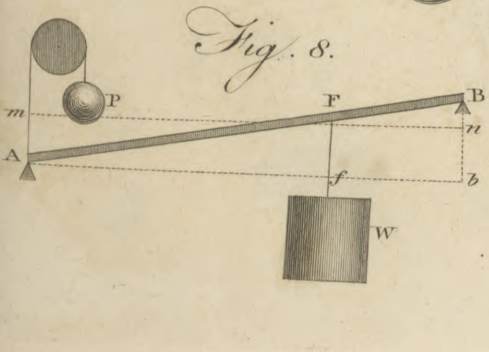

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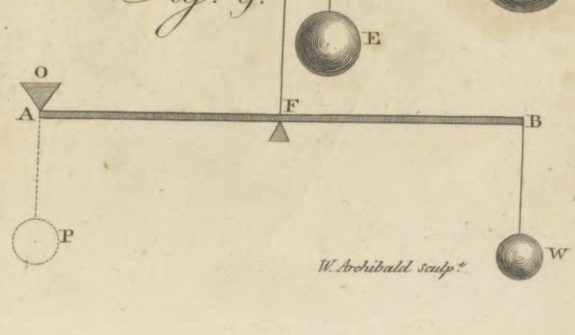

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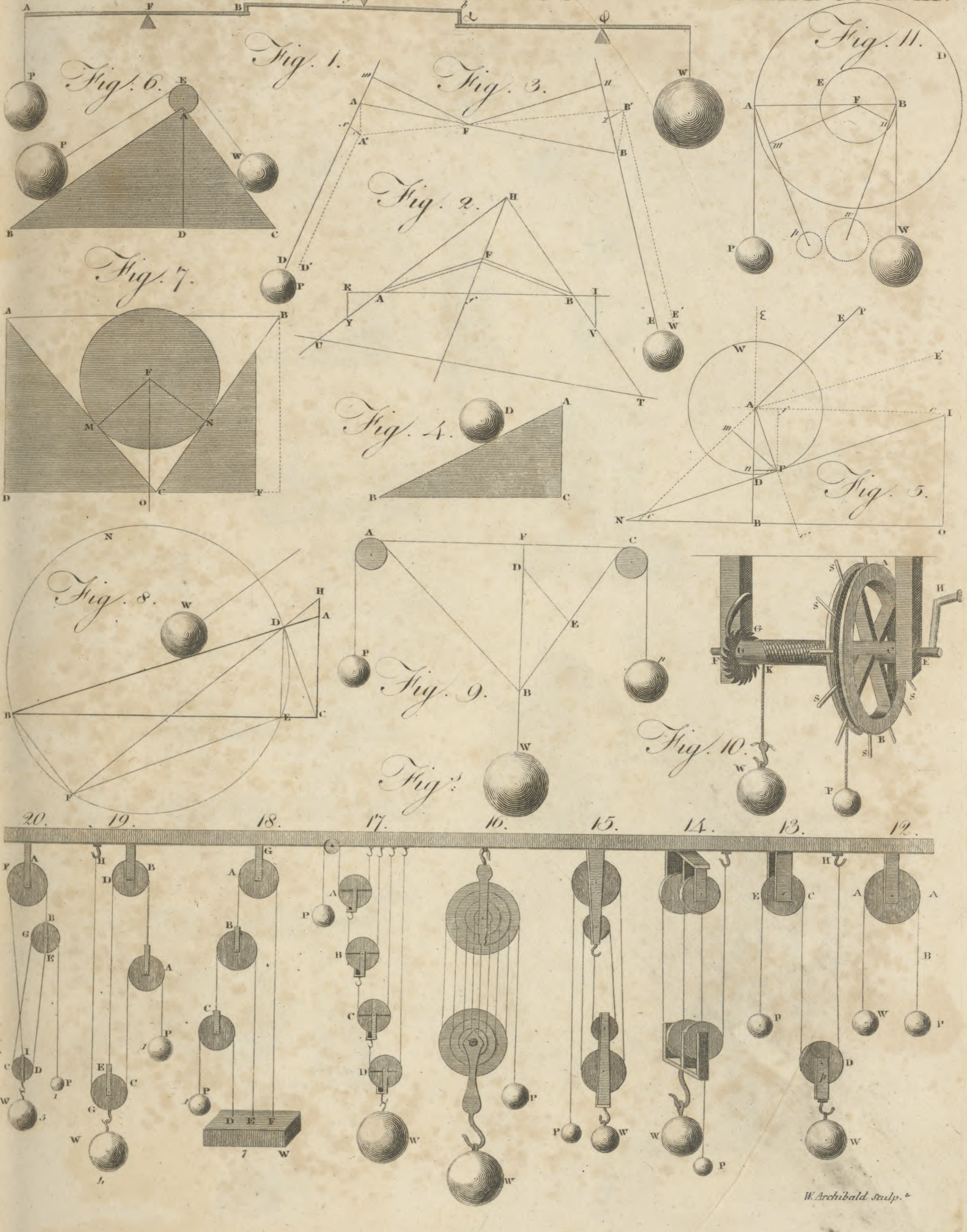

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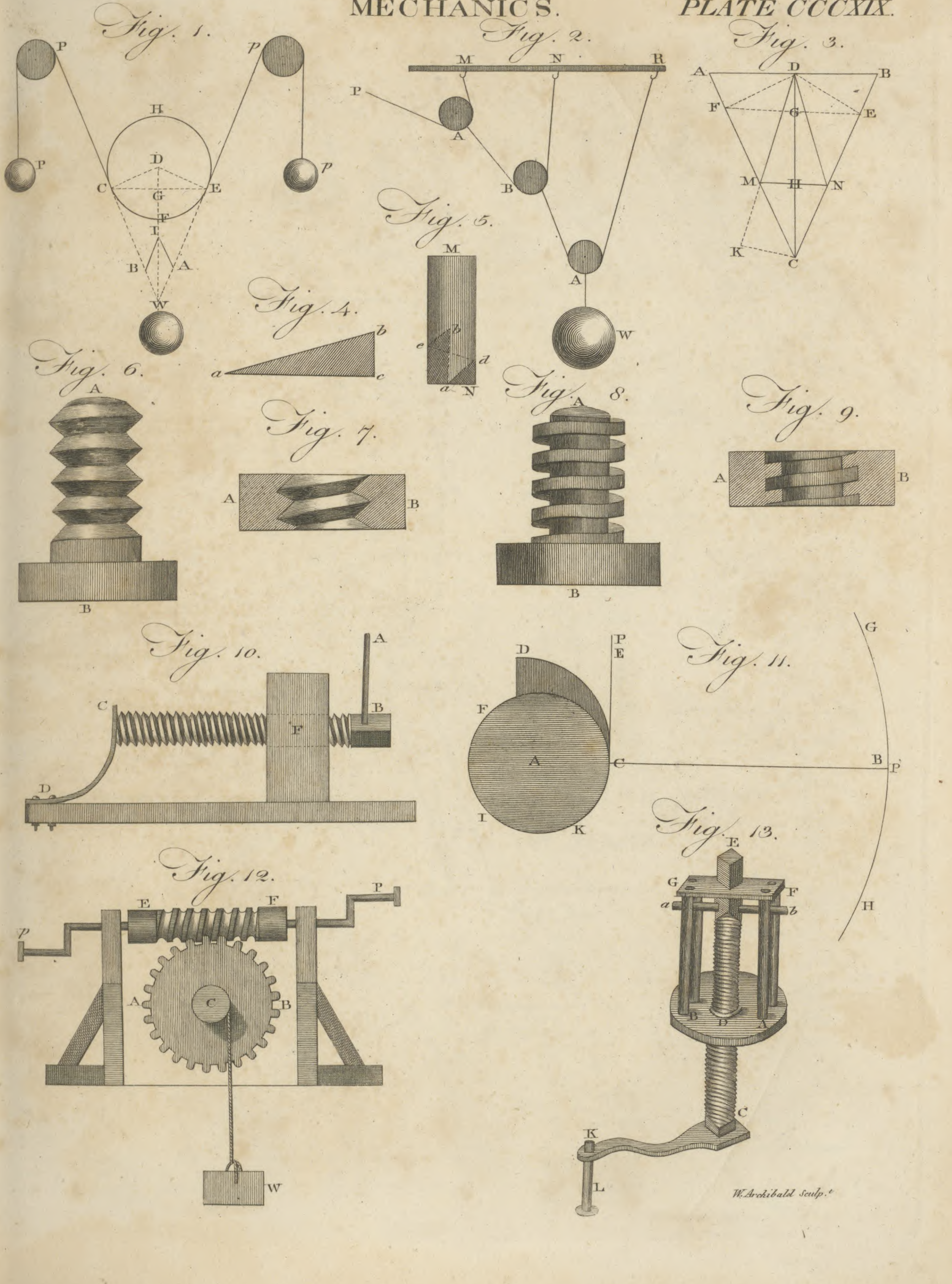

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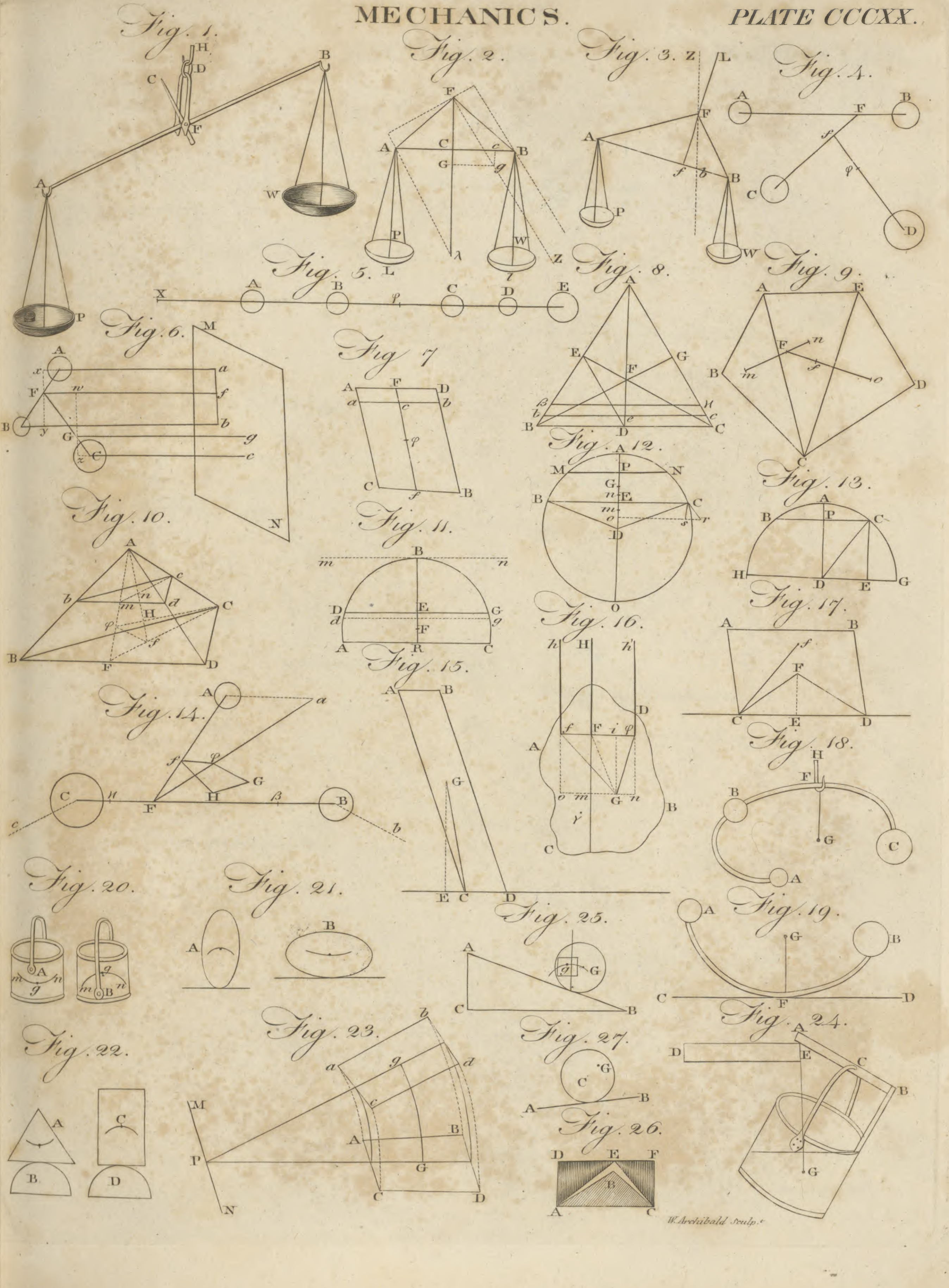

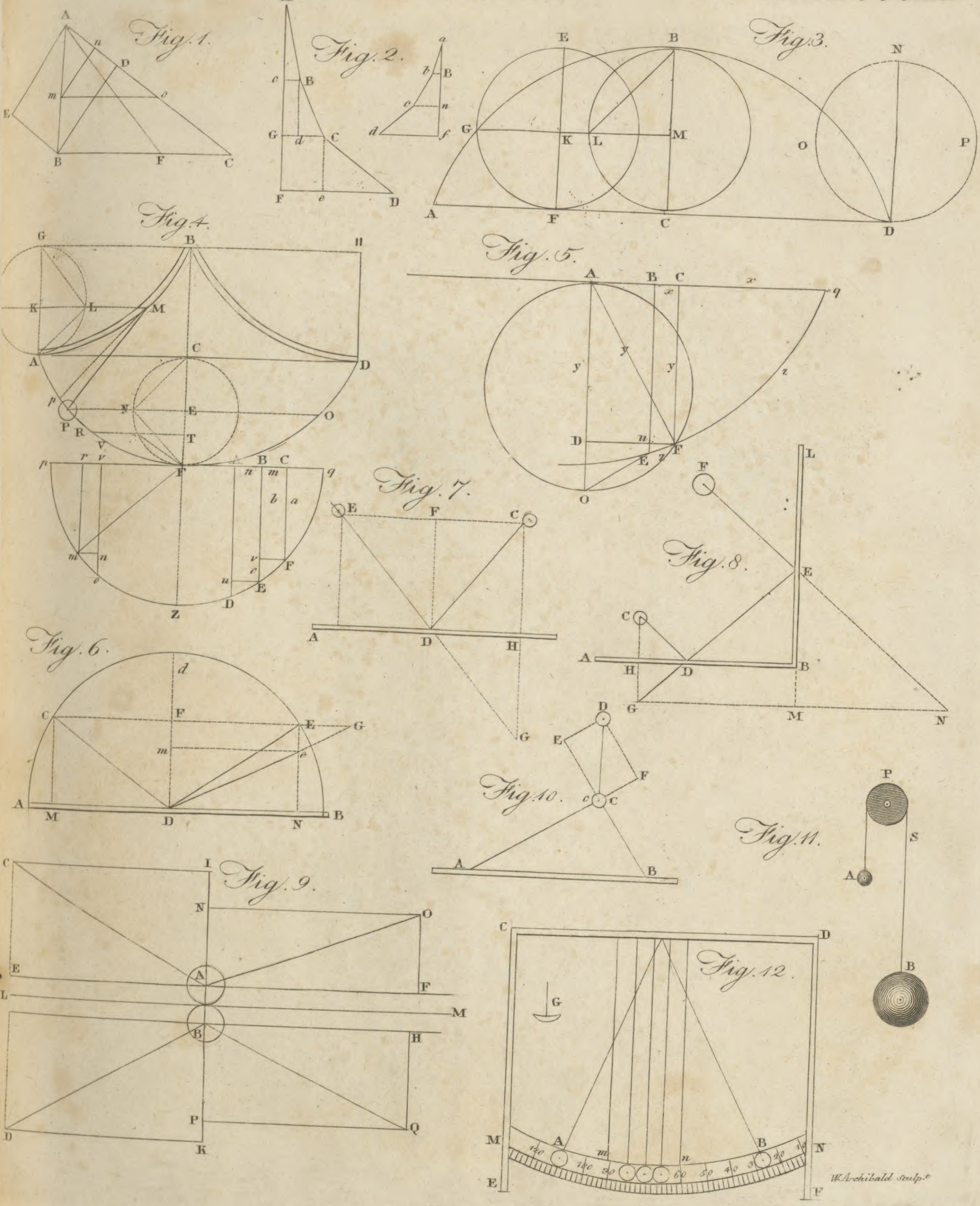

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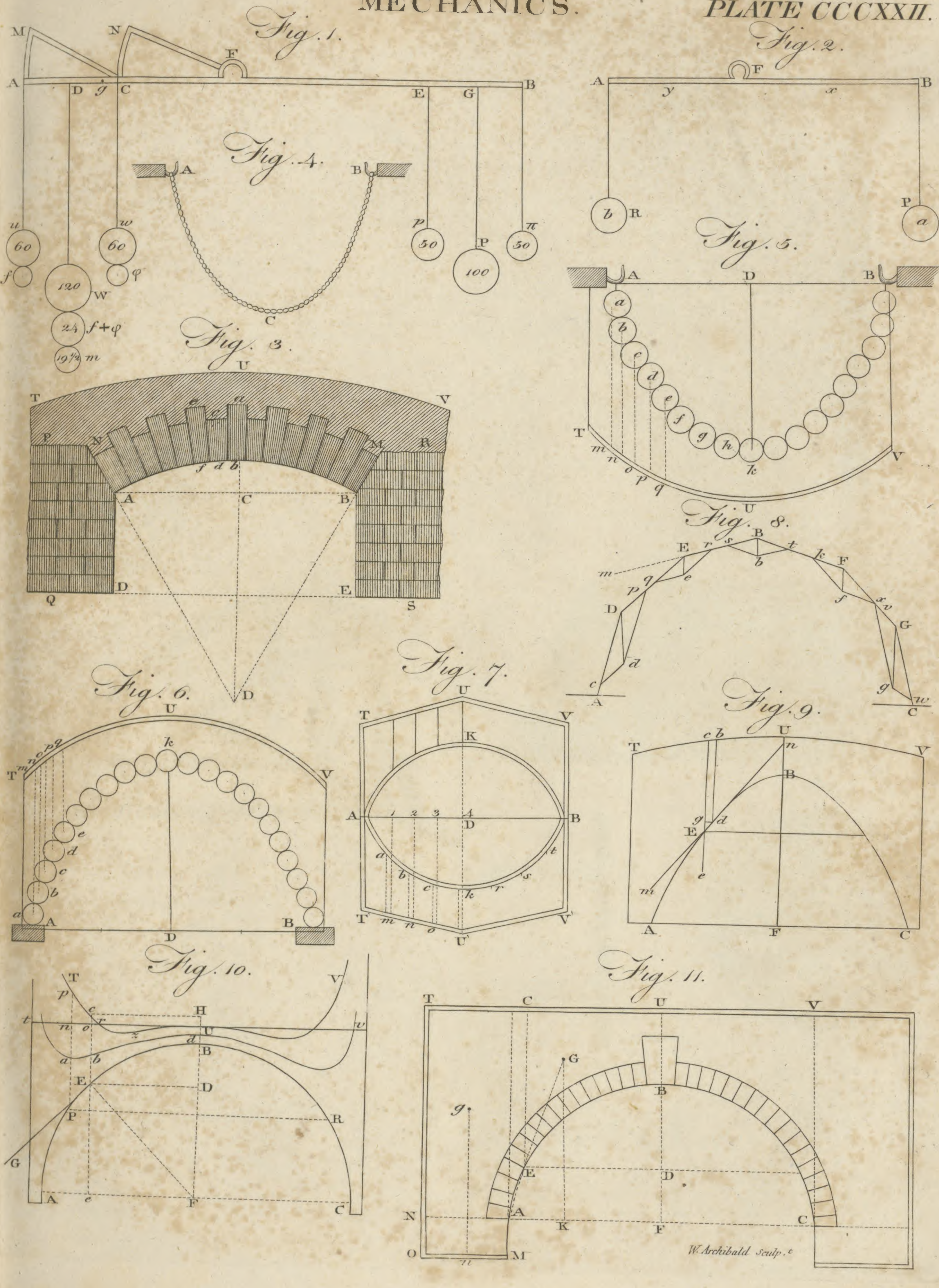
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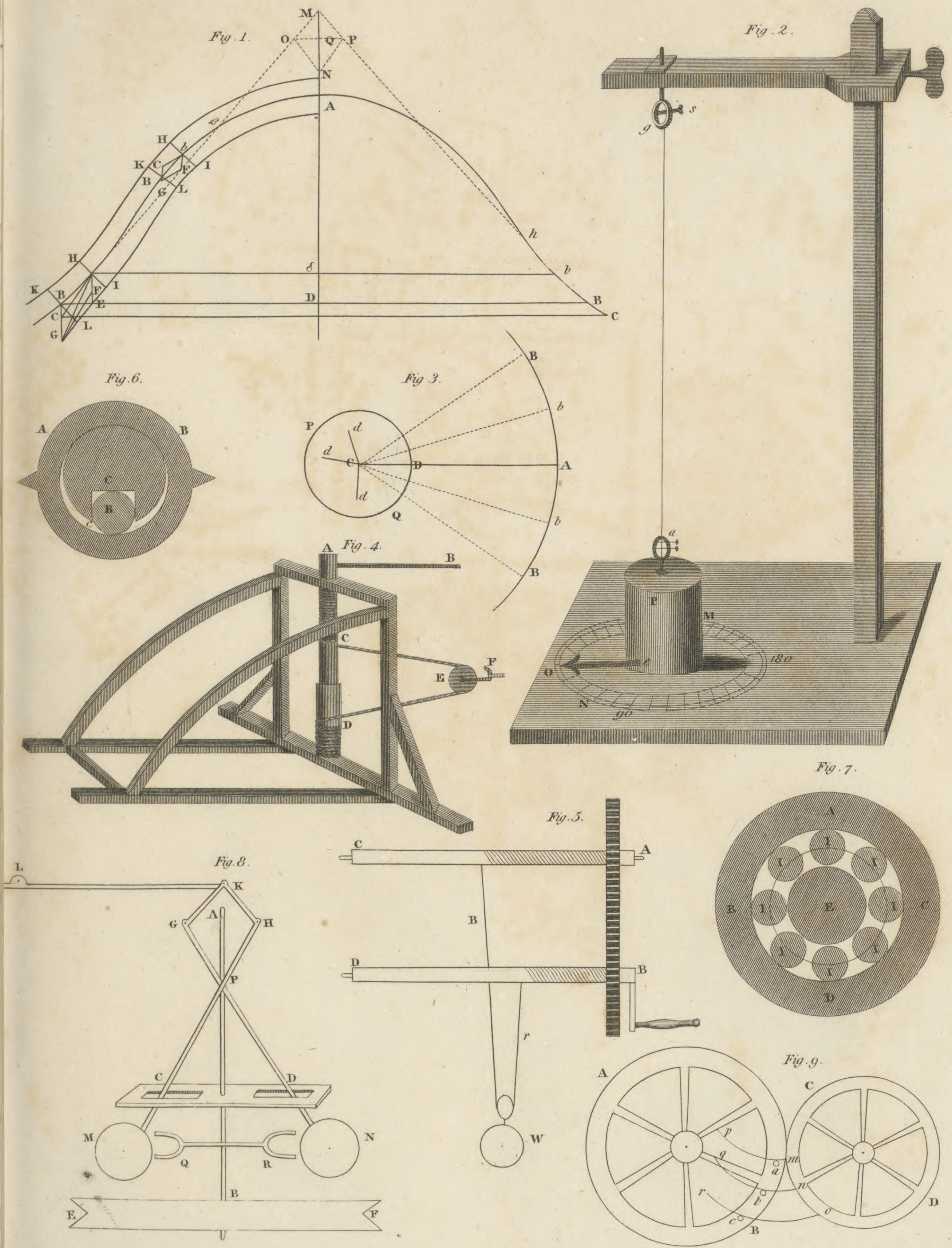

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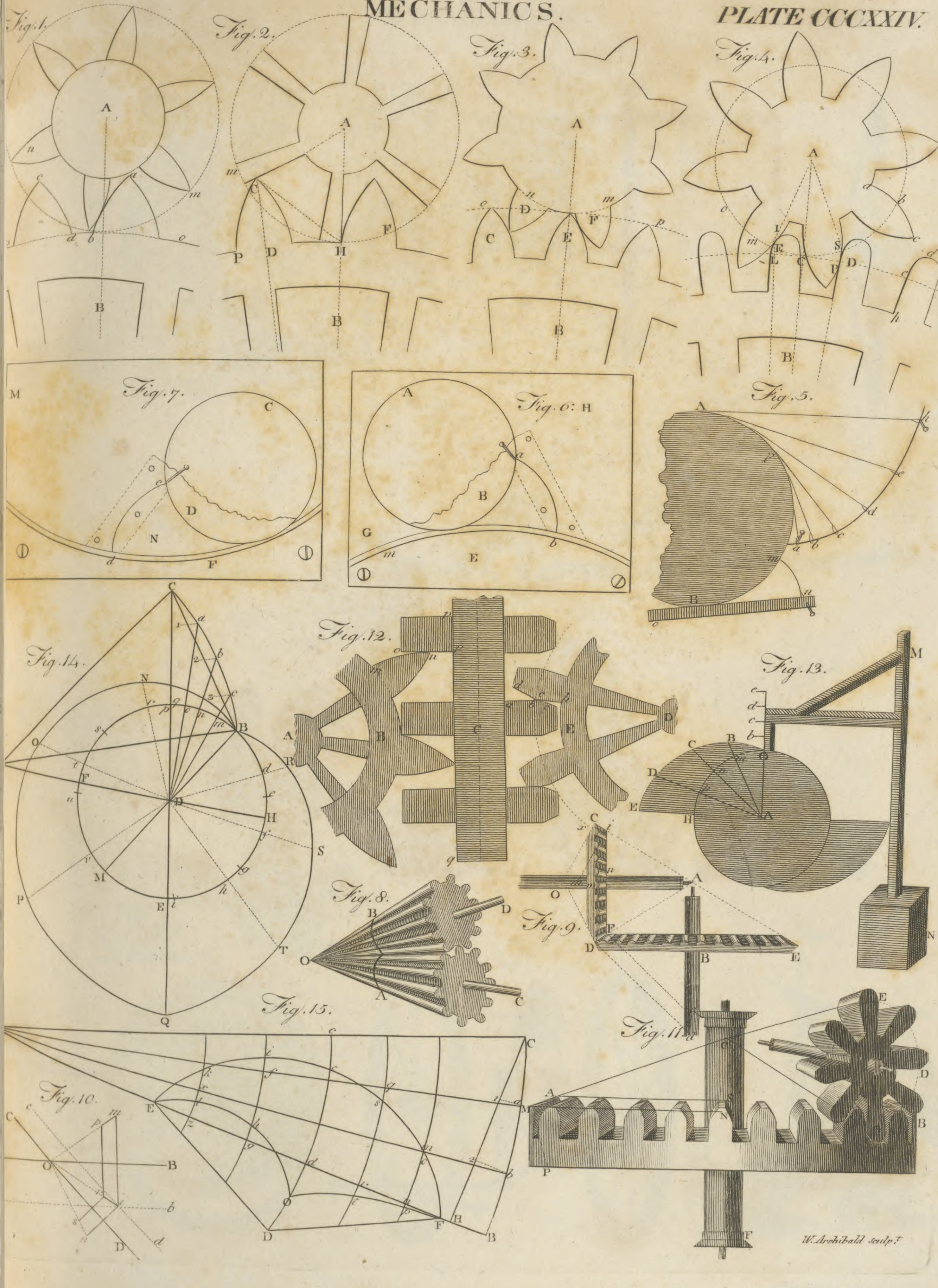

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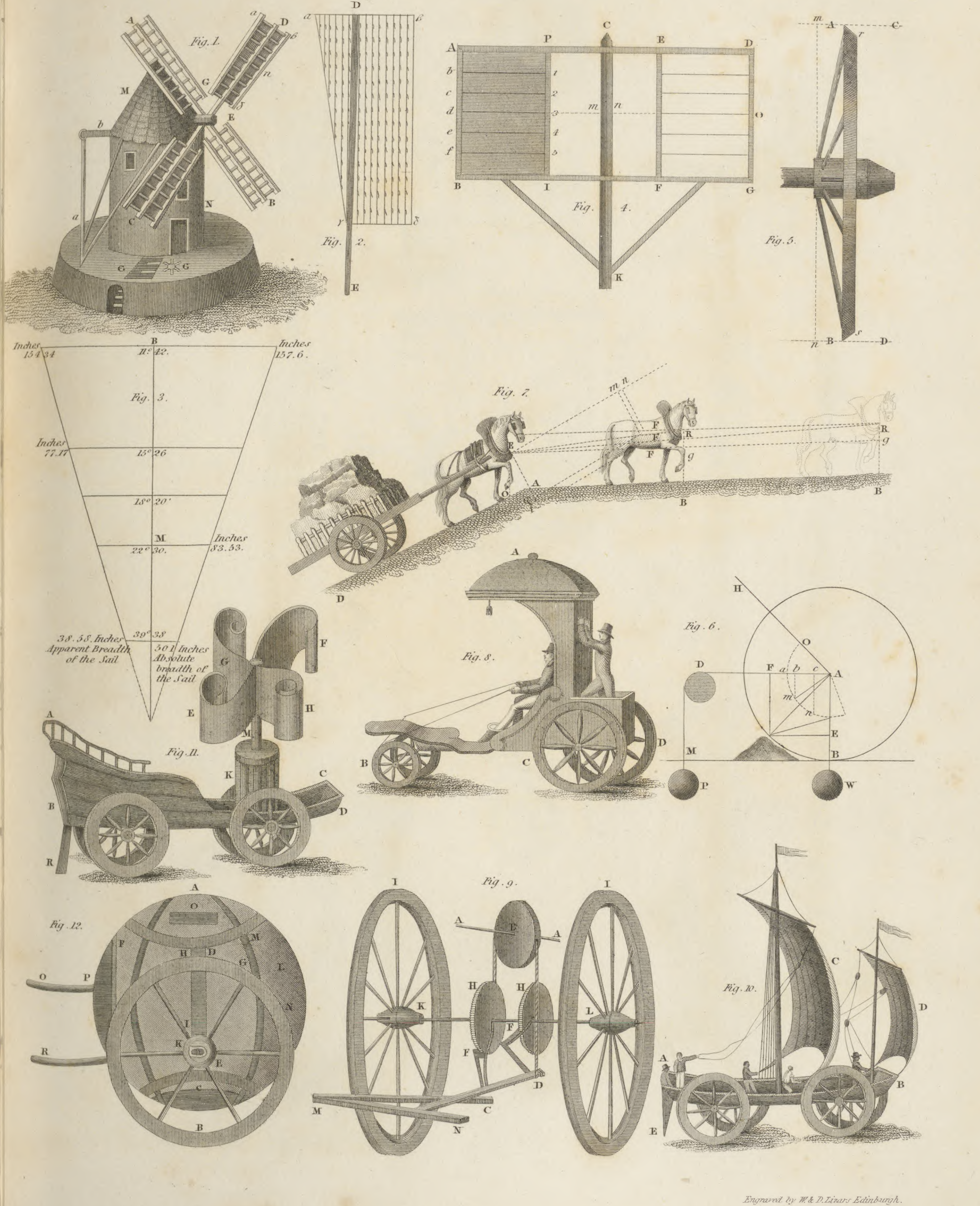

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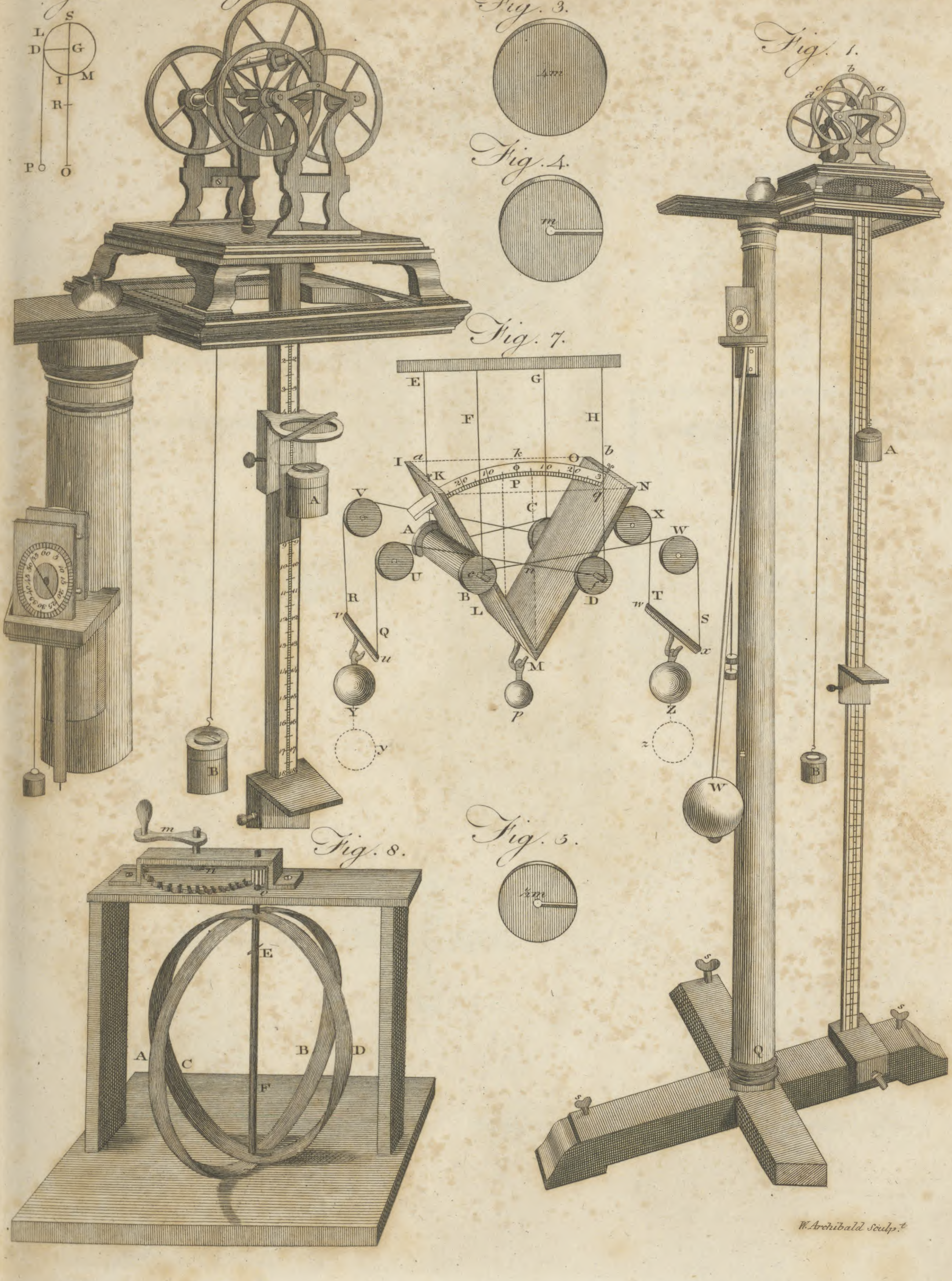

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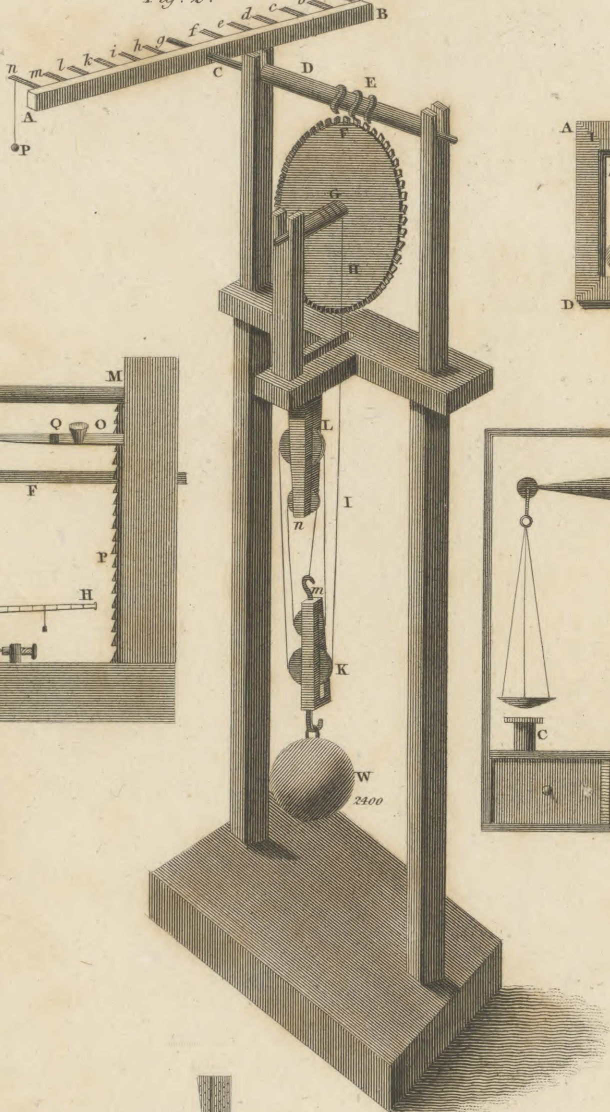

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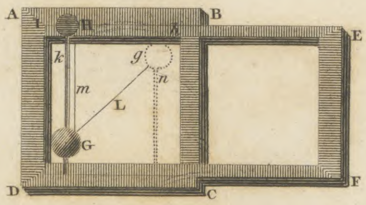

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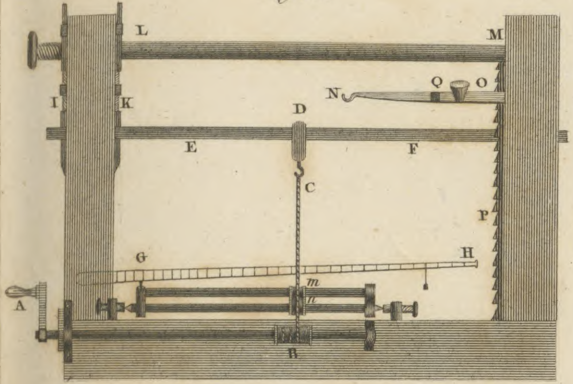

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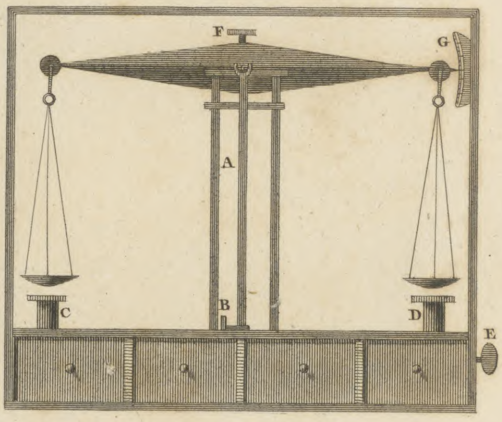

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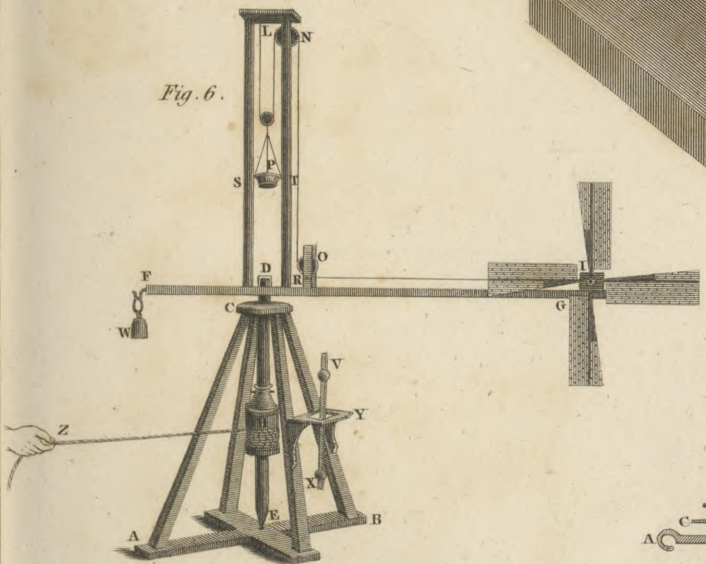

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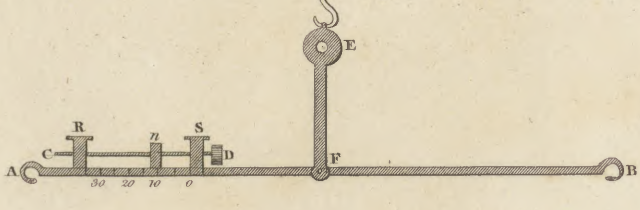

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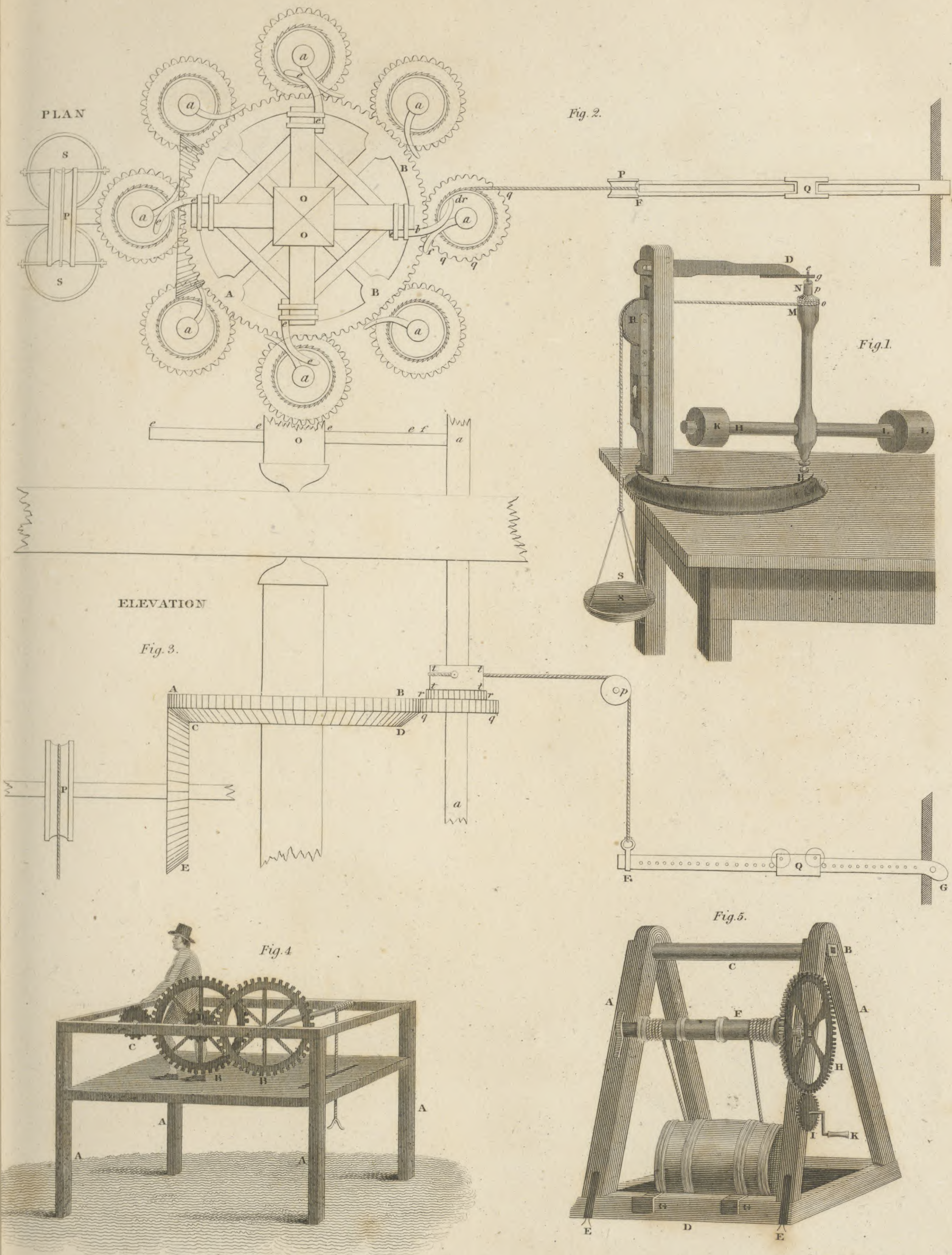

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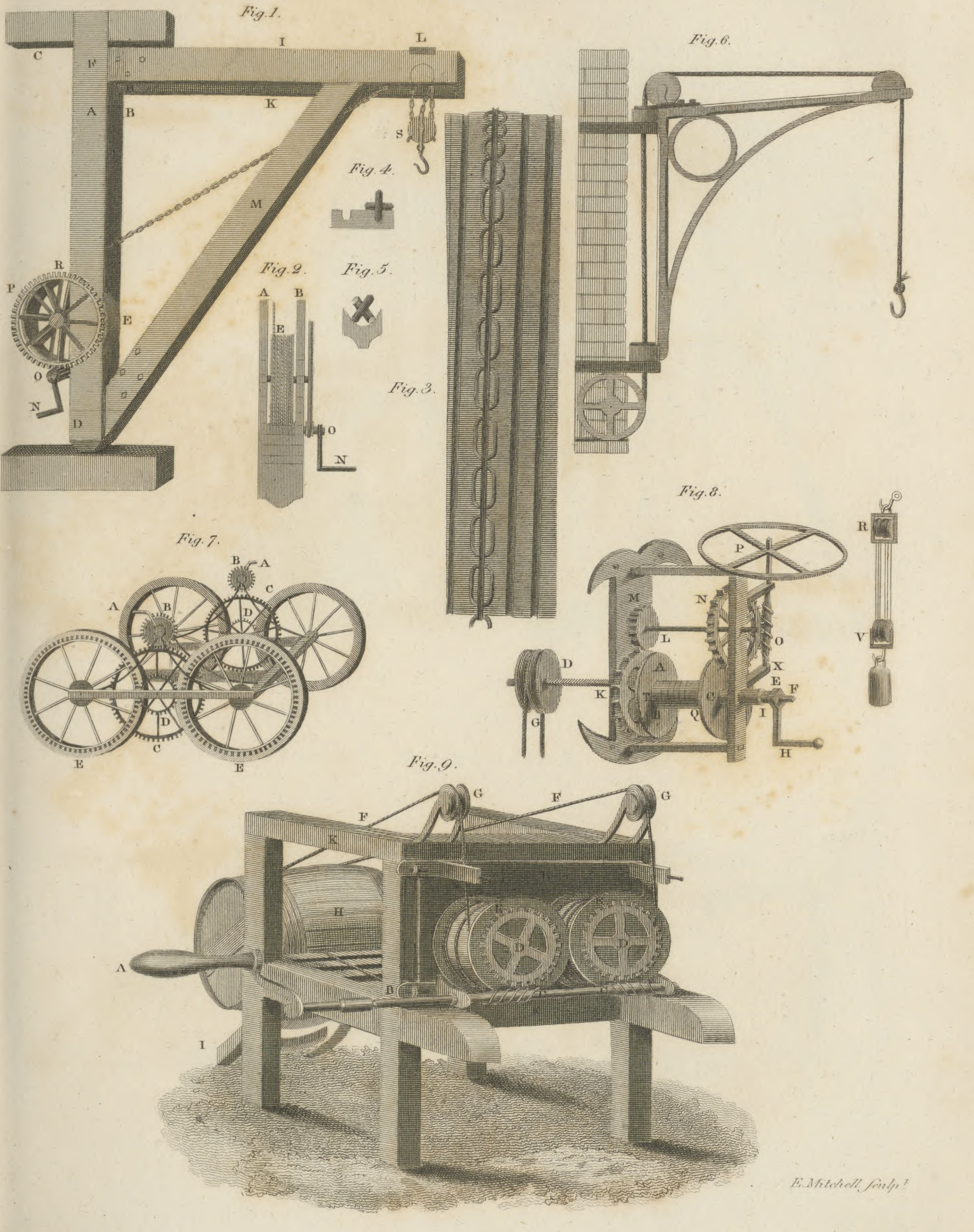

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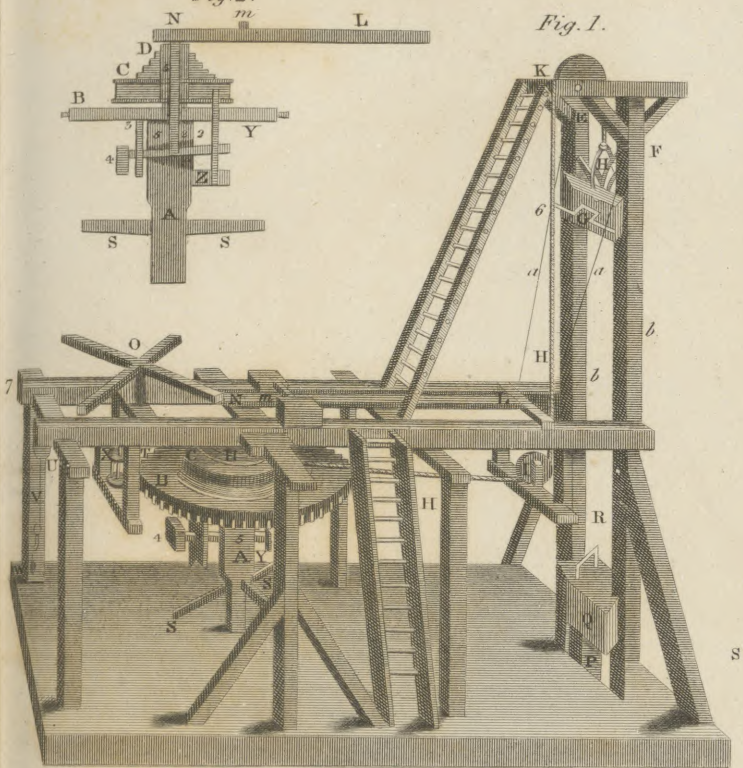
Vauloue's Pile Engine.

Fig. 2.



Bunces Pile Engine.

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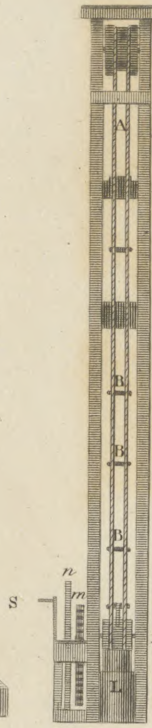

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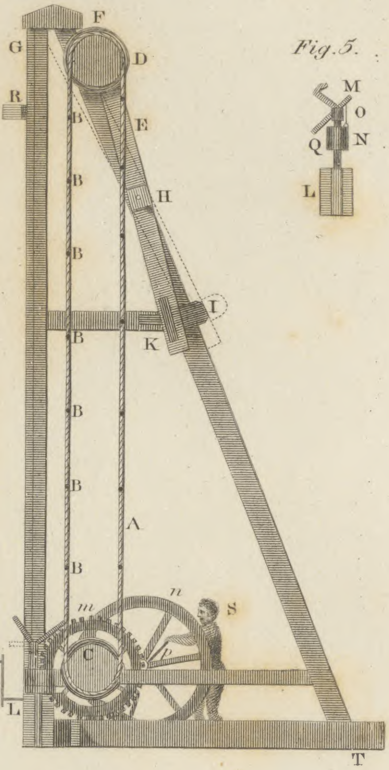
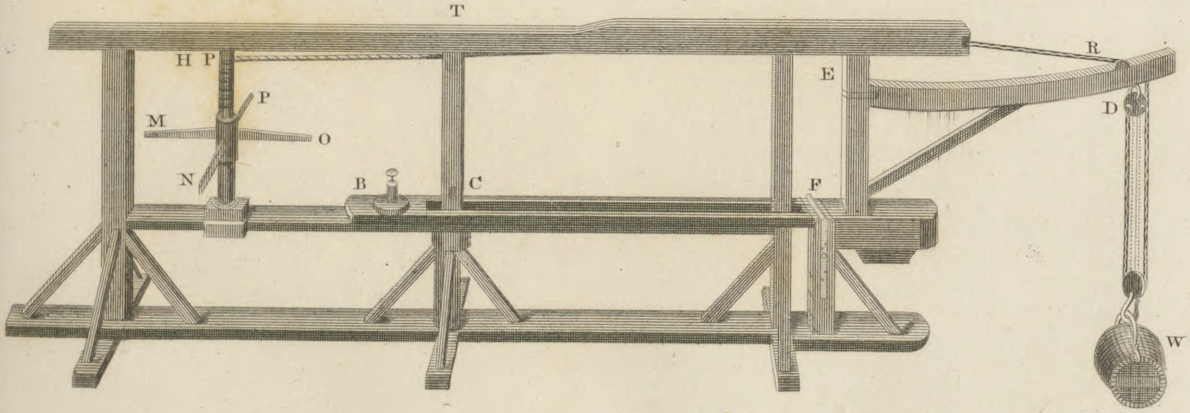


Andrew's Weighing Crane.

Fig. 6.



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Mechanism || Mecklenburg.

MECHANISM, either the construction or the machinery employed in any thing; as the mechanism of the barometer, of the microscope, &c.

MECHOACAN, a province of Mexico, or New Spain, in America, bounded on the north by Panuco and Guadalajara, on the east by Panuco and Mexico Proper, on the south by the Pacific ocean, and on the west by Guadalajara and the South sea. It is about 200 miles in circumference. The soil is exceedingly fertile; and the climate so wholesome, that the Spaniards imagine it to be possessed of some peculiarly restorative quality; for which reason the sick and infirm flock to it from all quarters. The commodities are sulphur, indigo, sarsaparilla, sassafras, cacao, vanelloes, ambergris, hides, wool, cotton, silk, sugar, the root mechoacan or white jalap, and silver. This province formed an independent kingdom at the time Mexico was reduced by Cortez. The sovereign had long been the inveterate enemy of the Mexicans, and was considered next to the republic of Tlascala, as the most formidable barrier against the extension of the imperial frontier. However, he submitted to Cortez without striking a blow, being intimidated by the wonders he had performed with a handful of men; and thus Mechoacan became a province of the Spanish empire, and a valuable addition to Mexico. The country at that time was exceedingly populous, but the natives are now much thinned; and that rather by the luxury and effeminacy introduced by the Spaniards, than by their tyranny. The capital of the province is also called *Mechoacan* by the natives, but *Valladolid* by the Spaniards.

MECHOACAN, or *White Jalap*, in the materia medica, the root of an American species of convolvulus, brought from Mechoacan, a province of Mexico, in thin slices like jalap, but larger, and of a whitish colour. It was first introduced into Europe about the year 1524 as a purgative: but since jalap became known, mechoacan has been little employed.

MECKLENBURG, a duchy of Germany, containing those of Schwerin and Gustro, is bounded by Pomerania on the east, by part of the marquisate of Brandenburg and the duchy of Lunenburg on the south, the Baltic on the north, and Holstein and Saxe Lawenburg on the west. Their greatest length is about 135 miles, and greatest breadth upwards of 90. With respect to the soil, much cannot be said in favour of it, as it consists in general, either of sand, or large and desolate heaths interspersed with moors, woods, fens, and lakes. It yields very little wheat, and not a great deal of oats, rye, and barley; but breeds a considerable number of sheep and cattle, has plenty of fish, with stone quarries, salt springs, alum, iron, and some copper. The principal rivers here are the Elde and Stor, which fall into the Elbe as it glides along the borders of this country to the southwest; the Reckenitz, which discharges itself into the Baltic; as do the Peene, the Warno, and the Stopenitz. This country has only one harbour on the Baltic, namely that of Rostock. In both duchies, exclusive of Rostock, are 45 great and small cities, with three convents, and a great number of manors and farms, belonging either to the duke, the nobility, or convents. The peasants are in a state of villenage; but the nobility enjoy very considerable privileges,

Mecklenburg, Meconium.

The states are composed of the nobility and towns; and the diets, which are summoned annually, are held alternately at Sternberg and Malehin. The duchy of Schwerin appoints four provincial counsellors, and that of Gustro as many; who rank according to seniority, with the duke's actual privy counsellors, as their marshals do with the colonels. The lesser committee represents the whole body of the nobility and commons, by whom the members are chosen freely and without controul, and no edict relative to the whole country can be published without their consent, or in prejudice of their rights. The inhabitants of this country are mostly Lutherans, under their superintendants. There are also some Calvinists and Roman Catholics. Besides the grammar schools in the towns, there is an university at Rostock. The commodities of the duchy are corn, flax, hemp, hops, wax, honey, cattle, butter, cheese, wool, and wood, a part of which is exported; but hardly any manufactures.

Of the house of Mecklenburg, there are two lines still subsisting, viz. that of Schwerin and that of Strelitz. The latter commenced in Duke Adolphus Frederick II. younger brother of the duke of Schwerin, and grandfather of Adolphus Frederick IV. who entered on the government in 1752, and whose family received a great additional lustre by his Britannic majesty's taking his second sister for his consort, and by her own great merit and noble deportment in that high station. Besides the duchy of Strelitz, to this duke belong the principality of Ratzeburg, with the lordship of Stargard, the ancient commanderies of Miro and Nemero; and a yearly pension of 9000 dollars out of the Boitzenburg toll. The title assumed by both the dukes is *duke of Mecklenburg; prince of Wenden, Schwerin, and Ratzburg; count of Schwerin and the country of Rostock, and lord of Stargard*. By the agreement concluded at Wittstock in 1442, the elector of Brandenburg, on the extinction of the male line of the dukes of Mecklenburg, is entitled to their whole succession. The duke of Schwerin has two votes both in the diet of the empire and that of the circle. The matricular assessment for the duchies of Schwerin and Gustro is 40 horse and 67 foot, or 748 florins monthly, including what is paid by Sweden for Wismar, and the bailiwicks of Poll and Neukloster. To the chamber of Wetzlar, these two duchies pay each 243 rix dollars, 43 kruitzers. For the government of Mecklenburg, the administration of justice, and the management of the revenue, there is the privy council of regency, the demesne chamber, the high and provincial court of justice to which appeals lie in most causes, both from the consistory and the inferior civil courts, and which are common to both the dukes. As to the revenues, those of the Schwerin line must be very considerable, those arising from the demesne bailiwicks and regalia alone amounting to 300,000 rix dollars per annum. There is a tax on land that produces no contemptible sum, and that called the *princess's tax* is fixed at 20,000 rix dollars: besides all these, there are also free gifts. The whole revenues of the Strelitz branch are estimated at 120,000 rix dollars. Each of these princes maintains a body of troops.

MECONIUM, the excrement contained in the intestines of an infant at its birth.

MEDALS.

Utility of them in Hiſtory, &c. MEDAL, denotes a piece of metal in the form of coin, ſuch as was either current money among the ancients, or ſtruck on any particular occaſion, in order to preſerve to poſterity the portrait of ſome great perſon, or the memory of ſome illuſtrious action. Scaliger derives the word *medal* from the Arabic *methalia*; a ſort of coin with a human head upon it. But the opinion of Voſſius is generally received; viz. that it comes from *metallum*, "metal;" of which ſubſtance medals are commonly made.

Sect. I. *Utility of Medals in Hiſtory, and various other Sciences.*

There are few ſtudies of more importance to hiſtory than that of medals; the ſole evidence we can have of the veracity of a hiſtorian being only ſuch collateral documents as are evident to every body, and cannot be falſified. In modern times, theſe are found in public memoirs, inſtructions to ambaſſadors, and ſtate papers of various kinds. Such memorials, however, are ſubject to various accidents, and beſides commonly remain in the countries where they are firſt publiſhed, and cannot therefore give to the world at large that perfect and entire ſatisfaction which ought to be derived from genuine hiſtory; ſo that more durable and widely diffuſed monuments are ſtill to be wiſhed for. Such are public buildings, inſcriptions, and ſtatues; but theſe, excepting a few inſtances of the two laſt, are always confined to particular countries; ſo that medals alone remain as infallible documents of truth, capable of being diffuſed over all countries in the world, and of remaining through the lateſt ages.

1 Various writers on medals. The firſt who ſhowed the importance of medals in aſcertaining the dates, and arranging the order of events, in ancient hiſtory, by means of medals, was Vaillant, in his Hiſtory of the Kings of Syria, printed at Paris in 1681. By medals alone, he has been enabled to fix the chronology and important events of hiſtory, in the three moſt ancient kingdoms of the world, viz. Egypt, Syria, and Parthia. Many coins have been diſcovered ſince his time, which confirm the accounts he has given. He was followed in this method by Father Hardouin, though with leſs ſucceſs. Hardouin's beſt work is his *Herodiades*, or Series of Succeſſors to Herod king of Judæa. The ſame plan was purſued by Noris, in his learned Treatiſe on the Syro-Macedonian princes, and by Bayer in his Hiſtory of Oſrhoene, as well as by Froelich, in the work entitled *Annales Regum et Rerum Syriæ*, Vien. 1754, and another named Kevenhullers *Regum veterum Numiſmata Anecdota, auct. Perrara*, Vien. 1752, 4to, of which Froelich was properly the author. Corſini and Cary likewiſe publiſhed works of a ſimilar nature; the former in 1744, *De Minniſari, aliorumque Armeniæ Regum, Nummis*, &c.; the latter in 1752, *Hiſtoire des Rois de Thrace, et du Boſphore Cimmerien, eclaircie par les Medailles.*

The ſtudy of the Greek coins does not ſhow the dates of events, though it illuſtrates the chronology of reigns. This defect, however, is abundantly ſupplied by thoſe of Rome, which commonly mark the date of the prince's conſulſhip, the year of his tribunician power; giving alſo, upon the reverſe, the repreſentation or poetical ſymbol of ſome grand event. The year of the tribunician power is ſometimes imagined by antiquaries to be ſynonymous with that of the emperor's reign: but this is not the caſe; and Mr Pinkerton is at ſome pains to ſet them right in this reſpect. He finds fault with Julius Cæſar, when he aſſumed the ſovereign authority, for taking upon him the title of Perpetual Dictator, as being ſynonymous with that of king or abſolute governor, which the Romans abhorred. "He ought (ſays our author), under the diſguiſe of ſome ſupreme magiſtrate of annual election, to have lulled the people with a dream, that they might terminate his power when they pleaſed; or that he himſelf would reſign it, when the neceſſities of ſtate which had required his temporary elevation had ſubſided." To this error Mr Pinkerton aſcribes the aſſaſſination of the dictator, and commends the policy of Auguſtus, who, with far inferior abilities, continued in poſſeſſion of the moſt abſolute authority as long as he lived. The tribuneſhip was an office of annual election; and if put into the hands of any others than plebeians, muſt have been the ſupreme power of the ſtate, as it belonged to that office to put a negative upon every public meaſure whatever. Auguſtus, being of ſenatorial rank, could not aſſume this office: but he inveſted himſelf with the tribunician power, which had the advantages of appearing to be only a temporary ſupremacy, though in truth it was continued during his whole lifetime. Towards the end of his reign, he frequently aſſumed his deſtined ſucceſſor, Tiberius, for his colleague, though in the beginning he had enjoyed it alone. This, with his artifice of reſigning his power every ten years, and reaſſuming it at the deſire, as was pretended, of the ſenate, ſecured his ſovereignty as long as he lived.— His example was followed by his ſucceſſors; ſo that moſt of them have the inſcription *Tribunicia Poteſtate* upon their medals, with the date affixed to it thus, *Tr. Pot.* VII. Yet though this date generally implies the year of the emperor's reign, it ſometimes happens that the emperor, by ſpecial favour from a former prince, had been endowed with this title before he came to the throne, as being the ſucceſſor to that prince, of which we have already given an inſtance in Tiberius. Beſides the tribunician power, the emperors very frequently enjoyed that of the conſuls; and the date of their conſulſhip is frequently expreſſed in their coins.

Utility of them in Hiſtory, &c.

2 Of the Greek coins.

3 Method uſed by Auguſtus to ſecure his power.

The office of Pontifex Maximus was likewiſe aſſumed by the Roman emperors, in order to ſecure themſelves in their authority; which, Mr Pinkerton obſerves, was one of the moſt efficacious artifices they could have fallen upon. "In the Greek heroic times (ſays

Utility of them in History, &c.

(says he), king and prieſt were carefully united in one perſon; and when ſovereigns aroſe in Denmark and Sweden, the ſame plan was followed, as appears from Snorro, and other writers. Nothing could lend more ſecurity to the perſon of the monarch than an office of ſupreme ſanctity, which alſo confirmed his power by all the terrors of ſuperſtition. Even the Chriſtian ſyſtem was afterwards debaſed by a mock alliance with government; though it be clear from the whole New Teſtament, that ſuch an alliance is ſubverſive of its genuine inſtitution, and the greateſt of all its corruptions. But the Roman Catholic clergy, in the dark ages, were the authors of 'no church no king,' for their own intereſt; while the Roman emperors only ſought to ſtrengthen their power by the dark awe of ſuperſtition. The title of Pontifex Maximus was ſo important, that it was retained even by the Chriſtian emperors till the time of Gratian. Its influence in the ſtate was, indeed, prodigious. Cicero obſerves, that to this office were ſubject, temples, altars, penates, gods, houſes, wealth, and fortune of the people.—That of augur is alſo borne by many emperors; and its authority was ſuch, that by the law of the twelve tables no public buſineſs could be tranſacted without a declaration from the augur concerning its event.—The proconſular power was alſo given to Auguſtus and the other emperors. It conferred a direct authority over all the provinces, and implied the emperor to be chief proconſul, or governor of each, and of all. Another ſpecial power aſſigned to the emperors, but not occurring on coins, was the *Jus Relationis Tertiæ*, *Quartæ*, &c. or the right of making three or four motions in the ſenate on the ſame day, while the ſenators could only propoſe one.

Hence our author infers, that medals afford the moſt authentic documents of the Roman hiſtory, in particular, that could have been invented by man.—The hiſtories of Nerva and Trajan are much better elucidated by medals than by authors; for the hiſtory of Suetonius ends with Domitian, and the *Hiſtoriæ Auguſtæ Scriptores* begin with Adrian: ſo that the reigns of the two emperors juſt mentioned are almoſt unknown; and Mr Pinkerton is ſurpriſed that none of the learned have attempted to ſupply the defect.—"Capitolinus (ſays he), in his life of Maximinus Junior, is quite puzzled to know if Maximus and Pupienus were two emperors, or two names for the ſame. Had he happened on any of thoſe coins which bear M. CL. PUPIENUS MAXIMUS AUG. he would have ſeen at once that Maximus was only another name for Pupienus."

4
Uſe of medals in geography.

Medals are uſeful in other ſciences beſides hiſtory. In geography, we find the ſituation of towns determined by their vicinity to ſome noted river, mountain, &c. Thus, ΜΑΓΝΗΤΩΝ ΣΙΠΥΛΟΥ ſhows that Magneſia was ſituated under Mount Sipylus. In like manner, it is ſhown from a medal, that Epheſus ſtood on the river Cayſter; and there is extant a medal, bearing an inſcription, which ſignifies Alexandria on the Scamander; a name given to Troy by Alexander the Great. The reverſe has upon it the famous Apollo Smintheus of Homer.

5
In natural hiſtory.

In natural hiſtory alſo, medals are uſeful chiefly from the coins ſtruck on the celebration of the ſecular games, in which the figures of various animals are preſerved; and thus it may very often be determined whether any animal be known to the ancients or not. On many of the Greek medals are ſeveral uncommon plants and animals. Thus, on moſt of the medals of Cyrene is the figure of the celebrated *Sylphium*; and on thoſe of Tyre, the ſhell-fiſh from which the famous Tyrian purple was procured.

6
In architecture.

By means of medals, alſo, the exact delineations of many noble edifices are preſerved, though not even a veſtige of their ruins be now exiſting; ſo that the uſes of them to the architect are very conſiderable.

7
In the fine arts.

To the connoiſſeur they are abſolutely neceſſary; becauſe by them alone he is enabled to aſcribe ancient buſts and ſtatues to their proper perſons, with multitudes of other points of knowledge which cannot be otherwiſe determined. The elucidations of obſcure paſſages in ancient authors by means of medals are ſo numerous and well known, that it is needleſs to inſiſt upon them.

Mr Addiſon has treated the connexion betwixt medals and poetry at conſiderable length; but Mr Pinkerton finds fault with him for preferring the Latin to the Greek poets. He obſerves alſo, that the knowledge of Greek medals is moſt neceſſary for a ſculptor, and perhaps an architect; but an acquaintance with Latin ones is preferable for a poet, or perhaps a painter.

8
Latin medals of uſe to a poet.

The reaſon of this difference is, that the former generally have on the obverſe the head of ſome king, god, or goddeſs, of exquiſite relief and workmanſhip; but the reverſe ſeldom affords much fancy of ſymbol in the early Greek coins; and in the imperial Greek coins, is chiefly impreſſed with the temples of their deities. To a perſon of poetical imagination, however, the Roman coins afford the greateſt entertainment, from the fine perſonifications and ſymbols to be found on their reverſes; of which our author gives the following inſtances:

9
Perſonifications on Roman medals.

"HAPPINESS has ſometimes the caduceus, or wand of Mercury, which Cicero, 1. *Offic.* tells us was thought to procure every wiſh. She has, in a gold coin of Severus, heads of poppy, to expreſs that our prime bliſs lies in oblivion of misfortune.

"HOPE is repreſented as a ſprightly girl, walking quickly, and looking ſtraight forward. With her left hand ſhe holds up her garments, that they may not impede the rapidity of her pace; while in her right hand ſhe holds forth the bud of a flower; an emblem infinitely more fine than the trite one of an anchor, which is the ſymbol of Patience, and not of Hope. This perſonification, with ſome others, muſt have been very familiar to the ancients; for often in this, and in a few more inſtances, no name, as SPES AUG. or the like, is inſerted in the legend.

"ABUNDANCE is imagined as a ſedate matron, with a cornucopiæ in her hands, of which ſhe ſcatters the fruits, and does not hold up her cornucopiæ and keep the contents to herſelf as many modern poets and painters make her do.

"The emperor Titus, having cauſe to import a great ſupply of corn during a ſcarcity at Rome, that ſupply, or the ANNONA, is finely repreſented as a ſedate lady, with a filled cornucopiæ in her left hand, which ſhe holds upright, to indicate that ſhe does not, however, mean to ſcatter it, as Abundance has a title to do, but to give it to Equity to deal out. This laſt particular is ſhown by her holding a little image of

Equity,

Utility of them in Hiſtory, &c.

Equity, known by her ſcales, and *haſta pura*, or pointleſs ſpear, in her right hand, over a baſket filled with wheat. Behind the Annona is the prow of a ſhip decked with flowers, to imply that the corn was brought by ſea (from Africa), and that the ſhips had had a proſperous voyage. The beſt poet in the world would not have given us a finer train of imagery; the beſt painter would have been puzzled to expreſs ſo much matter in ſo ſmall a compaſs.

"Security ſtands leaning upon a pillar, indicative of her being free from all deſigns and purſuits; and the poſture itſelf correſponds to her name. Horace, in deſcribing the wiſe man, mentions his being *teres atque rotundus;* round and poliſhed, againſt all the rules of chance: an idea ſeemingly derived from the column upon which this ideal lady reclines.

"The emblems of Piety, Modesty, and the like, are equally appoſite and poetical.

"The happineſs of the ſtate is pictured by a ſhip ſailing before a proſperous breeze: an image than which the ſuperlative genius of Gray could find none more exquiſite; and he has accordingly uſed it in his moſt capital production "The Bard," with due ſucceſs.

"The different countries of the then known world are alſo delineated with great poetical imagery. It affords patriotic ſatisfaction in particular to a Briton, to ſee his native iſland often repreſented upon the earlieſt imperial coins ſitting on a globe, with a ſymbol of military power, the *labarum*, in her hand, and the ocean rolling under her feet. An emblem almoſt prophetic of the vaſt power which her dominion over the ſea will always give her, provided ſhe exerts her element of empire with due vigour and perſeverance.

"Coins alſo preſent us with Achaia, Africa, Alamannia, Alexandria, Arabia, Armenia, Aſia, Bithynia, Cappadocia, Dacia, Dardania, Egypt, Gallia, Hiſpania, Italia, Judæa, Macedon, Mauritania, Pannonia, Parthia, Phrygia, Sarmatia, Sicily, Scythia, Syria, and the rivers Danube, Nile, Rhine, Tyber. This perſonification of provinces ſeems to have ariſen from the figures of provinces carried in triumphs; as the perſonification of our old poets ſprung from the ideal perſons actually repreſented in the myſterial plays.

"There is one colonial medal of rude execution of Auguſtus and Agrippa, which has a high claim to merit in diſplaying the ancient poetical imagery. It is inſcribed Imp. and Divi. f. and on the reverſe, the conqueſt of Egypt is repreſented by the metaphor of a crocodile, an animal almoſt peculiar to that country, and at that period eſteemed altogether ſo; which is chained to a palm tree, at once a native of the country, and ſymbolic of victory.

10
Medals uſeful to a painter.

"As the reverſes are ſo uſeful for knowledge of perſonification, ſymbols of countries and actions, and the like; ſo the portraits to be ſeen on old coins are no leſs important to a painter; the high merit of a great number of them, in every character, juſtly entitling them to be regarded as the beſt ſtudies in the world. Not to mention, that, to an hiſtoric painter, the ſcience of ancient medals is abſolutely neceſſary, that he may delineate his perſonages with the features they really bore while in exiſtence. This can only be attained in this way, or from ſtatues and buſts; any one of which will coſt as much as hundreds of medals; and indeed a collection of ſuch is only attainable by princes.

Entertainment from ſtudying them.

11
To a ſculptor.

The ſame things which render the ſtudy of medals important to a painter, do ſtill more ſo to a ſculptor; and, in this particular, the ſtudy of the Greek coins is remarkably uſeful. The ſkill of the Greeks in the art of ſculpture has always been admired throughout the world; and on their coins the heads of ſeveral deities are repreſented in the moſt exquiſite *alto relievo*. Our author, therefore, thinks it ſtrange, that the Grecian coins ſhould have hitherto been ſo little attended to by men of learning and taſte. They may have been looked upon, he ſuppoſes, as belonging only to the province of the antiquary; but he aſſures us, that the Greek medals will afford ſatisfaction to the perſons who value them only as pieces of workmanſhip. In moſt reſpects, they greatly excel thoſe of Rome even in its beſt times: which our author ſuppoſes to have been from the days of Auguſtus to Adrian. "In the days of Adrian, in particular (ſays he), the Roman mint ſeems to have been the very ſeat of art and genius; witneſs the vaſt number of exquiſite perſonifications, engraven with equal workmanſhip, which ſwarm on the medals of that prince. Yet from his time down to Poſthumus, coins of admirable workmanſhip are to be found. Thoſe of the Fauſtinas and Lucilla deſerve particular mention. There is one, and not an uncommon one, of the latter, in great braſs, which yields to nothing of the kind. The reverſe is a Venus with the name around her. The portrait of the obverſe ſeems to ſpring from the field of the coin; it looks and breathes, nay talks, if you truſt your eyes. The coins of Tarſus are extremely remarkable for a kind of perſpective in the figures, as Froelich obſerves. On others are found triumphal arches, temples, fountains, aqueducts, amphitheatres, circi, hippodromes, palaces, baſilicas, columns and obeliſks, baths, ſea-ports, pharoſes, and the like. Theſe furniſh much pleaſure and inſtruction to the architect, and ſerve to form his taſte to the ancient manner; that manner which unites perfect ſimplicity with ſublimity and grace; that manner which every age admires, in proportion as it has genius to imitate."

Sect. II. *Entertainment ariſing from the Study of Medals.*

Besides the purpoſes which the ſtudy of medals anſwers in the uſeful arts, a great variety of ſources of entertainment are to be found in it. Mr Pinkerton obſerves, that the moſt barbarous nations are more pleaſed with the rudeſt efforts of art, than with the moſt admirable works of nature; and that in proportion as the powers of the mind are large and various, ſuch are alſo the pleaſures which it receives from thoſe ſuperlative productions of art, which can only be the offspring of vaſt genius. Hence works of art are agreeable both to the enlightened and to the ignorant. The chief amuſement, therefore, which attends the ſtudy of medals, originates from the ſtrength and ſpirit, the finiſh and beauty, which the engraver has diſplayed in the execution of them. It beſides gives a kind of perſonal acquaintance with the perſons of whom the are the repreſentations. Portraits have always been

Entertainment from studying them.

been highly entertaining to mankind; and our author is of opinion, that the love of them gave rise both to painting and sculpture. They are nowhere to be found so ancient, so numerous, and so well preserved as in medals. Amusement is also derived even from the representations of ideal heads and persons; nay, even from the minutest symbols. Thus the Greek coins of cities present us with heads of deities of exquisite workmanship, apparently copied from statues or paintings; so that we may even guess at the works of Apelles and Praxiteles from some of the Greek medals. Their reverses afford still greater variety; there being scarce an object either in art or nature which is not represented upon some of them: and to the satisfaction arising from a view of these, we may likewise add that of beholding, in a lively manner, the dresses, manners and customs, religious and civil ceremonies, of the ancients: so that from medals we may obtain an interesting history of manners; which, though very lately cultivated, may perhaps afford the most useful and entertaining of all the provinces of history.

12 Difference betwixt a medallist and antiquary.

There is a very considerable difference betwixt the study of medals and that of a mere antiquary. The latter frequently seems to take delight in coins merely in proportion to their rust and deformity; so that it is often a recommendation of some of their pieces, that neither portrait, reverse, nor legend, can be discovered; at least in such manner as can be intelligibly explained. "The delight of the antiquarist (says Mr Pinkerton), may be called a depraved appetite of the mind, which feeds on trash, and fills itself with emptiness. It is perhaps a mere childish curiosity mingled with caprice and hypochondricism. Against this character the ridicule of Severus is particularly shot, but with little effect; for our antiquists exceed in visions and nonsense. I say *antiquists;* for the name of antiquary is sacred. By *antiquary*, in foreign countries, is implied a man who illustrates their ancient laws, manners, poetry; but especially their ancient history. There, men of the most elevated minds are antiquaries; as Muratori, Leibnitz, Montesquieu, Du Bos. Here men of talents will not stoop, forsooth, to studies the most important to their country, but leave its antiquities to chance. Every thing is important but our history; and we are profound in every ancient matter that is superficial; and superficial in what is profound. Even England cannot boast of one general historian, but trusts to the inaccuracy of Rapin, and the ignorant neatness of Hume. It is therefore no wonder that the study of antiquity is here ridiculous, though most important in other countries; none requiring greater talents, learning, or industry. But the historic antiquary has the pleasure of benefiting society, and enlightening whole nations, while the medallic has only an innocent amusement. This amusement, considered merely as rising from antiquarian objects, has not been explained, though felt by most people, and more by the learned. It seems analogical with that which we derive from an extensive prospect: for as the mind delights to expand itself into distant places, so also into distant times. We connect ourselves with these times, and feel as it were a double existence. The passions are singularly affected by minute circumstances, though mute to generalities; and the relicks of antiquity impress us more than its general history."

History.

Sect. III. *History of Medals.*

The study of medals is not of very ancient date: None of the classic writers give any account of collections of them; though indeed many little particulars are passed without notice by them. In the times of the Greeks, a collection of such coins as then existed must have been but little regarded, as consisting only of those struck by the numerous little states which at that time used the Greek characters and language. Hence they would have had an air of domestic coinage, and no attention would have been paid to them, however exquisite their workmanship might have been. The little intercourse at that time carried on betwixt the different provinces also, greatly impeded any communication of knowledge to those who wrote histories; so that it is no wonder to find any small collections that might then have existed altogether unnoticed by them.

13 Greek coins imitated by the Romans.

Almost as soon as any communication was opened between the Greeks and Romans, the latter treated the arts of the Greeks with all due respect and applause. Their coins were imitated by the Romans, and preserved in cabinets by the senators among their choicest treasures. Suetonius informs us, that on solemn occasions Augustus was accustomed to present his friends with medals of foreign states and princes, along with other valuable testimonies of his friendship. In a more advanced period of the Roman empire, however, individuals would undoubtedly form collections of coins peculiar to their own state; for Dr Stukeley, in his Medallic History of Carausius, informs us, that a complete series of silver coins was lately found in Britain, containing all the emperors down to Carausius inclusively. From Banduri we also know, that certain Greek coins were specially preserved by the Romans; and it appears from their code, that ancient gold and silver coins were made use of instead of gems; to which distinction those of Sicily were particularly entitled. From the decline of the Roman empire till towards the end of the fifth century, almost all branches of literature were involved in darkness, and the medallic science among the rest. While the Christian dominion of Constantinople lasted, indeed, almost all the arts and sciences may be said to have been kept within its own boundaries; though the Arabs and eastern nations had some arts and sciences of their own: but after the destruction of the imperial city by the Turks, the Greeks were once more compelled to become fathers to the European science. Even before this time, indeed, some vestiges of a revival of literature had appeared in Italy; "and so intimate and necessary a connexion (says Mr Pinkerton), has now the study of medals with that of ancient erudition, that on the earliest appearance of a revival of the latter, the former was also disclosed."

14 Collectors of medals.

The first among the moderns who began to study the metallic science was Petrarch. Being desired by the emperor Charles IV. to compose a book containing the lives of eminent men, and to place him in the list, he replied, that he would do so whenever the emperor's life and conduct deserved it. In consequence of this conversation, he afterwards sent the emperor a collection of gold and silver coins bearing the representations

History. ſentations of eminent men, with an addreſs ſuitable to his former declaration. A collection of coins was made in the next age by Alphonſo king of Arragon; but though this monarch collected all that could be found throughout Italy, we know that there could not have been very many, as the whole were contained in an ivory cabinet, and carried always about with him. A very conſiderable collection was made by Anthony Cardinal St Mark, nephew to Eugene IV. who aſcended the pontifical chair in 1431; and ſoon after the grand muſeum at Florence was begun by Coſmo de Medici, where a collection of ancient coins and medals had a place among other curioſities. Corvinus king of Hungary about the ſame time formed a noble collection of coins along with ancient manuſcripts and other valuable relicks of antiquity.

Mr Pinkerton conſiders Agnolo Poliziano, more commonly known by the name of *Angelus Politianus*, as the firſt writer who adduced medals as vouchers of ancient orthography and cuſtoms. He cites different coins of the Medicean collection in his Miſcellanea written about the year 1490. By means of a cabinet of medals collected by Maximilian I. emperor of Germany, Joannes Huttichius was enabled to publiſh a book of the lives of the emperors, enriched with their portraits, delineated from ancient coins. It is generally ſuppoſed that this book, which appeared in 1525, was the firſt work of the kind; but Labbé, in his *Bibliotheca Nummaria*, mentions another named *Illuſtrium Imagines*, by one Andreas Fulvius, printed in 1517, in which moſt of the portraits ſeem to be from medals. About the year 1512 alſo, Guillaume Bude, a French author, had written his treatiſe *De Aſſe*, though it was not printed till many years afterwards. M. Grollier, treaſurer of the French armies in Italy, during part of the 16th century, had a great collection of coins of different kinds of metals. After his death, his braſs medals were ſent to Provence, and were about to be ſent into Italy; when the king of France, having got information of the tranſaction, gave orders to ſtop them, and purchaſe the whole at a very high price for his own cabinet of antiquities. M. Grollier had an aſſortment of gold and ſilver as well as of braſs medals; the cabinet in which they were contained fell two centuries afterwards into the hands of M. l'Abbe de Bothelin; and was known to have been that of Grollier from ſome ſlips of paper, on which was his uſual inſcription for his books, *Joannis Grollierii, et amicorum.*

15 Number of cabinets. Cotemporary with Grollier was Guillaume de Choul, who was likewiſe a man of rank and fortune. He had a good collection of medals, and publiſhed many in his Treatiſe on the Religion of the ancient Romans in 1557. In the Low Countries we know, from the letters of Eraſmus, that the ſtudy of medals was begun about the beginning of the 16th century. About the middle of that century, Hubertzus Goltzius, a printer and engraver, travelled over moſt countries in Europe ſearching for coins and medals, in order to publiſh books concerning them. From one of theſe works it appears, that there were then in the Low Countries 200 cabinets of medals; 175 in Germany, upwards of 380 in Italy, and 200 in France. It is probable, however, that there are now four times as many in theſe countries, beſides 500 in Britain; but we are not to imagine that all theſe were grand collections, for of ſuch there are not above a dozen even in Italy: moſt of thoſe juſt mentioned were of the claſs named *caſkets* of medals, containing from 100 to 1000 or 2000.

16 Number of coins found in Britain. There are few countries, Italy excepted, in which a greater number of coins have been found than in Britain; though we are by no means well acquainted with the time when the ſtudy of them commenced. Mr Pinkerton ſuſpects that Camden was one of the firſt, if not the very firſt Britiſh author, who produced medals in his works, and who muſt have had a ſmall collection. Speed's Chronicle, publiſhed in the 17th century, was illuſtrated with coins from Sir Robert Cotton's cabinet. Gorlæus's collection was purchaſed by Henry prince of Wales, brother to Charles I. to whom he left it at his death. According to Joſeph Scaliger, it conſiſted of 30,000 coins and medals. A collection of 5500 coins was purchaſed by Archbiſhop Laud for 600l. and given to the Bodleian library. Thomas earl of Arundel, earl-marſhal of England, well known from the Arundelian tables and other antiquities which he imported from Greece and Italy into Britain, had a rich cabinet of medals collected by Daniel Niſum. The dukes of Buckingham and Hamilton, Sir William Paſton, Sir Thomas Fanſhaw of Ware-Park, Sir Thomas Hanmer, Ralph Sheldon, Eſq. Mr Selden, &c. are enumerated by Evelyn as collectors of medals. Charles I. as well as his hiſtorian the earl of Clarendon, were alſo collectors. The king had a very fine cabinet; which, however, was diſſipated and loſt during the civil commotions. Oliver Cromwell had a ſmall collection; and the cabinet of Charles II. is mentioned by Vaillant in the preface to his treatiſe entitled "*Nummi in Coloniis*," &c. This branch of magnificence has not been much attended to by ſucceeding Britiſh monarchs; though his preſent majeſty has a very good collection of ancient gold coins.

17 Cabinets. A great number of fine cabinets have been formed in Britain ſince the time of Evelyn. About the year 1720, Haym makes mention of thoſe of the duke of Devonſhire, the earls of Pembroke and Winchelſea, Sir Hans Sloane, Sir Andrew Fontaine, Mr Sadler, Mr Abdy, Mr Wren, Mr Chicheley, and Mr Kemp. At preſent there are many remarkable collections; but that of the late Dr William Hunter is deſervedly eſteemed the moſt remarkable in Europe, excepting that of the late French king. It was not only formed at a great expence, but with much care and ability; many foreign medals offered to it having been rejected (A). The other remarkable collections are thoſe of the duke of Devonſhire, the earl of Pembroke, Earl Fitzwilliam, formerly the marquis of Rockingham's, the honourable Horace Walpole, the reverend Mr Crachrode, the reverend Mr Southgate, Mr Townley, Mr R. P.

(A) This collection, as well as the reſt of Dr Hunter's Muſeum, is now in the poſſeſſion of the univerſity of Glaſgow, to which it was bequeathed by the doctor's will.

Of what constructed

R. P. Knight, Mr Edward Knight, Mr Tyson, Mr Barker, Mr Brown, and several others. The British museum and universities in England have also collections; as well as the Advocates library, the Antiquarian Society, and the universities in Scotland.

SECT. IV. *Materials of which Medals are constructed.*

18 Ancient gold coins.

MEDALS are formed of gold, silver, and the various modifications of copper. The gold usually made use of in coinage is about the fineness of 22 carats; and as the art of purifying this metal was very much unknown in former times, the most ancient medals are for this reason much more impure than the modern coins. Gold is never found in its native state above 22 carats fine; and the very ancient medals are much under that standard. Many of them are composed of a mixture of gold and silver, called by the ancients *electrum.* The gold medals were made of much finer metal after Philip of Macedon became possessed of the gold mines of Philippi in Thrace; and the medals of his son Alexander the Great are equally fine; as well as those of some other princes of that age. Those of the Egyptian Ptolemies are of the fineness of 23 carats three grains, with only one grain of alloy. The Roman coins are very pure even from the earliest times; the art of refining gold being well known before any was coined at Rome. Some authors are of opinion, that the Roman coins begin to fall short of their purity after the time of Titus; but Mr Pinkerton denies that any thing of this kind takes place till the time of the emperor Severus; and even then only in a very few instances. Most of the Roman gold was brought from Dalmatia and Dacia, where that metal is still to be met with. A very remarkable circumstance is observed in the eastern part of Hungary, which belonged to the ancient Dacia. It germinates in the vines of Tokay, and is found in their stems; as it is elsewhere in the straw of corn.

19 Metal called *electrum.*

Pliny informs us, and indeed it is generally known, that gold and silver are found mixed together in the earth. Where the silver amounted to one-fifth part of the gold, the metal was called *electrum;* but sometimes the quantity of silver was added artificially. The gold was in those days as well as at present refined by means of mercury: and the ancient artists had certainly attained to great perfection in this branch of metallurgy; as Bodin tells us, that the goldsmiths of Paris upon melting one of Vespasian's gold coins found only $\frac{1}{788}$ part of alloy.

20 Ancient silver.

Most of the ancient silver, particularly that of Greece, is less pure than that of succeeding times; even the Roman silver is rather inferior to the present standard, and that from the very beginning; but in the time of Severus, the silver appears very bad, and continues so until the time of Dioclesian. Many writers upon this subject have mistaken the *denarii ærei,* "coins of brass washed with silver," for silver currency. Silver coins are extremely scarce from the time of Claudius Gothicus to that of Dioclesian, or from the year 270 to 284: in which short space no fewer than eight emperors reigned. Silver at that time was found mostly in Spain; and the commerce with that country was disturbed by the usurpers who arose in Gaul; and such were the troubles of the times, that not only the silver but also the gold coins of those eight emperors, are extremely scarce. There is still, however, some silver extant of these eight emperors; and it is certain, that copper washed was never used as silver currency, but was entirely a distinct coinage. Occasional depravations of silver had taken place long before; as Pliny tells us, that Mark Antony mixed iron with his silver denarii; and Mr Pinkerton informs us, that he had seen a denarius of Antony, which was attracted by a magnet.

21 Ancient brass.

The ancient brass coins consist of two kinds: the red or Cyprian, which indeed is no other than copper; and the common yellow brass. Our author observes, that in the Roman coinage brass was of double the value of copper, and he is of opinion, that it was the same among the Greeks; and the latter is the metal most commonly made use of in the Greek coinage. The Roman sestertii was always of brass: the middling-sized kind are partly copper and partly brass; the former being double the value of the latter, which are the *ases.*

22 Mixed metals.

Mr Pinkerton next proceeds to give an account of the mixed metals used among the Romans. In Britain all kinds of coins made of mixed metal are without hesitation alleged to be forgeries; although it is certain that the variety of mixed metals used in coinage was very considerable. The most valuable mixture was that of gold or silver, already mentioned, named *electrum;* the silver commonly amounting to one-fifth part of the gold made use of, or perhaps more. Of this mixture are many of the early coins of Lydia, and some other Asiatic states; also those of the kings of the Bosphorus Cimmerius, during the imperial ages of Rome. Next to the electrum were the coins of Corinthian brass: but Mr Pinkerton informs us, that not a single coin was ever struck of this metal by the ancients; it having been constantly employed only in the fabrication of vases or toys. It was in use at any rate only for a very short time; being altogether unknown in the days of Pliny the Elder. Our author therefore ridicules those who pretend not only to find out imperial coins of this metal, but to discover three kinds of it; viz. one in which the gold predominates, another in which the silver prevails, and a third where the brass is most conspicuous. He gives Æneas Vico, one of the most ancient writers on medals, as the author of this idea; but whose opinions were confuted by one Savot, a writer in the 17th century. Vico mentions a coin of this kind struck under Augustus, another of Livia, and a third of Claudius. The mistake, he is of opinion, arose from the circumstance of the first propagator not being able to account for the various mixtures and modifications of brass observable in ancient coins of the large size; and which in so common a metal appear very odd to the moderns. Besides the authority of Pliny and other antiquaries of more modern a date, who all declare that they never saw a single medal of Corinthian brass, or of that metal mixed with silver and gold, our author adduces another evidence which he looks upon to be superior to either; viz. that those who have given into this supposition, imagine, that the large pieces called *sestertii,* and others called *dupondiarii,* worth about twopence or a penny, are said to have been composed of this precious metal. It is unreasonable to think, that any proportion of gold

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gold or silver could have been made ue of in these. The coins said to have been struck upon Corinthian brass are only done upon a modification of common brass; of which we know, that in proportion to the quantity of zinc made use of in conjunction with the copper, the metal assumes a variety of hues. On the authority of Pliny he informs us, that the coins mistaken for Corinthian brass were no other than prince's metal.

24 Egyptian silver coins.

The Egyptian silver coins struck under the Roman emperors are at first of tolerably pure silver; but afterwards degenerate into a mixture of copper and tin with a little silver. They are very thick, but many of them are elegantly struck, with uncommon reverses. There are likewise three sets of brass coins belonging to this country from the earliest times of the Roman emperors there. Some of these are of bell-metal or pot-metal; and after the time of Gallienus and Valerian, the coinage of brass with a small addition of silver, becomes authorised by the state; the coins struck upon it, being called *denarii æerei*. Those of lead or copper plated with silver have been fabricated by Roman forgers. Some coins of lead, however, have been met with of undoubted antiquity: and an ancient writer informs us, that tin money was coined by Dionysius; but none has been found. The lead coins of Tigranes king of Armenia, mentioned as genuine by Jobert, are accounted forgeries by Mr Pinkerton and other modern medallists. Plautus, however, makes mention of leaden coins, and several of them have been found; but our author looks upon them to have been chiefly essay pieces, struck in order to let the artist judge of the progress of the die. Others are the plated kind already mentioned, fabricated by ancient forgers, but having the plating worn off. A great number of leaden coins are mentioned by Fricorini in a work entitled *Piombi Antichi*, in which he supposes them to have served as tickets for guests; and coins of the same kind are also mentioned by Passeri. In the work entitled *Notitia Imperii Romani*, there is mention of coins made of leather, but none of them have ever been found.

Sect. V. *Of Ancient Money.*

25 Knowledge of ancient money imperfect.

In considering the different sizes, values, &c. of the Greek and Roman coins, our author treats of the medals as money; a knowledge of which, he says, is essentially necessary to every reader of the classics; insomuch that it may almost dispute the preference with the studies of ancient geography and chronology. Notwithstanding all that has been written upon the subject, however, our author is of opinion, that the science is still in its infancy, in as far as it relates to the real money of the ancients. "The ideal (says he), which is indeed the most important province of discussion, has been pretty clearly ascertained; and we are almost as well acquainted with the Attic *mna* or *mina*, and the perplexing progress of the Roman *sestertia*, as with our own *pounds*. But with the actual coin of the ancients the case is different; and the ignorance even of the learned in this point is wonderful."

Our author now goes on, with great asperity of language, to particularize the ignorant manner in which modern authors have treated the subject of medals. "Arbuthnot and Clarke (says he), are, if possible, more ignorant of medals than Budæus the very first. The latter professes his love of medals, but quotes a consular coin with the head of Cicero; and looks upon one of the 30 pieces of silver, the reward of the treachery of Judas, and which was said to be preserved among some relicks at Paris, to be worthy of reference and commemoration. Arbuthnot, if we may judge from his book, had never seen any ancient coins; and Clarke, it is well known, was quite ignorant of them. The latter, with all his labour, seems even to have known nothing of the theoretic part of the real ancient money. Indeed Dr Mead's catalogue seems to have been almost the only *book* on medals which had undergone his perusal. On the other hand, the ignorance of medallists on this score is no less profound. To this day they look upon the *didrachms* of Ægina, so celebrated in antiquity, as *tridrachms* of Ægium; and upon the early obolus as a brass coin. In the Roman class the large brass is esteemed the *as*, while it shall be proved that it is the *sestertius*, and worth four *ases*. The *denarius* is reckoned at ten ases even in the imperial times; whereas it only went at that rate for the first 90 years after the coinage of silver at Rome. The denarius æreus is taken for silver currency; with other mistakes, which evince that medallists are as ignorant of the theory, as the others are of the practice."

26 Money first coined in the east.

In his account of the ancient Greek money, Mr Pinkerton observes, that the light of science, like that of the sun, has proceeded from east to west. "It is most probable (says he), that the first invention of money arose like the other arts and sciences; and spread from thence into the western parts of the world. In its first shape it appeared as mere pieces of metal without any stated form or impression; in lieu of which, it was regulated by weight. Even down to the Saxon government in England, large sums were regulated by weight; and in our own times every single piece is weighed in gold; though with regard to silver this nicety is not minded, nor indeed does it seem practicable. Among the ancients, whose commercial transactions were less important and extensive than those of the moderns, silver was weighed as well as gold; nay even brass, in some cases.

27 Its first rude state.

28 Greek money.

In Greece, large sums were determined by *mnæ* or *minæ*; and the most capital sums by *talents*. In every country the mina is supposed to have contained 100 drachmæ, or small silver coins, of that country, and the talent 60 minæ. The mina is supposed to be a pound weight of the country to which it belonged. The Attic pound, according to Dr Arbuthnot, contained 16 ounces, equal to our avoirdupois pound: but Mr Pinkerton looks upon this as a very absurd opinion, and accuses the doctor of having adopted it merely that he may explain a passage in Livy. He is of opinion, that the Attic pound is very nearly the same with the pound Troy. The mina of Athens had at first 73 drachms; but by Solon it was fixed at 100. The ancient drachm weighed the same which it does at present in medical weight, viz. the eighth part of an ounce. The mina or pound of 12 ounces had consequently 96 of these drachms; but four of them were given to the round sum to supply defects in the alloy; "and indeed (says our author), in consequence of a

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common practice in all ages and in all countries, of giving some addition to a large weight. Thus the pound in weight had but 96 drachmæ in fact, while the pound in tale had 100; as the Roman libra in weight had but 84 denarii, in tale 108; and as our pound in tale, by an inverse progress, is not a third of our pound in common weight.

29 Of the ancient *talents.*

Notwithstanding the very severe criticism on Dr Arbuthnot just mentioned, however, we find our author adopting his account of the *talents* used in coinage in several countries. Thus, according to the doctor,

The Syrian talent had	15 Attic minæ
Ptolemaic -	20
Antiochian -	60
Eubœan - -	60
Babylonian -	70
Larger Attic -	80
Tyrian - -	80
Egyptian - -	80
Æginean -	100
Rhodian -	100

Notwithstanding the concession made here by Mr Pinkerton to the doctor, he tells us, that he very much questions this list of talents, and that many ancient writers are little to be relied upon. "Writers on this subject confess, that the numbers in all ancient manuscripts are the parts most subject to error, as being almost always contracted. They ought to allow that the authors themselves must often be liable to wrong information.

"Herodotus mentions, that King Darius ordered gold to be paid into his treasury by the Euboic talent, and silver by the Babylonian. The Euboic is esteemed the same with that called afterwards the Attic; and as we estimate gold by carats, so it is natural to suppose, that the most precious metal would be regulated by the most minute weight. But I confess, I take the Babylonic talent to be the same with that of Ægina. Mr Raper has proved the first coins of Macedon to be upon the standard of Ægina. Now the early Persian coins are upon that very scale, the largest tetradrachms weighing from 430 to 440 grains. Hence it follows, that the Persian silver coins were of the Æginean standard; and the payment was certainly to be made according to the standard of the money. The larger Attic talent was of 80 lesser minæ; because the larger Attic mina was of 16 ounces. The Alexandrian talent, according to Festus, consisted of 12,000 denarii, being the same with that used by the Egyptian kings in their coins; and is shown by Mr Raper to have been the same with the talent of Ægina. Perhaps the whole of the ancient coins of Asia, Africa, Greece, Magna Græcia, and Sicily, are reducible to three talents or standards. 1. That of Ægina, used in most of the more ancient silver coinages; as would seem in even the later of Egypt, Carthage, Cyrene, &c. 2. The Attic (being the Asiatic gold standard, afterwards used by Phidon king of Argos in estimating gold, and called Euboic from Eubœa, one of the quarters of the city of Argos), used in Athens and the greater part of the world as the standard both of gold and silver. 3. The Doric or Sicilian talent of 24 nummi, each worth an obolus and a half; whence the talent is estimated at six Attic drachms or three darics. These weights continued to be the standard of money after it began to be distinguished by impression; nay, to the fall of Greece and prevalence of the Roman empire."

30 Coinage originates in Lydia.

Coinage, according to Herodotus, was first invented by the Lydians, from whom the Greeks quickly received it. The former could not have received it from the Persians, whose empire did not begin till 570 B. C. though our author supposes that it might have proceeded from the Syrians, who carried on commerce in very ancient times. The most ancient Greek coins of silver have an indented mark upon one side, and a tortoise upon the other; and those of the greatest antiquity have no letters upon them. Those of later date have ΑΙΓΙ marked upon them, which medallists interpret of Ægium in Achaia; being led into that supposition by the tortoise, which they look upon as the sure mark of the Peloponnesus. But though our author agrees that the tortoise was so, he thinks that they are otherwise very far wrong in their conclusions. Ægium in Achaia was a place of no consequence till the times of Aratus and the Achæan league; but there are 11 of these coins in Dr Hunter's cabinet, which show that they must have been struck in times of the most remote antiquity, and that the place where they were struck was rich and flourishing at the time. The coins we speak of are not common; but those which have the name ΑΙΓΕΙΩΝ at full length, and which may perhaps belong to Ægium in Achaia, are extremely scarce; insomuch that in all Dr Hunter's vast collection there are not above one or two. They are likewise constructed upon a scale quite different from all other Grecian money; being of 8, 13, $15\frac{1}{7}$, 90, and about 186 grains. The Grecian drachma at an average is 66 grains; and Mr Pinkerton thinks it would have been strange if pieces had been struck of eight-tenths of an obolus, of an obolus and a half, or of a drachma and a half. Ægium being originally an obscure village, could not be the first which coined money: so that Mr Pinkerton supposes the name ΑΙΓΙ to have stood for Ægialus, the ancient name of Sicyon, a wealthy and powerful city; or rather Ægina, the mint of which was much celebrated, and perhaps the most ancient in Greece.

31 Most ancient Greek coins described.

Other arguments in favour of these coins being derived from Ægina, are drawn from their weight as well as their workmanship, which are quite different from those bearing the name of Ægium at full length. The coinage of Ægina is known to have been different from that of the rest of Greece; insomuch that its drachma was worth 10 Attic oboli, while the Attic drachma was valued only at six. Hence the drachmas of Ægina were named by the Greeks *παχειαν*, or *thick;* a name very applicable to the coins in question. From these observations, our author is of opinion, that we may even distinguish the precise weight of the ancient coins of Ægina. According to the exact proportion, the drachma of this place should weigh exactly 110 grains; and one of them very much rubbed weighed above 90. The others of larger size, which seem to be didrachms of Ægina, weigh from 181 to 194 grains; but the latter being the only one he could meet with in good preservation, it was impossible to form any just medium. Even in those best preserved, he

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he thinks that 10 grains may be allowed for a waſte of the metal in ſo long a time as 2400 years, which would bring the drachma of Ægina near its proper ſtandard. The obolus of Ægina was in proportion to its drachma of ſix oboli. It is the piece of $15\frac{1}{2}$ grains, and 13 when very much rubbed. The hemiobolon is that of eight, but when rubbed it falls ſhort of this weight.

32 The drachma the moſt general denomination.

The general denomination of the Greek money is the drachma, or eighth part of an ounce; which to this day is retained in the medical weights, the Grecian coins receiving their names from the weights they bore; though in ſome inſtances the weights received their appellations from the coins. The ſilver drachma, according to Mr Pinkerton, was about ninepence ſterling; and he finds fault with thoſe who make the drachma and denarius both equal to one another, the latter being no more than eightpence. The didrachm of ſilver, according to the ſame calculation, was worth 18d.; but the *tridrachm* occurs very rarely: and Mr Pinkerton is even of opinion, that medalliſts give this name to the didrachm of Ægina. The largeſt of all the Grecian coins is the tetradrachm, which on the Æginean ſtandard is worth five ſhillings; but in thoſe of the other ſtates only four. There are, however, many ſubdiviſions in the ſilver drachma; the higheſt being the tetraobolion or coin of four oboli; being in proportion to the drachma as our groat to a ſixpence, weighing about 44 grains, and being in value about ſixpence. The hemidrachm or triobolion comes next in value, weighing about 33 grains, and worth fourpence halfpenny. The ſilver diobolion, or third of the drachma, weighs about 22 grains, and is worth threepence. The obolus of ſilver weighs about 11 grains, and is worth only three halfpence. There is likewiſe a hemiobolion in ſilver, or half the obolus, of five grains and a half, value three farthings: and another called *tetraobolion dichalcos* or quarter obolus, which is the moſt minute coin yet met with; and by reaſon of its extreme ſmallneſs, weighing only two grains and a quarter, is now very ſcarce: but there is one in the cabinet of Dr Hunter, and ſome more have been lately brought from Athens by Mr Stuart. Some of them are likewiſe met with at Tarentum. It would appear, however, that there were ſome ſtill ſmaller, and of value only three-fourths of a farthing. None of theſe have been met with; and the ſmallneſs of the ſize renders it improbable that any will ever be met with; as the peaſants, who commonly diſcover coins, would probably either not obſerve them at all, or, if they did, would neglect them as things of no value.

33 Different names of Greek coins.

Many different names have been impoſed on the coins belonging to the different ſtates of Greece: thus Κορη, *the maiden*, was a name often applied to the tetradrachm, and which would ſeem to apply to thoſe of Athens; though there are coins of other cities with the head of Proſerpine, and the word Κορη, to which it would appear more applicable in our author's opinion. Χελωνε, *the ſhell*, was the name of another coin, from its type. A Sicilian coin was named Δεμαρετιον, from Gelon's wife. A tetradrachm was named Κραπαταγους, and had eight ευθειας or hemidrachms. The Τροισηνιον, ſo called from its country Troizene, had Pallas on one ſide and a trident on the reverſe. The hemiobolion was the πελανος of Lacedæmon; and the κολλυβος is ſuppoſed to have been equal to the Roman ſeſtertius or quarter drachma. The *cyſtophori* were coins with the myſtic cheſt or hamper of Bacchus upon them, out of which a ſerpent riſes; and are much celebrated in antiquity. We are told by Livy, that Marcus Acilius, in his triumph over Antiochus and the Ætolians, carried off 248,000 of them; Cneius Manlius Vulſo in that over Gallo-Græcia had 250,000; and Lucius Emilius Regillus, in his naval triumph over the fleets of Antiochus, had 131,300. Cicero likewiſe mentions his being poſſeſſed of a vaſt ſum in them. The moſt probable opinion concerning them ſeems to be, that they are all ſilver tetradrachms; ſuch as belong to the cities of Apamea and Laodicea in Phrygia; Pergamus in Myſia; Sardis and Tralles in Lydia; and Epheſus: but it is a miſtake to aſcribe any to Crete. Mr Pinkerton thinks it abſurd to imagine that Crete, a ſmall iſland, ſhould ſtrike ſuch vaſt numbers of coins; though Cicero mentions his being in poſſeſſion of an immenſe treaſure in them at the time he was governor of Aſia Minor. "It is moſt likely (ſays Mr Pinkerton), that his wealth ſhould be in the coin of the country to which he belonged. But what had theſe triumphs of Cicero's government to do with Cretan money? But indeed the coins themſelves, as above noticed, eſtabliſh the fact."

34 Coins of Cyzicus.

Another ſet of coins famous in antiquity were thoſe of Cyzicus in Myſia, which were of gold; but they are now almoſt entirely vaniſhed by being recoined in other forms. The Αρυανδικον νομισμα, or *money of Aryandes*, who was made governor of Egypt by Cambyſes, is made mention of by Heſychius; but none of them, as far as is known, have reached our times. They muſt have been marked with Perſian characters, if with any. The coin of Queen *Philiſtis* is mentioned by the ſame writer, and many of theſe pieces are ſtill extant; but we know not where this queen reigned, nor does there ſeem to be any method of finding it out. Mr Pinkerton inclines to believe, that ſhe preſided over Sicily; and as a confirmation of that ſuppoſition, mentions ſome inſcriptions of ΒΑΣΙΛΙΣΣΑΣ ΦΙΛΙΣΤΙΔΟΣ on the *Gradini* of the theatre at Syracuſe; but which appear not older than the Roman times. Some authors are of opinion, that ſhe reigned in Coſſara or Malta; which our author thinks much more improbable.

35 Athenian coins.

The moſt particular attention with regard to the names and ſtandard of coins is due to thoſe of Athens; and it is remarkable, that moſt of them which have reached us are of a very late period, with the names of magiſtrates inſcribed upon them. Some of theſe bear the name of Mithridates; and few are older than the era of that prince; who, it is well known, took the city of Athens in his war with the Romans. I ſuſpect (ſays Mr Pinkerton), that no Athenian coins of ſilver are poſterior to Sylla's infamous deſtruction of that city; an event the more remarkable, as Salluſt tells us, that Sylla was learned in Greek. Indeed Caligula, Nero, and moſt of the peſts of ſociety, have been learned men, in ſpite of a noted axiom of Ovid,

Sed ingenuas didiciſſe feliciter artes
Emollit mores, nec ſinit eſſe feros.

It is ſtill more remarkable, that the fabric of Athenian

nian coins is almoſt univerſally very rude; a ſingular circumſtance, if we reflect how much the arts flouriſhed there. It can only be accounted for from the excellence of their artiſts being ſuch as to occaſion all the good ones to be called into other countries, and none but the bad left at home. In like manner, the coins ſtruck at Rome in the imperial times are excellent, as being done by the beſt Greek artiſts; while thoſe of Greece, though famous at that time for producing miraculous artiſts, are during that period commonly of very mean execution. The opulence of Athens in her days of glory was very great; owing in an eminent degree to her rich commerce with the kingdoms on the Euxine ſea, carried on chiefly from Delos, which belonged to Athens, and was the grand centre of that trade." Hence it has become matter of ſurpriſe to Neumann, that when there are ſo many coins of Mycene, an iſland even proverbially poor, there ſhould be none of Delos. But Mr Pinkerton accounts for this from Mycene's being a free ſtate, and Delos ſubject to Athens. "It may be well ſuppoſed (ſays he), that Athens had a mint at Delos; and ſuch Athenian coins as have ſymbols of Apollo, Diana, or Latona, were ſtruck in this iſland."

36 Greek copper money.

The copper money of the Greeks is next in antiquity to the ſilver. Mr Pinkerton is of opinion, that it was not uſed at Athens till the 26th year of the Peloponneſian war; about 404 years before Chriſt, and 300 after ſilver was firſt coined there. The firſt copper coins were thoſe of Gelo of Syracuſe, about 490 B. C.

37 Of the chalcos.

The chalcos of braſs, of which eight went to the ſilver obolus, ſeems to have been the firſt kind of Greek coin. At firſt it was looked upon as of ſo little conſequence, that it became proverbial; and to ſay that a thing was not worth a *chalcos*, was equivalent to ſaying that it was worth nothing. As the Greeks became poor, however, even this diminutive coin was ſubdivided into two, four, nay eight λεπτα or ſmall coins; but our author cenſures very ſeverely thoſe who have given an account of thoſe diviſions. "Pollux, and Suidas copying from him (ſays he), tell us, that there were ſeven lepta to one chalcos; a number the moſt unlikely that can be, from its indiviſibility and incapacity of proportion.

"Pollux lived in the time of Commodus, ſo was too late to be of the ſmalleſt authority: Suidas is four or five centuries later, and out of the queſtion. Pliny tells us, that there were ten chalci to the obolus; Diodorus and Cleopatra that there were ſix; Iſidorus ſays there were four: and if ſuch writers differ about the larger denomination, we may well imagine that the ſmaller equally varied in different ſtates; an idea ſupported by theſe undeniable witneſſes, the coins which remain. Moſt of the Greek copper coin which has reached our times conſiſts of chalci; the lepta being ſo ſmall as to be much more liable to be loſt." In Dr Hunter's cabinet, however, there are ſeveral of the dilepta of Athens: and from being ſtamped with the repreſentation of two owls, ſeem to be the ſame with the ſilver diobolus: "a circumſtance (ſays Mr Pinkerton), of itſelf ſufficient to confute Pollux; for a dilepton can form no part of ſeven; a number indeed which never appeared in any coinage of the ſame metals, and is contradictory to common ſenſe. It may be obſerved, that the whole braſs coins of Athens publiſhed by Dr Combe are reducible to four ſizes, which may be the *lepton*, *dilepton*, *tetralepton* or *hemichalcos*, and *chalcos*. The firſt is not above the ſize of one of King James I.'s farthing tokens; the laſt about that of our common farthing." The *lepta* was alſo called κερμα, as being change for the poor. The κιδαβος, perhaps ſo called from the figure of a wolf upon it, was the coin of a particular ſtate, and if of braſs muſt have weighed three chalci. The other names of the copper coins of Greece are but little known. Lycurgus ordered iron money to be coined at Sparta; but ſo periſhable is this metal, that none of that kind of money has reached our times.

38 Lepton, dilepton, &c.

After the conqueſt of Greece by the Romans, moſt of the coins of that country diminiſhed very much in their value, the gold coinage being totally diſcontinued: though ſome of the barbarous kings who uſed the Greek character were permitted to coin gold, but they uſed the Roman model; and the ſtandard uſed by the few cities in Aſia who ſpoke the Greek language in the times of the emperors is entirely unknown. Copper ſeems to have been the only metal coined at that time by the Greeks themſelves; and that upon the Roman ſtandard, then univerſal through the empire, that there might be no impediment to the circulation of currency. They retained, however, ſome of their own terms, uſing them along with thoſe of the Romans. The *aſſarion* or *aſſarium* of Rome, the name of the diminiſhed *as*, being 16 to the drachma or denarius, the obolus was ſo much diminiſhed in value as to be ſtruck in braſs not much larger than the old chalcos, and valued at between two and three aſſaria; which was indeed its ancient rate as to the drachma. This appears from the copper coins of Chios, which have their names marked upon them. The braſs obolus, at firſt equal in ſize to the Roman ſeſtertius or large braſs, leſſens by degrees to about the ſize of a ſilver drachma. From the badneſs of the imperial coinage in Greece alſo, it appears that braſs was very ſcarce in that country, as well as in all the cities uſing the Greek characters; being found moſtly in the weſtern countries of the Roman empire. The time of this declenſion in ſize of the Greek coins is by Mr Pinkerton ſuppoſed to have been from Auguſtus down to Gallienus. He is of opinion, however, that the copper obolus, at firſt above the ſize of large braſs, was uſed in Greece about the time of its firſt ſubjection to Rome; and that the lepta ceaſing, the chalci came in their room, with the dichalcus and the hemiobolion of braſs.

39 Era of the declenſion of the Greek coinage.

40 Gold coins of Greece.

With reſpect to the gold coins of the Greeks, Mr Pinkerton is of opinion that none of that metal was coined before the time of Philip of Macedon, as none have reached our times prior to the reign of that monarch. From a paſſage in Thucydides our author concludes, that in the beginning of the Peloponneſian war the Athenians had no gold coin. Mentioning the treaſure in the Acropolis or citadel of Athens, at the commencement of that war, the hiſtorian mentions ſilver coin, and gold and ſilver in bullion; and had any of the gold been in coin, he would certainly have mentioned it. Philip began his reign about 68 years after the beginning of the Peloponneſian war; and we can ſcarce ſuppoſe that any city would have preceded

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ceded the elegant and wealthy Athens in the coining of gold.

41 Gold coined early in Sicily.

Notwithſtanding, however, this deficiency of gold coin among the Greeks, it is certain that the coinage of gold had taken place in Sicily long before; as we have gold coins of Gelo about 491 B. C. of Hiero I. 478, and of Dionyſius I. in 404, all uſing the Greek characters; though not to be ranked among the gold coins of Greece, as Philip cauſed his to be. Gold coins of Syracuſe even appear of the third claſs of antiquity, or with an indented ſquare, and a ſmall figure in one of its ſegments. Gold coins are uſed in the cities of Brettium, Tarentum, and throughout Magna Græcia; alſo in Panticapæa in Thrace, and likewiſe Coſa in that country; but not in Tuſcany, as is commonly believed, though Neumann proves that they were ſtruck by Brutus, and are unqueſtionably as ancient as the Greek coins. The Thebans and Athenians probably coined the firſt gold after Philip had ſet them the example, and when they were attempting to reſiſt the projects of that enterpriſing monarch. The Ætolians probably coined their gold during the time of their greateſt power, about a century after Philip, and when they were combating the power of Aratus and the Achæan league. "There is (ſays Mr Pinkerton) but one ἡμιχρυσος of Thebes, much worn, in Dr Hunter's cabinet, and weighing but 59 grains; and perhaps not above two or three χρυσοι or gold didrachms of Athens in the world; one of which is alſo in the collection of Dr Hunter, and weighs 132½ grains. It appears to be more modern than the reign of Philip. That monarch having got poſſeſſion of the mines of Philippi in Thrace, improved them ſo much, that they produced him annually above a thouſand talents of gold, or 2,880,000l. of our money. From this gold the firſt coins named from the monarch, *Philippi*, were ſtruck. They were marked with his portrait; and for many ages after were ſo numerous, that they were common in the Roman empire; whence the name *Philippi* became at length common to gold, ſilver, and at laſt even braſs coins of their ſize. Even in the time of Philip gold was very ſcarce in Greece; but after the Phocians had plundered the temple of Delphos, this precious metal which had been valued as gems, and conſecrated only to the decoration of the temples of the gods, began to be known among the Greeks. The comparative value of gold and ſilver, however, ſeem to have been at that time very different from what they are now. Herodotus values gold at 13 times its weight in ſilver; Plato in his Hipparchus at 12; and even the low value of 10 to 1 ſeems to have been the ſtated value in Greece, though in Rome the plenty of ſilver from the Spaniſh mines made the value of gold to be much higher; and there is no reaſon to think that it was ever valued in that city at leſs than 12 times its weight in ſilver. The *Philippus* χρυσος, gold piece, or *ſtater*, is a didrachm, and is the moſt common of all the ancient coins. Mr Pinkerton is of opinion that it went for 20 ſilver drachms on its firſt appearance; but in latter times for 25 Greek drachmæ or Roman denarii. There are proofs of the Philippi being didrachms, both from the writings of ancient authors and from numbers of the coins themſelves, which remain to this day; and that the χρυσος, or principal gold coin of Greece, was of

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the ſame weight, is alſo evident from ancient writings. It was anciently worth about 15s. but valuing gold now at the medium price of 4l. per ounce, it is worth about 20s. The ἡμιχρυσος, or half the former coin, ſcarcely occurs of the coinage of Philip and Alexander, though it does of Hiero I. of Syracuſe and of King Pyrrhus. It paſſed for ten ſilver drachmas, and was valued only at 7s. 6d. though now worth 10s. There was another diviſion of this kind worth about 5s. There were beſides ſome leſſer diviſions of gold coins, which could not be worth above two drachmas. Theſe were coined in Cyrene; and there were beſides ſeveral old gold coins of Aſia Minor, the value of which is now unknown. Our author ſuppoſes that they were coined not with relation to their weight as parts of the drachma, but merely to make them correſpond with ſo many ſilver pieces as was neceſſary. There are alſo larger coins than the χρυσος, the διχρυσος of Alexander and Lyſimachus being double its value. Some others are met with of Lyſimachus, Antiochus III. and ſome of the Egyptian monarchs, weighing four times the χρυσος, and now worth about 4l. ſterling. Some weigh even more; but this our author ſuppoſes owing to a difference in the purity of the gold.

In Rome, as well as in Greece, the money was at 42 Roman money.
firſt eſtimated by weight; and the firſt metal coined by that people was copper, ſilver being long unknown in Rome; nor is it certainly known that any ſilver has ever been found in the Italian mines. In Rome the firſt valuation of money was by the *libra gravis æris*, or pound of heavy braſs: and in the progreſs of their conqueſts, the little ſilver and gold that came in their way was regulated by the ſame ſtandard, as appears from the ſtory of Brennus. The weights made 43 Of the Roman pound.
uſe of were the ſame with thoſe which continue to this day. The pound conſiſted of 12 ounces of 458 grains each; but the pound by which the money was weighed appears to have conſiſted only of 420 grains to the ounce, or to have contained in all 5040 grains. This became the ſtandard of copper; and when ſilver came to be coined, ſeven denarii went to the ounce as eight drachms did in Greece. Gold was regulated by the *ſcriptulum* or *ſcrupulum*, the third part of a denarius, and by the larger weights juſt mentioned. The number 10 was at firſt uſed by the Romans in counting their money; but finding afterwards that a ſmaller number was more convenient, they divided it into quarters; and as the quarter of 10 is 2½, they for this reaſon beſtowed upon it the name of *ſeſtertius* or "half 44 Seſtertius, as, &c.
the third;" to expreſs that it was two of any weights, meaſures, &c. and half a third; whence the ſeſtertius came at laſt to be the grand eſtimate of Roman money. The *as* being at firſt the largeſt, and indeed the only Roman coin, the word *ſeſtertius* means *ſeſtertius as*, or "two aſes and a half." On the firſt coining of ſilver, the denarius of ten aſes was ſtruck in the moſt common and convenient denary diviſion of money, or that by tens; the ſeſtertius being of courſe two aſes and a half. But the denarius being afterwards eſtimated at 16 aſes, the name ſeſtertius was ſtill applied to a quarter of the denarius, though it now contained four aſes. The term *ſeſtertius* was applied to all ſums not exceeding 1000 ſeſtertii, or 8l. 6s. 8d.; but for greater ſums the mode of the ſeſtertius was likewiſe altered, though not to exclude the former. Very large ſums

ſums of money were eſtimated by the hundred weight of braſs; for the Romans were at firſt unacquainted with the talent. The hundred weight, by way of eminence, was diſtinguiſhed by the name of *pondus*, and *ſeſtertium pondus* became a phraſe for two hundred weight and a half. Mr Pinkerton is of opinion, that we may value the *as libralis* of ancient Rome at about eightpence Engliſh. Eſtimating the *as* therefore at a pound weight, the *ſeſtertium pondus* was equal to 1000 *ſeſtertii*, or 8l. 6s. 8d.; and by coincidence which our author ſuppoſes to have been the effect of deſign, as ſoon as the ſilver coinage appeared, the *ſeſtertium centum denariorum* was always equal to 8l. 6s. 8d. alſo. The word *ſeſtertium* itſelf, however, ſeems to have been unknown prior to the coinage of ſilver money at Rome: the *pondera gravis æris* being ſufficient before that time for all the purpoſes of a ſtate in which money was ſo ſcarce. But however this may be, the *pondus* or hundred weight of braſs was preciſely worth 100 denarii, or a pound of ſilver. As the great ſeſtertium was always valued at 1000 of the ſmaller, or 8l. 6s. 8d. we never find one ſeſtertium mentioned in authors, but two, three, or more; ten thouſand of them being equal to 83,333l. 6s. 8d.

45 Whence the Romans derived their coinage.

The ſtates from which the Romans may be ſuppoſed firſt to have derived their coinage, were the Etruſcans and the Greek colonies in Magna Græcia and Sicily. Joſeph Scaliger, Gronovius, &c. contend that it was from the Sicilians that the Romans firſt derived their knowledge of money; but Mr Pinkerton argues that it was from the Etruſcans. In confirmation of his opinion, he appeals to the ſtate of the Roman territories in the time of Servius Tullius, who is looked upon to have been the firſt who coined money at Rome. At that time the whole Roman dominion did not extend beyond ten miles round the city; and was entirely ſurrounded by the Etruſcan and Latin ſtates; Cumæ being the next Greek colony to it that was of any conſequence, and which was in the neighbourhood of Naples, at about the diſtance of 150 miles. Our author aſks, Is it reaſonable to think that the Romans received the uſe of money from the Etruſcans and Latins who were their neighbours, or from the Greeks, who were at a diſtance, and at that time, as far as appears from their hiſtory, abſolutely unknown to them? "If this argument (adds he), is ſtrong with regard to the neareſt Grecian colonies, what muſt it be with reſpect to Sicily, an iſland 300 miles diſtant from Rome, where it was not known, at that time, if a boat went by land or water?" Arguments, however, for this opinion have been derived from the ſimilarity betwixt the Sicilian and Roman coins; which Mr Pinkerton now proceeds to examine. The Greek pound in Sicily was called λιτρα, and conſiſted, like the Roman, of 12 ουγκιαι, or ounces; and Mr Pinkerton grants that the Roman *libra* was derived from the Greek λιτρα, but denies that the *as*, or libra, a coin, was from Sicilian model. The Sicilians had indeed a coin named λιτρα; but it was of ſilver, and of equal value to the Æginean ſtandard, ten of which went to the Sicilian δεκαλιτρα. He differs from Gronovius, that the ſtandard of Ægina was uſed at Corinth, and of courſe at Syracuſe; and it appears from Ariſtotle, that the Sicilians had a talent or ſtandard of their own. The Sicilian obolus or λιτρα contained alſo 12 ounces or *chalci*, ſo named at firſt becauſe they weighed an ounce weight; but the ουγκιαι of Hiero weigh more than a troy ounce; and the braſs coins of Agrigentum are marked with cyphers as far as ſix: the largeſt weighing only 186 grains, or about one-third of the primitive ounce. Our author denies that even the Roman denarius took its riſe from the Sicilian δεκαλιτρον, as many authors aſſert. Were this the caſe, it would have weighed 180 grains; whereas the Roman denarii are not above the third part of the quantity.

From all theſe conſiderations, our author is of opinion that the Sicilians borrowed the diviſion of their λιτρα from the Etruſcans, or poſſibly from the Romans themſelves; which our author thinks is more probable than that the Romans had it from Sicily. The ſtrongeſt argument, however, againſt the Roman coinage being borrowed from the Sicilian is, that though great numbers of Sicilian coins are to be found in the cabinets of medalliſts, yet none of them reſemble the *as libralis* of the Romans in any degree. In moſt cabinets alſo there are Etruſcan coins upon the exact ſcale of the *as libralis*, and ſeveral of its diviſions; from whence Mr Pinkerton concludes, that "theſe, and theſe alone, muſt have afforded a pattern to the primitive Roman coinage." The Etruſcans were a colony from Lydia, to which country Herodotus aſcribes the firſt invention of coinage. "Thoſe coloniſts (ſays Mr Pinkerton), upon looking round their ſettlements, and finding that *no* ſilver was to be had, and *much leſs* gold," ſupplied the mercantile medium with copper; to which the caſe of Sweden is very ſimilar, which, as late as the laſt century, had copper coins of ſuch magnitude, that wheelbarrows were uſed to carry off a ſum not very conſiderable. 46 Origin of the Sicilian coins.

Some coins are found which exceed the *as libralis* in weight; and theſe are ſuppoſed to be prior to the time of Servius Tullius. Some of them are met with of 34 and of 53 Roman ounces; having upon one ſide the figure of a bull rudely impreſſed, and upon the other the bones of a fiſh. They are moſt commonly found at Tudder, or Tudertum, in Umbria; but they appear always broken at one end: ſo that Mr Pinkerton is of opinion, that perhaps ſome might be ſtruck of the decuſſis form, or weighing ten pounds. Theſe pieces, in our author's opinion, make it evident, that the Romans derived their large braſs coins from the Etruſcans and the neighbouring ſtates: they are all caſt in moulds; and the greater part of them appear much more ancient than the Roman aſes, even ſuch as are of the greateſt antiquity. 47 Of the moſt ancient Roman coins.

Mr Pinkerton agrees with Sir Iſaac Newton as to the time that Servius Tullius reigned in Rome, which he ſuppoſes to be about 460 B. C. His coinage ſeems to have been confined to the as, or piece of braſs having the impreſſion of Janus on the one ſide, and the prow of a ſhip on the other; becauſe Janus arrived in Italy by ſea. Varro, however, informs us, that the very firſt coins of Tullius had the figure of a bull or other cattle upon them, like the Etruſcan coins, of which they were imitations. Thoſe with the figure of Janus and the prow of a ſhip upon them may be ſuppoſed firſt to have appeared about 400 B. C. but in a ſhort time, various ſubdiviſions of the as were coined. The *ſemis*, or half, is commonly ſtamped with the head of Jupiter 48 Subdiviſions of the as.

Jupiter laureated; the *triens* or third, having four cyphers, as being originally of four ounces weight, has the head of Minerva; the *quadrans* or quarter, marked with three cyphers, has the head of Hercules wrapt in the lion's ſkin; the *ſextans* or ſixth, having only two cyphers, is marked with the head of Mercury with a cap and wings; while the *uncia* having only one cypher, is marked with the head of Rome. All theſe coins appear to have been caſt in moulds, by a conſiderable number at a time; and in the Britiſh muſeum there are four of them all united together as taken out of the mould in which perhaps dozens were caſt together. In proceſs of time, however, the ſmaller diviſions were ſtruck inſtead of being caſt; but the larger ſtill continued to be caſt until the as fell to two ounces. Even after this time it was ſtill called *li-*

49 Larger denominations of it ſtruck.

bra, and accounted a pound of copper; though there were now larger denominations of it coined, ſuch as the *biſſas* or double as; *treſſis* and *quadruſſis* of three and four aſes; nay, as far as *decuſſis* or ten aſes, marked X. Olivieri mentions one in his own cabinet weighing upwards of 25 ounces, and caſt when the as was about three ounces weight. There is likewiſe in the Muſæum Etruſcum a decuſſis of 40 Roman ounces, caſt when the as was at four ounces. There was likewiſe a curious decuſſis in the Jeſuits library at Rome, for which an Engliſh medalliſt offered 20l.; but it was ſeized by the pope along with every other thing belonging to the ſociety.

50 Decreaſe of the as in weight.

Mr Pinkerton conteſts the opinion of Pliny that the as continued of a pound weight till the end of the firſt Punic war. His opinion (he ſays), is confuted by the coins which ſtill remain; and it appears probable to him that the as decreaſed gradually in weight; and, from one or two of the pieces which ſtill exiſt, he ſeems to think that the decreaſe was ſlow, as from a pound to eleven ounces, then to ten, nine, &c.; but neither the as nor its parts were ever correctly ſized. During the time of the ſecond Punic war, when the Romans were ſore preſſed by Hannibal, the as was reduced to a ſingle ounce. It is ſaid to have taken place in the 215th year before our era, being about 36 years after the former change. This as libralis, with the faces of Janus upon it, is the form moſt commonly met with previous to its being reduced to two ounces. Our author ſuppoſes that the as libralis continued for at leaſt a century and a half after this coinage of Tullius down to 300 B. C. about the year of Rome 452, between which and the 502d year of Rome a gradual diminution of the as to two ounces muſt have taken place. The following table of the dates of the Roman coinage is given by Mr Pinkerton.

The libralis, coined by Tullius with the figures of oxen, &c. about 167 years after the building of Rome, according to Sir Iſaac Newton, or about the year before Chriſt	460
As libralis with Janus and the prow of a ſhip	400
As of ten ounces - -	300
Eight - - -	290
Six - -	280
Four - - -	270
Three - - -	260
Two, according to Pliny - -	250
One, according to the ſame author -	214

About 175 B. C. alſo, we are informed by Pliny that the as was reduced to half an ounce by the Papyrian law, at which it continued till the time of Pliny himſelf, and long after.

After the Romans began to have an intercourſe with Greece, a variety of elegant figures appear upon the parts of the as, though not on the as itſelf till after the time of Sylla. Towards the latter end of the republic alſo, *dupondii*, or double aſes, were coined, together, with the ſeſtertii æerei, which came in place of the *quadruſſes*, when the denarius began to be reckoned at 16 aſſes; probably at the time the latter was reduced to half an ounce. In ſome inſtances it is to be obſerved,

52 Coins on the Greek ſcale marked as Roman.

that the Romans accommodated their coins to the country where their army was ſtationed; whence we have many coins marked as Roman, which have been coined in Magna Græcia and Sicily, and are evidently upon the Greek and not the Roman ſcale. In the latter part of the republican times, alſo, the types begin to vary; ſo that we have a braſs coin ſuppoſed to be ſtruck by Sextus Pompeius in Sicily, having upon it a double head of that warrior, repreſenting a Janus. Mr Pinkerton ſuppoſes it to have been a dupondius; which indeed appears to be the caſe from the double head. This coin is of copper, and ſtill weighs an ounce, notwithſtanding its antiquity.

52 Of the ſeſtertius.

The largeſt imperial copper coin was the ſeſtertius, a piece worth about twopence of our money. Mr Pinkerton cenſures ſeverely the opinion of other medalliſts, all of whom ſay that the ſeſtertius was of ſilver. "In fact (ſays he), it would be as rational in any antiquary, a thouſand years hence, to contend that the halfpenny and farthing are of ſilver, becauſe they were ſo in the reign of Henry VIII." In confirmation of his own opinion, he quotes the following paſſage from Pliny: "The greateſt glory of braſs is now due to the Marian, called alſo that of Cordova. This, after the Livian, moſt abſorbs the lapis calaminaris, and imitates the goodneſs of native orichalcum in our ſeſtertii and dupondiarii, the aſes being contented with their own copper." Gronovius confeſſes that he does not know what to make of this paſſage, and that it cauſes him heſitate in his opinion. The *Livian* mine mentioned here by Pliny, is ſuppoſed to have got its name from *Livia* the wife of Auguſtus; and it is probable that the pieces marked with her portraits, entitled JUSTITIA, SALUS, VIRTUS, &c. were dupondii from this very mine, the metal being exceedingly fine, and of the kind named *Corinthian braſs* by the ancient medalliſts. "Perhaps (ſays Mr Pinkerton), the mine received its name from this very circumſtance of her coins being ſtruck in the metal taken from it."

53 Coinage of yellow braſs.

No change took place in the Roman coinage from the time that the as fell to half an ounce to the days of Pliny: but Mr Pinkerton obſerves, that before the time of Julius Cæſar yellow braſs began to be uſed, and was always looked upon to be double the value of Cyprian or red copper. There are but few coins in large braſs immediately before Julius Cæſar, or even belonging to that emperor; but from the time of Auguſtus downward, the large coins are all found of braſs, and not one of them copper. The largeſt of what are called the middle ſize are all of yellow braſs; and the next ſize, which is the as, and weighs half an ounce, is univerſally copper. What the ancients named

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med *orichalcum*, or what we call *braſs*, was always looked upon to be greatly ſuperior in value to the æs Cyprium. Procopius, ſpeaking of a ſtatue of Juſtinian, tells us, that braſs inferior in colour to gold is almoſt equal in value to ſilver. The mines of native braſs were very few in number, and were owing entirely to the ſingular combination of copper and lapis calaminaris in the bowels of the earth, which very ſeldom occurs; and the ancients were far from being well acquainted with the method of combining theſe two bodies artificially; ſo that yellow braſs was always eſteemed at double the value of copper; and hence, in the ancient coinages, the braſs and copper pieces were kept as diſtinct as thoſe of gold and ſilver.

Mr Pinkerton challenges to himſelf the diſcovery that the imperial ſeſtertius was of braſs; and is at conſiderable pains to bring proofs of it. Beſides the teſtimony of Pliny, which of itſelf would be deciſive, this is ſupported by the ſtrongeſt collateral evidence of other authors. From a paſſage in Julius Africanus, who wrote the Ιατρικα, or *Treatiſe on Medicine*, it appears that the nummus, or ſeſtertius, weighed an ounce, and of conſequence that it could not be ſilver but braſs; and all the large imperial Roman coins weigh an ounce. We know not the age in which Julius Africanus lived; and as he makes the denarius to contain 16 aſes, he muſt have been before the age of Gallienus, when it had 60. Gronovius ſuppoſes him to have been the ſame mentioned by Euſebius. This author ſpeaks of a Julius Africanus who lived in the time of Heliogabalus, and whom Mr Pinkerton ſuppoſes to have been the ſame with him above mentioned.

54 Diminution of the ſeſtertius.

The ſeſtertius underwent no change till the time of Alexander Severus, when it was diminiſhed by one-third of its weight. Trajanus Decius was the firſt who coined double ſeſtertii, or quinarii, of braſs; but from the time of Trebonianus Gallus to that of Gallienus, when the firſt braſs ceaſes, the ſeſtertius does not weigh above the third part of an ounce; the larger coins are accounted double ſeſtertii; and after the time of Gallienus it totally vaniſhes. In the times of Valerian and Gallienus we find a new kind of coinage, mentioned by the name of *denarii æris*, or *Philippi ærei*. Two ſizes of denarii began to be uſed in the time of Caracalla; the larger of ſix ſeſtertii, or 24 aſſaria; the ſmaller of four ſeſtertii, or 16 aſſaria as uſual. In the time of Pupienus, the latter was reduced to ſuch a ſmall ſize as not to weigh more than 36 grains; though in Caracalla's time it weighed 56. After the time of Gordian III. the ſmaller coin fell into diſuſe, as breeding confuſion. The larger denarius of ſix ſeſtertii, though diminiſhed at laſt to the ſize of the early denarius, ſtill retained its value of ſix ſeſtertii, or 24 aſſaria. The *Philippus æreus* came at length in place of the ſeſtertius. It was alſo called *denarius;* from which we may learn not only their ſize, but that they were in value ten aſſaria as the firſt denarius. In the reign of Diocleſian, the place of the ſeſtertius was ſupplied by the *follis*, that emperor having reſtored the ſilver coin to its purity, and likewiſe given this form to the copper; but it would ſeem that this reſtoration of the coinage only took place towards the end of his reign; whence we have but few of his ſilver coins, and ſtill fewer of the *folles*, though the *denarii ærei* continue quite common down to the time of Conſtantine. The follis of Diocleſian ſeems to have weighed above half an ounce; and Mr Pinkerton is of opinion, that Diocleſian deſigned this coin to ſupply the place of the denarius æreus; which of courſe was worth ten aſſariæ, and ſix of them went to the ſilver denarius. From this time the aſſarium diminiſhes to the ſize of 30 grains; and ſoon after the follis appeared, the denarius æreus was entirely dropped, the former having gradually ſupplied its place. Some mints appear to have retained the uſe of the denarius longer than others; and in ſome the change was preceded, and gradually brought in, by waſhing the follis with ſilver or tin, as the denarius had formerly been. Pieces of this kind occur in the times of Diocleſian, Maximian I. and II. and Conſtantius I.; that is, for about ten years after the follis made its appearance. Some countries, however, retained the denarius æreus; others the follis; and ſome had a medium betwixt the two, or the follis waſhed in imitation of the denarius.

55 New coinage introduced by Conſtantine I.

Towards the end of the reign of Conſtantine I. a new coinage was introduced throughout the whole empire. The follis coined by this prince was of half an ounce weight; 24 of them going to the milliarenſis, or larger ſilver coin. The word *follis* ſignifies alſo a purſe, in which ſenſe we ſometimes find it mentioned in the Byzantine hiſtory. The common follis of ſilver, when it occurs by itſelf, means a purſe of 250 milliarenſes, as the ſeſtertium was 250 denarii; and by a law of Conſtantine I. every man paid to the ſtate a follis or purſe according to his income. The method of counting by purſes continues in Turkey to this day.

56 Of the dupondius.

The *dupondius* was only half the value of the ſeſtertius, or about one penny ſterling; and before the yellow braſs appeared it ſeems to have been ſtruck upon copper, and double the ſize of the as. There are ſome of this coin, ſtruck in the time of Julius Cæſar, in yellow braſs, weighing half an ounce, with a head of Venus Victrix upon one ſide; on the reverſe, a female figure, with ſerpents at her feet: while others have a Victory on the reverſe, with Q. Oppius Pr. After the time of Auguſtus, the dupondius was ſtruck in yellow braſs; which Pliny tells us was alſo the caſe in his time. The word dupondiarius ſeems to have been uſed by Pliny, and adopted, not to expreſs that the coin was *dupondius*, but that it was of dupondiary value. Neither was the former word confined to ſignify double weight, but was uſed alſo for double length or meaſure, as in the inſtance of *dupondius pes*, or two feet, &c. In the imperial times, therefore, *dupondius* was uſed, not to ſignify a coin of double the weight of the as, but of double the value. It was one of the moſt common of the Roman coins; and ſeems to have been very common even in Conſtantinople. In the time of Juſtinian, it ſeems there was a cuſtom of nicknaming young ſtudents of the law *dupondii*, againſt which the emperor made a law; but it is not known what gave riſe to the name. The dupondius, though of the ſame ſize with the as, is commonly of finer workmanſhip, the metal being greatly ſuperior in value. It continues to be of yellow braſs, as well as the ſeſtertius, to the time of Gallienus; but the as is always in copper.

57 Of the aſſarium.

The imperial as, or *aſſarium*, was worth only a halfpenny.

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halfpenny. At firſt it weighed half an ounce, and was always of copper till the time of Gallienus, when it was made of braſs, and weighed only the eighth part of an ounce. From the time of Gallienus to that of Diocleſian, it continued to diminiſh ſtill more, the ſize being then twenty to an ounce. This was the ſame with the lepta, or ſmalleſt coins but the νουμια, which weighed only ten grains.

58 Parts of the as.

The parts of the as occur but ſeldom: which may, indeed, be well expected, conſidering the low value of it; though there ſtill occur ſome of thoſe called ſemis, triens, quadrans, ſextans, and uncia, coined in the times of Nero and Domitian. There is no ſmall braſs from the time of Pertinax to that of Gallienus, excepting that of Trajanus Decius; but in the time of Gallienus it becomes extremely common; and the coins of ſmall braſs, as well as the larger, are always marked S. C. ſuch as want it being univerſally accounted forgeries; and were plated with ſilver, though the plating be now worn off. The ſmall pieces ſtruck for ſlaves during the time of the ſaturnalia, muſt alſo be diſtinguiſhed from the parts of the as. The S. C. upon theſe moſt probably ſignifies *Saturni Conſulto*, and were ſtruck in ridicule of the true coins, as the ſlaves on that occaſion had every privilege of irony.

59 Of the ſmalleſt Roman coins.

The ſeſtertius diminiſhes from Pertinax to Gallienus ſo faſt, that no parts of the as are ſtruck, itſelf being ſo ſmall. Trajanus Decius, indeed, coined ſome ſmall pieces, which went for the ſemis of the time. The ſmall braſs coins under Gallienus were called aſſaria, ſixty of which went to the ſilver denarius. They are about the ſize of the denarius, and ſome of them occur of the coinage of Gallus and his family, of half that ſize, which appear to have been ſtruck during the latter part of his reign, when the aſſarium was diminiſhed to a ſtill ſmaller ſize. It is probable, however, that ſome of theſe very ſmall coins had been ſtruck in all ages of the empire, in order to ſcatter among the people on ſolemn occaſions. Mr Pinkerton is of opi-

60 Of the miſſilia.

nion that they are the *miſſilia*, though moſt other medalliſts think that they are medallions. "But if ſo (ſays our author), they were certainly called *miſſilia à non mittendo*; for it would be odd if fine medallions were ſcattered among the mob. It is a common cuſtom juſt now to ſtrike counters to ſcatter among the populace on ſuch occaſions, while medals are given to peers of the kingdom; and we may very juſtly reaſon from analogy on this occaſion."

The *aſſarion* or *lepton* of the Conſtantinopolitan empire was, as we have already obſerved, one of the ſmalleſt coins known in antiquity, weighing no more than 20 grains; and the *noumia* were the very ſmalleſt which have reached our times, being only one half of the former. By reaſon of their extreme ſmallneſs, they are very ſcarce; but Mr Pinkerton informs us, that he has in his poſſeſſion a fine one of Theodoſius II. which has on it the emperor's head in profile. Theodoſius P. F. AV.; on the reverſe a wreath, having in the centre VOT. XX.: MULT. XXX.

61 Coins of the lower empire.

The principal coin of the lower empire was the follis, which was divided into an half and quarter, named ἡμισοφολεος and τεταρτον; the latter of which is ſhown by Du Cange to have been a ſmall braſs coin, as the other is ſuppoſed to have been by Mr Pinkerton.—Beſides theſe, the follis was divided into eight oboli, 16 aſſaria or lepta, and 32 noumia, though in common computation it contained 40 of theſe laſt. This coin, notwithſtanding ſo many diviſions, was of no more value than a halfpenny.

Mr Pinkerton controverts an opinion, common among medalliſts, that the largeſt braſs coin or follis of the lower empire had 40 ſmall coins, expreſſed by the letter M upon it; the next had 30, expreſſed by the letter Λ; the half by the letter K; and the quarter marked I, which contained only 10. Mr Pinkerton informs us, that he has three coins of Anaſtaſius, all marked M in large; one of them weighs more than half an ounce; the ſecond 40 grains leſs; and the third of 160 grains, or one-third of an ounce; but the ſize is ſo very unequal, that the laſt, which is very thick, does not appear above half the ſize of the firſt. There are pieces of Juſtinian which weigh a whole ounce; but the ſize of copper was increaſed as the ſilver became ſcarcer; and the value of the coinage cannot be deduced from the weight of the coins, as it is plain that our own coinage is not of half the value with regard to the metal. A great number of medallions were ſtruck by Conſtantius II. but there is no other copper larger than the half ounce, excepting that of Anaſtaſius, when the follis began to be ſtruck larger. All medalliſts allow the others to be medallions.

The metal employed in theſe very ſmall coins, though at firſt of braſs, was always a baſe and refuſe kind; but copper is generally made uſe of in the parts of the as from the earlieſt times to the lateſt; and if braſs be ſometimes employed, it is never ſuch as appears in the ſeſtertii and dupondiarii, which is very fine and beautiful, but only the refuſe. "Yellow braſs of the right ſort (ſays Mr Pinkerton), ſeems totally to have ceaſed in the Roman coinage with the ſeſterſtius, under Gallienus, though a few ſmall coins of very bad metal appear under that hue as late as Julian II."

Silver was coined in Rome only as late as the 485th 62 Roman ſilver.
year of the city, or 266 B. C. Varro indeed ſpeaks of ſilver having been coined by Servius Tullius, and the libella having been once in ſilver; but Pliny's authority muſt be accounted of more weight than that of this author, as he miſtakes the λιτρα of Sicily for Roman coins, having been current at Rome during the time of the firſt Punic war. Even Pliny, according to our author, very frequently miſtakes with regard to matters much antecedent to his own time; and among the moderns he criticiſes ſeverely Eraſmus and Hume. "Eraſmus (ſays he), who had been in England for ſome time, talks of leaden money being uſed here." Not even a leaden token was ſtruck in the reign of Henry VIII.; yet his authority has been followed with due deference to ſo great a name; for how could Eraſmus, who muſt have ſeen the matter with his own eyes, aſſert a direct falſehood? To give a later inſtance in a writer of reputation, Mr Hume, in Vol. VI. of his hiſtory, has theſe words, in treating of the reign of James I. "It appears that copper halfpence and farthings began to be coined in this reign. Tradeſmen had commonly carried on their retail buſineſs by leaden tokens. The ſmall ſilver penny was ſoon loſt; and at this time was nowhere to be found." Copper halfpence and farthings were not ſtruck till Charles II. 1672: there were ſmall tokens

for

for farthings ſtruck in copper by James I. but not one for the halfpenny. The ſilver farthings had ceaſed with Edward VI. but the ſilver halfpence continued the ſole coins till Edward II. It was by copper tokens that ſmall buſineſs was carried on. The ſilver penny was much uſed till the end of the reign of George I.; and ſo far from being nowhere to be found, is ſuper-abundant of every reign ſince that period, not excepting even the preſent reign of George III. From theſe inſtances the reader may judge how ſtrangely writers of all ages blunder, when treating a ſubject of which they are entirely ignorant."

63 Denarii when firſt coined.

The firſt ſilver denarii coined at Rome, are ſuppoſed by our author to have been thoſe which are impreſſed with the Roma; and he inclines to account thoſe the moſt ancient that have a double female head on the one ſide, and on the reverſe Jupiter in a car, with Victory holding the reins, and the word Roma indented in a rude and ſingular manner. The double female head ſeems to denote Rome, in imitation of the Janus then upon the as. There are 15 of theſe in the cabinet of Dr Hunter; one of the largeſt weighs 98¾ grains: and the reſt, which ſeem to be of greateſt antiquity, are of various weights betwixt that and 84; the ſmaller and more modern weigh 58 or 59 grains; but Mr Pinkerton is of opinion, that the large ones are of the very firſt Roman coinage, and ſtruck during that interval of time betwixt the coinage of the firſt ſilver denarius and the as of two ounces. He takes the indentation of the word Roma to be a mark of great antiquity; ſuch a mode being ſcarcely known any where elſe, except in Caulonia, Crotona, and other towns of Italy; all of them allowed to be ſtruck at leaſt 400 B. C. As theſe coins are not double denarii, they muſt have been ſtruck prior to the ſmall ones; and Neumann has given an account of one of them recoined by Trajan, in which the indentation of Roma is carefully preſerved. The firſt denarius was in value 10 aſes, when the as weighed three ounces; and allowing 90 grains at a medium for one of theſe large denarii, the proportion of copper to ſilver muſt have been as 1 to 160: but when the as fell to one ounce, the proportion was as 1 to 80; when it fell to half an ounce, ſo that 16 aſes went to the denarius, the proportion was as 1 to 64, at which it remained. Copper with us, in coinage, is to ſilver as one to 40; but in actual value as 1 to 72.

At Rome the denarius was worth 8d.; the quinarius 4d.; and the ſeſtertius, whether ſilver or braſs, 2d. The denarius is the coin from which our penny is de-

64 Value of the denarius and its parts.

rived, and was the chief ſilver coin in Rome for 600 years. According to Celſus, ſeven denarii went to the Roman ounce, which in metals did not exceed 430 grains; but as all the denarii hitherto met with weigh at a medium only 60 grains, this would ſeem to make the Roman ounce only 420 grains; though perhaps this deficiency may be accounted for from the unavoidable waſte of metal even in the beſt preſerved of theſe coins. According to this proportion the Roman pound contained 84 denarii; but in tale there was a very conſiderable exceſs; for no fewer than 100 denarii went to the Roman pound. The Greek ounce appears to have been conſiderably larger than that of Rome, containing about 528 grains; yet notwithſtanding this apparently great odds, the difference in the coins was ſo ſmall, that the Greek money went current in Rome, and the Roman in Greece. The denarius at firſt went for 10 aſes, and was marked X: it was afterwards raiſed to 16; which Mr Pinkerton ſuppoſes to have been about 175 B. C. Some are met with bearing the number XVI. nay, with every number up to CCCCLXXVI. Theſe large numbers are ſuppoſed to have been mint-marks of ſome kind or other. After being raiſed to 16 aſes, it continued at the ſame value till the time of Gallienus; ſo that till that time we are to look upon its conſtituent parts to be 16 aſes or aſſaria, eight dupondii, four braſs ſeſtertii, and two ſilver quinarii. Under the emperor Severus, however, or his ſucceſſor Caracalla, denarii were ſtruck of two ſizes, one of them a third heavier than the common; which we muſt of conſequence ſuppoſe to have borne a third more value. This large piece obtained the name of *argentus*, and *argenteus Philippus*, or the "ſilver Philip;" the name of Philip having become common to almoſt every coin. The common denarii now began to be termed *minuti* and *argenti Philippi minutuli*, &c. to expreſs their being ſmaller than the reſt. Some have imagined that the large denarii were of the ſame value with the ſmall, only of worſe metal; but Mr Pinkerton obſerves, that among the few which have any difference of metal, the ſmalleſt are always the worſt. The firſt mention of the *minuti* is in the time of Alexander Severus, who reduced the price of pork from eight minuti at Rome to two and to one. The *minutus argenteus* of that age was about 40 grains; and from the badneſs of the metal was not worth above 4d. of our money. Thus the price of meat was by this prince reduced firſt to 8d. and then to 4d.

65 Reſtoration of the purity of the Roman coins.

According to Zoſimus and other writers, the purity of the Roman coin was reſtored by Aurelian: but Mr Pinkerton controverts this opinion; thinking it more probable, that he only made the attempt without ſucceſs; or that his reformation might be entirely confined to gold, on which there is an evident change after the time of this emperor. His ſucceſſor Tacitus is ſaid to have allowed no braſs to be mixed with ſilver upon any account; yet the few coins of this emperor are very much alloyed. We are certain, however, that the emperor Diocleſian reſtored the ſilver to its ancient purity; the denarii ſtruck in his reign being very ſmall indeed, but of as fine ſilver as the moſt ancient coins of the empire. After Gordian III. the ſmall denarius entirely vaniſhed, while the large one was ſo much diminiſhed, that it reſembled the *minutus*, or ſmall one of Caracalla, in ſize. Gallienus introduced the *denarii ærei* inſtead of the *ſeſtertii*. The *argenteus*, though reduced more than one-third in ſize, contained ſix denarii ærei, the old ſtandard of ſeſtertii. According to the writers of this period, and ſome time afterwards, the denarius or argenteus contained 60 aſſaria; whence it follows, that each denarius æreus had 10; and from this it probably had its name. The aſſaria are of the ſize of the argentei already mentioned; and ſhow the copper to have retained nearly its old proportion of value to the ſilver, viz. 1 to 60.

66 Reformation of the ſilver coin by Conſtantine.

A larger ſilver coin was introduced by Conſtantine I. who accommodated the new money to the pound of gold in ſuch a manner, that 1000 of the former in tale were equal to the latter in value; ſo that this new piece from thence obtained the name of the

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milliarensis or "thousander." Its weight at a medium is 70 grains, or 70 to the pound of silver: but Mr Pinkerton is of opinion, that it might have contained 72 grains, of which two have now perished by the softness of the silver; that the pound contained 72; or that two of the number might be allowed for coinage; while the alloy alone would pay for coining gold. The code says, that 60 went to the pound; but the numbers of this are quite corrupt. The *milliarensis* was worth about a shilling sterling. The argentei or denarii, however, were still the most common currency; and having been originally rated at 100 to the pound of silver in tale, they from thence began to be called *centenionales*, or "hundreders." Those of Constantine I. and II. Constans, and Constantius, weigh from 50 grains down to 40; those of Julian and Jovian, from 40 to 30; and of the succeeding emperors from that time to Justinian, from 30 to 20. Under Heraclius they ceased entirely; and from Justinian to their total abolition, had been brought down from 15 to 10 grains. A like decrease of weight took place in the milliarensis; those of Constantine and Constans being above 70 grains in weight; those of Arcadius not above 60; and the milliarensis of Justinian not more than 30 grains; but, from the weight of those in Dr Hunter's cabinet, Mr Pinkerton deduces the medium to have been exactly $70\frac{8}{11}$ grains. These coins were also called *majorinæ*.

67 Account of the small Roman coins.

The smaller silver coins of Rome were, 1. The *quinarius*, at first called *victoriatus*, from the image of Victory on its reverse; and which it continued to bear from first to last. Its original value was five ases, but it was afterwards raised to eight, when the value of the denarius increased to 16. According to Pliny, it was first coined in consequence of the *lex Clodia*, about the 525th year of Rome. Some are of opinion, that it was called κεϱατιον under the Constantinopolitan empire, because it was worth a κεϱατιον of gold, 144 of which went to the ounce: but this is denied by Mr Pinkerton, because, at the time that the word κεϱατιον first appears in history, the denarius did not weigh above 30 grains; and of consequence, as 25 must have gone to the gold solidus, of which there were six in the ounce, 130 denarii must have gone to the ounce of gold. He is therefore of opinion, that the word κεϱατιον, was only another name for the denarius when much reduced in size; probably owing to the great scarcity of silver in Constantinople, though in the same city there was plenty of gold; and of consequence, the gold solidus was never diminished. "For Montesquieu (says our author) has well observed, that gold must be common where silver is rare. Hence gold was the common regulation of accounts in the Eastern empire." The διχεϱατιον met with in ancient authors, according to Mr Pinkerton, was merely an improper name for the *milliarensis*; when, on account of the scarcity of silver, the denarius was reduced, and no milliarenses coined: so that the current milliarensis of former reigns happened to be double to the denarius or centenionalis. The quinarius diminishes in size along with the other coins: those of Augustus weighing 30 grains, of Severus 25, of Constantine I. 20, of Justinian 12, and of Heraclius only 5. A new silver coinage seems to have taken place after the days of this emperor; as the little we then meet with, which in the best cabinets scarce exceeds a dozen of coins, consists entirely of large unshapely pieces of coarse metal.

68 Divisions of the denarius.

2. The consular denarius had also four silver sestertii, till the as fell to half an ounce, when it was thought proper to coin the sestertius in brass, as it continued to be ever afterwards. "The very last silver sestertius (says Mr Pinkerton) which appears, is one with a head of Mercury, and H. S.; on the reverse a caduceus P. SEPVLLIVS; who appears to be the P. SEPVLLIVS MACER of the denarii of Julius Cæsar. If so, as is most probable, the sestertius was coined in silver down to Augustus; and it is of course not to be expected that any of brass can appear till Augustus, under whom they are actually quite common. I have indeed seen no coin which could be a consular brass sestertius; and though we have certainly brass dupondii of Cæsar, yet it is reasonable to infer, that the brass sestertius was first coined by Augustus. Not one silver sestertius appears during the whole imperial period, yet we know that the sestertius was the most common of all silver coins. The consular sestertii of silver, marked H. S. are not uncommon, nor the quinarii; but the latter are very scarce of all the emperors, if we except one instance, the ASIA RECEPTA of Augustus.

69 Roman gold.

"The Roman gold coinage was still later than that of silver. Pliny tells us, that "gold was coined 62 years after silver; and the scruple went for 60 sesterces. It was afterwards thought proper to coin 40 pieces out of the pound of gold. And our princes have by degrees diminished their weight to 45 in the pound." This account is confirmed by the pieces which still remain; for we have that very coin weighing a scruple, which went for 20 sesterces. On one side is the head of Mars, and on the other an eagle; and it is marked XX. We have another coin of the same kind, but double, marked XXXX; and its triple, marked ↓X or 60; the ↓ being the old numeral character for 50. Mr Pinkerton, the discoverer of this, treats other medallists with great asperity. Savot and Hardouin are mentioned by name; the latter (he says) is "ignorant of common sense;" and neither he nor Savot could explain it but by reading backward; put the ↓ for the Roman V, and thus making it XV. Other readings have been given by various medallists, but none have hit upon the true one excepting our author, though the coin itself led to it; being just three times the weight of that marked XX. We have likewise half the largest coin, which is marked XXX, and which weighs 26 grains; the smallest is only $17\frac{1}{2}$; the XXXX weighs 34; and the LX or drachma 53. There is also the didrachm of this coinage, of 106 grains.

70 Account of the aurei.

The *aurei*, or Roman gold coins, were at first 48 in the pound; but they were afterwards diminished in number to 40, owing to an augmentation in the weight of each coin. In the time of Sylla, the aureus weighed no less than from 164 to 168 grains, and there were only 30 in the pound; but such confusion in the coinage was introduced by that conqueror, that no person could know exactly what he was worth. Till this time the aureus seems to have continued of the value of 30 silver denarii, about one pound sterling; for about that time it was enlarged a whole third,

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that it might still be equivalent to the full number of denarii. But after Sylla had taken Athens, and the arts and manners of Greece became objects of imitation to the Romans, the aureus fell to 40 in the pound, probably when Sylla had abdicated his dictatorship. Thus, being reduced near to the scale of the Greek χςυσος, it passed for 20 denarii, as the latter did for as many drachmas, being in currency 13s. 4d. sterling. "This (says Mr Pinkerton) is the more probable, because we know from Suetonius, that the great Cæsar brought from Gaul so much gold, that it sold for nine times its weight of silver: but the Gallic gold was of a very base sort."

In the time of Claudius, the aureus was valued at 100 sestertii, or 25 silver denarii, at which it continued till the time of Heliogabalus, when it fell to about 92 grains at a medium, or rose in number to 55 in the pound. In the reign of Philip, during which the city completed its thousandth year, the aureus was coined of two or three sizes. These are impressed with a head of Rome on one side, and various figures on the other; but the workmanship is so rude, that they are supposed to have been struck in some of the more uncivilized provinces of the empire. The practice of having different gold coins, however, continued under Valerian, Gallienus, and his successors. In the time of Gallienus, they were of 30, 65, and from 86 to 93 grains; the double aurei being from 172 to 183½ grains; but the aureus properly so called was from 86 to 93; those of 30 and 32 being the *trientes aurei* of the *Historiæ Augustæ Scriptores*; while the larger, from 62 to 65, are to be accounted double trientes, and were perhaps called *minuti aurei*. The value of these different sizes of aurei is not known.

71 Alteration of the gold coin made by Aurelian.

That Aurelian made some alteration in the coin is certain; but Mr Pinkerton supposes it to have been only in the gold; because under him and his successor Probus, the common aureus was of 100 grains, a size confined to those emperors: there are likewise halves of about 50 grains; and double aurei, commonly of very fine workmanship, of upwards of 200 grains. In the time of Gallienus, the precious metal was so common, that this emperor vied in magnificence with Nero and Heliogabalus. Aurelian, who plundered the rich city of Palmyra, and thus became master of the treasures of the east, obtained such a profusion of gold, that he looked upon it to be produced by nature in greater plenty than silver. It is remarkable that during this emperor's reign there was a rebellion among the money coiners, which could not be quelled but by the destruction of several thousands; which Mr Pinkerton ascribes to his having ordered the gold to be restored to its former size, but to go for no more silver than it formerly did. "So very little silver (says he) occurs of this period, that it is plain no alteration in the silver produced the war with the moneyers; and in the brass he made no change; or if he had, it were strange that such commotions should arise about so trifling a metal. But if, as appears from the coins, he ordered the aureus, which had fallen to 80 grains, to be raised to about 100, it is no wonder that the contractors should be in an uproar; for a whole quarter of their coinage, amounting as would seem, to all their profits, was lost. Aurelian judged, that when he found gold so common in the east, it was equally so in the west; and that the moneyers must have made a most exorbitant profit; but his ideas on this subject were partial and unjust: and after his short reign, which did not exceed five months after the alteration, the gold returned to its former course; though a few pieces occur of Aurelian's standard, struck, as would seem, in the commencement of the reign of Probus his successor.

From this time to that of Constantine I. the aureus weighed between 70 and 80 grains; but in his reign it was changed for the solidus, of which six went to the ounce of gold, which went for 14 milliarenses, and 25 denarii as before; the value of silver being now to gold as 14 to 1. This new coin continued of the same value to the final downfall of the Constantinopolitan empire; gold being always very plentiful in that city, though silver became more and more scarce. The solidus was worth 12s. sterling. Here again our author most severely criticises Mr Clarke and Mr Raper: the former (he says) with respect to the value of gold in the time of Constantine I. "has left all his senses behind him. In page 267, he absurdly asserts, that 20 denarii went to the solidus in the time of Theodosius I. and proceeds with this deplorable error to the end of his work. He then tells us, that only 14 denarii went to the solidus under Constantine I." &c. To Mr Raper, however, he is a little more merciful, as he owns, that "though he (Mr Raper) has strangely confounded the milliarensis with the denarius, he has yet kept common sense for his guide." Mr Pinkerton, indeed, argues with great probability, "that had any change in the coinage taken place between the time of Constantine and Theodosius I. that is, in less than 50 years, the laws of that period, which are all in the Theodosian code, must have noticed it." To this and other arguments upon the subject, Mr Pinkerton adds the following observation upon the value of gold and silver: "As a state advances to its height, gold increases in value; and as a state declines, it decreases, providing the metals are kept on a par as to purity. Hence we may argue, that gold decreased in its relation to silver perhaps four or five centuries, furnished most European kingdoms with gold in coin, which otherwise would, from their want of arts and of intercourse with the east, then the grand seminary of that metal, have almost been ignorant of what gold was. These gold coins were called *Bezants* in Europe, because sent from Byzantium or Constantinople; and were *solidi* of the old scale, six to the ounce. In Byzantine writers, the solidus is also called *nomisma*, or "the coin;" *crysinos*, because of gold; *hyperperos*, from its being refined with fire, or from its being of bright gold flaming like fire. The *solidi* also, as the *aurei* formerly, received names from the princes whose portraits they bore; as *Michelati*, *Manuelati*. *Solidus* is a term used also for the aureus by Apuleius, who lived in the time of Antoninus the Philosopher; nay, as early as the prætorian edicts of the time of Trajan. It was then a distinction from the semissis or half. In the time of Valerian, when aurei of different sizes had been introduced, it became necessary to distinguish the particular aurei meant. Hence in the Imperial Rescripts, published by the *Historiæ Augustæ Scriptores*, Valerian uses the term *Philippeos nostri vultus*, for the common aurei. Aurelian uses the same term *aurei* *Philippei*,

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Philippei, for the aurei which he had reftored to their fize in fome degree. Gallienus ufes *aurei Valeriani* for his father's coins. *Aurei Antoniniani* are likewife put by Valerian for coins of the early Antonini, of fuperior ftandard to any then ufed.

72 Divifion of the aureus.

In the firft gold coinage at Rome the aureus was divided into four parts: the femiffis of 60 feftertii; the tremiffis or third, of 40; the fourth, the name of which is not mentioned, of 30; and the fcrupulum of 20. But in a fhort time all of thefe fell into difufe, except the femiffis or half, which is extremely fcarce; fo that it is probable that few have been ftruck. It is an erroneous opinion (according to Mr Pinkerton), that the femiffis was called a *denarius aureus*. The aureus itfelf indeed had this name; but the name of *quinarius* is applied to the femiffis with greater propriety than the former. Trientes, or tremiffes of gold, are found of Valerian and his fon Gallienus, and weigh about 30 grains. Thofe of Salonina the wife of Gallienus weigh 33 grains. Under the Conftantinopolitan empire, tremiffes again made their appearance; and from the time of Valentinian downwards, the thirds are the moft common coins of gold, being worth about 4s. fterling. The femiffis is likewife mentioned, but none occur earlier than the time of Bafilifcus. The gold tremiffis was the pattern of the French and Spanifh gold coins; as the filver denarius, in its diminifhed ftate, was of the Gothic and Saxon penny.

73 Account of the Roman method of coining.

We fhall clofe this account of the Roman money with fome remarks concerning the mint, and method of coinage. This at firft feems to have been under the direction of the quæftor. About the time that filver was firft coined in Rome, viz. about 266 B. C. the *triumviri monetales* were created. They were at firft of fenatorial rank, but were by Auguftus chofen from among the equeftrian; and the title of *triumviri* was continued till after the time of Caracalla; but under Aurelian there was probably but one mafter of the mint, called *rationalis;* and Mr Pinkerton is of opinion that the change took place under Gallienus. He feems alfo to have permitted the provincial cities to coin gold and filver, as well as to have altered the form of the mints in the capital, and to have ordered them all to ftrike money with Latin legends, and of the fame forms; as in his time we firft meet with coins with mint marks of cities and offices. The violent infurrection which took place in his reign has already been mentioned, as well as its probable caufe; and Mr Gibbon has fhown, that the concealed enemies of Aurelian took fuch advantage of this infurrection, that it coft 7000 of his beft troops before it could be quelled. About this time the *procurator monetæ* feems to have fucceeded the *rationalis* as director of the mint. In the colonies, the direction of the mint feems to have been given to the decemviri, whofe names frequently occur on colonial coins; "which (fays Mr Pinkerton), though generally of rude invention, and ruder execution, are yet often interefting and important."

The engraving of the ancient dies ufed in coinage was a work of much genius and labour; and at Rome Greek artifts were generally employed in it; but it has been thought a matter of great furprife, that fcarce any two ancient coins are to be found exactly the fame. Hence fome antiquaries have imagined that only a fingle coin was thrown off from each die. M. Beauvais informs us, that the only two Roman imperial coins of the firft times which he had feen perfectly alike were thofe of the emperor Galba. It is, however, the opinion of the beft judges, that a perfect fimilarity betwixt two medals is a very great reafon for fuppofing one of them to be forged. "It muft alfo be obferved (fays Mr Pinkerton), that the differences in coins, apparently from the fame die, are often fo minute as to efcape an eye not ufed to microfcopic obfervations of this fort. But it would be furprifing if any two ancient coins were now found ftruck with the fame die; for out of each million iffued, not above one has reached us. Dies foon give way by the violence of the work, and the ancients had no puncheons nor matrices, but were forced to engrave many dies for the fame coin. Even in our mint, upon fending for a fhilling's worth of new halfpence, it will appear that three or four dies have been ufed. Sometimes the obverfe of the die gives way, fometimes the reverfe; but among us it is renewed by puncheons, though with variations in the lettering or other minute ftrokes; while the ancients were forced to recur to another die differently engraven. The engravers of the die were called *cælatores;* other officers employed in the mint were the *fpectatores*, *expectatores*, or *nummularii*. The melters were ftyled *fufarii*, *flatuarii*, *and flaturarii;* thofe who adjufted the weight were called *æquatores monetarum;* thofe who put the pieces into the die *fuppofitores*, and thofe who ftruck them *malleatores*. At the head of each office was an officer named *primicerius*, and the foreman was named *optio et exactor*."

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In order to affift the high relief on the coins, the metal, after being melted and refined, was caft into bullets, as appears from the ancient coins not being cut or filed on the edges, but often cracked, and always rough and unequal. Thefe bullets were then put into the die, and received the impreffion by repeated ftrokes of the hammer, though fometimes a machine appears to have been ufed for this purpofe: for Boiterue informs us, that there was a picture of the Roman mintage in a grotto near Baiæ, where a machine was reprefented holding up a large ftone as if to let it fall fuddenly, and ftrike the coin at once. None of the ancient money was caft in moulds, excepting the moft ancient and very large Roman brafs, commonly called *weights*, and other Italian pieces of that fort; all the reft being mere forgeries of ancient and modern times. Some Roman moulds which have been found are a proof of this; and from thefe fome medallifts have erroneoufly imagined that the ancients firft caft their money in moulds, and then ftamped it, in order to make the impreffion more clear and fharp.

The ancients had fome knowledge of the method of crenating the edges of their coins, which they did by cutting out regular notches upon them; and of this kind we find fome of the Syrian and ancient confular coins, with a few others. The former were caft in this fhape, and then ftruck; but the latter were crenated by incifion, to prevent forgery, by fhowing the infide of the metal: however, the ancient forgers alfo found out a method of imitating this; for Mr Pinkerton informs us, that he had a Roman confular coin, of which the incifions, like the reft, were plated with filver over the copper.

SECT.

Preſerva-tion.

Sect. VI. *Of the Preſervation of Medals.*

We now come to conſider what it is that diſtinguiſhes one medal from another, and why ſome are ſo highly prized more than others. This, in general, beſides its genuineneſs, conſiſts in the high degree of preſervation in which it is. This, by Mr Pinkerton, is called the *conſervation* of medals, and is by him regarded as *good* and as *perfect*. In this, he ſays that a true judge is ſo nice, that he will reject even the rareſt coins if in the leaſt defaced either in the figures or legend. Some, however, are obliged to content themſelves with thoſe which are a little rubbed, while thoſe of ſuperior taſte and abilities have in their cabinets only ſuch as are in the very ſtate in which they came from the mint; and ſuch, he ſays, are the cabinets of Sir Robert Auſtin, and Mr Walpole, of Roman ſilver, at Strawberryhill. It is abſolutely neceſſary, however, that a coin be in what is called *good* preſervation; which in the Greek or Roman emperors, and the colonial coins, is ſuppoſed to be when the legends can be read with ſome difficulty; but when the conſervation is perfect, and the coin juſt as it came from the mint, even the moſt common coins are valuable.

74 Braſs and copper beſt preſerved by the ruſt that covers them.

The fine ruſt, like varniſh, which covers the ſurface of braſs and copper coins, is found to be the beſt preſerver of them; and is brought on by lying in a certain kind of ſoil. Gold cannot be contaminated but by iron mold, which happens when the coin lies in a ſoil impregnated with iron; but ſilver is ſuſceptible of various kinds of ruſt, principally green and red; both of which yield to vinegar. In gold and ſilver coins the ruſt muſt be removed, as being prejudicial; but in

75 Different kinds of this ruſt.

braſs and copper it is preſervative and ornamental; a circumſtance taken notice of by the ancients. "This fine ruſt (ſays Mr Pinkerton), which is indeed a natural varniſh not imitable by the art of man, is ſometimes a delicate blue, like that of a turquoiſe; ſometimes of a bronze brown, equal to that obſervable in ancient ſtatues of bronze, and ſo highly prized; and ſometimes of an exquiſite green, a little on the azure hue, which laſt is the moſt beautiful of all. It is alſo found of a fine purple, of olive, and of a cream colour or pale yellow: which laſt is exquiſite, and ſhows the impreſſion to as much advantage as paper of cream colour, uſed in all great foreign preſſes, does copperplates and printing. The Neapolitan patina (the ruſt in queſtion) is of a light green; and when free from excreſcence or blemiſh is very beautiful. Sometimes the purple patina gleams through an upper coat of another colour, with as fine effect as a variegated ſilk or gem. In a few inſtances a ruſt of a deeper green is found; and it is ſometimes ſpotted with the red or bronze ſhade, which gives it quite the appearance of the Eaſt Indian ſtone called the *blood-ſtone*. Theſe ruſts are all, when the real product of time, as hard as the metal itſelf, and preſerve it much better than any artificial varniſh could have done; concealing at the ſame time not the moſt minute particle of the impreſſion of the coin."

76 Medals how diminiſhed in value.

The value of medals is lowered when any of the letters of the legend are miſplaced; as a ſuſpicion of forgery is thus induced. Such is the caſe with many of thoſe of Claudius Gothicus. The ſame, or even greater, diminution in value takes place in ſuch coins as have not been well fixed in the die, which has occaſioned their ſlipping under the ſtrokes of the hammer, and thus made a double or triple image. Many coins of this kind are found in which the one ſide is perfectly well formed, but the other blundered in the manner juſt mentioned. Another blemiſh, but of ſmaller moment, and which to ſome may be rather a recommendation, is when the workmen through inattention have put another coin into the die without taking out the former. Thus the coin is convex on one ſide, and concave on the other, having the ſame figure upon both its ſides.

77 Counter-marked medals.

The medals ſaid by the judges in this ſcience to be *countermarked* are very rare, and highly valued. They have a ſmall ſtamp impreſſed upon them, in ſome a head, in others a few letters, ſuch as Aug : n. probus, &c. which marks are ſuppoſed to imply an alteration in the value of the coin; as was the caſe with the countermarked coins of Henry VIII. and Queen Mary of Scotland. Some have a ſmall hole through them; ſometimes with a little ring faſtened in it, having been uſed as ornaments; but this makes no alteration in their value. Neither is it any diminution in the value of a coin that it is ſplit at the edges; for coins of undoubted antiquity have often been found in this ſtate, the cauſe of which has been already explained. On the contrary, this cracking is generally conſidered as a great merit; but Mr Pinkerton ſuſpects that one of theſe cracked coins has given riſe to an error with reſpect to the wife of Carauſius who reigned for ſome time in Britain. The inſcription is read oriuna Aug : and there is a crack in the medal juſt before the O of oriuna. Without this crack Mr Pinkerton ſuppoſes that it would have been read Fortuna Aug.

78 Silver and gold how tarniſhed.

Some particular ſoils have the property of giving ſilver a yellow colour as if it had been gilt. It naturally acquires a black colour through time, which any ſulphureous vapour will bring on in a few minutes. From its being ſo ſuſceptible of injuries, it was always mixed by the ancients with much alloy, in order to harden it. Hence the impreſſions of the ancient ſilver coins remain perfect to this day, while thoſe of modern coins are obliterated in a few years. On this account Mr Pinkerton expreſſes a wiſh that modern ſtates would allow a much greater proportion of alloy in their ſilver coin than they uſually do. As gold admits of no ruſt except that from iron above-mentioned, the coins of this metal are generally in perfect conſervation, and freſh as from the mint.

79 How to cleanſe them.

To cleanſe gold coins from this ruſt, it is beſt to ſteep them in aquafortis, which, though a very powerful ſolvent of other metals, has no effect upon gold. Silver may be cleanſed by ſteeping for a day or two in vinegar, but more effectually by boiling in water with three parts of tartar and one of ſea ſalt; on both theſe metals, however, the ruſt is always in ſpots, and never forms an entire incruſtation as on braſs or copper. The coins of theſe two metals muſt never be cleanſed, as they would thus be rendered full of ſmall holes eaten by the ruſt. Sometimes, however, they are found ſo totally obſcured with ruſt, that nothing can be diſcovered upon them; in which caſe it is beſt to clear them with a graver; but it may alſo be done by boiling them for 24 hours in water with three

How to distinguish true from counterfeits.

three parts of tartar and one of alum; not sea salt as in silver coins.

80 When ancient coins are in such a high state of preservation.

The high state of preservation in which ancient coins are usually found, is thus accounted for by Mr Hancarville. He observes, that the chief reason is the custom of the ancients always to bury one or more coins with their dead, in order to pay for their passage over the river Styx. "From Phidon of Argos (says he) to Constantine I. are 36 generations: and from Magna Græcia to the Euphrates, from Cyrene to the Euxine sea, Grecian arts prevailed, and the inhabitants amounted to about 30,000,000 There died, therefore, in that time and region, not less than ten thousand millions of people, all of whom had coins of one sort or other buried with them. The tombs were sacred and untouched; and afterwards neglected, till modern curiosity or chance began to disclose them. The urn of Flavia Valentina, in Mr Towley's capital collection, contained seven brass coins of Antoninus Pius and Heliogabalus. Such are generally black, from being burnt with the dead. The best and freshest coins were used on these occasions from respect to the dead; and hence their fine conservation. At Syracuse a skeleton was found in a tomb, with a beautiful gold coin in its mouth; and innumerable other instances might be given, for hardly is a funeral urn found without coins. Other incidents also conspire to furnish us with numbers of ancient coins, though the above-recited circumstance be the chief cause of perfect conservation. In Sicily, the silver coins with the head of Proserpine were found in such numbers as to weigh 600 French livres or pounds. In the 16th century, 60,000 Roman coins were found at Modena, thought to be a military chest hid after the battle of Bedriacum, when Otho was defeated by Vitellius. Near Brest, in the year 1760, between 20 and 30,000 Roman coins were found. A treasure of gold coins of Lysimachus was found at Deva on the Marus; and Strabo, lib. vii. and Pausan. in *Attic.* tell that he was defeated by the Getæ; at which time this treasure seems to have fallen into their hands."

81 Number of ancient coins.

Thus Mr Pinkerton, from the authority of Mr Hancarville and others: but considering these vast numbers of coins found in various places, it seems surprising how so few should now remain in the cabinets of the curious, as the same author informs us that the whole of the different ancient coins known to us amount only to about 80,000, though he owns that the calculation cannot be esteemed accurate.

SECT. VII. *How to distinguish true Medals from counterfeits.*

THE most difficult and the most important thing in the whole science of medals is the method of distinguishing the true from the counterfeit. The value put upon ancient coins made the forgery of them almost coeval with the science itself; and as no laws inflict a punishment upon such forgers, men of great genius and abilities have undertaken the trade: but whether to the real detriment of the science or not, is a matter of some doubt; for if only exact copies of genuine medals are sold for the originals, the imposition may be deemed trifling: but the case must be accounted very different, if people take it upon them to forge medals which never existed. At first the forgeries were extremely gross; and medals were forged of Priam, of Aristotle, Artemisia, Hannibal, and most of the other illustrious personages of antiquity. Most of these were done in such a manner, that the fraud could easily be discovered; but others have imposed even upon very learned men. Mr Pinkerton mentions a remarkable medal of the emperor Heraclius, representing him in a chariot on the reverse, with Greek and Latin inscriptions, which Joseph Scaliger and Lipsius imagined to have been struck in his own time, but which was certainly issued in Italy in the 15th century. "Other learned men (says our author) have been strangely misled, when speaking of coins; for to be learned in one subject excludes not gross ignorance in others. Budæus, de Asse, quotes a denarius of Cicero, M. TULL. Erasmus, in one of his Epistles, tells us with great gravity, that the gold coin of Brutus struck in Thrace, ΚΟΣΩΝ, bears the patriarch Noah coming out of the ark with his two sons, and takes the Roman eagle for the dove with the olive branch. Winkelman, in his letters informs us, that the small brass piece with Virgil's head, reverse EPO, is undoubtedly ancient Roman; and adds, that no knowledge of coins can be had out of Rome: but Winkelman, so conversant in statues, knew nothing of coins. It is from other artists and other productions that any danger of deceit arises. And there is no wonder that even the skilful are misled by such artists as have used this trade; for among them appear the names of Victor Gambello, Giovani del Cavino, called the PADUAN, and his son Alessandro Bassiano, likewise of Padua, Benvenuto Cellini, Alessandro Greco, Leo Aretino, Jacobo da Frezzo, Federigo Bonzagna, and Giovani Jacopo, his brother; Sebastiano Plumbo, Valerio de Vizenza, Gorlæus, a German, Carteron of Holland, and others, all or most of them of the 16th century; and Cavino the Paduan, who is the most famous, lived in the middle of that century. The forgeries of Cavino are held in no little esteem, being of wonderful execution. His and those of Carteron are the most numerous, many of the other artists here mentioned not having forged above two or three coins. Later forgers were Dervieu of Florence who confined himself to medallions, and Cogornier who gave coins of the 30 tyrants in small brass. The chief part of the forgeries of Greek medals which have come to my knowledge are of the first mentioned, and a very gross kind, representing persons who could never appear upon coin, such as Priam, Æneas, Plato, Alcibiades, Artemisia, and others. The real Greek coins were very little known or valued till the works of Goltzius appeared, which were happily posterior to the æra of the grand forgers. Why later forgers have seldom thought of counterfeiting them cannot be easily accounted for, if it is not owing to the masterly workmanship of the originals, which sets all imitation at defiance. Forgeries, however, of most ancient coins may be met with, and of the Greek among the rest.

82 Coins forged by excellent artists.

83 Roman forgeries more conspicuous than Greek.

"The forgeries are more conspicuous among the Roman medals than any other kind of coins; but we are not to look upon all these as the work of modern artists. On the contrary, we are assured that many of them were fabricated in the times of the Romans themselves, some of them being even held in more estimation than the genuine coins themselves, on account of

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of their being plated, and otherwise executed in a manner to which modern forgers could never attain. Even the ancients held some of these counterfeits in such estimation, that Pliny informs us there were frequently many true denarii given for one false one."—Caracalla is said to have coined money of copper and lead plated with silver; and plated coins, the work of ancient forgers, occur of many Greek cities and princes; nay, there are even forgeries of barbaric coins. "Some Roman coins (says Mr Pinkerton), are found of iron or lead plated with brass, perhaps trials of the skill of the forger. Iron is the most common; but one decursio of Nero is known of lead plated with copper. Neumann justly observes, that no historic faith can be put in plated coins, and that most faulty reverses, &c. arise from plated coins not being noticed as such. Even to the Roman consular coins not very many have ever been forged. The celebrated silver denarius of Brutus, with the cap of liberty and two daggers, is the chief instance of a consular coin of which a counterfeit is known. But it is easily rejected by this mark: in the true coin the cap of liberty is below the guard or hilt of the daggers; in the false, the top of it rises above that hilt."

84 Denarius of Brutus.

85 Imperial medals.

The imperial series of medals is the grand object of modern medallic forgeries; and the deception was at first extended to the most eminent writers upon the subject. The counterfeits are by Mr Pinkerton divided into six classes.

I. Such as are known to be imitations, but valued on account of the artists by whom they are executed. In this class the medals of the Paduan rank highest; the others being so numerous, that a complete series of imperial medals of almost every kind, nay almost of every medallion, may be formed from among them. In France, particularly, by far the greater part of the cabinets are filled with counterfeits of this kind. They are distinguished from such as are genuine by the following marks: 1. The counterfeits are almost universally thinner. 2. They are never worn or damaged. 3. The letters are modern. 4. They are either destitute of varnish entirely, or have a false one, which is easily known by its being black, shining, and greasy, and very easily hurt with the touch of a needle, while the varnish of ancient medals is as hard as the metal itself. Instead of the greasy black varnish above mentioned, indeed, they have sometimes a light green one, spotted with a kind of iron marks, and is composed of sulphur, verdigrise, and vinegar. It may frequently be distinguished by the hairstrokes of the pencil with which it was laid on being visible upon it. 5. The sides are either filed or too much smoothed by art, or bear the marks of a small hammer. 6. The counterfeits are always exactly circular, which is not the case with ancient medals, especially after the time of Trajan.

86 Paduan forgeries how known.

The Paduan forgeries may be distinguished from those of inferior artists by the following marks: 1. The former are seldom thinner than the ancient. 2. They very seldom appear as worn or damaged, but the others very frequently, especially in the reverse, and legend of the reverse, which sometimes, as in forged Othos, appear as half consumed by time. 3. The letters in moulds taken from the antique coins have the rudeness of antiquity. 4. False varnish is commonly light green or black, and shines too much or too little. 5. The sides of forged coins are frequently quite smooth, and indistinguishable from the ancient, though to accomplish this requires but little art. 6. Counterfeit medals are frequently as irregular in their form as the genuine; but the Paduan are generally circular, though false coins have often little pieces cut off, in perfect imitation of the genuine. 7. In cast coins the letters do not go sharp down into the medal, and have no fixed outline; their minute angles, as well as those of the drapery, are commonly filled up, and have not the sharpness of the genuine kind. Where the letters or figures are faint, the coin is greatly to be suspected.

87 Letters the principal criterion of medals.

The letters form the great criterion of medals, the ancient being very rude, but the modern otherwise; the reason of which, according to Cellini, is, that the ancients engraved all their matrices with the graver or burin, while the modern forgers strike theirs with a punch.

88 Vico's account of false patina.

According to Vico, the false patina is green, black, russet, brown, gray, and iron colour. The green is made from verdigrise, the black is the smoke of sulphur, the gray is made of chalk steeped in urine, the coin being left for some days in the mixture. The russet is next to the natural, by reason of its being a kind of froth which the fire forces from ancient coins; but when false, it shines too much. To make it they frequently took the large brass coins of the Ptolemies, which were often corroded, and made them red hot in the fire; put the coins upon them, and a fine patina adhered. Our author does not say in what manner the iron-coloured patina was made. "Sometimes (adds he) they take an old defaced coin, covered with real patina, and stamp it anew; but the patina is then too bright in the cavities, and too dull in the protuberances. The trial of brass coins with the tongue is not to be despised; for if modern the patina tastes bitter or pungent, while if ancient it is quite tasteless."

Mr Pinkerton informs us, that all medallions from Julius Cæsar to Adrian are much to be suspected of forgery; the true medals of the first 14 emperors being exceedingly valuable, and to be found only in the cabinets of princes.

89 Medals cast from the Paduan forgeries.

II. The second class of counterfeit medals contains those cast from moulds taken from the Paduan forgeries, and others done by eminent masters. These are sometimes more difficult to be discovered than the former, because in casting them they can give any degree of thickness they please; and, filling the small sandholes with mastic, they retouch the letters with a graver, and cover the whole with varnish. The instructions already given for the former class, however, are also useful for those of the second, with this addition, that medals of this class are generally lighter than the genuine, because fire rarefies the metal in some degree, while that which is struck is rather condensed by the strokes. In gold and silver medals there cannot be any deception of this kind; because these metals admit not of patina, and consequently the varnish betrays the imposition. The marks of the file on the margin of those of the second class are a certain sign of forgery; though these do not always indicate the forgery to be of modern date, because the Romans often filed the edges of coins to accommodate them to the purposes of ornament, as quarter guineas are sometimes

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times put into the bottom of punch ladles. It is common to imitate the holes of medals made by time by means of aquafortis; but this destroys the sides of a coin more effectually than if it had been eat into naturally. The fraud, however, is not easily distinguished.

90 Medals cast from an antique.

III. *Medals cast in moulds from an antique.*—In this mode some forgers, as Beauvais informs us, have been so very careful, that they would melt a common medal of the emperor whom they meant to counterfeit, lest the quality of the metal should betray them. "This (says Mr Pinkerton), has been done in the silver Septimius Severus, with the reverse of a triumphal arch, for which a common coin of the same prince has been melted; and in other instances." Putting metals in the fire or upon hot iron to cleanse them, gives them an appearance of being cast; for some spots of the metal being softer than the rest will run, which makes this one of the worst methods of cleaning medals.—The directions given for discovering the two former deceptions hold good also in this.

91 Ancient medals retouched.

IV. *Ancient medals retouched and altered.*—This is a class of counterfeits more difficult to be discovered than any other. "The art (says Mr Pinkerton) exerted in this class is astonishing; and a connoisseur is the less apt to suspect it, because the coins themselves are in fact ancient. The acute minds of the Italian artists exerted themselves in this way, when the other forgeries became common and known. With graving tools they alter the portraits, the reverses, and the inscriptions themselves, in a surprising manner. Of a Claudius struck at Antioch they make an Otho; of a Faustina, a Titiana; of a Julia Severa, a Didia Clara; of a Macrinus, a Pescennius, &c. Give them a Marcus Aurelius, he starts up a Pertinax, by thickening the beard a little, and enlarging the nose. In short, wherever there is the least resemblance in persons, reverses, or legends, an artist may from a trivial medal generate a most scarce and valuable one. This fraud is distinguishable by the false varnish which sometimes masks it; but, above all, by the letters of the legend, which are always altered. Though this be sometimes done with an artifice almost miraculous, yet most commonly the characters straggle, are disunited, and not in a line."

In counterfeits of this kind sometimes the obverse is not touched, but the reverse made hollow, and filled with mastic coloured like the coin, and engraven with such device and legend as was most likely to bring a great price; others are only retouched in some minute parts, by which, however, the value of the coin is much diminished. "Against all these arts (says Mr Pinkerton), severe scrutiny must be made by the purchaser upon the medal itself; and the investigation and opinion of eminent antiquaries had upon its being altered, or genuine as it is issued from the mint."

92 Medals with new devices, or soldered.

V. *Medals impressed with new devices, or soldered.*—In the first article of this class the reverses have been totally filed off, and new ones impressed with a die and hammer. This is done by putting the face or obverse, whichever is not touched, upon different folds of pasteboard, afterwards applying the die and striking it with a hammer. The forgery in this class is very easily discovered, as the devices and inscriptions on the counterfeits are known not to exist on true medals: as the Pons Ælius on the reverse of Adrian; the Expeditio Judaica of the same emperor, &c. The difference of fabrication in the face or reverse will be discovered at the first glance by any person of skill.

The soldered medals consist of two halves belonging to different medals, sawed through the middle and then joined with solder. This mode of counterfeiting is common in silver and brass coins. "They will take an Antoninus, for example, and saw off the reverse, then solder to the obverse which they have treated in the same manner. This makes a medal, which, from an unknowing purchaser, will bring a hundred times the price of the two coins which compose it. When the deceit is used in brass coins, they take care that the metals be of one hue; though indeed some pretenders in this way sometimes solder copper and brass together, which at once reveals the deceit. Medals which have a portrait on each side, and which are generally valuable, are the most liable to a suspicion of this fraud. To a very nice eye the minute ring of solder is always visible; and upon inserting a graver, the fabrication falls into halves."

In the same manner reverses are sometimes soldered to faces not originally belonging to them; as one mentioned by Pere Jobert, of Domitian with an amphitheatre, a reverse of Titus joined to it. Another art is sometimes made use of in this kind of counterfeits, of which there is an instance of the temple of Janus upon Nero's medals; where the middle brass is taken off, and inserted in a cavity made in the middle of a large coin of that prince. In the coins of the lower empire, however, the reverses of medals are sometimes so connected with their obverses, that a suspicion of forgery sometimes occurs without any foundation. They are met with most commonly after the time of Gallienus, when such a number of usurpers arose, that it was difficult to obtain an exact portrait of their features; the coiners had not time, therefore, to strike a medal for these as they could have done for other emperors who reigned longer. Hence, on the reverse of a medal of Marius, who reigned only three days, there is PACATOR ORBIS, which shows that at that time they had reverses ready fabricated, to be applied as occasion might require.

93 Plated medals, &c.

VI. *Plated medals, or those which have clefts.*—It has been already remarked, that many true medals are cracked in the edges; owing to the repeated strokes of the hammer, and the little degree of ductility which the metal possesses. This the forgers attempt to imitate by a file; but it is easy to distinguish betwixt the natural and artificial cleft by means of a small needle. The natural cleft is wide at the extremity, and appears to have a kind of almost imperceptible filaments; the edges of the crack corresponding with each other in a manner which no art can imitate.

The plated medals which have been forged in ancient times were long supposed to be capable of resisting every effort of modern imitation; but of late years, "some ingenious rogues (says Mr Pinkerton), thought of piercing false medals of silver with a red-hot needle, which gave a blackness to the inside of the coin, and made it appear plated to an injudicious eye. This fraud is easily distinguished by scraping the inside of the metal." It is, however, very difficult to distinguish

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distinguish the forgeries of rude money when not cast; and our author gives no other direction than to consult a skilful medallist. Indeed, notwithstanding all the directions already given, this seems to be a resource which cannot by any means with safety be neglected.

94 Mr Pinkerton's directions for knowing medals.

A real and practical knowledge of coins "is only to be acquired (says he) by seeing a great number, and comparing the forged with the genuine. It cannot therefore be too much recommended to the young connoisseur, who wishes to acquire some knowledge in this way, to visit all the sales and cabinets he can, and to look upon all ancient medals with a very microscopic eye. By these means only is to be acquired that ready knowledge which enables at first glance to pronounce upon a forgery, however ingenious. Nor let the science of medals be from this concluded to be uncertain; for no knowledge is more certain and immediate, when it is properly studied by examination of the real objects. A man who buys coins, trusting merely to his theoretic perusal of medallic books, will find himself wofully mistaken. He ought to study coins first, where only they can be studied, in themselves. Nor can it be matter of wonder or implication of caprice, that a medallist of skill should at one perception pronounce upon the veracity or falsehood of a medal; for the powers of the human eye, employed in certain lines of science, are amazing. Hence a student can distinguish a book among a thousand similar, and quite alike to every other eye: hence a shepherd can discern, &c.; hence the medallist can say in an instant, 'this is a true coin, and this is a false,' though to other people no distinction be perceptible."

95 Forgeries of modern coins.

Forgeries of modern coins and medals, Mr Pinkerton observes, are almost as numerous as of the ancient. The satiric coin of Louis XII. PERDAM BABYLONIS NOMEN, is a remarkable instance: the false coin is larger than the true, and bears date 1512. The rude coins of the middle ages are very easily forged, and forgeries have accordingly become common. Forged coins of Alfred and other early princes of England have appeared, some of which have been done with great art. "The two noted English pennies of Rich I. says our author, are of this stamp; and yet have imposed upon Messrs Folkes and Snelling, who have published them as genuine in the two best books upon English coins. But they were fabricated by a Mr White of Newgate-street, a noted collector, who contaminated an otherwise fair character by such practices. Such forgeries, though easy, require a skill in the history and coinage of the times, which luckily can hardly fall to the lot of a common Jew or mechanic forger. But the practice is detestable, were no gain proposed: and they who stoop to it must suppose, that to embarrass the path of any science with forgery and futility, implies no infamy. In forgeries of ancient coin, the fiction is perhaps sufficiently atoned for by the vast skill required; and the artist may plausibly allege, that his intention was not to deceive, but to excite his utmost powers, by an attempt to rival the ancient masters. But no possible apology can be made for forging the rude money of more modern times. The crime is certainly greater than that which leads the common coiner to the gallows; inasmuch as it is committed with more ease, and the profit is incomparably larger."

Value.

SECT. VIII. *Of the Value of Medals.*

ALL ancient coins and medals, though equally genuine, are not equally valuable. In medals as well as in every thing else, the scarcity of a coin stamps a value upon it which cannot otherwise be derived from its intrinsic worth. There are four or five degrees of rarity reckoned up; the highest of which is called *unique*. The cause is generally ascribed to the fewness of number thrown off originally, or to their having been called in, and recoined in another form. To the former cause Mr Pinkerton ascribes the scarcity of the copper of Otho and the gold of Pescennius Niger; to the latter that of the coinage of Caligula; "though this last (says he) is not of singular rarity; which shows that even the power of the Roman senate could not annihilate an established money; and that the first cause of rarity, arising from the small quantity originally struck, ought to be regarded as the principal."

96 Causes of the scarcity of medals in ancient cities.

In the ancient cities Mr Pinkerton ascribes the scarcity of coin to the poverty or smallness of the state; but the scarcity of ancient regal and imperial coins arises principally from the shortness of the reign; and sometimes from the superabundance of money before, which rendered it almost unnecessary to coin any money during the reign of the prince. An example of this we have in the scarcity of the shillings of George III. which shows that shortness of reign does not always occasion a scarcity of coin: and thus the coins of Harold II. who did not reign a year, are very numerous, while those of Richard I. who reigned ten, are almost unique.

97 Rare coins sometimes become common, and *vice versa.*

Sometimes the rarest coins lose their value, and become common. This our author ascribes to the high price given for them, which tempts the possessors to bring them to market; but chiefly to the discovering of hoards of them. The former cause took place with Queen Anne's farthings, some of which formerly sold at five guineas; nay, if we could believe the newspapers, one of them was some years ago sold for 960l.: the latter with the coins of Canute, the Danish king of England; which were very rare till a hoard of them was discovered in the Orkneys. As discoveries of this kind, however, produce a temporary plenty, so when they are dispersed the former scarcity returns; while, on the other hand, some of the common coins become rare through the mere circumstance of neglect.

98 Silver coins in what cases most esteemed.

As double the number of copper coins of Greek cities are to be met with that there are of silver, the latter are of consequence much more esteemed: but the reverse is the case with those of the Greek princes. All the Greek civic coins of silver are very rare, excepting those of Athens, Corinth, Messana, Dyrrhachium, Massilia, Syracuse, and some others. Of the Greek monarchic coins, the most rare are the tetradrachms of the kings of Syria, the Ptolemies, the sovereigns of Macedon and Bithynia, excepting those of Alexander the Great and Lysimachus. Those of the kings of Cappadocia are of a small size, and scarce to be met with. Of those of Numidia and Mauritania, the coins of Juba, the father, are common; but those of

Value. of the ſon, and nephew Ptolemy, ſcarce. Coins of the kings of Sicily, Parthia, and Judæa, are rare; the laſt very much ſo. We meet with no coins of the kings of Arabia and Comagene except in braſs; thoſe of the kings of Boſphorus are in electrum, and a few in braſs, but all of them rare; as are likewiſe thoſe of Philetenis king of Pergamus, and of the kings of Pontus. In the year 1777, a coin of Mithridates ſold for 26l. 5s. Didrachms of all kings and cities are ſcarce, excepting thoſe of Corinth and her colonies; but the gold coins of Philip of Macedon, Alexander the Great, and Lyſimachus, as has already been obſerved, are common. The ſilver tetradrachms of all kings bear a very high price. The didrachm of Alexander the Great is one of the ſcarceſt of the ſmaller Greek ſilver coins; ſome of the other princes are not uncommon.

99 Greek copper coins. In moſt caſes the copper money of the Greek monarchs is ſcarce; but that of Hiero I. of Syracuſe is uncommonly plenty, as well as that of ſeveral of the Ptolemies.

100 Roman conſular coins. The moſt rare of the conſular Roman coins are thoſe reſtored by Trajan: of the others the gold conſular coins are the moſt rare, and the ſilver the moſt common; excepting the coin of Brutus with the cap of liberty, already mentioned, with ſome others. Some of the Roman imperial coins are very ſcarce, particularly thoſe of Otho in braſs; nor indeed does he occur at all on any coin ſtruck at Rome: but the reaſon of this may with great probability be ſuppoſed to have been the ſhortneſs of his reign. His portrait upon the braſs coins of Egypt and Antioch is very bad; as well as almoſt all the other imperial coins of Greek cities. The beſt likeneſs is on his gold and ſilver coins; the latter of which are very common. The Greek and Egyptian coins are all of ſmall or middling ſizes, and have reverſes of various kinds: thoſe of Antioch have Latin legends, as well as moſt of the other imperial coins of Antioch. They have no other reverſe but the SC in a wreath; excepting in one inſtance or two of the large and middle braſs, where the inſcriptions are in Greek. Latin coins of Otho in braſs, with figures on the reverſe, are certainly falſe; though in the cabinet of D'Ennery at Paris there was an Otho in middle braſs reſtored by Titus, which was eſteemed genuine by connoiſſeurs.

101 Leaden Roman coins. The leaden coins of Rome are very ſcarce: Moſt of them are pieces ſtruck or caſt on occaſion of the ſaturnalia; others are tickets for feſtivals and exhibitions, both private and public. The common tickets for theatres were made of lead, as were the *contorniati*; perpetual tickets, like the Engliſh ſilver tickets for the opera. Leaden medallions are alſo found below the foundations of pillars and other public buildings, in order to perpetuate the memory of the founders. From the time of Auguſtus alſo we find that leaden ſeals were uſed. The work of Ticorini upon this ſubject, entitled *Piombi Antiochi*, is much recommended by Mr Pinkerton.

102 Of coins blundered in the mintage. The Roman coins, which have been blundered in the manner formerly mentioned, are very rare, and undeſervedly valued by the connoiſſeurs. The blunders in the legends of theſe coins, which in all probability are the mere effects of accident, have been ſo far miſtaken by ſome medalliſts, that they have given riſe to imaginary emperors who never exiſted. A coin of Fauſtina, which has on the reverſe SOUSTI. S. C. puzzled all the German antiquaries, till at laſt Klotz gave it the following facetious interpretation: *Sine omni utilitate ſectamini tantas ineptias.* Purchaſe.

103 Heptarchic coins of England. The heptarchic coins of England are generally rare, except thoſe called *ſtycas*, which are very common, as well as thoſe of Burgred king of Mercia. The coins of Alfred which bear his buſt are ſcarce, and his other money much more ſo. Thoſe of Hardyknute are ſo rare, that it was even denied that they had an exiſtence; but Mr Pinkerton informs us, that there are three in the Britiſh muſeum, upon all of which the name HARTHCANUT is quite legible. No Engliſh coins of King John are to be met with, though there are ſome Iriſh ones; and only French coins of Richard I. "Leake (ſays Mr Pinkerton) made a ſtrange blunder, in aſcribing coins of different kings with two faces, and otherwiſe ſpoiled in the ſtamping, to this prince; in which, as uſual, he has been followed by a miſled number."

104 Scottiſh coins. Coins of Alexander II. of Scotland are rather ſcarce, but thoſe of Alexander III. are more plentiful. Thoſe of John Baliol are rare, and none of Edward Baliol are to be found.

Sect. IX. *Of the Purchaſe of Medals.*

Medals are to be had at the ſhops of goldſmiths and ſilverſmiths, with thoſe who deal in curioſities, &c. but in great cities there are profeſſed dealers in them. The beſt method of purchaſing medals, however, is that of buying whole cabinets, which are every year expoſed to auction in London. In theſe the rare medals are ſold by themſelves: but the common ones are put up in large lots, ſo that the dealers commonly purchaſe them. Mr Pinkerton thinks it would be better that medals were ſold one by one; becauſe a lot is often valued and purchaſed for the ſake of a ſingle coin; while the others ſeparately would ſell for perhaps four times the price of the whole lot. "If any man of common ſenſe and honeſty (ſays Mr Pinkerton), were to take up the trade of ſelling coins in London, he would make a fortune in a ſhort time. This profitable buſineſs is now in the hands of one or two dealers, who ruin their own intereſt by making an elegant ſtudy a trade of knavery and impoſition. If they buy 300 coins for 10s. they will aſk 3s. for one of the worſt of them! nay, ſell forged coins as true to the ignorant. The ſimpletons complain of want of buſineſs. A knave is always a fool."

105 Price of gold coins of Carthage, &c. The gold coins of Carthage, Cyrene, and Syracuſe, are worth about twice their intrinſic value as metal; but the other gold civic coins from 5l. to 30l. each. The only gold coins of Athens certainly known to exiſt are two lately procured by the king. One of theſe remains in poſſeſſion of his majeſty, but the other was given by the queen to Dr Hunter. There was another in the Britiſh muſeum, but ſuſpected not to be genuine. Dr Hunter's coin, then, if ſold, would bear the higheſt price that could be expected for a coin.

106 Of ſilver coins. The ſilver coins of Syracuſe, Dyrrhachium, Maſſilia, Athens, and a few other ſtates, are common; the drachmas and coins of leſſer ſize are worth about five

Purchase. five shillings; the didrachms, tetradrachms, &c. from five to ten, according to their size and beauty; the largest, as might naturally be expected, being more valuable than the small ones. The tetradrachms, when of cities whose coins are common, are worth from 7s. 6d. to 1l. 1s.; but it is impossible to put a value upon the rare civic coins; ten guineas have been given for a single one.

107 Greek copper coins. The Greek copper coins are common, and are almost all of that kind called *small brass*; the middle size being scarce, and the largest in the ages prior to the Roman emperors extremely so. The common Greek coins of brass bring from 3d. to 18d. according to their preservation; but when of cities, whose coins are rare, much higher prices are given. "The want of a few cities, however (says Mr Pinkerton), is not thought to injure a collection; as indeed new names are discovered every dozen of years, so that no assortment can be perfect. To this it is owing that the rarity of the Grecian civic coins is not much attended to."

108 Gold coins of Philip and Alexander. The gold coins of Philip and Alexander the Great being very common, bear but from five to ten shillings above their intrinsic value; but those of the other princes, being rare, sell from 3l. to 30l. each, or even more.

The tetradrachms are the dearest of the silver monarchic money, selling from five to ten shillings; and if very rare, from 3l. to 30l. Half these prices may be obtained for the drachmas, and the other denominations in proportion.

109 Greek copper coins more rare than the silver. The Greek copper coins are for the most part scarcer than the silver, except the Syro-Grecian, which are common, and almost all of the size called small brass. "They ought (says Mr Pinkerton), to bear a high price; but the metal and similarity to the copper civic coins, which are common, keep their actual purchase moderate, if the seller is not well instructed, and the buyer able and willing to pay the price of rarity."

The name of weights given to the ancient Roman ases is, according to our author, exceedingly improper; as that people had weights of lead and brass sides, without the least appearance of a portrait upon them. These denote the weight by a certain number of knobs; and have likewise small *fleurettes* engraved upon them. According to Mr Pinkerton, whenever we meet with a piece of metal stamped on both sides with busts and figures, we may lay it down as a certain rule that it is a coin; but when slightly ornamented and marked upon one side only, we may with equal certainty conclude it to be a weight.

110 Price of the ancient Roman ases. The ancient Roman ases are worth from 2s. to 2l. according to the singularity of their devices. Consular gold coins are worth from 1l. to 5l. Pompey with his sons 21l. and the two Bruti 25l. The silver coins are universally worth from a shilling to half a crown, excepting that of the cap of liberty and a few others, which, if genuine, will bring from 10s. to 5l. The consular copper bears an equal price with the silver, but is more rare; the consular silver coins restored by Trajan are worth 20s. each.

With regard to the Roman imperial coins, it is to be observed, that some of those which belong to princes whose coins are numerous, may yet be rendered extremely valuable by uncommon reverses. Mr Pinkerton particularly points out that of Augustus, with the legend C. MARIVS TROGVS, which is worth three guineas, though the silver coins of that prince in general are not worth above a shilling. In like manner, the common gold coins of Trajan are not worth above twenty shillings; while those with *Basilica Ulpia*, *Forum Trajani*, *Divi Nerva et Trajanus*, *Pater*, *Divi Nerva et Platina Aug.* *Profectio Aug.* *Regna Assignata*, *Rex Parthus*. and some others, bear from three to six pounds. The ticket medals belong to the Roman senate, and are worth from three to ten shillings. The forged coins and medallions of the Paduan sell from one to three shillings each.

Arrangement, &c.

Of the coins of other nations, those of Hilderic king of the Vandals are in silver, and worth 10s.; the small brass of Athanaric, 5s.; the gold of Theodoric 2l.; the second brass of Theodahat 5s.; the second brass of Badueta rare, and worth 10s.; the third brass, 3s. The British coins are very rare, and worth from ten shillings to two guineas each, sometimes much more. Medals with unknown characters are always scarce and dear. Saxon pennies of the heptarchy are rare, and worth from ten shillings to *ten pounds*, according to their scarcity and preservation. The coins of the English kings are common; those of Edward the Confessor, in particular; others are rare, and worth from ten shillings to two guineas, while two of Hardyknute are worth no less than ten guineas. The gold medals of Henry, in 1545, and the coronation of Edward, are worth 20l. each: the Mary of Trezzo, 3l.; Simon's head of Thurloe in gold is worth 12l.; his oval medal in gold upon Blake's naval victory at sea is worth 30l.; and his trial piece, if brought to a sale, would, in Mr Pinkerton's opinion, bring a still higher price. The medals of Queen Anne, which are intrinsically worth about two guineas and a half, sell for about 3l. each; the silver, of the size of a crown piece, sell for 10s. and the copper from five to ten shillings. Dassier's copper pieces sell from two to five shillings, and a few bear a higher price. 111 Barbaric coins.

The Scottish gold coins sell higher than the English, but the others are on a par. The shilling of Mary with the bust is rare, and sells for no less than 30l.; the half 3l.; and the royal 5l. 5s. The French testoon of Francis and Mary brings 10l. 10s. and the Scottish one of Mary and Henry would bring 50l. as would also the medal of James IV. The coronation medal of Francis and Mary is worth 20l. Briot's coronation medal sold in 1755 only for two guineas at Dr Mead's sale; but would now bring 20l. if sold according to rarity. 112 Gold coins of Scotland.

The English coins struck in Ireland are of much the same price with those of the native country; but the St Patrick's halfpence and farthings are rather scarce, and the rare crown of white metal is worth 4l. The gun-money of James II. and all other Irish coins are very common. 113 English coins struck in Ireland.

SECT. X. *Arrangement of Medals, with the Instruction to be derived from them.*

HAVING thus given a full account of every thing in general relative to medals, we must now come to some particulars respecting their arrangement, and the entertainment

Arrangement, &c.

tainment which a medallift may expect from the trouble and expence he is at in making a collection.

It has already been obferved, that one of the principal ufes of medals is the elucidation of ancient hiftory. Hence the arrangement of his medals is the firft thing that muft occur in the formation of a cabinet. The moft ancient medals with which we are acquainted are thofe of Alexander I. of Macedon, who began to reign about 501 years before Chrift. The feries ought of confequence to begin with him, and to be fucceeded by the medals of Sicily, Caria, Cyprus, Heraclia, and Pontus. Then follow Egypt, Syria, the Cimmerian Bofphorus, Thrace, Bithynia, Parthia, Armenia, Damafcus, Cappadocia, Paphlagonia, Pergamus, Galatia, Cilicia, Sparta, Pæonia, Epirus, Illyricum, Gaul, and the Alps, including the fpace of time from Alexander the Great to the birth of Chrift, and which is to be accounted the third medallic feries of ancient monarchs. The laft feries goes down to the fourth century, including fome of the monarchs of Thrace, Bofphorus, and Parthia, with thofe of Comagene, Edeffa or Ofrhoene, Mauritania, and Judæa. A moft diftinct feries is formed by the Roman emperors, from Julius Cæfar to the deftruction of Rome by the Goths; nay, for a much longer period, were it not that towards the latter part of it the coins become fo barbarous as to deftroy the beauty of the collection. Many feries may be formed of modern potentates.

114
Diadem an ancient emblem of fovereign authority.

By means of medals we can with great certainty determine the various ornaments worn by ancient princes as badges of diftinction. The Grecian kings have generally the diadem, without any other ornament; and though in general the fide of the face is prefented to view, yet in fome very ancient Greek and Roman confular coins, full faces of excellent workmanfhip are met with. On feveral coins alfo two or three faces are to be feen, and thefe are always accounted very valuable.

The diadem, which was no more than a ribbon tied round the head with a floating knot behind, adorns all the Grecian princes from firft to laft, and is almoft an infallible mark of fovereign power. In the Roman confular coins it is feen in conjunction with Numa and Ancus, but never afterwards till the time of Licinius, the colleague of Conftantine. Dioclefian, indeed, according to Mr Gibbon, firft wore the diadem, but his portrait upon coins is never adorned with it. So great an averfion had the Romans to kingly power, that they rather allowed their emperors to affume the radiated crown, the fymbol of divinity, than to wear a diadem; but, after the time of Conftantine, it becomes common. The radiated crown appears firft on the pofthumous coins of Auguftus as a mark of deification, but in fomewhat more than a century became common.

The laurel crown, at firft a badge of conqueft, was afterwards permitted by the fenate to be worn by Julius Cæfar, in order to hide the baldnefs of his head. From him all the emperors appear with it on their medals, even to our own times. In the lower empire the crown is fometimes held by a hand above the head, as a mark of piety. Befides thefe, the naval, mural, and civic crowns appear on the medals both of emperors and other eminent men, to denote their great actions. The laurel crown is alfo fometimes worn by the Greek princes. The Arfacidæ of Parthia wear a kind of fafh round the head, with their hair in rows of curls like a wig. The Armenian kings have the *tiara*, a kind of cap which was efteemed the badge of imperial power in the eaft. Conical caps are feen on the medals of Xerxes, a petty prince of Armenia, and Juba the father, the former having a diadem around it.

115
Symbols of divinity on the coins of Alexander and his fucceffors.

The impious vanity of Alexander and his fucceffors in affuming divine honours is manifeft on their medals, where various fymbols of divinity are met with. Some of them have an horn behind their ear, either to denote their ftrength, or that they were the fucceffors of Alexander, to whom this badge might be applied as the fon of Jupiter Ammon. This, however, Mr Pinkerton obferves, is the only one of thefe fymbols which certainly denotes an earthly fovereign, it being doubted whether the reft are not all figures of gods.—According to Eckhet, even the horn and diadem belong to Bacchus, who invented the latter to cure his headaches; and, according to the fame author, the only monarch who appears on coins with the horn is Lyfimachus. We are informed, however, by Plutarch, that Pyrrhus had a creft of goats horns to his helmet; and the goat, we know, was a fymbol of Macedon. Perhaps the fucceffors of Alexander wore this badge of the horn in confequence. The helmet likewife frequently appears on the heads of fovereigns, and Conftantine I. has helmets of various forms curioufly ornamented.

The diadem is worn by moft of the Greek queens, by Orodaltis, daughter of Lycomedes, king of Bithynia; and though the Roman empreffes never appear with it, yet this is more than compenfated by the variety of their headdreffes. Sometimes the buft of an emprefs is fupported by a crefcent, to imply that fhe was the moon, as her hufband was the fun of the ftate. The toga, or vail drawn over the face, at firft implied that the perfon was invefted with the pontifical office; and accordingly we find it on the bufts of Julius Cæfar, while pontifex maximus. It likewife implies the augurfhip, the augurs having a particular kind of gown called *lana*, with which they covered their heads when obferving an omen. In latter times this implies only confecration, and is common in coins of empreffes. It is firft met with on the coins of Claudius Gothicus as the mark of confecration of an emperor. The *nimbus*, or glory, now appropriated to faints, has been already mentioned. It is as ancient as Auguftus, but is not to be met with on many of the imperial medals, even after it began to be appropriated to them. There is a curious coin, which has upon the reverfe of the common piece, with the head of Rome, URBS ROMA, in large brafs, Conftantine I. fitting amid Victories and genii, with a triple crown upon his head for Europe, Afia, and Africa, with the legend SECURITAS ROMÆ.

116
Portraits upon medals.

In general only the buft is given upon medals, though fometimes half the body or more; in which latter cafe the hands often appear with enfigns of majefty in them; fuch as the globe, faid to have been introduced by Auguftus as a fymbol of univerfal dominion; the fceptre, fometimes confounded with the confular ftaff; a roll of parchment, the fymbol of legiflative

Arrangement, &c. tive power; and an handkerchief, expressive of the power over the public games, where the emperor gave the signal. Some princes hold a thunderbolt, showing that their power on earth was equal to that of Jupiter in heaven; while others hold an image of Victory.

Medals likewise afford a good number of portraits of illustrious men; but they cannot easily be arranged in chronological order, so that a series of them is not to be expected. It is likewise vain to attempt the formation of a series of gods and goddesses to be found on ancient coins. Mr Pinkerton thinks it much better to arrange them under the several cities or kings whose names they bear. A collection of the portraits of illustrious men may likewise be formed from medals of modern date.

117 Reverses of Greek and Roman coins.

The reverses of ancient Greek and Roman coins afford an infinite variety of instruction and amusement. They contain figures of deities at full length, with their attributes and symbols, public symbols and diversions, plants, animals, &c. &c. and in short almost every object of nature or art. Some have the portrait of the queen, son, or daughter of the prince whose image appears on the face obverse; and these are esteemed highly by antiquaries, not only because every coin stamped with portraits on both sides is accounted valuable, but because they render it certain that the person represented on the reverse was the wife, son, or daughter of him who appears on the obverse; by which means they assist greatly in the adjusting of a series. Some, however, with two portraits are common, as Augustus, the reverse of Caligula; and Marcus Aurelius, reverse of Antoninus Pius.

We find more art and design in the reverses of the Roman medals than of the Greek; but on the other hand, the latter have more exquisite relief and workmanship. The very ancient coins have no reverses, excepting a rude mark struck into the metal, resembling that of an instrument with four blunt points on which the coin was struck; and was owing to its having been fixed by such an instrument on that side to receive the impression upon the other. To this succeeds the image of a dolphin, or some small animal, in one of the departments of the rude mark, or in an hollow square: and this again is succeeded by a more perfect image, without any mark of the hollow square. Some of the Greek coins are hollow in the reverse, as those of Caulonia, Crotona, Metapontum, and some other ancient cities of Magna Græcia. About 500 B. C. perfect reverses appear on the Greek coins, of exquisite relief and workmanship. "The very muscles of men and animals (says Mr Pinkerton), are seen, and will bear inspection with the largest magnifier as ancient gems. The ancients certainly had not eyes different from ours; and it is clear that they must have magnified objects. A drop of water forms a microscope; and it is probable this was the only one of the ancients. To Greek artists we are indebted for the beauty of the Roman imperial coins; and these are so highly finished, that on some reverses, as that of Nero's decursion, the *adventus* and *progressio* of various emperors, the *fundator pacis* of Severus, the features of the emperor, riding or walking, are as exact as on the obverse. But though the best Greek artists were called to Rome, yet the Greek coins under the Roman emperors are sometimes well executed, and always full of variety and curiosity. No Roman or Etruscan coins have been found of the globular form, or indented on the reverse like the early Greek. The first Greek are small pieces of silver, while the Roman are large masses of copper. The former are struck; the latter cast in moulds. The reverses of the Roman coins are very uniform, the prow of a ship, a car, or the like, till about the year 100 B. C. when various reverses appear on their consular coins in all metals. The variety and beauty of the Roman imperial reverses are well known. The medallist much values those which have a number of figures; as the *Puellæ Faustinianæ*, of Faustina, a gold coin no larger than a sixpence, which has 12 figures; that of Trajan, *regna assignata*, has four; the *congiarium* of Nerva five; the allocution of Trajan seven; of Hadrian 10; of Probus 12. Some Roman medals have small figures on both sides, as the *Apollini sancto* of Julian II. Such have not received any peculiar name among the medallists. Others have only a reverse, as the noted *spintriati*, which have numerals I. II. &c. on the obverse."

118 Of the deities represented upon ancient coins.

The *names* of the deities represented on the reverses of Greek coins are never expressed; perhaps, as Mr Pinkerton supposes, out of piety, a symbolical representation of their attributes being all that they thought proper to delineate; but the Roman coins always express the name, frequently with an adjunct, as VENERI VICTRICI, &c. In others, the name of the emperor or empress is added; as PUDICITIÆ AUGUSTÆ, round an image of modesty; VIRTUS AUGUSTI, a legend for an image of virtue.

The principal symbols of the divine attributes to be met with on the Greek medals are as follow:

1. Jupiter is known on the coins of Alexander the Great by his eagle and thunderbolts; but when the figure occurs only on the obverses of coins, he is distinguished by a laurel crown, and placid bearded countenance. Jupiter Ammon is known by the ram's horn twisting round his ear; a symbol of power and strength, assumed by some of the successors of Alexander the Great, particularly by Lysimachus.

2. Neptune is known by his trident, dolphin, or being drawn by sea horses; but he is seldom met with on the Grecian coins.

3. Apollo is distinguished by an harp, branch of laurel, or tripod; and sometimes by a bow and arrows. In the character of the sun, his head is surrounded with rays; but when the bust only occurs, he has a fair young face, and is crowned with laurel. He is frequent on the coins of the Syrian princes.

4. Mars is distinguished by his armour, and sometimes by a trophy on his shoulders. His head is armed with a helmet, and has a ferocious countenance.

5. Mercury is represented as a youth, with a small cap on his head, wings behind his ears and on his feet. He is known by the cap, which resembles a small hat, and the wings. He appears also with the caduceus, or wand twined with serpents, and the *marsupium*, or purse, which he holds in his hand.

6. Æsculapius is known by his bushy beard, and his leaning on a club with a serpent twisted round it. He

He ſometimes occurs with his wiſe Hygeia or Health, with their ſon *Teleſphorus* or Convaleſcence between them.

7. Bacchus is known by his crown of ivy or vine, his diadem and horn, with a tyger and ſatyrs around him.

8. The figure of Hercules is common on the coins of Alexander the Great, and has frequently been miſtaken for that of the prince himſelf. He appears ſometimes as a youth and ſometimes with a beard. He is known by the club, lion's ſkin, and remarkable apparent ſtrength; ſometimes he has a cup in his hand; and a poplar tree, as a ſymbol of vigour, is ſometimes added to the portrait.

9. The Egyptian Serapis is known by his buſhy beard, and a meaſure upon his head.

10. Apis is delineated in the form of a bull, with a flower of the lotos, the water lily of the Nile, ſuppoſed by Macrobius to be a ſymbol of creation; and Jamblichus tells us, that Oſiris was thought to have his throne in it.

11. Harpocrates, the god of Silence, appears with his finger on his mouth; ſometimes with the ſiſtrum in his left hand; a ſymbol common to moſt of the Egyptian deities.

12. Canopus, another Egyptian deity, appears in the ſhape of a human head placed on a kind of pitcher. "This deified pitcher (ſays Mr Pinkerton), ſeems to refer to an anecdote of ancient ſuperſtition, which, I believe, is recorded by Plutarch. It ſeems ſome Perſian and Egyptian prieſts had a conteſt which of their deities had the ſuperiority. The Egyptian ſaid, that a ſingle vaſe, ſacred to Serapis, would extinguiſh the whole power of the Perſian deity of fire. The experiment was tried; and the wily Egyptian, boring holes in the vaſe and ſtopping them with wax, afterwards filled the vaſe with water; which, guſhing through the holes as the wax melted, extinguiſhed the Perſian deity. Hence the vaſe was deified."

13. The *Holy Senate* and *Holy People*, appear frequently on the Greek imperial coins, ſometimes repreſented as old men with beards, at others as youths.

The goddeſſes repreſented on medals are,

1. Juno, repreſented by a beautiful young woman, ſometimes with a diadem, ſometimes without any badge, which is reckoned a ſufficient diſtinction, as the other goddeſſes all wear badges. Sometimes ſhe appears as the goddeſs of marriage; and is then veiled to the middle, and ſometimes to the toes. She is known by the peacock, a bird ſacred to her from the fable of Argus.

2. Minerva is very common on the coins of Alexander the Great; and her buſt has been miſtaken by the celebrated painter Le Brun for the hero himſelf. She is very eaſily diſtinguiſhed by the helmet. Her ſymbols are, her armour; the ſpear in her right hand, and the ægis, with a Meduſa's head, in her left; an owl commonly ſtanding by her.

3. Diana of Epheſus is commonly repreſented on the Greek imperial coins; and appears with a great number of breaſts, ſuppoſed to denote univerſal Nature. She is ſupported by two deer, and carries a pannier of fruit upon her head. The buſt of this goddeſs is known by the creſcent on her brow, and ſometimes by the bow and quiver at her ſide.

4. Venus is known by an apple, the prize of beauty, in her hand. Sometimes ſhe is diſtinguiſhed only by her total want of dreſs; but is always to be known by her extraordinary beauty, and is ſometimes adorned with pearls about the neck.

5. Cupid is ſometimes met with on the Syrian coins, and is known by his infancy and wings.

6. Cybele is known by a turreted crown and lion; or is ſeen in a chariot drawn by lions.

7. Ceres is known by her garland of wheat, and is common on the Sicilian coins; that iſland being remarkable for its fertility. Sometimes ſhe has two ſerpents by her, and is ſometimes drawn in a chariot by them. She carries in her hands the torches with which ſhe is fabled to have gone in ſearch of her daughter Proſerpine.

8. Proſerpine herſelf is ſometimes met with on coins, with the name of *κορη*, or the *girl*.

9. The Egyptian Iſis has a bud or flower on her head; a ſymbol of the perpetual bloom of the inhabitants of heaven. She carries alſo a ſiſtrum in her hand.

10. The Sidonian Aſtarte appears on a globe ſupported on a chariot with two wheels, and drawn by two horſes.

Theſe are the deities moſt commonly repreſented on the Greek coins. The more uncommon are, Saturn with his ſcythe, or with a hook on the Heraclian coins; Vulcan with his tongs on the reverſe of a coin of Thyatira, repreſented at work in the preſence of Minerva. Adranus, a Sicilian god, is ſometimes repreſented on coins with a dog. Anubis, an Egyptian deity, has a dog's head. Atis is known by his Phrygian bonnet; Caſtor and Pollux by a ſtar on the head of each; Dis, by his old face, diſhevelled hair and beard, and a hook: Flora by her crown of flowers; Nemeſis by her wheel; and Pan by his horns and ears belonging to ſome kind of beaſt.

There are likewiſe to be found on medals many 119 Table of ſymbols.
different ſymbols by themſelves; of the moſt remarkable of which we ſhall give the following table, with their ſignification:

Symbols.	*Significations.*
1. Vaſes with ſprigs,	Solemn games.
2. Small cheſt or hamper, with a ſerpent leaping out,	Myſtic rites of Bacchus.
3. Anchor on Seleucian medals,	Coin ſtruck at Antioch, where an anchor was dug up.
4. Apollo on Syrian coins, on an inverted hamper,	Covered tripod.
5. Bee,	Ariſteus the ſon of Apollo.
6. Laurel,	Apollo.
7. Reed,	A river.
8. Ivy and grapes,	Bacchus.
9. Poppy,	Ceres and Proſerpine.
10. Corn,	Ceres.
11. Owl and olive,	Minerva.
12. Dove,	Venus.

13.

Arrangement, &c.

Symbols.	*Significations.*
13. Torch - - -	Diana, Ceres, or Proſerpine.
14. Mudnis, or conic ſtone,	The ſun, Belus, or Venus.
Symbols of Countries, &c.	
15. Pomegranate flowers, -	Rhodes.
16. Owl, - - -	Athens.
17. Pegaſus, - -	Corinth.
18. Wolf's head, - -	Argos.
19. Bull's head, - -	Bœotia.
20. Minotaur's head and labyrinth,	Crete.
21. Horſe's head, - -	Pharſalia.
22. Lion, - - -	Marſeilles.
23. Tortoiſe, - -	Peloponneſus.
24. Sphinx, - - -	Scio.
25. Three legs joined, as in the Iſle of Man money, - -	Sicily.
26. Horſe, - - -	Theſſaly.
27. The creſcent, - -	Byzantium (A).
28. Bull, - - -	Suppoſed to be a river.
29. Enſign, with the letters Col.	A colony drawn from one legion.
30. Bull, - - -	Apis, ſtrength or ſecurity.
31. Caduceus, - -	Peace and concord.
32. Cornucopiæ, - -	Abundance.
33. Pontifical hat, - -	Prieſthood.
34. Parazonium, - -	Batoon of command.
35. Globe on an altar with three ſtars, - -	The world preſerved by the gods for the three ſons of Conſtant. I.
36. Fort and gate, - -	Security.
37. Tribuli, a kind of chevaux de frize, - -	Unknown.
38. Altar or tripod, - -	Piety.
39. Dolphin, - -	Apollo.
40. Lectiſternia, - -	Feſtivals.
41. Lituus, or twiſted wand, -	Augurſhip.
42. Apex, or cap with ſtrings,	Pontificate.
43. Thenſa, or chariot employed to carry images, - -	Conſecration of an empreſs.
44. Peacock, - - -	Ditto.
45. Eagle, - - - -	Conſecration of an emperor.

Arrangement, &c.

120 Legends of medals.

The legends put upon medals are deſigned as explanations of them; but as the compaſs of even the largeſt coins does not admit of any great length of inſcription, it has always been found neceſſary to uſe abbreviations; and in readily decyphering theſe lies a conſiderable part of the difficulty of the ſcience. This, however, is greater in the Roman than in the Greek medals; for the Greeks commonly inſert as much of the word as is ſufficient to enable us eaſily to underſtand its meaning; but it is common for thoſe who attempt to explain letters that do not often occur, to fall into very ridiculous errors. Of this Mr Pinkerton gives a moſt remarkable inſtance in Fortunius Licetus, a learned man, who finding upon a coin of Adrian the letters, Γ. ΙΔ ſignifying the 14th year of that emperor's reign, imagined that they ſignified *Lucernas invenit Delta;* "Delta invented lanthorns;" and thence aſcribed the origin of lanthorns to the Egyptians. Tables explaining the meaning of the abbreviations found upon medals have been publiſhed by Patin, Urſatus, and others.

121 Extraordinary miſtake of Fortunius Licetus.

Sect. XI. *Of Medallions, Medalets*, &c.

Besides the ordinary coins of the ancients, which paſſed in common circulation through the country, there were others of a larger ſize, which are now termed *medallions*. Theſe were ſtruck on the commencement of the reign of a new emperor and other ſolemn occaſions: frequently alſo, by the Greeks in particular, as monuments of gratitude or of flattery. Sometimes they were mere trial or pattern pieces; and thoſe abound after the time of Maximian, with the words *Tres Monetæ* on the reverſe. The common opinion is, that all the Roman pieces of gold exceeding the denarius aureus, all in ſilver exceeding the denarius, and all in braſs exceeding the ſeſtertius, went under the denomination of *medallions:* but Mr Pinkerton thinks that many of theſe large pieces went in circulation, though not very commonly, as our five and two guinea pieces, ſilver crowns, &c. do in this country. The fineſt medallions were preſented by the mint maſters to the emperor, and by the emperor to his friends, as ſpecimens of fine workmanſhip. The beſt we have at preſent are of braſs, and many of them compoſed of two ſorts of metal; the centre being copper, with a ring of braſs around it, or the contrary; and the inſcription is ſometimes confined to one of the metals, ſometimes not. There is a remarkable difference between the Greek and Roman medallions in point of thickneſs; the latter being frequently three or four lines thick, while the other ſeldom exceed one. Very few medallions, however, were ſtruck by the Greeks before the time of the Roman emperors; but the Greek medallions of the emperors are more numerous than thoſe

(A) This appears on the early coins of Byzantium, with the legend ΒΥΖΑΝΤΙΝ. ΣΩΤ. "the preſerver of Byzantium." The reaſon of this was, that when Philip of Macedon beſieged the city, and was about to ſtorm it in a cloudy night, the moon ſhone out on a ſudden and diſcovered him; by which means the inhabitants had time to collect their forces and repulſe him. The Turks on entering Conſtantinople, found this badge in many places; and ſuſpecting ſome magical power in it, aſſumed the ſymbol, and its power, to themſelves; ſo that the creſcent is now the chief Turkiſh enſign.

thoſe of the Romans themſelves. All theſe pieces, however, are of ſuch high price that few private perſons are able to purchaſe them. In the laſt century Chriſtina queen of Sweden procured about 300. In the king of France's collection there are 1200; a number formerly ſuppoſed not to exiſt; and Dr Hunter's collection contains about 400, excluſive of the Egyptian.

Beſides theſe large pieces, there are ſmaller ones, of a ſize ſomewhat larger than our half-crowns; and by Italian medalliſts are called *medaglion cini*, or ſmall medallions. They are ſtill ſcarcer than the large kind.

122 Of medalets.

There is ſtill a third kind, which have almoſt eſcaped the notice of medalliſts, viz. the ſmall coins or *miſſilia* ſcattered among the people on ſolemn occaſions; ſuch as thoſe ſtruck for the ſlaves on account of the ſaturnalia; counters for gaming; tickets for baths and feaſts; tokens in copper and in lead, &c. Theſe are diſtinguiſhed by Mr Pinkerton by the name of *medalets*. Many, or perhaps almoſt all, of thoſe ſtruck for the ſaturnalia were ſatirical; as the ſlaves had then a licenſe to ridicule not only their maſters but any perſon whatever. Mr Pinkerton mentions one of the moſt common pieces of this kind, which has on the obverſe the head of an old woman veiled, with a laurel crown; the reverſe only S. C. within a wreath. Baudelot is of opinion that it is the head of Acea Laurentia, the nurſe of Romulus, to whom a feſtival was ordained. "Perhaps (ſays Mr Pinkerton), it was ſtruck in ridicule of Julius Cæſar; for the manner of the laurel crown, and its high appearance over the head, perfectly reſemble that of Julius on his coins." Some have a ſhip upon one ſide; on the reverſe T, or a croſs, which was the image of Priapus; and occaſioned many falſe invectives againſt the firſt Chriſtians, who paid ſuch reſpect to the croſs. Some pieces have the heads of the emperors upon one ſide; on the reverſe only numerals, III. IV. V. &c, and the noted *ſpintriati* of Tacitus. Both theſe kinds appear tickets for the baths, as the number ſeems to denote the particular bath. Some have the head of a girl with a veſſel uſed at the baths in her hand. The ſpintriati are ſo immodeſt, that few will bear mention. But ſome are merely ludicrous; as one which has an aſs with a bell about his neck, and a ſoldier riding him; another with two figures hoiſting a woman in a baſket into the air. Of thoſe that will juſt bear mention, is a man with titles around him, as chief of the games; and a woman in ridicule of the modeſt bath-girl above mentioned. There is alſo one marked XIX, on which appears an imperator triumphing in a car: this car is placed on the back of a camel; and behind the imperator is a monkey mimicking him.

123 Of the contorniati.

A fourth claſs of medals are called *contorniati* from the Italian *contorniato*, "encircled;" becauſe of the hollow circle which commonly runs around them. They are diſtinguiſhed from medallions by their thinneſs, faint relief, reverſes ſometimes in relief, ſometimes hollow; and in general by the inferiority in their workmanſhip. The opinions of medalliſts concerning theſe pieces are very various; ſome ſuppoſe them to have been ſtruck by Gallienus to the memory of illuſtrious men and celebrated *athletæ*, at the time that he cauſed all the conſecration coins of his predeceſſors to be reſtored; others aſcribe their invention to Greece, &c. but Mr Pinkerton is of opinion that they were only tickets for places at public games. Many of them, notwithſtanding their inferior workmanſhip, are very valuable on account of their preſerving the portraits of ſome illuſtrious authors of antiquity, nowhere elſe to be found. Much dependance, however, cannot be put on the portraits of Greek authors and eminent men found upon ſome of them; for though we know that the buſts of Salluſt, Horace, &c. muſt have been ſtruck when their perſons were freſh in the memory of the artiſts, yet it was otherwiſe with Homer, Solon, Pythagoras, &c. which are to be found on ſome of them. Even theſe, however, are valuable, as being ancient and perhaps traditional portraits of theſe great men. The laſt whoſe portraits are ſuppoſed to have been delineated in this way, are Apollonius Tyaneus who flouriſhed in the time of Domitian, and Apuleius in that of Marcus Antoninus. Mr Pinkerton thinks it a confirmation of his opinion concerning theſe medals, that the reverſes always contain ſome device alluding to public games, as that of a charioteer driving a chariot, &c.

Sect. XII. *Directions for making Cabinets.*

We muſt now proceed to the laſt part of our ſubject, viz. that of giving directions for the formation of cabinets. As we have already ſeen that the formation of any one muſt be attended with very conſiderable expence, it is neceſſary for every one who attempts this to proportion the cabinet to his own circumſtances. There are, properly ſpeaking, three kinds of cabinets. 1. Thoſe meant to contain a coin of every ſort that has been iſſued from the mint in every age and country; but this which may be called the large and complete cabinet, is not to be purchaſed by private perſons. That of Dr Hunter already mentioned is perhaps one of the beſt private cabinets ever known; and coſt 23,000l. but as many duplicates were ſold as coſt 2000l. by which means the expence was reduced to 21,000l. The vaſt collection made by the king of France coſt upwards of 100,000l. 2. The ſmaller cabinet may be ſuppoſed to conſiſt only of middle and ſmall Roman braſs, Engliſh pennies, groats, &c. with a few medals of the more valuable kind, and may be ſuppoſed to incur an expence of from 200l. to 1000l. 3. The ſmalleſt kind is called a *caſket* of medals, and does not conſiſt of above 1000 at moſt of various kinds; and conſequently the expence muſt depend on the pleaſure of the proprietor.

In the formation of the grand cabinet, it muſt be obſerved that the Greek medals of every denomination do not admit of any arrangement by the metals like the Roman; not any regular ſeries of this kind being met with even in the moſt opulent cabinets. Hence in all collections the civic coins are ranged according to an alphabetical order; and the monarchic in a chronological one. The ſame rule is to be obſerved in the Roman conſular medals; they are ranged, like the coins of the Greek cities, in an alphabetical ſeries of the families. The Roman imperial coins are only

Directions for making Cabinets.

only those capable of being arranged according to sizes and metals. Even from this must be excepted the minimi, or very smallest coins; which are so scarce, that the only regular series of them in the world is that belonging to the king of Spain, which was formed by a most skilful French medallist, and consists of all the metals. The arrangement of a grand cabinet, according to Mr Pinkerton, is as follows.

" I. The coins of cities and of free states in alphabetical order: whether using Greek, Roman, Punic, Etruscan, or Spanish characters.

" II. Kings in chronological series, both as to foundation of empire and seniority of reign.

" III. Heroes, heroines, founders of empires, and cities.

" IV. Other illustrious persons.

" V. Roman ases.

" VI. Coins of families, commonly called consular.

" VII. Imperial medallions.

" VIII. Imperial gold.

" IX. Imperial *minimi* of all metals.

" X. Imperial silver.

" XI. Imperial first brass.

" XII. Second brass.

" XIII. Third brass.

" XIV. Colonial coins, which are all of brass.

" XV. Greek cities under the emperors, of all metals and sizes. In a smaller cabinet they may be put with the Roman, according to their metal and size. Those without the emperor's head go to class I. though struck in Roman times.

" XVI. Egyptian coins struck under the Roman emperors, of all metals and sizes. They are mostly of a base metal called by the French *patin*; it is a kind of pot-metal or brittle brass.

" XVII. Contorniati, or ticket medals.

" XVIII. Coins of Gothic princes, &c. inscribed with Roman characters.

" XIX. Coins of southern nations using uncommon alphabets; as the Persian, Punic, Etruscan, and Spanish.

" XX. Coins of northern nations using uncommon characters, as the Runic and German.

" In the modern part no series can be formed of copper that will go back above two centuries; but sequences (chronological series) of gold and silver may be arranged of all the different empires, kingdoms, and states, as far as their several coinages will allow. Those of England and France will be the most perfect. Modern silver is commonly arranged in three sequences; the dollar, the groat, and the penny sizes. The medals of each modern country ought of course to be separated; though it is best to arrange each set in chronological order, let their size of metal be what they will. It may be remarked here, that our modern medals, of the size of a tea-saucer, are only so many monuments of barbarism. The ancient medallions are almost universally but little larger than our crown-piece, though three or four of them may extend to about two inches diameter, but very many modern medals to four inches and more. A large medal always declares an ignorant prince or an ignorant artist. Into the size of a crown-piece the ancients threw more miracles in this way than will ever appear in these monstrous productions."

These directions will likewise apply to the formation of a cabinet of the second kind: but if the collector means to form a series of large Roman brass, he will find the coins of four or five emperors so scarce as not to be attainable in that series, even at any price. He must therefore supply their places with middle brass, as is allowed with regard to Otho, even in the best cabinets; there not being above three coins of that emperor in large brass known in the world: whereas of the middle brass, two or three hundred may exist. For this reason Mr Pinkerton concludes, that in cabinets of the second class, the collector may mingle the large and second brass together as he thinks proper, in order to save expence; though it would not do so well to unite such disproportionate sizes as the large and small. " In the small sequence, however (says he), there can be no harm in his mixing gold, silver, and brass, as chance or curiosity may lead him to purchase any of these metals. And though your starched bigotted medallist may sneer because such a sequence would controvert his formal and narrow way of thinking, common sense will authorize us to laugh at the pedant in our turn, and to pronounce such a series more various, rich, and interesting, than if the collector had arranged only one metal, and rejected a curious article because he did not collect gold or silver. In like manner, if, in the modern part of the smaller cabinet, any coin of a series is of high price, or of bad impression, there can be no impropriety in putting another of the same reign, which is cheaper, or better executed, though of a different denomination or of a little larger size. In short, the collector has no rules but in the Greek cities and Roman families, to observe alphabetical order and chronology in every thing else."

Ancient Coins.

TABLES *of Ancient Coins.*

The most ancient coins, according to Froelich, are distinguished by the following marks, which he accounts infallible. 1. Their oval circumference, and globulous swelling shape. 2. Antiquity of alphabet. 3. The characters being retrograde, or the first division of the legend in the common style, while the next is retrograde. 4. The indented square already described. 5. The simple structure of the mintage. 6. Some of the very old coins are hollowed on the reverse, with the image impressed on the front. 7. The dress, symbols, &c. frequently of the rudest design and execution.

TABLE I. *Ancient Greek Coins.*

1. Those without impression.

2. With one or more hollow indented marks on one side, and an impression in relief on the other.—Of Chalcedon on the Hellespont, Lebos, Abdera in Thrace, Acanthus in Macedon, those said to belong to Egium in Achaia. This class continues from about 900 to 700 B. C.

3. With an indented square divided into segments, having a small figure in one of them; the rest blank, with a figure in relief on the obverse.—Of Syracuse and other places adjacent.—Continue from 700 to 600 B. C.

4. Coins

Ancient Coins

4. Coins hollow on the reverſe, with figures in relief on the obverſe.—Of Caulonia, Crotona, Metapontum, &c. Suppoſed by ſome to be a local coinage of Magna Græcia; but probably of equal antiquity with the former.

5. Coins in which a ſquare die is uſed on one or both ſides.—Of Athens, Cyrene, Argos, &c.—Of Alexander I. and Archelaus I. of Macedon. Diſuſed in the reign of the latter about 420 B. C.

6. Complete coins, both in obverſe and reverſe, occur firſt in Sicily in the time of Gelo, about 491 B. C.

7. Coins of Alexander the Great and his ſucceſſors. About the time of this hero the Greek coins began to attain to perfection, and were ſtruck of uncommon beauty. It is remarkable, that on the coins of this monarch his own image ſeldom occurs. The only one yet found of Alexander with his portrait upon it, and ſtruck during his reign, is a ſilver hemidrachm in Dr Hunter's cabinet, which is repreſented Plate CCCXXXI. N° 3. After his death many coins bear his portrait. Trebellius Pollio informs us, that ſome coins, particularly thoſe of Alexander, uſed to be worn as amulets; and many medals are met with in cabinets, bored ſeemingly with that intention.

8. Coins of the Succeſſors of Alexander.—Thoſe of the Syrian monarchs almoſt equal the coins of Alexander himſelf in beauty. Thoſe of Antiochus VI. are ſuppoſed to be the moſt perfect patterns of male beauty to be met with any where. The Egyptian Ptolemies are ſomewhat inferior.

9. The coins of the Arſacidæ of Parthia done by Greek workmen.

10. The Greek imperial coins, being ſuch as have the head of an emperor or empreſs: ſuch as have not theſe impreſſions being claſſed with the civic coins, though ſtruck under the Roman power. None of the imperial coins occur in gold. Of ſilver there are thoſe of Antioch, Tyre, Sidon, Tarſus, Berytus, Cæſarea, Egyptian ſilver coins of baſe metal, Syrian ſilver coins, which ſometimes bear on the reverſe the club of Hercules, or the Tyrian ſhell-fiſh. Thoſe of Sidon bear the image of the goddeſs Aſtarte, or her chariot. Thoſe of Cæſarea in Cappadocia of better work than the Syrian. Lycian coins of good workmanſhip: on the reverſe two harps and an owl ſitting upon them. Silver coins of Gelon in Sarmatia reſembling the Syrian. The ſituation of this town is very much unknown. It ſeems to have been ſituated on the north of the Euxine ſea, where ſome Sarmatic or Sclavonic tribes were mingled with the Scythians or Goths. The Greek imperial braſs coins are very numerous. A ſeries of almoſt all the emperors may be had from thoſe of Antioch, with a Latin legend on the obverſe and Greek on the reverſe. Thoſe of Bithynia and Phrygia remarkable for good workmanſhip. The coins of Tarſus remarkable for their curious views of objects, almoſt in perſpective. The Egyptian coins, from the time of Auguſtus to Nero, are worſe executed than afterwards. From Nero to Commodus they are frequently of admirable workmanſhip, and in a peculiar ſtyle, diſtinct both from the Greek and Roman. From the time of Commodus they decline, and are loſt after the reign of Conſtantius I. The Egyptian braſs coins of the Roman period are likewiſe of excellent workmanſhip, eſpecially in the time of Antoninus Pius.

Ancient Coins.

Table II. *Roman Coins.*

I. The conſular coins, called alſo the coins of families, and arranged alphabetically in cabinets, according to the names of the families which appear on them. They are,

1. *Braſs Coins.*—Theſe conſiſt chiefly of large pieces of rude workmanſhip without any intereſting imagery. In cabinets they are generally kept in boxes apart by themſelves. The as bears the head of Janus; the ſemis of Jupiter with S; the triens of Minerva with four cyphers; the quadrans of Hercules with three cyphers; the ſextans of Mercury with two cyphers; and the uncia bears the head of Rome with one cypher. In all theſe pieces the prow of a ſhip is conſtantly the figure on the reverſe, with very few exceptions. Sometimes indeed they have a ſhell, two heads of barley, a frog, an anchor or a dog, on the reverſe. About the time of Julius Cæſar both the obverſes and the reverſes of the coins began to be altered.

2. *Silver.*—Of this the denarius was the firſt and principal coin. It was ſtamped originally with X, denoting that the value was ten aſes. On the reverſe was Caſtor and Pollux, or a chariot of Victory. Afterwards the buſts of various deities make their appearance; and in the ſeventh century of Rome the portraits of illuſtrious perſons deceaſed are met with: but till the time of Julius Cæſar no figure of any living perſon is to be met with; Julius himſelf being the firſt who aſſumed that honour. The workmanſhip on the beſt and worſt ſilver is much the ſame. The reverſes are very curious, and point out many remarkable events in Roman hiſtory; but none of theſe occur till about a century before the Chriſtian era. The large denarii, with ROMA, are the moſt ancient; and ſome of theſe bear the Pelaſgic A, not the Roman. The ſilver ſeſtertii have a head of Mercury, with a caduceus on the reverſe. The quinarii have always a head of Jupiter, with a Victory on the reverſe.

3. *Gold.*—Moſt of theſe are of great value. The number of theſe exceeds not 100; thoſe of braſs 200; and of ſilver 2000. The aureus is the general gold coin; but two or three gold ſemiſſes of families likewiſe occur.

II. Roman imperial coins.

1. *Braſs.*—This is of three ſizes; large, middle, and ſmall. The firſt forms a moſt beautiful ſeries, but very expenſive. The various colours of the patina have the fineſt effect. It is the moſt important of all the Roman coins, and exceeds even the gold in value.

The middle braſs is next in value to the former; and in it are many rare and curious coins, particularly intereſting to Britons, as elucidating the hiſtory of the iſland. Of theſe are the triumphal arch of Claudius; the EXERC. BRITANNICUS of Adrian; the coins of Antoninus Pius, Commodus, Severus, with a Victory, VICTORIA BRITAN.: but eſpecially thoſe perſonifying the country BRITANNIA. "The number of Roman coins relating to Britain (ſays Mr Pinkerton) is remarkable, more than 20 having been ſtruck at various times; while thoſe perſonifying Italy, Gaul, Spain, Ancient Coins.

Spain, and other regions of the empire, exceed not four or six at most for each country." Only one country vies with Britain, and that is Dacia on the extreme north-east of the empire, as Britain on the extreme north-west. No doubt this circumstance of remoteness in these two countries recommended them to this particular attention, as more expressive of the Roman power.

The small brass series abounds also with curious coins. They are scarce till the time of Valerian and Gallienus, but very common afterwards. Mr Pinkerton recommends, therefore, to form a series in silver as well as brass; both being the cheapest of all the Roman coins. "In this series (says he), it is a common fault to arrange many coins which have been plated with gold or silver, the forgeries of ancient times, but which time has worn off either wholly or in part." All real brass coins have the S. C. till the time of Gallienus; as the senate alone had the power of striking brass, while the emperor himself had that of gold and silver. When the S. C. therefore, is wanting, the coin was certainly once plated; as, in general, the different type and fabric, being those of gold and silver, sufficiently show themselves. With Pertinax, A. D. 192, there is a temporary cessation of small brass; nor after him do any princes occur in that series till Valerian, A. D. 254, excepting Trajanus Decius, A. D. 250 only. After Valerian the series is continuous and common. The brass coinage gradually declined in size from the time of Severus; so that parts of the as could not be struck, or at least it was held unnecessary to strike them. Trajanus Decius attempted in vain to restore the coinage; and Valerian and Gallienus were forced to issue denarii æerei and small assaria. The series of large and of middle brass are of two fixed and known sizes; the former about that of our crown, the latter of the half crown: though after Severus they gradually lessen. But the small brass takes in all parts of the as; and every brass coin not larger than our shilling belongs to this series. The *minimi*, indeed, or very smallest, it is proper to keep apart. The coins of Julius Cæsar in this size are of peculiarly fine workmanship. They bear his portrait reverse of Augustus, or the reverse has a crocodile EGYPTO CAPTA. There are several with Mark Antony, and some with Cleopatra; but the more common pieces are those with only numerals on the obverse, which go the length of XIII.; probably tickets for the baths. A great many occur in the time of Nero; of which Mr Pinkerton particularizes one which has "on the reverse a table ornamented with griffins and other devices. Upon it is placed a wreath of laurel and a beautiful vase, of which the embossed human figures are so minute, and finished so surprisingly, as to stamp these coins the most exquisite productions of the ancient mint." From the time of Nero to that of Vespasian no small brass occurs: but there are many of this emperor, and of his son Titus; while Domitian has as many as Nero, and Domitia his wife has almost as many. Succeeding emperors to the time of Pertinax have also many brass coins; but from his time to that of Valerian there are no real small brass excepting those of Trajanus Decius. After Gallienus there are a great many coins of this kind; and Mr Pinkerton mentions one in Dr Hunter's cabinet, of an unknown person named Nigrianus. The coin seems to have been struck at Carthage; and our author concludes that he was an African usurper, father to Nigrianus.

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2. *Silver*.—This series is very complete, and the cheapest of any; especially as the small brass becomes a fine supplement to it: the latter being had in plenty when the silver become scarce, and the silver being plentiful when the brass is scarce.

3. *Gold*.—The Roman imperial gold coins form a series of great beauty and perfection; but on account of their great price, are beyond the purchase of private persons.

4. *The colonial coins* occur only in brass; none, excepting that of Nemausus, having a right to coin silver. They begin in Spain with Julius Cæsar and Antony, and cease with Caligula, who took away the privilege of coinage from the Spanish colonies. The most beautiful are those of Corinth. The other remarkable colonial coins are those of Emerita, Ilice, Terraco, Cassandria, Babba, Berytus, Cæsarea, Patræ, Emisa, Heliopolis or Balbec, Ptolemais, Sidon, Tyre, Deulton, Dium, Troas, Rhesaina, Neapolis of Samaria, which bears a representation of Mount Gerizzim with the temple on it, Hippo in Africa, &c. On many of these coins we meet with fine representations of temples, triumphal arches, gods, goddesses, and illustrious persons. But coins with those representations are by no means common; the colonial coins till the time of Trajan bearing only a plough, or some other simple badge of a colony. Camelodunum is the only colony in Britain of which we have any coins.

5. The *minimi*.—This includes the smallest coins of all denominations, most of which do not exceed the size of a silver penny. They are the most curious of all; but no series of them was ever formed by any person except the abbe Rothelin, whose collection, formed of all metals, passed to the queen of Spain. The reason of the scarcity of these small coins is probably their diminutive size; by reason of which they are mostly lost,

It is surprising that numbers of Roman coins are found through all countries once subject to that powerful people. Some have been met with in the Orkneys, and many in the most remote parts of Europe, Asia, and Africa, known to the ancients.

TABLE III. *Coins of other Ancient Nations*.

1. The Lydians appear to have invented coinage; though, perhaps, this honour may be disputed with them by the Greeks.

2. The Assyrians, Medes, Babylonians, Phœnicians, and Egyptians, had no coins. In the mouths of the mummies, are only thin, unstamped, and round pieces of gold, to pay Charon's fare.

3. No Indian or Chinese coins are to be met with till a very late period; and even then so rude as scarce to be worth notice. Voltaire mentions a collection of ancient Chinese and Indian coins made by the emperor of China in 1700; but Mr Pinkerton supposes it to have consisted only of the Greek and Roman money which had been introduced into these countries.

4. The Lydian coins have no legends; so that mere conjecture only determines the ancient coins of electrum

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and filver found in Afia, and different from the Perfian, to belong to Lydia. Crœfus coined gold into a form which he called *ftaters*; and Mr Pinkerton mentions a very ancient gold coin in Dr Hunter's cabinet, which he fuppofes to have been one of thefe. It has a globous figure, with indented marks on one fide, and on the other a man kneeling, with a fifh held out in the left hand, and a fword depending in the right. It weighs four drachms; which Jofephus tells us was the weight of the Lydian gold coins. In the fame collection are other gold coins little inferior in antiquity; the moft ancient of which, our author fuppofes, may have been coined by the cities of Afia Minor, as coinage paffed through them to Greece. They are of admirable workmanfhip, and as much fuperior to the beft Sicilian coins, as the latter are to all the reft in the world. Thefe gold coins are all extremely pale; owing to the want of knowledge in refining gold.

5. Perfian coins.—Thefe were firft ftruck by Darius Hyftafpes, whence they had the name of *darics*. They are of gold, and generally have the figure of an archer: they weigh about four drachms; and fome occur with the indented mark on one fide, while others have figures upon both. The filver coins have generally a king in a chariot of two horfes, with a charioteer, and fometimes another figure on foot behind, on the obverfe: while the reverfe prefents a fhip, fometimes a ram, bull, or other animal. The gold coins, which only had the title of *darics*, are extremely fcarce, having been melted down, as is fuppofed, and recoined by Alexander the Great on his conqueft of Afia.

There is a fecond feries of Perfian coins beginning with Artaxares, or Artaxerxes, who overthrew the Parthian monarchy about the year 210. Thefe are large and thin, with the king's buft on one fide, and the altar of Mithras on the other; generally with a human figure on each fide. Thefe coins continue till the year 636, when Perfia was conquered by the Saracens. Thefe have only Perfian letters upon them, which have never been explained by any antiquaries. Mr Pinkerton fays that they feem to partake of the ancient Greek, Gothic, and Alanic.

6. The Hebrew fhekels, originally didrachms, but after the times of the Maccabees tetradrachms, are almoft all forgeries of modern Jews, as well as the brafs coins with Samaritan characters upon them. They have all a fprig upon one fide and a vafe on the other. Mr Pinkerton fays, that the admiffion of one of them into a cabinet would almoft be a difgrace to it.

7. Phœnician and Punic coins are very interefting on account of the great power and wealth of thefe nations. The alphabets have been cleared by their relation to the Hebrew and Syriac languages.

8. The coins of Palmyra come under the fame denomination with the former, Palmyra being a Syrian city.

9. The Etrufcan coins have the characters of that nation, which have been explained by their affinity to the Pelafgic, or oldeft Greek and Latin.

10. The Spanifh coins are infcribed with two or three alphabets allied to the old Greek or Punic; but the infcriptions have not been fufficiently explained.

11. Gaulifh coins.—Thefe are numerous, but the moft ancient have no legends; and even after the Greek letters were introduced into Gaul by a colony at Marfeilles, the legends are very difficult to be explained.

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12. Britifh coins.—From a paffage in Cæfar's Commentaries, it has been inferred that the Britons ufed fome kind of coins even in his time. Mr Pinkerton informs us, that fome rude coins of copper very much mingled with tin are frequently found in England; which, he fuppofes, may be fome of the ancient Britifh money. They are of the fize of a didrachm, the common form of the nummus aureus among the ancients. After the time of Cæfar, coinage increafed among the Britons; and there are many found of Cunobelinus mentioned in the Roman hiftory. Moft of thefe have on one fide CUNO, with an ear of wheat, a horfe, a kind of head of Janus, or other fymbol; and have frequently alfo the letters CAMU; fuppofed to mean Camelodunum. Sometimes the word TASCIA occurs; the meaning of which has not yet been explained.

13. Gothic coins of France, Italy, and Spain, to the time of Charles the Great. Thefe have the Roman characters upon them. The Italian coins are moftly of the fize of fmall brafs; and in this way we meet with coins of Athalaric, Theodahat, Witigez, and other Gothic princes. Many others occur, the infcriptions of which, though meant for Roman, are fo perverted as to be illegible.

TABLE IV. *Modern Coins.*

1. Of Japan.—Thefe are thin plates of gold and filver, of an oval figure, with fmall marks or figures ftamped on them.

2. China.—Thefe are only copper, about the fize of a farthing, with a fquare hole in the middle to put them on ftrings. The infcriptions on them do not exprefs the name of the fovereign, but the year of his reign; as the *happy year*, the *illuftrious year*, &c.

3. The Tartarian coins are rude, having only infcriptions upon them; and they are all pofterior to the time of Jenghiz khan.

4. Coins of Thibet, Pegu, and Siam, are much the fame, prefenting only infcriptions without any figures. They are alfo of late date.

5. India.—Some old coins have been found in the neighbourhood of Calcutta, of gold, filver, copper, and tin, all mixed together. Thefe have commonly a warrior with a fword on one fide, and an Indian female idol on the other, of the fame form with the celebrated fculptures in the ifland of Elephanta; but it is impoffible to tell what antiquity they are of. The modern coins are the pagoda of gold, worth little more than fix fhillings; the roupee of filver upwards of two fhillings; and the cafh, of copper. There is a remarkable fet of roupees, which fhow the twelve figns; a lion on one, a bull on another, &c. but the occafion on which they were ftruck is unknown. The other coins of India have generally Perfian infcriptions upon them.

6. Perfia.—The Perfic coins fince its conqueft by the Arabs continue on the Arabian model.

7. Arabia.—Some coins of the petty princes of Arabia are met with as old as the imperial ages of Rome; but till the time of Haroun Alrafhid, no regular

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gular coinage appears in the vast empire of the Saracens. Even then the reverse has only an inscription, and the obverse is copied from any Greek or Syrian coin which happened to fall in the moneyer's way. The later Arabian coins are mostly silver, with the name and titles of the prince on one side, and some inscription from the Koran on the other. The more modern coins of this country are in the shape of a fish-hook, with Arabic inscriptions.

8. Turkey.—No regular coinage was formed by the Turks till they became masters of Constantinople. They resemble those of Persia and Arabia, having merely inscriptions on both sides.

9. The coins of the African states, at least such as profess the Mohammedan religion, have merely inscriptions without any figures: those of the internal parts are unknown; and no coinage was used among the Mexicans and Peruvians, the only civilized nations in America; but La Hontan mentions an American savage who had a square medal of copper depending from his neck. Mr Pinkerton supposes it to have come from Japan.

10. Modern Italic coins. Besides the Gothic princes mentioned in the former table, the exarchs of Ravenna coined money with the inscription FELIX RAVENNA, &c. The Lombards issued no coins, but there are some still extant of Charlemagne. The following list shows the origin of the coinage in various Italian states.

Rome.—Papal coinage originates with Hadrian I. Size of silver pennies, with the Pope's name on one side, and SCOS PETRUS on the other. No coins appear from 975 to 1099, excepting of Leo IX. In 1303 appear pennies of the senate and people of Rome, with Peter on the one side and Paul on the other. There are groats of Clement V. with his portrait three quarters length; but the side-head begins with Sixtus V. in 1470. Gold was first coined by John XXII. in 1316. The coins of Alexander VI. Julius II. and Leo X. are remarkable for beauty and elegance.

Milan. Coinage began with Charlemagne. The first coin of the family of Visconti occurs in 1330, under Azo. The set finishes with Louis XII.

Naples. Coinage begins in 840 and 880, with Duke Sergius and Bishop Athanasius. The next coins are of Roger of Sicily, and Roger II. in 1130, William I. II. and Tancred. Naples and Sicily were subdued in 1194 by the emperor of Germany; in 1255 Manfred appears; in 1266 Charles of Provence; and others till Joan in 1414: after which follow the house of Arragon, and later kings.

Venice begins in the 10th century. The first coins are silver pennies marked VENECI. Then follow the coins of Henrico Dandulo in 1192, of Ziani in 1205, &c. Gold was first coined at Venice in 1280, and copper in 1471; but the silver groats are as old as 1192.

Florence. Silver was coined here in the 12th century, or before; but in 1252 the first gold coins struck in Europe after the 8th century made their appearance, and were named *florins* from the flower of the lily upon them. They were imitated by the popes, by France, and England. They have on one side St John the Baptist standing, on the other a large *fleur de lis*, and it is not doubted that the French *fleurs de lis* took their origin from these coins. They weigh a drachm, and are no less than 24 carats fine, according to Italian writers, and are worth about 12 shillings.

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Geneva first began to coin money in 1129, under the government of Conrad. Those of the dukes of Savoy began in the same century.

Aquileia. Coins were issued from this city by the patriarchs from 1204 to 1440.

Ferrara. Coins of the marquises from 1340.

11. French coins. During the race of Clovis, from 490 till 751, the coins are chiefly gold *trientes*, with some *solidi* and *semisses*. The former are of good workmanship, with the heads of kings. The reverse has a cross, with the name of the town where they were struck.

The coins of the second race begin with Pepin in 751, and continue till Hugh Capet in 987. The coins of the first race are elegant, but those of the second entirely the reverse, being almost all silver pennies, and seldom bearing the portrait of the king. Those of Charlemagne have only CAROLUS in the field; while the reverse bears R. F. or some such inscription; though one piece struck at Rome has a rude bust of him. The coins of Louis le Debonnaire are better done.

The third race begins with Hugh Capet in 987, and extends to this time. The coinage did not begin to improve till 1226 under St Louis, when the groat appears. Its name in Italian is *grosso*, in French *grosse*, in English *groat*, or great coin; so called from its size in comparison with the penny; and it passed from Italy to France, to Germany, and to England. After the conquest of France by the English, base coins of many kinds were introduced; and in the year 1574, in the time of Henry III. copper was first introduced into the French coinage. Besides these, the other remarkable coins of France are, the blancs or billon groats first issued in 1348; the *ecus a la couronne*, or crowns of gold, so called from the crown on one side, and begun by Charles VI. in 1384; those of Ann of Bretagne in 1498: the *teston*, or piece with the king's head, of Louis XII; the *Henri* of Henry II. with Gaul sitting in armour, and a Victory in her hand. There are many coins of Cardinal Bourbon, elected king in 1589; and in 1642, Louis XIV. takes the title of CATALONIÆ PRINCEPS. The first *louis d'or* made its appearance in 1640; but such was the poverty of France, if we believe certain authors, that in 1719 the duke of Orleans regent struck copper for silver.

12. Spanish coins. The most early series of these consists almost entirely of trientes, finely done. On one side they have the head of the king with his name, and on the other a cross, with the name of the town, commonly in Bætica, or the south part of Spain, where there were a great many Roman colonies, and which was fertile to a proverb. The Moresque coins of Spain, like those of the rest of the Mohammedan states, present us only with insipid inscriptions on both sides. Indeed the Mohammedan religion, by its absolute refusal to allow the representation of any living creature, has prevented the progress of coinage in any degree throughout those regions which it has over-

spread.

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spread. The inscriptions on the ancient Spanish coins are in the Cufic or old Arabic characters.

13. Portugal. No description of the coins of this kingdom has yet appeared.

14. Germany. No account of the German coins has been published; though it is well known that not only the emperors, but many of the cities, particularly those called *Hanse-towns*, issued money; and many of the coins issued by the cities were superior in elegance even to those issued by the emperors.

15. Denmark. Here the coinage begins with Canute the Great in 1014. The pieces are at first extremely rude, ornamented only with rings and Runic characters. These are succeeded by copper pieces, some of which have a cross, others a pastoral staff, on one side, with the letter A on the other. Later coins have strokes IIII, &c. all round them; but those of Harold, Hardicanute, and Magnus Bonus, in 1041, are of neat workmanship, and have the portraits of the princes at half length. The coins of Nicolas, or Niel, as he is called by the Danes, are rude, as well as those of Waldemar I. and the celebrated Margaret. In 1376 Olaf caused money to be struck with a grinning full face, with a crowned O upon the other side. "The Swedes (says Mr Pinkerton) took these coins extremely ill, as they thought they grinned at them." Silver was first coined in Denmark by Philippa queen of Eric, and daughter to Henry IV. of England.

16. Sweden. The coinage of this kingdom began in 818 under Biorno, on the plan of Charlemagne. The coins are marked with a cross. Next follow those of Olaf in 1019; which Mr Pinkerton supposes to have been the first true Swedish coins; and that the art of coinage first passed from England into Denmark in the time of Canute the Great, and from Denmark into Sweden. These coins were struck on the English model. During the time that Sweden was subject to Denmark, or miserably harassed by the Danes, the coins of both kingdoms were the same; but after the time of Gustavus Vasa many elegant pieces appear. In 1634, dollars were coined with the portrait of Gustavus Adolphus, who was killed two years before: on the reverse they have the arms of Sweden, with the chemical marks of mercury and sulphur. In 1716, 1717, and 1718, Charles XII. being in extreme want of money, issued small copper coins with Saturn, Jupiter, Mars, &c. upon them, to go for dollars; and on account of this scheme, Baron Goertz, the suggestor of it, was brought to the block.

17. Norway. The coins of this country begin with Olaaf in 1006; after which time there are various coins of other princes; but copper was not coined till the year 1343.

Besides the coins already mentioned, there are ecclesiastic coins of France, Germany, Denmark, Sweden, Norway, &c. Those of Denmark and Sweden are numerous, but the Norwegian coins of this denomination are rare. Mr Pinkerton describes a silver one in his possession as having arms and a mitre, with the inscription on one side, SANCTUS OLAWS REX NORVEY; on the reverse, OLAWS DEI GRA. ARCEP. NID'SEN, meaning NIDROSIENSIS, or archbishop of *Nidros*, now Drontheim.

18. Bohemia. The coinage of this kingdom appears at a very early date, viz. in the year 909, under Duke Boleslaus I. These coins are followed by others of Boleslaus II. and Emma his wife in 970; of Boleslaus III. in 1002; Jaromir in 1020; Udalrich in 1030, and other princes. The *bracteate* money of Ottocar I. was coined in 1197.

19. Poland. The coinage of this country is nearly as ancient as that of Bohemia. The coins are on the German model, but no particular account of them has been published.

20. Russia. None of the Russian money appears to be more ancient than the 13th century. The first are the *kopecks* or silver pennies, which have upon them rude figures of animals on one side, and a man standing with a bow or spear on the other. There are likewise coins of Moscow struck by Aristoteles the architect in 1482. The *roubles* or dollars and their halfs. There are some of the impostor Demetrius in 1605, which are very scarce.

21. Prussia. The first Prussian coins were struck at Culm by the Teutonic knights in 1230. They were silver pennies, and upon the German plan. In the next century were struck shillings, groats, and *schots*; the last were the largest, and are extremely rare. They have the Prussian shield, an eagle surmounting a cross, with a rose-shaped border, MONETA DOMINORUM PRUSSIÆ: on the reverse is a cross fleurie, within a border of a similar kind, having the inscription HONOR MAGISTRI, JUSTITIAM DILIGET.—Gold coins were struck in the same century. In the time of Copernicus the money was so debased, that 12 or 13 marks were worth but one of pure silver.

22. England. The English coins are of various kinds.

1st. *Heptarchic*. These are only of two sorts, viz. the *skeatta* or penny of silver, and the *styca* of copper. Few of the pennies appear till after the year 700; though some are met with which bear the name of Ethelbert I. king of Kent, as old as 560. At first they had only rude figures of serpents, but in latter times legends were likewise added. Most of these pennies have pagan symbols upon them. The styca was only coined in Northumberland, and was a very small piece, about the value of half a farthing.

2d. Coins of the *chief monarchs* of England. Mr Pinkerton denies that an end was put to the heptarchy by Egbert in 832, as is commonly supposed; though he owns that he was *chief monarch* of the country, as several others had been before him. Edgar, who reigned in 959, according to him, was the first king of England; and the coins of the chief monarchs form almost a complete series from the time of Egbert to Edgar. The only chief monarch of whom there are no coins is Ethelbald, who reigned in 857. Most of these coins bear rude portraits; but the reverses are sometimes curious and interesting. Some have views of cathedrals and other buildings; particularly one of Edward the Elder in 900; which has the cathedral of York with three rows of windows, round arched as the other Saxon and Norman buildings: the Gothic arch being quite unknown till after the 12th century. Some coins of Anlaf king of Northumberland have the famous raven, the Danish ensign: and those

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those of other princes have frequently very curious reverses.

3d. *Ecclesiastic* coins appear of the archbishops of Canterbury, Wulfred in 804, Ceolnoth, in 830, and Plegmund in 889.

4th. Coins of the *kings* of England. The silver penny, which had begun during the heptarchy, continued to be the general coin after the kingdom had been united under one head; and extends in a continued series from Egbert almost to the present reign. The only kings wanting are Edmund Ironside, Richard I. and John. At first the penny weighed $22\frac{1}{2}$ grains: but towards the close of the reign of Edward III. it fell to 18 grains; and in that of Edward IV. to 12. In the time of Edward VI. it was diminished to 8 grains; and in Queen Elizabeth's reign to $7\frac{1}{31}$; at which it still continues.

Halfpennies and farthings were first struck in silver by Edward I. in 1280; the former continued to the time of the commonwealth, but the latter ceased with Edward VI. The groat was introduced by Edward III. in 1354, and continues to this day, though not in common circulation. The half-groat or two-pence is of the same date, and also continues to the present time.

Shillings were first coined by Henry VII. in 1503. At first it was called *testoon*, from the *teste*, *tete*, or head of the king upon it; the name *shilling* being derived from the German *schelling*; under which appellation coins had been struck at Hamburgh in 1407. The crown was first coined in its present form by Henry VIII. Formerly it had appeared only in gold, whence the phrase of crowns of gold; though these indeed were the largest gold coins known for a long time in France and other countries on the continent, being worth about 10s. sterling. They had their name from the crown stamped on one side, and were first coined by Charles VI. in 1384, and continued till the time of Louis XIV. The half-crown, sixpence, and threepence, were coined by Edward VI. In 1558 Queen Elizabeth coined three halfpenny, and in 1561 three farthing pieces; but they were discontinued in 1582. From the year 1601 to the present time the coins of England remain the same.

Gold was coined in England by Henry III. in 1257; the piece was called a *gold penny*, and was larger than the silver one; and the execution is by no means bad for the time. The series of gold coinage, however, commences properly from Edward III. In 1344, this monarch first struck florins, in imitation of those in Italy; and it is remarkable, that though these coins at the time they were first issued bore only six shillings value, they are now intrinsically worth 19s.; so much has the value of gold increased since that time. The half and quarter florin were struck at the same time, but only the last has been found. The florin, however, being found inconvenient, gave place to the noble of 6s. 8d. value, and exactly half a mark. The latter had its name from being a limited sum in accounts; and was eight ounces in weight, two-thirds of the money pound. It is sometimes also called *selibra*, as being one half of the commercial pound of 16 ounces. The noble had its name from the nobility of the metal; the gold of which it was coined being of the finest sort. Sometimes it was called *rose noble*, from both sides being impaled in an undulating circle. It continued with the half and quarter noble to be the only gold coin till the angels of Edward IV. appeared in 1465. These had their name from being stamped with the image of Michael and the dragon. The angelets of 3s. 4d. value were substituted in their place. In 1527 Henry VIII. added to the gold coined the crown and half-crown at their present value; and the same year he gave *sovereigns* of 22s. 6d. and *ryals* of 11s. 3d. angels at 7s. 6d. and nobles at their old value of 6s. 8d. In 1546 he caused sovereigns to be coined of the value of 20s. and half-sovereigns in proportion. His gold crown is about the size of our shilling, and the half-crown of six-pence, but thin. All his coins, however, gold as well as silver, are much debased; and it was not without much labour and trouble that Edward VI. brought it back to its former standard. On the union of the two crowns, James gave the sovereign the name of *unite*; the value continuing of 20s. as before. He coined also rose-ryals of 30s. value, spur-ryals of 15s. angels of 10s. and angelets of 5s. Under the commonwealth, the sovereign got the name of the *twenty-shilling* piece, and continued current till the coinage of guineas. These were so called from their being coined of Guinea gold, and were at first only to go for 20s. though by an universal but tacit consent they always passed for 21s. Half-guineas, double guineas, and five guinea pieces, were also coined during the same reign; which still continue, though the two latter are not in common circulation. Quarter guineas were coined by George I. and likewise by his present majesty; but they were found so troublesome on account of their small size, that they were stopped within a year or two, when received at the bank of England, and thus are not to be met with at present. A few pieces of 7s. value have likewise been coined, and are known by the lion above the helmet; but none have been issued. In 1688 the guinea rose to 21s. 6d. and continued to increase in value till 1696, when it was as high as 30s.; but after the recoinage in 1697 and 1698 it fell by degrees, and in 1717 was at its old standard of 21s. and at that time silver was fixed at its present standard value, viz. as 1 to $15\frac{1}{2}$ in weight.

Though the first money coined in Britain, as we have already observed, was copper, yet, excepting the Northumbrian stycas, no copper coin was found in England from the time of the Saxon conquest till the year 1672. An aversion to a copper coinage it seems was prevalent throughout the nation; and Queen Elizabeth, who without hesitation used base money for Ireland, yet scrupled at coining copper for England. This want of small coin occasioned such an increase of private tokens for halfpennies and farthings, that it became a serious object to government; and in 1594 a copper coinage was seriously thought of. This year a small copper coin was struck about the size of a silver two-pence, with the queen's monogram on one side, and a rose on the other; the running legend on both sides being, THE PLEDGE OF A HALFPENNY. Of this there are patterns both in copper and silver, but both of them soon fell into disuse. On the 19th of May 1613, King James by royal proclamation issued farthing tokens. They are generally of the same size with the two pence, with two sceptres in saltier surmounted

with

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with a crown, and the harp upon the other; with an intention, as it would seem, that if they were refused in England, they might pass in Ireland. In 1635 Charles I. coined those with the rose instead of the harp; but the circulation of these was entirely stopped by the vast number of counterfeits which appeared, and by the king's death in 1648. After this the private tokens began again to be circulated, till put a stop to by the coinage of farthings in 1672. The workmanship of the tokens is quite contemptible. In 1672 the halfpence as well as the farthings which had been struck two years before began to circulate. They were of pure Swedish copper, the dies engraved by Roettier; and they continued till the year 1684, when some disputes arose about the copper lately obtained from the English mines. Tin farthings were coined with a stud of copper in the centre, and inscribed round the edge as the crown pieces, with NUMMORUM FAMULUS. 1685 or 1686. In 1686 halfpence of the same kind were coined; and the tin coinage continued till the year 1692, to the value of more than 65,000l.; but next year the tin was all called in by government, and the copper coinage recommenced. The farthings of Queen Anne are all trial pieces, excepting those of 1714, the last year of her reign. "They are (says Mr Pinkerton) of exquisite workmanship, exceeding most copper coins either ancient or modern, and will do honour to the engraver Mr Croker to the end of time." The one, whose reverse is Peace in a car, PAX MISSA PER ORBEM, is the most esteemed; and next to it the BRITANNIA under a portal. The other halfpence and farthings are less valuable.

23. Scotland. Silver pennies of Alexander I. who reigned in 1107, are believed to exist; and there certainly are some of Alexander II. in 1214. There are likewise coins of David in 1124; but perhaps none of Malcom IV. his successor, whose reign was very short. There are many coins of William I. in 1165; and a large hoard of his pennies was found at Inverness in 1780.

The money of Scotland continued to be of the same value with that of England till the country was drained by the vast ransom of David II. after which it became necessary to reduce its size; and so much did this diminution affect England, that Edward III. found himself obliged to lessen the English coin also. The diminution of the Scottish coin, however, continued still to go on until it became impracticable to keep par with that of England. In the first year of Robert III. it passed only for one half of its nominal value in England: in 1393, Richard II. ordered it only to go for the weight of the genuine metal it contained. In 1600 it had sunk to such a degree as to pass only for a twelfth part of the English money, and continued at that low ebb till the coinage of Scotland was entirely cancelled by the union of the two kingdoms.

Of silver coins we have only pennies till the year 1293, when Edward I. having coined halfpence and farthings, Alexander III. of Scotland coined also halfpence, of which we have a few, but no farthings are to be met with; but there are silver farthings of Robert I. and David II. The latter introduced the great and half-groat, which completed the set of Scottish silver. It continued unaltered till the time of Queen Mary, when they all ceased to be coined in silver, on account of the high price of that metal. In 1553 shillings were first coined, with the bust of the queen on one side and the arms of France and Scotland on the other. The silver crown was first coined in 1565, which went for 30s. Scots; lesser pieces of 20s. and 10s. having likewise been struck, and marks of silver, worth 3s. 4d. English, were also coined about the same time. These coins have upon them the marks XXX. XX. X. to denote their value. They are commonly called Cruickstone dollars, from the palm-tree upon them, mistaken for a remarkable yew at Cruickstone near Glasgow, where Henry Darnley resided. It is described, however, in the act as a palm, with a "shell-padoc" (a tortoise) crawling up. This alludes to Darnley's marriage with the queen, as the motto from Propertius DAT GLORIA VIRES also implies. The motto NEMO ME IMPUNE LACESSET first appears on the Scottish coins in 1578, and the invention is given to the celebrated Buchanan. In 1582, the crown of an ounce weight went for 40s. Scots, and was accordingly marked XL.; in 1597 the mark was L. the Scottish money being then only one tenth of the English: the mark was LX. in 1601, the value being then reduced to one-twelfth, at which it has ever since continued. In the time of Charles I. half marks, 40 and 20 penny pieces, were coined. In 1675 the Scottish dollars first appeared, in value 56s. Scots, with halves and quarters of proportional value. In 1686, James VII. coined 60s. 40s. 20s. 10s. and 5s. pieces; but only those of 40s. and 10s. are known, with these numbers under the bust. At the union of the kingdoms, all the Scottish coins were called in, and recoined at Edinburgh, with the mark E under the bust to distinguish it: since which there has been no coinage in Scotland. The Scottish silver coins are in general equal, if not superior, in the workmanship to the English.

Gold was first issued by Robert II. about 30 years after Edward III. of England had coined the same metal in that country. The pieces were at first called St Andrews, from the figure of that tutelar saint upon the cross, and who appears on the obverse with the arms of Scotland, and on the reverse a lion in a shield. The lion was another name for the largest gold coin in Scotland, from the arms of the kingdom upon it. The next was the unicorn, under James III.; which were followed by the bonnet-pieces of James V. These last are of admirable workmanship, being almost equal to the ancient coins in this respect. In imitation of the French, the monarch we speak of diminished the size of the coin without lessening its weight; an improvement not adopted by the English for a whole century. The last gold coined in Scotland was the pistole and half pistole, of twelve and six pounds Scots. These coins have the sun under the head. The gold coins of Scotland fell in the same proportion with the silver.

The copper coinage of Scotland is of more early date than that of England. It was preceded by money of *billon*, or copper washed with silver, called black money. James III. first coined black farthings in 1466; and this is recorded by historians as one of his greatest faults. This kind of coinage, however, continued as late as the reign of James VI. In his time the

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the true copper coinage began; but as the value of Scottish money had now declined almost to the utmost, the pieces suddenly assumed a form almost resembling that of the French coins. The *bodle*, so called from Bothwell the mintmaster, being equal in size to the *liard*, and worth two pennies Scottish, was struck. The billon coin, formerly called *bas piece*, and worth six pennies Scots, was now coined in copper, and termed the *baw-bee*. Thus it corresponded with the French half sol and English halfpenny, the Scots penny being now equivalent to the French *denier*. Some pieces named *Atkinsons* were coined by James VI. in 1582, when the Scottish money was to the English as 1 to 8; but on its being still farther reduced, they went for 8 pennies, a third more than the value of the baw-bee. Besides these there were the hardie and plack, the former being worth three and the latter four pennies Scots. This coinage continued through the reigns of Charles I. and II. but Scottish coins of the former are, perhaps, the scarcest of any.

24. Ireland. The first coins introduced into this kingdom seem to have been those of the Danes, and which have only a number of strokes around them instead of letters. In the tenth century, however, this coinage had been considerably improved; and in 930 and 994 there are pennies struck in Dublin, with the inscription ON DVFLI or DYFLI, *Duflin* or *Dyflin* being the Danish name of that city. There are likewise coins of the Irish princes themselves, and of the English monarchs, struck in Ireland as early as the ninth century; and it is asserted by some, that Ireland even in these days had been conquered by England; of which, indeed, these coins seem to be a proof. None of the Irish coins of Henry II. are to be met with, but we have some of the coins of John; and from his time to that of Henry V. the Irish coins are known by a triangle enclosing the king's head, which appears also upon the coins of other nations at this period. The harp does not appear upon the Irish coins till the time of Henry VIII. Till the time of this monarch, the English and Irish coins are the same; but the same debasement of the coin which at that time took place in England extended also to Ireland; but in 1601 copper halfpence and farthings were coined also for this kingdom. These circulated in Ireland when James VI. issued his farthing-tokens of copper, the latter being of two sizes, that if they failed in England they might be sent to Ireland as pennies and halfpence. In 1635 a mint was established in Dublin by Charles I. but it was stopped by the Irish massacre, and the many disturbances which followed; since which time the scheme has not been resumed. After the massacre, St Patrick's halfpence and farthings were coined by the Papists, bearing the legends FLOREAT REX, and on the reverse ECCE GREX; on the farthing QUIESCAT PLEBS. Copper tokens were struck by towns and tradesmen, as in England and Scotland. In 1680, halfpence and farthings were issued by authority, with the harp and date. In 1689, James II. having invaded Ireland, instituted a mint, and coined shillings and half-crowns of all the refuse metal he could find, particularly some brass guns were employed, whence the coinage is commonly called *gun-money*. Even this metal, however, soon became so scarce, that a diminution in its size is quite apparent from June 1689 to July 1690; and as the month of their mintage is marked upon them, this decrease is easily perceived. In March 1690, pennies of lead mixed with tin were issued; and on the 15th of June the same year, crowns of white metal were coined; but these are now very scarce. In 1722, the patent for coining halfpence and farthings was given to William Wood, which excited such discontent in Ireland. From the small size allowed by the patent to these pieces, it was supposed that the patentee would have gained 60,000l. but as he caused them to be struck of a size still smaller, his gains were estimated at 100,000l. The coins, however, are of admirable workmanship, and very fine copper, bearing the best portrait of King George I. to be found any where. Sir Isaac Newton, at that time at the head of the mint, declared that they were superior to the English coins in every thing except the size. In 1737 the Irish halfpence and farthings, with the harp on the reverse, were coined, and continue to the present time. In 1760, there was such a scarcity of copper coin, that some private persons applied for leave to coin halfpence, which appeared with a very bad portrait of George II. and the words VOCE POPULI around it. No gold or silver has been coined in Ireland since the massacre of 1641.

TABLE V. *Modern Medals, properly so called.*

1. Scottish medals. These take the lead in the present article, the first modern medals of gold being those of David II. struck between the years 1330 and 1370. Only two of them are known to exist; one in the collection of Mr Barker of Birmingham, and the other in that of Dr Hunter. In 1487, there is a medal of James III. sent to the shrine of St Amboise in France. It is described as of two inches and a third in diameter; the weight near two ounces; having on the obverse a beardless king, with long hair, sitting on a throne, holding in one hand a naked sword; in the other a shield, with the Scottish arms. On the borders of the canopy above the throne is an inscription in Gothic letters, IN MI DEFFEN, being corrupt French for *In my defence;* a common motto in the Scottish arms. Above the canopy is VILLA BERWICHI: the reverse bears St Andrew and his cross, SALVUM FAC POPULUM TUUM DOMINE. There is also a medal of James IV. in the collar of St Michael, having on the reverse a Doric pillar surmounted by a young Janus, standing on a hill, beyond which is the sea, and land on either side. This, however, is by some suspected to be a forgery.

The most remarkable Scottish medals are those of the unfortunate Mary. The first is properly French, having been issued at her coronation as queen of France, along with her husband King Francis II. On the obverse of this piece there are portraits of Francis and Mary, face to face, with three legends around them, the outermost containing their titles; the middle one the following sentence: HORA NONA DOMINUS J. H. S. EXPIRAVIT HELLI CLAMANS; the innermost the name of the city (Paris). On the reverse are the arms of France and Scotland. Fine testoons were also coined upon the same plan, and are now so rare that Dr Hunter gave ten guineas for one which

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which is in his collection. The same portraits appear on the fine crown of Mary and Henry, in 1565, which is so rare as to be esteemed a medal of the highest value; and Mr Pinkerton imagines, that if offered to sale it would bring 40 or 50 guineas.

Another remarkable medal of Mary represents her full-faced, and weeping, with the inscription, O GOD GRANT PATIENCE IN THAT I SVFFER VRANG. The reverse has in the centre, QUHO CAN COMPARE WITH ME IN GRIEF, I DIE AND DAR NOCHT SEEK RELIEF; with this legend around, HOURT NOT THE (figure of a heart) QUHAIS JOY THOU ART. There are also many counters of this unfortunate princess, being thin silver pieces of the size of a shilling. "They all appear (says Mr Pinkerton) to have been done in France, by the direction of Mary, who was fond of devices. Her cruel captivity could not debar her from intercourse with her friends in France, who must with pleasure have executed her orders, as affording her a little consolation."

The coronation medal of Charles II. struck at Edinburgh for his inauguration, June 18. 1663, is remarkable as being the only one ever coined of Scottish gold, and the first in Britain struck with a legend on the edge. With respect to the workmanship, it is inferior to Simon's. Of these medals only three are known to exist, of which one is in the Museum. It is not uncommon in silver; in which case it sometimes wants the legend on the edge.

2. Italian medals. These appear in the 15th century, and from that time successively in most European countries. Vittore Pisano, a painter of Verona, is celebrated as the restorer of the art, but it remains to be accounted for how the medals of King David, already mentioned, came to exist so long before. Mr Pinkerton considers this artist rather as an inventor than a restorer, his medals having no resemblance to the ancient coins, as being large, and all cast. They were first modelled in wax, then a mould taken from the model in fine sand and other ingredients. After a good cast was procured, it was touched up, and made a model for the rest. These medals of Pisano, are almost always inscribed *Opus Pisani Pictoris*. The portraits of a great number of illustrious men were done by him in this manner; and in the British Museum is a large brass medal of Pisano by himself.—Other artists were Boldu, Marescotto, Matthæus de Pastus, Sperandes, Misaldone, &c. Towards the end of the century, however, the medals began to assume a more elegant appearance; and the papal ones are not only the most elegant but the most ancient series of all the modern medals. The improvement began in the reign of Alexander VI. so famous for his own crimes, and those of his nephew Cæsar Borgia. His successors, Julius II. Leo X. Hadrian VI. and Clement VII. had many of their medals designed by Raphael, Julio Romano, and other eminent painters, and the engraving executed by artists of equal merit. Among these were the celebrated Cellini, and the noted Paduan forgers of Roman coins, Cavino and Bassiano. In 1644, Cormanni, a medallic artist, was imprisoned on account of a piece which represented the Pope upon one side, and Olympia Maidalchina, the *relation* of his holiness, on the other. The unfortunate Cormanni poisoned himself. About this time the family of the Hamerani, originally from Germany, began to engrave the papal medals; which they did with surprising merit for several generations. Each of the daughters did a fine medal, as we are informed by Venuti.

Besides the papal medals, many have been issued by the various states of Italy. There are medals of Frederic II. of Sicily in 1501, of several Venetian generals in 1509, of Alfonso duke of Ferrara in 1511, and of the celebrated Andrew Doria in 1528.

3. French medals. Till the reign of Louis XIV. the medals of this country are neither fine nor numerous; but this monarch exceeds all modern princes in this way. Many of his pieces are well designed and executed, though objectionable on account of their falsehood.

4. Danish medals. These appear of Christian II. in 1516, of Frederic and Sophia in 1532, of Frederic I. and Christian III. in bonnets worn in the 16th century. The elephant of the house of Oldenburg is frequent upon Danish medals.

5. Swedish medals. These begin with Gustavus Vasa; and several of Christina are likewise to be met with. There are also some curious ones of Charles XII.

6. Dutch medals. These begin in 1566; and many of them are remarkable for maps and plans, which must be very interesting to posterity. "Had the Greeks and Romans (says Mr Pinkerton) given us maps and plans, what a fine system of ancient geography and topography a cabinet of medals must have been!"

7. Medals of Spain, Portugal, and Germany. The Spanish medals began with Gonsalo in 1503, many of which are curious and interesting. Under Charles V. there are many curious Spanish medals; but those of Germany begin with Frederic in 1453. They are extremely numerous; as we may easily supppose from the greatness of the empire, and the various states which compose it. There is a famous medal of Sebastian king of Portugal, famous for his unfortunate expedition into Africa in 1578; with his bust, full face, and three quarters in length. On the reverse is a shell-fish in the sea, with the moon and seven stars, bearing the inscription SERENA CALSA FAVENT. There is also a curious lozenge-shaped coin of the same, with the arms of Portugal, and the king's name and title: On the reverse is a cross with the inscription IN HOC SIGNO VINCES, 1578.

8. Satiric medals. These began almost as soon as the knowledge of the art of coining medals was revived. They seem to have been almost unknown to the ancients. One indeed of the emperor Gallienus is supposed to have been satiric. It has on the front the emperor's bust, with the inscription GALLIENÆ AUG. the reverse is Peace in a car, PAX UBIQUE; but this has been proved to be only a blundered coin. Some other ancient medals, however, are not liable to this objection. The first modern satiric medal published was that of Frederic king of Sicily in 1501, against his antagonist Ferdinand king of Spain. It has on one side the head of Ferdinand, with the inscription FERDINANDUS R. AR. VETUS VULPES ORBIS; on the reverse a wolf carrying off a sheep, JVGVM MEVM SVAVE EST ET ONVS MEVM LEVE. Many others have been struck, of which the wit would now perhaps be difficult

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difficult to be found out; but of all nations the Dutch have moſt diſtinguiſhed themſelves in this way; and paid very dear for their conduct, as they brought upon themſelves by one or two ſatiric medals the whole power of France under Louis XIV.

9. Engliſh medals. The firſt of theſe is in the duke of Devonſhire's collection. It is of a large ſize, and done on the plan of the early Italian medals. It has on the reverſe the arms of Kendal, with the inſcription TEMPORE OBSIDIONIS TURCORUM, MCCCCLXXX. On the other ſide is a portrait with IO KENDAL RHODI TVRCVPELLERIVS. It was found laſt century in Knareſborough foreſt; but Mr Pinkerton has no doubt of its having been done in Italy. The next is that of Henry VIII. in 1545, and is of gold, larger than the crown-piece, with the king's head upon the obverſe, and three legends within each other, including his titles, &c. The reverſe contains two inſcriptions, declaring him to be the head of the church; the one in Hebrew, the other in Greek. It was imitated exactly by Edward VI. whoſe coronation medal is the firſt we have. There are two medals of Philip and Mary, whoſe execution is tolerably good; but thoſe of Elizabeth are very poor. There are good medals of James I. and his queen; with a fine one of Charles I. and Henrietta, though the workmanſhip is much inferior to the antique. There are many good medals of Charles, with various devices upon their reverſes. Under the commonwealth the celebrated Simon produced medals which are deſervedly reckoned the moſt admirable pieces of modern workmanſhip. There are many good medals of Charles II. James II. and William III. Some are alſo found of James after his abdication. Some fine gold, ſilver, and copper medals, were iſſued in the time of Queen Anne; the two laſt affording a ſeries of all the great actions of the duke of Marlborough. About the year 1740, a ſeries of medals was engraved in London by Daſſier, a native of Geneva, containing all the kings of England; being 36 in number. They are done upon fine copper, and executed with great taſte. There are beſides many medals of private perſons in England; ſo that it may juſtly be ſaid, that this country for medals exceeds almoſt every other in Europe.

To this account of modern coins and medals we ſhall add that of another ſet called *ſiege-pieces*, and which were iſſued during the time of a ſiege in caſes of urgent neceſſity. Theſe were formed of any kind of metal; ſometimes of no metal; and Patin mentions a remarkable one ſtruck at Leyden in 1574, when the place was beſieged by the Spaniards. It was of thick paper or paſteboard, having a lion rampant, with this inſcription, PVGNO PRO PATRIA, 1574; and on the reverſe, LVGDVNVM BATAVORVM. There are various ſiege-pieces of Charles I. both in gold and ſilver, ſome of the latter being of the value of 20 ſhillings.

The *nummi bracteati* are a ſpecies of modern coins ſomewhat between counters and money; and have their name from the word BRACTEA, a ſpangle or thin bit of metal. They are commonly little thin plates of ſilver, ſtamped as would ſeem with wooden dies upon one ſide only, with the rude impreſſion of various figures and inſcriptions. Moſt of them are eccleſiaſtic, and were ſtruck in Germany, Switzerland, Denmark, Sweden, Norway, and a few in Poland. They continued to be in uſe in Germany till the end of the 15th century; and ſome are ſtill uſed in Switzerland at this day.

Abbreviations.

TABLE of ABBREVIATIONS uſed in the Legends of Medals; from Mr Pinkerton.

GREEK COINS.

A.

Α. Athens, Argos, Aulus, Aſylum; primi or firſt; as Εφεσιων Α. Ασιας, "Epheſians, firſt people of Aſia.
Α. Abaſſus, Abdera, Abydus on Helleſpont
ΑΒ. Abydus in Egypt
ΑΒΥ. Abydus on Helleſpont
ΑΘ. ΑΘΕ. Athens
ΑΙΓ. Ægina
ΑΙΓΟΣΠΟ. Aigoſpotamos
ΑΙΑ. Ælius, Ælia Capitolina
ΑΙΝ. Ænos
ΑΚ.—ΑΚΡΑΤΑΝ. Agrigentum
ΑΚΙ. Acilium
ΑΚΤ. Actium
ΑΛΕ. Alexandria
ΑΜ. Amyntas
ΑΜΒΡ. Ambracia
ΑΜΦΙ. Amphilochia
ΑΝΘ. Ανθυπατον, Proconſul
ΑΝΤΙΣ. Antiſſa
ΑΝΑ. Anactoria
ΑΝΤΙ. Antium
ΑΝ. Ancyra
ΑΝΤ. Antoninus, Antioch
ΑΞ. Axus in Crete
ΑΟΝ. Aonitæ
ΑΟΥΕ. Avenio, *Pell.*
ΑΠ. Appius
ΑΠΑ. Apamea
ΑΠΟ. Apollonia
ΑΠΤΑ. Aptara
ΑΡ. Aradus, Harma
ΑΡΓΕ. Argennos
ΑΡΓ. Argos
ΑΡΙ. Aricanda
ΑΡΙΜ. Ariminum
ΑΡΣΙ. Arſinoë
ΑΡΥ. Aryca
ΑΡΧ. Αρχιερευς or Αρχον, high prieſt or magiſtrate
ΑΣΙΑΡΧ. Aſiarchæ, preſidents of the games of Aſia (B)
ΑΣ. Aſylum
Α. Σ. Προτοι Συριας, Firſt of Syria
ΑΣΚ. Aſcalon
ΑΤ. Atabyrium
ΑΤΑΡ. Atarnæ
ΑΥΓ. Auguſtus
ΑΥΡΗΛ. Aurelius
ΑΥ. ΑΥΤ. Αυτοκρατορ, Emperor
ΑΥΤΟΝ. Αυτονομοι, enjoying their own laws
ΑΦΙ. Aphyta
ΑΦΡ. Africanus
ΑΧ. Achaii

B

Β. Βουλης, Council: Berytus: Bithynia
ΒΑΓΗΔΑΟ. Bagadaonia
ΒΑΛ. Valerius
ΒΗ. Berytus
ΒΙΤΟΝ. Bitontum
ΒΟΙ. Bœotia
ΒΡΥΝ. Brunduſium.
ΒΥ. Byzantium

Γ.

Γ. ΓΡ. ΓΡΑΜ. Grammaticus, or keeper of the records
Γ. Gaius, or Caius
ΓΑ. Gallus, Gallerius, Gallienus
Γ. Γνωριμου, Illuſtrious
ΓΕΛ. Gelas
ΓΕΡ. Germanicus
ΓΝ. Gneius
ΓΟΡΤΥ. Gortyna
ΓΡΑ. Graviſca

Δ.

Δ. Decimus, Dymæ
ΔΑΚ. Dacicus
ΔΑΜ. Damaſcus
ΔΑΡ. Dardanum
ΔΗ. Δημος, the people
ΔΗΜΑΡΧ. ΕΞΟΥΣ. with Tribunitian power
ΔΕ. Decelia
ΔΕΚ. Decius.

ΔΕΡ.

(B) There were alſo Syriarchæ, Lyciarchæ, Galatarchæ, Bithyniarchæ, Cappadociarchæ, &c. *Morel. Spec.*

Abbreviations.

ΔΕΡ. Derbe in Lycaonia
ΔΗ. Delos
ΔΙ. Dioſpolis
ΔΡΕ. Drepanum
ΔΥΡ. Dyrrhachium

E

E. Eryce
E. ΕΡΕΣ. Ereſus
ΕΛΕΥ. Eleuſis
ΕΛΕΥΘ. Ελευθεροι, Free
ΕΠΙ, Epidaurus
ΕΡΙ. Eriza in Caria
ΕΡΧ. Erchia
ΕΡΥ. Erythræ
ET. ETO. Ετους, Year
ET. Etenna in Pamphylia
EX. Εχουσια, Power
EY. EYBO. Eubœa
ΕΥΣ. Ευσεβης, Pious
EYT. Ευτυχης, Happy
ΕΦ. ΕΦΕ. Epheſus

Z.

ZA. Zacynthus
ZANKA. Zancle, Meſſana anciently ſo called

H.

H. Elium
ΗΓ. Ηγεμονος, Preſident
ΗΡΑΚ. Heraclea

Θ

ΘΑ. Thaſus
ΘΕ. Theſpiæ
ΘΕΣ. Theſſalonica
ΘΕ. ΘΗΒ. Thebæ

I.

I. IEP. Ιερος, Sacred
ΙΕΡΑΠΥ. Hyerapytha
ΙΚΑΡ. Hiccara
ΙΛΙ. Ilium
ΙΟΥ. Julis, a city, or Julius
ΙΟΥΛ. Julia
ΙΠΑ. Hippana
ΙΡ. Irene Inſ. *Pellerin.*
ΙΣ. Iſus, Iſtiæa

K.

K. Caius; Κουιντος, Quintus
K. ΚΑΙΣ. Cæſar
K. K. Κοινον Κιλικιας, Community of Cilicia
ΚΑΙΛ. Cælius
ΚΑΛ. Chalcedon
ΚΑΛΛΙ. Callipolis
ΚΑΜΑ. Camara
ΚΑΝ. Canata
ΚΑΠ. Capua
ΚΑΠΠ. Cappadocia
ΚΑΡ. Carrhæ
ΚΑΡΤ. Carthago
ΚΑΥ. Caulonia
ΚΕ. Ceos
ΚΕΦ. Cephalædis
ΚΙ. Cianus, Cibæum
ΚΙΛ. Cilbiani
ΚΛ. Clæonæ, Claudius
ΚΛΑ. Clazomene
ΚΝΙ. Cnidus
ΚΟ. Corinth
ΚΟΙΝ. Κοινον, Community
ΚΟΛ. Κολονιας, Colony, Colophon
ΚΟΜ. Commodus
ΚΟΡ. Corcyra
ΚΡ. Cragus in Lycia
ΚΡΑ. Cranos
ΚΡΗ. Crete
ΚΤΗ. Ctemenæ, *Pell.*
ΚΥ. Cuma, Cydonium, Cyon
ΚΥΘ. Cythnus
ΚΥΠ. Cyprus
ΚΥΡ. Cyrene

Λ.

Λ. or L. Λυκαβαντος, Year
Λ. Lucius
ΛΑ. Lacedæmon
ΛΑΜ. Lamea; Lampſacus
ΛΑΡ. Lariſſa
ΛΑΡΙ. Larinum
ΛΕ. ΛΕΥ. Leucas
ΛΕΟΝ. Leontium
ΛΗΜ. Lemnos
ΛΙΠ. Lipara
ΛΙΥΙ. Liviopolis
ΛΟ. ΛΩΚ. Locri
ΛΟΓ. Longone
ΛΥΓ. ΛΥΚ. Lyctus

M.

M. Marcus, Malea, Megalopolis, Mazaka
MA. Maronea, Maſſilia, Macedonia
ΜΑΓ. Magneſia
ΜΑΚΡΟ. Macrocephali
ΜΑΜ. Mamertini
ΜΑΣΣ. Maſſilia
ΜΑΖ. Mazara
ΜΕ. Menelais, on Syrian regal coins
ΜΕΝΕΚ. Menecrates
ΜΕ. ΜΕΓ. Megara, Megalopolis, Melite
ΜΕΓ. Μεγαλος, Great
ΜΕΣ. Meſſana
ΜΕΤΑ. Metapontum
Μ. ΜΗΤΡΟ. Metropolis
ΜΙ. Miletus
ΜΚ. Maſſaka of Cappadocia, on coins of Mithridates VI.
ΜΟΡ. Morgantia
ΜΥ. Mycenæ
ΜΥΡ. Myrlea
ΜΥΤΙ. Mytilene

N.

N. Naupactus
ΝΑΞ. Naxos
ΝΑΥΑΡΧ. Ναυαρχιδοι, enjoying a ſea-port
ΝΕ. Nemea
Ν. ΝΕΩΚ. Neocori
ΝΕΟΠ. Neopolis
ΝΕΡ. Nerva
ΝΙΚ. Nicæum, Nicomedia
ΝΥΣ. Nyſæi, on coins of Scythopolis, *Pell.*

O.

ΟΙ. Oethæi
ΟΝ. Οντος, Being
ΟΠΕΛ. Opelius
ΟΠ. Opus
ΟΡΥ. Orycus
ΟΡΧ. Orchomenus
ΟΥΠ. or ΥΠ. Ουπατος or Υπατος, Conſul
ΟΥΕΡ. Verus
ΟΥΗ. Verus
ΟΥΕΣΠ. Veſpaſianus
ΟΥΙΤΕΛ. Vitellius
ΟΦΡΥ. Ophrynium.

Π.

Π. Παρα, Προς, upon
Π. ΠΟΠΛ. Publius
Π. ΠΑ. Paphos or Paros
ΠΑΙΣ. Pæſtum
ΠΑΝ. Panormus
ΠΑΡ. Paropinum
ΠΑΡΙ. Paros
ΠΑΡΘ. Parthicus
ΠΕ. Perinthus.
ΠΕΛ. Pella
ΠΕΡ. Pergus
ΠΕΡΤ. Pertinax
ΠΕΣΚ. Peſcennius
Π. ΠΗ. Peluſium
ΠΙΝ. Pinamytæ
ΠΛΑ. Plateæ
ΠΟ. Pontus
ΠΟΛΥ. Polyrrhenum
ΠΟΣ. Poſidonia
ΠΡΑΣ. Praſſus
Π. ΠΡΥ. Πρυτανος, Præfect
ΠΡ. ΠΡΕΣ. Πρεσβεος, Legate
ΠΡΟ. Proconneſus
ΠΡΟΔΙ. Προδικος, Curator
Π. ΠΡΩΤ. Προτος, Firſt
ΠΤ. Ptolemais
ΠΥ. Pylos

P.

PO. Rhodes

Σ.

Σ. ΣΑ. Salamis, Samos, Syria.
ΣΑ. Samoſate
ΣΑΛΑΠ. Salapia
ΣΑΡ. Sardis
ΣΕ. Seriphus, Segeſte
ΣΕΒ. Σεβαστος, Auguſtus
ΣΕΛ. Selinus, Seleucia
ΣΕΠΤ. Septimius
ΣΙ. Siphnos
ΣΙΔ. Side
ΣΙΝΩ. Sinope
ΣΜΥ. Smyrna
ΣΤΡ. ΣΤΡΑ. Στρατηγος, Prætor
ΣΥΒ. Sybaris
ΣΥ. ΣΥΡΑ. Syracuſe
ΣΥΡ. Syria
ΣΩ. Solæ

T.

T. Titus
ΤΑΒΑΛ. Tabala
ΤΑ. ΤΑΝΑ. Tanagra
ΤΑΡ. Tarentum, Tarſus
ΤΑΥΡ. Tauromenum
ΤΕ. Tementis
ΤΕΡ. Terina
ΤΗ. Tenus
ΤΙ. ΤΙΒ. Tiberius
ΤΡΑ. Trallis
ΤΡΙ. Tripolis
ΤΡΟ. Troizene
ΤΥΑΝ. Tyana
ΤΥ. Tyndarus
ΤΥΡ. Tyre (monogram)

Υ.

ΥΕ. ΥΕΛ. Velia
ΥΠ. ΥΠΑΤ. Υπατος, Conſul

Φ.

Φ. Philip, Phœſtus, Philuntium
ΦΑ. Phaſelis
ΦΑΡ. Pharſalus
ΦΙ. Vibius, Philippopolis
ΦΙΝΕ. Phineium
ΦΛ. Flavius
ΦΟΚ. Phocæum
ΦΟΥΛ. Fulvia
ΦΥ. Phycus in Cyrene

X.

X. Chios
ΧΑΛ. Chalcis
ΧΕΡ. Cherſoneſus
ΧΙ. Chytri in Crete

Greek Numerals.

Α.	1.	Ι.	10.	Ρ.	100.
Β.	2.	Κ.	20.	Σ. or C	200.
Γ.	3.	Λ.	30.	Τ.	300.
Δ.	4.	Μ.	40.	Υ.	400.
Ε.	5.	Ν.	50.	Φ.	500.
ς. or ϛ	6.	Ξ.	60.	Χ.	600.
Ζ.	7.	Ο.	70.	Ψ.	700.
Η.	8.	Π.	80.	Ω.	800.
Θ.	9.	q. or ϥ	90.	q.	900.

Example.

Abbreviations.

Examples. I is 10: add A to I, and IA makes 11: ſo IB, 12; IΓ, 13, &c. K is 20, KA, 21, &c. PIA makes 111. The Engliſh word AIR marks the grand initial numerals. On coins the numerals are often placed in retrograde order; which makes no difference in the value, as every letter is appropriated to its number. Thus TAΓ or ΓAT imply the ſame, 333. But this advantage being unknown to the Roman numerals and Arabic cyphers, is apt to puzzle the beginner.

ROMAN COINS.

A

A. AULUS: in the exergue it implies the firſt mint, as ANT. A. coined at Antioch in the firſt mint
A. A. A. F. F. Auro, Argento, Ære, Flando, Feriundo
A. or AN. Annus
A. A. Apollo Auguſti
A. F. A. N. Auli filius, Auli nepos
ABN. Abnepos
ACT. Actiacus, or Actium
AD. FRV. EMV. Ad fruges emundas
ADIAB. Adiabenicus
ADOP. Adoptatus
ADQ. Adquiſita
ADV. Adventus
AED. Ædes
AED. P. Ædilitia poteſtate
AED. S. Ædes ſacræ
AED. CVR. Ædilis Curulis
AED. PL. Ædilis Plebis
AEL. Ælius
AEM. or AIMIL. Æmilius
AET. Æternitas
AFR. Africa, or Africanus
ALBIN. Albinus
ALIM. ITAL. Alimenta Italiæ
ANN. AVG. Annona Auguſti
A. N. F. F. Annum Novum Fauſtum Felicem
ANIC. Anicius
ANN. DCCCLXIIII. NAT. VRB. P. CIR. CON. Anno 864, Natali Urbis Populo Circenſes conſtituti
ANT. AVG. Antonius Augur
ANT. Antonius, or Antoninus
AP. Appius
A. P. F. Argento Publico Feriundo
A. POP. FRVG. AC. A Populo Fruges Acceptæ
AQ. or AQL. Aquilius
AQVA MAR. Aqua Martia
ARAB. ADQ. Arabia Adquiſita
ARR. Arrius
AVG. Augur, Auguſtus, Auguſta
AVG. D. F. Auguſtus Divi Filius
AVGG. Two Auguſti
AVGGG. Three Auguſti
AVR. or AVREL. Aurelius

B.

B. The mark of the ſecond mint in any city
BON. EVENT. Bonus Eventus
B. R. P. NAT. Bono Reipublicæ Nato
BRIT. Britannicus
BRVT. Brutus

C.

C. Caius, Colonia
C. A. Cæſarea Auguſta
C. CAE. or CAES. Cæſar
CAESS. Cæſares
CARTH. Carthage
CEN. Cenſor
CENS. P. Cenſor Perpetuus
CEST. Ceſtius, or Ceſtianus
CIR. CON. Circum Condidit, or Circenſes Conceſſit
CIVIB. ET SIGN. MILIT. A. PARTH. RECVP. Civibus et Signis Militaribus a Parthis Recuperatis
CN. Cneius
COEL. Cœlius
CON. OB. Conſtantinopoli Obſignata, or Conſtantinopoli Officina ſecunda, or Conflata Obryzo
COL. Colonia
CON. SVO. Conſervatori ſuo
CONCORD. Concordia
CL. V. Clypeus Votivus
COMM. Commodus
CLOD. Clodius
CL. or CLAVD. Claudius
COS. Conſul
COSS. Conſules
CORN. Cornelius
CVR. X. F. Curavit Denarium Faciendum

D.

D. Decimus, Divus, Deſignatus
DAC. Dacicus
D. F. Dacia felix
D. M. Diis Manibus
DES. or DESIG. Deſignatus
DICT. Dictator
DOMIT. Domitianus
D. N. Dominus noſter
DID. Didius
D. P. Dii Penates
DV. Divus

E.

EID. MAR. Idus Martiæ
EX. CONS. D. Ex Conſenſu Decuriorum
EX. S. C. Ex Senatus Conſulto
EQ. ORDIN. Equeſtris Ordinis
EX. A. PV. Ex Argento or Auctoritate Publica
EXER. Exercitus
ETR. Etruſcus

F.

F. Filius, or Filia, or Felix, or Faciendum, or Fecit
FEL. Felix
FELIC. Felicitas
FL. Flavius
FLAM. Flamen
FORT. RED. Fortunæ Reduci
FOVRI. Fourius for Furius
FONT. Fonteius
FRVGIF. Frugiferæ (Cereri)
FVL. Fulvius
FVLG. Fulgerator

G.

G. Gneius, Genius, Gaudium
GA. Gaditanus
G. D. Germanicus Dacicus
GEN. Genius
GERM. Germanicus
GL. E. R. Gloria Exercitus Romani
GL. P. R. Gloria Populi Romani
GOTH. Gothicus
G. P. R. Genio Populi Romani
G. T. A. Genius Tutelaris Ægypti, or Africæ

H.

HEL. Helvius
HEL. Heliopolis
HER. Herennius, or Herennia
HO. Honos
HS. Seſtertius

I

I. Imperator, Jovi, Julius
IAN. CLV. Janum cluſit for clauſit
IMP. Imperator
IMPP. Imperatores
I. S. M. R. Juno Soſpita, Mater or Magna Regina
IT. Italia, Iterum
ITE. Iterum
IVL. Julius or Julia
IVST. Juſtus
I-I. S. Seſtertius
I. O. M. SACR. Jovi Optimo, Maximo, Sacrum
II. VIR. Duumvir
III. VIR. R. P. C. Triumvir Reipublicæ Conſtituendæ
IIII. VIR. A. P. F. Quatuorvir, or Quatuorviri, Auro, or Argento, or Ære, Publico Feriundo
IVN. Junior

L.

L. Lucius
LAT. Latinus
LEG. PROPR. Legatus Proprætoris
LEG. I. &c. Legio Prima, &c.
LEP. Lepidus
LENT. CVR. X. P. Lentulus Curavit Denarium Faciundum
LIBERO P. Libero Patri
LIB. PVB. Libertas Publica
LIC. Licinius
L. S. DEN. Lucius Sicinius Dentatus
LVC. Lucifera
LVD. CIR. Ludi Circenſes
LVD. EQ. Ludi Equeſtres
LVD. SAEC. F. Ludos Sæculares Fecit

M.

M. Marcus, or Marius
MAR. CL. Marcellus Clodius
M. F. Marci Filius
M. OTACIL. Marcia Otacilia
MAG. or MAGN. Magnus
MAC. Macellum
MAX. Maximus
MAR. Martia (aqua)
MAX. VLT. Marti Ultori
MES. Meſſius
METAL. Metallum
MINAT. Minatius
MINER. Minerva

Abbreviations.

M. M. L. V. Municipes Municipii Julii Uticenfis
MON. or MONET. Moneta

N.

N. Nepos or Nofter
N. C. Nobiliffimus Cæfar
NAT. VRB. Natalis Urbis
NEP. Nepos
NEP. RED. Neptuno Reduci

O.

O. Optimo
OB. C. S. Ob Cives Servatos
OF. Officina.
OPEL. Opelius
ORB. TERR. Orbis Terrarum

P.

P. or POT. Poteftate
PAC. ORB. TER. Pacatori Orbis Terrarum
PAPI. Papius or Papirius
PARTH. Parthicus
PERP. Perpetuus
PERT. or PERTIN. Pertinax
PESC. Pefcennius
P. F. Pius Felix
PLAET. Plætonius
P. L. N. Pecunia Londini Notata
P. LON. S. Pecunia Londini Signata
P. M. or PONT. MAX. Pontifex Maximus
POMP. Pompeius
P. P. Pater Patriæ
PR. Prætor
P. R. Populus Romanus
PRAEF. CLAS. ET. OR. MARIT. Præfectus Claffis et Oræ Maritimæ
PRINC. IVVENT. Princeps Juventutis
PRIV. Privernum
PROC. Proconful.
PRON. Pronepos
PROP. Proprætor
PROQ. Proquæftor.
PROV. DEOR. Providentia Deorum
PVPIEN. Pupienus

Q.

Q. Quintus, or Quæftor
Q. C. M. P. I. Quintus Cæcilius Metellus Pius Imperator
Q. DESIG. Quæftor Defignatus
Q. P. Quæftor Prætorius
Q. PR. Quæftor Provincialis

R.

R. Roma, Reftituit
RECEP. Receptis, or Receptus
REST. Reftituti
ROM. ET. AVG. Romæ et Augufto
R. P. Refpublica

S.

SAEC. AVR. Sæculum Aureum
SAEC. FEL. Sæculi Felicitas
SAL. Salus
SALL. Salluftia
SARM. Sarmaticus
S. C. Senatus Confulto
SCIP. ASIA. Scipio Afiaticus
SEC. ORB. Securitas Orbis
SEC. PERP. Securitas Perpetua
SEC. TEMP. Securitas Temporum
SEN. Senior
SEPT. Septimius
SERV. Servius
SEV. Severus
SEX. Sextus
SIC. V. SIC. X. Sicut Quinquennalia, fic Decennalia
SIG. Signis
S. M. Signata Moneta
S. P. Q. R. Senatus Populufque Romanus
STABIL. Stabilita (terra)
SVL. Sulla

T.

T. Titus, Tribunus
TER. Terentius, or Tertium
TEMP. Temporum
TI. Tiberium
TR. or TREV. Treveris
TREB. Trebonianus
TR. MIL. Tribunus Militaris
TR. P. or TRIB. POT. Tribunicia Poteftate

V.

V. Quintum
V. C. Vir Clariffimus
VESP. Vefpafianus
VIB. Vibius
VICT. Victoria
VII. VIR. EPVL. Septemvir Epulonum
VIL. PVB. Villa Publica
VIRT. Virtus
VN. MR. Venerandæ Memoriæ
VOT. X. MVLT. XX. Votis Decennalibus Multiplicatis Vicennalibus

X.

X. Decem, Denarius
XV. VIR. SARR. FAC. Quindecim Vir Sacris Faciundis

Abbreviations on the Exergue; from Bouduri and Monaldini. Pinkerton.

A. Officina Prima
ALE. Alexandria
AMB. Antiochenfis Moneta Secundæ Officinæ
AN. ANT. ANTI. Antiochia
ANB. Antiochiæ Secunda Officina: to ANH. Antiochiæ Octava Officina
A. P. L. (In officina) Prima percuffa Lugduni
AQ. AQL. Aquileiæ
AQ. O. B. F. Aquileiæ Officina Secundæ Fabrica
AQ. P. S. Aquileiæ Pecunia Signata
A. AR. ARL. Arelate
A. SISC. Prima (in officina) Sifciæ
B. SIRM. Secunda Sirmii
B. S. L. C. Secunda Signata Lugduni
C. Θ. Conftantinopoli Nona
COMOB. Conflata Moneta Obryzo. Only on gold or filver from a gold die
CON. Conftantinopoli
CONOB. Conflata Obryzo. Only on gold.
CONS. Conftantinopoli
KART. Carthago
K. O. Carthaginenfis Officina
L. LC. LVC. LVG. Lucduni, Lugduni
L. LON. Londini
L. P. Lugdunenfis vel Londinenfis Pecunia
LVC. P. S. Lugduni Pecunia Signata
MDPS. Mediolani Pecunia Signata
M. K. V. T. Moneta Kartaginenfis Urbs (in officina Tertia
M. L. Moneta Lugdunenfis vel Londinenfis
MOSTT. Moneta Officinæ Secundæ Treverorum
MSTR. Moneta Signata Treveris
O. Officina
OFF. III. CONST. Officina Tertia Conftantinopoli
PARL. Percuffa or Pecunia Arelate
PLON. Pecunia Londinenfis
PLVG. Pecunia Lugdunenfis
P. R. Pecunia Romana, or Percuffa Romæ
P. T. Pecunia Treverenfis
Q. AR. Quincta Arelatenfis (officina)
R. RO. ROM. Romæ
RA. Ravennæ
ROPS. Romæ Pecunia Signata
S. AR. Signata Arelate
S. CONST. Signata Conftantinopoli
SIS. Sifciæ
SS. P. Sifcienfis Pecunia
SISC. V. Sifcia Urbs
SMA. Signata Moneta Antiochiæ
S. M. HER. Signata Moneta Heracleæ
S. M. N. Signata Moneta Nicomediæ
S. M. R. Signata Moneta Romæ
S. T. Signata
TESOB. Teffalonicæ Officina Secunda
THEOPO. Theopoli
TR. Treveris
TROB. Treveris Officina Secunda

A Lift of Roman Colonies whofe Coins remain; and Abbreviations on thefe Coins.

Abdera in Spain
Acci in Spain
Achulla in Africa
Ælia Capitolina in Judæa
Agrippina in Germany
Antiochia in Pifidia
———— in Syria
Apamea in Bithynia
Arna in Theffaly
Aftigi in Spain
Balba in Mauritania Tingitana
Berytus in Phœnicia
Bilbilis in Spain
Boftra in Arabia
Bracara Augufta in Spain
Buthrotum in Epirus
Cabellio in Gaul
Cæfar-Augufta in Spain
Cæfarea in Paleftine

Calagurris

Abbreviations.

Calagurris in Spain
Calpe in Spain
Camalodunum in Britain
Carrhæ in Mesopotamia
Carteia in Spain
Carthago in Africa
Carthago Nova in Spain
Cascantum in Spain
Cassandria in Macedon
Celsa in Spain
Clunia in Spain
Coillu in Numidia
Comana in Cappadocia
Corinthus in Greece
Cremna in Pisidia
Culla in Thrace
Damascus in Cœlesyria
Dertosa in Spain
Deulton in Thrace
Dium in Macedon
Ebora in Spain
Edessa in Mesopotamia
Emerita in Spain
Emesa in Phœnicia
Ergavica in Spain
Germe in Galatia
Graccuris in Spain
Hadrumetum in Africa
Heliopolis in Cœlesyria
Hippo Regius in Africa
Iconium in Lycaonia
Ilerda in Spain
Illergavonia in Spain
Illeci in Spain
Iol in Mauritania
Italica in Spain
Lælia in Spain
Laodicea in Syria
Leptis in Africa
Lugdunum in Gaul
Neapolis in Palestine
Nemausus in Gaul
Nesibis in Mesopotamia
Norba Cæsarea in Mauritania
Obulco in Spain
Oea in Africa
Olba in Pamphylia
Osca in Spain
Osicarda in Spain
Panormus in Sicily
Parium in Mysia
Parlais in Lycaonia
Patricia (Corduba) in Spain
Pella in Macedon
Philippi in Macedon
Philippopolis in Arabia
Ptolemais in Phœnicia
Rhesæna in Mesopotamia
Romula (Hispalis) in Spain
Ruscino in Gaul
Sabaria in Hungary
Saguntum in Spain
Sebaste in Palestine
Segobriga in Spain
Sidon in Phœnicia
Singara in Mesopotamia
Sinope in Pontus
Stobi in Macedon
Tarraco in Spain
Thessalonica in Macedon
Traducta (Julia) in Spain
Troas in Phrygia
Turiaso in Spain
Tyana in Cappadocia
Tyrus in Phœnicia
Valentia in Spain
Vienna in Gaul
Viminacium in Mœsia
Utica in Africa

Abbreviations on Colonial Coins.

ACCI. Accitana Colonia, *Guadix in Spain*
ADI. Adjutrix *legio*
AEL. MVN. COEL. Ælium Municipium Cœla, *near Sestos on the Hellespont*
AST. Astigitana, *Eceja* in Andalusia
B. A. Braccara Augusti, *Brague in Portugal*
C. A. Cæsarea Antiochiæ
C. A. A. P. or PATR. Colonia Augusta Aroë Patrensis
CAB. Cabellio
C. A. BVT. Colonia Augusti Buthrotum, *in Epirus*
C. A. C. Colonia Augusta Cæsarea
C. A. I. Colonia Augusta Julia, *Cadiz*
C. A. E. Colonia Aug. Emerita, *Merida*
CAL. Calagurris, *Calahorra in Spain*
C. A. O. A. F. Colonia Antoniana Oea Aug. Felix, *Tripoli in Africa*
C. A. PI. MET. SID. Colonia Amelia Pia Metropolis Sidon
C. A. R. Colonia Augusta Rauracorum, or Colonia Asta Regia: Augst in Switzerland, or Ast near Xeres de la Frontera in Spain.
C. C. A. Colonia Cæsarea Augusta, *Saragossa in Spain*
C. C. COL. LUG. Claudia Copia Colonia Lugdunensis
C. C. I. B. Colonia Campestris Julia Balba, *in Mauritania.*
C. C. I. B. D. D. Colonia Campestris Julia Balba, Decreto Decurionum
C. C. I. H. P. A. Colonia Concordia Julia Hadrumetina, Pia Augusta
C. CIV. D. D. P. Corona Civica data Decreto Publico
C. C. N. A. Colonia Carthago Nova Augusta
C. C. N. C. D. D. Colonia Concordia, Norba Cæsareana, Decreto Decurionum.
C. COR. Colonia Corinthus
C. C. T. Ducentesima Remissa
C. C. S. Colonia Claudia Sabaria, *in Hungary*
C. F. P. D. Colonia Flavia Pacensis Develtum, *Develtum in Thrace.*
C. G. I. H. P. A. Colonia Gemella Julia Hadriana, Pariana, Augusta
C. I. C. A. Colonia Julia Concordia, Apamea
C. I. A. D. Colonia Julia Augusta Dertona, *Tortona near Milan*
C. I. AV. Colonia Julia Aug. *Cadiz*
C. I. AVG. F. SIN. Colonia Julia Augusta Felix Sinope
C. I. B. Colonia Julia Balba, *in Mauritania*
C. I. C. A. P. A. Colonia Julia Carthago Augusta Pia Antiqua, or Corinth, or Carthago Nova
C. I. CAL. Colonia Julia Calpe, *Gibraltar*
C. I. F. Colonia Julia Felix, *Cadiz*
C. I. G. A. Colonia Julia Gemella (c) Augusta
C. I. I. A. Colonia Immunis Illici Augusta, *Elche in Spain*
C. I. N. C. Colonia Julia Norba Cæsareana, or Alcantara: sometimes it means Col. Julia Nova Carthago
C. I. V. Colonia Julia Valentia, *Valencia in Spain*
C. V. T. Colonia Victrix Tarraco
C. L. I. COR. Colonia Laus Julia Corinthus
C. L. I. N. AVG. Colonia Laus Julia Nova Augusta, *Laus or Lodi in Lucania*
C. M. L. Colonia Metropolis Laodicea, *in Cœlesyria*
CO. DAM. METRO. Colonia Damascus Metropolis
COHH. PRET. VII. P. VI. F. Cohortes Prætorianæ Septimum Piæ, Sextum Felices
COH. I. CR. Cohors prima Cretensis
COH. PRET. PHIL. Cohors Prætoriana Philippensium
COL. AEL. A. H. MET. Colonia Ælia Augusta Hadrumetina Metropolis, *in Africa*
COL. AEL. CAP. COMM. P. F. Colonia Ælia Capitolina Commodiana Pia Felix
COL. ALEX. TROAS. Colonia Alexandriana Troas
COL. AMAS. or AMS. Colonia Amastriana, *in Paphlagonia*
COL. ANT. *Antioch in Pisidia*
COL. ARELAT. SEXTAN. Colonia Arelate Sextanorum, *Arles*
COL. AST. AVG. Colonia Astingitana Augusta, *Eceja in Spain*

COL.

(c) Gemella implies a colony drawn from two others.

Abbreviations.

COL. AVG. FEL. BER. Colonia Auguſta Felix Berytus

COL. AVG. FIR. Colonia Aug. Firma, *Eceja*

COL. AVG. IVL. PHILIP. Colonia Auguſta Julia Philippenſis

COL. AVG. PAT. TREVIR. Colonia Auguſta Paterna Trevirorum, *Trêves in Germany, ſent from Paternum in Italy*

COL. AVR. KAR. COMM. P. F. Colonia Aurelia Karrhæ Commodiana Pia Felix, or Carneatum Commagene, or *Carrhæ in Aſia*

COL. B. A. Colonia Braccara Auguſta, *Brague*

COL. BRYT. L. V. Colonia Berytus Legio Quinta

COL. CABE. Colonia Cabellio

COL. CAES. AVG. Colonia Cæſarea Auguſta, *in Paleſtine*

COL. CAMALODVN. Colonia Camalodunum, *England*

COL. CASILIN. Colonia Caſilinum, *Caſtellazo in Italy*

COL. CL. PTOL. Colonia Claudia Ptolemais, *Acre in Phœnicia*

COL. DAMAS. METRO. Colonia Damaſcus Metropolis

COL. F. I. A. P. BARCIN. Colonia Flavia Julia Auguſta Pia, Barcino *or Barcelona*

COL. FL. PAC. DEVLT. Colonia Flavia Pacenſis Deultum, *Develtum in Thrace*

COL. HA. ME. T. Colonia Hadriana Mercurialis Thænitana, Mercuriali, *Fermo in Italy and Thenes in Africa*

COL. H. (or HEL.) LEG. H. Colonia Heliopolis Legio Heliopolitana

COL. HEL. I. O. M. H. Colonia Heliopolis Jovi Optimo Maximo Heliopolitano

COL. IVL. AVG. C. I. F. COMAN. Colonia Julia Auguſta Concordia Invicta Felix Comanorum, *drawn from Concordia in Italy, and ſent to Comana in Cappadocia*

COL. IVL. AVG. FEL. CREMNA. Colonia Julia Auguſta Felix Cremna, *in Pamphylia*

COL. IVL. CER. SAC. AVG. FEL. CAP. OECVM. ISE. HEL. Colonia Julia Certamen Sacrum Auguſtum Felix Capitolenum Oecumenicum Iſelaſticum Heliopolitanum.

COL. IVL. CONC. APAM. AVG. D. D. Colonia Julia Concordia Apamea Auguſta Decreto Decurionum

COL. IVL. PATER. NAR. Colonia Julia Paterna Narbonenſis

COL. NEM. Colonia Nemauſus

COL. NICEPH. COND. Colonia Nicephorium Condita, *in Meſopotamia*

COL. PATR. Colonia Patrenſis *or* Patricia, *Patras in Greece*, or *Cordova in Spain*

COL. P. F. AVG. F. CAES. MET. Colonia Prima Flavia Aug. Felix Cæſarea Metropolis, *in Paleſtine*

COL. P. FL. AVG. CAES. METROP. P. S. P. *ſame as above*, P. S. P. *is* Provinciæ Syriæ Paleſtinæ.

COL. PR. F. A. CAESAR. Colonia Prima Flavia Auguſta Cæſarea, *in Paleſtine*

COL. R. F. AVG. FL. C. METROP. Colonia Romana Felix Aug. Flavia Cæſarea Metropolis. *The ſame*

COL. ROM. Colonia Romulea, or *Seville*

COL. ROM. LVG. Colonia Romana Lugdunum

COL. RVS. LEG. VI. Colonia Ruſcino Legio Sexta, *Rouſſillon in France*

COL. SABAR. Colonia Saburiæ

COL. SABAS. Sebaſte, *in Paleſtine*

COL. SER. G. NEAPOL. Colonia Servii Galbæ Neapolis, *in Paleſtine*

COL. V. I. CELSA, or COR. VIC. IVL. CELSA. Colonia Victrix Julia Celſa, *Kelſa in Spain*

COL. VIC. IVL. LEP. Colonia Victrix Julia Leptis, *in Africa*

COL. VIM. AN. I. or II. &c. Colonia Viminacium Anno primo, *Widin in Servia*

COL. VLP. TRA. Colonia Ulpia Trajana: *Kellen*, or *Warhal in Tranſylvania*

CO. P. F. COE. METRO. Colonia Prima Flavia Cæſarea Metropolis

CO. P. I. A. Colonia Pacenſis Julia Auguſta, *or* Col. Octaviana

C. R. I. F. S. Colonia Romana Julia Felix Sinope

C. T. T. Colonia Togata Tarraco

C. V. IL. Colonia Victrix Illice, *Elche in Spain*

D. Decuriones

D. C. A. Divus. Cæſ. Aug.

DERT. Dertoſa

GEN. COL. NER. PATR. Genio Coloniæ Neronianæ Patrenſis

G. L. S. Genio Loci Sacrum

M. A. ILLERGAVONIA DERT. Municipium Hibera Illergavonia Dertoſa, *Tortoſa in Catalonia*

M. M. I. V. Municipes Municipii Julii Uticenſis

M. R. Municipium Ravennatium

MVN. CAL. IVL. Municipium Calagurris Julia, *in Spain*

MVN. CLVN. Municipium Clunia, *Corunna in Spain*

MVN. FANE. AEL. Municipium Faneſtre Aelium, *Fano*

MVN. STOB. Municipium Stobenſe, *Stobi in Macedon*

MV. TV. Municipium Turiaſo, *in Spain*

N. TR. ALEXANDRIANAE COL. BOSTR. Nerviæ Trajanæ Alexandrianæ Coloniæ Boſtræ, *in Paleſtine*

SEP. COL. LAVD. Septimia Colonia Laudicea *or* Laodicea

SEP. TYR. MET. Septima Tyrus Metropolis.

Explanation of Plates.

Explanation of the Plates.

Plates CCCXXXI. and CCCXXXII.

Fig. 1. A Perſian daric

2. A drachm of Egina

3. A ſilver hemidrachm of Alexander the Great

4. Tigranes the younger of Armenia, with his ſiſter

5. One of the coins of the Arſacidæ of Parthia

6. A coin of the Saſſanidæ of Perſia. Firſt publiſhed by Mr Pinkerton

7. Denarius of Cneius Pompey from Mr Pinkerton. Reverſe repreſents him as received by Spain

8. A braſs coin of Cunobelinus

9. Peſcennius Niger. Struck at Antioch; unique. In Dr Hunter's cabinet; publiſhed by Mr Pinkerton

10. A ſilver coin of Carauſius

11. Reverſe of Claudius in firſt braſs

12. Reverſe of Adrian

13. Of Antoninus Pius

14. Of Commodus

15. Of Severus

16. A Saxon penny

17. A Saxon ſtyca

18. 19. Ancient pennies, ſuppoſed to be Scottiſh

20. A penny of William of Scotland

21. A penny of Robert the Great

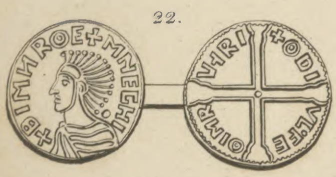
22. An Iriſh penny

23. The

E. Mitchell sculp.t

MEDALS: *PLATE CCCXXXII.*

22.



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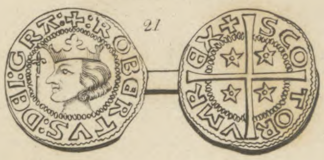

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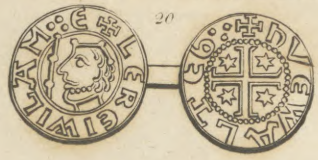

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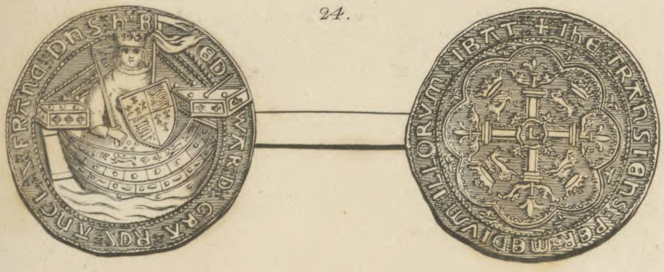
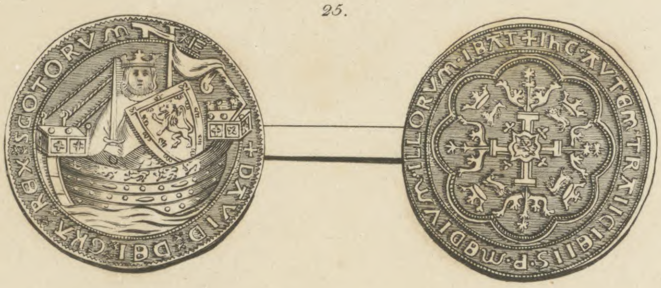


23.

26.

25.



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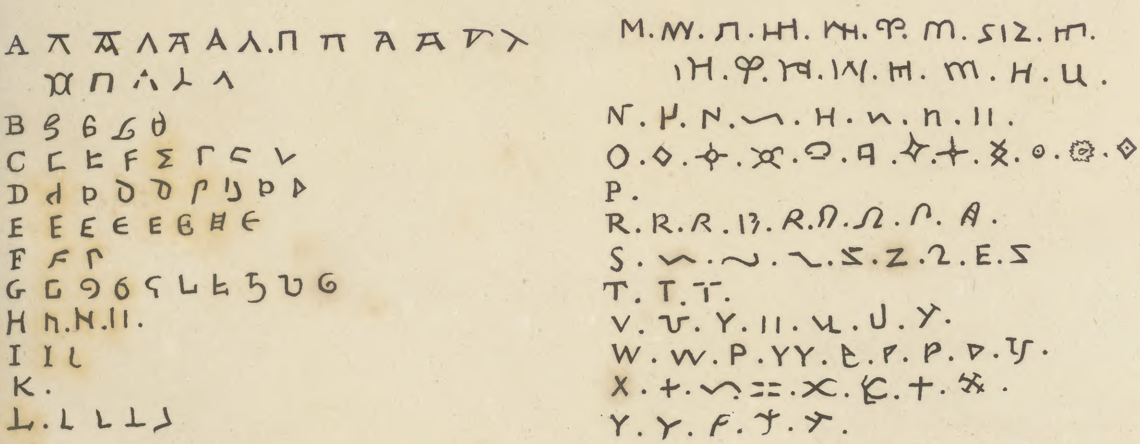

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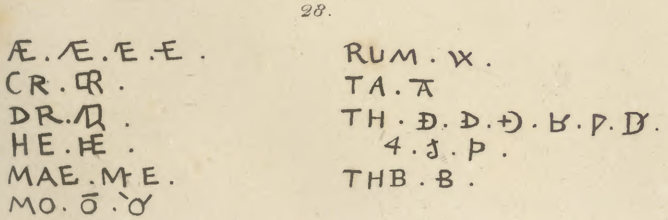

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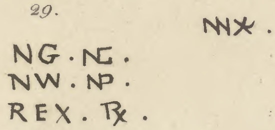

E. Mitchell Sculp.t

Explanation of Plates.

23. The gold penny of Henry III.
24. The large noble of the first coinage of Edward III.
25. The gold medal of David II. of Scotland
26. The ryal of Queen Mary of Scotland
27. Letters on Anglo-Saxon coins
28. Abbreviations on ditto
29. Monetarius

Medals || Medea.

Impressions of MEDALS. See CASTING.

MEDALLION, or MEDALION, a medal of an extraordinary size, supposed to be anciently struck by the emperors for their friends, and for foreign princes and ambassadors. But, that the smallness of their number might not endanger the loss of the devices they bore, the Romans generally took care to stamp the subject of them upon their ordinary coins.

Medallions, in respect of the other coins, were the same as modern medals in respect of modern money: they were exempted from all commerce, and had no other value than what was set upon them by the fancy of the owner. Medallions are so scarce, that there cannot be any set made of them, even though the metals and sizes should be mixed promiscuously.

MEDEA, in fabulous history, a celebrated sorceress, daughter of Æetes king of Colchis. Her mother's name, according to the more received opinion of Hesiod and Hyginus, was Idyia, or, according to others, Ephyre, Hecate, Asterodia, Antiope, and Neæra. She was the niece of Circe. When Jason came to Colchis in quest of the golden fleece, Medea became enamoured of him, and it was to her well directed labours that the Argonauts owed their preservation. Medea had an interview with her lover in the temple of Hecate; where they bound themselves by the most solemn oaths to eternal fidelity. No sooner had Jason overcome all the difficulties which Æetes had placed in his way, than Medea embarked with the conquerors for Greece. To stop the pursuit of her father, she tore to pieces her brother Absyrtus, and left his mangled limbs in the way through which Æetes was to pass. This act of barbarity, some have attributed to Jason, and not to her. When Jason reached Iolchos his native country, the return and victories of the Argonauts were celebrated with universal rejoicings: but Æson the father of Jason was unable to assist at the solemnity on account of the infirmities of his age. Medea, at her husband's request, removed the weakness of Æson; and by drawing away the blood from his veins, and filling them again with the juice of certain herbs, she restored him to the vigour and sprightliness of youth. This sudden change in Æson astonished the inhabitants of Iolchos; and the daughters of Pelias were also desirous to see their father restored by the same power to the vigour of youth. Medea, willing to revenge the injuries which her husband's family had suffered from Pelias, increased their curiosity; and betrayed them into the murder of their father as preparatory to his rejuvenescence, which she afterwards refused to accomplish. This action greatly irritated the people of Iolchos; and Medea with her husband fled to Corinth to avoid their resentment. Here they lived for 10 years with mutual attachment, when the love of Jason for Glauce the king's daughter interrupted their harmony, and Medea was divorced. Medea revenged the infidelity of Jason, by causing the death of Glauce, and the destruction of her family. She also killed two of her children in their father's presence; and when Jason attempted to punish the barbarity of the mother, she fled through the air upon a chariot drawn by winged dragons. From Corinth Medea came to Athens, where, after she had undergone the necessary purification of her murder, she married King Ægeus, or (according to others) lived in an adulterous manner with him. From her conduct with Ægeus, Medea had a son who was called *Medus*. Soon after, when Theseus wished to make himself known to his father, Medea, jealous of his fame and fearful of his power, attempted to poison him at a feast which had been prepared for his entertainment. Her attempts, however, failed of success, and the sight of the sword which Theseus wore by his side convinced Ægeus that the stranger against whose life he had so basely conspired was his own son. The father and the son were reconciled; and Medea, to avoid the punishment which her wickedness deserved, mounted her fiery chariot and disappeared through the air. She came to Colchis; where, according to some, she was reconciled to Jason, who had sought her in her native country after her sudden departure from Corinth. She died at Colchis, as Justin mentions, when she had been restored to the confidence of her family. After death she married Achilles in the Elysian fields, according to the tradition mentioned by Simonides. The murder of Mermerus and Pheres, the youngest of Jason's children by Medea, is not to be attributed to the mother, according to Elian; but to the Corinthians, who assassinated them in the temple of Juno Acræa. To avoid the resentment of the gods, and to deliver themselves from the pestilence which visited their country after so horrid a massacre, they engaged the poet Euripides for five talents to write a tragedy, which cleared them of the murder, and represented Medea as the cruel assassin of her own children. And besides, that this opinion might be the better credited, festivals were appointed, in which the mother was represented with all the barbarity of a fury murdering her own sons.

Medea || Media.

MEDEOLA, CLIMBING AFRICAN ASPARAGUS, a genus of plants belonging to the hexandria class, and in the natural method ranking under the 11th order, *Sarmentaceæ*. See BOTANY *Index*.

MEDIA, now the province of GHILAN in Persia, once the seat of a potent empire, was bounded, according to Ptolemy, on the north by part of the Caspian sea; on the south by Persis, Susiana, and Assyria; on the east by Parthia and Hyrcania; and on the west by Armenia Major. It was anciently divided into several provinces, viz. Tropatene, Charomithrene, Darites,

rites, Marciane, Amariace, and Syro-Media. By a later division, however, all these were reduced to two; the one called *Media Magna*, the other *Media Atropatia*, or simply *Atropatene*. Media Magna was bounded by Persis, Parthia, Hyrcania, the Hyrcanian sea, and Atropatene, and contained the cities of Ecbatan, Laodicea, Apamea, Raga, Ragcia or Ragea, &c. Atropatene lay between the Caspian mountains and the Caspian sea.

This country originally took its name from Madai, the third son of Japhet; as is plain from Scripture, where the Medes are constantly called *Madai*. Among profane authors, some derive the name *Media*, from one Medus the son of Jason and Medea; others from a city called *Media*. Sextus Rufus tells us that in his time it was called *Medena*, and from others we learn that it was also called *Aria*. The most probable history of the Medes is as follows:

This people lived in subjection to the Assyrians till the reign of Sennacherib, when they threw off the yoke, and lived for some time in a state of anarchy. But at last, rapine and violence, the natural consequences of such a situation, prevailed so much, that they were constrained to have recourse to some kind of government, that they might be enabled to live in safety. Accordingly, about 699 B. C. one Dejoces having procured himself to be chosen king, united the scattered tribes into which the Medes were at that time divided; and having applied himself as much as possible to the civilization of his barbarous subjects, left the throne to his son Phraortes, after a reign of 53 years.

The new king, who was of a warlike and enterprising disposition, subdued almost all the Upper Asia lying between Mount Taurus and the river Halys which runs through Cappadocia into the Euxine sea. Elated with this good success, he invaded Assyria, the empire of which was now much declined, and greatly weakened by the revolt of many nations which had followed the example of the Medes. Nebuchadonosor or Chyniladan, however, the reigning prince, having assembled what forces he could, engaged Phraortes, defeated, took him prisoner, and put him to death; after which, entering Media, he laid waste the country, took the metropolis of Ecbatan itself, and levelled it with the ground.

On the death of Phraortes, his son Cyaxares was placed on the throne. He was no less valiant and enterprising than his father, and had better success against the Assyrians. With the remains of that army which had been defeated under his father, he not only drove the conquerors out of Media, but obliged Chyniladan to shut himself up in Nineveh. To this place he immediately laid close siege; but was obliged to give over the enterprise on account of an irruption of the Scythians into his own country. Cyaxares engaged these new enemies with great resolution; but was utterly defeated; and the conquerors overran not only all Media, but the greatest part of Upper Asia, extending their conquests into Syria, and as far as the confines of Egypt. They continued masters of all this vast tract of country for 28 years, till at last Media was delivered from their yoke by a general massacre at the instigation of Cyaxares.

After this deliverance, the Medes soon repossessed themselves of the territories they had lost; and once more extended their frontiers to the river Halys, their ancient boundary to the westward. After this we find the Medes engaged in a war with the Lydians; which, however, ended without any remarkable transaction: but on the conclusion of it, Cyaxares having entered into a strict alliance with Nebuchadnezzar king of Babylon, returned in conjunction with the Babylonians before Nineveh: which they took and levelled with the ground, putting most of the inhabitants to the sword.

After this victory the Babylonian and Median empires seem to have been united: however, after the death of Nebuchadnezzar, or rather in his lifetime, a war ensued, which was not extinguished but by the dissolution of the Babylonian empire. The Medes, under Astyages the son of Cyaxares I. withstood the power of the Babylonian monarchs: and under Cyrus and Cyaxares II. utterly destroyed their empire by the taking of BABYLON, as is related under that article. After the death of Cyaxares, the kingdom fell to Cyrus, by whom the seat of the empire was transferred to PERSIA, under which article the history of Media now falls to be considered, as also the manners, &c. of the inhabitants.

MEDIANA, the name of a vein or little vessel, made by the union of the cephalic and basilic, in the bend of the elbow.

MEDIASTINUM, in *Anatomy*, a double membrane, formed by a duplicature of the pleura; serving to divide the thorax and the lungs into two parts, and to sustain the viscera, and prevent their falling from one side of the thorax to the other. See ANATOMY, N° 117.

MEDIATE, or INTERMEDIATE, something that stands betwixt and connects two or more terms considered as extremes; in which sense it stands opposed to *immediate*.

MEDIATOR, a person that manages or transacts between two parties at variance, in order to reconcile them. The word, in Scripture, is applied, 1. To Jesus Christ, who is the only intercessor and peace-maker between God and man, (1 Tim. ii. 5.) 2. To Moses, who interposed between the Lord and his people, to declare unto them his word; (Deut. v. 5. iii. 19.).

MEDICAGO, SNAIL TREFOIL, a genus of plants belonging to the diadelphia class, and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY *Index*. For the properties and culture of LUCERN, a species of this genus, see AGRICULTURE *Index*.

MEDICINAL, any thing belonging to medicine.

MEDICINAL Springs, a general name for any fountain, the waters of which are of use for removing certain disorders. They are commonly either chalybeate or sulphureous. See SPRINGS and WATER.

MEDICINE.

Definition. MEDICINE is the art of preventing, curing, or alleviating, those diseases to which the human species are subjected.

HISTORY of Medicine.

1
Origin of medicine among the Jews; THE fabulous history of the ancients derives this art immediately from their gods; and, even among the moderns, some are of opinion that it may justly be considered as of divine revelation. But without adopting any supposition of which no probable evidence can be given, we may conclude, that mankind were naturally led to it from casual observation on the diseases to which they found themselves subjected; and that therefore, to a certain degree at least, it is as ancient as the human race. But at what period it began to be practised as an art, by particular individuals following it as a profession, is not known. The most ancient physicians we read of were those who embalmed the patriarch Jacob by order of his son Joseph. The sacred writer styles these physicians *servants* to Joseph: whence we may be assured that they were not *priests*, as the first physicians are generally supposed to have been; for in that age we know the Egyptian priests were in such high favour, that they retained their liberty, when, through a public calamity, all the rest of the people were made slaves to the prince.

It is not probable, therefore, that among the Egyptians religion and medicine were originally conjoined; and if we suppose the Jews not to have invented the art, but received it from some other nation, it is as little probable that the priests of that nation were their physicians as those of Egypt.

That the Jewish physicians were absolutely distinct from their priests, is very certain. Yet as the Jews resided for such a long time in Egypt, it is probable they would retain many of the Egyptian customs, from which it would be very difficult to free them. We read, however, that when King Asa was diseased in his feet, "he sought not to the Lord, but to the physicians." Hence we may conclude, that among the Jews the medical art was looked upon as a mere human invention; and it was thought that the Deity never cured diseases by making people acquainted with the virtues of this or that herb, but only by his miraculous power. That the same opinion prevailed among the nations who were neighbours to the Jews, is also probable from what we read of Ahaziah king of Judah, who having sent messengers to inquire of Baalzebub god of Ekron concerning his disease, he did not desire any remedy from him or his priests, but simply to know whether he should recover or not.

What seems most probable on this subject therefore is, that religion and medicine came to be mixed together only in consequence of that degeneracy into ignorance and superstition which took place among all nations. The Egyptians, we know, came at last to be sunk in the most ridiculous and absurd superstition; and then, indeed, it is not wonderful that we should find their priests commencing physicians, and mingling charms, incantations, &c. with their remedies. That this was the case, long after the days of Joseph, we are very certain; and indeed it seems as natural for ignorance and barbarism to combine religion with physic, as it is for a civilized and enlightened people to keep them separate. Hence we see, that among all modern barbarians their priests or conjurors are their only physicians. Origin of Medicine.

We are so little acquainted with the state of physic among the Egyptians, that it is needless to say much concerning them. They attributed the invention of medicine, as they did also that of many other arts, to Thoth, the HERMES or MERCURY of the Greeks. He is said to have written many things in hieroglyphic characters upon certain pillars, in order to perpetuate his knowledge, and render it useful to others. These were transcribed by Agathodemon, or the second Mercury, the father of Tat, who is said to have composed books of them, that were kept in the most sacred places of the Egyptian temples. The existence of such a person, however, is very doubtful, and many of the books ascribed to him were accounted forgeries as long ago as the days of Galen; there is also great reason to suspect that those books were written many ages after Hermes, and when physic had made considerable advances. Many of the books attributed to him are trifling and ridiculous; and though sometimes he is allowed to have all the honour of inventing the art, he is on other occasions obliged to share it with Osiris, Isis, and Apis or Serapis. 2 among the Egyptians;

After all, the Egyptian physic appears to have been little else than a collection of absurd superstitions. Origen informs us, that they believed there were 36 demons, or gods of the air, who divided the human body among them; that they had names for each of them; and that by invoking them according to the part affected, the patient was cured. Of natural medicines we hear none recommended by the father of Egyptian physic; except the herb *moly*, which he gave to Ulysses in order to secure him from the enchantments of Circe; and the herb *mercury*, of which he first discovered the use. His successors made use of venesection, cathartics, emetics, and clysters. There is no proof, however, that this practice was established by Hermes; on the contrary, the Egyptians themselves pretended that the first hint of those remedies was taken from some observations on brute animals. Venesection was taught them by the hippopotamus, which is said to perform this operation upon itself. On certain occasions, he comes out of the river, and strikes his leg against a sharp-pointed reed. As he takes care to direct the stroke against a vein, the consequence must be a considerable effusion of blood; and this being suffered to run as long as the creature thinks proper, he at last stops up the orifice with mud. The hint of clysters was taken from the Ibis, a bird which is said to give itself clysters with its bill, &c. They used venesection, however, but very little, probably on account of the

warmth

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warmth of the climate; and the exhibition of the remedies above mentioned, joined with abſtinence, formed the moſt of their practice.

3 Among the Greeks.

The Greeks too had ſeveral perſons to whom they attributed the invention of phyſic, particularly Prometheus, Apollo or Pæan, and Æſculapius; which laſt was the moſt celebrated of any. But here we muſt obſerve, that as the Greeks were a very warlike people, their phyſic ſeems to have been little elſe than what is now called *ſurgery*, or the cure of wounds, fractures, &c. Hence Æſculapius, and his pupils Chiron, Machaon, and Podalirius, are celebrated by Homer only for their ſkill in curing theſe, without any mention of their attempting the cures of internal diſeaſes. We are not, however, to ſuppoſe that they confined themſelves entirely to ſurgery. They no doubt would occaſionally preſcribe for internal diſorders; but as they were moſt frequently converſant with wounds, we may naturally ſuppoſe the greateſt part of their ſkill to have conſiſted in knowing how to cure theſe. If we may believe the poets, indeed, the knowledge of medicine ſeems to have been very generally diffuſed. Almoſt all the heroes of antiquity are reported to have been phyſicians as well as warriors. Moſt of them were taught phyſic by the centaur Chiron. From him Hercules received inſtructions in the medicinal art, in which he is ſaid to have been no leſs expert than in feats of arms. Several plants were called by his name; from which ſome think it probable that he found out their virtues, though others are of opinion that they bore the name of this renowned hero on account of their great efficacy in removing diſeaſes. Ariſtæus king of Arcadia was alſo one of Chiron's ſcholars; and is ſuppoſed to have diſcovered the uſe of the drug called *ſilphium*, by ſome thought to be aſafœtida. Theſeus, Telamon, Jaſon, Peleus, and his ſon Achilles, were all renowned for their knowledge in the art of phyſic. The laſt is ſaid to have diſcovered the uſe of verdegriſe in cleanſing foul ulcers. All of them, however, ſeem to have been inferior in knowledge to Palamedes, who hindered the plague from coming into the Grecian camp after it had ravaged moſt of the cities of the Helleſpont, and even Troy itſelf. His method was to confine his ſoldiers to a ſpare diet, and to oblige them to uſe much exerciſe.

The practice of theſe ancient Greek phyſicians, notwithſtanding the praiſes beſtowed on them by their poets, ſeems to have been very limited, and in ſome caſes even pernicious. All the external remedies applied to Homer's wounded heroes were fomentations; while inwardly their phyſicians gave them wine, ſometimes mingled with cheeſe ſcraped down. A great deal of their phyſic alſo conſiſted in charms, incantations, amulets, &c. of which, as they are common to all ſuperſtitious and ignorant nations, it is ſuperfluous to take any farther notice.

In this way the art of medicine continued among the Greeks for many ages. As its firſt profeſſors knew nothing of the animal economy, and as little of the theory of diſeaſes, it is plain, that whatever they did muſt have been in conſequence of mere random trials, or empiriciſm, in the ſtrict and proper ſenſe of the word. Indeed, it is evidently impoſſible that this or almoſt any other art could originate from another ſource than trials of this kind. Accordingly, we find, that ſome ancient nations were accuſtomed to expoſe their ſick in temples, and by the ſides of highways, that they might receive the advice of every one who paſſed.

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4 Æſculapius.

Among the Greeks, however, Æſculapius was reckoned the moſt eminent practitioner of his time, and his name continued to be revered after his death. He was ranked amongſt the gods; and the principal knowledge of the medical art remained with his family to the time of Hippocrates, who reckoned himſelf the ſeventeenth in a lineal deſcent from Æſculapius, and who was truly the firſt who treated of medicine in a regular and rational manner.

5 Hippocrates.

Hippocrates, who is ſuppoſed to have lived 400 years before the birth of Chriſt, is the moſt ancient author whoſe writings expreſsly on the ſubject of the medical art are preſerved; and he is therefore juſtly conſidered as the father of phyſic. All the accounts which we have prior to this time, if not evidently fabulous, are at the utmoſt highly conjectural. Even the medical knowledge of Pythagoras, ſo much celebarted as a philoſopher, can hardly be conſidered as reſting on any other foundation. But from the time of Hippocrates, medicine, ſeparated from philoſophy and religion, ſeems to have aſſumed the form of a ſcience, and to have been practiſed as a profeſſion. It may not, therefore, be improper to give a particular account of the ſtate of medical ſcience as tranſmitted to us in his writings. The writings of Hippocrates, however, it may be remarked, are even more than preſerved. Many things have been repreſented as written by Hippocrates which are probably ſpurious.

6 His writings.

Nor is it wonderful that attempts ſhould have been made to increaſe the value of manuſcripts, by attributing them to a name of ſuch eminence. But although what are tranſmitted to us under the title of his works may have been written by different hands, yet the preſumption is, that moſt, if not all of them, are of nearly as early a date, and contain the prevailing opinions of thoſe times.

According to the moſt authentic accounts, Hippocrates was a native of the iſland of Cos, and born in the beginning of the 88th Olympiad. In the writings tranſmitted to us as his, we find a general principle adopted, to which he gives the name of *Nature*. To this principle he aſcribes a mighty power. "Nature (ſays he) is of itſelf ſufficient to every animal. She performs every thing that is neceſſary to them, without needing the leaſt inſtruction from any one how to do it." Upon this footing, as if Nature had been a principle endowed with knowledge, he gives her the title of *juſt*; and aſcribes virtues or powers to her, which are her ſervants, and by means of which ſhe performs all her operations in the bodies of animals: and diſtributes the blood, ſpirits, and heat, through all parts of the body, which by theſe means receive life and ſenſation. And in other places he tells us, that it is this faculty which gives nouriſhment, preſervation, and growth, to all things.

7 His idea of nature.

The manner in which Nature acts, or commands her ſubſervient power to act, is by attracting what is good and agreeable to each ſpecies, and by retaining, preparing, and changing it; and on the other ſide in rejecting whatever is ſuperfluous or hurtful, after ſhe has ſeparated it from the good. This is the foundation of the doctrine of depuration, concoction, and criſis in fevers,

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fevers, ſo much inſiſted upon by Hippocrates and many other phyſicians. He ſuppoſes alſo, that every thing has an inclination to be joined to what agrees with it, and to remove from every thing contrary to it; and likewiſe that there is an affinity between the ſeveral parts of the body, by which they mutually ſympathize with each other. When he comes to explain what this principle called *nature* is, he is obliged to reſolve it into *heat*, which, he ſays, appears to have ſomething immortal in it.

8 Of the cauſes of diſeaſes.

As far as he attempts to explain the cauſes of diſeaſe, he refers much to the humours of the body, particularly to the blood and the bile. He treats alſo of the effects of ſleep, watchings, exerciſe, and reſt, and all the benefit or miſchief we may receive from them. Of all the cauſes of diſeaſes, however, mentioned by Hippocrates, the moſt general are diet and air. On the ſubject of diet he has compoſed ſeveral books, and in the choice of this he was exactly careful; and the more ſo, as his practice turned almoſt wholly upon it. He alſo conſidered the air very much; he examined what winds blew ordinarily or extraordinarily; he conſidered the irregularity of the ſeaſons, the riſing and ſetting of ſtars, or the time of certain conſtellations; alſo the time of the ſolſtices, and of the equinoxes; thoſe days, in his opinion, produeing great alterations in certain diſtempers.

9 His diviſions of diſeaſes.

He does not, however, pretend to explain how, from theſe cauſes, that variety of diſtempers ariſes which is daily to be obſerved. All that can be gathered from him with regard to this is, that the different cauſes above mentioned, when applied to the different parts of the body, produce a great variety of diſtempers. Some of theſe diſtempers he accounted *mortal*, others *dangerous*, and the reſt eaſily *curable*, according to the cauſe from whence they ſpring, and the parts on which they fall. In ſeveral plaees alſo he diſtinguiſhes diſeaſes, from the time of their duration into *acute* or *ſhort*, and *chronical* or *long*. He likewiſe diſtinguiſhes diſeaſes by the particular places where they prevail, whether ordinary or extraordinary. The firſt, that is, thoſe that are frequent and familiar to certain plaees, he called *endemic* diſeaſes; and the latter, which raged extraordinarily ſometimes in one plaee, ſometimes in another, which ſeized great numbers at certain times, he called *epidemic*, that is, *popular* diſeaſes; and of this kind the moſt terrible is the plague. He likewiſe mentions a third kind, the oppoſite of the former; and theſe he calls *ſporadic*, or ſtraggling diſeaſes: theſe laſt include all the different ſorts of diſtempers which invade at any one ſeaſon, which are ſometimes of one ſort, and ſometimes of another. He diſtinguiſhed between thoſe diſeaſes whieh are hereditary, or born with us, and thoſe which are contracted afterwards; and likewiſe between thoſe of a *kindly* and thoſe of a *malignant* nature, the former of which are eaſily and frequently cured, but the latter give the phyſicians a great deal of trouble, and are ſeldom overcome by all their care.

Hippocrates remarked four ſtages in diſtempers; viz. the beginning of the diſeaſe, its augmentation, its ſtate or height, and its declination. In ſuch diſeaſes as terminate fatally, death comes in place of the declination. In the third ſtage, therefore, the change is moſt conſiderable, as it determines the fate of the ſick perſon; and this is moſt commonly done by means of a *criſis*. By this word he underſtood any ſudden change in ſickneſs, whether for the better or for the worſe, whether health or death ſucceed immediately. Such a change, he ſays, is made at that time by *nature*, either abſolving or condemning the patient. Hence we may conclude, that Hippocrates imagined diſeaſes to be only a diſturbance of the animal economy, with which Nature was perpetually at variance, and uſing her utmoſt endeavours to expel the offending cauſe. Her manner of acting on theſe occaſions is to reduee to their natural ſtate thoſe humours whoſe diſcord occaſions the diſturbance of the whole body, whether in relation to their quantity, quality, mixture, motion, or any other way in which they become offenſive. The principal means employed by nature for this end is what Hippoerates calls *concoction*. By this he underſtood the bringing the morbific matter lodged in the humours to ſuch a ſtate, as to be eaſily fitted for expulſion by whatever means nature might think moſt proper. When matters are brought to this paſs, whatever is ſuperfluous or hurtful immediately empties itſelf, or nature points out to phyſicians the way by which ſuch an evacuation is to be accompliſhed. The criſis takes place either by bleeding, ſtool, vomit, ſweat, urine, tumors or abſceſſes, ſcabs, pimples, ſpots, &c. But theſe evaeuations are not to be looked upon as the effects of a true eriſis, unleſs they are in conſiderable quantity; ſmall diſeharges not being ſufficient to make a criſis. On the contrary, ſmall diſcharges are a ſign that nature is depreſſed by the load of humours, and that ſhe lets them go through weakneſs and continual irritation. What comes forth in this manner is crude, becauſe the diſtemper is yet too ſtrong; and while matters remain in this ſtate, nothing but a bad or imperfect criſis is to be expected. This ſhows that the diſtemper triumphs, or at leaſt is equal in ſtrength to nature, which prognoſticates death, or a prolongation of the diſeaſe. In this laſt caſe, however, nature often has an opportunity of attempting a new criſis more happy than the former, after having made freſh efforts to advance the concoction of the humours.—It muſt here be obſerved, however, that, according to Hippocrates, concoction cannot be made but in a certain time, as every fruit has a limited time to ripen; for he compares the humours which nature has digeſted to fruits come to maturity.

10 His opinion of a criſis.

The time required for concoction depends on the differences among diſtempers mentioned above. In thoſe which Hippoerates calls *very acute*, the digeſtion or criſis happens by the fourth day; in thoſe which are only *acute*, it happens on the 7th, 11th, or 14th day; which laſt is the longeſt period generally allowed by Hippocrates in diſtempers that are truly acute: though in ſome places he ſtretehes it to the 20th or 21ſt, nay, ſometimes to the 40th or 60th day. All diſeaſes that exceed this laſt term are called *chronical*. And while in thoſe diſeaſes that exceed 14 days, he conſiders every fourth day as critical, or at leaſt remarkable, by which we may judge whether the criſis on the following fourth day will be favourable or not; ſo in thoſe which run from 20 to 40 he reckons only the ſevenths, and in thoſe that exceed 40 he begins to reckon by 20. Beyond the 120th he thinks that the number of days has no power over the criſis. They are

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are then referred to the general changes of the ſeaſons; ſome terminating about the equinoxes; others about the ſolſtices; others about the riſing or ſetting of the ſtars of certain conſtellations; or if numbers have yet any place, he reckons by months, or even whole years. Thus (he ſays), certain diſeaſes in children have their criſis in the ſeventh month after their birth, and others in their ſeventh or even their 14th year.

Though Hippocrates mentions the 21ſt as one of the critical days in acute diſtempers, as already noticed; yet, in other places of his works, he mentions alſo the 20th. The reaſon he gives for this in one of thoſe places of his work is, that the days of ſickneſs were not quite entire. In general, however, he is much attached to the odd days: inſomuch that in one of his aphoriſms he tells us, "The ſweats that come out upon the 3d, 5th, 7th, 9th, 11th, 14th, 17th, 21ſt, 27th, 31ſt, or 34th days, are beneficial; but thoſe that come out upon other days ſignify that the ſick ſhall be brought low, that his diſeaſe ſhall be very tedious, and that he ſhall be ſubject to relapſes." He further ſays, "That the fever which leaves the ſick upon any but an odd day is uſually apt to relapſe." Sometimes, however, he confeſſes that it is otherwiſe; and he gives an inſtance of a ſalutary criſis happening on the ſixth day. But theſe are very rare inſtances, and therefore cannot, in his opinion, overthrow the general rule.

Beſides the criſis, however, or the change which determines the fate of the patient, Hippocrates often ſpeaks of another, which only changes the ſpecies of the diſtemper, without reſtoring the patient to health; as when a vertigo is turned to an epilepſy, a tertian fever to a quartan, or to a continued, &c.

11
His accuracy in prognoſtics;

But what has chiefly contributed to procure the great reſpect generally paid to Hippocrates, is his induſtry in obſerving the moſt minute circumſtances of diſeaſes, and his exactneſs in nicely deſcribing every thing that happened before, and every accident that appeared at the ſame time with them; and likewiſe what appeared to give eaſe, and what to increaſe the malady: which is what we call *writing the hiſtory of a diſeaſe.*—Thus he not only diſtinguiſhed one diſeaſe from another by the ſigns which properly belonged to each; but by comparing the ſame ſort of diſtemper which happened to ſeveral perſons, and the accidents which uſually appeared before and after, he could often foretel a diſeaſe before it began, and afterwards give a right judgment of the event of it. By this way of prognoſticating, he came to be exceedingly admired: and this he carried to ſuch a height, that it may juſtly be ſaid to be his maſter-piece; and Celſus, who lived after him, remarks, that ſucceeding phyſicians, though they found out ſeveral new things relating to the management of diſeaſes, yet were obliged to the writings of Hippocrates for all that they knew of ſigns.

From the look;

The firſt thing Hippocrates conſidered, when called to a patient, was his looks.—It was a good ſign with him to have a viſage reſembling that of a perſon in health, and the ſame with what the ſick man had before he was attacked by the diſeaſe. As it varied from this, ſo much the greater danger was apprehended. The following is the deſcription which he gives of the looks of a dying man.—"When a patient (ſays he) has his noſe ſharp, his eyes ſunk, his temples hollow, his ears cold and contracted, the ſkin of his forehead tenſe and dry, and the colour of his face tending to a pale green, or lead colour, one may pronounce for certain that death is very near at hand; unleſs the ſtrength of the patient has been exhauſted all at once by long watchings, or by a looſeneſs, or being a long time without eating." This obſervation has been confirmed by ſucceeding phyſicians, who have, from him, denominated it the *Hippocratic face.* The lips hanging relaxed and cold, are likewiſe looked upon by Hippocrates as a confirmation of the foregoing prognoſtic. He alſo took his ſigns from the diſpoſition of the eyes in particular. When a patient cannot bear the light; when he ſheds tears involuntarily; when, in ſleeping, ſome part of the white of the eye is ſeen, unleſs he uſually ſleeps after that manner, or has a looſeneſs upon him: theſe ſigns, as well as the foregoing ones, prognoſticate danger. The eyes deadened, as it were with a miſt ſpread over them, or their brightneſs loſt, likewiſe preſages death, or great weakneſs. The eyes ſparkling, fierce, and fixed, denote the patient to be delirious, or that he ſoon will be ſeized with a frenzy. When the patient ſees any thing red, and like ſparks of fire and lightning paſs before his eyes, you may expect an hæmorrhagy; and this often happens before thoſe criſes which are to be attended by a loſs of blood.

From the poſture in bed;

The condition of the patient is alſo ſhown by his poſture in bed. If you find him lying on one ſide, his body, neck, legs, and arms, a little contracted, which is the poſture of a man in health, it is a good ſign: on the contrary, if he lies on his back, his arms ſtretched out, and his legs hanging down, it is a ſign of great weakneſs; and particularly when the patient ſlides or lets himſelf fall down towards the feet, it denotes the approach of death. When a patient in a burning fever is continually feeling about with his hands and fingers, and moves them up before his face and eyes as if he was going to take away ſomething that paſſed before them; or on his bed-covering, as if he was picking or ſearching for little ſtraws, or taking away ſome filth, or drawing out little flocks of wool; all this is a ſign that he is delirious, and that he will die. Amongſt the other ſigns of a preſent or approaching delirium he alſo adds this: When a patient who naturally ſpeaks little begins to talk more than he uſed to do, or when one that talks much becomes ſilent, this change is to be reckoned a ſort of delirium, or is a ſign that the patient will ſoon fall into one. The frequent trembling or ſtarting of the tendons of the wriſt, preſage likewiſe a delirium. As to the different ſorts of delirium, Hippocrates is much more afraid of thoſe that run upon mournful ſubjects, than ſuch as are accompanied with mirth.

From reſpiration;

When a patient breathes faſt, and is oppreſſed, it is a ſign that he is in pain, and that the parts above the diaphragm are inflamed. Breathing long, or when the patient is a great while in taking his breath, ſhows him to be delirious; but eaſy and natural reſpiration is always a good ſign in acute diſeaſes. Hippocrates depended much on reſpiration in making his prognoſtics; and therefore has taken care in ſeveral places to deſcribe the different manner of a patient's breathing. Continual watchings in acute diſeaſes, are ſigns of preſent pain, or a delirium near at hand.

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Hippocrates.

From excrementitious discharges.

Hippocrates alſo drew ſigns from all excrements, whatever they are, that are ſeparated from the body of man. His moſt remarkable prognoſtics, however, were from the urine. The patient's urine, in his opinion, is beſt when the ſediment is white, ſoft to the touch, and of an equal conſiſtence. If it continue ſo during the courſe of the diſtemper, and till the time of the criſis, the patient is in no danger, and will ſoon be well. This is what Hippocrates called *concocted urine*, or what denotes the concoction of the humours; and he obſerved, that this concoction of the urine ſeldom appeared thoroughly, but on the days of the criſis which happily put an end to the diſtemper. "We ought (ſaid Hippocrates) to compare the urine with the purulent matter which runs from ulcers. As the pus, which is white, and of the ſame quality with the ſediment of the urine we are now ſpeaking of, is a ſign that the ulcer is on the point of cloſing; ſo that which is clear, and of another colour than white, and of an ill ſmell, is a ſign that the ulcer is virulent, and in the ſame manner difficult to be cured: the urines that are like this we have deſcribed are only thoſe which may be named good; all the reſt are ill, and differ from one another only in the degrees of more and leſs. The firſt never appear but when nature has overcome the diſeaſe; and are a ſign of the concoction of humours, without which you cannot hope for a certain cure. On the contrary, the laſt are made as long as their crudity remains, and the humours continue unconcocted. Among the urines of this laſt ſort, the beſt are reddiſh, with a ſediment that is ſoft and of an equal conſiſtence; which denotes, that the diſeaſe will be ſomewhat tedious, but without danger. The worſt are thoſe which are very red, and at the ſame time clear and without ſediment; or that are muddy and troubled in the making. In urine there is often a ſort of cloud hanging in the veſſel in which it is received; the higher this riſes, or the farther diſtant it is from the bottom, or the more different from the colour of the laudable ſediment above mentioned, the more there is of crudity. That which is yellow, or of a ſandy colour, denotes abundance of bile; that which is black is the worſt, eſpecially if it has an ill ſmell, and is either altogether muddy or altogether clear. That whoſe ſediment is like large ground wheat, or little flakes or ſcales ſpread one upon another, or bran, preſages ill, eſpecially the laſt. The fat or oil that ſometimes ſwims upon the top of the urine, and appears in a form ſomething like a ſpider's web, is a ſign of a conſumption of the fleſh and ſolid parts. The making of a great quantity of urine is the ſign of a criſis, and ſometimes the quality of it ſhows how the bladder is affected. We muſt alſo obſerve, that Hippocrates compared the ſtate of the tongue with the urine; that is to ſay, when the tongue was yellow, and charged with bile, the urine he knew muſt of courſe be of the ſame colour; and when the tongue was red and moiſt, the urine was of its natural colour.

Urine.

Fæces.

Among his prognoſtics from the excretions by ſtool are the following:—Thoſe that are ſoft, yellowiſh, of ſome conſiſtence, and not of an extraordinary ill ſmell, that anſwer to the quantity of what is taken inwardly, and that are voided at the uſual hours, are the beſt of all. They ought alſo to be of a thicker conſiſtence when the diſtemper is near the criſis; and it ought to be taken for a good prognoſtic, when ſome worms, particularly the round and long, are evacuated at the ſame time with them. The prognoſis, however, may ſtill be favourable, though the matter excreted be thin and liquid, provided it make not too much noiſe in coming out, and the evacuation be not in a ſmall quantity nor too often; nor in ſo great abundance, nor ſo often, as to make the patient faint. All matter that is watery, white, of a pale green or red colour, or frothy and viſcous, is bad. That which is blackiſh, or of a livid hue, is the moſt pernicious. That which is pure black, and nothing elſe but a diſcharge of black bile, always prognoſticates very ill; this humour, from what part ſoever it comes, ſhowing the ill diſpoſition of the inteſtines. The matter that is of ſeveral different colours, denotes the length of the diſtemper; and, at the ſame time, that it may be of dangerous conſequence. Hippocrates places in the ſame claſs the matter that is bilious or yellow, and mixed with blood, or green and black, or like the dregs or ſcrapings of the guts. The ſtools that conſiſt of pure bile, or entirely of phlegm, he alſo looks upon to be very bad.

Hippocrates.

Matter ejected by vomiting ought to be mixed with bile and phlegm; where one of theſe humours only is obſerved, it is worſe. That which is black, livid, green, or of the colour of a leek, indicates alarming conſequences. The ſame is to be ſaid of that which ſmells very ill; and if at the ſame time it be livid, death is not far off. The vomiting of blood is very often a mortal ſymptom.

Expectoration.

The ſpittings which give eaſe in diſeaſes of the lungs and in pleuriſies, are thoſe that come up readily and without difficulty; and it is good if they be mixed at the beginning with much yellow: but if they appear of the ſame colour, or are red, a great while after the beginning of the diſtemper, if they are ſalt and acrimonious, and cauſe violent coughings, they are not good. Spittings purely yellow are bad; and thoſe that are white, viſcous, and frothy, give no eaſe. Whiteneſs is a good ſign of concoction in regard to ſpittings; but they ought not at all to be viſcous, nor too thick, nor too clear. We may make the ſame judgment of the excrements of the noſe according to their concoction and crudity. Spittings that are black, green, and red, are of very bad conſequence. In inflammations of the lungs, thoſe that are mixed with bile and blood preſage well if they appear at the beginning, but are bad if they ariſe not about the ſeventh day. But the worſt ſign in theſe diſtempers is, when there is no expectoration at all, and the too great quantity of matter that is ready to be diſcharged this way makes a rattling in the breaſt. After ſpitting of blood, the diſcharge of purulent matter often follows, which brings on a conſumption, and at laſt death.

Sweat.

A kind good ſweat is that which ariſes on the day of the criſis, and is diſcharged in abundance all over the body, and at the ſame time from all parts of the body, and thus carries off the fever: A cold ſweat is alarming, eſpecially in acute fevers, for in others it is only a ſign of long continuance. When the patient ſweats no where but on the head and neck, it is a ſign that the diſeaſe will be long and dangerous. A gentle ſweat in ſome particular part of the head and breaſt, for inſtance, gives no relief, but denotes the ſeat of the diſtemper, or the weakneſs of the part. This

Hippocrates.

This kind of ſweat was called by Hippocrates *ephidroſis*.

The hypochondria, or the abdomen in general ought always to be ſoft and even, as well on the right ſide as on the left. When there is any hardneſs or unevenneſs in thoſe parts, or heat and ſwellings, or when the patient cannot endure to have it touched, it is a ſign the inteſtines are indiſpoſed.

From the pulſe.

Hippocrates alſo inquired into the ſtate of the pulſe, or the beating of the arteries. The moſt ancient phyſicians, however, and even Hippocrates himſelf, for a long time, by this word underſtood the violent pulſation that is felt in an inflamed part, without putting the fingers to it. It is obſerved by Galen, and other phyſicians, that Hippocrates touches on the ſubject of the pulſe more ſlightly than any other on which he treats. But that our celebrated phyſician underſtood ſomething even on this ſubject, is eaſily gathered from ſeveral paſſages in his writings; as when he obſerves, that in acute fevers the pulſe is very quick and very great; and when he makes mention, in the ſame place, of trembling pulſes, and thoſe that beat ſlowly. He likewiſe obſerves, that in ſome diſeaſes incident to women, when the pulſe ſtrikes the finger faintly, and in a languiſhing manner, it is a ſign of approaching death. He remarks alſo, in the *Coacæ Prænotiones*, that he whoſe vein, that is to ſay, whoſe artery of the elbow, beats, is juſt going to run mad, or elſe that the perſon is at that time very much under the influence of anger.

From this account of Hippocrates, it will appear, that he was not near ſo much taken up with reaſoning on the phenomena of diſeaſes, as with reporting them. He was content to obſerve theſe phenomena accurately, to diſtinguiſh diſeaſes by them, and judged of the event by comparing them exactly together. For his ſkill in prognoſtics he was indeed very remarkable, as we have already mentioned, inſomuch that he and his pupils were looked upon by the vulgar as prophets. What adds very much to his reputation is, that he lived in an age when phyſic was altogether buried in ſuperſtition, and yet he did not ſuffer himſelf to be carried away by it; on the contrary, on many occaſions, he expreſſes his abhorrence of it.

Having thus ſeen in what Hippocrates makes the difference between health and ſickneſs to conſiſt, and likewiſe the moſt remarkable ſigns from whence he drew his prognoſtics, we muſt now conſider the means he preſcribed for the preſervation of health, and the cure of diſeaſes.

12 His maxims for the preſervation of health.

One of his principal maxims was this, That, to preſerve health, we ought not to overcharge ourſelves with too much eating, nor neglect the uſe of exerciſe and labour. In the next place, That we ought by no means to accuſtom ourſelves to too nice and exact a method of living; becauſe thoſe who have once begun to act by this rule, if they vary in the leaſt from it, find themſelves very ill; which does not happen to thoſe who take a little more liberty, and live ſomewhat more irregularly. Notwithſtanding this he does not neglect to inquire diligently into the articles which thoſe who were in health uſed for food in his time.

Diet.

Here we cannot help taking notice of the prodigious diſparity between the delicacy of the people in our days and in thoſe of Hippocrates: for he takes great pains to tell the difference between the fleſh of a dog, a fox, a horſe, and an aſs; which he would not have done if at that time they had not been uſed for victuals, at leaſt by the common people. Beſides theſe, however, Hippocrates ſpeaks of all other kinds of proviſion that are now in uſe; for example, ſalads, milk, whey, cheeſe, fleſh as well of birds as of four-footed beaſts, freſh and ſalt fiſh, eggs, all kinds of pulſe, and the different kinds of grain we feed on, as well as the different ſorts of bread that are made of it. He alſo ſpeaks very often of a ſort of liquid food, or broth, made of barley-meal, or ſome other grain, which they ſteeped for ſome time, and then boiled in water. With regard to drink, he takes a great deal of pains to diſtinguiſh the good waters from the bad. The beſt, in his opinion, ought to be clear, light, without ſmell or taſte, and taken out of the fountains that turn towards the eaſt. The ſalt waters, thoſe that he calls hard, and thoſe that riſe out of fenny ground, are the worſt of all; he condemns alſo thoſe that come from melted ſnow. But though Hippocrates makes all thoſe diſtinctions, he adviſes thoſe who are in health to drink of the firſt water that comes in their way. He ſpeaks alſo of alum waters, and thoſe that are hot; but does not enlarge upon their qualities. He adviſes to mix wine with an equal quantity of water: and this (he ſays) is the juſt proportion; by uſing which the wine will expel what is hurtful to the body, and the water will ſerve to temper the acrimony of the humours.

Exerciſe.

For thoſe that are in health, and likewiſe for ſuch as are ſick, Hippocrates adviſes exerciſe. The books, however, which treat on this ſubject, M. Le Clerc conjectures to have been written by Herodicus, who firſt introduced gymnaſtic exerciſe into medicine, and who is ſaid by Hippocrates himſelf to have killed ſeveral people by forcing them to walk while they were afflicted with fevers and other inflammatory diſorders. The advices given in them conſiſt chiefly in directions for the times in which we ought to walk, and the condition we ought to be in before it; when we ought to walk ſlowly, and when to run, &c.; and all this with deſign to bring the body down, or diſſipate the humours. Wreſtling, although a violent exerciſe, is numbered with the reſt. In the ſame place alſo mention is made of a play of the hands and fingers, which was thought good for health, and called *chironomie*; and of another diverſion which was performed round a ſort of ball hung up, which they called *corycus*, and which they ſtruck forward with both their hands.

Excretions.

With regard to thoſe things which ought to be ſeparated from, or retained in the human body, Hippocrates obſerves, that people ought to take great care not to load themſelves with excrements, or keep them in too long; and beſides the exerciſe above mentioned, which carries off one part of them, and which he preſcribes chiefly on this account, he adviſes people to excite and rouſe up nature when ſhe flagged, and did not endeavour to expel the reſt, or take care of the impediments by which ſhe was reſiſted. For this reaſon he preſcribed meats proper for looſening the belly; and when theſe were not ſufficient, he directed the uſe of clyſters and ſuppoſitories. For thin and emaciated perſons he directed clyſters compoſed only of milk and oily unctuous ſubſtances, which they mixed with a decoction

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coction of chick-pease; but for such as were plethoric, they only made use of salt or sea-water.

As a preservative against distempers, Hippocrates also advised the use of vomits, which he directed to be taken once or twice a month during the time of winter and spring. The most simple of these were made of a decoction of hyssop, with an addition of a little vinegar and salt. He made those that were of a strong and vigorous constitution take this liquor in a morning fasting; but such as were thin and weakly took it after supper.—Venery, in his opinion, is wholesome, provided people consult their strength, and do not pursue it to excess; which he finds fault with on all occasions, and would have excess avoided also in relation to sleep and watching. In his writings are likewise to be found several remarks concerning good and bad air; and he makes it appear that the good or bad disposition of this element does not depend solely on the difference of the climate, but on the situation of every place in particular. He speaks also of the good and bad effects of the passions, and recommends moderation in regard to them.

From what we have already related concerning the opinions of Hippocrates, it may naturally be concluded, that for the most part he would be contented with observing what the strength of nature is able to accomplish without being assisted by the physician. That this was really the case, may be easily perceived from a perusal of his books entitled, "Of epidemical distempers;" which are, as it were, journals of the practice of Hippocrates: for there we find him often doing nothing more than describing the symptoms of a distemper, and informing us what has happened to the patient day after day, even to his death or recovery, without speaking a word of any kind of remedy. Sometimes, however, he did indeed make use of remedies; but these were exceedingly simple and few, in comparison of what have been given by succeeding practitioners. These remedies we shall presently consider, after we have given an abridgement of the principal maxims on which his practice was founded.

13 His maxims for the cure of diseases.

Hippocrates asserted in the first place, That contraries, or opposites, are the remedies for each other; and this maxim he explains by an aphorism; in which he says, that evacuations cure those distempers which come from repletion, and repletion those that are caused by evacuation. So heat is destroyed by cold, and cold by heat, &c. In the second place, he asserted that physic is an addition of what is wanting, and a subtraction or retrenchment of what is superfluous: an axiom which is thus explained, that there are some juices or humours, which in particular cases ought to be evacuated, or driven out of the body, or dried up; and some others which ought to be restored to the body, or caused to be produced there again. As to the method to be taken for this addition or retrenchment, he gives this general caution, That you ought to be careful how you fill up, or evacuate, all at once, or too quickly, or too much; and that it is equally dangerous to heat or cool again on a sudden; or rather, you ought not to do it: every thing that runs to an excess being an enemy to nature. In the fourth place, Hippocrates allowed that we ought sometimes to dilate, and sometimes to lock up: to dilate, or open the passages by which the humours are voided naturally, when they are not sufficiently opened, or when they are closed; and, on the contrary, to lock up or straiten the passages that are relaxed, when the juices that pass there ought not to pass, or when they pass in too great quantity. He adds, that we ought sometimes to smooth, and sometimes to make rough; sometimes to harden, and sometimes to soften again; sometimes to make more fine or supple; sometimes to thicken; sometimes to rouse up, and at other times to stupify or take away the sense; all in relation to the solid parts of the body, or to the humours. He gives also this farther lesson, That we ought to have regard to the course the humours take, from whence they come, and whither they go; and in consequence of that, when they go where they ought not, that we make them take a turn about, or carry them another way, almost like the turning the course of a river: or, upon other occasions, that we endeavour if possible to recal, or make the same humours return back again; drawing upward such as have a tendency downward, and drawing downward such as tend upward. We ought also to carry off, by convenient ways, that which is necessary to be carried off; and not let the humours once evacuated enter into the vessels again. Hippocrates gives also the following instruction, That when we do any thing according to reason, though the success be not answerable, we ought not easily, or too hastily, to alter the manner of acting, as long as the reasons for it are yet good. But as this maxim might sometimes prove deceitful, he gives the following as a corrector to it: "We ought (says he) to mind with a great deal of attention what gives ease, and what creates pain; what is easily supported, and what cannot be endured." We ought not to do any thing rashly; but ought often to pause, or wait, without doing any thing: by this way, if you do the patient no good, you will at least do him no hurt.

These are the principal and most general maxims of the practice of Hippocrates, and which proceed upon the supposition laid down at the beginning, viz. that nature cures diseases. We next proceed to consider particularly the remedies employed by him, which will serve to give us further instructions concerning his practice.

14 His maxims respecting diet.

Diet was the first, the principal, and often the only remedy made use of by this great physician to answer most of the intentions above mentioned: by means of it he opposed the moist to dry, hot to cold, &c.; and what he looked upon to be the most considerable point was, that thus he supported nature, and assisted her to overcome the malady. The dietetic part of medicine was so much the invention of Hippocrates himself, that he was very desirous to be accounted the author of it; and the better to make it appear that it was a new remedy in his days, he says expressly, that the ancients had wrote almost nothing concerning the diet of the sick, having omitted this point, though it was one of the most essential parts of the art.

15 Diet in acute diseases.

The diet prescribed by Hippocrates for patients labouring under acute distempers, differed from that which he ordered for those afflicted with chronical ones. In the former, which require a more particular exactness in relation to diet, he preferred liquid food to that which was solid, especially in fevers. For these he used a sort of broth made of cleansed barley; and to this he gave the name of *ptisan*. The manner in which the ancients prepared a ptisan was as follows:

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They firſt ſteeped the barley in water till it was plumped up; and afterwards they dried it in the ſun, and beat it to take off the huſk. They next ground it; and having let the flour boil a long time in the water, they put it out into the ſun, and when it was dry they preſſed it cloſe. It is properly this flour ſo prepared that is called *ptiſan*. They did almoſt the ſame thing with wheat, rice, lentils, and other grain: but they gave theſe ptiſans the name of the grain from whence they were extracted, as *ptiſan of lentils*, *rice*, &c. while the ptiſan of barley was called ſimply *ptiſan*, on account of the excellency of it. When they wanted to uſe it, they boiled one part of it in 10 or 15 of water; and when it began to grow plump in boiling, they added a little vinegar, and a very ſmall quantity of aniſe or leek, to keep it from clogging or filling the ſtomach with wind. Hippocrates preſcribed this broth for women that have pains in their belly after delivery. "Boil ſome of this ptiſan (ſays he), with ſome leek, and the fat of a goat, and give it to the woman in bed." This will not be thought very ſingular, if we reflect on what has been hinted above concerning the indelicate manner of living in thoſe times. He preferred the ptiſan to all other food in fevers, becauſe it ſoftened and moiſtened much, and was beſides of eaſy digeſtion. If he was concerned in a continual fever, he would have the patient begin with a ptiſan of a pretty thick conſiſtence, and go on by little and little, leſſening the quantity of barley-flour as the height of the diſtemper approached; ſo that he did not feed the patient but with what he called the *juice of the ptiſan;* that is, the ptiſan ſtrained, where there was but very little of the flour remaining, in order that nature being diſcharged in part from the care of digeſting the aliments, ſhe might the more eaſily hold out to the end, and overcome the diſtemper, or the cauſe of it. With regard to the quantity, he cauſed the ptiſan to be taken twice a-day by ſuch patients as in health uſed to take two meals a-day, not thinking it convenient that thoſe who were ſick ſhould eat oftener than when they were well. He alſo would not allow eating twice a-day to thoſe who ate but once in that time when in health. In the paroxyſm of a fever he gave nothing at all; and in all diſtempers where there are exacerbations, he forbade nouriſhment while the exacerbations continued. He let children eat more; but thoſe who were grown up to man's eſtate, or were of an advanced age, leſs; making allowance, however, for the cuſtom of each particular perſon, or for that of the country.

But though he was of opinion that too much food ought not to be allowed to the ſick, he did not agree with ſome phyſicians who preſcribed long abſtinence, eſpecially in the beginning of fevers. The reaſon he gave for this was, that the contrary practice weakened the patients too much during the firſt days of the diſtemper, by which means their phyſicians were obliged to allow them more food when the illneſs was at its height, which in his opinion was improper. Beſides, in acute diſtempers, and particularly in fevers, Hippocrates made choice of refreſhing and moiſtening nouriſhment; and amongſt other things preſcribed orange, melon, ſpinach, gourd, &c. This ſort of food he gave to thoſe that were in a condition to eat, or could take ſomething more than a ptiſan.

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[15] Drink.

The drink he commonly gave to his patients was made of eight parts of water and one of honey. In ſome diſtempers he added a little vinegar; but beſides theſe, they had another ſort named κυκεων, or *mixture*. One preſcription of this ſort we find intended for a conſumptive perſon; it conſiſted of rue, aniſe, celery, coriander, juice of pomegranate, the roughest red wine, water, flour of wheat and barley, with old cheeſe made of goats milk. Hippocrates did not approve of giving plain water to the ſick; but though he generally preſcribed the drinks above mentioned, he did not abſolutely forbid the uſe of wine, even in acute diſtempers and fevers, provided the patients were not delirious nor had pains in their head. Beſides, he took care to diſtinguiſh the wines proper in theſe caſes; preferring to all other ſorts white wine that was clear and had a great deal of water, with neither ſweetneſs nor flavour.

16 Diet in chronic diſeaſes.

Theſe are the moſt remarkable particulars concerning the diet preſcribed by Hippocrates in acute diſtempers; in chronical ones he made very much uſe of milk and whey; though we are not certain whether this was done on account of the nouriſhment expected from them, or that he accounted them medicines.

17 His maxims reſpecting bathing.

There were many diſeaſes for which he judged the bath was a proper remedy; and he takes notice of all the circumſtances that are neceſſary in order to cauſe the patient receive benefit from it, among which the following are the principal. The patient that bathes himſelf muſt remain ſtill and quiet in his place without ſpeaking while the aſſiſtants throw water over his head or are wiping him dry; for which laſt purpoſe he deſired them to keep ſponges, inſtead of that inſtrument called by the ancients *ſtrigil*, which ſerved to rub off from the ſkin the dirt and naſtineſs left upon it by the unguents and oils with which they anointed themſelves. He muſt alſo take care not to catch cold; and muſt not bathe immediately after eating and drinking, nor eat or drink immediately after coming out of the bath. Regard muſt alſo be had whether the patient has been accuſtomed to bathe while in health, and whether he has been benefited or hurt by it. Laſtly, he muſt abſtain from the bath when the body is too open, or too coſtive, or when he is too weak; or if he has an inclination to vomit, a great loſs of appetite, or bleeds at the noſe. The advantage of the bath, according to Hippocrates, conſiſts in moiſtening and refreſhing, taking away wearineſs, making the ſkin ſoft and the joints pliant; in provoking urine, and opening the other excretories. He allows two baths in a day to thoſe who have been accuſtomed to it in health.

18 His maxims reſpecting exerciſe.

In chronical diſtempers Hippocrates approved very much of exerciſe, though he did not allow it in acute ones: but even in theſe he did not think that a patient ought always to lie in bed; but tells us, that "we muſt ſometimes puſh the timorous out of bed, and rouſe up the lazy."

19 His maxims reſpecting purgation.

When he found that diet and exerciſe were not ſufficient to eaſe nature of a burden of corrupted humours, he was obliged to make uſe of other means, of which *purgation* was one. By this word he underſtood all the contrivances that are made uſe of to diſcharge the ſtomach and bowels; though it commonly ſignifies only

only the evacuation by ſtool. This evacuation he imagined to be occaſioned by the purgative medicines attracting the humours to themſelves. When firſt taken into the body, he thought they attracted that humour which was moſt ſimilar to them, and then the others, one after another.—Moſt of the purgatives uſed in his time were emetics alſo, or at leaſt were very violent in their operation downwards. Theſe were the white and black hellebore; the firſt of which is now reckoned among the poiſons. He uſed alſo the Cnidian berries, cneorum peplium, thapſia; the juice of hippophaë, a ſort of rhamnus; elaterium, or juice of the wild cucumber; flowers of braſs, coloquintida, ſcammony, the magneſian ſtone, &c.

As theſe purgatives were all very ſtrong, Hippocrates was extremely cautious in their exhibition. He did not preſcribe them in the dog-days; nor did he ever purge women with child, and very ſeldom children or old people. He principally uſed purgatives in chronical diſtempers; but was much more wary in acute ones. In his books entitled "Of Epidemical Diſtempers," there are very few patients mentioned to whom he gave purgative medicines. He alſo takes notice expreſsly, that theſe medicines having been given in caſes of the diſtempers of which he was treating, had produced very bad effects. We are not, however, from this to conclude, that Hippocrates abſolutely condemned purging in acute diſtempers; for in ſome places he expreſsly mentions his having given them with ſucceſs. He was of opinion, for inſtance, that purging was good in a pleuriſy when the pain was ſeated below the diaphragm; and in this caſe he gave black hellebore, or ſome peplium mixed with the juice of *laſerpitium*.

The principal rule Hippocrates gives with relation to purging is, that we ought only to purge off the humours that are concocted, and not thoſe that are yet crude, taking particular care not to do it at the beginning of the diſtemper, leſt the humours ſhould be diſturbed or ſtirred up, which happens pretty often. He was not, however, the firſt who remarked that it would be of ill conſequence to ſtir the humours in the beginning of an acute diſtemper. The Egyptian phyſicians had before obſerved the ſame thing. By the *beginning* of a diſtemper, Hippocrates underſtood all the time from the firſt day to the fourth complete.

Hippocrates imagined that each purgative medicine was adapted to the carrying off ſome particular humour; and hence the diſtinction of purgatives into hydragogue, cholagogue, &c. which is now juſtly exploded. In conſequence of this notion, he contended that we knew if a purgative had drawn from the body what was fit to be evacuated according as the patient was found well or ill upon it. If we found ourſelves well, it was a ſign that the medicine had effectually expelled the offending humour. On the contrary, if we were ill, he imagined, whatever quantity of humour came away, that the humour which cauſed the illneſs ſtill remained; not judging of the goodneſs or badneſs of a purge by the quantity of matters that were voided by it, but by their quality and the effect that followed after it.

Vomits were alſo pretty much uſed as medicines by Hippocrates. We have already ſeen what thoſe were which he preſcribed to people in health by way of preventives. With regard to the ſick, he ſometimes adviſed them to the ſame, when his intentions were only to cleanſe the ſtomach. But when he had a mind to recal the humours, as he termed it, from the inmoſt receſſes of the body, he made uſe of briſker remedies. Among theſe was white hellebore; and this indeed he moſt frequently uſed to excite vomiting. He gave this root particularly to melancholy and mad people; and from the great uſe made of it in theſe caſes by Hippocrates and other ancient phyſicians, the phraſe *to have need of hellebore*, became a proverbial expreſſion for being out of one's ſenſes. He gave it alſo in defluxions, which come, according to him, from the brain, and throw themſelves on the noſtrils or ears, or fill the mouth with ſaliva, or that cauſe ſtubborn pains in the head, and a wearineſs or an extraordinary heavineſs, or a weakneſs of the knees, or a ſwelling all over the body. He gave it to conſumptive perſons in broth of lentils, to ſuch as were afflicted with the dropſy called *leucophlegmatia*, and in other chronical diſorders. But we do not find that he made uſe of it in acute diſtempers, except in the cholera morbus, where he ſays he preſcribed it with benefit. Some took this medicine faſting; but moſt took it after ſupper, as was commonly practiſed with regard to vomits taken by way of prevention. The reaſon why he gave this medicine moſt commonly after eating was, that by mixing with the aliments, its acrimony might be ſomewhat abated, and it might operate with leſs violence on the membranes of the ſtomach. With the ſame intention alſo he ſometimes gave a plant called *ſeſamoides*, and ſometimes mixed it with hellebore. Laſtly, in certain caſes he gave what he called *ſoft* or *ſweet* hellebore. This term had ſome relation to the quality of the hellebore, or perhaps the quantity he gave.

When Hippocrates intended only to keep the body open, or evacuate the contents of the inteſtines, he made uſe of ſimples; as for example, the herb mercury, or cabbage; the juice or decoction of which he ordered to be drank. For the ſame purpoſe he uſed whey, and alſo cows and aſſes milk; adding a little ſalt to it, and ſometimes letting it boil a little. If he gave aſſes milk alone, he cauſed a great quantity of it to be taken, ſo that it muſt of neceſſity looſen the body. In one place he preſcribes no leſs than nine pounds of it to be taken as a laxative, but does not ſpecify the time in which it was to be taken. With the ſame intention he made uſe of ſuppoſitories and clyſters. The former were compounded of honey, the juice of the herb mercury, of nitre, powder of colocynth, and other ſharp ingredients, to irritate the anus. Theſe they formed into a ball, or into a long cylindrical maſs like a finger. The clyſters he made uſe of for ſick people were ſometimes the ſame with thoſe already mentioned as preventives for people in health. At other times he mixed the decoction of herbs with nitre, honey, and oil, or other ingredients, according as he imagined he could by that means attract, waſh, irritate, or ſoften. The quantity of liquor he ordered was about 36 ounces; from which it is probable he did not intend that it ſhould all be uſed at one time.

On ſome occaſions Hippocrates propoſed to purge the head alone. This practice he employed after purging the reſt of the body, in an apoplexy, inveterate

pains

Hippocrates.

pains of the head, a certain ſort of jaundice, a conſumption, and the greateſt part of chronical diſtempers. For that purpoſe he made uſe of the juices of ſeveral plants, as celery; to which he ſometimes added aromatic drugs, making the patients ſnuff up this mixture into their noſtrils. He uſed alſo powders compounded of myrrh, the flowers of braſs, and white hellebore, which he cauſed them put up into the noſe, to make them ſneeze, and to draw the phlegm from the brain. For the ſame purpoſe alſo he uſed what he calls *tetragonon*, that is, "ſomething having four angles;" but what this was, is now altogether unknown, and was ſo even in the days of Galen. The latter phyſician, however, conjectures it to be antimony, or certain flakes found in it.

In the diſtemper called *empyema* (or a collection of matter in the breaſt), he made uſe of a very rough medicine. He commanded the patient to draw in his tongue as much as he was able; and when that was done, he endeavoured to put into the hollow of the lungs a liquor that irritated the part, which raiſing a violent cough, forced the lungs to diſcharge the purulent matter contained in them. The materials that he uſed for this purpoſe were of different ſorts; ſometimes he took the root of arum, which he ordered to be boiled with a little ſalt, in a ſufficient quantity of water and oil; diſſolving a little honey in it. At other times, when he intended to purge more ſtrongly, he took the flowers of copper and hellebore; after that he ſhook the patient violently by the ſhoulders, the better to looſen the pus. This remedy, according to Galen, he received from the Cnidian phyſicians; and it has never been uſed by the ſucceeding ones, probably becauſe the patients could not ſuffer it.

20 His maxims reſpecting blood-letting.

Blood-letting was another method of evacuation pretty much uſed by Hippocrates. Another aim he had in this, beſides the mere evacuation, was to divert or recal the courſe of the blood when he imagined it was going where it ought not. A third end of bleeding was to procure a free motion of the blood and ſpirits.

Hippocrates had alſo a fourth intention for bleeding, and this was refreſhment. So in the iliac paſſion, he orders bleeding in the arm and in the head; to the end, ſays he, that the ſuperior venter, or the breaſt, may ceaſe to be overheated. With regard to this evacuation, his conduct was much the ſame as to purging, in reſpect of time and perſons. We ought, ſays he, to let blood in acute diſeaſes, when they are violent, if the party be luſty and in the flower of his age. We ought alſo to have regard to the time, both in reſpect to the diſeaſe and to the ſeaſon in which we let blood. He alſo informs us, that blood ought to be let in great pains, and particularly in inflammations. Among theſe he reckons ſuch as fall upon the principal viſcera, as the liver, lungs, and ſpleen, as alſo the quinſy and pleuriſy, if the pain of the latter be above the diaphragm. In theſe caſes he would have the patients blooded till they faint, eſpecially if the pain be very acute; or rather he adviſes that the orifice ſhould not be cloſe dtill the colour of the blood alters, ſo that from livid it turn red, or from red livid. In a quinſy he blooded in both arms at once. Difficulty of breathing he alſo reckons among the diſtempers that require bleeding; and he mentions another ſort of inflammation of the lungs, which he calls a ſwelling or tumor of the lungs ariſing from heat; in which caſe he adviſes to bleed in all parts of the body; and directs it particularly by the arms, tongue, and noſtrils. To make bleeding the more uſeful in all pains, he directed to open the vein neareſt the part affected; in a pleuriſy he directs to take blood from the arm of the ſide affected; and for the ſame reaſon, in pains of the head, he directs the veins of the noſe and forehead to be opened. When the pain was not urgent, and bleeding was adviſed by way of prevention, he directed the blood to be taken from the parts fartheſt off, with a deſign to divert the blood inſenſibly from the ſeat of pain. The higheſt burning fevers, which ſhow neither ſigns of inflammation nor pain, he does not rank among thoſe diſtempers which require bleeding. On the contrary, he maintains that a fever itſelf is in ſome caſes a reaſon againſt bleeding. If any one, ſays he, has an ulcer in the head, he muſt bleed, *unleſs he has a fever*. He ſays further, thoſe that loſe their ſpeech of a ſudden muſt be blooded, unleſs they have a fever. Perhaps he was afraid of bleeding in fevers, becauſe he ſuppoſed that they were produced by the bile and pituita, which grew hot, and afterwards heated the whole body, which is, ſays he, what we call *fever*, and which, in his opinion, cannot well be evacuated by bleeding. In other places alſo he looks upon the preſence or abundance of bile to be an objection to bleeding; and he orders to forbear veneſection even in a pleuriſy, if there be bile. To this we muſt add, that Hippocrates diſtinguiſhed very particularly between a fever which followed no other diſtemper, but was itſelf the original malady, and a fever which came upon inflammation. In the early ages of phyſic, the firſt only were properly called *fevers:* the others took their names from the parts affected; as *pleuriſy*, *peripneumony*, *hepatitis*, *nephritis*, &c. which names ſignify that the pleura, the lungs, the liver, or the kidneys, are diſeaſed, but do not intimate the fever which accompanies the diſeaſe. In this latter ſort of fever Hippocrates conſtantly ordered bleeding, but not in the former. Hence, in his books on Epidemic Diſtempers, we find but few directions for bleeding in the acute diſtempers, and particularly in the great number of continual and burning fevers there treated of. In the firſt and third book we find but one ſingle inſtance of bleeding, and that in a pleuriſy; in which, too, he ſtaid till the eighth day of the diſtemper. Galen, however, and moſt other commentators on Hippocrates, are of opinion that he generally blooded his patients plentifully in the beginning of acute diſorders, though he takes no notice of it in his writings. But had this been the caſe, he would not perhaps have had the opportunity of ſeeing ſo many fevers terminate by criſes, or natural evacuations, which happen of themſelves on certain days. Hippocrates, in fact, laid ſo much weight upon the aſſiſtance of nature and the method of diet, which was his favourite medicine, that he thought if they took care to diet the patients according to rule, they might leave the reſt to nature. Theſe are his principles, from which he never deviates; ſo that his writings on Epidemical Diſeaſes ſeem to have been compoſed only with an intention to leave to poſterity an exact model of management in purſuance of theſe principles.

With

Hippocrates.

With regard to the rules laid down by Hippocrates for bleeding, we muſt farther take notice, that in all diſeaſes which had their ſeat above the liver, he blooded in the arm, or in ſome of the upper parts of the body; but for thoſe that were ſituated below it, he opened the veins of the foot, ankle, or ham. If the belly was too looſe, and bleeding was at the ſame time thought neceſſary, he ordered the looſeneſs to be ſtopped before bleeding.

Almoſt all theſe inſtances, however, regard ſcarcely any thing but acute diſtempers; but we find ſeveral concerning chronical diſeaſes. "A young man complained of great pain in his belly, with a rumbling while he was faſting, which ceaſed after eating: this pain and rumbling continuing, his meat did him no good; but, on the contrary, he daily waſted and grew lean. Several medicines, as well purges as vomits, were given him in vain. At length it was reſolved to bleed him by intervals, firſt in one arm and then in the other, till he had ſcarcely any blood left, and by this method he was perfectly cured."

Hippocrates let blood alſo in a dropſy, even in a tympany; and in both caſes he preſcribes bleeding in the arm. In a diſeaſe occaſioned by an overgrown ſpleen, he propoſes bleeding ſeveral times repeated at a vein of the arm which he calls the *ſplenetic*; and in one ſpecies of jaundice, he propoſes bleeding under the tongue. On ſome occaſions he took away great quantities of blood, as appears from what we have already obſerved. Sometimes he continued the blooding till the patient fainted: at other times he would blood in both arms at once; at others, he did it in ſeveral places of the body, and at ſeveral times. The veins he opened were thoſe of the arm, the hands, the ankles on both ſides, the hams, the forehead, behind the head, the tongue, the noſe, behind the ears, under the breaſts, and thoſe of the arms; beſides which, he burnt others, and opened ſeveral arteries. He likewiſe uſed cupping-veſſels, with intent to recal or withdraw the humours which fell upon any part. Sometimes he contented himſelf with the bare attraction made by the cupping-veſſels, but ſometimes alſo he made ſcarifications.

21 His maxims reſpecting diuretics and ſudorifics.

When bleeding and purging, which were the principal and moſt general means uſed by Hippocrates for taking off a plethora, proved inſufficient for that purpoſe, he had recourſe to diuretics and ſudorifics. The former were of different ſorts, according to the conſtitution of the perſons: ſometimes baths, and ſometimes ſweet wine, were employed to provoke urine; ſometimes the nouriſhment which we take contributes to it: and amongſt thoſe herbs which are commonly eaten, Hippocrates recommends garlic, leeks, onions, cucumbers, melons, gourds, fennel, and all other things which have a biting taſte and a ſtrong ſmell. With theſe he numbers honey, mixed with water or vinegar, and all ſalt meats. But, on ſome occaſions, he took four cantharides, and, pulling off their wings and feet, gave them in wine and honey. Theſe remedies were given in a great number of chronical diſtempers after purging, when he thought the blood was overcharged with a ſort of moiſture which he calls *ichor*; or in ſuppreſſions of urine, and when it was made in leſs quantity than it ought. There were alſo ſome caſes in which he would force ſweat as well as urine; but he neither mentions the diſeaſes in which ſudorifics are proper, nor lets us know what medicines are to be uſed for this purpoſe, except in one ſingle paſſage, where he mentions ſweating, by pouring upon the head a great quantity of water till the feet ſweat; that is, till the ſweat diffuſes itſelf over the whole body, running from head to foot. After this he would have them eat boiled meat, and drink pure wine, and being well covered with clothes, lay themſelves down to reſt. The diſeaſe for which he propoſes the above-mentioned remedy is a fever; which is not, according to him, produced by bile or pituita, but by mere laſſitude, or ſome other ſimilar cauſe; from whence we may conclude that he did not approve of ſweating in any other kind of fever.

Other remedies which Hippocrates tells us he made uſe of were thoſe that purged neither bile nor phlegm, but act by cooling, drying, heating, moiſtening, or by cloſing and thickening, reſolving and diſſipating. Theſe medicines, however, he does not particularly mention; and it is probable they were only ſome particular kinds of food. To theſe he joined *hypnotics*, or ſuch things as procure ſleep; but theſe laſt were uſed very ſeldom, and, it is moſt probable, were only different preparations of poppies.

22 The uſe he made of ſpecifics

Laſtly, beſides the medicines already mentioned, which acted in a ſenſible manner, Hippocrates made uſe of others called *ſpecifics*; whoſe action he did not underſtand, and for the uſe of which he could give no reaſon but his own experience, or that of other phyſicians. Theſe he had learned from his predeceſſors the deſcendants of Æſculapius, who, being *empirics*, did not trouble themſelves about inquiring into the operation of remedies, provided their patients were cured.

23 His external applications.

Of the external remedies preſcribed by Hippocrates, fomentations were the chief. Theſe were of two kinds. The one was a ſort of bath, in which the patient ſat in a veſſel full of a decoction of ſimples appropriated to his malady; ſo that the part affected was ſoaked in the decoction. This was chiefly uſed in diſtempers of the womb, of the arms, the bladder, the reins, and generally all the parts below the diaphragm. The ſecond way of fomenting was, to take warm water and put it into a ſkin or bladder, or even

24 Fomentations.

into a copper or earthen veſſel, and to apply it to the part affected; as, for example, in a pleuriſy. They uſed likewiſe a large ſponge, which they dipped in the water or other hot liquor, and ſqueezed out part of the liquor before they applied it. The ſame uſe they made of barley, vetches, or bran, which were boiled in ſome proper liquor, and applied in a linen bag. Theſe are called *moiſt* fomentations. The dry ones were made of ſalt or millet, heated conſiderably, and applied to the part. Another kind of fomentation was the vapour of ſome hot liquor; an inſtance of which we find in his firſt book of the Diſtempers of Women. He caſt, at ſeveral times, bits of red-hot iron into urine, and, covering up the patient cloſe, cauſed her to receive the ſteam below. His deſign in theſe kinds of fomentations was to warm the part, to reſolve or diſſipate, and draw out the peccant matter, to mollify and aſſuage pain, to open the paſſages, or even to ſhut them, according as the fomentations were emollient or aſtringent.

Fumigations

Hippocrates.

25 Fumigations.

Fumigations were likewise very often used by Hippocrates. In the quinsy, he burned hyssop with sulphur and pitch, and caused the smoke to be drawn into the throat by a funnel; and by this means he brought away abundance of phlegm through the mouth and through the nose. For this purpose he took nitre, marjoram, and cress-seeds, which he boiled in water, vinegar, and oil, and, while it was on the fire, caused the patient to draw in the steam by a pipe. In his works we find a great number of fumigants for the distempers of women, to promote the menstrual flux, to check it, to help conception, and to ease pains in the matrix, or the suffocation of it. On these occasions he used such aromatics as were then known, viz. cinnamon, cassia, myrrh, and several odoriferous plants; likewise some minerals, such as nitre, sulphur, and pitch, and caused the patient to receive the vapours through a funnel into the uterus.

26 Gargles.

Gargles, a kind of fomentations for the mouth, were also known to Hippocrates. In the quinsy he used a gargle made of marjoram, savory, celery, mint, and nitre, boiled with water and a little vinegar. When this was strained, they added honey to it, and washed their mouths frequently with it.

27 Oils and ointments.

Oils and ointments were likewise much used by Hippocrates, with a view to mollify and abate pain, to ripen boils, resolve tumours, refresh after weariness, make the body supple, &c. For this purpose, sometimes pure oil of olives was used; sometimes certain simples were infused in it, as the leaves of myrtle and roses; and the latter kind of oil was in much request among the ancients. There were other sorts of oils sometimes in use, however, which were much more compounded. Hippocrates speaks of one named Susinum, which was made of the flowers of the iris, of some aromatics, and of an ointment of narcissus made with the flowers of narcissus and aromatics infused in oil. But the most compounded of all his ointments was that called *netopon*, which he made particularly for women; and consisted of a great number of ingredients. Another ointment, to which he gave the name of *ceratum*, was composed of oil and wax. An ointment which he recommends for the softening a tumor, and the cleansing a wound, was made by the following receipt: "Take the quantity of a nut of the marrow or fat of a sheep, of mastic or turpentine the quantity of a bean, and as much wax; melt these over a fire, with oil of roses, for a ceratum." Sometimes he added pitch and wax, and, with a sufficient quantity of oil, made a composition somewhat more consistent than the former, which he called *cerapissus*.

28 Cataplasms.

Cataplasms were a sort of remedies less consistent than the two former. They were made of powders or herbs steeped or boiled in water or some other liquor, to which sometimes oil was added. They were used with a view to soften or resolve tumors, ripen abscesses, &c. though they had also cooling cataplasms made of the leaves of beets or oak, fig or olive-trees, boiled in water.

29 Collyria.

Lastly, To complete the catalogue of the external remedies used by Hippocrates, we shall mention a sort of medicine called *collyrium*. It was compounded of powders, to which was added a small quantity of some ointment, or juice of a plant, to make a solid or dry mass; the form of which was long and round, which was kept for use. Another composition of much the same nature was a sort of lozenge of the bigness of a small piece of money, which was burnt upon coals for a perfume, and powdered for particular uses. In his works we find likewise descriptions of powders for several uses, to take off fungous flesh, and to blow into the eyes in ophthalmies, &c.

These were almost all the medicines used by Hippocrates for external purposes. The compound medicines given inwardly were either liquid, solid, or lambative. The liquid ones were prepared either by decoction or infusion in a proper liquor, which, when strained, were kept for use; or by macerating certain powders in such liquors, and so taking them together, or by mixing different kinds of liquors together. The solid medicines consisted of juices inspissated; of gums, resins, or powders, made up with them or with honey, or something proper to give the necessary consistence to the medicine. These were made up in a form and quantity fit to be swallowed with ease. The lambative was of a consistence between solid and fluid; and the patients were obliged to keep it for some time to dissolve in the mouth, that they might swallow it leisurely. This remedy was used to take off the acrimony of those humours which sometimes fall upon this part, and provoke coughing and other inconveniences. The basis of this last composition was honey. It is worth our observation, that the compound medicines of Hippocrates were but very few, and composed only of four or five ingredients at most; and that he not only understood pharmacy, or the art of compounding medicines, but prepared such as he used himself, or caused his servants prepare them in his house by his directions.

We have thus given some account of the state of medicine as practised and taught by Hippocrates, who, as we have already observed, has for many ages been justly considered as the father of physic. For when we attend to the state in which he found medicine, and the condition in which he left it, we can hardly bestow sufficient admiration on the judgment and accuracy of his observations. After a life spent in unwearied industry, he is said to have died at Larissa, a city in Thessaly, in the 101st year of his age, 361 years before the birth of Christ.

After the days of Hippocrates, medicine in ancient Greece gradually derived improvement from the labour of other physicians of eminence. And we may particularly mention three to whom its future progress seems to have been not a little indebted; viz. Praxagoras, Erasistratus, and Herophilus.

The first physician of eminence who differed consi- 30 Praxagoras. derably in his practice from Hippocrates was Praxagoras. Cœlius Aurelianus acquaints us, that he made great use of vomits in his practice, insomuch as to exhibit them in the iliac passion till the excrements were discharged by the mouth. In this distemper he also advised, when all other means failed, to open the belly, cut the intestine, take out the indurated fæces, and then to sew up all again; but this practice has not probably been followed by any subsequent physician.

Erasistratus was a physician of great eminence, 31 Erasistratus. and flourished in the time of Seleucus, one of the successors of Alexander the Great. According to Galen, Erasistratus.

Galen, he entirely banished venesection from medicine; though some affirm that he did not totally discard it, but only used it less frequently than other physicians. His reasons for disapproving of venesection are as follow: It is difficult to succeed in venesection, because we cannot always see the vein we intend to open, and because we are not sure but we may open an artery instead of a vein. We cannot ascertain the true quantity to be taken. If we take too little, the intention is by no means answered: if we take too much, we run a risk of destroying the patient. The evacuation of the venous blood also is succeeded by that of the spirits, which on that occasion he supposes to pass from the arteries into the veins. It must likewise, he contends, be observed, that as the inflammation is formed in the arteries by the blood coagulated in their orifices, venesection must of course be useless and of no effect.

As Erasistratus did not approve of venesection, so neither did he of purgatives, excepting very rarely, but exhibited clysters and vomits; as did also his master Chrysippus. He was of opinion, however, that the clysters should be mild; and condemned the large quantity and acrid quality of those used by preceding practitioners. The reason why purgatives were not much used by him was, that he imagined purging and venesection could answer no other purpose than diminishing the fulness of the vessels; and for this purpose he asserted that there were more effectual means than either phlebotomy or purging. He asserted that the humours discharged by cathartics were not the same in the body that they appeared after the discharge; but that the medicines changed their nature, and produced a kind of corruption in them. This opinion has since been embraced by a great number of physicians. He did not believe that purgatives acted by attraction; but substituted in the place of this principle what Mr Le Clerc imagines to be the same with Aristotle's *fuga vacui.* The principal remedy substituted by him in place of purging and venesection was abstinence. When this, in conjunction with clysters and vomits, was not sufficient to eradicate the disease, he then had recourse to exercise. All this was done with a view to diminish plenitude, which, according to him, was the most frequent cause of all diseases. Galen also informs us, that Erasistratus had so great an opinion of the virtues of succory in diseases of the viscera and lower belly, and especially in those of the liver, that he took particular pains to describe the method of boiling it, which was, to boil it in water till it was tender; then to put it into boiling water a second time, in order to destroy its bitterness; afterwards to take it out of the water, and preserve it in a vessel with oil; and lastly, when it is to be used, add a little weak vinegar to it. Nay, so minute and circumstantial was Erasistratus with regard to the preparation of his favourite succory, that he gave orders to tie several of the plants together, because that was the more commodious method of boiling them. The rest of Erasistratus's practice consisted almost entirely of regimen; to which he added some topical remedies, such as catapsalms, fomentations, and unctions. In short, as he could neither endure compounded medicines, nor superstitious and fine-spun reasonings, he reduced medicine to a very simple and compendious art.

Herophilus.

With regard to surgery, Erasistratus appears to have been very bold; and as an anatomist he is said to have been exceedingly cruel, insomuch that he is represented by some as having dissected criminals while yet alive *. In a scirrhous liver, or in tumors of that organ, Cœlius Aurelianus observes, that Erasistratus made an incision through the skin and integuments, and having opened the abdomen he applied medicines immediately to the part affected. But though he was thus bold in performing operations on the liver, yet he did not approve of the paracentesis or tapping in the dropsy; because (said he) the waters being evacuated, the liver, which is inflamed and become hard like a stone, is more pressed by the adjacent parts which the waters kept at a distance from it, so that by this means the patient dies. He declared also against drawing teeth which were not loose; and used to tell those who talked with him on this operation, That in the temple of Apollo there was to be seen an instrument of lead for drawing teeth; in order to insinuate that we must not attempt the extirpation of any but such as are loose, and call for no greater force for their extirpation than what may be supposed in an instrument of lead.

* See Anatomy, *Hist.*

32 Herophilus.

Herophilus, the disciple of Praxagoras, and contemporary of Erasistratus, followed a less simple practice: he made so great use of medicines both simple and compound, that neither he nor his disciples would undertake the cure of any disorder without them. He seems also to have been the first who treated accurately of the doctrine of pulses, of which Hippocrates had but a superficial knowledge. Galen, however, affirms, that on this subject he involved himself in difficulties and advanced absurdities; which indeed we are not greatly to wonder at, considering the time in which he lived. He took notice of a disease at that time pretty rare, and to which he ascribes certain sudden deaths. He calls it a *palsy of the heart*; and perhaps it may be the same disease with what is now termed the *angina pectoris*.

According to Celsus, it was about this time that medicine was first divided into three branches, viz. the dietetic, the pharmaceutical, and the chirurgical medicine. The first of these employed a proper regimen in the cure of diseases; the second, medicines; and the third, the operation of the hands. The same author informs us, that these three branches became now the business of as many distinct classes of men; so that from this time we may date the origin of the three professions of physicians, apothecaries, and surgeons.—Before this division, those called *physicians* discharged all the several offices belonging to the three professions; and there were only two kinds of them, viz. one called ἀρχιτεκτονικοι, who gave only their advice to the patients, and directions to those of an inferior class, who were called δημιουργοι, and worked with their hands either in the performing operations, or in the composition and application of remedies.

33 The Empirics.

The first grand revolution which happened in the medicinal art, after the days of Herophilus and Erasistratus, was occasioned by the founding of the empiric sect by Serapion of Alexandria about 287 years before Christ. The division into dogmatists and empirics had indeed subsisted before; but about this time the latter party began to grow strong, and to have cham-

34 Serapion.

Serapion

pions publicly aſſerting its cauſe. Galen informs us, that Serapion uſed Hippocrates very ill in his writings, in which he diſcovered an exceſs of pride, ſelf-ſufficiency, and contempt for all the phyſicians that went before him. We have ſome ſketches of his practice in Cœlius Aurelianus, from which we may infer that he retained the medicines of Hippocrates and the other phyſicians who went before him, though he rejected their reaſoning. We know not what arguments he advanced for the ſupport of his ſentiments, ſince his works are loſt, as well as thoſe of the other empirics; and we ſhould know nothing at all of any of them, if their adverſaries had not quoted them in order to confute them.

The empirics admitted only one general method of obtaining ſkill in the medical art, which was by experience, called by the Greeks εμπειρια. From this word they took their name, and refuſed to be called after the founder or any champion of their ſect. They defined experience a knowledge derived from the evidence of ſenſe. It was either fortuitous, or acquired by deſign. For acquiring practical ſkill they recommended what they called τηρησις, or one's own obſervation, and the reading of hiſtories or caſes faithfully related by others. Hence they thought that we might be enabled to know a diſeaſe by its reſemblance to others; and, when new diſeaſes occurred, to conclude what was proper to be done from the ſymptoms they had in common with others that were before known. They aſſerted, that obſervation ought principally to be employed in two different ways; firſt in diſcovering what things are ſalutary, and what are of an indifferent nature; and, ſecondly, what particular diſeaſe is produced by a certain concurrence of ſymptoms; for they did not call every ſymptom a diſeaſe, but only ſuch a combination of them as from long experience they found to accompany each other, and produced ſuch diſorders as began and terminated in the ſame manner.

On the other hand, the dogmatiſt affirmed, that there was a neceſſity for knowing the latent as well as the evident cauſes of diſeaſes, and that the phyſician ought to underſtand the natural actions and functions of the human body, which neceſſarily preſuppoſes a knowledge of the internal parts. By ſecret or latent cauſes they meant ſuch as related to the elements or principles of which our bodies are compoſed, and which are the origin of a good or bad ſtate of health. They aſſerted that it was impoſſible to know how to cure a diſeaſe without knowing the cauſe whence it proceeded; becauſe undoubtedly it behoved diſeaſes to vary prodigiouſly in themſelves according to the different cauſes by which they were produced.

35 Aſclepiades.

The next remarkable perſon in the hiſtory of phyſic is Aſclepiades, who flouriſhed in the century immediately preceding the birth of Chriſt. He introduced the philoſophy of Democritus and Epicurus into medicine, and ridiculed the doctrines of Hippocrates. He aſſerted, that matter conſidered in itſelf was of an unchangeable nature; and that all perceptible bodies were compoſed of a number of ſmaller ones, between which there were interſperſed an infinity of ſmall ſpaces totally void of all matter. He thought that the ſoul itſelf was compoſed of theſe ſmall bodies. He laughed at the principle called *Nature* by Hippocrates, and alſo at the imaginary faculties ſaid by him to be ſubſervient to her; and ſtill more at what he called *Attraction*. This laſt principle Aſclepiades denied in every inſtance, even in that of the loadſtone and ſteel, imagining that this phenomenon proceeded from a concourſe of corpuſcles, and a particular diſpoſition or modification of their pores. He alſo maintained, that nothing happened or was produced without ſome cauſe; and that what was called *nature* was in reality no more than *matter* and *motion*. From this laſt principle he inferred that Hippocrates knew not what he ſaid when he ſpoke of Nature as an intelligent being, and aſcribed qualities of different kinds to her. For the ſame reaſon he ridiculed the doctrine of Hippocrates with regard to criſes; and aſſerted that the termination of diſeaſes might be as well accounted for from mere matter and motion. He maintained, that we were deceived if we imagined that nature always did good; ſince it was evident that ſhe often did a great deal of harm. As for the days particularly fixed upon by Hippocrates for criſes, or thoſe on which we uſually obſerve a change either for the better or the worſe, Aſclepiades denied that ſuch alterations happened on thoſe days rather than on others. Nay, he aſſerted that the criſis did not happen at any time of its own accord, or by the particular determination of nature for the cure of the diſorder, but that it depended rather on the addreſs and dexterity of the phyſician; that we ought never to wait till a diſtemper terminates of its own accord, but that the phyſician by his care and medicines muſt haſten on and advance the cure.—According to him, Hippocrates and other ancient phyſicians attended their patients rather with a view to obſerve in what manner they died than in order to cure them; and this under pretence that Nature ought to do all herſelf, without any aſſiſtance.

According to Aſclepiades, the particular aſſemblage of the various corpuſcles above mentioned, and repreſented as of different figures, is the reaſon why there are ſeveral pores or interſtices within the common maſs, formed by theſe corpuſcles; and why theſe pores are of a different ſize. This being taken for granted, as theſe pores are in all the bodies we obſerve, it muſt of courſe follow that the human body has ſome peculiar to itſelf, which, as well as thoſe of all other bodies, contain certain minute bodies, which paſs and repaſs by thoſe pores that communicate with each other; and as theſe pores or interſtices are larger or ſmaller, ſo the corpuſcles which paſs through them differ proportionably as to largeneſs and minuteneſs. The blood conſiſts of the largeſt of theſe corpuſcles, and the ſpirits, or the heat, of the ſmalleſt.

From theſe principles he infers, that as long as the corpuſcles are freely received by the pores, the body remains in its natural ſtate; and on the contrary, it begins to recede from that ſtate, when the corpuſcles find any obſtacle to their paſſage. Health therefore depends on the juſt proportion between the pores and the corpuſcles they are deſtined to receive and tranſmit; as diſeaſes, on the contrary, proceed from a diſproportion between theſe pores and the corpuſcles. The moſt uſual obſtacle on this occaſion proceeds from the corpuſcles embracing each other, and being retained in ſome of their ordinary paſſages, whether theſe corpuſcles

Asclepiades. cles arrive in too large a number, are of irregular figures, move too fast or too slow, &c.

Among the diseases produced by the corpuscles stopping of their own accord, Asclepiades reckoned phrensies, lethargies, pleurisies, and burning fevers. Pains, in particular, are classed among the accidents which derive their origin from a stagnation of the largest of all the corpuscles of which the blood consists. Among the disorders produced by the bad state and disposition of the pores, he placed deliquiums, languors, extenuations, leanness, and dropsies. These last disorders he thought proceeded from the pores being too much relaxed and opened: the dropsy in particular, he thinks, proceeds from the flesh being perforated with various small holes, which convert the nourishment received into them into water. Hunger, and especially that species of it called *fames canina*, proceeds from an opening of the large pores of the stomach and belly; and thirst from an opening of their small ones. Upon the same principles he accounted for intermittent fevers. According to him, quotidian fevers are caused by a retention of the largest corpuscles, those of the tertian kind by a retention of corpuscles somewhat smaller, and quartan fevers are produced by a retention of the smallest corpuscles of all.

The practice of Asclepiades was suited to remove these imaginary causes of disorders. He composed a book concerning common remedies, which he principally reduced to three, viz. gestation, friction, and the use of wine. By various exercises he proposed to render the pores more open, and to make the juices and small bodies, which cause diseases by their retention, pass more freely; and while the former physicians had not recourse to gestation till towards the end of long continued disorders, and when the patients, though entirely free from fever, were yet too weak to take sufficient exercise by walking, Asclepiades used gestation from the very beginning of the most burning fevers. He laid it down as a maxim, that one fever was to be cured by another; that the strength of the patient was to be exhausted by making him watch and endure thirst to such a degree, that, for the two first days of the disorder, he would not allow them to cool their mouths with a drop of water. Celsus also observes, that though Asclepiades treated his patients like a butcher during the first days of the disorder, he indulged them so far afterwards as even to give directions for making their beds in the softest manner. On several occasions Asclepiades used frictions to open the pores. The dropsy was one of the distempers in which this remedy was used; but the most singular attempt was, by this means, to lull phrenetic patients asleep. But though he enjoined exercise so much to the sick, he denied it to those in health; a conduct not a little surprising and extraordinary. He allowed wine freely to patients in fevers, provided the violence of the distemper was somewhat abated. Nor did he forbid it to those who were afflicted with a phrensy: nay, he ordered them to drink it till they were intoxicated, pretending by that means to make them sleep; because, he said, wine had a narcotic quality and procured sleep, which he thought absolutely necessary for those who laboured under that disorder. To lethargic patients he used it on purpose to excite them, and rouse their senses: he also made them smell strong-scented substances, Asclepiades, &c.
such as vinegar, castor, and rue, in order to make them sneeze; and applied to their heads cataplasms of mustard made up with vinegar.

Besides these remedies, Asclepiades enjoined his patients abstinence to an extreme degree. For the first three days, according to Celsus, he allowed them no aliment whatever, but on the fourth began to give them victuals. According to Cælius Aurelianus, however, he began to nourish his patients as soon as the accession of the disease was diminished, not waiting till an entire remission; giving to some aliments on the first, and some on the second, to some on the third, and so on to the seventh day. It seems almost incredible to us, that people should be able to fast till this last-mentioned term; but Celsus assures us, that abstinence till the seventh day was enjoined even by the predecessors of Asclepiades.

The next great revolution which happened in the medicinal art, was brought about by Themison, the disciple of Asclepiades, who lived not long before the time of Celsus, during the end of the reign of Augustus, or beginning of that of Tiberius. The sect founded by him was called *methodic*, because he endeavoured 36 Methodic
to find a method of rendering medicine more easy than sect.
formerly.

He maintained, that a knowledge of the causes of 37 Themison.
diseases was not necessary, provided we have a due regard to what diseases have in common and analogous to one another. In consequence of this principle, he divided all diseases into two, or at most three, kinds. The first included diseases arising from stricture; the second, those arising from relaxation; and the third, those of a mixed nature, or such as partook both of stricture and relaxation.

Themison also asserted, that diseases are sometimes acute, and sometimes chronical; that for a certain time they increase; that at a certain time they are at their height; and that at last they were observed to diminish. Acute diseases, therefore, according to him, must be treated in one way, and chronical diseases in another; one method must be followed with such as are in their augmentation, another with such as are at their height, and a third with such as are in their declension. He asserted that the whole of medicine consisted in the observation of that small number of rules which are founded upon things altogether evident. He said, that all disorders, whatever their nature was, if included under any of the kinds above mentioned, ought to be treated precisely in the same way, in whatever country and with whatever symptoms they happen to arise. Upon these principles he defined medicine to be a method of conducting to the knowledge of what diseases have in common with each other.

Themison was old when he laid the foundation of the methodic sect; and it was only brought to perfec-
tion by Thessalus, who lived under the emperor Nero. 38 Thessalus.
Galen and Pliny accuse this physician of intolerable insolence and vanity, and report that he gave himself the air of despising all other physicians; and so intolerable was his vanity, that he assumed the title of *the conqueror of physicians*, which he caused to be put upon his tomb in the Appian way. Never was mountebank (says Pliny) attended by a greater number of

Thessalus, &c. spectators than Thessalus had generally about him; and this circumstance is the less to be wondered at, if we consider that he promised to teach the whole art of medicine in less than six months. In reality, the art might be learned much sooner if it comprehended no more than what the methodics thought necessary: for they cut off the examination of the causes of diseases followed by the dogmatics; and substituted in the room of the laborious observations of the empirics, indications drawn from the analogy of diseases, and the mutual resemblance they bear to each other. The

39 Soranus. most skilful of all the methodic sect, and he who put the last hand to it, was Soranus. He lived under the emperors Trajan and Adrian, and was a native of Ephesus.

40 Celsus. One of the most celebrated medical writers of antiquity was Celsus, whom we have already had occasion to mention. Most writers agree that he lived in the time of Tiberius, but his country is uncertain. It is even disputed whether or not he was a professed physician. Certain it is, however, that his books on medicine are the most valuable of all the ancients next to those of Hippocrates. From the latter, indeed, he has taken so much, as to acquire the name of the *Latin Hippocrates*; but he has not attached himself to him so closely as to reject the assistance of other authors. In many particulars he has preferred Asclepiades. With him he laughs at the critical days of Hippocrates, and ascribes the invention of them to a foolish and superstitious attachment to the Pythagorean doctrine of numbers. He also rejected the doctrine of Hippocrates with regard to venesection, of which he made a much more general use; but did not take away so much blood at a time, thinking it much better to repeat the operation than weaken the patient by too great an evacuation at once. He used cupping also much more frequently, and differed from him with regard to purgatives. In the beginning of disorders, he said, the patients ought to endure hunger and thirst: but afterwards they were to be nourished with good aliments; of which, however, they were not to take too much, nor fill themselves suddenly, after having fasted long. He does not specify how long the patient ought to practise abstinence; but affirms, that in this particular it is necessary to have a regard to the disease, the patient, the season, the climate, and other circumstances of a like nature. The signs drawn from the pulse he looked upon to be very precarious and uncertain. "Some (says he) lay great stress upon the beating of the veins or the arteries; which is a deceitful circumstance, since that beating is slow or quick, and varies very much, according to the age, sex, and constitution of the patient. It even sometimes happens that the pulse is weak and languid when the stomach is disordered, or in the beginning of a fever. On the contrary, the pulse is often high, and in a violent commotion, when one has been exposed to the sun, or comes out of a bath, or from using exercise; or when one is under the influence of anger, fear, or any other passion. Besides, the pulse is easily changed by the arrival of the physician, in consequence of the patient's anxiety to know what judgment he will pass upon his case. To prevent this, the physician must not feel the patient's pulse on his first arrival: he must first sit down by him, assume a cheerful air, inform himself of his condition; and if he is under any dread, endeavour to remove it by encouraging discourse; after which he may examine the beating of the artery. This, nevertheless, does not hinder us from concluding, that if the sight of the physician alone can produce so remarkable a change in the pulse, a thousand other causes may produce the same effect." But although Celsus thought for himself, and in not a few particulars differed from his predecessors, yet in his writings, which are not only still preserved, but have gone through almost innumerable editions, we have a compendious view of the practice of almost all his predecessors: and he treats of the healing art in all its branches, whether performed *manu, victu, vel medicamentis*. His writings, therefore, will naturally be consulted by every one who wishes either to become acquainted with the practice of the ancients prior to the fall of the Roman empire, or to read medical Latin in its greatest purity.

About the 131st year after Christ, in the reign of the emperor Adrian, lived the celebrated Galen, a native of Pergamus, whose name makes such a conspicuous figure in the history of physic. At this time the dogmatic, empiric, methodic, and other sects, had each their abettors. The methodics were held in great esteem, and looked upon to be superior to the dogmatics, who were strangely divided among themselves, some of them following Hippocrates, others Erasistratus, and others Asclepiades. The empirics made the least considerable figure of any. Galen undertook the reformation of medicine, and restored dogmatism. He seems to have been of that sect which was called *eclectic*, from their choosing out of different authors what they esteemed good in them, without being particularly attached to any one more than the rest. This declaration he indeed sets out with; but, notwithstanding this, he follows Hippocrates much more than any other, or rather follows nobody else but him. Though before his time several physicians had commented on the works of Hippocrates, yet Galen pretends that none of them had understood his meaning. His first attempt, therefore, was to explain the works of Hippocrates; with which view he wrote a great deal, and after this set about composing a system of his own. In one of his books entitled, "Of the establishment of medicine," he defines the art to be one which teaches to preserve health and cure diseases. In another book, however, he proposes the following definition: "Medicine (says he) is a science which teaches what is sound, and what is not so; and what is of an indifferent nature, or holds a medium between what is sound and what is the reverse." He affirmed, that there are three things which constitute the object of medicine, and which the physician ought to consider as sound, as not sound, or of a neutral and indifferent nature. These are the body itself, the signs, and the causes. He esteems the human body sound, when it is in a good state or habit with regard to the simple parts of which it is composed, and when besides there is a just proportion between the organs formed of these simple parts. On the contrary, the body is reckoned to be unsound, when it recedes from this state, and the just proportion above mentioned. It is in a state of neutrality or indifference, when it is in a medium between soundness and its opposite state. The salutary signs

Celsus, &c.

41 Galen.

Galen.

signs are such as indicate present health, and prognosticate that the man may remain in that state for some time to come. The insalubrious signs, on the contrary, indicate a present disorder, or lay a foundation for suspecting the approach of one. The neutral signs, or such as are of an indifferent nature, denote neither health nor indisposition, either for the present, or for the time to come. In like manner he speaks of causes salutary, unsalutary, and indifferent.

These three dispositions of the human body, that is, soundness, its reverse, and a neutral state, comprehend all the differences between health and disorder or indisposition: and each of these three states or dispositions has a certain extent peculiar to itself. A sound habit of body, according to the definition of it already given, is very rare, and perhaps never to be met with; but this does not hinder us to suppose such a model for regulating our judgment with respect to different constitutions. On this principle Galen establishes eight other principal constitutions, all of which differ more or less from the perfect model above mentioned. The four first are such as have one of the four qualities of hot, cold, moist, or dry, prevailing in too great a degree; and accordingly receive their denomination from that quality which prevails over the rest. The four other species of constitutions receive their denominations from a combination of the above mentioned; so that, according to his definition, there may be a hot and dry, a hot and moist, a cold and moist, and a cold and dry, constitution. Besides these differences, there are certain others which result from occult and latent causes, and which, by Galen, are said to arise from an *idiosyncrasy* of constitution. It is owing to this idiosyncrasy that some have an aversion to one kind of aliment and some to another; that some cannot endure particular smells, &c. But though these eight last-mentioned constitutions fall short of the perfection of the first, it does not thence follow, that those to whom they belong are to be classed among the valetudinary and diseased. A disease only begins when the deviation becomes so great as to hinder the due action of some parts.

Galen describes at great length the signs of a good or bad constitution, as well as those of what he calls a *neutral habit*. These signs are drawn from the original qualities of cold, hot, moist, and dry, and from their just proportion or disproportion with respect to the bulk, figure, and situation, of the organical parts. With Hippocrates he establishes three principles of an animal body; the parts, the humours, and the spirits. By the parts he properly meant no more than the solid parts; and these he divided into similar and organical. Like Hippocrates, he also acknowledged four humours; the blood, the phlegm, the yellow bile and black bile. He established three different kinds of spirits; the natural, the vital, and the animal. The first of these are, according to him, nothing else but a subtle vapour arising from the blood, which draws its origin from the liver, the organ or instrument of sanguification. After these spirits are conveyed to the heart, they, in conjunction with the air we draw into the lungs, become the matter of the second species, that is, of the vital spirits, which are again changed into those of the animal kind in the brain. He supposed that these three species of spirits served as instruments to three kinds of faculties, which reside in the respective parts where these faculties are formed. The natural faculty is the first of these, which he placed in the liver, and imagined to preside over the nutrition, growth, and generation, of the animal. The vital faculty he lodged in the heart, and supposed that by means of the arteries it communicated warmth and life to all the body. The animal faculty, the noblest of all the three, and with which the reasoning or governing faculty was joined, according to him, has its seat in the brain; and, by means of the nerves, distributes a power of motion and sensation to all the parts, and presides over all the other faculties. The original source or principle of motion in all these faculties, Galen, as well as Hippocrates, defines to be *Nature*.

Galen.

Upon these principles Galen defined a disease to be "such a preternatural disposition or affection of the parts of the body, as primarily, and of itself, hinders their natural and proper action." He established three principal kinds of diseases: the first relates to the similar parts; the second, to the organical; and the third is common to both these parts. The first kind of diseases consists in the intemperature of the similar parts; and this is divided into an intemperature *without matter*, and an intemperature *with matter*. The first discovers itself when a part has more or less heat or cold than it ought to have without that change of quality in the part being supported and maintained by any matter. Thus, for instance, a person's head may be overheated and indisposed by being exposed to the heat of the sun, without that heat being maintained by the continuance or congestion of any hot humour in the part. The second sort of intemperature is when any part is not only rendered hot or cold, but also filled with a hot or cold humour, which are the causes of the heat or cold felt in the part. Galen also acknowledged a simple intemperature: that is, when one of the original qualities, such as heat or cold, exceeds the natural standard alone and separately; and a compound intemperature, when two qualities are joined together, such as heat and dryness, or coldness and humidity. He also established an equal and unequal temperature. The former is that which is equally in all the body, or in any particular part of it, and which creates no pain, because it is become habitual, such as dryness in the hectic constitution. The latter is distinguished from the former, in that it does not equally subsist in the whole of the body, or in the whole of a part. Of this kind of intemperature we have examples in certain fevers, where heat and cold, equally, and almost at the same time, attack the same part; or in other fevers which render the surface of the body cold as ice, while the internal parts burn with heat; or, lastly, in cases where the stomach is cold and the liver hot.

The second kind of disorders, relating to the organical parts, results from irregularities of these parts, with respect to the number, bulk, figure, situation, &c. as when one has six fingers, or only four; when one has any part larger or smaller than it ought to be, &c. The third kind, which is common both to the similar and the organical parts, is a solution of continuity, which happens when any similar or compound part is cut, bruised, or corroded.

Galen.

Like Hippocrates, Galen diſtinguiſhed diſeaſes into acute and chronical; and, with reſpect to their nature and genius, into benign and malignant; alſo into epidemic, endemic, and ſporadic.

After having diſtinguiſhed the kinds of diſeaſes, Galen comes to explain their cauſes; which he divides into external and internal. The external cauſes of diſeaſes, according to him, are ſix things, which contribute to the preſervation of health when they are well diſpoſed and properly uſed, but produce a contrary effect when they are imprudently uſed or ill diſpoſed. Theſe ſix things are, the air, aliments and drink, motion and reſt, ſleeping and watching, retention and excretion, and laſtly the paſſions. All theſe are called the *procatarctic* or *beginning* cauſes, becauſe they put in motion the internal cauſes; which are of two kinds, the *antecedent* and the *conjunct*. The former is diſcovered only by reaſoning; and conſiſts for the moſt part in a peccancy of the humours, either by plenitude or cacochymy, i. e. a bad ſtate of them. When the humours are in too large a quantity, it is called a *plethora;* but we muſt obſerve, that this word equally denotes too large a quantity of all the humours together, or a redundance of one particular humour which prevails over the reſt. According to theſe principles, there may be a ſanguine, a bilious, a pituitous, or a melancholy plenitude: but there is this difference between the ſanguine and the three other plenitudes, that the blood, which is the matter of the former, may far ſurpaſs the reſt: whereas, if any of the three laſt-mentioned ones do ſo, the caſe is no longer called *plenitude*, but *cacochymia;* becauſe theſe humours, abounding more than they ought, corrupt the blood. The cauſes he alſo divides into ſuch as are manifeſt and evident, and ſuch as are latent and obſcure. The firſt are ſuch as ſpontaneouſly come under the cognizance of our ſenſes when they act or produce their effects: the ſecond are not of themſelves perceptible, but may be diſcovered by reaſoning: the third ſort, i. e. ſuch as he calls *occult* or *concealed*, cannot be diſcovered at all. Among this laſt he places the cauſe of the hydrophobia.

He next proceeds to conſider the ſymptoms of diſeaſes. A ſymptom he defines to be "a preternatural affection depending upon a diſeaſe, or which follows it as a ſhadow does a body." He acknowledged three kinds of ſymptoms: the firſt and moſt conſiderable of theſe conſiſted in the action of the parts being injured or hindered; the ſecond in a change of the quality of the parts, their actions in the mean time remaining entire: the third related to defects in point of excretion and retention.

After having treated of ſymptoms, Galen treats of the *ſigns* of diſeaſes. Theſe are divided into *diagnoſtic* and *prognoſtic*. The firſt are ſo called becauſe they enable us to know diſeaſes, and diſtinguiſh them from each other. They are of two ſorts, *pathognomonic* or *adjunct*. The firſt are peculiar to every diſeaſe, make known its preciſe ſpecies, and always accompany it, ſo that they begin and end with it. The ſecond are common to ſeveral diſeaſes, and only ſerve to point out the difference between diſeaſes of the ſame ſpecies. In a pleuriſy, for inſtance, the pathognomonic ſigns are a cough, a difficulty of breathing, a pain of the ſide, and a continued fever; the adjunct ſigns are the various ſorts of matter expectorated, which is ſometimes bloody, ſometimes bilious, &c.—The diagnoſtic ſigns were drawn from the defective or diſordered diſpoſition of the parts, or from the diſeaſes themſelves; ſecondly, from the cauſes of diſeaſes; thirdly, from their ſymptoms; and laſtly, from the particular diſpoſitions of each body, from things which prove prejudicial and thoſe that do ſervice, and from epidemical diſeaſes.—The prognoſtic ſigns he gathered from the ſpecies, virulence, and peculiar genius of the diſeaſe: but as we have already ſpoken ſo largely concerning the prognoſtics of Hippocrates, it is ſuperfluous to be particular on thoſe of Galen.—His method of cure differed little from that of Hippocrates: but from the ſpecimen already given of Galen's method of teaching the medical art, it is evident that his ſyſtem was little elſe than a collection of ſpeculations, diſtinctions, and reaſonings; whereas that of Hippocrates was founded immediately upon facts, which he had either obſerved himſelf, or had learned from the obſervation of others.

Oribaſius, &c.

The ſyſtem of Galen, however, notwithſtanding its defects and abſurdities, remained almoſt uncontradicted for a very long period. Indeed it may be conſidered as having been the prevailing ſyſtem till the inundation of the Goths and Vandals put an almoſt entire ſtop to the cultivation of letters in Europe. But during the general prevalence of the ſyſtem of Galen, there appeared ſome writers to whom medicine was indebted for improvements, at leaſt in certain particulars. Among the moſt diſtinguiſhed of theſe we may mention Oribaſius, Ætius, Alexander, and Paulus.

42 Oribaſius.

Oribaſius flouriſhed about the year 360, and was phyſician to the emperor Julian. He ſpeaks very fully of the effects of bleeding by way of ſcarification, a thing little taken notice of by former writers; from his own experience he aſſures us that he had found it ſucceſsful in a ſuppreſſion of the menſes, defluxions of the eyes, headach, and ſtraitneſs of breathing even when the perſon was extremely old. He tells his own caſe particularly, when the plague raged in Aſia and he himſelf was taken ill. On the ſecond day he ſcarified his leg, and took away two pounds of blood; by which means he entirely recovered, as did ſeveral others who uſed it. In this author alſo we find the firſt deſcription of a ſurpriſing and terrible diſtemper, which he termed λυκανθρωπια, a ſpecies of melancholy and madneſs, which he deſcribes thus. "The perſons affected get out of their houſes in the night-time, and in every thing imitate wolves, and wander among the ſepulchres of the dead till day-break. You may know them by theſe ſymptoms: Their looks are pale; their eyes heavy, hollow, dry, without the leaſt moiſture of a tear; their tongue exceedingly parched and dry, no ſpittle in their mouth, extreme thirſt; their legs, from the falls and the bruiſes they receive, full of incurable ſores and ulcers."

43 Ætius.

Ætius lived very near the end of the fifth, or in the beginning of the ſixth century. Many paſſages in his writings ſerve to ſhow us how much the actual and potential cautery were uſed by the phyſicians of that age. In a palſy, he ſays, that he ſhould not at all heſitate to make an eſchar either way, and this in ſeveral places; one in the nape, where the ſpinal marrow takes its riſe, two on each ſide of it; three or

Alexander. four on the top of the head, one juſt in the middle, and three others round it. He adds, that in this caſe, if the ulcers continue running a conſiderable time, he ſhould not doubt of a perfect recovery. He is ſtill more particular when he comes to order this application for an inveterate aſthma, after all other remedies have been tried in vain. One, he ſays, ſhould be made on each ſide near the middle of the joining of the clavicle, taking care not to touch the wind-pipe: two other little ones are then to be made near the carotids under the chin, one on each ſide, ſo that the cauſtic may penetrate no further than the ſkin; two others under the breaſts, between the third and fourth ribs; and again, two more backwards towards the fifth and ſixth ribs. Beſides theſe there ought to be one in the middle of the thorax, near the beginning of the xiphoid cartilage, over the orifice of the ſtomach; one on each ſide between the eighth and ninth ribs; and three others in the back, one in the middle, and the two others juſt below it, on each ſide of the vertebræ. Thoſe below the neck ought to be pretty large, not very ſuperficial, not very deep: and all theſe ulcers ſhould be kept open for a very long time.

Ætius takes notice of the worms bred in different parts of the body, called *dracunculi*, which were unknown to Galen. He ſeems alſo to be the firſt Greek writer among the Chriſtians, who gives us any ſpecimen of medicinal ſpells and charms; ſuch as that of a finger of St Blaſius for removing a bone which ſticks in the throat, and another in relation to a fiſtula. He gives a remedy for the gout, which he calls the *grand drier;* the patient is to uſe it for a whole year, and obſerve the following diet each month. "In September, he muſt eat and drink milk: In October he muſt eat garlic; in November, abſtain from bathing; in December, he muſt eat no cabbage; in January, he is to take a glaſs of pure wine in the morning; in February, to eat no beet; in March, to mix ſweet things both in eatables and drinkables; in April, not to eat horſe-radiſh, nor in May the fiſh called *polypus;* in June, he is to drink cold water in a morning; in July, to avoid venery; and laſtly, in Auguſt, to eat no mallows." This may ſufficiently ſhow the quackery of thoſe times, and how ſuperſtition was beginning to mix itſelf with the art.

44 Alexander. Alexander, who flouriſhed in the reign of Juſtinian, is a more original author than either of the two former. He confines himſelf directly to the deſcribing the ſigns of diſeaſes, and the methods of cure, without meddling with anatomy, the materia medica, or ſurgery, as all the reſt did. He employs a whole book in treating of the gout. One method he takes of relieving this diſeaſe is by purging; and in moſt of the purges he recommends hermodactyls, of which he has a great opinion. In a cauſus, or burning fever, where the bile is predominant, the matter fit for evacuation, and the fever not violent, he prefers purging to bleeding, and ſays that he has often ordered purging in acute fevers with ſurpriſing ſucceſs. In the cauſus alſo, if a ſyncope happens from crude and redundant humours, he recommends bleeding. In a ſyncope ſucceeding the ſuppreſſion of any uſual evacuation, he recommends bleeding, with frictions. The diagnoſtics upon which he founds this practice are the following: viz. a face paler and more ſwelled than uſual, a bloated habit of body, with a ſmall ſluggiſh pulſe, having long intervals between the ſtrokes. In tertian, and much more in quartan fevers, he recommends vomits above all other remedies, and affirms that by this remedy alone he has cured the moſt inveterate quartans. On the bulimus, or canine appetite, he makes a new obſervation, viz. that it is ſometimes cauſed by worms. He mentions the caſe of a woman who laboured under this ravenous appetite, and had a perpetual gnawing at her ſtomach and pain in her head: after taking *hiera*, ſhe voided a worm above a dozen of cubits long, and was entirely cured of her complaints.—He is alſo the firſt author who takes notice of *rhubarb;* which he recommends in a weakneſs of the liver and in dyſentery.—Alexander is recommended by Dr Freind as one of the beſt practical writers among the ancients, and well worthy the peruſal of any modern.

Arabian Phyſicians.

45 Paulus. Paulus was born in the iſland Ægina, and lived in the 7th century. He tranſcribes a great deal from Alexander and other phyſicians. His deſcriptions are ſhort and accurate. He treats particularly of women's diſorders; and ſeems to be the firſt inſtance upon record of a profeſſed *man-midwife*, for ſo he was called by the Arabians: and accordingly he begins his book with the diſorders incident to pregnant women. He treats alſo very fully of ſurgery; and gives ſome directions, according to Dr Freind, not to be found in the more ancient writers.

46 Arabian phyſicians. After the downfal of the Roman empire, and when the inundation of Goths and Vandals had almoſt completely exterminated literature of every kind in Europe, medicine, though a practical art, ſhared the ſame fate with more abſtract ſciences. Learning in general, baniſhed from the ſeat of arms, took refuge among the eaſtern nations, where the arts of peace ſtill continued to be cultivated. To the Arabian phyſicians, as they have been called, we are indebted both for the preſervation of medical ſcience, as it ſubſiſted among the Greeks and Romans, and likewiſe for the deſcription of ſome new diſeaſes, particularly the ſmall-pox. Among the moſt eminent of the Arabians, we may mention Rhaſes, Avicenna, Albucaſis, and Aven- 47 Rhaſes.
zoar. But of their writings it would be tedious, and is unneceſſary, to give any particular account.—They were for the moſt part, indeed, only copiers of the Greeks. We are, however, indebted to them for ſome improvements. They were the firſt who introduced chemical remedies, though of theſe they uſed but few, nor did they make any conſiderable progreſs in the chemical art. Anatomy was not in the leaſt improved by them, nor did ſurgery receive any advancement till the time of Albucaſis, who lived probably in the 12th century. They added a great deal to botany and the materia medica, by the introduction of new drugs, of the aromatic kind eſpecially, from the eaſt, many of which are of conſiderable uſe. They alſo found out the way of making ſugar; and by help of that, ſyrups; which two new materials are of great uſe in mixing up compound medicines.

With regard to their practice, in ſome few particulars they deviated from the Greeks. Their purging medicines were much milder than thoſe formerly in uſe; and even when they did preſcribe the old ones, they gave them in a much leſs doſe than the Greek and Roman phyſicians. The ſame reflection may be made concerning

Arabian Physicians. concerning their manner of bleeding, which was never to that excessive degree practised by the Greeks. They deviated from Hippocrates, however, in one very trivial circumstance, which produced a violent controversy. The question was, Whether blood in a pleurisy ought to be drawn from the arm of the affected side or the opposite? Hippocrates had directed it to be drawn from the arm of the affected side; but the Arabians, following some other ancient physicians, ordered it to be drawn from the opposite one. Such was the ignorance of those ages, that the university of Salamanca in Spain made a decree, than no one should dare to let blood but in the contrary arm; and endeavoured to procure an edict from the emperor Charles V. to second it; alleging that the other method was of no less pernicious consequence to medicine, than Luther's heresy had been to religion.

In consequence of the general decay of learning in the western parts of the world, the Greek writers were entirely neglected, because nobody could read the language; and the Arabians, though principally copiers from them, enjoyed all the reputation that was due to the others. The Arabian physic was introduced into Europe very early, with the most extravagant applause: and not only this, but other branches of their learning, came into repute in the west; insomuch that in the 11th century, the studies of natural philosophy and the liberal arts were called *the studies of the Saracens*. This was owing partly to the crusades undertaken against them by the European princes; and partly to the settlement of the Moors in Spain, and the intercourse they and other Arabians had with the

48 College of Salernum. Italians. For, long before the time of the crusades, probably in the middle of the 7th century, there were Hebrew, Arabic, and Latin professors of physic settled at Salernum: which place soon grew into such credit, that Charles the Great thought proper to found a college there in the year 802; the only one at that

49 Constantine. time in Europe. Constantine the African flourished there towards the latter end of the 11th century. He was a native of Carthage; but travelled into the east, and spent 30 years in Babylon and Bagdad, by which means he became master of the oriental languages and learning. He returned to Carthage; but being informed of an attempt against his life, made his escape into Apulia, where he was recommended to Robert Guiscard, created in 1060 duke of that country, who made him his secretary. He was reputed to be very well versed in the Greek, as well as in the eastern tongues; and seems to have been the first who introduced either the Greek or Arabian physic into Italy. His works, however, contain nothing that is new, or material; though he was then accounted a very learned man.

50 State of medicine in the 15th and 16th centuries. From this time to the end of the 15th and beginning of the 16th century, the history of physic furnishes us with no interesting particulars. This period, however, is famous for the introduction of chemistry into medicine, and the description of three new distempers, the sweating sickness, the venereal disease, and the scurvy. The sweating sickness began in 1485

51 Sweating sickness in England. in the army of Henry VII. upon his landing at Milford-haven, and spread itself at London from the 21st of September to the end of October. It returned there five times, and always in summer; first in 1495, then in 1506, afterwards in 1517, when it was so violent that it killed many in the space of three hours, so that numbers of the nobility died, and of the commonalty in several towns often the one-half perished. It appeared the fourth time in 1528, and then proved mortal in six hours; many of the courtiers died of it, and Henry VIII. himself was in danger. In 1529, and only then, it infested the Netherlands and Germany, in which last country it did much mischief. The last return of it was in 1551, and in Westminster it carried off 120 in a day. Dr Caius describes it as a pestilent contagious fever, of the duration of one natural day; the sweat he reckoned to be only a natural symptom, or crisis of the distemper. It first affected some particular part, attended with inward heat and burning, unquenchable thirst, restlessness, sickness at stomach, but seldom vomiting, headach, delirium, then faintness, and excessive drowsiness. The pulse was quick and vehement, and the breath short and laborious.—Children, poor and old people, were rarely subject to it. Of others, scarce any escaped the attack, and most of them died. Even by travelling into France or Flanders they did not escape; and what is still more strange, the Scots were said not to be affected; abroad the English only were seized, and foreigners in England were free. At first the physicians were much puzzled how to treat this disease. The only cure they ever found, however, was to carry on the sweat for a long time; for, if stopped, it was dangerous or fatal. The way, therefore, was for the patient to lie still, and not expose himself to cold. If nature was not strong enough to force out the sweat, it was necessary to assist her by art, with clothes, wine, &c. The violence of the distemper was over in 15 hours; but there was no security for the patient till 24 were passed. In some strong constitutions there was a necessity to repeat the sweating, even to 12 times. The removing out of bed was attended with great danger; some who had not sweated enough fell into very bad fevers.—No flesh-meat was to be allowed in all the time of the distemper; nor drink for the first five hours. In the seventh, the distemper increased; in the ninth the delirium came on, and sleep was by all means to be avoided. However terrible this distemper appeared at first, it seldom proved obstinate, if treated in the above-mentioned manner.

In the beginning of the 16th century, the famous chemist Paracelsus introduced a new system into medicine, founded on the principles of chemistry. The Galenical system had prevailed till his time; but the practice had greatly degenerated, and was become quite trifling and frivolous. The physicians in general rejected the use of opium, mercury, and other efficacious remedies. Paracelsus, who made use of these, had therefore greatly the advantage over them; and now all things relating to medicine were explained on imaginary chemical principles. It will easily be conceived that a practice founded in this manner could be no other than the most dangerous quackery. At this time, however, it was necessary; for now a new disease overran the world, and threatened greater destruction than almost all the old ones put together, both by the violence of its symptoms, and its baffling the most powerful remedies at that time known.—This was the venereal disease, which is supposed to have been imported 52 Paracelsus.

Moderns.

imported from the West Indies by the companions of Christopher Columbus. Its first remarkable appearance was at the siege of Naples in 1494, from whence it was soon after propagated through Europe, Asia, and Africa. The symptoms with which it made the attack at that time were exceedingly violent, much more so than they are at present; and consequently were utterly unconquerable by the Galenists. The quacks and chemists, who boldly ventured on mercury, though they no doubt destroyed numbers by their excessive use of it, yet showed that a remedy for this terrible distemper was at last found out, and that a proper method of treating it might soon be fallen upon. Shortly after, the West Indian specific, guaiacum, was discovered: the materia medica was enriched with that and many other valuable medicines, both from the East and West Indies: which contributed considerably to the improvement of the practice of physic. At this period, as sea voyages of considerable duration were more frequent, the scurvy became a more common distemper, and was of course more accurately described. But probably, from supposed analogy to the contagions which at that time were new in Europe, very erroneous ideas were entertained with regard to its being of an infectious nature: And it is not impossible, that from its being attended also with ulcers, it was on some occasions confounded with syphilitic complaints.

53 Appearance of the venereal disease.

54 Progress of medicine in the 17th and 18th centuries.

The revival of learning, which now took place throughout Europe, the appearance of these new distempers, and the natural fondness of mankind for novelty, contributed greatly to promote the advancement of medicine as well as other sciences. While at the same time, the introduction of the art of printing rendered the communication of new opinions as well as new practices so easy a matter, that to enumerate even the names of those who have been justly rendered eminent for medical knowledge would be a very tedious task. It was not, however, till 1628 that Dr William Harvey of London demonstrated and communicated to the public one of the most important discoveries respecting the animal economy, the circulation of the blood. This discovery, more effectually than any reasoning, overturned all the systems which had subsisted prior to that time. It may justly be reckoned the most important discovery that has hitherto been made in the healing art: for there can be no doubt that it puts the explanation of the phenomena of the animal body, both in a state of health and disease, on a more solid and rational footing than formerly. It has not, however, prevented the rise of numerous fanciful and absurd systems. These, though fashionable for a short time, and strenuously supported by blind adherents, have yet in no long period fallen into deserved contempt. And notwithstanding the abilities and industry of Stahl, Hoffman, Boerhaave, and Cullen, we may confidently venture to assert that no general system has yet been proposed which is not liable to innumerable and unsurmountable objections. Very great progress has indeed been made in explaining the philosophy of the human body, from ascertaining by decisive experiment the influence of the circulating, the nervous, and the lymphatic systems in the animal economy. But every attempt hitherto made to establish any general theory in medicine, that is, to conduct the cure of every disease on a few general principles, has equally deviated from truth with those of Hippocrates and Galen; and has equally tended to mislead those who have adopted it. Many systems of our own days, such for example as that of Brown, though adopted with enthusiasm by the young and inexperienced, have evidently been attended with the most pernicious consequences in practice. Indeed we may with confidence venture to assert, that from the very nature of the subject itself, medicine does not admit of such simplicity. No one can deny that the human body consists of a very great number of different parts, both solids and fluids. It is, however, equally certain, that each of these is from many different causes liable to deviations from the sound state. And although some slight changes may take place without what can be called a morbid affection, yet we well know, that every change taking place to a certain degree in any one part will necessarily and unavoidably produce an affection of the whole. Hence we may without hesitation venture to affirm, that every general theory which can be proposed, attempting to explain the phenomena, and conduct the cure of all diseases on a few general principles, though for some time it may have strenuous advocates, will yet in the end be found to be both ill-grounded and pernicious.

55 Discovery of the circulation.

The art of medicine has been much more usefully improved by careful attention to the history, theory, and practice of particular diseases, and by endeavouring to ascertain from cautious observation the symptoms by which they are to be distinguished, the causes by which they are induced, and the means by which they are to be prevented, alleviated, or cured. On this footing, therefore, we shall endeavour to give a brief account of at least the most important affections to which the human body is subjected, delivering what appear to us to be the best established facts and observations respecting each.

But before entering on the consideration of particular diseases, or what has commonly been styled the practice of medicine, it is necessary to give a general view of the most important functions of the animal body, and of the chief morbid affections to which they are subjected; a branch which has usually been named the *Theory* or *Institutions of Medicine*.

Theory of Medicine, or an Account of the principal Functions of the Animal Body.

WHILE the functions of living animals, but particularly of the human species, are very numerous, the accounts given of these both in a state of health and disease are very various. Without, therefore, pretending to enumerate the contradictory opinions of different authors, we shall here present the reader with a view of this subject,

ſubject, chiefly extracted from the *Conſpectus Medicinæ Theoreticæ* of Dr James Gregory, who has collected from other writers the opinions at preſent moſt generally adopted.

56 Diviſion of the functions into animal, vital, and natural.

In this work, which was firſt publiſhed in 1780, and afterwards reprinted under an enlarged form in 1782, Dr Gregory introduces his ſubject by obſerving, that ſome functions of the human body relate to itſelf only, and others to external things. To the latter claſs belong thoſe which by phyſicians are called the *animal functions;* to which are to be referred all our ſenſes, as well as the power of voluntary motion, by which we become acquainted with the univerſe, and enjoy this earth. Among the functions which relate to the body, ſome have been named *vital*, ſuch as the circulation of the blood and reſpiration; becauſe, without the conſtant continuance of theſe life cannot ſubſiſt; others, intended for repairing the waſte of the ſyſtem, have been termed the *natural functions:* for by the conſtant attrition of the ſolids and the evaporation of the fluid parts of the body, we ſtand in need of nouriſhment to ſupply the waſte; after which the putrid and excrementitious parts muſt be thrown out by the proper paſſages. The digeſtion of the food, ſecretion of the humours, and excretion of the putrid parts of the food, are referred to this claſs; which, though neceſſary to life, may yet be interrupted for a conſiderable time without danger. This diviſion of the functions into animal, vital, and natural, is of very ancient date, and is perhaps one of the beſt that has yet been propoſed.

57 Diſtinction of diſeaſes into ſimple and compound.

A *diſeaſe* takes place, when the body has ſo far declined from a ſound ſtate, that its functions are either quite impeded, or performed with difficulty. A diſeaſe therefore may happen to any part of the body either ſolid or fluid, or to any one of the functions: and thoſe may occur either ſingly, or ſeveral of them may be diſeaſed at the ſame time; whence the diſtinction of diſeaſes into *ſimple* and *compound.*

We have examples of the moſt ſimple kinds of diſeaſes, in the rupture or other injury of any of the corporeal organs, by which means they become leſs fit for performing their offices; or, though the organs themſelves ſhould remain ſound, if the ſolids or fluids have degenerated from a healthy ſtate; or if, having loſt their proper qualities, they have acquired others of a different, perhaps of a noxious nature; or laſtly, if the moving powers ſhall become too weak or too ſtrong, or direct their force in a way contrary to what nature requires.

58 Symptoms.

The moſt ſimple diſeaſes are either productive of others, or of *ſymptoms*, by which alone they become known to us. Every thing in which a ſick perſon is obſerved to differ from one in health is called a *ſymptom;* and the moſt remarkable of theſe ſymptoms, which moſt conſtantly appear, define and conſtitute the diſeaſe.

The cauſes of diſeaſes are various; often obſcure, and ſometimes totally unknown. The moſt full and perfect proximate cauſe is that which, when preſent, produces a diſeaſe, when taken away removes it, and when changed, changes it.—There are alſo remote cauſes, which phyſicians have been accuſtomed to divide into the *prediſponent* and *exciting* ones. The

59 Prediſponent cauſe.

former are thoſe which only render the body fit for a diſeaſe, or which put it into ſuch a ſtate that it will readily receive one. The exciting cauſe is that which immediately produces the diſeaſe in a body already diſpoſed to receive it.

60 Exciting cauſe.

The prediſponent cauſe is always inherent in the body itſelf, though perhaps it originally came from without; thus heat or cold, a very ſparing or a very luxurious diet, and many other particulars, may operate as cauſes of prediſpoſition, inducing plethora, inanition, or the like. But the exciting cauſe may either come from within or without.

From the combined action of the prediſponent and exciting cauſes comes the *proximate* cauſe, which neither of the two taken ſingly is often able to produce.—

61 Proximate cauſe.

A body prediſpoſed to diſeaſe therefore has already declined ſomewhat from a ſtate of perfect health, although none of its functions are impeded in ſuch a manner that we can truly ſay the perſon is diſeaſed. Yet ſometimes the prediſponent cauſe, by continuing long, may arrive at ſuch a height, that it alone, without the addition of any exciting cauſe, may produce a real diſeaſe.—The exciting cauſe alſo, though it ſhould not be able immediately to bring on a diſeaſe; yet if it continues long, will by degrees deſtroy the ſtrongeſt conſtitution, and render it liable to various diſeaſes; becauſe it either produces a prediſponent cauſe, or is converted into it, ſo that the ſame thing may ſometimes be an exciting cauſe, ſometimes a prediſponent one, or rather a cauſe of prediſpoſition; of which the inclemencies of the weather, ſloth, luxury, &c. are examples.

62 Hereditary diſeaſes.

Diſeaſes, however, ſeem to have their origin from the very conſtitution of the animal machine; and hence many diſeaſes are common to every body when a proper exciting cauſe occurs, though ſome people are much more liable to certain diſeaſes than others. Some are hereditary; for as healthy parents naturally produce healthy children, ſo diſeaſed parents as naturally produce a diſeaſed offſpring. Some of theſe diſeaſes appear in the earlieſt infancy; others occur equally at all ages; nor are there wanting ſome which lurk unſuſpected even to the lateſt old age, at laſt breaking out with the utmoſt violence. Some diſeaſes are born with us, even though they have no proper foundation in our conſtitution, as when a fœtus receives ſome hurt by an injury done to the mother; while others, neither born with us nor having any foundation in the conſtitution, are ſucked in with the nurſe's milk.

63 Diſeaſes from age and ſex.

Many diſeaſes accompany the different ſtages of life; and hence ſome are proper to infancy, youth, and old age. Some alſo are proper to each of the ſexes: eſpecially the female ſex, proceeding, no doubt, from the general conſtitution of the body, but particularly from the ſtate of the parts ſubſervient to generation. Hence the diſeaſes peculiar to virgins, to menſtruating women, to women with child, to lying-in women, to nurſes, and to old women.

64 Diſeaſes from climate.

The climate itſelf, under which people live, produces ſomes diſeaſes; and every climate has a tendency to produce particular diſeaſes, either from its exceſs of heat or cold, or from the mutability of the weather. An immenſe number of diſeaſes alſo may be produced by impure air, or ſuch as is loaded with putrid, marſhy, and other noxious vapours. The ſame

Causes of Diseases.

same thing may happen likewise from corrupted aliment, whether meat or drink; though even the best and most nutritious aliment will hurt if taken in too great quantity; not to mention poisons, which are endowed with such pernicious qualities, that even when taken in a very small quantity they produce the most grievous diseases or perhaps even death itself. Lastly, from innumerable accidents and dangers to which mankind are exposed, they frequently come off with broken limbs, wounds, and contusions, sometimes quite incurable; and these misfortunes, though proceeding from an external cause at first, often terminate in internal diseases.

65 Diseases from accidents.

Hitherto we have mentioned only the dangers which come from without; but those are not less, nor fewer in number, which come from within. At every breath, man pours forth a deadly poison both to himself and others. Neither are the effluvia of the lungs alone hurtful: there flows out from every pore of the body a most subtile and poisonous matter, perhaps of a putrescent nature, which being long accumulated, and not allowed to diffuse itself through the air, infects the body with most grievous diseases; nor does it stop here, but produces a contagion which spreads devastation far and wide among mankind. From too much or too little exercise of our animal powers also no small danger ensues. By inactivity either of body or mind, the vigour of both is impaired; nor is the danger much less from too great employment. By moderate use, all the faculties of the mind, as well as all the parts of the body, are improved and strengthened; and here nature has appointed certain limits, so that exercise can neither be too much neglected, nor too much increased, with impunity. Hence those who use violent exercise, as well as those who spend their time in sloth and idleness, are equally liable to diseases; but each to diseases of a different kind: and hence also the bad effects of too great or too little employment of the mental powers.

66 Diseases from passions of the mind.

Besides the dangers arising from those actions of the body and mind which are in our own power, there are others arising from those which are quite involuntary. Thus, passions of the mind, either when carried to too great excess, or when long continued, equally destroy the health; nay, will even sometimes bring on sudden death. Sleep also, which is of the greatest service in restoring the exhausted strength of the body, proves noxious either from its too great or too little quantity. In the most healthy body, also, many things always require to be evacuated. The retention of these is hurtful, as well as too profuse an evacuation, or the excretion of those things either spontaneously or artificially which nature directs to be retained. As the solid parts sometimes become flabby, soft, almost dissolved, and unfit for their proper offices; so the fluids are sometimes inspissated, and formed even into the hardest solid masses. Hence impeded actions of the organs, vehement pain, various and grievous diseases. Lastly, some animals are to be reckoned among the causes of diseases: such particularly, as support their life at the expence of others; and these either invade us from without, or take up their residence within the body, gnawing the bowels while the person is yet alive, not only with great danger and distress to the patient, but sometimes even producing death itself.

Animal Solids.

67 Vis medicatrix naturæ.

Man, however, is not left without defence against so many and so great dangers. The human body is possessed of a most wonderful power, by which it preserves itself from diseases, keeps off many, and, in a very short time, cures some already begun, while others are by the same means more slowly brought to a happy conclusion. This power, called the *autocrateia*, or *vis medicatrix naturæ*, is well known both to physicians and philosophers. This alone is often sufficient for curing many diseases, and is of service in all. Nay, even the best medicines operate only by exciting and properly directing this force; for no medicine will act on a dead carcase. But though physicians justly put confidence in this power, and though it generally cures diseases of a slighter nature, it is not to be thought that those of the more grievous kind are to be left to the unassisted efforts of the *vis medicatrix*. Physicians therefore have a twofold error to avoid, either despising the powers of nature too much, or putting too great confidence in them; because in many diseases these efforts are either too feeble or too violent, insomuch that sometimes they are more to be dreaded than even the disease itself. So far therefore is it from being the duty of a physician always to follow the footsteps of nature, that it is often necessary for him to take a directly contrary course, and oppose her efforts with all his might.

68 Chemical analysis of the animal solids.

After a general view of the functions of the animal body, of the nature and causes of disease, and of the powers by which these are to be combated, Dr Gregory proceeds to treat of the solid materials of which the body is formed. He tells us, that the animal solid, when chemically examined, yields earth, oil, salt, water, phlogiston or inflammable air, and a great quantity of mephitic air. These elements are found in various proportions in the different parts of the body; and hence these parts are endowed with very different mechanical powers, from the hardest and most solid bone to the soft and almost fluid retina. Nay, it is principally in this difference of proportion between the quantities of the different elements, that the difference between the solid and fluid parts of the animal consist, the former having much more earth and less water in their composition than the latter. The cohesion, he thinks, is owing to something like a chemical attraction of the elements for one another; and its cause is neither to be sought for in the gluten, fixed air, nor earth. This attraction, however, is not so strong but that even during life the body tends to dissolution; and immediately after death putrefaction commences, provided only there be as much moisture in it as will allow an intestine motion to go on. The greater the heat, the sooner does putrefaction take place, and with the greater rapidity does it proceed; the mephitic air flies off, and together with it certain saline particles; after which, the cohesion of the body being totally destroyed, the whole falls into a putrid colluvies, of which at length all the volatile parts being dissipated, nothing but the earth is left behind.

This analysis, he owns, is far from being perfect, and is by no means in the language of modern chemistry.

Animal Solids.

try. But no modern chemiſt has ever been able, by combining the chemical principles of fleſh, to reproduce a compound any thing like what the fleſh originally was; yet, however imperfect the analyſis may be, it ſtill has the advantage of ſhowing in ſome meaſure the nature and cauſes of certain diſeaſes, and thus leads phyſicians to the knowledge of proper remedies.

69 Qualities of the animal ſolids.

The ſolid parts are fitted for the purpoſes of life in three ſeveral ways; namely, by their coheſion, their flexibility, and their elaſticity, all of which are various in the various parts of the body. Moſt of the functions of life conſiſt in various motions. In ſome the moſt violent and powerful motions are required; and therefore ſuch a degree of coheſion is neceſſary in theſe parts as will be ſufficient for allowing them to perform their offices without any danger of laceration. It is therefore neceſſary that ſome of the ſolid parts ſhould be more flexible than others; and it is likewiſe neceſſary that theſe parts, along with their flexibility, ſhould have a power of recovering their former ſhape and ſituation, after the removal of the force by which they were altered.

Theſe variations in flexibility, within certain limits, ſeldom produce any material conſequence with regard to the health: though ſometimes, by exceeding the proper bounds, they may bring on real and very dangerous diſeaſes; and this either by an exceſs or diminution of their coheſion, flexibility, or elaſticity. By augmenting the coheſion, the elaſticity is alſo for the moſt part augmented, but the flexibility diminiſhed; by diminiſhing the coheſion, the flexibility becomes greater, but the elaſticity is diminiſhed.

The cauſe of theſe affections, though various, may be reduced to the following heads. Either the chemical compoſition of the matter itſelf is changed; or, the compoſition remaining the ſame, the particles of the ſolid may be ſo diſpoſed, that they ſhall more or leſs ſtrongly attract one another. As to the compoſition, almoſt all the elements may exiſt in the body in an undue proportion, and thus each contribute its ſhare to the general diſorder. But of many of theſe things we know very little; only it is apparent, that the fluid parts, which conſiſt chiefly of water, and the ſolid, which are made up of various elements, are often in very different proportions: the more water, the leſs is the coheſion or elaſticity, but the greater the flexibility; and the reverſe happens, if the ſolid or earthy part predominates.

70 Cauſes affecting the ſolids.

The remote cauſes of theſe different ſtates, whether prediſponent or exciting, are very various. In the firſt place, idioſyncraſy itſelf, or the innate conſtitution of the body, contributes very much to produce the abovementioned effects. Some have naturally a much harder and drier temperament of the body than others; men, for inſtance, more than women; which can with the utmoſt difficulty, indeed ſcarce by any means whatever, admit of an alteration. The ſame thing takes place at different periods of life; for, from firſt to laſt, the human body becomes always drier and more rigid. Much alſo depends on the diet made uſe of, which always produces a correſponding ſtate of the ſolids in proportion to its being more or leſs watery. Neither are there wanting ſtrong reaſons for believing, that not only the habit of the body, but even the diſpoſition of the mind, depends very much on the diet we make uſe of. The good or bad concoction of the aliment alſo, the application of the nouriſhment prepared from it, and likewiſe the ſtate of the air with regard to moiſture or dryneſs, affect the temperament of the body not a little; and hence thoſe who inhabit mountains or dry countries, are very different from the inhabitants of low marſhy places. Laſtly, the manner of living contributes ſomewhat to this effect: Exerciſe preſſes out and exhales the moiſture of the body, if in too great quantity; on the contrary, ſloth and lazineſs produce an effect directly oppoſite, and cauſe a redundancy of fluid.

But, putting the chemical compoſition of the ſolid parts out of the queſtion altogether, they may be affected by many other cauſes. The condenſation, for inſtance, or compreſſion of the particles, whether by mechanical cauſes or by means of cold or heat, makes a conſiderable alteration in the ſtrength and elaſticity of every ſolid body. How much mechanical preſſure contributes to this may be underſtood from the experiments of Sir Clifton Wintringham: and hence alſo are we to deduce the reaſon of many facts of the higheſt importance in the animal economy; namely, the growth, ſtate, decreaſe of the body; its rigidity daily increaſing; and at laſt the unavoidable death incident to old age from a continuance of the ſame cauſes.

Perhaps the different denſity of the ſolids is in ſome meaſure owing to Nature herſelf; but it ſeems to depend more on the powers of exerciſe or inactivity in changing the ſtate of the ſolids, the effects of which on the body whether good or bad, may hence be eaſily underſtood.

Heat relaxes and expands all bodies, but cold renders them more denſe and hard; the effects of which on the human body are well known to moſt people. Though the body is found to preſerve a certain degree of heat almoſt in every ſituation, yet its ſurface muſt unavoidably be affected by the temperature of the circumambient atmoſphere; and we have not the leaſt reaſon to doubt that every part of the body may thus feel the effects of that temperature. What a difference is there between one who, expoſed to the ſouth wind, becomes lazy and languid, ſcarce able to drag along his limbs; and one who feels the force of the cold north wind, which renders the whole body alert, ſtrong, and fit for action?

That theſe various cauſes, each of which is capable of affecting the conſtitution of the body when taken ſingly, will produce much greater effects when combined, is ſufficiently evident. The experiments of Bryan Robinſon, the effects of the warm bath, and indeed daily experience, ſhow it fully.

It is not yet certainly known what is the ultimate ſtructure of the minuteſt parts of the animal-ſolid; whether it conſiſts of ſtraight fibres or threads, whoſe length is very conſiderable in proportion to their breadth, variouſly interwoven with one another, as Boerhaave ſuppoſes; or of ſpiral ones, admirably convoluted and interwoven with one another, as ſome microſcopical experiments ſeem to ſhow; or whether the cellular texture be formed of fibres or *laminæ*, and from thence the greateſt part of the body, as the celebrated Haller hath endeavoured to prove.

The

Animal Solids.

71 Cellular texture.

The cellular texture is obſerved throughout the whole body: it ſurrounds and connects the fibres themſelves, which are ſufficiently apparent in many of the organs; and ſlightly joins the different parts which ought to have any kind of motion upon the neighbouring ones. By a condenſation of this ſubſtance alſo, the ſtrongeſt, and what ſeem the thinneſt, membranes are formed; the moſt ſimple of which being accurately examined, diſcover the cellular ſtructure. This cellular ſubſtance ſometimes increaſes to a ſurpriſing degree, and all parts formed of it, membranes, veſſels, &c. eſpecially by a gentle diſtenſion; for a ſudden and violent diſtenſion either breaks it altogether, or renders it thinner. Sometimes alſo it grows between neighbouring parts, and joins thoſe which nature has left free. Preternatural concretions of this kind are often obſerved after an inflammation of the lungs or of the abdominal viſcera; and theſe new membranes are found to be truly cellular. This ſubſtance, when cut, or by any other means divided, grows together of its own accord; but if, by reaſon of very great inflammation and ſuppuration, a large portion of the cellular texture has been deſtroyed, it is never again completely renewed, and an ugly ſcar is left. It is even ſaid, that this ſubſtance, in certain caſes, is capable of joining the parts either of the ſame body with one another, or of a foreign body with them; and upon this, if on any foundation, reſts the art of Taliacotius and that of tranſplanting teeth, lately ſo much talked of.

The cellular texture is in ſome places merely a kind of net-work, in others filled with fat. Wherever too great bulk or compreſſion would have been inconvenient or dangerous, as in the head, lungs, eyes, eyebrows, penis, ſcrotum, &c. there it collects no fat, but is lax, and purely reticulated; but between the muſcles of the body and limbs below the ſkin, in the abdomen, eſpecially in the omentum and about the kidneys, very much fat is ſecreted and collected.

72 Animal fat.

The fat is principally a pure animal oil, not very different from the expreſſed and mild vegetable ones; during life it is fluid, but of different degrees of thickneſs in different parts of the body. It is ſecreted from the blood, and is often ſuddenly reabſorbed into it, though pure oil is very rarely obſerved in the blood. It is indeed very probable, that oil, by digeſtion, partly in the primæ viæ, and partly in the lungs, is converted into gluten, and this again into oil by means of ſecretion; though no glandular organs ſecreting the fat can be ſhown by anatomiſts. It is, however, probable, that there are ſuch organs; and that the cellular texture has ſome peculiar ſtructure in thoſe parts which are deſtined to contain the fat already ſecreted, without ſuffering it to paſs into other places; for it never paſſes into thoſe parts which are purely reticulated, although the cellular texture is eaſily permeable by air or water over the whole body from head to foot.

The fat is augmented by the uſe of much animal-food, or of any other that is oily and nouriſhing, provided the digeſtion be good; by the uſe of ſtrong drink, eſpecially malt-liquor; by much reſt of body and mind, much ſleep and inactivity, caſtration, cold, repeated blood-letting, and in general by whatever diminiſhes the vital and animal powers. Much, however, depends on the conſtitution of the body itſelf; nor is it poſſible to fatten a human creature at pleaſure like an ox. A certain degree of fatneſs, according to the age of the perſon, is a ſign and effect of good health; but when too great, it becomes a diſeaſe of itſelf, and the cauſe of other diſeaſes. It may always be very certainly removed by ſtrong exerciſe, little ſleep, and a ſpare diet. The fat commonly makes up a conſiderable part of the bulk of the body, and ſometimes by far the greateſt part. Its uſe ſeems to be to make the motion of the body more eaſy and free, by leſſening the friction of the moving parts, and thus preventing the abraſion of the ſolids, which would otherwiſe happen. It is alſo of uſe to hinder the parts from growing together, which ſometimes happens, when by an ulcer or any other accident a part of the cellular texture containing the fat is deſtroyed. Beſides all this, the fat contributes not a little to the beauty of the body, by filling up the large interſtices between the muſcles, which would otherwiſe give the perſon a deformed and ſhocking appearance. It is thought to be nutritious, when abſorbed from its cells into the blood; but of this we have no certain proof. It ſeems to have ſome power of defending from the cold; at leaſt, nature has beſtowed it in very great quantity on thoſe animals which inhabit the colder regions, as whales, bears, &c.

Thoſe parts of the body which enjoy ſenſe and mobility, are called *living* or *vital* ſolids. They are the brain, cerebellum, medulla oblongata, ſpinal marrow, the nerves ariſing from theſe and diffuſed throughout the whole body, and which are diſtributed through the various organs of ſenſe and through the muſcles, and laſtly the muſcles themſelves. Senſation is much more general than mobility, as being common to all the parts already mentioned. Mobility is proper to the muſcular fibres alone: wherever there is ſenſation, therefore, we may believe that there are nerves; and wherever there is mobility, we may believe that muſcular fibres exiſt. Nay, even mobility itſelf ſeems to originate from the connection which the muſcles have with the nerves; for ſoon after the nerves are compreſſed, or tied, or cut, the muſcles to which they are diſtributed loſe their faculties; which happens too when the brain itſelf, or the origin of the nerves, is affected. Some reckon that the muſcles are produced from the nerves, and conſiſt of the ſame kind of matter. Both indeed have a ſimilar ſtructure, as being fibrous and of a white colour: for the muſcles, when well freed from the blood, of which they contain a great abundance, are of this colour as well as the nerves; neither can the nervous fibres by any means be diſtinguiſhed from the muſcular fibres themſelves. Both have alſo ſenſation; and both ſtimulants and ſedatives act in the ſame manner, whether they be applied to the muſcles themſelves or to the nerves. Theſe circumſtances have led Dr Cullen and many others to conſider the muſcular fibre as being merely a continuation of nerve. But to this opinion there are many ſtrong objections; though there can be no doubt that the contraction of the muſcular fibre is intimately connected with nervous influence. 73 Vital ſolids.

It is difficult for us to diſcover the origin of many parts of the body, or to aſcertain whether they are produced all at the ſame time or one after another: yet it muſt be owned, that many of the muſcular parts are obſerved to have attained a remarkable degree of

ſtrength,

External Senses. ſtrength, while the brain is ſtill ſoft and almoſt fluid; and that the action of theſe muſcular parts is required for the action and growth of the brain. The muſcles are alſo of a much firmer contexture than the nerves; and enjoy a power of their own, namely, that of irritability, of which the nerves never participate. Of neceſſity, therefore, either the muſcles muſt be conſtructed of ſome kind of matter different from that of the nerves; or if both are made of the ſame materials, their organization muſt be exceedingly different. But if the ſubſtance of the muſcles and nerves be totally different, we may eaſily be convinced that much of the one is always mixed with the other; for it is impoſſible to prick a muſcle, even with the ſmalleſt needle, without wounding or lacerating many nervous fibres at the ſame time. Since, therefore, there is ſuch a cloſe connection between the muſcles and nerves both as to their functions and ſtructure, they are deſervedly reckoned by phyſiologiſts to be parts of the ſame genus, called the *genus nervoſum*, or *nervous ſyſtem*.

74 Senſe of feeling. After treating of ſenſe in general, Dr Gregory proceeds to conſider particularly each of the ſenſes both external and internal. He begins with the ſenſe of feeling, as being the moſt ſimple, and at the ſame time in common to every part of the nervous ſyſtem. In ſome places, however, it is much more acute than in others; in the ſkin, for inſtance, and eſpecially in the points of the fingers. Theſe are reckoned to have *nervous papillæ*, which by the influx of the blood are ſomewhat erected in the action of contact, in order to give a more acute ſenſation; though indeed this opinion ſeems rather to be founded on a conjecture derived from the ſtructure of the tongue, which is not only the organ of taſte, but alſo a moſt delicate organ of touch, than upon any certain obſervations.

75 Pain. From the ſenſe of feeling, as well as all the other ſenſes, either pain or pleaſure may ariſe; nay, to this ſenſe we commonly refer both pain and almoſt all other troubleſome ſenſations, though in truth pain may ariſe from every vehement ſenſation. It is brought on by any great force applied to the ſentient part; whether this force comes from within or from without. Whatever, therefore, pricks, cuts, lacerates, diſtends, compreſſes, bruiſes, ſtrikes, gnaws, burns, or in any manner of way ſtimulates, may create pain. Hence it is ſo frequently conjoined with ſo many diſeaſes, and is often more intolerable than even the diſeaſe itſelf. A moderate degree of pain ſtimulates the affected part, and by degrees the whole body; produces a great flux of blood to the part affected, by increaſing the action of its veſſels; and it ſeems alſo to increaſe the ſenſibility of the part affected to future impreſſions. It often ſtimulates to ſuch motions as are both neceſſary and healthful. Hence, pain is ſometimes to be reckoned among thoſe things which guard our life. When very violent, however, it produces too great irritation, inflammation and its conſequences, fever, and all thoſe evils which flow from too great force of the circulation; it diſorders the whole nervous ſyſtem, and produces ſpaſms, watching, convulſions, delirium, debility, and fainting. Neither the mind nor body can long bear very vehement pain; and indeed Nature has appointed certain limits beyond which ſhe will not permit pain to be carried, without bringing on delirium, convulſions, ſyncope, or even death, to reſcue the miſerable ſufferer from his torments.

Long-continued pain, even though in a more gentle degree, often brings on debility, torpor, palſy, and rigidity of the affected part. But if not too violent, nor accompanied with fever, ſickneſs, or anxiety, it ſometimes ſeems to contribute to the clearneſs and acuteneſs of the judgment, as ſome people teſtify who have been afflicted with the gout.

Anxiety is another diſagreeable ſenſation, quite different from pain, as being more obtuſe and leſs capable of being referred to any particular part, though frequently more intolerable than any pain. But we muſt take care to diſtinguiſh between this anxiety of which we treat in a medical ſenſe, and that which is ſpoken of in common diſcourſe. The latter does not at all depend on the ſtate of the body, but belongs entirely to the mind; and ariſes from a ſenſe of danger, or a foreſight of any misfortune. The former is truly corporeal; and derives, no leſs than pain, its origin from a certain ſtate of the body. Notwithſtanding this difference, however, it is very poſſible for both theſe kinds of anxiety to be preſent at the ſame time, or for the one to be the cauſe of the other. A very great bodily anxiety will ſtrike fear and deſpondency into the moſt reſolute mind; and mental anxiety, on the contrary, if very violent and long-continued, may induce the former, by deſtroying the powers of the body, eſpecially thoſe which promote the circulation of the blood. 76 Anxiety.

Anxiety, in the medical ſenſe of the word, ariſes in the firſt place from every cauſe diſturbing or impeding the motion of the blood through the heart and large veſſels near it. Anxiety, therefore, may ariſe from many diſeaſes of the heart and its veſſels, ſuch as its enlargement, too great conſtriction, oſſification, polypus, palpitation, ſyncope, inflammation, debility, and alſo ſome affections of the mind. It is likewiſe produced by every difficulty of breathing, from whatever cauſe it may ariſe; becauſe then the blood paſſes leſs freely through the lungs: anxiety of this kind is felt deep in the breaſt. It is ſaid alſo to ariſe from the difficult paſſage of the blood through the liver or other abdominal viſcera.

A certain kind of anxiety is very common and troubleſome to hypochondriacal people; and ariſes from the ſtomach and inteſtines being either loaded with indigeſted and corrupted food, or diſtended with air produced by fermentation and extricated from the aliments. By ſuch a load, or diſtention, the ſtomach, which is a very delicate organ, becomes greatly affected. Beſides, the free deſcent of the diaphragm is thus hindered, and reſpiration obſtructed. Anxiety of this kind is uſually very much and ſuddenly relieved by the expulſion of the air; by which, as well as by other ſigns of a bad digeſtion, it is eaſily known. In theſe caſes the anxiety is uſually, though with little accuracy, referred to the ſtomach.

Anxiety alſo frequently accompanies fevers of every kind, ſometimes in a greater and ſometimes in a leſſer degree. In this caſe it ariſes as well from the general debility as from the blood being driven from the ſurface of the body and accumulated in the large veſſels; as in the beginning of an intermittent fever. Or it may ariſe from an affection of the ſtomach, when

External Senſes. when overloaded with crude, corrupted aliment; or diſtended and nauſeated with too much drink, eſpecially medicated drink. As the fever increaſes, the anxiety of the patient becomes greater and greater; remarkably ſo, according to the teſtimony of phyſicians, either immediately before the criſis or on the night preceding it; as before the breaking out of exanthemata, hæmorrhagy, ſweat, or diarrhœa, which ſometimes remove fevers. The patient feels likewiſe an anxiety from the ſtriking in of any eruption or critical metaſtaſis. This ſenſation alſo accompanies fevers and moſt other diſeaſes, when the vital power is exhauſted, and death approaches, of which it is the forerunner and the ſign. It happens at that time, becauſe the vital powers, unable to perform their functions, cannot make the blood circulate. But what kind of anxiety this is, the other ſigns of approaching death ſhow very evidently. Moreover, even in the time of ſleep, anxiety may ariſe from the ſame cauſes: hence frightful dreams, which frequently diſturb our repoſe with ſurpriſe and terror.

77 Itching. Itching, an uneaſy ſenſation, with a deſire of ſcratching the place affected, is often very troubleſome, although it ſeems to be more a-kin to pleaſure than to pain. As pain proceeds from too great an irritation, either chemical or mechanical, ſo does itching proceed from a ſlight one. Titillation, or friction, of a woollen ſhirt, for inſtance, upon the ſkin of a perſon unaccuſtomed to it, and of a delicate conſtitution, excites itching; as do alſo many acrid foſſils, vegetables, and animals. Hence an itching is the firſt ſenſation after the application of cantharides, although the ſame, when augmented becomes painful. The ſame effect is produced by any thing acrid thrown out upon the ſkin; as in exanthematic fevers, the diſeaſe called the *itch*, &c. Lice, worms, eſpecially aſcarides, irritating either the ſkin or the inteſtines, excite a troubleſome itching.

Too acute a ſenſation over the whole body is very rarely if ever obſerved. In a particular part the ſenſe of feeling is often more acute than it ought to be, either from the cuticle itſelf being too thin and ſoft, or being removed; or from the part itſelf being inflamed, or expoſed to too great heat. It becomes obtuſe, or is even quite deſtroyed over the whole body, or in great part of it, from various affections of the brain and nerves; as when they are wounded, compreſſed, or defective in vital power. This is called *anæſtheſia*, and ſometimes accompanies palſy.

This ſenſe may be deficient in a particular part, either from the nerve being diſeaſed, or from its being compreſſed or wounded, or from the part itſelf being expoſed to too great a degree of cold;—or from the ſcarf-ſkin which covers it being vitiated, either becoming too thick or hard, by the handling of rough, or hard, or hot bodies, as is the caſe with glaſs-makers and ſmiths; or from the elevation of the cuticle from the ſubjacent cutis, or true ſkin itſelf, by the interpoſition of blood, ſerum, or pus; or from the cutis being macerated, relaxed, or become torpid, which ſometimes happens to hydropic perſons; or laſtly, from the whole organ being corrupted by gangrene, burning, cold, or contuſion. This ſenſe is very rarely depraved, unleſs perhaps in the caſe of delirium, when all the functions of the brain are diſturbed in a ſurpriſing manner.

The ſenſe next to be conſidered is that of taſte, the principal organ of which is the tongue; the nearer the tip of it, the more acute is the ſenſe, and the nearer the glottis ſo much the more obtuſe. It muſt be owned, however, that ſome kind of acrid ſubſtances, the taſte of which is ſcarcely perceived upon the tip of the tongue, excite a moſt vehement ſenſation about its roots, or even in the throat itſelf. The tongue is endowed with many large and beautiful nervous papillæ, which ſeem to be the chief ſeat of this ſenſe, and in the act of taſting are elevated and erected, in order to give the more acute ſenſation. External Senſes. 78 Taſte.

Nothing can be taſted which is not ſoluble in the ſaliva, that, being applied in a fluid form, it may pervade the involucra of the tongue, and affect its nervous pulp; and hence inſoluble earths are quite inſipid. Neither is it ſufficient for a body to be ſoluble that it may be taſted: it muſt alſo have ſomething in it ſaline, or at leaſt acrid, in order to ſtimulate the nervous ſubſtance; and hence, whatever has leſs ſalt than the ſaliva is totally inſipid.

The taſte is rarely found to be too acute, unleſs through a fault in the epidermis which covers the tongue. If this be removed or wounded, or covered with ulcers, aphthæ, &c. then the taſte, becoming too acute, is painful: or ſometimes, no other ſenſation than that of pain is felt. It may be impaired, as well as the ſenſe of feeling, from various diſeaſes of the brain and nerves; of which, however, the inſtances are but rare. In ſome people it is much more dull than in others; and in ſuch the ſenſe of ſmelling is uſually deficient alſo. The taſte is moſt commonly deficient on account of the want of ſaliva; for a dry tongue cannot perceive any taſte: hence this ſenſe is very dull in many diſeaſes, eſpecially in fevers, catarrhs, &c. as well on account of the defect of ſaliva as of appetite, which is of ſo much ſervice in a ſtate of health; or by reaſon of the tongue being covered with a viſcid mucus.

The taſte is frequently depraved; when, for example, we have a perception of taſte without the application of any thing to the tongue; or if any thing be applied to it, when we perceive a taſte different from what it ought to be. This happens for the moſt part from a vitiated condition of the ſaliva, which is itſelf taſted in the mouth. Hence we may perceive a ſweet, ſaline, bitter, putrid, or rancid taſte, according to the ſtate of the ſaliva: which may be corrupted either from the general vitiated condition of the maſs of humours, or the glands which ſecrete it; of the mouth itſelf; or even of the ſtomach, the vapours and eructations of which riſe into the mouth, eſpecially when the ſtomach is diſeaſed.

Beſides the faults of the ſaliva, however, the taſte may be vitiated from other cauſes; as, for inſtance, the condition of the nervous papillæ. This, however, is as yet but little known to us; for the taſte is ſometimes plainly vitiated, when at the ſame time the ſaliva appears quite inſipid when taſted by other people.

Phyſicians, in almoſt every diſeaſe, but eſpecially in fevers, inquire into the ſtate of the tongue; not, indeed, without the greateſt reaſon: for from this they can judge of the condition of the ſtomach; of the thirſt, or rather the occaſion the patient has for drink, when, on account of his delirium or ſtupor, he neither feels his thirſt, External Senses.

thirst, nor is able to call for drink. And, lastly, from an inspection of the tongue, physicians endeavour to form some judgment concerning the nature, increase, and remission of the fever.

79 Smell. After the sense of taste, we shall next treat of that of smell. Its seat is in that very soft and delicate membrane, filled with nerves and blood-vessels, which covers the internal parts of the nose, and the various sinuses and cavities proceeding from thence. This sense is more acute about the middle of the septum, and the *ossa spongiosa*, where the membrane is thicker and softer, than in the deeper cavities, where the membrane is thinner, less nervous, and less filled with blood-vessels; although even these do not seem to be altogether destitute of the sense of smelling.

As by our taste we judge of the soluble parts of bodies, so by our smell we judge of those very volatile and subtile parts which fly off into the air; and like the organ of taste, that of smell is kept moist, that it may have the more exquisite sensation, partly by its proper mucus, and partly by the tears which descend from the eyes.

Some kinds of odours greatly affect the nervous system, and produce the most surprising effects. Some gratefully excite it, and immediately recruit the spirits when almost sinking; while some produce fainting, nay, as it is alleged, even sudden death. To this head also are we to refer those antipathies, which, though truly ridiculous, are often not to be subdued by any force of mind.

This sense is sometimes too acute, as well from some disease in the organ itself, which happens more rarely, as from the too great sensibility of the nervous system in general, as is sometimes observed in nervous fevers, phrenitis, and hysteria. It is more frequently, however, too dull, either from diseases of the brain and nerves, as from some violence done to the head, or from some internal cause; or it may proceed from a dryness of the organ itself, either on account of the customary humours being suppressed or turned another way; or from the membranes being oppressed with too great a quantity of mucus or of tears. Of both these cases we have instances in the catarrh, where at first the nostrils are dry, but afterwards are deluged with a thin humour, or stopped up with a thick one. But in these, and many other examples, the membrane of the nose itself is affected with inflammation, relaxation or too great tension, by which the nerves, which constitute a great part of it, must be vitiated. It is evident also, that whatever obstructs the free entrance of the air into the nostrils, or impedes its passage through them, must prove detrimental to the sense of smelling.

80 Hearing. The sense of hearing is more frequently vitiated than almost any of the rest, as having a most delicate organ, and one composed of many and very small parts, of which an account is given under the article ANATOMY.—It frequently becomes too acute; either from the general habit of the body being too irritable, such as often happens to hysterical and lying-in-women; or from too great a sensibility of the brain itself, which is not unfrequently observed in fevers, as well as in phrenitis, and sometimes in the true mania; or it may be from a disease of the ear itself, as when it is affected with inflammation, pain, or too great tension.—It may be rendered dull, or even be altogether destroyed, so that the person shall become totally deaf, from the same causes acting with different degrees of force. This happens especially from the want of the external ear; or from the meatus auditorius being stopped up with mucus, wax, or other matters; or from the sides of the canal growing together, as sometimes happens after suppuration or the small-pox; or by the membrane of the tympanum becoming rigid or relaxed, or being eroded or ruptured; or the tympanum itself, or the Eustachian tube, may from certain causes be obstructed; or some of the little bones or membranes, or some of the muscles of the labyrinth, may be affected with concretion, spasm, palsy, or torpor; or, lastly, it may happen from diseases of the brain and nerves, all the organs of hearing remaining sound. Hence deafness is often a nervous disease, coming suddenly on, and going off spontaneously. Hence also it is common in old people, all of whose solid parts are too rigid, while their nervous parts have too little sensibility.

Persons labouring under fevers, especially of the typhous kind, often become deaf. When this comes on along with other signs of an oppressed brain, and a great prostration of strength, it may be a very bad symptom; but for the most part it is a very good one, even though accompanied with some degree of torpor or sleepiness.

A very common disease in the sense of hearing is when certain sounds, like those of a drum, a bell, the falling of water, &c. are heard without any tremor in the air, or without a sound person's hearing any thing. This disease is called *tinnitus aurium*, of which various kinds have been observed. For the most part it is a very slight transient disorder; but sometimes it is most obstinate, long-continued, and troublesome. It often arises from the slightest cause, such as any thing partially stopping up the meatus auditorius or Eustachian tube itself, so that access is in part denied to the air; whence it happens that the latter strikes the membrane of the tympanum, or perhaps the interior parts, unequally, and with too much force. Hence *bombi*, a kind of tinnitus, are heard even by the most healthy when they yawn.

A much more frequent and troublesome species of tinnitus accompanies many diseases both of the febrile and nervous kind. This is occasioned partly by the increased impetus of the blood towards the head, with an increase of sensibility in the nervous system itself, so that the very beatings of the arteries are heard; and partly from the increased sensation and mobility of the nerves and muscles of the labyrinth: whence it happens, that the parts which ought to be at rest until excited by the tremor of the air, begin to move of their own accord, and impart their motion to other parts which are already in a morbid state of too great sensibility.

A tinnitus sometimes arises from any vehement affection of the mind; sometimes from a disorder in the stomach; sometimes from a rheumatic disorder affecting the ears and head; or from a catarrh, which commonly affects the Eustachian tube. Sometimes, however, the tinnitus alone affects the patient; and even this is a disease of no small consequence. These various causes, however, both of this and other disorders of the hearing,

hearing, are often very difficult to be diſtinguiſhed, as well on account of the inacceſſible ſituation of the organ, as on account of the little knowledge we have of its action. But from whatever cauſe it ariſes, both this and the other affections of the hearing can neither be cured certainly nor eaſily, but by the removal of the cauſe whatever it may be.

81
Sight.

Concerning the nature of the ſenſe of ſight, the reader may conſult the articles ANATOMY and OPTICS. Of this ſenſe ſome ſlight diſorders, or rather varieties, are often obſerved. Thoſe perſons are called *ſhort-ſighted* who cannot ſee diſtinctly unleſs the object be very near them. This diſorder ariſes from too great a refraction of the rays by reaſon of their being too ſoon collected into a focus by the cryſtalline lens, and diverging again before they fall upon the retina, by which means they make an indiſtinct picture upon it. The moſt common cauſe is too great a convexity of the eye or ſome of its humours, as too prominent a cornea. It is a diſorder common to young people, which is ſometimes removed when they grow older. As ſoon as the firſt approaches of ſhort-ſightedneſs are obſerved, it is ſuppoſed it may be obviated by the perſon's accuſtoming himſelf to view remote objects, and keeping his eyes off very ſmall and near ones; as, on the contrary, it may be brought on by the oppoſite cuſtom; becauſe the eye accommodates itſelf ſomewhat to the diſtances of thoſe objects which it is accuſtomed to view. But a concave glaſs, which cauſes the rays of light to diverge more than naturally they would before falling upon the cornea, is the moſt ſimple and certain remedy.

Long-ſighted people are thoſe who cannot ſee an object diſtinctly unleſs it be at a conſiderable diſtance from them. This ariſes from cauſes contrary to the former; namely, the eye being too flat, ſo that there is no room for refracting the rays and bringing them into a focus. Hence this defect is common in old people, and remedied by the uſe of convex glaſſes.

Thoſe are called *nyctalopes* who ſee better with a very weak than with a ſtrong light. It is a defect very ſeldom to be met with in the human race, though every perſon is ſenſible of it who hath been long kept in the dark and is then ſuddenly brought into the light. The diſeaſe ariſes from too great a ſenſibility of the retina, and the pupil being too open.

The ſight is liable to many and grievous diſorders. It is ſharpened beyond meaſure, ſo that the perſon either perceives nothing diſtinctly or with great pain, from the ſame cauſes that induce a ſimilar diſorder in the other ſenſes; namely, exceſſive ſenſibility in the general habit of body; or a particular ſtate of the brain common in phrenitis, or even in thoſe afflicted with fevers ariſing from inflammation or too great excitement; though more frequently from the condition of the eye itſelf, one becomes unable to bear the light. The inflammation of the tunica adnata, and the fore-part of the ſclerotica, is communicated to the back parts of it, and from thence to the choroides and retina itſelf. Hence the light becomes intolerable, and viſion is attended with pain and great irritation, ſometimes inducing or augmenting a delirium.

The ſenſe of ſeeing is made dull, or even totally aboliſhed, by age; the aqueous humour not being ſupplied in ſufficient quantity, and the cornea and lens, or the vitreous humour, becoming ſhrivelled or decayed. It may likewiſe happen from the cornea becoming dry and opaque; which is to be imputed to the languid motion of the blood, and to great numbers of the ſmall veſſels being obſtructed or having their ſides concreted;—or from the cryſtalline lens becoming yellow like amber, and the retina itſelf leſs ſenſible, for old age diminiſhes every ſenſation. It is totally aboliſhed by injuries of the brain, the optic nerve, or the retina, even though the ſtructure of the organ ſhould remain ſound. This diſeaſe is called an *amauroſis*; and is eaſily known by the dilatation and immobility of the pupil, the humours of the eye remaining clear. It is commonly owing to congeſtion of blood; and ſometimes, where no congeſtion of blood can be diſcovered, to mere torpor of the nerves. If it be only a torpor of part of the retina, we ſee black ſpots in thoſe things at which we look; or flies ſeem to paſs before our eyes, a very bad ſign in fevers, and almoſt always mortal. The ſight is aboliſhed alſo by the obſcurity or opacity of any of the parts through which the rays ought to paſs and be refracted; as if the cornea loſe its tranſparency by being covered with ſpots; or the aqueous humours become corrupted with blood, ſerum, or pus; or the lens (which often happens and which is called a *cataract*) becomes of a gray or brown colour, or the vitreous humour be in like manner corrupted; or laſtly, when all the humours being diſſolved, confuſed and mixed together, by inflammation and ſuppuration, either do not ſuffer the light to paſs at all, or to paſs imperfectly and unequally; whence either no image is formed on the retina, or it appears obſcure, diſtorted, imperfect, and ill-coloured.

The ſight is alſo depraved, when things appear to it of a colour different from their own, or even in another ſituation and of another ſhape than they ought to have. This happens from the humours being tinctured with any unuſual colour, as is ſaid to happen in ſome inſtances of jaundice; or from an extravaſation and mixture of the blood with the aqueous humour. A ſurpriſing depravation alſo, or conſtant and perpetual defect of viſion, is not unfrequently obſerved in men otherwiſe very healthy, and who ſee quite clearly; namely, that they cannot diſtinguiſh certain colours, green, for example, from red. Another depravation is, when, without any light being admitted to the eyes, ſparks, ſmall drops of a flame or gold colour, and various other colours, are obſerved to float before us. This is generally a very ſlight and tranſient diſorder, common to thoſe whoſe conſtitutions are very irritable; and ariſes from the ſlight impulſe, as it would ſeem, on the retina, by the veſſels beating more vehemently than uſual. A fiery circle is obſerved by preſſing the eye with the finger after the eyelids are ſhut. The ſame reaſon, perhaps, may be given for thoſe ſparks which are ſeen by perſons labouring under the falling ſickneſs, and increaſing to the ſize of an immenſe and luminous beam before they fall down in convulſions. A ſimilar beam thoſe who have recovered from hanging or drowning teſtify that they have obſerved: for by reaſon of the reſpiration being ſuppreſſed, the veſſels of the head ſwell and compreſs the whole brain and nervous parts of the head. Sparks of the ſame kind, and theſe too of no good

External Senses.

omen, are observed in patients labouring under a fever, where a phrenitis or fierce delirium is at hand; and likewise in those who are threatened with palsy, apoplexy or epilepsy.—A distinct but false perception, namely of visible things which do not exist, is to be imputed to some injury of the brain, to madness or a delirium, not to any disease of the eye.

A very frequent defect of vision remains to be mentioned, namely, squinting. A person is said to squint who has the axes of the eyes more oblique than usual, and directed to different points. Hence a great deformity, and often an imperfect and confused vision by which the objects are sometimes seen double. It is an evil for the most part born with the person, and often corrected by those attempts which an infant makes to see more pleasantly and distinctly; and this even without being conscious of its own defects. It is also easily learned, especially in infants, even without their own knowledge, by that kind of imitation which has a great influence over the human race, especially in their tender years.—It is by no means, however, so easily unlearned.

Squinting is frequently occasioned by a spasm, palsy, rigidity, &c. of the muscles which manage the eye; by epilepsy; by certain diseases of the head, the hydrocephalus especially; or by any great injury done to the head. Sometimes, though very rarely, it comes on suddenly without any known cause. It is very probable, however, that squinting often arises from a fault of the retinæ, when their central points, for instance, and those similarly placed with respect to the centre, do not agree. In this case there must be a contortion of the eye, that the object may not be seen double. This seems also to be the reason why squinting is much increased when the person brings the object near his eye in order to view it more perfectly. Or if the central point of either, or both, of the retinæ be insensible, or nearly so, it is necessary for the person to distort his eyes that he may have any distinct vision of objects. If the optic nerve had not entered the retina obliquely, but passed directly through its centre, we would all either have squinted or seen double.

82 Vertigo.

Physicians have referred to the sense of vision that most troublesome sensation which we call a *vertigo;* though it seems rather to belong to that of feeling, or of consciousness; for in many instances the disorder is not removed either in the dark or by shutting the eyelids. The vertigo takes place when external objects really at rest seem to reel, to whirl round, to tremble, or to move in any manner of way. If the disorder be very violent, the person is neither able to see, on account of a dimness of sight; nor can he stand, as the powers fail which ought to govern the limbs. A nausea also usually accompanies the vertigo, and the one generally produces the other.

This disorder is observed to be both the symptom and forerunner of some dangerous diseases; such as apoplexy, epilepsy, hysteria; hæmorrhages from the nose and other parts; suppressions of the menses; plethora; fevers, as well such as are accompanied with debility as those in which there is an increased impetus of the blood towards the head. An injury done to the head also, but rarely one done to the eyes, unless as it affects the whole head, brings on a vertigo. A vertigo may be likewise produced by a very great and sudden loss of blood or other fluid; by debility; syncope; various diseases of the alimentary canal, of the stomach especially; poisons admitted into the body, particularly of the narcotic kind, as opium, stramonium, wine, &c. and hence vertigo is a symptom of every kind of drunkenness. Various motions also, either of the head or the whole body, being tossed in a ship, especially if the vessel be small and the sea runs high, produce a vertigo. In these and similar examples, the unusual and inordinate motions of the blood are communicated to the nervous parts which are in the head; or these being affected by sympathy from the neighbouring parts, produce a confused sensation as if of a rotatory motion. Nay, it is often produced from an affection of the mind itself, as from beholding any thing turned swiftly round, or a great cataract, or looking down a precipice, or even by intense thought without looking at any thing.

Though a vertigo be for the most part a symptom and concomitant of other diseases, yet it is sometimes a primary disease, returning at intervals, increasing gradually, and equally impeding and destroying the functions of the body and mind.

83 Memory.

After having treated of the external senses, we shall next proceed to consider those properly called *internal;* which are, the *memory*, the *imagination*, and the *judgement.* The first is lessened, disturbed, or even totally destroyed, in many diseases, especially those which affect the brain; as in apoplexy, palsy, internal tumours of the head, external violence applied, fevers, especially those in which there is an increased motion of the blood towards the head, or where the brain is any other way very much affected. It is very rarely, however, depraved in such a manner that ideas are not represented to the mind in their proper order; or if at any time such a disorder occurs, it is considered rather as a disorder of the imagination, or as a delirium, than a failure of the memory. The mind is said to be disordered when the perceptions of memory or imagination are confounded with those of sense, and of consequence those things believed to be now present which are really past or which never existed; or when the sense of the person concerning ordinary things is different from that of other people. The general name for such disorders is *vesania:* if from fever, it is called *delirium.* A general fury without a fever, is called *mania* or *madness:* but a partial madness, on one or two points, the judgment remaining sound in all other respects, is called *melancholia.* There is, however, no exact and accurate limits between a sound mind and madness. All immoderate vivacity borders upon madness; and, on the other hand, a sorrowful and gloomy disposition approaches to melancholy.

84 Delirium.

Delirium accompanies fevers of many different kinds. Sometimes it is slight, easily removed, and scarce to be accounted a bad sign. Often, however, it is very violent, and one of the very worst of signs, requiring the utmost care and attention.

A delirium is either fierce or mild. The fierce delirium is preceded and accompanied by a redness of the countenance, a pain of the head, a great beating of the arteries, and noise in the ears; the eyes in the mean time looking red, inflamed, fierce, shining, and unable to bear the light; there is either no sleep at all, Delirium. all; or ſleep troubled with horrid dreams; the wonted manners are changed; an unuſual peeviſhneſs and ill-nature prevail. The depravation of judgment is firſt obſerved between ſleep and waking, and by the perſon's crediting his imagination, while the perceptions of ſenſe are neglected, and the ideas of memory occur in an irregular manner. Fury at laſt takes place, and ſometimes an unuſual and incredible degree of bodily ſtrength, ſo that ſeveral attendants can ſcarce keep a ſingle patient in his bed.

The mild delirium, on the contrary, is often accompanied with a weak pulſe, a pale collapſed countenance, and a vertigo when the patient ſits in an erect poſture; he is ſeldom angry, but often ſtupid, and ſometimes remarkably grieved and fearful. The loſs of judgment, as in the former kind, is firſt perceived when the patient is half awake; but a temporary recovery enſues upon the admiſſion of the light and the converſation of his friends. The patient mutters much to himſelf, and attends little to the things around him; at laſt, becoming quite ſtupid, he neither feels the ſenſations of hunger or thirſt, nor any of the other propenſities of nature, by which means the urine and excrements are voided involuntarily. As the diſorder increaſes, it terminates in ſubſultus tendinum, tremors, convulſions, torpor, and death. The other ſpecies of delirium alſo frequently terminates in death, when the ſpirits and ſtrength of the patient begin to fail.

The ſymptoms accompanying either of theſe kinds of delirium ſhow an unuſual, inordinate, and unequal motion of the blood through the brain, and a great change in that ſtate of it which is neceſſary to the exerciſe of the mental powers. It is very probable, that an inflammation of the brain, more or leſs violent and general, ſometimes takes place, although the ſigns of univerſal inflammation are frequently ſlight. This we learn from the diſſection of dead bodies, which often ſhow an unuſual redneſs of the brain or of ſome of its parts, or ſometimes an effuſion or ſuppuration.

The ſtate of the brain, however, may be much affected, and delirium induced, by many other cauſes beſides the motion of the blood. In many fevers, typhus, for inſtance, the nervous ſyſtem itſelf is much ſooner and more affected than the blood's motion; and though the morbid affections of the nervous ſyſtem are as inviſible to the ſenſes as the healthy ſtate of it, the ſymptoms of its injuries plainly ſhow that its action, or *excitement*, as ſome call it, is unequal and inordinate. In this way, too, delirium is produced by ſeveral poiſons.

85 Melancholy and mania. The pathology of melancholy and mania is much more obſcure; as coming on without any fever, or diſturbance in the blood's motion. Often alſo they are hereditary, depending on the original ſtructure of the body, eſpecially of the brain; the fault of which, however, cannot be detected by the niceſt anatomiſt. But it is well known, that various diſeaſes of the brain, obſtructions, tumors, either of the brain itſelf, or of the cranium preſſing upon it, any injury done to the head, and, as ſome phyſicians relate, the hardneſs and dryneſs of the brain, and ſome peculiar irritations affecting the nervous ſyſtem, are capable of bringing on this malady. And indeed ſo great are the irritations affecting the nervous ſyſtem in mad people, that they often ſleep little or none for a long time.—Yet even this ſo defective and imperfect knowledge of the diſeaſes of the brain and nerves, is by no means free from difficulties. For though we know that the brain, or a certain part of it, is hurt, or that it is irritated by a ſwelling, or a pointed bone growing into it, nobody can foretel how great, or what may be the nature of the malady from ſuch a hurt: for examples are not wanting of people who, after loſing a large part of the brain, have recovered and lived a long time; there are many inſtances alſo of perſons who have perceived no inconvenience from a large portion of that viſcus being corrupted, until at length they have fallen ſuddenly down and died in convulſions.

Another diſeaſe of the internal ſenſes, quite different from theſe, is *fatuity* or *idiotiſm*. Thoſe are called *idiots* who are deſtitute either of judgment or memory, or elſe have theſe faculties unequal to the common offices of life. A weak memory, however, is by no means eſſential to idiotiſm. For there are ſome inſtances of idiots who have had very correct and very extenſive memories. A kind of idiotiſm is natural and common to all infants; neither is it to be accounted a diſeaſe; but if it laſt beyond the ſtate of infancy, it is a real diſeaſe, and for the moſt part incurable. It has the ſame cauſes with the other diſeaſes of the internal ſenſes; although theſe can ſcarcely be detected by the eye or by the knife of the anatomiſt. It frequently accompanies, or is the effect of, epilepſy. Hence, if the epilepſy derives its origin from cauſes not ſeated in the head, as from worms lodging in the inteſtines, the fatuity may be cured by diſlodging theſe, and removing the epilepſy. It is not unlikely that the fatuity of children, and the dotage of old men, may ariſe from the brain being in the former too ſoft, and in the latter too hard; or perhaps in the one caſe not evolved, and in the other ſomewhat decayed. 86 Idiotiſm.

The muſcular power may be diſeaſed in a great number of ways. The mobility itſelf may be too great; but this muſt be carefully diſtinguiſhed from vigour. By mobility is meant the eaſe with which the muſcular fibres are excited into contraction. The vigour, on the other hand, is that power with which the contraction is performed. They are ſometimes joined, but more frequently ſeparate, and for the moſt part the exceſſes of each are owing to contrary cauſes. 87 Diſorders in the muſcular power.

Too great mobility is when motions are excited by a very ſlight ſtimulus, or when very violent motions are produced by the cuſtomary ſtimulus. A certain habit of body, ſometimes hereditary, renders people liable to this diſeaſe. Women have a greater ſhare of mobility than men. Infants have a great deal of mobility, often too great; youth has leſs than infancy, but more than man's eſtate; though old age has commonly too little. A lazy, ſedentary life, full diet, a ſuppreſſion of the uſual evacuations, fulneſs of the blood-veſſels, and ſometimes their being ſuddenly emptied, laxity, flaccidity of the ſolids in general, but ſometimes too great a tenſion of the moving fibres, the uſe of diluents, eſpecially when warm, or heat applied in any manner, produce too great mobility. And this may be either general or particular, according as the cauſes have been applied to the whole body, or only to a part of it. 88 Mobility.

Vigour in general is rarely morbid; although ſometimes certain muſcular parts appear to have too great ſtrength. In maniacs and phrenitics, an immenſe ſtrength 89 Vigour.

Diſorders in the Muſcular Power

ſtrength is obſerved in all the muſcles, eſpecially in thoſe which ſerve for voluntary motion; this is not unjuſtly reckoned morbid. The reaſon of this exceſs is very obſcure; however, it is plainly to be referred to a diſeaſed ſtate of the brain.

A more frequent and more important exceſs of vigour is obſerved in thoſe muſcular fibres that do not obey the will, ſuch as thoſe which move the blood. Its circulation is thus often increaſed, not without great inconvenience and danger to the patient. But a ſlighter exceſs of this kind, pervading the whole body, renders people apt to receive inflammatory diſeaſes, and is uſually called a *phlogiſtic diatheſis*. But this is better obſerved when local, as in inflammation itſelf.

Too great vigour of the muſcular fibres may ariſe from the nervous power increaſed beyond meaſure, as in mania, phrenitis, or violent affections of the mind; from too great a tenſion of the fibres, by which they more eaſily and vehemently conceive motions, as of the arteries when filled with too much blood; from catching cold, by being expoſed either to cold or heat, as uſually happens in the ſpring; or, laſtly, though the nervous power and tenſion of the fibres ſhould not at all be changed, their action may become too great, from a ſtimulus more violent than uſual being applied, or from the uſual ſtimulus, if the fibres themſelves have already acquired too great a ſhare of mobility.

90 Torpor.

The oppoſite to too great mobility is torpor, and to too great vigour is debility. Torpor is ſuch a diminution of mobility as renders the parts unequal to their functions. It ariſes from cauſes directly oppoſite to mobility; ſuch as, a harder and more rigid contexture of the parts themſelves, or even ſometimes from one too lax and flaccid; from old age; from ſome peculiar temperament of body, ſuch as one phlegmatic, frigid, or inſenſible; too great and inceſſant labour, cold, ſpare diet, and an exhauſted body. This evil is the more to be dreaded, becauſe, the powers of the body being deficient, nature is neither able to make any effort of herſelf, nor are the remedies, in other caſes the moſt efficacious, capable of affording her any aſſiſtance.

91 Debility.

Debility takes place, when the motion of the muſcles, either voluntary or involuntary, is not performed with ſufficient ſtrength. A greater or leſſer ſhare of debility, either general or of ſome particular part, accompanies almoſt all diſeaſes, and is indeed no ſmall part of them: for it is hardly poſſible that a diſeaſe can ſubſiſt for any length of time without inducing ſome degree of debility. When a ſtate of debility is induced, it renders a man obnoxious to innumerable diſorders, and throws him as it were defenceleſs in their way. It often depends on the original ſtructure of the body, ſo that it can be corrected neither by regimen nor medicines of any kind. A different degree of ſtrength alſo accompanies the different ages of mankind; and thus, in ſome caſes, debility cannot be reckoned morbid. But a truly morbid and unuſual debility ariſes from the nervous energy being diminiſhed; from diſeaſes of the brain and nerves, or of the muſcles through which they are diſtributed; from a decay of the nerves themſelves; from a want of the due tenſion of the fibres, or the fibres themſelves becoming torpid; from the body exhauſted by ſpare diet, want, evacuations; or laſtly, from diſeaſes affecting the whole body, or ſome particular parts of it.

Diſorders in the Muſcular Power.

92 Palſy.

The higheſt degree of debility, namely, when the ſtrength of the muſcles is altogether or nearly deſtroyed, is called *paralyſis* or *palſy*; and is either univerſal, or belonging only to ſome particular muſcles. An univerſal palſy ariſes from diſeaſes of the brain and nerves, ſometimes very obſcure, and not to be diſcovered by the anatomiſt; for the nervous power itſelf is often deficient, even when the ſtructure of the nerves remains unhurt; yet often a compreſſion, obſtruction, or injury of the veſſels, extravaſation of blood or ſerum, collections of pus, ſwellings, &c. are diſcovered. It frequently ariſes from certain poiſons acting on the nerves; from the fumes of metals; from the diſeaſes of parts, and affections of the muſcles, very remote from the brain, as in the colic of Poictou. A palſy of ſingle muſcles, but leſs perfect, often ariſes without any defect of the brain or nerves, from any violent and continued pain, inflammation, too great tenſion, relaxation, reſt, or deſtruction of the texture of the parts, ſuch as commonly happens after the rheumatiſm, gout, luxations, fractures of the bones, and iſchuria.

An *univerſal* palſy, however, as it is called, ſeldom affects the whole body, even though it ſhould originate from a diſeaſe of the brain. We moſt commonly ſee thoſe who are paralytic affected only on one ſide, which is called an *hemiplegia*. It is ſaid that the ſide of the body oppoſite to the diſeaſed ſide of the brain is moſt commonly affected. If all the parts below the head become paralytic, it is called a *paraplegia*. In theſe diſeaſes the ſenſes for the moſt part remain; though ſometimes they are aboliſhed, and at others rendered dull. Sometimes, though rarely, and which is an exceeding bad ſymptom, the motion, ſenſation, pulſe, and heat of the paralytic limbs are loſt; in which caſe the arteries themſelves become paralytic. A palſy of the whole body, as far as regards the voluntary motions, with anæstheſia and ſleep, is called an *apoplexy*. This proceeds from ſome injury of the brain: though a ſtate very ſimilar to it is induced by narcotics, opium, wine itſelf, or any generous liquor taken to exceſs; and laſtly, by breathing in air corrupted by noxious impregnations, ſuch as a large proportion of carbonic acid, hydrogenous gas, or ſimilar active aeriform fluids.

93 Spaſms.

Another diſeaſe to which muſcular motion is liable, and that neither ſlight nor unfrequent, is called *ſpaſm*. This is a violent and irregular motion of the muſcles. Of ſpaſms there are two kinds, the tonic and clonic. The latter is frequently called a *convulſion*; in order to diſtinguiſh it from the other, which is more peculiarly called *ſpaſm*.

Spaſm therefore is a violent, conſtant, and preternatural contraction of the muſcular fibres; but a convulſion is an unuſual and violent contraction alternated with relaxation. People are rendered liable to ſpaſm by too ſenſible a habit of body, or too great mobility; and hence it is a diſeaſe common in women, in infants, and in weak, luxurious, lazy, and plethoric people. It is brought on thoſe already prediſpoſed to it, by any kind of ſtimulus applied to the brain, or to any nerve, muſcle, or nervous part connected with it: of of which we have examples in dentition; worms lodged in the inteſtines, and irritating them; any acrid matter infecting the blood, or much affecting the ſtomach and inteſtines; the irritation of any nerve, or of the brain itſelf, by an exoſtoſis, ſwelling, too great fulneſs of the veſſels, pain, vehement affections of the mind, ſudden evacuation, or poiſons admitted into the body. Frequently, however, the malady originates from ſlight cauſes, little known, and not eaſily obſerved.

Spaſm is both the cauſe and effect, and frequently conſtitutes the greateſt part, of many diſeaſes. It is often very difficult either to be known or cured; becauſe it is ſo multiform, and produces as many different ſymptoms as there are organs affected; of which it ſurpriſingly diſturbs, impedes, or increaſes the functions. It is a diſeaſe ſeated in the original ſtamina of the conſtitution; and neither to be removed by ſlight remedies, nor in a ſhort time.

94 Sleep.

With regard to ſleep, its uſe is ſufficiently apparent from the effects which it produces in the body. It reſtores the powers both of mind and body when exhauſted by exerciſe, giving vigour to the one, and reſtoring its wonted alacrity to the other. It renders the muſcles again active and moveable, after they have become wearied, rigid, painful, and trembling by hard labour. It moderates the quickneſs of the pulſe, which uſually increaſes at night, and brings it back to its morning ſtandard. It ſeems alſo to aſſiſt the digeſtion of the aliment; leſſens both the ſecretions and excretions; and renders the fluids thicker than otherwiſe they would be, eſpecially in a body endowed with much ſenſibility or mobility. Hence ſleep is not only uſeful, but abſolutely neceſſary for preſerving life and health; and is a moſt excellent remedy both for alleviating, and totally removing, many diſeaſes.

Want of ſleep is hurtful in many different ways, eſpecially to the nervous ſyſtem. It renders the organs of ſenſe both external and internal, as well as thoſe of every kind of motion, unfit for performing their offices. Hence the ſenſations are either aboliſhed, or become imperfect or depraved; and hence imbecility of mind, defect of memory, a kind of delirium, mania itſelf, pain of the head, weakneſs of the joints, an imperfect or inordinate action of the vital organs, quickneſs of pulſe, heat, fever, depraved digeſtion, atrophy, leanneſs, and an increaſe or perturbation of the ſecretions and excretions.

Sleep may be prevented both in healthy and ſick people from various cauſes; ſuch as ſtrong light, noiſe, pain, anger, joy, grief, fear, anxiety, hunger, thirſt, vehement deſire, motion of the body, memory, imagination, intenſe thought, &c. On the other hand, ſleep is brought on by a ſlight impreſſion on the organs of ſenſe, or none at all; by the humming of bees, the noiſe of falling water, cold and inſipid diſcourſe; or laſtly, by ſuch an exerciſe of the memory as is neither too laborious nor diſturbing to the mind.—Too great an impulſe of the blood towards the head, ſuch as often happens in fevers, prevents ſleep; but a free and equal diſtribution of the blood through the whole body, eſpecially the extreme parts, frequently brings it on. Whatever weakens the body alſo favours ſleep; and hence various kinds of evacuations, the warm bath, fomentations, ſometimes heat itſelf, are uſeful for promoting it. It alſo comes on eaſily after taking food, or indulging venery; the violent ſenſation being then quieted, and the body itſelf ſomewhat weakened. Cold produces a deep ſleep of long continuance, not eaſily diſturbed, and often terminating in death. Laſtly, There are certain ſubſtances which, when applied to the body, not only do not excite the nervous ſyſtem, but plainly lay us aſleep, and render us unfit for ſenſation; of this kind are thoſe called *narcotics*, as opium and the like; among which alſo we may reckon wine taken in too great quantity. Laſtly, Watching itſelf is often the cauſe of ſleep; becauſe while a man is awake he always more or leſs exerciſes the organs of his body, by which the nervous influence is diminiſhed, and thus the more violently the body is exerciſed, in the ſame proportion is the perſon under a neceſſity of ſleeping.

Sleep is deficient in many diſeaſes; for there are few which do not excite pain, anxiety, or uneaſineſs, ſufficient to prevent the approach of ſleep, or to diſturb it. Fevers generally cauſe thoſe who labour under them to ſleep ill; as well on account of the uneaſineſs which accompanies this kind of diſeaſe, as by reaſon of the impetus of the blood towards the head being frequently increaſed; and likewiſe from the ſtomach being diſordered, loaded with meat, or diſtended with drink. Hence alſo we may ſee the reaſon why many hypochondriac and hyſteric patients ſleep ſo ill; becauſe they have a bad digeſtion, and their ſtomach is diſpoſed to receive many though frequently ſlight diſorders; the ſlighteſt of which, however, is ſufficient to deprive the patient of reſt, provided the body be already irritable, and endowed with too great a ſhare of mobility.

Want of ſleep will hurt in diſeaſes as well as in health; and for the ſame reaſon; but in a greater degree, and more quickly, in the former than in the latter; and is therefore not only a very troubleſome ſymptom of itſelf, but often produces other very dangerous ones.

Too much ſleep, on the other hand, produces many miſchiefs, rendering the whole body languid, torpid, and lazy; and it even almoſt takes away the judgment. It alſo diſturbs the circulation, and diminiſhes moſt of the ſecretions and excretions. Hence plethora, fatneſs, flaccidity, and an inability for the common offices of life.—The cauſes of this exceſs are, either the uſual cauſes of ſleep above mentioned increaſed beyond meaſure, or ſome fault in the brain, or a compreſſion of it by an extravaſation of the humours; or ſometimes, as it would ſeem, from great debility produced by an unuſual cauſe, as in thoſe who are recovering from typhous fevers and other diſeaſes. In theſe examples, however, this exceſs of ſleep is by no means hurtful; nor even, perhaps, in thoſe caſes where an exceſs of grief continued for a long time, or a great fright, have produced a ſurpriſing and unexpected ſomnolency. Laſtly, Many people have accuſtomed themſelves, and that not without a great deal of hurt to their conſtitutions, to ſleep too much. Nor there are examples wanting of ſome who have paſſed whole days, and even months, in ſleep almoſt uninterrupted.

With regard to the manner in which the circulation of the blood is performed, and the various principles of which it is compoſed, ſee the articles Blood, and Anatomy. As for the diſorders to which the blood and its circulation are ſubject, it has been obſerved, that 95 Circulation.

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that in our younger years the veins are much more denfe, firm, and ftrong, than the arteries; but the latter, by reafon of the continual preffure upon them, and the ftrength which they exert, become daily more firm, hard, and ftrong, until at laft they equal or exceed the veins themfelves in ftrength; and it is not uncommon in old men to find fome part of the arteries converted into a horny fubftance, or even into a folid bone. Hence in the ftate of infancy the greateft part of the blood is contained in the arteries, and in old age in the veins; an affair indeed of no fmall moment, as it fhows the reafon, in fome meafure, of the ftate of increafe and decreafe of the body. Befides, if any difeafe happens from too great a quantity of blood, it thence appears that it muft fhow itfelf in young fubjects in the arteries, and in old ones in the veins; and this is the reafon of many difeafes which accompany certain periods of life.

In moft, if not in all fpecies of animals, the arteries of the females are much more lax and capacious when compared with the veins, and the veins much lefs, than in the males of the fame genus. The defign of nature in this conformation, is probably that they may be the better able to nourifh the fœtus in their womb. The fame likewife feems to be the reafon why women are more inclined to plethora than men; and to this greater capacity of the arteries and fmallnefs of the veins are we to afcribe that beauty and elegant fhape of the arms in women, not disfigured or livid with veins as in men.

The blood is alfo diftributed in various proportions to the different parts of the body, and that proportion too differs at different periods of our lives. At firft a great quantity is fent to the head, becaufe that part of the body is firft to be evolved and fitted for its offices; but as foon as the parts begin to make a confiderable refiftance to the efforts of the blood, and the veffels cannot eafily be further dilated, it is neceffarily fent off to other parts; by which means the reft of the body increafes in bulk, and becomes fitted for performing its proper functions. The effect of this change is alfo very foon obferved, namely, when none of the blood paffes through the navel, and of confequence a greater quantity is fent by the iliac arteries to the inferior extremities. Thefe, though fo fmall and flender in the fœtus, increafe very fuddenly; fo that often in not many months the child can not only ftand on its feet, but even walk tolerably well. And during the earlieft periods of infancy, the inferior extremities grow more rapidly than any other part of the body.

96 Pulfation of the arteries.

Phyficians are wont to judge of the ftate of the circulation by the pulfe, which indeed is very various, as well with regard to its frequency, as to the ftrength and equality of its ftrokes and intervals.—Its common quicknefs in a healthy adult is about 70 ftrokes in a minute. In a fœtus, perhaps, it is more than double; and in an infant a few months old, hardly lefs than 120. As we grow up, this quicknefs gradually diminifhes; fo that in extreme old age it fometimes does not exceed 50, or is even flower. This rule, however, is not without exceptions: for many, efpecially thofe of an irritable habit, have the pulfe much quicker; while others, even in the vigour of their age, have their pulfe remarkably flow. It is for the moft part fomewhat quicker in women than in men.

The pulfe is alfo rendered quicker, both in a healthy and difeafed body, by the application of ftimuli of many different kinds. Exercife efpecially, by accelerating the return of the blood through the veins, increafes the quicknefs of the pulfe to a furprifing degree. Various kinds of irritations affecting the nervous fyftem, as intenfe thinking, paffions of the mind, pain, heat, ftimulating medicines, wine, fpices, &c. likewife produce the fame effect. The acrimony of the blood itfelf alfo is thought to quicken the pulfe.

When a perfon firft awakes in the morning, the pulfe is flow, but becomes quicker by degrees on account of the many irritating matters applied to the body. Its quicknefs is increafed after taking food, efpecially of the animal kind, or fuch as is hot or feafoned with fpices. In the evening a flight fever comes on, for which reft and fleep are the remedy. Thefe things, however, are fcarcely to be obferved in a healthy perfon, but are very evident in one that is feverifh, efpecially when the fever is a hectic.—Again, even debility itfelf often renders the pulfe quicker than ufual; becaufe the ventricle of the heart not being quite emptied, it is the fooner dilated again, and of confequence contracts the fooner. For this reafon a phyfician can never judge of the ftrength of the circulation from the frequency of the pulfe.

Laftly, In all fevers, however different from one another, the pulfe is found to be too quick, partly perhaps from debility, partly from the acrimony of the fluids, and partly from the repulfion of the blood from the furface of the body, and the accumulation of it in the large veffels where it acts as a ftimulus; though it muft be owned, that a great deal of this is obfcure, if not totally unknown; nor in truth are we able to underftand in what manner the *autocrateia* acts with regard to the frequency of the pulfe.

The pulfe is feldom obferved too flow, unlefs when the mobility of the body is much diminifhed, as in decrepid old age, or from a compreffion or difeafe of the brain, as is exemplified in the fecond ftage of hydrocephalus; but a greater compreffion of the brain ufually produces a ftill more remarkable flownefs of the pulfe, as in the third ftage of hydrocephalus.—Sometimes alfo the pulfe is too flow in thofe who are recovering from tedious fevers. But this is a matter of little moment, and feems to be owing to fome kind of torpor. Indeed it has generally been confidered as a mark of a thorough and complete folution of the fever; for it is commonly obferved, that when this ftate of the pulfe takes place, the patient feldom fuffers a relapfe.

While the frequency of the pulfe continues the fame, its ftrokes may be either full, great, ftrong, and hard; or foft, fmall, and weak. A full, great, and ftrong pulfe takes place when the ventricle ftrongly and completely empties itfelf; throwing out a great quantity of blood into the arteries, which fully diftends them and ftimulates them to a ftrong contraction. A pulfe of this kind is common in ftrong healthy men, and is feldom to be accounted a fymptom of difeafe. But if it be too ftrong, and ftrike the finger of the perfon who feels it violently and fharply, it is called a *hard pulfe*. This hardnefs is produced by a fudden and violent contraction of the heart and arteries, which diftends even the remote branches, as thofe of the wrift, too fuddenly and

and fmartly, and excites them alfo to fudden and violent contractions.

A hard pulfe therefore denotes too great an action of the heart and arteries. It may arife from various caufes: in the firft place, from too great a tenfion of the veffels; for inftance, from their being too full, and by that means more prone to motion, and the more fit for receiving violent motions. It may arife alfo from too great a denfity and firmnefs of the folids; and hence it is moft frequent in cold countries, among ftrong robuft people, and fuch as are accuftomed to hard labour. It may likewife arife from various caufes irritating the whole nervous fyftem, or only the heart and arteries. Laftly, It accompanies many fevers, as well as moft inflammatory diforders, whether the inflammation arifes from a general ftimulus applied to the whole body, or from the irritation of particular parts, by degrees extended over the whole body. In fuch a ftate of the circulation, the patient frequently ftands in need of blood-letting, and almoft always bears it well.

A fmall, weak, and foft pulfe is generally owing to caufes oppofite to the former, and indicates a contrary ftate of the circulation and nervous fyftem. It frequently requires ftimulants; nor does it generally require blood-letting, or eafily bear it. Sometimes, however, a pulfe of this kind is obferved even in the cafe of a dangerous inflammation, of the ftomach for inftance, or inteftines. But in thefe and the like examples we ought to attend to the nature of the malady, much more than to the ftate of the pulfe.

The pulfe is faid to intermit, when the ftroke does not return after the ufual interval, and perhaps not till after twice, thrice, or four times the ufual fpace. A pulfe of this kind feems to be almoft natural and conftant in fome animals, and is common to fome men even in the moft perfect health; and if thefe happen to be feized with a fever, the pulfe fometimes becomes regular, nor can the difeafe be removed before the intermiffion has returned.

Moreover, in fome people, though their pulfe beats equally while in health, yet the flighteft illnefs makes it intermit; and in others, efpecially thofe who have a great deal of mobility in their conftitution, fuch as hypochondriac and hyfteric people, the intermiffion of the pulfe is felt, without applying the finger to the artery, merely by the uneafinefs which they perceive in their breafts during thofe intervals in which the pulfe is deficient. An intermittent pulfe likewife occurs in many difeafes of the breaft, efpecially when water is collected in it; and the like happens in the end of all difeafes, efpecially fevers, when the ftrength is nearly exhaufted, and death approaches, of which it is frequently the forerunner.

An intermitting pulfe therefore feems to arife from an unequal influx of the nervous power into the heart, or from the decay and exhauftion of the nervous power, by which means the heart is not able to contract till it has been diftended beyond its due pitch. Or laftly, It may arife from difeafes of the organ itfelf, or the neighbouring parts; from fwellings, water, &c. preffing upon them, and impeding the action of the heart: which indeed is a very dangerous diforder, and almoft always mortal.

Many other variations of the pulfe are enumerated by phyficians, but moft of them are uncertain, and not confirmed by experience. We fhall therefore now confider the motion of the blood, which may be either too great, too fmall, or irregular.

A quick pulfe, *cæteris paribus*, produces a more rapid circulation, becaufe the fooner that the ventricle of the heart is emptied, the more quickly is the blood thrown into the arteries; and their actions muft anfwer to this ftronger ftimulus. Hence exercife, heat, ftimulants, plethora, every kind of irritation, paffions of the mind, and fever, increafe the circulation. The effect of this increafe is a diftention of the veffels, a ftimulus applied to the whole body, an increafe of heat, and often a debility. The fecretion of fweat is increafed while the other fecretions are diminifhed, and the various functions of the body impeded; thirft comes on, the appetite is loft, the fat confumed, and a difpofition to putrefcency introduced. Sometimes the fmaller veffels are burft; whence effufions of blood and hæmorrhages. But we are by no means to forget, that this violent motion of the blood, however hurtful it may feem, is among the beft remedies made ufe of by nature in curing many difeafes.

The motion of the blood is diminifhed, efpecially by debility, torpor, the want of irritation or of exercife: the fame thing happens to all the fluids, if there be any obftruction in the veffels, or any caufe by which their return is hindered or rendered more difficult. Thus, from the very weight of the blood itfelf, if a perfon has ftood long on his feet, the humours return more flowly from the inferior extremities. Any difeafe of the heart and arteries alfo, as an aneurifm, contraction, offification, muft neceffarily obftruct the circulation. The fame thing happens from obftructions of the veins, or interrupted refpiration, by which the paffage of the blood through the lungs to the left fide of the heart is impeded.

But, from whatever caufes this diminution of the circulation takes place, the bad confequences are perceived chiefly in the veins, becaufe in them the blood always moves more flowly than in the arteries. Hence varices, and congeftions of blood, efpecially in thofe parts of the body where the veins are deftitute of valves, and of confequence where the motion of the mufcles cannot affift the circulation. Hence alfo arife dropfies from an impeded or languid motion of the blood; becaufe the refiftance of the veins being increafed, the blood is received into them with the greater difficulty, and more of the thin humour is driven into the exhaling veffels, and by them depofited in fuch quantities as cannot be reabforbed by the lymphatics. Thefe difeafes, as well as all others proceeding from defects of the circulation, are alfo more difficult of cure than others, becaufe all the vital powers are weakened at the fame time.

Another diforder of the circulation is where the blood is carried to one part of the body in too great quantity, by which means the other parts are deprived of their due proportion. This irregular diftribution of the vital fluid frequently arifes from a ftimulus applied to the part itfelf, or to the brain, or at length acting on the mind, which, according to the laws of fympathy, produces a certain definite diftribution of

the

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the blood. It arises also not unfrequently from a spasm taking place in some other parts, which drives the blood out of its ordinary course.

In proportion to this irregularity of the circulation are the consequences; heat, swelling, redness, inflammation, rupture of vessels, hæmorrhages, effusions, destruction, corruption, and suppuration of the cellular texture and adjoining parts, &c. Even this evil, however, nature often converts into an excellent remedy; and physicians, following her steps, frequently attempt to direct the distribution of the blood in particular diseases, well knowing that a change in the distribution of the blood is frequently efficacious either for radically curing some diseases, or relieving their most urgent symptoms.

97 Palpitation.

Lastly, Some disorders in the motion of the heart itself, and those of no small consequence, remain yet to be taken notice of, namely, palpitation and syncope. A palpitation is a violent and irregular action of the heart, such as for the most part is perceived by the patient himself, and that not without a great deal of uneasiness and oppression at his breast; and it is also manifest to the by-standers, if they apply their hands, or look at his naked breast; the pulse of the arteries in the mean time being weak, unequal, and intermittent. This is a spasmodic disorder; and is induced by various causes affecting either the nervous system in general, or the heart in particular. Every disease of the organ itself, such as a constriction of its valves and blood-vessels, an ossification, enlargement, or polypus, hindering the free action of the heart, and evacuation of blood from it, are capable of exciting it to violent and unusual contractions. The same effect will also follow plethora, or too violent an impulse of the blood. The heart will likewise frequently palpitate from a violent excitement of the nervous system, especially where the constitution is endowed with a great deal of mobility. Hence palpitations arise from any affection of the mind, and in hysteric women. Palpitation may likewise arise from an affection of the stomach, occasioned by worms, a surfeit, flatus, or stimulation by various acrid substances. It frequently also accompanies the gout when repelled, or even when a fit is coming on. Sometimes it arises from debility, whatever may be the cause; frequently from any difficulty in breathing; and many of these causes may be joined at the same time, or some of them produce others.

Hence we may see why the evil is sometimes slight and of short continuance; at other times altogether incurable, and certainly mortal in a longer or shorter time; why it sometimes returns at intervals, often coming on and being increased by every kind of irritation and exercise, and sometimes relieved or totally removed by stimulants or exercise.

98 Syncope.

A syncope takes place when the action of the heart, and along with it that of the arteries, is suddenly and very much lessened; whence the animal powers, the senses, and voluntary motions, immediately cease. This may be produced by almost all the causes of palpitation; because whatever can disturb and disorder the motion of the heart, may also weaken or suspend it. The vitiated structure of the heart itself therefore violent passions of the mind, whether of the depressing kind, or those which suddenly and vehemently excite, various kinds of nervous diseases, those of the stomach, every kind of debility and evacuation, especially a great loss of blood, excessive and unremitting labour, long watching, heat, pain, many kinds of poisons, &c. produce fainting.

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Hence we see, that whatever weakens the motion of the blood through the brain tends to produce fainting; and, on the contrary, whatever tends to augment that motion, also tends to refresh, and to prevent the person from fainting. Hence also we see how the mere posture of the body may either bring on or keep off fainting, or remove it after it has already come on. We likewise see how this disorder may sometimes be of little consequence and easily removed; at others very dangerous, not only as a symptom, but even of itself, as sometimes terminating in death; and lastly, how it may be used as a remedy by a skilful physician, and artificially induced, either to free the patient from violent pain, or to stop an immoderate effusion of blood scarce to be restrained by any other method.

99 Buff-coloured crust on the blood.

With regard to the disorders of the blood itself, the glutinous part of it, or, more properly, its fibrine separated from the red particles, produces that buff-coloured appearance often seen upon blood drawn from people afflicted with inflammatory disorders, and even sometimes when no such diseases are present. This crust indeed is nothing else than the fibrine of the blood taking longer time than usual to coagulate, by which means the red particles have an opportunity of falling to the bottom. This indicates no lentor, density, thickness, or tenacity of the blood, as was formerly thought; but rather its thinness, or at least a less tendency in it to coagulate. It arises for the most part from a violent agitation and conquassation of the blood within the body; and hence it accompanies many fevers, all inflammations, sometimes hæmorrhages, exanthemata, plethora, pain, and many irritations. It must, however, be allowed, that in several of these diseases it is rendered highly probable at least, from experiments apparently accurate, that the quantity of the fibrine of the blood is really increased in the proportion which it bears to the other parts. This crust, however, is not always to be accounted morbid, as it often happens to the most healthy; and may even be produced or destroyed by the slightest causes while the blood is running from the vein, so that frequently we shall see a very thick and tenacious crust on the blood flowing into one cup, while that which runs into another has little or none at all. In general, however, the appearance of this crust shows, that the patient will bear blood-letting well, though those have been in a great mistake who have directed this operation to be repeated till no more crust appeared on the blood.

The coagulable part of the blood also frequently produces those masses called *polypi*, which sometimes take place during life, but more frequently after death, in the large vessels near the heart, or even in the cavities of that organ. Similar masses also are frequently formed in the uterus, and are called *moles*.

The quantity of blood contained in a healthy body is very various, and difficult to be ascertained. Many diseases, however, may arise from its being either too scanty or too abundant. Too great a quantity of blood is produced by the use of rich, nourishing diet, strong drink, accompanied with a good digestion; from a lazy, sedentary life, or much sleep, especially 100 Plethora.

in

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in thoſe who have been formerly accuſtomed to much exerciſe; with many other cauſes of the ſame kind. It renders the perſon dull and languid, and ſometimes almoſt totally oppreſſes him; nor are thoſe organs deſtined for moving the blood ſufficient for driving forward ſuch a load. The pulſe ſinks; and ſometimes a ſyncope, vertigo, or palpitation takes place. More frequently, however, the veſſels are too much diſtended, and ready to be thrown into violent and irregular motions. Hence a diſpoſition to fevers, inflammations, an unequal diſtribution of the blood, unuſual congeſtions, rupture of the veſſels, and hæmorrhages. Beſides this, in conſequence of the cloſe connection between the ſanguiferous and the nervous ſyſtem, a fulneſs of blood produces a diſpoſition to ſpaſm and other diſeaſes of that kind.

Hence we may underſtand why a plethora is ſometimes accompanied with a weak and ſometimes with a ſtrong and hard pulſe, why it is the cauſe as well as a part of ſo many diſtempers, why it is the effect of a high ſtate of health, &c.

The want of a due quantity of blood is no leſs pernicious than too great an abundance of it. It debilitates the perſon, and renders him unable to perform the proper duties of life; produces a languid circulation, ſyncope, ſpaſms, and at laſt death itſelf. In a ſlighter degree of the diſeaſe the body is emaciated through want

101 Inanition

of nouriſhment, and its functions are vitiated in various ways. It may ariſe from want, bad food, or ſuch as affords little nouriſhment: from bad digeſtion, or the chyle being hindered from paſſing into the blood: from fevers, or other diſeaſes which exhauſt the body and hinder nutrition: or laſtly, from various evacuations, particularly of blood; and that the more eſpecially if they are ſudden, for in ſlow evacuations the veſſels accommodate themſelves ſurpriſingly to the quantity left in them. Beſides, if the body be ſlowly exhauſted, the excretions are leſſened by reaſon of the deficiency of the vital power; ſo that the unuſual expence is eaſily compenſated by the unuſual retention. But if the evacuation happens to be very ſudden and great, it may either prove mortal in a ſhort time, or break the conſtitution to a degree beyond recovery.

102 Morbid thinneſs of the blood.

By a great and long-continued deficiency of blood the quality of it alſo is impaired; becauſe the thin part of it is eaſily and ſoon made up; but the glutinous, and red part, not ſo eaſily. Hence the blood becomes thin, pale, ſcarcely capable of coagulation, or of affording a proper ſupport to the body. Too great thinneſs of the blood alſo proceeds from uſing much drink, eſpecially of the aqueous kind, ſlender and unnutritious diet, a bad digeſtion in the ſtomach; from diſeaſes of the lungs and thoſe organs which elaborate the red part; or from ſuppreſſion of the uſual evacuations of thin humours, as ſweat or urine, induced by cold, a fault of the ſecreting organs, or from putreſcency. But along with this, other diſorders of the blood concur.

A too thin and watery blood makes the face pale, the body weak and languid. The ſolid parts become flaccid from want of nouriſhment, and having too great a quantity of water in their compoſition. It brings on hydropic effuſions of water in all parts of the body, by reaſon of the increaſed exhalation of that thin fluid which moiſtens all the inward parts; partly by reaſon of the veſſels being relaxed beyond their uſual pitch, and not making a proper reſiſtance. Beſides, in this caſe, the lymphatics are ſo far from abſorbing more than uſual, that, partaking likewiſe of the general debility, they are ſcarcely fitted for performing their proper offices.

Nature, however, has taken care, by the moſt ſimple means, to provide againſt ſo many and ſo great evils; for neither does the blood ſo eaſily become thin as ſome have imagined, nor when this quality takes place does it want a proper remedy. For almoſt inſtantly, if the perſon be otherwiſe in health, the excretions of watery matters are greatly augmented, and the whole maſs of blood in a ſhort time becomes as thick as formerly.

103 Morbid thickneſs of the blood.

The oppoſite to this, namely, too great a thickneſs of the blood, though often ſpoken of by phyſicians, is very rarely if ever obſerved; and thoſe fevers and inflammations which have been thought to ariſe from thence, are now found to originate from other cauſes. The following would ſeem to be the law of the human conſtitution. As ſoon as the blood has attained the due degree of thickneſs, or gone in the leaſt beyond it, the excretions are either ſuppreſſed or diminiſhed, the body attracts more moiſture from the air, the perſon is thirſty, and drinks as much as is neceſſary for diluting the blood. But if water be wanting, and the perſon cannot ſatisfy his thirſt, then the blood is ſo far from being thickened, that by reaſon of a putreſcency begun or augmented, it is much diſſolved, becomes acrid, and is with difficulty contained in the veſſels.

104 Acrimony of the blood.

The acrimony of the fluids has afforded a large field for declamation to ſpeculative phyſicians, and upon this ſlender foundation many perplexed and intricate theories have been built. It is certain indeed, that the blood in a ſtate of health has ſome ſmall ſhare of acrimony; and this acrimony, from certain cauſes, may be a little increaſed ſo as to produce various diſeaſes of a dangerous nature. This we are aſſured of from the increaſe of motion in the heart and arteries, and the ſimilar augmentation of the action of the ſecretory organs, when certain acrid ſubſtances are taken inwardly. The ſame thing alſo appears from the unuſual acrimony of the ſecreted fluids in ſuch caſes, by which the veſſels are ſometimes greatly ſtimulated, and ſometimes even quite croded. Very many acrid ſubſtances, however, are daily taken into the ſtomach; ſo that theſe muſt either be corrected in the *primæ viæ*, or changed by digeſtion before they paſs into the blood; or at leaſt by dilution with much water, or being blunted by an admixture with gluten, oil, or different gaſes, they muſt depoſit much of their acrimony, and at laſt be thrown out of the body as noxious ſubſtances. Thus a vaſt quantity of ſalts, acid, alkaline, and neutral, may paſs through the body, without in the leaſt affecting the health; though theſe ſalts, if taken in very large quantity, undiluted, or not thrown out of the body, will do much hurt.

Moreover, even while life continues, putrefaction is going on, and produces much of that ſubſtance called *animal* ſalt; for into this a great part of our food is converted, and paſſes off by the urine. But if this putreſcent diſpoſition be too great, it will produce too large a quantity of animal ſalt; eſpecially if much of any ſaline ſubſtance is otherwiſe thrown into the body without

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without proper dilution: and this kind of disease is well known to sailors who have been long at sea, without having an opportunity of getting fresh provisions.

For this spontaneous putrescency, nature has suggested a proper remedy, namely, fresh meat, especially of the vegetable and acescent kind, and such as is much impregnated with acid, which it may impart to the body. But where this kind of food is wanting, the putrefaction goes on apace, and a very great thinness and acrimony of the juices take place; especially if there be also a scarcity of urine, or the excretions which ought to carry the putrid matters out of the body languish, either from cold, sloth, torpor, depressing passions of the mind, or from the constitution being broken by diseases; or, lastly, from too great heat, which always favours putrefaction.

Besides, it would seem, that sometimes a disposition to putrefaction is much increased by the reception of a putrid ferment into the body; of which we have examples in some infectious fevers, where the contagion is very much assisted by heat, animal diet, certain kinds of salts, debility and nastiness.

Lastly, Any single part of the body may putrefy from various causes, as from inflammation, cold, &c. and thus may the whole body be infected; although for the most part the disease proves fatal before the corruption has spread over the whole body.

But when the mass of blood begins to putrefy greatly, it not only becomes very acrid, but thin also, so that it either will not coagulate at all, or shows only a slight and very loose crassamentum. Nay, even the red globules are broken down and destroyed; in which case it necessarily follows, that the blood must become very acrid, as well on account of the evolution of the salt, as by reason of the rancid and putrid gluten, which stimulates, and frequently even erodes, the vessels; producing spots, first red, then livid and black, tumors, and ulcers scarce possible to be cured, without first removing the putrescent disposition of the humours. From the same causes proceed hæmorrhages from every part of the body, hardly to be restrained; a most intolerable fetor of the breath and all the excrements; the highest debility and laxity of the solids; the putrefaction acting as a poison to the nervous system, and at length bringing on death.

An acrimony of the acid kind never takes place in the human blood, nor in any of the humours secreted from it; though one of them, namely the milk, turns acid spontaneously in a very short time after it is drawn from the breast. Neither does an alkaline acrimony seem ever to take place in the blood. Putrescency indeed tends this way, and at last terminates in it; but scarcely while the person lives, though the nature of the urine, even while recent, seems to be but little distant from that of an alkali.

Many kinds of acrimony may exist in the blood from too liberal an use of spices, wine, spirits, &c. but of these we know nothing certain. We well know, however, that the body is often infected with various kinds of morbid acrimony, which bring on many and dangerous diseases, as the small-pox, measles, cancers, lues venerea, &c. of which the origin and manner of acting are very little understood, though the effects are abundantly evident. In most cases, nature has taken no less care to provide against the *acrimony* than against the too great *viscidity* of the blood. Sometimes an antidote is afforded, either by the excitement of thirst, that the acrid substance may be diluted with plenty of drink; or by increasing the evacuations, that it may be thrown out of the body; or lastly, by exciting various motions and actions of the vital powers, by which it may be either subdued, changed, rendered innocent, or expelled from the body by new and unwonted passages.

Disorders of Respiration.

105 Respiration.

With regard to respiration, it may be obstructed from various causes seated either in the lungs themselves or the surrounding parts. But from whatever cause this obstruction may arise, it undoubtedly produces all those diseases which proceed from an interrupted circulation. The lungs themselves also being at length compressed, and not suffered to dilate sufficiently, cannot throw off the vapour which arises from them; and hence they are frequently oppressed with moisture. At the same time they are irritated, so that a greater quantity of mucus, and that of a thicker kind than usual, is secreted; by which means the passages through which the air enters them are stopped up, till a violent cough at length throws off the load.

The respiration is also subjected to some other disorders, as a cough and sneezing, which, though at first sight they may seem very dangerous, are not destitute of use, and may even be reckoned among the most salutary attempts of nature to relieve the patient. Often, however, they are attended with danger, or very great uneasiness; namely, when they are either too violent or exerted in vain. At any rate, it is necessary for a physician to know the nature, causes, and effects of these, that he may be enabled to promote them when necessary, to moderate them when too violent, and to stop them when noxious or of no use.

106 Cough.

A cough is a violent, frequently involuntary, and sonorous exspiration, suddenly expelling the air with great force through the glottis somewhat contracted. The convulsion of the muscles serving for exspiration, gives a great force to the air, while the contraction of the glottis produces the sound. It is often long continued, being repeated at certain intervals, during each of which the inspiration is imperfect and obstructed by reason of the contraction of the glottis. It is excited by any kind of acrid substance, either chemically or mechanically applied to those passages through which the air enters. These are lined with a membrane so exceedingly delicate and impatient of stimulus, that it cannot even bear the touch of the mildest substance, such as a small drop of water, without throwing the muscles serving for exspiration into a violent convulsion; the glottis at the same time contracting by means of the sympathy between it and the neighbouring parts. Thus the air is thrown out with such violence, that it drives the irritating substance along with it; and thus a cough becomes not only useful, but absolutely necessary for the preservation of life, as being able to free the lungs from every kind of irritating substance or foulness, which might soon bring on a suffocation. Hence a cough is almost an inseparable companion of every inflammation of the lungs, as well as every difficulty in respiration; and even frequently accompanies the entrance of the purest air when the trachea

Disorders of Respiration.

trachea and bronchiæ are excoriated, or become too fenfible. Examples alfo are not wanting, where a violent and troublefome cough has arifen from an irritability of the nervous fyftem, or even of fome particular part, of the ear, for inftance, the ftomach and inteftines, the liver by inflammation, &c.

Coughing may alfo be voluntarily excited, and may then be managed at pleafure. Even when involuntary, it may be moderated, or fuppreffed, by a contrary effort: though a violent fit of coughing cannot by any means be refifted. When it is once excited, the cough goes on till the irritating fubftance be expelled, or the fenfe of irritation abolifhed, or perhaps overcome by a more uneafy fenfation than even the cough itfelf; after which the irritation again returning at a certain interval, the cough alfo returns. Hence we are taught a method of allaying and quieting this moft troublefome malady, though frequently it is not in our power to remove the caufe of it altogether.

A very violent cough is often dangerous: For by the retention of the breath, and the ftrong efforts made in coughing, a great quantity of blood is collected in the lungs, of which the veffels are diftended, and frequently broken; and hence there fometimes happens a violent and even fatal hæmorrhage. More frequently, however, it is the caufe of a flower, though equally fatal, difeafe. Nay, a frequent and troublefome cough, without any great hæmorrhage, or even without any hæmorrhage at all, may injure the lungs to fuch a degree, efpecially if they be of a more tender ftructure than ufual, as to lay the foundation of a phthifis almoft always incurable.

Again, by a long-continued and violent cough, the paffage of the blood through the lungs being impeded, it muft neceffarily flow through the veins towards the head: hence rednefs and lividnefs in the countenance, hæmorrhages, palfies, apoplexies, and fometimes fatal convulfions. Laftly, by a violent cough the abdominal vifcera are compreffed with remarkable violence; and if any part happens to be weaker than ufual, a hernia, prolapfus uteri, abortion, or fimilar accidents, may happen.

Even when the cough is more gentle, if it happens to be importunate and frequent, although we have nothing of this kind to fear, yet the patient is by no means free from danger; as he is thereby agitated, fatigued, has his conftitution broken, is deprived of reft, has a fever brought upon him, his lungs are fhaken and irritated, digeftion and all the other functions are impeded, till at laft he finks under a complication of maladies.

107 Sneezing.

Sneezing is fomewhat fimilar to cough, as confifting of a very full infpiration, to which fucceeds a moft violent exfpiration, by which the air is driven out through the noftrils with immenfe violence, and fweeps the paffage through them as it goes out. It is a convulfion much more violent than a cough, and is befides very difficult to be ftopped when once a propenfity to it has taken place. As a cough proceeds from an irritation of the glottis, trachea, bronchia, and lungs, fo fneezing arifes from an irritation of the membrane of the noftrils, but rarely from fympathy with any diftant part. It is fometimes of fervice, as well as a cough; though it is alfo fometimes prejudicial, for the reafons which have been already affigned.

Disorders of Digeftion.

The laft affections of which we fhall here fpeak, are thofe arifing from a bad digeftion, difordered motion of the inteftines, and fome of the principal fecretions. The firft of thefe are fometimes very troublefome, though feldom dangerous. The principal fymptoms are oppreffion, anxiety, pain at the ftomach; eructations, by reafon of air extricated from the fermenting aliments, and irritating the ftomach; naufea and vomiting, from the irritation and diftention of the fame organ; the belly fometimes too coftive, and fometimes too loofe; a defect of nourifhment; a general debility; relaxation of the folid parts; too great thinnefs of the fluids; all the functions impeded; pain of the head; vertigo, fyncope, afthma, palpitation; great finking of the fpirits, efpecially if the patient has been of a peculiar conftitution; fometimes the gout, fometimes a dropfy, or a flow fever which may prove fatal. 108 Digeftion.

The motion of the inteftines may be either too great or too little; and hence proceeds either coftivenefs or loofenefs. The former is frequently not to be accounted morbid; but, when it is, it may arife from the ftructure of the inteftines being injured, or from their being fhut up or obftructed by fpafm or otherwife, or from a deficiency of thofe humours which moiften the inteftines; or, it may arife from mere debility, from a palfy of the fibres, perhaps, or from a deficiency of the ufual ftimulus, of the bile, for inftance, or from too dry or flender a diet. 109 Coftivenefs.

The confequences of long-continued coftivenefs, are, firft, an affection of the alimentary canal, and then of the whole body. The ftomach is difeafed, and does not digeft the aliments properly; the whole body is left deftitute of its ufual ftimulus; the blood is corrupted, perhaps from the reforption of the putrid matter into it. The circulation through the abdominal vifcera is impeded; hence frequent and irregular congeftions, varices of the veins, hæmorrhoids, &c. Nay, the inteftines themfelves being overloaded, diftended and irritated by an heavy, acrid, and putrid load of aliment or other matters, are excited to new and unufual contractions, which, if they do not get the better of the obftruction, bring on tormina, colic, or an iliac paffion, inflammation and gangrene, fatal in a very fhort time.

Loofenefs, or diarrhœa, is a malady extremely common; being fometimes a primary difeafe, and fometimes only a fymptom or an effect of others. Sometimes it is a falutary effort of nature, fuch as the phyfician ought to imitate and bring on by art. It is alfo familiar to infants, and to people of a certain conftitution; and to them coftivenefs is very prejudicial. It may arife, in the firft place, from fomething taken into the body, or generated in the inteftines; from a fermentation and corruption of the mafs of aliments; from the bile being too abundant and acrid, or from blood or pus poured into the inteftines; from the inteftines themfelves being eroded, or deprived of their natural mucus; from the humours being driven from the furface of the body towards the inward parts, as by cold, efpecially when applied to the feet; or from a general corruption of the whole body, as in the phthifis, hectic, or putrid fever, efpecially towards the end of thefe diforders. In fevers it is fometimes falutary, or even puts an end to the difeafe altogether, or at 110 Loofenefs.

Disorders of the Alimentary Canal.

at least renders it milder; more frequently, however, deriving its origin from putrescency, it is of no service, but rather exhausts the strength of the patient. A diarrhœa likewise, almost incurable, and often fatal in a short time, frequently arises after the operation for the fistula in ano. Some have their intestines so extremely weak and moveable, that from the slightest cause, such as catching cold, any violent commotion of the mind, &c. they are subject to a violent diarrhœa. Lastly, whatever be its origin, if it has continued for a long time, the viscera are rendered so weak and irritable, that the disease, though often removed, still returns from the slightest causes, and even such as are not easily discovered.

A diarrhœa proves very pernicious, by hindering digestion and the nourishment of the body; for the stomach is commonly affected, and the aliments pass through the intestines so quickly, that they can neither be properly digested, nor are the lacteals able to absorb the chyle from them as they go along. Such a violent evacuation is also hurtful by exhausting the body, and carrying off a great quantity of the nutritious matter from the blood. Neither indeed, is it only the alimentary mass which is thrown out sooner than it ought to be; but at the same time, a great quantity of the fluids secreted in the intestines, so that the whole body quickly partakes of the debility.

Sometimes a violent and long-continued diarrhœa rises to such a height, that the aliment is discharged with little or no alteration. Sometimes also, though rarely, from a similar cause, or from the obstruction of the mesenteric glands, and its other passages into the blood, the chyle itself is thrown out like milk along with the excrements; and this disease is called
111 the *fluxus cœliacus*.

Dysentery.

A dysentery is attended with very severe gripes in the belly, a frequent desire of going to stool, and vain efforts, when nothing is excreted besides the mucus of the intestines mixed with a little blood; it is also accompanied with excessive debility, and frequently with putrescency and fever. It is thought to arise from the constriction of some part of the intestines, of the colon especially: by which means the bowels, though ever so much irritated, can pass nothing; neither can the disease be removed, until the belly has been well
112 purged by proper medicines.

Tenesmus.

A tenesmus is a frequent and insatiable propensity to stool, without being able to pass any thing, notwithstanding the most violent efforts. It may be occasioned by any kind of irritation, either of the rectum itself or of the neighbouring parts, by acrid substances taken into the body; by some of the stronger purges, especially aloes, a substance very difficult of solution, which will pass even to the rectum with very little alteration; by a violent and obstinate diarrhœa, dysentery, hæmorrhoids, worms, fistula, calculus, ulcer in the bladder, urethra, &c. It is often very pernicious, both from the excessive uneasiness it occasions to the patient, and from its exhausting his strength, by the frequent and vain efforts bringing on a prolapsus ani, and communicating the violent irritation to the neigh-
113 bouring parts, as the bladder, &c.

Nausea and vomiting.

A nausea and vomiting are disorders very common, and owing to almost innumerable causes; not only to affections of the stomach itself, but also to affections and irritations of the remotest parts of the body which may act upon the stomach by sympathy. Every irritation and distention of that viscus therefore, a load of crude aliment, an obstruction about the pylorus, all acrid substances taken into it, diseases of the liver, intestines, kidneys, uterus, the head, the feet, the skin, or indeed the whole body, inflammation, the stone, king's evil, schirrus, apoplexy, compression of the brain, fracture of the skull, vertigo, syncope, violent pain, the gout, especially when repelled, fevers, passions of the mind, disagreeable imaginations or discourses, frequently induce nausea and vomiting.

These affections are often serviceable by freeing the stomach from something with which it was overloaded; promoting spitting in some cases where the lungs are overcharged with mucus, blood, pus, or water; producing sweat, and a free and proper distribution of blood to the surface of the body; partly, perhaps, by the great straining which accompanies vomiting, but rather by that wonderful sympathy which takes place between the stomach and skin: and hence, in many diseases, vomiting is a most excellent remedy. It is however in some cases hurtful, if too violent or too frequently repeated, partly by debilitating and making the stomach more easily moved; and partly by fatiguing the patient with violent strainings, which occasion hernias, abortions, &c.

Sometimes we find the motion of the intestines 114
totally inverted, from the anus to the mouth; a most dangerous distemper, which hath obtained the name of the *iliac passion*. It most frequently arises from some obstruction in the alimentary canal hindering the descent of the excrements, as schirrus, spasm, inflammation, &c.: though the most perfect iliac passion takes place without any obstruction, so that clysters will be vomited; and even after this has continued for several days, the patients have at length recovered.

Iliac passion.

A slighter degree of the iliac passion, namely the inversion of the peristaltic motion of the duodenum, always takes place in long-continued and violent vomiting, as in sea-sickness, or when a person has taken too large a dose of an emetic; by which means a vast quantity of bile frequently ascends into the stomach, and is discharged by vomiting.

An excessive vomiting with looseness is called a *cholera*, when the matter discharged has a bilious appearance. It arises from a very great irritation of the alimentary canal without any obstruction; and is for the most part occasioned by too great a quantity, or from an acrimony of the bile, from whence it takes its name. It may originate from several causes, as too strong a dose of an emetic and cathartic medicine, eating too great a quantity of summer-fruits, &c. and is a very violent malady, often killing the patient in a few hours, unless proper remedies be applied in time. 115

Cholera.

From a suppression of any of the secretions, or a disorder of any of the secretory organs, many mischiefs may arise. A diminution of perspiration produces plethora, lassitude, languor, depression of mind, bad digestion, loss of appetite, and even a general corruption of the humours from the retention of such a quantity of putrescent matter.—The more suddenly the diminution or suppression of the perspiration takes place, 116

Obstructed perspiration.

Disorders of Secretion. place, the sooner the mischief is produced, and the greater it is; not only by retaining the matter which ought to be thrown out, but by repelling the humours from the surface of the body, and directing them to other parts; whence fevers, inflammations, congestions of the blood, &c. frequently take place.

This suppression of perspiration may arise from many different causes; as from cold suddenly applied to the body when very hot; sometimes from very violent passions of the mind; or from spasmodic diseases, as the hysteries, &c. It may be suppressed also by that kind of constriction of the vessels of the skin which is produced by various kinds of fevers, the nature of which has hitherto been but little known.

117 Excessive perspiration. Excessive perspiration or sweating is injurious by debilitating the body, relaxing the skin, and exposing the patient to all the evils which arise from catching cold. It may even be carried to such a height as to produce fainting and death; though it must be owned that we cannot easily bring examples of people having, from this cause, their blood inspissated, corrupted, or being thence made liable to inflammations and fevers.

118 Suppression of urine. A suppression of urine is still more dangerous than that of perspiration, and unless relieved in a short time will certainly prove fatal. This disorder, which is called *ischuria*, may arise from various diseases of the kidneys, ureters, bladder, urethra, &c. Thus any obstruction or irritation of one or other of the kidneys or ureters, by a stone, gravel, mucus, blood, inflammations, spasm, suppuration, schirrus, swellings of the neighbouring parts, &c. may either prevent the urine from being secreted, or may give rise to a scanty or depraved secretion, or, finally, may obstruct its passage into the bladder after it is secreted.

The urine also, after it has entered the bladder, is there frequently suppressed, by reason of various disorders to which that organ is liable, as an irritation or inflammation, spasm, acrid substances injected, or sympathy with the neighbouring parts; or by reason of the texture of the bladder itself being destroyed, or from a palsy, schirrus, ulcer, &c. in the bladder. Or, lastly, the urine may be retained in the bladder from a general stupor, as from a disease of the brain, which happens in some fevers, when the patient is neither sensible of the usual stimulus, nor even of one much greater, so that the fibres can scarcely be excited to contraction by any means whatever. This, in fevers, is always a bad sign, and sometimes even proves fatal.

A suppression of urine for any length of time produces an immense distension of the bladder, oppression, uneasiness, and pain, not only of the part itself, but of the surrounding ones, and even of the whole body; a spasm, or insuperable constriction of the sphincter; an inflammation, gangrene, or laceration of the bladder itself; a violent irritation of the whole habit; then a nausea, vomiting, vertigo, general stupor, and an impregnation of the whole mass of blood with a humour of an urinous nature, which at last being poured out into various cavities of the body, especially of the head, soon brings on a deep sleep, convulsions, and death.

119 Dysuria. From the same causes, but acting with less force, proceeds that disease called a *dysuria*, when the urine passes with difficulty and pain, and is frequently red, black, bloody, purulent, mucous, and sandy; the reason of all which appearances is very much unknown.—The most frequent complaint, however, in making water, is where the patient has a continual and violent desire of passing his urine, while at the same time only two or three drops can be passed at once, and that not without some pain. This may be occa- 120 Strangury. sioned even in healthy people, by some acrid substance taken into the stomach; and is very common to old people, who are generally subject to disorders of the kidneys and bladder. It arises also frequently from a stone irritating the bladder, or from an inflammation of it, or of its being deprived of its mucus, or this last being somehow or other corrupted; or lastly, from certain diseases, or some particular state of the neighbouring parts, as of the uterus, vagina, urethra, prostate gland, &c.

121 Incontinence of urine. Akin to the strangury is an incontinence of urine, when the patient's water either comes away against his will, or altogether without his knowledge. This disorder may arise from debility, palsy, an ulcer or wound, or any long-continued and violent irritation of the bladder, especially of its sphincter, as from a stone, a general palsy, or in females difficult labour, injuring the neighbouring parts.—This symptom occurs in a great number of diseases, especially in the hydrocephalus.—Sometimes the urine is expelled with violence, either by reason of universal spasms, or by violent contractions of the muscles of respiration, as in sneezing, laughter, &c.

122 Urinary calculi. Among the disorders incident to the urine we may reckon the production of calculi, which frequently bring on the most excruciating and dangerous diseases.—The urine, besides the water and salts, contains no small share of the glutinous part of the blood already somewhat corrupted, and still inclined to farther corruption. Hence the urine even of the most healthy people deposits a sediment after it has stood for some time; and though none of this sediment be formed in a healthy body, yet if the smallest particle of foreign matter be introduced into the bladder, a crust soon gathers round it, and it is sure to become the basis of a concretion, which by degrees grows to a very great size. It is not unlikely, also, that some unknown fault of the fluids may contribute to the production of those calculi, as the stone is well known to be an hereditary disease, and to be born with the patient. Calculous persons also are commonly subject to complaints of the stomach, especially to an acidity of it; and many have received no little relief from alkalescent or alkaline medicines.—From the same causes may calculi be formed in the kidneys; from which proceed a horrid train of symptoms described in the subsequent part of this treatise.

It is now found, by accurate experiments of the most able chemists, that urinary calculi do not, as was once supposed, consist almost entirely of an earthy matter. Their principal constituent is a peculiar acid approaching more nearly to the phosphoric found in the bones than to any other. But the acid of calculus being in some respects peculiar in its nature, has among modern chemists obtained a peculiar name, and been distinguished by the appellation of the *lithic* or *uric acid*. It is highly probable that this acid present in the circulating mass, is precipitated and disengaged by the introduction

Disorder of the Glands. introduction of other acids, and thus thrown off in greater quantities by the kidneys. Thus, then, we can understand the influence of acids as tending to the generation of calculus, and of alkalies as tending to prevent it.

123 Schirrus. The last disorder here to be taken notice of is a disorder of the glands themselves, owing to some kind of obstruction, and is one of the most dreadful diseases incident to human nature. Hence happens a great swelling and surprising hardness, not only without pain, but sometimes even with a diminution of sensation in the part affected; and when the gland is thus affected, it is called a *schirrus*. Sometimes it remains in this state for a long time; but sooner or later produces the most excruciating torment. By degrees it is infected with a slow and malignant suppuration, degenerating into an horrid ulcer, consuming not only the part itself, but eating away the neighbouring ones, and corrupting the whole body with the most acrid and incurable poison. This disease is called a *cancer*, of which the causes are very little known.

Versatility of the Human Constitution. Of the organs in both sexes concerned in the function of generation, and of that function as far as we yet know any thing respecting it, an account has already been given in Anatomy; and after what has been said of the different functions, and of the morbid affections, to which these are subjected, we may conclude our remarks on the theory of medicine, with mentioning the remarkable versatility of the human constitution; which more than that of any other animal, is capable of accommodating itself to every climate and to all kinds of diet. Hence we may conclude, that a large proportion of the diseases to which we are subjected are produced by ourselves.

Practice of Medicine, or an Account of the principal Diseases to which the Human Body is subjected.

124 General Arrangement of Diseases. We have already defined medicine to be the art of preventing, curing, and alleviating, those diseases to which mankind are subjected. While these affections, however, are in number almost infinite, each in its progress is subjected to almost endless varieties from differences in climate, constitution, treatment, and a variety of other particulars. Hence we may readily explain both the difficulty of distinguishing morbid affections from each other in actual practice, and the diversity of names which have been affixed to them in the writings of ancient physicians. It may readily be supposed, that in this, as well as other subjects, there has been a gradual improvement from the progressive labours of industrious and ingenious men. And although much yet remains to be done in the proper arrangement and distinction of diseases, or what has been called *methodical nosology*, yet there cannot be a doubt, that during the course of the 18th century, this subject has received very great improvements. For these, we are, in the first place, highly indebted to the labours of Franciscus Boissier de Sauvages, an eminent professor of medicine at Montpelier, who, following out an idea suggested by the sagacious Dr Sydenham of England, first successfully attempted to arrange diseases, as botanists had done plants, into classes, orders, genera, and species. Since the publication of the *Nosologia Methodica* of Sauvages, this subject has been successfully cultivated by several ingenious men, particularly by Sir Charles Linnæus of Upsal, to whose genius for arrangement every branch of natural history, but botany in particular, has been so highly indebted; by Rudolphus Augustus Vogel, an eminent professor at Gottingen; and by John Baptist Sagar, a distinguished physician at Iglaw in Moravia: But of all the systems of arrangement yet presented to the medical world, that published by the late illustrious Dr William Cullen of Edinburgh, may justly be considered as the best. In treating, therefore, of the principal diseases to which the human body is subjected, we shall follow his plan, endeavouring to deliver the best established observations respecting the history, theory, and practice of each. In treating of particular genera of disease, although we follow the arrangement of Dr Cullen, yet for the satisfaction of the reader, we shall often point out the classes to which the same affection is referred by the other eminent writers whom we have mentioned. And on this account, it may not be improper briefly to enumerate the general classes to which each of them have referred the affections of the human body.

The Classes of Sauvages are,

1. Vitia.	6. Debilitates.
2. Febres.	7. Dolores.
3. Phlegmasiæ.	8. Vesaniæ.
4. Spasmi.	9. Fluxus.
5. Anhelationes.	10. Cachexiæ.

The Classes of Linnæus are,

1. Exanthematici.	7. Motorii.
2. Critici.	8. Suppressorii.
3. Phlogistici.	9. Evacuatorii.
4. Dolorosi.	10. Deformes.
5. Mentales.	11. Vitia.
6. Quietales.	

The Classes of Vogel are,

1. Febres.	7. Hyperæstheses.
2. Profluvia.	8. Cachexiæ.
3. Epischeses.	9. Paranoiæ.
4. Dolores.	10. Vitia.
5. Spasmi.	11. Deformitates.
6. Adynamiæ.	

The Classes of Sagar are,

1. Vitia.	8. Anhelationes.
2. Palgæ.	9. Debilitates.
3. Cachexiæ.	10. Exanthemata.
4. Dolores.	11. Phlegmasiæ.
5. Fluxus.	12. Febres.
6. Suppressiones.	13. Vesaniæ.
7. Spasmi.	

Besides

General Arrangement of Diseases.

Besides these, two other systems have been presented to the public, which may be considered as deserving attention; those, viz. of the late learned Dr M'Bride of Dublin, and of the late ingenious Dr Darwin.

The Classes and Orders of M'Bride.

Clafs I. *Univerfal Difeafes.*

Or. 1. Fevers.
2. Inflammations.
3. Fluxes.
4. Painful difeafes.
5. Spafmodic difeafes.
6. Weakneffes or privation.
7. Afthmatic diforders.
8. Mental diforders.

Clafs II. *Local Difeafes.*

Or. 1. Of the internal fenfes.
2. Of the external fenfes.
3. Of the appetites.
4. Of the fecretions and excretions.
5. Impeding different actions.
6. Of the external habit.
7. Diflocations.
8. Solutions of continuity.

Clafs III. *Sexual Difeafes.*

Or. 1. General proper to men.
2. Local proper to men.
3. General proper to women.
4. Local proper to women.

Clafs IV. *Infantile Difeafes.*

Or. 1. General.
2. Local.

The Claffes and Orders of Darwin.

Clafs I. *Difeafes of Irritation.*

Or. 1. Increafed irritation.
2. Decreafed irritation.
3. Retrograde irritative motions.

Clafs II. *Difeafes of Senfation.*

Or. 1. Increafed fenfation.
2. Decreafed fenfation.
3. Retrograde fenfitive motions.

Clafs III. *Difeafes of Volition.*

Or. 1. Increafed volition.
2. Decreafed volition.

Clafs IV. *Difeafes of Affociation.*

Or. 1. Increafed affociated motions.
2. Decreafed affociated motions.
3. Retrograde affociated motions.

After this fhort view of different claffifications, we fhall next prefent to our readers a more particular account of the arrangement of Dr Cullen; which, although it can by no means be reprefented as free from errors or imperfections, is yet in many refpects the beft that has hitherto been publifhed.

General Arrangement of Difeafes.

Cullen's *Arrangement.*

Class I. PYREXIÆ. A frequent pulfe coming on after a horror; confiderable heat; many of the functions injured; the ftrength of the limbs efpecially diminifhed.

Order I. Febres. Pyrexia without any primary local affection, following languor, laffitude, and other fymptoms of debility.

Sect. I. *Intermittentes.* Fevers arifing from the miafma of marfhes; with an apyrexia, or at leaft a very evident remiffion; but the difeafe returns regularly, and for the moft part with a horror or trembling.

Genus I. Tertiana. Similar paroxyfms after an interval of about 48 hours, coming on moft commonly at mid-day. A tertian hath either;

I. An apyrexia interpofed.

1. Varying in the duration of the paroxyfms.

A, The tertian whofe paroxyfms are not extended beyond 12 hours.

B, The tertian with paroxyfms extended beyond 12 hours.

2. Varying in the return of paroxyfms.

C, The tertian returning every day with unequal paroxyfms alternately fimilar to one another.

D, The tertian returning every third day with two paroxyfms on the fame day.

E, The tertian returning every day, with two paroxyfms on every third day, and only one on the intermediate ones.

F, The tertian returning every day, with an evident remiffion interpofed between the odd and the even days, but a lefs remarkable one between the even and the odd days.

3. Varying in its fymptoms.

G, The tertian accompanied with a difpofition to fleep.

H, Accompanied with fpafms and convulfive motions.

I, Accompanied with an efflorefcence on the fkin.

K, with phlegmafia.

4. Varying in being complicated with other difeafes.

5. Varying as to its origin.

II. With the interpofition only of a remiffion between the paroxyfms.

Genus II. Quartana. Similar paroxyfms, with an interval of about 72 hours, coming on in the afternoon.

I. With the interpofition of an apyrexia.

1. Varying in the type.

A, The quartan with fingle paroxyfms, returning every fourth day, none on the other days.

B, With two paroxyfms every fourth day, and none on the other days.

C, With three paroxyfms every fourth day, and none on the intermediate days.

D, Of the four days having only the third free from fever, with fimilar paroxyfms every fourth day.

E, The quartan coming on every day, with fimilar paroxyfms every fourth day.

2. Varying in its fymptoms.

3. Varying in being complicated with other difeafes.

II. With a remiffion only between the paroxyfms.

Genus III. Quotidiana. Similar paroxyfms with an

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an interval of about 24 hours, coming on commonly in the morning.

I. With the interposition of an apyrexia.

1. Varies in being solitary.

A, Universal.

B, Partial.

2. Complicated with other diseases.

II. With a remission only between the paroxysms.

Sect. II. *Continuæ.* Fevers without evident intermission, and not occasioned by marsh miasmata; but attended with exacerbations and remissions, though not always very remarkable.

Genus IV. Synocha. Great heat; a frequent, strong, and hard pulse; high-coloured urine; the functions of the sensorium a little disturbed.

Genus V. Typhus. A contagious disease; the heat not much above the natural; the pulse small, weak, and for the most part frequent; the urine little changed; the functions of the sensorium very much disturbed, and the strength greatly diminished.

The species are,

I. Typhus *petechialis.* Typhus for the most part with petechiæ.

Varying in degree. 1. Mild typhus. 2. Malignant typhus.

II. Typhus *icterodes.* Typhus with a yellowness of the skin.

Genus VI. Synochus. A contagious disease. A fever compounded of synocha and typhus; in the beginning a synocha, but towards the end a typhus.

Order II. Phlegmasiæ. A synocha fever, with inflammation or topical pain, the internal function of the parts being at the same time injured; the blood drawn and concreted exhibiting a white coriaceous surface.

Genus VII. Phlogosis. Pyrexia; redness, heat, and painful tension, of some external part.

The species are,

I. Phlogosis (*phlegmone*) of a vivid red colour; a swelling well defined, for the most part elevated to a point, and frequently degenerating into an abscess, with a beating or throbbing pain.

The variations are, 1. In the form. 2. In the situation.

II. Phlogosis (*erythema*) of a reddish colour, vanishing by pressure; of an unequal and creeping circumference, with scarce any swelling; ending in the scaling off of the cuticle, in pustules, or blisters.

The variations are, 1. In the degree of violence. 2. In the remote cause. 3. In being complicated with other diseases.

The consequences of a phlogosis are, an imposthume, gangrene, sphacelus.

Genus VIII. Ophthalmia. A redness and pain of the eye, with an inability to bear the light; for the most part with an effusion of tears.

The species and varieties of the ophthalmia are,

I. Idiopathic.

1. Ophthalmia (*membranarum*), in the tunica adnata, and the membranes lying under it, or the coats of the eye.

A, Varying in the degree of the external inflammation.

3

B, In the internal coats affected.

2. Ophthalmia (*tarsi*), of the eye-lids, with swelling, erosion, and glutinous exudation.

II. Symptomatic.

1. From a disease of the eye itself.

2. From diseases of other parts, or of the whole body.

Genus IX. Phrenitis. Violent pyrexia; pain of the head; redness of the face and eyes; inability to endure the light or any noise; watchfulness; a furious delirium, or typhomania.

I. Idiopathic.

II. Symptomatic.

Genus X. Cynanche. Pyrexia sometimes inclining to a typhus; difficulty of swallowing and breathing; with a sensation of narrowness in the fauces.

The species are,

I. Cynanche (*tonsillaris*) affecting the mucous membrane of the fauces, but especially the tonsils, with redness and swelling, accompanied with a synocha.

II. Cynanche (*maligna*) affecting the tonsils, and mucous membrane of the fauces with swelling, redness, and mucous crusts of a whitish or ash-colour, creeping, and covering ulcers; with a typhous fever and exanthemata.

III. Cynanche (*trachealis*) attended with difficult respiration, noisy and hoarse inspiration, loud cough, without any apparent tumor in the fauces, somewhat difficult deglutition, and a synocha.

IV. Cynanche (*pharyngæa*) attended with redness in the bottom of the fauces, very difficult and painful deglutition, respiration sufficiently free, and a synocha.

V. Cynanche (*parotidæa*) with great swelling in the parotids and maxillary glands appearing on the outside: the respiration and deglutition but little injured; a synocha, for the most part mild.

Diseases of this genus are symptomatic, either from external or internal causes.

Genus XI. Pneumonia. Pyrexia, with a pain in some part of the thorax, difficult respiration, and cough. The species are,

I. Peripneumony, with a pulse not always hard, but sometimes soft; an obtuse pain of the breast; the respiration always difficult; sometimes the patient cannot breathe unless in an upright posture; the face swelled, and of a livid colour; the cough for the most part moist, frequently bloody.

1. Simple idiopathic peripneumonies.

Varying in degree.

2. Idiopathic peripneumonies complicated with fever.

3. Symptomatic peripneumonies.

II. Pleurisy, with a hard pulse; for the most part attended with a pungent pain of one side, augmented chiefly during the time of inspiration; an uneasiness when lying on the side; a most painful cough, dry in the beginning of the disease, afterwards moist, and frequently bloody.

1. Simple idiopathic pleurisies.

2. Pleurisies, complicated, (1.) With fever. (2.) With catarrh.

3. Symptomatic pleurisies.

4. False pleurisies.

The consequences of pleurisy are a vomica or empyema.

Genus

Genus XII. Carditis. Pyrexia; pain about the heart; anxiety; difficulty of breathing; cough; unequal pulse; palpitation of the heart, and fainting.

I. Idiopathic.

II. Symptomatic.

Genus XIII. Peritonitis. Pyrexia; pain of the belly, exasperated by an upright posture, without the proper signs of other abdominal phlegmasiæ.

I. Peritonitis (*propria*), situated in the peritonæum, properly so called, surrounding the inside of the abdomen.

II. Peritonitis (*omentalis*), in the peritonæum extended through the omentum.

III. Peritonitis (*mesenterica*), in the peritonæum spread through the mesentery.

Genus XIV. Gastritis. Pyrexia inclining to a typhus; anxiety; pain and heat of the epigastrium, augmented when any thing is taken into the stomach; an inclination to vomit, and an immediate rejection of every thing swallowed; an hiccough.

I. Idiopathic.

1. From internal causes.

A, Gastritis (*phlegmonodæa*), attended with acute pain and violent pyrexia.

2. From external causes.

B, Gastritis (*erysipelatosa*), with a less violent fever and pain: an erysipelatous redness appearing on the fauces.

II. Symptomatic.

Genus XV. Enteritis. Pyrexia of a typhous nature; pungent pain of the belly, stretching and twisting about the navel; vomiting; the belly obstinately bound.

I. Idiopathic.

1. Enteritis (*phlegmonodæa*), with acute pain, violent fever, vomiting, and constipation of the belly.

2. Enteritis (*erysipelatosa*), with less acute fever and pain, without vomiting; but accompanied with a diarrhœa.

II. Symptomatic.

Genus XVI. Hepatitis. Pyrexia; tension and pain of the right hypochondrium; sometimes pungent like that of a pleurisy, but more frequently obtuse; a pain reaching to the clavicle and top of the right shoulder; a difficulty of lying on the left side; dyspnœa; dry cough, vomiting, and hiccough.

Genus XVII. Splenitis. Pyrexia; tension, heat, and swelling of the left hypochondrium, the pain increasing by pressure; without the signs of nephritis.

Genus XVIII. Nephritis. Pyrexia; pain in the region of the kidney, often following the course of the ureter: frequent discharge of urine, either thin and colourless, or very red; vomiting; stupor of the thigh; with a retraction or pain of the testicle of the same side. The species are,

I. Idiopathic. Spontaneous.

II. Symptomatic.

Genus XIX. Cystitis. Pyrexia; pain and swelling of the hypogastrium: frequent and painful discharge of urine, or ischuria; and tenesmus. The species are,

I. Those arising from internal causes.

II. Those from external causes.

Genus XX. Hysteritis. Pyrexia; heat, tension, swelling, and pain of the hypogastrium; the os uteri painful when touched; vomiting.

Genus XXI. Rheumatismus. A disease arising from an external and frequently very evident cause; pyrexia; pain about the joints, frequently following the course of the muscles; infesting the knees and other large joints rather than those of the feet or hands; increased by external heat.

The species are either idiopathic or symptomatic. The former varies in situation.

A, In the muscles of the loins.

B, In the muscles of the coxendix.

C, In the muscles of the breast.

Genus XXII. Odontalgia; a rheumatism of the jaws from a caries of the teeth.

Genus XXIII. Podagra. An hereditary disease, arising without any evident external cause, but for the most part preceded by an unusual affection of the stomach; pyrexia; pain of a joint for the most part of the great toe of the foot, at least infesting chiefly the wrists and ankles; returning by intervals; and often alternated with affections of the stomach and other internal parts.

I. Podagra (*regularis*), with a pretty violent inflammation of the joints remaining for some days, and by degrees going off with swelling, itching, and desquamation of the affected part.

II. Podagra (*atonica*), with an atony of the stomach, or some other internal part; and either without the usual inflammation of the joints, or only with slight and wandering pains; and frequently alternated with dyspepsia, or other symptoms of atony.

III. Podagra (*retrograda*), with the inflammation of the joints suddenly disappearing, and an atony of the stomach and other parts immediately following.

IV. Podagra (*aberrans*), with the inflammation of an internal part either preceding or not, and suddenly disappearing.

Genus XXIV. Arthropuosis. Deep, obtuse, and long-continued pains of the joints or muscular parts, frequently following contusions; with either no swelling, or a moderate and diffused one; no phlogosis; pyrexia, at first gentle, afterwards hectic, and at length an imposthume.

Order III. Exanthemata. Contagious diseases; affecting a person only once in his life; beginning with fever; after a certain time appear phlogoses, for the most part small and in considerable number, and dispersed over the skin.

Genus XXV. Erysipelas. A synocha of two or three days, for the most part attended with drowsiness, often with a delirium. In some parts of the skin, most frequently the face, appears a phlogosis. The species are,

I. Erysipelas (*vesiculosum*), with erythema, redness creeping, occupying a large space, and in some parts ending in large blisters.

II. Erysipelas (*phlyctænodes*), with an erythema formed of a number of papulæ, chiefly occupying the trunk of the body, ending in phlyctenæ or small blisters.

The disease is also symptomatic.

Genus XXVI. Pestis. An exceedingly contagious typhus, with the highest debility. On an uncertain day of the disease buboes and carbuncles break forth. It is various in degree, but the species are uncertain.

Genus

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Genus XXVII. Variola; a contagious synocha, with vomiting, and pain on pressing the epigastrium. On the third day begins, and on the fifth is finished, the eruption of inflammatory pustules, which suppurate in the space of eight days, and at last go off in crusts; frequently leaving depressed cicatrices or pockpits in the skin. The species are,

I. Variola (*discreta*), with few, distinct, turpid, pustules, having circular bases; the fever ceasing immediately after the eruption.

II. Variola (*confluens*), with numerous, confluent, irregularly shaped pustules, flaccid and little elevated; the fever remaining after the eruption.

Genus XXVIII. Varicella. Synocha; papulæ breaking out after a short fever, similar to those of the small-pox, but hardly ever coming to suppuration; after a few days going off in small scales, without leaving any mark.

Genus XXIX. Rubeola. A contagious synocha, with sneezing, epiphora, and dry hoarse cough. On the fourth day, or a little later, break forth small, clustered, and scarcely elevated papulæ; after three days going off in very small branny scales.

I. Rubeola (*vulgaris*), with very small confluent corymbose papulæ, scarcely rising above the skin.

Varying,

1. In the symptoms being more severe, and the course of the disease less regular.

2. In being accompanied with a cynanche.

3. With a putrid diathesis.

II. Rubeola (*variolodes*), with distinct papulæ, raised above the skin.

Genus XXX. Miliaria. Synochus with anxiety, frequent sighing, unctuous sweat, and a sense of pricking as of pin points in the skin. On an uncertain day of the disease, break out red, small, distinct papulæ, spread over the whole body as well as the face; the apices of which, after one or two days, become very small white pustules, remaining for a short time.

Genus XXXI. Scarlatina. A contagious synocha. On the fourth day of the disease the face swells a little; at the same time an universal redness occupies the skin in large spots, at length running together; after three days going off in branny scales; frequently succeeded by an anasarca. The species are,

I. Scarlatina (*simplex*), not accompanied with cynanche.

II. Scarlatina (*cynanchica*), with an ulcerous cynanche.

Genus XXXII. Urticaria. A quotidian fever. On the second day of the disease, red spots resembling the stinging of nettles, almost vanishing during the day, but returning in the evening with the fever, and after a few days going off altogether in very small scales.

Genus XXXIII. Pemphigus. A contagious typhus. On the first, second, or third day of the disease, blisters break out in several parts of the body, of the bigness of a bean, remaining for many days, and at last pouring out a thin ichor.

Genus XXXIV. Aphtha. Synochus; the tongue somewhat swelled and of a livid colour, as well as the fauces; eschars first appearing in the fauces, but at length occupying the whole internal parts of the mouth, of a white colour, sometimes distinct, often running together, quickly growing again when taken off; and remaining for an uncertain time.

The species are, 1. Idiopathic. 2. Symptomatic.

Order IV. HÆMORRHAGIÆ. Pyrexia, with a discharge of blood, without any external violence: the blood drawn from a vein hath the same appearance as in phlegmasiæ.

Genus XXXV. Epistaxis. Pain or weight of the head, redness of the face; a discharge of blood from the nose.

I. Idiopathic.

Varying according to the time of life.

1. Epistaxis of young people, with symptoms of an arterial plethora.

2. Epistaxis of old people, with symptoms of a venous plethora.

II. Symptomatic.

1. From internal causes.

2. From external causes.

Genus XXXVI. Hæmoptysis. Redness of the cheeks; a sensation of uneasiness, or pain, and sometimes of heat in the breast; difficulty of breathing; tickling of the fauces; either a severe or less violent cough, bringing up florid and frequently frothy blood.

The idiopathic species are,

1. Hæmoptysis (*plethorica*), without any external violence, and without being preceded by any cough or suppression of any customary evacuation.

2. Hæmoptysis (*violenta*), from external violence applied.

3. Hæmoptysis (*phthisica*), after a long-continued cough, with a leanness and debility.

4. Hæmoptysis (*calculosa*), in which some calculous molecules, for the most part of a calcareous nature, are thrown up.

5. Hæmoptysis (*vicaria*), after the suppression of a customary evacuation.

Besides these, there are a number of symptomatic species mentioned by different authors. The consequence of an hæmoptysis is, a

Phthisis. A wasting and debility of the body, with a cough, hectic fever, and for the most part a purulent expectoration. The species are,

I. An incipient phthisis, without any expectoration of pus.

II. A confirmed phthisis, with an expectoration of pus.

Both species vary, 1. As to their remote cause. 2. As to the origin of the purulent matter.

Genus XXXVII. Hæmorrhois. Weight and pain of the head; vertigo; pain of the loins; pain of the anus; livid painful tubercles, from which for the most part blood flows out; which sometimes also drops out of the anus, without any apparent tumor. The species are,

1. Hæmorrhois (*tumens*), external from mariscæ.

Varying,

A, Bloody.

B, Mucous.

2. Hæmorrhois (*procidens*), external from a *procidentia ani.*

3. Hæmorrhois (*fluens*), internal, without any swelling, or *procidentia ani.*

4. Hæmorrhois

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4. Hæmorrhois (*cæca*), with pain and ſwelling of the anus, without any profuſion of blood.

Genus XXXVIII. Menorrhagia. Pains of the back, belly, and loins, like thoſe of child-birth; an unuſually copious flux of the menſes or blood from the vagina. The ſpecies are,

1. Menorrhagia (*rubra*), bloody in women neither with child nor in child-birth.

2. Menorrhagia (*abortus*), bloody in women with child.

3. Menorrhagia (*lochialis*), bloody in women after delivery.

4. Menorrhagia (*vitiorum*), bloody from ſome local diſeaſe.

5. Menorrhagia (*alba*), ſerous, without any local diſeaſe, in women not pregnant.

6. Menorrhagia (*Nabothi*), ſerous in women with child.

Order V. Profluvia. Pyrexia, with an increaſed excretion, naturally not bloody.

Genus XXXIX. Catarrhus. Pyrexia frequently contagious; an increaſed excretion of mucus, at leaſt efforts to excrete it.

The ſpecies are,

1. From cold.

2. From contagion.

Genus XL. Dyſenteria. Contagious pyrexia; frequent mucous or bloody ſtools, while the alvine fæces are for the moſt part retained; gripes; teneſmus.

Varying,

1. Accompanied with worms.

2. With the excretion of ſmall fleſhy or ſebaceous bodies.

3. With an intermittent fever.

4. Without blood.

5. With a miliary fever.

Class II. NEUROSES. A preternatural affection of ſenſe and motion, without an idiopathic pyrexia or any local affection.

Order I. Comata. A diminution of voluntary motion, with ſleep, or a deprivation of the ſenſes.

Genus XLI. Apoplexia. Almoſt all voluntary motion aboliſhed, with ſleep more or leſs profound; the motion of the heart and arteries remaining.

The idiopathic ſpecies are,

1. Apoplexia (*ſanguinea*), with ſymptoms of univerſal plethora, eſpecially of the head.

2. Apoplexia (*ſeroſa*), with a leucophlegmatia over the whole body, eſpecially in old people.

3. Apoplexia (*hydrocephalica*), coming on by degrees; affecting infants, or thoſe below the age of puberty, firſt with laſſitude, a ſlight fever and pain of the head, then ſlowneſs of the pulſe, dilatation of the pupil of the eye, and drowſineſs.

4. Apoplexia (*atrabiliaria*), taking place in thoſe of a melancholic conſtitution.

5. Apoplexia (*traumatica*), from ſome external injury mechanically applied to the head.

6. Apoplexia (*venenata*), from powerful ſedatives taken internally or applied externally.

7. Apoplexia (*mentalis*), from an affection or emotion of the mind.

8. Apoplexia (*cataleptica*), the muſcles remaining contractile, by external motion of the limbs.

9. Apoplexia (*ſuffocata*), from ſome external ſuffocating power.

The apoplexy is frequently ſymptomatic.

1. Of an intermittent fever. 2. Continued fever. 3. Phlegmaſia. 4. Exanthema. 5. Hyſteria. 6. Epilepſia. 7. Podagra. 8. Worms. 9. Iſchuria. 10. Scurvy.

Genus XLII. Paralyſis. Only ſome of the voluntary motions impaired, frequently with ſleep.

The idiopathic ſpecies are,

1. Paralyſis (*partialis*) of ſome particular muſcles only.

2. Paralyſis (*hemiplegica*) of one ſide of the body. Varying according to the conſtitution of the body.

a, Hemiplegia in a plethoric habit.

b, In a leucophlegmatic habit.

3. Paralyſis (*paraplegica*) of one half of the body taken tranſverſely.

4. Paralyſis (*venenata*) from ſedative powers applied either internally or externally.

A ſymptom either of an Aſthenia or Palſy is,

Tremor; an alternate motion of a limb by frequent ſtrokes and intervals.

The ſpecies are, 1. Aſthenic. 2. Paralytic. 3. Convulſive.

Order II. Adynamiæ. A diminution of the involuntary motions, whether vital or natural.

Genus XLIII. Syncope; a diminution, or even a total ſtoppage, of the motion of the heart for a ſhort time.

I. Idiopathic.

1. Syncope (*cardiaca*), returning frequently without any manifeſt cauſe, with violent palpitations of the heart during the intervals.—From a fault of the heart or neighbouring veſſels.

2. Syncope (*occaſionalis*) ariſing from ſome evident cauſe.—From an affection of the whole ſyſtem.

II. Symptomatic; of diſeaſes either of the whole ſyſtem, or of other parts beſides the heart.

Genus XLIV. Dyſpepſia. Anorexia, nauſea, vomiting, inflation, eructation, rumination, cardialgia, gaſtrodynia, more or fewer of thoſe ſymptoms at leaſt concurring; for the moſt part with a conſtipation of the belly, and without any other diſeaſe either of the ſtomach itſelf or of other parts.

I. Idiopathic.

II. Symptomatic.

1. From a diſeaſe of the ſtomach itſelf.

2. From a diſeaſe of other parts, or of the whole body.

Genus XLV. Hypochondriaſis. Dyſpepſia, with languor, ſadneſs and fear, without any adequate cauſes, in a melancholy temperament.

Genus XLVI. Chloroſis. Dyſpepſia, or a deſire of ſomething not uſed as food; a pale or diſcoloured complexion; the veins not well filled: a ſoft tumor of the whole body; aſthenia; palpitation; ſuppreſſion of the menſes.

Order III. Spasmi. Irregular motions of the muſcles or muſcular fibres.

Sect. I. *In the animal functions.*

Genus

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Genus XLVII. Tetanus. A ſpaſtic rigidity of almoſt the whole body.

Varying according to the remote cauſe, as it riſes either from ſomething internal, from cold, or from a wound. It varies likewiſe, from whatever cauſe it may ariſe, according to the part of the body affected.

Genus XLVIII. Triſmus. A ſpaſtic rigidity of the lower jaw.—The ſpecies are,

1. Triſmus (*naſcentium*), attacking infants under two months old.

2. Triſmus (*traumaticus*), attacking people of all ages either from a wound or cold.

Genus XLIX. Convulſio.—An irregular clonic contraction of the muſcles without ſleep.

I. Idiopathic.

II. Symptomatic.

Genus L. Chorea, attacking thoſe who have not yet arrived at puberty, moſt commonly within the 10th or 14th year, with convulſive motions for the moſt part of one ſide in attempting the voluntary motion of the hands and arms, reſembling the geſticulations of mountebanks; in walking, rather dragging one of their feet than lifting it.

Genus LI. Raphania. A ſpaſtic contraction of the joints, with a convulſive agitation, and moſt violent periodical pain.

Genus LII. Epilepſia. A convulſion of the muſcles, with ſleep.

The idiopathic ſpecies are,

1. Epilepſia (*cerebralis*), ſuddenly attacking without any manifeſt cauſe, without any ſenſe of uneaſineſs preceding, excepting perhaps a ſlight vertigo or dimneſs of ſight.

2. Epilepſia (*ſympathica*), without any manifeſt cauſe, but preceded by the ſenſation of a kind of air riſing from a certain part of the body towards the head.

3. Epilepſia (*occaſionalis*), ariſing from a manifeſt irritation, and ceaſing on the removal of that irritation.

Varying according to the difference of the irritating matter. And thus it may ariſe,

From injuries of the head; pain; worms; poiſon; from the repulſion of the itch, or an effuſion of any other acrid humour; from crudities in the ſtomach; from paſſions of the mind; from an immoderate hæmorrhagy; or from debility.

Sect. II. *In the vital functions.*

In the action of the heart.

Genus LIII. Palpitatio. A violent and irregular motion of the heart.

In the action of the lungs.

Genus LIV. Aſthma. A difficulty of breathing returning by intervals, with a ſenſe of ſtraitneſs in the breaſt, and a noiſy reſpiration with hiſſing. In the beginning of the paroxyſm there is either no cough at all, or coughing is difficult; but towards the end the cough becomes free, frequently with a copious ſpitting of mucus.—The idiopathic ſpecies are,

1. Aſthma (*ſpontaneum*), without any manifeſt cauſe or other concomitant diſeaſe.

2. Aſthma (*exanthematicum*), from the repulſion of the itch or other acrid effuſion.

3. Aſthma (*plethoricum*), from the ſuppreſſion of ſome cuſtomary ſanguineous evacuation, or from a ſpontaneous plethora.

Genus LV. Dyſpnœa. A continual difficulty of breathing, without any ſenſe of ſtraitneſs, but rather of fulneſs and infarction in the breaſt; a frequent cough throughout the whole courſe of the diſeaſe.

The idiopathic ſpecies are,

1. Dyſpnœa (*catarrhalis*), with a frequent cough, bringing up plenty of viſcid mucus.

2. Dyſpnœa (*ſicca*), with a cough for the moſt part dry.

3. Dyſpnœa (*aëria*), increaſed by the leaſt change of weather.

4. Dyſpnœa (*terrea*), bringing up with the cough an earthy or calculous matter.

5. Dyſpnœa (*aquoſa*), with ſcanty urine and œdematous feet; without any fluctuation in the breaſt, or other ſigns of an hydrothorax.

6. Dyſpnœa (*pinguedinoſa*), in very fat people.

7. Dyſpnœa (*thoracica*), from an injury done to the parts ſurrounding the thorax, or from ſome malconformation of them.

8. Dyſpnœa (*extrinſeca*), from evident external cauſes.

The ſymptomatic ſpecies of dyſpnœa are conſequences,

1. Of diſeaſes of the heart or large veſſels.

2. Of a ſwelling in the abdomen.

3. Of various other diſeaſes.

Genus LVI. Pertuſſis. A contagious diſeaſe; convulſive ſtrangulating cough reiterated with noiſy inſpiration; frequent vomiting.

Sect. III. *In the natural functions.*

Genus LVII. Pyroſis. A burning pain in the epigaſtrium, with plenty of aqueous humour, for the moſt part inſipid, but ſometimes acrid, belched up.

Genus LVIII. Colica. Pain of the belly, eſpecially twiſting round the navel; vomiting; and a conſtipation.

The idiopathic ſpecies are,

1. Colica (*ſpaſmodica*), with retraction of the navel, and ſpaſms of the abdominal muſcles.

Varying, by reaſon of ſome ſymptoms ſuperadded. Hence,

a, Colica, with vomiting of excrements, or of matters injected by the anus.

b, Colica, with inflammation ſupervening.

2. Colica (*pictonum*), preceded by a ſenſe of weight or uneaſineſs in the belly, eſpecially about the navel; then comes on the colic pain, at firſt ſlight and interrupted, chiefly augmented after meals: at length more ſevere and almoſt continual, with pains of the arms and back, at laſt ending in a palſy.

Varying according to the nature of the remote cauſe; and hence,

a, From metallic poiſon.

b, From acids taken inwardly.

c, From cold.

d, From a contuſion of the back.

3. Colica (*ſtercorea*), in people ſubject to coſtiveneſs.

4. Colica (*accidentalis*), from acrid matter taken inwardly.

5. Colica (*meconialis*), in new-born children from a retention of the meconium.

6. Colica

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6. Colica (*callosa*), with a sensation of stricture in some part of the intestines, and frequently of a collection of flatus with some pain; which flatus also passing through the part where the stricture is felt, gradually vanishes; the belly flow, and at last passing only a few liquid fæces.

7. Colica (*calculosa*), with a fixed hardness in some part of the abdomen, and calculi sometimes passed by the anus.

Genus LIX. Cholera. A vomiting of bilious matter, and likewise a frequent excretion of the same by stool; anxiety; gripes; spasms in the calves of the legs.

I. Idiopathic.

1. Cholera (*spontanea*), arising in a warm season, without any manifest cause.

2. Cholera (*accidentalis*), from acrid matters taken inwardly.

II. Symptomatic.

Genus LX. Diarrhœa. Frequent stools; the disease not infectious; no primary pyrexia.

I. Idiopathic.

1. Diarrhœa (*crapulosa*), in which the excrements are voided in greater quantity than naturally.

2. Diarrhœa (*biliosa*), in which yellow fæces are voided in great quantity.

3. Diarrhœa (*mucosa*), in which either from acrid substances taken inwardly, or from cold, especially applied to the feet, a great quantity of mucus is voided.

4. Diarrhœa (*cœliaca*), in which a milky humour of the nature of chyle is discharged by stool.

5. Diarrhœa (*lienteria*), in which the aliments are discharged with little alteration soon after eating.

6. Diarrhœa (*hepatirrhœa*), in which a bloody serous matter is discharged without pain.

II. Symptomatic.

Genus LXI. Diabetes. A chronical profusion of urine, for the most part preternatural, and in immoderate quantity.

I. Idiopathic.

1. Diabetes (*mellitus*), with urine of the smell, colour, and taste of honey.

2. Diabetes (*insipidus*), with limpid, but not sweet, urine.

II. Symptomatic.

Genus LXII. Hysteria. Rumbling of the bowels; a sensation as of a globe turning itself in the belly, ascending to the stomach and fauces, and there threatening suffocation; sleep; convulsions; a great quantity of limpid urine; the mind involuntarily fickle and mutable.

The following are by Sauvages reckoned distinct idiopathic species; but, by Dr Cullen, only varieties of the same species.

A, From a retention of the menses.

B, From a menorrhagia cruenta.

C, From a menorrhagia serosa, or fluor albus.

D, From an obstruction of the viscera.

E, From a fault of the stomach.

F, From too great salacity.

Genus LXIII. Hydrophobia. A dislike and horror at any kind of drink, as occasioning a convulsion of the pharynx; induced, for the most part, by the bite of a mad animal. The species are,

1. Hydrophobia (*rabiosa*), with a desire of biting the bystanders, occasioned by the bite of a rabid animal.

II. Hydrophobia (*simplex*), without madness, or any desire of biting.

Order IV. Vesaniæ. Disorders of the judgment, without any pyrexia or coma.

Genus LXIV. Amentia; an imbecility of judgement, by which people either do not perceive, or do not remember, the relations of things. The species are,

I. Amentia (*congenita*), continuing from birth.

II. Amentia (*senilis*), from the diminution of the perceptions and memory through extreme old age.

III. Amentia (*acquisita*), occurring in people formerly of a sound mind, from evident external causes.

Genus LXV. Melancholia; a partial madness, without dyspepsia.

Varying according to the different subjects concerning which the person raves; and thus it is,

1. With an imagination in the patient concerning his body being in a dangerous condition, from slight causes; or his affairs in a desperate state.

2. With an imagination concerning a prosperous state of affairs.

3. With violent love, without satyriasis or nymphomania.

4. With a superstitious fear of a future state.

5. With an aversion from motion and all the offices of life.

6. With restlessness, and an impatience of any situation whatever.

7. With a weariness of life.

8. With a deception concerning the nature of the patient's species.

Dr Cullen thinks that there is no such disease as that called *dæmonomania*, and that the diseases mentioned by Sauvages under that title are either,

1. Species of melancholy or mania; or

2. Of some disease by the spectators falsely ascribed to the influence of an evil spirit; or

3. Of a disease entirely feigned; or

4. Of a disease partly true and partly feigned.

Genus LXVI. Mania; universal madness.

1. Mania (*mentalis*), arising entirely from passions of the mind.

2. Mania (*corporea*), from an evident disease of the body.

Varying according to the different disease of the body.

3. Mania (*obscura*), without any passion of mind or evident disease of the body preceding.

The symptomatic species of mania are,

1. Paraphrosyne from poisons.

2. Paraphrosyne from passion.

3. Paraphrosyne febrilis.

Genus LXVII. Oneirodynia. A violent and troublesome imagination in time of sleep.

1. Oneirodynia (*activa*), exciting to walking and various motions.

2. Oneirodynia (*gravans*), from a sense of some weight incumbent, and pressing on the breast especially.

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Class III. CACHEXIÆ; a depraved habit of the whole or greatest part of the body, without primary pyrexia or neurosis.

Order I. Marcores; emaciation of the whole body.

Genus LXVIII. Tabes. Leanness, asthenia, hectic fever. The species are,

1. Tabes (*purulenta*), from an external or internal ulcer, or from a vomica.

Varying in its situation: hence,

2. Tabes (*scrophulosa*), in scrophulous constitutions.

3. Tabes (*venenata*), from poison taken inwardly.

Genus LXIX. Atrophia. Leanness and asthenia, without hectic fever. The species are,

1. Atrophia (*inanitorum*), from too great evacuation.

2. Atrophia (*famelicorum*), from a want of nourishment.

3. Atrophia (*cacochymica*), from corrupted nourishment.

4. Atrophia (*debilium*), from the function of nutrition being depraved, without any extraordinary evacuation or cacochymia having preceded.

Order II. Intumescentiæ. An external swelling of the whole or greatest part of the body.

Sect. I. *Adiposæ*.

Genus LXX. Polysarcia; a troublesome swelling of the body from fat.

Sect. II. *Flatuosæ*.

Genus LXXI. Pneumatosis; a tense elastic swelling of the body, crackling under the hand. The species are,

1. Pneumatosis (*spontanea*), without any manifest cause.

2. Pneumatosis (*traumatica*), from a wound in the breast.

3. Pneumatosis (*veneneta*), from poison injected or applied.

4. Pneumatosis (*hysterica*), with hysteria.

Genus LXXII. Tympanites; a tense, elastic, sonorous swelling of the abdomen; costiveness; a decay of the other parts. The species are,

1. Tympanites (*intestinalis*), with a tumor of the abdomen frequently unequal, and with a frequent evacuation of air relieving the tension and pain.

2. Tympanites (*abdominalis*), with a more evident noise, a more equable tumor, and a less frequent emission of flatus, which also gives less relief.

Genus LXXIII. Physometra; a slight elastic swelling in the epigastrium, having the figure and situation of the uterus.

Sect. III. *Aquosæ* or *Dropsies*.

Genua LXXIV. Anasarca. A soft, inelastic swelling of the whole body, or some part of it. The species are,

1. Anasarca (*serosa*), from a retention of serum on account of the suppression of the usual evacuations, or from an increase of the serum on account of too great a quantity of water taken inwardly.

2. Anasarca (*oppilata*), from a compression of the veins.

3. Anasarca (*exanthematica*), arising after exanthemata, especially succeeding erysipelas.

4. Anasarca (*anæmia*), from the thinness of the blood produced by hæmorrhagy.

5. Anasarca (*debilium*), in weak people after long diseases, or from other causes.

Genus LXXV. Hydrocephalus. A soft inelastic swelling of the head, with the sutures of the cranium opened.

Genus LXXVI. Hydrorachitis. A soft, slender tumor above the vertebræ of the loins; the vertebræ gaping from each other.

Genus LXXVII. Hydrothorax. Dyspnœa; paleness of the face; œdematous swellings of the feet; scanty urine; difficult lying in a recumbent posture; a sudden and spontaneous starting out of sleep, with palpitation; water fluctuating in the breast.

Genus LXXVIII. Ascites. A tense, scarce elastic, but fluctuating swelling of the abdomen. The species are,

1. Ascites (*abdominalis*), with an equal swelling of the whole abdomen, and with a fluctuation sufficiently evident.

Varying according to the cause.

A, From an obstruction of the viscera.

B, From debility.

C, From a thinness of the blood.

2. Ascites (*saccatus*), with a swelling of the abdomen, in the beginning at least, partial, and with a less evident fluctuation.

Genus LXXIX. Hydrometra. A swelling of the hypogastrium in women, gradually increasing, keeping the shape of the uterus, yielding to pressure, and fluctuating; without ischuria or pregnancy.

Genus LXXX. Hydrocele. A swelling of the scrotum, not painful; increasing by degrees, soft, fluctuating, and pellucid.

Sect. IV. *Solidæ*.

Genus LXXXI. Physconia. A swelling chiefly occupying a certain part of the abdomen, gradually increasing, and neither sonorous nor fluctuating. The species are,

Physconia hepatica.
Physconia splenica.
Physconia renalis.
Physconia uterina.
Physconia ab ovario.
Physconia mesenterica.
Physconia intestinalis.
Physconia omentalis.
Physconia polysplachna.
Physconia visceralis.
Physconia externa lupialis.
Physconia externa schirrhodea.
Physconia externa hydatidosa.
Physconia ab adipe subcutaneo.
Physconia ab excrescentia.

Genus LXXXII. Rachitis. A large head, swelling most in the fore part, the ribs depressed; abdomen swelled, with a decay of the other parts.

Varying,

1. Simple, without any other disease.
2. Joined with other diseases.

Order III. Impetigines. Cachexies chiefly deforming the skin and external parts of the body.

Genus

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Genus LXXXIII. Scrophula. Swelling of the conglobate glands, especially in the neck; swelling of the upper lip and of the nose; the face florid, skin thin, abdomen swelled. The species are,

1. Scrophula (*vulgaris*), simple, external and permanent.

2. Scrophula (*mesenterica*), simple, internal, with paleness of the face, want of appetite, swelling of the abdomen, and unusual fetor of the excrements.

3. Scrophula (*fugax*), most simple, appearing only about the neck; for the most part proceeding from the resorption of the matter of ulcers in the head.

4. Scrophula (*Americana*), joined with the yaws.

Genus LXXXIV. Syphilis. A contagious disease; ulcers of the tonsils, after impure venery, and a disorder of the genitals; clustered pimples of the skin, especially about the margin of the hair, ending in crusts and crusty ulcers; pains of the bones; exostoses.

Genus LXXXV. Scorbutus; in cold countries, attacking after putrescent diet, especially such as is salt and of the animal kind, where no supply of fresh vegetables is to be had; asthenia; stomacace; spots of different colours on the skin, for the most part livid, and appearing chiefly among the roots of the hair.

Varying in degree.

a, Scorbutus incipiens.
b, Scorbutus crescens.
c, Scorbutus inveteratus.

Varying also in symptoms.

d, Scorbutus lividus.
e, Scorbutus petechialis.
f, Scorbutus pallidus.
g, Scorbutus ruber.
h, Scorbutus calidus.

Genus LXXXVI. Elephantiasis; a contagious disease; thick, wrinkled, rough, unctuous skin, destitute of hairs, anæsthesia in the extremities, the face deformed with pimples, the voice hoarse and nasal.

Genus LXXXVII. Lepra; the skin rough, with white, branny, and chopped eschars, sometimes moist beneath, with itching.

Genus LXXXVIII. Frambœsia; swellings resembling fungi, or the fruit of the mulberry or raspberry, growing on various parts of the skin.

Genus LXXXIX. Trichoma; a contagious disease; the hairs thicker than usual, and twisted into inextricable knots and cords.

Genus XC. Icterus; yellowness of the skin and eyes; white fæces; urine of a dark red, tinging what is put into it of a yellow colour.

The idiopathic species are,

1. Icterus (*calculosus*), with acute pain in the epigastric region, increasing after meals; biliary concretions voided by stool.

2. Icterus (*spasmodicus*), without pain, after spasmodic diseases and passions, of the mind.

3. Icterus (*hepaticus*), without pain, after diseases of the liver.

4. Icterus (*gravidarum*), arising during the time of pregnancy, and going off after delivery.

5. Icterus (*infantum*), coming on in infants a few days after birth.

Class IV. LOCALES. An affection of some part, but not of the whole body.

Order I. Dysæsthesiæ. The senses depraved or destroyed, from a disease of the external organs.

Genus XCI. Caligo. The sight impaired or totally destroyed, on account of some opaque substance interposed between the objects and the retina, inherent in the eye itself or the eyelids. The species are,

1. Caligo (*lentis*), occasioned by an opaque spot behind the pupil.

2. Caligo (*corneæ*), from an opacity of the cornea.

3. Caligo (*pupillæ*), from an obstruction of the pupil.

Varying according to the different causes from which it proceeds.

4. Caligo (*humorum*), from a disease or defect of the aqueous humour.

Varying according to the different state of the humour.

5. Caligo (*palpebrarum*), from a disease inherent in the eyelids.

Varying according to the nature of the disease in the eyelids.

Genus XCII. Amaurosis. The sight diminished, or totally abolished, without any evident disease of the eye; the pupil for the most part remaining dilated and immoveable. The species are,

1. Amaurosis (*compressionis*), after the causes and attended with the symptoms of congestion in the brain.

Varying according to the nature of the remote cause.

2. Amaurosis (*atonica*), after the causes and accompanied with symptoms of debility.

3. Amaurosis (*spasmodica*), ater the causes and with the signs of spasm.

4. Amaurosis (*venenata*), from poison taken into the body or applied outwardly to it.

Genus XCIII. Dysopia. A depravation of the sight, so that objects cannot be distinctly perceived, except at a certain distance, and in a certain situation.

The species are,

1. Dysopia (*tenebrarum*), in which objects are not seen unless they be placed in a strong light.

2. Dysopia (*luminis*,) in which objects are not distinctly seen unless by a weak light.

3. Dysopia (*dissitorum*), in which distant objects are not perceived.

4. Dysopia (*proximorum*), in which the nearest objects are not perceived.

5. Dysopia (*lateralis*), in which objects are not perceived unless placed in an oblique posture.

Genus XCIV. Pseudoblepsis; when the sight is diseased in such a manner that the person imagines he sees things which really do not exist, or sees things which do exist after some other manner than they really are. The species are,

1. Pseudoblepsis (*imaginaria*), in which the person imagines he sees things which really do not exist.

Varying according to the nature of the imagination.

2. Pseudoblepsis (*mutans*), in which objects really existing appear somehow changed.

 Varying

Varying according to the change perceived in the objects, and according to the remote cause.

Genus XCV. Dysecœa. A diminution or total abolition of the sense of hearing. The species are,

1. Dysecœa (*organica*), from a disease in the organs transmitting sounds to the internal ear.

Varying according to the nature of the disease and of the part affected.

2. Dysecœa (*atonica*), without any evident disease of the organs transmitting the sounds.

Varying according to the nature of the cause.

Genus XCVI. Paracusis; a depravation of the hearing. The species are,

1. Paracusis (*imperfecta*), in which though sounds coming from external objects are heard, yet it is neither distinctly nor in the usual manner.

Varying,

a, With a dulness of hearing.

b, With a hearing too acute and sensible.

c, When a single external sound is doubled by some internal causes.

d, When the sounds which a person desires to hear are not perceived, unless some other violent sound is raised at the same time.

2. Paracusis (*imaginaria*), in which sounds not existing externally are excited from internal causes.

Varying according to the nature of the sound perceived, and according to the nature of the remote cause.

Genus XCVII. Anosmia; a diminution or abolition of the sense of smell. The species are,

1. Anosmia (*organica*), from a disease in the membrane lining the internal parts of the nostrils.

Varying according to the nature of the disease.

2. Anosmia (*atonica*), without any evident disease of the membrane of the nose.

Genus XCVIII. Agheustia; a diminution or abolition of the sense of taste.

1. Agheustia (*organica*), from a disease in the membrane of the tongue, keeping off from the nerves those substances which ought to produce taste.

2. Agheustia (*atonica*), without any evident disease of the tongue.

Genus XCIX. Anæsthesia; a diminution or abolition of the sense of feeling. The species from Sauvages, adopted by Dr Cullen, are,

1. Anæsthesia à spina bifida.
2. Anæsthesia plethorica.
3. Anæsthesia nascentium.
4. Anæsthesia melancholica.

Order II. Dysorexiæ; error or defect of appetite.

Sect. I. *Appetitus erronei.*

Genus C. Bulimia; a desire for food in greater quantities than can be digested.

The idiopathic species are,

1. Bulimia (*helluonum*), an unusual appetite for food, without any disease of the stomach.

2. Bulimia (*syncopalis*), a frequent desire of meat, on account of a sensation of hunger threatening syncope.

3. Bulimia (*emetica*), an appetite for a great quantity of meat, which is thrown up immediately after it is taken.

Genus CI. Polydipsia; an appetite for an unusual quantity of drink.

The polydipsia is almost always symptomatic, and varies only according to the nature of the disease which accompanies it.

Genus CII. Pica; a desire of swallowing substances not used as food.

Genus CIII. Satyriasis; an unbounded desire of venery in men. The species are,

1. Satyriasis (*juvenilis*), an unbounded desire of venery, the body at the same time being little disordered.

2. Satyriasis (*furens*), a vehement desire of venery with a great disorder of the body at the same time.

Genus CIV. Nymphomania; an unbounded desire of venery in women.

Varying in degree.

Genus CV. Nostalgia; a violent desire in those who are absent from their country of revisiting it.

1. Nostalgia (*simplex*), without any other disease.

2. Nostalgia (*complicata*), accompanied with other diseases.

Sect. II. *Appetitus deficientes.*

Genus CVI. Anorexia. Want of appetite for food. Always symptomatic.

1. Anorexia (*humoralis*), from some humour loading the stomach.

2. Anorexia (*atonica*), from the tone of the fibres of the stomach being lost.

Genus CVII. Adipsia; a want of desire for drink. Always a symptom of some disease affecting the sensorium commune.

Genus CVIII. Anaphrodisia; want of desire for, or impotence to, venery.

The true species are,

1. Anaphrodisia paralytica.
2. Anaphrodisia gonorrhoica.

The false ones are,

1. Anaphrodisia à mariscis.
2. Anaphrodisia ab urethræ vitio.

Order III. Dyscinesiæ. An impediment, or depravation of motion from a disorder of the organs.

Genus CIX. Aphonia; a total suppression of voice without coma or syncope. The species are,

1. Aphonia (*gutturalis*), from the fauces or glottis being swelled.

2. Aphonia (*trachealis*), from a compression of the trachea.

3. Aphonia (*atonica*), from the nerves of the larynx being cut.

Genus CX. Mutitas; a want of power to pronounce words. The species are,

1. Mutitas (*organica*), from the tongue being cut out or destroyed.

2. Mutitas (*atonica*), from injuries done to the nerves of the tongue.

3. Mutitas (*surdorum*), from people being born deaf, or the hearing being destroyed during childhood.

Genus CXI. Paraphonia; a depraved sound of the voice. The species are,

1. Paraphonia (*puberum*), in which, about the time of puberty, the voice from being acute and sweet, becomes more grave and harsh.

2. Paraphonia (*rauca*), in which, by reaſon of the dryneſs or flaccid tumor of the fauces, the voice becomes rough and hoarſe.

3. Paraphonia (*reſonans*), in which, by reaſon of an obſtruction in the noſtrils, the voice becomes hoarſe, with a ſound hiſſing through the noſtrils.

4. Paraphonia (*palatina*), in which, on account of a defect or diviſion of the uvula, for the moſt part with a hare-lip, the voice becomes obſcure, hoarſe, and unpleaſant.

5. Paraphonia (*clangens*), in which the voice is changed to one acute, ſhrill, and ſmall.

6. Paraphonia (*comatoſa*), in which, from a relaxation of the velum palati and glottis, a ſound is produced during inſpiration.

Genus CXII. Pſelliſmus; a defect in the articulation of words. The ſpecies are,

1. Pſelliſmus (*hæſitans*), in which the words, eſpecially the firſt ones of a diſcourſe, are not eaſily pronounced, and not without a frequent repetition of the firſt ſyllable.

2. Pſelliſmus (*ringens*), in which the ſound of the letter R is always aſpirated, and, as it were, doubled.

3. Pſelliſmus (*lallans*), in which the ſound of the letter L becomes more liquid, or is pronounced inſtead of R.

4. Pſelliſmus (*emolliens*), in which the hard letters are changed into the ſofter ones, and thus the letter S is much uſed.

5. Pſelliſmus (*balbutiens*), in which, by reaſon of the tongue being large, or ſwelled, the labial letters are better heard, and often pronounced inſtead of others.

6. Pſelliſmus (*acheilos*), in which the labial letters cannot be pronounced at all, or with difficulty.

7. Pſelliſmus (*lagoſtomatum*), in which, on account of the diviſion of the palate, the guttural letters are leſs perfectly pronounced.

Genus CXIII. Strabiſmus; the optic axes of the eyes not converging. The ſpecies are,

1. Strabiſmus (*habitualis*), from a bad cuſtom of uſing only one eye.

2. Strabiſmus (*commodus*), from the greater debility or mobility of one eye above the other; ſo that both eyes cannot be conveniently uſed.

3. Strabiſmus (*neceſſarius*), from a change in the ſituation or ſhape of the parts of the eye.

Genus CXIV. Dyſphagia; impeded deglutition, without phlegmaſia or the reſpiration being affected.

Genus CXV. Contractura; a long-continued and rigid contraction of one or more limbs. The ſpecies are,

1. Contractura (*primaria*), from the muſcles becoming contracted and rigid.

a, From the muſcles becoming rigid by inflammation.

b, From muſcles becoming rigid by ſpaſm.

c, From muſcles contracted by reaſon of their antagoniſts having become paralytic.

d, From muſcles contracted by an irritating acrimony.

2. Contractura (*articularis*), from ſtiff joints.

Order IV. Apocenoses. A flux either of blood or ſome other humour flowing more plentifully than uſual, without pyrexia, or an increaſed impulſe of fluids.

Genus CXVI. Profuſio; a flux of blood.

Genus CXVII. Ephidroſis; a preternatural evacuation of ſweat.

Symptomatic ephidroſes vary according to the nature of the diſeaſes which they accompany, the different nature of the ſweat itſelf, and ſometimes the different parts of the body which ſweat moſt.

Genus CXVIII. Epiphora; a flux of the lachrymal humour.

Genus CXIX. Ptyaliſmus; a flux of ſaliva.

Genus CXX. Enureſis; an involuntary flux of urine without pain. The ſpecies are,

1. Enureſis (*atonica*), after diſeaſes injuring the ſphincter of the bladder.

2. Enureſis (*irritata*), from a compreſſion or irritation of the bladder.

Genus CXXI. Gonorrhœa; a preternatural flux of humour from the urethra in men, with or without a deſire of venery. The ſpecies are,

1. Gonorrhœa (*pura*), in which, without any impure venery having preceded, a fluid reſembling pus, without dyſuria or propenſity to venery, flows from the urethra.

2. Gonorrhœa (*impura*), in which, after impure venery, a fluid like pus flows from the urethra with dyſuria. The conſequence of this is,

Gonorrhœa (*mucoſa*), in which, after an impure gonorrhœa, a mucous humour flows from the urethra with little or no dyſuria.

3. Gonorrhœa (*laxorum*), in which an humour for the moſt part pellucid, without any erection of the penis, but with a propenſity to venery, flows from the urethra while the perſon is awake.

4. Gonorrhœa (*dormientium*), in which the ſeminal liquor is thrown out, with erection and deſire of venery, in thoſe who are aſleep and have laſcivious dreams.

Order V. Epischeses; ſuppreſſions of evacuations.

Genus CXXII. Obſtipatio; the ſtools either ſuppreſſed, or ſlower than uſual. The ſpecies are,

1. Obſtipatio (*debilium*), in lax, weak, and for the moſt part dyſpeptic perſons.

2. Obſtipatio (*rigidorum*), in people whoſe fibres are rigid, and frequently of an hypochondriac diſpoſition.

3. Obſtipatio (*obſtructorum*), with ſymptoms of the colica, 1ſt, 2d, 4th, and 7th, above-mentioned.

Genus CXXIII. Iſchuria; an abſolute ſuppreſſion of urine. The ſpecies are,

1. Iſchuria (*renalis*), coming after a diſeaſe of the kidneys, with pain, or troubleſome ſenſe of weight in the region of the kidneys, and without any ſwelling of the hypogaſtrium, or deſire of making water.

2. Iſchuria (*ureterica*), coming after a diſeaſe of the kidneys, with a ſenſe of pain or uneaſineſs in ſome part of the ureter, and without any tumor of the hypogaſtrium, or deſire of making water.

3. Iſchuria (*veſicalis*), with a ſwelling of the hypogaſtrium, pain at the neck of the bladder, and a frequent ſtimulus to make water.

4. Iſchuria (*urethralis*), with a ſwelling of the hypogaſtrium, frequent ſtimulus to make water, and pain in ſome part of the urethra.

All theſe ſpecies are ſubdivided into many varieties, according to their different cauſes.

Genus CXXIV. Dyſuria; a painful, and ſomehow impeded emiſſion of urine. The ſpecies are,

1. Dyſuria

General Arrangement of Diſeaſes.

1. Dyſuria (*ardens*), with heat of urine, without any manifeſt diſorder of the bladder.

2. Dyſuria (*ſpaſmodica*), from a ſpaſm communicated from the other parts to the bladder.

3. Dyſuria (*compreſſionis*), from the neighbouring parts preſſing upon the bladder.

4. Dyſuria (*phlogiſtica*), from an inflammation of the neighbouring parts.

5. Dyſuria (*irritata*), with ſigns of a ſtone in the bladder.

6. Dyſuria (*mucoſa*), with a copious excretion of mucus.

Genus CXXV. Dyſpermatiſmus; a ſlow, impeded, and inſufficient emiſſion of ſemen in the venereal act. The ſpecies are,

1. Dyſpermatiſmus (*urethralis*), from diſeaſes of the urethra.

2. Dyſpermatiſmus (*nodoſus*), from knots on the corpora cavernoſa penis.

3. Dyſpermatiſmus (*præputialis*), from too narrow an orifice of the prepuce.

4. Dyſpermatiſmus (*mucoſus*); from mucus infarcting the urethra.

5. Dyſpermatiſmus (*hypertonicus*), from too ſtrong an erection of the penis.

6. Dyſpermatiſmus (*epilepticus*), from a ſpaſmodic epilepſy happening during the time of coition.

7. Dyſpermatiſmus (*apractodes*), from an imbecility of the parts of generation.

8. Dyſpermatiſmus (*refluus*), in which there is no emiſſion of ſemen, becauſe it returns from the urethra into the bladder.

Genus CXXVI. Amenorrhœa. The menſes either flowing more ſparingly than uſual, or not at all, at their uſual time, without pregnancy. The ſpecies are,

1. Amenorrhœa (*emanſionis*), in thoſe arrived at puberty, in whom, after the uſual time, the menſes have not yet made their appearance, and many different morbid affections have taken place.

2. Amenorrhœa (*ſuppreſſionis*), in adults, in whom the menſes which had already begun to flow are ſuppreſſed.

3. Amenorrhœa (*difficilis*), in which the menſes flow ſparingly, and with difficulty.

Order VI. Tumores; an increaſed magnitude of any part without phlogoſis.

Genus CXXVII. Aneuriſma; a ſoft tumor, with pulſation, above an artery.

Genus CXXVIII. Varix; a ſoft tumor, without pulſation, above a vein.

Genus CXXIX. Ecchymoma; a diffuſed, little eminent, and livid tumor.

Genus CXXX. Schirrus; an hard tumor of ſome part, generally of a gland, without pain, and difficultly brought to ſuppuration.

Genus CXXXI. Cancer; a painful tumor of a ſchirrous nature, and degenerating into an ill conditioned ulcer.

Genus CXXXII. Bubo; a ſuppurating tumor of a conglobate gland.

Genus CXXXIII. Sarcoma; a ſoft ſwelling, without pain.

Genus CXXXIV. Verruca; a harder ſcabrous ſwelling.

Genus CXXXV. Clavus; a hard, lamellated thickneſs of the ſkin.

Genus CXXXVI. Lupia. A moveable, ſoft tumor below the ſkin, without pain.

Genus CXXXVII. Ganglion. A hard moveable ſwelling, adhering to a tendon.

Genus CXXXVIII. Hydatis; a cuticular veſicle filled with aqueous humour.

Genus CXXXIX. Hydarthrus; a moſt painful ſwelling of the joints, chiefly of the knee, at firſt ſcarce elevated, of the ſame colour with the ſkin, diminiſhing the mobility.

Genus CXL. Exoſtoſis; a hard tumor adhering to a bone.

Order VII. Ectopiæ; tumors occaſioned by the removal of ſome part out of its proper ſituation.

Genus CXLI. Hernia; an ectopia of a ſoft part as yet covered with the ſkin and other integuments.

Genus CXLII. Prolapſus; a bare ectopia of ſome ſoft part.

Genus CXLIII. Luxatio; the removal of a bone from its place in the joints.

Order VIII. Dialyses. A ſolution of continuity; manifeſt to the ſight or touch.

Genus CXLIV. Vulnus; a recent and bloody ſolution of the unity of ſome ſoft part by the motion of ſome hard body.

Genus CXLV. Ulcus. A purulent or ichorous ſolution of a ſoft part.

Genus CXLVI. Herpes; a great number of phlyctenæ or ſmall ulcers, gathering in cluſters, creeping, and obſtinate.

Genus CXLVII. Tinea; ſmall ulcers among the roots of the hair of the head, pouring out a fluid which changes to a white friable ſcurf.

Genus CXLVIII. Pſora. Itchy puſtules and little ulcers of an infectious nature, chiefly infecting the hands.

Genus CXLIX. Fractura; bones broken into large fragments.

Genus CL. Caries; an ulceration of a bone.

Having thus preſented to our readers Dr Cullen's general ſyſtematic view of all the diſeaſes to which the human body is ſubjected, we come next to give a more particular account of the more important affections, treating of them in the order which Dr Cullen has arranged them.

Class I. PYREXIÆ, or the Febrile Diſeaſes. 125

Order I. FEBRES, Or Fevers ſtrictly ſo called.

Sauvag. Claſs II. *Vog.* Claſs I. *Sagar.* Claſs XII. Morbi Febriles Critici, *Lin.* Claſs II.

Sect. I. INTERMITTENTS.

Intermittentes of many authors; *Sauv.* Claſs II. Order III. *Lin.* Claſs II. Order II. *Vog.* Claſs I. Order I. *Sag.* Claſs XII. Order III.

The

Febres. The *remittentes* of others, *Sauv.* Class II. Order II. *Sag.* Class XII. Order II.

Exacerbantes, *Lin.* Class II. Order III.

Continuæ, *Vog.* Class I. Order II.

Genus I. TERTIANA; the TERTIAN FEVER.

(*Tertiana*, Sauv. G. 88. Lin. 16. Hoffm. Stahl. Cleghorn. Senac.)

The *Genuine* TERTIAN.

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1. *Description.* This disease, in its most regular form, consists of repeated paroxysms, returning every second day, the patient during the intermediate period enjoying apparently a state of good health. This is the most common form of ague, as it is commonly called in Britain. Each paroxysm consists of three parts, the cold, the hot, and the sweating stages. The paroxysm commonly begins with a remarkable shivering, increasing frequently to a convulsive shaking of the limbs. The extremities are always cold, sometimes remarkably so. The cold for the most part is first perceived about the lumbar regions, from thence ascending along the spine it turns towards the pit of the stomach. Sometimes it begins in the first joint of the fingers and tip of the nose. Sometimes it attacks only a particular part of the body, as one of the arms, the side of the head, &c. This cold is often preceded by a heavy and sleepy torpor, languor, and lassitude, which we are partly to ascribe to real weakness and partly to mere languor. To these symptoms succeed yawning and stretching; after which the cold comes on as above described, not unfrequently with a pain of the back, and a troublesome sensation of tension in the precordia and hypochondria. To this succeed nausea and vomiting: and the more genuine the disease, the more certainly does the vomiting come on; by which a great deal of tough mucous matter, and sometimes bilious stuff or indigested food, is evacuated during the first paroxysm. In some there is only a violent straining to vomit, without bringing up any thing: sometimes, instead of these symptoms, a diarrhœa occurs, and this chiefly in weak, phlegmatic, and aged people, or where an indigested mucous saburra has long remained in the primæ viæ.

When these symptoms have continued for an hour or two, the cold begins to go off, and is succeeded by a lassitude, languor, and flaccidity of the whole body, but chiefly in the limbs, with an uneasy soreness as if the parts had been bruised; excepting in those cases where the nausea continues for a longer time. After this languor, a heat comes on, the increase of which is generally slow, but sometimes otherwise, with pain of the head, thirst, and bitterness in the mouth. The pulse is quick and unequal; sometimes beating 130 strokes in a minute. As soon as this heat has abated, a little moisture or sweat is observed to break forth; not always indeed in the first, but always in the succeeding paroxysms, and the urine lets fall a quantity of lateritious sediment. The whole paroxysm is seldom over in less than six hours, more frequently eight, and in violent cases it extends to 12 hours; but that which exceeds 12 hours is to be reckoned a spurious kind, and approaching to the nature of continued fevers. All these symptoms, however, are repeated every second day, in such a manner that the patient is quite free from fever for at least 24 hours. The paroxysms return much about the same time, though sometimes a little sooner or later.

Tertiana. 2. *Causes of this disease and persons subject to it.* The genuine tertian attacks men rather than women, young people rather than old: the latter being more subject to anomalous tertians. It likewise seizes the lusty and active, rather than the lazy and indolent. Those, however, who are apt to nauseate their meat fall easily into a tertian fever. The cause, according to Dr Cullen, is the miasma of marshes, and that only. Other physicians have taken in many more causes, almost every thing indeed which debilitates the body: but the Doctor denies that any of these, though they may dispose the body for receiving the disease, or may augment it, can by any means produce it without the concurrence of the marsh miasma; and it cannot be denied, that it is a disease almost peculiar to marshy situations. Thus we find it very frequent in the fenny counties of Britain, although in other parts of this island it may be considered as a very rare disease; nay, in many it may perhaps be said that it never occurs. And it is also well known that intermittents have almost entirely disappeared in many parts of Britain, in which they were very common before the marshes of these places were drained.

3. *Prognosis.* The genuine simple tertian, unless improper medicines be administered, is generally very easily cured; nay, the vulgar reckon it of such a salutary nature, that after it they imagine a person becomes more strong and healthy than before. Hippocrates has observed, that these fevers terminate of their own accord after seven or nine paroxysms. Juncker tells us, that it frequently terminates before the seventh paroxysm, but rarely before the fourth. He also denies that any thing critical is to be observed in its going off; but in this he differs from Vogel, who tells us, that the urine, for some days after the fever is quite gone off, appears slimy, and lets fall much sediment. The latter also informs us, that besides the common crisis by sweat and urine, the tertian hath one peculiar to itself, namely, dry scabby ulcers breaking out upon the lips. These sometimes appear about the third or fourth paroxysm; and then we may venture to foretel that the disease will go off spontaneously after the seventh. But though the disease be never dangerous, in cold climates at least, when properly treated; yet the improper use of hot and stimulating medicines may change it into a continued fever, more or less dangerous according to the quantity of medicines taken and the constitution of the patient; in which case the prognosis must be regulated by the particular symptoms which occur. In warm climates, however, the tertian fever may be considered as a much more alarming disease; and unless the most powerful remedies be employed, the patient is in danger of falling a victim to every paroxysm.

A variety of theories have been proposed for explaining the phenomena of this affection; but we may assert, that every thing hitherto said upon the subject is highly unsatisfactory. For although it be now almost universally admitted, that this fever does arise from the effluvia of marshes, yet in what manner the action

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action of thofe effluvia induces fever, and particularly why this fever returns in regular paroxyfms, are queftions with regard to which we are ftill totally in the dark. Dr Cullen, with much ingenuity, attempted to prove, that the remote caufes of this, as well as of other fevers, operate by inducing a ftate of debility; that this debility gives rife to fpafm, which induces increafed action, from which the phenomena are to be explained. But this theory is liable to no lefs numerous and unfurmountable objections than the exploded hypothefes which had before been propofed by others. For it is an undeniable truth, that debility often exifts, even to the higheft imaginable degree, without any fever; nay, that when fever has taken place, the debility is often much greater after it is entirely gone than at any period during its courfe. When fpafm and increafed action do take place, we have no reafon to view them in any other light than merely as fymptoms of the difeafe; and while they are often abfent in this affection, they frequently occur in others where the ficknefs, anxiety, and other characterizing fymptoms of fever are entirely abfent: and, upon the whole, a probable or rational theory of intermittents, as well as of other fevers, ftill remains to be difcovered.

Cure. The treatment of all genuine intermittents, whether *tertians*, quotidians, or quartans, being almoft precifely the fame, the general method of cure applicable to all of them may be here given, to which it will be eafy to refer when we come to defcribe the others.

In treating intermittent fevers, phyficians have formed indications of cure according to their different theories. The followers of Boerhaave, Stahl, &c. who imagined that the difeafe proceeded from a lentor or other diforders in the blood, always thought it neceffary to correct and evacuate thefe peccant humours by emetics and purgatives, before they attempted to ftop the difeafe by the Peruvian bark or any other medicine. Cinchona indeed, among fome, feems to be held in very little eftimation: fince Vogel affirms, that this medicine, inftead of deferving to have the preference of all other febrifuge medicines, ought rather to be ranked among the loweft of the whole; and for this reafon he afcribes the cures, faid to be obtained by the ufe of the Peruvian bark, entirely to nature.

According to Dr Cullen, the indications of cure in intermitting fevers may be reduced to the following:

1. In the time of intermiffion, to prevent the return of the paroxyfms.

2. In the time of paroxyfms, to conduct thefe in fuch a manner as to obtain a final folution of the difeafe.

3. To take off certain circumftances which might prevent the fulfilling of the two firft indications.

The firft indication may be anfwered in two ways: 1. By increafing the action of the heart and arteries fome time before the period of acceffion, and fupporting that increafed action till the period of acceffion be over, and thus preventing the recurrence of that atony and fpafm of the extreme veffels, which he thinks give occafion to the recurrence of paroxyfms. 2. By fupporting the tone of the veffels, and thereby preventing atony and the confequent fpafm, without increafing the action of the heart and arteries, the recurrence of paroxyfms may be prevented.

The action of the heart and arteries may be increafed, 1. By various ftimulant remedies internally given or externally applied, and that without exciting fweat. 2. By the fame remedies, or by others, managed in fuch a manner as to excite fweating, and to fupport that fweating till the period of acceffion be for fome time paft. 3. By emetics, fupporting for the fame time the tone and action of the extreme veffels.

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The tone of the extreme veffels may be fupported without increafing the action of the heart and arteries, by various tonic medicines; as, 1. Aftringents alone. 2. Bitters alone. 3. Aftringents and bitters conjoined. 4. Aftringents and aromatics conjoined. 5. Certain metallic tonics; and, 6. Opiates. A good deal of exercife, and as full a diet as the condition of the patient's appetite and digeftion allow, will be proper during the time of intermiffion, and may be confidered as belonging to this head. Although many particulars in this plan of cure are deduced from Dr Cullen's theory, yet there can be no doubt that the object chiefly to be aimed at is to employ fuch remedies during the intermiffions as will prevent a recurrence of the paroxyfm. Of all the remedies hitherto employed with this intention, the moft celebrated, perhaps the moft certainly effectual, is the Peruvian bark; or, to fpeak more properly, the bark of the *Cinchona officinalis* of Linnæus. But it muft be obferved, that good effects are only to be expected from this medicine when employed in fubftance and in large quantity; and for its ufe the following rules or obfervations have been given:

1. The cinchona may with fafety be employed at any period of intermitting fevers, providing that at the fame time there be neither a phlogiftic diathefis prevailing in the fyftem, nor any confiderable or fixed congeftion prefent in the abdominal vifcera.

2. The proper time for exhibiting the cinchona in intermittent fevers is during the time of intermiffion, and it is to be abftained from in the time of paroxyfms.

3. In the cafe of genuine intermittents, while a due quantity of cinchona is employed, the exhibition of it ought to be brought as near to the time of acceffion as the condition of the patient's ftomach will allow.

4. In all cafes of intermittents, it is not fufficient that the recurrence of paroxyfms be ftopped for once by the ufe of the cinchona; a relapfe is commonly to be expected, and fhould be prevented by the exhibition of the cinchona repeated at proper intervals.

The advantage of adminiftering the medicine as early as poffible, was fully afcertained by Dr Lind in the years 1765, 1766, and 1767, during an uncommon prevalence of intermittents. When the difeafe was ftopped by the cinchona immediately after the firft or fecond fit, which was the cafe with 200 of the Doctor's patients as well as himfelf, neither a jaundice nor dropfy enfued; whereas, when the cinchona could not be adminiftered, on account of the imperfect intermiffion of the fever, or when the patient had neglected to take it, either a dropfy, jaundice, or conftant headach, were the certain confequences, and the violence of the difeafe was in proportion to the number of the preceding fits, or to the continuance of the fever. By every paroxyfm the dropfical fwellings were vifibly increafed, and the colour of the fkin rendered of a deeper yellow. When the fever continued a few days without intermiffion, the belly and legs generally fwelled; a violent headach, likewife, and vertigo, for the moft part diftreffed the patient;

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patient; so that some, even after the fever had left them, were not able to walk across their chamber for a fortnight or three weeks. When the returns of the fever were regular and even, but slight, four or five fits of a simple tertian were sometimes followed by the most dangerous symptoms; especially in the year 1765, when these fevers raged with the greatest violence. If, as frequently happened, a dropsical patient relapsed into the intermittent, there was an absolute necessity for putting an immediate stop to it by the cinchona; and in upwards of 70 such patients, Dr Lind observed the most beneficial effects to accrue from this practice. Without regard to a cough, or any other chronical indisposition, he ordered it to be given in large doses.

Cinchona has been often observed to fail in removing intermittents, from not continuing the use of it for a sufficient length of time, from administering it in too small a dose, or from giving it in an improper form. It was a prevailing opinion, that an ounce, or an ounce and a half, taken during one intermission, was sufficient to prevent the return of another paroxysm. But this is not always the case; for a severe fit will often attack a patient who has taken such a quantity. When this happens, the patient ought to persevere during the following intermissions, with an increase of the dose, till five or six ounces at least have been taken. The medicine also ought not to be omitted as soon as one fit is stopped, but should be continued in a smaller dose, and after longer intervals, for at least ten days or a fortnight. Even for several months after the disease is entirely removed, it would be advisable to take a little occasionally in damp weather, or during an easterly wind, to prevent a relapse. Where the intervals between the fits are short, as in quotidians and double tertians, from one to two drams of it ought to be taken every two or three hours.

The form in which this medicine is administered is of some consequence. Mucilages and syrups have been recommended to conceal the taste of it; but, from various experiments, Dr Lind found nothing more effectual for this purpose than small beer or milk, especially the latter. A dram of bark mixed with two ounces of milk, and quickly drank, may easily be taken by a person of the most delicate taste, and by washing the mouth afterwards with milk, there will not remain the least flavour of the bark; but if the mixture be not drank immediately, the bark will impart a bitter taste to the milk. This medicine is commonly given in electuaries or boluses; but Dr Lind observes, that in these forms it proves much less efficacious than when administered in juleps or draughts, with the plentiful addition of wine or spirits. He has remarked, that six drams of powdered bark, given in a julep, consisting of one-fourth or one-third of brandy, is as effectual as an ounce of the powder in the form of an electuary, and proves less disagreeable to the stomach. For patients unaccustomed to wine or spirits, each draught should be warmed with spiritus ammoniæ, or tinct. myrrh. by both of which the efficacy of the bark is he thinks increased. Dr Lind is also fully convinced that wine or spirits improve the virtues of the bark much more than elixir vitrioli, tinct. rosar. or such other medicines as have been recommended by different physicians.

For those who nauseate cinchona from a weakness of the stomach or other cause, he advises it to be given in clysters, in which form it is, he tells us, as efficacious as when taken by the mouth. For this purpose the extract is most proper with the addition of a sufficient quantity of the tinctura thebaica, in order to its being longer retained. For children labouring under intermitting fevers, Dr Lind orders the spine of the back to be anointed, at the approach of the fit, with a liniment composed of equal parts of tinctura thebaica and liniment. sapon. which has often prevented it. If this should not produce the desired effect, he informs us that two or three tea-spoonfuls of syrup. è mecon. given in the hot fit, will generally mitigate the symptoms. But for the entire removal of the disease, after purging with magnesia alba, he prescribes a dram of the extract. cinchonæ with a few drops of tinct. thebaic. in a clyster, to be repeated every three hours for a child of about a year old. When the stomach is oppressed with phlegm, the magnesia frequently occasions vomiting, which should be promoted with warm water. The constant heaviness of the head occasioned by those fevers in such tender constitutions is best relieved by the application of a blister to the back.

Cinchona has also proved effectual for the cure of intermittents in children, even when externally applied, by putting the powder of it into a quilted waistcoat. Of its efficacy in this way several instances are related by Dr Samuel Pye in the second volume of Medical Observations and Inquiries. In short, so effectual was it found in removing these fevers when properly applied, that of between four and five hundred afflicted with them in the year 1765, Dr Lind lost only two, neither of whom had taken this medicine.

In all these cases, a vomit was administered whenever the patient complained of a sickness and retching to vomit, or was seized with a spontaneous vomiting; and cinchona was never given till this sickness was removed, or a purgative taken to clear more perfectly the whole alimentary canal. In those patients who were troubled with a cough, attended with a pain in the side affecting the breathing, when the pain was not relieved by warm fomentations, the balsamum anodynum, or by a blister, Dr Lind generally ordered a few ounces of blood to be taken away, and endeavoured to stop the fever as soon as possible by the administration of cinchona; having found that every return of the fever increased all such pains.—When the headach was very violent, and harassed the patient during the intermissions, the success of cinchona was rendered more complete by the application of a blister to the back.—A giddiness of the head, which is the symptom most commonly remaining after even a slight intermitting fever, was generally relieved by the sal C. C. and cinchona in wine. The former of these was administered in the following manner.

R. Aq. Alex. Simp. ℥vii.
Sal C. C. ʒß.
Syr. è Cort. Aurant. ℥i. M. f. julep. Cap. cochlear. ij. subindè.

If from the continuance of the fever the patient was distressed with a flatulence, a distention of the abdomen, and a swelling of the legs, a spoonful of tinctura sacra, with the addition of 30 drops of the spirit. lavend. compos. was ordered to be taken every night.—A

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continuance of cinchona, a change of air, and the cold bath, were often found requisite to prevent a relapse.

Such is the method of cure recommended by this experienced author, who has also discovered the efficacy and success of opium in intermitting fevers. He informs us, that he has prescribed an opiate to upwards of 300 patients labouring under this disease; and he observed, that, if taken during the intermission, it had not the least effect either in preventing or mitigating the succeeding paroxysm: when given in the cold fit, it once or twice seemed to remove it; but when given half an hour after the commencement of the hot fit, it generally gave immediate relief.—When given in the hot fit, the effects of opium are as follow: 1. It shortens and abates the fit; and this with more certainty than an ounce of cinchona is found to remove the disease. 2. It generally gives a sensible relief to the head, takes off the burning heat of the fever, and occasions a profuse sweat. This sweat is attended with an agreeable softness of the skin, instead of the burning sensation which affects patients sweating in the hot fit, and is always much more copious than in those who have not taken opium. 3. It often produces a soft and refreshing sleep to a patient tortured in the agonies of the fever, from which he awakes bathed in sweat, and in a great measure free from all complaints.

Dr Lind has always observed, that the effects of opium are more uniform and constant in intermitting fevers than in any other disease, and are then more quick and obvious than those of any other medicine. An opiate thus given soon after the commencement of the hot fit, by abating the violence and lessening the duration of the fever, preserves the constitution so entirely uninjured, that, since he used opium in agues, a dropsy or jaundice has seldom attacked any of his patients in those diseases. When opium did not immediately abate the symptoms of the fever, it never increased their violence. On the contrary, most patients reaped some benefit from an opiate given in the hot fit, and many of them bore a larger dose at that time than they could do at any other. He assures us, that even a delirium in the hot fit is not increased by opium, though opium will not remove it. Hence he thinks it probable, that many symptoms attending these fevers are spasmodic; but more especially the headach. However, if the patient be delirious in the fit, the administration of the opiate ought to be delayed until he recovers his senses, when it will be found greatly to relieve the weakness and faintness which commonly succeed the delirium. Dr Lind is of opinion, that opium in this disease is the best preparative for cinchona; as it not only produces a complete intermission, in which case alone that remedy can be safely administered; but occasions such a salutary and copious evacuation by sweat, as generally to render a much less quantity of cinchona requisite. He commonly prescribes the opiate in about two ounces of tinctura sacra, when the patient is costive, who is to take the cinchona immediately after the fit. By these means the paroxysm is shortened, and the intestines are cleansed, previous to the administration of cinchona; as the opiate doth not prevent, but only somewhat retards, the operation of the purgative. When a vomit is given immediately before the paroxysm, the administration of the opiate should be postponed till the hot fit be begun.

In the administration of cinchona, care should be taken that it be of a good quality. And different opinions have been entertained with respect to the choice, even where there is no reason to believe that it has been adulterated by the mixture of other articles. For a long time, the preference was given to small quilled pieces of pale-coloured bark; but of late the red bark, which is generally in larger masses, of an apparently coarser texture, and evidently of a more resinous nature, has been highly celebrated by Dr Saunders and others. And in cases where it does not disagree with the stomach or excite looseness, it is admitted by the most accurate observers to be more powerful in preventing the return of intermittents. Whether the red bark be the product of a different species of the cinchona, or be obtained as well as the pale quilled bark from the cinchona officinalis, is not yet ascertained with sufficient accuracy. Cinchona of a yellow colour has lately been imported into Britain and highly extolled. Its botanical history is not ascertained. It contains more bitter extractive matter, and more tannin and gallic acid, than either the pale or red; but less gum than the pale, and less resin than the red. It seems to produce the same medical effects in smaller doses. And it has sometimes succeeded in the cure of intermittents where the pale and red cinchona have before been employed in vain.

A species of cinchona, distinguished by the title of *cinchona Jamaicensis*, has been discovered in Jamaica and other islands in the West Indies. A very accurate description of it has been given by Dr Wright of Jamaica in the Philosophical Transactions of London. The bark of this species also has been recommended in the cure of intermittents; but the advantages of it have not hitherto been sufficiently confirmed by experience.

The barks of various trees readily cultivated in Britain, particularly different species of the salix, the prunus, the fraxinus, and the quercus, have by some been represented as no less efficacious than the cinchona. But we may safely venture to assert, that although several of them may possess some power in stopping intermittents, yet that none hitherto tried can be considered as in any degree approaching to the cinchona in point of efficacy.

But although the Peruvian bark be the best cure for intermittents hitherto discovered, yet while it can by no means be represented as the only cure, it is very certain that other remedies have in different cases succeeded after the cinchona has failed. Cures have often been obtained by the use of different aromatics, bitters, and astringents. Many articles from the mineral kingdom also have been employed with advantage. And intermittents have unquestionably been in certain cases stopped by different preparations of iron, zinc, copper, lead, and mercury. But of all the articles of this nature, arsenic has of late been the most celebrated. Arsenic is on good grounds conjectured to be the basis of an article much employed in the cure of intermittents in some of the countries where they are most prevalent, and sold under the title of the *tasteless ague drop*. The great success attending the use of this article, led Dr Fowler, an ingenious physician of Stafford, to examine it with particular attention. And in a treatise which he has lately published, entitled *Medical Reports* on the effects of arsenic in the cure of agues, he has given a formula for an arsenical solution, Febres. solution, which he has found very succesful in affections of this kind, and which is probably very nearly the same with the tasteless ague drop. Dr Fowler's mineral solution, as he styles it, is found by dissolving 64 grains of arsenic and as much fixed vegetable alkaline salt in a pound of distilled water. This solution is given in doses from three to 12 drops, varied according to the condition of the patient, and repeated two or three times a-day. And where the cinchona has failed in stopping intermittents, it seems to be one of the most powerful remedies yet discovered. But after all remedies prove ineffectual, intermittents are often stopped by change of season and of situation.

But besides the remedies employed in tertians and other intermittents, with the view of preventing the return of paroxysms, it is often also necessary to employ powerful articles with other intentions, particularly to mitigate and shorten the paroxysm when present; to obviate urgent symptoms, especially those of an inflammatory or putrid nature; and to obtain a complete apyrexia or intermission from fever after the paroxysm has ceased. With these intentions, recourse is not unfrequently had to emetics, laxatives, blood-letting, blisters, opium, diluents, or sudorifics, as the circumstances of the case may require.

127 The *Irregular* or *Spurious* TERTIAN.
Sp. I. var. 1. B.
Tertiana notha sive spuria, *Sauv.* sp. 2. *Sennert. Cleghorn. Hoffman.*

The characteristic marks of this fever are, that its paroxysms last longer than 12 hours, and consequently it inclines more to the quotidian or continued fever than the former. Its paroxysms have no stated hour of attacking. The cure, however, is precisely the same with that above described, observing the proper cautions already mentioned with regard to the use of the cinchona.

128 The *Double* TERTIAN. Sp. I. var. 2. C.
Tertiana duplex, *Sauv.* sp. 13. *Vog.* G. 12. *Sennert. Cleghorn.*
Duplicata, *Lin.* 18.

The double tertian comes on every day; but differs from the quotidian in this, that its paroxysms do not answer to each other singly, but alternately. The first day, for instance, the fit will come on in the forenoon, in the second in the afternoon, the third in the forenoon, and the fourth in the afternoon.

Of these fevers we shall give the following description from Cleghorn's treatise on the diseases of Minorca: "They are called *double tertians* when there are two fits and two intervals within the time of each period. But commonly there is some difference between the two fits, either in respect of the hour they come at, the time of their duration, or the nature and violence of their concomitant symptoms. Some double tertians begin in this manner.—On the evening of Monday, for example, a slight fit comes on, and goes off early next morning; but on Tuesday, towards the middle of the day, a more severe paroxysm begins, and continues till night. Then there is an interval to Wednesday evening, when a slight fit commences a new period of the fever, which proceeds in the same manner as the first; so that according to the way physicians calculate the days of diseases, (by beginning to reckon from the first hour of their invasion), both paroxysms happen on the odd days, while the greatest part of the even days is calm and undisturbed. But in most double tertians the patient has a fit every day of the disease; the severe one commonly appearing at noon upon the odd days, the slight one towards evening on the even days; though sometimes the worst of two fits happen on the even days.

Tertiana. "There is a tertian fever sometimes to be met with, during each period of which there are three different fits, and as many intervals. For example, towards Monday noon the patient is seized with a paroxysm, which declines about five or six o'clock the same evening; a few hours after, another fit begins, and continues until morning; from which time there is an interval to Tuesday evening, when a third fit comes on, and lasts most part of the night. On Wednesday there are again two paroxysms, as on Monday, and on Thursday like that of Tuesday; and thus the fever goes on with a double fit on each of the odd days, and a single fit on the even days.

"In double tertians, that interval is the most considerable which follows the severe fit; for the slight fit oftener ends in a remission than intermission, and frequently lingers till the other approaches: Hence it is, that the night preceding the vehement fit is much more restless than that which comes after it, as has been observed by Hippocrates. In double tertians, the vehement fit often comes on a little earlier in each period, while the slight fit returns at the same hour, or perhaps later and later every second day: so that the motions of one have no influence on those of the other; from whence it appears, that each of these fits hath its own proper independent causes."

Duplicated TERTIAN. Sp. I. var. 2. D. 129
Tertiana duplicata, *Sauv.* sp. 14. *Jones. River.*

This hath two fits on the same day, with an intermediate day on which there are none. This also does not differ in any remarkable particular from those already described.

The *Triple* TERTIAN. Sp. I. var. 2. D. 130
Tertiana triplex, *Sauv.* sp. 15. *Cleghorn.*
Semitertiana, *Hoffman.*
Semitertiana primi ordinis, *Spig.*

This differs from the former in having a single and double fit alternately: thus, for instance, if there be two fits the first day, there is only one the second, two the third, one the fourth, &c. Its cure is the same as before.

The *Semi*-TERTIAN. Sp. I. var. 2. F. 131
Hemitritæus, *Cels.*
Semitertiana, *Cleghorn.*
Semitertiana secundi ordinis, *Spig.*
Amphimerina hemitritæus, *Sauv.* sp. 8.
Amphimerina pseudo-hemitritæus, *Sauv.* sp. 9.

The semitertian is described by Dr Cullen as having only an evident *remission* between its paroxysms; more remarkable between the odd and even day, but less so between the even and odd one. For this reason, he adds, that possibly some semitertians ought rather to

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to be classed among the remittents; and owns that it is difficult to settle the boundaries between them. But Cleghorn, whom he quotes, describes it in the following manner. "A fit begins on Monday noon, for example, and goes off the same night. On Tuesday afternoon a second fit comes on, and gradually increases till Wednesday night, when it terminates. On Thursday morning there is such another interval as happened on Tuesday morning: But on Thursday afternoon another long fit like the preceding commences; and returning regularly every second day, leaves only a short interval of ten or twelve hours during the eight and forty.

Concerning the cure of these fevers Dr Cullen observes, that though no entire apyrexia occurs, cinchona may be given during the remissions: and it should be given even though the remissions be inconsiderable; if, from the known nature of the epidemic, intermissions or considerable remissions are not to be expected, and that great danger is apprehended from repeated exacerbations.

132 The *Sleepy* TERTIAN. Sp. I. var. 3. G.

Tertiana carotica, *Sauv.* sp. 10. *Werlhof.*
Tertiana hemiplegica, *Sauv.* sp. 20. *Werlhof.*
Quotidiana soporosa, *Sauv.* sp 8. *Car. Pis.*
Febris caput impetens, *Sydenham*, ep. ad. R. Brady.

This, according to Vogel, is a most dangerous species, and very commonly fatal; for which reason he ranks it among those intermittents which he calls *malignant*. Sometimes he tells us the alarming symptom of a sleepiness comes on, not at the beginning of the disease, but will unexpectedly occur during the third, fourth, fifth, or sixth paroxysm. It commonly begins with the cold fit, and continues during the whole time of the paroxysm, and, becoming stronger at every succeeding one, at last terminates in a mortal apoplexy. Sometimes fevers of this kind rage epidemically. Vogel relates, that he saw a simple tertian changed into one of these dangerous fevers. The patient was a woman of a delicate constitution, and the symptoms appeared in consequence of her being put in a violent passion: however, it occurred but once, and she recovered. Hoffman mentions a carus in a double tertian occurring seven times without proving mortal; though Vogel says, that the powers of nature are very seldom sufficient to conquer the disease.

In 1678, Dr Sydenham tells us that intermittents raged epidemically at London, where none had appeared before from 1664. Of them "it is to be noted (says he), that though quartans were most frequent formerly, yet now tertians or quotidians were most common, unless the latter be entitled double tertians: and likewise, that though these tertians sometimes began with chilness and shivering, which were succeeded first by heat, and soon after by sweat, and ended at length in a perfect intermission, returning again after a fixed time; yet they did not keep this order after the third or fourth fit, especially if the patient was confined to his bed and used hot cardiacs, which increase the disease. But afterwards this fever became so unusually violent, that only a remission happened in the place of an intermission; and approaching every day nearer the species of continued fevers, it seized the head, and proved fatal to abundance of persons."

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From this description of Sydenham's we may have an idea of the nature of the disease. As to its cure he strongly recommends cinchona; telling us, that, even in the *most continued* kind of intermittents, "the nearer the intermittent approaches to a continued fever, either spontaneously, or from using too hot a regimen, so much the more necessary is it to exhibit a larger quantity of the bark; and that he took advantage of a remission, though ever so small."

The *Spasmodic* or *Convulsive* TERTIAN. Sp. I. var. 3. H. 133

Tertiana asthmatica, *Sauv.* sp. 6. *Bonnet.*
Tertiana hysterica, *Sauv.* sp. 8. *Wedel.* A. N. C. Dec. I. A. II. obs. 193.
Hysteria febricosa, *Sauv.* G. 135. sp. 8. A. N. C. Dec. I. Ann. II.
Tertiana epileptica, *Sauv.* sp. 16. *Calder. Lautter.*
Quotidiana epileptica, *Sauv.* sp. 3. Edinb. Essays, vol. v. art. 49.
Ecclampsia febricosa, *Sauv.* G. 139. sp. 17.
Epilepsia febricosa, *Sauv.* G. 134. sp. 9.
Tertiana tetanodes Med. Beobacht I. Band.
Tetanus febricosus, *Sauv.* G. 122. sp. 10. *Stork*, Ann. Med. II.

Tertians of this kind occur with very different symptoms from those of the true ones, and sometimes even with those which are very extraordinary. In some they are attended with symptoms of asthma, in others with those of hysterics, in others with convulsions. Where the symptoms of asthma occur, the disease must be treated with diuretics and antispasmodics joined with cinchona. In the hysteric asthma the fit comes on with cold, yawning, cardialgia, terror and dejection of mind. The disease is to be removed by mild aperients and antihysterics joined with cinchona.

Of the convulsive tertian we have a most remarkable instance in the Edinburgh Medical Essays, vol. v. The patient was a farmer's son about 26 years of age, of a strong plethoric habit of body. He had laboured under an ague half-a year, and had taken a great deal of Peruvian bark. While he was telling his case to the surgeon (Mr Baine of Pembroke), he was suddenly taken with a violent stamping of his feet; and the convulsions gradually ascended from the soles of the feet to his legs, thighs, belly, back, and shoulders. His head was then most violently convulsed, with a total deprivation of speech; but he had a most dismal vociferation, which might have been heard at a considerable distance, his abdomen and thorax working and heaving violently and unusually in the mean time. This fit having lasted half an hour, a profuse sweat broke out over all his body, which relieved him; and he then became capable of answering such questions as were put. These extraordinary fits, he said, had been occasioned by a fright, and his neighbours had concluded that he was bewitched. They returned sometimes twice a-day, and always at the times the ague used to return. During the paroxysm his pulse was very high and quick, his face much inflamed, and his eyes ready to start out of his head. After the

Febres. the fit was over, he complained of a most torturing pain of the bowels. His tongue was generally moist, and he had a suppression of urine.—This formidable disease, however, was totally subdued by the use of cinchona, mercurials, antispasmodics, opiates, and saline draughts.

134 The *Eruptive* TERTIAN. Sp. I. var. 3. I.

Tertiana petechialis, *Sauv.* sp. 3. *Donat. Lautter.*
Tertiana scorbutica, *Wedel.* A. N. C. Dec. I. A. II. obs. 193.
Tertiana urticata, *Sauv.* sp. 22. *Planchon.* Journ. de Med. 1765. *Cleghorn.*
Tertiana miliaris, *Sauv.* sp. 21. *Walthieri* de Med. Ger.

This species of tertian is accompanied with red or livid blotches on the skin, or an eruption like that occasioned by the stinging of nettles. In the latter case Dr Cleghorn says the disease is very dangerous; and as the former indicates an incipient dissolution and putrefaction of the blood, it must also be reckoned of very dangerous tendency.

135 The *Inflammatory* TERTIAN. Sp. I. var. 3. K.

Tertiana pleuritica, *Sauv.* sp. 4. *Valesf. Lautt.*
Pleuritis periodica, *Sauv.* G. 103. sp. 14.
Tertiana arthritica, *Sauv.* sp. 5. *Morton. Lautt.*

Sauvages informs us, that he has seen a true and genuine pleurisy having all the pathognomic signs of the disease, but assuming the form of an intermittent; that is, the patient is one day affected with the pleurisy, and the next seemingly in perfect health. He also tells us, that in the month of May 1760, a tertian raged epidemically, which after the third fit imitated a pleurisy, the pain of the side, and difficulty of breathing coming regularly on, and the fever from an intermittent becoming remittent; the blood had also the same appearance with that of pleuritic persons, and the distemper yielded to bleeding and gentle cathartics.—Morton also informs us, that he has observed similar disorders an hundred times, which were always certainly and safely cured by the Peruvian bark.

136 The TERTIAN *complicated* with other *Disorders.* Sp. I. var. 4.

Tertiana scorbutica, *Sauv.* sp. 9. *Etmuller, Timæus.*
Tertiana syphilitica, *Sauv.* sp. 17. *Deidier.*
Tertiana verminosa, *Sauv.* sp. 18. *Stisser.* in act. Helmstad. *Lancis.* de noxiis palud. *Pringle. Ramazzini. Van den Bosch.* de const. vermin.

The scorbutic tertian, according to Sauvages, is exceedingly anomalous, its periods being sometimes much anticipated, and sometimes much postponed. It is exceedingly obstinate, and will return if the body be not cleared of its scorbutic taint. The patient is affected with lancinating pains of a wandering nature. The urine lets fall a dusky red sediment, or a thick branny matter is copiously scattered up and down in it, seemingly tinged with blood. The usual symptoms of scurvy, viz. livid spots, and rotten fetid gums, also frequently occur. For this the Peruvian bark is very useful, both as a febrifuge and antiscorbutic.

A tertian accompanied with worms is taken notice of by Sir John Pringle in his treatise on the diseases of the army. The worms, he tells us, were of the round kind; and though we are by no means to reckon them the cause of the fever, they never failed to make it worse, occasioning obstinate gripings or sickness at stomach. In these cases stitches were frequent; but, being flatulent, were not often relieved by bleeding. The worms were discharged by vomiting as well as by stool. For discharging these worms, he commonly gave half a dram of rhubarb with 12 grains of calomel; without observing any inconvenience from such a large dose of mercury. Anthelmintics, which act slowly, had little chance of doing good; for though worms will sometimes lie long in the bowels without giving much uneasiness to a person otherwise well, yet in a fever, especially one of a putrid kind (to which his intermittents always seemed to incline), the worms being disturbed by the increase of heat, and the corruption of the humours in the *primæ viæ*, begin to move about, and struggle to get out. Lancisius, who makes this remark, adds, that upon opening the bodies of some who had died at Rome of fevers of this kind, wounds were found in the intestines made by the biting of the worms; nay, that some of them had even pierced through the coats of the guts, and lay in the cavity of the abdomen. Pringle never had any instance of this; but knew many cases in which the worms escaped by the patient's mouth, though there had been no previous retching to bring them up. One soldier was thrown into violent convulsions, but was cured by the above-mentioned powder.

The TERTIAN *varied* from its *Origin.* Sp. I. var. 5. 137

Tertiana accidentalis, *Sauv.* sp. 12. *Sydenham.*
Tertiana à scabie, *Sauv.* sp. 12. *Juncker,* tab. 80. *Hoffman,* II. p. 12.

The existence of fevers of this kind, as we have already observed, is denied by Dr Cullen; the accidental fever of Sauvages was said to arise from any slight error in the non-naturals, and consequently was very easily cured. That which arose from the repulsion of the itch, was cured as soon as the eruption returned.

The TERTIAN with only a *remission* between the fits. Sp. II. 138 Remittent tertian.

Tritæophya, *Sauv.* Gen. 85. *Sag.* p. 695.
Tritæus, *Lin.* 21.
Hemitritæa, *Lin.* 23.
Tertianæ remittentes et continuæ Auctorum.
Tertianæ subintrantes, proportionatæ, subcontinuæ, *Torti.*
Tertiana subcontinua, *Sauv.* sp. 19.
Quotidiana deceptiva, *Sauv.* sp. 2.
Amphimerina semiquintana, *Sauv.* sp. 24.
Tritæophya deceptiva, *Sauv.* sp. 10.
Causus *Hippocratis.*
Tritæophya causus, *Sauv.* sp. 2.
Febris ardens *Boerhaavii,* aph. 738.
Tertiana perniciosa, quæ simulata tertiani circuitus effigie lethalis, et mille accidentibus periculosissimis implicata, existit. *Lud. Mercatus.*
Tertiana pestilens, *P. Sal. Diversus.*

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Tertiana maligna pestilens, *Riverii.*
Morbus Hungaricus. *Lang. Lemb. Sennert. Jordan.*
Languor Pannonicus, *Cober.*
Amphimerina Hungarica, *Sauv.* sp. 10.
Hemitritæus pestilens, *Schenck.* ex *Corn. Gamma.*
Febres pestilentes Ægyptiorum, *Alpin.*
Febris tertiana epidemica, *Bartholin.*
Febres epidemicæ, autumni 1657 et 1658, *Willis.*
Febris syneches epidemica, ab anno 1658 ad 1664. et postea ab anno 1673 ad 1691, *Morton.*
Febres autumnales incipientes, *Sydenham.*
Affectus epidemicus Leidensis, *Fr. Sylvii.*
Morbus epidemicus Leidensis, 1669, *Fanois.*
Tertianæ perniciosæ et pestilentes, et febres castrenses epidemicæ, *Lancisi.*
Febres intermittentes anomalæ et mali moris, *Hoffman.*
Febris cholerica minus acuta, *Hoffman.*
Febris epidemica Leidensis, anno 1719, *Koker* apud *Haller*, Disp. tom. v.
Amphimerina paludosa, *Sauv.* sp. 19.
Febris paludum, *Pringle.*
Bononiensis constitutio hiemalis 1729, *Beccari* in A. N. C. vol. iii.
Amphimerina biliosa, *Sauv.* sp. 22.
Febris castrensis, *Pringle.*
Febris putrida epidemica, *Huxham de aëre ad ann.* 1729.
Febris biliosa Lausanensis, *Tissot.*
Tritæophya Wratislaviensis, *Sauv.* sp. 3. Hahn. Epidemia verna Wratislav. in App. ad A. N. C. vol. x.
Tritæophya Americana, *Sauv.* sp. 12.
Febris anomala Batava, *Grainger.*
Morbus Naronianus, *Pujati.*
Febris continua remittens, *Hillary's* diseases of Barbadoes.
Febris remittens Indiæ Orientalis, *Lind.* diss. inaug. 1768.
Febris critica et febr. biliosa æstatis, *Rouppe.*
Febris remittens regionum calidarum, *Lind* on the diseases of hot climates.

A. Tertiana cholerica sive dysenterica, *Tort.* Therap. Special. lib. iii. cap. 1. *Lautter.* Hist. Med. cas. 6. 16. 17. 20. *Morton*, App. ad Exerc. II.

B. Tertiana subcruenta sive atrabiliaris, *Tort.* ibid. Never seen by *Cleghorn.*

C. Tertiana cardiaca, *Tort.* ibid. *Lautter.* Hist. Med. cas. 15. 16. 23.
Amphimerina cardiaca, *Sauv.* sp. 5.
Tritæophya assodes, *Sauv.* sp. 6.
Febris continua assodes, *Vog.* 27.

D. Tertiana diaphoretica, *Tort.* ibid.
Tritæophya typhodes, *Sauv.* sp. 4.
Tritæophya elodes, *Sauv.* sp. 5.
Febris continua elodes, *Vog.* 21.

E. Tertiana syncopalis, *Tort.* ibid. *Lautter.* cas. 11. 12. 13. 15. 16.
Tritæophya syncopalis, *Sauv.* sp. 1.
Amphimerina syncopalis, *Sauv.* sp. 4.
Amphimerina humorosa, *Sauv.* sp. 6.
Febris continua syncopalis, *Vog.* 29.

F. Tertiana algida, *Tort.* ibid. *Lautter.* cas. 13.
Amphimerina epiala, *Sauv.* sp. 3.
Amphimerina phricodes, *Sauv.* sp. 7.
Tritæophya leipyria, *Sauv.* sp. 9.
Tertiana leipyria, *Sauv.* sp. 23. *Valcarenghi* Med. Ration. p. 18.
Febris continua epiala et leipyria, *Vog.* 19. et 24.

G. Tertiana lethargica, *Tort.* ib.
Tritæophya carotica, *Sauv.* sp. 7. *Lautter.* 1. 7. 14.
Tertiana apoplectica, *Morton.* Exerc. I. cap. ix. hist. 25.
Tertiana soporosa, *Werlhof.* de febr. p. 6.
Febris epidemica Urbevetana, *Lancis.* de noxiis pal. effluv. I. II. c. 3.

The remittent fevers are much more dangerous than the true intermittents, as being generally attended with much greater debility of the nervous system and tendency to putrescency in the fluids than the latter. Sauvages divides his tritæophya, a remittent tertian into the following species:

139 1. *Tritæophya syncopalis*, or that attended with fainting. It begins like a tertian, with cold succeeded by heat and profuse sweating; but attended with much more dangerous symptoms, such as cardialgia, enormous vomiting, great weakness, small contracted pulse, coldness of the extremities, and, unless timely assistance be given, kills during the second or third paroxysm.

140 2. The *causus*, or burning fever of Hippocrates, returns every third day without any new sensation of cold; and is attended with great thirst, heat, but without diarrhœa or sweat, and continues only for one week or two at the utmost. It attacks chiefly young people of a robust and bilious habit of body, who have been accustomed to much exercise, and exposed to the sun during the heats of summer, and have also used a phlogistic regimen. The tongue is dry, sometimes black; the urine of a red or flame colour; together with pain of the head, anxiety, and sometimes other symptoms still more dangerous.

141 3. *Tritæophya Vratislaviensis*, was a pestilential disease occasioned by famine, during which the people fed on putrid aliments: the air was infected by the vast numbers of bodies of those slain in battle, and the inhabitants were also dejected by reason of being deprived of their harvest, and other calamities; to all which was added the continuance of a calm in the atmosphere for a long time. It began with an acute fever, leipyria or coldness of the external parts and a sensation of burning heat inwardly; general weakness; pain of the head and præcordia; serous, or bilious diarrhœa; a delirium, in some furious, and accompanied with a dread of being exposed to the air; on the second day the thirst was violent, attended with a bilious vomiting, as well as diarrhœa, tough viscid spitting, fainting, burning heat in the bowels, the tongue dry and seeming as if burnt with a hot iron, a suppression of the voice, anxiety, stupor, after which quickly followed convulsions and death. In some fevers leipyria came on with an exceeding great cold of the extremities, presently followed by an intolerable heat of the viscera, with symptomatic sweats, violent diarrhœa, followed by a very itchy miliary eruption. On the fourth day came on copious sweats, spasms of the lower jaw, nausea, involuntary passing of urine, slight delirium, a flux of ichorous matter from the nostrils, an exceeding tough spitting, an epilepsy, and death. Professor Hahn, who gives

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gives the hiſtory of this diſeaſe, was himſelf attacked by it, and ſuffered in the following manner: On the firſt day was a violent feveriſh paroxyſm without rigor, a ſharp pain in the occiput, and immediately an inflammatory pain over the whole head; the feet were extremely cold, and the extremities rigid with ſpaſms. The pain continued to increaſe daily to ſuch a degree, that the contact of the air itſelf became at laſt intolerable; a dejection of mind and incredible weakneſs followed; he paſſed reſtleſs nights with continual ſweating, heavy and pained eyes, and an univerſal ſenſation of rheumatiſm over the whole body. On the third day the pains were aſſuaged, but he had a very bad night. On the fourth day all the ſymptoms were worſe, the feet quite chilled, the hands very red and agitated with convulſive motions; he was terrified with apprehenſions of death, and had a vomiting every now and then: this day ſponges dipped in cold water were applied over the whole body, and he uſed cold water for his drink. On the eighth day the pulſe was convulſive; and the pains were ſo violent that they made him cry out almoſt continually. On the ninth day he was delirious, and threw up ſome grumous blood. On the 11th his pulſe was more quiet, and he had a ſweat; a decoction of cinchona was given: his voice was broken, his ſpeech interrupted, and his teeth chattered upon one another. On the 12th his jaw was convulſed, he had a riſus ſardonicus, and deafneſs; after which the paroxyſms returned leſs frequently, and only towards night. On the 14th he had a chilling cold over the whole body, a cold ſweat; frequent lotions were applied, and all the ſymptoms became milder. On the 18th he had a quick delirium, but fainted as ſoon as taken out of bed; a ſenſation of hunger, followed by copious ſweats; profound ſleep; an averſion from noiſe; every thing appeared new and extraordinary. On the 36th a cholera; on the 48th a ſcaling off of the ſkin, and falling off of the nails. This epidemic carried off above 3000 people at Warſaw. Frequent lotion of the body either cold or tepid, watery glyſters, and the copious introduction of watery fluids under the form of drink, were of ſervice. But the moſt favourable criſis was under the form of ſome cutaneous eruption.

142 4. *Tritæophya typhodes*. The principal ſymptom of this fever was a continual ſweat with which the patients were almoſt always wet; with paroxyſms returning every third day. Sauvages tells us, that he had twice an opportunity of obſerving this fever; one was in the teacher of an academy, about 40 years of age, and of a melancholic temperament. He ſweated every ſecond night ſo plentifully, that he was obliged to change his linen nine times; and even on the intermediate days was never perfectly free of fever, and had his ſkin moiſtened with ſweat. The other was of a woman who went about in man's clothes, and was diſcovered only after her death. The diſeaſe began with a ſlight ſenſation of cold, after which ſhe ſweated for eight hours. It was attended with the higheſt debility, anxiety, and at the ſame time an inſatiable hunger.

143 5. *Tritæophya elodes*, was an inflammatory epidemic, but not contagious, terminating about the 14th or 21ſt day. The diſeaſe came on in the night time, with diſturbed reſt, univerſal weakneſs, watchings, great heat and ſweat, redneſs of the face and almoſt of the whole body, ſparkling eyes, the tongue dry and white; a hard, tenſe, and turgid pulſe: about the third day a kind of frenzy frequently came on with the feveriſh paroxyſm, the forerunner of an univerſal miliary eruption; or, what was worſe, with purple ſpots ſo cloſe together, that they looked like an eryſipelas of the whole body. Sometimes bliſters of the ſize of ſmall pearls, filled with acrid ſerum, appeared on the neck, armpits, and trunk of the body, which were of all the ſymptoms the moſt dangerous. There was a variety of the diſeaſe, which Sauvages calls the *humoralis*, and in which the pulſe was ſoft and feeble, with greater weakneſs over the whole body, and the diſpoſition to ſleep more frequent than in the other; the eyes languid; the tongue very white, but not dry; and worms were ſometimes diſcharged.

6. *Tritæophya aſſodes*. This ſpecies aroſe from a foulneſs of the primæ viæ, and the effluvia of waters in which hemp had been ſteeped. It began with rigor, followed by great heats, reſtleſsneſs, toſſing of the limbs, faintings, immoderate thirſt, dryneſs of tongue, delirium, and at length exceſſive watchings; theſe laſt, however, were leſs dangerous than vertigo or a comatoſe diſpoſition, which brought on convulſions or apoplexies. 144

7. *Tritæophya carotica*. This had exacerbations every other evening; and its diſtinguiſhing ſymptom was an exceſſive inclination to ſleep, preceded by a ſevere headach, and followed by delirium, and ſometimes convulſions; the tongue was black, and the patient inſenſible of thirſt after the delirium came on. In thoſe caſes where the diſeaſe proved fatal, a ſubſultus tendinum and other alarming ſymptoms, came on. 145

8. *Tritæophya leipyria* is only a variety of the tritæophya cauſus, already deſcribed. 146

9. *Tritæophya deceptiva*. This ſpecies at firſt aſſumes the appearance of a continued fever; but afterwards degenerates into a remittent, or even an intermittent. It is deſcribed by Sydenham, but attended with no remarkable ſymptoms. 147

10. The laſt of Sauvages's ſpecies of Tritæophya belonging to the remitting tertian is the *Americana*. This, according to Sauvages, is the ardent fever with which the Europeans are uſually ſeized on their firſt arrival in America, and generally carries off one half of them. Of this there are two varieties, the *very acute* and the *acute*. The very acute ends before the ſeventh day. It comes on a few days after the perſon's arrival, with loſs of appetite, with dyſpnœa and ſighing from weakneſs, headach, laſſitude, and pain of the loins: a pyrexia ſucceeds, with great thirſt, ſweat, and heat; the ſickneſs increaſes, nauſea comes on, with vomiting of porraceous bile; the tongue rough, the extremities often cold; watching, furious delirium; and the patient frequently dies on the third day. Copious ſweats, and a plentiful hæmorrhagy from the noſe on the fifth day, but not ſooner, are ſerviceable; but a bilious diarrhœa is the beſt criſis of all. 148

The acute kind terminates moſt frequently on the ninth, but very rarely goes beyond the fifteenth day. Death frequently comes on between the fourth and ſeventh days. It begins with headach, pain in the loins, and ſometimes ſhivering; great laſſitude, dyſpnœa,

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pnœa, thirst; burning fever, increasing every third day; inflation of the abdomen, pain at the pit of the stomach, nausea, and bilious vomiting. Such is the state of the disease within twenty-four hours. The eyes are red, and full of tears; the urine pellucid; there is a low delirium, and continual anxiety; the tongue is dry and red, and sometimes, though rarely, black, which is a still worse sign; the pulse, formerly strong and full, sinks about the fourth day, and becomes tense and spasmodic: if a carus then comes on, the patient dies the fifth or sixth day; but if the pulse keeps up, and no carus comes on, a crisis is to be expected by sweat, by a copious hemorrhagy from the nose, or, which is still more safe, by a bilious diarrhœa, which is never salutary if it comes on before the fifth day.

To the remitting tertian also belong the following species mentioned by Sauvages, viz.

149 1. *Tertiana subcontinua.* This begins like a genuine tertian, and at first hath distinct paroxysms; but these grow gradually more and more obscure, the disease acquiring daily more of the appearance of continued fever, by which it is to be distinguished from the other varieties of this species. It is not unfrequently joined with those symptoms which attend the fatal fever already mentioned; as cardialgia, cholera, syncope, &c. but in a much less degree. The disease commonly begins with little or no sense of cold, but rather a sensation of heat; when the tertian is doubled, it has first a slighter and then a more severe fit; and thus goes on with an exacerbation on the even days: and though it should change from a double into a single tertian, we are still to suspect it, if a weak fit is the forerunner of a very strong one. This change of the tertian into a continued fever is also to be prognosticated if a heat remarkable to the touch is perceived on the day of intermission, together with some disturbance of the pulse, thirst, and dryness of the tongue; all of which show a tendency to inflammation: the same is foretold by the urine being in small quantity, and very red, or of a saffron colour; also an ulcerous or aphthous inflammation of the throat, with difficulty of swallowing, or any very severe symptom coming on in the beginning of the disease, excepting only a delirium, which is easily removed.

150 2. *Quotidiana deceptiva.* This is a disorder of an inflammatory kind, with a strong tendency to putrescency, and sometimes assumes the form of a quotidian. In it the patient frequently complains of cold when he really is hot, and the remission is very indistinct. The disease is known by the great languor of the patient and the foulness of his tongue.

151 3. *Amphimerina cardiaca* is an acute malignant fever, with daily exacerbations, attended with fainting and vomiting of green bile. Afterwards, the weakness increasing, the patient's extremities grow cold, and a profuse sweat comes on, which is frequently succeeded by death on the fourth day. Another species resembling this Sauvages calls the *syncopalis;* but the cardiaca differs from it in being attended with cardialgia.

152 4. *Amphimerina paludosa.* This is the fever described by the British physicians under many different names, and appearing under various forms, according to the different constitutions of the patients. This fever in the East Indies, according to Dr Lind of Windsor, generally comes on suddenly, and begins with a sense of debility and a very great lowness of spirits. These symptoms are attended with a greater or less degree of chilliness, vertigo, nausea, very acute pains in the head and loins, and a trembling of the hands; the countenance is pale, the skin commonly very dry and corrugated, the eyes dull and heavy, the pulse quick and small, the breath generally difficult, and interrupted with hiccough.

As the paroxysm increases, the chilliness now and then gives way to irregular heats, which soon become violent and permanent; the nausea likewise increases; and in some there comes on a vomiting, in which they throw up a great deal of bile. Sometimes bile is likewise voided by stool. The skin grows red; the eyes appear small, and sometimes not a little inflamed. The pulse becomes fuller, and the breath more difficult, attended with great restlessness and a troublesome thirst; notwithstanding which (so great is the nausea) the patient cannot endure any kind of liquids. The tongue becomes foul, and the pain of the head and loins more violent; a delirium then follows; a slight moisture appears on the face, and from thence spreads to the other parts; whilst the violence of the other symptoms abates, and shows the beginning of a remission, which is completed by plentiful sweats.

On the fever's remitting, the pulse returns almost to its natural state; the pains of the head and loins still continue, though somewhat less violent, as likewise the nausea and want of appetite. When the disease gains strength, the remission is scarcely obvious, and is immediately followed by another paroxysm; which begins, not indeed with so great a shivering, but is attended with a greater pain of the head, the greatest anxiety, a heartburn, nausea, vomiting, and bilious stools. The matter most commonly evacuated by vomit and stool is whitish like chalk and water, or curdled milk which is vomited by sucking children, when the curd is much broke down. A heat, immoderate thirst, and delirium now come on. The tongue becomes more foul; the teeth and inside of the lips are covered with a black crust; the breath grows hot and fetid: another remission ensues, attended with a sweat; but this remission is both shorter and less obvious than the first.

This second remission is succeeded by a paroxysm, in which the symptoms are far more violent than in the former; that which the patient discharges by vomiting and purging is more fetid; the mouth, teeth, and inside of the lips, are not only covered with a black crust, but the tongue becomes so dry and stiff, that the patient's voice can scarce be heard. Violent delirium, with restlessness and anxiety, come on chiefly during the paroxysm; nor do these symptoms abate till the fever remits, and the patient sweats.

When the fever becomes so violent, during the third fit, as to end in death, which is often the case, some of the sick have a coma; in others the delirium becomes more violent. The discharges now become more fetid, and have a cadaverous smell; the stools are involuntary; the pulse is so quick, small, and irregular, that it is scarce to be counted, or even felt; a cold sweat is diffused over the whole body, especially the head and neck: the face becomes Hippocratic and convulsed; the patient picks the bed-clothes; a subsultus tendinum comes on; the sick lie constantly on their backs, and insensibly

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insensibly slide down to the foot of the bed; their extremities grow cold; they are then seized with convulsions, with which the scene closes.

In this fever, the urine, which at the beginning is pale, becomes of a deeper colour by degrees, but without depositing any sediment. There seldom or never appear any petechiæ, and the prickly heat which was before on the skin vanishes on the first appearance of the fever. But though these were the general symptoms of this disorder, they varied in the different subjects, and at different seasons of the same year. The pulse, for example, in some, was quick in the beginning of the disorder; in others, it varied with the other symptoms. The skin was generally dry in the beginning of the fit; but in some it was moist, and covered with sweat from the very beginning of the disease. In the month of September, when the disorder raged most, the remissions were very imperfect and obscure; but, on the return of winter and the healthy season, they became more regular, and the disease assumed the appearance of an intermitting fever, to such a degree as at length not to be distinguished from it. In some the remissions could scarce be perceived, and the fever continued for two weeks without any material change for the better or the worse. At this time numbers were seized with it. When the disorder continued for any time without a change, it generally ended in death; while the weather grew better, it sometimes, in the space of a few days, from a common fever became an intermitting one, and the patient recovered, unless his liver, which was sometimes the case, happened to be affected. The cure of an inflammation of the liver proved uncertain and tedious; as it was commonly followed by a colliquative diarrhœa, which generally endangered the patient's life.—Every succeeding paroxysm was observed to be more dangerous than the preceding; the third generally proved fatal; some died during the first. When this happened, the fever, in the language of the country, was called a *puca*, that is a strong fever.

This disease, according to Dr Lind of Haslar hospital, is the autumnal fever of all hot countries, the epidemic disease between the tropics, and the disease most fatal to Europeans in all hot and unhealthy climates. All authors agree that intermittents in general, but particularly this dangerous kind of them, are produced by heat and moisture, but particularly the evaporation of moisture from marshes. Dr Lind of Windsor remarks, that the European seamen are very subject to the fever above mentioned when they happen to arrive at Bengal in autumn. They are predisposed to it from the nature of their food, their confinement on board, the very great heats to which they are exposed during the voyage, and their lying for hours together exposed to the night colds.

Most of the meat used by the crews of those ships is salted, and often in a putrid state, without any fresh vegetables, they having only biscuits, and some other farinaceous matters. The quantity of the vinous or spirituous liquors allowed them is, in his opinion, by far too small to subdue the putrescent disposition of their animal-food. Their fluids consequently become, from day to day, more and more putrescent, and of course more apt to breed and contract this disorder. This disposition is likewise induced by their being stowed very close together, and that for a considerable length of time, and in a foul air, especially when the weather happens to be too stormy to permit the hatches and port-holes to be kept open.

Though the heats they endure in the voyage to India are less considerable than those of the country itself, yet they are too much for an European constitution to bear. The general heat at sea within the tropics is about 84° of Fahrenheit's thermometer, which is sufficient to relax them, and promote a corruption of their humours, especially when it coincides with the above causes. It likewise creates a languor and indolence, which alone are sufficient to increase that putrescence. These causes are apt to be considerably aggravated by the men's being often exposed, when on duty, for hours together, to rain, damp, and cold air; a circumstance which frequently happens to them when working their ships up the river Ganges in the night-time. Hence the perspiration is checked, and the excrementitious fluid which used to be discharged by the skin being retained in the body, contributes, he thinks, very much towards the predisposition to this disease.

But the most powerful of all the remote causes is justly thought to be the effluvia of marshes replete with putrid animal-substances. We have not, however, been able to determine from what kind of putrid animal-substances these effluvia derive their virus. For that every kind of putrefaction has not such an effect appears from this, that neither practical anatomists, nor those who by their trades are exposed to the putrid effluvia of animals, for instance such tanners and butchers as keep their shops and stalls very dirty, are more subject than others to putrid diseases. Nor are the ship-stewards and their servants, whose business it is to deliver out the provisions to the ships crews, and who spend the most of their time amongst the putrid and rancid effluvia of the places in which those provisions are kept, more subject to putrid fevers than their ship-mates. But whatever be in this, we are well assured that some particular putrid fermentations produce noxious vapours, which, united with those of marshes, render them more pernicious. Hence evidently proceeds the extreme unhealthfulness of a place called *Culpi*, on the eastern bank of the Ganges. The shores about it are full of mud, and the banks covered with trees. Opposite to the place where the ships lie there is a creek, and about a mile from its entrance stands the town of Culpi: the ships lie about a mile from the shore. None of the sailors on board the ships stationed at this place enjoyed their health. The burying ground also contributed not a little to spread the infection. The ground being marshy, the putrid water flowed from the old graves into the new ones, which infected the grave-diggers and those that attended the funerals; and from this cause many were suddenly seized while they were performing the last duty to their companions. This place has ever been remarkable for the unhealthfulness of its air. It was once customary to send some of the Company's servants here to receive the cargoes of the ships, and send them to Calcutta; but so many of them died on this duty, that the Company was at length obliged to dispense with it.

Hence it plainly appears, how apt putrid animal and vegetable substances are to render the effluvia of

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fenny places more pernicious than they would otherwise be. The reason why great inundations of the Nile and Ganges are followed by a healthy season is, that by this means the putrid animal and vegetable substances dispersed over the contiguous countries are carried off into the sea.—The noxious vapours arising from fens spread but a little way. Dr Lind has often known ships crews at a very little distance from the shore quite free from this disorder. But although these marsh miasmata first bring on the disease, yet contagion particularly spreads it, and renders it more epidemic. Thus the Drake East Indiaman continued free from the disorder for two weeks together, when she had no communication with the other ships; but as soon as the disorder was brought on board, many were seized with it within a few days in such a manner as to leave no room to entertain the least doubt concerning its contagious nature.

Dr Lind of Haslar hospital has given a very curious and learned account of the appearance of this fever throughout the various parts of the globe. It was very common in England in the years 1765 and 1766, one obvious cause of which was the prevalence of the eastern wind. This wind in England is often said to bring with it a fog from the sea; but the truth of the matter is, that in many places of this island the east-wind frequently raises a copious vapour from water, mud, and all marshy or damp places. To this exhaling quality of the eastern wind Dr Lind has often been an eye-witness. When the wind changes to the east, the mud sometimes sends up a vapour as thick as smoke; and the doctor has observed two fish-ponds in his neighbourhood, one of fresh and the other of salt-water, which on the approach of an easterly wind sometimes also emit a dense vapour, as from a pot of boiling water. In order to view this phenomenon distinctly, the person should stand at about 100 yards distance from the mud or ponds. If the sun shines when the wind changes to the east, he will observe a constant steam of vapours arising out of the ponds, from about five to ten yards in height, while the air about him remains serene. As the vapour or fog arising from other bodies glides along the surface of the earth, and is brought by the easterly wind to the ponds, he will still be able, for some time, to distinguish the vapours ascending perpendicularly out of the ponds from those which are carried in an horizontal direction by the wind; especially if the sun continues to shine, though faintly.

This evaporating quality of the east-wind seems to manifest itself also by its effects both on the thermometer and the human body; for a thermometer hung over a damp piece of ground during the fogs or exhalations arising from it, will often indicate a degree of cold below the freezing point. The chilliness of the body, so sensibly perceived when in this situation, seems to proceed from the same cause, and to produce nearly the same sensations, which the damp arising from the wet floor of a chamber communicates to those who happen to be in it.

Winds are not constant in their effects. As we have sometimes warm weather with a north-wind, and sometimes very little heat with one blowing from the south; so the fogs attending an east-wind are not constant, neither is the evaporation above mentioned at all times to be perceived. It is possible, however, that in all this there may be a deception; and that instead of supposing the quantity of vapours exhaled to be increased by an easterly wind, the coldness of that wind may only condense and render visible the vapours in the air at that time. But even this supposition is liable to great objections, as our coldest north-winds seldom or never produce such an effect, but on the contrary are attended with dry and serene weather.

Be this as it will, however, an east-wind is usually accompanied with a cold, damp, and unwholesome vapour, which is observed to affect the health both of animals and vegetables, and in many places to produce obstinate intermitting fevers, and also to occasion frequent relapses. In particular spots of the low damp island of Portsea, the ague frequently prevails during the autumnal season, and in some years is much more frequent and violent than in others. It is also observable, that this disease always attacks strangers, or those who have formerly lived on a drier soil, and in a more elevated situation, with greater severity than those who are natives of the island.

The year 1765 was remarkable, not only for the long continuance of the easterly winds, but for an excessive degree of heat, which produced a more violent and general appearance of those diseases than had been known for many years before. In the month of August the quicksilver in Fahrenheit's thermometer often rose to 82° in the middle of the day. This considerable addition of heat, together with the want of refreshing rains, greatly spread the fever, increased its violence, and even changed its form in many places. At Portsmouth, and throughout almost the whole island of Portsea, an alarming continual or remitting fever raged, which extended itself as far as Chichester. At the same time, the town of Gosport, though distant only one mile from Portsmouth, enjoyed an almost total exemption from sickness of every kind; whereas in the neighbouring villages and farm-houses, a mild regular tertian ague affected whole families. The violence of the fever, with its appearances in a continued, remitting, or intermitting form, marked in some measure the nature of the soil. In Portsmouth the symptoms were bad, worse at Kingston, and still more dangerous and violent at a place called *Half-way Houses*; a street so named, about half a mile from Portsmouth, where scarcely one in a family escaped this fever, which generally made its first attack with a delirium. In the large suburb of Portsmouth called the *Common*, it seemed to rage with more violence than in the town, some parts excepted; but even whole streets of this suburb, together with the houses in the dock-yard, escaped its attack.

The marines, who were three times a-week exercised early in the morning on South-sea beach, suffered much from the effect of the stagnant water in an adjoining morass. Half a dozen of them were frequently taken ill in their ranks when under arms; some being seized with such a giddiness of their head, that they could scarcely stand; while others fell down speechless, and upon recovering their senses complained of a violent headach. When such patients were received into the hospital, it was observed that some few had a regular ague, but that far the greater number laboured under a remitting fever, in which sometimes indeed there was

was no perceptible remiffion for feveral days. A conftant pain and giddinefs of the head were the moft infeparable and diftreffing fymptoms of this difeafe. Some were delirious, and a few vomited up a quantity of bile; but in all the countenance was yellow. A long continuance of the fever produced a dropfy or jaundice, or both. Even a flight attack reduced the moft robuft conftitution to a ftate of extreme debility; and this weaknefs, together with the giddinefs, continued for a long time after the fever. A fcabby eruption now and then made its appearance on the lips and the corners of the mouth: but dry itchy fpots over the whole body, refembling much the common itch, and feeming to partake of the nature of that difeafe, were more frequently obferved in the patients at Portfmouth, where there was not the leaft reafon to fufpect any infection.

Such is the appearance of the remitting fever occafioned by marfh miafmata in England. In the Netherlands its fymptoms are not much different. Dr Lind informs us, that at Middleburg, the capital of Weft Zealand, a ficknefs generally reigns towards the latter end of Auguft, or the beginning of September, which is always moft violent after hot fummers. It commences after the rains which fall in the end of July; the fooner it begins the longer it continues, and it is only checked by the coldnefs of the weather. Towards the end of Auguft and beginning of September it is a continual burning fever, attended with a vomiting of bile, which is called the *gall-ficknefs*. This fever, after continuing three or four days, intermits, and affumes the form of a double tertian; leaving the patient in a fortnight, or perhaps fooner. Strangers that have been accuftomed to breathe a dry pure air do not recover fo quickly. Foreigners in indigent circumftances, fuch as the Scots and German foldiers, who are garrifoned in the adjacent places, are apt after thofe fevers to have a fwelling in their legs and a dropfy; of which many die.

Thefe difeafes, the doctor obferves, are the fame with the double tertians common within the tropics. Such as are feized with the gall-ficknefs have at firft fome flufhes of heat over the body, a lofs of appetite, a white foul tongue, a yellow tinct in the eyes, and a pale colour in the lips. Such as live well, drink wine, and have warm clothes and good lodgings, do not fuffer fo much during the fickly feafon as the poor people; however, thefe difeafes are not infectious, and feldom prove mortal to the natives.

Sir John Pringle obferves, that the prevailing epidemic of autumn in all marfhy countries, is a fever of an intermitting nature, commonly of a tertian form, but of a bad kind; which, in the dampeft places and worft feafons, appears as a double tertian, a remitting, or even an ardent fever. But however thefe fevers may vary in their appearance according to the conftitution of the patient and other circumftanees, they are all of a fimilar nature. For though, in the beginning of the epidemic, when the heat or rather the putrefaction in the air is the greateft, they affume a continued or a remitting form, yet by the end of autumn they ufually terminate in regular intermittents.

In Zealand where the air is more corrupted than in other parts of the Netherlands, this diftemper is called the *gall-ficknefs;* and indeed both the redundance and depravation of the bile is fometimes fo great, that it has been generally afcribed to the corruption and overflowing of that humour. But though it cannot with juftice be faid to originate from corrupted bile, it is certain that the difeafe may be continued, and the fymptoms aggravated, by an increafed fecretion and putrefaction of the bile occafioned by the fever. In proportion to the coolnefs of the feafon, to the height and drynefs of the ground, this diftemper is milder, remits or intermits more freely, and removes further from the nature of a continued fever. The higher ranks of people in general are leaft liable to the difeafes of the marfhes; for fuch countries require dry houfes, apartments raifed above the ground, moderate exercife, without labour in the fun or evening damps, a juft quantity of fermented liquors, plenty of vegetables, and frefh meats. Without fuch helps, not only ftrangers, but the natives themfelves, are fickly, efpecially after hot and clofe fummers. The hardieft conftitutions are very little excepted more than others; and hence the Britifh in the Netherlands have always been liable to fevers.

By this diftemper the Britifh troops were haraffed throughout the whole of the war from 1743 to 1747. It appeared in the month of Auguft 1743; the paroxyfms came on in the evening, with great heat, thirft, a violent headach, and often a delirium. Thefe fymptoms lafted moft of the night, but abated in the morning, with an imperfect fweat, fometimes with a hæmorrhagy from the nofe or a loofenefs. The ftomach from the beginning was difordered with a naufea and fenfe of oppreffion, frequently with a bilious and offenfive vomiting. If evacuations were either neglected, or too fparingly ufed, the patient fell into a continued fever, and fometimes grew yellow as in a jaundice. When the feafon was further advanced, this fever was attended with a cough, rheumatic pains, and fizy blood. The officers being better accommodated than the common men, and the cavalry who had cloaks to keep them warm, were not fo fubject to it: and others who belonged to the army, but lay in quarters, were leaft of all affected; and the lefs in proportion to their being little expofed to heats, night-damps, and the other fatigues of the fervice.

In this manner did the remitting fever infeft the army for the remaining years of the war; and that exactly in proportion to their diftance from the marfhy places, of which we have feveral notable inftances in Pringle's obfervations. In Hungary the fame difeafe appears with ftill more violence, and is readily complicated with fevers of a truly peftilential nature, by which means it becomes extremely dangerous. Hungary is acknowledged to be the moft fickly climate in Europe, and indeed as bad as any in the world. Here it was where the crufaders in only marching through the country to invade Afia, often loft half their number by ficknefs; and where the Auftrians not long fince buried, in a few years, above 40,000 of their beft troops, who fell a facrifice to the malignant difpofition of the Hungarian air. The reafon of this uncommon malignity is, that Hungary abounds with rivers, which, by often overflowing, leave that low flat country overfpread with lakes and ponds of ftagnating water, and with large unwholefome marfhes. So great is the impurity of thefe ftagnated waters, that by them the rivers, even the Danube, whofe courfe is flow, become in fome places corrupted and offenfive. The air is moift,

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moist, and in summer quite sultry. In the nights of harvest, Kramer tells us, it was so very damp, that the Austrian soldiers could not secure themselves from the moisture even by a triple tent-covering. Here epidemical distempers begin constantly to rage during the hottest months of the year; which are July, August, and September: and these complaints, according to the observations of the physician above mentioned, are the same with those which are epidemic upon the coast of Guinea, and in the sickly climates of the East and West Indies, of which malignant fevers of the remitting and intermitting kind are the most common and dangerous.

The heat of the sun in Hungary is more intense than in any other country of Europe; and in proportion to the heat is the pestilential quality of the marshy exhalations. It is constantly observed, that the nearer any city or fort is to a morass or a large river with foul and oozy banks, the more unhealthy are the inhabitants. At such seasons and places, the air swarms with numberless insects and animalcules, a sure sign of its malignant disposition; and the hotter the summer, the more frequent and mortal are the diseases. In short, this country, on account of its unhealthiness, has been termed *the grave of the Germans*; and in Italy, the Campania of Rome is almost equally unhealthy. Lancisius, physician to Pope Clement XI. furnishes us with a very striking instance of the malignant quality of the air of Campania. Thirty gentlemen and ladies of the first rank in Rome having made an excursion, upon a party of pleasure, towards the mouth of the Tyber, the wind suddenly shifting, blew from the south over the putrid marshes, when 29 were immediately seized with a tertian fever, only one escaping.

The island of Sardinia is annually visited with an epidemical sickness, which rages from June to September, and is called by the natives the *intemperies*. In some years there is a want of rain for four or five months; and then it is that this sickness exerts its utmost violence, being always more fatal in some places than in others, and in particular to strangers. Of this the British had a severe proof in 1758.—Admiral Broderick, in the Prince ship of war, anchored in the bay of Oristagni, where 27 of his men, sent ashore on duty, were seized with the epidemical distemper of this island; twelve of them in particular, who had slept on shore, were brought on board delirious. All of them in general laboured under a low fever, attended with great oppression at the breast and at the pit of the stomach, a constant retching, and sometimes a vomiting of bile; upon which a delirium often ensued. These fevers changed into double tertians, and terminated in obstinate quartan agues. It is worthy of remark, that in this ship, which lay only two miles from the land, none were taken ill but such as had been on shore, of whom seven died. The prior of a convent, making a visit to the English officers, informed them, that the intemperies of the island was a remitting or intermitting fever, and that he himself had suffered several attacks of it. Sardinia was formerly so remarkable for its unwholesome air, that the Romans used to banish their criminals thither; and it is at present but thinly peopled, owing to the mortality occasioned by this annual sickness. For although it is about 140 miles long, and in several places 75 miles broad, yet it is computed that the whole number of its inhabitants does not exceed 250,000: an inconsiderable number, when compared with the inhabitants of the lesser, but comparatively more healthful, island of Corsica; though even there the French lost a number of their troops by intermitting and remitting fevers. In the island of Minorca, too, Dr Cleghorn informs us, that fevers of this kind prevail exceedingly; that their types are various, their symptoms violent, the intermissions fallacious, and that they frequently and suddenly prove fatal. It is more than probable, he adds, from the accounts of several physicians and travellers, that epidemical tertians are not wholly confined to the coasts and islands of the Mediterranean, but that they are equally frequent and destructive in many other parts of the globe; and perhaps may be deemed the anniversary autumnal distempers of most hot countries in the world. And though in the mild climate of Britain, a tertian may easily be cured when it is discovered; yet in warm climates, such is the rapid progress of the distemper, that it is necessary to know it in the very beginning, which is very difficult for those who have never seen any but the tertians usually met with in Britain.

From Dr Cleghorn's account of Minorca, however, it doth not appear why that island should be so much infested with fevers of this kind, since it is far from being a marshy country; nay, on the contrary, is very dry. The south wind, he observes, is very unhealthy; and it is the prevalence of this wind which brings on the fever: but still the difficulty is not removed, because the sea air is so far from bringing on such dangerous diseases, that it is one of the greatest preservatives against them. As to the moisture which must necessarily accompany an insular situation, that cannot reasonably be admitted as a cause of this or any other disease. In the London Medical Observations we find a paper on a subject very similar to the present, namely, the mischiefs produced by lying in damp sheets, or being exposed to moist vapour. The author tells us, that he hardly knows a distemper the origin of which has not by some been ascribed to lying in a damp bed, or sitting in a wet room; and yet he does not know any one which will certainly be produced by these causes, and people frequently expose themselves to such causes without suffering any ill effects. "It must be owned indeed, (says he), that the vapours arising from the bilge-water of ships tend to produce a scurvy. The swampy plains also near the mouths of great rivers which are often overflowed, and low grounds which cannot readily be drained, and those tracts of land where the thickness and extent of the woods keep the ground moist and half putrid for want of ventilation, are destructive to the neighbouring inhabitants, by occasioning obstinate intermittents in the colder climates, and pestilential fevers in the hotter regions. But all this mischief arises not merely from moisture, but from an unventilated and putrid moisture; for the inoffensiveness of mere wetness, untainted with putridity, may be reasonably inferred from the following considerations. The air is often fully saturated with moisture; and yet neither is any epidemical distemper produced by it, nor are those remarkably aggravated with which the sick happen at that time to be afflicted. The air from rivers and from the sea is probably more replenished

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"Where the ſailors are cleanly, and not too much crowded, they are often as healthy during long voyages at ſea, as they would have been upon any part of the land. Venice is not obſerved to be leſs healthy than London or Paris.

"Thoſe who are much diſpoſed to ſweat, lie many hours in bedclothes impregnated probably with a leſs wholeſome moiſture than would have been left in the ſheets half-dried after waſhing; and there is no reaſon to think that any remarkable injury was done to the health by the continuance of ſuch ſweats almoſt every night for weeks, and for months, except what aroſe from the too great copiouſneſs of this evacuation.

"Children, and ſuch as are troubled with the ſtone, and thoſe who, from other infirmities or age, conſtantly wet their beds with their urine, do not appear to ſuffer in their health on this account.

"It is a common practice, in ſome diſorders, to go to bed with the legs or arms wrapped in linen cloths thoroughly ſoaked in Malvern water, ſo that the ſheets will be in many places as wet as they can be; and I have known theſe patients and their bedfellows receive no harm from a continuance of this practice for many months. Nor can it be ſaid that the Malvern water is more innocent than any other water might be, on account of any ingredients with which it is impregnated; for the Malvern water is purer than that of any other ſpring in England which I ever examined.

"The greateſt valetudinarians do not ſcruple to ſprinkle lavender-water upon their ſheets; and yet, when the ſpirit is flown off, there is left what is as truly water as if it had been taken from the river.

"Is it obſerved, that laundreſſes are peculiarly unhealthy above other women, though they live half their time in the midſt of wet linen, in an air fully ſaturated with vapours? Many other employments might be mentioned, the perſons occupied in which are conſtantly expoſed to wet floors or pavements, or to be ſurrounded with watery vapours, or to have their clothes often wet for many hours together.

"Is it the coldneſs of wet linen which is to be feared? But ſhirts and ſheets, colder than any unfrozen water can be, are ſafely worn and lain in by many perſons, who, during a hard froſt, neither warm their ſhirts nor their ſheets.—Or does the danger lie in the dampneſs? But then how comes it to paſs, that a warm or cold bath, and long-continued fomentations, can be uſed, without the deſtruction of thoſe who uſe them? Or is it from both together? Yet we have long heard of the thickneſs and continuance of the cold fogs in the ſeas north-weſt of England, but have never yet been told of any certain ill effect which they have upon thoſe that live in theſe countries."

With regard to the cauſes of fevers, however, Dr Lind is of opinion, that noxious vapours ariſing from the earth are for the moſt part to be blamed. Even in countries ſeemingly dry, and where violent rains are not frequent, he thinks that the air may load itſelf with putrid exhalations from the ground; and that, except in the burning deſerts of Arabia or Africa, people are nowhere exempt from diſeaſes occaſioned by putrid moiſture. In moſt of the hot countries the pernicious effects of the putrid vapours are by no means equivocal. In Guinea, they ſeem to be more extraordinary than anywhere elſe in the world; neither indeed can it be ſuppoſed, that a hot and moiſt atmoſphere can be without putreſcency. It may in general be remarked, that in ſultry climates, or during hot weather, in all places ſubject to great rains, where the country is not cleared and cultivated, but is overrun with thickets, ſhrubs, or woods, eſpecially if there are marſhes or ſtagnating waters in the neighbourhood, ſickneſs may be dreaded, and particularly the remitting fever of which we now treat. The fens, even in different counties of England, are known to be very prejudicial to the health of thoſe who live near them, and ſtill more ſo to ſtrangers; but the woody and marſhy lands in hot countries are much more pernicious to the health of Europeans. In all thoſe unhealthy places, particularly during fogs or rains, a raw vapour, diſagreeable to the ſmell, ariſes from the earth, and eſpecially in the huts or houſes. But of all the vapours which infeſt the torrid zone, the moſt malignant and fatal are the *harmattans*: They are ſaid to ariſe from the conflux of ſeveral rivers in the king of *Dormeo's* dominions at Benin (the moſt unwholeſome part of Guinea), where travellers are obliged to be carried on men's backs for ſeveral days journey, through ſwampy grounds, and over marſhes, amidſt ſtinking ooze, and thickets of mangrove trees which are annually overflown. Theſe vapours come up the coaſt to a ſurpriſing diſtance, with the ſouth-eaſt and north-eaſt winds: and it has been obſerved, that in their progreſs they have often changed both the courſe of the winds and of the ſea-currents. The times of their appearance at Cape Coaſt are the months of December, January, or February. The north-eaſt and ſouth-eaſt winds are always unhealthy, but particularly ſo during the harmattan ſeaſon. In ſome years this vapour is ſcarce perceptible; but in others it is thick, noxious, and deſtructive to the blacks as well as whites.—The mortality is in proportion to the denſity and duration of the fog. It has a raw putrid ſmell; and is ſometimes ſo thick, that a perſon or houſe cannot be diſcerned through it at the diſtance of 15 or 20 yards: and it continues ſo for 10 or 14 days; during which it opens the ſeams of ſhips, ſplits or opens the crevices of wood as if ſhrunk or dried with a great fire, and deſtroys both man and beaſt.—In the year 1754 or 1755, the mortality occaſioned in Guinea by this ſtinking fog was ſo great, that in ſeveral negro towns the living were ſcarce ſufficient to bury the dead.—Twenty women brought from Holland by a new governor to the Caſtle *del Mina*, periſhed, together with moſt of the men in the garriſon. The gates of Cape Coaſt caſtle were ſhut up for want of centinels to do duty; the blacks dying at this time as well as the white people. It is lucky that it is only in ſome years that *harmattans* are ſo very thick and noxious, otherwiſe that part of the country would be depopulated. It is obſerved that all fogs are extremely unhealthy in thoſe parts, particularly before and after the rainy ſeaſons; but the above account of the *harmattans* appeared ſo very extraordinary and incredible to ſome of Dr Lind's readers, that he thought proper to publiſh

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publiſh a further corroboration of the facts above mentioned. "A gentleman (ſays he), who had long reſided at Cape Coaſt caſtle, informed me, that during the time of this fog, being in the upper chambers of the fort, the boards of the floor ſhrunk ſo much, that he could diſcern the candles burning in the apartments below him (there are no plaſter ceilings uſed in thoſe hot countries), and that he could then even diſtinguiſh what people were doing in the apartments below; the ſeams of the floor having opened above half an inch while the fog laſted, which afterwards, upon its being diſpelled, became cloſe and tight as before."

In Africa the rains and dews ſeem to be poſſeſſed of qualities almoſt equally pernicious with the fogs. This much is certain, that in Guinea, many of the principal negroes, and eſpecially of the mulatto Portugueſe, take the utmoſt precaution to avoid being wet with thoſe rains, eſpecially ſuch as fall firſt. At the ſetting in of the rainy ſeaſon, they generally ſhut themſelves up in a cloſe well-thatched hut, where they keep a conſtant fire, ſmoke tobacco, and drink brandy, as preſervatives againſt the noxious quality of the air at that time. When wet by accident with the rain, they immediately plunge themſelves into ſalt-water, if near it. Thoſe natives generally bathe once a day, but never in the freſh water rivers when they are overflown with the rains: at ſuch times they prefer for that purpoſe the water of ſprings. The firſt rains which fall in Guinea are commonly ſuppoſed to be the moſt unhealthy. They have been known, in 48 hours, to render the leather of the ſhoes quite mouldy and rotten, they ſtain clothes more than any other rain; and ſoon after their commencement, even places formerly dry and parched ſwarm with frogs. At this time ſkins, part of the traffic of Senegal, quickly generate large worms; and it is remarked, that the fowls, which greedily prey on other inſects, refuſe to feed on theſe. It has been farther obſerved, that woollen cloths wet in thoſe rains, and afterwards hung up to dry in the ſun, have ſometimes become full of maggots in a few hours.—It is alſo probable, that as in ſome of thoſe countries the earth, for ſix or eight months of the year, receives no moiſture from the heavens but what falls in dews, which every night renew the vegetation, the ſurface of the ground in many places becomes hard and incruſtated with a dry ſcurf, which pens up the vapours below; until, by the continuance of the rains for ſome time, this cruſt is ſoftened, and the long pent up vapours ſet free. That theſe dews do not penetrate deep into the earth is evident from the conſtant dryneſs and hardeſs of ſuch ſpots of ground in thoſe countries as are not covered with graſs and other vegetables. Thus the large rivers in the dry ſeaſon being confined within narrow bounds, leave a great part of their channel uncovered, which having its moiſture totally exhaled, becomes a ſolid hard cruſt; but no ſooner the rains fall than by degrees this long parched up cruſt of earth and clay gradually ſoftens, and the ground, which before had not the leaſt ſmell, begins to emit a ſtench, which in four or five weeks becomes exceedingly noiſome, at which time the ſickneſs is generally moſt violent.

This ſickneſs, however, is not different from the remitting fever which has been deſcribed under ſo many various forms and names. An inflammatory fever is ſeldom obſerved, during the ſeaſon of ſickneſs, in this part of the world; and we ſhall conclude our deſcription of the *amphimerina paludoſa* with ſome extracts from the ſurgeon's journal in a ſhip that ſailed up the rivers of Guinea.

"On the 5th of April we ſailed up the river of Gambia, and found all the Engliſh in the fort in perfect health. The ſurgeons of the factory informed me, that a relaxation of the ſtomach, and conſequently a weakened digeſtion, ſeemed to bring on moſt of the diſeaſes ſo fatal to Europeans in the ſickly ſeaſon. They were generally of a bilious nature, attended with a low fever, ſometimes of a malignant, at other times of a remitting kind.—On the 12th of April, after ſailing 30 miles up the river St Domingo, we came to Catchou, a town belonging to the Portugueſe in Lat. 20° N. In this town were only four white people, the governor, and three friars. The number of whites in the trading ſhips was 51. One morning, towards the latter end of April, a little rain fell. On the 13th of May there was a ſecond ſhower, accompanied with a tornado. On the 18th of May it rained the whole day; and the rain continued, with but ſhort intervals, until the beginning of October.

"In the month of June almoſt two-thirds of the white people were taken ill. Their ſickneſs could not be well characteriſed by any denomination commonly applied to fevers: it however approached neareſt to what is called a *nervous fever*, as the pulſe was always low, and the brain and nerves ſeemed principally affected. It had alſo a tendency to frequent remiſſions. It began ſometimes with a vomiting, but oftener with a delirium. Its attack was commonly in the night; and the patients, being then delirious, were apt to run into the open air. I obſerved them frequently recover their ſenſes for a ſhort time, by means of the heavy rain which fell upon their naked bodies. But the delirium ſoon returned: they afterwards became comatoſe, their pulſe ſunk, and a train of nervous ſymptoms followed; their ſkin often became yellow; bilious vomitings and ſtools were frequent ſymptoms. The fever reduced the patient's ſtrength ſo much, that it was generally ſix weeks or two months before he was able to walk abroad. A conſuming flux, a jaundice, a dropſy or obſtructions in the bowels, were the conſequences of it. Of 51 white men, being the companies of four ſhips which were at Catchou, one-third died of the fever, and one-third more of the flux, and other diſeaſes conſequent upon it; and of theſe not one was taken ill till the rains began.

"I believe, on the whole face of the earth, there is hardly to be found a more unhealthy country than this during the rainy ſeaſon: and the idea I then conceived of our white people was by making a compariſon of their breathing ſuch a noxious air, with a number of river-fiſh put into ſtagnating water; where, as the water corrupts, the fiſh grow leſs lively, they droop, pine away, and many die.

"Thus ſome perſons became dull, inactive, ſlightly delirious, at intervals; and, without being ſo much as confined to their beds, they expired in that delirious and comatoſe ſtate in leſs than 48 hours after being in apparent good health. The white people in general became yellow; their ſtomach could not receive much food without loathing and retchings. Indeed it is no wonder that this ſickneſs proved ſo fatal, that recoveries

ries from it were so tedious, and that they were attended with fluxes, dropsies, the jaundice, ague-cakes, and other dangerous chronical distempers. It seems more wonderful to me that any white people ever recover, while they continue to breathe so pestiferous an air as that at Catchou during the rainy season. We were, as I have already observed, 30 miles from the sea, in a country altogether uncultivated, overflowed with water, surrounded with thick impenetrable woods, and overrun with slime. The air was vitiated, noisome, and thick; insomuch that the lighted torches or candles burnt dim, and seemed ready to be extinguished: even the human voice lost its natural tone. The smell of the ground and of the houses was raw and offensive; but the vapour arising from putrid water in the ditches was much worse. All this, however, seemed tolerable, when compared with the infinite numbers of insects swarming every where, both on the ground and in the air; which, as they seemed to be produced and cherished by the putrefaction of the atmosphere, so they contributed greatly to increase its impurity. The wild bees from the woods, together with millions of ants, overran and destroyed the furniture of the houses; at the same time, swarms of cockroaches often darkened the air, and extinguished even candles in their flight; but the greatest plague was the musquettoes and sand-flies, whose incessant buzz and painful stings were more insupportable than any symptom of the fever. Besides all these, an incredible number of frogs on the banks of the river made such a constant and disagreeable croaking, that nothing but being accustomed to such an hideous noise could permit the enjoyment of natural sleep. In the beginning of October, as the rains abated, the weather became very hot; the woods were covered with abundance of dead frogs, and other vermin, left by the recess of the river; all the mangroves and shrubs were likewise overspread with stinking slime."

After so particular a description of the remitting fever in many different parts of the world, we presume it will be needless to take notice of any little varieties which may occur in the warm parts of America, as both the nature and cure of the distemper are radically the same: neither shall we lengthen out this article with further descriptions of remitting fevers from the works of foreign authors, as, from what we have already said, their nature cannot easily be mistaken.

Cure. The great difficulty in the cure of remitting fevers arises from their not being simple diseases, but a complication of several. Fevers, properly speaking, have but three or four different appearances which they can assume without a complication. One is, when they are attended with a phlogistic diathesis: another is, when they assume the form of genuine intermittents; a third is, when they produce a great debility of the nervous system; and the fourth is, when along with this debility there is also a rapid tendency to putrefaction. If, therefore, all these species happen to make an attack at once, the most dangerous fever we can imagine will be produced; and however contrary it may be to our theories to admit the possibility of such an attack, the truth of the fact is too often confirmed by fatal experience. In the beginning of remittent fevers, for instance, the symptoms indicate a high degree of inflammation: but if the practitioner attempts to remove this inflammation by blood-letting or other evacuations, the pulse sinks irrecoverably, and the person dies with such symptoms as show that the nervous system has been from the beginning greatly affected; at the same time the high stimulants and cordials, or cinchona, which would have conquered the nervous part of the disease, increase the inflammatory part of it to such a degree, that, by a too early exhibition of them, the patient also dies, but after another manner.

In the remitting fever of the East Indies, Dr Lind of Windsor formed the following indications of cure. 1. To allay the violence of the fever. 2. To evacuate the putrid humours, and take great care to prevent the body from inclining to putrefaction. 3. To keep up the strength of the patient as much as possible during the disorder. 4. To lose no time in preventing the return of the paroxysms.

To allay the violence of the fever, every thing that can contribute to increase it ought to be carefully avoided or removed; such as great heat, too strong a light falling on the eyes, noise, and motion. If during the paroxysm the head and loins be affected with violent pains, the pulse be full and hard, and the heat intense, bleeding may be used, but with the greatest caution: for, however useful this operation may be in cold climates, the success of it in warm ones is so far from being certain, that the lives of the patients have been often very much endangered, nay even destroyed by it. Dr Badenoch, and the surgeon of the Ponsborne, endeavoured each of them to relieve two patients by blood-letting; and the consequence was, that each of them lost one patient. Dr Lind bled two patients; one of whom was Mr Richardson, the first mate of the ship, who complained of a most violent pain in his head, with a full hard pulse. About four or five ounces of blood were taken from him, by which he was greatly relieved: nor was the cure retarded by it; nay, the fever afterwards became less irregular. At the time the other patient was bled, the disease was exceedingly frequent and violent. He was so earnest for bleeding, that he fired all the rest with the same desire, swearing, that by refusing them this only remedy, every one of them would be sent to their graves. To quiet them, therefore, and get quit of their importunities, the doctor complied with their request, and took about five or six ounces from him who had been the first to require it. The consequence was, that he immediately lost his strength; and in less than an hour, during which time he made his will, was carried off by the next fit. It is necessary, however, to observe, and indeed the doctor himself makes the observation, with regard to this patient, that he was bled at an improper time, namely, between the fits; whereas, had he been bled in the hot fit, it is possible he might have been relieved.

In support of the advantages to be derived from bleeding under proper circumstances, we have the authority both of Cleghorn and Pringle. As Dr Cleghorn practised in a very hot country, his observations must in the present case have greater weight than those of Pringle, who practised in a colder one. The former acquaints us, that if he was called in early enough, unless there was a strong contra-indication, he always used to take away some blood from people

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people of all ages; namely, from robuſt adults, 10 or twelve ounces; from others a ſmaller quantity, in proportion to their ſtrength and years. And further, if a violent headach, obſtinate delirium, and heat or pains of the bowels, were urgent, the bleeding was repeated within a day or two. By this ſeaſonable evacuation, he found the vehemence of all the paroxyſms ſomewhat diminiſhed; the apyrexia became more complete; the operation of emetics and cathartics rendered ſafer and more ſucceſsful; and the terrible ſymptoms which happened about the height of the diſtemper, ſuch as raving *ſopor*, difficulty of breathing, inflammations of the abdominal viſcera, &c. were either prevented or mitigated. But if the fever had continued for ſome time before he was called, and the maſs of blood appeared to be too much melted down or inclined to a putrid diſſolution, he either abſtained from bleeding entirely, or took away a very ſmall quantity, though ſome urgent ſymptoms might ſeem to require a larger evacuation. As to the time of performing the operation, he acquaints us, that it is ſafe enough, except when the cold fit laſts or is ſoon expected, or while the ſkin is covered with critical ſweats; and that he uſually opened a vein in the beginning of the hot fit; by which means the ſick were relieved, the immoderate heat of the body, which is often productive of fatal effects, was diminiſhed, and the critical ſweats brought on ſooner and in greater abundance.

But though Dr Lind found veneſection to be of ſuch pernicious tendency in his patients, cooling acidulated liquors were of the utmoſt ſervice, as they corrected the putrid humours, leſſened the heat and thirſt, and of courſe prevented the fever from arriving at ſo great an height as it would otherwiſe have done. Thoſe cooling liquors are the beſt which are made up with ſome farinaceous ſubſtance, as they moſt eaſily unite with our fluids. Foſſile acids too, and cryſtals of tartar, eſpecially the latter, are of conſiderable uſe, not only in this, but in other fevers. The neutral ſalts, prepared with the juice of lemons, were likewiſe given with ſucceſs during the heat of the fever. They leſſen the nauſea, the fits become more regular, and the remiſſions more full; and they are particularly grateful when given in a ſtate of efferveſcence. The good effects of theſe draughts we are in a great meaſure to aſcribe to the antiſeptic quality of the fixed air extricated from them during the efferveſcence.

During the remiſſion, it is proper to evacuate the putrid humours by ſmall doſes of ipecacuanha, or rather tartar emetic. The tartar emetic indeed appears to be endowed with ſome kind of febrifuge virtue, which Dr Cullen thinks is owing to its relaxing the febrile ſpaſm taking place in the capillary veſſels. But ſhould there appear any ſymptoms of a topical inflammation in ſome of the abdominal viſcera, a thing which never happens unleſs the diſorder has been of ſome ſtanding, vomiting is to be avoided, and we are to depend upon purgatives alone for the evacuation of the putrid bile. Theſe are always uſeful in the cure of this diſorder. But all acrid and ſtrong purgatives are to be carefully avoided, and only the mild antiſeptic ones made uſe of, ſuch as cryſtals of tartar, or tamarinds made up with manna or with Glauber's ſalt.

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Though in theſe diſeaſes there is a great quantity of putreſcent bile collected in the body, yet it ſeems much more probable that this is the *effect* than the *cauſe* of the diſorder; and therefore, though we carry off the quantity collected ever ſo often, more of the ſame kind will ſtill be produced by the putreſcent diſpoſition of the other fluids, at the ſame time that the ſtrength of the patient muſt neceſſarily be diminiſhed by repeated evacuations, when it ought rather to be kept up by all poſſible means. We ought well to obſerve, however, that the mineral acids have not that property of ſweetening putrid bile which the vegetable ones have; and therefore the ſame relief will not be given by them which might reaſonably be expected from vinegar or lemon juice.

In order to keep up the ſtrength of the patient, good food is abſolutely neceſſary. Dr Lind allowed the ſick ſmall meſſes of panada made with boiled rice and barley mixed with currants or raiſins and prunes, ſeaſoned with ſugar and a little wine, eſpecially claret. During the paroxyſms, they had gruel made of flour and rice, with ſugar and the juice of acid fruit; and when the fit went off, a little wine was added to this mixture.

The ſhirts and bedding muſt be very often changed and well aired; their ſtools, and all filth and naſtineſs, are to be immediately removed; the places where they are lodged ſhould be well aired and frequently ſprinkled with vinegar; and, in the laſt place, the ſick muſt be exceedingly well nurſed. Bliſters, according to Dr Lind, ſhould never be uſed till the fever has been of long continuance, or the ſpirits and pulſe of the patient have begun to flag. But here our author has implicitly followed Dr Huxham, whoſe theory concerning the uſe of bliſters is now found to be erroneous. According to that celebrated author, bliſters are capable of doing conſiderable hurt in all caſes where there is a tendency to inflammation, by increaſing the motion of the fluids and the oſcillatory power of the veſſels, both of which are already too great. They are alſo improper, according to him, where there is a conſiderable tendency of the fluids to putrefaction; becauſe he ſuppoſes the ſalts of theſe flies to operate in the ſame manner with volatile alkalies, that is, by diſſolving and putrefying the blood ſtill farther. But Sir John Pringle has ſhown, that, in inflammatory fevers as well as thoſe of the putrid kind, both bliſters and volatile ſalts may be of ſervice; the latter, particularly, he hath experimentally proved to be ſo far from promoting putrefaction, that they are exceedingly ſtrong antiſeptics.

In the Eaſt Indies, Dr Lind found it abſolutely neceſſary to exhibit the Peruvian bark in large quantities, and as early as poſſible. By this method he not only ſecured the patient from the imminent danger of death to which he was expoſed at every fit, but likewiſe conquered thoſe obſtructions which were apt to enſue in the abdominal viſcera, and which are to be attributed to the continuance of the diſorder, and not to the bark employed to cure it. He always gave the cinchona during the ſecond remiſſion, as all his care was during the firſt to cleanſe the primæ viæ. He obſerves, however, that it is to no purpoſe to give the bark till the neceſſary purgations are over; but aſſures us, that it never fails, unleſs from the coming on of a vomiting or

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or diarrhœa it cannot be taken in ſufficient quantities before the return of a paroxyſm. To prevent the medicine from vomiting or purging, he mixed a few drops of liquid laudanum with every doſe of it. Half a dram was given every half hour in ſome convenient vehicle, beginning as ſoon as the fever had conſiderably abated, and the pulſe was returned nearly to its natural ſtate; both which generally happened before the ſweats were over. An ounce of the bark was ſometimes found too little to check the fever, but an ounce and a half never failed. It muſt be continued daily in ſmall doſes till the patient has recovered his ſtrength, and then a greater quantity muſt be given, eſpecially at the ſeaſon when the rivers overflow the country.

Dr Pringle found the autumnal remittents in the Netherlands complicated with a great many inflammatory ſymptoms; for which reaſon it was generally found neceſſary to open a vein in the beginning. The vernal and later autumnal remitting fevers are accompanied with pleuritic and rheumatic pains from the coldneſs of the weather, and on that account require more bleeding. A phyſician unacquainted with the nature of the diſeaſe, and attending chiefly to the paroxyſms and remiſſions, would be apt to omit this evacuation entirely, and give the cinchona too ſoon, which would bring on a continued inflammatory fever. In theſe countries a vein may be ſafely opened either during the remiſſion or in the height of a paroxyſm; and our author alſo found good effects reſulting from bleeding in the hot fits of the marſh fever, even after it had almoſt come to regular intermiſſions. After bleeding, a purgative was uſually exhibited, of which he gives us the following formula.

℞. Infuſi ſenæ commun. ℥iij.
Elect. Lenitiv. ℥ſs.
Nitr. pur. ʒi.
Tinct. ſen. ʒvi. M.

Of this only one half was taken at once; and if it did not operate twice in four hours, the remainder was then taken. This potion agreed with the ſtomach, purged plentifully, and therefore was a very uſeful compoſition. Next morning, when there was almoſt always ſome remiſſion, he gave one grain of emetic tartar rubbed with 12 grains of crabs-eyes, and repeated the doſe in two hours, if the firſt had little or no effect; or at any rate in four hours. This medicine was intended not only to vomit, but alſo to operate by ſtool, and excite a ſweat. If theſe evacuations were procured, the fever generally became eaſier, and was even ſometimes cured. This he prefers to the ipecacuanha, and therefore in the latter years of his practice diſuſed that root entirely. The ſame medicine was repeated next day or the day following; or if not, a laxative clyſter was thrown up: and this method was continued till the fever either went off altogether, or intermitted in ſuch a manner as to be cured by the cinchona.

A ſimilar method was followed by Dr Huck in the remitting fevers of the Weſt Indies and North America. In the beginning he let blood; and in the firſt remiſſion gave four or five grains of ipecacuanha, with from half a grain to two grains of emetic tartar. This powder he repeated in two hours, taking care that the patient ſhould not drink before the ſecond doſe; for then the medicine more readily paſſed into the bowels after it had operated by vomiting. If, after two hours more, the operation either way was ſmall, he gave a third doſe, which commonly had a good effect in opening the firſt paſſages; and then the fever either went quite off, or intermitted in ſuch a manner as to yield to the bark. On the continent, he found little difficulty after the intermiſſion; but in the Weſt Indies, unleſs he gave the cinchona upon the very firſt intermiſſion, though imperfect, the fever was apt to aſſume a continued and dangerous form.

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In the remitting fevers of hot countries, however, it muſt be obſerved, that the lancet muſt in all caſes be much more ſparingly uſed than in ſimilar diſeaſes of the colder regions; and we muſt alſo be ſparing of veneſection in thoſe countries where the marſh effluvia are very ſtrong and prevail much. For this reaſon Dr Lind of Haſlar greatly condemns the practice of indiſcriminate bleeding when people firſt arrive in hot climates. The firſt diſeaſes indeed which occur in a voyage to the ſouthward are, for the moſt part, of an inflammatory nature, and owing to a ſudden tranſition from cold to hot weather. This occaſions a fulneſs and diſtenſion of the veſſels; whence all Europeans, on their firſt arrival under the tropic, bear evacuations much better than afterwards. The practice of indiſcriminately bleeding, however, a number of the ſhip's company when they firſt come into a warm latitude, is by no means found to anſwer the purpoſe of a preventive. In ſuch caſes, indeed, as plainly indicate a plethoric diſpoſition brought on by the heat, blood-letting is certainly uſeful. The ſigns of this are a pain and giddineſs in the head; a heavineſs and dulneſs of the eyes, which ſometimes appear ſlightly inflamed: there is alſo commonly a ſenſe of weight and fulneſs in the breaſt, the pulſe at the ſame time being quick and oppreſſed.

But the caſe is quite different after a longer continuance of ſultry weather, and when the conſtitution is in ſome meaſure habituated to the hot climate. For it is then obſerved, that the ſymptoms of inflammations in the bowels, even the moſt dangerous, are not near ſo ſevere in ſuch climates as in cold countries; nor can the patients bear ſuch large evacuations. The phyſician, however, muſt take care not to be miſled by the apparent mildneſs of the ſymptoms: for he will find, notwithſtanding ſuch deceitful appearances, that the inflammation makes a more rapid progreſs in hot countries than in cold, ſuppurations and mortifications being much more ſuddenly formed; and that in general all acute diſtempers come ſooner to a criſis in the warm than in colder regions. Hence it is an important rule of practice in thoſe climates, to ſeize the moſt early opportunity, in the commencement of all threatening inflammations, to make frequent though not copious evacuations by blood-letting. For by delay the inflammation quickly paſſes from its firſt to its laſt or fatal ſtage; at leaſt, an imperfect criſis in ſuch inflammatory fevers enſues, which fixes an obſtruction in the viſcera extremely difficult to remove.

It is indeed a general maxim with ſome phyſicians in the Weſt Indies, that in moſt acute diſtempers bleeding in that country is prejudicial. This is founded upon a ſuppoſition that the craſſamentum of the blood is

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is thinned, and the solids greatly weakened, by the heat of the climate. It is therefore objected, that bleeding in such an habit of body weakens the powers of nature, and withdraws the strength which is requisite to support the patient until the crisis of the fever.

This reasoning is partly just; but, like all general maxims, will admit of exceptions. First, with regard to sailors, it is to be remembered, that they are more exposed to quick vicissitudes of heat, cold, damps, and to various changes of the air and weather, than most of the other inhabitants of the Torrid Zone. Add to this, that their intemperance, and the excesses they are apt to fall into whenever it is in their power to commit them, render them more liable to inflammations than any other set of people. Hence their diseases require more plentiful evacuations than the land-inhabitants of those parts of the world, and generally they bear them better. But with regard to the natives of the country, or those who have remained long there, it must be proper to bleed them very sparingly, making allowance for the different seasons of the year, the temperature of the air, and the situation of the places where they reside. Thus, in some parts, even on the island of Jamaica, at particular seasons, the weather is cool; wherefore, in these places, and at such seasons, the inhabitants having their fibres more rigid, and a firmer crasis of their blood, bear venesection much better.

In cold countries the state of the air greatly assists in restoring the impaired spring of the fibres; whereas every thing almost in warm weather, such as heat, moisture, &c. concur to relax and weaken the habit of body. Thus we may daily see persons in Britain, after having suffered a most severe fit of sickness, recover their strength and spirits in a few days, and in a very short time their natural constitution. But the case is very different in the sultry regions of the Torrid Zone, or indeed in any part of the world where the heat of the season causes the mercury to stand for any length of time at the 77th degree and upward of Fahrenheit's thermometer. During such an excess of heat, debility after fevers is apt to remain with European constitutions for several months. In Jamaica, the convalescents are sent to the cool summits of the mountains; but a retreat to a more northern climate is often absolutely necessary to recover their wonted tone and vigour of body. It is a well-established observation, that the negroes and aborigines of the Torrid Zone cannot bear plentiful evacuations by the lancet. They commonly mix the most stimulating poignant spices with their ordinary light food, and this is found by experience suitable to their constitutions.

As proper preventives for the dangerous fevers of which we are treating, Dr Lind on all occasions recommends the avoiding of stagnant water, or putrid marshes; the use of proper food, cleanliness, and sobriety. Of the propriety of removing from the neighbourhood of those places whose pestilential effluvia produce the disorders, we cannot possibly entertain a doubt; and of the efficacy of proper food in preventing putrid disorders he gives a remarkable instance in the Sheerness man of war, bound to the East Indies. As they went out, the men being apprehensive of sickness in so long a voyage, petitioned the captain not to oblige them to take up their salt provisions, but rather to permit them to live upon the other species of their allowance. It was therefore ordered, that they should be served with salt-meat only once a-week; and the consequence was, that after a passage of five months and one day, the ship arrived at the Cape of Good Hope without having a single person sick on board. As the use of Sutton's pipes had been then newly introduced into the king's ships, the captain was willing to ascribe part of such an uncommon healthfulness to their beneficial effects; but it was soon discovered, that, by the neglect of the carpenter, the cock of the pipes had all this while been kept shut. This ship remained in India some months, where none of the men, except the boats crew, had the benefit of going on shore; notwithstanding which, the crew continued to enjoy the most perfect state of health; they were, however, well supplied with fresh meat. On leaving India, knowing they were to stop at the Cape of Good Hope, and trusting to a quick passage, and the abundance of refreshments to be had there, they ate their full allowance of salt meats, during a passage of only 10 weeks; and it is to be remarked the air-pipes were now opened. The effect of this was, that when they arrived at the Cape, 20 of them were afflicted in a most miserable manner with scorbutic and other disorders. These, however, were speedily recovered by the refreshments they met with on shore. Being now thoroughly sensible of the beneficial effects of eating, in these southern climates, as little salt meat as possible when at sea, they unanimously agreed, in their voyage home from the Cape, to refrain from their too plentiful allowance of salt flesh. And thus the Sheerness arrived at Spithead, with her full complement of 160 men in perfect health and with unbroken constitutions, having in this voyage of 14 months and 15 days buried but one man, who died in a mercurial salivation.

Thus we see, that a free and pure air is not a sufficient preservative against a putrescent state of the fluids, without proper food; and, on the other hand, we have a very remarkable instance of the inefficacy of the most salutary food to prevent putrid diseases, in a very noxious state of the atmosphere. In the year 1717, at the siege of Belgrade in Hungary, the fever of the country, and the flux, occasioned a most extraordinary mortality among the troops. The dread of these diseases caused every one, as may naturally be supposed, to have recourse to different precautions for self-preservation. Prince Eugene, the commander in chief, had water and the provisions for his table sent him twice a-week from Vienna. The pure stream of the river Kahlenberg was regularly brought to him: he avoided all excesses, and lived regularly, or rather abstemiously; refreshed himself often by eating a cool melon; and mixed his usual wine, which was Burgundy, with water. Yet, notwithstanding his utmost care, he was seized with a dysentery; which would have quickly put an end to his life, had not the speedy conclusion of that campaign permitted him to make a quick retreat.

At this unhealthy season, when hardly one imperial officer, much less their several domestics, escaped those malignant diseases, the renowned Count Bonneval and his

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The intemperance and irregular living of thoſe Europeans who viſit the hot climates is frequently accuſed as the cauſe of their deſtruction; but, our author thinks, without ſufficient reaſon; for though intemperance will make the body more liable to receive ſuch diſeaſes, it will not bring them on. It muſt by no means, however, be imagined, that in thoſe climates Europeans may with impunity be guilty of exceſſes in eating or drinking: for the leaſt error in that way will often prove fatal by debilitating the body, whoſe utmoſt ſtrength in time of full health was perhaps ſcarce ſufficient to reſiſt the peſtilential miaſmata of the atmoſphere.

It appears, therefore, from the concurrent teſtimony of the moſt eminent phyſicians, that the moſt proper medicine to be uſed, either as a preventive or cure for remitting and intermitting diſorders, is the Peruvian bark, adminiſtered with proper precautions and after the *primæ viæ* have been evacuated of the putrid bilious matter collected in them. In thoſe ſpecies of *tritæophya*, &c. belonging to this claſs, enumerated by Sauvages, the ſame remedies only were uſeful; but in that peſtilential diſtemper which he calls *tritæophya Vratiſlavienſis*, he tells us, that waſhing the body with water ſometimes hot, ſometimes cold, watery clyſters, and plenty of aqueous drink, were likewiſe of uſe.

Genus II. QUARTANA; the Quartan Fever.

Quartana auctorum, *Sauv.* Gen. 89. *Lin.* 17. *Vog.* 3. *Sag.* 711. *Hoffm.* II. p. 23. *Junck.* tab. 81.

The *Genuine* Quartan. Sp. I. var. I. A.
Quartana legitima, *Sauv.* ſp. 1. *Sydenham* de morb. acut. cap. v.

Deſcription. The genuine quartan, according to Juncker, keeps its form more exactly than other intermittents; ſcarcely coming on at any other time than four or five in the afternoon. The cold is leſs violent than in the tertian; but is very perceptible, though it doth not proceed to ſuch a height as to make the limbs ſhake; it continues for about two hours. It is preceded and accompanied by a languor both of body and mind. There is ſeldom any vomiting unleſs when the ſtomach is manifeſtly overloaded with aliment; neither is there any diarrhœa, but the belly in general is rather bound, not only on the days on which the paroxyſm takes place, but alſo on the intermediate ones. The heat, which ſlowly ſucceeds the cold, is leſs troubleſome to the patient by its violence than by the uneaſy dryneſs of the ſkin, which is ſcarcely ever moiſtened with ſweat. This heat rarely continues longer than four or five hours, unleſs perhaps at the firſt or ſecond paroxyſm. It is accompanied alſo with a giddineſs and dull pain of the head. On the termination of the paroxyſm, the patient returns to a middling ſtate of health, and continues in the ſame for the reſt of the intermediate days; only there remains ſomewhat of a loathing, and a deep-ſeated pain as if the perſon was all over bruiſed or broken, which kind of ſenſation the phyſicians are wont to call *oſteocopus*. The fit returns every fourth day, and that preciſely at the ſame hours, being rarely poſtponed.

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Cauſes of, and perſons ſubject to, this diſorder. The ſame general cauſes concur in producing this as other intermittents, namely marſh miaſmata, and whatever can diſpoſe the body to be eaſily affected by them. Studious people, and thoſe of a melancholic turn, are ſaid to be particularly ſubject to quartans; but what are the immediate cauſes which produce a return of the fits every fourth day, inſtead of every day, or every third day, muſt probably lie for ever concealed, as depending upon the ſecret and inexplicable mechaniſm of the human body.

Prognoſis. A ſimple quartan, where there is no reaſon to dread any induration of the viſcera, may very certainly admit of a cure; and the prognoſis can never be unfavourable, unleſs in caſes of extreme weakneſs, or where the diſtemper hath been unſkilfully treated.

Cure. This does not in the leaſt differ from that which hath been fully laid down for the ſimple tertian, and which it is therefore needleſs to repeat here.

The *Duplicated* Quartan. Sp. I. var. I. B.
Quartana duplicata, *Sauv.* ſp. 4. *Bonet.* 153

This is entirely ſimilar to the duplicated tertian already mentioned; proper allowance being made for the difference between the type of a tertian and quartan.

The *Triplicated* Quartan. Sp. I. var. I. C.
Quartana triplicata, *Sauv.* ſp. 16. 154

This hath three paroxyſms every fourth day, while the intermediate days are entirely free from fever.

The *Double* Quartan. Sp. I. var. I. D.
Quartana duplex, *Sauv.* ſp. 3. *Vog.* ſp. 13. 155

In the double quartan, the fits come on every day except the third; but ſo that the firſt paroxyſm anſwers to the third, the ſecond to the fourth, and ſo on.

The *Triple* Quartan. Sp. I. var. I. E.
Quartana triplex, *Sauv.* ſp. 5. *Vog.* ſp. 14. *Bartholin.* H. anat. c. 1. 95. 156

This comes on every day, but the quartan type is ſtill

ſtill preſerved by the times of acceſſion; that is, the time of the fourth paroxyſm's coming on anſwers to that of the firſt, the fifth to the ſecond, the ſixth to the third, &c.

The QUARTAN, accompanied with *Symptoms* of other diſeaſes. Sp. I. var. 2.

157 Quartana cataleptica, *Sauv.* ſp. 7. *Bonet.* polyalth. vol. i. p. 805.
Quartana comatoſa, *Sauv.* ſp. 15. *Werholf.* de febr. *C. Piſonis* Obſerv. de morbis à colluvie ſeroſ. obſ. 166, 167, 168, 169, 171, 172, 173, 174.
Quartana epileptica, *Sauv.* ſp. 8. *Scholzii* Conſ. 379, 380.
Quartana hyſterica, *Sauv.* ſp. 10. *Morton,* Pyrct. exerc. 1. cap. ix H. 10, 11.
Quartana nephralgica, *Sauv.* ſp. 9.
Quartana metaſtatica, *Sauv.* ſp. 17.
Quartana amens, *Sauv.* ſp. 12. *Sydenham* de morb. acut. cap. v.
Quartana ſplenetica, *Sauv.* ſp. 2. *Etmuller,* Coll. conſult. caſ. 25.

The QUARTAN *complicated* with other *Diſeaſes.* Sp. I. var. 3.

158 Quartana ſyphilitica, *Sauv.* ſp. 6. *Plateri,* obſerv. L. III. p. 676. Edin. Eſſ. art. xlvii. obſ. 8.
Quartana arthriticia, *Sauv.* ſp. 11. *Muſgr. de Arthr.* ſympt. cap. ix. H. 4. et 5.
Arthritis febriſequa, *Sauv.* ſp. 10.
Arthritis febricoſa, *Sauv.* ſp. 10. *Werlhof.* de febr. *Cockburn* de morbis navigantium, obſ. 19.
Quartana ſcorbutica, *Sauv.* ſp. 14. *Barthol.* de med. Dan. diſſ. iv. *Tim.* L. VIII. caſ. 18.

The *Remitting* QUARTAN. Sp. II.

159 Tetartophya, *Sauv.* gen. 85. *Sag.* 699. *Lin.* 21.
Quartana remittens auctorum.

Var. 1. Tetartophya ſimplex, *Sauv.* ſp. 1.
2. Amphimerina ſemiquartana, *Sauv.* ſp. 23.
3. Tetartophya ſemitertiana, *Sauv.* ſp. 5.
4. Tetartophya maligna, *Sauv.* ſp. 6. *Lautter.* Hiſt. med. caſ. 21. *M. Donat.* L. III. cap. 14. ex *M. Gatenaria Horſt.* L. I. obſ. 15.
5. Tetartophya carotica, *Sauv.* ſp. 4. *Werlhof.* de febr. *Bianchi* Hiſt. hep. pars III. conſt. ann. 1718, p. 751.
6. Tetartophya ſplenalgica, *Sauv.* ſp. 2.
7. Tetartophya hepatalgica, *Sauv.* 3. *Car. Piſ.* in prefat. p. 33.
8. Amphimerina ſpaſmodica, *Sauv.* ſp. 16.

To the tertian or quartan fevers alſo belong the *Erraticæ* of authors. As all thoſe above mentioned differ only in the ſlight circumſtance of the type from the intermitting and remitting tertians already deſcribed at length, it is unneceſſary here to take up time in deſcribing every minute circumſtance related by phyſicians concerning them, eſpecially as it could contribute nothing towards the laying down a better method of cure than what hath been already ſuggeſted.

GENUS III. QUOTIDIANA; the QUOTIDIAN FEVER.

Quotidiana auctorum, *Sauv.* gen. 86. *Lin.* 15. *Vog.* I. *Hoffm.* II. 33. *Junck.* tab. 79.

The *Genuine* QUOTIDIAN. Sp. I. var. 1. A.

Quotidiana ſimplex, *Sauv.* ſp. 1. 160
Quotidiana legitima, *Sennert.* de febr. cap. 18.

Deſcription. This kind of fever generally comes on about ſix or ſeven o'clock in the morning, beginning with a conſiderable degree of cold and ſhivering, which laſts for about an hour; and is often accompanied with vomiting or ſpontaneous diarrhœa, or both. It is ſucceeded by a pretty ſtrong heat, accompanied with thirſt, reſtleſſneſs, and pain of the head. When the heat abates a little, a ſpontaneous ſweat commonly follows, and the whole paroxyſm rarely exceeds ſix hours. It returns, however, every day almoſt always at the ſame hour, unleſs it be evidently diſturbed.

Cauſes of, and perſons ſubject to, the diſeaſe. The ſame general cauſes are to be aſſigned for the quotidian as for other intermittents. This kind occurs but rarely; and is ſaid to attack people of a phlegmatic temperament rather than any other: alſo old people rather than young, and women rather than men.

The prognoſis and method of cure are not different from thoſe of tertians and quartans.

The *Partial* QUOTIDIAN. Sp. I. var. 1. B.

Quotidiana partialis, *Sauv.* ſp. 16. *Cnoffel,* E. N. C. D. I. A. III. obſ. 205. Edin. Med. Eſſ. vol. i. art. 31 vol. ii. art. 16. 161
Quotidiana cephalalgica, *Sauv.* ſp. 6. Mort. pyretol. exerc. i. hiſt. 27. *Van Swieten in Boerh.* p. 534.
Cephalalgia intermittens, *Sauv.* ſp. 7.
Cephalæa febricoſa, *Sauv.* ſp. 4.
Quotidiana ophthalmica, *Morton,* ibid. hiſt. 17. *Van Swieten,* ibid.
Ophthalmia febricoſa, *Sauv.* ſp. 23.

Theſe diſtempers attack only ſome particular part of the body, as the head, the eye, arm, &c. producing periodical affections of thoſe parts returning once in 24 hours; they are to be cured by cinchona, as other intermittents. They are known to belong to this claſs, by the evident intermiſſion of the pain or other affection of the part. The *quotidiana hysterica, Sauv.* ſp. 3. *quotidiana catarrhalis, Sauv.* ſp. 9. and *quotidiana ſtranguriosa, Sauv.* ſp. 11. ſeem to be ſymptomatic diſorders.

The *Remitting* QUOTIDIAN. Sp. II.

Amphimerina, *Sauv.* gen. 84. *Lin.* 20. 162
Quotidiana continua, *Vog.* 15.
Quotidianæ remittentes et continuæ auctorum.
Amphimerina latica, *Sauv.* ſp. 1.
Febris continua lymphatica, *Etmuller,* Coll. conf. caſ. 32. *River.* Obſ. cent. 1. obſ. 57.
Amphimerina ſingultuoſa, *Sauv.* ſp. 14.
Febris continua Lyngodes, *Vog.* 26.

Concerning theſe alſo nothing remains neceſſary to be mentioned in this place, having already ſo fully diſcuſſed the remitting fevers in all the different parts of the

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Sect. II. CONTINUED FEVERS.

Continuæ, *Sauv.* clafs ii. ord. 1. *Vog.* clafs i. ord. 2. *Sag.* 666. *Boerh.* 727.

Continentes, *Lin.* clafs ii. ord. 1. *Stahl.* Caf. mag. 35. Caf. min. 87. *Junck.* 58. *Sennert.* de febr. L. ii. cap. 2. et 10.

Genus IV. SYNOCHA.

163 Synocha, *Sauv.* gen. 80. *Lin.* 12. *Junck.* 58.

Synocha, five febris acuta fanguinea, *Hoffm.* II. 105.

Synochus, *Vog.* 16.

Continua non putris, *Boerh.* 720.

Ephemera, *Sauv.* g. 79. *Boerh.* 728. *Junck.* 57.

Diaria, *Lin.* 11.

Febris inflammatoria auctorum.

Defcription. The moft fimple kind of fynocha is the ephemera or diary fever. It begins without any fenfation of cold or fhivering, unlefs there be fome internal inflammation, or the fmallpox or meafles happen to be prefent. A continual heat without any intermiffion conftitutes the effence of this difeafe. The heat, however, is more tolerable than in the fynocha properly fo called. In fome, the pains of the head are pungent and throbbing, anfwering to the pulfations of the arteries; but in others they are dull and heavy. The face is red and bloated; and there is a remarkable laffitude of the limbs, with a ftrong, full, and frequent pulfe. The urine is red, and depofits a fediment almoft of the colour of orange-peel; and in the very firft day of the difeafe, figns of concoction (according to the Hippocratic phrafe) appear. The fever commonly goes off with a gentle fweat; but fometimes, though more rarely, with a hemorrhagy by the nofe. Its fhorteft period is 24 hours: but if it goes beyond the fourth day, it is then a *fynocha* properly fo called.

The fimple fynocha, according to Vogel, begins with cold and fhivering, fucceeded by vehement heat, rednefs, and drynefs of the fkin. The face, efpecially, is very red, and the thirft intenfe. The head is either pained or heavy. The patient either doth not fleep at all, or is difturbed with dreams. A moift fweat then breaks out all over the fkin. The pulfe is full, quick, and frequent; the judgment is fometimes a little difturbed; young people are apt to be terrified with imaginations; and they for the moft part incline to fleep; the refpiration is difficult, and the belly coftive; at the fame time that a tenfive kind of laffitude is perceived over the whole body. A complete crifis takes place either on the fourth or at the fartheft on the eleventh day. The characteriftic marks of the fimple fynocha, therefore, are, A rednefs of the face, moifture of the fkin, a ftrong and frequent pulfe.

Caufes of, and perfons fubject to, this difeafe. As we have already remarked of intermittents, fo muft we alfo now remark of continued fevers, that it is impoffible to difcover thofe minute caufes which occafion the difference of type betwixt one inflammatory fever and another, though moft authors pretend to enumerate thefe with great certainty. Thus Juncker tells us, that the caufe of the fimple ephemera is plethora, together with any immoderate agitation and commotion of the fluids while in that ftate. Vogel reckons among the caufes of his *febris diaria*, paffions of the mind, pain, want, expofure to the fun, &c.; a repulfion or abforption of certain humours; wounds, fractures, luxations, &c.; fo that in general we may reckon every thing tending to increafe the action of the arterial fyftem to be in certain circumftances a caufe of inflammatory fever.—Hence we find thofe are moft fubject to the fynocha whofe conftitution is either naturally robuft, or who are expofed to thofe caufes which tend to produce an increafed action of the arterial fyftem; fuch as hard labour, high living, &c.

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Prognofis. The moft fimple kind of fynocha, that is, the ephemera or diary fever, is commonly cured without the affiftance of medicine, and therefore the prognofis is for the moft part favourable: yet, if it be improperly treated by heating medicines, it may eafily be converted into the other kind; or, if there be a putrid difpofition of the fluids, into a fever of a very dangerous nature. The fame thing is to be underftood even of the moft violent kind; for fimple inflammatory fevers are not dangerous unlefs complicated with an affection of fome particular part, as the pleura, ftomach, &c.

Cure. Dr Cullen objects to the plan of thofe who are for leaving the cure of continued fevers to the operations of nature; becaufe thefe operations are neither certain in themfelves, nor are they fo well underftood as to enable us to regulate them properly; and it is likewife poffible to fuperfede them by art. The plan therefore on which he proceeds is, to form his indications of cure upon the means of obviating the tendency to death in fevers; and thefe he reduces to three. 1. To moderate the violence of re-action.—2. To remove or obviate the caufes of debility; and, 3. To obviate or correct the tendency of the fluids to putrefaction.

The *firft* indication may be anfwered, 1. By all thofe means which diminifh the action of the heart and arteries. 2. By thofe which take off the fpafm of the extreme veffels, which, according to his theory, is the chief caufe of violent re-action.

I. The action of the heart and arteries may be diminifhed, 1. By avoiding or moderating thofe irritations which, in one degree or other, are almoft conftantly applied to the body. 2. By the ufe of certain fedative powers. 3. By diminifhing the tenfion or tone of the arterial fyftem.

[1.] The irritations above mentioned are the impreffions made upon our fenfes, the exercife of the body and mind, and the taking in of aliments. The avoiding of thefe as much as poffible, or the moderating their force, makes what is properly called the *antiphlogiftic regimen*, proper to be employed in *almoft* every continued fever. This regimen is to be directed in the following manner.

1. Impreffions on the external fenfes, as ftimulant to the fyftem, and a chief fupport of its activity, fhould be avoided as much as poffible; efpecially fuch as are of a ftronger kind, and which give pain and uneafinefs. No impreffion is to be more carefully guarded againft than that of external heat; and at the fame

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fame time every other means of increafing the heat of the body is to be fhunned. Both thefe precautions are to be taken as foon as a hot ftage is fully formed; and to be attended to during its continuance, except in certain cafes, where a determination to fweating is neceffary, or where the ftimulant effects of heat may be compenfated by circumftances which determine it to produce relaxation and revulfion.

2. All motion of the body is to be avoided as much as poffible, and that pofture only chofen which employs the feweft mufcles, and keeps none of them long in a ftate of contraction. Speaking, as it accelerates refpiration, is particularly to be avoided. It muft alfo be obferved, that every motion of the body is more ftimulant in proportion as the patient is weaker.

3. The exercife of the mind is alfo to be avoided, as being a ftimulus to the body; but here an exception is to be made in the cafe of a delirium coming on, when the prefenting of accuftomed objects may divert the irregular train of ideas then arifing in the mind.

4. The prefence of recent aliment in the ftomach proves always a ftimulus to the fyftem, and ought therefore to be as moderate as poffible. A total abftinence for fome time may be of fervice; but as this cannot be long continued with fafety, we muft avoid the ftimulus of aliment by choofing that kind which gives the leaft. Alimentary matters are alfo to be accounted more ftimulant in proportion to their alkalefcent qualities; and this leads us to avoid all animal, and ufe only vegetable food. For the fame reafon, aromatic and fpirituous liquors are to be avoided; and in anfwering the prefent indication, we muft abftain from all fermented liquors except thofe of the loweft quality. Other ftimuli are, the fenfation of thirft, crudities or corrupted humours in the ftomach, a preternatural retention of the fæces in the inteftines, and a general acrimony of all the humours, which is in moft fevers to be fufpected. Thefe are to be removed by fuch methods as the urgency of the fymptoms require, by diluting liquors, vomiting, the ufe of acids, laxative clyfters, and large quantities of antifeptic drinks.

[2.] The fecond method of moderating the violence of reaction is by the employment of certain fedative powers, with a view to diminifh the activity of the whole body, and particularly that of the fanguiferous fyftem. The firft of thefe to be mentioned is the application of cold. Heat is the chief fupport of the activity of the animal-fyftem; and the fyftem is therefore provided with a power of generating heat: but at the fame time we may obferve, that this would go to excefs, were it not conftantly moderated by a cooler temperature in the furrounding atmofphere. When, therefore, the generating power of heat in the fyftem is increafed, as is commonly the cafe in fevers, it is neceffary not only to avoid all further means of increafing it, but alfo to apply air of a cooler temperature; or at leaft to apply it more entirely and freely than in a ftate of health. This is fhown, from fome late obfervations, to be a very powerful means of moderating the violence of re-action: but what is the mode of its operation, to what circumftances of fever it particularly applies, or what limitations it requires, are not yet fully afcertained.

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Another fedative power very frequently employed in fevers, is that of certain medicines known in the materia medica by the name of *refrigerants*. The chief of thefe are acids of all kinds when fufficiently diluted, and which are, in feveral refpects, remedies adapted to continued fevers. Thofe efpecially in ufe are the fulphuric and vegetable; and on many accounts the latter are to be preferred. Another fet of refrigerants are the neutral falts formed of the fulphuric, nitrous or vegetable acids, with alkalies either fixed or volatile. All thefe neutrals, while they are diffolved in water, generate cold; but as that cold ceafes foon after the diffolution is finifhed, and as the falts are generally exhibited in a diffolved ftate, their refrigerant power in the animal body does not all depend upon their power of generating cold with water. Nitre is the refrigerant chiefly employed; but all the others, compounded as above mentioned, partake more or lefs of the fame quality. Befides thefe neutrals, fome metallic falts have alfo been employed in fevers, particularly the acetite of lead: but the refrigerant powers of this falt are by no means afcertained, and its deleterious qualities are too well known to admit of its being freely ufed.

[3.] The third general method of diminifhing the reaction, is by leffening the tenfion, tone, and activity of the fanguiferous fyftem. As the activity of the fyftem in a great meafure depends upon the tone, and this again upon the tenfion, of the veffels, given to them by the quantity of fluids they contain, it is evident, that the diminution of the quantity of thefe muft diminifh the activity of the fanguiferous fyftem. The moft efficacious means of diminifhing the quantity of fluids is by the evacuations of blood-letting and purging. The former is evidently one of the moft powerful means of diminifhing the activity of the whole body, and efpecially of the fanguiferous fyftem; and it muft therefore be the moft effectual means of moderating the reaction in fevers. When the violence of reaction, and its conftant attendant a phlogiftic diathefis, are fufficiently evident; when thefe conftitute the principal part of the difeafe, and may be expected to continue through the whole of it, as in the cafes of fynocha; then blood-letting is the principal remedy, and may be employed as far as the fymptoms of the difeafe may feem to require, and the conftitution of the patient will bear. It muft, however, be remarked, that a greater evacuation than is neceffary may occafion a flower recovery, and render the perfon more liable to a relapfe, or bring on other difeafes. It is alfo to be obferved, that this evacuation is the more effectual, as the blood is more fuddenly drawn off, and as the body is at the fame time more free from all irritation, and therefore when it is in a pofture in which the feweft mufcles are in action.

With regard to purging, when we confider the quantity of fluids conftantly prefent in the cavity of the inteftines, and the quantity which may be drawn off from the innumerable excretories that open into this cavity, it will be obvious, that a very great evacuation may be made in this way; and if this be done by a ftimulus that is not at the fame time communicated to the reft of the body, it may, by emptying both the cavity of the inteftines and the arteries which furnifh

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furnish the excretions poured into it, induce a considerable relaxation in the whole system; and is therefore suited to moderate the violence of reaction in fevers. But it is to be observed, that as the fluid drawn from the excretories opening into the intestines is not all drawn immediately from the arteries, and as what is even more immediately drawn from these is drawn off slowly; so the evacuation will not, in proportion to its quantity, occasion such a sudden depletion of the red vessels as blood-letting does; and therefore cannot act so powerfully in taking off the phlogistic diathesis of the system.

At the same time this evacuation may induce a considerable degree of debility; and therefore, in those cases in which a dangerous state of debility is likely to occur, purging is to be employed with a great deal of caution; and this caution is more difficult to be observed than in the case of blood-letting: and it is further to be noticed, that as purging takes off in some measure the determination of the blood to the vessels on the surface of the body, it seems to be less adapted to the cure of fevers.

II. The other method of moderating the violence of reaction in fevers is by the exhibition of those remedies suited to take off the spasm of the extreme vessels, supposed to be the irritation which chiefly supports the reaction. The means to be employed for this purpose are either internal or external.

First, The internal means are, 1. Those which determine the force of the circulation to the extreme vessels on the surface of the body, and by restoring the tone and activity of those vessels, overcome the spasm on their extremities. 2. Those medicines which have the power of taking off spasm in any part of the system, and which are known under the title of ANTISPASMODICS.

(1.) Those remedies which are fit to determine to the surface of the body are, 1. Diluents. 2. Neutral salts. 3. Sudorifics. 4. Emetics.

1. Water enters, in a large proportion, into the composition of all the animal fluids, and a large quantity of it is always diffused through the whole of the common mass. In a sound state, the fluidity of the whole mass depends upon the quantity of water present in it. Water therefore is the proper diluent of our mass of blood, and other fluids are diluent only in proportion to the quantity of water they contain.

In a healthy state, also the fulness of the extreme vessels and the quantity of excretion are in proportion to the quantity of water present in the body. But in fever, though the excretions be in some measure interrupted, they continue in such quantity as to exhale the more fluid parts of the blood; and, while a portion of them is at the same time necessarily retained in the larger vessels, the smaller, and the extreme vessels, both from the deficiency of fluid and their own contracted state, are less filled, and therefore allowed to remain in that condition. To remedy this contracted state, nothing is more necessary than a large supply of water or watery fluids taken in by drinking or otherwise; for as any superfluous quantity of water is forced off by the several excretories, such a force applied may be a means of dilating the extreme vessels, and of overcoming the spasm affecting their extremities. Accordingly, the throwing in a large quantity of watery fluids, has been, at all times, a remedy much employed in fevers; and in no instance more remarkably than by the Spanish and Italian physicians, in the use of what they call the *diæta aquea*. This practice consists in taking away every other kind of aliment and drink, and in giving, in divided portions, every day for several days together, six or eight pounds of plain water, generally cold, but sometimes warm. This, however, is to be done only after the disease has continued for some time, and at least for a week.

2. A second mean of determining to the surface of the body, is by the use of neutral salts. These neutrals, in a certain dose, taken into the stomach, produce soon after a sense of heat upon the surface of the body; and, if the body be covered close and kept warm, a sweat is readily brought out. The same medicines taken during the cold stage of a fever, very often put an end to it, and bring on the hot one; and they are also remarkable for stopping the vomiting which so frequently attends the cold stage of fevers. All this shows, that neutral salts have a power of determining the blood to the surface of the body, and may therefore be of use in taking off the spasm which subsists there in fevers. The neutral most commonly employed in fevers, is that formed of an alkali with the native acid of vegetables. But all the other neutrals have more or less of the same virtue; and perhaps some of them, particularly the ammoniacal salts, possess it in a stronger degree. As cold water taken into the stomach often shows the same diaphoretic effects with the neutral salts, it is probable that the effect of the latter depends upon their refrigerant powers.

3. A third method of determining to the surface of the body, and taking off the spasm subsisting there, is by the use of sudorifics and by sweating, The propriety of this practice has been much disputed; and many specious arguments may be adduced both for and against it. In its favour may be urged, 1. That in healthy persons, in every case of increased action of the heart and arteries, a sweating takes place, and is, seemingly, the means of preventing the bad effects of such increased action. 2. That, in fevers, their most usual solution and termination is by spontaneous sweating. 3. That, even when excited by art, it has been found useful at certain periods and in certain species of fever.—On the other hand, it may be urged against the practice of sweating, 1. That in fevers, as a spontaneous sweating does not immediately come on, there are some circumstances different from those in the state of health, and which may render it doubtful whether the sweating can be safely excited by art. 2. That in many cases the practice has been attended with bad consequences. The means commonly employed have a tendency to produce an inflammatory diathesis; which, if not taken off by the sweat succeeding, must be increased with much danger. Thus sweating employed to prevent the accessions of intermitting fevers has often changed them into a continued form, which is always dangerous. 3. The utility of the practice is doubtful; as sweating, when it happens, does not always give a final termination, as must be manifest in the case of intermittents, and in many continued fevers which are sometimes in the beginning attended with sweatings which do not prove final; and, on the contrary, whether they be sponta-

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neous or excited by art, they ſeem often to aggravate the diſeaſe.

From theſe conſiderations, it is doubtful if the practice of ſweating can be admitted very generally; but, at the ſame time, it is alſo very doubtful if the failure of the practice, or the miſchiefs ſaid to ariſe from it, have not been owing to the improper conduct of the practitioner. With reſpect to the laſt, it is almoſt agreed among phyſicians, 1. That ſweating has been generally hurtful when excited by ſtimulant, heating, and inflammatory medicines. 2. That it has been hurtful when excited by much external heat, and continued with a great increaſe of the heat of the body. 3. That it is always hurtful when it does not relieve; and rather increaſes the frequency and hardneſs of the pulſe, the anxiety and difficulty of breathing, the headach, and delirium. 4. That it is always hurtful if it be urged when the ſweat is not fluid, and when it is partial and on the ſuperior parts of the body only.

In theſe caſes, it is probable, that either an inflammatory diatheſis is produced, which increaſes the ſpaſm on the extreme veſſels; or that, from other cauſes, the ſpaſm is too much fixed to yield eaſily to the increaſed action of the heart and arteries: and upon either ſuppoſition it muſt be obvious, that urging the ſweat may produce determinations to ſome of the internal parts, with very great danger.

Notwithſtanding theſe doubts, however, it ſtill remains true, 1. That ſweating has been often uſeful in preventing the acceſſions of fevers when they have been certainly foreſeen, and a proper conduct employed. 2. That even after fevers have in ſome meaſure come on, ſweating has interrupted their progreſs when properly employed, either at the very beginning of the diſeaſe, or during its approach and gradual formation. 3. That even after pyrexiæ have continued for ſome time, ſweating has been ſucceſsfully employed in curing them, as is particularly exemplified in the caſe of a rheumatiſm. 4. That certain fevers produced by a very powerful ſedative contagion, have been generally treated moſt ſucceſsfully by ſweating.

Theſe inſtances are in favour of ſweating, but give no general rule; and it muſt be left to farther experience to determine how far any general rule can be eſtabliſhed in this matter. In the mean time, if the practice of ſweating is to be attempted, the following rules may be laid down for the conduct of it: 1. That a ſweat ſhould be excited without the uſe of ſtimulant inflammatory medicines. 2. That it ſhould be excited with as little external heat, and with as little increaſe of the heat of the body, as poſſible. 3. That, when excited, it ſhould be continued for a due length of time; not leſs than 12 hours, and ſometimes for 24 or 48 hours; always, however, ſuppoſing that it proceeds without the dangerous circumſtances already mentioned. 4. That for ſome part of the time, and as long as the perſon can eaſily bear, it ſhould be carried on without admitting of ſleep. 5. That it ſhould be rendered univerſal over the whole body; and therefore particularly that care ſhould be taken to bring the ſweating to the lower extremities. 6. That the practice ſhould be rendered ſafer by moderate purging excited at the ſame time. 7. That it ſhould not be ſuddenly checked by cold anyhow applied to the body.

When attention is to be given to theſe rules, the ſweating may be excited, 1. By warm bathing, or a fomentation of the lower extremities. 2. By frequent draughts of tepid liquors, chiefly water, rendered more grateful by the addition of a light aromatic, or more powerful by that of a ſmall quantity of wine. 3. By giving ſome doſes of neutral ſalts. 4. Moſt effectually, and perhaps moſt ſafely, by a large doſe of an opiate, joined with a portion of neutral ſalts, and of an emetic.

The fourth mean of determining to the ſurface of the body, and thereby taking off the ſpaſm affecting the extreme veſſels, is by the uſe of emetics. Theſe, particularly of the antimonial kind, have been employed in the cure of fevers ever ſince the introduction of chemical medicines; but though of late their uſe has become very general, their efficacy is ſtill diſputed, and their manner of operating is differently explained.

Vomiting is in many reſpects uſeful in fevers: as it evacuates the contents of the ſtomach, as it emulges the biliary and pancreatic ducts, and evacuates the contents of the duodenum, and perhaps alſo of a large portion of the inteſtines; as it agitates the whole of the abdominal viſcera, it expedes the circulation in them, and promotes their ſeveral ſecretions; and, laſtly, as it agitates alſo the viſcera of the thorax, it has like effects there.

It is not to this cauſe, however, that we are to impute the effect vomiting has in determining to the ſurface of the body. This muſt be attributed to the particular operation of emetics upon the muſcular fibres of the ſtomach, whereby they excite the action of the extreme arteries on the ſurface of the body, and by this means effectually determine the blood to theſe veſſels, remove the atony, and take off the ſpaſm affecting them. For this purpoſe they are exhibited in two different ways; that is, either in ſuch doſes as may excite full and repeated vomitings, or in ſuch doſes as may excite ſickneſs and nauſea only, with little or no vomiting at all.

Full vomiting is well ſuited to determine to the ſurface of the body, and thereby to obviate the atony and ſpaſm which lay the foundation of fever. Thus, vomiting excited a little before the expected acceſſion of the paroxyſm of an intermittent, has been found to prevent the paroxyſm altogether. It has been obſerved alſo, that when contagion has been applied to a perſon, and firſt diſcovers its operation, an emetic given has prevented the fever which might otherwiſe have been expected.

Theſe are the advantages to be obtained by exciting vomiting at the firſt approach of fevers, or of the paroxyſm of fevers; and they may alſo be applied after fevers are formed, to take off, perhaps entirely, the atony and ſpaſm, or at leaſt to moderate theſe, ſo that the fever may proceed more gently and ſafely. It is ſeldom, however, that vomiting is found to produce a final ſolution of fevers; and after they are once formed, it is commonly neceſſary to repeat the vomiting ſeveral times; but this is attended with inconveniency, and ſometimes with diſadvantage. The operation of full

full vomiting is tranſitory, and the exerciſe of vomiting is a debilitating power; and therefore, when the vomiting does not remove the atony and ſpaſm very entirely, it may give occaſion to their recurrence with greater force. For theſe reaſons, after fevers are fully formed, ſome phyſicians have thought proper to employ emetics in nauſeating doſes only. Theſe are capable of exciting the action of the extreme veſſels, and their operation is more permanent. At the ſame time they often ſhow their power by exciting ſome degree of ſweat, and their operation is rendered more ſafe by their commonly producing ſome evacuation by ſtool. But nauſea continued for any great length of time, is to moſt patients a ſenſation highly diſtreſſing, and almoſt inſufferable.

The emetics chiefly in uſe at preſent are, ipecacuanha and antimony. The former may be employed for determining to the ſurface of the body: but, even in very ſmall doſes, it ſo readily excites vomiting, that it is with difficulty employed for the purpoſe of nauſeating only; and in whatever manner employed, there is reaſon to ſuſpect that its effects are leſs permanent, and leſs powerfully communicated from the ſtomach to the reſt of the ſyſtem, than thoſe of antimony. This laſt is therefore generally preferred; and its preparations, ſeemingly various, may all be reduced to two heads; one comprehending thoſe in which the reguline part is in a condition to be acted upon by acids, and therefore on meeting with acids in the ſtomach it becomes active; and another, comprehending thoſe preparations in which the reguline part is already joined with an acid, rendering it active. Of each kind there are great numbers, but not differing eſſentially from one another; the two moſt worthy of notice are, the *calx nitrata antimonii*, and *emetic tartar*, or *tartrite of antimony*, of the Edinburgh Diſpenſatory. Both theſe are very efficacious medicines; but the latter ſeems preferable, becauſe its doſe is capable of being better aſcertained; though the former, on account of its ſlower operation, may have ſome advantages, and in certain caſes be more efficacious as a purgative and ſudorific.

The *calx nitrata antimonii*, when firſt introduced into the pharmacopœia of the Edinburgh college was ſuppoſed to be very nearly, if not preciſely, the ſame with a medicine which has of late been highly celebrated in the cure of fevers, Dr James's powder. But from more accurate obſervations, there is now reaſon to believe that the pulvis antimonialis of the London Pharmacopœia, formed by the calcination of antimony with hartſhorn, approaches more nearly to that celebrated arcanum. But at any rate, the calx antimonii nitrata, the pulvis antimonialis, and James's powder, are probably not eſſentially different from each other. The two latter, however, have the moſt near reſemblance; and accordingly the Edinburgh college, in their Pharmacopœia, have introduced an article under the title of *antimonium calcareo-phoſphoratum*, which they conſider as ſo much ſimilar to James's powder, that they have uſed as a ſynonyme for it, the title of *pulvis Jacobi*.

The time moſt proper for exhibiting thoſe medicines is a little before the acceſſion, when that can be certainly known. In continued fevers the exacerbations are not always very obſervable; but there is reaſon to believe, that one commonly happens about noon or ſoon after it; and that theſe, therefore, are the moſt proper times for exhibiting emetics.

With reſpect to the manner of adminiſtration, that of the *calx nitrata* is ſimple, as the whole of what is thought a proper doſe may be given at once; and no more can be properly given till the next acceſſion. The adminiſtration of the emetic tartar is different. It is to be given in ſmall doſes, not ſufficient to excite vomiting; and theſe doſes are to be repeated after ſhort intervals for ſeveral times, till ſickneſs, nauſea, and ſome, though not much, vomiting come on. The difference of adminiſtration muſt depend upon the doſe, and the length of the interval at which it is given. If it be intended that the medicine ſhould certainly operate by ſtool, the doſes are made ſmall, and the intervals long. On the contrary, when vomiting is proper, or when much purging ought to be avoided, and therefore ſome vomiting muſt be admitted, the doſes are made larger, and the intervals ſhorter. With reſpect to both kinds of preparations, the repetition is to be made at the times of acceſſion, but not very often: for if the firſt exhibitions, duly managed, have little effect, it is ſeldom that the after exhibitions have much; and it ſometimes happens that the repeated vomiting, and eſpecially repeated purging, does harm by weakening the patient.

(2.) The other ſet of internal medicines which are ſuppoſed uſeful in taking off the ſpaſm of the extreme veſſels, are thoſe named *antiſpaſmodics*. But whatever may be the virtues of ſome of them in this way, ſuch is their power of ſtimulating at the ſame time, that very few of them can with ſafety be adminiſtered in fevers of an inflammatory nature. Almoſt the only one which can with ſafety be exhibited in theſe caſes is camphor; and the operations of this are by no means well aſcertained. Dr Huxham mentions it as a corrector of the acrimony of cantharides; and aſſures us, that it very effectually promotes a diaphoreſis. But from the remarks of other practitioners, we have no juſt reaſon to ſuppoſe that it acts perceptibly in a doſe of five or ſix grains, though in 15 or 20 it produces a particular kind of intoxication.

Secondly, The external means ſuited to take off the ſpaſm of the extreme veſſels, are bliſtering and warm bathing.

1. What are the effects of bliſtering ſo frequently employed in fevers is not yet agreed among phyſicians. Dr Cullen is of opinion, that the ſmall quantity of cantharides abſorbed from a bliſtering plaſter, is not ſufficient to change the conſiſtence of the maſs of blood; and therefore, that ſuch a quantity can neither do good by reſolving phlogiſtic lentor if it exiſts, nor do harm by increaſing the diſſolution of the blood ariſing from a putrid tendency in it. The effects of cantharides upon the fluids, therefore, may be entirely neglected. The inflammation produced by the application of cantharides to the ſkin, affords a certain proof of their ſtimulant power: but in many perſons the effect of that ſtimulus is not conſiderable; in many it is not communicated to the whole ſyſtem; and even when it does take place in the whole ſyſtem, it ſeems to be taken off very entirely by the effuſion and evacuation of ſerum from the bliſtered part. It may be concluded, therefore, that neither much good is to be expected,

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nor much harm to be apprehended, from the ſtimulant power of bliſtering; and the certainty of this concluſion is eſtabliſhed by the great benefit ariſing from the proper practice of bliſtering in inflammatory diſeaſes. Much has been imputed to the evacuation made by bliſtering; but it is never ſo conſiderable as to affect the whole ſyſtem; and therefore can neither, by a ſudden depletion, relax the ſanguiferous ſyſtem, nor by any revulſion affect the general diſtribution of the fluids. The evacuation, however, is ſo conſiderable as to affect the neighbouring veſſels; and the manifeſt utility of bliſtering near the part affected in inflammatory diſeaſes leads us to think, that bliſtering, by deriving to the ſkin, and producing an effuſion there, relaxes the ſpaſm of the deeper ſeated veſſels. It is in this manner, moſt probably, that the tumor of a joint, from an effuſion into the cellular texture under the ſkin, takes off the rheumatic pain formerly affecting that joint. Analogous to this, probably, is the good effect of bliſtering in continued fevers, ariſing from the relaxation of the ſpaſm of the extreme veſſels by a communication of the bliſtered part with the reſt of the ſkin. A bliſter may be employed at any period in continued fevers; but it will be of moſt advantage in the advanced ſtate of ſuch fevers, when, the reaction being weaker, all ambiguity from the ſtimulating power of bliſtering is removed, and when it may beſt concur with other circumſtances tending to a final ſolution of the ſpaſm.

From this view of the matter, it will appear, that the part of the body to which bliſters ought to be applied is indifferent, except upon the ſuſpicion of topical affection, when the bliſtering is to be made as near as poſſible to the part affected. Whether ſinapiſms and other *rubefacientia* act in a manner analogous to what has been ſuppoſed of bliſtering may be doubtful; but their effects in rheumatiſm and other inflammatory diſeaſes render it probable.

2. The other external means of taking off the ſpaſm of the extreme veſſels is warm bathing. This was frequently, and in different circumſtances, employed by the ancients; but has, till very lately, been neglected by modern phyſicians. As the heat of the bath ſtimulates the extreme veſſels, and, with the concurrence of moiſture, alſo relaxes them, it ſeems to be a ſafe ſtimulus, and well ſuited to take off the ſpaſm affecting theſe veſſels. It may be applied to the whole body by immerſion; but this is in many reſpects inconvenient. From extenſive experience it appears, that moſt of the purpoſes of warm bathing can be obtained by a fomentation of the legs and feet, if properly adminiſtered, and continued for a due length of time, not leſs than an hour. The marks of the good effects of ſuch a fomentation are, the patient's bearing it eaſily, its relieving delirium, and inducing ſleep.

364 GENUS V. TYPHUS; *the Typhous* FEVER.
Typhus, *Sauv.* gen. 82. *Sag.* 677.

365 I. Typhus mitior, or the *Slow Nervous* FEVER. Sp. I. var. I.

Febris maligna hectica convulſiva, ſive lues νευρωδης, *Willis* de morb. convulſiv. cap. 8.

Febris peſtilens, *Fracaſtor.* de morb. contag. lib. ii. cap. 4.

Typhus.

Febris peſtilens, ſine charactere veneni, *Foreſt*, l. vi. obſ. 26.

Febris hectica peſtilens, *Foreſt*, l. vi. obſ. 32.

Febris nova ann. 1685, *Sydenham*, Sched. monitor.

Febris putrida nervoſa, *Wintringh.* Com. Noſolog. ad ann. 1720, 1721.

Febris lenta nervoſa, *Huxham* on fevers, chap. 8.

Febris contagioſa, *Lind* on fevers and infection, *paſſim.*

Typhus nervoſus, *Sauv.* ſp. 2.

Typhus comatoſus, *Sauv.* ſp. 3.

Tritæophya typhodes Mangeti, *Sauv.* ſp. 11. *Raym. Fort.* de febribus.

Deſcription. Of all the deſcriptions we have of the nervous fever, that of Dr Huxham is perhaps the beſt. According to him, the patient at firſt grows ſomewhat liſtleſs, and feels ſlight chills and ſhudders, with uncertain fluſhes of heat, and a kind of wearineſs all over, like what is felt after great fatigue. This is always attended with a ſort of heavineſs and dejection of ſpirit, and more or leſs of a load, pain, or giddineſs of the head; a nauſea or diſreliſh of every thing ſoon follows, without any conſiderable thirſt, but frequently with retching to vomit, though little but inſipid phlegm is brought up. Though a kind of lucid interval of ſeveral hours ſometimes intervenes, yet the ſymptoms return with aggravation, eſpecially towards night; the head grows more giddy or heavy; the heat greater; the pulſe quicker, but weak; with an oppreſſive kind of breathing. A great torpor, or obtuſe pain and coldneſs, affects the hinder part of the head frequently, and oftentimes a heavy pain is felt on the top all along the *coronary ſuture;* this, and that of the back part of the head, generally attend nervous fevers, and are commonly ſucceeded by ſome degree of a delirium. In this condition the patient often continues for five or ſix days, with a heavy, pale, ſunk countenance; ſeemingly not very ſick, and yet far from being well; reſtleſs, anxious, and commonly quite void of ſleep, though ſometimes very drowſy and heavy; but although he appears to thoſe about him actually to ſleep, he is utterly inſenſible of it. The pulſe during all this time is quick, weak, and unequal; ſometimes fluttering, and ſometimes for a few moments ſlow; nay, even intermitting, and then, with a ſudden fluſh in the face, immediately very quick, and perhaps ſoon after ſurpriſingly calm and equal; and thus alternately. The heats and chills are as uncertain and unequal; ſometimes a ſudden colour and glow ariſe in the cheeks, while the tip of the noſe and ears is cold, and the forehead at the ſame time in a cold dewy ſweat. Nay, it is very common, that a high colour and heat appear in the face, when the extremities are quite cold. The urine is commonly pale, and often limpid; frequently of a whey colour, or like vapid ſmall beer, in which there is either no manner of ſediment, or a kind of looſe matter like bran irregularly ſcattered up and down in it. The tongue at the beginning is ſeldom or never dry or diſcoloured, but ſometimes covered with a thin whitiſh mucus: at length, indeed, it often appears very dry, red, and chapped, or of the colour of pomegranate rind; but this chiefly at the cloſe of the diſeaſe: yet, however dry the tongue and lips ſeem, the patient ſeldom complains of thirſt, though ſometimes of a heat in the tongue. About the ſeventh or eighth day, the giddineſs,

giddineſs, pain, or heavineſs of the head become much greater, with a conſtant noiſe in it, or *tinnitus aurium;* which is very diſturbing to the ſick, and frequently brings on a delirium. The load on the præcordia, anxiety and faintneſs, grow much more urgent; and patients often fall into an actual deliquium, eſpecially if they attempt to ſit up; cold ſweats ſuddenly come out on the forehead, and on the backs of the hands (though at the ſame time there be too much heat in the cheeks and palms), and as ſuddenly go off. If the urine now grow more pale and limpid, a delirium is certainly to be expected, with univerſal tremors and *ſubſultus tendinum;* the delirium is ſeldom violent, but as it were a confuſion of thought and action, muttering continually and faltering in their ſpeech. Sometimes they awake only in a hurry and confuſion, and preſently recollect themſelves, but forthwith fall into a muttering dozy ſtate again. The tongue grows often very dry at the height, eſpecially in its middle part, with a yellowiſh liſt on each ſide, and trembles greatly when the ſick attempts to put it out. Frequently profuſe ſweats pour forth all at once, about the ninth, tenth, or eleventh day, commonly coldiſh and clammy on the extremities; oftentimes very thin ſtools are diſcharged, and then nature ſinks apace; the extremities grow cold, the nails pale or livid; the pulſe may be ſaid to tremble and flutter, rather than to beat, the vibrations being ſo exceedingly weak and quick that they can ſcarce be diſtinguiſhed; though ſometimes they creep on ſurpriſingly ſlow, and very frequently intermit. The ſick become quite inſenſible and ſtupid, ſcarce affected with the loudeſt noiſe or the ſtrongeſt light; though, at the beginning, ſtrangely ſuſceptible of the impreſſions of either. The delirium now ends in a profound coma, and that ſoon in death. The ſtools, urine, and tears, run off involuntarily, and denounce a ſpeedy diſſolution, as the tremblings and twitchings of the nerves and tendons are preludes to a general convulſion, which at once ſnaps the thread of life. In one or other of theſe ways are the ſick carried off, after having languiſhed for 14, 18, or 20 days; nay, ſometimes much longer. Moſt patients grow deaf and ſtupid towards the end of this diſeaſe (ſome extremely deaf), though too quick and apprehenſive at the beginning; inſomuch that the leaſt noiſe or light greatly offended them. Many from their immoderate fears ſeem to hurry themſelves out of life, where little danger is apparent at the beginning: nay, ſome will not allow themſelves to ſleep, from a vain fear of dozing quite away; and others from the vaſt hurry, anxiety, and confuſion of which they are ſenſible either during ſleep or at their waking.

Cauſes of, and perſons ſubject to, this diſorder. The nervous fever is moſt frequently the conſequence of contagion. It moſt commonly attacks perſons of weak nerves, a lax habit of body, and a poor thin blood; thoſe who have ſuffered great evacuations, a long dejection of ſpirits, immoderate watchings, ſtudies, fatigue, &c.; alſo thoſe who have uſed much crude unwholeſome food, vapid impure drinks, or who have been confined long in damp foul air; who have broken the vigour of their conſtitutions by ſalivations, too frequent purging, immoderate venery, &c. Hence we ſee how the diſeaſe is connected with an extreme debility of the nervous ſyſtem; for when people are prepared for this fever by having their nerves already weakened, the contagious particles immediately attack the nervous ſyſtem, without ſo much affecting the ſtate of the blood or juices, though the latter are greatly affected in the putrid malignant fevers.

Prognoſis. In nervous fevers, the prognoſis is very much the ſame with that of the putrid malignant kind. And although death be not ſo frequent as in that modification of fever, yet it may juſtly be conſidered as a very fatal diſeaſe.

Cure. As this fever is produced by contagion affecting the nervous ſyſtem of a perſon already debilitated, and thus producing weakneſs in an extreme degree, we have now occaſion to conſider Dr Cullen's *two indications* of cure omitted under the *Synocha;* namely, to remove the cauſe and obviate the effects of debility, and to correct the putreſcent tendency of the fluids; for though, in the beginning of nervous fevers, the tendency to putrefaction be not remarkable, it becomes exceedingly great towards their concluſion.

[1.] In anſwering the firſt indication, Dr Cullen obſerves, that moſt of the ſedative powers inducing debility ceaſe to act ſoon after they have been firſt applied; and therefore the removing them is not an object of the preſent indication. There is only one which may be ſuppoſed to continue to act for a long time, and that is the contagion applied; but we know nothing in the nature of contagion that can lead us to any meaſures for removing or correcting it. We know only its effects as a ſedative power inducing debility, or as a ferment inducing a tendency to putrefaction in the fluids, the former of which at preſent falls under our conſideration.—The debility induced in fevers by contagion, or other cauſes, appears eſpecially in the weaker energy of the brain; but in what this conſiſts, or how it may be reſtored, we do not well know; but as nature, ſeemingly for this purpoſe, excites the motion of the heart and arteries, we muſt aſcribe the continuance of the debility to the weaker re-action of the ſanguiferous ſyſtem: the means, therefore, which we employ for obviating debility, are immediately directed to ſupport and increaſe the action of the heart and arteries; and the remedies employed are tonics or ſtimulants.

In contagious diſeaſes we know, both from the effects which appear, and from diſſections, that the tone of the heart and arteries is conſiderably diminiſhed; and that tonic remedies are therefore properly indicated. We are to conſider theſe remedies as of two kinds; 1. The power of cold; 2. That of tonic medicines.

The power of cold as a tonic in fevers may be employed in two ways: either as thrown into the ſtomach, or as applied to the ſurface of the body. As we have already obſerved that the power of cold may be communicated from any one part to every other part of the ſyſtem, ſo it will be readily allowed that the ſtomach is a part as fit as any other for this communication, and that cold drink taken into the ſtomach may prove an uſeful tonic in fevers. This the experience of all ages has confirmed, but at the ſame time it has been frequently obſerved, that, in certain circumſtances, cold drink taken into the ſtomach has proved very hurtful; and therefore that its uſe in fevers requires ſome limitations.

tations. What these limitations should be, and what are all the circumstances which may forbid the use of cold drink, it is difficult to determine; but it seems clearly forbidden in all cases where a phlogistic diathesis prevails in the system, and more especially when there are topical affections of an inflammatory nature.

The other method of employing cold as a tonic, is by applying it to the surface of the body, as a refrigerant power fit to moderate the violence of reaction; but probably it may here also be considered properly as a tonic, and useful in cases of debility.—Not only cool air, but cold water also may be applied to the surface of the body as a tonic. The ancients frequently applied it with advantage to particular parts as a tonic; but it is a discovery of modern times, that, in the case of putrid fevers attended with much debility, the body may be washed all over with cold water. This was first practised at Breslaw in Silesia, as appears from a dissertation under the title of *Epidemia Verna, quæ Wratislaviam, anno* 1737 *afflixit*, to be found in the *Acta Nat. Curios.* vol. x. And from other writers it appears, that the practice has passed into some of the neighbouring countries. But in Britain the use of cold water externally applied has of late been more extensively introduced than into any other country of Europe. For this we are chiefly indebted to the late ingenious Dr Currie of Liverpool. He has recommended the dashing cold water over the whole surface of the body, as a means not only of obviating heat, delirium, and other symptoms most urgent; but of putting an immediate stop to the disease. And there can be no doubt that the practice has often been attended with the most salutary consequences. But it is by no means so generally advantageous as Dr Currie and some others are inclined to believe. It is in but very rare instances that an artificial termination of fever can thus be obtained; and even as obviating symptoms, it is not unfrequently attended with bad consequences. It can never be employed with safety unless where the heat is very urgent. And perhaps all the advantages of cold immersion may be obtained merely from cold washing, a practice now very common in Britain.

The medicines which have been employed in fevers as tonics are various. If the acetite of lead hath been found useful, it is probably as a tonic rather than as a refrigerant; and the *ens veneris*, or other preparations of iron which have been employed, can act as tonics only. The preparations of copper, from their effects in epilepsy, are presumed to possess a tonic power; but whether their use in fevers be founded on their tonic or emetic powers, is uncertain. And upon the whole there may no doubt occur some instances of fevers being cured by tonics taken from the fossil kingdom; but the vegetable tonics are the most efficacious, and among these the cinchona certainly holds the first place.

The cinchona has commonly been considered as a specific, or a remedy of which the operation was not understood. We must observe, however, that, as in many cases the effects of the bark are perceived soon after its being taken into the stomach, and before it can possibly be conveyed to the mass of blood, we may conclude, that its effects do not arise from its operating on the fluids; and must therefore depend upon its acting on the nerves of the stomach, and being thereby communicated to the rest of the nervous system. This operation seems to be a tonic power, the bark being a remedy in many cases of debility, particularly in gangrene; and if its operation may be explained from its possessing a tonic power, we may easily perceive why it is improper when a phlogistic diathesis prevails; and from the same view we can ascertain in what cases of continued fever it may be admitted. These cases are either where considerable remissions have appeared, when it may be employed to prevent the return of exacerbations, on the same footing as it is used in intermitting fevers; or in the advanced state of fevers, when all suspicion of an inflammatory condition is removed, and a general debility prevails in the system; and its being then employed is sufficiently agreeable to the present practice.

Another set of medicines to be employed for obviating debility and its effects, are the direct stimulants. These, in some measure, increase the tone of the moving fibres; but are different from the tonics, as they more directly excite and increase the action of the heart and arteries. This mode of operation renders their use ambiguous; and when an inflammatory diathesis is present, the effects of the stimulants may be very hurtful; but it is still probable, that in the advanced state of these fevers, when debility prevails, they may be useful.

Of all the stimulants which may be properly employed, wine seems to be the most eligible. It has the advantage of being grateful to the palate and stomach, and of having its stimulant parts so much diluted, that it can be conveniently given in small doses; and therefore it may be employed with sufficient safety. —It may be suspected that wine has an operation analogous to that of opium; and on good grounds. But we can distinctly remark its stimulant power only; which renders its effects in the phrenetic delirium manifestly hurtful; and in the mild delirium depending on debility, as remarkably useful.

[2.] We must now proceed to the other indication of cure, namely, to correct or obviate the tendency in the fluids to putrefaction. This may be done, 1. By avoiding any new application of putrid or putrescent matter. 2. By evacuating the putrid or putrescent matter already present in the body. 3. By correcting the putrid or putrescent matter remaining in the body by diluents and antiseptics. 4. By supporting the tone of the vessels, and thereby resisting further putrefaction, or obviating its effects. 5. By moderating the violence of reaction, considered as a means of increasing putrefaction.

The further application of putrid or putrescent matter may be avoided, 1. By removing the patient from places filled with corrupted air. 2. By preventing the accumulation of the patient's own effluvia, by a constant ventilation, and by a frequent change of bedclothes and body linen. 3. By the careful and speedy removal of all excremental matters from the patient's chamber. 4. By avoiding animal food.

The putrid or putrescent matter already present in the body, may be evacuated partly by frequent evacuations of the contents of the intestines; and more effectually still by supporting the excretions of perspiration

Febres. ration and urine by the plentiful uſe of diluents. That which remains in the body may be rendered more mild and innocent by the uſe of diluents, or may be corrected by the uſe of antiſeptics. Theſe laſt are of many and various kinds; but which of them are conveniently applicable, or more particularly ſuited to the caſe of fevers, is not well aſcertained. Thoſe moſt certainly applicable and uſeful are aceſcent aliments, particularly fruits, acids of all kinds, and neutral ſalts.

The progreſs of putrefaction may be conſiderably retarded, and its effects obviated, by ſupporting the tone of the veſſels; and this may be done by tonic medicines, of which the chief are cold, and the Peruvian bark, as already mentioned. The violence of reaction increaſing the tendency to putrefaction, may be moderated by the means already mentioned under *Synocha*.

Theſe are the proper indications to be obſerved in the cure of the ſlow nervous fever; and they are chiefly fulfilled by cleanlineſs, cool air, and diluents; which, perhaps, upon the whole, are more uſeful in fevers, than all other practices put together. Dr Huxham obſerves, that evacuations (eſpecially bleeding), are improper even at the beginning. Even a common purgative given at this time hath been followed by ſurpriſing languors, ſyncope, and a train of other ill ſymptoms. It may, however, ſometimes be neceſſary to cleanſe the ſtomach and primæ viæ by a gentle emetic, or a mild laxative. Indeed, where nauſea, ſickneſs and load at ſtomach are urgent, as is frequently the caſe in the beginning of this fever, a vomit is neceſſary. Clyſters of milk, ſugar, and ſalt, may be injected with ſafety and advantage every ſecond or third day, if nature wants to be prompted to ſtool. The temperate, cordial, diaphoretic medicines, are certainly, according to our author, moſt proper in theſe fevers; and a well-regulated, ſupporting, diluting diet is neceſſary. The latter of itſelf, judiciouſly managed, will go a great way in the cure, eſpecially if aſſiſted by well-timed and well-applied bliſters, and a due care to keep the patient as quiet as poſſible both in body and mind. But it ſhould be noted, that ſtrong opiates are commonly very pernicious, however much the want of ſleep and reſtleſſneſs may ſeem to demand them. Mild diaphoretics, ſuch as neutral draughts or elixir paregoricum, have much better effects; which, by raiſing a gentle eaſy ſweat, or at leaſt a plentiful perſpiration, calm the hurry of the ſpirits, and a refreſhing ſleep enſues. Where the confuſion and dejection of ſpirits are very conſiderable, bliſters have been adviſed to be applied to the neck, occiput, or behind the ears; and during all this a free uſe of thin wine whey, ſome pleaſant ptiſan or gruel, with a little pure wine, muſt be directed. Indeed the patients, in this caſe ſhould drink frequently: though ſuch quantities may not be neceſſary as in the ardent or even putrid malignant fevers; yet they ſhould be ſufficient to carry on the work of dilution, ſupport the ſweats, and ſupply the blood with freſh and wholeſome fluids, in place of that noxious matter which is continually paſſing off. In this view alſo a thin chicken-broth is of ſervice, both as food and phyſic, eſpecially towards the decline of the diſeaſe; and for the ſame reaſon thin jellies of hartſhorn, ſago, and panada, are uſeful, adding a little wine to them, and the juice of orange or lemon.

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The above-mentioned difficulty of breathing, anxiety, and oppreſſion, many times precede a miliary eruption, which often appears on the ſeventh, ninth, or eleventh day of the fever, and ſometimes later. Indeed great anxiety and oppreſſion on the præcordia always precede puſtular eruptions of any kind in all ſorts of fevers. This eruption ſhould be promoted by ſoft eaſy cordials and proper diluents; to which ſhould be ſometimes added ſome gentle aromatics. Theſe tend to calm the univerſal uneaſineſs commonly complained of, and alſo very effectually promote a diaphoreſis, with which the miliary eruptions freely and eaſily advance. But however advantageous theſe commonly are, profuſe ſweats are ſeldom or never ſo, even though attended with a very large eruption. Two or three crops of theſe miliary puſtules have been known to ſucceed one another, following profuſe ſweats, not only without advantage, but with great detriment to the patients, as they were thereby reduced to an extreme degree of weakneſs; ſo that they may juſtly be reckoned ſymptomatic rather than any thing elſe, and the conſequent eruption is often merely the ſymptom of a ſymptom.

In theſe profuſe colliquative ſweatings a little generous red wine (diluted ſomewhat, if neceſſary) may be given with the greateſt advantage; as it preſently moderates the ſweats, ſupports the patient, and keeps up the miliary papulæ if they happen to attend. Towards the decline of the fever alſo, where the ſweats are abundant and weakening, ſmall doſes of the tincture of cinchona with ſaffron and ſnakeroot may be given with the greateſt advantage, frequently interpoſing a doſe of rhubarb to carry off the putrid colluvies in the firſt paſſages; which withal makes the remiſſions or intermiſſions that often happen in the decline of nervous fevers

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fevers more distinct and manifest, and gives a fairer opportunity of throwing in the bark; for in the proper exhibition of this medicine we are to place our chief hope of curing both the nervous and putrid malignant fevers.

166 II. Typhus gravior, or the *putrid*, *pestilential*, or *malignant FEVER*. Sp. I. var. 2.

Febris pestilens, *P. Sal. Divers.* de febre pestilenti.

Febris pestilens Ægyptiorum, *Alpin.* de med. Ægypt. l. i. cap. 14.

Typhus Ægyptiacus, *Sauv.* sp. 6.

Febris pestilens maligna, *Sennert.* de febribus, l. iv. cap. 10.

Febris maligna pestilens, *River*, l. xvii. sect. iii. cap. 1.

Febris pestilens maligna, ann. 1643, *Willis*, de febribus, cap. 14.

Typhus carcerum, *Sauv.* sp. 1.

Febris nautica pestilentialis, *Huxham* de aëre ad ann. 1740.

Miliaris nautica, *Sauv.* sp. g.

Febris putrida contagiosa in carceribus genita, *Huxham* de aëre ad ann. 1742.

Miliaris purpurata, *Sauv.* sp. h.

Febris carcerum et nosocomiorum. *Pringle*, Diseases of the army, p. 294. *Van Swieten*, Maladies des armés, p. 136.

Typhus castrensis, *Sauv.* sp. 5.

Febris castrensis, quam vulgò cephalalgiam epidemicam vocant, *Henr. Maii* et *A. Ph. Koph.* Diss. apud *Hallerum*, tom. v.

Febris Hungarica sive castrensis, *Juncker*, 74. et *plurium auctorum.*

Febris castrensis Gallorum in Bohemiâ, ann. 1742, *Scrinci.* Diss. apud *Haller.* tom. v.

Febris petechialis, *Sennert.* l. iv. cap. 13. *River.* prax. l. xvii. sect. iii. cap. 1. *Hoffm.* ii. p. 84. *Juncker*, 73. *Huxham* on fevers, chap. 8. *Ludwig.* Inst. med. clin. N° 146. *Schreiber* von erkentness, und cur der Krank heiten, p. 126. *Monro*, Diseases of military hospitals, p. 1.

Febris catarrhalis maligna petechizans, *Juncker*, 72. *Hoffm.* ii. 75. *Eller* de cogn. et cur. morb. sect. vi.

Febris quæ lenticulas, puncticula, aut peticulas vocant, *Fracastorius* de morb. contag. lib. ii. cap. 6.

Febris peticularis Tridenti, ann. 1591. *Roboretus* de febr. peticul.

Febris petechialis epidemica Coloniæ, ann. 1672. *Donckers*, Idia febris petechialis.

Febris petechialis epidemica Posonii, 1683, *C. F. Loeu* in App. ad. A. N. C. vol. ii.

Febris petechialis epidemica Mutinæ, 1692. *Ramazzini.* Const. Mutinensis, oper. p. 177.

Febris maligna petechizans, ann. 1698. *Hoffm.* ii. p. 80.

Febris petechialis Wratislaviæ, ann. 1699. *Helwich*, Ephem. Germ. D. III. A. VII. et VIII. obs. 132. p. 616.

Febris epidemica Lipsiæ, 1718. *M. Adolph.* A. N. C. III. obs. 131. p. 296.

Febris endemica et epidemica Corcagiensis, ann. 1708, 1718, et seq. *Rogers*, Essay on Epidemic diseases.

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Febris continua epidemica Corcagiensis, ann. 1719. et seq. *M. O'Connel*, Obs. de morbis.

Febris petechialis epidemica Cremonæ, 1734. *Valcarenghi* Med. ration. sect. 3.

Febris petechizans Petropoli, 1735. *Weitbrecht.* Diss. apud Haller. tom. v.

Febris petechialis, ann. 1740, 1741, in Hassia. *Ritter.* A. N. C. vol. vii. obs. 4.

Febris maligna petechialis Rintelli, 1741. *Furstenau*, A. N. C. vol. vii. obs. 5.

Febris petechialis epidemica Silesiæ, 1741, et seq. *Bandhorst.* Diss. apud *Haller.* tom. v.

Febris petechialis epidemica Viennæ, 1757. *Hasenohrl.* Hist. med. cap. 2.

Febris petechialis epidemica Lipsiæ, 1757. *Luduvig.* Adversar. tom. i. pars 1.

Febris petechialis epidemica variis Germaniæ locis ab ann. 1755 ad 1761. *Strack* de morbo cum petechiis.

Description. This disease has been supposed to differ from the former in degree only; and there are many circumstances which would lead us to conclude, that both frequently originate from a contagion precisely of the same nature. In the same manner we see, during different seasons, and in different circumstances, various degrees of malignity in smallpox. Though every instance of the disease depends on the introduction of a peculiar and specific contagion into the body, yet this contagion in particular epidemics evidently possesses peculiar malignancy. The same is probably the case with the typhoid fever: But whether this observation be well founded or not, there cannot be a doubt that the typhus gravior or putrid fever is a disease of the most dangerous nature, as, besides the extreme debility of the nervous system, there is a rapid tendency of the fluids to putrefaction, which sometimes cuts off the patient in a few days, nay, in the warm climates, in 12 or 14 hours; or if the patient recovers, he is for a long time, even in this country, in an exceedingly weak state, and requires many weeks to recover his former health.

The putrid fevers, according to Huxham, make their attack with much more violence than the slow nervous ones; the rigors are sometimes very great, though sometimes scarce felt; the heats much sharper and permanent; yet, at first, sudden, transient, and remittent: the pulse more tense and hard, but commonly quick and small; though sometimes slow, and seemingly regular for a time, and then fluttering and unequal. The headach, nausea, and vomiting, are much more considerable even from the beginning. Sometimes a severe fixed pain is felt in one or both temples, or over one or both eyebrows; frequently in the bottom of the orbits of the eyes. The eyes always appear very dull, heavy, sometimes yellowish, and very often a little inflamed. The countenance seems bloated, and more dead-coloured than usual. Commonly the temporal arteries throb much, and a tinnitus aurium is very troublesome: a strong vibration also of the carotid arteries frequently takes place in the advance of the fever, though the pulse at the wrist may be small, nay even slow: this is a certain sign of an impending delirium, Febre- rium, and generally proceeds from some considerable obstructions in the brain.

The prostration of spirits, weakness, and faintness, are often surprisingly great and sudden, though no inordinate evacuation happens; and this too sometimes when the pulse seems tolerably strong. The respiration is most commonly laborious, and interrupted with a kind of sighing or sobbing, and the breath is hot and offensive.

Few or none of these fevers are without pain in the back and loins; always an universal weariness or soreness is felt, and often much pain in the limbs. Sometimes a great heat, load, and pain, affect the pit of the stomach, with perpetual vomiting of porraceous or black bile, and a most troublesome singultus; the matter discharged is frequently of a very nauseous smell. The tongue, though only white at the beginning, grows daily more dark and dry; sometimes of a shining livid colour, with a kind of dark bubble at top; sometimes exceeding black; and so continues for many days together; nor is the tinct to be got off many times for several days, even after a favourable crisis: at the height of the disease, it generally becomes very dry, stiff, and black, or of a dark pomegranate colour. Hence the speech is very inarticulate, and scarce intelligible. The thirst in the increase of the fever is commonly very great, sometimes unquenchable; and yet no kind of drink pleases, but all seem bitter and mawkish; at other times, however, no thirst is complained of, though the mouth and tongue are exceedingly foul and dry; this is always a dangerous symptom, and ends in a frenzy or coma. The lips and teeth, especially near the height, are covered with a very black tenacious sordes. At the commencement of the fever, the urine is often crude, pale, and vapid, but grows much higher coloured in the advance, and frequently resembles a strong lixivium, or citrine urine, tinged with a small quantity of blood; it is without the least sediment or cloud, and so continues for many days together: by degrees it grows darker, like dead strong high-coloured beer, and smells very rank and offensive. In petechial fevers, the urine has often been seen almost black and very *fetid*. The stools, especially near the height, or in the decline of the fever, are for the most part intolerably fetid, green, livid, or black, frequently with severe gripes and blood. When they are more yellow or brown, the less is the danger; but the highest when they run off insensibly, whatever their colour may be. It is likewise a very bad symptom when the belly continues tense, swollen, and hard, after profuse stools; for this is generally the consequence of an inflammation or mortification of the intestines. A gentle diarrhœa is often very beneficial, and sometimes seems to be the only way which nature takes to carry off the morbific matter.

Sometimes black, livid, dun, or greenish spots appear on different parts of the skin, particularly on the breast, which always indicate a high degree of malignity; but the more florid the spots are, the less danger is to be feared. It is also a good sign when the black or violet petechiæ become of a brighter colour. The large, black, or livid spots, are almost always attended with profuse hæmorrhagies; and the small, dusky, brown spots, like freckles, are not much less dangerous than the livid or black; though they are seldom accompanied with fluxes of blood: excessively profuse, cold, clammy sweats are often concomitant, by which also they sometimes vanish, though without any advantage to the patient. The eruption of the petechiæ is uncertain; sometimes they appear on the fourth or fifth day, though sometimes not till the eleventh, or even later. The *vibices*, or large dark blue or greenish marks, seldom appear till very near the fatal period. Frequently also we meet with an efflorescence like the measles in malignant fevers, but of a much more dull and livid hue; in which the skin, especially on the breast, appears as it were marbled or variegated. This in general is an ill symptom, and is often attended with fatal consequences.

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Sometimes about the 11th or 14th day, on the occurrence of profuse sweats, the petechiæ disappear, and vast quantities of white miliary pustules break out. This is seldom found of any considerable advantage; but an itching, smarting, red rash, commonly gives great relief; and so do the large, fretting, watery bladders, which many times rise upon the back, breast, shoulders, &c. A scabby eruption likewise about the lips and nose is one of the salutary symptoms; and the more hot and angry it is, so much the better. But of much more uncertain and dangerous event are the brown-coloured aphthæ; nor are those that are exceeding white and thick, like lard, of a very promising aspect. They are soon succeeded by great difficulty of swallowing, pain and ulceration of the fauces, œsophagus, &c. and with an incessant singultus: the whole *primæ viæ* become at last affected; a bloody dysentery comes on, followed by a sphacelation of the intestines; as is evident from the black, sanious, and bloody stools, extremely fetid and infectious. Vibices, or large black and bluish marks resembling bruises, are frequently seen towards the close of the fever; and, when attended with lividity and coldness of the extremities, are certain tokens of approaching death. In some cases, the blackness has been known to reach almost to the elbows, and the hands have been dead-cold for a day or two before the death of the patient.

Such are the general appearances of the putrid malignant fever in this country, among those who enjoy a free air, and are not crowded together, or exposed to the causes of infection: but in jails, hospitals, or other places where the sick are crowded, and in some measure deprived of the benefit of the free air, the symptoms are, if possible, more terrible. Sir John Pringle, who had many opportunities of observing it, tells us, that the jail or hospital fever, in the beginning, is not easy to be distinguished from a common fever. The first symptoms are slight interchanges of heat and cold, a trembling of the hands, sometimes a sense of numbness in the arms, weakness of the limbs, loss of appetite; and the disorder increasing towards night, the body grows hot, the sleep is interrupted, and not refreshing. With these symptoms, for the most part, there is some pain or confusion in the head; the pulse at first is a little quicker than natural, and the patients find themselves too much indisposed to go about business, though too well to be wholly confined. When the fever advances, the above-mentioned symptoms are in a higher degree; and in particular the patient

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patient complains of a lassitude, nausea, pains in his back, a more constant pain and confusion in his head, attended with an uncommon dejection of spirits. At this time the pulse is never sunk, but beats quick, and often varies in the same day both as to strength and fulness. It is little affected by bleeding, if a moderate quantity of blood be taken away; but if the evacuation be large, and especially if it be repeated, to answer a false indication of inflammation, the pulse, increasing in frequency, is apt to sink in force, and often irrecoverably, whilst the patient becomes delirious. But we must observe, that, in every case, independent of evacuations, the pulse sooner or later sinks, and then gives certain evidence of the nature of the disease. The appearance of the blood is various; for though it be commonly little altered, yet sometimes it will be sizy, not only on the first attack, but after the fever is formed. The worst appearance is when the crassamentum is dissolved; though this does not happen till the advanced state of the fever: indeed this seems not easy to be ascertained, as blood has been so seldom taken away at that time. The urine is also various. Sometimes it is of a reddish or flame colour, which it preserves a long time; but it is oftener pale, and changes from time to time in colour as well as crudity, being sometimes clear, sometimes clouded: towards the end, upon a favourable crisis, it becomes thick, but does not always deposit a sediment. If the sick lie warm, and have had no preceding flux, the belly is generally bound; but when they lie cold, as they often do in field-hospitals, the pores of the skin being shut, a diarrhœa is a common symptom, but is not critical. In the worst cases, a flux appears in the last stage; then the stools are involuntary, colliquative, ichorous, or bloody, and have a cadaverous smell; the effects of a mortification of the bowels, and the sign of approaching death. When the hospitals are filled with dysenteric patients, some of the nurses will be infected with the flux only, and others with this fever, ending in these bloody and gangrenous stools.

In the beginning the heat is moderate; and even in the advanced state, on first touching the skin, it seems inconsiderable: but upon feeling the pulse for some time, we are sensible of an uncommon heat (the *calor mordicans*, as it has been called), leaving an unpleasant sensation on the fingers for a few minutes. A day or two before death, if care be not taken, the extremities become cold, and the pulse is then hardly to be felt. The skin is generally dry and parched; though sometimes there are longer or shorter sweats, especially in the beginning. Such as are produced by medicine are of no use, except on the first attack, at which time they will often remove the fever; and natural sweats are never critical till the distemper begins to decline. These last are rarely profuse, but gentle, continued, and equally diffused over the body: sometimes the disease will terminate by an almost imperceptible moisture of the skin; the sweats are usually fetid, and offensive even to the patient himself.

The tongue is commonly dry; and, without constant care of the nurse, becomes hard and brown, with deep chops: but this symptom is common to most fevers. At other times, though rarely, the tongue is soft and moist to the last, but with a mixture of a greenish or yellowish colour. The thirst is sometimes great, but more frequently moderate. In the advanced state, the breath is offensive, and a blackish furring gathers about the roots of the teeth.

Some are never delirious, but all lie under a stupor or confusion; few retain their senses till death: many lose them early, and from two causes; either from immoderate bleeding, or the premature use of warm and spirituous medicines. They rarely sleep; and, unless delirious, have more of a dejected and thoughtful look than what is commonly seen in other fevers. The face is late in acquiring either a ghastly or a very morbid appearance; yet the eyes are always muddy, and generally the white is of a reddish cast as if inflamed. The confusion of head commonly rises to a delirium, especially at night; but, unless by an unseasonable hot regimen, it seldom turns to rage, or to those high flights of imagination common in other fevers. When the delirium comes to that height, the face is flushed, the eyes red, the voice is quick, and the patient struggles to get up. But when that symptom is owing to large evacuations, or only to the advanced state of the disease, the face appears meagre; the eye-lids in slumbers are only half shut; and the voice, which is commonly low and slow, sinks to a degree scarce to be heard. From the beginning there is generally a great dejection and failure of strength. A tremor of the hands is more common than a starting of the tendons; and if the subsultus occurs, it is in a lesser degree than in many other fevers. In every stage of the disease, as the pulse sinks, the delirium and tremors increase; and in proportion as the pulse rises, the head and spirits are relieved. Sometimes in the beginning, but for the most part in the advanced state, the patient grows dull of hearing, and at last almost deaf. When the fever is protracted, with a slow and low voice, the sick have a particular craving for something cordial, and nothing is so cordial or so acceptable as wine. They long for no food, yet willingly take a little panada if wine be added. But such as are delirious, with a quick voice, wild looks, a subsultus tendinum, or violent actions, though their pulse be sunk, yet bear neither hot medicines, wine, nor the common cordials.

Vomiting, and complaints of a load and sickness at stomach, though usual symptoms, are not essential to the disease; nor are pleuritic stitches, difficulty in breathing, or flying pains, to be referred so much to it as to the constitution of the patient, or to a preceding cold.

A petechial efflorescence is a frequent, though not an inseparable, attendant of this fever. It sometimes appears of a brighter or paler red, at other times of a livid colour, but never rises above the skin. The spots are small; but generally so confluent, that at a little distance the skin appears only somewhat redder than ordinary, as if the colour was uniform; but upon a nearer inspection interstices are seen. For the most part this eruption is so little conspicuous, that unless it be looked for attentively, it may escape notice. The spots appear thickest on the back and breast, less on the legs and arms, and Sir John Pringle never remembers to have seen any on the face. As to the time of their appearance, he agrees entirely with Dr Huxham. These spots are never critical, nor are they reckoned among the mortal symptoms; but only concur with other signs to ascertain the nature of the disease. The nearer they

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they approach to purple, the more they are to be dreaded. In a few cafes, inftead of fpots, purple ftreaks and blotches were obferved. Sometimes the petechiæ did not appear till after death; and there was one cafe in which, after bleeding, the petechiæ were feen only on the arm below the ligature, and nowhere elfe on the fkin.

The hofpital fever, though accounted one of the continued kind, yet has generally fome exacerbations at night, with a remiffion and often partial fweats in the day; and after a long continuance it is apt to change into a hectic, or an intermitting form. The length of the difeafe is uncertain. Sometimes it was terminated, either in death or recovery, in feven days after the patient took to his bed; but in the hofpitals it generally continued from 14 to 20, and fome died or recovered after four weeks. From the time of the finking of the pulfe until death or a favourable crifis, there is perhaps lefs change to be feen from day to day in this than in moft other fevers. When its courfe is long, it fometimes terminates in fuppurations of the parotid or axillary glands; and when thefe do not appear, it is probable that the fever is kept up by the formation of fome internal abfcefs. The parotid glands themfelves do not fuppurate, but only fome of the lymphatic glands that lie over them. Sir John Pringle obferved one inftance of a fwelling of this kind on both fides, without any previous indifpofition, when the perfon, not fufpecting the caufe, and applying difcutient cataplafms, was, upon the tumour fubfiding, feized with the hofpital-fever. Many patients after the crifis of this fever complain of a pain in the limbs and want of reft; and almoft all of them mention great weaknefs, confufion in their head, vertigo, and a noife in their ears.

Ten of the bodies of thofe who died of this diftemper in Houghton's regiment were opened. In fome, all the cavities were examined; in others, only the brain and the bowels. In fome of them, the brain appeared to be fuppurated. The firft of this kind Sir John Pringle met with at Ghent; but the man being brought into the hofpital from the barracks no earlier than two days before he died, he could only conjecture from the fymptoms and the imperfect accounts he had of him, that his death was owing to a fever of this kind, after lingering near a month in it. About three ounces of purulent matter were found in the ventricles of the brain, and the whole cortical and medullary fubftance was uncommonly flaccid and tender; nay, fome of the fame kind of matter was found in the fubftance of the upper part of the cerebellum: yet this perfon, with fome ftupor and deafnefs, had his fenfes till the night before he died; fo far, at leaft, that he anfwered diftinctly when roufed and fpoken to; but about that time the mufcles of his face began to be convulfed. Of two other inftances of men who undoubtedly died of this fever, in one the cerebrum was fuppurated, in the other the cerebellum. In the former cafe, the patient was under a ftupor, with deafnefs from the beginning; but was never delirious, nor altogether infenfible. His pulfe funk early; and about ten days before his death his head began to fwell, and continued very large till within two days before he died, when it fubfided a little. For feveral days before his end, he would tafte nothing but cold water, and during his illnefs he lay conftantly upon one fide. The head being opened, an abfcefs as large as an egg was found in the fubftance of the forepart of the right hemifphere of the brain, full of thin matter like whey. At that time five more, ill of the fame fever, had the like fwelling of their heads, but recovered. In the other cafe, the abfcefs in the cerebellum was about the fize of a fmall pigeon's egg, and contained alfo a thin ichorous matter; nor had this patient ever been fo thoroughly infenfible as not to anfwer reafonably when fpoken to. Two days before he died his urine turned pale.

Thefe fuppurations, however, were not conftant; for another who died about the fame time, and had been ill about the fame number of days with the like fymptoms, the pale water excepted, had no abfcefs either in the brain or cerebellum. Two were opened afterwards, in whom the cortical fubftance of the brain had an inflammatory appearance, but no fuppuration. In one of them the large inteftines were corrupted; that man went off with a loofenefs; and juft before he died, an ichorous matter was difcharged from his nofe. In the military hofpital at Ipfwich, one who unexpectedly died of this fever after having been feemingly in a fair way of recovery, had no fuppuration in his brain; but in another, who died after an abfcefs in both orbits, the brain was found flaccid, and about two ounces of a thin ferum in the ventricles.

Caufes of, and perfons fubject to, this diforder. The caufe of this fever, as well as that of the flow nervous fever, is an infection or contagion from fome difeafed animal-body, or from corrupted vegetables; and therefore is very little, if at all, different from thofe peftilential diforders which have arifen after battles, where great numbers of dead bodies were allowed to lie above ground, and infect the air with their effluvia. This is confirmed by an obfervation of Foreftus, who was eyewitnefs to a diftemper of this kind (which indeed he calls a *plague*) owing to the fame caufe, attended with buboes and a high degree of contagion. The fame author alfo gives an account of a malignant fever breaking out at Egmont in North-Holland, occafioned by the rotting of a whale which had been left on the fhore. We have a like obfervation of a fever affecting the crew of a French fhip, by the putrefaction of fome cattle which they had killed on the ifland of Nevis in the Weft Indies. Thefe men were feized with a pain in their head and loins, great weaknefs, and a diforder of the ftomach, accompanied with fever. Some had carbuncles; and on others purple fpots appeared after death.

Galen affigns two caufes for peftilential fevers: 1. The great heat of the weather, when the humours happen to be in a more putrefcent ftate than ufual. 2. A putrid ftate of the air, arifing either from a multitude of dead bodies left unburied, as after a battle, or from the evaporation of corrupted lakes and marfhes.

One of the moft remarkable difeafes incident to an army is related by Diodorus, as breaking out among the Carthaginians at the fiege of Syracufe. That author not only relates fome of its moft diftinguifhing fymptoms, but reafons well about its caufe. He obferves, that pains in the back and eruptions (φλυκταιναι) were common; that fome had bloody ftools; that others were feized with a delirium, fo as to run about and beat all that came in their way; that the phyficians

cians knew no cure; and that it was the more fatal as the ſick were abandoned by every body on account of the contagion. As to the cauſe, the author takes notice of the multitude of people confined within a narrow compaſs; of the ſituation of the camp in low and wet ground; of the ſcorching heats in the middle of the day, ſucceeded by the cold and damp air from the marſhes in the night-time; to theſe he adds, the putrid ſteams ariſing firſt from the marſhes, and afterwards from the bodies of thoſe who lay unburied.—This diſtemper ſeems to have been a compound of the marſh and peſtilential fever.

Foreſtus remarks, that, from the putrefaction of the water only, the city of Delft, where he practiſed, was ſcarce ten years together free from the plague or ſome peſtilential diſtemper. He adds, that the magiſtrates, upon his repreſentation of the cauſe, erected a wind-mill for moving and refreſhing the water. At that time Holland was much more ſubject to inundations and the ſtagnation of water than at preſent. In 1694, a fever broke out at Rochfort in France, which, on account of the uncommon ſymptoms and great mortality, was at firſt believed to be the plague. But M. Chirac, who was ſent by the court to inquire into its nature, found the cauſe to ariſe from ſome marſhes that had been made by an inundation of the ſea; and obſerved, that the corrupted ſteams, which ſmelled like gun-powder, were carried to the town by the wind, which had long blown from that quarter. About two-thirds of thoſe who were taken ill died. In ſuch as were opened, the brain was found either inflamed or loaded with blood; the fibres of the body were uncommonly tender; and the bowels had either ſuppurated or were mortified.

It is needleſs to mention more inſtances of peſtilential fevers being brought on by the ſteams of corrupted ſubſtances, whether animal or vegetable. In general it may be remarked, that the putrefaction of theſe ſubſtances in a dry air is more apt to bring on a fever of the continued form; but in a moiſt air has a greater tendency to produce remitting fevers. But it muſt alſo be obſerved, that, even in caſes where the moſt malignant fevers prevail, all perſons are not equally diſpoſed to receive the infection, though equally expoſed to it with others. Some, through mere vigour of body and mind, cannot be infected with the moſt contagious diſeaſes; while, on the other hand, thoſe whoſe bodies are debilitated by a former diſeaſe, by ſtudy, low diet, or want, or thoſe who have laboured under any of the depreſſing paſſions of the mind for ſome time, ſeldom or never eſcape. Men, therefore, who have been weakened by accidents (as thoſe who have undergone a mercurial ſalivation) are very apt to fall into this diſtemper. Thoſe who are taken into crowded hoſpitals, ill of the ſmallpox, however good the ſort may be, fall readily into this fever, and run a greater riſk of dying of it than others. The ſecond fever is attended with double danger, ſeeing the patient has been ſo much weakened by the firſt. A ſure ſign of the corruption of the air in an hoſpital is when many of the nurſes fall ſick.

Prognoſis. In theſe fevers we cannot draw a prognoſtic from any ſymptom by itſelf; and perhaps all of them together are more fallible than in others. Generally the following are good: To have little delirium; the ſtrength little impaired; turbid urine in the decline of the diſeaſe; and at that time a gentle ſweat or moiſture diffuſed over the body, or even the ſkin ſoft and the tongue moiſt; or to have ſome looſe ſtools ſucceeded by a diaphoreſis; the pulſe to riſe by wine or cordials, with an abatement of the ſtupor, tremor, and other affections of the brain. Deafneſs is rather a good ſign. A ſediment in the urine, without other changes for the better, is no ſure ſign of recovery; and ſome have recovered in whoſe urine there was no ſediment.—The bad ſigns are, a ſubſultus tendinum; the eyes much inflamed and ſtaring; the ſpeech quick, and the ſound of the voice altered; a high delirium; perpetual watchfulneſs; conſtant ſickneſs at the ſtomach, and vomitings; frequent ſtools, with a ſinking pulſe, and the diſorder of the head increaſed; coldneſs of the extremities, and a tremulous motion of the tongue. It is obſerved to be among the worſt ſigns when the patient complains of blindneſs; when he ſwallows with difficulty, or cannot put out his tongue when deſired to do it; when he can lie on his back only, and pulls up his knees; or when inſenſible he endeavours to uncover his breaſt, or makes frequent attempts to get out of bed without aſſigning any reaſon. If to any of theſe are added ichorous, cadaverous, and involuntary ſtools, it is a ſign of a mortification of the bowels and approaching death. It will not ſeem ſtrange to find moſt of theſe prognoſtics common to the advanced ſtate of other fevers, when we conſider, that from whatever cauſe fevers begin, by a long continuance the humours are corrupted, and the brain and nerves affected much in the ſame manner as in thoſe which ariſe from infection.

Prevention and cure. As diſtempers of the putrid kind never ariſe without an infection received from ſome quarter or other, the methods of prevention muſt evidently be reduced to two general heads. 1. To avoid receiving the infection into the body; and, 2. To put the body in ſuch a ſituation as may enable it to reſiſt the infection when received. On both theſe methods ſcarce any writer hath equalled Dr Lind of Haſlar, whoſe opinions and directions therefore we ſhall give pretty fully.

As putrid diſeaſes are very common and violent in the hot countries, it is very neceſſary for Europeans who viſit theſe climates to be well informed, in the firſt place, of the ſigns of an unhealthy country, that they may be upon their guard as ſoon as they enter any foreign region. Theſe ſigns are by this author enumerated as follows.

1. A ſudden and great alteration in the air, at ſunſet, from intolerable heat to a chilling cold. This is perceived as ſoon as the ſun is down, and is for the moſt part accompanied with a very heavy dew: it ſhows an unhealthy ſwampy ſoil, the nature of which is ſuch, that no ſooner the ſun-beams are withdrawn, than the vapours emitted from it render the air damp, raw, and chilling, in the moſt ſultry climates; ſo that even under the equator, in ſome unhealthy places, the night-air is very cold to an European conſtitution.

2. Thick noiſome fogs, chiefly after ſunſet, ariſing from the valleys, and particularly from the mud, ſlime, or other impurities. In hot countries, the ſmell of theſe

these fogs may be compared to that of a new-cleaned ditch. Diseases, therefore, arising from this cause, generally take place in the night, or before sunrising.

3. Numerous swarms of flies, gnats, and other insects which attend stagnated air and unhealthy places covered with wood.

4. When all butchers meat soon corrupts, and in a few hours becomes full of maggots; when metals are quickly corroded on being exposed to the air; and when a corpse becomes intolerably offensive in less than six hours; these are proofs of a close, hot, and unwholesome country. And in such places, during excessive heats and great calms, it is not altogether uncommon for Europeans, especially such as are of a gross habit of body, to be seized at once with the most alarming and fatal symptoms of what is called the *yellow-fever*, without even any previous complaint of sickness or other symptoms of the disease. There has first been perceived an uneasy itching sensation, commonly in the legs; and upon pulling down the stockings, streams of thin dissolved blood followed, a ghastly yellow colour quickly diffused itself over the whole body, and the patient has been carried off in less than forty-eight hours.

5. A sort of sandy soil, commonly a small, loose, white sand, as that at Pensacola, Whydah, and the island of Bonavista, which is found by experience to be injurious to health. The pestiferous vapour arising, during the summer months and in the heat of the day, from such a sandy soil, is best characterized by its effects in the extensive deserts of Asia and Africa. It there constitutes what is called the *Samiel-wind;* a blast which, in the parched desert, proves instantly fatal both to man and beast; but when it passes over a soil well covered with grass and vegetables, has its effects greatly mitigated; it is, however, even then, productive of sickness: thus the southerly winds, while they blow from the deserts of Libya during the summer, at Algiers, Tunis, and Tripoli, produce an unhealthy season; and at Madras the winds, which, in the months of April and May, pass over a large tract of sand, are always hot, disagreeable, and unwholesome.

During these land-winds, sudden gusts of a more hot and suffocating nature are often observed to come from these sands once or twice, or even more frequently, in a day, which seem to be this vapour in a purer form. These gusts pass very quickly, and affect persons who happen to stand with their faces towards them in the same manner as the hot air which issues from a burning furnace, or from a heated oven, and obliges them immediately to turn away from it in order to recover breath. The effect of this hot suffocating blast or vapour on the human body, even when mitigated by passing through a moist atmosphere, is the same as that of intense cold; it shuts up every pore of the skin, and entirely stops the perspiration of such as are exposed to it. These blasts come only in the day-time, and always from the deserts. Water is the only known corrector or antidote against them: hence, coarse thick cloths, kept constantly wet, and hung up at the windows or doors, greatly mitigate their violence. A house so built as to have no windows or doors towards the deserts, is an excellent protection against their pernicious effects. The hot land-winds constantly blow at Madras and other places on the coast of Coromandel, at that season, from midnight till noon; the sea-breezes then begin, which relieve the difficulty in breathing, and the obstructed perspiration, which the former occasioned.

That the heat of these land-winds, as also of the sudden gusts which accompany them, proceeds from large tracts of sand heated by the sun, is evident from the increased heat and suffocating quality of those winds, in proportion as the day advances, and as the heat of the season is increased. The opposite winds, blowing from each side of the Balagate mountains, are a further proof of this. These mountains running from north to south, divide the hither Peninsula of India into two equal parts, and separate what is called the *Malabar* from the *Coromandel* coast. To the former they are very near, but at a great distance from the latter. The winds blowing from those hills are on the Malabar coast always remarkably cool; but on the coast of Coromandel, in the months of April, May, June, and July, are extremely hot and suffocating, as they pass over a large tract of intermediate sand, heated during those months by an almost vertical sun. Hence the Malabar coast is always covered with an agreeable verdure; whereas the Coromandel coast, during the continuance of these hot winds, seems a barren wilderness, nothing appearing green except the trees. On the contrary, the winds that pass over these sands, after being wet with the rains, are the coldest which blow at Madras. Bottles of liquor inclosed in bags of coarse cloth, kept constantly wet, and suspended in the shade, where those hot winds may have access to them, become as cold as if they had been immersed in a solution of nitre; an effect owing undoubtedly to the constant evaporation of water from the surface.

It is an observation of the natives on the coast of Coromandel, which is confirmed by the experience of many Europeans, that the longer the hot land-winds blow, the healthier are the ensuing months; these winds, as they express it, purifying the air. Are not the winds therefore the cause why the air on the coast of Coromandel, except during their continuance, is more healthy than in other parts of India where these winds do not blow? Does not this also suggest a very probable reason, why the plague in Egypt generally ceases in the beginning of June; the periodical hot winds which come from the deserts of Nubia and Ethiopia having then rendered the air of Egypt pure and wholesome? Many have ascribed that effect to the north winds; as the plague not only ceases when they blow, but all infected goods, household-furniture, and wearing apparel, are then said to become entirely free from the contagion: these, however, cannot be the cause, as the most destructive plague is abated in its violence, if not wholly eradicated, before they set in. With equal propriety we may reject the opinion that the overflowing of the Nile is productive of that salutary effect, as the plague generally ceases before the increase of that river is perceptible.

Thus the plague, the greatest calamity which can afflict mankind, seems to be destroyed by those hot winds, which are otherwise so pernicious to animal and vegetable life. And although, during the continuance of these winds, the most fruitful fields wear the

the aspect of a parched desert, yet no sooner the rains fall, but vegetation is restored, the plants revive, and a beautiful verdure is again spread over the face of the country.

Having thus given an account of the signs of an unhealthy country, Dr Lind next proceeds to mention such employments as are particularly dangerous to Europeans on their first arrival. One of these is the cutting down of trees, shrubs, &c. or *clearing the ground*, as it is called. Of the unhealthiness of this employment he gives two instances. At the conclusion of the late peace, the captain of a ship of war went on shore at the island of Dominica, with 12 of his men, to cut down the wood, and to clear a piece of ground which he intended to have purchased: but, in a few days, sickness obliged him to desist from this dangerous work; the captain and 11 of his men being seized with violent fevers, which terminated in obstinate intermittents, and of which several died. The survivors suffered so much in their constitutions, that, even after they came to England, the return of an east-wind was apt to bring on a violent fit of the ague. The Ludlow-Castle, a ship of war of 40 guns, in a voyage to the coast of Guinea, also lost 25 of her men at Sierra Leona, who were employed in cutting down wood for the ship. This is an occupation which has often proved destructive to Europeans in those climates, and in which they ought never to be employed, especially during the rainy season; there being numberless instances of white persons, when cutting down the woods at that season, who have been taken ill in the morning, and dead before night.

Another evil, less known, and less suspected, but no less dangerous, is the sending Europeans in open boats after sunset, where the soil is swampy, or where there are great night-fogs. The single duty alone of fetching fresh-killed butchers meat at night for the use of our ships companies in the East and West Indies, has destroyed every year several thousand seamen. In those parts of the world, butchers meat must be brought on board at night immediately after it is killed, otherwise it will not be fit for use the next day; but a contract made with the natives to send it on board at that time, which might be done for a trifling sum, would be the means of preserving many useful lives. During the sickly season at Batavia, a boat belonging to the Medway, which attended on shore every night, was three times successively manned, not one having survived that service. They were all taken ill in the night, when on shore, or when returning on board; so that at length the officers were obliged to employ none but the natives on that business. Great numbers of men have perished from being employed in this manner at Bengal, where the European ships often anchor in the must unhealthy spots of the river; and even when the great night-fogs arise, after the rainy season, the men are often obliged to perform such night-services in boats. Now since it is so dangerous for Europeans in unhealthy countries, particularly during a season of sickness, to be exposed in an open boat to the foggy night-air, it must appear that sending them unsheltered, in open boats, far up rivers, in unhealthy southern climates, for the sake of wood, water, trade, or other purposes, must be attended with the most destructive and fatal consequences.

Burying the dead in swampy countries is another occupation which has proved fatal to many, and which ought to be entrusted to negroes or the natives of the country. The effluvia from the ground when newly opened, whether from graves or ditches, are far more dangerous than from the same swampy soil when the surface is undisturbed; nay, in some places, it has been found almost certain death for an European to dig a grave, unless long seasoned to the country. In such a place, the attendance of friends at funerals ought to be dispensed with.

In all cases where it is practicable, the ships which visit these unhealthy countries should anchor at as great a distance as possible from shore; or if obliged to anchor near marshy grounds or swamps, especially during summer or in hot weather, and when the wind blows directly from thence, the gun-ports which would admit the noxious land-breeze ought to be kept shut, especially at night. Or if the ship rides with her head to the wind, a thick sail ought to be put upon the fore-mast, along which the smoke from the fire-place might be made constantly to play and ascend. If the sail should occasion a little smoke between decks, this inconvenience will be sufficiently compensated by its keeping off the direct stream of the swampy shore effluvia; which now being obliged to form a curve before they reach the more distant parts of the vessel, must needs be greatly diverted and scattered.

The best preservative against the mischievous impressions of a putrid fog, or of a marshy exhalation, is a close, sheltered, and covered place; such as the lower apartments in a ship, or a house in which there are no doors or windows facing the swamps. If in such places a fire be kept either at the doors and other inlets to a house, or in the chambers, as is practised in some unhealthy countries during the rainy or foggy season, it will prove an excellent and effectual protection against the injuries of a bad air. On board of ships also fires may be made at the hatchways; and of the good effects of this we have the following example. When the Edgar, a ship of war of 60 guns, was upon the coast of Guinea in the year 1768, her men were very sickly, and many of them died: however it was observed, that in a sloop of war, which was constantly in company with her, few were taken ill, and not one died during the whole voyage. This could be ascribed to no other cause, but that in the sloop the fire-place for cooking victuals was on the same level with the deck where the men lay; and every morning when the fire was lighted, especially when there was but little wind, the smoke from the cook-room spread itself all over the ship, and particularly over those parts where the men lay; but from the construction of the fire-place of the Edgar, no smoke from it ever came between her decks.

Persons on board any ship whatever, are much more safe, and their situation is much preferable to that of those who make distant inland excursions in small boats upon the rivers, and who are for the most part ignorant of the cause of those maladies which destroy them. The intolerable heat at noon often obliges such persons to go in a manner half naked; while a free and plentiful perspiration issues from every pore. A near approach to putrid swamps at this time is apt to produce an immediate sickness, vomiting, and afterwards

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Where such exposure becomes unavoidable, the only method is to defend the body as much as possible against the pernicious miasmata with which the air abounds.—All those who are employed in cutting down woods, or in other laborious and dangerous services in hot climates, during the heat of the day, ought to have their heads covered with a bladder dipt in vinegar, and to wash their mouths often with the same liquor; never to swallow their spittle, but rather to chew a little rhubarb or some other bitter, and spit it out frequently; to stop their nostrils with a small bit of linen or tow dipped in camphorated vinegar; and to infuse some Peruvian bark, garlic, and rhubarb, in brandy, of which a dram is to be taken, either by itself or diluted with water, morning and evening.

In the evening before sunset they should leave off work, and not return to their labour in the morning till the sun has dispersed the unwholesome dews and vapours. Those who must of necessity remain on shore, and sleep in dangerous places, should take care not to sleep upon the ground exposed to the dews, but in hammocks in a close tent, standing upon a dry sand, gravel, or chalk, near the sea shore, and where there is no subterraneous water for at least four feet below the surface of the ground. The door of this tent should be made to open towards the sea; and the back part of it, which receives the land breeze, must be well secured by double canvas, or covered with branches of trees. But in such circumstances, a hut, when it can be procured, is preferable to a tent, especially if it be well thatched, so as to prove a defence both against the excessive heat of the sun by day, and the noxious dews which fall at night. Here the men may be enjoined to smoke tobacco. When the air is thick, moist, and chill, the earth being overspread with cold dew, a constant fire must be kept in and about the tent or hut, as the most excellent means of purifying such unwholesome air, and of preserving the health of those who either sleeping or waking are exposed to its influence. The centinels who guard the water-casks, ought likewise at such a time to have a fire burning near them. All old and forsaken habitations, natural caves and grottos in the earth, where the men may be induced to take up their abode, must before their admission be perfectly dried and purified with sufficient fires. Fire and smoke are undoubtedly the great purifiers of all tainted and unwholesome air, and the most excellent preservatives against its noxious influence. It is the custom of the negroes in Guinea, and also of some Indians (who both sleep for the most part on the ground), to have a fire, producing a little smoke, constantly burning in their huts where they sleep. This not only corrects the moisture of the night, but also, by occasioning more smoke than heat, renders the damp from the earth less noxious; of which Dr Lind gives the following remarkable instance. A Guinea ship being up one of the rivers for the sake of trade, it was found to be very dangerous to sleep on shore: without which their trade could not be so conveniently carried on. First the captain, then the mate, and two or three of the seamen, were taken ill; each of them the morning after they had lain on shore. By these accidents the men were greatly intimidated from lying ashore; till the surgeon boldly offered to try the experiment on himself. Next morning when he waked, he found himself seized, as the rest, with a giddiness and pain in the head. He immediately acquainted one of the negroes with his condition, who carried him to his hut, and set him down in the smoke of it; when his shiverings and giddiness soon left him. He then took a dram of the bark bitter; and found himself greatly relieved, especially by breathing some time in the smoke.—Thus instructed by the negro he ordered a large fire to dry the hut he slept in; and afterwards had every night a small fire sufficient to raise a gentle smoke without occasioning a troublesome heat: and by this means he and several others, using the same precautions, slept many nights on shore without any inconvenience. Typhus.

Fire and smoke indeed are found to be certain correctors, or rather destroyers, of infection in all cases, whether arising from the noxious effluvia of marshes, or from the contagion of diseased bodies. Even those most extraordinary and fatal damps called *harmattans*, are unable to resist the salutary effects of smoke. In other cases, Dr Lind remarks, that, under some circumstances, the source of an infection in a sick chamber, or any other place, may be removed or destroyed by accidental means, for which we cannot account, and which we often cannot ascertain. But it oftener happens, that it is very difficultly rooted out; and that exact cleanliness, with the benefit of a pure air, often proves insufficient to remove the evil. Smoke, however, has never been known to fail. It is not to be doubted, that, excepting the true plague, there has been an infection fully as pestilential and as mortal in some ships as in any other place whatever; yet it has never been heard, that any ship, after having been carefully smoked, did not immediately become healthy: and if afterwards they turned sickly, it was easy to trace that sickness from other infected ships, jails, and the like places.

There are three methods practised for purifying vessels after the men have been removed out of them. The first is by burning of tobacco. A quantity of tobacco is spread on several fires, made with such old pieces of rope as are called *junk*. These are dispersed into different places of the ship, and their heat and smoke afterwards closely confined below for a considerable time.—The second method is by charcoal fires strewed with brimstone. The heat and steam of these burning materials must also be long and close shut up: but, although this fume, properly applied, has been found by experience to purify most effectually tainted apartments, ships, clothes, &c. yet there are some kinds of vermin which it will not destroy, particularly lice. The third method of purification is performed by the addition of arsenic to the materials of the second process,

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cess, in the following manner. After carefully stopping up all the openings and every small crevice of the ship (as was also necessary in the preceding processes), a number of iron pots, properly secured, are to be placed in the *hold*, *orlope*, *gun-deck*, &c. Each of these is to contain a layer of charcoal at the bottom, then a layer of brimstone, and so alternately three or four layers of each, upon which the arsenic is to be sprinkled, and on the top of it some oakum dipped in tar is to be laid to serve as a match. The men, upon setting fire to the oakum, must speedily leave the place, shutting close the hatchway by which they came up.

From the known and experienced efficacy of these processes, it appears, that fire and smoke are powerful agents for annihilating infection; and, it may be presumed, even the plague itself. This is in some measure agreeable to what we learn from the ancient records of physic. But the preposterous use, or rather abuse, of fire on such occasions, has caused its effects to be disregarded by some, and to be suspected of mischief by others. The modern practice of burning large fires in the open air, in the streets, and about the walls of towns infected with the plague or other contagion, is founded on principles groundless and erroneous; and has therefore been found by experience not only unsuccessful, but hurtful. But though this must be allowed, it does not thence by any means follow, that when once a house has been infected, and the patients removed from it, the doors and windows at the same time being shut, that such fires will then prove hurtful; or that, by this method of purification, all the seeds of contagion may not be effectually destroyed, Whenever, therefore, persons die of a spotted fever, a malignant sore throat, the small pox, or any distemper found to be communicable from the sick to the sound, the corpse ought quickly after death to be removed into another room; that in which the person died should be well aired, by having the windows opened, till a charcoal fire be kindled, with some rolls of sulphur upon it; after which, both doors and windows should be kept shut for a considerable time, not less than eight or ten hours, till the room be thoroughly smoked. In several ships, where there are the fairest opportunities of trying and judging things of this nature, the contagion of the small-pox has been entirely stopped by wood-fires, sprinkled with brimstone, kept burning and closely confined in the infected place. In a word, a judicious and proper application of fire and smoke is a powerful agent for the destruction and utter extinction of the most malignant sources of disease; and they are besides great purifiers of all bad and tainted air.

Next to the smoke of wood for purifying a tainted air, that of gun-powder is to be esteemed the best; and it has this further good property, that it is entirely inoffensive to the lungs. The cascarilla bark, when burning. gives a most agreeable scent to the chamber of the sick; thus it is at least an elegant preservative, and may prevent bad smells from taking effect. The steam of camphorated vinegar, warmed, is still more powerful for this purpose. But, besides correcting the ill quality of the air, and purifying the chamber, another good effect is produced from such steams and smoke as are inoffensive to the lungs. As soon as the vapour becomes dense, the nurses and patients become desirous of the admission of fresh air by the doors or windows. Now it is certain, that the air in the chambers of the sick cannot be too often changed, provided the patient be well covered, and the curtains of his bed, if necessary, be drawn close. No argument is so forcible to obviate the danger of foul air in a room or ward (occasioned by the obstinacy of nurses and relations), as ordering it to be frequently fumigated or smoked: A practice more frequent in other countries than in this, but of great benefit to the sick.

Lastly, with regard to the method of purifying goods, moveables, clothes, &c. which are supposed to harbour infection, it must be observed, that the usual custom of only unpacking and exposing such materials to the open air, is in many instances insufficient to destroy the latent seeds of disease. It is certain indeed, that in most cases the contagious particles are more readily and fatally communicated from the clothes of a sick person than from his body. The spreading abroad, therefore, of contaminated clothes to dry or to be aired, without a previous fumigation of them, may be of dangerous and fatal consequence. All such suspected substances should be first fumigated in a close place, and in the same manner as an infected chamber, after which they may be spread abroad and exposed to the air. In infectious diseases, especially fevers, the linen of the sick, or such clothes about them as will admit of being washed, ought never at first to be put in warm water, as it is dangerous to receive the steam that may hence arise. It is necessary to steep them first either in cold water or in cold soap-lees for several hours, that the filth may be washed off.

But although the destruction of contagion by smoke is unquestionably a very important practice, yet it cannot now be said, that it is the most powerful agent for this purpose. By the ingenious observations and experiments of M. Morveau in France, and of Dr Smyth Carmichael in England, it is now ascertained, that we possess still more powerful means of destroying contagions, either in the muriatic or nitrous acid gas. The former may easily be detached from common sea salt, and the latter from nitre, by means of the sulphuric acid. Rooms may, with the utmost safety and ease, be filled with these fumes, although the sick be not removed from them. But for disinfecting a room, ward, or ship, when empty, the most powerful article yet discovered is the oxygenated muriatic acid gas, detached from a mixture of manganese and sea salt, by means of the sulphuric acid.

We must now proceed to give an account of the method of cure, after these means of preventing the infection from being received into the body have either been neglected or proved ineffectual. Here it is of the utmost importance to take the disease in the very beginning, before it has time to corrupt the fluids to such a degree as to endanger life. In slight degrees of infection, a vomit properly administered, especially if succeeded by a blister, never fails to remove the disorder, and prevent the fever which would otherwise unavoidably follow. Of this Dr Lind gives the following instances. A lady afflicted with the bilious cholic, had intolerably fetid discharges of corrupted matters upwards and downwards. A gentlewoman, only in passing the room, was immediately seized with a retching and sickness, which continued 24 hours. The nurse who attended was suddenly seized

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zed with a giddiness and vomiting from the bad smell, which, as she expressed it, reached into her stomach. The vomiting became more severe at night, accompanied with a purging and frequent shiverings. By means of an emetic both evacuations were stopped: notwithstanding which, for some days afterwards, she continued to have frequent tremors, and a violent headach, with a low irregular pulse; and did not recover so soon as the patient.

Such slight degrees of infection have been often observed to be derived from patients of a gross habit of body when labouring under inflammatory distempers, and even other complaints. A man was sent to Haslar Hospital, supposed to have a fever. He was furiously delirious, with a quick full pulse. Notwithstanding plentiful evacuations, this delirium continued for two months with short intervals: when the case was found to be plainly maniacal. A nurse, upon raising this person up in her arms, perceived an intolerably bad small, and was instantly seized with shiverings, sickness, and headach. Finding herself very ill, she took a vomit in six hours afterwards, and passed the night in profuse sweats by means of a sudorific draught. Next morning the violence of the headach was but little abated; upon every attempt to move, she complained of a burning heat and pain in her forehead, and became giddy. Her inclination to drink was frequent, and her pulse low and quick. A blister was immediately applied to the back; as soon as the blister took effect, the headach and thirst entirely left her, and the pulse was calm. Next day she arose and was well.

Many similar instances of infection have been observed from putting the dead into their coffins. In particular, one man, from performing that duty to his messmate, was so ill, even after the operation of the vomit, as to require a blister. In the course of one week two nurses were infected by a person in the smallpox. Both were seized in like manner with shiverings, sickness, and headach; the one upon receiving the patient's breath, the other upon making his bed. In one, a pain darted into her breast; in the other, into the breast and in the small of the back. The complaints of the former were speedily removed by a vomit, though she continued to have irregular returns of shiverings for three days afterwards. But in the latter, though the headach, sickness, and rigors, were greatly abated by the vomit, yet a constant heat and thirst, with a low pulse, and a violent pain in the breast, indicated the necessity of applying a blister to the affected parts, which next morning removed all her complaints.

A person is often immediately sensible of his having received infection from the first attack: they generally compare the first impression to an earthy disagreeable smell, reaching down, as they express it, into their stomach, as from a grave newly opened, but not quite so raw as the cadaverous stench; and the effects of it, shivering and sickness, are instantaneous. It is a smell difficult to describe; but it is well known to the nurses and attendants about the sick, as it usually accompanies fevers of extreme malignity, and, with the peculiar discharges from the blistered parts, may be reckoned among the most constant symptoms of a bad fever. Some compare the smell to that of rotten straw. It often resembles the disagreeable smell of a person labouring under the confluent smallpox at their turn, though not so strong. One person, on receiving the infection, was sensible of something like an electric shock through his body. But many are not sensible of any effect from infection at first; and an infection from a fever will sometimes continue for many days, nay weeks, discovering itself chiefly by irregular shiverings, sometimes so severe as to oblige the patients to have recourse to their beds once or twice a-day; sometimes every other day. Among a number thus affected, it also appears, that such as are put into unseasoned chambers, or have sat down on the cold ground, lain in raw damp apartments, &c. are immediately seized with a sickness at stomach, sometimes with a dangerous purging, and often with fevers accompanied with bad symptoms, which others have entirely escaped.

It now remains to consider the proper method of curing putrid fevers, on the supposition that the infection has been allowed to operate till the blood becomes radically tainted, and of consequence the nervous system affected to such a degree, that its power cannot be restored by any of the simple practices above mentioned. Here all authors agree, that a change of air, when it can be effected, is highly advantageous, and often contributes more towards the removing the disease than all the medicines that can be exhibited. The utility of this change will appear from what has been formerly said; and we shall only further mention one instance from Dr Lind, in which the effects of bad air appear to a degree almost incredible. "It is remarkable (says he), that, in the last war, the English ships which touched at Batavia suffered more by the malignant and fatal diseases of that climate, than they did in any other part of India, if we except a fatal scurvy which once raged in that fleet at sea. Soon after the capture of Manilla, the Falmouth, a ship of 50 guns, went to Batavia, where she remained from the latter end of July to the latter end of January; during which time she buried 100 soldiers of the 79th regiment, and 75 of the ship's company; not one person in the ship having escaped a fit of sickness, except her commander Captain Brereton. The Panther, a ship of 60 guns, was there in the years 1762 and 1764; and both times during the rainy season. In the former of these years, she buried 70 of her men; and 92 of them were very ill when she left the place. In the year 1764, during a short stay, 25 of her men died. The Medway, which was in company with her, lost also a great number of men. Nor was the sickness at that time confined to the ships: the whole city afforded a scene of disease and death: streets crowded with funerals, bells tolling from morning to night, and horses jaded with dragging the dead in herses to their graves. At that time a slight cut of the skin, the least scratch of a nail, or the most inconsiderable wound, turned quickly to a spreading putrid ulcer, which in 24 hours consumed the flesh even to the bone. This fact is so extraordinary, that upon a single testimony, credit would hardly be given to it; yet on board the Medway and Panther they had the most fatal experience of it, and suffered much from it."

But where a change of air is impracticable or ineffectual, and where the fever has already made some progress, Sir John Pringle generally took away some blood if the pulse was full. When the symptoms run high,

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high, a plentiful evacuation of that kind seemed indicated; yet it was observed, that large bleedings generally did harm, by sinking the pulse, and affecting the head. Nor was a moderate bleeding to be repeated without caution; even those whose blood was fizy, unless their lungs were inflamed, were the worse for a second bleeding. If the head only suffered, it was much safer to use leeches than to open a vein in the arm; but in the delirium with a sunk pulse, even leeches were hurtful. Many recovered without letting blood, but few who lost much of it.

Emetics also must be used with caution; for though they may be of service by way of prevention, yet in the advanced state of the disease, when the patient has all along complained of a sickness at stomach, they are evidently unsafe. Here the antiseptic quality of fixed air is of much use, and the neutral draughts given in the act of effervescence are generally attended with happy effects. Nay, clysters of fixed air itself have been found very serviceable. Even in very bad stages of the distemper, where a putrid and colliquative looseness has taken place, clysters of fixed air have been known to alleviate the symptoms. We must not, however, put too much confidence in medicines of this kind. Mild tonic cordials, especially wine and cinchona, are the only resources in these disorders. Concerning the former, Sir John Pringle observes, in the low state of these fevers, and in great sinkings, which either come after unseasonable bleedings or long want of nourishment, it was a most grateful and efficacious cordial, to which nothing was comparable. The common men had an allowance, from a quarter to half a pint in a day, of a strong kind made into whey, or added to the panada which was their ordinary food. But to others out of the hospital, he usually prescribed Rhenish or a small French wine, whereof some consumed near a quart per day, and part of that undiluted. Nay, so great was the virtue of wine in this stage of the fever, that several were known to recover from the lowest condition, when, refusing the bark on account of its taste, they took nothing but a little panada with wine, and a volatile diaphoretic mixture, every two or three hours by turns. Perhaps there is no rule more necessary in this state, than not to let the patient when low remain long without taking something cordial and nourishing; as many have been observed past recovery, by being suffered to pass a whole night without any support about the time of the crisis. In the advanced state of this fever the sick are remarkably low; and therefore Hoffman advises in such cases, that they should be constantly kept in bed, and not permitted even to sit up in it. In the last stage of this fever, as well as in that of the sea-scurvy, it would seem that the force of the heart was too small to convey the blood to the brain, except when the body is in a horizontal posture.

But, however necessary wine and cinchona may be in the low stage of this fever, we must remember, that these remedies are to be administered only as antiseptics and supporters of the *vis vitæ*, without aiming at thoroughly raising the pulse or relieving the head, or at forcing a sweat by them, before nature points that way, and which Sir John Pringle seldom observed before the 14th day.

In the low state of the hospital fever, a stupor was a constant attendant, which was very apt, in the evening, to change to a slight delirium. If this was all, nothing was done. But if the delirium increased upon using wine, if the eyes looked wild, or the voice became quick, there was reason to apprehend a phrenitis; and accordingly it was observed, that at such times all internal heating medicines aggravated the symptoms; and in these cases, blisters were of the greatest service. Fomentations of vinegar and warm water for the feet, Sir John Pringle is of opinion, would answer better than either sinapisms or blisters, provided they were long enough and often enough applied. In the inflammatory fevers, he has known these fomentations have little effect for the first hour, and yet succeed afterwards. For internal medicine, cinchona was omitted for some time, but the patient was continued with an acidulated drink, viz. barley-water and vinegar; and treated also with camphire, *pulvis contrayervæ compositus*, and nitre, as was usual in the beginning of the fever. If the delirium was of the low kind, a decoction of cinchona and wine were the only remedies; for in no instance was the delirium perfectly removed till the time of the crisis. It must also be observed, that a delirium may arise in putrid fevers from two opposite errors; one from large and repeated bleedings, and the other from wine and the cordial medicines being taken too early. It appears, therefore, how nice the principles are that regard the cure; as neither a hot nor a cool regimen will answer with every patient, or in every state of the disease.

If a diarrhœa came on in the decline of the fever, it was moderated, but not suppressed, by adding an opiate to the usual medicines. For though the looseness may be considered as critical; yet as the sick were too low to bear evacuations, there was a necessity for restraining it in some measure; and it has often been observed, that when it has been treated in this manner, about the usual time of the crisis, the patient has fallen into a gentle sweat, which has carried off the disease. In the worst cases of this fever, and especially when it coincides with the dysentery, the stools are frequently bloody; in which dangerous state, if any thing could be done, it was attempted by medicines of the same kind. In proportion to the putrid nature of the stools, opiates and astringents were used with the greater caution.

If the disease terminate in a suppuration upon one of the parotid glands, the abscess was opened without waiting for a fluctuation, which might never happen; the pus being often here so viscid, that after it was ripe the part felt nearly as hard as if the suppuration had not begun.

Almost every patient, after the fever, complained of want of rest, frequently of a vertigo or confusion of the head, of a continuation of the deafness, or of other symptoms commonly called *nervous*. An opiate was then given at night; and in the day some strengthening medicines, such as cinchona and the sulphuric acid. In these cases, the bark was found not only to be the best strengthener, but the surest preservative against a return of the disease. For this last intention the convalescent was ordered about three drams a-day for six or seven days together; and afterwards, if he remained longer in the hospital, some smaller quantity daily. But if there was any appearance of a hectic

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tic fever from an inward abfcefs, the cafe was treated accordingly. Upon comparing fome of the remaining fymptoms of thofe who recovered, with the condition of the brain in thofe who died and were opened, Sir John Pringle was induced to think, that fome part even of that fubftance might fuppurate, and yet the perfon recover.

Sometimes the patient falls into an irregular intertermittent; which, if not of a hectic nature from an internal abfcefs, may proceed from neglecting to clear the *primæ viæ*. For it is eafy to conceive, that after a long fever of fuch a putrid nature, often attended with languor of the bowels, the fæces may be fo much accumulated, and fo corrupted, as to occafion new diforders. In fuch cafes, after proper evacuation by a purge, cinchona was almoft an infallible remedy.

The Yellow FEVER.

Typhus cum flavedine cutis.
Typhus icteroides, *Sauv.* fp. 7.
167 *Febris flava Indiæ Occidentalis*, *Warren.* Malignant Fever of Barbadoes, *Hillary's* Difeafes of Barbadoes. *Lining* on the Yellow Fever of South Carolina, Edin. Phyf. and Liter. Effays, vol. ii. *M'Kittrick* de Febre Flavâ Indiæ Occidentalis, Edin. 1766.

Defcription. This is one of the moft fatal difeafes to which the inhabitants of warm climates are fubject, and is the fame with that called, from one of its worft fymptoms, the *black vomit*, which is fo terribly deftructive in fome of the warm parts of America, particularly at Carthagena; and which of late has proved fo fatal in Philadelphia, New York, and the Britifh Weft India iflands, as defcribed by Drs Rufh, Chifholm, Clerk, and other late writers. This, though by fome confidered as a new difeafe, is evidently from the fame contagion which has produced fatal fevers on many former occafions.

The yellow or putrid bilious fever has been in particular minutely defcribed by Dr Hillary. It moft commonly feizes the patient at firft with a faintnefs, then with a ficknefs at ftomach, accompanied in general with a giddinefs of the head; and foon after with a flight chilnefs and horror, very rarely with a rigor. Thefe fymptoms are foon followed by a violent heat and high fever, attended with acute darting pains in the head and back. A flufhing in the face, with an inflamed rednefs and a burning heat in the eyes, great anxiety and oppreffion about the præcordia, are the pathognomonic figns of the diftemper, efpecially when attended with ficknefs at ftomach, violent retchings, and bilious yellow vomitings, with frequent fighing. The pulfe is now generally very quick, high, foft, and fometimes throbbing, but never hard: in fome it is very quick, foft, low, and oppreffed; the refpiration quick, full, and fometimes difficult; the fkin very hot, and fometimes dry, though more frequently moift. Blood taken from the patient, even at the very beginning of the difeafe, is often of an exceeding florid red colour, without the leaft appearance of fize; and the craffamentum, when it has ftood till it is cold, will fcarce cohere, but fluctuates; the ferum is often yellow.

Moft of the above-mentioned fymptoms continually increafe, and are much aggravated: the retching and vomiting become almoft inceffant; the anxiety great, and fighing frequent; great reftleffnefs; continual toffing; no eafe in any pofture; little fleep, and that difturbed and uneafy, and without any refrefhment to the fick. When they are fainting, they turn yellow about the face and neck, inftead of turning pale; and as the fainting goes off, they recover their natural colour. Thefe fymptoms generally continue to the third day, though fometimes not longer than the firft or fecond; in others to the end of the fourth: the firft fhows the greater diffolution of the blood, and the greater malignity of the difeafe; the laft, the contrary; which the improper manner of treating the difeafe fometimes haftens and increafes, or the proper method retards. This may be called the firft ftadium of the difeafe, and generally ends on the third day.

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Blood taken from the fick on the fecond or third day, is much more diffolved, the ferum more yellow, and the craffamentum florid, loofe, fcarcely cohering, but undulates like fizy water when fhaken, and fometimes has dark blackifh fpots on its furface, fhowing a ftrong gangrenefcent diathefis.

About the third day, the pulfe, which was quick and full before, now generally finks greatly, and becomes very low: though fometimes it remains very quick, yet in others it is not much quicker than when the patient was in health, but is always low; the vomiting becomes almoft inceffant if not fo before, and the matter thrown up is black; the patient then becomes comatofe, with interrupted delirium. The thirft in fome is very great, in others but little; the pulfe ftill low and quick, attended with cold clammy fweats, and fometimes with deliquium. The eyes, which were inflamed and red before, and began to be of a more dufkifh colour, now turn yellow; and this yellownefs alfo foon after appears round the mouth, eyes, temples, and neck, and in a fhort time diffufes itfelf all over the body. But this yellownefs is fo far from being always an encouraging prognoftic, as fome would have it, that it moft commonly proves a mortal fymptom. Sometimes indeed, though feldom, this fuffufion of bile upon the furface has proved critical; but then it did not come on till the eighth or ninth day, nor appear till the coma and all the other bad fymptoms began to abate; and then in proportion as the yellownefs increafes, all the bad fymptoms decreafe. But the cafe is moft commonly quite the reverfe; efpecially when the yellownefs comes foon on: and then it ufhers in the moft fatal fymptoms of the difeafe, viz. a deep coma, a low, vermicular, and intermitting pulfe, great hæmorrhages from various parts of the body, a delirium with laborious and interrupted refpiration, great anxiety, deep fighing, reftleffnefs, a fubfultus tendinum, coldnefs of the extreme parts firft, and then all over the body, a faltering of the fpeech, tremors, and convulfions, which are foon after followed by death. So that from the firft appearance of the yellownefs we may fay the patient is in the laft ftage of the difeafe, whether it terminates in death or recovery.

It has been obferved, that, in fome ftrong fanguine conftitutions, when the patients have not been bled to a fufficient quantity in the beginning of the difeafe, the pulfe has continued full, ftrong, and rapid, but never hard; the face flufhed, eyes inflamed; the tongue dry, with great thirft and heat, till the fecond or laft ftage of the fever is come on, when the pulfe has fuddenly

fuddenly funk, and death foon after enfued. Yet in others, who feemed to be of a plethoric habit, the tongue has been moift all along, though they have been delirious moft of the time, and the heat of their fkin and the ftrength and quicknefs of their pulfe have continued, after the firft ftage of the difeafe was over, pretty near to that of their natural ftate in health, till within a few hours of death; and when they have had a coma on them, one who is not well acquainted with the nature of this difeafe would, from the pulfe, heat, breathing, and other fymptoms, have taken them to be in a natural fleep. Others, when the pulfe has begun to fink, and the fatal period feemed to be juft approaching, to the great furprife of all prefent have recovered their fenfes, fat up and talked pretty cheerfully for an hour or two, and in the midft of this feeming fecurity have been fuddenly feized with convulfions which carried them off immediately.

In the latter ftage of this fever, the blood is fo attenuated and diffolved, that we frequently fee it flowing not only out of the nofe and mouth, but from the eyes, and even through the pores of the fkin; great quantities alfo of black, half-baked, or half-mortified blood, are frequently voided both by vomiting and by ftool, with great quantities of yellow and blackifh putrid bile by the fame paffages; and the urine, which was before of a high icteritious colour, is now almoft black, and is frequently mixed with a confiderable quantity of half-diffolved blood. The pulfe, which was much funk before, now becomes very low, unequal, and intermitting; the breathing difficult and laborious; and the anxiety inexpreffible; an oppreffion with a burning heat about the præcordia comes on, though the extremities are cold, and often covered with cold clammy fweats; a conftant delirium follows; and then a total lofs of the outward fenfes as well as the judgment, with livid fpots in many parts of the body, efpecially about the præcordia; and fometimes gangrenes in other parts of the body, which are very foon fucceeded by death.

In a fhort time after death, the body appears much more full of livid, large, mortified fpots, particularly about the præcordia and hypochondres, efpecially the right; which parts feem, even from the firft feizure, to be the principal feat of this terrible difeafe; and, upon opening the bodies of thofe who die of it, we generally find the gall-bladder and biliary ducts turgid, and filled with a putrid blackifh bile; and the liver, ftomach, and adjoining parts, full of livid or blackifh mortified fpots; and the whole corpfe foon putrefies after death, and can be kept but a few hours above ground.

Dr Lind is of opinion, that the remarkable diffolution of the blood, the violent hæmorrhages, black vomit, and the other fymptoms which characterize the yellow fever, are only accidental appearances in the common fever of the Weft Indies; that they are to be efteemed merely as adventitious, in the fame manner as purple fpots and bloody urine are in the fmallpox, or as an hiccough in the dyfentery: like thefe they only appear when the difeafe is attended with a high degree of malignity, and therefore always indicate great danger. This opinion, he thinks, is confirmed by an obfervation of Dr Wind's, that in 1750 the crew of a Dutch fhip of war were diftreffed by the yellow fever, accompanied with the black vomit; but when the fhip left the harbour, and changed the noxious land air for one more healthy, the fever continued, but was not accompanied with the black vomit.

Difeafes fimilar to this fever, Dr Lind informs us, may arife in any part of the world where the air is intenfely hot and unwholefome; and therefore he treats as chimerical the notion of its being imported from one part of the world to another. An example of this happened at Cadiz in Spain, in the months of September and October 1764, when exceffive heat, and want of rain for fome months, gave rife to violent, epidemic, bilious diforders, refembling thofe of the Weft Indies, of which 100 perfons often died in a day. At this time the winds blew principally from the fouth, and after funfet there fell an unufual and very heavy dew. But his opinion on this fubject is liable to ftrong objections. And however the difeafe may originate, yet the late introduction of it from Spain into the fortrefs of Gibraltar, from which, by proper attention, it had been excluded in former epidemics, demonftrates the contagious nature of this fever beyond all poffibility of doubt.

It has been a matter of much difpute, whether the yellow fever is of an infectious nature or not. Some time ago it became an object of confideration before the Right Hon. the Lords Commiffioners of Trade and Plantations, where it was urged among other reafons, for not removing the feat of government and juftice in the ifland of Jamaica from Spanifh Town to Kingfton, that there was danger from Greenwich hofpital, fituated near Kingfton, of an infection from the yellow fever being frequently communicated to that town. On this affair a phyfician was confulted, who had long practifed in that ifland, and who gave it as his opinion, that from the yellow fever in that ifland there was no infection. This was the opinion not only of that gentleman, but of many others who had an opportunity of being well acquainted with this fever in Jamaica. But this opinion probably only arofe from thefe practitioners having confounded the ordinary remittent fever of the Weft Indies, which is often accompanied with bilious fymptoms, and is from thence often denominated the yellow fever, with the typhus icteroides, a difeafe effentially different from the bilious remittent which often prevails both in the Weft and Eaft Indies. Dr Lind gives a remarkable inftance of its being of an infectious nature.—A gentleman dying at Barbadoes of a yellow fever, his wearing apparel and linen, packed up in a cheft, were fent to his friends at Philadelphia; where, upon opening the cheft, the family was taken ill; and the clothes being unluckily hung abroad to be aired, they prefently diffufed the contagion of the yellow fever over the whole town, by which 200 perfons died.

In the defcription of the fame fever by Dr Lining, as it appeared in South Carolina, there are feveral particulars confiderably different from that by Dr Hillary. According to the former, people complained for a day or two before the attack, of a headach, pain in the loins and extremities, efpecially in the knees and calves of the legs, lofs of appetite, debility, and a fpontaneous laffitude. Some, however, were feized fuddenly, without any fuch previous fymptoms. After a chillinefs and horror, with which this difeafe generally invades, a fever fucceeded. The pulfe was very frequent, till near the termination of the fever, and was generally full,

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full, hard, and confequently ftrong: in fome, it was fmall and hard; in others, foft and fmall; but in all thofe cafes, it frequently varied in its fulnefs and hardnefs. Towards the termination of the fever, the pulfe became fmaller, harder, and lefs frequent. In fome there was a remarkable throbbing in the carotids and in the hypochondria; in the latter of which it was fometimes fo great, that it caufed a conftant tremulous motion of the abdomen. The heat generally did not exceed 102 degrees of Fahrenheit's thermometer; in fome it was lefs; it varied frequently, and was commonly nearly equal in all parts, the heat about the præcordia being feldom more intenfe than in the extremities when thefe were kept covered. On the firft day of the difeafe, fome had frequent returns of a fenfe of chillinefs, though there was not any abatement of the heat. In a few, there happened fo great a remiffion of the heat for fome hours, when at the fame time the pulfe was foft and lefs frequent, and the fkin fo moift, that one from thefe circumftances might reafonably have hoped that the fever would only prove a remittent or intermittent. About the end of the fecond day, the heat began to abate. The fkin was fometimes (though rarely) dry; but oftener, and indeed generally, it was moift, and difpofed to fweat. On the firft day, the fweating was commonly profufe and general; on the fecond day, it was more moderate: but on both thefe, there happened frequent and fhort remiffions of the fweatings; at which times the febrile heat increafed, and the patient became more uneafy. On the third day, the difpofition to fweat was fo much abated, that the fkin was generally dry; only the forehead and backs of the hands continued moift. The refpiration was by no means frequent or difficult; but was foon accelerated by motion, or the fatigue of drinking a cup of any liquid. The tongue was moift, rough, and white, even to its tip and edges. On the fecond day, its middle in fome was brown. On the third day, the whitenefs and roughnefs of the tongue began to abate. The thirft in very few was great. A naufea, vomiting, or frequent retchings to vomit, efpecially after the exhibition of either medicines or food, came on generally the third day, as the fever began to leffen; or rather as the fulnefs of the pulfe, heat, and difpofition to fweat, began to abate. Some indeed, but very few, on the firft day, had a vomiting, either bilious or phlegmatic. Very few complained of anxiety or oppreffion about the præcordia or hypochondria, nor was there any tenfion or hardnefs about the latter. On the firft day they generally dozed much, but were afterwards very watchful. Reftleffnefs and almoft continual jactations came on the fecond day. A great defpondency attended the fick, and the ftrength was much proftrated from the firft attack. The pain in the head, loins, &c. of which they had complained before the attack, was much increafed, and in fome the pain in the forehead was very acute and darting; but thofe pains went generally off the fecond day. The face was flufhed; and the eyes were hot, inflamed, and unable to bear much light. On the firft day, many of them at times were a little delirious, but afterwards not until the recefs of the fever. The blood drawn by venefection had not any inflammatory cruft; in warm weather, it was florid like arterial blood, and continued in one foft homogeneous-like mafs, without any feparation of the ferum after it was cold. When there was any feparation, the craffamentum was of a very lax texture. The ftools, after the firft day, were fetid, inclined to a black colour, and were very rarely bilious, foft, or liquid, excepting when forced by art; for an obftinate coftivenefs attended the febrile ftate. The urine was difcharged in a large quantity, was pale, fometimes limpid, and rarely of a higher than a ftraw colour, except when the weather was very warm, and then it was more faturated, of a deep colour, and difcharged in fmaller quantities. It had a large cloud, except when it was very pale or limpid; but more generally it had a copious white fediment, even on the firft day of the fever. On the fecond day, the urine continued to be difcharged very copioufly; in fome it was then turbid, and depofited a more copious fediment than on the firft day; this fediment was fometimes of a brownifh colour; in which cafe it was generally followed by bloody urine, either about the end of the fecond or beginning of the third day.—The colour and quantity of the urine, difcharged in equal times, were remarkably variable, being now limpid, then of a deeper colour; now difcharged in a larger, then in a fmaller quantity; which could not be afcribed to any change made either in the quantity or quality of the drink.

The fever accompanied with thofe fymptoms terminated on the third day, or generally in lefs than 72 hours from the firft attack, not by any affimilation or coction and excretion of the morbid matter: for if by the latter, there would have been fome critical difcharge by fweat, urine, ftool, or otherwife, none of which happened; and if by the former, nothing then would have remained but great debility. This fever, however, did not terminate in either of thefe falutary ways, excepting in fome, who were happy enough to have the difeafe conquered in the beginning by proper evacuations, and by keeping up a plentiful fweat, till the total folution of the fever, by proper mild diaphoretics and diluents. But in thofe who had not that good fortune, however tranquil things might appear, yet the face of affairs was quickly changed: for this period was foon fucceeded by the fecond *ftadium*; a ftate, though without any fever, much more terrible than the firft: the fymptoms in which were the following. The pulfe, immediately after the recefs of the fever, was very little more frequent than in health, but hard and fmall. However, though it continued fmall, it became, foon afterwards, flower and very foft; and this foftnefs of the pulfe remained as long as the pulfe could be felt. In many, in this ftage of the difeafe, the pulfe gradually fubfided, until it became fcarce perceptible; and this, notwithftanding all the means ufed to fupport and fill it; and when this was the cafe, the icteritious-like fuffufion, the vomiting, delirium, reftleffnefs, &c. increafed to a great degree. In fome, the pulfe, after being exceedingly fmall and fcarce perceptible, recovered confiderably its fulnefs; but that favourable appearance was generally of but fhort continuance. The heat did not exceed the natural animal heat; and when the pulfe fubfided, the fkin became cold, and the face, breaft, and extremities acquired fomewhat of a livid colour. The fkin was dry when the weather was cold, but was moift and clammy when the weather was hot. The refpiration

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was natural, or rather ſlow. The tongue was moiſt, and much cleaner than in the former ſtage; its tip and edges, as alſo the gums and lips, were of a more florid red colour than uſual. Very few complained of thirſt, though they had a great deſire for cold liquors. The vomiting or retching to vomit increaſed, and in ſome was ſo conſtant that neither medicines nor aliment of any kind were retained. Some vomited blood; others only what was laſt exhibited mixed with phlegm; and others again had what is called the black vomit. The retching to vomit continued a longer or ſhorter time according to the ſtate of the pulſe; for as that became fuller, and the heat greater, the retching to vomit abated, and *è contra*. The inquietude was very obſtinate; and when they dozed their ſlumbers were but ſhort and unrefreſhing. There were ſome who were drowſy; but theſe always awaked, after the ſhorteſt ſlumbers, with a great dejection of ſpirits and ſtrength. The jactations or reſtleſſneſs were ſurpriſing: it was frequently ſcarce poſſible to keep the patients in bed; though, at the ſame time, they did not complain of any anxiety or uneaſineſs; but if aſked how they did? the reply was, *Very well*. The debility was ſo great, that, if the patient was raiſed erect in the bed, or, in ſome, if the head was only raiſed from the pillow, while a cup of drink was given, the pulſe ſunk immediately, and became ſometimes ſo ſmall, that it could ſcarce be felt; at this time, they became cold, as in a horripilatio, but without the anſerine-like ſkin: their lips and ſkin, eſpecially about the neck, face, and extremities, together with their nails, acquired a livid colour. The delirium returned and increaſed; it was generally conſtant in thoſe whoſe pulſe was ſmall and ſubſiding. The inflammation of the tunica conjunctiva or white of the eyes increaſed much, but without pain. A yellowneſs in the white of the eyes, if it did not appear before in the febrile ſtate, became now very obſervable, and that icteritious tinct was ſoon diffuſed over the whole ſurface of the body, and was continually acquiring a deeper ſaffron-like colour. In ſome, indeed, no yellowneſs was obſervable, excepting in the white of the eyes, until a little before death, when it increaſed very quickly, eſpecially about the breaſt and neck. There were many ſmall ſpecks, not raiſed above the ſkin, which appeared very thick in the breaſt and neck, but leſs ſo in the extremities, and were of a ſcarlet, purple, or livid colour. In women the menſtrua flowed, and ſometimes exceſſively, though not at their regular period.

There was ſuch a putrid diſſolution of the blood in this ſtadium of the diſeaſe, that there were hæmorrhages from the noſe, mouth, ears, eyes, and from the parts which were bliſtered with cantharides. Nay, in the years 1739 and 1745, there were one or two inſtances of an hæmorrhage from the ſkin, without any apparent puncture or loſs of any part of the ſcarf-ſkin.

An obſtinate coſtiveneſs continued in ſome; in others, the ſtools were frequent and looſe: in ſome they were black, liquid, large, and greatly fatiguing; in others, when the ſtools were moderate, even though they were black, they gave great relief; in others, again, the ſtools nearly reſembled tar in ſmoothneſs, tenacity, colour, and conſiſtence.

The urine was diſcharged in a large quantity, in proportion to the drink retained by the patient: it was pale if the patient was not yellow; but if yellow, then it was of a deep ſaffron-colour: in either caſe, it had a ſediment, or at leaſt a large cloud, which remained at the bottom of the glaſs; in ſome, it was very turbid; in others it was bloody: and the quantity of blood diſcharged with the urine bore always ſome proportion to the ſtate of the pulſe; when that became fuller, the quantity of blood in the urine was diminiſhed; when the pulſe ſubſided, the bloody urine increaſed, and even returned after it had ceaſed ſome days, ſoon after the pulſe became ſmaller. This ſtage of the diſeaſe continued ſometimes ſeven or eight days before the patient died.

When this ſtadium of the diſeaſe terminated in health, it was by a receſs or abatement of the vomiting, hæmorrhages, delirium, inquietude, jactations, and icteritious-like ſuffuſion of the ſkin and white of the eyes; while, at the ſame time, the pulſe became fuller, and the patient gained ſtrength, but very ſlowly. But when it terminated in death, thoſe ſymptoms not only continued, but ſooner or later increaſed in violence, and were ſucceeded with the following, which may be termed the third *ſtadium* of the diſeaſe, which quickly ended in death. The pulſe, though ſoft, became exceedingly ſmall and unequal; the extremities grew cold, clammy, and livid; the face and lips, in ſome, were fluſhed; in others, they were of a livid colour; the livid ſpecks increaſed ſo faſt, that in ſome the whole breaſt and neck appeared livid; the heart palpitated ſtrongly; the heat about the præcordia increaſed much; the reſpiration became difficult, with frequent ſighing; the patient now became anxious, and extremely reſtleſs; the ſweat flowed from the face, neck, and breaſt; blood flowed from the mouth, or noſe, or ears, and in ſome from all thoſe parts at once; the deglutition became difficult; the hiccoughs and ſubſultus tendinum came on, and were frequent; the patients trifled with their fingers, and picked the naps of the bedclothes; they grew comatoſe, or were conſtantly delirious. In this terrible ſtate, ſome continued eight, ten, or twelve hours before they died, even after they had been ſo long ſpeechleſs, and without any perceptible pulſation of the arteries at the wriſts; whereas, in all other acute diſeaſes, after the pulſe in the wriſts ceaſes, death follows almoſt immediately. When the diſeaſe was very acute, violent convulſions ſeized the unhappy patient, and quickly brought this ſtadium to its fatal end. After death, the livid blotches increaſed faſt, eſpecially about the face, breaſt, and neck, and the putrefaction began very early, or rather increaſed very quickly.

Such was the progreſs of this terrible diſeaſe through its ſeveral ſtadia. But in hot weather, and when the ſymptoms in the firſt ſtage were very violent, it paſſed through thoſe ſtages with ſuch precipitation that there was but little opportunity of diſtinguiſhing its different ſtadia, the whole tragedy having been finiſhed in leſs than 48 hours. It was remarkable, that, 1. The infection was increaſed by warm and leſſened by cold weather. 2. The ſymptoms in the ſeveral ſtadia were more or leſs violent, according to the heat or coolneſs of the weather. In hot days, the ſymptoms were not only more violent, but in thoſe who ſeemed in moderate weather to be on the recovery, or at leaſt in no danger, the ſymptoms were all ſo greatly heightened, when

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when the weather grew considerably warmer, as frequently to become fatal. In cool days, the symptoms were not only milder, but many who were apparently in great danger in hot days were saved from the very jaws of death by the weather becoming happily cooler. 3. The disease was generally more fatal to those who lay in small chambers not conveniently situated for the admission of fresh air, to those of an athletic and full habit, to strangers who were natives of a cold climate, to those who had the greatest dread of it, and to those who before the attack of the disease had overheated themselves by exercise in the sun, or by excessive drinking of strong liquors; either of which indeed seemed to render the body more susceptible of the infection. Lastly, The disease proved most certainly fatal to valetudinarians, or to those who had been weakened by any previous disease.

Causes of, and persons subject to, this disease. The yellow fever attacks principally Europeans, especially those who have but lately arrived in the hot climates. Negroes are entirely exempt from it, though the mulattoes and tawnies are as liable to be seized with it as the whites themselves. The cause of the disease seems to be a particular kind of contagion; but Dr Lind seems to be of opinion, that the immediate cause of the symptoms is a disposition in the glutinous part of the blood to separate from the others, and to become putrescent. In some persons who have been bled in the yellow fever, the blood has been observed very viscid; the crassamentum covered with a yellow gluten half an inch in thickness, and impenetrable to the finger unless cut by the nail; the serum being at the same time of the consistence of a thin syrup, and of a deep yellow tinct. This serum tasted bitter, and resembled a composition of soot. The appearances on dissection, with his conclusions from them, we shall give in his own words: "In a man who died on the eleventh day of a yellow fever, whose body emitted no bad smell 36 hours after death, and was still yellow, I found all the bowels of the abdomen sound; the liver and spleen were remarkably so; as also the stomach and intestines. There was no suffusion of the bile either in the intestines or stomach. The gall-bladder, of the natural size, contained the usual quantity of bile, somewhat thicker than common, and grumous (B).

"Upon examining further, this disease was found to have lain wholly on the left side, where, within the breast, was found near a quart of yellowish water, in which were many large flakes of yellowish gluten, appearing, by comparison, precisely the same with the thick pellicle which had covered the blood taken from his arm. These flakes bore in several places a resemblance to a membranous substance beginning to be converted into a purulent jelly. The pleura, both on its inside and outside, as also its continuation, the investing membrane of the lungs, were covered with cakes of this gluten, hanging in some places loosely, in others adhering more strongly: and all in different states of yellow or purulent corruption. The right cavity of the breast, and all the other parts of his body, were found entirely free from disease.

"His complaints had been chiefly in his breast; and a small quantity of blood taken from him two days before his death, was covered with an impenetrable, yellow, thick gluten; the red portion below it being quite loose.

"In those fevers, I have also seen (says Dr Lind) the disease entirely confined to the heart and pericardium. In one who died on the tenth day of the fever, without having been yellow, a quantity of pus and purulent crusts were found mixed with the water of the pericardium. The heart in different places was excoriated; and, together with the inside of the pericardium, was lined with a thick membranous cake, similar to that already mentioned on the lungs and pleura. In some places this cake had a purulent, in others a gelatinous appearance, exactly resembling the coagulum of the blood. His complaints had been, a great oppression on the breast, and an extreme difficulty of breathing. In a third person, who died on the thirteenth day of the fever, above two quarts of pus and purulent jelly were found in the cavity of the belly. The source of such an extraordinary quantity of matter was not from any preceding inflammation, nor any imposthume, that we could discover; but from innumerable ulcerations on the surface of the intestines, omentum, mesentery, and peritoneum. Neither did those ulcerations (or excoriations, as they rather appeared in several places) seem to be the primary fountains of the matter, but to have been occasioned by its acrimony.

"This purulent appearance seems to arise merely from an extravasation of one of the component parts of the blood, the gluten or fibrine as it is now called. Blood taken from persons in a fever, and frequently even from persons in perfect health, after standing in a clean vessel for a short time, commonly separates into three distinct portions; viz. the serum, or water of the blood, the red concreted mass, and a viscid pellicle termed the *size*, which spreads itself on the top of the red concretion. Some time ago, when making experiments with the blood taken from persons in the scurvy, I was surprised to find it often covered with that sizy crust. This induced me to extend my experiments to large quantities of blood from different subjects, which I had opportunities of inspecting at once in so large an hospital. For this purpose I one morning ordered ten patients in the scurvy to be bled, taking two ounces from each. A larger quantity was taken, for its inspection, from two men in health. That day I had occasion to prescribe bleeding to a woman in labour, two hours before her delivery; to a girl of sixteen years of age afflicted with a lunacy proceeding from the chlorosis; to three patients in the rheumatism; and to a person labouring under an obstruction of the liver.

"From a nice comparison, and an examination of the blood in these cases, I found in general, that the more

(B) In others who died in this yellow state, the bile in the gall-bladder was found of a thick ropy consistence like pitch, but the liver never appeared in the least affected. Dr Lind at first in several bodies opened the head only; but afterwards judged that all the cavities ought to be inspected.

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more ſize there was on the top, and the thicker and more viſcid this white pellicle ſhowed itſelf, the concretion below it was of a more looſe coherence. This was not ſo obſervable when only ſome ſlight white ſtreaks appeared on the top. But when much ſize had ſeparated itſelf, the red maſs became very ſoft at the bottom of the veſſel, and leſs compact in its different parts, in proportion to their diſtance from the ſurface, towards which this whitiſh portion had aſcended.

"From this and from other experiments it appears, that this cruſt or pellicle is the natural gluten which becomes ſtrongly diſpoſed, in certain circumſtances and diſeaſes, to ſeparate itſelf. And whereas the ſerum and red concretion are eaſily incorporated together, it will be found, that this glue, after its ſeparation, becomes immiſcible with either. We have, by gentle drying, converted it into a perfectly tough elaſtic membrane; and, by the means of a ſmall portion of the red maſs being left adhering to it, into a ſubſtance reſembling muſcular fleſh; and it is capable of undergoing various changes into corruption, in the ſame manner as either of theſe.

"Now, I can ſee no reaſon why this gluten, in its morbid ſtate, may not ſeparate itſelf from the circulating blood, and be depoſited in the cavities of the body, as readily as the ſerum does in dropſies; the former having always a leſs diſpoſition than the latter to incorporate with the maſs.

"In diſſecting perſons who died of fevers in London and Minorca, and where no infection was ſuſpected, appearances ſimilar to theſe have alſo fallen under the inſpection of thoſe accurate anatomiſts Drs Hunter and Cleghorn. Hence it may be preſumed very difficult to diſtinguiſh fevers that are produced by infection, from ſome others. I cannot, however, be induced to think, as thoſe gentlemen ſeem to do, that theſe preternatural ſubſtances which were found in the cavities of the body are the conſequence, but rather that they are the cauſe, of the inflammation and excoriations. I believe theſe ſubſtances to be at firſt diſeaſed extravaſated gluten, and conjecture their different ſtates greatly to depend upon the different times at which they were depoſited.

"I have remarked, in a variety of dead bodies, three different kinds of extravaſation; theſe occurred in ſuch as had died of the ſcurvy, of conſumption, and of fevers. In the former of thoſe diſeaſes, red coagulated blood is found extravaſated in almoſt all parts of the body, not only into the tela cellulosa, but into the bellies of the muſcles, particularly of the legs and thighs, which often become quite ſtuffed and even diſtorted with large grumous maſſes. The inteſtines and meſentery are often ſpotted alſo with extravaſated blood; and I have ſeen large ecchymoſes on the ſtomach. Thoſe appearances at firſt ſight reſembled ſo many diſtinct mortifications; and by this appearance ſome anatomiſts have been deceived; but, upon a nice examination, the texture of the parts is found to be ſound and firm. There is likewiſe, in that diſeaſe, ſometimes, an extravaſation of water, chiefly collected in the tela cellulosa.

"But as, in the limbs of ſcorbutic perſons, it is extremely difficult to make a good diſſection by reaſon of ſuch quantities of extravaſated blood that everywhere obſtruct the operator; ſo, on the contrary, the lower extremities of thoſe who have died conſumptive, with ſwelled legs, are, of all ſubjects, in the beſt ſtate to afford a ſatisfactory view of the muſcles. The water encloſed in their legs having inſinuated itſelf, by paſſing the tela cellulosa, into the ſpaces between the muſcles, the muſcles are eaſily ſeparated from each other; and their ſeveral origins and inſertions may be diſtinctly traced by means of their having been cleanſed and waſhed by the water in the inveſting cellular membrane. Thus there are extravaſations of three ſorts; viz. Firſt, The grumous maſs in the ſcurvy; and this I have often remarked where no ſerum was obſerved. Secondly, The ſerum alone in anaſarcous ſwellings. The third and laſt is what was taken notice of in thoſe who died of fevers, being the gluten of the blood, accompanied for the moſt part with ſome ſerum; both of them altogether confined to the large cavities of the body.

"I conjecture, that in thoſe fevers there is always an ulcerous or purulent diſpoſition in the blood; and that the gluten is greatly diſeaſed. I have frequently ſeen it have a true purulent appearance ſoon after it was drawn off, when the patient ſeemed not very ill.

"And I further conjecture, that the miſchief often lies within the breaſt; as alſo that the great benefit derived from the very early application of bliſters, in a great meaſure flows from ſo many ulcerations and vents being timely provided for the free diſcharge of thoſe purulent and tainted particles from the body.

"If an infection depends, as many have imagined, on the admiſſion of certain foreign particles into the blood, this gluten ſeems to be primarily affected by it; and a diſcharge of this, by waſhing thoſe particles out of the body, tends in a great meaſure to remove that diſeaſe.

"It is an obſervation of the beſt practical writers, that iſſues and ſetons are moſt excellent preſervatives againſt receiving an infection, even that of the plague itſelf. And indeed a ſuppuration and plentiful diſcharge from a proper ulcer, whether produced by nature or by art, ſeems to open a channel the beſt appropriated for an exit out of the body to ſome of the moſt malignant poiſons. Thus the moſt favourable criſis in the plague, and in moſt peſtilential fevers, happens when nature excites tumors kindly ſuppurating in the groin or armpits, by whoſe beneficial and plentiful diſcharge the deadly poiſon is expelled from the conſtitution.

"I have obſerved it to be amongſt the moſt certain characteriſtics of the worſt fevers, that the bliſters either do not riſe and fill, or diſcharge ſuch yellow, greeniſh, fetid, and highly offenſive ſtuff, that even experienced nurſes could give a pretty certain conjecture from the bliſters of the different degrees of malignity in the fever. We have more than once endeavoured to conceal the bad ſtate of ſome patients in the hoſpital; but a diſcovery was always made of their condition in the waſhhouſe, from the linen ſent there ſtained with the diſcharges from the bliſtered parts. And indeed a careful inſpection of the ſtate and diſcharge from the bliſters, together with their effects, furniſhes us, in thoſe diſeaſes, with ſome of the moſt certain diagnoſtics of their nature, and prognoſtics of their event."

Prognoſis. This diſtemper, where it attacks with violence,

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violence, is generally fatal; the prognosis therefore must be commonly unfavourable, and always uncertain; neither can any thing more be said on this subject, than that an abatement of the symptoms already enumerated affords a favourable prognostic, and an increase of them the contrary.

Cure. The cure of this terrible disease, according to Dr Hilary, is very easy and simple. His indications are, 1. To moderate the too great and rapid motion of the fluids, and abate the too great heat and violence of the fever in the two first days of the disease, as much and as safely as we can. 2. To evacuate and carry out of the body as much of the putrid bile and other humours, and as expeditiously and safely as possible. 3. To put a stop to the putrescent disposition of the fluids, and to prevent the gangrenes from coming on, by suitable antiseptics.

The first indication is answered by bleeding, which, in the first stage of this fever, is sometimes absolutely necessary in some degree: the quantity to be taken away must be determined by the age and strength of the patients, the degree of plethora, fulness of the pulse, &c. When called at the beginning, he orders 12, 14, 16, 18, or 20 ounces of blood to be taken away on the first or second day; and if the patient's pulse rise after the first bleeding, or if the fever still continue high and the pulse full, he repeats the bleeding once on the days above mentioned. But bleeding a third time is seldom or never required; neither is bleeding on the third day almost ever necessary; and when it is performed on that day, it ought to be done with the greatest caution and judgment: neither should a vein be opened after the third day in this fever, unless some very extraordinary symptoms and circumstances require it; which seldom or never happen. On that day, indeed, the pulse generally sinks, and the blood is in such a dissolved state, that bleeding must be accounted highly pernicious. Nevertheless, it is indispensably necessary in the beginning of the distemper; and if omitted at that time, the violent heat and motion of the blood increase the putrescence of the humours to such a degree as to bring on the fatal consequences much sooner than would otherwise have happened. If blood-letting be thus advised by Dr Hilary, it has been still more strongly recommended by Dr Rush, who, in his first publication on the subject of the dreadful yellow fever which proved so fatal at Philadelphia, represented it as an almost infallible remedy for the disease. But the observations and experience of others have by no means confirmed the practice which he recommended.

After bleeding, we come to the second indication of cure, namely, to evacuate as much of the bilious and putrid humours as soon and as safely as we can. The great irritation of the stomach, by the putrid bilious humours constantly attending this fever, with almost continual retchings and violent vomitings, seem to indicate the giving of an emetic: but the stomach is always observed to be so violently stimulated and irritated, and most commonly inflamed, by the acrimony of the putrescent bile, that any emetic, even the most mild and gentle, given in the smallest dose, brings on an incessant vomiting, which continues, in spite of all remedies, till a mortification and death ensue. Instead of this, it is proper to give large draughts of warm water, which, without any additional stimulus to the stomach, evacuates its acrid and putrid contents, commonly with great relief to the patient: the warm water also acts as an emollient fotus to the inflamed coats of the stomach; and thus abates the inflammation, and prevents gangrene and mortification from coming on.

After the patient has by this means vomited seven or eight times, or oftener, and discharged a great quantity of yellow and blackish bilious matter, a grain or a grain and a half of thebaic extract is given, in order to procure some respite from the violent retching, vomiting, and anxiety. The person is desired to take nothing into his stomach for two hours after this, by which means it is seldom or never rejected; and thus all the symptoms are considerably abated, the retching and vomiting either totally cease or are very much lessened, so that medicines may now be exhibited which the stomach would not have retained before. These are cooling acid juleps, or other antiseptic remedies; but neither nitre nor any of its preparations will commonly be found to stay on the stomach, nor, according to Dr Hilary, are the nitrous medicines, or even the common antiemetic draughts, proper to be given in this disease, even though they should agree with the stomach, on account of their attenuating property.

If the patient has not a stool or two after drinking the warm water and vomiting, it is necessary to give a gentle purging clyster; and when six or eight hours rest have been obtained, a gentle antiphlogistic and antiseptic purge, in order to evacuate by stool as much of the bilious matter as we possibly can. Or if the patient has a purging before, which sometimes though very rarely happens, a dose of toasted rhubarb is given, and an antiseptic anodyne after it has operated, to abate and check the too great purging, but not to stop it, as this evacuation has been always observed to be of service, provided it be not very violent.

After this indication is completely answered, the next is to exhibit such proper antiseptic medicines as may stop the putrescent disposition of the fluids. Here the cinchona would seem to be the most proper remedy; but unluckily the stomachs of the patients in this disease are so much irritated, and so apt to reject every thing, that it cannot be retained in any form whatever. In this case Dr Percival recommends columbo root, the infusion of which is found to be a powerful antiemetic and antiputrescent medicine, and might perhaps so far alter the state of the stomach as to make it bear the bark. Dr Hilary, however, who was ignorant of the virtues of columbo, substituted the *radix serpentariæ Virginianæ* with success. A slight infusion of this root not only sat easily on the stomach of the patients, but moderately raised the pulse and fever, both of which are now too low. The following receipt was found the most agreeable and efficacious:

℞ Rad. serpent. Virginian. ℥ij.
Croc. Ang. ʒ ſs. M. et infunde vase clauso in aq. bul. q. per horam unam ut col. ℥vj. Adde aq. menth. simp. ℥ij. Vin. Maderiens. ℥iv. Syr. croc. vel syr. è mecon. ℥i. Elix. vitriol. acid. q. s. ad grat. acid. sap. Exhibe cochlearia duo vel tria singulis horis vel bihoris, vel sæpius pro re nata.

By the use of this medicine, and soft light nourishment taken in small quantities, the pulse is usually kept up

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up and the diſtemper goes off. But if, after taking this a little while, we find that the pulſe does not riſe, but on the contrary that a coldneſs of the extreme parts comes on, the medicines muſt be made more warming, by increaſing the quantity of the ſnakeroot and ſaffron, or by adding *vinum croceum*, *confectio cardiaca*, or the like, but not by the uſe of volatile ſpirits and ſalts, which hurt by their ſtimulating and diſſolving qualities. Bliſters Dr Hilary reprobates in the ſtrongeſt terms, and affirms that he has ſeen the place where a bliſter was applied turned perfectly black and ſphacelated; ſo that if the ſpine and end of the ribs had not hindered, a large ſquare paſſage would have been opened into the cavity of the thorax, had the patient lived a few hours after it.

At the ſame time that the ſtrength of the patient is kept up by the medicines above mentioned, or by others ſimilar, he gave repeated gentle purgatives every ſecond or third day, and ſometimes, when the ſymptoms were very urgent, every day, for four or five days ſucceſſively. But if proper methods be taken in the beginning of the diſeaſe, it is ſeldom that ſuch a repetition of purging is neceſſary.

Dr Hilary's plan of treating the yellow fever is, in our opinion, as judicious as any that has yet been propoſed. But, among the late writers, ſome have recommended mercury, particularly under the form of calomel, as the moſt efficacious remedy which can be employed. In ſome caſes it has certainly been given to an almoſt incredible extent, in a very ſhort time, without exciting either purging or ſalivation. And it cannot be denied, that patients have not unfrequently recovered under the uſe of it. But calomel can no more be reckoned an infallible remedy for this diſeaſe than blood-letting.

Since the introduction of cold affuſion, in the cure of typhus fevers, by Dr Currie, it has been imagined by ſome, that this practice would afford a very efficacious remedy in the typhus icteroides, as well as in the typhus mitior. But experience has not yet confirmed the utility of this practice.

Some have ſuggeſted the internal uſe of the oxygenated muriatic acid, properly diluted, as an article from which great benefit may be expected in the yellow fever. This practice deſerves, we think, a fair trial: but the utility of it ſtill remains to be determined by experience.

To the genus of *typhus* alſo belong all thoſe fevers attended with very profuſe and debilitating ſweats, and which have ſometimes, not without good reaſon, been accounted plagues; ſuch as the Engliſh ſweating-ſickneſs, Miliaris ſudatoria, *Sauv.* ſp. 5. Ephemera ſudatoria, *Sauv.* ſp. 7. Ephemera Britannica, *Caius de ephem. Britan.*

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Genus VI. SYNOCHUS.

Synochus, *Sauv.* gen. 81. *Lin.* 13.
Lenta, *Lin.* 14.
Phrenitis, *Vog.* 18.
Febris continua putrida, *Boerh.* 730.

This is a contagious diſtemper, being a complication of a ſynocha and typhus; for the deſcription and cure of which, we muſt of conſequence refer to what hath been already ſaid concerning theſe diſeaſes.

Hectica.

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The *Hectic* Fever.

Hectica, *Sauv.* gen. 83. *Lin.* 24. *Vog.* 80. *Sag.* 684.

This diſeaſe is reckoned by Dr Cullen to be merely ſymptomatic; as indeed ſeems very probable, ſince it generally accompanies abſorption of pus into the blood from internal ſuppurations, or indeed from ſuch as are external, provided they be very large or of a bad kind.

Deſcription. The beſt, perhaps the only proper, deſcription of this diſorder we have is that by Dr Heberden. According to him, the appearance of the hectic fever is not unlike that of the genuine intermittent; from which, however, the diſeaſe is very different in its nature, while at the ſame time it is much more dangerous. In the true intermittent, the three ſtages of cold, heat, and ſweat, are far more diſtinctly marked, the whole fit is much longer, the period which it obſerves is more conſtant and regular, and the intermiſſions are more perfect, than in the hectic fever. For in the latter, even during the cleareſt remiſſion, there is uſually a feveriſh quickneſs perceptible in the pulſe, which ſeldom fails to exceed the utmoſt limit of a healthy one by at leaſt 10 ſtrokes in a minute.

The chilneſs of the hectic fever is ſometimes ſucceeded by heat, and ſometimes immediately by a ſweat without any intermediate ſtate of heat. The heat will ſometimes come on without any remarkable chilneſs preceding; and the chilneſs has been obſerved to go off without being followed either by heat or ſweat. The duration of theſe ſtages is ſeldom the ſame for three fits together; and as it is not uncommon for one of them to be wanting, the length of the whole fit muſt vary much more than in the true intermittent; but in general it is much ſhorter.

A patient ſubjected to hectic fever is little or nothing relieved by the occurrence of the ſweat; but is often as anxious and reſtleſs under it as during the chilneſs or heat. When the ſweat is over, the fever will ſometimes continue; and in the middle of the fever the chilneſs will return; which is a moſt certain mark of this diſeaſe.

The hectic fever will return with great exactneſs, like an intermittent, for two or perhaps three fits; but Dr Heberden informs us, that he does not remember ever to have known it keep the ſame period for four fits ſucceſſively. The paroxyſm will now and then keep off for 10 or 12 days; and at other times, eſpecially when the patient is very ill, it will return ſo frequently on the ſame day, that the chilneſs of a new fit will follow immediately the ſweat of the former. It is not unuſual to have many threatenings of a ſhivering in the ſame day; and ſome degree of drowſineſs is apt to attend the ceſſation of a fit.

The urine in a true intermittent is clear during the fits and turbid during the intervals; but in the hectic fever it is liable to all kinds of irregularity. It will be equally clear or turbid in both ſtages; or turbid in the fits and clear in the intervals; and ſometimes it will be, as in a true intermittent, clear during the fever, and thick at the going off.

Hectic patients often complain of pains like thoſe of the rheumatiſm, which either affect by turns almoſt every

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Dr Heberden has seen this fever attack those who seemed in tolerable health, in a sudden and violent manner, like a common inflammatory one; and like that, also, in a very short time bring them into imminent danger of their lives; after which it has begun to abate, and to afford hopes of a perfect recovery. But though the danger might be over for the present, and but little of a fever remain; yet that little has soon demonstrated, that it was kept up by some great mischief within, and, proving unconquerable by any remedies, has gradually undermined the health of the patient, and never ceased except with his life. This manner of its beginning, however, is a rare occurrence. It much oftener dissembles its strength at first; and creeps on so slowly, that the subjects of it, though they be not perfectly well, yet for some months hardly think themselves ill; complaining only of being sooner tired with exercise than usual, of want of appetite, and of falling away. But gentle as the symptoms may seem, if the pulse be quicker than ordinary, so as to have the artery to beat 90 times and perhaps 120 times in a minute, there is the greatest reason to be apprehensive of the event. In no disorder, perhaps, is the pulse of more use to guide our judgment than in the hectic fever: yet even here we must be upon our guard, and not trust entirely to this criterion; for one in about twenty patients, with all the worst signs of decay from some incurable cause, which irresistibly goes on to destroy his life, will show not the smallest degree of quickness, nor any other irregularity of the pulse, to the day of his death.

Causes, &c. This fever will supervene whenever there is a great collection of matter formed in any part of the body; but it more particularly attends upon the inflammation of a scirrhous gland, and even upon one that is slight and only just beginning; the fever growing worse in proportion as the gland becomes more inflamed, ulcered, or gangrenous. And such is the lingering nature of those glandular disorders, that the first of those stages will continue for many months, and the second for some years.

If this scirrhous inflammation be external, or in the lungs, or some of the abdominal viscera, where the disturbance of their functions plainly points out the seat of the disorder, no doubt can be entertained concerning the cause of the fever. But if the part affected be not obvious to the senses, and its precise functions be not known, the hectic, which is there only part of the train of another disease, may be mistaken for the primary or only affection.

Hectica. Lying-in-women, on account of the violence sustained in delivery, generally die when affected with this fever. Women of the age of near 50 and upwards are particularly liable to it. For, upon the cessation of their natural discharge, the glands of the breasts, ovaries, or womb, too commonly begin to grow scirrhous, and proceed to be cancerous. Not only these, but the glandular parts of all the abdominal viscera, are disposed to be affected at this particular time, and to become the seats of incurable disorders.

The injuries done to the stomach and liver by hard drinking are attended with similar symptoms, and terminate in the same manner.

Dr Heberden observes, that the slightest wound by a fine-pointed instrument is known upon some occasions to bring on the greatest disturbances, and the most alarming symptoms, nay even death itself. For not only the wounded part will swell and be painful, but by turns almost every part of the body; and very distant parts have been known to come even to suppuration. These symptoms are constantly accompanied with this irregular intermittent, which lasts as long as any of them remain.

Prognosis. This anomalous fever is never less dangerous than when it originates from a kindly suppuration, into which all the diseased parts are melted down, and for which there is a proper outlet.

The symptoms and danger from some small punctures, with their concomitant fever, most frequently give way in a few days; though in some persons they have continued for two or three months, and in others have proved fatal.

The inflammation of internal scirrhous glands, or of those in the breasts, sometimes goes off, and the fever, which depended upon it, ceases; but it much oftener happens, that it proceeds to cancerous and gangrenous ulcers, and terminates only in death. Death is also, almost universally, the consequence of hectic fever from tubercles of the lungs, which have in general at least been considered as glandular bodies in a scirrhous state.

Cure. It is not to be expected that the same remedies will in every case be adapted to a fever which, arising from very different causes, is attended with such a variety of symptoms. A mixture of assafœtida and opium has in some persons seemed singularly serviceable in this fever, when brought on by a small wound; but in most other cases the principal if not the sole attention of the physician must be employed in relieving the symptoms, by tempering the heat, by preventing both costiveness and purging, by procuring sleep, and by checking the sweats. If, at the same time, continues Dr Heberden, he put the body into as good general health as may be, by air, exercise, and a proper course of mild diet, he can perhaps do nothing better than to leave all the rest to nature. In some few fortunate patients, nature appears to have such resources, as may afford reason for entertaining hopes of cure, even in very bad cases. For some have recovered from this fever attended with every symptom of an abdominal viscus incurably diseased, after all probable methods of relief from art had been tried in vain, and after the flesh and strength were so exhausted as to leave scarce any hopes from nature. In those deplorable

Phlegmaſiæ. ble circumſtances, there has ariſen a ſwelling not far from the probable ſeat of the diſorder, and yet without any diſcoverable communication with it. This ſwelling has come to an abſceſs; in conſequence of which the pulſe has ſoon returned to its natural ſtate, as have alſo the appetite, fleſh, and ſtrength. What nature has performed in thoſe rare caſes, Dr Heberden acquaints us, he has often endeavoured to imitate, by making iſſues or applying bliſters near the ſeat of the diſeaſe; but he cannot ſay with the ſame ſucceſs.

It ſeems at preſent, Dr Heberden obſerves, to be the opinion of many practitioners, that gangrenes will be ſtopped, and ſuppuration become more kindly, by the uſe of Peruvian bark; and therefore this remedy is always either adviſed or permitted in the irregular fever joined with ſuppurations and gangrenes. But he affirms he does not remember ever to have ſeen any good effect from cinchona in this fever unattended with an apparent ulcer; and even in gangrenes it ſo often fails, that in ſucceſsful caſes, where it has been adminiſtered, there muſt be room for ſuſpicion that the ſucceſs was owing to another cauſe. Dr Heberden acknowledges, at the ſame time, that he never ſaw any harm from cinchona, in theſe, or indeed in any other caſes, except a ſlight temporary purging or ſickneſs, where it has happened to diſagree with the ſtomach, or where the latter has been loaded by taking the medicine too faſt, eſpecially in dry boluſes wrapped in wafer-paper.

In hectic illneſſes, where all other means have proved ineffectual, a journey to Bath is uſually propoſed by the friends, and wiſhed for by the ſick; but Dr Heberden juſtly obſerves, that, beſides the fatigue and many inconveniences of a journey to a dying perſon, the Bath waters are peculiarly hurtful in this fever, which they never fail to increaſe, and thereby aggravate the ſufferings and haſten the death of the patient.

170 ORDER II. PHLEGMASIÆ.

Phlegmaſiæ membranoſæ et parenchymatoſæ, *Sauv.* Claſs III. Ord. I. II. *Sag.* 605.
Morbi febriles phlogiſtici, *Lin.* Claſs III.
Febres continuæ compoſitæ inflammatoriæ, *Vog.*
Morbi acuti febriles, *Boerh.* 770.
Febres inflammatoriæ, *Hoffm.* II. 105. *Junck.* 61.

The phlegmaſiæ, or topical inflammations, are a very numerous aſſemblage of diſeaſes. Their great characteriſtics are, the general ſymptoms of fever, and a topical inflammation, attended with the leſion of ſome important function. In moſt inſtances, when blood is drawn, it is found upon coagulation to be covered with a buffy coat. Under this order, many important genera are comprehended, each requiring a ſeparate conſideration.

171 GENUS VII. PHLOGOSIS.

172 Sp. I. PHLOGOSIS PHLEGMONE.

Phlegmone auctorum, *Sauv.* gen. 15. *Lin.* 39. *Vog.* 351.
Inflammatio, *Lin.* 231. *Boerh.* 370. *Junck.* 20.

This diſeaſe is a ſynocha fever, accompanied with an inflammation of ſome particular part either external or internal, and conſequently it varies very much in its form and the degree of danger attending it, according to the ſituation and functions of the part affected with topical inflammation. To this ſpecies, therefore, belong the following diſeaſes: Phlogoſis.

Furunculus, *Sauv.* gen. 18. *Vog.* 352.
Tereminthus, *Vog.* 381.
Pupula, *Lin.* 275. *Sauv.* p. 6.
Varus, *Vog.* 436. *Lin.* 269. *Sauv.* p. 7.
Bacchia, *Lin.* 270.
Gutta roſea, *Sauv.* gen. 4.
Gutta roſacea, *Vog.* 437.
Hordeolum, *Sauv.* gen. 27. *Lin.* 276. *Vog.* 434.
Otalgia, *Sauv.* gen. 197. *Lin.* 44. *Vog.* 148.
Dolor otalgicus, *Hoffm.* II. 336.
Parulis, *Vog.* 362.
Maſtodynia, *Sauv.* gen. 210. *Vog.* 153.
Paronychia, *Sauv.* gen. 21. *Lin.* 258. *Vog.* 345.
Arthrocace, *Sauv.* gen. 78. *Lin.* 256.
  Pædarthrocace, *Vog.* 419.
  Spina ventoſa, *Boerh.* 526.
Phimoſis, *Sauv.* gen. 22. *Lin.* 297. *Vog.* 348.
  Paraphimoſis, *Vog.* 349.

For the cure of inflammations, Dr Cullen lays down the following indications. 1. To remove the remote cauſes when they are evident and continue to operate. 2. To take off the phlogiſtic diatheſis affecting the whole ſyſtem, or the particular part. 3. To take off the ſpaſm of the particular part, by remedies applied to the whole ſyſtem, or to the part itſelf.

The means of removing the remote cauſes will readily occur, from conſidering the particular nature and circumſtances of the different kinds. Acrid matters muſt be removed, or their action muſt be prevented, by the application of demulcents. Compreſſing and overſtretching powers muſt be taken away; and from their ſeveral circumſtances, the means of doing ſo will be obvious.

The means of taking off the phlogiſtic diatheſis of the ſyſtem are the ſame with thoſe already mentioned under the cure for ſynocha. The means of taking off the ſpaſm alſo from the particular part, are much the ſame with thoſe already mentioned. Only it is to be remembered, that topical bleedings, ſuch as cupping with ſcarifications, applying leeches, &c. are in this caſe much more indicated; and that ſome of the other remedies are to be directed more particularly to the part affected, as ſhall be more fully conſidered when we treat of thoſe diſeaſes attended with particular inflammations.

When a tendency to ſuppuration is perceived, the proper indication is to promote the production of perfect pus as much as poſſible. For this purpoſe various remedies, ſuppoſed to poſſeſs a ſpecific power, have been propoſed: but it does not appear that any of them are poſſeſſed of a virtue of this kind; and, in Dr Cullen's opinion, all that can be done is to favour the ſuppuration by ſuch applications as may ſupport a moderate heat in the part, by ſome tenacity confine the perſpiration, and by an emollient quality may weaken the coheſion of the teguments, and favour their eroſion. As all abſceſſes are occaſioned by the effuſion of fluids, and as in the caſe of certain effuſions a ſuppuration becomes

Phlegmasiæ. comes not only unavoidable but desirable, it may be supposed that most of the means of procuring a resolution, by diminishing the force of circulation, &c. ought to be avoided. But as we observe on the one hand, that a certain degree of increased impetus, or of the original symptoms of inflammation, is necessary to produce a proper suppuration; so it is then especially necessary to avoid those means of resolution which may diminish too much the force of circulation. And on the other hand, as the impetus of the blood, when violent, is found to prevent the proper suppuration; so, in such cases, though a tendency to suppuration may have begun, it may be proper to continue those means of resolution which moderate the force of the circulation. With respect to the opening of abscesses when completely formed, see the article SURGERY.

When an inflammation has taken a tendency to gangrene, that event is to be prevented by every possible means; and these must be different according to the nature of the several causes: but after a gangrene has in some degree taken place, it can be cured only by the separation of the dead from the living parts. This in certain circumstances can be performed, and most properly, by the knife. In other cases it can be done by exciting a suppuratory inflammation on the verge of the living part, whereby its cohesion with the dead part may be everywhere broken off, so that the latter may fall off by itself. While this is doing, it is proper to prevent the further putrefaction of the part, and its spreading wider. For this purpose various antiseptic applications have been proposed: but Dr Cullen is of opinion, that while the teguments are entire, these applications can hardly have any effect; and therefore that the fundamental procedure must be to scarify the part so as to reach the living substance, and, by the wounds made there, to excite the suppuration required. By the same incisions also we give access to antiseptics, which may both prevent the progress of the putrefaction in the dead, and excite the inflammation necessary on the verge of the living parts.

When the gangrene proceeds from loss of tone, and when this, communicated to the neighbouring parts, prevents that inflammation which, as we have said, is requisite to the separation of the dead parts from the living, it will be necessary to obviate this loss of tone by tonic medicines given internally; and for this purpose cinchona has been found to be most effectual. But when the gangrene arises from the violence of inflammation, the bark may not only fail of proving a remedy, but may do harm: for its power as a tonic is especially suited to those cases of gangrene which proceed from an original loss of tone, as in the case of palsy and œdema; or in those cases where a loss of tone takes place after the original inflammatory symptoms are removed.

On the other hand, Mr Bell is of opinion, that incisions made with a view to admit the operation of antiseptic remedies in gangrenes, as well as the remedies themselves, must be pernicious from the irritation they occasion, and from the danger of wounding blood-vessels, nerves, or tendons, and also by allowing a free passage for the putrescent fluids into the parts not yet affected. And unless they be carried so deep as to reach the sound parts, applications of the antiseptic kind can never have any effect in answering the purpose for which they were intended. The same author also remarks, that all the advantages commonly observed from the great number of applications recommended for gangrene, are obtained with more ease, and generally too with more certainty, from the use of some gentle stimulating embrocation; which, by exciting a slight irritation upon the surface, especially when assisted by a free use of cinchona, produces for the most part such a degree of inflammation as is wished for. With this view he has frequently known a weak solution of sal ammoniac, a dram of the salt to two ounces of vinegar and six of water, form a mixture of very proper strength for every purpose of this kind. But the degree of stimulus can easily be either increased or diminished according to circumstances, by using a larger or smaller proportion of the salt. Phlogosis.

Whenever, either by the means recommended, or by a natural exertion of the system, a slight inflammation appears between the diseased and sound parts, we may in general, with tolerable certainty, expect, that in due time the parts will be separated; and when a full suppuration is once fairly established, there can be little doubt that the mortified parts will be soon and easily removed.

A complete separation being effected, the sore is to be treated in the manner described under the article SURGERY; with a proper attention, at the same time, to the support of the general system by the continuance of nourishing diet, and cinchona with such quantities of wine as may seem necessary.

With regard to the bark, however, it is proper to take notice of another case of mortification in which it is likewise unsuccessful, as well as in that attended with a high degree of inflammation; and that is, in those mortifications of the toes and feet, common in old people, or which arise from any cause increasing the rigidity of the vessels to such a degree as to prevent the motion of the fluids through them. In this case Mr Pott has discovered, that all kinds of warm applications are very unsuccessful; but by the free use of opium, together with sedatives and relaxants externally applied, he has frequently seen the tumefaction of the feet and ankles subside, the skin recover its natural colour, and all the mortified parts separate in a very short time, leaving a clean sore. But as to scarifications, or any other attempt to separate artificially the mortified from the sound parts, he thinks them very prejudicial, by giving pain; which is generally of itself violent in this disease, and which seems to have a great share in producing the other evils.

The other terminations of inflammation either do not admit of any treatment except that of preventing them by resolution, or properly belong to the article SURGERY.

Sp. II. PHLOGOSIS ERYTHEMA. 173

Erythema, *Sauv.* gen. 11.
  Erysipelas auctorum, *Vog.* 343.
  Hieropyr. *Vog.* 344.
Anthrax, *Sauv.* gen. 19. *Lin.* 272. *Vog.* 353.
  Carbo et carbunculus auctorum.
  Erythema gangrænosum, *Sauv.* sp. 7.
Erythema à frigore.
  Erythema pernio, *Sauv.* sp. 4.
  Pernio, *Lin.* 259. *Vog.* 350.

Erythema

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Erythema ambuſtio, *Sauv.* ſp. 2.
Eryſipelas ambuſtio, *Sauv.* ſp. 4.
Combuſtura, *Lin.* 245.
Combuſtio, *Boerh.* 476.
Encauſis, *Vog.* 347.
Erythema ab acri alieno applicato.
Eryſipelas Sinenſe, *Sauv.* ſp. 7.
Erythema ab acri inquilino.
Erythema intertrigo, *Sauv.* ſp. 5.
Intertrigo, *Lin.* 247. *Vog.* 502.
Erythema à compreſſione.
Erythema paratrima, *Sauv.* ſp. 6.
Erythema à punctura, *Sauv.* ſp. 9.
Eryſipelas à veſpis, *Sauv.* ſp. 19.
Pſydracia à veſpis, *Sauv.* ſp. 2.
Erythema cum phlegmone.
Eryſipelas phlegmonodes auctorum.
Erythema cum œdemate.
Eryſipelas ſymptomaticum, *Sauv.* ſp. 6.

The word *erythema* does not apply to any primary diſeaſe, but to a great number of thoſe cutaneous inflammations denominated by another general term, viz. the *eryſipelas*, or "St Anthony's fire;" and which being commonly ſymptomatic of ſome other inflammation or diſorder, are to be removed only by removing the primary diſeaſe: the erythema is found ſcarcely to bear any kind of warm application to itſelf; and is very apt, if treated as a primary diſeaſe, to terminate in a gangrene of the part affected, or ſome other diſorder ſtill more dangerous. The difference between the *phlegmon* or preceding ſpecies, and *erythema*, according to Dr Cullen, is, that, in the former, the inflammation ſeems particularly to affect the veſſels on the internal ſurface of the ſkin, communicating with the lax adjacent cellular texture; whence a more copious effuſion, and that too of ſerum convertible into pus, takes place. In the erythema the affection is of the veſſels on the external ſurface of the ſkin communicating with the *rete mucoſum*. This affection does not admit of any effuſion but what ſeparates the cuticle, and gives occaſion to the formation of a bliſter, while the ſmaller ſize of the veſſels admits only of the effuſion of a thin fluid very ſeldom convertible into pus. For the cure of the fever attended with erythema or *eryſipelas*, ſee below; and for the external treatment of erythema, ſee SURGERY.

174 GENUS VIII. OPHTHALMIA.

Inflammation of the EYES.

Ophthalmia, *Sauv.* gen. 196. *Lin.* 43. *Vog.* 341. *Sag.* 231. *Junck.* 24.
Chemoſis, *Vog.* 46.
Ophthalmites, *Vog.* 47.
Inflammatio oculorum, *Hoffm.* II. 165.
Ophthalmia taraxis, *Sauv.* ſp. 1.
Ophthalmia humida, *Sauv.* ſp. 8.
Ophthalmia chemoſis, *Sauv.* ſp. 12.
Ophthalmia eryſipelatoſa, *Sauv.* ſp. 7.
Ophthalmia puſtuloſa, *Sauv.* ſp. 6.
Ophthalmia phlyctænodes, *Sauv.* ſp. 21.
Ophthalmia choroeidea, *Sauv.* ſp. 13.
Ophthalmia tenebricoſa, *Sauv.* ſp. 10.
Ophthalmia trachoma, *Sauv.* ſp. 4.
Ophthalmia ſicca, *Sauv.* ſp. 5.

Ophthalmia.

Ophthalmia angularis, *Sauv.* ſp. 14.
Ophthalmia tuberculoſa, *Sauv.* ſp. 3.
Ophthalmia trichiaſis, *Sauv.* ſp. 2.
Ophthalmia cancroſa, *Sauv.* ſp. 15.
Ophthalmia à ſynechiâ, *Sauv.* ſp. 16.
Ophthalmia à lagophthalmo, *Sauv.* ſp. 17.
Ophthalmia ab elcomate, *Sauv.* ſp. 18.
Ophthalmia ab ungue, *Sauv.* ſp. 19.
Ophthalmia à corneæ fiſtulâ, *Sauv.* ſp. 20.
Ophthalmia uveæ, *Sauv.* ſp. 22.
Ophthalmia metaſtatica, *Sauv.* ſp. 24.
Ophthalmia ſcrophuloſa, *Sauv.* ſp. 9.
Ophthalmia ſiphylitica, *Sauv.* ſp. 11.
Ophthalmia febricoſa, *Sauv.* ſp. 23.

From reading this long liſt of diſtinctions which authors have invented in the ophthalmia, it is evident, that by far the greateſt part of them are ſymptomatic, or merely the conſequence of other diſorders preſent in the habit; and therefore the remedies muſt be directed towards the removal of theſe primary diſorders; and when they are gone the ophthalmia will be removed of courſe. Dr Cullen obſerves, that the inflammation of the eye may be conſidered as of two kinds; according as it is ſeated in the membranes of the ball of the eye, when it is named *ophthalmia membranarum;* or as it is ſeated in the ſebaceous glands placed in the tarſus, or edges of the eyelids, in which caſe it may be termed *ophthalmia tarſi*. Theſe two kinds are very frequently connected together, as the one may excite the other; but they are ſtill to be diſtinguiſhed according as the one or the other may happen to be the primary affection.

1. The inflammation of the *membranes* of the eye affects eſpecially, and moſt frequently, the adnata, and appears in a turgeſcence of its veſſels; ſo that the red veſſels which are naturally there, become not only increaſed in ſize, but many more appear than in a natural ſtate. This turgeſcence of the veſſels is attended with pain, eſpecially upon the motion of the ball of the eye; and this irritation, like every other, applied to the ſurface of the eye, produces an effuſion of tears from the lachrymal gland.

The inflammation commonly, and chiefly, affects the adnata ſpread on the anterior part of the bulb of the eye; but uſually ſpreads alſo along the continuation of the adnata on the inſide of the palpebræ; and as that is extended on the tarſus palpebrarum, the excretories of the ſebaceous glands opening there are alſo frequently affected. When the affection of the adnata is conſiderable, it may be communicated to the ſubjacent membranes of the eye, and even to the retina itſelf; which thereby acquires ſo great ſenſibility, that every impreſſion of light becomes painful. The inflammation of the membranes of the eye is in different degrees, according as the adnata is more or leſs affected, or according as the inflammation is either of the adnata alone, or of the ſubjacent membranes alſo; and upon theſe differences, different ſpecies have been eſtabliſhed; but they ſeem all to differ only in degree, and are to be cured by the ſame remedies more or leſs employed.

The proximate cauſe of ophthalmia is not different from that of inflammation in general; and the different circumſtances of ophthalmia may be explained by

Phlegmasiæ. by the difference of its remote causes, and by the different parts of the eye which it happens to affect; as may be understood from what has been already said. We shall therefore proceed to give an account of the method of cure.

The great objects to be aimed at in the treatment of ophthalmia, are, in the first place, the resolution of the inflammation which has already taken place; and, secondly, the removal of those consequences which frequently arise from the inflammation, especially if it have been of long standing. But besides these, while it has appeared from former observation, that there is a peculiar disposition to the disease, practices may often be successfully employed to combat this disposition, and thus prevent the return of the affection.

The ophthalmia membranarum requires the remedies proper for inflammation in general; and when the deeper-seated membranes are affected, and especially when a pyrexia is present, large general bleedings may be necessary. But this last is seldom requisite, and, for the most part, the ophthalmia is an affection merely local, accompanied with little or no pyrexia. General bleedings therefore have little effect upon it, and the cure is chiefly to be obtained by topical bleedings, that is, blood drawn from the vessels near the inflamed part; and opening the jugular vein, or the temporal artery, may be considered as in some measure of this kind. It is commonly sufficient to apply a number of leeches round the eye; but it is perhaps still better to draw blood by cupping and scarifying from the temples. In many cases, the most effectual remedy is to scarify the internal surface of the inferior eyelid, and to cut the turgid vessels upon the adnata itself.

Besides bloodletting, purging, as a remedy suited to inflammation in general, has been considered as peculiarly adapted to inflammation in any part of the head, and therefore to ophthalmia; and it is sometimes useful: but, for the reasons given before with respect to general bleeding, purging in the case of ophthalmia does not prove useful in any proportion to the evacuation excited.—For relaxing the spasm in the part, and taking off the determination of the fluids to it, blistering near the part has commonly been found useful. When the inflammation does not yield to the application of blisters after topical bleeding, great benefit is often obtained by supporting a discharge from the blistered part, under the form of an issue, by which means a more permanent determination of blood from the part is obtained.

It is probably also on the same principle that the good effects obtained from the use of errhine medicines in obstinate cases of ophthalmia are to be accounted for. By these errhines, in particular, which occasion and support for some time a great discharge from the nose, great benefit has often been obtained. The powder of asarabacca, or the infusion of hippocastanum, snuffed up the nose at bedtime in proper doses, are often productive of the best effects, when many other remedies have been tried in vain.

Ophthalmia, as an external inflammation, admits of topical applications. All those, however, which increase the heat and relax the vessels of the part, prove hurtful; and the admission of cool air to the eye, and the application of cooling and astringent medicines, which at the same time do not produce irritation, prove useful. Of all these the solution of acetite of lead, assiduously applied, is perhaps the best. In the cure of this distemper, indeed, all irritation must carefully be avoided, particularly that of light; and the only certain means of doing this is by keeping the patient in a very dark chamber.

Ophthalmia. 2. In the *ophthalmia tarsi*, the same medicines may be necessary, as have been already recommended for the ophthalmia membranarum. However, as the ophthalmia tarsi may often depend upon an acrimony deposited in the sebaceous glands of the part, so it may require various internal remedies according to the variety of the acrimony in fault; for which we must refer to the consideration of scrophula, siphylis, or other diseases with which this ophthalmia may be connected; and where these shall not be evident, certain remedies more generally adapted to the evacuation of acrimony, such as mercury, may be employed. In the ophthalmia tarsi, it almost constantly happens that some ulcerations are formed on the tarsus. These require the application of mercury and copper, which alone may sometimes cure the whole affection; and they may be useful even when the disease depends upon a fault of the whole system.

Both in the ophthalmia membranarum, and in the ophthalmia tarsi, it is necessary to obviate that gluing together of the eyelids which commonly happens in sleep; and which may be done by insinuating a little of any mild unctuous medicine between the eyelids before the patient shall go to sleep.

The slighter kinds of inflammations from the dust or the sun, may be removed by fomenting with warm milk and water, adding a small portion of brandy; and by anointing the borders of the eyelids with *unguentum tutiæ*, or the like, at night, especially when those parts are excoriated and sore. But in bad cases, after the inflammation has yielded a little to evacuations, the *cataplasma aluminis* of the London Pharmacopœia spread on lint, and applied at bedtime, has been found the best external remedy. Before the use of the latter, the solution of sulphate of zinc is prescribed with advantage; and in violent pains it is of service to foment frequently with a decoction of white poppy-heads. One of the most common and most disagreeable consequences of ophthalmia, is an offuscation of the cornea, so far obstructing the passage of light as to diminish or prevent vision. This is sometimes so considerable as to admit of removal by operation: but in slighter cases it may often be removed by the application of different gentle escharotics; and in this way, without the least danger of any inconvenience, good effects are often obtained, from gently introducing into the eye at bedtime a powder consisting of equal parts of supertartrite of potass and sugar, reduced together to a fine powder.

Where there is a disposition to frequent returns of this affection, cinchona is often employed with success in combating it: But nothing in general answers better than frequent and regular cold bathing of the eyes.

Besides the various species of ophthalmia which were before known in Britain, another has lately been introduced, that contagious ophthalmia, viz. with which the British

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Britiſh troops were affected in Egypt, and which they have imported into this iſland on their return from thence.

Of this affection many intereſting accounts have been publiſhed. Perhaps the beſt is an elaborate treatiſe by Mr Edmonſton, who has had many opportunities of witneſſing the affection, and extenſive practice in the treatment of the diſeaſe, both in Egypt and in Britain. To his work therefore we may refer thoſe who wiſh for the moſt full information reſpecting it. We ſhall only obſerve, that now, no doubt can be entertained reſpecting the contagious nature of the diſeaſe; and that therefore the firſt great object neceſſary in the treatment is the complete ſeparation of the diſeaſed from the ſound.

175 GENUS IX. PHRENITIS.

PHRENSY, or *Inflammation of the BRAIN.*

Phrenitis, *Sauv.* gen. 101. *Lin.* 25. *Sag.* gen. 301. *Boerh.* 771. *Hoffm.* II. 131. *Junck.* 63.
Phreniſmus, *Vog.* 45.
Cephalitis, *Sauv.* gen. 109. *Sag.* gen. 310.
Sphaceliſmus, *Lin.* 32.
Phrenitis vera, *Sauv.* ſp. 1. *Boerh.* 771.
Phrenitis idiopathica, *Junck.* 63.
Cephalalgia inflammatoria, *Sauv.* ſp. 9.
Cephalitis ſpontanea, *Sauv.* ſp. 3.
Cephalitis ſiriaſis, *Sauv.* ſp. 4.
Siriaſis, *Vog.* 34.
Cephalitis Littriana, *Sauv.* ſp. 5.

Dr Cullen obſerves, that the true phrenitis, or inflammation of the membranes or ſubſtance of the brain, is very rare as an original diſeaſe: but, as a ſymptom of others, much more frequent; of which the following kinds are enumerated by different authors:

Phrenitis ſynochi pleuriticæ, *Sauv.* ſp. 2.
Phrenitis ſynochi ſanguineæ, *Sauv.* ſp. 4.
Phrenitis calentura, *Sauv.* ſp. 11.
Phrenitis Indica, *Sauv.* ſp. 12.
Cephalitis Ægyptiaca, *Sauv.* ſp. 1.
Cephalitis epidemiea anno 1510, *Sauv.* ſp. 6.
Cephalitis verminoſa, *Sauv.* ſp. 7.
Cephalitis cerebelli, *Sauv.* ſp. 8.
Phrenitis miliaris, *Sauv.* ſp. 3.
Phrenitis varioloſa, *Sauv.* ſp. 5.
Phrenitis morbilloſa, *Sauv.* ſp. 6.
Phrenitis à plicâ, *Sauv.* ſp. 8.
Phrenitis aphrodiſiaca, *Sauv.* ſp. 9.
Phrenitis à tarantiſmo, *Sauv.* ſp. 14.
Phrenitis hydrophobica, *Sauv.* ſp. 15.
Phrenitis à dolore, *Sauv.* ſp. 13.
Cephalitis traumatica, *Sauv.* ſp. 2.

Deſcription. The ſigns of an impending phrenitis are, immoderate and continual watchings; or if any ſleep be obtained, it is diſturbed with dreams, and gives no refreſhment; acute and laſting pains, eſpecially in the hind part of the head and neck; little thirſt; a great and ſlow reſpiration, as if proceeding from the bottom of the breaſt; the pulſe ſometimes ſmall and ſlow, ſometimes quick and frequent; a ſuppreſſion of urine; and forgetfulneſs. The diſtemper when preſent may be know by the following ſigns: The veins of the head ſwell, and the temporal arteries throb much; the eyes are fixed, ſparkle, and have a fierce aſpect; the ſpeech is incoherent, and the patient behaves very roughly to the byſtanders, with furious attempts to get out of bed, not indeed continually, but returning as it were by paroxyſms; the tongue is dry, rough, yellow, or black; there is a coldneſs of the external parts; a proneneſs to anger; chattering of the teeth; a trembling of the hands, with which the ſick ſeem to be gathering ſomething, and actually do gather the naps off the bed-clothes.

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Cauſes of, and perſons ſubject to, this diſorder. People of a hot and bilious habit of body, and ſuch as are of a paſſionate diſpoſition, are apt to be affected with phrenitis. In the ſame danger are thoſe who make much uſe of ſpices, or are given to hot and ſpirituous liquors; who have been expoſed more than uſual to the ſun, or obliged to undergo immoderate ſtudies or watchings; who are ſubject to headachs, or in whom ſome cuſtomary hemorrhages have been ſtopped; or the diſeaſe may ariſe from ſome injury offered to the head externally. Sir John Pringle obſerves, that the phrenitis, when conſidered as an original diſeaſe, is apt to attack ſoldiers in the ſummer ſeaſon when they are expoſed to the heat of the ſun, and eſpecially when aſleep and in liquor. A ſymptomatic phrenitis is alſo more frequent in the army than elſewhere, on account of the violence done to all fevers when the ſick are carried in waggons from the camp to the hoſpital, where the very noiſe or light alone would be ſufficient, with more delicate natures, to raiſe a phrenſy. From theſe and ſimilar cauſes, a ſtate of active inflammation, affecting ſome parts within the cranium, is produced: and there can be no doubt, that from this all the ſymptoms of the diſeaſe ariſe, and particularly that peculiar delirium which characterizes it. But in what manner local diſeaſes, even of the brain itſelf, produce affections of the mind, we are ſtill totally in the dark.

Prognoſis. Every kind of phrenitis, whether idiopathic or ſymptomatic, is attended with a high degree of danger; and, unleſs removed before the fourth day, a gangrene or ſphacelus of the meninges readily takes place, and the patient dies delirious. The following are the moſt fatal ſymptoms: A continual and furious delirium, with watching; thin watery urine, white fæces, the urine and ſtools running off involuntarily, or a total ſuppreſſion of theſe excretions; a ready diſpoſition to become ſtupid, or to faint; trembling, rigor, chattering of the teeth, convulſions, hiccough, coldneſs of the extremities, trembling of the tongue, ſhrill voice, a ſudden ceſſation of pain, with apparent tranquillity. The following are favourable: Sweats, apparently critical, breaking out; a ſeeming effort of nature to terminate the diſeaſe by a diarrhœa; a large hemorrhagy from the noſe; ſwellings of the glands behind the ears; hæmorrhoids.

Cure. From what has been ſaid of the theory of this diſeaſe, the cure muſt entirely depend on obtaining a reſolution of the inflammation. The objects chiefly to be aimed at with this view are, 1. The removal of ſuch exciting cauſes as continue to operate. 2. The diminution of the momentum of the blood in the circulating ſyſtem in general. 3. The diminution of impetus at the brain in particular: and, 4. The avoiding

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Different practices may be used with these intentions; but the most powerful remedies are to be immediately employed. Large and repeated bleedings are especially necessary; and these too taken from vessels as near as possible to the part affected. The opening the temporal artery has been recommended, and with some reason: but as the practice is attended with inconveniences, perhaps the opening of the jugular veins may in general prove more effectual; with which, however, may be joined the drawing of blood from the temples by cupping and scarifying. It is also probable, that purging may be of more use in this than in some other inflammatory affections, as it may operate by revulsion. For the same purpose of revulsion, warm pediluvia are a remedy, but rather ambiguous. The taking off the force of the blood in the vessels of the head by an erect posture is generally useful. Blistering is also useful, but chiefly when applied near to the part affected. In short, every part of the antiphlogistic regimen is here necessary, and particularly the admission of cold air. Even cold substances applied to the head have been found useful; and the application of such refrigerants as vinegar is certainly proper. Opiates are thought to be hurtful in every inflammatory state of the brain. On the whole, however, it must be remarked, that practitioners are very uncertain with regard to the means proper to be used in this disease; and the more so, that the symptoms by which the disease is commonly judged to be present, appear sometimes without any internal inflammation; and on the other hand, dissections have shown that the brain has been inflamed, where few of the peculiar symptoms of inflammation had appeared before death.

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Cynanche, *Sauv.* gen. 110. *Lin.* 33. *Sag.* gen. 300.
Angina, *Vog.* 49. *Hoffm.* II. 125. *Junck.* 30.
Angina inflammatoria, *Boerh.* 798.

177 Sp. I. CYNANCHE TONSILLARIS.
The *Inflammatory QUINSY.*

Cynanche tonsillaris, *Sauv.* sp. 1.
Angina inflammatoria, sp. 5. *Boerh.* 805.

Description. This is an inflammation of the mucous membrane of the fauces, affecting principally that congeries of mucous follicles which forms the tonsils; and from thence spreading along the velum and uvula, so as frequently to affect every part of the mucous membrane. The disease appears by some tumour and redness of the parts; is attended with a painful and difficult deglutition; a troublesome clamminess of the mouth and throat; a frequent but difficult excretion of mucus; and the whole is accompanied with pyrexia. The inflammation and tumour are commonly at first most considerable in one tonsil; and afterwards, abating in that, increase in the other. This disease is not contagious.

Causes of, and persons subject to, this disorder. This disease is commonly occasioned by cold externally applied, particularly about the neck. It affects especially the young and sanguine; and a disposition to it is often acquired by habit. It occurs especially in the spring and autumn, when vicissitudes of heat and cold frequently take place. Cynanche.

Prognosis. This species of cynanche terminates frequently by resolution, sometimes by suppuration, but hardly ever by gangrene; though in some cases sloughy spots appear on the fauces: the prognosis therefore is generally favourable.

Cure. As the principal morbid affection in this disease, on which all its characterising symptoms immediately depend, is the active inflammation in the tonsils and neighbouring parts, the object first and principally to be aimed at in the cure is to obtain a resolution of this inflammation. Sometimes, however, it is necessary to have recourse to practices, with the view of obviating urgent symptoms before a resolution can be effected: and in other cases, where a resolution cannot be obtained, it must be the aim of the practitioner to promote a speedy and favourable suppuration. After suppuration has taken place, the proper means of promoting a discharge of the purulent matter will conclude the cure. Here some bleeding may be necessary; but large and general evacuations are seldom beneficial. The opening of the ranular veins is an insignificant remedy, according to Dr Cullen, but is recommended as efficacious by Sir John Pringle: more benefit, however, may in general be derived from leeches to the external fauces. The inflammation may be often relieved by moderate astringents, and particularly by acids applied to the parts affected. In many cases, nothing has been found to give more relief than the vapour of warm water received into the fauces.

Besides these, blistering, and still more frequently rubefacient medicines, are applied with success, as well as antiphlogistic purgatives; and every part of the antiphlogistic regimen is to be observed, except the application of cold. Sir John Pringle recommends a thick piece of flannel moistened with two parts of common sweet oil, and one of spirit of hartshorn (or in a larger proportion, if the skin will bear it), to be applied to the throat, and renewed once every four or five hours. By this means the neck, and sometimes the whole body, is put into a sweat, which after bleeding either carries off or lessens the inflammation. When the disease has a tendency to suppuration, nothing will be more useful than receiving into the fauces the steams of warm water. Benefit is also obtained from poultices applied to the external fauces. When the abscess is attended with much swelling, if it break not spontaneously, it ought to be opened by a lancet; and this does not require much caution, as even the inflammatory state may be relieved by some scarification of the tonsils. When this disease runs very rapidly to such a height as to threaten suffocation, it is sometimes necessary to have recourse to bronchotomy as the only means of saving the life of the patient. But there is reason to believe that this operation has sometimes been employed where it was not necessary: and we may safely venture to say, that it is but seldom requisite; insomuch that Dr Cullen tells us, he has never in his practice seen any case requiring bronchotomy.

Sp. II. CYNANCHE MALIGNA.
The *malignant, putrid*, or *ulcerous* SORE THROAT. 178

Cynanche maligna, *Sauv.* sp. 3.

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Cynanche.

Cynanche ulcerosa, *Sauv.* var. a. Journ. de Med. 1758.

Cynanche gangrænosa, *Sauv.* var. b. Journ. de Med. 1756.

Ulcera faucium et gutturis anginosa et lethalia, Hispanis *Garrotillo*, *Lud. Mercat.* consult. 24.

Angina ulcerosa, *Fothergill's* Account of the ulcerous sore throat, edit. 1751. *Huxham* on the malignant ulcerous sore throat, from 1751 to 1753.

Febris epidemica cum angina ulcusculosa, *Douglas's* Practical History, Boston, 1736.

Angina epidemica, *Russel*, Oecon. Natur. p. 105.

Angina gangrænosa, *Withering's* Dissert. Inaug. Edinb. 1766.

Angina suffocativa, *Bard's* Inquiry, New York, 1771.

Angina maligna, *Johnstone* on the malignant Angina, Worcester, 1779.

History and Description. This distemper is not particularly described by the ancient physicians; though perhaps the Syrian and Egyptian ulcers mentioned by Aretæus Cappadox, and the pestilent ulcerated tonsils we read of in Aetius Amideus, were of this nature. Some of the scarlet fevers mentioned by Morton seem also to have approached near to it. In the beginning of the last century, a disease exactly similar to this is described by the physicians of that time, as raging with great violence and mortality in Spain and some parts of Italy; but no account of it was published in this country till the year 1748, when a very accurate one was drawn up by Dr Fothergill, and in 1752 by Dr Huxham. The latter observes, that this disease was preceded by long, cold, and wet seasons; by which probably the bodies of people were debilitated, and more apt to receive contagion, which possibly also might be produced by the stagnant and putrid waters.

The attack of this disease was very different in different persons. Sometimes a rigor, with fulness and soreness of the throat, and painful stiffness of the neck, were the first symptoms complained of. Sometimes alternate chills and heats, with some degree of giddiness, drowsiness, or headach, ushered in the distemper. It seized others with more severe feverish symptoms; great pain of the head, back, and limbs; a vast oppression of the præcordia, and continual sighing. Some grown persons went about for days in a drooping state, with much uneasiness and anxiety, till at last they were obliged to take to their beds.—Thus various was the disease, says Dr Huxham, at the onset. But it commonly began with chills and heats, load and pain of the head, soreness of throat, and hoarseness; some cough, sickness at stomach, frequent vomiting and purging, in children especially, which were sometimes very severe; though a contrary state was more common to the adult. There was in all a very great dejection of spirits, very sudden weakness, great heaviness on the breast, and faintness, from the very beginning. The pulse in general was quick, small, and fluttering, though sometimes heavy and undulating. The urine was commonly pale, thin, and crude; however, in many grown persons, it was passed in small quantities and high coloured, or like turbid whey. The eyes were heavy, reddish, and as it were weeping; the countenance very often full, flushed, and bloated, though sometimes pale and sunk.

How slight soever the disorder might appear in the day-time, at night the symptoms became greatly aggravated, and the feverish habit very much increased, nay, sometimes a delirium occurred on the very first night; and this exacerbation constantly returned through the whole course of the disease. Indeed, when it was considerably on the decline, our author says he has been often pretty much surprised to find his patient had passed the whole night in a phrensy, whom he had left tolerably cool and sedate in the day.

Some few hours after the seizure, and sometimes cotemporary with it, a swelling and soreness of the throat was perceived, and the tonsils became very tumid and inflamed, and many times the parotid and maxillary glands swelled very much, and very suddenly, even at the very beginning; sometimes so much as even to threaten strangulation. The fauces also very soon appeared of a high florid red, or rather of a bright crimson, colour, very shining and glossy; and most commonly on the uvula, tonsils, velum palatinum, and back part of the pharynx, several whitish or ash-coloured spots appeared scattered up and down, which oftentimes increased very fast, and soon covered one or both the tonsils, uvula, &c.: those in the event proved sloughs of superficial ulcers (which sometimes, however, ate very deep into the parts). The tongue at this time, though only white and moist at the tip, was very foul at the root, and covered with a thick, yellowish or brown coat. The breath also now began to be very nauseous; which offensive smell increased hourly, and in some became at length intolerable, and that too sometimes even to the patients themselves.

The second or third day every symptom became much more aggravated, and the fever much more considerable; and those that had struggled with it tolerably well for 30 or 40 hours, were forced to submit. The restlessness and anxiety greatly increased, as well as the difficulty in swallowing. The head was very giddy, pained, and loaded; there was generally more or less of a delirium; sometimes a pervigilium and perpetual phrensy, though others lay very stupid, but often starting and muttering to themselves. The skin was very hot, dry, and rough; there was very rarely any disposition to sweat. The urine was pale, thin, crude; often yellowish and turbid. Sometimes vomiting was urgent, and sometimes a very great looseness, in children particularly. The sloughs were now much enlarged, and of a darker colour, and the surrounding parts tended much more to a livid hue. The breathing became much more difficult; with a kind of a rattling stertor, as if the patient was actually strangling, the voice being exceeding hoarse and hollow, exactly resembling that from venereal ulcers in the fauces: this noise in speaking and breathing was so peculiar, that any person in the least conversant with the disease might easily know it by this odd noise; from whence indeed the Spanish physicians gave it the name of *garrotillo*, expressing the noise made by persons when they are strangled with a rope. Dr Fothergill never observed in one of them the shrill barking noise that we frequently hear in inflammatory cynanche. The breath

Phlegmasiæ. breath of all the diseased was very nauseous; of some insufferably fetid, especially in the advance of the distemper to a crisis; and many about the fourth or fifth day spit off a vast quantity of stinking purulent mucus tinged sometimes with blood: and sometimes the matter was quite livid, and of an abominable smell. The nostrils likewise in many were greatly inflamed and excoriated, continually dripping down a very sharp ichor or sanious matter, so excessively acrid, that it not only corroded the lips, cheeks, and hands of the children that laboured under the disease, but even the fingers and arms of the very nurses that attended them: as this ulceration of the nostrils came on, it commonly caused an almost incessant sneezing in the children; but few adults were affected with it, at least to any considerable degree. It was surprising what quantities of matter some children discharged this way, which they would often rub on their face, hands, and arms, and blister them all over. A sudden stoppage of this rheum from the mouth and nostrils actually choaked several children; and some swallowed such quantities of it, as occasioned excoriations of the intestines, violent gripings, dysentery, &c. nay, even excoriations of the anus and buttocks. Not only the nostrils, fauces, &c. were greatly affected by this extremely sharp matter, but the wind-pipe itself was sometimes much corroded by it, and pieces of its internal membrane were spit up, with much blood and corruption; and the patients lingered on for a considerable time, and at length died tabid; though there were more frequent instances of its falling suddenly and violently on the lungs, and killing in a peripneumonic manner.

Dr Huxham was astonished sometimes to see several swallow with tolerable ease, though the tumour of the tonsils and throat, the quantity of thick mucus, and the rattling noise in breathing, were very terrible; which he thinks pretty clearly shows, that this malignant angina was more from the acrimony and abundance of the humours than the violence of the inflammation.

Most commonly the angina came on before the exanthemata; but many times the cuticular eruption appeared before the sore-throat, and was sometimes very considerable, though there was little or no pain in the fauces: on the contrary, a very severe angina seized some patients that had no manner of eruption; and yet, even in these cases, a very great itching and desquamation of the skin sometimes ensued; but this was chiefly in grown persons, very rarely in children. In general, however, a very considerable efflorescence broke out on the surface of the body, particularly in children; and it most commonly happened the second, third, or fourth day: sometimes it was partial, sometimes it covered almost the whole body, though very seldom the face: sometimes it was of an erysipelatous kind; sometimes more pustular: the pustules frequently eminent, and of a deep fiery red colour, particularly on the breast and arms; but oftentimes they were very small, and might be better felt than seen, and gave a very odd kind of roughness to the skin. The colour of the efflorescence was commonly of a crimson hue, or as if the skin had been smeared over with juice of raspberries, and this even to the fingers ends; and the skin appeared inflamed and swollen, as it were; the arms, hands, and fingers, were often evidently so, and very stiff, and somewhat painful. This crimson colour of the skin seemed indeed peculiar to this disease. Though the eruption seldom failed of giving some manifest relief to the patient, as to anxiety, sickness at stomach, vomiting, purging, &c. yet there was observed an universal fiery eruption on some persons, without the least abatement of the symptoms, nay almost every symptom seemed more aggravated, particularly the fever, load at breast, anxiety, and delirium; Dr Huxham knew more than one or two patients die in the most raging phrensy, covered with the most universal fiery rash he ever saw: so that, as in the highly confluent smallpox, it seemed only to denote the quantity of the disease, as he terms it. Cynanche.

He had under his care a young gentleman, about 12 years of age, whose tongue, fauces, and tonsils, were as black as ink, and he swallowed with extreme difficulty; he continually spit off immense quantities of a black, sanious, and very fetid matter, for at least eight or ten days:—about the seventh day, his fever being somewhat abated, he fell into a bloody dysentery, though the bloody, sanious, fetid expectoration still continued, with a most violent cough. He at length indeed got over it, to the very great surprise of every one that saw him. Now, in this patient, a severe and universal rash broke out upon the second and third day; and the itching of his skin was so intolerable, that he tore it all over his body in a most shocking manner: yet this very great and timely eruption very little relieved his fever and phrensy, or prevented the other dreadful symptoms mentioned.

An early and kindly eruption, however, was most commonly a very good omen; and, when succeeded by a very copious desquamation of the cuticle, one of the most favourable symptoms that occurred: but when the eruption turned of a dusky or livid colour, or prematurely or suddenly receded, every symptom grew worse, and the utmost danger impended, especially if purple or black spots appeared up and down, as sometimes happened; the urine grew limpid, and convulsions came on, or a fatal suffocation soon closed the tragedy.

The disease was generally at the height about the fifth or sixth day in young persons, in the elder not so soon; and the crisis many times was not till the 11th or 12th, and then very imperfect; some adults, however, were carried off in two or three days; the distemper either falling on the lungs, and killing in a peripneumonic manner; or on the brain, in which case the patient either died raving or comatose. In some, the disease brought on a very troublesome cough, purulent expectoration, hæmoptoë, and hectic fever; in which they lingered on for several weeks, and then died tabid.

If a gentle easy sweat took place on the third or fourth day; if the pulse became more slow, firm, and equal; if the sloughs of the fauces cast off in a kindly manner, and appeared at the bottom tolerably clean and florid; if the breathing was more soft and free, and some degree of vigour and quickness returned in the eyes; all was well, and a salutary crisis followed soon by a continuance of the sweat, and a turbid, subsiding, farinaceous urine, a plentiful expectoration, and a very large desquamation of the cuticle. But if a rigor came on, and the exanthemata suddenly disappeared or turned livid;

Phlegmasiæ. livid; if the pulse grew very small and quick, and the skin remained hot and parched as it were, the breathing more difficult, the eyes dead and glassy, the urine pale and limpid, a phrensy or coma succeeded, with a coldish clammy sweat on the face or extremities; life was despaired of, especially if a singultus and choaking or gulping in the throat attended, with sudden, liquid, involuntary, livid stools, intolerably fetid. In some few patients, Dr Huxham observed, some time before the fatal period, not only the face bloated, sallow, shining and greasy as it were, but the whole neck very much swollen, and of a cadaverous look; and even the whole body became in some degree œdematous; and the impression of a finger would remain fixed in a part, the skin not rising again as usual; an indication that the blood stagnated in the capillaries, and that the elasticity of the fibres was quite lost.

Medical writers are still much divided in opinion, whether the cynanche maligna is to be considered as the same disease with the scarlatina anginosa, afterwards to be treated of, or not. This question will afterwards come to be more fully discussed. At present we may only observe, that although ulcerous sore throats of a malignant nature often appear sporadically, yet that the disease above described appears only as an epidemic, and is always the consequence of contagion.

We have, therefore, no doubt that the cynanche maligna of Huxham, Fothergill, and Cullen, is precisely the same disease with the scarlatina anginosa of Sauvage, Withering, and other late writers. This is abundantly demonstrated by the diversities which take place in the appearance of the disease among children of the same family during the same epidemic.

Prognosis. This may be easily gathered from the above description. The malignant and putrid tendency of the disease is evident, and an increase of the symptoms which arise from that putrescent disposition of the body must give an unfavourable prognostic. On the contrary, a decrease of these, and an apparent increase of the *vis vitæ*, are favourable: in general, what is observed to be favourable in the nervous and putrid malignant fevers, is also favourable in this, and *vice versa*.

Causes. Since the accurate accounts given by Dr Fothergill and Huxham of the epidemics which prevailed about 50 years ago, this disease has frequently been observed at times epidemic in almost every different part of Britain. Like smallpox, measles, and chincough, it seems in every case to be the effect of a peculiar and specific contagion. It has been observed to prevail, equally generally in every situation, and at every season; and on exposure to the contagion, no age, sex, or condition, is exempted from it. But the having once had the disease, seems in this affection to afford the same security against future contagion as in the small-pox: at least instances, where it can be said that the same individual has been twice affected with it, are both very rare and very doubtful, as well as in small-pox.

Cure. Like other febrile contagions, the malignant ulcerous sore throat is terminated only by a natural course; and the chief business of the practitioner is to combat unfavourable occurrences. In this the septic tendency of the disease is chiefly to be kept in view. The debility with which it is attended renders all evacuations by bleeding and purging improper, except in a few instances where the debility is less, and the inflammatory symptoms more considerable. The fauces are to be preserved from the effects of the acrid matter poured out upon them, and are therefore to be frequently washed out by antiseptic gargles or injections; and the putrescent state of the whole system should be guarded against and corrected by internal antiseptics, especially by the Peruvian bark given in the beginning and continued through the course of the disease. Great benefit is also often derived from the liberal use of the mineral acids. Both the sulphuric and muriatic, in a state of proper dilution, have been highly extolled by different medical writers, and are productive of the best effects in actual practice, when they can be introduced to a sufficient extent. In particular, the oxygenated muriatic acid, as recommended by Mr Braithwaite, has been found productive of the greatest advantages. Emetics, both by vomiting and nauseating, prove useful. When any considerable tumor occurs, blisters applied externally will be of service, and in any case may be proper to moderate the inflammation.

Cynanche. Very lately, the internal use of the capsicum annuum, or Cayenne pepper, as it is commonly called, has been highly celebrated in this affection; and it is particularly said to have been employed with singular success in the West Indies.

But of all the remedies lately proposed, none has been more highly extolled than the external use of cold water. It has even been contended by some that by dashing cold water on the surface of the body, an immediate artificial cure of this disease may be obtained. We are, however, fully persuaded, that cold water will no more destroy the contagion of this disease than of small-pox; and we cannot help thinking that the practice is seldom necessary, and sometimes hurtful.

Sp. III. Cynanche trachealis. 179

The Croup.

Cynanche trachealis, *Sauv.* sp. 5.
Cynanche laryngea auctorum, *Eller* de cogn. et curand. morb. sect. 7.
Anginæ inflammatoriæ, sp. 1. *Boerh.* 801.
Angina latens et difficilis, *Dodon.* obs. 18.
Angina interna, *Tulp.* l. 1. obs. 51.
Angina perniciosa, *Greg. Horst.* Obs. l. iii. obs. 1.
Suffocatio stridula, *Home* on the Croup.
Asthma infantum, *Millar* on the Asthma and Chincough.
Asthma infantum spasmodicum, *Rush*, Dissertation, Lond. 1770.
Cynanche stridula, *Crawford* Dissert. Inaug. Edin. 1771.
Angina epidemica anno 1743. *Molloy* apud *Rutty's* History of the weather.
Morbus strangulatorius, *Starr*, Phil. Trans. N° 495.
Morbus truculentus infantum, *Francof.* ad Viadrum et in vicinia grassans ann. 1758. C. a Bergen. A nova. N. C. tom. ii. p. 157.
Catarrhus suffocativus Barbadensis ann. 1758. *Hillary's* Diseases of Barbadoes.

Angina

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Angina inflammatoria infantum, *Ruſſel*, Oecon. nat. p. 70.

Angina polypoſa five membranacea *Michealis*. Argentorati 1778, et auctores ab eo allegati.

The beſt deſcription of this diſeaſe we have in Dr Cullen's Practice of Phyſic. He informs us, that it conſiſts in an inflammation of the glottis, larynx, or upper part of the trachea, whether it affect the membranes of theſe parts or the muſcles adjoining. It may ariſe firſt in theſe parts, and continue to ſubſiſt in them alone; or it may come to affect theſe parts from the cynanche tonſillaris, or maligna, ſpreading into them.

In either way it has been a rare occurrence, and few inſtances of it have been marked and recorded by phyſicians. It is to be known by a peculiar croaking ſound of the voice, by difficult reſpiration, with a ſenſe of ſtraitening about the larynx, and by a pyrexia attending it.

From the nature of theſe ſymptoms, and from the diſſection of the bodies of perſons who died of this diſeaſe, there is no doubt of its being of an inflammatory kind. It does not, however, always run the courſe of inflammatory affections; but frequently produces ſuch an obſtruction of the paſſage of the air, as ſuffocates, and thereby proves ſuddenly fatal.

It particularly proves fatal, in conſequence of the trachea being obſtructed by a membranous ſubſtance lining the inſide of it, and very nearly approaching in appearance to the inflammatory exudation often diſcovered on the inteſtinal canal in thoſe dying of enteritis.

If we judge rightly of the nature of this diſeaſe, it will be obvious, that the cure of it requires the moſt powerful remedies of inflammation to be employed upon the very firſt appearance of the ſymptoms. When a ſuffocation is threatened, whether any remedies can be employed to prevent it, is not yet determined by ſufficient experience: but it is evident, that in certain caſes the life of the patient can be preſerved only by the removal of that matter which obſtructs the paſſage of air through the trachea.

The accounts which books have hitherto given us of inflammations of the larynx, and the parts connected with it, amount to what we have now ſaid; and many inſtances are recorded of the diſeaſe happening in adult perſons: but there is a peculiar affection of this kind happening to infants, which has been little taken notice of till lately. Dr Francis Home is the firſt who has given any diſtinct account of this diſeaſe; but, ſince he wrote, ſeveral other authors have taken notice of it, and have given different opinions concerning it.

This diſeaſe ſeldom attacks infants till after they have been weaned. After this period, the younger they are, the more they are liable to the diſeaſe. The frequency of it becomes leſs as children become more advanced; and there are few inſtances of children above 12 years of age being affected with it. It attacks children of the midland countries, as well as thoſe who live near the ſea; but it occurs much more frequently at certain places than at others. It does not appear to be contagious; and its attacks are frequently repeated in the ſame child. It is often manifeſtly the effect of cold applied to the body; and therefore appears moſt frequently in the winter and ſpring ſeaſons. It very commonly comes on with the ordinary ſymptoms of a catarrh; but ſometimes the peculiar ſymptoms of the diſeaſe ſhow themſelves at the very firſt.

Cynanche.

Theſe peculiar ſymptoms are the following: A hoarſeneſs, with ſome ſhrillneſs and ringing ſound, both in ſpeaking and coughing, as if the noiſe came from a brazen tube. At the ſame time, there is a ſenſe of pain about the larynx, ſome difficulty of reſpiration, with a whizzing ſound in inſpiration, as if the paſſage of the air were ſtraitened. The cough which attends it, is commonly dry; and if any thing be ſpit up, it is matter of a purulent appearance, and ſometimes films reſembling portions of a membrane. With all theſe ſymptoms, there is a frequency of pulſe, a reſtleſſneſs, and an uneaſy ſenſe of heat. When the internal fauces are viewed, they are ſometimes without any appearance of inflammation; but frequently a redneſs, and even ſwelling, appears; and ſometimes there is an appearance of matter like to that rejected by coughing, together with the ſymptoms now deſcribed, and particularly with great difficulty of breathing, and a ſenſe of ſtrangling in the fauces, by which the patient is ſometimes ſuddenly taken off.

Many diſſections have been made of infants who had died of this diſeaſe, and almoſt conſtantly there has appeared a preternatural ſubſtance, apparently membranous, lining the whole internal ſurface of the upper part of the trachea, and extending in the ſame manner downwards into ſome of its ramifications. This preternatural membrane may be eaſily ſeparated, and ſometimes has been found ſeparated in part from the ſubjacent proper membrane of the trachea. This laſt is commonly found entire, that is, without any appearance of eroſion or ulceration; but it frequently ſhows the veſtiges of inflammation, and is covered by a matter reſembling pus, like to that rejected by coughing; and very often a matter of the ſame kind is found in the bronchiæ, ſometimes in conſiderable quantity.

From the remote cauſes of this diſeaſe; from the catarrhal ſymptoms commonly attending it; from the pyrexia conſtantly preſent with it; from the ſame kind of preternatural membrane being found in the trachea when the cynanche maligna is communicated to it; and from the veſtiges of inflammation on the trachea diſcovered upon diſſection; we muſt conclude, that this diſeaſe conſiſts in an inflammatory affection of the mucous membrane of the larynx and trachea, producing an exudation analogous to that found on the ſurface of inflamed viſcera, and appearing partly in a membranous cruſt, and partly in a fluid form reſembling pus.

Though this diſeaſe conſiſts in an inflammatory affection, it does not commonly end either in ſuppuration or gangrene. The moſt troubleſome circumſtance of it ſeems to conſiſt in a ſpaſm of the muſcles of the glottis, threatening ſuffocation.

When this diſeaſe terminates in health, it is by reſolution of the inflammation, by ceaſing of the ſpaſm of the glottis, by an expectoration of the matter exuding from the trachea, and of the cruſts formed there,

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there, and frequently it ends without any expectoration, or at least with such only as attends an ordinary catarrh. But in some instances, a salutary termination has very speedily taken place, in consequence of the discharge of the membranous substance from the trachea, even under its proper tubular form.

When the disease ends fatally, it is by a suffocation seemingly depending upon a spasm affecting the glottis; but sometimes, probably, depending upon a quantity of matter filling the bronchiæ, or obstructing the trachea.

As we suppose the disease to be an inflammatory affection, so we attempt the cure of it by the usual remedies of inflammation. Bleeding, both general and topical, has often given immediate relief, and, by being repeated, has entirely cured the disease. Blistering also, near to the part affected, has been found useful. Upon the first attack of the disease, vomiting, immediately after bleeding, seems to be of considerable use, and sometimes suddenly removes the disease. But emetics are still more useful in advanced periods. By the employment of these, the matter obstructing the trachea, and inducing spasmodic affections, has often been successfully removed, when the situation of the patient seemed to be almost desperate. And as in the progress of the disease fresh effusions of this matter are very apt to take place, the frequent repetition of emetics becomes necessary. It is often necessary to have recourse to these operating the most expeditiously, such as sulphate of zinc even in large doses. In every stage of the disease, the antiphlogistic regimen is necessary, and particularly the frequent use of laxative glysters. Some practitioners consider mercury, particularly under the form of calomel, as an almost infallible remedy in this disease. It has particularly been extolled by Mr James Anderson, an eminent surgeon in Edinburgh. But we are sorry to say that in some cases at least, after the fairest trial, it has been found to fail. Though we suppose that a spasm affecting the glottis is often fatal in this disease, antispasmodic medicines have not in general been found of great service. Some, however, have strongly recommended the use of asafœtida under the form of injection; others place great confidence in oil or oily mixtures, taken by the mouth: but more immediate benefit is derived from tepid bathing, and the employment of sulphuric ether, both externally and internally.

By these, when the disease is spasmodic, it is often successfully removed. But by much the most dangerous form of the disease is the inflammatory state giving the exudation. And when this inflammatory exudation has even been removed from the upper part of the trachea, yet it has sometimes proved fatal from the inflammation and exudation extending to the branches of the aspera arteria. By such an occurrence the writer of the present article had the misfortune to lose a favourite son; an amiable youth, in the fourteenth year of his age, who was highly admired and sincerely regretted by all to whom he was known.

180 Sp. IV. Cynanche pharyngea.

Cynanche pharyngea, *Sauv.* sp. 6. *Eller* de cogn. et cur. sect. 7.
Anginæ inflammatoriæ, sp. 4. *Boerh.* 804.

This is not materially different from the cynanche tonsillaris; only that the inflammation is said to begin in the pharynx, though Dr Cullen says he never knew an instance of it. The symptoms are almost the same, and the cure is precisely so, with that of the cynanche tonsillaris.

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Sp. V. Cynanche parotidæa. 181

Cynanche parotidæa, *Sauv.* sp. 14. *Gallis* Oreillons et Ourles, *Tissot* Avis au peuple, N° 116. *Encyclopédie*, au mot *Oreillons*.
Angina externa, *Anglis* the Mumps, *Russel* œcon. natur. p. 114. *Scotis* the Branks.
Catarrhus Bellinsulanus, *Sauv.* sp. 4.
Osservazioni di *Girol. Gaspari*, Venez. 1731.
Osservazioni di *Targ. Tozetti*, Racolta 1ma, p. 176.

This is a disease well known to the vulgar, but little taken notice of by medical writers. It is often epidemic, and manifestly contagious. It comes on with the usual symptoms of pyrexia, which is soon after attended with a considerable tumor of the external fauces and neck. The swelling appears first as a glandular moveable tumor at the corner of the lower jaw; but it soon becomes uniformly diffused over a great part of the neck, sometimes on one side only, but more commonly on both. The swelling continues to increase till the fourth day; but from that period it declines, and in a few days more goes off entirely. As the swelling of the fauces recedes, it not unfrequently happens that some tumor affects the testicles in the male sex, or the breasts in the female. These tumors are sometimes large, hard, and somewhat painful; but are seldom either very painful or of long continuance. The pyrexia attending this disease is commonly slight, and goes off with the swelling of the fauces; but sometimes, when the swelling of the testicles does not succeed to that of the fauces, or when the one or the other has been suddenly repressed, the pyrexia becomes more considerable, is often attended with delirium, and has sometimes proved fatal.

As this disease commonly runs its course without either dangerous or troublesome symptoms, so it hardly requires any remedies. An antiphlogistic regimen, and avoiding cold, are all that will be commonly necessary. But when, upon the receding of the swellings, the pyrexia comes to be considerable, and threatens an affection of the brain, it will be proper, by warm fomentations, to bring back the swelling; and by vomiting, bleeding, or blistering, to obviate the consequences of its absence.

Genus XI. PNEUMONIA. 182

Febris pneumonica, *Hoffm.* II. 136.

Sp. I. Peripneumonia. 183

Peripneumony, or Inflammation of the Lungs.

Peripneumonia, *Sauv.* gen. 112. *Lin.* 34. *Vog.* 51. *Sag.* gen. 311. *Boerh.* 820. *Juncker* 67.
Peripneumonia pura sive vera Auctorum, *Sauv.* sp. 1.
Peripneumonia gastrica, *Sauv.* sp. 11. *Morgagn.* de caus. et sed. Epist. xx. art. 30, 31.
Peripneumonia catarrhalis, *Sauv.* sp. 6.

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Peripneumonia notha, *Sydenh.* ſect. 6. cap. 4. *Boerh.* 867. *Morgagni* de cauſ. et ſed. Epiſt. xxi. 11.—15.
Peripneumonia putrida, *Sauv.* ſp. 2.
Peripneumonia ardens, *Sauv.* ſp. 3.
Peripneumonia maligna, *Sauv.* ſp. 4.
Peripneumonia typhodes, *Sauv.* ſp. 5.
Amphimerina peripneumonica, *Sauv.* ſp. 15.

184 Sp. II. Pleuritis.

The *Pleuriſy*, or Inflammation of the Pleura.

Pleuritis, *Sauv.* gen. 103. *Lin.* 27. *Vog.* 56. *Sag.* gen. 303. *Boerh.* 875. *Junck.* 67.
Paraphreneſis, *Sauv.* gen. 102. *Lin.* 26.
Paraphrenitis, *Vog.* 55. *Boerh.* 907.
Diaphragmitis, *Sag.* gen. 304.
Pleuritis vera, *Sauv.* ſp. 1. *Boerh.* 875. *Verna* princeps morb. acut. pleuritis, l. 1. cap. 2. 3. *Zeviani* della parapleuritide, cap. 3. *Morgagni* de ſed. et cauſ. morb. Epiſt. xx. art. 56. xxi. 45. *Wendt* de pleuritide, apud *Sandifort*, theſ. ii.
Pleuritis pulmonis, *Sauv.* ſp. 2. *Zevian.* dell. parapleur. iii. 28, &c.
Pleuropneumonia, pleuro-peripneumonia, peripneumo-pleuritis Auctorum. *Baronius* de pleuri-pneumonia. Ill. *Halleri* opuſcul. patholog. obſ. 13. *Morgagni* de ſed. et cauſ. Epiſt. xx and xxi. paſſim. *Cleghorn*, Minorca, p. 247. *Triller* de pleuritide, aph. 1, 2, 3. cap. i. 8. *Huxham*, Diſſert. on pleuriſies, &c. chap. i. Ill. *Pringle*, Diſ. of the army.
Pleuritis convulſiva, *Sauv.* ſp. 13. *Bianch.* Hiſt. hep. vol. i. p. 234.
Pleuritis hydrothoracica, *Sauv.* ſp. 15. *Morgagni* de cauſ. et ſed. xx. 34.
Pleuritis dorſalis, *Sauv.* ſp. 3. *Verna*, p. 3. cap. 8.
Pleuritis mediaſtini, *Sauv.* ſp. 3. *P. Sal. Div.* de affec. part. cap. 6. *Friend*, Hiſt. Med. de Avenzoare.
Mediaſtina, *Vog.* 52.
Pleuritis pericardii, *Sauv.* ſp. 5. *Verna*, p. iii. cap. 9.
Parapleuritis, *Zeviani* della parapleuritide.
Pleurodyne parapleuritis, *Sauv.* ſp. 19.
Paraphreneſis diaphragmatica, *Sauv.* ſp. 1. *De Haen.* Rat. med. i. 7. iii. p. 31.
Paraphreneſis pleuritica, *Sauv.* ſp. 2.
Paraphreneſis hepatica, *Sauv.* ſp. 3.

Under the general head of *Pneumonia*, Dr Cullen, comprehends all inflammations of the thoracic viſcera, or membrane lining the inſide of that cavity; as the ſymptoms do not always ſufficiently diſtinguiſh the ſeat of the affection, nor does a difference in the ſituation of the affected place make any difference in the cure.

Deſcription. Pneumonic inflammation, however various in the ſeat, always diſcovers itſelf by pyrexia, difficult breathing, cough, and pain in ſome part of the thorax. It almoſt always comes on with a cold ſtage, and is accompanied with the other ſymptoms of pyrexia; though in ſome few inſtances the pulſe may not be more frequent, nor the heat of the body increaſed beyond what is natural. Sometimes the pyrexia is from the beginning accompanied with the other ſymptoms; but frequently it is formed ſome hours before them, and particularly before the pain be felt. The pulſe for the moſt part is frequent, full, ſtrong, hard, and quick; but, in a few inſtances, eſpecially in the advanced ſtate of the diſeaſe, it is weak, ſoft, and at the ſame time irregular. The difficulty of breathing is moſt conſiderable in inſpiration, both becauſe the lungs do not eaſily admit of a full dilatation, and becauſe the dilatation increaſes the pain attending the diſeaſe. The difficulty of breathing is alſo greater when the patient is in one poſture of the body rather than another. It is generally greater when he lies on the ſide affected; though ſometimes the contrary happens. Very often the patient cannot lie upon either ſide, and can find eaſe only when lying on the back; and ſometimes he cannot breathe readily, except when in ſomewhat of an erect poſture. The cough, in different caſes, is more or leſs urgent or painful. It is ſometimes dry, or without any expectoration, eſpecially in the beginning of the diſeaſe; but more commonly it is, even from the beginning, moiſt, and the matter ſpit up various both in conſiſtence and colour, and frequently it is ſtreaked with blood. The pain is alſo different in different caſes, and felt in different parts of the thorax, but moſt frequently in one ſide. It has been ſaid to affect the right ſide more frequently than the left; but this is uncertain, and we are ſure that the left ſide has been very often affected. Sometimes it is felt as if it was under the ſternum; ſometimes in the back between the ſhoulders; and when in the ſides, its place has been higher or lower, more forward or backward; but the place of all moſt frequently affected is about the ſixth or ſeventh rib, near the middle of its length, or a little more forward. The pain is often ſevere and pungent; but ſometimes more dull and obtuſe, with a ſenſe of weight rather than of pain. It is moſt eſpecially ſevere and pungent when occupying the place laſt mentioned. For the moſt part it continues fixed in one part, but ſometimes ſhoots from the ſide to the ſcapula on one hand, or to the ſternum and clavicle on the other.

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Dr Cullen ſuppoſes that the diſeaſe is always ſeated, or at leaſt begins, in ſome part of the pleura, taking that membrane in its greateſt extent, as now commonly underſtood; that is, as covering not only the internal ſurface of the cavity of the thorax, but alſo as forming the mediaſtinum, and as extended over the pericardium, and over the whole ſurface of the lungs. But as the ſymptoms never clearly indicate where the ſeat of the diſeaſe is, there is but little foundation for the different names by which it has been diſtinguiſhed. The term *pleuriſy* is improperly limited to that inflammation which begins in and chiefly affects the pleura coſtalis. This Dr Cullen thinks is a rare occurrence; and that the pneumonia much more frequently begins in the pleura inveſting the lungs, producing all the ſymptoms which belong to what hath been called the *pleuritis vera*. The word *peripneumony* has been applied to an inflammation beginning in the parenchyma, or cellular texture of the lungs, and having its ſeat chiefly there. But to Dr Cullen it ſeems very doubtful if any acute inflammation of the lungs, or any diſeaſe which has been called *peripneumony*, be of that kind. It ſeems probable, that

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that every acute inflammation begins in membranous parts; and in every dissection of persons who have died of peripneumony, the external membrane of the lungs, or some part of the pleura, has appeared to have been considerably affected. An inflammation of the pleura covering the upper surface of the diaphragm, has been distinguished by the appellation of *paraphrenitis*, as supposed to be attended with the peculiar symptoms of delirium, *risus sardonicus*, and other convulsive motions: but it is certain, that an inflammation of that portion of the pleura, and affecting also even the muscular substance of the diaphragm, has often taken place without any of the symptoms above mentioned; and neither the dissections which have fallen under Dr Cullen's observation, nor any accounts of dissections, support the opinion that an inflammation of the pleura covering the diaphragm is attended with delirium more commonly than any other pneumonic inflammation.—It is to be observed, however, that though the inflammation may begin in one particular part of the pleura, the morbid affection is commonly communicated to the whole extent of the membrane.

The pneumonic inflammation, like others, may terminate by resolution, suppuration, or gangrene: but it has also a termination peculiar to itself; namely, when it is attended with an effusion of blood into the cellular texture of the lungs, which, soon interrupting the circulation of the blood through the viscus, produces a fatal suffocation. This indeed appears to be the most common termination of pneumonic inflammation when it ends fatally; for upon the dissection of almost every person who has died of this disease, it appears that such an effusion had happened. From the same dissections we learn, that pneumonic inflammation commonly produces an exsudation from the internal surface of the pleura, which appears partly as a soft viscid crust, often of a compact membranous form, covering every where the surface of the pleura, and particularly those parts where the lungs adhere to the pleura costalis, or mediastinum; and this crust seems always to be the cement of such adhesion. The same exsudation shows itself also by a quantity of a serous fluid commonly found in the cavity of the thorax; and some exsudation or effusion is usually found to have been made into the cavity of the pericardium. It seems likewise probable, that an effusion of this kind is sometimes made into the cavity of the bronchiæ; for in some persons who have died after labouring under a pneumonic inflammation for a few days only, the bronchiæ have been found filled with a considerable quantity of serous and thickish fluid, which must be considered rather as the effusion above mentioned, having had its thinner parts taken off by respiration, than as a pus so suddenly formed in the inflamed part. It is, however, not improbable, that this effusion, as well as that made into the cavities of the thorax and pericardium, may be a matter of the same kind with that which in other inflammations is poured into the cellular texture of the parts inflamed, and there converted into pus; but in the thorax and pericardium it does not always put on this appearance, because the crust covering the surface prevents the absorption of the thinner part. This absorption, however, may be compensated in the bronchiæ, by the drying power of the air; and therefore the effusion into them may assume a more purulent appearance. In many cases of pneumonic inflammation, when the expectoration is very copious, it is difficult to suppose that the whole proceeds from the mucous follicles of the bronchiæ; and it seems probable that a great part of it may come from the effused serous fluid just mentioned; and this too will account for the appearance of the expectoration being so often purulent. Perhaps the same thing will account for that purulent matter found in the bronchiæ, which Mr de Haen says he had often observed when there was no ulceration in the lungs, and which he accounts for in a very strange manner, namely, by supposing a pus formed in the circulating blood.

Dr Cullen is of opinion, that the effusion into the bronchiæ above mentioned often concurs with the effusion of red blood into the cellular substance of the lungs to occasion the fatal suffocation which frequently terminates peripneumony: that the effusion of serum alone may have this effect: and that the serum poured out in a certain quantity, rather than any debility in the powers of expectoration, is the cause of that cessation of spitting which precedes the fatal event; for in many cases the expectoration has ceased, when no other symptoms of debility have appeared, and when, upon dissection, the bronchiæ have been full of liquid matter. Nay, it is even probable, that in some cases such an effusion may take place without any symptoms of violent inflammation; and in other cases the effusion taking place may seem to remove the symptoms of inflammation which had appeared before, and thus account for those unexpected fatal terminations which have sometimes happened.

Pneumonic inflammation seldom terminates by resolution, without being attended with some evident evacuation. An hæmorrhagy from the nose happening on some of the first days of the disease has sometimes put an end to it; and it is said, that an evacuation from the hæmorrhoidal veins, a bilious evacuation by stool, and an evacuation of urine with a copious sediment, have severally had the same effect; but such occurrences have been rare. The evacuation most frequently attending, and seeming to have the greatest effect in promoting resolution, is an expectoration of a thick, white, or yellowish matter, a little streaked with blood, copious, and brought up without much or violent coughing. Very frequently the resolution of this disease is attended with, and perhaps produced by, a sweat, if it be warm, fluid, copious, over the whole body, and attended with an abatement of the frequency of the pulse, heat of the body, and other febrile symptoms. Although, from the history now given, it appears that pleurisy and peripneumony cannot with propriety be considered as different diseases, yet it is certain that in different cases this affection occurs with an assemblage of symptoms separate and distinct. Thus even Dr Cullen himself, in his Nosology, has defined pleuritis to consist in pyrexia, attended with pungent pain of the side, painful respiration, difficulty of lying down, particularly on the affected side, and distressing cough, in the beginning dry, but afterwards humid, and often with bloody expectoration. While again he has defined peripneumony to consist in pyrexia, attended with a dull pain under the sternum and between the shoulders, anxiety, difficulty of breathing, humid

mid cough, expectoration generally bloody, a soft pulse, and a tumid livid appearance of the countenance. It is highly probable, that the first of these sets of symptoms chiefly arises from a state of active inflammation, and the second from effusion. Thus, in certain cases, the symptoms may appear perfectly separate and distinct; but more frequently both inflammation and effusion are united; and thus the symptoms in both definitions are in general combined in the same patient. But still pleuritis, strictly so called, may be considered as characterized by the acute pungent pain at a particular spot of the chest, and that pain much aggravated on a full inspiration; while proper peripneumonia is distinguished by the dull gravative pain extended over the whole chest, and by the laborious respiration.

Causes of, and persons subject to, this disorder. The remote cause of pneumonic inflammation is commonly cold applied to the body, obstructing perspiration, and determining to the lungs, while at the same time the lungs themselves are exposed to the action of cold. These circumstances operate chiefly when an inflammatory diathesis prevails in the system; and therefore those principally affected with this disease are persons of the greatest vigour, in cold climates, often in the winter season, but particularly in the spring, when vicissitudes of heat and cold are frequent. This disease, however, may arise in any season when such varieties take place. Other remote causes also may have a share in producing this distemper; such as every means of obstructing, straining, or otherwise injuring, the pulmonary organs. The pneumatic inflammation has sometimes been so much an epidemic, that it hath been suspected of depending on a specific contagion; but Dr Cullen never met with an instance of its being contagious.

Prognosis. In pneumatic inflammations, a violent pyrexia is always dangerous. The danger, however, is chiefly denoted by the difficulty of breathing. When the patient can lie on one side only; when he can lie on neither side, but only on his back; when he cannot breathe with tolerable ease, except when the trunk of his body is erect; when even in this posture the breathing is very difficult, and attended with a turgescence and flushing of the face, with partial sweats about the head and neck, and an irregular pulse; these circumstances mark the difficulty of breathing in different degrees; and consequently, in proportion, the danger of the disease. A frequent violent cough, aggravating the pain, is always the symptom of an obstinate disease; and as the disease is seldom or never resolved without some expectoration, so a dry cough must always be an unfavourable symptom.

The proper characteristics of the expectoration have been already laid down; and though an expectoration which has not these marks must indicate a doubtful state of the disease, yet the colour alone can give no certain prognostic. An acute pain, very much interrupting inspiration, is always the mark of a violent disease; but not of a more dangerous disease than an obtuse pain, attended with very difficult respiration, demonstrating effusion into the cells.

When the pains, which had at first affected one side only, shall afterwards spread into the other; or when, leaving the side first affected, they pass entirely into the other; these are always marks of a dangerous disease.

A delirium coming on during a pneumonic inflammation is always a symptom denoting much danger.

When pneumonic disorders terminate fatally, it is on one or other of the days of the first week, from the third to the seventh. This is the most common case; but, in a few instances, death has happened at a later period. When the disease is violent, but admitting of resolution, this also happens frequently in the course of the first week; but in a more moderate disease the resolution is often put off to the second week. The disease generally suffers a remission on some of the days; from the third to the seventh: which, however, may be often fallacious, as it sometimes returns again with as much violence as before; and in such a case with great danger. Sometimes it disappears on the third day, while an erysipelas makes its appearance on some external part; and if this continue fixed, the pneumatic inflammation does not recur. If the disease continue beyond the 14th day, it will terminate in a suppuration, or PHTHISIS. The termination by gangrene is much more rare than has been imagined: and when it does occur, it is usually joined with the termination by effusion; the symptoms of the one being hardly distinguishable from those of the other.

Cure. This must proceed upon the general plan mentioned under SYNOCHA; but, on account of the importance of the part affected, the remedies must be employed early, and as fully as possible: and these are chiefly directed with one of three views, viz. for obtaining a resolution of the inflammation in the thorax, for mitigating the urgent symptoms before a resolution can be effected, and for counteracting or obviating the consequences of the disease. Venesection is the remedy chiefly to be depended on; and may be performed in either arm, as the surgeon finds most convenient; and the quantity taken away ought in general to be as large as the patient's strength will allow. The remission of pain, and the relief of respiration, during the flowing of the blood, may limit the quantity to be then drawn; but if these symptoms of relief do not appear, the bleeding should be continued to a considerable extent, unless symptoms of a beginning syncope come on. It is seldom that one bleeding, however large, will cure this disease; and though the pain and difficulty of breathing may be much relieved by the first bleeding, these symptoms commonly and after no long interval recur, often with as much violence as before. In this case the bleeding is to be repeated even on the same day, and perhaps to the same quantity as before. Sometimes the second bleeding may be larger than the first. There are persons, who, by their constitution, are ready to faint even upon a small bleeding; and in such persons this may prevent the drawing so much blood at first as a pneumonic inflammation may require: but as the same persons are found to bear after-bleedings better than the first, this allows the second and subsequent bleedings to be larger, and to such a quantity as the symptoms of the disease may seem to require.

Bleedings are to be repeated according to the state of the symptoms, and they will be more effectual when practised in the course of the first three days than afterwards; but they are not to be omitted though four days of the disease may already have elapsed. If the physician has not been called in time, or the first bleed-

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ings have not been sufficiently large, or even though they should have procured some remission, yet upon the return of the urgent symptoms, bleeding may be repeated at any time within the first fortnight, or even after that period, if a suppuration be not evident, or if after a seeming solution the disease shall have returned.

With respect to the quantity of blood which may be taken away with safety, no general rules can be given; as it must be very different according to the state of the disease, and the constitution of the patient. In an adult male of tolerable strength, a pound of blood is a full bleeding. Any quantity above 20 ounces is a large, and any quantity below 12 is a small, bleeding. An evacuation of four or five pounds, in the course of two or three days, is generally as much as most patients will bear; but if the intervals between the bleedings, and the whole of the time during which the bleedings have been employed, have been long, the quantity taken upon the whole may be greater.

When a large quantity of blood has been taken from the arm, and it is doubtful if more can be taken in that manner with safety, some blood may still be taken by cupping and scarifying. This will especially be proper, when the recurrence of the pain, rather than the difficulty of breathing, becomes the urgent symptom; and then the cupping and scarification should be made as near as possible to the pained part.

An expectoration sometimes takes place very early in this disease; but if the symptoms continue urgent, the bleedings must be repeated notwithstanding the expectoration: but in a more advanced state, and when the symptoms have suffered a considerable remission, we may then trust the cure to the expectoration alone. It is not observed that bleeding, during the first days of the disease, stops expectoration; on the contrary, it has been often found to promote it; and it is only in a more advanced state of the disease, when the patient has been already exhausted by large evacuations and a continuance of his illness, that bleeding seems to put a stop to expectoration; and even then, this stoppage seems not to take place so much from the powers of expectoration being weakened by bleeding, as by its favouring the serous effusion in the bronchiæ, already taken notice of.

Besides bleeding, every part of the antiphlogistic regimen ought here to be carefully employed; the patient must keep out of bed as much as he can bear; must have plenty of warm diluting drinks, impregnated with vegetable acids, accompanied with nitre or some other cooling neutral salt; and the belly also ought to be kept open by emollient clysters or cooling laxative medicines. Vomiting in the beginning is dangerous; but in a somewhat advanced state of the disease emetics have been found the best means of promoting expectoration. Fomentations and poultices to the pained part have been found useful; but blistering is found to be much more effectual. A blister, however, ought not to be applied till at least one bleeding has been premised, as venesection is less effectual when the irritation of a blister is present. If the disease be moderate, a blister may be applied immediately after the first bleeding; but in violent cases, where it may be presumed that a second bleeding may soon be necessary after the first, it will be proper to delay the blister till after the second bleeding, when it may be supposed that the irritation occasioned by the blister will be over before another bleeding becomes necessary. It may frequently be of use in this disease to repeat the blistering; and in that case the plasters should always be applied somewhere on the thorax, for when applied to more distant parts they have less effect. The keeping the blistered parts open, and making what is called a *perpetual blister*, has much less effect than a repeated blistering.

Many methods have been proposed for promoting expectoration, but none appear to be sufficiently effectual; and some of the expectorants, being acrid stimulant substances, are not very safe. The gums usually employed seem to be too heating; the squills less so; but they are not very powerful, and sometimes inconvenient, by the constant nausea they occasion. The volatile alkali may be of service as an expectorant, but it ought to be reserved for an advanced state of the disease. Mucilaginous and oily demulcents appear to be useful, by allaying that acrimony of the mucus which occasions too frequent coughing; and which coughing prevents the stagnation and thickening of the mucus, and thereby its becoming mild. The receiving into the lungs the steams of warm water, impregnated with vinegar, has often proved useful in promoting expectoration; and, for this purpose, the machine called the INHALER, lately invented by Dr Mudge of Plymouth, promises to be of great service. But of all others, the antimonial emetics, given in nauseating doses, are perhaps the most powerful for promoting expectoration. The kermes mineral has been greatly recommended; but does not seem to be more efficacious than tartrite of antimony or antimonial wine; and the dose of the kermes is much more uncertain than that of the others.

Though this disease often terminates by a spontaneous sweating, this evacuation ought not to be excited by art, unless with much caution. When, after some remission of the symptoms, spontaneous sweats arise, they may be encouraged; but it ought to be without much heat, and without stimulant medicines. If, however, the sweats be partial and clammy only, and a great difficulty of breathing still remain, it will be very dangerous to encourage them.

Physicians have differed much with regard to the use of opiates in pneumonic affections. It appears, however, that in the beginning of the disease, and before bleeding and blistering have produced some remission of the pain, and of the difficulty of breathing, opiates have had a bad tendency, by their increasing the difficulty of breathing and other inflammatory symptoms. But in a more advanced state of the disease, when the difficulty of breathing has abated, and when the urgent symptom is a cough, proving the chief cause of the continuance of pain and want of rest, opiates may be employed with great advantage and safety. The interruption of the expectoration which they seem to occasion, is for a short time only; and they seem often to promote it, as they occasion a stagnation of what was by frequent coughing dissipated insensibly: and therefore give the appearance of what physicians have called *concocted matter*.

Opium combined with calomel has of late been highly extolled in this and other inflammatory diseases by Dr Hamilton of Lynn Regis; who has given a full account

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count of the success attending his practice with this remedy for the space of 16 years, in the 9th volume of the Edinburgh Medical Commentaries. And since his recommendation, the same remedy has often been employed by others with great benefit.

VOMICA, or *Abscess* of the *Lungs*.

186 Vomica, *Boerh.* 835. *Junck.* 35.
Pleurodyne vomica, *Sauv.* sp. 21.

Phthisis sometimes follows pneumonia, though the case is not frequent. The symptoms of it so much resemble ordinary phthisis, that it can most properly be treated of under that head.

187 EMPYEMA.

This is another consequence of a pneumonia terminating unfavourably, and is occasioned by the effusion of a quantity of purulent matter into the cavity of the thorax, producing a lingering and painful disorder, very often incurable.

Description. The first sign of an empyema is a cessation of the pain in the breast, which before was continual: this is followed by a sensation of weight on the diaphragm; and a fluctuation of matter, sometimes making a noise that may be heard by the bystanders: the acute fever is changed into a hectic, with an exacerbation at night: a continual and troublesome dry cough remains. The respiration is exceedingly difficult, because the lungs are prevented by the matter from fully expanding themselves. The patient can lie easily on that side where the matter is effused, but not on the other, because then the weight of the matter on the mediastinum produces uneasiness. The more the hectic heat is augmented, the more is the body emaciated, and its strength decayed. In some there is danger of suffocation when they stoop down, which goes off when they alter that posture of the body; and in some there is a purulent spitting.—These symptoms are accompanied with great anxiety, palpitations of the heart, and faintings. Sometimes the patients have a sensation like a hot vapour ascending from the cavity of the thorax to their mouth. Others, in a more advanced state of the disease, have a putrid taste in the mouth. At the same time, profuse night sweats waste the body, and greatly weaken the patient. The face at first grows red on that side where the matter lies, at last the Hippocratic face comes on, and the eyes become hollow. The pulse is quick, but more frequently intermitting. Sometimes the nails are crooked, and pustules appear on the thorax; and frequently, according to the testimony of Hippocrates, the feet swell, and, on the affected side of the breast, there is an inflation and swelling of the skin.

Causes, &c. An empyema may arise either from the bursting of a vomica of the lungs, or from a suppuration taking place after the inflammatory stage of pneumonia; or sometimes from a suppuration in the case of a quinsy, when the inflammation had extended to the aspera arteria, from whence arises a kind of bloody spittle, and the patients are afflicted with an empyema, unless they die on the 7th day of the disease, according to the observation of Hippocrates. It may arise also from external violence, as wounds of the thorax, &c. blood extravasated, corrupted, or changed into pus. Like the vomica, it is a rare distemper, but may attack all those subject to pneumonia.

Peritonitis.

Prognosis. Very few recover after an empyema has been once formed, especially if the operation of paracentesis be neglected. After this operation is performed, if a great quantity of bloody fetid pus be discharged, if the fever continue, and if the patient spit up a purulent, pale, frothy, livid, or green matter, with a decay of strength, there is no hope: But when a small quantity of pus, of a white colour, not very fetid, is discharged; when the fever and thirst presently cease, the appetite returns, and fæces of a good consistence are discharged, the strength also returning in some degree; there is then hope of a perfect recovery. If the matter be not dried up in seven weeks time, the disease readily changes to a fistulous ulcer, which is very difficult to cure. An empyema affecting both sides of the thorax is more dangerous than that which affects only one.

Cure. This consists in evacuating the purulent matter contained in the cavity of the thorax, which is best done by the operation of paracentesis of the thorax. See SURGERY. Afterwards the ulcer is to be treated with abstergent and consolidating medicines, and the same internal ones are to be given as in a PHTHISIS.

GENUS XIII. CARDITIS. 188

Inflammation of the *HEART*.

Carditis, *Sauv.* gen. 111. *Vog.* 54.
Pericarditis, *Vog.* 53.
Carditis spontanea, *Sauv.* sp. 1. *Senac.* Traité de Cœur, l. iv. c. 7. *Meckel*, Mem. de Berlin, 1756.
Erysipelas pulmonis, *Lomm.* Observ. lib. ii.

Description. This disease is attended with all the symptoms of pneumonia, but in a higher degree; it is besides said to be accompanied with hydrophobic symptoms, fainting, palpitation of the heart, a seeming madness, a sunk and irregular pulse, watery eyes, and a dejected countenance, with a dry and black tongue. On dissection, the heart and pericardium are found very much inflamed, and even ulcerated, with many polypous concretions.

Causes, &c. The same as in the pneumonia.

Prognosis. In the carditis the prognosis is more unfavourable than in the pneumonia; and indeed, unless the disease very quickly terminates, it must prove fatal, on account of the constant and violent motion of the heart, which exasperates the inflammation, and increases all the symptoms.

Cure. Here bleeding is necessary in as great a degree as the patient can possibly bear, together with blistering, and the antiphlogistic regimen likewise carried to a greater height than in the pneumonia; but the general method is the same as in other inflammatory diseases.

GENUS XIV. PERITONITIS. 189

Inflammation of the *PERITONÆUM*.

Sp. I. *Inflammation* of the *PERITONÆUM* properly so called.

Peritonitis, *Vog.* 62. *Lieutad.* Hist. anat. med. lib. i. obs.

obſ. 3. *Raygerus* apud eund. lib. i. obſ. 341. *Morgagn.* de ſed. LVII. 20.

190 Sp. II. *Inflammation* of the *PERITONÆUM* extended over the *Omentum*.

Epiploitis, *Sauv.* gen. 106. *Sag.* gen. 308.
Omentitis, *Vog.* 61.
Omenti inflammatio, *Boerh.* 985. et Ill. *Van Swieten*, Comm. *Stork.* An. Med. I. 132. *Hulme* on the puerperal fever.

191 Sp. III. *Inflammation* of the *PERITONÆUM* ſtretched over the *Meſentery*.

Meſenteritis, *Vog.* 60.
Enteritis meſenterica, *Sauv.* ſp. 4.

192 GENUS XV. GASTRITIS.

193 *Inflammation* of the *STOMACH*.

A. *GASTRITIS PHLEGMONODÆA*, or the *genuine Gaſtritis*.

Gaſtritis legitima, *Sauv.* ſp. 1. *Eller.* de cogn. et cur. morb. ſect. xii. *Haller.* obſ. 14. hiſt. 3. *Lieut.* Hiſt. Anat. Med. lib. i. 74.
Gaſtritis cryſipelatoſa, *Sauv.* ſp. 4.
Cardialgia inflammatoria, *Sauv.* ſp. 13. *Tralles*, de opio ſect. ii. p. 231.

Theſe diſeaſes Dr Cullen has thought proper to conſider all under the general head of GASTRITIS, as there are no certain ſigns by which they can be diſtinguiſhed from each other, and the method of cure muſt be the ſame in all.

Deſcription. The inflammation of the ſtomach is attended with great heat and pain in the epigaſtric region, extreme anxiety, an almoſt continual and painful hiccough, with a moſt painful vomiting of every thing taken into the ſtomach. Sometimes a temporary madneſs enſues; and there is an inſtance in the Edinburgh Medical Eſſays of the diſorder being attended with an hydrophobia. The pulſe is generally more ſunk than in other inflammations, and the fever inclines to the nature of a typhus. The diſorder is commonly of the remitting kind, and during the remiſſions the pulſe frequently intermits. During the height of the diſeaſe, a mortal phrenſy frequently ſupervenes. The diſeaſe terminates on the fourth, ſeventh, or ninth day, or from the eleventh to the fifteenth; and is more apt to end in a gangrene than pneumonic inflammations, and more frequently in a ſcirrhus than in an abſceſs.

Cauſes, &c. The inflammation of the ſtomach may ariſe from any acrid ſubſtance taken into it; from a vehement paſſion, too large draughts of cold liquor, eſpecially when the perſon is very hot; from a ſurfeit; a ſtoppage of perſpiration; repulſion of the gout; inflammations of the neighbouring viſcera; or from external injuries, ſuch as wounds, contuſions, &c.—It affects chiefly thoſe of a plethoric habit and hot bilious conſtitution.

Prognoſis. This diſeaſe is always very dangerous, and the prognoſis doubtful, which alſo muſt always be in proportion to the ſeverity of the ſymptoms. A ceſſation of pain, coldneſs about the præcordia, great debility, with a languid and intermitting pulſe, with an abatement of the hiccough, denote a gangrene and ſpeedy death. From the ſenſibility of the ſtomach alſo, and its great connexion with the reſt of the ſyſtem, it muſt be obvious, that an inflammation of it, by whatever cauſes produced, may be attended with fatal conſequences; particularly, by the great debility it produces, it may prove ſuddenly fatal, without running through the uſual courſe of inflammations.—Its tendency to admit of reſolution may be known by its having ariſen from no violent cauſe, by the moderate ſtate of the ſymptoms, and by a gradual remiſſion of theſe ſymptoms in the courſe of the firſt or at moſt of the ſecond week of the diſeaſe. The tendency to gangrene may be ſuſpected from the ſymptoms continuing with unremitting violence, notwithſtanding the uſe of proper remedies; and a gangrene already begun may be known by the ſymptoms above mentioned, particularly great debility and ſudden ceſſation of pain. The tendency to ſuppuration may be known by the ſymptoms continuing but in a moderate degree for more than one or two weeks, and by a conſiderable remiſſion of the pain, while a ſenſe of weight and anxiety ſtill remain. When an abſceſs has been formed, the frequency of the pulſe is firſt abated: but ſoon after it increaſes, with frequent cold ſhivering, and an exacerbation in the afternoon and evening; followed by night ſweats, and other ſymptoms of hectic fever. Theſe at length prove fatal, unleſs the abſceſs open into the cavity of the ſtomach, the pus be evacuated by vomiting, and the ulcer ſoon healed.

Cure. It appears from diſſections, that the ſtomach may very often be inflamed when the characteriſtic marks of it have not appeared; and therefore we are often expoſed to much uncertainty in the cure. But when we have ſufficient evidence that a ſtate of active inflammation has taken place in the ſtomach, the principal object to be aimed at is to obtain a reſolution. Before, however, this can be accompliſhed, it will often be neceſſary to employ meaſures with the view of obviating urgent ſymptoms. When the ſymptoms appear in the manner above deſcribed, the cure is to be attempted by large and repeated bleedings employed early in the diſeaſe; and from theſe we are not to be deterred by the weakneſs of the pulſe, for it will commonly become fuller and ſofter after the operation. A bliſter ought alſo to be applied to the region of the ſtomach; and the cure will be aſſiſted by fomentations of the whole abdomen, and by frequent emollient and laxative clyſters. The irritability of the ſtomach in this diſeaſe will admit of no medicines being thrown into it; and if any can be ſuppoſed neceſſary, they muſt be exhibited in clyſters. Diluting drinks may be tried; but they muſt be of the very mildeſt kind, and given in very ſmall quantities at a time. Opiates, in whatever manner exhibited, cannot be retained in the ſtomach during the firſt days of the diſeaſe; but when the violence of the diſeaſe ſhall have abated, and when the pain and vomiting recur at intervals only, opiates given in clyſters are frequently employed with advantage; and after bleeding and bliſters no remedy is more effectual either in allaying the pain or vomiting. As ſoon as the ſtomach will retain any laxative, gentle refrigerant cathartics, taken by the mouth, ſuch as the ſoda phoſphorata, ſoda tartariſata, or the like, are

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are productive of great benefit. A tendency to gangrene in this disease is to be obviated only by the means just now mentioned; but when it does actually supervene, it admits of no remedy. A tendency to suppuration is to be obviated by the same means employed early in the disease. After a certain period it cannot be prevented by any means whatever; and, when actually begun, must be left to nature; the only thing that can be done by art being to avoid all irritation.

194 B. *GASTRITIS ERYSIPELATOSA*, or the *Erysipelatous Gastritis*.

Description. This species of inflammation takes place in the stomach much more frequently than the former. From dissections it appears that the stomach has been often affected with inflammation, when neither pain nor fever had given any notice of it; and such is justly looked upon to have been of the erysipelatous kind. This kind of inflammation also is especially to be expected from acrimony of any kind applied to the stomach; and would certainly occur much more frequently, were not the interior surface of this organ commonly defended by mucus exsuding in large quantity from the numerous follicles placed immediately under the villous coat. On many occasions, however, the exsudation of mucus is prevented, or the liquid poured out is of a less viscid kind, so as to be less fitted to defend the subjacent nerves; and it is in such cases that acrid matters may readily produce an erysipelatous affection of the stomach.

In many cases this kind of inflammation cannot be discovered, as it takes place without pain, pyrexia, or vomiting: but in some it may; namely, when it spreads into the œsophagus, and appears on the pharynx and on the whole internal surface of the mouth. When therefore an erysipelatous inflammation affects the mouth and fauces, and there shall be at the same time in the stomach an unusual sensibility to all acrids, and also a frequent vomiting, there can be little doubt of the stomach's being affected in the same manner. Even when no inflammation appears in the fauces, if some degree of pain be felt in the stomach, if there be a want of appetite, an anxiety and frequent vomiting, an unusual sensibility with regard to acrids, some thirst, and frequency of pulse, there will then be room to suspect an inflammation in the stomach; and such symptoms, after some time, have been known to discover their cause by the inflammation rising to the fauces or mouth. Inflammation of this kind is often disposed to pass from one place to another on the same surface, and, in doing so, to leave the place it had at first occupied. Such an inflammation has been known to spread successively along the whole tract of the alimentary canal; occasioning, when in the intestines, diarrhœa, and in the stomach vomitings; the diarrhœa ceasing when the vomitings came on, and the vomitings on the coming on of the diarrhœa.

Causes, &c. An erysipelatous inflammation may arise from acrid matters taken into the stomach; or from some internal causes not yet well known. It frequently occurs in putrid diseases, and in those recovering from fevers.

Cure. When the disease is occasioned by acrid matters taken internally, and these may be supposed still present in the stomach, they are to be washed out by drinking a large quantity of warm and mild medicines, and exciting gentle vomiting. At the same time, if the nature of the acrimony and its proper corrector be known, this should be thrown in; or if a specific corrector be not known, some general demulcents should be employed.

These measures, however, are more suited to prevent than to cure inflammation after it has taken place. When this last may be supposed to have happened, if it be attended with a sense of heat, with pain and pyrexia, according to the degree of these symptoms, the measures proposed for the cure of the other kind are to be more or less employed. When an erysipelatous inflammation of the stomach has arisen from internal causes, if pain and pyrexia occur, bleeding may be employed in persons not otherwise weakened; but in case of its occurring in putrid diseases, or where the patients are already debilitated, bleeding is inadmissible; all that can be done being to avoid irritation, and only throwing into the stomach what quantity of acids and acescent aliments it shall be found able to bear. In some conditions of the body in which this disease is apt to occur, cinchona and bitters may seem to be indicated; but an erysipelatous state of the stomach will seldom allow them to be used.

Enteritis.

Genus XVI. ENTERITIS. 195

Inflammation of the *INTESTINES.*

Enteritis, *Sauv.* gen. 105. *Lin.* 29. *Vog.* 57. *Sag.* gen. 307.
Intestinorum inflammatio, *Boerh.* 959.
Febris intestinorum inflammatoria ex mesenterio, *Hoffm.* ii. 170.

Sp. I. *ENTERITIS PHLEGMONODÆA*, or the *Acute Enteritis*. 196

Enteritis iliaca, *Sauv.* sp. 1.
Enteritis colica, *Sauv.* sp. 2. *Boerh.* 963.

Description. This disease shows itself by a fixed pain in the abdomen, attended with fever, vomiting, and costiveness. The pain is often felt in different parts of the abdomen, but more frequently spreads over the whole, and is particularly violent about the navel.

Causes, &c. Inflammations of the intestines may arise from the same causes as those of the stomach; though commonly the former will more readily occur from cold applied to the lower extremities, or to the belly itself. It is also found supervening on the spasmodic colic, incarcerated hernia, and volvulus.

Prognosis. Inflammations of the intestines have the same terminations with those of the stomach, and the prognosis in both cases is much the same.

Cure. The cure of enteritis is in general the same with that of gastritis; but in this disease there is commonly more opportunity for the introduction of liquids, of acid, acescent, and other cooling remedies, and even of laxatives; but as a vomiting frequently attends the enteritis, care must be taken not to excite that vomiting by the quantity or quality of any thing thrown into the stomach. With regard to the suppuration

Phlegmasiæ. ration and gangrene of the inteftines following the enteritis, the obfervations made refpecting thefe terminations of gaftritis are equally applicable in this difeafe.

197 Sp. II. *ENTERITIS ERYSIPELATOSA*, or *Eryfipelatous Enteritis*.

Concerning this nothing farther can be faid, than what hath been already delivered concerning the gaftritis.

198 GENUS XVII. HEPATITIS.

Inflammation of the *LIVER*.

Hepatitis, *Sauv.* gen. 113. *Lin.* 35. *Vog.* 58. *Sag.* gen. 312. *Boerh.* 914. *Hoffm.* ii. 14. *Junck.* 66.

Defcription. The inflammation of the liver is thought to be of two kinds, acute and chronic; but the latter very often does not difcover itfelf except by an abfcefs found in the liver after death, and which is fuppofed to have been occafioned by fome degree of inflammation; for this reafon the chronic inflammation often efcapes obfervation, and we fhall here only treat of the acute hepatitis.

The acute hepatitis is attended with confiderable fever; a frequent, ftrong, and hard pulfe; high-coloured urine; an acute pain in the right hypochondrium, increafed by preffing upon the part. The pain is very often in fuch a part of the fide as to make it appear like a pleurify; and frequently, like that, is increafed on infpiration. The difeafe is alfo commonly attended with a cough, which is generally dry, though fometimes moift; and when the pain thus refembles a pleurify, the patient cannot lie eafily except upon the fide affected. The pain is frequently extended to the clavicle, and to the top of the fhoulder; and is attended fometimes with hiccough, and fometimes with vomiting. Some have added jaundice, or a yellownefs of the eyes, to the fymptoms of this diftemper; but experience fhows that it has often occurred without any fuch fymptom.

When hepatitis is of the chronic kind, depending more on an accumulation and effufion in the liver, than on an increafed action of its fmall veffels, the patient complains rather of a fenfe of weight than of pain; and the fever is by no means either acute or conftant: but it often returns in paroxyfms fomewhat refembling the attacks of an intermittent. This difeafe is very flow in its progrefs, frequently continuing for many months, and at laft terminating in a very confiderable fuppuration. In moft cafes, however, it may be difcovered by careful examination of the region of the liver externally. By this means, a confiderable enlargement of that vifcus may in general be detected.

Caufes, &c. The remote caufes of hepatitis are not always to be difcerned, and many have been affigned on a very uncertain foundation. It is principally a difeafe of warm climates. It has been fuppofed that the difeafe may be an affection either of the extremities of the hepatic artery, or thofe of the vena portarum; and the fuppofition is by no means improbable. The opinion, however, moft commonly adopted is, that the acute hepatitis is an affection of the external membrane of the liver, and the chronic kind an affection of the parenchyma of that vifcus. The acute difeafe may be feated either on the convex or concave furface of the liver; and in the former cafe a more pungent pain and hiccough may be produced, and the refpiration is more confiderably affected. In the latter there occurs lefs pain; and a vomiting is produced, commonly by fome inflammation communicated to the ftomach. The inflammation on the concave furface of the liver may be readily communicated to the gall-bladder and biliary ducts: and this, perhaps, is the only cafe of idiopathic hepatitis attended with jaundice. Hepatitis.

Prognofis. The inflammation of the liver, like others, may end by refolution, fuppuration, or gangrene; and the tendency to the one or to the other of thofe events may be known from what has been already mentioned concerning the prognofis in gaftritis. The refolution of hepatitis is often the confequence of, or is attended with, evacuations of different kinds. A hæmorrhage fometimes from the nofe, and fometimes from the hæmorrhoidal veffels, gives a folution of the difeafe. Sometimes the fame thing is accomplifhed by a bilious diarrhœa; and fometimes the refolution is attended with fweating, and an evacuation of urine depofiting a copious fediment. Sometimes it may be cured by an eryfipelas appearing in fome external part. When the difeafe has ended in fuppuration, the pus collected may be difcharged by the biliary ducts; or, if the fuppurated part does not adhere anywhere clofely to the neighbouring parts, it may be difcharged into the cavity of the abdomen: but if, during the firft ftate of inflammation, the affected part of the liver fhall have formed a clofe adhefion to fome of the neighbouring parts, the difcharge after fuppuration may be various, according to the different feat of the abfcefs. When feated on the convex part of the liver, if the adhefion be to the peritonæum lining the common teguments, the pus may make its way through thefe, and be difcharged outwardly: or if the adhefion fhall have been to the diaphragm, the pus may penetrate through this, and into the cells of the lungs; from whence it may be difcharged by coughing. When the abfcefs is feated on the concave part of the liver, in confequence of adhefions, the pus may be difcharged into the ftomach or inteftines; and into thefe laft, either directly, or by the intervention of the biliary ducts. Upon a confideration of all thefe different circumftances, therefore, together with the general principles of inflammation, muft the prognofis of this difeafe be eftablifhed.

Cure. For the cure of hepatitis, we muft have recourfe to the general means of refolving other inflammatory diforders. Bleeding is to be ufed according to the degree of fever and pain. Blifters are to be applied: fomentations of the external parts, emollient clyfters, gentle laxatives, diluents and refrigerants, are alfo ufeful. The cure, however, particularly in warm climates, where the difeafe is much more common than it is in Britain, is chiefly trufted to mercury. Not only in cafes of the chronic kind, but in acute hepatitis alfo, after an attempt has been made to alleviate the urgent fymptoms by bleeding and bliftering, recourfe is immediately had to this powerful mineral. It is employed by different practitioners, and in

Phlegmasiæ. in different cafes, under various forms. Some are very fond of the ufe of calomel. But the preference is in general given, and perhaps with juftice, to friction with mercurial ointment over the region of the liver. But under whatever form it may be employed, it is neceffary that it fhould be introduced to fuch an extent as to keep the patient on the verge of falivation for fome length of time; the duration being regulated by the circumftances of the cafe.

From the liberal ufe of mercury, there can be no doubt that a fuccefsful refolution has been obtained in many cafes, which would otherwife have infallibly terminated in fuppuration. But notwithftanding the moft careful employment of it in fome cafes, fuppuration will enfue; and then it is very doubtful whether any benefit will be derived from the continuance of it. But when a fuppuration has been formed, and the abfcefs points outwardly, the part muft be opened, the pus evacuated, and the ulcer healed according to the ordinary methods in ufe for healing abfceffes and ulcers in other parts.

Chronic hepatitis often terminates in fcirrhus. Againft this, after mercury has failed, nitric acid taken internally has fometimes been employed with fuccefs.

Genus XVIII. SPLENITIS.

199 *Inflammation* of the *SPLEEN*.

Splenitis, *Sauv.* gen. 114. *Lin.* 36. *Vog.* 59. *Junck.* 67. *Sag.* gen. 313.
Lienis inflammatio, *Boerh.* 958. et *Van Swieten*, Comm.
Splenitis phlegmonodæa, *Sauv.* fp. 1. *Foreft*, l. xx. obf. 5, 6. *De Haen*, apud *Van Swieten*, p. 958.
Pleuritis fplenica, *Sauv.* fp. 19.
Splenalgia fuppuratoria, *Sauv.* fp. 3.

Defcription. This difeafe, according to *Juncker*, comes on with a remarkable fhivering, fucceeded by a moft intenfe heat and very great thirft; a pain and tumour are perceived in the left hypochondrium, and the paroxyfms for the moft part affume a quartan form. When the patients expofe themfelves for a little to the free air, their extremities immediately grow very cold. If a hæmorrhage happens, the blood flows out of the left noftril. The other fymptoms are the fame with thofe of the hepatitis. Like the liver, the fpleen is alfo fubject to a chronic inflammation, which often happens after agues; and the tumour which fucceeds the inflammation is in many cafes very confiderable, and is called the *ague cake*, though that name is alfo frequently given to a fcirrhous tumour of the liver fucceeding intermittents.

Caufes, &c. The caufes of this diftemper are in general the fame with thofe of other inflammatory diforders; but thofe which determine the inflammation to that particular part more than another, are very much unknown. It attacks perfons of a very plethoric and fanguine habit of body rather than others.

Prognofis. What has been faid of the inflammation of the liver applies alfo to that of the fpleen, though the latter is lefs dangerous than the former. Here alfo a vomiting of black matter, which in other acute difeafes is fuch a fatal fymptom, fometimes proves critical, according to the teftimony of Juncker. Sometimes the hæmorrhoids prove critical; but very often the inflammation terminates by fcirrhus.

Cure. This is not at all different from what has been already laid down concerning the hepatitis.

Genus XIX. NEPHRITIS.

Inflammation of the *KIDNEYS*. 200

Nephritis, *Sauv.* gen. 115. *Lin.* 37. *Vog.* 65. *Sag.* gen. 314.
Nephritis vera, *Sauv.* fp. 1.

Nephritis. *Defcription.* The nephritis has the fame fymptoms which take place in other inflammations; but its diftinguifhing mark is the pain in the region of the kidney, which is fometimes obtufe, but more frequently pungent. The pain is not increafed by the motion of the trunk of the body fo much as a pain of the rheumatic kind affecting the fame region. It may alfo frequently be diftinguifhed by the pain fhooting along the courfe of the ureter, and it is often attended with a drawing up of the tefticle, and a numbnefs of the limb on the fide affected; though indeed thefe fymptoms moft commonly attend the inflammation arifing from a calculus in the kidney or ureter. The difeafe is alfo attended with frequent vomiting, and often with coftivenefs and colic pains. The urine is moft commonly of a deep red colour, and is voided frequently and in a fmall quantity at a time. In more violent cafes the urine is commonly colourlefs.

Caufes, &c. The remote caufes of this difeafe may be various; as external contufion, violent or long-continued riding; ftrains of the mufcles of the back incumbent on the kidneys; various acrids in the courfe of circulation conveyed to the kidneys; and perhaps fome other internal caufes not yet well known: the moft frequent is that of calculous matter obftructing the *tubuli uriniferi*, or calculi formed in the pelvis of the kidneys, and either fticking there or falling into the ureter.

Prognofis. This is not different from that of other inflammatory difeafes.

Cure. When any of thofe caufes operating as inducing the inflammation ftill continue to act, the firft object in the cure muft be the removal of thefe; but the principal intention to be had in view, is the refolution of the inflammation which has already taken place. But when, notwithftanding efforts for this purpofe, the difeafe terminates in fuppuration, it muft be the endeavour of the practitioner to promote the difcharge of purulent matter, and the healing of the ulceration in the kidney.

Thefe different objects are principally accomplifhed by bleeding, external fomentation, frequent emollient clyfters, antiphlogiftic purgatives, and by the free ufe of mild and demulcent liquids. The ufe of blifters is fcarce admiffible, or at leaft will require great care to avoid any confiderable abforption of the cantharides.

The other fpecies of nephritis enumerated by authors are only fymptomatic.

Genus

Phlegmasiæ.

201 Genus XX. CYSTITIS.

Inflammation of the *BLADDER.*

Cyſtitis, *Sauv.* gen. 108. *Lin.* 31. *Vog.* 66. *Sag.* gen. 309.
Inflammatio veſicæ, *Hoffm.* ii. 157.

202 The Cystitis from *Internal Cauſes.*

Cyſtitis ſpontanea, *Sauv.* ſp. 1.

203 The Cystitis from *External Cauſes.*

Cyſtitis à cantharidibus, *Sauv.* ſp. 2.
Cyſtitis traumatica, *Sauv.* ſp. 3.

The inflammation of the bladder from internal cauſes is a very rare diſtemper; and when it does at any time occur, is to be cured in the ſame manner with other inflammations, avoiding only the uſe of bliſters. When the diſeaſe ariſes from the internal uſe of theſe flies, camphor is recommended, beſides other cooling medicines, and particularly cooling and emollient clyſters.

204 Genus XXI. HYSTERITIS.

Inflammation of the *UTERUS.*

Hyſteritis, *Lin.* 38. *Vog.* 63.
Metritis, *Sauv.* gen. 107. *Sag.* gen. 315.
Inflammatio et febris uterina, *Hoffm.* II. 156.

Deſcription. This diſeaſe is often confounded with that called the *puerperal* or *child-bed fever;* but is eſſentially diſtinct from it, as will be ſhown in its proper place. The inflammation of the uterus is often apt to terminate by gangrene: there is a pain in the head, with dilirium; and the uterine region is ſo exceedingly tender, that it cannot bear the moſt gentle preſſure without intolerable pain. When the *fundus uteri* is inflamed, there is great heat, throbbing, and pain, above the pubes; if its poſterior part, the pain is more confined to the loins and rectum, with a teneſmus; if its anterior part, it ſhoots from thence towards the neck of the bladder, and is attended with a frequent irritation to make water, which is voided with difficulty; and if its ſides or the ovaria are affected, the pains will then dart into the inſide of the thighs.

Cauſes, &c. Inflammations of the uterus, and indeed of the reſt of the abdominal viſcera, are very apt to take place in child-bed women; the reaſon of which ſeems to be the ſudden change produced in the habit, and an alteration in the courſe of the circulating blood by the contraction of the uterus after delivery. The preſſure of the gravid uterus being ſuddenly taken off from the *aorta deſcendens* after delivery, the reſiſtance to the impulſe of the blood paſſing through all the veſſels derived from it, and diſtributed to the contiguous viſcera, will be conſiderably leſſened: it will therefore ruſh into thoſe veſſels with a force ſuperior to their reſiſtance; and, by putting them violently on the ſtretch, may occaſion pain, inflammation, and fever. This contraction of the uterus alſo renders its veſſels impervious to the blood which had freely paſſed through them for the ſervice of the child during pregnancy; and conſequently a much larger quantity will be thrown upon the contiguous parts, which will ſtill add to their diſtention, and increaſe their tendency to inflammation.

Rheumatiſmus.

Prognoſis. An inflammation of the uterus may in general be expected to produce an obſtruction of the lochia; but the fever produced ſeldom proves fatal, unleſs the inflammation be violent, and end in a gangrene.

Cure. This is to be attempted by the ſame general means already recommended, and the management of this diſorder entirely coincides with that of the puerperal fever.

Genus II. RHEUMATISMUS. 205

The *RHEUMATISM.*

Rheumatiſmus, *Sauv.* gen. 185. *Lin.* 62. *Vog.* 138. *Boerh.* 1400. *Junck.* 19.
Dolores rheumatici et arthritici, *Hoffm.* II. 317.
Myoſitis, *Sag.* gen. 301.

The *Acute RHEUMATISM.*

Rheumatiſmus acutus, *Sauv.* ſp. 1.
Rheumatiſmus vulgaris, *Sauv.* ſp. 2.

A. The Lumbago, or *Rheumatiſm in the Muſcles of the Loins.* 206

Lumbago rheumatica, *Sauv.* gen. 212. *Sag.* p. 1.
Nephralgia rheumatica, *Sauv.* ſp. 4.

B. The Sciatica, *Iſchias,* or *Hip-Gout.* 207

Iſchias rheumaticum. *Sauv.* 213. ſp. 10.

C. The *Baſtard PLEURISY,* or *Rheumatiſm in the Muſcles of the Thorax.* 208

Pleurodyne rheumatica, *Sauv.* gen. 148. ſp. 3.
Pleuritis ſpuria, *Boerh.* 878.

The other ſpecies, which are very numerous, are all ſymptomatic; as,
Lumbago plethorica, *Sauv.* ſp. 3.
Iſchias ſanguineum, *Sauv.* ſp. 2.
Pleurodyne plethorica, *Sauv.* ſp. 1.
Rheumatiſmus hyſtericus, *Sauv.* ſp. 7.
Iſchias hyſtericum, *Sauv.* ſp. 3.
Pleurodyne hyſterica, *Sauv.* ſp. 6.
Rheumatiſmus ſaltatorius, *Sauv.* ſp. 8.
Pleurodyne flatulenta, *Sauv.* ſp. 4.
Pleurodyne à ſpaſmate, *Sauv.* ſp. 9.
Rheumatiſmus ſcorbuticus, *Sauv.* ſp. 4.
Lumbago ſcorbutica, *Sauv.* ſp. 5.
Pleurodyne ſcorbutica, *Sauv.* ſp. 11.
Iſchias ſyphiliticum, *Sauv.* ſp. 7.
Pleurodyne venerea, *Sauv.* ſp. 5.
Lumbago ſympathica, *Sauv.* ſp. 13.
Lumbago à ſaburrâ, *Sauv.* ſp. 8.
Pleurodyne à cocochyliâ, *Sauv.* ſp. 7.
Rheumatiſmus ſaltatorius verminoſus, *Sauv.* ſp. 8.
Iſchias verminoſum, *Sauv.* ſp. 8.
Pleurodyne verminoſa, *Sauv.* ſp. 2.
Rheumatiſmus metallicus, *Sauv.* ſp. 10.
Lumbago à hydrothorace, *Sauv* ſp. 14.
Lumbago pſeudoiſchuria, *Sauv.* ſp. 16.
Pleurodyne à rupto œſophago, *Sauv.* ſp. 20.
Pleurodyne rachitica, *Sauv.* ſp. 13.
Iſchias à ſparganoſi, *Sauv.* ſp. 5.
Pleurodyna catarrhalis, *Sauv.* ſp. 14.

Phlegmasiæ.

Rheumatiſmus necroſeos, *Sauv.* ſp. 14.
Rheumatiſmus dorſalis, *Sauv.* ſp. 11.
Lumbago à ſatyriaſi, *Sauv.* ſp. 15.
Rheumatiſmus febricoſus, *Sauv.* ſp. 9.
Lumbago febrilis, *Sauv.* ſp. 4.
&c. &c.

Deſcription. The rheumatiſm is particularly diſtinguiſhed by pains affecting the joints, and for the moſt part the joints alone; but ſometimes alſo the muſcular parts. Very often they ſhoot along the courſe of the muſcles from one joint to another, and are always much increaſed by the action of the muſcles belonging to the joint or joints affected. The larger joints are thoſe moſt frequently affected, ſuch as the hip-joint and knees, of the lower extremities, and the ſhoulders and elbows of the upper ones. The ancles and wriſts are alſo frequently affected; but the ſmaller joints, ſuch as thoſe of the toes or fingers, ſeldom ſuffer. Sometimes the diſeaſe is confined to one part of the body, yet very frequently it affects many parts; and then it begins with a cold ſtage, which is immediately ſucceeded by the other ſymptoms of pyrexia, and particularly by a frequent, full, and hard pulſe. Sometimes the pyrexia is formed before any pains are perceived; but more commonly pains are felt in particular parts before any ſymptoms of fever occur. When no pyrexia is preſent, the pain may be confined to one joint only; but when any conſiderable pyrexia takes place, though the pain may chiefly be felt in one joint, yet it ſeldom happens that it does not affect ſeveral joints, often at the very ſame time, but for the moſt part ſhifting their place, and having abated in one joint they become more violent in another. They do not commonly remain long in the ſame joint, but frequently ſhift from one to another, and ſometimes return to joints formerly affected; and in this manner the diſeaſe often continues for a long time. The fever attending theſe pains has an exacerbation every evening, and is moſt conſiderable during the night, when the pains alſo become more violent; and it is at the ſame time that the pains ſhift their place from one joint to another. Theſe ſeem to be alſo increaſed during the night by the body being covered more cloſely, and kept warmer.

A joint, after having been for ſome time affected with pain, commonly becomes alſo affected with ſome ſwelling and redneſs, which is painful to the touch. It ſeldom happens that a ſwelling coming on does not take off the pain entirely, but it rarely ſecures the joint againſt a return of it. This diſeaſe is commonly attended with more or leſs ſweating, which occurs early, but is ſeldom free or copious, and ſeldom proves critical, though it may give temporary relief of the pain. The urine is high-coloured, and in the beginning without ſediment. This, however, does not prove entirely critical, for the diſeaſe often continues long after ſuch a ſediment has appeared in the urine. The blood is always ſizy. The acute rheumatiſm differs from all other inflammatory diſeaſes, in not being liable to terminate in ſuppuration: this almoſt never happens; but the diſeaſe ſometimes produces effuſions of a tranſparent gelatinous fluid into the ſheaths of the tendons: but if theſe effuſions be frequent, it is certain that the liquor muſt often be abſorbed; for it very ſeldom happens, that conſiderable or permanent tumours have been produced, or ſuch as required to be opened and to have the contained fluid evacuated. Such tumours, however, have ſometimes occurred, and the opening made in them has produced ulcers very difficult to heal.

Rheumatiſmus.

Sometimes rheumatiſm will continue for ſeveral weeks; but it ſeldom proves fatal, and it is rare that the pyrexia continues to be conſiderable for more than two or three weeks. While the pyrexia abates in its violence, if the pains of the joints continue, they are leſs violent; more limited in their place, being confined commonly to one or a few joints only; and are leſs ready to change their place.

It is often a very difficult matter to diſtinguiſh rheumatiſm from gout: but in rheumatiſm there in general occurs much leſs affection of the ſtomach; it affects chiefly the larger joints, and ſeveral of theſe are often affected with ſevere pain at the ſame time: it occurs at an earlier period of life than gout; it is not obſerved to be hereditary; and it can in general be traced to ſome obvious exciting cauſe, particularly to the action of cold.

Cauſes, &c. This diſeaſe is frequent in cold, and more uncommon in warm climates. It appears moſt frequently in autumn and ſpring; leſs frequently in winter, while the froſt is conſtant; and very ſeldom during the heat of ſummer. It may, however, occur at any ſeaſon, if viciſſitudes of heat and cold be for the time frequent. For the moſt part, the acute rheumatiſm ariſes from the application of cold to the body when unuſually warm; or when the cold is applied to one part of the body, whilſt the other parts are kept warm; or laſtly, when the application of the cold is long continued, as when moiſt or wet clothes are applied to any part of the body.—Theſe cauſes may affect perſons of all ages; but the rheumatiſm ſeldom appears either in very young or in elderly perſons, and moſt commonly occurs from the age of puberty to that of 35. Theſe cauſes may alſo affect perſons of any conſtitution, but they moſt commonly affect thoſe of a ſanguine temperament.

With reſpect to the proximate cauſe of rheumatiſm, there have been various opinions. It has been imputed to a peculiar acrimony; of which, however, there is no evidence; and the conſideration of the remote cauſes, the ſymptoms, and cure, render it very improbable. A diſeaſe of a rheumatic nature, however, may be occaſioned by an acrid matter applied to the nerves, as is evident from the toothach, a rheumatic affection generally ariſing from a carious tooth. Pains ariſing from deep-ſeated ſuppurations may alſo reſemble the rheumatiſm; and many caſes have occurred in which ſuch ſuppurations occaſioned pains reſembling the lumbago and iſchias; but from what has been already ſaid, it ſeems improbable that ever any pure rheumatic caſe ſhould end in ſuppuration.

The proximate cauſe of rheumatiſm has by many been ſuppoſed to be a lentor in the fluids obſtructing the veſſels of the part; but in the obſervations formerly made, ſufficient reaſons have been already laid down for rejecting the doctrine of lentor. While we cannot therefore find either evidence or reaſon for ſuppoſing that the rheumatiſm depends on any change in the ſtate of the fluids, we muſt conclude that the proximate cauſe of it is the ſame with that of other inflammations not depending upon a direct ſtimulus.

Rheumatifmus.

In the cafe of rheumatifm, it is fuppofed that the moft common remote caufe of it, that is, cold applied, operates efpecially on the veffels of the joints, thefe being lefs covered by a cellular texture than thofe of the intermediate parts of the limbs. It is farther fuppofed, that the application of cold produces a conftriction of the extreme veffels, and at the fame time an increafe of tone or phlogiftic diathefis in the courfe of them, from which arifes an increafed impetus of the blood, and at the fame time a refiftance to the free paffage of it, and confequently inflammation and pain. It is alfo fuppofed, that the refiftance formed excites the *vis medicatrix* to a further increafe of the impetus of the blood; and to fupport this, a cold ftage arifes, a fpafm is formed, and a pyrexia and phlogiftic diathefis are produced in the whole fyftem.

Hence the caufe of rheumatifm appears to be exactly analogous to that of inflammations depending on an increafed afflux of blood to a part while it is expofed to the action of cold. But there feems to be further in this difeafe fome peculiar affection of the mufcular fibres. Thefe feem to be under fome degree of rigidity; and therefore lefs eafily admit of motion, and are pained upon the exertions of it. This alfo feems to be the affection which gives opportunity to the propagation of pains from one joint to another, and which are moft feverely felt in the extremities terminating in the joints, becaufe beyond thefe the ofcillations are not propagated. This affection of the mufcular fibres explains the manner in which ftrains and fpafms produce rheumatic affections; and, on the whole, fhows, that with an inflammatory affection of the fanguiferous fyftem, there is alfo in rheumatifm a peculiar affection of the mufcular fibres, which has a confiderable fhare in producing the phenomena of the difeafe. And it would even appear, that in what has commonly been called *acute rheumatifm*, in contradiftinction to the chronic, of which we are next to treat, there exifts not only a ftate of active inflammation in the affected parts, but alfo of peculiar irritability; and that this often remains after the inflammation is very much diminifhed or has even entirely ceafed. Hence a renewal of the inflammation and recurrence of the pain take place from very flight caufes; and in the treatment of the difeafe both the ftate of inflammation and irritability muft be had in view.

Cure. For counteracting the ftate of active inflammation, the chief aim of the practitioner muft be to diminifh the general impetus of the circulation, and the impetus at the part particularly affected. For counteracting the ftate of irritability, he muft endeavour to remove the difpofition to increafed action in the veffels; to prevent the action of caufes exciting painful fenfations; and to obviate their influence on the part. The cure therefore requires, in the firft place, an antiphlogiftic regimen, and particularly a total abftinence from animal food, and from all fermented or fpirituous liquors; fubftituting a mild vegetable or milk diet, and the plentiful ufe of foft diluting liquors. On this principle alfo, blood-letting is the chief remedy of acute rheumatifm. The blood is to be drawn in large quantity; and the bleeding is to be repeated in proportion to the frequency, fulnefs, and hardnefs of the pulfe, and the violence of the pain. For the moft part, large and repeated bleedings during the firft days of the difeafe feem to be neceffary, and accordingly have been very much employed; but to this fome bounds are to be fet; for very profufe bleedings occafion a flow recovery, and are ready to produce a chronic rheumatifm.

To avoid that debility of the fyftem which general bleedings are apt to occafion, the urgent fymptom of pain may be often relieved by topical bleedings; and when any fwelling or rednefs has come upon a joint, the pain may very certainly be relieved by this evacuation: but as the pain and continuance of the difeafe feem to depend more upon the phlogiftic diathefis of the whole fyftem than upon the affection of particular parts, fo topical bleedings will not fupply the place of the general bleedings propofed above in moft inftances.

To take off the phlogiftic diathefis prevailing in this difeafe, purging may be ufeful, if procured by medicines which do not ftimulate the whole fyftem, as neutral falts, and other medicines which have a refrigerant power. Purging, however, is not fo ufeful as bleeding in removing the phlogiftic diathefis; and when the difeafe has become general and violent, frequent ftools are inconvenient, and even hurtful, by the motion and pain which they occafion.

Next to blood-letting, nothing is of fo much fervice, both in alleviating the pains in this difeafe and in removing the phlogiftic diathefis, as the ufe of fudorifics: and of all the medicines belonging to this clafs, what has commonly been known by the name of Dover's powder, a combination of powder of ipecacuan and opium, is the moft convenient and the moft effectual. Copious fweating, excited by this medicine, and fupported for 10 or 12 hours by tepid diluents, fuch as decoction of the woods, or the like, will in moft inftances produce a complete remiffion of the pain: and by this practice, combined with blood-letting and proper regimen, the difeafe may often be entirely removed.

If, however, after complete intermiffions from pain for fome length of time have been obtained by thefe means, it be found that there is a great tendency to a return of the pains without any obvious caufe, recourfe may be had with very great benefit to the ufe of the Peruvian bark. By the early ufe of this, where a complete intermiffion from pain is obtained, the neceffity of repeated blood-letting and fweating is often fuperfeded; but where a complete remiffion cannot be obtained, it has been fufpected by fome to be hurtful: and in thefe cafes, when blood-letting and fudorifics have been pufhed as far as may be thought prudent, without being productive of the defired effect, very great benefit is often derived from the ufe of calomel combined with opium, as recommended in the Edinburgh Medical Commentaries, by Dr Hamilton of Lynn Regis.

In this difeafe, external applications are of little fervice. Fomentations in the beginning of the difeafe rather aggravate than relieve the pains. The rubefacients and camphire are more effectual: but they commonly only move them from one part to another, and do not prove any cure of the general affection. Bliftering may alfo be very effectual in removing the pain

pain from a particular part; but will be of little uſe, except where the pains are much confined to one place.

209 ARTHRODYNIA, or *Chronic* RHEUMATISM.

Rheumatiſmus chronicus Auctorum.

Deſcription. When the pyrexia attending the acute rheumatiſm has ceaſed; when the ſwelling and redneſs of the joints are entirely gone, but pains ſtill continue to affect certain joints, which remain ſtiff, feel uneaſy upon motion, changes of weather, or in the night time only, the diſeaſe is then called the *chronic rheumatiſm*, as it often continues for a very long time.

The limits between the acute and chronic rheumatiſms are not always exactly marked. When the pains are ſtill ready to ſhift their place; when they are eſpecially ſevere in the night time; when, at the ſame time, they are attended with ſome degree of pyrexia, and with ſome ſwelling, and eſpecially ſome redneſs of the joints; the diſeaſe is to be conſidered as partaking of the nature of the acute rheumatiſm. But when there is no longer any degree of pyrexia remaining; when the pained joints are without redneſs; when they are cold and ſtiff; when they cannot eaſily be made to ſweat; or when, while a free and warm ſweat is brought out on the reſt of the body, it is only clammy and cold on the pained joints; and when, further, the pains of theſe are increaſed by cold, and relieved by heat, applied to them; the caſe is to be conſidered as that of a purely chronic rheumatiſm: or, perhaps more properly, the firſt of the conditions now deſcribed may be termed the ſtate of irritability, and the ſecond the ſtate of atony.

The chronic rheumatiſm, or rather the atonic, may affect different joints; but is eſpecially apt to affect thoſe which are ſurrounded with many muſcles, and thoſe of which the muſcles are employed in the moſt conſtant and vigorous exertions. Such is the caſe of the vertebræ of the loins, the affection of which is named *lumbago;* or of the hip joint, when the diſeaſe is named *iſchias* or *ſciatica*.

Violent ſtrains and ſpaſms occurring on ſudden and ſomewhat violent exertions, bring on rheumatic affections, which at firſt partake of the acute, but very ſoon change into the nature of the chronic, rheumatiſm.—Such are frequently the lumbago, and other affections, which ſeem to be more ſeated in the muſcles than in the joints. The diſtinction of the rheumatic pains from thoſe reſembling them which occur in the ſiphylis and ſcurvy muſt be obvious, either from the ſeat of the pains, or from the concomitant ſymptoms peculiar to thoſe diſeaſes. The diſtinction of the rheumatiſm from the gout will be more fully underſtood from what is laid down under the genus Podagra.

Cauſes, &c. The phenomena of the purely chronic rheumatiſm lead us to conclude, that its proximate cauſe is an atony both of the blood-veſſels and of the muſcular fibres of the part affected, together with ſuch a degree of rigidity and contraction in the latter as frequently attend them in a ſtate of atony: and indeed this atony, carried to a certain extent, gives riſe to a ſtate of paralyſis, with an almoſt total loſs of motion in the affected limbs. The paralytic ſtate of rheumatiſm therefore may be pointed out as a fourth condition of the diſeaſe, often claiming the attention of the practitioner.

Cure. From the view juſt now given of the proximate cauſe of chronic rheumatiſm, the chief indication of cure muſt be, to reſtore the activity and vigour of the part, which is principally to be done by increaſing the tone of the moving fibres, but which may ſometimes alſo be aided by giving condenſation to the ſimple ſolid. When, however, the diſeaſe has degenerated into the ſtate of paralyſis, the objects to be aimed at are, the reſtoration of a due condition to the nervous energy in the part affected; the obtaining free circulation of blood through the veſſels of the part; and the removal of rigidity in membranes and ligaments.

For anſwering theſe purpoſes, a great variety of remedies, both external and internal, are had recourſe to. The chief of the external are, the ſupporting the heat of the part, by keeping it conſtantly covered with flannel; the increaſing the heat of the part by external heat, applied either in a dry or humid form; the diligent uſe of the fleſh-bruſh, or other means of friction; the application of electricity in ſparks or ſhocks; the application of cold water by affuſion or immerſion; the application of eſſential oils of the moſt warm and penetrating kind; the application of ſalt brine; the employment of the warm bath or of the vapour baths, either to the body in general or to particular parts; and, laſtly, the employment either of exerciſe of the part itſelf as far as it can eaſily bear, or by riding or other modes of geſtation.

The internal remedies are, large doſes of eſſential oils drawn from reſinous ſubſtances, ſuch as turpentine; ſubſtances containing ſuch oils, as guaiac.; volatile alkaline ſalts, &c. Theſe or other medicines are directed to procure ſweat; and calomel, or ſome other preparation of mercury, in ſmall doſes, may be continued for ſome time. But of all the remedies which have been found uſeful in atonic rheumatiſm, perhaps the beſt is cinchona. It is particularly ſerviceable in the earlier periods of the diſeaſe. It has often been highly efficacious in preventing the degeneracy of the inflammatory into the atonic ſtate of the diſeaſe; and by ſome practitioners, particularly Dr Haygarth of Bath, it has been highly extolled in acute rheumatiſm. Beſides theſe, there are ſeveral other remedies recommended. The cicuta, aconitum, and hyoſciamus, have in particular been highly extolled; and an infuſion of the rhododendron chryſanthum is ſaid to be employed by the Siberians with very great ſucceſs. An account of the Siberian mode of practice is given by Dr Matthew Guthrie of Peterſburgh, in the fifth volume of the Edinburgh Medical Commentaries, and has been followed with ſucceſs at other places. Among other internal remedies for rheumatiſm, the uſe of arſenic has of late been recommended by Dr Bardſley of Liverpool. It is adviſed to be given under the form of the mineral ſolution propoſed by Dr Fowler as a remedy in intermittent fever and in periodic headachs. Under this form, it is now aſcertained by extenſive experience that arſenic may be taken internally with as much ſafety as any other active medicine; and in ſome caſes of rheumatiſm in which it has been employed at Edinburgh, there is reaſon to believe that it has been productive of benefit.

Phlegmasiæ. Podagra.

Genus XXIII. ODONTALGIA, the Toothach.

210 Odontalgia, *Sauv.* gen. 198. *Lin.* 45. *Vog.* 145. *Sag.* gen. 159. *Junck.* 25.
Odontalgia sive rheumatismus odontalgicus, *Hoffm.* II. 330.
Odontalgia cariosa, *Sauv.* sp. 1.
Odontalgia scorbutica, *Sauv.* sp. 4.
Odontalgia catarrhalis, *Sauv.* sp. 3.
Odontalgia arthritica, *Sauv.* sp. 6.
Odontalgia gravidarum, *Sauv.* sp. 2.
Odontalgia hysterica, *Sauv.* sp. 8.
Odontalgia stomachica, *Sauv.* sp. 9.

Description. This well-known disease makes its attack by a most violent pain in the teeth, most frequently in the *molares*, more rarely in the *incisores*, reaching sometimes up to the eyes, and sometimes backward into the cavity of the ear. At the same time there is a manifest determination to the head; and a remarkable tension and inflation of the vessels takes place, not only in the parts next to that where the pain is seated, but over the whole head.

Causes, &c. The toothach is sometimes merely a rheumatic affection, arising from cold, but more frequently from a carious tooth. It is also a symptom of pregnancy, and takes place in some nervous disorders; it may attack persons at any time of life, though it is most frequent in the young and plethoric.

Cure. Many empirical remedies have been proposed for the cure of the toothach, but none have in any degree answered the purpose. When the affection is purely rheumatic, blistering behind the ear will almost always remove it; but when it proceeds from a carious tooth, the pain is much more obstinate. In this case it has been recommended to touch the pained part with a hot iron, or with sulphuric acid, in order to destroy the aching nerve; to hold strong spirits in the mouth; to put a drop of oil of cloves into the hollow of the tooth, or a pill of equal parts of opium and camphor: but one of the most useful applications of this kind is strong nitrous acid, diluted with three or four times its weight of spirit of wine, and introduced into the hollow of a tooth from which great pain arises, either by means of a hair pencil or a little cotton. Cinchona has also been recommended, and perhaps with more justice, on account of its tonic and antiseptic powers; but very often all these remedies will fail, and the only infallible cure is the extraction of the tooth. See SURGERY.

211 Genus XXIV. PODAGRA, the Gout.

Podagra, *Vog.* 175. *Boerh.* 1254.
Febris podagrica, *Vog.* 69.
Arthritis, *Sauv.* gen. 183. *Lin.* 60. *Vog.* 139. *Sag.* gen. 142.
Dolor podagricus et arthriticus verus, *Hoffm.* II. 339.
Dolores arthritici, *Hoffm.* II. 317.
Affectus spastico-arthritici, *Junck.* 46.

212 Sp. I. The *Regular* Gout.

Arthritis podagrica, *Sauv.* sp. 1.
Arthritis rachialgica, *Sauv.* sp. 11.
Arthritis æstiva, *Sauv.* sp. 4.

Sp. II. The *Atonic* Gout. 213

Arthritis melancholica, *Sauv.* sp. 6.
Arthritis hiemalis, *Sauv.* sp. 2.
Arthritis chlorotica, *Sauv.* sp. 5.
Arthritis asthmatica, *Sauv.* sp. 9.

Sp. III. The *Retrocedent* Gout. 214

Sp. IV. The *Misplaced* Gout. 215

Description. What we call a *paroxysm of the gout* is principally constituted by an inflammatory affection of some of the joints. This sometimes comes on suddenly, without any warning, but is generally preceded by several symptoms; such as the ceasing of a sweating which the feet had been commonly before affected with; an unusual coldness of the feet and legs; a frequent numbness, alternating with a sense of prickling along the whole of the lower extremities; frequent cramps of the muscles of the legs; and an unusual turgescence of the veins.

While these symptoms take place in the lower extremities, the body is affected with some degree of torpor and languor, and the functions of the stomach in particular are more or less disturbed. The appetite is diminished; and flatulency, or other symptoms of indigestion, are felt. These symptoms take place for several days, sometimes for a week or two, before a paroxysm comes on; but commonly, upon the day immediately preceding it, the appetite becomes keener than usual.

The circumstances of paroxysms are chiefly the following. They come on most commonly in the spring, and sooner or later according as the vernal heat succeeds sooner or latter to the winter's cold, and, perhaps, sooner or later also, according as the body may happen to be more or less exposed to vicissitudes of heat and cold.

The attacks are sometimes felt first in the evening, but more commonly about two or three o'clock in the morning. The paroxysm begins with a pain affecting one foot, most frequently in the ball or first joint of the great toe, but sometimes in other parts of the foot. With the attack of this pain, there is commonly more or less of a cold shivering; which, as the pain increases, gradually ceases; and is succeeded by a hot stage of pyrexia, which continues for the same time with the pain itself. From the first attack, the pain becomes, by degrees, more violent, and continues in this state with great restlessness of the whole body till next midnight, after which it gradually remits; and, after it has continued for twenty-four hours from the commencement of the first attack, it commonly ceases almost entirely; and, with the coming on of a gentle sweat, allows the patient to fall asleep. The patient, upon coming out of this sleep in the morning, finds the pained part affected with some redness and swelling, which, after having continued for some days, gradually abate.

When a paroxysm has thus come on, although the violent pain after 24 hours be considerably abated, the patient is not entirely relieved from it. For some days

Phlegmasiæ. days he has every evening a return of more considerable pain and pyrexia, and these continue with more or less violence till morning. After going on, in this manner, for several days, the disease sometimes goes entirely off, not to return till after a long interval.

When the disease, after having thus remained for some time in a joint, ceases entirely, it generally leaves the person in very perfect health, enjoying greater ease and alacrity in the functions of both body and mind than he had for a long time before experienced.

At the beginning of the disease, the returns of it are sometimes only once in three or four years: but as it advances, the intervals become shorter, and at length the attacks are annual; afterwards they come twice each year; and at length recur several times during the course of autumn, winter, and spring; and as, when the fits are frequent, the paroxysms become also longer, so, in the advanced state of the disease, the patient is hardly ever tolerably free from it, except perhaps for two or three months in summer.

The progress of the disease is also marked by the parts which it affects. At first, it commonly affects one foot only; afterwards every paroxysm affects both feet, the one after the other; and as the disease proceeds, it not only affects both feet at once, but, after having ceased in the foot which was last attacked, returns again into the first, and perhaps a second time also into the other. Its changes of places are not only from one foot to another, but from the feet into other joints, especially those of the upper extremities; so that there is hardly a joint of the body which, on one occasion or another, is not affected. It sometimes affects two different joints at the very same time; but more commonly it is at any one time severe in a single joint only, and passes in succession from one joint to another; so that the patient's affliction is often protracted for a long time.

When the disease has often returned, and the paroxysms have become very frequent, the pains are commonly less violent than they were at first; but the patient is more affected with sickness, and the other symptoms of the atonic gout, which shall be hereafter mentioned.

After the first paroxysm of the disease, the joints which have been affected are entirely restored to their former suppleness and strength: but after the disease has recurred very often, the joints affected do neither so suddenly nor entirely recover their former state, but continue weak and stiff; and these effects at length proceed to such a degree, that the joints lose their motion entirely.

In many persons, but not in all, after the disease has frequently recurred, concretions of a chalky nature are formed upon the outside of the joints, and for the most part immediately under the skin. The matter seems to be deposited at first in a fluid form, afterwards becoming dry and firm. In their firm state, these concretions are a hard earthy substance, very entirely soluble in acids. After they have been formed, they contribute, with other circumstances, to destroy the motion of the joints.

In most persons who have laboured under the gout for many years, a nephritic affection comes on, and discovers itself by all the symptoms which usually attend calculous concretions in the kidneys, and which we shall have occasion to describe in another place. All that is necessary to be observed here is, that the nephritic affection alternates with paroxysms of the gout; and that the two affections, the nephritic and the gouty, are hardly ever present at the same time. This also may be observed, that children of gouty or nephritic parents commonly inherit one or other of these diseases; but whether the principal disease of the parent may have been either gout or nephritis alone, some of the children have the one and some the other. In some of them the nephritic affection occurs alone, without any gout supervening; and this happens to be frequently the case with the female children of gouty parents.

Podagra. In the whole of the history already given, we have described the most common form of the disease, and which therefore, however diversified in the progress of it, may be still called the regular state of the gout.—Upon some occasions, however, the disease assumes different appearances: but as we suppose the disease to depend always upon a certain diathesis, or disposition of the system; so every appearance which we can perceive to depend upon that same disposition, we still consider as symptomatic, and view the disease to be a case of the gout. The principal circumstance, in what we term the *regular gout*, is the inflammatory affection of the joints; and whatever symptoms we can perceive to be connected with, or to depend upon, the disposition which produces that inflammatory affection, but without its taking place or being present at the same time, we name the *irregular gout*.

Of such irregular gout there are three different states, which may be named the *atonic*, the *retrocedent*, and the *misplaced* gout.

The first is, when the gouty diathesis prevails in the system; but, from certain causes, does not produce the inflammatory affection of the joints. In this case, the morbid symptoms which appear, are chiefly affections of the stomach, such as loss of appetite, indigestion, and its various attendants of sickness, nausea, vomiting, flatulency, acid eructations, and pains in the region of the stomach. These symptoms are frequently accompanied with pains and cramps in several parts of the trunk and the upper extremities of the body, which are relieved by the discharge of wind from the stomach. Together with these affections of the stomach, there commonly occurs a costiveness; but sometimes a looseness, with colic pains. These affections of the alimentary canal are often attended with all the symptoms of hypochondriasis, such as dejection of mind, a constant and anxious attention to the slightest feelings, an imaginary aggravation of these, and an apprehension of danger from them.

In the same atonic gout, the viscera of the thorax also are sometimes affected, and palpitations, faintings, and asthma occur.

In the head also occur headachs, giddiness, apoplectic and paralytic affections.

When the several symptoms now mentioned occur in habits having the marks of a gouty disposition, this may be suspected to have laid the foundation for them; and especially when either, in such habits, a manifest tendency to the inflammatory affection has formerly appeared, or when the symptoms mentioned are

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are intermixed with, and are relieved by some degree of the inflammatory gout. In such cases there can be no doubt of considering the whole as a state of the gout.

Another state of the disease we name the *retrocedent* gout. This occurs when an inflammatory state of the joints has, in the usual manner, come on, but without arising to the ordinary degree of pain and inflammation; or at least without these continuing for the usual time, or without their receding gradually in the usual manner; these affections of the joints suddenly and entirely cease, while some internal part becomes affected. The internal part most commonly attacked is the stomach; which then is affected with anxiety, sickness, vomiting, or violent pain: but sometimes the internal part is the heart, which gives occasion to a syncope; sometimes it is the lungs, which are affected with asthma; and sometimes it is the head, giving occasion to apoplexy or palsy. In all these cases there can be no doubt that the symptoms are all a part of the same disease, however different the affection may seem to be in the parts which it attacks.

The third state of irregular gout, which we name the *misplaced*, is when the gouty diathesis, instead of producing the inflammatory affection of the joints, produces an inflammatory affection of some internal part, and which appears from the same symptoms that attend the inflammations of those parts arising from other causes.

Whether the gouty diathesis does ever produce such inflammation of the internal parts without having first produced it in the joints, or whether the inflammation of the internal part be always a translation from the joints previously affected, we dare not determine; but, even supposing the latter to be always the case, we think the difference of the affection of the internal part must still distinguish the *misplaced* from what we have named the *retrocedent gout*.

With regard to the misplaced gout, Dr Cullen, whom we here follow, tells us, that he never met with any cases of it in his practice, nor does he find any distinctly marked by practical writers, except that of a pneumonic inflammation.

There are two cases of a translated gout; the one of which is an affection of the neck of the bladder, producing pain, strangury, and a *catarrhus vesicæ*: the other is an affection of the rectum, sometimes indicated by pain alone in that part, and sometimes by hæmorrhoidal symptoms. In gouty persons such affections have been known to alternate with inflammatory affections of the joints; but whether these belong to the retrocedent or to the misplaced gout, Dr Cullen pretends not to determine.

It is commonly supposed, that there are some cases of rheumatism which are scarcely to be distinguished from the gout; but these, Dr Cullen thinks, are but few; and that the two diseases may be for the most part distinguished with great certainty, by observing the predisposition, the antecedent circumstances, the parts affected, the recurrences of the disease, and its connection with the system; which circumstances, for the most part, appear very differently in the two diseases.

Causes, &c. The gout is generally an hereditary disease: but some persons, without any hereditary disposition, seem to acquire it; and in some an hereditary disposition may be counteracted from various causes. It attacks the male sex especially; but it sometimes, though more rarely, attacks also the female. The females liable to it are those of the more robust and full habits; and it very often happens to those before the menstrual evacuation has ceased. Dr Cullen hath also found it occurring in several females whose menstrual evacuations were more abundant than usual.

The gout seldom attacks eunuchs; and when it does, seems to fall upon those who happen to be of a robust habit, to lead an indolent life, and to live very full. It attacks especially men of robust and large bodies, who have large heads, are of full and corpulent habits, and whose skins are covered with a thick *rete mucosum*, which gives a coarse surface. To speak in the style of the ancient physicians, the gout will seldom be found to attack those of a sanguine, or such as are of a purely melancholic temperament; but very readily those of a *cholerico-sanguine* temperament. It is, however, very difficult to treat this matter with precision. The gout seldom attacks persons employed in constant bodily labour, or those who live much upon vegetable aliment. It does not commonly attack men till after the age of 35; and generally not till a still later period. There are indeed instances of the gout appearing more early; but these are few in comparison of the others. When the disease does appear early in life, it seems to be in those who have the hereditary disposition very strong, and to whom the remote causes hereafter mentioned have been applied in a very considerable degree.

As the gout is an hereditary disease, and affects men particularly of a certain habit, its remote causes may be considered as predisponent and occasional. The predisponent cause, as far as expressed by external appearances, has been already marked; and physicians have been very confident in assigning the occasional causes: but in a disease depending so much upon a predisposition, the assigning occasional causes must be uncertain; as in the predisposed the occasional causes may not always appear, and in persons not predisposed they may appear without effect; and this uncertainty must particularly affect the case of the gout.

The occasional causes of the disease seem to be of two kinds. First, Those which induce a plethoric state of the body. Secondly, Those which in plethoric habits, induce a state of debility. Of the first kind are a sedentary, indolent manner of life, and a full diet of animal food. Of the second kind of occasional causes which induce debility are excess in venery; intemperance in the use of intoxicating liquors; indigestion, produced either by the quantity or quality of the aliments; much application to study or business, night watching, excessive evacuations; the ceasing of usual labour; a sudden change from a very full to a very spare diet; the large use of acids and acescents; and, lastly, cold applied to the lower extremities. The former seem to act by increasing the predisposition; the latter are commonly the exciting causes, both of the first attacks, and of the repetitions of the disease.

With respect to the proximate cause of the gout, it has generally been thought that it depends on a certain

tain morbific matter always preſent in the body; and that this matter, by certain cauſes, thrown upon the joints or other parts, produces the ſeveral phenomena of the diſeaſe.

This doctrine, however ancient and generally received, appears to Dr Cullen to be very doubtful. For,

Firſt, There is no direct evidence of any morbific matter being preſent in perſons diſpoſed to the gout. There are no experiments or obſervations which ſhow that the blood or other humours of gouty perſons are in any reſpect different from thoſe of the ſound. Previous to attacks of the gout, there appear no marks of any morbid ſtate of the fluids; for the diſeaſe generally attacks thoſe perſons who have enjoyed the moſt perfect health, and appear to be in that ſtate when the diſeaſe comes on. At a certain period of the diſeaſe, a peculiar matter indeed appears in gouty perſons; but this, which does not appear in every inſtance, and which appears only after the diſeaſe has ſubſiſted for a long time, ſeems manifeſtly to be the effect, not the cauſe, of the diſeaſe. Further, Though there be certain acrids which, taken into the body, ſeem to excite the gout, it is probable that theſe acrids operate otherwiſe in exciting the diſeaſe, than by affording the material cauſe of it. In general, therefore, Dr Cullen thinks there is no proof of any morbific matter being the cauſe of the gout.

Secondly, The ſuppoſitions concerning the particular nature of the matter producing the gout, have been ſo various, and ſo contradictory, as to allow us to conclude, that there is truly no proof of the exiſtence of any of them. With reſpect to many of theſe ſuppoſitions, they are ſo inconſiſtent with chemical philoſophy, and with the laws of the animal economy, that they muſt be entirely rejected.

Thirdly, The ſuppoſition of a morbific matter as the cauſe, is not conſiſtent with the phenomena of the diſeaſe, particularly with its frequent and ſudden tranſlations from one part to another.

Fourthly, The ſuppoſition is further rendered improbable by this, that if a morbific matter did exiſt, its operation ſhould be ſimilar in the ſeveral parts which it attacks: whereas it ſeems to be very different, being ſtimulant, and exciting inflammation, in the joints; but ſedative and deſtroying tone in the ſtomach; which, upon the ſuppoſition of the ſame particular matter acting in both caſes, is not to be explained by any difference in the part affected.

Fifthly, Some facts alleged in proof of a morbific matter, are not confirmed; ſuch as thoſe which would prove the diſeaſe to be contagious. There is, however, no proper evidence of this, the facts given being not only few, but exceptionable, and the negative obſervations innumerable.

Sixthly, Some arguments brought in favour of a morbific matter are founded upon a miſtaken explanation. The diſeaſe has been ſuppoſed to depend upon a morbific matter, becauſe it is hereditary. But the inference is not juſt: for moſt hereditary diſeaſes do not depend upon any morbific matter, but upon a particular conformation of the ſtructure of the body tranſmitted from the parent to the offspring; and this laſt appears to be particularly the caſe in the gout. It may be alſo obſerved, that hereditary diſeaſes depending upon a morbific matter, appear always much more early in life than the gout commonly does.

Seventhly, The ſuppoſition of a morbific matter being the cauſe of the gout, has been hitherto uſeleſs, as it has not ſuggeſted any ſucceſsful method of cure. Particular theories of gout have often corrupted the practice, and have frequently led from thoſe views which might have been uſeful, and from that practice which experience had approved. Further, Though the ſuppoſition of a morbific matter has been generally received, it has been as generally neglected in practice. When the gout has affected the ſtomach, nobody thinks of correcting the matter ſuppoſed to be preſent there, but merely of reſtoring the tone of the moving fibres.

Eighthly, The ſuppoſition of a morbific matter is quite ſuperfluous: for it explains nothing, without ſuppoſing that matter to produce a change in the ſtate of the moving powers; and a change in the ſtate of the moving powers, produced by other cauſes, explains every circumſtance without the ſuppoſition of a morbific matter; and it may be obſerved, that many of the cauſes exciting the gout, do not operate upon the ſtate of the fluids, but directly and ſolely upon that of the moving powers.

Laſtly, Dr Cullen contends that the ſuppoſition of a morbific matter is ſuperfluous; becauſe, without that, the diſeaſe can be explained, he thinks, in a manner more conſiſtent with its phenomena, with the laws of the animal economy, and with the method of cure which experience has approved. We now proceed to give this explanation; but, before entering upon it, we muſt premiſe ſome general obſervations which Dr Cullen ſtates.

The firſt obſervation is, That the gout is a diſeaſe of the whole ſyſtem, or depends upon a certain general conformation and ſtate of the body, which manifeſtly appears from the facts above mentioned. But the general ſtate of the ſyſtem depends chiefly upon the ſtate of its primary moving powers; and therefore the gout may be ſuppoſed to be an affection of theſe.

The ſecond obſervation is, That the gout is manifeſtly an affection of the nervous ſyſtem; in which the primary moving powers of the whole ſyſtem are lodged. The occaſional or exciting cauſes are almoſt all ſuch as act directly upon the nerves and nervous ſyſtem; and the greater part of the ſymptoms of the atonic or retrocedent gout are manifeſtly affections of the ſame ſyſtem. This leads us to ſeek for an explanation of the whole of the diſeaſe, in the laws of the nervous ſyſtem, and particularly in the changes which may happen in the balance of its ſeveral parts.

The third obſervation is, That the ſtomach, which has ſo univerſal a conſent with the reſt of the ſyſtem, is the internal part that is the moſt frequently, and often very conſiderably, affected by the gout. The paroxyſms of the diſeaſe are commonly preceded by an affection of the ſtomach; many of the exciting cauſes act firſt upon the ſtomach; and the ſymptoms of the atonic and retrocedent gout are moſt commonly and chiefly affections of the ſame organ. This obſervation leads us to remark, that there is a balance ſubſiſting between the ſtate of the internal and that of the external parts; and, in particular, that the ſtate of the ſtomach is connected with that of the external parts, ſo that the

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ſtate of tone in the one may be communicated to the other.

Theſe obſervations being premiſed, Dr Cullen offers the following pathology of the gout.

In ſome perſons there is a certain vigorous and plethoric ſtate of the ſyſtem, which at a certain period of life is liable to a loſs of tone in the extremities. This is in ſome meaſure communicated to the whole ſyſtem, but appears more eſpecially in the functions of the ſtomach. When this loſs of tone occurs while the energy of the brain ſtill retains its vigour, the *vis medicatrix naturæ* is excited to reſtore the tone of the parts; and accompliſhes it, by exciting an inflammatory affection in ſome part of the extremities. When this has ſubſiſted for ſome days, the tone of the extremities and of the whole ſyſtem is reſtored, and the patient returns to his ordinary ſtate of health.

This is the courſe of things in the ordinary form of the diſeaſe, which we name the *regular gout;* but there are circumſtances of the body, in which this courſe is interrupted or varied. Thus, when the atony has taken place, if the reaction do not ſucceed, the atony continues in the ſtomach, or perhaps in other internal parts; and produces that ſtate which Dr Cullen, for reaſons now obvious, named the *atonic gout.*

A ſecond caſe of variation in the courſe of the gout is, when to the atony the reaction and inflammation have to a certain degree ſucceeded, but from cauſes either internal or external the tone of the extremities and perhaps of the whole ſyſtem is weakened; ſo that the inflammatory ſtate, before it had either proceeded to the degree, or continued for the time, requiſite for reſtoring the tone of the ſyſtem, ſuddenly and entirely ceaſes: whence the ſtomach, and other internal parts, relapſe into the ſtate of atony; and perhaps have that increaſed by the atony communicated from the extremities: all which appears in what has been termed the *retrocedent ſtate of the gout.*

A third caſe of variation from the ordinary courſe of the gout, is, when to the atony, uſually preceding, an inflammatory reaction fully ſucceeds, but has its uſual determination to the joints prevented by ſome circumſtances; and is therefore directed to ſome internal part, where it produces an inflammatory affection, and that ſtate of things which we have named the *miſplaced gout.*

Though this theory of Dr Cullen's be ſupported with much ingenuity, yet we may confidently venture to aſſert, that on this ſubject he has been leſs ſucceſsful in eſtabliſhing his own opinions, than in combating thoſe of others; and this theory, as well as others formerly propoſed, is liable to numerous and unſurmountable objections. According to the hypotheſis, a vigorous and plethoric habit ſhould in every caſe exiſt prior to the appearance of gout; which is by no means conſiſtent with fact: nor is it true that a vigorous and plethoric habit is liable at a certain age to a loſs of tone in the extremities; which is another neceſſary condition in the hypotheſis. Loſs of tone often occurs in the extremities without exerting any peculiar influence on the ſtomach; and why a loſs of tone in the ſtomach ſhould excite the *vis medicatrix naturæ* to reſtore it, by exciting an inflammatory affection in ſome part of the extremities, is very inconceivable. Were the hypotheſis true, every dyſpeptic patient ſhould infallibly be affected with gout; which however, is by no means the caſe. In ſhort, every ſtep in the theory is liable to unſurmountable objections; and it by no means, any more than former hypotheſes, explains the phenomena of the diſeaſe, particularly what Dr Cullen has himſelf ſo accurately pointed out, the connection of gouty with calculous complaints.

A very ingenious work has lately been publiſhed by an anonymous author, entitled "A Treatiſe on Gravel and upon Gout;" in which the ſources of each are inveſtigated, and effectual means of preventing or removing theſe diſeaſes recommended. In this treatiſe an attempt is made to prove, that both diſeaſes depend upon a peculiar concreting acid, the acid of calculi, or the *lithic* or *uric acid,* as it has been ſtyled by ſome. He ſuppoſes this acid, conſtantly preſent to a certain degree in the circulating fluids, to be precipitated by the introduction of other acids; and in this manner he explains the influence of acid wines and other liquors, as claret, cyder, &c. inducing gout; for he conſiders the circumſtance chiefly conſtituting the diſeaſe as being an inflammation in parts of which the functions have been interrupted by the redundant acid precipitated. Although this theory be ſupported with much ingenuity, yet it is alſo liable to many objections. The ſudden attack of the affection; its ſudden tranſition from one part of the body to another; the inſtant relief of one part when another comes to be affected; and the various anomalous forms which the diſeaſe puts on, having an exact reſemblance to different affections; are altogether irreconcileable to the idea of its depending on any fixed obſtruction at a particular part ariſing from concreting acid. Nor does the plan of prevention and cure which he propoſes, and which conſiſts chiefly in abſtinence from acid, and in the deſtruction of acid, by any means correſpond in every particular to the beſt eſtabliſhed facts reſpecting the treatment of gout; to which we next proceed.

Cure. In entering upon this, we muſt obſerve, in the firſt place, that a cure has been commonly thought impoſſible; and we acknowledge it to be very probable, that the gout, as a diſeaſe of the whole habit, and very often depending upon original conformation, cannot be cured by medicines, the effects of which are always very tranſitory, and ſeldom extend to the producing any conſiderable change of the whole habit.

It would perhaps have been happy for gouty perſons if this opinion had been implicitly received by them; as it would have prevented their having been ſo often the dupes of ſelf-intereſted pretenders, who have either amuſed them with inert medicines, or have raſhly employed thoſe of the moſt pernicious tendency. Dr Cullen, who has treated of the cure of the diſeaſe with great judgment, as he has done the theory with much ingenuity, is much diſpoſed to believe the impoſſibility of the cure of the gout by medicines; and more certainly ſtill inclined to think, that, whatever may be the poſſible power of medicines, yet no medicine for curing the gout has hitherto been found. Although almoſt every age has preſented a new remedy, all hitherto offered have, very ſoon after, been either neglected as uſeleſs, or condemned as pernicious.

But though unwilling to admit the power of medicines, yet he contends, that a great deal can be done towards

Phlegmasiæ. towards the cure of the gout by a regimen: and he is firmly perſuaded, that any man who, early in life, will enter upon the conſtant practice of bodily labour, and of abſtinence from animal food, will be preſerved entirely from the diſeaſe.

Whether there be any other means of radically curing the gout, the Doctor is not able to ſay. There are hiſtories of caſes of the gout, in which it is ſaid, that by great emotions of mind, by wounds, and by other accidents, the ſymptoms have been ſuddenly relieved, and never again returned; but how far theſe accidental cures might be imitated by art, or would ſucceed in other caſes, is at leaſt extremely uncertain.

The practices proper and neceſſary in the treatment of the gout, are to be conſidered under two heads: *Firſt*, As they are to be employed in the intervals of paroxyſms; or, *ſecondly*, As during the time of theſe. In the intervals of paroxyſms, the indications are, to prevent altogether the return of paroxyſms; or at leaſt to render them leſs frequent and more moderate. During the time of paroxyſms, the indications are, to moderate the violence and ſhorten the duration of them as much as can be done with ſafety.

It has been already obſerved, that the gout may be entirely prevented by conſtant bodily exerciſe, and by a low diet; and Dr Cullen is of opinion, that this prevention may take place even in perſons who have a hereditary diſpoſition to the diſeaſe. Even when the diſpoſition has diſcovered itſelf by ſeveral paroxyſms of inflammatory gout, he is perſuaded that labour and abſtinence will abſolutely prevent any returns of it for the reſt of life. Theſe, therefore, are the means of anſwering the firſt indication to be purſued in the intervals of paroxyſms.

Exerciſe in perſons expoſed to the gout, in Dr Cullen's opinion, operates by anſwering two purpoſes: One of theſe is the ſtrengthening of the tone of the extreme veſſels; and the other, the guarding againſt a plethoric ſtate. For the former, if exerciſe be employed early in life, and before intemperance has weakened the body, a very moderate degree of it will anſwer the purpoſe; and, for the latter, if abſtinence be at the ſame time obſerved, leſs exerciſe will be neceſſary.

With reſpect to exerciſe, this in general is to be obſerved, that it ſhould never be violent; for if violent, it cannot be long continued, and muſt always endanger the bringing on an atony in proportion to the violence of the preceding motions.

It is alſo to be obſerved, that the exerciſe of geſtation, though conſiderable and conſtant, will not, if it be entirely without bodily exerciſe, anſwer the purpoſe of preventing the gout. For this end, therefore, the exerciſe muſt be in ſome meaſure that of the body; and muſt be moderate, but at the ſame time conſtant and continued through life.

In every caſe and circumſtance of the gout in which the patient retains the uſe of his limbs, bodily exerciſe, in the intervals of paroxyſms, will be always uſeful; and in the beginning of the diſeaſe, when the diſpoſition to it is not yet ſtrong, exerciſe may prevent a paroxyſm which otherwiſe would have come on. In more advanced ſtates of the diſeaſe, however, when there is ſome diſpoſition to a paroxyſm, much walking

Podagra. will bring it on; either as it weakens the tone of the lower extremities, or as it excites an inflammatory diſpoſition in them; and thus it ſeems to be that ſprains or contuſions often bring on a paroxyſm of the gout.

Abſtinence, the other part of the regimen for preventing the gout, is of more difficult application. If an abſtinence from animal food be entered upon early in life, while the vigour of the ſyſtem is yet entire, Dr Cullen has no doubt of its being both ſafe and effectual; but if the motive for this diet ſhall not have occurred till the conſtitution has been broken by intemperance, or by the decline of life, a low diet may then endanger the induction of an atonic ſtate.

Further, If a low diet be entered upon only in the decline of life, and be at the ſame time a very great change from the former manner of living, the withdrawing of an accuſtomed ſtimulus of the ſyſtem may readily throw it into an atonic ſtate.

The ſafety of an abſtemious courſe will be greater or leſs according to the management of it. Animal food eſpecially diſpoſes to the plethoric and inflammatory ſtate, and that food is to be therefore eſpecially avoided; but on the other hand, vegetable aliment of the loweſt quality is in danger of weakening the ſyſtem too much by not affording ſufficient nouriſhment, and more particularly of weakening the tone of the ſtomach by its aceſcency. It is therefore a diet of a middle nature that is to be choſen; and milk is preciſely of this kind, as containing both animal and vegetable matter.

As approaching to the nature of milk, and as being a vegetable matter containing the greateſt portion of nouriſhment, the farinaceous ſeeds are next to be choſen, and are the food moſt proper to be joined with milk.

With reſpect to drink, fermented liquors are uſeful only when they are joined with animal food, and that by their aceſcency; and their ſtimulus is only neceſſary from cuſtom. When, therefore, animal food is to be avoided, fermented liquors are unneceſſary; and by increaſing the aceſcency of vegetables, theſe liquors may be hurtful. The ſtimulus of fermented or ſpirituous liquors is not neceſſary to the young and vigorous, and when much employed impairs the tone of the ſyſtem. Theſe liquors, therefore, are to be avoided, excepting as cuſtom and the declining ſtate of the ſyſtem may have rendered them neceſſary. For preventing or moderating the regular gout, water is the only proper drink.

With reſpect to an abſtemious courſe, it has been ſuppoſed, that an abſtinence from animal food and fermented liquors, or the living upon milk and farinacea alone for the ſpace of one year, might be ſufficient for a radical cure of the gout: and it is poſſible that, at a certain period of life, in certain circumſtances of the conſtitution, ſuch a meaſure might anſwer the purpoſe. But this is very doubtful: and it is more probable, that the abſtinence muſt, in a great meaſure, be continued, and the milk diet be perſiſted in, for the remainder of life. It is well known, that ſeveral perſons who had entered on an abſtemious courſe, and had been thereby delivered from the gout, have, however, upon returning to their former manner of full living, had the diſeaſe return upon them with as much violence

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violence as before, or in a more irregular and more dangerous form.

It has been alleged, that, for preventing the return of the gout, blood-letting or ſcarifications of the feet, frequently repeated, and at ſtated times, may be practiſed with advantage; but of this Dr Cullen tells us he has had no experience; and the benefit of the practice is not, as far as we know, confirmed by the obſervation of any other practitioner.

Exerciſe and abſtinence are the means of avoiding the plethoric ſtate which gives the diſpoſition to the gout; and are therefore the means propoſed for preventing the paroxyſms, or at leaſt for rendering them leſs frequent and more moderate. But many circumſtances prevent the ſteadineſs neceſſary in purſuing theſe meaſures; and therefore in ſuch caſes, unleſs great care be taken to avoid the exciting cauſes, the diſeaſe may frequently return, and, in many caſes, the preventing of paroxyſms is chiefly to be obtained by avoiding thoſe exciting cauſes already enumerated.

A due attention in avoiding theſe different cauſes will certainly prevent fits of the gout; and the taking care that the exciting cauſes be never applied in a great degree, will certainly render fits more moderate when they do come on. But, upon the whole, it will appear, that a very ſtrict attention to the general conduct of life is in this matter neceſſary; and therefore, when the prediſpoſition has taken place, it will be extremely difficult to avoid the diſeaſe.

Dr Cullen is firmly perſuaded, that by obviating the prediſpoſition, and by avoiding the exciting cauſes, the gout may be entirely prevented: but, as the meaſures neceſſary for this purpoſe will, in moſt caſes, be purſued with difficulty, and even with reluctance, men have been very deſirous to find a medicine which might anſwer the purpoſe without any reſtraint on their manner of living. To gratify this deſire, phyſicians have propoſed, and, to take advantage of it, empirics have feigned, many remedies. Of what nature ſeveral of theſe remedies have been, it is difficult to ſay: but of thoſe which are unknown, we conclude, from their having been only of temporary fame, and from their having ſoon fallen into neglect, that they have been either inert or pernicious. We ſhall therefore make no inquiry after them; and ſhall now remark only upon one or two known remedies for the gout which have been lately faſhionable.

One of theſe is what has been named in England the *Portland powder*. This is not a new medicine, but is mentioned by Galen, and, with ſome little variation in its compoſition, has been mentioned by the writers of almoſt every age ſince that time. It appears to have been at times in faſhion, and to have again fallen into neglect; and Dr Cullen thinks that this laſt has been owing to its having been found to be, in many inſtances, pernicious. In every inſtance which he has known of its exhibition for the length of time preſcribed, the perſons who had taken it were indeed afterwards free from any inflammatory affection of the joints; but they were affected with many ſymptoms of the atonic gout; and many, ſoon after finiſhing their courſe of the medicine, have been attacked with apoplexy, aſthma, or dropſy, which proved fatal.

Another remedy which has had the appearance of preventing the gout, is alkali in various forms; ſuch as the fixed alkali, both mild and cauſtic, lime water, ſoap, and abſorbent earths; and of late the alkaline aërated water has been more faſhionable than any other. Since it became common to exhibit theſe medicines in nephritic and calculous caſes, it has often happened that they were given to thoſe who were at the ſame time ſubject to the gout; and it has been obſerved, that under the uſe of theſe medicines, gouty perſons have been longer free from the fits of their diſeaſe. That, however, the uſe of theſe medicines has entirely prevented the returns of gout, Dr Cullen does not know; becauſe he never puſhed the uſe of them for a long time, being apprehenſive that the long-continued uſe of them might produce a hurtful change in the ſtate of the fluids.

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As the prevention of gout depends very much on ſupporting the tone of the ſtomach, and avoiding indigeſtion; ſo coſtiveneſs, by occaſioning this, is very hurtful to gouty perſons. It is therefore neceſſary for ſuch perſons to prevent or remove coſtiveneſs, by a laxative medicine, when needful; but it is at the ſame time proper, that the medicine employed ſhould be ſuch as may keep the belly regular, without much purging. Aloetics, rhubarb, magneſia alba, oleum ricini, or flowers of ſulphur, may be employed, as the one or the other may happen to be beſt ſuited to particular perſons.

Theſe are the ſeveral meaſures to be purſued in the intervals of the paroxyſms; and we are next to mention the meaſures proper during the time of them.

As during the time of paroxyſms the body is in a feveriſh ſtate, no irritation ſhould then be added to it; every part, therefore, of the antiphlogiſtic regimen, except the application of cold, ought to be ſtrictly obſerved.

An exception to the general rule, however, may occur when the tone of the ſtomach is weak, and when the patient has been before much accuſtomed to the uſe of ſtrong drink; for then it may be allowable, and even neceſſary, to give ſome animal food and a little wine.

That no irritation is to be added to the ſyſtem during the paroxyſms of gout, except in the caſes mentioned, is agreed upon among phyſicians: but it is a more difficult matter to determine, whether, during the time of paroxyſms any meaſures may be purſued to moderate the violence of reaction and of inflammation. Dr Sydenham has given it as his opinion, that the more violent the inflammation and pain, the paroxyſm will be the ſhorter, as well as the interval between the preſent and the next paroxyſm longer; and, if this opinion be admitted as juſt, it will forbid the uſe of any remedies which might moderate the inflammation; which is, to a certain degree, undoubtedly neceſſary for the health of the body. On the other hand, acute pain preſſes for relief; and although a certain degree of inflammation may ſeem abſolutely neceſſary, there is reaſon to believe, a moderate degree of it may anſwer the purpoſe; and it is even probable, that in many caſes the violence of inflammation may weaken the tone of the parts, and thereby invite a return of paroxyſms. It ſeems to be in this way, that, as the diſeaſe advances, the paroxyſms become more frequent.

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From theſe laſt conſiderations, it ſeems probable, that, during the time of paroxyſms ſome meaſures may be taken to moderate the violence of the inflammation and pain, and particularly, that in firſt paroxyſms, and in the young and vigorous, blood-letting at the arm may be practiſed with advantage: but this practice cannot be repeated often with ſafety; becauſe blood-letting not only weakens the tone of the ſyſtem, but alſo contributes to produce plethora. However, bleeding by leeches on the foot, and upon the inflamed part, may be practiſed and repeated with greater ſafety; and inſtances have been known of its having been employed with ſafety to moderate and ſhorten paroxyſms; but how far it may be carried, we have not had experience enough to determine.

Beſides blood-letting and the antiphlogiſtic regimen, it has been propoſed to employ remedies for moderating the inflammatory ſpaſm of the part affected, ſuch as warm bathing and emollient poultices. Theſe have ſometimes been employed with advantage and ſafety; but, at other times, have been found to give occaſion to a retroceſſion of the gout.

Bliſtering is a very effectual means of relieving and diſcuſſing a paroxyſm of the gout; but has alſo frequently had the effect of rendering it retrocedent. The ſtinging with nettles is analogous to bliſtering; and probably would be attended with the ſame danger. The burning with moxa, or other ſubſtances, is a remedy of the ſame kind; but though not found hurtful, there is no ſufficient evidence of its proving a radical cure.

Camphor, and ſome aromatic oils, have the power of allaying the pain, and of removing the inflammation from the part affected: but theſe remedies commonly make the inflammation only ſhift from one part to another, and therefore with the hazard of its falling upon a part where it may be more dangerous; and they have ſometimes rendered the gout retrocedent.

Among other remedies which have of late been highly extolled during a paroxyſm of gout, ſome have recommended the uſe of ſtrong purgatives frequently repeated; others have highly extolled the aſſiduous application of cold water to the affected foot. But we may ſafely venture to aſſert that both practices are very doubtful, if not very dangerous.

From theſe reflections it will appear, that ſome danger muſt attend every external application to the parts affected during a paroxyſm; and that therefore the common practice of committing the perſon to patience and flannel alone, is eſtabliſhed upon the beſt foundation. Opiates give the moſt certain relief from pain; but, when given in the beginning of gouty paroxyſms, it has by ſome been thought that they occaſion theſe to return with greater violence. When, however, the paroxyſms ſhall have abated in their violence, but ſtill continue to return, ſo as to occaſion painful and reſtleſs nights, opiates may be given with ſafety and advantage; eſpecially in the caſe of perſons advanced in life, and who have been often affected with the diſeaſe. When, after paroxyſms have ceaſed, ſome ſwelling and ſtiffneſs ſtill remain in the joints, theſe ſymptoms are to be diſcuſſed by the diligent uſe of the fleſh-bruſh. Purging immediately after a paroxyſm will be always employed with the hazard of bringing it on again; but keeping the belly gently open even during the continuance of the paroxyſm is highly proper.

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Thus far of the REGULAR gout. We now proceed to conſider the management of the diſeaſe when it has become IRREGULAR.

In the *atonic* gout, the cure is to be accompliſhed by carefully avoiding all debilitating cauſes; and by employing, at the ſame time, the means of ſtrengthening the ſyſtem in general, and the ſtomach in particular.

For ſtrengthening the ſyſtem in general, Dr Cullen recommends frequent exerciſe on horſeback, and moderate walking. Cold bathing alſo may anſwer the purpoſe; and may be ſafely employed, if it appear to be powerful in ſtimulating the ſyſtem, and be not applied when the extremities are threatened with any pain.

For ſupporting the tone of the ſyſtem in general, when threatened with atonic gout, ſome animal food ought to be employed, and the more aceſcent vegetables ought to be avoided. In the ſame caſe, ſome wine alſo may be neceſſary; but it ſhould be in moderate quantity, and of the leaſt aceſcent kinds, and if every kind of wine ſhall be found to increaſe the acidity of the ſtomach, ardent ſpirits and water muſt be employed.

For ſtrengthening the ſtomach, bitters and the Peruvian bark may be uſed; but care muſt be taken that they be not conſtantly employed for any great length of time.

The moſt effectual medicine for ſtrengthening the ſtomach is iron, which may be employed under various preparations; but the beſt appears to be the ruſt in fine powder, which may be given in large doſes.

For ſupporting the tone of the ſtomach, aromatics may be exhibited; but ſhould be uſed with caution, as the frequent and copious uſe of them has an oppoſite effect; and they ſhould therefore be given only in compliance with former habits, or for palliating preſent ſymptoms.

When the ſtomach happens to be liable to indigeſtion, gentle vomits may be frequently given, and proper laxatives ſhould be always employed to obviate or to remove coſtiveneſs.

In the atonic gout, or in perſons liable to it, to guard againſt cold is eſpecially neceſſary; and the moſt certain means of doing this, is by repairing to a warm climate during the winter ſeaſon. In the more violent caſes, bliſtering the lower extremities may be uſeful; but that remedy ſhould be avoided when any pain threatens the extremities. In perſons liable to the atonic gout, iſſues may be eſtabliſhed in the extremities as in ſome meaſure a ſupplement to the diſeaſe.

A ſecond caſe of the irregular gout, is the *retrocedent*.

When this affects the ſtomach and inteſtines, relief is to be inſtantly attempted by the free uſe of ſtrong wines, joined with aromatics, and given warm; or, if theſe ſhall not prove powerful enough, ardent ſpirits muſt be employed, and are to be given in a large doſe. In moderate attacks, ardent ſpirits, impregnated with garlic or with aſafœtida, may be uſed; or, even without the ardent ſpirits, a ſolution of aſafœtida with the volatile alkali, may anſwer the purpoſe. Opiates are often an effectual remedy; and may be

Phlegmaſiæ. joined with aromatics, as in the electuarium opiatum; or they may be uſefully joined with volatile alkali and camphor. Muſk has likewiſe proved uſeful in this diſeaſe.

When the affection of the ſtomach is accompanied with vomiting, this may be encouraged, by taking draughts of warm water, at firſt with wine, and afterwards without it; having at length recourſe, if neceſſary, to ſome of the remedies above mentioned, and particularly the opiates.

In like manner, if the inteſtines be affected with diarrhœa, this is to be at firſt encouraged by taking plentifully of weak broth; and when this ſhall have been done ſufficiently, the tumult is to be quieted by opiates.

When the retrocedent gout ſhall affect the lungs, and produce aſthma, this is to be cured by opiates, by antiſpaſmodics, and perhaps by bliſtering on the back or breaſt.

When the gout, leaving the extremities, ſhall affect the head, and produce pain, vertigo, apoplexy, or palſy, our reſources are very precarious. The moſt probable means of relief is, bliſtering the head; and, if the gout ſhall have receded very entirely from the extremities, bliſters may be applied to theſe alſo. Together with theſe bliſterings, aromatics, and the volatile alkali, may be thrown into the ſtomach.

The third caſe of the irregular gout is the *miſplaced;* that is, when the inflammatory affection of the gout, inſtead of falling upon the extremities, falls upon ſome internal part. In this caſe, the diſeaſe is to be treated by blood-letting, and by ſuch other remedies as would be proper in an idiopathic inflammation of the ſame parts.

Whether the tranſlation ſo frequently made from the extremities to the kidneys, is to be conſidered as an inſtance of the miſplaced gout, ſeems uncertain: but Dr Cullen is diſpoſed to think it ſomething different; and therefore is of opinion, that, in the *nephralgia calculoſa* produced upon this occaſion, the remedies of inflammation are to be employed no farther than they may be ſometimes neceſſary in that diſeaſe, ariſing from other cauſes than the gout.

Beſides what have been mentioned, a variety of other practices may be neceſſary and proper againſt the various anomalous ſymptoms, which are at times produced by irregular gout. But of theſe we cannot propoſe to treat. And we may conclude with obſerving, that in every form of gout, the cure principally depends on avoiding occaſional cauſes, particularly luxury and lazineſs.

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Lumbago pſoadica, *Sauv.* ſp. 6. *Fordyce*, Practice of Phyſic, part ii. p. 70.
Lumbago apoſtematoſa, *Sauv.* ſp. 12.
Lumbago ab arthrocace, *Sauv.* p. 17.
Iſchias ex abſceſſu, *Sauv.* ſp. 6.
Morbus coxarius, *De Haen*, Rat. Med. Vol. I. c. xxxii.

This is a diſeaſe very much reſembling the rheumatiſm; but differing both from it and the gout, in that it occaſions ſuppurations, which they ſeldom or never do. It frequently, according to Sauvages, attacks the pſoas muſcle; and occaſions excruciating pains, and Eryſipelas. then collections of purulent matter.

The only cure, if ſuppuration cannot be prevented, is to lay open the part where the matter is contained, which would otherwiſe be abſorbed, and occaſion a fatal hectic.

ORDER III. EXANTHEMATA. 217

Exanthemata, *Sag.* Claſs X.
Phlegmaſiæ exanthematicæ, *Sauv.* Claſs III. Ord. I.
Morbi exanthematici, *Lin.* Claſs I. Ord. II.
Febres exanthematicæ, *Vog.* Claſs I. Ord. II.

GENUS XXVI. ERYSIPELAS.

St ANTHONY'S FIRE. 218

Eryſipelas, *Sauv.* gen. 97. *Lin.* 10. *Sag.* gen. 296.
Febris eryſipelacea, *Vog.* 68. *Hoffm.* II. 98.

Sp. I. ERYSIPELAS with *Bliſters.* 219

Eryſipelas roſeum, *Sauv.* ſp. 1. *Sennert. de febr.* lib. ii. c. 15.
Febris eryſipelatoſa, *Sydenham*, ſect. vi. cap. 5.
Eryſipelas typhodes, *Sauv.* ſp. 2.
Eryſipelas peſtilens, *Sauv.* ſp. 5.
Eryſipelas contagioſum, *Sauv.* ſp. 9.

Deſcription. The eryſipelas of the face, where this affection very frequently appears, comes on with a cold ſhivering, and other ſymptoms of pyrexia. The hot ſtage of this is frequently attended with a confuſion of the head, and ſome degree of delirium; and almoſt always with drowſineſs, and perhaps coma. The pulſe is always frequent, and commonly full and hard.—When theſe ſymptoms have continued for one, two, or at moſt three days, an *erythema* appears on ſome part of the face. This at firſt is of no great extent; but gradually ſpreads from the part it firſt occupied to the other parts of the face, till it has affected the whole; and frequently from the face it ſpreads over the hairy ſcalp, or deſcends on ſome part of the cheek. As the redneſs ſpreads, it commonly leaves, or at leaſt is abated in the parts it had before occupied. All the parts which the redneſs affects are alſo affected with ſome ſwelling, which continues for ſome time after the redneſs has abated. The whole face becomes conſiderably turgid; and the eyelids are often ſo much ſwelled as entirely to ſhut up the eyes. When the redneſs and ſwelling have continued for ſome time, there commonly ariſe, ſooner or later, bliſters of a larger or ſmaller ſize on ſeveral parts of the face. Theſe contain a thin colourleſs liquor, which ſooner or later runs out. The ſurface of the ſkin, in the bliſtered places, ſometimes becomes livid and blackiſh; but this ſeldom goes deeper, or diſcovers any degree of gangrene affecting the cutis vera. On the parts of the face not affected with bliſters, the cuticle ſuffers, towards the end of the diſeaſe, a conſiderable deſquamation. Sometimes the tumor of the eyelids ends in a ſuppuration.

The inflammation coming upon the face does not produce any remiſſion of the fever which had before prevailed; and ſometimes the fever increaſes with the ſpreading and increaſing inflammation. The inflammation

Exanthemata.

tion commonly continues for eight or ten days; and for the ſame time, the fever and ſymptoms attending it alſo continue. In the progreſs of the diſeaſe, the delirium and coma attending it ſometimes go on increaſing, and the patient dies apoplectic on the ſeventh, ninth, or eleventh day of the diſeaſe. In ſuch caſes it has been commonly ſuppoſed, that the diſeaſe is tranſlated from the external to the internal parts. But Dr Cullen thinks that the affection of the brain is merely a communication from the external affection, as this continues increaſing at the ſame time with the internal. When a fatal event does not take place, the inflammation, after having affected the whole face, and perhaps the other external parts of the head, ceaſes, and with that the fever alſo; and, without any other criſis, the patient returns to his ordinary health. This diſeaſe is not commonly contagious; but as it may ariſe from an acrid matter externally applied, ſo it is poſſible that the diſeaſe may ſometimes be communicated from one perſon to another; and certainly there are ſeveral well authenticated inſtances of its prevailing in ſuch a manner, even in particular wards of hoſpitals, as to leave no doubt reſpecting its contagious nature. Perſons who have once laboured under this diſeaſe are liable to returns of it.

Prognoſis. The event of this diſeaſe may be foreſeen from the ſtate of the ſymptoms which denote more or leſs the affection of the brain. If neither delirium nor coma come on, the diſeaſe is ſeldom attended with any danger; but when theſe ſymptoms appear early in the diſeaſe, and are in a conſiderable degree, the utmoſt danger is to be apprehended.

Cure. The eryſipelas of the face is to be cured, according to the opinion of moſt practitioners, much in the ſame manner as phlegmonic inflammations; by blood-letting, cooling purgatives, and by employing every part of the antiphlogiſtic regimen. Many obſervations, however, would lead us to conclude, that in not a few caſes the concomitant fever has here a tendency to the typhoid type; and therefore evacuations, apparently ſerviceable in the firſt inſtance, have afterwards a bad effect. The evacuations of blood-letting and purging are to be employed more or leſs according to the urgency of ſymptoms; particularly thoſe which mark an affection of the brain. As the pyrexia continues, and often increaſes with the inflammation of the face, ſo the evacuations above mentioned are to be employed at any time of the diſeaſe. When, however, the fever, in place of marks of the phlogiſtic diatheſis, particularly a full, hard, and ſtrong pulſe, is attended with ſymptoms of great debility, and with a ſmall pulſe eaſily compreſſible; evacuations, particularly under the form of blood-letting, muſt be uſed with very great caution. Even in ſuch caſes, however, the uſe of refrigerant cathartics may ſtill be perſiſted in with more ſafety and greater advantage. But whether evacuants have been employed or not, when ſymptoms of debility run to a great height, and marks of a putreſcent tendency appear, recourſe muſt be had to wine and the cinchona. In caſes which at the commencement require evacuation, theſe are often in the after periods employed with very great benefit.

Peſtis.

In this, as in other diſeaſes of the head, when that part happens to be the ſeat of eryſipelas, it is proper to put the patient, as often as he can eaſily bear it, into ſomewhat of an erect poſture; and as there is always an external affection, ſo various external applications have been propoſed to be made to the part affected; but almoſt all of them are of doubtful effect.

An eryſipelas frequently appears on other parts of the body beſides the face, and ſuch other eryſipelatous inflammations frequently end in ſuppuration; but theſe caſes are ſeldom dangerous. At coming on they are ſometimes attended with drowſineſs, and even with ſome delirium; but this ſeldom happens, and theſe ſymptoms do not continue after the inflammation is formed; and Dr Cullen does not remember to have ſeen an inſtance of the tranſlation of an inflammation from the limbs to an internal part; and though theſe inflammations of the limbs be attended with pyrexia, they ſeldom require the ſame evacuations as the eryſipelas of the face.

Sp. II. Erysipelas with *Phlyctenæ*. 220

Eryſipelas zoſter, *Sauv.* ſp. 8.
Zona; Anglis, *The* Shingles, *Ruſſel* de tab. gland. p. 124. Hiſt. 35.
Herpes zoſter, *Sauv.* ſp. 9.

This differs from the former in no other way than in being attended with an eruption of phlyctenæ or ſmall watery bladders on ſeveral parts of the body.—The method of cure is the ſame.

Genus XXVII. PESTIS, the *Plague*. 221

Peſtis, *Sauv.* gen. 91. *Lin.* 2. *Junck.* 78.
Febris peſtilentialis, *Vog.* 33. *Hoffm.* II. 93.
Peſtis benigna, *Sauv.* ſp. 2. Peſtis Maſſilienſis, Claſs III. Traité de la peſte, p. 41. Ejuſdem peſtis, Cl. 5ta, Traité, p. 228.
Peſtis remittens, *Sauv.* ſp. 9.
Peſtis vulgaris, *Sauv.* ſp. 1. Peſtis Maſſil. Cl. II. Traité, p. 38. Ejuſd. Cl. III. et IV. Traité, p. 225, &c. *Waldſchmidt.* de peſte Holſatica, apud *Halleri*, Diſſ. Pract. Tom. V. *Chenot.* de peſte Tranſylvanica, 1755, 1759, *De Haen*, Rat. Med. pars xiv.
Peſtis Egyptiaca, *Sauv.* ſp. 11. *Alpin.* de Med. Egypt.
Peſtis interna, *Sauv.* ſp. 3. Peſt. Maſſil. Cl. I. Traité, p. 37—224.

Hiſtory. Of this diſtemper Dr Cullen declines giving any particular hiſtory, becauſe he never ſaw it; from the accounts of other authors, however, he is of opinion, that the circumſtances peculiarly characteriſtic of it, eſpecially of its more violent and dangerous ſtates, are, 1. The great loſs of ſtrength in the animal functions, which often appears early in the diſeaſe. 2. The ſtupor, giddineſs, and conſequent ſtaggering, which reſembles drunkenneſs, or the headach and various delirium, all of them denoting a great diſorder in the functions of the brain. 3. Anxiety, palpitation, ſyncope, and eſpecially the weakneſs and irregularity of the pulſe, denoting a conſiderable diſturbance in the action of the heart. 4. Nauſea and vomiting, particularly the vomiting of bile, which ſhows

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an accumulation of vitiated bile in the gall-bladder and biliary ducts, and from thence derived into the intestines and stomach; and which denote a considerable spasm, and loss of tone in the extreme vessels on the surface of the body. 5. The buboes and carbuncles, which denote an acrimony prevailing in the fluids; and, lastly, The petechiæ, hæmorrhages, and colliquative diarrhœa, which denote a putrescent tendency prevailing in a great degree in the mass of blood.

To these characteristics of the plague enumerated by Dr Cullen, we shall add one mentioned by Sir John Pringle, which, though perhaps less frequent than the others, yet seems worthy of notice. It is this, That in the plague there is an extraordinary enlargement of the heart and liver. In nine dissections of bodies dead of the plague at Marseilles, this extraordinary enlargement of the heart is taken notice of in all of them, and of the liver in seven of them. The account was sent to the Royal Society by M. Didier, one of the physicians to the king of France, and has been published in the Philosophical Transactions. In the first case, the author takes notice, that "the heart was of an extraordinary bigness; and the liver was of double the natural size.—Case 2. The heart was of a prodigious bigness, and the liver much enlarged.—Case 3. The heart double the natural bigness.—Case 4. The heart was very large, and the liver was bigger and harder than ordinary.—Case 5. The heart was of a prodigious bigness.—Case 6. The heart was larger than in its natural state; the liver also was very large.—Case 7. The heart was of a prodigious size, and the liver was very large.—Case 8. The heart was much larger than natural, and the liver of a prodigious size.—Case 9. The heart was double the natural bigness, and the liver was larger than ordinary."—This preternatural enlargement, Sir J. Pringle thinks, is owing to the relaxation of the solid parts, by which means they become unable to resist the impetus of blood, and therefore are easily extended; as in the case of infancy, where the growth is remarkably quick. And a similar enlargement he takes notice of in the scurvy, and other putrid diseases.

A very elaborate work has lately been published on the subject of the plague by Dr Patrick Russel, formerly physician to the British factory at Aleppo. In this work, a very full history is given of the various forms and varieties of the disease. He makes particular observations on the following symptoms, which, in addition to the pestilential eruptions, he considers as the most important concomitants of plague, viz. fever, delirium, coma, impediment or loss of speech, deafness, muddiness of the eyes, white tongue, state of the pulse, respiration, anxiety, pain at the heart, inquietude, debility, fainting, convulsion, appearances of the urine, perspiration, vomiting, looseness, and hæmorrhage; and he concludes these remarks with some observations on the occurrence of the plague with pregnant women. To point out more distinctly the stable varieties of the disease, he arranges the pestilential cases which fell under his observation at Aleppo under six classes: and he concludes his description with a very minute and particular account of the pestilential eruptions. appearing under the form either of buboes, carbuncles, or other exanthemata. The presence of the two first, he observes, either separately or conjunctly, leaves the nature of the distemper unequivocal. But fatal has been the error of rashly pronouncing a distemper not to be a plague from their absence. Buboes affected the inguinal, axillary, parotid, maxillary, and cervical glands. But the first were the most commonly affected, and the two latter seldom observed to swell, without either the parotid swelling at the time, or soon after. Of the carbuncles, Dr Russel describes five different varieties. The other exanthemata, which he observed sometimes, though less frequently, attending the plague, were petechiæ, a marbled appearance of the skin, an erysipelatous redness, streaks of a reddish purple or livid colour, vibices or weals, and large blue or purple spots, the *maculæ magnæ* of authors. In some cases, an extraordinary concurrence of eruptions took place, which was chiefly observed among children under 10 years of age.

Causes, &c. From a consideration of the symptoms above mentioned, Dr Cullen concludes, that the plague is owing to a specific contagion, often suddenly producing the most considerable debility in the nervous system, or moving powers, and a general putrescency in the fluids. Dr Russel also considers the disease as being universally the consequence of what may be called *pestilential contagion*; and has judiciously repelled the objections which have been brought against this doctrine.

Prevention. Here we must refer to all those methods of preventing and removing the incipient contagion of putrid fevers, which have been so fully enumerated. Dr Cullen is persuaded that the disease never arises in the northern parts of Europe, but in consequence of being imported from some other country. The magistrate's first care, therefore, ought to be, to prevent the importation; and this may generally be done by a due attention to bills of health, and to the proper performance of quarantines.—With respect to the latter, he is of opinion, that the quarantines of persons may with safety be much less than 40 days; and if this were allowed, the execution of the quarantine would be more exact and certain, as the temptation to break it would be in a great measure avoided. With respect to the quarantine of goods, it cannot be perfect unless the suspected goods be unpacked, duly ventilated, and other means be employed for correcting the infection they may carry; and if all this be properly done, it is probable that the time commonly prescribed for quarantine may also be shortened.

A second measure in the way of prevention is required, when an infection has reached and prevailed in any place, to prevent that infection from spreading into others. This can only be done by preventing the inhabitants or the goods of any infected place from going out of it till they have undergone a proper quarantine.

The third measure, and which ought to be employed with great care, is, to prevent the infection from spreading among the inhabitants of a place in which it has arisen. And in this case, a great deal may be done by the magistrate: 1. By allowing as many of the inhabitants as are free from infection, and are not necessary to the service of the place, to go out of it. 2. By discharging all assemblies, or unnecessary intercourse of the people. 3. By ordering some necessary communications to be performed without contact.

Exanthemata. contact. 4. By making ſuch arrangements and proviſions as may render it eaſy for the families remaining to ſhut themſelves up in their own houſes. 5. By allowing perſons to quit houſes where an infection appears, upon condition that they go into lazarettos. 6. By ventilating and purifying, or deſtroying, at the public expence, all infected goods. 7. By avoiding hoſpitals, and providing ſeparate apartments for infected perſons.

The fourth and laſt part of the buſineſs of prevention reſpects the conduct of perſons neceſſarily remaining in infected places, eſpecially thoſe obliged to have ſome communication with perſons infected. Thoſe obliged to remain in places infected, but not to have any near communication with the ſick, muſt avoid all near communication with other perſons or their goods; and it is probable, that a ſmall diſtance will ſerve, if, at the ſame time, there be no ſtream of air to carry the effluvia of perſons or goods to ſome diſtance. Thoſe who are obliged to have a near communication with the ſick ought to avoid any of the debilitating cauſes which render the body ſuſceptible of infection, as a ſpare diet, intemperance in drinking, exceſs in venery, cold, fear, or other depreſſing paſſions of the mind. A full diet of animal food is alſo to be avoided, becauſe it increaſes the irritability of the body, and favours the operation of contagion; and indigeſtion, whether from the quantity or quality of the food, contributes very much to the ſame end.

Beſides theſe, it is probable that the moderate uſe of wine and ſpirituous liquors, moderate exerciſe, and the cold bath, may be of uſe; tonic medicines alſo, of which cinchona is deſervedly accounted the chief, may be uſed with ſome probability of ſucceſs. If any thing is to be expected from antiſeptics, Dr Cullen thinks camphor preferable to every other. In general, however, every one is to be indulged in the medicine of which he has the beſt opinion, provided it is not evidently hurtful. Whether iſſues be uſeful in preſerving from the effects of contagion, is a matter of doubt. Dr Ruſſel in his treatiſe enters very fully into the conſideration of the means of prevention, both with reſpect to quarantines, lazarettos, and bills of health. He is of opinion, that the preſent laws on theſe ſubjects are in many reſpects defective: and he thinks, that a ſet of new regulations would have the beſt chance of a deliberate and impartial diſcuſſion in the ſenate, if the inquiry were taken at a time free from all apprehenſion of immediate danger.

Cure. According to Dr Cullen, the indications are the ſame as in fever in general, but are not all equally important. The meaſures for moderating the violence of reaction, which operate by diminiſhing the action of the heart and arteries, have ſeldom, he thinks, any place here, excepting that the antiphlogiſtic regimen is generally proper. Some phyſicians have recommended bleeding, and Sydenham even ſeems to think it an effectual cure; but Dr Cullen ſuppoſes, that for the moſt part it is unneceſſary, and in many caſes might do much hurt. Dr Ruſſel, however, who on this ſubject ſpeaks from experience and actual obſervation, is of a different opinion. With moſt of his patients, a ſingle bleeding was employed with advantage; and even where the ſick under his inſpection were bled oftener than once, he did not find that the low ſtate was thereby hurried on. Purging has alſo been recommended; and in ſome degree it may be uſeful in drawing off the putreſcent matter frequently preſent in the inteſtines; but a large evacuation in this way may certainly be hurtful. Peſtis.

The moderating the violence of reaction, as far as it can be done, by taking off the ſpaſm of the extreme veſſels, is a meaſure, in Dr Cullen's opinion, of the utmoſt neceſſity in the cure of the plague; and the whole of the means formerly mentioned, as ſuited to this indication, are extremely proper. The giving an emetic, at the firſt approach of the diſeaſe, would probably be of great ſervice; and it is probable, that, at ſome other periods of the diſeaſe, emetics might be uſeful, both by evacuating bile abounding in the alimentary canal, and by taking off the ſpaſm of the extreme veſſels. Indeed Baron Aſh, and ſome other of the Ruſſian practitioners, repreſent the early and repeated uſed of emetics as the only effectual mode of cure.

According to the obſervations of Dr de Mertens, who wrote a very intereſting treatiſe on the fatal plague which raged at Moſcow in 1771, and which carried off upwards of 20,000 inhabitants in the ſpace of one month, emetics were often of the greateſt ſervice.

From ſome principles with reſpect to fever in general, and with reſpect to the plague in particular, Dr Cullen is of opinion, that after the exhibition of the firſt vomit, the body ſhould be diſpoſed to ſweat: but this ſweat ſhould be raiſed only to a moderate degree, though it muſt be continued for 24 hours or more if the patient bears it eaſily. The ſweating is to be excited and conducted according to the rules laid down under SYNOCHA; and muſt be promoted by the plentiful uſe of diluents rendered more grateful by vegetable acids, or more powerful by being impregnated with ſome portion of neutral ſalts. To ſupport the patient under the continuance of the ſweat, a little weak broth, acidulated with the juice of lemons, may be given frequently, and ſometimes a little wine if the heat of the body be not conſiderable. If ſudorific medicines be judged neceſſary, opiates will be found more effectual and ſafe; but they ſhould not be combined with aromatics, and probably may be more effectual if joined with a portion of emetics and of neutral ſalts. But if, notwithſtanding the uſe of emetics and ſudorifics in the beginning, the diſeaſe ſhould ſtill continue, the cure muſt turn upon the uſe of means for obviating debility and putreſcency; and for this purpoſe tonic medicines, eſpecially cinchona and cold drink, are the moſt proper.

GENUS XXVIII. VARIOLA.

The SMALLPOX. 222

Variola, *Sauv.* gen. 92. *Lin.* 3. *Sag.* gen. 290.
Febris varioloſa, *Vog.* 35. *Hoffm.* II. 49.
Variolæ, *Boerh.* 1371. *Junck.* 76.

Sp. I. *Diſtinct SMALLPOX.* 223

Variola diſcreta benigna, *Sauv.* ſp. 2.
Variolæ regulares diſcretæ, *Sydenh.* ſect. iii. cap. 2.

Variolæ

Exanthemata.

Variolæ difcretæ fimplices, *Helvet.* Ob. fp. 1.
Variola difcreta complicata, *Sauv.* fp. 2. *Helvet.* fp. 2.
Variolæ anomalæ, *Sydenh.* fect. iv. cap. 6.
Variola difcreta dyfenteriodes, *Sauv.* fp. 4. *Sydenh.* fect. iv. cap. 1.
Variola difcreta veficularis, *Sauv.* fp. 5.
Variola difcreta cryftallina. *Mead.* de variol. cap. 2.
Variola difcreta verrucofa, *Sauv.* fp. 6. *Mead.* ibid.
Variola difereta filiquofa, *Sauv.* fp. 7. *Freind* Oper. p. 358.
Variola difcreta miliaris, *Sauv.* fp. 8. *Helvet.* Obf. fp. 3.

224 Sp. II. *The Confluent* SMALLPOX.

Variola confluens, *Sauv.* fp. 9.
Variolæ regulares confluentes, ann. 1667. *Sydenham*, fect. iii. cap. 2.
Variolæ confluentes fimplices, *Helvet.* Obf. fp. 1.
Variola confluens cryftallina, *Sauv.* fp. 10.
Variola japoniea, *Kempfer*.
Vefieulæ divæ Barbaræ, *C. Pis.* Obf. 149.
Variola confluens maligna, *Helvet.* Obf. fp. 1.
Variola confluens cohærens, *Sauv.* fp. 11.
Variola confluens maligna, *Helvet.* fp. 2.
Variola confluens nigra, *Sauv.* fp. 12. *Sydenham*, fect. v. cap. 4
Variola confluens maligna, *Helvet.* fp. 3.
Variola fanguinea, *Mead* de variolis, cap. 2.
Variola confluens corymbofa, *Sauv.* fp. 13.
Variola confluens maligna, *Helvet.* fp. 4.

Defcription. In the diftinct fmallpox, the difeafe begins with a fynocha or inflammatory fever. This fever generally comes on about mid-day, with fome fymptoms of a cold ftage, and commonly with a confiderable languor and drowfinefs. A hot ftage is foon formed, and becomes more confiderable on the fecond and third day. During this courfe children are liable to frequent ftartings from their flumbers; and adults, if they are kept in bed, are difpofed to much fweating. On the third day, children are fometimes affected with one or two epileptic fits. Towards the end of the third day the eruption commonly appears, and gradually increafes during the fourth; appearing firft on the face, and fucceffively on the inferior parts, fo as to be completed over the whole body on the fifth day. From the third day the fever abates, and by the fifth it entirely ceafes. The eruption appears firft in fmall red fpots hardly eminent, but by degrees rifing into pimples. There are generally but few on the face; but, even when more numerous, they are feparate and diftinct from one another. On the fifth or fixth day, a fmall vefícle, containing an almoft colourlefs fluid, appears on the top of each pimple. For two days thefe vefícles increafe in breadth only, and there is a fmall hollow pit in their middle, fo that they are not raifed into fpheroidical puftules till the eighth day. Thefe puftules from their firft formation continue to be furrounded with an exactly circular inflamed margin, which, when they are numerous, diffufes fome inflammation over the neighbouring fkin, fo as to give fomewhat of a damafk-rofe colour to the fpaces between the puftules. As the puftules increafe in fize, the face fwells confiderably if they are numerous on it; and the eye lids particularly are fo much fwelled, that the eyes are entirely fhut. As the difeafe proceeds, the matter in the puftules becomes by degrees more opaque and white, and at length affumes a yellowifh colour. On the 11th day the fwelling of the face is abated, and the puftules feem quite full. On the top of each a darker fpot appears; and at this place the puftule, on the 11th day, or foon after, is fpontaneoufly broken, and a portion of the matter oozes out; in confequence of which the puftule is fhrivelled, and fubfides; while the matter oozing out dries, and forms a cruft upon its furface. Sometimes only a little of the matter oozes out, and what remains in the puftule becomes thick and even hard. After fome days, both the crufts and the hardened puftules fall off, leaving the fkin which they covered of a brownifh red colour; nor doth it refume its natural colour till many days after. In fome cafes, where the matter of the puftules has been more liquid, the crufts formed from it are later in falling off, and the part they covered fuffers fome defquamation, which occafions a fmall hollow or pit.

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On the legs and hands the matter is frequently abforbed; fo that at the height of the difeafe, thefe puftules appear as empty as vefícles. On the 10th and 11th days, as the fwelling of the face fubfides, a fwelling arifes in the hands and feet; but which again fubfides as the puftules come to maturity.—When the puftules on the face are numerous, fome degree of pyrexia appears on the 10th and 11th days; but difappears again after the puftules are fully ripened, or perhaps remains in a very flight degree till the puftules on the feet have finifhed their courfe; and it is feldom that any fever continues longer in the diftinct fmallpox. When the puftules are numerous on the face, upon the fixth or feventh day fome uneafinefs of the throat, with a hoarfenefs of the voice, comes on, and a thin liquid is poured out from the mouth. Thefe fymptoms increafe with the fwelling of the face; and the liquids of the mouth and throat becoming thicker are with difficulty thrown out; and there is at the fame time fome difficulty in fwallowing, fo that liquids taken in to be fwallowed are frequently rejected or thrown out by the nofe. But all thefe affections of the fauces are abated as the fwelling of the faee fubfides.

In the confluent fmallpox all the fymptoms above mentioned are much more fevere. The eruptive fever particularly is more violent; the pulfe is more frequent and more contracted, approaching to that ftate of pulfe which is obferved in typhus. The coma is more confiderable, and there is frequently a delirium. Vomiting alfo frequently attends, efpecially at the beginning of the difeafe. In very young infants epileptic fits are fometimes frequent on the firft days of the difeafe, and fometimes prove fatal before any eruption appears, or they ufher in a very confluent and putrid fmallpox. But at the fame time, it has been juftly remarked by Dr Sydenham, and other accurate obfervers, that epileptie attacks more frequently precede diftinct and mild than malignant and confluent fmallpox. The eruption appears in the confluent more early on the third day, and it is frequently preceded or accompanied with an eryfipelatous efflorefcence. Sometimes

Exanthemata. times the eruption appears in clusters like the measles. When the eruption is completed, the pimples are always more numerous upon the face, and at the same time smaller and less eminent. Upon the eruption the fever suffers some remission, but never goes off entirely; and after the fifth or sixth day it increases again, and continues to be considerable throughout the remaining part of the disease. The vesicles formed on the top of the pimples appear sooner; and while they increase in breadth, they do not retain a circular, but are every way of an irregular figure. Many of them run into one another, insomuch that very often the face is covered with one vesicle rather than with a number of pustules. The vesicles, as far as they are any way separated, do not arise to a spheroidal form, but remain flat, and sometimes the whole of the face appears an even surface. When the pustules are in any measure separated, they are not bounded by an inflamed margin, but the part of the skin that is free from pustules is commonly pale and flaccid. The liquor that is in the pustules changes from a clear to an opaque appearance, and becomes whitish or brownish, but never acquires the yellow colour and thick consistence that appears in the distinct smallpox. The swelling of the face, which only sometimes attends the distinct smallpox, always attends the confluent kind; it also comes on more early, and arises to a greater height, but abates considerably on the tenth or eleventh day. At this time the pustules or vesicles break and shrivel; pouring out at the same time a liquor, which is formed into brown or black crusts, which do not fall off for a long time after. Those of the face, in falling off, leave the skin subject to a desquamation, which pretty certainly produces pittings. On the other parts of the body the pustules of the confluent smallpox are more distinct than on the face; but never acquire the same maturity and consistence of pus as in the properly distinct kind.—The salivation, which sometimes only attends the distinct smallpox, very constantly attends the confluent; and both the salivation and the affection of the fauces above mentioned occur, especially in adults, in a higher degree. In infants a diarrhœa comes frequently in place of a salivation.

In this kind of smallpox there is often a very considerable putrescency of the fluids, as appears from petechiæ, from serous vesicles, under which the skin shows a disposition to gangrene, and from bloody urine or other hæmorrhages; all of which symptoms frequently attend this disease. In the confluent smallpox also, the fever, which had only suffered a remission from the eruption to the maturation, at or immediately after this period is frequently renewed again with considerable violence. This is what has been called the *secondary fever*, and is of various duration and event.

Causes, &c. It is evident that the smallpox is originally produced by a contagion; and that this contagion is a ferment with respect to the fluids of the human body, which assimilates a considerable portion of them to its own nature: or, at least, we have every reason to believe that a small quantity of contagious matter introduced, is somehow multiplied and increased in the circulating fluids of the animal body. This quantity passes again out of the body, partly by insensible perspiration, and partly by being deposited in pustules: Variola. The causes which determine more of the variolous matter to pass by perspiration, or to form pustules, are probably certain circumstances of the skin, which determine more or less of the variolous matter to stick in it, or to pass freely through it. The circumstance of the skin, which seems to determine the variolous matter to stick in it, is a certain state of inflammation depending much on the heat of it: thus we have many instances of parts of the body, from being more heated, having a greater number of pustules than other parts. Thus parts covered with plasters, especially those of the stimulant kind, have more pustules than others.—Certain circumstances also, such as adult age, and full living, determining to a phlogistic diathesis, seem to produce a greater number of pustules, and *vice versa*. It is therefore probable, that an inflammatory state of the whole system, and more particularly of the skin, gives occasion to a greater number of pustules; and the causes of this may produce most of the other circumstances of the confluent smallpox, such as the time of eruption, the continuance of the fever, the effusion of a more putrescent matter, and less fit to be converted into pus, together with the form and other circumstances of the pustules.

Prognosis. The more exactly the disease retains the form of the distinct kind, it is the safer; and the more completely the disease takes the form of the confluent kind, it is the more dangerous. It is only when the distinct kind shows a great number of pustules on the face, or otherwise by fever or putrescency, approaching to the circumstances of the confluent, that the distinct kind is attended with any danger.

In the confluent kind the danger is always very considerable; and the more violent and permanent the fever is, the greater the danger; and especially in proportion to the increase of the symptoms of putrescency. When the putrid disposition is very great, the disease sometimes proves fatal before the eighth day; but in most cases death happens on the eleventh, and sometimes not till the fourteenth or seventeenth day.

Though the smallpox may not prove immediately fatal, the more violent kinds are often followed by a morbid state of the body, sometimes of very dangerous event. These consequences, according to Dr Cullen, may be imputed sometimes to an acrid matter produced by the preceding disease, and deposited in different parts; and sometimes to an inflammatory diathesis produced and determined to particular parts of the body.

Since the introduction of smallpox into Europe, there is perhaps no disease which has produced a greater number of deaths. But, fortunately, a discovery is now made, by which there is reason to hope that this loathsome disease may be altogether exterminated; its prevention, viz. by the inoculation of the vaccine or cowpox.

This most important discovery we owe to the successful exertions of Dr Edward Jenner; to whom, for these exertions, repeated rewards have been voted by the British legislature, but who unquestionably enjoys a much higher reward in the satisfaction of having conferred an inestimable blessing on the human species.

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For an account of the progress of this discovery, we must refer our readers to Dr Jenner's publication. Here we shall only observe, that it had long been remarked in some parts of England, particularly in the neighbourhood of Berkley, where Dr Jenner resided, that cows were liable to a pustular disease on their udders, somewhat resembling smallpox; that this disease was communicated by contact to the fingers of those employed in milking the cows; and, finally, that those thus infected with cowpox, were completely protected against the contagion of smallpox.

Founding on these observations, Dr Jenner ascertained by experiment, that the inoculation of vaccine matter was an infallible preventive of smallpox; and that this vaccine matter had equal power in preventing variola when transferred from one human subject to another, as when obtained immediately from the cow. It is not therefore wonderful that this practice of vaccine inoculation should soon have become general, both in Britain and in every quarter of the world. Nor is it perhaps surprising, that it should have been violently opposed by ignorant and obstinate men. Hence numerous publications have of late appeared both for and against this practice. Many mistakes have undoubtedly been committed by ignorance and inattention; and thus the preventive has been supposed to fail. For the best account both of the method of performing the operation, of conveying the vaccine matter from one place to another, and of the tests of constitutional affection in those cases in which the inflammation is slight, and in which no fever is perceptible, we may refer our readers to a treatise published at Edinburgh in 1802, by Mr James Bryce, entitled Practical Observations on the Inoculation of Cowpox.

Of the efficacy of vaccine inoculation as a preventive of smallpox, few candid men will entertain any doubt, after the following report on vaccination, from the Royal College of Physicians in London, ordered to be printed on the 8th of July 1807, by the British parliament.

REPORT, &c.

The Royal College of Physicians of London, having received his majesty's commands, in compliance with an address from the house of commons, "to inquire into the state of vaccine inoculation in the united kingdom, to report their opinion and observations upon that practice, upon the evidence which has been adduced in its support, and upon the causes which have hitherto retarded its general adoption;—have applied themselves diligently to the business referred to them.

Deeply impressed with the importance of an inquiry which equally involves the lives of individuals, and the public prosperity, they have made every exertion to investigate the subject fully and impartially. In aid of the knowledge and experience of the members of their own body, they have applied separately to each of the licentiates of the college; they have corresponded with the colleges of physicians of Dublin and Edinburgh; with the colleges of surgeons of London, Edinburgh, and Dublin; they have called upon the societies established for vaccination, for an account of their practice, to what extent it has been carried on, and what has been the result of their experience; and they have, by public notice, invited individuals to contribute whatever information they had severally collected. They have in consequence been furnished with a mass of evidence communicated with the greatest readiness and candour, which enables them to speak with confidence upon all the principal points referred to them.

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I. During eight years which have elapsed since Dr Jenner made his discovery public, the progress of vaccination has been rapid, not only in all parts of the united kingdom, but in every quarter of the civilized world. In the British islands some hundred thousands have been vaccinated, in our possessions in the East Indies upwards of 800,000, and among the nations of Europe the practice has become general. Professional men have submitted it to the fairest trials, and the public have, for the most part, received it without prejudice. A few indeed have stood forth the adversaries of vaccination, on the same grounds as their predecessors who opposed the inoculation for the smallpox, falsely led by hypothetical reasoning in the investigation of a subject which must be supported, or rejected, upon facts and observation only. With these few exceptions, the testimony in favour of vaccination has been most strong and satisfactory, and the practice of it, though it has received a check in some quarters, appears still to be upon the increase in most parts of the united kingdom.

II. The college of physicians, in giving their observations and opinions on the practice of vaccination, think it right to premise, that they advance nothing but what is suppported by the multiplied and unequivocal evidence which has been brought before them, and they have not considered any facts as proved but what have been stated from actual observation.

Vaccination appears to be in general perfectly safe: the instances to the contrary being extremely rare. The disease excited by it is slight, and seldom prevents those under it from following their ordinary occupations. It has been communicated with safety to pregnant women, to children during dentition, and in their earliest infancy; in all which respects it possesses material advantages over inoculation for the smallpox; which though productive of a disease generally mild, yet sometimes occasions alarming symptoms, and is in a few cases fatal.

The security derived from vaccination against the smallpox, if not absolutely perfect, is as nearly so as can perhaps be expected from any human discovery; for amongst several hundred thousand cases, with the results of which the college have been made acquainted, the number of alleged failures has been surprisingly small, so much so, as to form certainly no reasonable objection to the general adoption of vaccination; for it appears that there are not nearly so many failures, in a given number of vaccinated persons, as there are deaths in an equal number of persons inoculated for the smallpox. Nothing can more clearly demonstrate the superiority of vaccination over the inoculation of the smallpox, than this consideration; and it is a most important fact, which has been confirmed in the course of this inquiry, that in almost every case, where the smallpox has succeeded vaccination, whether by inoculation or by casual infection, the disease has varied much from its ordinary course; it has neither been the same in the violence, nor in the duration of its symptoms, but has, with

with very few exceptions, been remarkably mild, as if the ſmallpox had been deprived, by the previous vaccine diſeaſe, of all its uſual malignity.

The teſtimonies before the college of phyſicians are very decided in declaring, that vaccination does leſs miſchief to the conſtitution, and leſs frequently gives riſe to other diſeaſes, than the ſmallpox, either natural or inoculated.

The college feel themſelves called upon to ſtate this ſtrongly, becauſe it has been objected to vaccination, that it produces new, unheard-of, and monſtrous diſeaſes. Of ſuch aſſertions no proofs have been produced, and, after diligent inquiry, the college believe them to have been either the inventions of deſigning, or the miſtakes of ignorant men. In theſe reſpects then, in its mildneſs, its ſafety, and its conſequences, the individual may look for the peculiar advantages of vaccination. The benefits which flow from it to ſociety are infinitely more conſiderable, it ſpreads no infection, and can be communicated only by inoculation. It is from a conſideration of the pernicious effects of the ſmallpox, that the real value of vaccination is to be eſtimated. The natural ſmallpox has been ſuppoſed to deſtroy a ſixth part of all whom it attacks; and that even by inoculation, where that has been general in pariſhes and towns, about one in 300 has uſually died. It is not ſufficiently known, or not adverted to, that nearly one-tenth, ſome years more than one-tenth of the whole mortality in London, is occaſioned by the ſmallpox; and however beneficial the inoculation of the ſmallpox may have been to individuals, it appears to have kept up a conſtant ſource of contagion, which has been the means of increaſing the number of deaths by what is called the natural diſeaſe. It cannot be doubted that this miſchief has been extended by the inconſiderate manner in which great numbers of perſons, even ſince the introduction of vaccination, are ſtill every year inoculated with the ſmallpox, and afterwards required to attend two or three times a-week at the places of inoculation, through every ſtage of their illneſs.

From this, then, the public are to expect the great and uncontroverted ſuperiority of vaccination, that it communicates no caſual infection, and, while it is a protection to the individual, it is not prejudicial to the public.

III. The college of phyſicians, in reporting their obſervations and opinions on the evidence adduced in ſupport of vaccination, feel themſelves authoriſed to ſtate that a body of evidence ſo large, ſo temperate, and ſo conſiſtent, was perhaps never before collected upon any medical queſtion. A diſcovery ſo novel, and to which there was nothing analogous known in nature, though reſting on the experimental obſervations of the inventor, was at firſt received with diffidence: it was not, however, difficult for others to repeat his experiments, by which the truth of his obſervations was confirmed, and the doubts of the cautious were gradually diſpelled by extenſive experience. At the commencement of the practice, almoſt all that were vaccinated were afterwards ſubmitted to the inoculation of the ſmallpox; many underwent this operation a ſecond, and even a third time, and the uniform ſucceſs of theſe trials quickly bred confidence in the new diſcovery. But the evidence of the ſecurity derived from vaccination againſt the ſmallpox does not reſt alone upon thoſe who afterwards underwent variolous inoculation, although amounting to many thouſands; for it appears, from numerous obſervations communicated to the college, that thoſe who have been vaccinated are equally ſecure againſt the contagion of epidemic ſmallpox. Towns, indeed, and diſtricts of the country in which vaccination had been general, have afterwards had the ſmallpox prevalent on all ſides of them without ſuffering from the contagion. There are alſo in the evidence a few examples of epidemic ſmallpox having been ſubdued by a general vaccination. It will not, therefore, appear extraordinary that many who have communicated their obſervations ſhould ſtate, that though at firſt they thought unfavourably of the practice, experience had now removed all their doubts.

It has been already mentioned, that the evidence is not univerſally favourable, although it is in truth nearly ſo, for there are a few who entertain ſentiments differing widely from thoſe of the great majority of their brethren. The college, therefore, deemed it their duty, in a particular manner, to inquire upon what grounds and evidence the oppoſers of vaccination reſted their opinions. From perſonal examination, as well as from their writings, they endeavoured to learn the full extent and weight of their objections. They found them without experience in vaccination, ſupporting their opinions by hearſay information and hypothetical reaſoning; and, upon inveſtigating the facts which they advanced, they found them to be either miſapprehended or miſrepreſented; or that they fell under the deſcription of caſes of imperfect ſmallpox, before noticed, and which the college have endeavoured fairly to appreciate.

The practice of vaccination is but of eight years ſtanding, and its promoters, as well as opponents, muſt keep in mind, that a period ſo ſhort is too limited to aſcertain every point, or to bring the art to that perfection of which it may be capable. The truth of this will readily be admitted by thoſe acquainted with the hiſtory of inoculation for the ſmallpox. Vaccination is now, however, well underſtood, and its character accurately deſcribed. Some deviations from the uſual courſe have occaſionally occurred, which the author of the practice has called ſpurious cowpox, by which the public have been miſled, as if there were a true and a falſe cowpox; but it appears, that nothing more was meant, than to expreſs irregularity or difference from that common form and progreſs of the vaccine puſtule from which its efficacy is inferred. Thoſe who perform vaccination ought therefore to be well inſtructed, and ſhould have watched with the greateſt care the regular progreſs of the puſtule, and learnt the moſt proper time for taking the matter. There is little doubt that ſome of the failures are to be imputed to the inexperience of the early vaccinators, and it is not unreaſonable to expect that farther obſervation will yet ſuggeſt many improvements that will reduce the number of anomalous caſes, and furniſh the means of determining, with greater preciſion, when the vaccine diſeaſe has been effectually received.

Though the college of phyſicians have confined themſelves in eſtimating the evidence to ſuch facts as have occurred in their own country, becauſe the accuracy of them could beſt be aſcertained, they cannot be inſenſible

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ble to the confirmation these receive from the reports of the successful introduction of vaccination, not only into every part of Europe, but throughout the vast continents of Asia and America.

IV. Several causes have had a partial operation in retarding the general adoption of vaccination; some writers have greatly undervalued the security it affords, while others have considered it to be of a temporary nature only; but if any reliance is to be placed on the statements which have been laid before the college, its power of protecting the human body from the smallpox, though not perfect indeed, is abundantly sufficient to recommend it to the prudent and dispassionate, especially as the smallpox, in the few instances where it has subsequently occurred, has been generally mild and transient. The opinion that vaccination affords but a temporary security is supported by no analogy in nature, nor by the facts which have hitherto occurred. Although the experience of vaccine inoculation be only of a few years, yet the same disease, contracted by the milkers of cows in some districts, has been long enough known, to ascertain that, in them at least, the unsusceptibility of the smallpox contagion does not wear out by time.

Another cause, is the charge against vaccination of producing various new diseases of frightful and monstrous appearance. Representations of some of these have been exhibited in prints in a way to alarm the feelings of parents, and to infuse dread and apprehension into the minds of the uninformed. Publications with such representations have been widely circulated, and though they originate either in gross ignorance, or wilful misrepresentation, yet they have lessened the confidence of many, particularly of the lower classes, in vaccination; no permanent effects, however, in retarding the progress of vaccination, need be apprehended from such causes, for, as soon as the public shall view them coolly and without surprise, they will excite contempt, and not fear.

Though the college of physicians are of opinion that the progress of vaccination has been retarded in a few places by the above causes, yet they conceive that its general adoption has been prevented by causes far more powerful, and of a nature wholly different. The lower orders of society can hardly be induced to adopt precautions against evils which may be at a distance; nor can it be expected from them, if these precautions are attended with expence. Unless therefore, from the immediate dread of epidemic smallpox, neither vaccination nor inoculation appear at any time to have been general, and when the cause of terror has passed by, the public have relapsed again into a state of indifference and apathy, and the salutary practice has come to a stand. It is not easy to suggest a remedy for an evil so deeply imprinted in human nature. To inform and instruct the public mind may do much, and it will probably be found that the progress of vaccination in different parts of the united kingdom will be in proportion to that instruction. Were encouragement given to vaccination, by offering it to the poorer classes without expence, there is little doubt but it would in time supersede the inoculation for the smallpox, and thereby various sources of variolous infection would be cut off; but till vaccination becomes general, it will be impossible to prevent the constant recurrence of the natural smallpox by means of those who are inoculated, except it should appear proper to the legislature to adopt, in its wisdom, some measure by which those who still, from terror or prejudice, prefer the smallpox to the vaccine disease, may, in thus consulting the gratification of their own feelings, be prevented from doing mischief to their neighbours.

From the whole of the above considerations, the college of physicians feel it their duty strongly to recommend the practice of vaccination. They have been led to this conclusion by no preconceived opinion, but by the most unbiassed judgment, formed from an irresistible weight of evidence which has been laid before them. For when the number, the respectability, the disinterestedness, and the extensive experience of its advocates, is compared with the feeble and imperfect testimonies of its few opposers; and when it is considered that many, who were once adverse to vaccination, have been convinced by further trials, and are now to be ranked among its warmest supporters, the truth seems to be established as firmly as the nature of such a question admits; so that the college of physicians conceive that the public may reasonably look forward with some degree of hope to the time when all opposition shall cease, and the general concurrence of mankind shall at length be able to put an end to the ravages at least, if not to the existence, of the smallpox.

LUCAS PEPYS, PRESIDENT.

Royal College of Physicians,
10th of April, 1807.

JA. HERVEY, *Register.*

APPENDIX.

N° I.

To the Royal College of PHYSICIANS of London.

GENTLEMEN,

I am ordered by the King and Queen's College of Physicians, in Ireland, to thank the Royal College of Physicians of London for the communication they have had the honour to receive from them, of certain propositions relative to vaccination, whereon his majesty has been pleased to direct an inquiry to be instituted, and in the prosecution of which, the co-operation of the college in Ireland is requested.

And I am directed to acquaint you, that the said college having referred the investigations of these propositions to a committee, have received from them a report, of which the inclosed is a copy; and that they desire the same may be considered as containing their opinion upon the subject.

I have the honour to be,

Gentlemen,

Your most obedient humble servant,

HUGH FERGUSON, *Register.*

By order of the King and Queen's College of Physicians in Ireland.

Dublin, 11th *Nov.* 1806.

"The practice of vaccination was introduced into this

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this city about the beginning of the year 1801, and appears to have made inconfiderable progrefs at firft. A variety of caufes operated to retard its general adoption, amongft which the novelty of the practice, and the extraordinary effects attributed to vaccination, would naturally take the lead.

"Variolous inoculation had been long, almoft exclufively, in the hands of a particular branch of the profeffion, whofe prejudices and interefts were ftrongly oppofed to the new practice; and by their being the ufual medical attendants in families, and efpecially employed in the difeafes of children, their opinions had greater effect upon the minds of parents. The fmallpox is rendered a much lefs formidable difeafe in this country by the frequency of inoculation for it, than it is in other parts of his majefty's dominions, where prejudices againft inoculation have prevailed; hence parents, not unnaturally, objected to the introduction of a new difeafe, rather than not recur to that, with the mildnefs and fafety of which they were well acquainted.

"In the beginning of the year 1804, the cowpox inftitution was eftablifhed under the patronage of the earl of Hardwicke, and it is from this period that we may date the general introduction of vaccination into this city, and throughout all parts of Ireland.

"The fuccefs of the inftitution, in forwarding the new practice, is to be attributed in a great meafure to the refpectability of the gentlemen who fuperintended it, and to the diligence, zeal, and attention of Dr Labatt, their fecretary and inoculator. In order to fhew the progrefs which has been made in extending vaccination, your committe refer to the reports of the Cowpox Inftitution for the laft two years, and to extracts from their regifter for the prefent year.

	Patients Inoculated.	*Packets iffued to Practitioners in general.*	*Packets to Army Surgeons.*
1804	578	776	236
1805	1032	1124	178
1806	1356	1340	220
Total	2966	3240	634

"In the above ftatement, the numbers are averaged to the end of the prefent year, on the fuppofition of patients reforting to the inftitution as ufual. The correfpondence of the inftitution appears to be very general throughout every part of Ireland, and by the accounts received, as well from medical practitioners as others, the fuccefs of vaccination feems to be uniform and effectual. At the prefent period, in the opinion of your committee, there are few individuals in any branch of the profeffion, who oppofe the practice of vaccination in this part of his majefty's dominions.

"It is the opinion of your committee, that the practice of cowpox inoculation is fafe, and that it fully anfwers all the purpofes that have been intended by its introduction. At the fame time, your committee is willing to allow that doubtful cafes have been reported to them as having occurred, of perfons fuffering from fmallpox, who had been previoufly vaccinated. Upon minute inveftigation, however, it has been found, that thefe fuppofed inftances originated generally in error, mifreprefentation, or the difficulty of difcriminating between fmallpox and other eruptions, no cafe having come to the knowledge of your committee, duly authenticated by refpectable and competent judges, of genuine fmallpox fucceeding the regular vaccine difeafe.

Variola.

"The practice of vaccination becomes every day more extended; and, when it is confidered that the period at which it came into general ufe in Ireland is to be reckoned from fo late a date, your committee is of opinion, that it has made already as rapid a progrefs as could be expected.

(Signed) "James Cleghorn.
"Daniel Mills.
"Hugh Ferguson."

N° II.

Phyficians Hall, Edinburgh 26th Nov. 1806.

Gentlemen,

THE Royal College of Phyficians of Edinburgh have but little opportunity themfelves of making obfervations on vaccination, as that practice is entirely conducted by furgeon apothecaries, and other medical practitioners not of their college, and as the effects produced by it are fo inconfiderable and flight, that the aid of a phyfician is never required.

The College know that in Edinburgh it is univerfally approved of by the profeffion, and by the higher and middle ranks of the community; and that it has been much more generally adopted by the lower orders of the people than ever the inoculation for fmallpox was, and they believe the fame to obtain all over Scotland.

With regard to any caufes which have hitherto prevented its general adoption, they are acquainted with none except the negligence or ignorance of parents among the common people, or their miftaken ideas of the impropriety or criminality of being acceffary to the production of any difeafe among their children, or the difficulty or impoffibility, in fome of our country diftricts, of procuring vaccine matter, or a proper perfon to inoculate.

The evidence in favour of vaccination appeared to the Royal College of Phyficians of Edinburgh fo ftrong and decifive, that in May laft, they fpontaneoufly and unanimoufly elected Dr Jenner an honorary fellow of their college;—a mark of diftinction which they very rarely confer, and which they confine almoft exclufively to foreign phyficians of the firft eminence.

They did this with a view to publifh their opinion with regard to vaccination, and in teftimony of their conviction of the immenfe benefits which have been, and which will in future be derived to the world, from inoculation for the cowpox, and as a mark of their fenfe of Dr Jenner's very great merits and ability in introducing and promoting this invaluable practice.

I have the honour to be,
Gentlemen,
Your moft obedient humble fervant,
Th. Spens, *C. R. M. Ed. Pr.*

To the Royal College of
Phyficians of London.

N° III.

N° III.

At a ſpecial court of aſſiſtants of the Royal College of Surgeons, convened by order of the Maſter, and holden at the College on Tueſday the 17th day of March 1807;

Mr Governor Lucas in the chair:

Mr Long, as chairman of the board of curators, reported, that the board are now ready to deliver their report on the ſubject of vaccination.

It was then moved, ſeconded, and reſolved, that a report from the board of curators, on the ſubject of vaccination, which was referred to their conſideration by the court of aſſiſtants, on the 21ſt day of November laſt, be now received.

Mr Long then delivered to Mr Governor Lucas (preſiding in the abſence of the maſter) a report from the board of curators.

It was then moved, ſeconded, and reſolved, that the report, delivered by Mr Long, be now read; and it was read accordingly, and is as follows.

To the Court of Aſſiſtants of the Royal College of Surgeons in London.

THE report of the Board of Curators, on the ſubject of vaccination, referred to them by the court, on the 21ſt day of November 1806; made to the court on the 17th of March 1807.

THE court of aſſiſtants having received a letter from the Royal College of Phyſicians of London, addreſſed to this college, ſtating, that his majeſty had been graciouſly pleaſed, in compliance with an addreſs from the honourable Houſe of Commons, to direct his Royal College of Phyſicians of London to enquire into the ſtate of vaccination in the united kingdom, to report their obſervations and opinion upon that practice, upon the evidence adduced in its ſupport, and upon the cauſes which have hitherto retarded its general adoption; that the college were then engaged in the inveſtigation of the ſeveral propoſitions thus referred to them, and requeſting this college to co-operate and communicate with them, in order that the report thereupon might be made as complete as poſſible.

And having, on the 21ſt day of November laſt, referred ſuch letter to the conſideration of the board of curators, with authority to take ſuch ſteps reſpecting the contents thereof as they ſhould judge proper, and report their proceedings thereon, from time to time, to the court: the board proceeded with all poſſible diſpatch to the conſideration of the ſubject.

The board being of opinion, that it would be proper to addreſs circular letters to the members of this college, with a view of collecting evidence, they ſubmitted to the conſideration of the court, holden on the 15th day of December laſt, the drafts of ſuch letter as appeared to them beſt calculated to anſwer that end; and the ſame having been approved by the court, they cauſed copies thereof to be ſent to all the members of the college in the united kingdom, whoſe reſidence could be aſcertained, in the following form; viz.

"Sir,

"The Royal College of Surgeons being deſirous to co-operate with the Royal College of Phyſicians of London, in obtaining information reſpecting vaccination, ſubmit to you the following queſtions, to which the favour of your anſwer is requeſted.

"By order of the Court of Aſſiſtants,

"Okey Belfour, *Secretary.*"

Lincoln's-Inn-Fields,
Dec. 15. 1806.

"1ſt, How many perſons have you vaccinated?

"2d, Have any of your patients had the ſmallpox after vaccination? In the caſe of every ſuch occurrence, at what period was the vaccine matter taken from the veſicle? How was it preſerved? How long before it was inſerted? What was the appearance of the inflammation? And what the interval between vaccination and the variolous eruption?

"3d, Have any bad effects occurred in your experience in conſequence of vaccination? And if ſo, what were they?

"4th, Is the practice of vaccination increaſing or decreaſing in your neighbourhood? If decreaſing, to what cauſe do you impute it?"

To ſuch letters the board have received 426 anſwers: and the following are the reſults of their inveſtigation:

The number of perſons, ſtated in ſuch letters to have been vaccinated, is 164,381.

The number of caſes in which ſmallpox had followed vaccination is 56.

The board think it proper to remark under this head, that, in the enumeration of caſes in which ſmallpox has ſucceeded vaccination, they have included none but thoſe in which the ſubject was vaccinated by the ſurgeon reporting the facts.

The bad conſequences which have ariſen from vaccination are, eruptions of the ſkin in 66 caſes, and inflammation of the arm in 24 inſtances, of which three proved fatal.

Vaccination, in the greater number of counties from which reports have been received, appears to be increaſing; it may be proper, however, to remark, that, in the metropolis, it is on the decreaſe.

The principal reaſons aſſigned for the decreaſe are,

Imperfect vaccination.
Inſtances of ſmallpox after vaccination.
Suppoſed bad conſequences.
Publications againſt the practice.
Popular prejudices.

And ſuch report having been conſidered, it was moved, ſeconded, and

Reſolved, That the report now read be adopted by this court, as the anſwer of the court to the letter of the Royal College of Phyſicians, of the 23d day of October laſt, on the ſubject of vaccination.

Reſolved, That a copy of theſe minutes and reſolutions, ſigned by Mr Governor Lucas (preſiding at this court in the preſence of the maſter) be tranſmitted by the ſecretary to the regiſter of the Royal College of Phyſicians.

(Signed) Wm. Lucas.

N° IV.

N° IV.

Sir, *Edinburgh, March* 3, 1807.

I mentioned in my former letter, that I would take the earliest opportunity of laying before the Royal College of Surgeons of Edinburgh, the communication with which the Royal College of Physicians of London had honoured them, on the 23d of October last:

I am now directed by the Royal College to send the following answer on that important subject.

The practice of vaccine inoculation, both in private, and at the vaccine institution established here in 1801, is increasing so rapidly, that for two or three years past, the smallpox has been reckoned rather a rare occurrence, even among the lower orders of the inhabitants of this city, unless in some particular quarters about twelve months ago; and, among the higher ranks of the inhabitants, the disease is unknown.

The members of the Royal College of Surgeons have much pleasure in reporting, that, as far as their experience goes, they have no doubt of the permanent security against the smallpox which is produced by the constitutional affection of the cowpox; and that such has hitherto been their success in vaccination, as also to gain for it the confidence of the public, insomuch that they have not been required, for some years past, to inoculate any person with smallpox who had not previously undergone the inoculation with the cowpox.

The members of the Royal College have met with no occurrence in their practice of cowpox inoculation, which could operate in their minds to its disadvantage; and they beg leave particularly to notice, that they have seen no instance of obstinate eruptions, or of new and dangerous diseases, which they could attribute to the introduction among mankind of this mild preventive of smallpox. The Royal College of Surgeons know of no causes which have hitherto retarded the adoption of vaccine inoculation here; on the contrary, the practice has become general within this city; and from many thousand packets of vaccine matter having been sent by the members of the Royal College, and the vaccine institution here, to all parts of the country, the Royal College have reason to believe that the practice has been as generally adopted throughout this part of the united kingdom as could have been expected from the distance of some parts of the country from proper medical assistance, and other circumstances of that nature.

I have the honour to be,
Sir,
Your most obedient servant,
WM FARQUHARSON,
President of the Royal College and Incorporation of Surgeons of Edinburgh.

N° V.

Royal College of Surgeons in Ireland,
Sir, *Dublin, Februry 4th,* 1807.

I am directed to transmit to you the inclosed report of a committee of the College of Surgeons in Ireland, to whom was referred a letter from the Royal College of Physicians in London, relative to the present state of vaccination in this part of the united kingdom; and to state, that the College of Surgeons will be highly gratified by more frequent opportunities of corresponding with the English College of Physicians on any subject which may conduce to the advancement of science, and the welfare of the public.

I have the honour to be,
Sir,
Your most obedient humble servant,
JAMES HENTHORN, *Secretary.*

At a meeting of the Royal College of Surgeons in Ireland, holden at their Theatre, on Tuesday the 13th day of January 1807.

FRANCIS M'EVOY, ESQ. *President.*

Mr Johnson reported from the committee, to whom was referred a letter from the College of Physicians, London, relative to the present state of vaccination in the united kingdom, &c. &c. that they met, and came to the following resolutions:

That it appears to this committee, That inoculation with vaccine infection is now very generally adopted by the surgical practitioners in this part of the united kingdom, as a preventive of smallpox.

That it appears to this committee, that from the 25th day of March 1800 to the 25th of November 1806, 11,504 persons have been inoculated with vaccine infection at the dispensary for infant poor, and 2831 at the cowpox institution, making a total of 14,335, exclusive of the number inoculated at hospitals and other places, where no registry is made and preserved.

That it is the opinion of this committee, that the cowpox has been found to be a mild disease, and rarely attended with danger, or any alarming symptom, and that the few cases of smallpox which have occurred in this country, after supposed vaccination, have been satisfactorily proved to have arisen from accidental circumstances, and cannot be attributed to the want of efficacy in the genuine vaccine infection as a preventive of smallpox.

That it is the opinion of this committee, that the causes which have hitherto retarded the more general adoption of vaccination in Ireland, have, in a great measure, proceeded from the prejudices of the lower classes of the people, and the interest of some irregular practitioners.

To which report the College agreed.

Extract from the minutes,
JAMES HENTHORN, *Secretary.*

After this report, we cannot help thinking that the British legislature would be fully warranted for passing an act prohibiting the inoculation of smallpox under very severe penalties, and ordering all those who may be subjected to smallpox by accidental contagion to be confined to lazarettos, or at least to their own houses, under a proper guard, to prevent the communication of infection, till their complete recovery. By such an act, there is good ground to believe, that the loathsome and dangerous disease of smallpox would in a few years be exterminated in Britain.

But

Exanthemata.

But although providence has thus furnished mankind with an easy mode of preserving their offspring from the danger of smallpox, by the inoculation of the cow-pox at an early period of life, yet not a few deaths from the natural smallpox have occurred in Britain even during the course of the present year.

When the preventive has not been duly employed, after the contagion of variola is introduced into the body, nothing yet known will prevent the disease from running its course, either under the mild or confluent form; and the endeavours of the medical practitioner are altogether to be employed in rendering that course as favourable as possible by mitigating symptoms.

In the mild or distinct smallpox, the strictest antiphlogistic regimen is to be enjoined. Gentle refrigerant cathartics are often useful, and mild diluents should be copiously employed. Under these remedies the disease will generally run its course without much inconvenience. But it will sometimes be necessary to employ remedies for obviating particular urgent symptoms, such as gargarisms or blisters for affections of the throat.

In the malignant smallpox, besides the same refrigerant plan of cure which is best accommodated to the mild, as the secondary fever shews evident marks of a putrid tendency, it is necessary to employ those remedies which are accommodated to typhus, and accordingly recourse is not only had to opiates and cardiacs, but to wine, cinchona, and the mineral acids.

Genus XXIX. VARICELLA.

226 *Chickenpox.*

Varicella, *Vog.* 42.
Variola lymphatica, *Sauv.* sp. 1.
Anglis, *The Chickenpox*, Edin. Med. Essays, vol. ii. art. 2. near the end. *Heberden*, Med. Transact. art. 17. *The Watery-Pox.*

This is in general a very slight disease; and is attended with so little danger, that it would not merit any notice, if it were not apt to be confounded with the smallpox, and thus give occasion to an opinion that a person might have the smallpox twice in his life; or they are apt to deceive into a false security those who have never had the smallpox, and make them believe that they are safe when in reality they are not. This eruption breaks out in many, according to Dr Heberden, without any illness or previous sign; in others it is preceded by a slight degree of chilness, lassitude, cough, broken sleep, wandering pains, loss of appetite, and feverish state for three days.

In some patients the chickenpox make their first appearance on the back; but this perhaps is not constant. Most of them are of the common size of the smallpox, but some are less. Dr Heberden never saw them confluent, nor very numerous. The greatest number was about 12 on the face, and 200 over the rest of the body.

On the first day of the eruption they are reddish. On the second day there is at the top of most of them a very small bladder, about the size of a millet seed. This is sometimes full of a watery and colourless, sometimes of a yellowish liquor, contained between the cuticle and skin. On the second, or, at the farthest, on the third day from the beginning of the eruption, as many of these pocks as are not broken seem arrived at their full maturity; and those which are fullest of that yellow liquor very much resemble what the genuine smallpox are on the fifth or sixth day, especially where there happens to be a larger space than ordinary occupied by the extravasated serum. It happens to most of them, either on the first day that this little bladder arises, or on the day after, that its tender cuticle is burst by the accidental rubbing of the clothes, or by the patient's hands to allay the itching which attends this eruption. A thin scab is then formed at the top of the pock, and the swelling of the other part abates, without its ever being turned into pus, as it is in the smallpox. Some few escape being burst; and the little drop of liquor contained in the vesicle at the top of them, grows yellow and thick, and dries into a scab. On the fifth day of the eruption they are almost all dried and covered with a slight crust. The inflammation of these pocks is very small, and the contents of them do not seem to be owing to suppuration, as in the smallpox, but rather to what is extravasated under the cuticle by the serous vessels of the skin, as in a common blister. It is not wonderful, therefore, that this liquor appears so soon as on the second day; and that, upon the cuticle being broken, it is presently succeeded by a slight scab: hence too, as the true skin is so little affected, no mark or scar is likely to be left, unless in one or two pocks, where, either by being accidentally much fretted or by some extraordinary sharpness of the contents a little ulcer is formed in the skin.

Varicella.

The patients scarce suffer any thing throughout the whole progress of this illness, except some languidness of strength, spirits, and appetite; all which is probably owing to the confining of themselves to their chamber.

Remedies are not likely to be much wanted in a disease attended with hardly any inconvenience, and which in so short a time is certainly cured of itself.

The principal marks by which the chickenpox may be distinguished from the smallpox are,

1. The appearance, on the second or third day from the eruption, of that vesicle full of serum upon the top of the pock.

2. The crust, which covers the pocks on the fifth day; at which time those of the smallpox are not at the height of their suppuration.

Foreign medical writers hardly ever mention the name of this distemper: and the writers of our own country scarce mention any thing more of it than its name. Morton speaks of it as if he supposed it to be a very mild genuine smallpox. But these two distempers are certainly totally different from one another, not only on account of their different appearances above mentioned, but because those who have had the smallpox are capable of being infected with the chickenpox; but those who have once had the chickenpox are not capable of having it again, though to such as have never had this distemper, it seems as infectious as the smallpox. Dr Heberden wetted a thread in the most concocted pus-like liquor of the chickenpox which he could find; and after making a slight incision, Exanthemata. ſion, it was confined upon the arm of one who had formerly had it; the little wound healed up immediately, and ſhowed no ſigns of any infection.

From the great ſimilitude between the two diſtempers, it is probable, that inſtead of the ſmallpox, ſome perſons have been inoculated from the chickenpox; and that the diſtemper which has ſucceeded, has been miſtaken for the ſmallpox by haſty or unexperienced obſervers.

There is ſometimes ſeen an eruption, concerning which Dr Heberden is in doubt whether it be one of the many unnoticed cutaneous diſeaſes, or only a more malignant ſort of chickenpox.

This diſorder is preceded for three or four days by all the ſymptoms which forerun the chickenpox; but in a much higher degree. On the fourth or fifth day the eruption appears, with a very little abatement of the fever: the pains likewiſe of the limbs and back ſtill continue, to which are joined pains of the gums. The pox are redder than the chickenpox, and ſpread wider; and hardly riſe ſo high, at leaſt not in proportion to their ſize. Inſtead of one little head or veſicle of a ſerous matter, theſe have from four to ten or twelve. They go off juſt like the chickenpox, and are diſtinguiſhable from the ſmallpox by the ſame marks; beſides which, the continuance of the pains and fever after the erruption, and the degree of both theſe, though there be not above 20 pocks, are circumſtances never happening in the ſmallpox.

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Genus XXX. RUBEOLA.

Measles.

Rubeola, *Sauv.* gen. 94. *Lin.* 4. *Sag.* 293.
Febris morbilloſa, *Vog.* 36. *Hoffm.* II. 62.
Morbilli, *Junck.* 76.

Sp. I. The *Regular Measles.*

Rubeola vulgaris, *Sauv.* ſp. 1.
Morbilli regulares, *Sydenh.* ſect. iv. cap. 5.

Var. 1. The *Anomalous Measles.*

Rubeola anomala, *Sauv.* ſp. 2.
Morbilli anomali, *Sydenh.* ſect. v. cap. 3.

Var. 2. The *Measles* attended with *Quinſy.*

Var. 3. The *Measles*, with *Putrid Diatheſis* of the Blood.

228 Sp. II. The *Variolodes.*
In Scotland commonly called the *Nirles.*

Rubeola variolodes, *Sauv.* ſp. 3.

Deſcription. This diſeaſe begins with a cold ſtage, which is ſoon followed by a hot, with the ordinary ſymptoms of thirſt, anorexia, anxiety, ſickneſs, and vomiting; and theſe are more or leſs conſiderable in different caſes. Sometimes from the beginning the fever is ſharp and violent: often, for the firſt two days, it is obſcure and inconſiderable; but always becomes violent before the eruption, which commonly happens on the fourth day. This eruptive fever, from the beginning of it, is always attended with hoarſeneſs, a frequent hoarſe dry cough, and often with ſome difficulty of breathing. At the ſame time, the eyelids are ſomewhat ſwelled; the eyes are a little inflamed, and pour out tears; and with this there is a coryza, and frequent ſneezing. For the moſt part, a conſtant drowſineſs attends the beginning of this diſeaſe. The eruption, as we have ſaid, commonly appears upon the fourth day, firſt on the face, and ſucceſſively on the lower parts of the body. It appears firſt in ſmall red points; but ſoon after, a number of theſe appear in cluſters, which do not ariſe in viſible pimples, but, by the touch, are found to be a little prominent. This is the caſe on the face; but, in other parts of the body, the prominency, or roughneſs, is hardly to be perceived. On the face, the eruption retains its redneſs, or has it increaſed, for two days; but on the third, the vivid redneſs is changed to a browniſh red; and in a day or two more the eruption diſappears, while a mealy deſquamation takes place. During the whole time of the eruption, the face is ſomewhat turgid, but ſeldom conſiderably ſwelled. Sometimes, after the eruption has appeared, the fever ceaſes entirely: but this is ſeldom the caſe; and more commonly the fever continues or is increaſed after the eruption, and does not ceaſe till after the deſquamation. Even then the fever does not always ceaſe, but continues with various duration and effect. Though the fever happen to ceaſe upon the eruption's taking place, it is common for the cough to continue till after the deſquamation, and ſometimes much longer. In all caſes, while the fever continues, the cough alſo continues, generally with an increaſe of the difficulty of breathing; and both of theſe ſymptoms ſometimes ariſe to a degree which denotes a pneumonic affection. This may happen at any period of the diſeaſe; but very often it does not come on till after the deſquamation of the eruption.

Rubeola.

After the ſame period, alſo, a diarrhœa frequently comes on, and continues for ſome time,

It is common for meaſles, even when they have not been of a violent kind, to be followed by inflammatory affections, particularly ophthalmia and phthiſis. If blood be drawn from a vein in the meaſles, with circumſtances neceſſary to favour the ſeparation of the fibrine, this always appears ſeparated, and lying on the ſurface of the craſſamentum, as in inflammatory diſeaſes. For the moſt part, the meaſles, even when violent, are without any putrid tendency; but in ſome caſes, ſuch a tendency appears both in the courſe of the diſeaſe, and eſpecially after the ordinary courſe of it is finiſhed.

Cauſes. The meaſles are occaſioned by a peculiar kind of contagion, the nature of which is not underſtood; and which, like that of the ſmallpox, affects a perſon only once in his life.

Prognoſis. From the deſcription of this diſtemper already given, it appears that the meaſles are attended with a catarrhal affection, and with an inflammatory diatheſis to a conſiderable degree; and therefore the danger of them is to be apprehended chiefly from the coming on of a pneumonic inflammation.

Cure. In meaſles, as well as in ſmallpox, the diſeaſe from its nature muſt neceſſarily run a determined courſe; and therefore the ſole aim of a practitioner is to conduct this courſe in the eaſieſt manner, by preventing and obviating urgent ſymptoms.

From the conſideration mentioned in the prognoſis, it

Exanthemata.

it will be obvious, that the remedies especially necessary are those which may obviate and diminish the inflammatory diathesis; and therefore, in a particular manner, blood-letting. This remedy may be employed at any time in the course of the disease, or after the ordinary course of it is finished. It is to be employed more or less, according to the urgency of the symptoms of fever, cough, and dyspnœa; and generally may be employed very freely. But as the symptoms of pneumonic inflammation seldom come on during the eruptive fever, and as this is sometimes violent immediately before the eruption, though a sufficiently mild disease be to follow; bleeding is seldom very necessary during the eruptive fever, and may often be reserved for the times of greater danger which are perhaps to follow.

In all cases of measles, where there are no marks of putrescency, and where there is no reason, from the known nature of the epidemic, to apprehend putrescency, bleeding is the remedy most to be depended upon: but assistance may also be drawn from cooling purgatives; and from blistering on the sides or between the shoulders. The dry cough may be alleviated by the large use of demulcent pectorals, mucilaginous, oily, or sweet. It may, however, be observed, with respect to these demulcents, that they are not so powerful in involving and correcting the acrimony of the mass of blood as has been imagined; and that their chief operation is by lubricating the fauces, and thereby defending them from the irritation of acrids, either arising from the lungs or distilling from the head. For moderating and quieting the cough in this disease, opiates certainly prove the most effectual means, whenever they can be safely employed. In the measles, in which an inflammatory state prevails in a considerable degree, opiates have indeed by some been supposed to be inadmissible: but experience abundantly demonstrates, that the objection made to their use is merely hypothetical: and even in cases where, from a high degree of pyrexia and of dyspnœa, there is reason to fear the presence, or at least the danger, of pneumonic inflammation, opiates are highly useful, after bleeding, to obviate or abate the inflammatory state, has been duly employed: in such cases, while the cough and watchfulness are the urgent symptoms, opiates may be safely exhibited, and with great advantage. In all the exanthemata, there is an acrimony diffused over the system, which gives a considerable irritation; and for obviating the effects of this, opiates are useful, and always proper, when no particular contraindication prevails.

When the desquamation of the measles is finished, though then there should be no disorder remaining, physicians have thought it necessary to purge the patient several times, with a view to draw off what have been called the *dregs of this disease;* that is, a portion of the morbific matter which is supposed to remain long in the body. Dr Cullen does not reject this supposition; but at the same time cannot believe that the remains of the morbific matter, diffused over the whole mass of blood, can be wholly drawn off by purging; and therefore thinks, that, to avoid the consequence of the measles, it is not the drawing off the morbific matter which we need to study, so much as to obviate and remove the inflammatory state of the system which had been induced by the disease. With this last view, indeed, purging may still be a proper remedy; but bleeding, in proportion to the symptoms of inflammatory disposition, is still more so.

Miliaria.

From our late experience of the use of cold air in the eruptive fever of the smallpox, some physicians have been of opinion that the practice may be transferred to the measles; but this point has not yet been determined by sufficiently extensive experience. We are certain, that external heat may be very hurtful in the measles, as in most other inflammatory diseases; and therefore, that the body ought to be kept in a moderate temperature during the whole course of the disease: but how far, at any period of the disease, cold air may be applied with safety, is still uncertain. Analogy, though so often the resource of physicians, is frequently fallacious; and further, though the analogy with the smallpox might lead to the application of cold air during the eruptive fever of the measles, the analogy with catarrh seems to be against the practice.

When the eruption is upon the skin, there are many instances of cold air making it disappear, and thereby producing much disorder in the system; and there are also frequent instances of these symptoms being removed by restoring the heat of the body, and thereby again bringing out the eruption.

Upwards of 20 years ago, inoculation for the measles was proposed, and practised in several instances with success, by Dr Home of Edinburgh. His method of communicating the infection was, by applying to an incision in each arm cotton moistened with the blood of a patient labouring under the measles; but with others who have made similar trials, the attempt has not yet succeeded. Attempts have been made to inoculate this disease by means of the fluid discharged under the form of tears, the squamæ falling from the surface and the like; but there is reason to believe, that where it was imagined the infection had thus been communicated, the contagion was only carried about the person inoculating and communicated in the ordinary way.

From inoculation of the measles, it is imagined that several advantages may be obtained; and among others, it is thought the soreness of the eyes may be mitigated, the cough abated, and the fever rendered less severe. But the practice was never much employed, and now is scarce ever heard of.

Genus XXXI. MILIARIA. 229

The *Miliary Fever*.

Miliaria, *Lin.* 7.
Miliaris, *Sauv.* gen. 95. *Sag.* gen. 295.
Febris miliaris, *Vog.* 37.
Febris purpurata rubra et alba miliaris, *Hoffm.* II. 68.
Febris purpurea seu miliaris, *Junck.* 75.
Germanis der Friesel. *God. Welsch.* Hist. Med de novo puerperarum morbo, qui der *Friesel* dicitur, Lips. 1655.
Hamilton, de febr. miliar. 1710. *Fontanus*, de febr. mil. 1747. *Allioni* de miliar. 1758. *Fordyce*, de febr. mil. 1748. *Fischer*, de febr. mil. 1767. De *Haen*, de divis. febr. 1760, et in Ration. med. passim. *Matt. Collin* ad *Baldinger* de miliar. 1764.

Miliaris

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Miliaria.

Miliaris benigna, *Sauv.* sp. 1.
Miliaris maligna, *Sauv.* sp. 2.
Miliaris recidivans, *Sauv.* sp. 3.
Miliaris Germanica, *Sauv.* sp. 5.
Miliaris Boia, *Sauv.* sp. *a.*
Miliaris Britannica, *Sauv.* sp. *i.*
Miliaris nova febris, *Sydenh.* Sched. monit. *Sauv.* sp. *d.*
Miliaris sudatoria, *Sauv.* sp. *e.*
Miliaris nautica, *Sauv.* sp. *g.*
Miliaris purpurata, *Sauv.* sp. *h.*
Miliaris lactea, *Sauv.* sp. *c.*
Miliaris puerperarum, *Sauv.* sp. *k.*
Miliaris scorbutica, *Sauv.* sp. *l.*
Miliaris critica, *Sauv.* sp. *b.*

History and Description. This disease is said to have been unknown to the ancients, and that it appeared for the first time in Saxony about the middle of the last century. It is said to have since spread from thence into all the other countries of Europe; and since the period mentioned, to have appeared in many countries in which it had never appeared before.

From the time of its having been first taken notice of, it has been described and treated of by many different writers; and by all of them, till very lately, has been considered as a peculiar idiopathic disease. It is said to have been constantly attended with peculiar symptoms. It comes on with a cold stage, which is often considerable. The hot stage, which follows, is attended with great anxiety, and frequent sighing. The heat of the body becomes great, and soon produces profuse sweating, preceded, however, with a sense of pricking, as of pin points in the skin; and the sweat is of a peculiar rank and disagreeable odour. The eruption appears sooner or later in different persons, but at no determined period of the disease. It seldom or never appears upon the face; but appears first upon the neck and breast, and from thence often spreads over the whole body.

The eruption named *miliary*, is said to be of two kinds; the one named the *red*, the other the *white miliary*. The former, which in English is strictly named a *rush*, is commonly allowed to be a symptomatic affection; and as the latter is the only one that has any pretensions to be considered as an idiopathic disease, it is this only that we shall more particularly describe and treat of under this genus.

What is then called the *white miliary eruption*, appears at first like the red, in very small red pimples, for the most part distinct, but sometimes clustered together. Their little prominence is better distinguished by the finger than by the eye. Soon after the appearance of this eruption, and, at least, on the second day, a small vesicle is visible upon the top of the pimples. At first the vesicle is whey-coloured: but soon becomes white, and stands out like a little globule. In two or three days, these globules break, or are rubbed off; and are succeeded by small crusts, which soon after fall off in small scales. While one set of pimples takes this course, another set arises to run the same; so that the disease often continues upon the skin for many days together. Sometimes when one crop of this eruption has disappeared, another, after some interval, is produced. And it has been further observed, that in some persons there is such a disposition to this disease, that they have been affected with it several times in the course of their lives.

This disease is said to affect both sexes, and persons of all ages and constitutions: but it has been observed at all times, to affect especially, and most frequently, lying-in women.

It is often accompanied with violent symptoms, and has frequently proved fatal. The symptoms, however, attending it are very various; but no symptom, or concourse of symptoms, are steadily the same in different persons, so as to give any specific character to the disease. When the disease is violent, the most common symptoms are phrenetic, comatose, and convulsive affections, which are also symptoms of all fevers treated by a very warm regimen.

While there is such a variety of symptoms appearing in this disease, it is not to be expected that any one particular method of cure can be proposed; and, accordingly, we find in different writers different methods and remedies prescribed; frequent disputes about the most proper; and those received and recommended by some, opposed and deserted by others.

It appears, however, to Dr Cullen, very improbable, that this was really a new disease, when it was first considered as such. There are very clear traces of it in authors who wrote long before that period; and though there were not, we know that ancient descriptions were often inaccurate and imperfect, particularly with respect to cutaneous affections; and we know also that those affections which commonly appeared as symptomatic only, were often neglected, or confounded together under a general appellation.

The antecedent symptoms of anxiety, sighing, and pricking of the skin, which have been spoken of as peculiar to this disease, are, however, common to many others: and perhaps to all those in which sweatings are forced out by a warm regimen. Of the symptoms said to be concomitant of this eruption, there are none which can be affirmed to be constant and peculiar but that of sweating. This, indeed, always precedes and accompanies the eruption: and, while the miliary eruption attends many different diseases, it never, however, appears in any of these but after sweating; and in persons labouring under the same diseases it does not appear, if in such persons sweating be avoided. It is therefore probable, that the eruption is the effect of sweating: and that it is the effect of a matter not before prevailing in the mass of blood, but generated under particular circumstances in the skin itself. That it depends upon particular circumstances of the skin, is also probable from its being observed that the eruption seldom or never appears upon the face, although it affects the whole of the body besides; and that it comes upon those places especially which are more closely covered; and that it can be brought out upon particular places by external applications.

It is to be observed, that this eruptive disease differs from the other exanthemata in many circumstances, especially the following; that it is not contagious, and therefore never epidemic; that the eruption appears at no determined period of the disease; that the eruption has no determined duration; that successive eruptions frequently appear in the course of the same fever,

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fever, and that ſuch eruptions frequently recur in the courſe of the ſame perſon's life. All this renders it very probable, that, in the miliary fever, the morbific matter is not a ſubſiſting contagion communicated to the blood, and thence, in conſequence of fever and aſſimilation, thrown out upon the ſurface of the body, but a matter occaſionally produced in the ſkin itſelf by ſweating.

This concluſion is further rendered probable from hence, that, while the miliary eruption has no ſymptoms or concourſe of ſymptoms peculiar to itſelf, it, upon occaſions, accompanies almoſt every febrile diſeaſe, whether inflammatory or putrid, if theſe happen to be attended with ſweating; and from thence it may be preſumed, that the miliary eruption is a ſymptomatic affection only, produced in the manner we have ſaid.

But as this ſymptomatic affection does not always accompany every inſtance of ſweating, it may be proper to inquire, what are the circumſtances which eſpecially determine this eruption to appear? And to this Dr Cullen gives no full and proper anſwer. He cannot ſay that there is any one circumſtance which in all caſes gives occaſion to this eruption; nor can he ſay what different cauſes, in different caſes, may give occaſion to it. There is only one obſervation that can be made to the purpoſe; and it is, that theſe perſons, ſweating under febrile diſeaſes, are eſpecially liable to the miliary eruption, who have been previouſly weakened by large evacuations, particularly of blood. This will explain why it happens to lying-in women more frequently than to any other perſons; and to confirm this explanation, he has obſerved, that the eruption has happened to other women, though not in childbed, but who had been much ſubjected to a frequent and copious menſtruation, and to an almoſt conſtant *fluor albus*. He has alſo obſerved it to have happened to men in fevers, after wounds from which they had ſuffered a great loſs of blood.

Further, That this eruption is produced by a certain ſtate of debility, is, he thinks, probable, from its ſo often attending fevers of the putrid kind, which are always accompanied with great debility. It is true, that it alſo ſometimes attends inflammatory diſeaſes, when it cannot be accounted for in the ſame manner; but he believes it may be obſerved, that it eſpecially attends thoſe inflammatory diſeaſes in which the ſweats have been long protracted, or frequently repeated, and which have thereby produced a debility, and perhaps a debilitating putrid diatheſis.

That, however, the miliary eruption is not neceſſarily or even generally connected with a certain ſtate of debility, is abundantly evident from its being entirely wanting in by much the greater number of inſtances of typhoid fever, and in a variety of other diſeaſes where every poſſible degree of debility occurs: And that it is not connected with any certain ſtate of debility, ſtill farther appears, both from the condition of thoſe affected with it in different inſtances, which in point of ſtrength is very various; and likewiſe from the continuance of freſh eruptions with the ſame individual, although during that time in very different ſtates with reſpect to debility. It appears, therefore, much more probable, that it depends on ſome peculiar ſtate of the ſurface, induced by the concurring influence of certain prediſpoſing and occaſional cauſes.

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It appears ſo clearly that this eruption is always a ſymptomatic and factitious affection, that Dr Cullen is perſuaded it may be, in moſt caſes, prevented merely by avoiding ſweats. Spontaneous ſweatings, in the beginning of diſeaſes, are very rarely critical; and all ſweatings not evidently critical ſhould be prevented, or at leaſt moderated; and the promoting them, by increaſing external heat, is commonly very pernicious. Even critical ſweats ſhould hardly be encouraged by ſuch means. If, therefore, ſpontaneous ſweats ariſe, they are to be checked by the coolneſs of the chamber; by the lightneſs and looſeneſs of the bedclothes; by the perſons laying out their arms and hands; and by their taking cold drink: and in this way Dr Cullen thinks he has frequently prevented miliary eruptions, which were otherwiſe likely to have appeared, particularly in puerperal women.

But it may happen, when theſe precautions have been neglected, or from other circumſtances, that a miliary eruption does actually appear; and the queſtion will then be put, how the caſe is to be treated? This is a queſtion of conſequence; as there is reaſon to believe that the matter here generated is often of a virulent kind; it is often the offspring of putreſcency; and, when treated by increaſing the external heat of the body, it ſeems to acquire a virulence which produces thoſe ſymptoms mentioned above, and proves certainly fatal.

It has been an unhappy opinion with moſt phyſicians, that eruptive diſeaſes were ready to be hurt by cold; and that it was therefore neceſſary to cover up the body very cloſely, and thereby increaſe the external heat. We now know that this is a miſtaken opinion; that increaſing the external heat of the body is very generally miſchievous; and that ſeveral eruptions not only admit, but require the application of cold air. Dr Cullen is perſuaded, therefore, that the practice which formerly prevailed in the caſe of miliary eruptions, of covering up the body cloſely, and both by external means and internal remedies encouraging the ſweatings which accompany this eruption, was highly pernicious, and commonly fatal. He is therefore of opinion, that even when a miliary eruption has appeared, in all caſes in which the ſweating is not manifeſtly critical, we ſhould employ all the means of ſtopping the ſweating that are mentioned above; and he has ſometimes had occaſion to obſerve, that even the admiſſion of cool air was ſafe and uſeful.

This is, in general, the treatment of miliary eruptions: but at the ſame time, the remedies ſuited to the primary diſeaſe are to be employed; and therefore when the eruption happens to accompany inflammatory affections, and the fulneſs and hardneſs of the pulſe or other ſymptoms ſhow an inflammatory ſtate preſent, the caſe is to be treated by blood-letting, purging, and other antiphlogiſtic remedies.

On the other hand, when the miliary eruption attends diſeaſes in which debility and putreſcency prevail, it will be proper to avoid all evacuations, and to employ tonic and antiſeptic remedies, particularly the cinchona, cold drink, and cold air.

The moſt diſtreſſing circumſtance attending this affection, is the almoſt unſupportable ſickneſs at ſtomach which frequently occurs, and which is often obſerved to precede freſh eruptions taking place during the

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the course of the disease. With the view of counteracting and alleviating this symptom, recourse is had to wine and other cordial medicines. But with many patients nothing is found to have so much influence as the use of camphor, particularly when introduced gradually in small doses, under the form of the *mistura camphorata* of the London Pharmacopœia, or of the *emulsio camphorata* of that of Edinburgh.

Genus XXXII. SCARLATINA.

239 *Scarlet Fever.*

Scarlatina, *Sauv.* gen. 98. *Vog.* 39. *Sag.* 294. *Junck.* 75.

Sp. I. The Mild *Scarlet Fever.*

Scarlatina febris, *Sauv.* sp. 1. *Sydenham*, sect. vi. cap. 2.

Sp. II. The *Scarlet Fever* with *Ulcerated Sore Throat.*

Scarlatina anginosa. *Withering* on the Scarlet Fever.

The mild scarlet fever is described by Sydenham, who tells us that he can scarce account it a disease; and indeed nothing more seems to be necessary in the treatment of it than an antiphlogistic regimen, avoiding the application of cold air and cold drink. The disease, however, often rages epidemically, and is attended with very alarming symptoms, in which case it is called *scarlatina anginosa.*—The best description of this distemper has been published by Dr Withering in the year 1778. This disease made its appearance, we are told, at Birmingham and the neighbouring villages, about the middle of May 1778. It continued in all its force and frequency to the end of October; varying, however, in some of its symptoms, as the air grew colder. In the beginning of November it was rarely met with; but towards the middle of that month, when the air became warmer, it increased again, and in some measure resumed those appearances it possessed in the summer months, but which it had lost during the cold winds in October.

It affected children more than adults; but seldom occurred in the former under two years of age, or in the latter if they had passed their fiftieth year.

Description. With various general symptoms of fever, the patient at first complains of a dejection of spirits, a slight soreness or rather stiffness in the neck, with a sense of straitness in the muscles of the neck and shoulders, as if they were bound with cords. The second day of the fever this soreness in the throat increases, and the patients find a difficulty in swallowing: but the difficulty seems less occasioned by the pain excited in the attempt, or by the straitness of the passage, than by an inability to throw the necessary muscles into action. The skin feels hot and dry, but not hard; and the patients experience frequent, small, pungent pains, as if touched with the point of a needle. The breath is hot and burning to the lips, and thirst makes them wish to drink; but the tendency to sickness, and the exertions necessary in deglutition, are so unpleasant, that they seldom care to drink much at a time. They have much uneasiness also from want of rest during the night. In the morning of the third day, the face, neck, and breast, appear redder than usual: in a few hours this redness becomes universal; and increases to such a degree of intensity, that the face, body, and limbs, resemble a boiled lobster in colour, and are evidently swollen. Upon pressure the redness vanishes, but soon returns again. The skin is smooth to the touch, nor is there the least appearance of pimples or pustules. The eyes and nostrils partake more or less of the general redness; and in proportion to the intensity of this colour in the eyes, the tendency to delirium prevails.

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Things continue in nearly this state for two or three days longer, when the intense scarlet gradually abates, a brown colour succeeds, and the skin becoming rough, peels off in small scales. The tumefaction subsides at the same time, and the patients gradually recover their strength and appetite.

During the whole course of the disease, the pulse is quick, small, and uncommonly feeble, the urine small in quantity; the sub-maxillary glands somewhat enlarged and painful to the touch. The velum pendulum palati, the uvula, the tonsils, and gullet, as far as the eye can reach, partake of the general redness and tumefaction; but although collections of thick mucus, greatly resembling the specks or sloughs in the putrid sore throat, sometimes occur, yet those are easily washed off; and real ulcerations of those parts were never observed.

These are the most usual appearances of this disorder; but it too frequently assumes a much more fatal form. In some children the delirium commences in a few hours after the first attack; the skin is intensely hot; the scarlet colour appears on the first or second day, and they die very early on the third. Others again, who survive this rapid termination, instead of recovering, as is usual, about the time the skin begins to get its natural colour, fall into a kind of lingering, and die at last in the course of six or eight weeks.

In adults, circular livid spots were frequently observed about the breast, knees, and elbows; also large blotches of red, and others of white intermixed, and often changing places.

In the month of October, when the air became colder, the scarlet colour of the skin was both less frequent and less permanent. Many patients had no appearance of it at all; while others, especially adults, had a few minute red pimples, crowned with white pellucid heads. The inside of the throat was considerably tumefied, its colour a dull red, sometimes tending to a livid. The pulse beat in general 130 or 140 strokes in a minute; was small, but hard, and sometimes sufficiently so to justify the opening of a vein; and the blood thus taken away, in every instance, when cool, appeared sizy, and the whole crassamentum firm.

Happy would it be, Dr Withering observes, if the baneful influence of this disorder terminated with the febrile symptoms. But in ten or fifteen days from the cessation of the fever, and when a complete recovery might be expected, another train of symptoms occurs, which at last frequently terminate fatally. The patients, after a few days amendment, feel a something that prevents their farther approach to health;

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health; an unaccountable languor and debility prevail, a ſtiffneſs in the limbs, an accelerated pulſe, diſturbed ſleep, diſreliſh to food, and a ſcarcity of urine. Theſe ſymptoms, we are told, are ſoon ſucceeded by ſwellings of a real dropſical nature, forming ſometimes an anaſarca, and on other occaſions an aſcites; and not unfrequently ſcarlatina has proved fatal, from ſupervening hydrothorax in conſequence of the effuſion of water into the cheſt. It is unneceſſary to remark, that when this happens, a fatal termination is more ſudden than from any other modification of dropſy.

Dr Withering, after examining the accounts given of this diſeaſe by different authors, proceeds to the diagnoſis. It may be diſtinguiſhed, he obſerves, from the petechial fever, by the eruption in the latter appearing ſeldom before the fourth day, by the regularity and diſtinctneſs of the ſpots, and by its principally occupying the neck, the back, and the loins. On the other hand, in the ſcarlet fever, the eruption generally appears about the third day; and conſiſts either of broad blotches, or elſe one continued redneſs, which ſpreads over the face and the whole body.

In the fever called *purpura*, the puſtules are prominent, keep their colour under preſſure, and never appear early in the diſeaſe; whereas in the ſcarlet fever, the eruption appears more early, is not prominent, but perfectly ſmooth to the touch, and becomes quite white under preſſure.

Although the *purple fever* and *ſcarlatina* may be connected by ſome general cauſe, yet our author takes occaſion to obſerve, that they cannot be mere modifications of the ſame eruption: for examples occur, he ſays, of the ſame perſon being firſt ſeized with one of theſe diſorders, and afterwards with the other; but he never met with an inſtance of the ſame perſon having the ſcarlet fever twice; and he believes it to be as great an improbability as a repetition of the ſmallpox.

This diſorder is particularly diſtinguiſhed from the *meaſles*, we are told, by the want of that cough, watery eye, and running at the noſe, which are known to be the predominant ſymptoms in the early ſtate of the meaſles, but are never known to exiſt in the ſcarlatina.

From the *eryſipelas* this diſeaſe is diſtinguiſhable, by the limited ſeat of the former, together with its not being contagious.

The *cynanche maligna*, however, is, according to Dr Withering, more difficult to diſtinguiſh from this diſeaſe than any other; and yet the diſtinction is, he thinks, a matter of the greateſt importance, as the method of treatment, according to him, ought to be extremely different.—Although, in a number of circumſtances, theſe two diſeaſes bear a very great reſemblance, yet, with a little attention, the one may in general, he thinks, be diſtinguiſhed from the other. From Dr Fothergill's account of the ſore throat attended with ulcers, our author has made out the following characteriſtical circumſtances of the two diſeaſes, contraſted to one another.

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Scarlatina Anginoſa.	Angina Gangrenoſa.
Seaſon. . Summer . . Autumn.	*Seaſon.* . Spring . . Winter.
Air. . Hot . . Dry.	*Air.* . Warm . . Moiſt.
Places. High . . Dry . . . Gravelly.	*Places.* Cloſe. . Low . . Damp. . Marſhy.
Subjects. Vigorous. Both ſexes alike. . Robuſt in moſt danger. . . .	*Subjects.* Delicate . . Women and female children. Robuſt adults not in danger.
Skin. Full ſcarlet . . . . ſmooth . . If pimply, the pimples white at the top . . Always dry and hot.	*Skin.* Red tinct . . pimply. . The pimples redder than the interſtices . . bedewed with ſweat towards morning.
Eyes. Shining, equable, intenſe redneſs, rarely watery.	*Eyes.* Inflamed and watery, or ſunk and dead.
Throat. In ſummer, tonſils, &c. little tumefied; no ſlough . . In autumn, more ſwelled. Integuments ſeparating . . Sloughs white.	*Throat.* Tonſils, &c. conſiderably ſwelled and ulcerated . . . Sloughs dark brown.
Breath. Very hot, but not fetid.	*Breath.* Offenſive to the patients and aſſiſtants.
Voice. In ſummer, natural.	*Voice.* Flat and rattling.
Bowels. Regular at the acceſſion.	*Bowels.* . Purging at the acceſſion.
Blood. Buffy. . Firm.	*Blood.* . Florid . . *Tender.*
Termination. The 3d, 5th, 8th, or 11th day.	*Termination.* No ſtated period.
Nature. Inflammatory.	*Nature.* Putrid.

It is not pretended, Dr Withering remarks, that all the above-contraſted ſymptoms will be met with in every caſe. It is enough, he obſerves, that ſome of them appear; and that if, conjoined with the conſideration of the prevailing conſtitution, they enable us to direct that mode of treatment which will moſt contribute to the relief of the ſick.

But notwithſtanding the attention which Dr Withering has beſtowed upon this ſubject, we are ſtill decidedly of opinion, that the diſeaſe which he has ſo accurately deſcribed under the title of *ſcarlatina anginoſa*, is in reality the ſame affection with the malignant ulcerous ſore throat of Huxham and Fothergill. During different epidemics, this diſeaſe, like ſmallpox and meaſles in different ſeaſons, is conſiderably varied in its appearance. But ſtill there occurs ſuch a ſimilarity as clearly marks the ſameneſs of the affection. And indeed this, as in the caſe of the ſmallpox, is abundantly demonſtrated by infection from one contagion giving protection againſt ſucceeding ones, although the appearances be much varied. This has particularly appeared at Edinburgh, where the diſeaſe has of late prevailed as an epidemic on five different years, viz. 1774-75, 1782-83, 1789-90, 1797-98, and 1804-5. During the firſt of theſe occaſions, in the greater part of patients, the ſore throats were of a very gangrenous and malignant nature: during the ſecond, the diſeaſe more commonly appeared under the form of what might be called *ſimple ſcarlatina*: and during the other epidemics, the contagion was, if we may be allowed the expreſſion, of an intermediate nature. But it is farther to be remarked, that during every one of thoſe epidemics, when ſeveral children of a family were at the ſame time ſubjected

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Cauſes. 1. Dr Withering affirms, that the immediate cauſe of this diſeaſe is a poiſon of a peculiar kind communicable by contagion.

2. That this poiſon firſt takes poſſeſſion of the mucous membrane lining the fauces and the noſe; and either by its action upon the ſecretory glands, or upon the mucus itſelf, aſſimilates that mucus to its own nature,

3. That it is from this beginning, and from this only, that it ſpreads to the ſtomach, &c. and at length acts upon the ſyſtem at large.

4. That its firſt action upon the nerves is of a ſedative or debilitating nature.

5. That in conſequence of certain laws of the nervous ſyſtem, when the debilitating effects operate upon the ſenſorium commune, a reaction takes place; and that this reaction is, *cæteris paribus*, proportioned to the debilitating power.

6. That, in conſequence of this reaction of the nervous ſyſtem, the vibratory motion of the capillary blood-veſſels dependant thereon is greatly increaſed; an unuſually large quantity of blood is accumulated in thoſe veſſels; the heart and large blood-veſſels are deprived of their cuſtomary proportion; and hence, though ſtimulated to more frequent contraction, the pulſe muſt neceſſarily be feeble.

7. That as violent exertions are followed by debility, upon the ceſſation of the fever, the capillary veſſels, which had acted with ſuch unuſual violence, are left in a ſtate of extreme debility, and are long in recovering their tone; hence it is that ſo many patients afterwards become dropſical.

Dr Withering next proceeds to the conſideration of the different remedies, which either are at preſent in common uſe, or have been recommended as proper in this diſeaſe.

Cure. Blood-letting has been recommended by authors; but ſuch was the ſtate of the pulſe in this diſorder, at leaſt during the ſummer months, that it was not in any inſtance thought adviſable to take away blood. In ſome caſes, indeed, where the fiery redneſs of the eyes ſeemed to demand the uſe of leeches, they were had recourſe to, but never with any advantage. In the harveſt months, when the pulſe was more firm, and when ſuffocation ſeemed to be threatened from the ſwelling in the fauces, blood-letting was ſometimes adviſed; but ſtill with leſs advantage than

one would have expected in almoſt any other ſituation. Scarlatina.

Vomiting.] This, Dr Withering obſerves, ſeems to be the remedy of nature; and he is ſurpriſed how it ſhould have been omitted by ſeveral authors who have gone before him. Vomiting, he ſays, moſt amply fulfils the indications ariſing both from a conſideration of the cauſe and of the effects; and a liberal uſe of the remedy he holds forth as the true foundation for ſucceſsful practice in ſcarlet fever and ſore throat. His common form of emetic is a combination of tartar emetic and ipecacuanha, given in pretty ſmart doſes; and theſe are to be repeated at leaſt once in 48 hours, and in the worſt caſes ſo often as twice in 24 hours.

Purging.] The action of purgatives is conſidered by Dr Withering as altogether repugnant to the curative indications in this diſeaſe: for the poiſons, as formerly remarked, being received into the ſyſtem by the fauces, the operation of a purge, inſtead of diſcharging it, can only promote its diffuſion along the alimentary canal; and, in fact, we are told, that when even a ſpontaneous purging ſupervenes in this diſeaſe, the patients ſink ſo amazingly faſt, that it is not within the reach of art to ſupport them. When, however, a conſiderable quantity of acrid matter paſſing from the fauces into the ſtomach, makes its way to the rectum, a conſiderable degree of looſeneſs often takes place. And although evacuations from the ſyſtem in general by means of cathartics may be hurtful, yet patients often obtain great relief from a free diſcharge of this matter; and by diſcharging it, purgatives have the effect even of preventing an evacuation from the ſyſtem, which would otherwiſe take place.

Sudorifics. Cordials. Alexipharmics.] None of theſe remedies were found beneficial. With reſpect to cordials, Dr Withering obſerves, that although they ſeem to be indicated by the great loſs of ſtrength and feeble pulſe, yet the certain conſequence of their uſe always was, an increaſe of reſtleſſneſs, of the delirium, and of the heat.

Diuretics.] Theſe were found very beneficial. The vegetable fixed alkali is recommended as the moſt proper article of this kind: a dram or two may be eaſily ſwallowed every 24 hours, by giving a ſmall quantity in every thing the patient drinks. Diuretics, however, have been found principally ſerviceable, by practitioners in general, in thoſe caſes where the urine is obſerved to be ſcanty, and where dropſical ſymptoms have taken place.

Cinchona.] No medicine, we are told, ever had a fairer trial in any diſeaſe than the Peruvian bark had in this epidemic; for the feeble pulſe, great proſtration of ſtrength, with here and there a livid ſpot, were thought to be ſuch undeniable evidences of a putrid tendency, that cinchona was poured down not with a ſparing hand. But this was only at firſt; for theſe livid ſpots and the ſloughs in the throat being found to be the effects of inflammation inſtead of putrefaction, and the bark inſtead of diminiſhing, rather increaſing theſe ſymptoms, it was at laſt entirely laid aſide by Dr Withering in his practice. But although cinchona may not have been ſucceſsful with a particular epidemic at a particular place; yet from the concurring teſtimony of many practitioners, it is very com-

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monly found to be productive of good effects: And there is perhaps no remedy on which greater dependance is in general put, particularly in the advanced periods of the disease, where the fœtor is considerable.

Upon the same principles that cinchona was prescribed, fixable air was at first likewise advised, but with no evident effects either one way or another. Dulcified acids were also had recourse to, but with no advantage.

Opiates.] These, although recommended by some authors for the removal of inquietude and watchfulness, yet in this epidemic, instead of effecting these purposes, always increased the distress of the patient.

Blisters.] In the summer appearance of the disease, blisters were universally detrimental; they never failed to hasten the delirium; and if the case was of the worst kind, they too often confirmed its fatal tendency. But although this may have been the case during the epidemic which Dr Withering describes, it has by no means been generally observed. On the contrary, by the early application of blisters to the external fauces, both the glandular swellings and likewise the discharge from the mouth and fauces have been much diminished; and practitioners have believed, not without probable reason, that the after-affections of the throat were less considerable than would otherwise have been the case.

Injected gargles of contrayerva decoction, sweetened with oxymel of squills, &c. were found very beneficial in bringing always large quantities of viscid ropy stuff from the fauces.

The immersion of the feet and legs in warm water, although it did no harm, yet did not either procure sleep or abate the delirium, as it frequently does in other kinds of fever.

As in summer it was found difficult to keep the patients sufficiently cool, they were ordered to lie upon a mattress instead of a feather-bed; a free circulation of air was kept up; and where the patients strength would admit of it, they were ordered frequently out of doors. Animal food and fermented liquors were denied them, and nothing allowed but tea, coffee, chocolate, milk and water, gruel, barley-water, and such articles.

With respect to the dropsical disorder which so frequently succeeds to this complaint, it was never observed, Dr Withering remarks, when the preceding symptoms had been properly treated,

When called upon to patients in the dropsical state, he began his practice by a dose of calomel at night, and a purgative in the morning. When a febrile pulse attended the other symptoms, emetics were useful, as well as the saline draughts and other neutral salts. When great debility, comatose or peripneumonic symptoms occurred, blisters were found very serviceable: but when dropsical symptoms were the principal cause of complaint, small doses of rhubarb and calomel were advised; recourse was also had to diluted solutions of fixed alkalies, squills, Seltzer waters, and other diuretics.

When the urine flows freely, steel and other tonics are recommended; together with gentle exercise, high-seasoned food, wine, and the wearing of flannel in contact with the skin.

Dr Withering concludes his essay with an enumeration of several cases, treated according to the principles above laid down. The successful termination of these cases demonstrates the propriety of the practice which he has recommended; at least for the epidemic under the form in which it then appeared.

Since Dr Withering's publication, two other practices have obtained considerable celebrity in this disease. The one is dashing cold water on the surface of the body in the manner recommended by Dr Currie in proper fevers. It is, however, very certain that although this may obviate symptoms, and particularly diminish the heat when very urgent, yet it never produces an artificial termination of the disease as some have alleged. When the contagion of scarlatina is introduced into a human body, never before subjected to the disease, it must, like smallpox and measles, run a certain course, and the attention of the practitioner must merely be employed in endeavouring to render that course as mild as he can, principally by obviating urgent symptoms.

The other remedy lately introduced, and highly commended in scarlatina anginosa, is the oxygenated muriatic acid. This has been particularly extolled by Mr John Ayrcy Braithwaite, surgeon at Lancaster. One dram of the oxygenated muriatic acid is mixed with eight ounces of distilled water. This quantity he directs to be taken by a patient at the age of puberty every day. But the quantity must be regulated by the age and situation of the patient. This remedy also is only useful as obviating symptoms, particularly the affection of the throat. But with this intention we have often employed it with great advantage.

Urticaria.

Genus XXXIII. URTICARIA. 131

Nettle-rash.

Febris urticata, *Vog.* 40.
Uredo, *Lin.* 8.
Purpura urticata, *Junck.* 75.
Scarlatina urticata, *Sauv.* sp. 2.
Erysipelatis species altera, *Sydenham*, sect. vi. cap. 6.
Febris scarlatina, et febris urticata, *Meyserey*, Mal. des armées, 291 et seq.

Description. This disease has its English name of nettle-rash from the resemblance of its eruption to that made by the stinging of nettles. These little elevations upon the skin in the nettle-rash often appear instantaneously, especially if the skin be rubbed or scratched, and seldom stay many hours in the same place, and sometimes not many minutes. No part of the body is exempt from them; and where many of them rise together, and continue an hour or two, the parts are often considerably swelled; which particularly happens in the face, arms, and hands. These eruptions will continue to infest the skin, sometimes in one place and sometimes in another, for one or two hours at a time, two or three times every day, or perhaps for the greatest part of the 24 hours.—In some persons they last only a few days, in others many months; nay, sometimes the disease has lasted for years with very short intervals.

But though the eruption of the urticaria resembles, as already observed, that produced by the stinging of nettles,

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nettles, it is fometimes accompanied with long weals, as if the part had been ftruck with a whip. Whatever be the fhape of thefe eminences, they always appear folid, without having any cavity or head containing either water or any other liquor: and this affords an eafy mark whereby this difeafe may be diftinguifhed from the itch. For it often happens, that the infufferable itching with which this eruption is attended, provokes the patient to fcratch the parts fo violently, that a fmall part of the cuticle on the top of thefe little tumors is rubbed off; a little fcab fucceeds; and, when the fwelling is gone down, there is left an appearance hardly to be diftinguifhed from the itch, but by the circumftance juft now mentioned. The nettle-rafh alfo further differs from the itch, in not being infectious.

Caufes, &c. Dr Heberden is inclined to afcribe this diftemper to fome mechanical caufe outwardly applied to the fkin. He obferves, that moft people fuffer in a fimilar manner from the real ftinging of nettles. Cowhage, or, as it is corruptly called, *cow-itch*, a fort of phafeolus, or French bean, the pod of which is covered over with a kind of down or hair, and the effect of which upon the fkin is much the fame as that of nettles; and almoft any hairs cut equally fhort, and fprinkled upon the fkin, whenever they happen to ftick in it, will make the part itch or fmart in fuch a manner as to give great uneafinefs; it is alfo a confiderable time before the fkin can be cleared of the finer ones, when once they are ftrewed upon it.

Reaumur, in the fourth memoir of his Hiftory of Infects, defcribes a fpecies of caterpillars to which belong a fort of hairs almoft invifible to the naked eye, which are eafily detached, and frequently float in the air round their neft, though it have not been at all difturbed. The touch of thefe hairs has a fimilar effect with the cow-itch; that is, they occafion intolerable itchings with little bumps and rednefs, arifing fometimes to a flight inflammation. Thefe he found would continue four or five days, if the animal or the neft had been much handled; and though they had not been touched at all, yet, by only walking near their nefts, the fame effects would be brought on, but for a fhorter time. Thefe hairs affect the fkin in this manner by fticking in it, as he could perceive with a glafs of a great magnifying power; for with one of a fmall power they were not vifible. The uneafy fenfations caufed by thefe fmall wounds, not only, as he fays, laft feveral days, but move from one part of the body to another; fo that they will ceafe upon one wrift, and immediately begin on the other; from the wrift they will go to the fingers or the face, or even to the parts of the body which are covered. He fuppofes, that the motions of the body, when much of this fine down lies near or upon the fkin, may drive it from one part to another, or change what was lying there inoffenfively to a fituation fit to make it penetrate into the fkin. Neither cold water, nor oil, nor fpirit of wine, with which the parts affected were bathed, had any effect in removing the itching. He thinks the moft efficacious remedy which he tried for this complaint was, to rub the parts ftrongly with parfley, which inftantly leffened the fenfations, and after two or three hours, entirely freed the patient from them. It is alfo well known, that many fpecies of caterpillars, by only walking over the hands, will produce fomething like this effect on the parts which they touch, and undoubtedly from the fame caufe.

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Dr Heberden afks, Is it impoffible that the nettle-rafh fhould arife from the fame caufes, or from others fimilar, which we mifs by looking too deeply for them in the blood and humours? Such, fays he, may have been its origin in fome inftances, where it has lafted only a few days; but where this affection has continued for fome years, in perfons who change their linen every day, and who bathe frequently all the time, it can hardly be afcribed to fuch an external caufe. He has obferved it frequently to arife from cantharides: but though it has continued many weeks after the removal of the blifter, yet it might be fufpected that this arofe from the fine fpiculæ of the cantharides fticking all this time about the fkin; it being cuftomary to ftrew much of the dry powder of the cantharides over the blifter-plafter, whence it may readily be carried to other parts of the body. But it is certain that fimilar effects will fometimes follow the internal ufe of wild valerian root, or the eating of fifh not fufficiently dreffed; mufcles, fhrimps, and even honey, and the kernels of fruits, will alfo fometimes produce fymptoms of a fimilar kind. But whatever be its caufe, Dr Heberden never faw any reafon to fuppofe that the nettle-rafh had in any way vitiated the humours to fuch a degree as to require the ufe of internal remedies; and if the itching could be certainly and expeditioufly allayed, there would be no occafion for any farther cure. He concludes this hiftory of the diforder with a cafe communicated to him by Dr Monfey, phyfician of Chelfea College and in which the difeafe appeared with uncommon violence.

W. A. aged near 30, of a thin fpare habit, was feized with a diforder attended with fymptoms of a very uncommon kind. Whenever he went into the air, if the fun fhined bright, he was feized with a tickling of his flefh on thofe parts expofed to the fun: this tickling, by his continuing in the air, increafed to a violent itching, attended with great heat and pain: the fkin would then be almoft as red as vermilion, and thicken like leather; and this remained till he went out of the open air, and then abated in about 15 or 20 minutes. This happened only when the fun was above the horizon; at other times he was what he called *quite well*.—But it was not owing to the heat of the fun; for the fun in winter affected him full as much, if not more, and the heat of the fire had no fuch effect. Thus he was confined to the houfe for 10 years. He tried feveral hofpitals, and had advices from many phyficians, without the leaft abatement of his complaints. At laft it was agreed by a confultation of phyficians, that he fhould try dipping in falt water; which he did at Yarmouth for 13 weeks, without any vifible amendment. One hot day, having pulled off his clothes and gone into the fea in the middle of the day, the heat diffufed itfelf fo violently all over his body that, by the time he had put on his clothes, his eyefight began to fail, and he was compelled to lie down upon the ground to fave himfelf from falling. The moment he lay down, the faintnefs went off: upon this he got up again; but had no fooner arifen, than he found himfelf in the former condition: he therefore lay down

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down again, and immediately recovered. He continued alternately getting up and lying down, till the diſorder began to be exhauſted, which was in about half an hour; and he was frequently obliged to have recourſe to the ſame expedient.

Having at laſt accidentally met with Dr Monſey, this phyſician queſtioned him concerning the cauſe of the diſorder; but nothing could be gueſſed at, excepting that the patient owned he had one winter lived entirely upon bullock's liver and porter, from inability to purchaſe better victuals. A comrade lived with him at that time, on the ſame proviſions; and he alſo was affected in a ſimilar manner, though in a leſs degree, and had recovered. This patient was then firſt put upon a courſe of Dover's ſweating powder without any effect, and afterwards tried a courſe of nitrous ones with the ſame bad ſucceſs. At laſt Dr Monſey determined to try the effect of mercury, which happily proved effectual in removing this obſtinate and uncommon diſtemper. The patient began with taking five grains of calomel for three nights running, and a cathartic next morning. In this courſe he went on for near a fortnight, at the end of which he found himſelf very ſenſibly relieved. This encouraged him to go on rather too boldly, by which means a ſlight ſalivation enſued; however, that went off ſoon, and in about ſix weeks he was quite well.—Some time after, he was threatened with a return of his diſorder; but this was effectually relieved by a doſe of calomel, which he had afterwards occaſion to repeat for the ſame reaſon, and with the ſame ſucceſs; but at laſt the diſorder ſeemed to be radically cured, by his having no further ſymptoms of a relapſe.

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Genus XXXIV. PEMPHIGUS.

Pemphigus, *Sauv.* gen. 93. *Sag.* 291.
Morta. *Lin.* 1.
Febris bulloſa, *Vog.* 41.
Pemphigus major, *Sauv.* ſp. 1.
  Exanthemata ſeroſa, *C. Piſon.* Obſ. 150.
  Febris pemphygodes, *Ephem. Germ.* D. I. A. viii. Obſ. 56.
Pemphigus caſtrenſis, *Sauv.* ſp. 2.
  Febres ſyneches, cum veſiculis per pectus et collum ſparſis, *Morton.* App. ad Exerc. II.
  Pemphigus Helveticus, *Sauv.* ſp. 3. *Langhans* in Act. Helvet. vol. ii. p. 260. et in *Beſchreibung* des Siementhals, Zurich 1753.

This is a very rare diſeaſe, inſomuch that Dr Cullen declares he never ſaw it. He declines taking the deſcriptions of foreign phyſicians: we ſhall therefore content ourſelves with giving an inſtance of this very uncommon diſtemper, as it was obſerved in the Infirmary at Aberdeen, and was treated by the late Dr David Stuart, then phyſician to that hoſpital, who ſoon after publiſhed an account of it in the Edinburgh Medical Commentaries. A private ſoldier of the 73d regiment, aged eighteen years, formerly a pedlar, and naturally of a healthy conſtitution, was received into the hoſpital at Aberdeen on the 25th of April. About twenty days before that, he had been ſeized with the meaſles when in the country; and, in marching to town, on the ſecond day of their eruption, he was expoſed to cold; upon which they ſuddenly diſappeared.

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Having arrived at Aberdeen, he was quartered in a damp, ill-aired, under-ground apartment. He then complained of ſickneſs at ſtomach, great oppreſſion about the præcordia, headach, laſſitude, and wearineſs, on the leaſt exertion; with ſtiffneſs and rigidity of his knees and other joints. The ſurgeon of the regiment viſited him: he was purged, but with little benefit. About ten days before, he obſerved on the inſide of his thighs a number of very ſmall, diſtinct, red ſpots, a little elevated above the ſurface of the ſkin, and much reſembling the firſt appearance of ſmall-pox. This eruption gradually ſpread itſelf over his whole body, and the puſtules continued every day to increaſe in ſize.

Upon being received into the hoſpital, he complained of headach, ſickneſs at ſtomach, oppreſſion about the præcordia, thirſt, ſore throat, with difficulty of ſwallowing; his tongue was foul, his ſkin felt hot and feveriſh; pulſe from 110 to 120, rather depreſſed; belly coſtive; eyes dull and languid, but without delirium. The whole ſurface of his ſkin was interſperſed with veſicles, or phlyctænæ, of the ſize of an ordinary walnut; many of them were larger, eſpecially on the arms and breaſt. In the interſtices, between the veſicles, the appearance of the ſkin was natural, nor was there any redneſs round their baſe; the diſtance from one to another was from half an inch to a hand-breadth or more. In ſome places two or three were joined together, like the puſtules in the confluent ſmall-pox. A few veſicles had burſt of themſelves, and formed a whitiſh ſcab or cruſt. Theſe were chiefly on the neck and face; others ſhowed a tolerably laudable pus. However, by far the greateſt number were perfectly entire, turgid, and of a bluiſh colour. Upon opening them, it was evident that the cuticle elevated above the cutis, and diſtended with a thin, yellowiſh, ſemi-pellucid ſerum, formed this appearance. Nor was the ſurface of the cutis ulcerated or livid; but of a red florid colour, as when the cuticle is ſeparated by a bliſter, or ſuperficial burning. No other perſon laboured under a ſimilar diſeaſe, either in the part of the country from which he came, or when he reſided in Aberdeen.

This caſe was treated in the following manner. The largeſt of the veſicles were ſnipped, and dreſſed with *unguent. è lap. calaminari.* In the evening he was vomited with a ſolution of tartar emetic, given in ſmall quantities and at intervals. This alſo procured two looſe ſtools. And he was ordered for drink, water-gruel acidulated with lemon juice.

" April 16. He ſtill complained of ſickneſs, ſome oppreſſion about his breaſt, and ſore throat; he had ſlept little during the night; his tongue was foul and blackiſh; his ſkin, however, was not ſo hot as the preceding day; his urine was high-coloured, but had the appearance of ſeparation; his pulſe 90, and ſoft; moſt of the ſores on the trunk of the body looked clean. Others, particularly where the veſicles were confluent, ſeemed beginning to ulcerate, and to have a bluiſh ſub-livid appearance. They were dreſſed afreſh with cerate, and he was ordered the following medicines:

℞ Decoct. Cort. Peruvian. ℥vj. Vini rubr. Luſitan. ℥ij. M. Hujus mixturæ capiat ℥ß. tertia quaque hora.

" His

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"His acidulated drink was continued; and on account of the very offenſive ſmell on approaching near him, ſome vinegar was placed in a baſon before the bed, and ſprinkled on the floor; and the room was kept properly aired.

"April 17. His ſores looked tolerably clean, unleſs on his arms and thighs; where they were livid, a little ulcerated, and diſcharged a bloody ichor.

"His headach, ſickneſs, &c. were almoſt gone; his tongue was rather cleaner; pulſe 68, and ſoft. As the decoction of the bark ſat eaſily on his ſtomach, the following preſcription was ordered:

℞ Pulv. ſubtiliſſ. Cort. Peruv. ℨß. Vini rubri Luſitan. Aquæ fontan. āā ℥ſs. M. ft. Hauſt. tertia quaque hora repetend.

The acidulated drink was continued, and freſh dreſſings applied to the ſores.

"April 18. The little ulcers in his arms and thighs ſtill diſcharged a bloody ichor, and looked ill; his other complaints were better; pulſe 82. The bark had not nauſeated him, and it was continued as well as his former drink.

"April 19. His ſores looked much cleaner and better; the fever was gone, his pulſe natural, and he had no complaint but weakneſs and a troubleſome itching of the ſkin: The Peruvian bark, &c. were continued.

"April 20. Some of the ulcers ſtill poured forth a bloody ichor; moſt of them, however, looked well, and had begun to heal—fever gone—medicines continued.

"From the 21ſt of April, he went on gaining ſtrength, and his ſores appeared to heal faſt; he was deſired to take only four doſes every day; and by the 27th his ſores, &c. were totally dried up—he had no complaint, and was diſmiſſed cured."

Since the publication of this caſe of pemphigus by Dr Stuart, obſervations on this diſeaſe have been publiſhed by Dr Stephen Dickſon of Dublin, in the Tranſactions of the Royal Iriſh Academy. In theſe obſervations, an account is given of ſix different caſes which Dr Dickſon has had an opportunity of ſeeing. Judging from theſe, Dr Dickſon thinks that Dr Cullen's definition of this diſeaſe requires correction; and that it ought to be defined, "a fever accompanied with the ſucceſſive eruption, from different parts of the body, internal as well as external, of veſicles about the ſize of an almond, which become turgid with a faintly yellowiſh ſerum, and in three or four days ſubſide."

From the caſes which have fallen under Dr Dickſon's obſervation, he concludes, that the diſeaſe varies conſiderably as to its mildneſs or malignity. In three of the caſes which he has ſeen, the ſymptoms were extremely mild, but in the other three ſtrong ſymptoms of putreſcency were manifeſted, and the life of the patient was in great danger. With reſpect to the method of cure, he is of opinion, that the general ſymptoms of weakneſs, and tendency to putrefaction, obviouſly point out the proper treatment. Nouriſhment muſt be ſupplied, and the Peruvian bark and wine carefully adminiſtered; and when veſicles appear on internal parts, irritation muſt be guarded againſt by opiates, demulcents, and gentle laxatives.

Some additional obſervations on the ſubject of pemphigus have lately been publiſhed in the London Medical Journal by Mr Thomas Chriſtie. From a caſe which Mr Chriſtie deſcribes, he is diſpoſed to agree with Dr Dickſon in thinking that ſometimes at leaſt pemphigus is not contagious. He remarks, however, that the pemphigus deſcribed by ſome foreign writers was extremely infectious; which he thinks may lead to a diviſion of the diſeaſe into two ſpecies, the pemphigus ſimplex and complicatus: both of which, but eſpecially the laſt, ſeem to vary much with reſpect to mildneſs and malignity.

Aphtha.

GENUS XXXV. APHTHA. 233

The *THRUSH*.

Aphtha, *Sauv.* gen. 100. *Lin.* 9. *Sag.* 298. *Boerh.* 978. *Hoffm.* II. 478. *Junck.* 137.
Febris aphthoſa, *Vog.* 44.

The only idiopathic ſpecies is the thruſh to which infants are ſubject; (Aphtha lactucimen, *Sauv.* ſp. 1.)

The aphthæ are whitiſh or aſh-coloured puſtules, invading the uvula, fauces, palate, tonſils, inſide of the cheeks, gums, tongue, and lips. They for the moſt part begin at the uvula, ſending forth a glutinous mucus, and the puſtules covering all or the greateſt number of the parts above mentioned, with a thick whitiſh cruſt adhering moſt tenaciouſly. This cruſt does not induce an eſchar on the parts on which it lies by eating into them, but comes off in whole pieces after the puſtules have arrived at maturity. This will often happen in a ſhort time, ſo that the throat and internal parts of the mouth are frequently obſerved to be clean, which a few years before were wholly covered with white cruſts. Neither is this diſeaſe confined to the throat and fauces, but is ſaid to affect the œſophagus, ſtomach, and all parts of the alimentary canal. Of this indeed there is no other proof, than that, after a great difficulty of ſwallowing, there is ſometimes an immenſe quantity of aphthæ evacuated by ſtool and vomiting, ſuch as the mouth could not be thought capable of containing.

Cauſes, &c. The aphthous fever ſeems to be produced by cold and moiſture, as it is found only in the northern countries, and eſpecially in marſhy places; and in them the aphthæ often appear without any fever at all.

Prognoſis. There is no ſymptom by which the coming out of aphthæ can be foretold, though they are common in many fevers; but they themſelves are in general a bad ſymptom, and always ſignify a very tedious diſorder: the danger denoted by them is in proportion to the difficulty of deglutition; and a diarrhœa accompanying them is likewiſe bad. This indeed generally carries off old people when they become affected with aphthæ. The dark-coloured aphthæ alſo are much more dangerous than ſuch as are of a brown or aſh colour; but it is a good ſign when the appetite returns, and the dark-coloured ones are ſucceeded by others of a whiter colour. Neither are thoſe which are unaccompanied with fever ſo dangerous as the other kind.

Cure. As the aphthæ are ſeldom a primary diſeaſe, we muſt generally endeavour to remove the diſorder upon which they depend, after which they will fall

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off; but in the mean time we are not to neglect applications to the aphthæ themselves, such as detergent and softening gargles made of the decoction of figs, with the addition of honey of roses, a little vinegar, and some tincture of myrrh.

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Hæmorrhages.

Hæmorrhagiæ, *Vog.* Class II. Ord. I. *Hoffm.* II. 194. *Junck.* 5.
Sanguifluxus, *Sauv.* Class IX. Ord. I. *Sag.* Class V. Ord. I.

235 ### Genus XXXVI. EPISTAXIS.

Bleeding at the *Nose.*

Hæmorrhagia, *Sauv.* gen. 239. *Lin.* 173. *Sag.* gen. 174.
Hæmorrhagia narium, *Hoffm.* II. 196. *Junck.* 6.
Hæmorrhagia plethorica, *Sauv.* sp. 22. *Hoffm.* II. 198.

The other species enumerated by authors are all symptomatic.

Description. The milder species of this hæmorrhage comes on more frequently in summer than in winter, and for the most part without giving any warning, or being attended with any inconvenience; but the less benign kind is preceded by several remarkable symptoms. These are, congestions of the blood sometimes in one part, and sometimes in another, and which are often very troublesome in the sides of the head: there is a redness of the cheeks; an inflation of the face, and of the vessels of the neck and temples; a *tinnitus aurium;* a heavy pain of the eyes, with a prominence, dryness, and sparks; there is a vertiginous affection of the head, with an itching of the nostrils, and a sense of weight, especially about the root of the nose. In some the sleep is disturbed with dreams about blood, fire, &c. Frequently the belly is costive, there is a diminution of the quantity of urine, a suppression of sweat, coldness of the lower extremities, and tension of the hypochondria, especially the right one.

Causes, &c. This hæmorrhage may occur at any time of life; but most commonly happens to young persons, owing to the peculiar state of the system at that time. Sometimes, however, it happens after the ακμη and during the state of manhood, at which time it is to be imputed to a plethoric state of the system; to a determination of the blood, by habit, to the vessels of the nose; or to the particular weakness of these vessels.

In all these cases the disease may be considered as an arterial hæmorrhage, and depending upon an arterial plethora; but it sometimes occurs in the decline of life, and may then be considered as the sign of a venous plethora in the vessels of the head. It often happens at any period of life in certain febrile diseases, which are altogether or partly of an inflammatory nature, and which show a particular determination of the blood to the vessels of the head. As by this evacuation, other diseases are often removed, it may on these occasions be deemed truly *critical.* It happens to persons of every constitution and temperament; but most frequently to the plethoric and sanguine, and more commonly to men than women.

Epistaxis.

Prognosis. In young people, the bleeding at the nose may be considered as a slight disease, and scarce worth notice. But, even in young persons, when it recurs very frequently and in great quantity, it is alarming; and is to be considered as a mark of an arterial plethora, which in the decline of life may give the blood a determination to parts from which the hæmorrhage would be more dangerous; and this will require more particular attention, as the marks of plethora and congestion preceding the hæmorrhage are more considerable, and as the flowing of the blood is attended with a more considerable degree of febrile disorder. These consequences are more especially to be dreaded, when the epistaxis happens to persons after their ακμη, returning frequently and violently. Even in the decline of life, however, it may be considered as in itself very salutary; but at the same time it is a mark of a dangerous state of the system, *i. e.* of a strong tendency to a venous plethora in the head, and it has accordingly been often followed by apoplexy, palsy, &c. When it happens in febrile diseases, and is in pretty large quantity, it may be generally considered as critical and salutary; but it is very apt to be too profuse, and thus becomes dangerous. It sometimes occurs during the eruptive fever of some exanthemata, and is in such cases sometimes salutary; but if these exanthemata be accompanied with any putrid disposition, this hæmorrhage, as well as artificial bloodlettings, may have a very bad tendency.

Cure. The treatment in cases of epistaxis may be referred to two heads. 1st, The treatment during the time of the discharge; and, 2dly, The treatment after the discharge is stopt, with the view of preventing the return of it. During the former of these periods, it is necessary in the first place to consider whether the discharge should be left to its natural course or stopped by artificial means. In determining this question, regard must be paid to the quantity of the discharge; the appearance of the blood; the constitution with which epistaxis occurs; the former habit of the patient; and the consequences which result from the discharge. When, from due consideration of these circumstances, there is reason to fear that further evacuation would be attended with bad consequences, though this disease has been generally thought very slight, it should seldom be left to the conduct of nature; and in all cases it should be moderated by keeping the patient in cool air, by giving cold drink, by keeping the body and head erect, by avoiding any blowing of the nose, speaking, or other irritation; and if the blood has flowed for some time without showing any tendency to stop, we are to attempt the suppression of the hæmorrhage, by pressing the nostril from which the blood flows, washing the face with cold water, or applying this to some other parts of the body. These measures Dr Cullen judges to be proper even on the first attacks, and even in young persons where the disease is in the least hazardous: but they will still be more requisite if the disease frequently recurs without any external violence; if the returns happen to persons not disposed

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disposed to a plethoric habit; and more particularly if no signs of plethora appear in the symptoms preceding the discharge.

When the bleeding is so profuse that the pulse becomes weak and the face pale, every means must be used to put a stop to it, and that whether the patient be young or old. Besides those methods above mentioned, we must use astringents both internal and external; but the latter are the most powerful, and the choice of these may be left to the surgeon. The internal astringents are either vegetable or fossil; but the vegetable astringents are seldom powerful in the cure of any hæmorrhages except those of the alimentary canal. The fossil astringents are more active, but differ considerably in strength from one another.—The chalybeates appear to have little strength: the preparations of lead are more powerful; but cannot be employed, on account of their pernicious qualities, unless in cases of the utmost danger. The *tinctura saturnina*, or *antiphthisica*, is a medicine of very little efficacy, either from the small quantity of lead it contains, or from the particular state in which it is. The safest and at the same time the most powerful astringent, seems to be alum.

For suppressing this and other hæmorrhages, many superstitious remedies and charms have been used, and said to have been employed with success. This has probably been owing to the mistake of the by-standers, who have supposed that the spontaneous cessation of the hæmorrhage was owing to their remedy. At the same time Dr Cullen is of opinion, that such remedies have sometimes been useful, by impressing the mind with horror or dread. Opiates have sometimes proved successful in removing hæmorrhages; and when the fulness and inflammatory diathesis of the system have been previously taken off by bleeding, they may, in Dr Cullen's opinion, be used with safety and advantage. Ligatures have been applied upon the limbs, for retarding the return of the venous blood from the extremities; but their use seems to be ambiguous. In the case of profuse hæmorrhages, no care is to be taken to prevent the patient from fainting, as this is often the most certain means of stopping them.

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Genus XXXVII. HÆMOPTYSIS.

Spitting of Blood.

Hæmoptysis, *Sauv.* gen. 240. *Lin.* 179. *Vog.* 84. *Sag.* gen. 175. *Junck.* 8.
Hæmoptoë, *Boerh.* 1198.
Sanguinis fluxus ex pulmonibus, *Hoffm.* II. 202.

Sp. I. *Hæmoptysis* from *Plethora.*

Sp. II. *Hæmoptysis* from *External Violence.*

Hæmoptysis accidentalis, *Sauv.* sp. 1.
Hæmoptysis habitualis, *Sauv.* sp. 2.
Hæmoptysis traumatica, *Sauv.* sp. 12.

Sp. III. *Hæmoptysis* with *Phthisis.*

Hæmoptysis phthisica, *Sauv.* sp. 9.
Hæmoptysis ex tuberculo pulmonum, *Sauv.* sp. 10.

Sp. IV. *The Calculous Hæmoptysis.*

Hæmoptysis calculosa, *Sauv.* sp. 14.

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Sp. V. *The Vicarious Hæmoptysis.*

Hæmoptysis catamenialis, *Sauv.* sp. 4.
Hæmoptysis periodica, *Sauv.* sp. 5.

Description. This hæmorrhage commonly begins with a sense of weight and anxiety in the chest, some uneasiness in breathing, pain of the breast or other parts of the thorax, and some sense of heat under the sternum: and very often it is preceded by a saltish taste in the mouth. Immediately before the appearance of blood, a degree of irritation is felt at the top of the larynx. The person attempts to relieve this by hawking, which brings up a little florid and somewhat frothy blood. The irritation returns; and in the same manner blood of a similar kind is brought up, with some noise in the windpipe, as of air passing through a fluid. Sometimes, however, at the very first, the blood comes up with coughing, or at least somewhat of coughing, and accompanies the hawking above mentioned.

The blood is often at first in very small quantity, and soon disappears; but in other cases, especially when it frequently recurs, it is in greater quantity, and often continues to appear at times for several days together. It is sometimes profuse, but rarely in such quantity as either by its excess or by a sudden suffocation to prove immediately mortal.

It is not always easy to discover whether the blood evacuated by the mouth proceeds from the internal surface of the mouth itself, from the fauces or adjoining cavities of the noise, from the stomach, or from the lungs. It is, however, very necessary to distinguish these different cases; and for this Dr Cullen offers the following considerations.

1. When the blood proceeds from some part of the internal surface of the mouth, it comes out without any hawking or coughing; and generally, upon inspection, the cause is evident.

2. When blood proceeds from the fauces, or adjoining cavities of the nose, it may be brought out by hawking, and sometimes by coughing. In this case, there may be a doubt concerning its real source, and the patient may be allowed to please himself with the thoughts that the blood does not come from the lungs. But the physician must remember that the lungs are much more frequently the source of a hæmorrhage than the fauces. The latter seldom happens but to persons who have before been liable to a hæmorrhage from the nose, or to some evident cause of erosion; and in most cases, by looking into the fauces, the distillation of the blood from thence will be perceived.

3. When blood proceeds from the lungs, the manner in which it is brought up will commonly show from whence it comes; but, independent of that, it may also be known from the causes of hæmoptysis from the lungs, to be afterwards mentioned, having preceded.

4. When vomiting accompanies the throwing out of blood from the mouth, we may generally know the source from whence it proceeds, by considering that blood does not proceed so frequently from the stomach as from the lungs: that blood proceeding from the stomach commonly appears in greater quantity than from the lungs. The pulmonary blood also is usually of a florid colour, and mixed with a little frothy mucus

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mucus only; but the blood from the ſtomach is of a darker colour, more grumous, and mixed with the other contents of the ſtomach. The coughing or vomiting, as the one or the other happens firſt to ariſe, may ſometimes point out the ſource of the blood; and this has alſo its peculiar antecedent ſigns and cauſes.

Cauſes, &c. A hæmoptyſis may be produced at any time of life by external violence; and, in adult perſons, while the arterial plethora prevails in the ſyſtem, i. e. from the age of 16 to 35, a hæmoptyſis may at any time be produced merely by a plethoric ſtate of the lungs. More frequently, however, it ariſes from a faulty proportion between the capacity of the lungs and that of the reſt of the body. Thus it is often an hereditary diſeaſe, which implies a peculiar and faulty conformation.

This diſeaſe eſpecially happens to perſons, who diſcover the ſmaller capacity of their lungs by the narrowneſs of their cheſt, and by the prominence of their ſhoulders; which laſt is a mark of their having been long liable to a difficulty of reſpiration. In ſuch caſes, too, the diſeaſe very frequently happens to perſons of a ſanguine temperament, in whom particularly the arterial plethora prevails. It happens alſo to perſons of a ſlender delicate make, of which a long neck is a mark; to perſons of much ſenſibility and irritability, and therefore of quick parts; to perſons who have formerly been liable to hæmorrhages from the noſe: to thoſe who have ſuffered a ſuppreſſion of any uſual hæmorrhage, the moſt frequent inſtance of which is in females who have ſuffered a ſuppreſſion of their menſtrual flux; and, laſtly, to perſons who have ſuffered the amputation of a limb.

All this conſtitutes the prediſponent cauſe of hæmoptyſis; and the diſeaſe may happen merely from the prediſponent cauſe ariſing to a conſiderable height. But in thoſe who are already prediſpoſed, it is often brought on by the concurrence of various occaſional and exciting cauſes. One of theſe, and perhaps a frequent one, is external heat; which, even when in no great degree, brings on the diſeaſe in ſpring, and the beginning of ſummer, while the heat rarefies the blood more than it relaxes the ſolids, which had before been contracted by the cold of winter. Another exciting cauſe is a ſudden diminution of the weight of the atmoſphere, eſpecially when concurring with any effort in bodily exerciſe. The effort alone, may often be the exciting cauſe in thoſe who are already prediſpoſed; and more particularly any violent exerciſe of reſpiration. In the prediſpoſed, alſo, the diſeaſe may be occaſioned by any degree of external violence.

Prognoſis. Hæmoptyſis may ſometimes be no more dangerous than a hæmorrhage from the noſe; as when it happens to females, in conſequence of a ſuppreſſion of their menſes; when, without any marks of prediſpoſition, it ariſes from external violence; or, from whatever cauſe it may proceed, when it leaves no cough, dyſpnœa, or other affection of the lungs, behind it. But, even in theſe caſes, a danger may ariſe from too large a wound being made in the veſſels of the lungs, from any quantity of red blood being led to ſtagnate in the cavity of the bronchiæ, and particularly from any determination of the blood being made into the veſſels of the lungs, which by renewing the hæmorrhage may have theſe conſequences.

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Cure. In the treatment of this diſeaſe, with a view of ſtopping the diſcharge, it is firſt neceſſary to have recourſe to thoſe meaſures which tend to diminiſh the impetus by which the blood is expelled. This is to be effected by a removal of plethora when it exiſts; by diminiſhing the general impetus of circulation; by diminiſhing local increaſed action when it takes place in the veſſels of the lungs; and by producing a determination of blood to other parts of the ſyſtem remote from the lungs. But beſides practices diminiſhing impetus, it is often alſo neceſſary to employ ſuch as augment the reſiſtance to the paſſage of blood through the ruptured veſſels of the lungs. With theſe views a variety of practices may be employed, particularly blood-letting, refrigerants, ſedatives, aſtringents, and the like.

On this ſubject Dr Cullen differs from thoſe who preſcribe chalybeates and cinchona in the cure of hæmoptyſis. Both of theſe, he obſerves, contribute to increaſe the phlogiſtic diatheſis then prevailing in the ſyſtem, and the hæmoptyſis from prediſpoſition is always accompanied with ſuch a diatheſis. Inſtead of theſe, therefore, he recommends blood-letting in greater or ſmaller quantity, and more or leſs frequently repeated as the ſymptoms ſhall direct. At the ſame time cooling purgatives are to be employed, and every part of the antiphlogiſtic regimen is to be ſtrictly enjoined. In the London Medical Obſervations, the uſe of nitre is greatly recommended by Dr Dickſon, to whom its efficacy was made known by Dr Letherland, phyſician to St Thomas's Hoſpital. The moſt commodious method of exhibiting it he found was in an electuary. Four ounces of conſerve of roſes were made into an electuary with half an ounce of nitre; of which the bulk of a large nutmeg was directed to be given, four, ſix, or eight times a day, according to the urgency of the caſe. The good effects of this, he tells us, have often aſtoniſhed him: and when given early in the diſeaſe, he ſays he can depend as much upon it for the cure of an hæmoptyſis, as on cinchona for the cure of an intermittent. He agrees with Dr Cullen, however, that in thoſe caſes where there is any hardneſs in the pulſe, and which almoſt always happens, there is a neceſſity for veneſection. A cool regimen, and quiet of body and mind, are certainly uſeful; but Dr Cullen obſerves that ſome kinds of geſtation, ſuch as ſailing, and travelling in an eaſy carriage on ſmooth roads, have often proved a remedy. When the cough is very troubleſome, it is abſolutely neceſſary to exhibit frequently a ſmall doſe of an opiate. Dr Dickſon alſo informs us, that the nitre joined with ſpermaceti, or *pulv. è tragacanth. comp.* has produced equally good effects with the electuary above mentioned; in the compoſition of which he at firſt conſidered the conſerve only as a vehicle for the nitre, though he means not to inſinuate that the former is totally deſtitute of efficacy.

When this hæmorrhage has reſiſted other modes of cure, and there is reaſon to apprehend, even from the mere quantity of blood evacuated, that the patient may ſink under the diſcharge, bliſters, particularly when applied to the breaſt, are often had recourſe to with great advantage; and the ſulphuric acid, properly diluted, Hæmorrhagiæ. luted, both as an aſtringent and refrigerant, is often employed with very good effects.

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PULMONARY CONSUMPTION.

Phthiſis, *Sauv.* gen. 276. *Lin.* 208. *Vog.* 319. *Sag.* 101. *Junck.* 33.
Phthiſis pulmonis, *Boerh.* 1196.
Affectio phthiſica, ſive tabes pulmonalis, *Hoffm.* II. 284.

238 Sp. I. The *Incipient PHTHISIS*, without expectoration of *Pus*.

Phthiſis incipiens, *Morton* Phyſiolog. L. II. cap. 3.
Phthiſis ſicca, *Sauv.* ſp. 1.

239 Sp. II. The *Confirmed PHTHISIS*, with an expectoration of *Pus*.

Phthiſis confirmata *auctorum*.
Phthiſis humida, *Sauv.* ſp. 2.

Sometimes, notwithſtanding all the care that can be taken, the hæmoptyſis will degenerate into a phthiſis pulmonalis, or conſumption of the lungs; and ſometimes hæmoptyſis will be the conſequence of this dangerous diſorder. It has indeed been ſuppoſed, that an ulceration of the lungs, or phthiſis, was the natural and almoſt neceſſary conſequence of hæmoptyſis: but according to Dr Cullen, this is in general a miſtake; for there are many inſtances of a hæmoptyſis from external violence without being followed by any ulceration. The ſame thing has often been obſerved where the hæmoptyſis aroſe from an internal cauſe; and this not only in young perſons, when the diſeaſe returned for ſeveral times, but when it has often recurred during the courſe of a long life; and it may eaſily be conceived, that a rupture of the veſſels of the lungs, as well as of the veſſels of the noſe, may be ſometimes healed. The cauſes of phthiſis, therefore, Dr Cullen reduces to five heads. 1. A hæmoptyſis. 2. A ſuppuration of the lungs in conſequence of a pneumonia. 3. A catarrh. 4. An aſthma; and, 5. Tubercles.

1. When a phthiſis ariſes from a hæmoptyſis, it is probable that it is occaſioned by particular circumſtances; and what theſe circumſtances are, may not always be eaſily known. It is poſſible, that merely the degree of rupture, or frequently repeated rupture, preventing the wound from healing, may occaſion an ulcer; or it is poſſible, that red blood effuſed, and not brought up entirely by coughing, may, by ſtagnating in the bronchiæ, become acrid, and erode the parts. But theſe hypotheſes are not ſupported by any certain evidence; and from many obſervations we are led to think, that ſeveral other circumſtances muſt concur in producing the diſeaſe from hæmoptyſis.

2. The ſecond cauſe of an ulceration of the lungs mentioned above is a ſuppuration formed in conſequence of pneumonia. When a pneumonia, with ſymptoms neither very violent nor very ſlight, has continued for many days, it is to be feared it will end in a ſuppuration; but this is not to be determined by the number of days; for, not only after the fourth, but even after the tenth day, there have been examples of a pneumonia ending by a reſolution; and if the diſeaſe has ſuffered ſome intermiſſion, and again recurred, there may be inſtances of a reſolution happening at a much later period from the beginning of the diſeaſe than that now mentioned. But if a moderate diſeaſe, in ſpite of proper remedies employed, be protracted to the 14th day without any conſiderable remiſſion, a ſuppuration is pretty certainly to be expected; and it will be more certain ſtill, if no ſigns of reſolution have appeared, or if an expectoration which had appeared ſhall have again ceaſed, and the difficulty of breathing has continued or increaſed, while the other ſymptoms have been rather abated.

That in a pneumonia, the effuſion is made which may lay the foundation of a ſuppuration, may be concluded from the difficulty of breathing becoming greater when the patient is in a horizontal poſture, or when the patient can lie more eaſily on the affected ſide. That, in ſuch caſes, a ſuppuration is actually begun, may be inferred from the patient's being frequently affected with ſlight cold ſhiverings, and with a ſenſe of cold felt ſometimes in one ſometimes in another part of the body. We form the ſame concluſion alſo from the ſtate of the pulſe, which is commonly leſs frequent and ſofter, but ſometimes quicker than before. That a ſuppuration is already formed, may be inferred from there being a conſiderable remiſſion of the pain which had before ſubſiſted; while with this the cough, and eſpecially the dyſpnœa, continue, and are rather increaſed. At the ſame time the frequency of the pulſe is rather increaſed, the feveriſh ſtate ſuffers conſiderable exacerbations every evening, and by degrees a hectic fever in all its circumſtances comes to be formed.

In this ſtate of ſymptoms, we conclude very confidently, that an abſceſs, or, as it is called, a *vomica*, is formed in ſome part of the pleura, and moſt frequently in that portion of it inveſting the lungs. Here purulent matter frequently remains for ſome time, as if encloſed in a cyſt; but commonly not long before it comes to be either abſorbed and transferred to ſome other part of the body, or breaks through into the cavity of the lungs, or into that of the thorax. In the latter caſe it produces the diſeaſe called *empyema*; but it is when the matter is poured into the cavity of the bronchiæ that it properly conſtitutes the phthiſis pulmonalis. In the caſe of empyema, the chief circumſtances of a phthiſis are indeed alſo preſent: but we ſhall here conſider only that caſe in which the abſceſs of the lungs gives occaſion to purulent expectoration.

An abſceſs of the lungs, in conſequence of pneumonia, is not always followed by a phthiſis: for ſometimes a hectic fever is not formed; the matter poured into the bronchiæ is a proper and benign pus, which frequently is coughed up very readily, and ſpit out; and though this purulent expectoration ſhould continue for ſome time, if it be without hectic fever, the ulcer ſoon heals, and every morbid ſymptom diſappears. This has ſo frequently happened, that we may conclude, that neither the acceſs of the air, nor the conſtant motion of the lungs, will prevent an ulcer of theſe parts from healing, if the matter of it be well-conditioned. An abſceſs of the lungs, therefore, does not neceſſarily produce phthiſis pulmonalis; and if it be followed by ſuch a diſeaſe, it muſt be in conſequence of particular circumſtances which corrupt the purulent

purulent matter produced, render it unfuitable to the healing of the ulcer, and at the fame time make it afford an acrimony, which, abforbed, produces a hectic fever and its confequences.

The corruption of the matter of fuch abfceffes may be owing to feveral caufes; as, 1. That the matter effufed during the inflammation had not been a pure ferum fit to be converted into a laudable pus, but had been joined with other matters which prevented that, and gave a confiderable acrimony to the whole. Or, 2. That the matter effufed and converted into pus, merely by long ftagnation in a vomica, or by its connexion with an empyema, had been fo corrupted as to become unfit for the purpofe of pus in the healing of the ulcer. Thefe feem to be poffible caufes of the corruption of matter in abfceffes, fo as to make it the occafion of a phthifis in perfons otherwife found; but it is probable that a pneumonic abfcefs efpecially produces phthifis when it happens to perfons previoufly difpofed to that difeafe, and therefore only as concurring with fome other caufes of it.

3. The third caufe fuppofed to produce a phthifis is a catarrh; which, in many cafes, feems in length of time to have the expectoration of mucus proper to it gradually changed to an expectoration of pus; and at the fame time, by the addition of a hectic fever, the difeafe, which was at firft a pure catarrh, is changed into a phthifis. But this fuppofition is, in the opinion at leaft of fome phyficians, liable to feveral difficulties. The catarrh is properly an affection of the mucous glands of the trachea and bronchiæ, analogous to the coryza and lefs violent kinds of cynanche tonfillaris, which very feldom end in fuppuration. And although a catarrh fhould be difpofed to do fo, the ulcer produced might readily heal up, as it does in the cafe of a cynanche tonfillaris; and therefore fhould not produce a phthifis.

Farther, The catarrh, as purely the effect of cold, is generally a mild difeafe as well as of fhort duration; and, according to Dr Cullen, there are at moft but very few of the numerous cafes of it, which can be faid to have ended in a phthifis. In all thefe cafes in which this feems to have happened, he thinks it probable that the perfons affected were peculiarly predifpofed to phthifis; and the beginning of phthifis fo often refembles a catarrh, that it may have been miftaken for fuch a difeafe. It often happens alfo, to increafe the fallacy, that the application of cold, which is the moft frequent caufe of catarrh, is alfo frequently the exciting caufe of the cough, which proves to be the beginning of a phthifis.

Many phyficians have fuppofed that an acrimony of the fluids eroding fome of the veffels of the lungs is a frequent caufe of ulceration and phthifis; but this appears to Dr Cullen to be a mere fuppofition. He acknowledges, that in many cafes an acrimony fubfifting in fome part of the fluids is the caufe of the difeafe; but obferves that it is at the fame time probable, that this acrimony operates by producing tubercles, rather than by any direct erofion.

But, notwithftanding thefe objections, experience affords numerous examples of cafes in which a difeafe long fubfifting under the form of catarrh has at laft degenerated into phthifis, and proved fatal from fupervening hectic fever. It muft, however, at the fame time be allowed, that catarrh, degenerating into a chronic ftate after fubfifting for many years, has of itfelf often proved fatal without inducing phthifis.

4. If phthifis does not frequently follow catarrh, it is ftill more rarely a confequence of afthma. Innumerable examples are unqueftionably afforded of that difeafe fubfifting for many years without any fymptom whatever of phthifis as a confequence of it. But, at the fame time, there are unqueftionable examples of phthifis deriving its origin from afthma; which, however, probably happens only in cafes where a peculiar ftate of the lungs at the fame time takes place. But, without the concurrence of afthma, this ftate would not of itfelf have been fufficient for inducing the affection.

5. Of all the caufes formerly mentioned, phthifis moft frequently arifes from tubercles. Dr Simmons informs us, that he has had opportunities of infpecting the bodies of many people who died in this way, and never found them totally abfent. He has likewife feen them in fubjects of different ages, who had been troubled with no fymptoms of an affection of the breaft during their lifetime. In thefe, however, they were fmall, and few in number. This proves that they may exift without inconvenience till they begin to difturb the functions of the lungs by their fize and number; or till fome degree of inflammation be excited, either by accidental caufes, or by certain changes that take place within their fubftance; for as yet we know but little of their true nature. Thefe little tumors vary in their confiftence; in fome they are compofed of a pulpy fubftance, and in others approach more to the nature of fcirrhus. They are moft commonly formed in confequence of a certain conftitutional predifpofition; but whatever is capable of occafioning a morbid irritability of the lungs feems alfo to be capable of generating them. Thus the fpafmodic afthma frequently ends in tubercles and confumption; and it is not unufual for millers, ftone-cutters, and others, to die confumptive, from their being fo conftantly expofed to duft, which in thefe cafes probably acts by producing fimilar concretions: Dr Kirkland obferves, that fcythe-grinders are fubject to a difeafe of the lungs, from particles of fand mixing with iron duft, which among themfelves they call the *grinders rot*. Tubercles, however, in by much the greater number of inftances, have their fource from a fcrophulous difpofition; and fome eminent phyficians have fuppofed that the generality of pulmonary confumptions are of this kind. This notion, however, they have perhaps carried too far: they have probably been mifled by thofe tuberculous concretions which, without good reafon, have been fuppofed to be difeafed glands, and of courfe analogous to the glandular affections we meet with in the fcrophula. Tubercles may likewife fometimes be owing to the fuddden repulfion of cutaneous eruptions, or of the matter of exanthemata, &c. or to other caufes.

The perfons who are moft liable to confumption are thofe of a fair complexion, fine and foft fkin, florid cheeks, and a flender make; with high cheek-bones, hollow temples, long neck, fhoulders ftanding out like wings, narrow cheft, and a remarkable prominence of the proceffes of the os facrum. To thefe marks we may add, that of *found teeth*, which, as the difeafe advances,

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vances, usually become of a milky white colour, and more or less transparent. Of those who are carried off by this disease, Dr Simmons asserts, the greater number will be found never to have had a carious tooth. This circumstance, however, does not seem to us to hold so generally as Dr Simmons is disposed to imagine: and instances not unfrequently occur of patients dying of phthisis, although they have had many teeth subjected to caries; and some of these beginning even at an early period of life.

Persons of the above description often remain for a long time without feeling any other inconvenience than some oppression at the breast in moist weather, or in hot apartments. Their breathing is easily hurried, sometimes by the slightest motion; and they become languid, paler, and thinner. All this time, however, they feel no heat or painful sensation in the breast. As the evil increases, the patient begins to be attacked with a slight, frequent, and dry cough, which is most troublesome in the night time. But this, by proper care, is often relieved; and the patient remains in this state for a considerable time, and even for many years, if he be sensible of his danger, and careful to guard against it by a suitable manner of living. More commonly, however, we find the cough increasing, and sometimes accompanied with more or less catarrh. This is usually ascribed to cold; and but too generally neglected, till the disease becomes alarming by its obstinacy and its effects. This may be considered as the *beginning*, or first period, of the disease. During this stage, the cough is sometimes dry from the first: and sometimes when it begins in the form of a catarrh, is attended with more or less expectoration of mucus.

When the cough begins in the form of a catarrh, and appears to be occasioned by an increased secretion of a thin saltish mucus irritating the membrane of the trachea, all judicious practitioners agree in recommending an attention to regimen, the free use of diluting liquors, bland emulsions, small doses of nitre, the taking away a few ounces of blood if there be much inflammation, the inhaling the steams of warm water by means of the machine contrived for that purpose, and the occasional use of such a dose of elixir paregoricum as will be sufficient to allay the irritation of the bronchiæ, and to promote a gentle moisture on the skin. These methods will generally be found to be efficacious, especially if the patient's chamber be of a moderate temperature, and he carefully avoid exposure to a cold, damp, or raw air, till the complaint be removed. In cases in which the cough has been obstinate, and the inflammatory symptoms considerable, Dr Simmons has often experienced the great advantages of the warm bath, the heat of which did not exceed 92°. When this is had recourse to, the patient should remain in it only a very few minutes, and go soon afterwards to bed; but not with a view to force a sweat by an increased weight of bedclothes, as is too often injudiciously practised.

Patients of a consumptive habit, who have had an attack of this kind at the beginning of winter, are particularly liable to a return of the complaint during the continuance of the cold season, on the slightest occasion and with greater violence. A relapse is therefore to be carefully guarded against; and nothing will be found to do this more effectually than the use of socks and a flannel under-waistcoat. The use of flannel has been condemned by several medical writers as increasing the insensible perspiration; but in the present case, to say nothing of some others in which it may be useful, it will in general be found to have the best effects. It will prevent a too great determination to the lungs, and should not be left off till the approach of summer. In some few instances in which flannel was found to have a disagreeable effect, a piece of dimity worn over the breast next the skin, will prevent the return of colds and coughs in persons of a delicate habit, who had before been liable to them on the slightest occasions. Shirts made of cotton cloth are much more effectual than linen in preserving an equable temperature of the surface, and guarding against the action of external cold; while at the same time they are much more pleasant to most people than even the finest flannel. In these cases, circumstances that are seemingly of the most trifling nature become of importance.

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Sometimes the cough is occasioned by an immediate inflammation of some part of the lungs, from some of the usual causes of inflammation; and when this happens, no time is to be lost in removing it. To do this will perhaps require more than one bleeding, together with a strict attention to a cooling plan of diet, diluting drinks, the inhalation of warm steams, and if convenient, the use of the warm bath; but above all, the speedy application of a large blister as near as may be to the supposed seat of the inflammation. The cough, in this case, will often remain after the original complaint is abated. A prudent use of opiates at bedtime, either by themselves or combined with gummy and mucilaginous medicines, will then generally be useful as a sedative and antispasmodic.

In this, as well as in the catarrhal cough just now mentioned, many practitioners are too eager to administer cinchona, with the view, as they term it, of *bracing* up the patient: but this never fails to increase the cough, and of course to do great and very irreparable mischief.

And here it will not be foreign to our subject to observe, that a symptomatic cough, which has its rise not from catarrh, or from an immediate inflammation of the lungs, but from their sympathy with the stomach, has sometimes laid the foundation of phthisis, from its having been mistaken, and of course improperly treated. It seems to be owing to a redundancy or vitiated state of the bile, or to some affection of the stomach, which it is perhaps not easy to define. It is sometimes a concomitant of other bilious symptoms; and when this happens to be the case, it cannot easily be mistaken; but we sometimes find it occurring singly, and in general attacking persons of a sedentary life. Dr Stoll of Vienna, who has noticed this cough, has very properly given it the name of *tussis stomachica*. This complaint is so far from being relieved by bleeding, that it constantly grows worse after it, especially if the evacuation be in any considerable quantity. The oily remedies seldom fail to exasperate this cough, which at first is dry, frequent, and often extremely violent, but which seldom fails to give way to one or two gentle pukes, and the occasional use of mild cathartics. The cough, as in other cases, often continues from habit after the cause that

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that gave riſe to it has been removed, and may then be checked by opiates.

When the diſeaſe has been neglected, or our attempts to remove it in the beginning has failed, both of which circumſtances but too frequently happen, the patient begins to complain of a ſoreneſs, and of ſlight lancinating pains ſhooting through the breaſt, ſometimes in the direction of the mediaſtinum, and ſometimes confined chiefly to one ſide. The ſoreneſs is pretty conſtant, and much increaſed by the cough. The pain in the ſide often prevents the patient from lying on the ſide affected; and this inability of lying except on one ſide, frequently occurs even when no ſuch pain is felt. In this ſtage of the diſeaſe, fluſhing heats are felt on the palms of the hands and ſoles of the feet: the breathing is ſhort and laborious; and it is not long before the patient begins to expectorate a thin and frothy phlegm, at firſt in ſmall quantities, coughed up with difficulty, and ſome pain of the breaſt, and now and then ſtreaked with blood: this may be conſidered as the *inflammatory period* of the diſeaſe, to which ſucceeds the *ſuppurative ſtage*. In the latter, the expectoration becomes more copious and purulent, the breath proportionably offenſive, and the exacerbations of the hectic fever more conſiderable: an increaſed quickneſs of the pulſe comes on about the middle of the day; but the moſt conſiderable paroxyſm of the fever is at night, and at firſt continues till towards morning, commonly till three or four o'clock, when it terminates in a ſweat, which uſually begins upon the breaſt. As the diſeaſe advances, theſe ſweats become more profuſe, and ſometimes come on almoſt as ſoon as the pulſe begins to quicken, but without affording any relief to the patient. During the exacerbations, we obſerve a circumſcribed redneſs of the cheeks, while the reſt of the face is pale, and appears as if it were not clean waſhed. The coſtiveneſs that commonly accompanies the beginning of the diſeaſe is uſually ſucceeded by a diarrhœa; the ſpitting leſſens, and all the purulent matter ſeems to be carried downwards. The waſting of the fat and the loſs of nouriſhment occaſion the nails to curve inwards, the hair to fall off, and the eyes to ſink in their ſockets. In the mean time, the legs commonly ſwell; till at length death cloſes a ſcene which is melancholy to all but the patient himſelf, who in general continues ſenſible to the laſt moment, and even then indulges a vain hope of prolonging a miſerable exiſtence. In ſome caſes, and that not unfrequently, a delirium comes on towards the cloſe of the diſeaſe.

The hectic fever that attends this and ſome other chronic diſeaſes, is evidently the effect of acrimony, and moſt commonly of pus abſorbed and carried into the circulation. The nature of this acrimony, and the different irritability of different patients, are probably the ſources of the variety we obſerve in fevers of this denomination; a variety which is doubtleſs much greater than we are aware of. Thus we find that the matter of the ſmallpox excites a fever of this kind; but this *ſecondary fever*, as it is called, differs from the hectic attendant on conſumptions; nor does the latter correſpond with that which ſometimes accompanies the ſuppuration of a cancerous ulcer. In the pulmonary conſumption, or at leaſt in the third ſtage of it, the fever induced often appears to be of the putrid kind, and has been denominated *febris hectica putrida* by the judicious Morton, who conſiders it as being combined with a peripneumonic or inflammatory fever, which recurs as often as freſh tubercles begin to inflame. For although we have named one period of the diſeaſe the *inflammatory*, and another the *ſuppurative period*, yet we are not to ſuppoſe that the latter is exempt from inflammation. While matter is poured into the bronchiæ, or abſorbed and carried into the ſyſtem from one part of the lungs, other parts are in a crude ſtate of inflammation, or advancing towards ſuppuration; ſo that, on examining the lungs of perſons who die conſumptive, we find ſome tubercles that are ſmall and juſt formed, ſome that are large and full of matter, and others that are in a ſtate of ulceration. This eaſily accounts for the occaſional combination of inflammatory ſymptoms with thoſe of the putrid hectic. When the matter abſorbed is a laudable pus, as in the caſe of the pſoas abſceſs, we find the form of the hectic fever differing from either of thoſe we have mentioned.

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Cure. In theſe different periods of the diſeaſe, the curative indications are ſufficiently obvious. To prevent the formation of freſh tubercles; to obviate the inflammation of thoſe already formed; to promote their reſolution; to allay morbid irritability, the cough, and other troubleſome ſymptoms; and, above all, to check the tendency to the hectic ſtate, are the views that every rational phyſician propoſes to himſelf in the treatment of the genuine conſumption. We know of no medicines that can exert their ſpecific effects upon the lungs by diſſolving tuberculous concretions; nor is it probable, from what we know of the animal economy, that any ſuch will ever be diſcovered. Yet medicines that operate in a general manner upon the ſyſtem, may, by promoting abſorption, and diminiſhing the determination to the lungs, tend to diſperſe tubercles, or to prevent their formation. There are not wanting inſtances of wonderful recoveries, in caſes where the evil was ſuppoſed to be beyond the power of phyſic; and in ſome, where nature was left to herſelf; ſo that a phyſician who has obſerved the various and powerful reſources nature has within herſelf, will be very cautious how he aſſerts that a diſeaſe is incurable.

The moſt formidable effects of ulcerated lungs are the abſorption and conſequent hectic. It ſeems evident, that, in many caſes, death is brought on by this, rather than by the lungs themſelves being rendered unfit for the purpoſes of reſpiration. So that if we can obviate the effects of the abſorption, diminiſh the preternatural determination to the lungs, and fulfil the other general indications juſt now mentioned, we may very often enable nature to recover herſelf. It may be alleged indeed, that the phyſicians art has hitherto proved very unſucceſsful in theſe caſes; but may not this be owing to the remedies that are employed being very often ſuch as are inimical to the cure?

The cinchona is, perhaps, the moſt commonly employed of any, and often confided in as an ultimate reſource in theſe caſes. But beſides this, the ſulphuric acid, the balſams, and frequent bleedings, have each had their partizans. The uſe of bliſters and iſſues, opiates, a milk and vegetable diet, exerciſe, and change of air, are pretty generally recommended by all. Concerning cinchona, Deſſault long ago obſerved, that it had been

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productive of great mifchief in confumptive cafes; and Dr Fothergill, in a paper lately publifhed by him on this fubject, very judicioufly remarks, that it is fo far from curing the hectic fever arifing from diftempered lungs, that according to the beft of his obfervations, it not only takes up that time which might probably have been better employed in the ufe of other medicines, but for the moft part aggravates the difeafe beyond remedy. Indeed it has been the opinion of feveral attentive obfervers, that, whenever pus or any kind of matter excites an hectic fever, by being abforbed and carried into the circulation, the cinchona will never fail to exafperate the complaint, efpecially if it be accompanied with any degree of inflammatory diathefis, unlefs the matter has a free outlet from the fyftem; as in the cafe of abfceffes, for inftance, in which we often find it productive of excellent effects. It is likewife well known to be ufed as a tonic, to obviate the effects of fluor albus, or any other immoderate evacuation in delicate perfons, which, by enfeebling the fyftem, very often lays the foundation of phthifis: but the moment we have reafon to fufpect that the lungs are ulcerated, efpecially if this ulceration be attended with an inflammatory difpofition; or if the feparation of vitiated pus be the confequence of a peculiar increafed morbid action of the veffels at the part, it ought to be laid afide; and in the genuine tuberculous confumption, perhaps, it is rarely admiffible.

Dr Fothergill, however, obferves, that there are two caufes of confumption, which often produce fymptoms fo fimilar to thofe of the genuine phthifis, as fometimes to have led him to make ufe of cinchona, in apparent tendencies to a genuine pulmonary confumption, with advantage.

One of the caufes is, the fuckling of children longer than is confiftent with the mother's ability. This cafe frequently occurs among the middling and lower claffes of females, of conftitutions naturally delicate and tender. In fuch a ftate of weaknefs, fome flight cold brings on a cough, which increafes gradually, till at length it produces the true pulmonary confumption. Here cinchona given early, in moderate dofes, and merely as a tonic remedy, is often of excellent ufe.

Another caufe, is any weakening difcharge, either from abfceffes, the greater operations of furgery, a copious and conftant *fluor albus*, or fimilar enfeebling evacuations. That cinchona is, for the moft part, of ufe in thefe cafes, when the lungs are not inflamed, is indubitable; and if they be fo affected, but not beyond a certain degree, it is alfo efficacious in preventing the progrefs of the confumption.

In phthifical complaints fucceeding fuch fituations, a prudent trial of cinchona feems neceffary. Small dofes of the decoction, either alone, or joined with the faline mixture or fuch other additions as the phyfician thinks proper, may be given. But if the breath becomes more tight and oppreffed, the cough dry, the pulfe more quick and hard, and efpecially if flight tranfitory pains or ftitches about the thorax are more frequently complained of, a perfeverance in the ufe of cinchona will increafe the difeafe. If fuch alfo fhould be the appearances in the progrefs of the difeafe, or, from whatever caufe, if cinchona be accompanied with fuch effects, the ufe of it ought to be withheld.

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If, on the other hand, no pain, tightnefs, or oppreffion, is perceived, and there appear a manifeft abatement of the fymptoms, it will be advifeable to proceed. The adminiftration of this medicine, however, requires a judicious obferver; and it ought neither to be given in the early inflammatory ftage of this difeafe, nor be continued in any fubfequent period, if it produce the effects above mentioned.

By its tonic virtues it will often enable nature to conquer many difficulties. In confirmation of this remark, Dr Fothergill farther obferves, that he has feen it of ufe in promoting expectoration, when this became deficient from want of ftrength towards the end of peripneumonic fevers; but that it ftops this difcharge, changes flight wandering pains into fuch as are fixed, and increafes them with all their confequences, in a variety of cafes.

The elixir of vitriol, or the fulphuric acid properly diluted, though in many inftances a highly ufeful remedy, is often exhibited in confumptive cafes with no lefs impropriety than cinchona. This medicine, from its aftringency, is obvioufly improper in the inflammatory ftate of the difeafe. But in the latter ftage, when a general tendency to putrefaction takes place, it is ferviceable in refifting the effect; it reftrains the colliquative fweats; and if the lungs be not injured paft reparation, it is allowed to be a very ufeful auxiliary.

Various are the opinions concerning the efficacy of Briftol water in this difeafe. The experienced author laft mentioned informs us, that he has feen many perfons recover from pulmonary difeafes after drinking thefe waters, whofe cure feemed to be doubtful from any other procefs; and he thinks this circumftance, added to the general reputation of Briftol waters in phthifical cafes, affords fufficient inducement to recommend the trial of them in the early ftages of fuch complaints. It is, however, before the approach of a confirmed phthifis that patients ought to repair to Briftol; otherwife a journey thither will not only be without benefit, but may even prove detrimental.

Some have imagined, that the journey, a better air, change of fituation and of objects, have contributed to the patient's recovery; and thefe may doubtlefs be of advantage. It feems, however, that the water drank frefh at the pump, actually contains principles conducive to the recovery of patients affected with phthifical complaints. It feems to poffefs a flight calcareous ftypticity, and perhaps the air it contains may alfo have an antifeptic quality. On the whole, it appears to be an efficacious medicine, and is often found of remarkable benefit to confumptive patients.

Change of air, particularly from bad to good, is of great confequence to all chronic difeafes of the lungs. In confumptive cafes, the air of all large cities is found to be particularly injurious.

A fea voyage has been much recommended in the cure of this difeafe. The benefit of exercife has alfo been ftrongly urged by many writers; but, however falutary when properly ufed, it certainly ought to be regulated with difcretion. Dr Dickfon declares himfelf of opinion, that riding on horfeback in confumptive cafes is moft commonly hurtful, without fuch regulations as

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as in general have been little regarded. For instance, he has known a person who, by a ride of an hour or two in the morning, was very much recruited, and who, at another time, in the afternoon and evening, without undergoing more bodily motion, has returned faint and languid, and apparently worse. This observation on the same person has been so frequently made, as to point out clearly the times when this exercise shall not do hurt in consumptive cases. In this disease, the pulse, however calm in the morning, becomes more frequent in the afternoon and night, attended with heat and other feverish symptoms. Exercise therefore, at this time, can only add to the mischief of the fever. For this reason he prudently recommends to all hectic persons, especially those who shall travel to distant places on account of a better air, or the benefit expected from any particular water, that their travelling should be slow, confined to a very few hours, and only in the morning.

Exercise on horseback seems to be chiefly beneficial in those cases where consumption is a secondary disease. For example, in the nervous atrophy; in the hypochondriacal consumption; or when it is the effect of long-continued intermittents, or of congestions in any of the abdominal viscera; or, in a word, whenever the consumption is not attended with an inflamed or ulcerated state of the lungs, long journeys on horseback will be beneficial. Such a practice may likewise be highly useful in obviating an attack of phthisis, or in carrying off a dry husky cough in a person of a consumptive habit, when there is reason to suppose that no tubercles are as yet formed. On the other hand, in the confirmed phthisis, when the lungs are inflamed or ulcerated, much or violent exercise will be improper; and there have been instances where the death of the patient was evidently accelerated by it. The exercise therefore should be gentle, proportioned to the strength of the patient, and employed only in the morning. In fine weather, an easy open carriage is perhaps the most eligible, not only on account of its being open to the air, but because it affords that kind of agitation which is most wanted in these cases. For if we consider the different modes of exercise, we shall find that walking, though the best exercise in health, as it employs the most muscles, is the worst for the sickly, who should have the benefit of exercise without fatigue. Riding on horseback agitates the viscera more than walking, and is therefore preferable to it in many chronic diseases; but when a preternatural determination to the lungs has taken place, it will be liable to increase the evil, and may likewise be hurtful by the fatigue that attends it. For these reasons it will be prudent to begin with a carriage; and if the patient gain strength, and the disease abates, recourse may afterwards be had to horse-exercise.

The gentle motion of a coach has been often found of great utility in pulmonary complaints. Its efficacy seems to depend chiefly on its increasing the determination to the surface of the body. The nausea which this motion excites in some persons is an effect of this increased determination. It has therefore been found beneficial in hæmoptysis; and Dr Simmons mentions the case of a lady, who, after trying various remedies to no purpose, was cured of this complaint by travelling several hundred miles through different parts of England in her own coach. At first, whenever she remained three or four days in any place, the disorder began to return again; but at length by persevering in her journeys, it gradually went off. Dessault, who practised at Bourdeaux about 40 years ago, tells us, he sent several consumptive patients to Bareges, and with good success; but that in these cases his reliance was not so much upon the Bareges waters, as upon the motion of the carriage and the change of air in a journey of more than 100 leagues.

It is now pretty generally acknowledged, that the good effects of sea voyages in consumptive cases depend more upon the constant and uniform motion of the ship, than upon any particular impregnation of the sea air; although this from its coolness and purity may likewise be of great use, especially in the hot months, when sea voyages are generally undertaken by consumptive patients. The ancients were no strangers to this remedy; and amongst the Romans it was no unusual thing for consumptive persons to sail to Egypt. Pliny observes, that this was done not for the sake of the climate, but merely on account of the length of the voyage.

Many of our English physicians have recommended a voyage to Lisbon in these cases. When this is done, the proper season of the year should be carefully attended to. Dr Simmons knew a gentlemen who went thither with symptoms of incipient phthisis, and who experienced some relief during the course of the voyage; but happening to arrive at Lisbon at the beginning of the rainy season, the disease was soon greatly increased, and terminated fatally.

Another species of motion has of late been extolled as highly useful in consumptive cases. Dr James Carmichael Smyth of London, has lately published an account of the effects of swinging, employed as a remedy in the pulmonary consumption and hectic fever. In this treatise Dr Smyth contends, that sea air, in place of being of advantage, is constantly prejudicial to hectic and consumptive patients, and even to those who have a tendency to such complaints. He thinks, therefore, that the benefit derived from sea voyages must certainly be referred to some other cause. In stating his sentiments on this subject, he attempts to establish a distinction between exercise and motion. By exercise, he understands muscular action, or the exertion of the locomotive powers of the body either alone or combined. This he represents as increasing the force and frequency of the heart's contraction, the velocity and momentum of the blood, the quickness of breathing, the heat, the irritability, and the transpiration of the whole body. By motion, in contradistinction to exercise, he means such motion as is not necessarily accompanied with any agitation or succussion of the body, and which is totally independent of any muscular exertion. The effects of this, both on the heart, the lungs, and indeed on the system in general, he considers as of the sedative kind; thus it suspends the action of coughing, and lessens the frequency of the pulse. He is, therefore, led to refer the good effects of sea voyages entirely to this cause. And on these grounds he was led to conclude, that the motion given by swinging might be of equal if not greater service. This conclusion, we are told, in the treatise above alluded to, experience in many cases

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cafes has fully confirmed; and he recommends it as a mode of cure which may be employed with advantage in every ftage of phthifis. While, however, the reafoning of Dr Smyth on this fubject feems to be liable to many objections, we are forry to add, that his obfervations in practice have by no means been confirmed by thofe of others, who have had recourfe to this mode of cure.

The beft adapted diet in confumptive cafes is milk; the milk of affes, both as an article of diet and as a medicine, has in particular been highly extolled. It may however be remarked, that there are conftitutions in which this falutary nutriment feems to difagree. A propenfity to generate bile, or too ftrong a difpofition to acefcency from a weaknefs of the digeftive organs, both merit attention. Whey, either from cows or goats milk, appears to be more fuitable in the former cafe; and for correcting acidity, lime water may be added to the milk. The method of adding rum or brandy to affes or cows milk, fhould be ufed with great caution: for when added beyond a certain quantity, as is often the cafe, they not only coagulate the milk, but heat the body; by which means the milk difagrees with the patient, and the fpirit augments the difeafe.

In confumptive cafes, Dr Simmons obferves, that the patient's tafte fhould be confulted; and fays that a moderate ufe of animal food, where the falted and high-feafoned kinds are avoided, is not to be denied. Shell-fifh, particularly oyfters, are ufeful, as well as fnails fwallowed whole, or boiled in milk.

Repeated bleedings, in fmall quantities, are by fome confidered in confumptive cafes as highly advantageous: and in particular circumftances they undoubtedly are fo; for inftance, when the conftitution apparently abounds with blood; when the fluid drawn off is extremely fizy; when there is much pain in the breaft; and when venefection is followed by an abatement of every fymptom. In thefe cafes, bleeding is certainly proper, and ought to be repeated fo long as it feems to be attended with advantage. In very delicate conftitutions, however, even where the pulfe is quick, with fome degree of fulnefs, and the blood laft drawn confiderably fizy, it may not prove ferviceable.

It deferves to be remarked, that the inflammatory appearance of the blood is not alone a fufficient reafon for bleeding; but, in determining the propriety of this evacuation, all other circumftances fhould be confidered; fuch as the patient's age, ftrength, habit, and the ftate of the difeafe.

A remark which has been judicioufly made by Dr Fothergill, ought not to be omitted in the account of this difeafe. It is, that young delicate females, about the age of 15 or 16, and upwards, are often fubject to confumptions. When the difeafe has advanced confiderably, the *menfes*, if they have made their appearance, moft generally ceafe. This alarms their female friends, and they call upon the phyfician to ufe his utmoft endeavours for reftoring the difcharge; believing the ceffation of it to be the immediate caufe of the phthifical complaint. Induced by their folicitations, medicines have fometimes been adminiftered, which, without obtaining this end, have tended to aggravate the diftemper. This deficiency is often of no real difadvantage in thofe cafes; and in many the evacuation would prove injurious, by diminifhing the ftrength, which is already too much impaired. Even fmall bleedings at the regular periods have often done more harm than good. A fudden fuppreffion may require bleeding; but when the evacuation fails through want of ftrength, and from poverty of blood, the renewal of it increafes the difeafe.

Phthifis.

Befides thefe remedies, Dr Simmons ftrongly recommends a frequent repetition of vomits. Many phyficians have fuppofed, that where there is any increafed determination to the lungs, vomits do mifchief: but Dr Simmons is perfuaded, that inftead of augmenting, they diminifh this determination; and that much good may be expected from a prudent ufe of this remedy, than which none has a more general or powerful effect on the fyftem. If any remedy be capable of difperfing a tubercle, he believes it to be emetics. The affections of the liver, that fometimes accompany pulmonary complaints, give way to repeated emetics fooner than to any other remedy. In feveral cafes where the cough and the matter expectorated, the flufhing heats, lofs of appetite, and other fymptoms, threatened the moft fatal event; the complaints were greatly relieved, and in others wholly removed, by the frequent ufe of emetics. Other fuitable remedies were indeed employed at the fame time; but the relief the patients generally experienced after the emetic, was a fufficient proof of its falutary operation. By this, however, he does not mean that vomits will be ufeful in every period of the difeafe, or in every patient. In general, it will be found that the earlier in the difeafe emetics are had recourfe to, the more likely they will be to do good, and the lefs likely to do harm. The cafes in which emetics may be reckoned improper, are commonly thofe in which the difeafe is rapid in its progrefs; or in that ftage of it when there is great debility, with profufe colliquative fweats.

In thefe cafes, when an emetic has been adminiftered twice a-week, and the cough is mitigated, the expectoration facilitated, and the other fymptoms relieved, both the patient and the phyfician will be encouraged to proceed, and to repeat the vomit every fecond day, or even every day, for feveral days together, as Dr Simmons has fometimes done when the good effects of it were obvious.

The choice of emetics to be employed in thefe cafes is by no means a matter of indifference. Carduus tea, chamomile tea, warm water, and others that act by their bulk, and by exciting naufea, relax the tone of the ftomach when they are frequently repeated, and of courfe will be improper. More active emetics are therefore to be preferred; and here fome of the preparations of antimony might naturally be thought of. But the operation of thefe is not confined to the ftomach. They produce evacuations by ftool, and a difpofition to fweat; and are therefore improper in the pulmonary hectic. The mildnefs and excellence of ipecacuanha as an emetic, are well known; but in thefe cafes, Dr Simmons has often employed the fulphate of copper, concerning the effects of which we meet with fome groundlefs affertions in feveral medical books. Its operation is confined to the ftomach; it acts almoft inftantaneoufly; and its aftringency feems to obviate the relaxation that is commonly fuppofed to attend the frequent ufe of emetics. In two cafes he

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he experienced its good effects, after vomits of ipecacuanha had been given ineffectually. It ſhould be adminiſtered in the morning, and in the following manner:

Let the patient firſt ſwallow about half a pint of water, and immediately afterwards ſulphate of copper diſſolved in a cupful of water. The doſe of it muſt be adapted to the age and other circumſtances of the patient, and may be varied from two grains to ten, fifteen, or twenty. As ſome perſons are much more eaſily puked than others, it will be prudent to begin with a ſmall doſe: not that any dangerous effects will be produced by a large one, for the whole of the medicine is inſtantly rejected; but if the nauſea be violent, and of long continuance, the patient may perhaps be diſcouraged from repeating it. In general, the moment the emetic has reached the ſtomach it is thrown up again. The patient muſt then ſwallow another half pint of water, which is likewiſe ſpeedily rejected; and this is commonly ſufficient to remove the nauſea.

Dr Marryat, in his *New Practice of Phyſic*, preſcribes with great freedom what he calls the *dry vomit*, from its being directed to be taken without drinking. This medicine conſiſts of ſulphate of copper and tartrite of antimony. It has the benefit alſo of producing inſtantaneous operation; but it is more apt to excite nauſea than the ſulphate of copper alone, and is liable to ſome of the objections ſtated to antimonial emetics.

Another remedy which Dr Simmons ſtrongly recommends in conſumptive caſes, both from his own obſervation, and on the authority alſo of many other eminent practitioners, is gum-myrrh. This given by itſelf to the extent of a ſcruple or half a drachm for a doſe, two or three times a-day, or, if there be much inflammatory tendency, combined with a proportion of nitre or of cream of tartar, has often been ſerviceable in caſes which were apparently inſtances of incipient phthiſis even of the tuberculous kind. But when the diſeaſe is far advanced, or even decidedly marked, as far as our experience goes it has rarely been productive of any benefit.

Beſides the uſe of internal remedies in pulmonary affections, phyſicians have often preſcribed the ſmoke of reſinous and balſamic ſubſtances to be conveyed into the lungs. The vapour of ſulphuric ether, dropt into warm water, has likewiſe been uſed in theſe caſes. The inhaling of fixed air has alſo been ſpoken of as an uſeful practice. Dr Simmons has ſeen all theſe methods tried at different times; but without being able to perceive any real advantages from them in the ſuppurative ſtage of the diſeaſe, where they might be expected to be of the greateſt uſe; and in the beginning he has often found the two firſt to be too ſtimulating. He therefore preferred the ſimple vapour of warm water, and has experienced its excellent effects in ſeveral inſtances; but when the complaint has made any conſiderable progreſs, its utility is leſs obvious; and when the patients have been much weakened, he has ſeen it bring on profuſe ſweats, eſpecially when uſed in bed, and therefore he generally recommended it to be uſed in the day time. Formerly he made uſe of a fumigating machine, deſcribed in the Gentleman's Magazine for 1748, in which the air, inſpired by the patient, is made to paſs through hot water by means of a tube that communicates with the external air, and with the bottom of the veſſel: but we have now a more elegant, and, on account of the valve and mouth-piece, a more uſeful inſtrument of this kind, the inhaler, invented by the ingenious Dr Mudge.

Phthiſis.

Another remedy recommended by ſome as a ſpecific in conſumptions is the earth-bath. Van Swieten, in his Commentaries on Boerhaave, tells us, from the information of a perſon of credit, that in ſome parts of Spain they have a method of curing the phthiſis pulmonalis by the uſe of this remedy; and he quotes the celebrated Solano de Luque in confirmation of this practice. Solano ſpeaks of the *banos de tierra*, or earth-baths, as a very old and common remedy in Granada and ſome parts of Andaluſia, in caſes of hectic fever and conſumptions; and relates ſeveral inſtances of their good effects in his own practice. The method he adopted on theſe occaſions was as follows: He choſe a ſpot of ground on which no plants had been ſown, and there he made a hole large and deep enough to admit the patient up to the chin. The interſtices of the pit were then carefully filled up with the freſh mould, ſo that the earth might everywhere come in contact with the patient's body. In this ſituation the patient was ſuffered to remain till he began to ſhiver or felt himſelf uneaſy; and during the whole proceſs, Solano occaſionally adminiſtered food or ſome cordial medicine. The patient was then taken out, and, after being wrapped in a linen cloth, was placed upon a mattreſs, and two hours afterwards his whole body was rubbed with an ointment, compoſed of the leaves of the *ſolanum nigrum* and hog's lard. He obſerves, that a new pit muſt be made every time the operation is repeated; and adviſes the uſe of theſe baths only from the end of May to the end of October. Dr Fouquet, an ingenious French phyſician, has tried this remedy in two caſes. In one, a confirmed phthiſis, he was unſucceſsful; but the remedy had not a fair trial. The patient, a man 30 years of age, had been for ſeveral months afflicted with cough, hectic fever, and profuſe colliquative ſweats. He was firſt put into the earth in the month of June; but ſoon complained of an uneaſy oppreſſion at his ſtomach, and was removed at the end of ſeven minutes. The ſecond time he was able to remain in it half an hour, and when taken out was treated in the way preſcribed by Solano. In this manner the baths were repeated five times, and the patient was evidently relieved; but having conceived a diſlike to the proceſs, he refuſed to ſubmit to any further trials, and died ſome months afterwards. In the ſecond caſe he was more fortunate: the patient, a girl 11 years of age, had been for three months troubled with a cough brought on by the meaſles, which was at length attended with a purulent expectoration, hectic fever, and night ſweats. She began the uſe of the earth-bath in Auguſt, and repeated it eight times in the ſpace of 20 days. At the end of that time the fever and diſpoſition to ſweat had entirely ceaſed, and by the uſe of the common remedies, the patient was perfectly reſtored. A phyſician at Warſaw has likewiſe preſcribed the earth-bath with good ſucceſs in caſes of hectic fever. The Spaniards confine it entirely to ſuch caſes; but in ſome other parts of the world we find a ſimilar method employed as a remedy for other diſeaſes, and particularly for the ſea-ſcurvy. Dr Prieſtley obſerves, that the Indians, he has been told, have a

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a cuftom of burying their patients labouring under putrid difeafes up to the chin in frefh mould, which is alfo known to take off the fœtor from flefh meat beginning to putrefy. The rancidity of a ham, for example, may be corrected by burying it for a few hours in the earth. The efficacy of this remedy in the fea fcurvy has, it is faid, frequently been experienced by the crews of our Eaft India fhips.

Solano, who is fond of philofophizing in his writings, is of opinion, that the earth applied in this way abforbs the morbid taint from the fyftem; but does it not feem more probable, that the effluvia of the earth, by being abforbed and carried into the circulation, correct the morbid ftate of the fluids, and thus are equally ufeful in the fea fcurvy and in the pulmonary hectic? That the earth when moiftened does emit a grateful odour is a fact generally known; and Baglivi long ago gave his teftimony in favour of the grateful effects of the effluvia of frefh earth. He afcribes thefe good effects to the nitre it contains.

The earth bath, both in confumptive cafes and likewife in a variety of other affections, has of late been extenfively employed in Britain by a celebrated empiric. But, as far as we can learn, in moft cafes it produced to the patient a very diftreffing fenfation of cold; in fome, it feemed to be productive of bad effects, probably in confequence of this cold; and we have not heard of any confumptive cafes in which good effects were decidedly obtained from it.

With regard to the drains, fuch as blifters, iffues, and fetons, which are fo frequently recommended in pulmonary complaints, there is lefs danger of abufe from them than from the practice of venefection. The difcharge they excite is not calculated to weaken the patient much; and the relief they have fo often been found to afford, is a fufficient reafon for giving them a trial. Blifters, as is well known, act in a twofold manner; by obviating fpafm, and producing revulfion: Iffues and fetons act chiefly in the latter of thefe two ways; and in this refpect their effects, though lefs fudden and lefs powerful at firft, are more durable from the continuance of the difcharge they occafion. It is perhaps hardly neceffary to remark, that, if much fervice is to be expected from either of thefe remedies, they fhould be applied early in the difeafe. The ingenious Dr Mudge, who experienced the good effects of a large fcapulary iffue on his own perfon, very properly obferves, that the difcharge in thefe cafes ought to be confiderable enough to be felt. But it is feldom poffible for us to prevail on the delicate perfons, who are moft frequently the victims of this difeafe, to fubmit to the application of a cauftic between the fhoulders. The difcharge produced by a feton is by no means inconfiderable; and as in thefe cafes there is generally fome part of the breaft that is more painful or more affected by a deep infpiration than the reft, a feton in the fide, as near as can be to the feat of the pain, will be an ufeful auxiliary. Dr Simmons has feen it evidently of great ufe in feveral cafes.

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HÆMORRHOIDS, or *PILES*.

Hæmorrhois, *Sauv.* gen. 217. *Lin.* 192. *Sag.* gen. 182.
Hæmorrhoidalis fluxus, *Hoffm.* 219.
Hæmorrhoides, *Junck.* 11. et 12.
Leucorrhois, *Vog.* 112.

Hæmorrhois.

Sp. I. *External PILES.* 241

Var. A. *Bloody PILES.*

Hæmorrhois moderata, *Sauv.* fp. 1.
Hæmorrhoides ordinatæ, *Junck.* 11.
Hæmorrhoides nimiæ, *Junck.* 11.
Hæmorrhois immodica, *Sauv.* fp. 2.
Hæmorrhoides excedentes, *Alberti* de hæmorrhoid. p. 179.
Hæmorrhois polypofa, *Sauv.* fp. 3.

Var. B. *Mucous PILES.*

Hæmorrhoides decoloratæ, albæ, et mucidæ, *Junck.* 13. *Alberti*, p. 248.

Sp. II. The *PILES* from a *Procidentia Ani.* 242

Hæmorrhois ab exania, *Sauv.* fp. 4.

Sp. III. The *Running PILES.* 243

Sp. IV. The *Blind PILES.* 244

Hæmorrhoides cœcæ, *Junck.* 12. *Alberti*, p. 274.

Defcription. The difcharge of blood from fmall tumors on the verge of the anus conftitutes what is called the *hæmorrhoids* or *piles*. They are diftinguifhed into the *external* and *internal*, according to the fituation of the tumors, either without or within the anus. Sometimes, however, thefe tumors appear without difcharging any blood; and in this cafe they are called the *hæmorrhoides cœcæ*, or *blind piles*. Sometimes the difeafe appears without the verge of the anus in diftinct feparate tumors; but frequently only one tumid ring appears, feeming as it were the anus pufhed without the body. Sometimes thefe tumors appear without any previous diforder of the body: but more frequently, before the blood begins to flow, and fometimes even before the tumors are formed, various affections are perceived in different parts of the body; as headach, vertigo, ftupor, difficulty of breathing, ficknefs, colic pains, pain of the back and loins, and frequently a confiderable degree of pyrexia; while along with thefe fymptoms there is a fenfe of fulnefs, heat, itching, and pain, in and about the anus. Sometimes the difeafe is preceded by a ferous difcharge from the anus; and fometimes this ferous difcharge, accompanied with fwelling, feems to come in place of the difcharge of blood, and to relieve the above-mentioned diforders of the fyftem. This ferous difcharge hath therefore been named the *hæmorrhois alba*.

In this difeafe the quantity of blood difcharged is different upon different occafions. Sometimes it flows only when the perfon goes to ftool, and commonly follows the difcharge of fæces. In other cafes it flows without any difcharge of fæces; and then generally in confequence of the diforders above mentioned, when it is alfo commonly in larger quantity. This is often very confiderable; and, by the repetition, fo great, that we could hardly fuppofe the body to bear it but with the

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the hazard of life. Indeed, though rarely, it has been so great as to prove suddenly fatal. These considerable discharges occur especially to persons who have been frequently liable to the disease. They often induce great debility, and frequently a leucophlegmatia or dropsy which proves fatal. Sometimes the tumors and discharges of blood in this disease recur exactly at stated periods. In the decline of life it frequently happens that the hæmorrhoidal flux, formerly frequent, ceases to flow; and in that case it generally happens that the persons are affected with apoplexy or palsy. Sometimes hæmorrhoidal tumors are affected with inflammation, which ends in suppuration, and gives occasion to the formation of fistulous ulcers in those parts.

The hæmorrhoidal tumors have often been considered as varices or dilatations of the veins; and in some cases varicous dilatations have appeared upon dissection. These, however, do not appear in the greater part of cases; and Dr Cullen is of opinion that they are usually formed by an effusion of blood into the cellular texture of the intestine near to its extremity. When recently formed, they contain fluid blood; but after they remain for some time they are usually of a firmer consistence, in consequence of the blood being coagulated.

Causes, &c. It would seem probable, that the hæmorrhoidal tumors are produced by some interruption of the free return of the blood from the rectum, by which a rupture of the extremities of the veins is occasioned. But considering that the hæmorrhage occurring here is often preceded by pain, inflammation, and a febrile state, and with many other symptoms which show a connection of the topical affection with the state of the whole system, it is probable that the interruption of the blood in the veins produces a considerable resistance to the motion of the blood through the arteries, and consequently that the discharge of blood is commonly from the latter. Some have thought, that a difference of the hæmorrhois, and of its effects upon the system, might arise from the difference of the hæmorrhoidal vessels from whence the blood issued. But Dr Cullen is of opinion, that we can scarce ever distinguish the vessels from which the blood flows, and that the frequent inosculations of both arteries and veins belonging to the lower extremity of the rectum, will render the effects of the hæmorrhage much the same, from whatever source it proceeds.

With regard to the hæmorrhoids, however, he is of opinion, that they are, for the most part, merely a topical affection. They take place before the period of life at which a venous plethora happens. They happen to females, in whom a venous plethora determined to the hæmorrhoidal vessels cannot be supposed to occur; and they happen to both sexes, and to persons of all ages, from causes which do not affect the system, and are manifestly suited to produce a topical affection only.

These causes are, in the first place, the frequent voiding of hard and bulky fæces, which, by their long stagnation in the rectum, and especially when voided, must necessarily press upon the veins of that part, and interrupt the course of the blood in them. For this reason the disease so frequently happens to those who are habitually costive. From the same causes, the disease happens frequently to those who are subject to a prolapsus ani. In voiding the fæces, it almost always happens that the internal coat of the rectum is more or less protruded; and, during this protrusion, it sometimes happens that the sphincter ani is contracted: in consequence of this, a strong constriction is made, which preventing the protruded gut from being replaced, and at the same time preventing the return of blood from it, occasions a considerable swelling, and the formation of a tumid ring round the anus.

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Upon the sphincter's being a little relaxed, as it is immediately after its strong contraction, the portion of the gut which had fallen out is commonly taken into the body again; but by the frequent repetition of the accident, the size and fulness of the ring formed by the prolapsed intestine is much increased. It is therefore more slowly and difficultly replaced; and in this consists the chief uneasiness of hæmorrhoidal persons. As the internal edge of this ring is necessarily divided by clefts, the whole often puts on the appearance of a number of distinct swellings; and it also frequently happens, that some portions of it are more considerably swelled, become more protuberant, and form those small tumors more strictly called *hæmorrhoids* or *piles*.

From considering that the pressure of the fæces, and other causes interrupting the return of venous blood from the lower extremity of the rectum, may operate a good deal higher up than that extremity, we may understand how tumors may be formed within the anus; and probably it also happens, that some of the tumors formed without the anus may continue when taken within the body, and even be increased by the causes just mentioned. Thus may the production of internal piles be explained, which, on account of their situation and bulk, are not protruded on the person's going to stool, and are therefore more painful.

The production of piles is particularly illustrated by this, that pregnant women are frequently affected with the disease.—This is to be accounted for, partly from the pressure of the uterus upon the rectum, and partly from the costive habit to which pregnant women are liable. Dr Cullen has known many instances of piles happening for the first time during the state of pregnancy; and there are few women who have born children, that are afterwards entirely free from piles. —Purgatives also, especially those of the more acrid kind, and particularly aloetics, are apt to produce the piles when frequently used; and as they stimulate particularly the larger intestines, they may be justly reckoned among the exciting causes of this disease.

Prognosis. Though the hæmorrhoids are commonly, as we have said, to be esteemed a topical disease, they may, by frequent repetition, become habitual and connected with the state of the whole system; and this will more readily happen in persons who have been once affected with the disease, if they be frequently exposed to a renewal of the causes which occasioned it. It happens also to persons much exposed to a congestion in the hæmorrhoidal vessels, in consequence of their being often in an erect position of the body, and in an exercise which pushes the blood into the depending vessels, while at the same time the effects of these circumstances are much favoured by the abundance and

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and laxity of the cellular texture about the anus. It is to be particularly obſerved, that when an hæmorrhoidal affection has either been originally or has become a diſeaſe of the ſyſtem, it then acquires a particular connexion with the ſtomach; ſo that certain affections of the ſtomach excite the hæmorrhoidal diſeaſe, and certain ſtates of this diſeaſe excite the diſorders of the ſtomach.

It has been an almoſt univerſally received opinion, that the hæmorrhoidal flux is a ſalutary evacuation, which prevents many diſeaſes which would otherwiſe have happened; and that it even contributes to give long life: and as this opinion has been ſtrenuouſly adopted by Dr Stahl, it has had a very conſiderable influence on the practice of phyſic in Germany. But Dr Cullen maintains that we can never expect to reap much benefit from this flux, which at firſt is purely topical; and, granting that it ſhould become habitual, it is never, he thinks, proper to be encouraged. It is a diſagreeable diſeaſe; ready to go to exceſs, and thereby to prove hurtful, and ſometimes even fatal: at beſt it is liable to accidents, and thus to unhappy conſequences. He is therefore of opinion, that even the firſt approaches of the diſeaſe are to be guarded againſt; and that, though it ſhould have proceeded for ſome time, it ought always to be moderated, and the neceſſity of it ſuperſeded.

Cure. The general intentions of cure in caſes of hæmorrhois are much varied, according to the circumſtances of the affection at the time. When hæmorrhois exiſts in the ſtate of tumor, the principal objects are to counteract inflammation, and to promote a diſcharge of blood from the part. When it is in the ſtate of evacuation, the chief intentions of cure are, to diminiſh the impetus of blood at the part affected, and to increaſe the reſiſtance to the paſſage of blood through the ruptured veſſels. And finally, when the diſeaſe exiſts in the ſtate of ſuppreſſion, the aims of the practitioner muſt chiefly be, to obviate the particular affections which are induced in conſequence of the ſuppreſſion; to reſtore the diſcharge, as a means of mitigating theſe and preventing others; or, when the diſcharge cannot with propriety or advantage be reſtored, to compenſate the want of it by vicarious evacuations.

With theſe various intentions in different caſes, a variety of different remedies may be employed with advantage.

When any evident cauſe for this diſeaſe is perceived, we ought immediately to attempt a removal of that cauſe. One of the moſt frequent remote cauſes is an habitual coſtiveneſs; which muſt be obviated by a proper diet, ſuch as the perſon's own experience will beſt direct; or if the management of diet be not effectual, the belly muſt be kept open by medicines, which may prove gently laxative, without irritating the rectum. In moſt caſes it will be of advantage to acquire a habit with regard to the time of diſcharge, and to obſerve it exactly. Another cauſe of the hæmorrhois to be eſpecially attended to is the prolapſus ani, which is apt to happen on a perſon's having a ſtool. If this ſhall occur to any conſiderable degree, and be not at the ſame time eaſily and immediately replaced, it moſt certainly produces piles, or increaſes them when otherwiſe produced. Perſons therefore who are liable to this prolapſus, ſhould, after having been at ſtool, take great pains to have the inteſtine immediately replaced, by lying down in a horizontal poſture, and preſſing gently upon the anus, till the reduction ſhall be completely obtained. When this prolapſus is occaſioned only by the voiding of hard and bulky fæces, it is to be removed by obviating the coſtiveneſs which occaſions it. But in ſome perſons it is owing to a laxity of the rectum; and in thoſe it is often moſt conſiderable on occaſion of a looſe ſtool. In theſe caſes, it is to be treated by aſtringents, and proper artifices are to be employed to keep the gut in its place.

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When the diſeaſe has frequently recurred from neglect, and is thus in ſome meaſure eſtabliſhed, the methods above mentioned are no leſs proper; but in this caſe ſome other meaſures muſt alſo be uſed. It is eſpecially proper to guard againſt a plethoric ſtate of the body; and therefore to avoid a ſedentary life, full diet, and intemperance in the uſe of ſtrong liquor, which in all caſes of hæmorrhage is of the moſt pernicious conſequence.

Exerciſe of all kinds is of great ſervice in obviating and removing a plethoric ſtate of the body; but upon occaſion of the hæmorrhoidal flux, when this is immediately to come on, both walking and riding, as increaſing the determination of the blood into the hæmorrhoidal veſſels, are to be avoided. At other times, when no ſuch determination is already formed, theſe modes of exerciſe may be very properly employed.

Another method of removing plethora is by cold bathing; but this muſt be employed with caution. When the hæmorrhoidal flux is approaching, it may be dangerous to divert it; but during the intervals of the diſeaſe, cold bathing may be employed with ſafety and advantage; and in thoſe who are liable to a prolapſus ani, the frequent waſhing of the anus with cold water may be uſeful.

Beſides general antiphlogiſtic regimen, in ſome caſes where the inflammation runs high, recourſe may be had with great advantage both to general blood-letting and to leeches applied at the anus. Relief is alſo often obtained from the external application of emollients, either alone or combined with different articles of the ſedative kind, as acetite of lead or opium, by which it is well known that pain in general, particularly when depending on increaſed ſenſibility, or augmented action of the veſſels, is powerfully allayed.

When the flux has actually come on, we are to moderate it as much as poſſible, by cauſing the patient lie in a horizontal poſture on a hard bed; by avoiding exerciſe in an erect poſture, uſing a cool diet, and avoiding external heat. But with reſpect to the further cure of this diſeaſe, we muſt obſerve, that there are only two caſes in which it is common for hæmorrhoidal perſons to call for medical aſſiſtance. The one is, when the affection is accompanied with much pain; and the other, when the piles are accompanied with exceſſive bleeding. In the firſt caſe, we muſt conſider whether the piles be external or internal. The pain of the external piles happens eſpecially when a conſiderable protruſion of the rectum has taken place; and while it remains unreduced, it is ſtrangled by the conſtriction of the ſphincter; and at the ſame time no bleeding happens to take off the ſwelling of the pro-

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In caſe of exceſſive bleeding, we are on all occaſions to endeavour to moderate the flux, even where the diſeaſe has occurred as a critical diſcharge; for if the primary diſeaſe ſhall be entirely and radically cured, the preventing any return of the hæmorrhois ſeems perfectly ſafe and proper. It is only when the diſeaſe ariſes from a plethoric habit, and from a ſtagnation of blood in the hypochondriac region, or when, though originally topical, it has by frequent repetition become habitual, and has thereby acquired a connection with the ſyſtem, that any doubt can ariſe about curing it entirely. In any of theſe caſes, however, Dr Cullen is of opinion, that it will be proper to moderate the bleeding, leſt, by its continuance or repetition, the plethoric ſtate of the body, and the particular determination of the blood into the hæmorrhoidal veſſels, be increaſed, and the return of the diſeaſe be too much favoured. Dr Stahl is of opinion, that the hæmorrhoidal flux is never to be accounted exceſſive, excepting when it occaſions great debility or leucophlegmatia: but Dr Cullen thinks, that the ſmalleſt approach towards producing either of theſe effects ſhould be conſidered as an exceſs which ought to be prevented from going farther; and even in the caſes of congeſtion and plethora, if the plethoric habit and tendency can be obviated and removed, the hæmorrhoidal flux may then with ſafety be entirely ſuppreſſed. In all caſes therefore of exceſſive bleeding, or any approach to it, aſtringents both internal and external may be ſafely and properly applied; not indeed to induce an immediate and total ſuppreſſion; but to moderate the hæmorrhage, and by degrees to ſuppreſs it altogether; while at the ſame time meaſures are to be taken for the removing the neceſſity of its recurrence.

Genus XXXIX. MENORRHAGIA.

245 *Immoderate Flow of the* MENSES.

Menorrhagia, *Sauv.* 244. *Lin.* 202. *Vog.* 96.
Menorrhagia, *Sag.* gen. 179.
Uteri hæmorrhagia, *Hoffm.* II. 224.
Hæmorrhagia uterina, *Junck.* 14.
Leucorrhœa, *Sauv.* gen. 267. *Lin.* 201. *Vog.* 119. *Sag.* gen. 202.
Cachexia uterina, ſive fluor albus, *Hoffm.* III. 348.
Fluor albus, *Junck.* 133.
Abortus, *Sauv.* gen. 245. *Lin.* 204. *Sag.* gen. 180. *Junck.* 92.
Abortio, *Vog.* 97.
Fluor uterini ſanguinis, *Boerh.* 1303.
Convulſio uteri, ſive abortus, *Hoffm.* III. 176.

246 Sp. I. The *Immoderate Flow* of the MENSES, properly ſo called.

Menorrhagia rubra, *Cul.*
Menorrhagia immodica, *Sauv.* ſp. 3.
Menorrhagia ſtillatitia, *Sauv.* ſp. 2.

Deſcription. The quantity of the menſtrual flux is different in different women, and likewiſe in the ſame woman at different times. Menorrhagia. An unuſual quantity therefore is not always to be conſidered as morbid: but when a large flow of the menſes has been preceded by headach, giddineſs, or dyſpnœa; has been uſhered in by a cold ſtage; and is attended with much pain of the back and loins, with a frequent pulſe, heat, and thirſt, it may then be conſidered as preternaturally morbid. On the other hand, when the face becomes pale, the pulſe weak, an unuſual debility is felt in exerciſe, and the breathing is hurried by little labour; when the back becomes pained from any continuance in an erect poſture, when the extremities become frequently cold, and when at night the feet appear affected with œdematous ſwelling: from all theſe ſymptoms we may conclude, that the flow of the menſes has been immoderate, and has already induced a dangerous ſtate of debility. The debility, induced in this caſe, often appears alſo by affections of the ſtomach, an anorexia, and other ſymptoms of dyſpepſia; by a palpitation of the heart, and frequent faintings; by a weakneſs of mind, liable to ſtrong emotions from ſlight cauſes, eſpecially thoſe preſented by ſurpriſe. A large flow of the menſes attended with barrenneſs in married women, may generally be conſidered as preternatural and morbid. Generally, alſo, that flow of the menſes may be conſidered as immoderate, which is preceded and followed by a leucorrhœa.

Cauſes, &c. The proximate cauſe of the menorrhagia is either the effort of the uterine veſſels preternaturally increaſed, or a preternatural laxity of the extremities of the uterine arteries.—The remote cauſes may be, 1. Thoſe which increaſe the plethoric ſtate of the uterine veſſels; as a full and nouriſhing diet, much ſtrong liquor, and frequent intoxications. 2. Thoſe which determine the blood more copiouſly and forcibly into the uterine veſſels; as violent ſtrainings of the whole body; violent ſhocks from falls; ſtrokes or contuſions on the lower belly; violent exerciſe, particularly in dancing; and violent paſſions of the mind. 3. Thoſe which particularly irritate the veſſels of the uterus; as exceſs in venery; the exerciſe of venery in the time of menſtruation; a coſtive habit, giving occaſion to violent ſtraining at ſtool; and cold applied to the feet. 4. Thoſe which have forcibly overſtrained the extremities of the uterine veſſels; as frequent abortions, frequent childbearing without nurſing, and difficult or tedious labours. Or, laſtly, Thoſe which induce a general laxity; as living much in warm chambers, and drinking much of warm enervating liquors, ſuch as tea, coffee, &c.

Cure. The treatment and cure of the menorrhagia, muſt be different according to the different cauſes of the diſeaſe. The practices employed, however, are chiefly uſed with one of two intentions; either with the view of reſtraining the diſcharge when preſent, or of preventing the return of an exceſſive diſcharge at the ſucceeding period. The firſt is chiefly to be accompliſhed by employing ſuch practices as diminiſh the force occaſioning the diſcharge of blood, or as augment the reſiſtance to its paſſage through the veſſels by which it is to be diſcharged. The laſt is in ſome degree to be obtained by avoiding cauſes which either increaſe the general impetus of the blood, or the impetus at the uterus in particular; but principally

pally by giving additional vigour to the uterine veſſels.

In all caſes, the firſt attention ought to be given to avoiding the remote cauſes, whenever that can be done; and by ſuch attention the diſeaſe may be often entirely cured. When the remote cauſes cannot be avoided, or when the avoiding them has been neglected, and a copious menſtruation has come on, it ſhould be moderated as much as poſſible, by abſtaining from all exerciſe at the coming on or during the continuance of the menſtruation; by avoiding even an erect poſture as much as poſſible; by ſhunning external heat, and of courſe warm chambers and ſoft beds; by uſing a light and cool diet; by taking cold drink, at leaſt as far as former habits will allow; by avoiding venery; by obviating coſtiveneſs, or removing it by laxatives which give little ſtimulus. The ſex are commonly negligent, either in avoiding the remote cauſes, or in moderating the firſt beginnings of this diſeaſe. It is by ſuch neglect that it ſo frequently becomes violent and of difficult cure; and the frequent repetition of a copious menſtruation may be conſidered as a cauſe of great laxity in the extreme veſſels of the uterus.

When the coming on of the menſtruation has been preceded by ſome diſorder in other parts of the body, and is accompanied with pains of the back, ſomewhat like parturient pains, with febrile ſymptoms, and when at the ſame time the flow ſeems to be copious, a bleeding at the arm may be proper, but is not often neceſſary; and it will in moſt caſes be ſufficient to employ, with great attention and diligence, thoſe means already mentioned for moderating the diſcharge.

When the immoderate flow of the menſes ſhall ſeem to be owing to a laxity of the veſſels of the uterus, as may be concluded from the general debility and laxity of the perſon's habit; from the remote cauſes that have occaſioned the diſeaſe; from the abſence of the ſymptoms which denote increaſed action in the veſſels of the uterus; from the frequent recurrence of the diſeaſe; and particularly from this, that the female in the intervals of menſtruation is liable to a leucorrhœa: in ſuch a caſe, the diſeaſe is to be treated, not only by employing all the means above mentioned for moderating the hæmorrhage, but alſo by avoiding all irritation, every irritation having a greater effect in proportion as the veſſels are more lax and yielding. If, in ſuch a caſe of laxity, it ſhall appear that ſome degree of irritation occurs, opiates may be employed to moderate the diſcharge; but in uſing theſe much caution is requiſite. If, notwithſtanding theſe meaſures having been taken, the diſcharge ſhall prove very large, aſtringents both external and internal may be employed. In ſuch caſes, Dr Cullen aſks, May ſmall doſes of emetics be of ſervice?

When the menorrhagia depends on the laxity of the uterine veſſels, it will be proper, in the intervals of menſtruation, to employ tonic remedies; as cold bathing and chalybeates. The exerciſes of geſtation alſo may be very uſeful, both for ſtrengthening the whole ſyſtem, and for taking off the determination of the blood to the internal parts.

Theſe remedies may be employed in all caſes of menorrhagia, from whatever cauſe it may have proceeded, if it ſhall have already induced a conſiderable degree of debility in the body.

Sp. II. *ABORTION.* 247

Menorrhagia abortus, *Cul.*
Menorrhagia gravidarum, *Sauv.* ſp. 6.
Abortus effluxio, *Sauv.* ſp. 1.
a, Abortus ſubtrimeſtris.
b, Abortus ſubſemeſtris.
c, Abortus octimeſtris.
Abortus ab uteri laxitate, *Sauv.* ſp. 2.

Sp. III. *Immoderate Flux* of the *LOCHIA.* 248

Menorrhagia lochialis, *Sauv.* ſp. 8. *Cul.*

For the deſcription, treatment, and cure, of theſe two laſt diſeaſes, ſee MIDWIFERY.

Sp. IV. *Immoderate Flow* of the *MENSES* from ſome local diſorder. 249

Menorrhagia vitiorum, *Cul.*
Menorrhagia ex hyſteroptoſi, *Sauv.* ſp. 5.
Menorrhagia ulceroſa, *Sauv.* ſp. 9.

Sp. V. The *Leucorrhœa*, *Fluor Albus*, or *WHITES.* 250

Menorrhagia alba, *Cul.*
Leucorrhœa, *Sauv.* gen. 267.
Menorrhagia decolor, *Sauv.* ſp. 7.
Leucorrhœa Americana, *Sauv.* ſp. 5.
Leucorrhœa Indica, *Sauv.* ſp. 6.
Leucorrhœa Nabothi, *Sauv.* ſp. 9.
Leucorrhœa gravidarum, *Sauv.* ſp. 8.

Deſcription. The *fluor albus*, female weakneſs, or *whites*, as it is commonly called, is a diſeaſe of the womb and its contiguous parts; from which a pale-coloured, greeniſh, or yellow fluid, is diſcharged, attended with loſs of ſtrength, pain in the loins, bad digeſtion, and a wan ſickly aſpect.

Cauſes, &c. The quantity, colour, and conſiſtence of the diſcharge, chiefly depend upon the time of its duration, the patient's habit of body, and the nature of the cauſe by which it was produced. Taking cold, ſtrong liquor, immoderate heat and moiſture, or violent exerciſe, are all obſerved to produce a bad effect, as to its quantity and quality.

Weakly women of lax ſolids, who have had many children, and long laboured under ill health, are of all the moſt ſubject to this diſagreeable diſeaſe; from which they unfortunately ſuffer more ſevere penance than others, as the niceſt ſenſations are often connected with ſuch a delicacy of bodily frame as ſubjects them to it.

In Holland it is very frequent, and in a manner peculiar to the place, from the dampneſs of its ſituation; the ſurrounding air being ſo overcharged with moiſture as to relax the body, ſtop perſpiration, and throw it upon the bowels or womb; producing in the firſt a diarrhœa or flux, in the laſt the *fluor albus* or female weakneſs.

The diſcharge often proceeds from the veſſels ſubſervient to menſtruation; becauſe, in delicate habits, where thoſe veſſels are weak, and conſequently remain too long

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long uncontracted, the *fluor albus* fometimes immediately follows the menfes, and goes off by degrees as they gradually clofe. It alfo comes from the mucous glands of the womb, as is particularly evident in very young females of eight and ten years old; in whom, though very rarely, it has been obferved, and where it muft then neceffarily have efcaped from thofe parts, as the uterine veffels are not fufficiently enlarged for its paffage at fo early a period.

Sometimes, as in women with child, it proceeds from the paffage to the womb, and not from the womb itfelf; which, during pregnancy, is clofely fealed up, fo that nothing can pafs from thence till the time of labour. The application of thofe inftruments called *peffaries*, from the pain and irritation they occafion, is alfo apt to bring on this difcharge. Hence we may conclude, that this difeafe may happen although the blood be in a pure ftate. Here the fault feems to be placed in the veffels at the part, by which the fluids are vitiated and changed from their natural qualities.

The *fluor albus* has been fuppofed to fupply the want of the menfes; becaufe where the firft prevails, the laft is generally either irregular or totally wanting: but it might more properly be faid, that the prefence of the *fluor albus*, which is a preternatural evacuation, occafions the abfence of that which is natural; as is evident from the return of the menfes after the *fluor albus* has been cured. Indeed, when this difcharge appears about the age of 13 or 14, and returns once a month, with fymptoms like thofe of the menfes, then it may be deemed ftrictly natural, and therefore ought not to be ftopped.

Prognofis. The *fluor albus* may be diftinguifhed into two kinds. The firft arifes from a fimple weaknefs, or the relaxation of the folids; which may either be *general*, where the whole bodily fyftem is enervated and unftrung; or *partial*, where the womb only is thus affected, in confequence of hard labour, frequent mifcarriages, a fuppreffion or immoderate quantity of the menfes, or a fprain of the back or loins.

In the firft cafe, the difcharge being generally mild, may be fafely taken away. In the fecond, it may proceed from a vitiated or impure blood, where the body, from thence, is loaded with grofs humours, which nature for her own fecurity and relief thus endeavours to carry off. In fuch cafes, the difcharge is often of a reddifh colour, like that from old ulcerous fores; being fometimes fo fharp as to excoriate the contiguous parts, and occafion a fmarting and heat of urine.

A deep-feated, darting pain, with a forcing down, attending fuch a difcharge is a very dangerous and alarming fign, and indicates an ulceration or cancerous ftate of the womb. This malignant ftate of the difeafe, if of long continuance, is extremely difficult to cure; and difpofes the patient to barrennefs, a bearing down, dropfy, or confumption.

Cure, &c. The caufes of thofe two kinds of this difeafe being different, fo they will require a very different method of cure. For this purpofe, in the firft cafe, nothing will be more proper than nourifhing fimple food; fuch as veal broths, jellies, frefh eggs, and milk diet. The acid fruits will alfo be proper; and the patient may take a reftorative, ftrengthening infufion, which will give firmnefs to the body, and affift the weakened fibres of the womb in returning to their natural ftate.

Leucorrhœa.

The fame method may be ufed with fuccefs, where the *fluor albus* follows the menfes, as already obferved.

The Tunbridge or Spa waters may be drank at the fame time; and, if neceffary, an infufion of green tea, or pure fmith's forge water, may be ufed with a womb-fyringe as an injection twice a-day. Should the difeafe prove uncommonly obftinate, the patient may go into the cold bath every fecond day; and alfo drink lime-water with milk, which will expedite the cure, and prevent a relapfe. Volatile liniment, and afterwards a ftrengthening plafter, may be applied to the fmall of the back.

By way of caution, the female fhould abftain from the immoderate ufe of tea; and be removed into a dry clear air; or if fhe be obliged to remain in one lefs proper, fhe may apply the flefh-brufh, and wear a flannel fhift next her fkin, impregnated with the fumes of burning frankincenfe or any of the grateful aromatic gums. Cold fpring water pumped on the loins, or a bliftering plafter applied to the bottom of the fpine or back, are both very powerful in their effects, and have fometimes fucceeded after other remedies had been tried in vain.

In the fecond fpecies of the difeafe, where the difcharge is fharp and of long ftanding, it would be extremely dangerous to fupprefs it fuddenly, either by aftringents internally taken, or applied as injections, until the fyftem be reftored to a more found and vigorous condition.

A purging potion may be taken twice a-week, and in the intervals an alterative pill night and morning. After this courfe has been continued a fortnight or three weeks, fhe may begin with the ftrengthening bitter infufion, or fome other tonic, in the quantity of a tea-cupful twice a-day, or to a greater extent if the ftomach will allow.

The fame fort of food and regimen will here be proper as in the firft kind of the difeafe. The patient fhould abftain from malt liquors, and drink rice-water, in each pint of which half an ounce of gum-arabic has been diffolved; or if fhe be weak, and of a cold bloated habit of body, a little French brandy may be added occafionally.

When fhe begins to take the bitter infufion, it will be proper to ufe the Tunbridge or Pyrmont water for common drink; but if thofe cannot conveniently be had, the *alkaline aërated water*, impregnated with iron, will make an excellent fubftitute. If it fhould render her coftive, and occafion headach, fhe may defift, and drink a folution of cryftals of tartar, or a little fenna tea fweetened with manna, till thofe complaints be removed.

In fhort, as this is a malady of the moft difagreeable kind, which by long continuance or neglect becomes difficult of cure, and often produces an *ulceration of the womb*, *bearing down*, *barrennefs*, a *dropfy*, or *confumption*; it were to be wifhed that women, on fuch occafions, would be more attentive to their own fafety, by ufing all poffible means, in due time, to prevent thofe diforders.

Dr Leake fays he has attended more patients labouring under the *fluor albus* in the autumn than at any other feafon ſeaſon of the year, eſpecially when the weather was uncommonly moiſt and cold: moſt of them were cured by change of diet, an increaſed perſpiration, and the proper uſe of cinchona with aromatics. He obſerved, that ſeveral about this time who eſcaped the diſorder, were viſited with bad colds, a defluxion on the throat, or a diarrhœa, which were removed by a ſimilar treatment.

Among other remedies which have been recommended in leucorrhœa, recourſe has lately been had to the internal uſe of cantharides. This remedy for leucorrhœa has, in particular, been highly extolled in a late publication on the powers of cantharides, when uſed internally, written by Mr John Roberton, ſurgeon in Edinburgh. The analogy between gleet and leucorrhœa, Mr Roberton tells us, ſuggeſted to him, that the cantharides, which he had employed with ſuch good effects in gleet, might alſo be uſed in leucorrhœa. The event, he affirms, fully anſwered his expectations, and he has employed the remedy with very great ſucceſs. The cantharides were uſed under the form of tincture: the *tinctura melöes veſicatorii* of the Edinburgh Pharmacopœia. This medicine he employed in much larger doſes than is commonly preſcribed. Thus a mixture containing an ounce of the tincture of cantharides, diffuſed in ſix ounces of water, was taken to the extent of half an ounce, four times a-day; nay, in ſome caſes, the tincture was exhibited to the extent of half an ounce in a day, without any inconvenience, and with the beſt effects. As examples of the power of this remedy, Mr Roberton has given a detail of ſix caſes, ſelected from a number which have been under his care. In three caſes, as being the moſt inveterate, the effects of the cantharides were moſt evident. And we ſhall only obſerve, that if this remedy be found by other practitioners to be equally ſucceſsful in the cure of leucorrhœa, it will be a very valuable acquiſition in the practice of medicine, eſpecially if it ſhall be found by others, as well as by Mr Roberton, that not only the general ſymptoms of leucorrhœa are removed, but that the tone and functions of the uterine ſyſtem are completely reſtored by the uſe of cantharides.

As women are ſometimes connected with thoſe who do not conſcientiouſly regard their ſafety, it is a circumſtance of the utmoſt conſequence *to diſtinguiſh a freſh venereal infection from the fluor albus or whites*: for if the firſt be miſtaken for the laſt, and be either neglected or improperly treated, the worſt conſequences may ariſe.

The following ſigns will beſt inform the patient whether there be occaſion for her doubts or not.

A freſh infection, called *gonorrhœa*, is malignant and inflammatory; the *fluor albus* moſt commonly ariſes from relaxation and bodily weakneſs: and therefore the remedies proper in the firſt diſorder would render the laſt more violent, by locking up and confining the infectious matter.

In the gonorrhœa, the diſcharge chiefly proceeds from the parts contiguous to the urinary paſſage, and continues whilſt the menſes flow; but in the *fluor albus* it is ſupplied from the cavity of the womb and its paſſage, and then the menſes are ſeldom regular.

In the gonorrhœa, an itching, inflammation, and heat of urine, are the forerunners of the diſcharge; the orifice of the urinary paſſage is prominent and painful, and the patient is affected with a frequent irritation to make water. In the *fluor albus*, pains in the loins, and loſs of ſtrength, attend the diſcharge; and if any inflammation or heat of urine follow, they happen in a leſs degree, and only after a long continuance of the diſcharge, which, becoming ſharp and acrimonious, excoriates the ſurrounding parts.

In the gonorrhœa, the diſcharge ſuddenly appears without any evident cauſe; but in the *fluor albus*, it comes on more ſlowly, and is often produced by irregularities of the menſes, frequent abortion, ſprains, or long-continued illneſs.

In the gonorrhœa, the diſcharge is greeniſh or yellow, leſs in quantity, *and not attended with the ſame ſymptoms of weakneſs*. In the *fluor albus*, although ſometimes of the ſame colour, eſpecially in bad habits of body, and after long continuance, it is uſually more offenſive and redundant in quantity.

All the other kinds of hæmorrhage enumerated by medical writers, are by Dr Cullen reckoned to be ſymptomatic.

STOMACACE, *Sauv.* gen. 241. *Lin.* 175. *Vog.* 85. *Sag.* gen. 177.

Species: Scorbutica, Purulenta, &c.

HÆMATEMESIS, *Sauv.* gen. 242. *Lin.* 184. *Vog.* 89. *Sag.* gen. 177.

Species: Plethorica, Catamenialis, Scorbutica, &c.

HÆMATURIA, *Sauv.* gen. 233. *Lin.* 198. *Vog.* 92. *Sag.* gen. 178.

Species: Purulenta, Calculoſa, Hæmorrhoidalis, &c.

ORDER V. PROFLUVIA.

GENUS XL. CATARRHUS. 251

The *CATARRH*.

Catarrhus, *Sauv.* gen. 186. *Vog.* 98. *Sag.* gen. 145.
Coryza, *Lin.* 174. *Vog.* 100. *Sag.* gen. 196.
Rheuma, *Sauv.* gen. 142.
Tuſſis, *Sauv.* gen. 142. *Lin.* 155. *Vog.* 205. *Sag.* gen. 245, 255. *Junck.* 30.
Tuſſis catarrhalis et rheumatica, *Hoffm.* III. 109.

Sp. I. *Catarrh* from *COLD*. 252

Catarrhus à frigore, *Cul.*
Catarrhus benignus, *Sauv.* ſp. 1.
Catarrhus pectoreus, *Sauv.* ſp. 6.
Coryza catarrhalis, *Sauv.* ſp. 1.
Coryza phlegmatorrhagia, *Sauv.* ſp. 2. *Salmuth.* Obſ. cent. 1, 37. *Junck.* 28. *Morgagn.* de ſed. xiv. 21.
Coryza febricoſa, *Sauv.* ſp. 6.
Tuſſis catarrhalis, *Sauv.* ſp. 1. *N. Röſen.* Diſſ. apud *Haller*, Diſput. Pract. tom. ii.
Rheuma catarrhale, *Sauv.* ſp. 1.
Amphimerina catarrhalis, *Sauv.* ſp. 2.
Amphimerina tuſſiculoſa, *Sauv.* ſp. 13.
Cephalalgia catarrhalis, *Sauv.* ſp. 10.

Sp. II.

Profluvia.

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Catarrhus.

Sp. II. *Catarrh* from CONTAGION.

Catarrhus à contagio, *Cul.*
Catarrhus epidemicus, *Sauv.* ſp. 3.
Rheuma epidemicum, *Sauv.* ſp. 2.
Synocha catarrhalis, *Sauv.* ſp. 5.

There are ſeveral ſymptomatic ſpecies: as, Catarrhus Rubeoloſus; Tuſſis Varioloſa, Verminoſa, Calculoſa, Phthiſica, Hyſterica, à dentitione, Gravidarum, Metallicolarum, &c.

Deſcription. The catarrh is an increaſed excretion of mucus from the mucous membrane of the noſe, fauces and bronchiæ, attended with pyrexia.

Practical writers and noſologiſts have diſtinguiſhed the diſeaſe by different appellations, according as it happens to affect different parts of the mucous membrane, one part more or leſs than the other: but Dr Cullen is of opinion that the diſeaſe in thoſe different parts is always of the ſame nature, and proceeds from the ſame cauſe in the one as in the other. Very commonly indeed, thoſe different parts are affected at the ſame time; and therefore there is little room for the diſtinction mentioned. The diſeaſe has been frequently treated of under the title of *tuſſis* or *cough*; and a cough, indeed, always attend the chief form of catarrh, that is, the increaſed excretion from the bronchiæ; but as it is ſo often alſo a ſymptom of many other affections, which are very different from one another, it is improperly uſed as a generic title.

The diſeaſe generally begins with ſome difficulty of breathing through the noſe, and with a ſenſe of ſome fulneſs ſtopping up that paſſage. This again is often attended with ſome dull pain and a ſenſe of weight in the forehead, as well as a ſtiffneſs in the motion of the eyes. Theſe feelings, ſometimes at their very firſt beginning, and always ſoon after, are attended with the diſtillation of a thin fluid from the noſe, and ſometimes from the eyes; and theſe fluids are often found to be ſomewhat acrid, both by their taſte and by their fretting the parts over which they paſs. Theſe ſymptoms conſtitute the coryza and gravedo of authors, and are commonly attended with a ſenſe of laſſitude over the whole body. Sometimes cold ſhiverings are felt; at leaſt the body is more ſenſible than uſual to the coldneſs of the air; and with all this the pulſe is more frequent than ordinary, eſpecially in the evenings.

Theſe ſymptoms have ſeldom continued long before they are accompanied with ſome hoarſeneſs, and a ſenſe of roughneſs and ſoreneſs in the trachea, with ſome difficulty of breathing, expreſſed by a ſenſe of ſtraitneſs in the cheſt, and with a cough which ſeems to ariſe from ſome irritation felt at the glottis. This cough is generally at firſt dry and painful, occaſioning pains about the cheſt, and more eſpecially in the breaſt; ſometimes, together with theſe ſymptoms, pains reſembling thoſe of the rheumatiſm are felt in ſeveral parts of the body, particularly about the neck and head. With all theſe ſymptoms, the appetite is impaired, ſome thirſt ariſes, and a feveriſh laſſitude is felt all over the body. Theſe ſymptoms mark the height and violence of the diſeaſe; but commonly it does not continue long. By degrees the cough comes to be attended with a more copious excretion of mucus; which is at firſt thin, but gradually becoming thicker, is brought up with leſs frequent and leſs laborious coughing. The hoarſeneſs and ſoreneſs of the trachea are alſo relieved or removed; and the febrile ſymptoms abating, the expectoration becomes again leſs conſiderable, and the cough leſs frequent, till at length they ceaſe altogether.

Such is generally the courſe of this diſeaſe, neither tedious nor dangerous; but it is ſometimes in both reſpects otherwiſe. The body ſubjected to catarrh ſeems to be more than uſually liable to be affected by cold air; and upon expoſure of the body to freſh cold, the diſeaſe, which ſeemed to be yielding, is often brought back with greater violence than before, and is rendered not only more tedious than otherwiſe it would be, but alſo more dangerous by the ſupervening of other diſeaſes. Some degree of the cynanche tonſillaris often accompanies the catarrh; and when this is aggravated by a freſh application of cold, the cynanche alſo becomes more violent and dangerous from the cough which is preſent at the ſame time. When a catarrh has been occaſioned by a violent cauſe, when it has been aggravated by improper management, and eſpecially when it has been rendered more violent by freſh and repeated applications of cold, it often paſſes into a pneumonic inflammation, attended with the utmoſt danger.

Unleſs, however, ſuch accidents as theſe happen, a catarrh, in ſound perſons not far advanced in life, is always a ſlight and ſafe diſeaſe: but, in perſons of a phthiſical diſpoſition, a catarrh may readily produce a hæmoptyſis, or perhaps form tubercles, in the lungs; and ſtill more readily in perſons who have tubercles already formed in the lungs, an accidental catarrh may occaſion the inflammation of theſe tubercles, and in conſequence produce a phthiſis pulmonalis.

In elderly perſons, a catarrh ſometimes proves a dangerous diſeaſe. Many perſons, as they advance in life, and eſpecially after they have arrived at old age, have the natural mucus of the lungs poured out in greater quantity, and requiring a frequent expectoration. If, therefore, a catarrh happen to ſuch perſons, and increaſe the afflux of fluids to the lungs, with ſome degree of inflammation, it may produce the peripneumonia notha, or more properly chronic catarrh, a diſeaſe continuing often for many years, or at leaſt returning regularly every winter; which in ſuch caſes is very often fatal.

Cauſes, &c. The proximate cauſe of catarrh ſeems to be an increaſed afflux of fluids to the mucous membrane of the noſe, fauces, and bronchiæ, along with ſome degree of inflammation affecting the ſame. The latter circumſtance is confirmed by this, that, in the caſe of catarrh, the blood drawn from a vein commonly exhibits the ſame inflammatory cruſt which appears in the caſe of phlegmaſiæ. The remote cauſe of catarrh is moſt commonly cold applied to the body. This application of cold producing catarrh is generally evident; and Dr Cullen is of opinion that it would always be ſo, were men acquainted with and attentive to the circumſtances which determine cold to act upon the body.

The application of cold which occaſions a catarrh probably operates by ſtopping the diſcharge uſually made

made by the ſkin, and which is therefore determined to the mucous membrane of the parts above mentioned. As a part of the weight which the body daily loſes by inſenſible evacuation, is owing to an exhalation from the lungs, there is probably a connexion between this exhalation and the cutaneous perſpiration, ſo that the one may be increaſed according as the other is diminiſhed; and therefore we may underſtand how the diminution of cutaneous perſpiration, by the application of cold, may increaſe the afflux of fluids to the lungs, and thereby produce a catarrh.

Dr Cullen remarks that there are ſome obſervations of Dr James Keil which may render this matter doubtful; but ſays there is a fallacy in thoſe obſervations. The evident effects of cold in producing coryza, leave the matter, in general, without doubt; and there are ſeveral other obſervations which ſhow a connexion between the lungs and the ſurface of the body.

Whether from the ſuppreſſion of perſpiration, a catarrh be produced merely by an increaſed afflux of fluids, or whether in addition to this the matter of perſpiration be at the ſame time determined to the mucous glands, and there excites a particular irritation, may be uncertain; but Dr Cullen thinks the latter ſuppoſition is moſt probable.

Although in the caſe of a common catarrh, which is in many inſtances ſporadic, it may be doubtful whether any morbific matter be applied to the mucous glands; yet we are certain that the ſymptoms of a catarrh do frequently depend upon ſuch a matter being applied to theſe glands, as appears from the caſe of meaſles, chincough, and eſpecially from the frequent occurrence of contagious and epidemical catarrh.

The phenomena of contagious catarrhs have been much the ſame with thoſe of the others; and the diſeaſe has always been particularly remarkable for this, that it has been the moſt widely and generally ſpreading epidemic known. It has ſeldom appeared in any one country of Europe, without appearing ſucceſſively in almoſt every different part of it; and, in ſome inſtances, it has been alſo transferred to America, and has been ſpread there in like manner, ſo far as we have had opportunities of being informed.

The catarrh from contagion appears with nearly the ſame ſymptoms as thoſe above mentioned. It ſeems often to come on in conſequence of the application of cold. And indeed catarrh from cold and contagion are in every reſpect ſo ſimilar, that when this epidemic rages, it is impoſſible to determine with a perſon having ſymptoms of catarrh after expoſure to cold, whether the diſeaſe proceeds from the one cauſe or the other. In moſt inſtances, however, catarrh from contagion comes on with more cold ſhivering than the catarrh ariſing from cold alone; and the former does alſo not only ſooner ſhow febrile ſymptoms, but to a more conſiderable degree. Accordingly, it more ſpeedily runs its courſe, which is commonly finiſhed in a few days. It ſometimes ends by a ſpontaneous ſweat; and this, in ſome perſons, produces a miliary eruption. It is, however, the febrile ſtate of this diſeaſe eſpecially that is finiſhed in a few days; for the cough and other catarrhal ſymptoms do frequently continue longer, and often when they appear to be going off they are renewed by any freſh application of cold.

Prognoſis. Conſidering the number of perſons who are affected with catarrh, of either the one ſpecies or the other, and eſcape from it quickly without any hurt, it may be allowed to be a diſeaſe commonly free from danger: but it is not always to be treated as ſuch; for in ſome perſons it is accompanied with pneumonic inflammation. In the phthiſically diſpoſed, it often accelerates the coming on of phthiſis; and in elderly perſons it often proves fatal in the manner we have explained above, viz. by degenerating into its chronic ſtate. But though chronic catarrh be often the termination of that ſpecies which ariſes from cold, we have not, in any caſe, obſerved it to ariſe as a conſequence of a catarrh from contagion. This ſpecies of catarrh, however, is not unfrequently followed by phthiſis; or rather, where a phthiſical tendency before exiſted, the affection has been begun and its progreſs accelerated from this cauſe.

Cure. The cure of catarrh is nearly the ſame, whether it proceeds from cold or contagion; only in the latter caſe remedies are commonly more neceſſary than in the former. In the caſes of a moderate diſeaſe, it is commonly ſufficient to avoid cold, or to abſtain from animal food for ſome days. In ſome caſes, where the febrile ſymptoms are conſiderable, it is proper for that length of time to lie in bed, and, by taking frequently ſome mild and diluted drink, a little warmed, to promote a very gentle ſweat; and after this to take care to return very gradually only to the uſe of the free air. When the diſeaſe is more violent, not only the antiphlogiſtic regimen, exactly obſerved, but various remedies alſo, become neceſſary. To take off the phlogiſtic diatheſis which always attends this diſeaſe, blood-letting, more or leſs, according as the ſymptoms ſhall require, is the proper remedy. After blood-letting, for reſtoring the determination of the fluids to the ſurface of the body, and at the ſame time for expediting the ſecretion of mucus in the lungs, which may take off the inflammation of its membrane, vomiting is the moſt effectual means. For the laſt-mentioned purpoſe, it has been ſuppoſed that ſquills, gum-ammoniac, the volatile alkali, and ſome other medicines, might be uſeful; but their efficacy has never been found conſiderable: and if ſquills have ever been very uſeful, it ſeems to have been rather by their emetic than by their expectorant powers. When the inflammatory affections of the lungs ſeem to be conſiderable, it is proper, beſides blood-letting, to apply bliſters to the back or ſides.

As a cough is often the moſt troubleſome circumſtance of this diſeaſe, ſo demulcents may be employed to alleviate it. But after the inflammatory ſymptoms are much abated, if the cough ſtill remains, opiates afford the moſt effectual means of relieving it; and, in the circumſtances juſt now mentioned, they may be very ſafely employed. Very conſiderable advantage is often derived from employing opiates in ſuch a manner as to act more immediately on the head of the wind-pipe. For this purpoſe, opium may often be advantageouſly conjoined with demulcents, melting ſlowly in the mouth. And perhaps no form is more convenient, or anſwers the purpoſe better, than the *trochiſci glycyrrhizæ cum opio* of the Edinburgh Pharmacopœia,

macopœia, where purified opium is combined with extract of liquorice, gum arabic, and other demulcents, to the extent of about a grain in a dram of the composition. After the inflammatory and febrile states of this disease are very much gone, the most effectual means of discussing all remains of the catarrhal affection is by some exercise of gestation diligently employed.

Besides the remedies above mentioned, Dr Mudge, in a treatise on this disease, recommends the steam of warm water as a most efficacious and safe remedy for a catarrh, and which indeed he seems to consider as little less than *infallible*. The method of breathing in these steams is described under the word INHALER; but he gives a caution to people in health, who may accidentally see his machine, not to make the experiment of breathing through cold water with it, or they will be almost certain of catching a severe cold. His directions for those troubled with the catarrh are as follow:

"In the evening, a little before bedtime, the patient, if of adult age, is to take three drams, or as many tea-spoonfuls, of elixir paregoricum, in a glass of water: if the subject be younger, for instance under five years old, one tea-spoonful; or between that and ten years, two. About three quarters of an hour after, the patient should go to bed, and, being covered warm, the inhaler three parts filled with water nearly boiling (which, from the coldness of the metal, and the time it ordinarily takes before it is to be used by the patient, will be of a proper degree of warmth), and being wrapped up in a napkin, but so that the valve in the cover is not obstructed by it, is to be placed at the arm-pit, and the bedclothes being drawn up and over it close to the throat, the tube is to be applied to the mouth, and the patient should inspire and expire through it for about twenty minutes or half an hour.

"It is very evident, as the whole act of respiration is performed through the machine, that in inspiration the lungs will be filled with air which will be hot, and loaded with vapour, by passing through the body of water; and in exspiration, all that was contained in the lungs will, by mixing with the steam on the surface of the water, be forced through the valve in the cover, and settle on the surface of the body under the bedclothes.

"The great use of this particular construction of the inhaler is this: First, As there is no necessity, at the end of every inspiration, to remove the tube from the mouth, in order to expire from the lungs the vapour which had been received into them, this machine may therefore be used with as much ease by children as older people. And, secondly, As a feverish habit frequently accompanies the disorder, the valve in that respect also is of the utmost importance: for a sweat, or at least a free perspiration, not only relieves the patient from the restless anxiety of a hot, dry, and sometimes parched skin, but is also, of all evacuations, the most eligible for removing the fever; and it will be generally found, that, after the inhaler so constructed has been used a few minutes, the warm vapour under the clothes will, by settling upon the trunk, produce a sweat, which will gradually extend itself to the legs and feet.

"In a catarrhous fever, or any feverish habit attending this cough, it would be proper to take a draught of warm thin whey a few minutes before the inhaler be used; and after the process is over, the sweat which it has produced may be continued by occasional small draughts of weak warm whey or barley-water. The sweating is by no means so necessary to the cure of the catarrhous cough, as that the success of the inhaler against that complaint at all depends upon it.

"After this respiratory process is over, the patient usually passes the night without the least interruption from the cough, and feels no further molestation from it than once or twice in the morning to throw off the trifling leakage which, unperceived, had dripped into the bronchiæ and vesicles during the night; the thinner parts of which being evaporated, what remains is soon got rid of by a very gentle effort.

"I cannot, however, take leave of this part of my subject, without pointedly observing, that if the patient means not to be disappointed by my assurances or his own expectations, it is essentially necessary that the following remarks, with regard to the time and manner of using this process, should be strictly attended to.

"First, That as tender valetudinary people are but too well acquainted with the first notices of the disorder, the remedy must, or ought to be, used the same evening; which will, in an ordinary seizure, be attended with an immediate cure: but if the soreness of the respiratory organs, or the petulance of the cough, show the cold which has been contracted to have been very severe, the inhaler, without the opiate, should be again repeated for the same time the next morning.

"Secondly, If the use of the inhaler, &c. be delayed till the second night, it will be always right to repeat it again the next morning without the opiate, but with it if the seizure has been violent.

"And, lastly, If the cough be of some days standing, it will be always necessary to employ both parts of the process at night and the succeeding morning, as the first simple inflammatory mischief is now most probably aggravated by an additional one of a chronic tendency.

"But if, through the want of a timely application, or a total neglect of this or any other remedy, the cough should continue to harass the patient, it is, particularly in delicate and tender constitutions, of the utmost consequence to attempt the removal of it as soon as possible, before any floating acrimony in the constitution (from the perpetual irritation) receives an habitual determination to an organ so essential to life as the lungs.

"If the patient expectorate with ease and freedom a thick and well-digested inoffensive phlegm, there is generally but little doubt of his spitting off the disorder, with common care, in a few days; and till that be accomplished, a proper dose of elixir paregoricum for a few successive nights will be found very useful in suppressing the fatiguing irritation and ineffectual cough, occasioned by a matter which, dripping in the early state of the disease into the bronchiæ during the night, is commonly at that time too thin to be discharged by these convulsive efforts.

"If, however, notwithstanding a free and copious expectoration, the cough should still continue, and the discharge,

diſcharge, inſtead of removing the complaint, ſhould itſelf, by becoming a diſeaſe, be a greater expence than the conſtitution can well ſupport, it is poſſible that a tender patient may ſpit off his life through a weak relaxed pair of lungs, without the leaſt appearance of purulence, or any ſuſpicion of ſuppuration. In thoſe circumſtances, beſides, as was mentioned before, increaſing the general perſpiration by the ſalutary friction of a flannel waiſtcoat, change of ſituation, and more eſpecially long journeys on horſeback, conducted as much as poſſible through a thin, ſharp, dry air, will ſeldom fail of removing the complaint.

"But, on the contrary, if the cough ſhould, at the ſame time that it is petulant and fatiguing to the breaſt, continue dry, huſky, and without expectoration; provided there be reaſon to hope that no tubercles are forming, or yet actually formed, there is not perhaps a more efficacious remedy for it than half a dram of gum-ammoniacum, with 18 or 20 drops of liquid laudanum, made into pills, and taken at bedtime, and occaſionally repeated. This excellent remedy Sir John Pringle did me the honour to communicate to me; and I have accordingly found it, in a great many inſtances, amazingly ſucceſsful, and generally very expeditiouſly ſo, for it ſeldom fails to produce an expectoration, and to abate the diſtreſſing fatigue of the cough. In thoſe circumſtances I have likewiſe found the common remedy of ʒſs or ℈ij of *balſ. ſulph. aniſat.* taken twice a-day, in a little powdered ſugar or any other vehicle, a very efficacious one. I have alſo, many times, known a ſalutary revulſion made from the lungs by the ſimple application of a large plaſter, about five or ſix inches diameter, of Burgundy pitch, between the ſhoulders; for the perſpirable matter, which is locked up under it, becomes ſo ſharp and acrid, that in a few days it ſeldom fails to produce a very conſiderable itching, ſome little tendency to inflammation, and very frequently a great number of boils. This application ſhould be continued (the plaſter being occaſionally changed), for three weeks or a month, or longer, if the complaint be not ſo ſoon removed.

"And here I cannot help obſerving, that, though ſeemingly a trifling, it is however by no means an uſeleſs caution to the tender patient, not to expoſe his ſhoulders in bed, and during the night, to the cold; but when he lies down, to take care they be kept warm, by drawing the bedclothes up cloſe to his back and neck.

"If, however, notwithſtanding theſe and other means, the cough, continuing dry or unattended with a proper expectoration, ſhould perſevere in haraſſing the patient; if, at laſt, it ſhould produce, together with a ſoreneſs, ſhooting pains through the breaſt and between the ſhoulders, attended alſo with ſhortneſs of the breath; and if, added to this, fluſhes of the cheeks after meals, ſcalding in the hands and feet, and other ſymptoms of a hectic, ſhould accompany the diſorder; there is certainly no time to be loſt, as there is the greateſt reaſon to apprehend that ſome acrimony in the habit is determined to the tender ſubſtance of the lungs, and that conſequently tubercular ſuppurations will follow. In this critical and dangerous ſituation, I think I can venture to ſay from long experience, that, accompanied with changes of air and occaſional bleedings, the patient will find his greateſt ſecurity in a drain from a large ſcapular iſſue, aſſiſted by a diet of aſſes milk and vegetables."

Genus XLI. DYSENTERIA. 254

The *Dysentery.*

Dyſenteria, *Sauv.* gen. 248. *Lin.* 191. *Vog.* 107. *Sag.* 183. *Hoffm.* III. 151. *Junck.* 76.

Deſcription. The dyſentery is a diſeaſe in which the patient has frequent ſtools, accompanied with much griping, and followed by a teneſmus. The ſtools, though frequent, are generally in ſmall quantity; and the matter voided is chiefly mucus, ſometimes mixed with blood. At the ſame time, the natural fæces ſeldom appear; and when they do, it is generally in a compact and hardened form, often under the form of ſmall hard ſubſtances known by the name of *ſcybala.* This diſeaſe occurs eſpecially in ſummer and autumn, at the ſame time with autumnal intermittent and remittent fevers; and with theſe it is often complicated. It comes on ſometimes with cold ſhiverings, and other ſymptoms of pyrexia; but more commonly the ſymptoms of the topical affection appear firſt. The belly is coſtive, with an unuſual flatulence in the bowels. Sometimes, though more rarely, ſome degree of diarrhœa is the firſt appearance.—In moſt caſes, the diſeaſe begins with griping, and a frequent inclination to go to ſtool. In indulging this, little is voided, but ſome teneſmus attends it. By degrees the ſtools become more frequent, the griping more ſevere, and the teneſmus more conſiderable.—With theſe ſymptoms there is a loſs of appetite, and frequently ſickneſs, nauſea, and vomiting, alſo affecting the patient. At the ſame time there is always more or leſs of pyrexia preſent. It is ſometimes of the remittent kind, and obſerves a tertian period.—Sometimes the pyrexia is manifeſtly inflammatory, and very often of a putrid kind. Theſe febrile ſtates continue to accompany the diſeaſe during its whole courſe, eſpecially when it terminates ſoon in a fatal manner. In other caſes, the febrile ſtate almoſt entirely diſappears, while the proper dyſenteric ſymptoms remain for a long time after. In the courſe of the diſeaſe, whether for a ſhorter or a longer time, the matter voided by ſtool is very various. Sometimes it is merely a mucous matter, without any blood, exhibiting that diſeaſe which is named by ſome the *morbus mucoſus*, and by others the *dyſenteria alba.* For the moſt part, however, the mucus diſcharged is more or leſs mixed with blood. This ſometimes appears only in ſtreaks among the mucus; but at other times is more copious, giving a tinct to the whole; and upon ſome occaſions a pure and unmixed blood is voided in conſiderable quantity. In other reſpects, the matter voided is variouſly changed in colour and conſiſtence, and is commonly of a ſtrong and unuſually fetid odour. It is probable, that ſometimes a genuine pus is voided, and frequently a putrid ſanies, proceeding from gangrenous parts. There are very often mixed with the liquid matter ſome films of a membranous appearance, and frequently ſome ſmall maſſes of a ſeemingly ſebaceous matter. While the ſtools voiding theſe various matters, are, in many inſtances, exceedingly frequent,

quent, it is feldom that natural fæces appear in them; and when they do appear, it is, as we have faid, in the form of fcybala, that is, in fomewhat hardened, feparate balls. When thefe are voided, whether by the efforts of nature or as folicited by art, they procure a remiffion of all the fymptoms, and more efpecially of the frequent ftools, griping, and tenefmus.

Accompanied with thefe circumftances, the difeafe proceeds for a longer or fhorter time. When the pyrexia attending it is of a violent inflammatory kind, and more efpecially when it is of a very putrid nature, the difeafe often terminates fatally in a very few days, with all the marks of a fupervening gangrene. When the febrile ftate is more moderate, or difappears altogether, the difeafe is often protracted for weeks, and even for months; but, even then, after a various duration, it often terminates fatally, and generally in confequence of a return and confiderable aggravation of the inflammatory and putrid ftates. In fome cafes, the difeafe ceafes fpontaneoufly; the frequency of ftools, the griping, and tenefmus, gradually diminifhing, while natural ftools return. In other cafes, the difeafe, with moderate fymptoms, continues long, and ends in a diarrhœa, fometimes accompanied with lienteric fymptoms.

Caufes, &c. The remote caufes of this difeafe have been varioufly reprefented. In general it arifes in fummer or autumn, after confiderable heats have prevailed for fome time, and efpecially after very warm and at the fame time very dry ftates of the weather: and the difeafe is much more frequent in warm than in cooler climates. It happens, therefore, in the fame circumftances and feafons which confiderably affect the ftate of the bile in the human body; but the cholera is often without any dyfenteric fymptoms, and copious difcharges of bile have been found to relieve the fymptoms of dyfentery; fo that it is difficult to determine what connexion the difeafe has with the ftate of the bile.

It has been obferved, that the effluvia from very putrid animal fubftances readily affect the alimentary canal, and, upon occafion, they certainly produce a diarrhœa; but whether they ever produce a genuine dyfentery, is not certain.

The dyfentery does often manifeftly arife from the application of cold, but the difeafe is always contagious; and, by the propagation of fuch contagion, independent of cold, or other exciting caufes, it becomes epidemic in camps and other places. It is, therefore, to be doubted if the application of cold ever produces the difeafe, unlefs where the fpecific contagion has been previoufly received into the body; and, upon the whole, it is probable that a fpecific contagion is to be confidered as being always the remote caufe of this difeafe.

Whether this contagion, like many others, be of a permanent nature, and only fhows its effects in certain circumftances which render it active, or if it be occafionally produced, we cannot determine. Neither, if the latter fuppofition be received, can we fay by what means it may be generated. As little do we know any thing of its nature, confidered in itfelf; or at moft, only this, that in common with many other contagions, it is very often fomewhat of a putrid nature, and capable of inducing a putrefcent tendency in the human body. This, however, does not at all explain the peculiar effect of inducing thofe fymptoms which properly and effentially conftitute dyfentery. Of thefe fymptoms the proximate caufe is ftill obfcure.—The common opinion has been, that the difeafe depends upon an acrid matter thrown upon or fomehow generated in the inteftines, exciting their periftaltic motion, and thereby producing the frequent ftools which occur in this difeafe. But this fuppofition cannot be adopted; for, in all the inftances known, of acrid fubftances applied to the inteftines, and producing frequent ftools, they at the fame time produce copious ftools, as might be expected from acrid fubftances applied to any length of the inteftines. This, however, is not the cafe in dyfentery, in which the ftools, however frequent, are generally in very fmall quantity, and fuch as may be fuppofed to proceed from the lower parts of the rectum only. With refpect to the fuperior portions of the inteftines, and particularly thofe of the colon, it is probable they are under a preternatural and confiderable degree of conftriction: for, as we have faid above, the natural fæces are feldom voided; and when they are, it is in a form which gives reafon to fuppofe they have been long retained in the cells of the colon, and confequently that the colon had been affected with a preternatural conftriction. This is confirmed by almoft all the diffections which have been made of the bodies of dyfenteric patients; in which, when gangrene had not entirely deftroyed the texture and form of the parts, large portions of the great guts have been found affected with a very confiderable conftriction.

The proximate caufe of dyfentery, or at leaft the chief part of the proximate caufe, feems to confift in a preternatural conftriction of the colon, occafioning, at the fame time, thofe fpafmodic efforts which are felt in fevere gripings, and which efforts, propagated downwards to the rectum, occafion there the frequent mucous ftools and tenefmus. But whether this explanation fhall be admitted or not, it will ftill remain certain, that hardened fæces, retained in the colon, are the caufe of the griping, frequent ftools, and tenefmus: for the evacuation of thefe fæces, whether by nature or by art, gives relief from the fymptoms mentioned; and it will be more fully and ufefully confirmed by this, that the moft immediate and fuccefsful cure of dyfentery is obtained by an early and conftant attention to the preventing the conftriction, and the frequent ftagnation of fæces in the colon.

Cure. In the early periods of this difeafe, the objects chiefly to be aimed at are the following: The difcharge of acrid matter depofited in the alimentary canal; the counteracting the influence of this matter when it cannot be evacuated; the obviating the effects refulting from fuch acrid matter as can neither be evacuated nor deftroyed; and, finally, the prevention of any further feparation and depofition of fuch matter in the alimentary canal. In the more advanced periods of the difeafe, the principal objects are, the giving a proper defence to the inteftines againft irritating caufes; the diminution of the morbid fenfibility of the inteftinal canal: and the reftoration of due vigour to the fyftem in general, but to the inteftines in particular.

The moft eminent of our late practitioners, and of of greatest experience in this disease, seem to be of opinion, that it is to be cured most effectually by purging, assiduously employed. The means may be various; but the most gentle laxatives are usually sufficient; and, as the medicine must be frequently repeated, these are the most safe, more especially as an inflammatory state so frequently accompanies the disease. Whatever laxatives produce an evacuation of natural fæces, and a consequent remission of the symptoms, will be sufficient to effectuate the cure. But if the gentle laxatives shall not produce the evacuation now mentioned, somewhat more powerful must be employed; and Dr Cullen has found nothing more proper or convenient than tartar emetic, given in small doses, and at such intervals as may determine its operation to be chiefly by stool. To the tartrite of antimony, however, employed as a purgative, the great sickness which it is apt to occasion, and the tendency which it has, notwithstanding every precaution, to operate as an emetic, are certainly objections. Another antimonial, at one time considered as an almost infallible remedy for this disease, the vitrum antimonii ceratum, is no less exceptionable, from the uncertainty and violence of its operation; and perhaps the safest and best purgatives are the different neutral salts, particularly those containing fossil alkali, such as the soda vitriolata tartarisata or phosphorata. Rhubarb, so frequently employed, is, Dr Cullen thinks, in several respects, amongst the most unfit purgatives; and indeed from its astringent quality, it is exceptionable at the commencement of the affection, unless it be conjoined with something to render its operation more brisk, such as mild muriated mercury, or calomel as it is commonly called.

Vomiting has been held a principal remedy in this disease; and may be usefully employed in the beginning, with a view both to the state of the stomach and of the fever: but it is not necessary to repeat it often; and, unless the emetics employed operate also by stool, they are of little service. Ipecacuanha is by no means a specific; and it proves only useful when so managed as to operate chiefly by stool.

For relieving the constriction of the colon, and evacuating the retained fæces, clysters may sometimes be useful; but they are seldom so effectual as laxatives given by the mouth; and acrid clysters, if they be not effectual in evacuating the colon, may prove hurtful by stimulating the rectum too much.

The frequent and severe griping attending this disease leads almost necessarily to the use of opiates; and they are very effectual for the purpose of relieving from the gripes: but, by occasioning an interruption of the action of the small intestines, they favour the constriction of the colon, and thereby aggravate the disease; and if, at the same time, the use of them supersede in any measure the employing purgatives, it is doing much mischief; and the neglect of purging seems to be the only thing which renders the use of opiates very necessary.

When the gripes are both frequent and severe, they may sometimes be relieved by the employment of the semicupium, or by fomentation of the abdomen continued for some time. In the same case, the pains may be relieved, and the constriction of the colon may be taken off, by blisters applied to the lower belly.

At the beginning of this disease, when the fever is any way considerable, bloodletting, in patients of tolerable vigour, may be proper and necessary; and, when the pulse is full and hard, with other symptoms of an inflammatory disposition, bloodletting ought to be repeated. But, as the fever attending dysentery is often of the typhoid kind, or does, in the course of the disease, become soon of that nature, bloodletting must be cautiously employed.

From our account of the nature of this disease, it will be sufficiently obvious, that the use of astringents in the beginning of it must be very pernicious. But although astringents may be hurtful at early periods of this affection, yet it cannot be denied, that where frequent loose stools remain after the febrile symptoms have subsided, they are often of great service for diminishing morbid sensibility, and restoring due vigour to the intestinal canal. Accordingly, on this ground a variety of articles have been highly celebrated in this affection; among others we may mention the quassia, radix indica lopeziana, verbascum, extractum catechu, and gum kino, all of which have certainly in particular cases been employed with great advantage. And perhaps also, on the same principles we are to account for the benefit which has been sometimes derived from the nux vomica, a remedy highly extolled in cases of dysentery by some of the Swedish physicians; but this article, it must be allowed, often proves very powerful as an evacuant. Its effects, however, whatever its mode of operation may be, are too precarious to allow its ever being introduced into common practice; and in this country, it has, we believe, been but very rarely employed. Whether an acrid matter be the original cause of the dysentery, may be uncertain; but, from the indigestion, and the stagnation of fluids, which attend the disease, we may suppose that some acrid matters are constantly present in the stomach and intestines; and therefore that demulcents may be always usefully employed. At the same time, from the consideration that mild oily matters thrown into the intestines in considerable quantity always prove laxative, Dr Cullen is of opinion, that the oleaginous demulcents are the most useful. Where, however, these are not acceptable to the patient's taste, those of the mucilaginous and farinaceous kind, as the decoctum hordei, potio cretacea, &c. are often employed with advantage.

As this disease is so often of an inflammatory or of a putrid nature, it is evident that the diet employed in it should be vegetable and acescent. Milk, in its entire state, is of doubtful quality in many cases; but even some portion of the cream is often allowable, and whey is always proper.—In the first stages of the disease, the sweet and subacid fruits are allowable, and even proper. It is in the more advanced stages only that any morbid acidity seems to prevail in the stomach, and to require some reserve in the use of acescents. At the beginning of the disease, absorbents seem to be superfluous; and, by their astringent and septic powers, they may be hurtful; but in after periods they are often of advantage.

When this disease is complicated with an intermittent, Comata. tent, and is protracted from that circumstance chiefly, it is to be treated as an intermittent, by administering the cinchona, which in the earlier periods of the disease is hardly to be admitted.

Class II. NEUROSES.

Order I. COMATA.

Comata, *Sauv.* Class VI. Ord. II. *Sag.* Class IX. Order V.
Soporosi, *Lin.* Class VI. Ord. II.
Adynamiæ, *Vog.* Class VI.
Nervorum resolutiones, *Hoffm.* III. 194.
Affectus soporosi, *Hoffm.* III. 209.
Motuum vitalium defectus, *Junck.* 114.

255 Genus XLII. APOPLEXIA.

The APOPLEXY.

Apoplexia, *Sauv.* gen. 182. *Lin.* 101. *Vog.* 229. *Boerh.* 1007. *Junck.* 117. *Sag.* gen. 288. *Wepfer.* Hist. apoplecticorum.
Carus, *Sauv.* gen. 181. *Lin.* 100. *Vog.* 231. *Boerh.* 1045. *Sag.* gen. 287.
Cataphora, *Sauv.* gen. 180. *Lin.* 99. *Vog.* 232. *Boerh.* 1045. *Sag.* gen. 286.
Coma, *Vog.* 232. *Boerh.* 1048.
Hæmorrhagia cerebri, *Hoffm.* II. 240.

To this genus also Dr Cullen reckons the following diseases to belong:

Catalepsis, *Sauv.* gen. 176. *Lin.* 129. *Vog.* 230. *Sag.* gen. 281. *Boerh.* 1036. *Junck.* 44.
Affectus cerebri spasmodico-ecstaticus, *Hoffm.* III. 44.
Ecstasis, *Sauv.* gen. 177. *Vog.* 333. *Sag.* gen. 283.

The following he reckons symptomatic:

Typhomania, *Sauv.* gen. 178. *Lin.* 97. *Vog.* 23. *Sag.* gen. 284.
Lethargus, *Sauv.* gen. 179. *Lin.* 98. *Vog.* 22. *Sag.* gen. 285.

This disease appears under modifications so various, as to require some observations with respect to each.

256 Sp. I. The *Sanguineous APOPLEXY.*

Description. In this disease the patients fall suddenly down, and are deprived of all sense and voluntary motion, but without convulsions. A giddiness of the head, noise in the ears, coruscations before the eyes, and redness of the face, usually precede. The distinguishing symptom of the disease is a deep sleep, attended with violent snorting; if any thing be put into the mouth, it is returned through the nose; nor can any thing be swallowed without shutting the nostrils; and even when this is done, the person is in the utmost danger of suffocation. Sometimes apoplectic patients will open their eyes after having taken a large dose of an emetic; but if they show no sign of sense, there is not the least hope of their recovery. Sometimes the apoplexy terminates in a hemiplegia; in which case it comes on with a distortion of the mouth towards the sound side, Apoplexia. a drawing of the tongue the same way, and stammering of the speech. Dissections sometimes show a rupture of some vessels of the meninges, or even vessels of the brain itself; though sometimes, if we may believe Dr Willis, no defect is to be observed either in the cerebrum or cerebellum.

Causes, &c. The general cause of a sanguineous apoplexy is a plethoric habit of body, with a determination to the head. The disease therefore may be brought on by whatever violently urges on the circulation of the blood; such as surfeits, intoxication, violent passions of the mind, immoderate exercise, &c. It takes place, however, for the most part, when the venous plethora has subsisted for a considerable time in the system. For that reason it commonly does not attack people till past the age of 60; and that whether the patients are corpulent and have a short neck, or whether they are of a lean habit of body. Till people be past the age of childhood, apoplexy never happens.

Prognosis. This disease very often kills at its first attack, and few survive a repetition of the fit; so that those who make mention of people who have survived several attacks of the apoplexy, have probably mistaken the epilepsy for this disease. In no disease is the prognosis more fatal; since those who seem to be recovering from a fit, are frequently and suddenly carried off by its return, without either warning of its approach or possibility of preventing it. The good signs are when the disease apparently wears off, and the patient evidently begins to recover; the bad ones are when all the symptoms continue and increase.

Cure. The great object to be aimed at, is to restore the connexion between the sentient and corporeal parts of the system; and when interruption to this connexion proceeds from compression in the brain by blood, this is to be attempted, in the first place, by large and repeated bleedings; after which, the same remedies are to be used as in the serous apoplexy, aftermentioned. The body is to be kept in a somewhat erect posture, and the head supported in that situation.

Sp. II. The *Serous APOPLEXY.* 257

Apoplexia pituitosa, *Sauv.* sp. 7. Apoplexia serosa, *Preysinger*, sp. 4. *Morg.* de causis, &c. IV. LX.
Carus à hydrocephalo, *Sauv.* sp. 16.
Cataphora hydrocephalica, *Sauv.* sp. 6.
Cataphora somnolenta, *Sauv.* sp. 1.
Lethargus literatorum, *Sauv.* 7. *Van Swieten* in Aphor. 1010. 2 γ and 3 α.

Description. In this species the pulse is weak, the face pale, and there is a diminution of the natural heat. On dissection, the ventricles of the brain are found to contain a larger quantity of fluid than they ought; the other symptoms are the same as in the former.

Causes, &c. This may arise from any thing which induces a debilitated state of the body, such as depressing passions of the mind, much study, watching, &c. It may also be brought on by a too plentiful use of diluting, acidulated drinks. It doth not, however, Comata. ever, follow, that the extravaſated ſerum above mentioned in the ventricles of the brain is always the cauſe of the diſeaſe, ſince the animal fluids are very frequently obſerved to ooze out in plenty through the coats of the containing veſſels after death, though no extravaſation took place during life.

Prognoſis. This ſpecies is equally fatal with the other; and what hath been ſaid of the prognoſis of the ſanguineous, may alſo be ſaid of that of the ſerous apoplexy.

Cure. In this ſpecies veneſection can ſcarcely be admitted: acrid purgatives, emetics, and ſtimulating clyſters, are recommended to carry off the ſuperabundant ſerum; but in bodies already debilitated, they may perhaps be liable to the ſame exceptions with veneſection itſelf. Volatile ſalts, cephalic elixirs, and cordials, are alſo preſcribed; and in caſe of a hemiplegia ſupervening, the cure is to be attempted by aperient ptiſans, cathartics, and ſudorifics; gentle exerciſe, as riding in a carriage; with bliſters and ſuch ſtimulating medicines as are in general had recourſe to in affections originally of the paralytic kind.

258 Sp. III. *Hydrocephalic APOPLEXY*, or *Dropſy* of the *Brain.*

Hydrocephalus interior, *Sauv.* ſp. 1.
Hydrocephalus internus, *Whytt's* works, page 725.
London Med. Obſ. vol. iv. art. 3, 6, and 25.
Gaudelius de hydroeephalo, apud *Sandifort* Theſaur. vol. ii.
Hydrocephalus acutus, *Quin. Diſſ.* de hydrocephalo, 1779.
Aſthenia à hydrocephalo, *Sauv.* ſp. 3.

Hiſtory and deſcription. This diſeaſe has been accurately treated within theſe few years by ſeveral eminent phyſicians, particularly the late Dr Whytt, Dr Fothergill, and Dr Watſon; who concur in opinion, with reſpect to the ſeat of the complaint, the moſt of its ſymptoms, and its general fatality. Out of twenty patients that had fallen under Dr Whytt's obſervation, he candidly owns that he had been ſo unfortunate as to cure only one who laboured under the characteriſtic ſymptoms of the hydrocephalus; and he ſuſpects that thoſe who imagine they have been more ſucceſsful, had miſtaken another diſtemper for this. It is by all ſuppoſed to conſiſt in a dropſy of the ventricles of the brain; and this opinion is fully eſtabliſhed by diſſections. It is obſerved to happen more commonly to healthy, active, lively children, than to thoſe of a different diſpoſition.

Dr Whytt ſuppoſes that the commencement of this diſeaſe is obſcure; that it is generally ſome months in forming; and that, after ſome obvious urgent ſymptoms rendering aſſiſtance neceſſary, it continues ſome weeks before its fatal termination. This, in general, differs from what has hitherto been obſerved by Dr Fothergill; the latter informing us, that he has ſeen children, who, from all appearance, were healthy and active, ſeized with this diſtemper, and carried off in about 14 days. He has ſeldom been able to trace the commencement of it above three weeks.

Though the hydroeephalus be moſt incident to children, it has been ſometimes obſerved in adults; as appears from a caſe related by Dr Huek, and from ſome others. Apoplexia.

When the diſeaſe appears under its moſt common form, the ſymptoms at different periods are ſo various as to lead Dr Whytt to divide the diſeaſe into three ſtages, which are chiefly marked by changes occurring in the condition of the pulſe. At the beginning it is quicker than natural; afterwards it becomes uncommonly ſlow; and towards the concluſion of the diſeaſe it becomes again quicker than natural, but at the ſame time often very irregular.

Thoſe who are ſeized with this diſtemper uſually complain firſt of a pain in ſome part below the head; moſt commonly about the nape of the neck and ſhoulders; often in the legs; and ſometimes, but more rarely, in the arms. The pain is not uniformly acute, nor always fixed to one place; and ſometimes does not affect the limbs. In the latter caſe, the head and ſtomach have been found to be moſt diſordered; ſo that when the pain occupied the limbs, the ſickneſs or headach was leſs conſiderable; and when the head became the ſeat of the complaint, the pain in the limbs was ſeldom or never mentioned. Some had very violent ſickneſſes and violent headachs alternately. From being perfectly well and ſportive, ſome were in a few hours ſeized with thoſe pains in the limbs, or with ſickneſs, or headach, in a ſlight degree, commonly after dinner; but ſome were obſerved to droop a few days before they complained of any local indiſpoſition. In this manner they continued three, four, or five days, more or leſs, as the children were healthy and vigorous. They then commonly complain of an acute deep-ſeated pain in the head, extending acroſs the forehead from temple to temple; of which, and a ſickneſs, they alternately complain in ſhort and affecting exclamations; doſing a little in the intervals, breathing irregularly, and ſighing much while awake. Sometimes their ſighs, for the ſpace of a few minutes, are inceſſant.

As the diſeaſe advances, the pulſe becomes ſlower and irregular, the ſtrokes being made both with unequal force and in unequal times, till within a day or two of the fatal termination of the diſorder, when it becomes exceeding quick; the breathing being at the ſame time deep, irregular, and laborious. After the firſt attack, which is often attended with feveriſh heats, eſpecially towards evening, the heat of the body is for the moſt part temperate, till at laſt it keeps pace with the increaſing quickneſs of the pulſe. The head and præcordia are always hot from the firſt attack. The ſleeps are ſhort and diſturbed, ſometimes interrupted by watchfulneſs; beſides which there are ſtartings.

In the firſt ſtage of the diſeaſe there ſeems to be a peculiar ſenſibility of the eyes, as appears from the intolerance of light. But in the progreſs of the diſeaſe a very oppoſite ſtate occurs: The pupil is remarkably dilated, and cannot be made to contract by the action even of ſtrong light; ſuch, for example, as by bringing a candle very near to it. In many caſes there is reaſon to believe that total blindneſs occurs: Often alſo the pupil of one eye is more dilated than that of another, and the power of moving the eyes is alſo morbidly affected. Thoſe children, who were never obſerved to ſquint before, often become affected

with

Comata. with a very great degree of ſtrabiſmus. The patients are unwilling to be diſturbed for any purpoſe, and can bear no poſture but that of lying horizontally. One or both hands are moſt commonly about their heads. The urine and ſtools come away inſenſibly. At length the eyelids become paralytic, great heat accompanied with ſweat overſpreads the whole body, reſpiration is rendered totally ſuſpirious, the pulſe increaſes in its trembling undulations beyond the poſſibility of counting, till the vital motions entirely ceaſe; and ſometimes convulſions conclude the ſcene.

Many of the ſymptoms above enumerated are ſo common to worm caſes, teething, and other irritating cauſes, that it is difficult to fix upon any which particularly characterize this diſeaſe at its commencement. The moſt peculiar ſeem to be the pains in the limbs, with ſickneſs and inceſſant headach; which, though frequent in other diſeaſes of children, are neither ſo uniformly nor ſo conſtantly attendant as in this. Another circumſtance obſerved to be familiar, if not peculiar to this diſtemper, is, that the patients are not only coſtive, but it is likewiſe with the greateſt difficulty that ſtools can be procured. Theſe are generally of a very dark greeniſh colour with an oilineſs or a glaſſy bile, rather than the ſlime which accompanies worms; and they are, for the moſt part, extremely offenſive. No poſitive concluſion can be drawn from the appearance of the urine; it being various, in different ſubjects, both in its colour and contents, according to the quantity of liquor they drank, and the time between the diſcharges of the urine. From their unwillingneſs to be moved, they often retain their water 12 or 15 hours, and ſometimes longer. In complaints ariſing from worms, and in dentition, convulſions are more frequent than in this diſorder. Children ſubject to fits are ſometimes ſeized with them a few days before they die. Sometimes theſe continue 24 hours inceſſantly, and till they expire.

Cauſes. The cauſes of internal hydrocephalus are very much unknown. Some ſuppoſe it to proceed from a rupture of ſome of the lymphatic veſſels of the brain. But this ſuppoſition is ſo far from being confirmed by any anatomical obſervation, that even the exiſtence of ſuch veſſels in the brain is not clearly demonſtrated. That lymphatics, however, do exiſt in the brain, cannot be doubted; and one of the moſt probable cauſes giving riſe to an accumulation of water in the brain is a diminiſhed action of theſe. Here, however, as well as in other places, accumulation may alſo be the conſequence of augmented effuſion; and in this way, an inflammatory diſpoſition, as ſome have ſuppoſed, may give riſe to the affection. But from whatever cauſe an accumulation of water in the ventricles of the brain be produced, there can be no doubt that from this the principal ſymptoms of the diſeaſe ariſe, and that a cure is to be accompliſhed only by the removal of it. It is, however, probable, that the ſymptoms are ſomewhat varied by the poſition of the water, and that the affection of viſion in particular is often the conſequence of ſome morbid ſtate about the *thalami nervorum opticorum*; at leaſt, in many caſes, large collections of water in the ventricles have occurred, without either ſtrabiſmus, intolerance of light, or dilatation of the pupil. And in caſes where theſe ſymptoms have taken place to a remarkable degree, while upon diſſection after death but a very ſmall collection of water was found in the ventricles, it has been obſerved, that a peculiar tumid appearance was diſcovered about the optic nerves, which upon examination was found to ariſe from water in the cellular texture. This may have given compreſſion producing a ſtate of inſenſibility; but it may have been preceded, or it may even have originated from ſome inflammatory affection of theſe parts, producing the intolerance of light.

Apoplexia.

Prognoſis and Cure. Till very lately this diſorder was reckoned totally incurable; but of late it has been alleged, that mercury, if applied in time, will remove every ſymptom. This remedy was firſt ſuggeſted by Dr Dobſon of Liverpool, and afterwards employed apparently with ſucceſs by Dr Percival, Dr Makie, and others. But the practice has by no means been found to be generally ſucceſsful. In a great majority of inſtances, after mercury has had the faireſt trial, the diſorder has proved fatal. And it is a very remarkable circumſtance, that in this diſeaſe, after great quantities of mercury have been uſed both externally and internally, it rarely affects the mouth. But even in caſes where ſalivation has been induced, a fatal concluſion has yet enſued.

Of late the digitalis purpurea has been thought, in ſome caſes of hydrocephalus, as well as in other obſtinate dropſies, to be employed with benefit. But this alſo, in the hands of moſt practitioners, has very generally failed. Perhaps there is no remedy from which benefit has more frequently been obſerved than from bliſters. But we may conclude with obſerving, that the cure of the apoplexia hydrocephalica ſtill remains to be diſcovered.

Sp. IV. Apoplexy *from Atrabilis.* 259

Apoplexia atrabiliaris, *Sauv.* ſp. 12. *Preyſinger.* ſp. 6.

This takes place in the laſt ſtage of the diffuſion of bile through the ſyſtem, i. e. of the black jaundice; and in ſome caſes the brain has been found quite tinged brown. It cannot be thought to admit of any cure.

Sp. V. Apoplexy *from External Violence.* 260

Apoplexia traumatica, *Sauv.* ſp. 2.
Carus traumaticus, *Sauv.* ſp. 5.

The treatment of this diſeaſe, as it ariſes from ſome external injury, properly falls under the article Surgery.

Sp. VI. Apoplexy *from Poiſons.* 261

Apoplexia temulenta, *Sauv.* ſp. 3.
Carus à narcoticis, *Sauv.* ſp. 14.
Lethargus à narcoticis, *Sauv.* ſp. 3.
Carus à plumbagine, *Sauv.* ſp. 10.
Apoplexia mephitica, *Sauv.* ſp. 14.
Aſphyxia à mephitide, *Sauv.* ſp. 9.
Aſphyxia à muſto, *Sauv.* ſp. 3.
Catalepſis à fumo, *Sauv.* ſp. 3.
Aſphyxia à fumis, *Sauv.* ſp. 2.
Aſphyxia à carbone, *Sauv.* ſp. 16.
Aſphyxia foricariorum, *Sauv.* ſp. 11.
Aſphyxia ſideratorum, *Sauv.* ſp. 10.
Carus ab inſolatione, *Sauv.* ſp. 12.

Carus

4

Comata. Apoplexia.

Carus à frigore, *Sauv.* sp. 15.
Lethargus à frigore, *Sauv.* sp. 6.
Asphyxia congelatorum, *Sauv.* sp. 5.

The poisons which bring on an apoplexy when taken internally may be either of the stimulant or sedative kind, as spirituous liquors, opium, and the more virulent kinds of vegetable poisons. The vapours of mercury, or of lead, in great quantity, will sometimes produce a similar effect; though commonly they produce rather a paralysis, and operate slowly. The vapours of charcoal, or fixed air, in any form, breathed in great quantity, also produce an apoplexy, or a state very similar to it; and even cold itself produces a fatal sleep, though without the apoplectic stertor. To enumerate all the different symptoms which affect the unhappy persons who have swallowed opium, or any of the stronger vegetable narcotics, is impossible, as they are scarcely to be found the same in any two patients. The state induced by them seems to differ somewhat from that of a true apoplexy; as it is commonly attended with convulsions, but has the particular distinguishing sign of apoplexy, namely, a very difficult breathing or snorting, more or less violent according to the quantity of poisonous matter swallowed.

Of the poisonous effects of fixed air, Dr Percival gives the following account. "All these noxious vapours, whether arising from burning charcoal, the fermenting grape, the Grotti di Cani, or the cavern of Pyrmont, operate nearly in the same manner. When accumulated and confined, their effects are often instantaneous: they immediately destroy the action of the brain and nerves, and in a moment arrest the vital motions. When more diffused, their effects are slower, but still evidently mark out a direct affection of the nervous system.

"Those who are exposed to the vapours of the fermenting grape, are as instantly destroyed as they would be by the strongest electrical shock. A state of insensibility is the immediate effect upon those animals which are thrust into the Grotti di Cani, or the cavern of Pyrmont: the animal is deprived of motion, lies as if dead; and if not quickly returned into the fresh air, is irrecoverable. And if we attend to the histories of those who have suffered from the vapours of burning charcoal, we shall in like manner find, that the brain and moving powers are the parts primarily affected.

"A cook who had been accustomed to make use of lighted charcoal more than his business required, and to stand with his head over these fires, complained for a year of very acute pain in the head; and after this was seized with a paralytic affection of the lower limbs, and a slow fever.

"A person was left reading in bed with a pan of charcoal in a corner of the room. On being visited early the next morning, he was found with his eyes shut, his book open and laid on one side, his candle extinguished, and to appearance like one in a deep sleep. Stimulants and cupping-glasses gave no relief: but he was soon recovered by the free access of fresh air.

"Four prisoners, in order to make their escape, attempted to destroy the iron work of their windows, by the means of burning charcoal. As soon as they commenced their operations, the fumes of the charcoal being confined by the closeness of the prison, one of them was struck dead; another was found pale, speechless, and without motion; afterwards he spoke incoherently, was seized with a fever, and died. The other two were with great difficulty recovered.

"Two boys went to warm themselves in a stove heated with charcoal. In the morning they were found destitute of sense and motion, with countenances as composed as in a placid sleep. There were some remains of pulse, but they died in a short time.

"A fisherman deposited a large quantity of charcoal in a deep cellar. Some time afterwards his son, a healthy strong man, went down into the cellar with a pan of burning charcoal and a light in his hand. He had scarcely descended to the bottom, when his candle went out. He returned, lighted his candle, and again descended. Soon after, he called aloud for assistance. His mother, brother, and a servant, hasted to give him relief; but none of them returned. Two others of the village shared the same fate. It was then determined to throw large quantities of water into the cellar: and after two or three days they had access to the dead bodies.

"Cœlius Aurelianus says, that those who are injured by the fumes of charcoal become cataleptic. And Hoffman enumerates a train of symptoms, which in no respect correspond with his idea of suffocation. Those who suffer from the fumes of burning charcoal, says he, have severe pains in the head, great debility, faintness, stupor, and lethargy.

"It appears from the above histories and observations, that these vapours exert their noxious effects on the brain and nerves. Sometimes they occasion sudden death: at other times, the various symptoms of a debilitated nervous system, according as the poison is more or less concentrated. The olfactory nerves are first and principally affected, and the brain and nervous system by sympathy or consent of parts. It is well known, that there is a strong and ready consent between the olfactory nerves and many other parts of the nervous system. The effluvia of flowers and perfumes, in delicate or irritable habits, produce a train of symptoms, which, though transient, are analogous to those which are produced by the vapours of charcoal; viz. vertigo, sickness, faintness, and sometimes a total insensibility. The female malefactor, whom Dr Mead inoculated by putting into the nostrils dossils of cotton impregnated with variolous matter, was immediately on the introduction, afflicted with an excruciating headach, and had a constant fever till after the eruption.

"The vapours of burning charcoal, and other poisonous effluvia, frequently produce their prejudicial, and even fatal effects, without being either offensive to the smell or oppressive to the lungs. It is a matter of importance, therefore, that the common opinion should be more agreeable to truth; for where suffocation is supposed to be the effect, there will be little apprehension of danger, so long as the breast keeps free from pain or oppression.

"It may be well to remember, that the poison itself is distinct from that gross matter which is offensive to the smell; and that this is frequently in its most active state when undistinguished by the sense. Were the

Comata. the following cautions generally attended to, they might in ſome inſtances be the happy means of preſerving life. Never to be confined with burning charcoal in a ſmall room, or where there is not a free draught of air by a chimney or ſome other way. Never to venture into any place in which air has been long pent up, or which from other circumſtances ought to be ſuſpected; unleſs ſuch ſuſpected place be either previouſly well ventilated, or put to the teſt of the lighted candle: for it is a ſingular and well-known fact, that the life of flame is in ſome circumſtances ſooner affected and more expeditiouſly extinguiſhed by noxious vapours than animal-life; a proof of which I remember to have received from a very intelligent clergyman, who was preſent at a muſical entertainment in the theatre at Oxford. The theatre was crowded; and during the entertainment the candles were obſerved to burn dim, and ſome of them went out. The audience complained only of faintneſs and languor; but had the animal effluvia been ſtill further accumulated or longer confined, they would have been extinguiſhed as well as the candles.

"The moſt obvious, effectual, and expeditious means of relief to thoſe who have unhappily ſuffered from this cauſe, are ſuch as will diſlodge and waſh away the poiſon, reſtore the energy of the brain and nerves, and renew the vital motions. Let the patient therefore be immediately carried into the open air, and let the air be fanned backwards and forwards to aſſiſt its action; let cold water be thrown on the face; let the face, mouth, and noſtrils, be repeatedly waſhed; and as ſoon as practicable, get the patient to drink ſome cold water. But if the caſe be too far gone to be thus relieved, let a healthy perſon breathe into the mouth of the patient; and gently force air into the mouth, throat, and noſtrils. Frictions, cupping, bleeding, and bliſters, are likewiſe indicated. And if, after the inſtant danger is removed, a fever be excited, the method of cure muſt be adapted to the nature and prevailing ſymptoms of the fever."

With regard to the poiſon of opium, Dr Mead recommends the following method of cure. Beſides evacuations by vomiting, bleeding, and bliſtering, acid medicines and lixivial ſalts are proper. Theſe contract the relaxed fibres, and by their diuretic force make a depletion of the veſſels. Dr Mead ſays he has given repeated doſes of a mixture of ſalt of wormwood and juice of lemons, with extraordinary ſucceſs. But nothing perhaps is of greater conſequence, than to uſe proper means for the prevention of ſleep, by rouſing and ſtirring the patient, and by forcing him to walk about; for if he be once permitted to fall into a ſound ſleep, it will be found altogether impoſſible to awake him.

Of a kind ſomewhat akin to the poiſon of opium ſeems to be that of laurel-water, a ſimple water diſtilled from the leaves of the lauro-ceraſus or common laurel. The bad effects of this were particularly obſerved in Ireland, where it had been cuſtomary to mix it with brandy for the ſake of the flavour; and thus two women were ſuddenly killed by it. This gave occaſion to ſome experiments upon dogs, in order to aſcertain the malignant qualities of the water in queſtion; and the event was as follows: All the dogs fell immediately into totterings and convulſions of the limbs, which were ſoon followed by a total paralyſis, ſo that no motion could be excited even by pricking or cutting them. No inflammation was found upon diſſection, in any of the internal membranes. The moſt remarkable thing was a great fulneſs and diſtenſion of the veins, in which the blood was ſo fluid, that even the lymph in its veſſels was generally found tinged with red. The ſame effects were produced by the water injected into the inteſtines by way of clyſter. Apoplexia.

To make the experiment more fully, Dr Nicholls prepared ſome of this water ſo ſtrong, that about a dram of heavy eſſential oil remained at the bottom of three pints of it, which by frequent ſhaking was again quite incorporated with it. So virulent was this water, that two ounces of it killed a middle-ſized dog in leſs than half a minute, even while it was paſſing down his throat. The poiſon appeared to reſide entirely in the above-mentioned eſſential oil, which comes over by diſtillation, not only from the leaves of laurel, but from ſome other vegetables; for ten drops of a red oil diſtilled from bitter almonds, when mixed with half an ounce of water, and given to a dog, killed him in leſs than half an hour.

Volatile alkalies are found to be an antidote to this poiſon; of which Dr Mead gives the following inſtance. About an ounce of ſtrong laurel-water was given to a ſmall dog. He fell immediately into the moſt violent convulſions, which were ſoon followed by a total loſs of his limbs. When he ſeemed to be expiring, a phial of good ſpirit of ſal ammoniac was held to his noſe, and a ſmall quantity of the ſame forced down his throat: he inſtantly felt its virtue; and by continuing the uſe of it for ſome time, he by degrees recovered the motion of his legs; and in two hours walked about with tolerable ſtrength, and was afterwards quite well.

With regard to the pernicious effects of cold, there is no other way of counteracting them but by the application of external heat. We are apt to imagine, that the ſwallowing conſiderable quantities of ardent ſpirits may be a means of making us reſiſt the cold, and preventing the bad effects of it from ariſing to ſuch a height as to deſtroy life; but theſe do not appear to be in the leaſt poſſeſſed of any ſuch virtue in thoſe countries liable to great exceſſes of cold. The cinchona, by ſtrengthening the ſolids, as well as increaſing the motion of the fluids, is found to anſwer better than any other thing as a preſervative: but when the pernicious effects have already begun to diſcover themſelves, nothing but increaſing by ſome means or other the heat of the body can poſſibly be depended upon: and even this muſt be attempted with great care; for as, in ſuch caſes, there is generally a tendency to mortification in ſome of the extremities, the ſudden application of heat will certainly increaſe this tendency to ſuch a degree as to deſtroy the parts. But for the external treatment of ſuch mortifications, ſee the article SURGERY.

Sp. VII. APOPLEXY from *Paſſions* of the *Mind*. 262

Carus à pathemate, *Sauv.* ſp. 11.
Aſphyxia à pathemate, *Sauv.* ſp. 7.
Ecſtaſis catoche, *Sauv.* ſp. 1.
Ecſtaſis reſoluta, *Sauv.* ſp. 2.

Apoplexies

Comata. Apoplexies from violent paſſions may be either ſanguineous or ſerous, though more commonly of the former than the latter ſpecies. The treatment is the ſame in either caſe. Or they may partake of the nature of catalepſy; in which caſe the method of treatment is the ſame with that of the genuine catalepſy.

263 Sp. VIII. The *Cataleptic* Apoplexy.

Catalepſis, *Sauv.* gen. 176. *Lin.* 129. *Vog.* 230. *Sag.* gen. 281. *Boerh.* 1036. *Junck.* 44.

Dr Cullen ſays he has never ſeen the catalepſy except when counterfeited; and is of opinion that many of thoſe caſes related by other authors have alſo been counterfeited. It is ſaid to come on ſuddenly, being only preceded by ſome languor of body and mind; and to return by paroxyſms. The patients are ſaid to be for ſome minutes, ſometimes (though rarely) for ſome hours, deprived of their ſenſes, and all power of voluntary motions; but conſtantly retaining the poſition in which they were firſt ſeized, whether lying or ſitting; and if the limbs be put into any other poſture during the fit, they will keep the poſture in which they are placed. When they recover from the paroxyſm, they remember nothing of what paſſed during the time of it, but are like perſons awaked out of ſleep.—Concerning the cure of this diſorder we find nothing that can be depended upon among medical writers.

264 Sp. IX. Apoplexy from *Suffocation.*

Aſphyxia ſuſpenſorum, *Sauv.* ſp. 4.
Aſphyxia immerſorum, *Sauv.* ſp. 1.

This is the kind of apoplexy which takes place in thoſe who are hanged or drowned. For the treatment of thoſe perſons, ſee the articles Drowning and Hanging.

Beſides the ſpecies above mentioned, the apoplexy is a ſymptom in many other diſtempers, ſuch as fevers both continued and intermitting, exanthemata, hyſteria, epilepſy, gout, worms, iſchuria, and ſcurvy.

265 Genus XLIII. PARALYSIS.

The Palsy.

Paralyſis, *Boerh.* 1057.
Hemiplegia, *Sauv.* gen. 170. *Lin.* 103. *Vog.* 220.
Paraplexia, *Sauv.* gen. 171.
Paraplegia, *Lin.* 102. *Vog.* 227.
Paralyſis, *Sauv.* gen. 169. *Lin.* 104. *Vog.* 226. *Junck.* 115.
Atonia, *Lin.* 120.

266 Sp. I. The *Partial Palsy.*

Paralyſis, *Sauv.* gen. 169. *Lin.* 104. *Vog.* 226. *Junck.* 115.
Paralyſis plethorica, *Sauv.* ſp. 1.
Paralyſis ſeroſa, *Sauv.* ſp. 12.
Paralyſis nervea, *Sauv.* ſp. 11.
Mutitas à gloſſolyſi, *Sauv.* ſp. 1.
Aphonia paralytica, *Sauv.* ſp. 8.

Sp. II. Hemiplegia, or *Palsy of one ſide of the* Body. Paralyſis. 267

Hemiplegia, *Sauv.* gen. 170. *Lin.* 108. *Vog.* 228. *Sag.* gen. 276.
Hemiplegia ex apoplexia, *Sauv.* ſp. 7.
Hemiplegia ſpaſmodica, *Sauv.* ſp. 2.
Hemiplegia ſeroſa, *Sauv.* ſp. 10.

Sp. III. Paraplegia, or *Palsy of one half of the* Body *taken tranſverſely.* 268

Paraplexia, *Sauv.* gen. 171. *Sag.* gen. 277.
Paraplegia, *Lin.* 102. *Vog.* 227.
Paraplexia ſanguinea, *Sauv.* ſp. 2.
Paraplexia à ſpina bifida, *Sauv.* ſp. 3.
Paraplexia rheumatica, *Sauv.* ſp. 1.

Deſcription. The palſy under all the different forms here mentioned as particular ſpecies, ſhows itſelf by a ſudden loſs of tone and vital power in a certain part of the body. In the ſlighter degrees of the diſeaſe, it only affects a particular muſcle, as the ſphincter of the anus or bladder, thus occaſioning an involuntary diſcharge of excrements or of urine; of the muſcles of the tongue, which occaſions ſtammering, or loſs of ſpeech; of the muſcles of the larynx, by which the patient becomes unable to ſwallow ſolids, and ſometimes even liquids alſo.—In the higher degrees of the diſeaſe, the paralytic affection is diffuſed over a whole limb, as the foot, leg, hand, or arm; and ſometimes it affects a whole ſide of the body, in which caſe it is called *hemiplegia;* and ſometimes, which is the moſt violent caſe, it affects all the parts below the waiſt, or even below the head, though this laſt be exceedingly rare. In theſe violent caſes, the ſpeech is either very much impeded, or totally loſt. Convulſions often take place in the ſound ſide, with the cynic ſpaſm or involuntary laughter, and other diſtortions of the face. Sometimes the whole paralytic part of the body becomes livid, or even mortifies before the patient's death; and ſometimes the paralytic parts gradually decay and ſhrivel up, ſo as to become much leſs than before. Whether the diſeaſe be more or leſs extended, many different varieties may be obſerved in its form. Sometimes there occurs a total loſs of ſenſe while motion is entire; in others a total loſs of motion with very ſlight or even no affection of ſenſe; and in ſome caſes, while a total loſs of motion takes place in one ſide, a total loſs of ſenſe has been obſerved on the other. This depends entirely on the particular nerves or branches of nerves in which the affection is ſituated; loſs of ſenſe depending on an affection of the ſubcutaneous nerves; and loſs of motion on an affection of thoſe leading to the muſcles.

Cauſes, &c. Palſies moſt commonly ſupervene upon the different ſpecies of coma, eſpecially the apoplexy. They are alſo occaſioned by any debilitating power applied to the body, eſpecially by exceſſes in venery. Sometimes they are a kind of criſis to other diſtempers, as the colic of Poictou, and the apoplexy. The hemiplegia eſpecially often follows the laſt-mentioned diſeaſe. Aged people, and thoſe who are by any other means debilitated, are ſubject to palſy; which will ſometimes alſo affect even infants, from the repulſion of exanthemata of various kinds. Palſies are alſo the infallible conſequences of injuries to the large nerves.

Comata.

Prognoſis. Except in the ſlighter caſes of palſy, we have little room to hope for a cure; however, death does not immediately follow even the moſt ſevere paralytic affections. In hemiplegia it is not uncommon to ſee the patients live ſeveral years; and even in the paraplegia, if death do not enſue within two or three weeks, it may not take place for a conſiderable time. It is a promiſing ſign when the patient feels a ſlight degree of painful itchineſs in the affected parts; and if a fever ſhould ariſe, it bids fair to cure the palſy. When the ſenſe of feeling remains, there is much more room to hope for a cure than where it is gone, as well as the power of motion. But when we obſerve the fleſh to waſte, and the ſkin to appear withered and dry, we may look upon the diſeaſe to be incurable. Convulſions ſupervening on a palſy are a fatal ſign.

Cure. Many remedies have been recommended in palſies: but it muſt be confeſſed, that, except in the ſlighter caſes, medicines ſeldom prove effectual; and before any plan of cure can be laid down, every circumſtance relative to the patient's habit of body and previous ſtate of health ſhould be carefully weighed. If hemiplegia or paraplegia ſhould come on after an apoplexy, attended with thoſe circumſtances which phyſicians have ſuppoſed to denote a viſcid ſtate of the blood, a courſe of the attenuant gums, with fixed alkaline ſalts, and chalybeate waters, may do ſervice; to which it will be proper to add frictions with the volatile liniment down the ſpine: but in habits where the blood is rather inclined to the watery ſtate, it will be neceſſary to give emetics from time to time; to apply bliſters, and inſert iſſues.

The natural hot baths are often found uſeful in paralytic caſes; and where the patients cannot avail themſelves of theſe, an artificial bath may be tried by diſſolving ſalt of ſteel in water, and impregnating the water with fixed air. Frictions of the parts, and ſcourging them with nettles, have alſo been recommended, and may do ſervice, as well as volatile and ſtimulating medicines taken inwardly. And it is probably by operating in this manner, that the uſe of camphor, or a mercurial courſe continued for ſome length of time to ſuch a degree as gently to affect the mouth, have been found productive of a cure in obſtinate caſes of this affection. Of late years, an infuſion of the arnica montana or German leopard's bane, has been highly extolled in the cure of this diſeaſe, by ſome foreign writers: but the trials made with it in Britain, particularly at Edinburgh, have been by no means equally ſucceſsful with thoſe related by Dr Collins, who has ſtrongly recommended this medicine to the attention of the public. Another remedy has of late been highly extolled in palſy, the rhus toxicodendron or poiſon oak. It has been employed with ſome ſucceſs in France by Mr Freſnoi; and Dr Alderſon of Hull, in a late diſſertation on this plant, has publiſhed ſeveral caſes, even of very obſtinate palſy, in which its uſe was attended with wonderful ſucceſs. In ſome caſes alſo at Edinburgh, it has been uſed with apparent advantage, but in a much greater number without any benefit.

In certain caſes of palſy, unexpected cures have been accompliſhed both by electricity and by galvaniſm. But in a conſiderable majority of inſtances, palſy from which the patient has not what may be called a natural recovery, will be found incurable by any remedies which have hitherto been recommended.

Syncope.

Sp. IV. The Palsy from *Poiſons*. 269

Paralyſis metallariorum, *Sauv.* ſp. 22.
Hemiplegia ſaturnina, *Sauv.* ſp. 14.

This kind of palſy ariſes moſt frequently from lead taken into the body, and is a conſequence of the colica pictonum, under which it is more particularly treated.

TREMOR, or Trembling. 270

Tremor, *Sauv.* gen. 129. *Lin.* 139. *Vog.* 184. *Sag.* 236.

This by Dr Cullen is reckoned to be always ſymptomatic either of palſy, aſthenia, or convulſions; and therefore need not be treated of by itſelf.

Order II. ADYNAMIÆ. 271

Adynamiæ, *Vog.* Claſs VI.
Defectivi, *Lin.* Claſs VI. Order I.
Leipopſychiæ, *Sauv.* Claſs VI. Order IV. *Sag.* Claſs IX. Order IV.

Genus XLIV. SYNCOPE. 272

Fainting.

Syncope, *Sauv.* gen. 174. *Sag.* 94. *Vog.* 274. *Sag.* 280. *Junck.* 119.
Leipothymia, *Sauv.* gen. 173. *Lin.* 93. *Vog.* 273. *Sag.* 279.
Aſphyxia, *Sauv.* gen. 175. *Lin.* 95. *Vog.* 275. *Sag.* 281.
Virium lapſus et animi deliquia, *Hoffm.* III. 267.

Sp. I. The *Cardiac Syncope*. 273

Syncope plethorica, *Sauv.* ſp. 5. *Senac.* Tr. de Cœur, p. 540.
Syncope à cardiogmo, *Sauv.* ſp. 7. *Senac.* de Cœur, 414. *Morgagn.* de Sed. XXV. 2. 3. 10.
Syncope à polypo, *Sauv.* ſp. 8. *Senac.* p. 471.
Syncope ab hydrochardia, *Sauv.* ſp. 12. *Senac.* 533. *Schreiber* Almag. L. III. § 196.
Syncope *Lanzoni*, *Sauv.* ſp. 18. *Lanzon.* Op. II. p. 462.
Aſphyxia Valſalviana, *Sauv.* ſp. 13.

Sp. II. *Occaſional Syncope*. 274

Leipothymia à pathemate, *Sauv.* ſp. 1. *Senac.* p. 544.
Syncope pathetica, *Sauv.* ſp. 21.
Aſphyxia à pathemate, *Sauv.* ſp. 7.
Syncope ab antipathia, *Sauv.* ſp. 9. *Senac.* p. 544.
Syncope à veneno, *Sauv.* ſp. 10. *Senac.* p. 546.
Syncope ab apoſtematis, *Sauv.* ſp. 11. *Senac.* p. 554.
Syncope à ſphacelo, *Sauv.* ſp. 14. *Senac.* p. 553.
Syncope ab inanitione, *Sauv.* ſp. 1. *Senac.* p. 536.
Syncope à phlebotomia, *Sauv.* ſp. 4.
Syncope à dolore, *Sauv.* ſp. 2. *Senac.* ſp. 583.

Adynamiæ. Aſphyxia traumatica, *Sauv.* ſp. 14.
Aſphyxia neophytorum, *Sauv.* ſp. 17.

Deſcription. A ſyncope begins with a remarkable anxiety about the heart; after which follows a ſudden extinction, as it were, not only of the animal powers and actions, but alſo of the vital powers, ſo that the patients are deprived of pulſe, ſenſe, and motion, all at once. In thoſe caſes which phyſicians have diſtinguiſhed by the name of *leipothymia*, the patient does not entirely loſe his ſenſes, but turns cold and pale; and the pulſe continues to beat, though weakly; the heart alſo ſeems to tremble rather than beat; and the reſpiration is juſt perceptible. But in the true ſyncope or full aſphyxia, not the ſmalleſt ſign of life can be perceived; the face has a death-like paleneſs, the extremities are cold, the eyes ſhut, or at leaſt troubled; the mouth ſometimes ſhut, and ſometimes gaping wide open; the limbs flaccid, and the ſtrength quite gone; as ſoon as they begin to recover, they fetch deep and heavy ſighs.

Cauſes, &c. Fainting is occaſioned moſt commonly by profuſe evacuations, eſpecially of blood; but it may happen alſo from violent paſſions of the mind, from ſurfeits, exceſſive pain, &c. People of delicate conſtitutions are very ſubject to it from ſlight cauſes; and ſometimes it will ariſe from affections of the heart and large veſſels not eaſy to be underſtood. Fainting is alſo a ſymptom of many diſorders, eſpecially of that fatal one called a *polypus of the heart*, of the plague, and many putrid diſeaſes.

Prognoſis. When fainting happens in the beginning of any acute diſtemper, it is by no means a good omen; but when it takes place in the increaſe or at the height of the diſeaſe, the danger is ſomewhat leſs; but in general, when fainting comes on without any evident cauſe, it is to be dreaded. In violent hæmorrhagies it is favourable; as the bleeding veſſels thus have time to contract and recover themſelves, and by this means the patient may eſcape.

Cure. When perſons of a full habit faint through exceſs of paſſion, they ought to be blooded without delay, and ſhould drink vinegar or lemon juice diluted with water; and, after the bowels are emptied by a clyſter, take a paregoric draught, and go to bed.

The paſſion of anger, in a peculiar manner, affects the biliary ſecretion, cauſes an oppreſſion at the ſtomach, with nauſea and retching to vomit, and a bitter taſte in the mouth, with giddineſs: theſe ſymptoms ſeem to indicate an emetic; which, however, in theſe caſes muſt be carefully avoided, as it might endanger the patient, by bringing on an inflammation of the ſtomach.

The general effects of a ſudden fright have been mentioned on a former occaſion. When theſe are ſo violent as to require medical aid, our firſt endeavours muſt be to take off the ſpaſmodic conſtriction, and reſtore freedom to the circulation; by bleeding, if the habit be at all inclined to fulneſs; and by giving a mixture, with equal parts of the vinum antimoniale and tinctura opii camphorata, in ſome agreeable vehicle, which will bring on ſleep and encourage perſpiration. It was formerly mentioned, that convulſions, or even an epilepſy, may be brought on by frights; which ſhould make people cautious of playing fooliſh tricks in Dyſpepſiæ. this way.

When a ſurfeit, or any ſpecies of ſaburra, occaſions a leipothymia, an emetic is the immediate remedy, as ſoon as the patient, by the help of acrid ſtimulants, ſhall be ſo far rouſed as to be able to ſwallow one: in theſe caſes, tickling the fauces with a feather dipt in ſpirit of hartſhorn, will be proper, not only to rouſe the patient, but alſo to bring on vomiting.

A ſyncope is moſt commonly brought on by profuſe diſcharges or evacuations, either of the blood or of the ſecreted humours.

In order to revive the patients, they ought to be laid along in a horizontal poſture, in an airy place; the legs, thighs, and arms, are to be rubbed with hot flannels; very ſtrong vinegar, aromatic vinegar, or ſalt of hartſhorn, or volatile alkaline ſpirit, are to be held to the noſtrils, and rubbed into them; or, being properly diluted, poured down the throat; cold water is to be ſprinkled on the face and neck; and when by theſe means the patient ſhall be ſufficiently revived, wine boiled up with ſome grateful aromatic, is to be given in the proper quantity.

In the fainting conſequent upon profuſe uterine hæmorrhagies, it will be a ſafer practice to abſtain from all heating and ſtimulant things; as life, in theſe caſes, is preſerved by the coagulation of the blood in the extremities of the open veſſels; which might be prevented by the pouring in hot wine or volatile alkaline ſpirits.

When a ſyncope is the conſequence of the too violent operation of either an emetic or cathartic, the tinctura thebaica, mixed with ſpiced wine, is the moſt efficacious remedy; but the opiate muſt be given gradually, and in very ſmall doſes.

A ſyncope, or even aſphyxia, wherein the patient ſhall lie for ſeveral hours, is frequent in hyſteric conſtitutions; and during the fit requires fetid antiſpaſmodics, together with acrid ſtimulants: to prevent returns, nothing anſwers better than the cinchona joined with chalybeates.

Genus XLV. DYSPEPSIA. 275

Depraved DIGESTION.

Dyſpepſia, *Vog.* 277.
Apepſia, *Vog.* 276.
Diaphora, *Vog.* 278.
Anorexia, *Sauv.* gen. 162. *Lin.* 116. *Sag.* gen. 286.
Cardialgia, *Sauv.* gen. 202. *Lin.* 48. *Vog.* 157. *Sag.* gen. 160.
Gaſtrodynia, *Sauv.* gen. 203. *Sag.* gen. 161.
Soda, *Lin.* 47. *Vog.* 161.
Nauſea, *Sauv.* gen. 250. *Lin.* 182. *Vog.* 159. *Sag.* gen. 185.
Vomitus, *Sauv.* gen. 251. *Lin.* 183. *Vog.* 214. *Sag.* gen. 186.
Flatulentia, *Sauv.* gen. 272. *Lin.* 165. *Vog.* 127. *Sag.* gen. 207.

The idiopathic ſpecies are,

Anorexia pituitoſa, *Sauv.* ſp. 2.
Anorexia à ſaburra, *Sauv.* ſp. 9.
Anorexia exhauſtorum, *Sauv.* ſp. 8.

Adynamiæ.

Anorexia paralytica, *Sauv.* ſp. 1.
Nauſea ex cacochylia, *Sauv.* ſp. 11.
Vomitus pituitoſus, *Sauv.* ſp. 26.
Vomitus ruminatio, *Sauv.* ſp. 6.
Vomitus à ſaburra, *Sauv.* ſp. 2.
Vomitus à crapula, *Sauv.* ſp. 1.
Vomitus lacteus, *Sauv.* ſp. 3.
Flatulentia infantilis, *Sauv.* ſp. 5.
Flatulentia acida, *Sauv.* ſp. 1.
Flatulentia nidroſa, *Sauv.* ſp. 2.
Cardialgia bradypepta, *Sauv.* ſp. 9.
Cardialgia à ſaburra, *Sauv.* ſp. 2.
Cardialgia lactantium, *Sauv.* ſp. 11.
Cardialgia flatulenta, *Sauv.* ſp. 3.
Cardialgia paralytica, *Sauv.* ſp. 7.
Gaſtrodynia ſaburralis, *Sauv.* ſp. 1.
Gaſtrodynia flatulenta, *Sauv.* ſp. 2.
Gaſtrodynia periodynia, *Sauv.* ſp. 7.
Gaſtrodynia aſtringens, *Sauv.* ſp. 9.
Gaſtrodynia atterens, *Sauv.* ſp. 10.
Gaſtrodynia à frigore, *Sauv.* ſp. 18.

Beſides theſe there are a great number of ſymptomatic ſpecies.

Deſcription. It is by no means eaſy to define exactly the diſtemper called *dyſpepſia*, when conſidered as an original diſeaſe, as there are very few maladies which ſome way or other do not ſhow themſelves by an affection of the ſtomach; and much more difficult ſtill muſt it be to enumerate all its ſymptoms. The moſt remarkable, however, and the moſt common, are the following: Want of appetite; diſtention of the ſtomach when no food has been taken for ſome time before; ſlight dejection of ſpirits; a gradual decay of the muſcular ſtrength; languor, and averſion from motion; the food which is taken without appetite is not well digeſted; the ſtomach and inteſtines are much diſtended with flatus, whence the patients are tormented with ſpaſms, gripes, and ſickneſs: frequently a limpid water, having an acid or putrid taſte, is brought up; ſometimes the food itſelf is thrown up by mouthfuls; and ſometimes, though rarely, the ſame is ſwallowed again, after the manner of ruminating animals. While matters are in this ſituation, the heart ſometimes palpitates, and the breath is quick, and drawn with difficulty; the head aches and is giddy; and ſometimes both theſe ſymptoms are continual, and very violent, inſomuch that the patient is not only tormented with pain, but ſtaggers as if he was drunk. From the too great aceſcency or putrefaction of the aliment a cardialgia or heartburn comes on; and in this ſituation a ſpontaneous diarrhœa ſometimes carries off the diſeaſe; but in other caſes there is an obſtinate coſtiveneſs, attended with colic-pains. Frequently the pulſe is quick, ſometimes ſlow, but always weak: the circulation is ſo languid, that the blood can ſcarce reach the extreme veſſels, or at leaſt ſtagnates in them, ſo that the face becomes livid, ſwelled and has an unuſual appearance: and at the ſame time that the circulation and nervous power are in this languid ſtate, the perſpiration becomes leſs copious; the ſkin becomes dry and corrugated; the natural heat, eſpecially of the extremities, is much diminiſhed; the tongue is white; and an univerſal laxity takes place, inſomuch that the uvula and velum pendulum palati are ſometimes enlarged to ſuch a degree as to become extremely troubleſome. The patient is either deprived of reſt, or wakes ſuddenly out of his ſleep, and is diſturbed by frightful dreams; at the ſame time that the mind ſeems to be affected as well as the body, and he becomes peeviſh, fretful, and incapable of paying attention to any thing as uſual. At laſt hectic ſymptoms come on, and the whole frame becomes ſo irritable, that the ſlighteſt cauſe excites an univerſal tremor, and ſometimes violent vomiting and diarrhœa. Sometimes the ſalivary glands are ſo relaxed, that a ſalivation comes on as if excited by mercury; the ſerum is poured out into the cavity of the abdomen and cellular ſubſtance of the whole body, and the patient becomes affected with anaſarca or aſcites.

Dyſpepſia.

Cauſes, &c. The cauſes of dyſpepſia may be any thing which debilitates the ſyſtem in general, but in a particular manner affects the ſtomach. Such are, opium taken in immoderate quantities, which hurts by its ſedative and relaxing powers; ſpirituous liquors drunk to exceſs; tobacco, tea, coffee, or any warm relaxing liquor, taken in too great quantity; acid, unripe fruits; vomits or purges too frequently taken; an indolent ſedentary life, &c. &c. All theſe act chiefly upon people of a weak and delicate habit; for the robuſt and hardy ſeldom labour under a dyſpepſia, or at moſt a very ſlight one.

Prognoſis. When a dyſpepſia firſt occurs, it is frequently removed without great difficulty; when it is ſymptomatic, we muſt endeavour to cure the primary diſeaſe; and without this we cannot expect a complete removal of the affection; but when it frequently returns, with ſymptoms of great debility, hectic fever, or dropſy, we have great reaſon to dread the event.

Cure. A radical cure of dyſpepſia is only to be expected by removing from the ſtomach and ſyſtem that debility on which the diſeaſe depends. On this ground, the objects chiefly to be aimed at in the cure are, 1ſt, The avoiding whatever will tend to diminiſh the vigour of the ſtomach; 2d, The employing ſuch remedies as have influence in increaſing that vigour; and, in the third place, The obviating urgent ſymptoms, particularly thoſe which tend to increaſe and ſupport the affection. Of the avoiding cauſes, which tend to diminiſh the vigour of the ſtomach, after what has already been ſaid of the cauſes inducing the diſeaſe, it is unneceſſary to make any farther obſervations; and indeed every dyſpeptic patient will be taught by experience what is to be done with this intention. The medicines chiefly employed with the view of increaſing vigour are thoſe of the tonic kind: but, previous to their uſe, it will be neceſſary to evacuate the contents of the alimentary canal by vomits or purgatives. If there be a tendency to putreſcency, antiſeptics muſt then be exhibited; but more frequently there is a prevailing acidity, which creates an intolerable heart-burn. To palliate this ſymptom, magneſia alba may be given; which is much preferable to the common teſtaceous powders, as being purgative while diſſolved in an acid, when the others are rather aſtringent. In the third volume of the Medical Obſervations, we have an account of two caſes of dyſpepſia attended with a very uncommon degree of cardialgia, in which magneſia was ſo ſucceſsful, that we can hardly doubt of its efficacy in ſlighter degrees of the diſorder.

But

But although acidity may often be succefsfully obviated in this manner, yet the beft way of counteracting this fymptom, as well as of obviating coftivenefs, flatulence, and a variety of others, is by reftoring the tone of the ftomach in particular, and indeed of the fyftem in general. With this intention, recourfe is had to a variety of tonics both from the mineral and vegetable kingdom; particularly chalybeates in different forms, gentian, colombo, and the like; but of all the tonics which can be employed in this affection, none are attended with greater benefit than exercife and cold bathing; and the proper and prudent employment of thefe is no lefs effectual in removing the difeafe, than in preventing the return of it after it is once removed.

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Genus XLVI. HYPOCHONDRIASIS.

Hypochondriac Affection.

Hypochondriafis, *Sauv.* gen. 220. *Lin.* 76. *Vog.* 218. *Sag.* 332.
Morbus hypochondriacus, *Boerh.* 1098.
Malum hypochondriacum, *Hoffm.* III. 65. *Junck.* 36.

Although fome of the nofological writers, particularly Sauvages, have confidered this genus as confifting of different fpecies, Dr Cullen is of opinion, that there is only one idiopathic fpecies, the *hypochondriafis melancholica*. He confiders not only the hypochondriafis hyfterica, phthifica, and afthmatica, but alfo the biliofa, fanguinea, and pituitofa, as being only fymptomatic; but he views the true melancholic hypochondriafis as being a proper idiopathic difeafe, perfectly diftinct from hyfteria, with which it has often been confounded.

Defcription. The fymptoms of hypochondriafis are, ftretching, preffing, griping, and tormenting pains under the ribs, and chiefly in the left fide; which fometimes are exafperated, and become pungent, burning, or lancinating. Frequently there is an inflation of the left hypochondrium, which fometimes becomes ftationary, and by Hippocrates was taken for a fymptom of an enlarged fpleen. When thefe fymptoms take place in the right hypochondrium, they are commonly attended with colic pains, uncertain flying heats, efpecially in the head, with a tranfient rednefs of the face, and very frequently an œdematous fwelling of the feet fucceeds. To thefe are fuperadded almoft all the affections of the ftomach occurring in dyfpepfia, befides a variety of other fymptoms, fuch as palpitations, fleeplefs nights, and the like. But befides thefe, there occurs alfo a particular depreffion of fpirit and apprehenfion of danger, which may be confidered as one of the great characteriftic fymptoms of the difeafe.

Caufes, &c. The general caufes of the hypochondriac affection are faid to be a plethora, and preternatural thicknefs of the blood; fuppreffions of cuftomary evacuations; high and full diet, together with a fparing quantity of drink; an hereditary difpofition; indolence; atony of the inteftines; violent paffions of the mind, &c.

Prognofis. The hypochondriac affection, when left to itfelf, is more troublefome than dangerous; but, if improperly treated, it may bring on various difeafes of a more fatal tendency, fuch as the melancholy, bloody urine and nephritis, jaundice, vertigo, palfy, apoplexy, &c.

Cure. This is to be attempted by fuch medicines as counteract occafional caufes, and obviate urgent fymptoms, which may be all comprehended under bleeding, gentle evacuants, chalybeates, the cinchona, and exercife, efpecially riding on horfeback, which in this difeafe is greatly preferable to any other. When the circumftances of the patient can afford it, a voyage to Spain, Portugal, or fome of the warmer countries in Europe, will be of great fervice.

Genus XLVII. CHLOROSIS. 277

Green Sickness.

Chlorofis, *Sauv.* gen. 309. *Lin.* 222. *Vog.* 305. *Sag.* gen. 135. *Boerh.* 1285. *Hoffm.* iii. 311. *Junck.* 86.

Of this genus alfo Dr Cullen thinks there is but one idiopathic fpecies: viz. what fome diftinguifh by the title of *chlorofis virginea*, others of *chlorofis amatoria*.

Defcription. This difeafe ufually attacks girls a little after the time of puberty, and firft fhows itfelf by fymptoms of dyfpepfia. But a diftinguifhing fymptom is, that the appetite is entirely vitiated, and the patient will eat lime, chalk, afhes, falt, &c. very greedily; while at the fame time there is not only a total inappetence to proper food, but it will even excite naufea and vomiting. In the beginning of the difeafe, the urine is pale, and afterwards turbid; the face becomes pale, and then affumes a greenifh colour; fometimes it becomes livid or yellow: the eyes are funk, and have a livid circle round them; the lips lofe their fine red colour; the pulfe is quick, weak, and low, though the heat is little fhort of a fever, but the veins are fcarcely filled; the feet are frequently cold, fwell at night, and the whole body feems covered with a foft fwelling; the breathing is difficult: nor is the mind free from affection more than the body; it becomes irritated by the flighteft caufes; and fometimes the patients love folitude, become fad and thoughtful. There is a retention of the menfes throughout the whole courfe of the diforder; and at laft all the bad fymptoms increafing, a leucophlegmafia, anafarca, atrophy, and death fucceed.

Caufes. The caufe of chlorofis is thought to be an atony of the mufcular fibres of the alimentary canal, efpecially of the ftomach, joined with a fimilar atony of the perfpiratory veffels over the whole furface of the body, and the whole depending on an atony of thofe fmall arteries which pour out the menftrual blood. This atony may be occafioned by the fame caufes which bring on dyfpepfia and hypochondriafis, but very frequently arifes from love and other paffions of the mind.

Prognofis. The chlorofis in all cafes is tedious, though it does not generally prove fatal; but we can never promife a certain cure unlefs the menfes make their appearance.

Cure. The remedies here in general are the fame as in the dyfpepfia and hypochondriafis; only in the chlorofis ftronger purgatives may be made ufe of: thofe which ftimulate the rectum are ufeful by ftimulating

Spasmi. lating also the vessels of the uterus; and for this reason indulgence in venery has sometimes been said to produce a cure, particularly with love-sick maids. The cold bath is also extremely proper.

278 ORDER III. SPASMI.

SPASMI, *Sauv.* Class IV. *Vog.* Class V. *Sag.* Class VIII.
Motorii, *Lin.* Class VII.
Morbi spasmodici et convulsivi, *Hoffm.* III. 9.
Spasmi et convulsiones, *Junck.* 45, 54.
Epilepsia, *Boerh.* 1071, 1088.

279 GENUS XLVIII. TETANUS.

Tetanus, *Sauv.* gen. 122. *Lin.* 127. *Vog.* 180. *Sag.* gen. 228.
Catochus, *Sauv.* gen. 123. *Lin.* 128. *Vog.* 183. *Sag.* gen. 229.
Opisthotonos, *Vog.* 181.
Episthotonos, *Vog.* 182

On this distemper Dr Lionel Chalmers has published a dissertation in the first volume of the Medical Observations, which being superior to any thing that has appeared in other medical writers on the subject, we shall here lay before the reader.

"Of all the diseases to which man is subject, none deserves more to be considered than the opisthotonos and tetanus, either with regard to the variety of painful symptoms which almost without intermission distract the sick, or the danger of the diseases themselves, from which few recover, in comparison of the number they attack. In both, the vital actions are very imperfectly performed, most of those which are called *natural* being as it were suspended at once; and so far is the patient from being able to execute any voluntary motion, that the whole machine undergoes the most excruciating distortions, from the violent and unnatural contractions of the muscles. Happy it is for the inhabitants of the more temperate climates, that such diseases appear rarely among them; but in those countries which lie in the more southern and warmer latitudes, they are endemic, especially to negro slaves. In South Carolina, they show themselves at all seasons, but not so often in winter, more frequently in spring and autumn; and are most common in the summer, when people work abroad and are alternately exposed to the scorching heat of the sun and heavy showers, which often happen suddenly, and greatly alter the temperature of the air. Others are seized with the opisthotonos after sleeping without doors, that they may enjoy the deceitful refreshment of the cool night-air, when the weather is warm: one youth chose to cut off his hair and shave his head on a warm day in March, and went to bed without a cap; but the weather changed, and became cold in the night, and he was found rigid with tetanus next morning.

"These diseases so rarely appear as originals in Europe, that a good history of them cannot be expected from the physicians who practise in that part of the world; nor has any thing like a full description been given of them by any ancient or modern author which I have seen. Hippocrates indeed takes notice of them in many places, and seems to regard them only as consequences of other diseases, or of wounds or ulcers of the nervous or tendinous parts; of which symptomatic kind of opisthotonos he gives three remarkable cases in *lib.* v. § vii. *de Morb. vulg.* and repeats them in another place: but the few symptoms he recounts do not show themselves with us. Galen, Cœlius Aurelianus, Aretæus, &c. seem only to have copied Hippocrates, with the addition of some supposititious symptoms, which really do not appear; and the little that Bontius says of it is very faulty.

Tetanus.

"Among the numerous class of spasmodic diseases, there are three which distinguish themselves in a very particular manner, on which the names of *emprosthotonos*, *opisthotonos*, and *tetanus*, have been justly enough bestowed, as being expressive of the posture into which they throw and confine the patient. When therefore those muscles which bend the head, neck, and body forwards, suffer such involuntary, violent, and continued contractions, as to fix the chin to the breast, incurvate the spine and body, and retain the sick in this painful and prone posture, the disease is called *emprosthotonos*. When the posterior muscles are similarly affected, so that the head is drawn towards the spine, and the spine itself is recurvated, it has then the name of *opisthotonos*; although in fact, in this, all those muscles which act in deglutition, bend the head forwards, or turn it to either side, are equally contracted with those which raise the head and spine. The *tetanus* differs from, or rather is compounded of, both the others; for in this the patient is found rigid and inflexible, being as it were braced between the opposite contractions of the anterior and posterior muscles; yet, even here the head is much retracted.

"I never saw the *emprosthotonos*; and shall only speak of the *opisthotonos* and *tetanus*, the first being by far the most common, and in the last stage of which the tetanus frequently supervenes. Let it be observed, that the following description by no means respects such symptomatic contractions as often happen immediately before death, both in acute and chronic diseases; neither will it agree with that spurious *opisthotonos* or *tetanus* which appear sometimes in the first and second stages of quotidian intermittents in this country, however they may emulate the true diseases in some of their symptoms.

"STAD. I. The *opisthotonos*, contrary to what Bontius asserts, often comes on gradually and by slight approaches, the patient complaining rather of an uneasy stiffness in the back-part of the neck and about the shoulders, than of any acute pain, with some degree of a general lassitude. These increase, and become so troublesome when he attempts to turn his head, or to bend it forward, as to oblige him to walk very erect; for he can by no means look downward, nor to either side, without turning his whole body. He cannot open his jaws without pain; and has some difficulty in swallowing, which discourages him from attempting to eat. At times he feels a sudden and painful traction under the *cartilago ensiformis*, which strikes through to the back, and instantly increases the rigidity about the neck and shoulders, draws the head backward a little, and shuts the jaws closer. The pain under the *sternum* returns more frequently and with greater violence;

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lence; and the other contractions become so strong, that the head from this time continues much retracted, and he now refuses nourishment, as swallowing is attended with great pain, and occasions a return of the spasm; which extends along the spine quite to the lower extremities, so that they will no longer support him, and he is under the necessity of going to bed.

"In this manner passes over the first stage of the *opisthotonos*, which sometimes takes up three or four days; the patient, as well as those about him, mistaking the first appearances of it for that rheumatic complaint, which is commonly called a *crick in the neck*; but it sometimes forms itself much quicker, and invades the unfortunate person with the whole train of its mischievous symptoms in a few hours: in which case, the danger may truly be estimated from the violence of the first attack; for such generally die in 24, 36, or 48 hours, and very rarely survive the third day. But when it is less acute, few are lost after the ninth or eleventh; which number of days it would not be possible for them to complete, unless the violence of the disease was in a good measure subdued; although I had one who recovered, after having been subject to its tyrannical attacks daily for six weeks. In this stage the pulse is slow, and very hard, and the belly is bound; blood taken away seems not to be altered from the natural state, so that no indication can be deduced therefrom, and it only varies with regard to laxity or compaction, according to the age of the person and season of the year.

"Stad. II. The spasm under the sternum (which is the pathognomonic symptom of this disease) becomes more violent, returning every 10 or 15 minutes; and never fails to be instantly succeeded by a stronger retraction of the head, with great rigidity and pain all round the neck, and along the spine to the lower extremities, which are suddenly put to the stretch. The countenance is very pale and contracted; the jaws are that moment snapped together, and cannot afterwards be opened so wide as to receive the end of one's little finger; an attempt to do which, by way of experiment, almost constantly hurries on the spasm. The mastoid, coraeo-hyoid and sterno-hyoid muscles, as well as all the others concerned in deglutition, and the deltoid and pectorals, are most violently contracted, so that the shoulders are strongly raised forward, and the arms are stretched out or drawn across the body; but the wrists and fingers seem not to be affected.

"Such is the condition of the patient in the time of the spasm, which ceases in a few seconds: after which the shoulders and arms recline, and the inferior extremities relax; yet not so entirely, but that such a degree of rigidity for the most part remains as will not permit them to bend when this is attempted by another person; for as to the sick himself, he cannot at all move them. The muscles on the sides and forepart of the neck continue still contracted, although not so strongly; but their action is overcome by the number and strength of the posterior ones; so that the retraction of the head constantly remains. The patient breathes quick for some minutes, as if he had been excessively exercised; and the pulse is small, fluttering, and irregular, but both become more calm and slow. The face is sometimes pale in the intervals, but oftener flushed; and the whole countenance expresses strong appearances of the most melancholy distress, as well because of the dread he has of a return of the spasm, which he is sure will soon happen, as from the pain he suffers by the present contractions, and the more general and severe ones which he has so lately sustained. The tongue is stiff and torpid; but so far as it can be seen, is not foul. The belly is always bound, and cannot easily be loosened. In drinking, the liquid passes with great difficulty to the stomach, even in the smallest quantity; and if the spasm should seize him at that time, which an attempt to swallow for the most part occasions, the liquor returns through the nose with some force. The patients desire to lie still as much as possible; and avoid drinking, speaking, or being moved, either of which are apt to occasion a return of the spasm.

"Stad. III. In this last stage, the patient is reduced to the most calamitous and distressful circumstances: for he is on a continual rack, according to the most literal meaning of that word; the spasm returning oftener than once in a minute, is much more violent, and holds him longer, so that he has scarcely any remission. The anterior muscles of the whole body now suffer equal contractions with the posterior; but the last overcome the force of the others, so that the spine is strongly recurvated, and forms a hollow arch with the bed, and he rests on the back part of the head and the heels. The belly is flat, and is drawn inward; and the muscles are so rigidly contracted, that they will not give way to pressure, and do not seem in the least to yield to the descent of the diaphragm in inspiration; the several muscles about the neck, sides, and abdomen, being plainly distinguishable from each other. Although the lower extremities are always rigid in this state, yet are they so suddenly and violently distended in the time of the spasms, that were it not for the standers by, the patient would be projected feet foremost off the bed; while others again are as it were pushed upward with such a spring, that the head is struck with great force against whatever happens to be in the way, the thighs and legs being in this case no less rigid than the other parts. The tongue is spasmodically darted out, and is often miserably torn, as the teeth are that moment snapped together; so that it is necessary to prevent this by keeping the handle of a spoon, wrapped round with soft rags, between the teeth, when this can be done. At the time that the tongue is thus thrust out, the muscular flesh, which lies between the arch of the lower jaw and head of the trachea, seems to be drawn upwards within the throat. The countenance is very much contracted, and he is in a foam of sweat, the heat being very great; and the pulse between the spasms is exceedingly quick, small, and irregular, although the heart throbs so strongly, that its emotions may be plainly seen, and a palpitating subsultory kind of undulation may not only be felt, but perceived all over the epigastric region. The eyes are watery and languid, and a pale or bloody froth bubbles out from between the lips. The jaws are for the most part locked fast, so that it is impossible to give drink or nourishment, nor could he swallow any thing that was put into his mouth. In this state patients are commonly delirious: and as they cannot subsist many hours under so great a suspension of the vital and natural functions, a mortal anxiety ensues and releases

Spasmi. releases them; oftener a continued and severe spasm finishes the tragedy, when it was before almost at an end: but most frequently a general convulsion puts a period to their sufferings; and whichever way this happens, they for the most part relax just before death.

"In the *tetanus*, the general symptoms are nearly the same as in the opisthotonos, except that from the first attack, the lateral, abdominal, and other anterior muscles, are equally contracted with the posterior ones; and the arms become rigid as well as the lower extremities. The abdomen is always flat and rigid as in the last stage of the opisthotonos, and its contents seem to be thrust up into the thorax, which at the same time appears to be much dilated. There are here also some intervals between the spasms, in the time of which the cheeks are drawn towards the ears, so that all the teeth may be seen as in the spasmus cynicus. Deglutition is more free in this than in the other disease; yet so far is the sick from being equally balanced between the contractions of the opposite muscles, that the head is retracted and the spine is recurvated, although not quite so much as in the opisthotonos. And the spasm, which commences under the sternum, is likewise common to the tetanus, which terminates as the other, and on the same fatal days. But whoever recovers from either, labours long under a general atonia; and they cannot for some months raise themselves from a supine or recumbent posture without pain, nor without help for some time."

Prognosis and Cure. There has never been any thing like a crisis observed in these frightful cases, or favourable termination from the mere efforts of nature; and therefore all the physician's dependence must be upon art. As in cases of tetanic affections, the disease often arises from some particular irritation, the removal of this must necessarily be an important object in the cure: But where it cannot be removed, benefit may often be obtained by the prevention of its influence being communicated to the brain. When, however, that influence is communicated to the brain, a cure is to be expected only by diminishing and obviating it. This is principally brought about by the use either of those means which have a general tendency to diminish action, or of those which induce a different state of action. On these grounds the operation of those remedies which are employed with greatest success in this affection, may, we apprehend, be explained. Fortunately it has been found, that opium is capable of giving some relief, if administered in proper time, and if the disease happens not to be in the most violent degree: the warm bath must also be brought in aid; and the patients should lie horizontally in the bath, and while in it have the whole body extremely well rubbed: when taken out, they are not to be dried, but immediately put to bed wrapt in the softest blankets; and while they remain there, the belly ought either to be stuped, or two or three bladders filled with warm water kept constantly lying on it. The bowels at the same time must, if possible, be kept open, by solutions of manna and *sal polychrest*, or some other purging salt, mixed with *oleum ricini;* or if that should not be at hand, with oil of sweet almonds and a little tincture of senna. The opiates are to be given in large and frequently repeated doses; such as a grain of the *extractum thebaicum*, or 20 drops of the tincture, every second or third hour; and it will be safest not to trust to the thebaic tincture which is kept ready prepared in the shops, but to order the necessary dose of solid opium, and either give it in pills or dissolve it in some convenient liquid. If swallowing should be difficult, or the jaws closed up, the opium must be given in clysters; for during the whole course of the disease it will be of service to order emollient clysters to be injected from time to time, since these will answer not only as a relaxing fomentation, but also contribute to keep the intestinal canal perfectly free. Tetanus.

When the patients recover, they continue for a long time very relaxed and weak: and no wonder, since it is the nature of all spasmodic affections to leave behind them extreme weakness and relaxation of the muscular fibres. In order to perfect the recovery, a course of the cinchona and the Peruvian balsam is to be tried; and the spine may be rubbed with spirituous liniments, or with a mixture of rum and Barbadoes tar: but these and all other stimulating things, either internally or externally, during the violence of the spasms, must, in the opinion of some practitioners, be omitted, since all of them as well as blisters have been alleged to exasperate the disease.

This, in general, is the plan of treatment recommended by Dr Chalmers.

The same dreadful disorders frequently attack young children in the warm climates. Dr Hillary tells us, that they will there arise from the same causes which usually produce convulsions with children in Britain, viz. from a retention of the meconium or first excrement after birth; or from a glutinous matter which is too often found in the intestines of young children soon after the other is discharged; or from a cheesy matter from the coagulation of the milk by an acid in the stomach; or from hard excrements; or from something taken in by the mouth which is over acrid, or too hard to digest, which irritates their tender bowels, and so produces startings and convulsive spasms, with all the other symptoms which precede and accompany convulsions in young children in Britain. And this shows how much more readily and easily the nerves are affected and irritated in that warm climate, and the *tetanus* produced from a much less cause there, than it is in Britain, where it is but seldom seen. But these causes not being timely removed, their acrimony is increased, partly by the heat of the climate, and partly by the fever which they produce, which still renders them more acrid, and so increases the irritation of their bowels, that it first brings on startings, then convulsive spasms, and regular convulsion fits; which, if not soon removed, usually end in a perfect *tetanus*, and the disease is but seldom cured in such young children when it arrives at that state: for when the child lies in this miserable, rigid, immoveable condition, upon moving its hands or feet in the most gentle manner, or softly touching any part of its body, or giving it the least motion, even feeling its pulse in the most tender manner, or the least noise, or even touching its clothes, will bring on the convulsive spasms, and cause it to be strongly convulsed backwards, or drawn into a rigid straight line, strongly extended and immoveable like a statue, and will so remain immoveable out of either of those postures for a considerable time, a minute or two; and when the disease is arrived at this degree, Dr Hillary thinks

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thinks it is never cured. But if the physician be called in time, before the *tetanus* has come on (which is too seldom the case there), though he finds strong convulsive spasms have seized the child, or that it has had a convulsive fit or two, it may most commonly be relieved, the coming of the *tetanus* be prevented, and the life of the babe saved, as Dr Hillary has more than once seen, by removing and carrying off the irritating cause which stimulates their tender bowels, by such gentle evacuations as are suitable to their age; and then quieting and composing the irritation of their nerves by proper anodynes, and correcting the remaining acrimony of the nutritious juices in the *primæ viæ*.

To answer these intentions, the following method, with variations *pro re nata et pro ratione ætatis*, as the cause is different, has been found to answer the desired effect the best: ℞ *Seri lactis* ℥ij. *Sapon. Venet.* ℈j. *Mannæ Calab.* ʒij. *vel* iij. *Ol. amygd. dul.* ℥ſs. *Ol. fœniculi dul. gut.* ij. *Balſ. Peruv. gut.* v. *Miſc. Fi enema quam primum injiciendum.*

And if the symptoms of the approaching *tetanus* will permit, he gives something of the following nature to assist the operation of the clyster, and to carry off the acrimony the sooner: ℞ *Aq. ſem. fœniculi* ℥iij. *Magneſ. albæ* ʒſs. *Ocul. cancr. præp.* ʒj. *Syr. è cichor. cum rheo, Roſar. ſolut. ana* ʒiij. *Miſce.* Or, ℞ *Aq. ſem. fœniculi* ʒiij. *Sapon. amygdal.* ʒſs. *Magneſ. albæ* ʒſs. *Syr. è cichor. cum rheo. Mannæ opt. ana* ʒij. *Ol. amygd. dul.* ʒiij. *Miſce: Exhibe cochl. parv. vel duo pro ratione ætatis, omni ſemihora, vel omni hora, donec reſpond. alvus.*

Two or three stools being obtained by these, the following is exhibited in order to abate the convulsive twitchings, and prevent the *tetanus* from coming on: ℞ *Aq. ſem. fœniculi* ℥iij. *Magneſ. albæ* ʒſs. *Ocul. cancr. præp.* ʒj. *Moſchi orient. gr.* iij. *Spir. C. C. gut.* xv. *Syr. è mecon.* ʒſs. *Miſce: Exhibe cochl. parv.* (a child's spoonful) *ter quaterve de die, vel ſæpius, urgent. convulſ. vel ſpaſm.*

But if the symptoms show that the *tetanus* is more immediately coming on, so that we have no time to wait till the operation of the clyster and opening laxative be over, something of the following nature must be immediately given; or the *tetanus* will come on, and most probably prove fatal to such tender babes. ℞ *Aq. fœnicul.* ʒiiij. *Moſchi orient. gr.* j. *Tinct. thebaic. gut.* iiij. *Syr. è mecon.* ʒij. *Miſce pro duobus doſ. de quibus exhibe unam quam primum, et alteram ſi convul. ſpaſm. redeunt.*

This, Dr Hillary observes, may be thought a bold attempt, to give *tinct. thebaica* to such a tender young infant: but it is to be considered that the little patient will certainly die if the *tetanus* seize it, and that it will come on if this do not prevent it: and he has known a bold ignorant old midwife give four or five drops of that tincture to a very young infant without any prejudice more than its dosing three or four hours, though not in this case, but in one much less violent.

The clyster may be given at the same time, and the opening laxative not long after it; though it may retard the operation of that for some time, yet it operates soon after, and gives relief; after which the other medicines, and fomenting the body and anointing it as before, may be used, if the physician finds it necessary; also a little of the laxative mixture may be given once or twice a-day, if the above julep does not answer the intention of keeping the child's body open for a few days afterwards, which in this case is generally found necessary to be observed.

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These methods and medicines may be varied according to circumstances. For neither the same method nor the same medicines will answer in all cases, though the disease be the same; but they must be changed as the causes differ, or the constitution of the sick, or the time of the disease, or as some other circumstances may require: which is a thing of great importance, not only in this, but in the cure of most other diseases.

When proper medicines are thus timely and judiciously given in this case, they seldom fail to carry off the irritating cause, quiet and ease the nerves, remove the convulsions and spasms: and consequently prevent the tetanus from coming on, and the death of the patient. But if calling in the physician be deferred till the tetanus has already strongly seized the child, as is too often the case here, neither warm bathing, fomenting, nor any other methods or medicines whatever, will remove it or its causes, nor save the life of the little tender patient.

Dr Chalmers gives an account of his having cured one child seized with a *tetanus*, by purging with an infusion of rhubarb: to which a few grains of musk, and a little *ol. tartar. per deliq.* were added, together with the warm bath, and the frequent injection of clysters made with an infusion of chamomile flowers, to each of which was added a small portion of Castile soap. It is much to be regretted, however, that in those cases where the assistance of the medical art is most wanted, it most generally fails. We have been assured by a gentleman who practised for some time in the warm parts of America, that out of 30 cases of the tetanus he had seen, not one of the patients recovered, though he had given opium to the quantity of 20 grains thrice a-day; and others, he was assured, had taken 30 grains thrice a-day. In the beginning of the disease, the medicine produced a violent headach; but towards the end, it had no manner of effect whatever. In two patients, the disease came on from the slightest causes imaginable. The one accidentally fell in attempting to avoid a loaded cart, and put the heel of his shoe upon one of his thumbs in rising; the other, in avoiding the same cart, slightly ruffled the skin of his nose. Both were seized with the tetanus; and both died, notwithstanding all possible assistance was given. The former had his thumb amputated without effect.

In the Edinburgh Physical and Literary Essays, vol. iii. Dr Donald Monro describes a new method of cure, communicated to him by a gentleman who was formerly a practitioner in Jamaica. While this gentleman practised in that island, he had under his care a great number of cases of tetanus attended with the locked jaw. At first, he used to give very freely of opium, musk, and other medicines of this class; to bleed, and make other evacuations; while he used baths, fomentations, embrocations, and other external applications, but all without the least success; and, as he had lost a great many patients without being so lucky as to make one cure, he began to believe that this disorder always proved fatal, and was not to be cured by medicine, notwithstanding what some practitioners

Spasmi. Tetanus.

titioners had alleged. However, having received an unexpected hint concerning the good effects of the mercurial ointment in such cases, he resolved to try it; and ordered the first patient that offered to be put into a warm room, and to be rubbed two or three times a day with the ointment, till such time as a salivation was raised; when he with pleasure observed, that, as soon as the mercury began to affect the mouth, the convulsions of the muscles of the jaws, as well as all the other spasms and convulsions, ceased, and the patient was freed of all his complaints. After this, he treated every case of this kind which came under his care in the same manner, and cured twelve, which were all who applied to him for advice so early in the disorder that there was time to bring the mercury to the mouth before the fatal period was expected. A few died, in whom the disease was so far advanced before he saw them that there was no time to raise a salivation. None of the cases which were under this gentleman's care in the West Indies were the consequences of wounds or capital operations; nor has he had any opportunity of trying it since in cases of the locked jaw, which sometimes follows capital operations, owing to his having given over practice: but he thinks, that from the similarity of the complaint, there is no doubt that the mercurial frictions would be equally efficacious in such cases, as when the disorder comes from catching cold or other such causes.

In the second volume of the Medical Transactions, we have an account of a cure performed by Dr William Carter of Canterbury, by means very different from any of those above related.—On the 17th of May 1767, the doctor was called to a strong healthy man, in the 21st year of his age, and who had been confined to his bed for three weeks. What gave rise to his present disorder was an wound on the inner ankle of his right leg, which he had received six weeks before from a joiner's chisel. At that time his mouth was so far closed, as to admit only the most liquid nourishment, which he constantly sucked through his teeth: but his legs and jaw, and the whole length of the spina dorsi, were quite immoveable, being as stiff and rigid as those of a person long dead; his head was drawn backward, and he was frequently strongly convulsed. The motion indeed of both his arms was but little impaired. From the beginning to the end, his sight, hearing, and memory, continued perfect; his appetite was good; and his senses, in the daytime, entire, though sometimes wandering in the night. As to his pulse, it was regular; if it deviated at all from the pulse of a person in health, it was rather slow than quick, and somewhat fuller than natural. Such was the situation of his patient; a detail of which had been given before the doctor set out on his journey, which he undertook with a determined resolution to make use of the method recommended by Dr Silvester, in the first volume of Medical Observations and Inquiries, published in the year 1757, (and which has been related from Dr Chalmers and Dr Hillary.) But, on his arrival at the house, he found great quantities of the *extractum thebaicum* dissolved had been already given him; and that, for the five last days, he had taken no less than 28 grains of that medicine, with 50 grains of musk, in the space of 24 hours, without any sensible effect, except the bringing on a confused sleep, out of which he frequently awoke in great hurries, attended with a violent pain in the head, which almost deprived him of his senses. The doctor was afraid to extend the dose; and soon determined to take some other method, though at a loss what method to pursue, as, during a course of almost 30 years practice, nothing of the same kind had ever fallen under his cognizance before. Reflecting, however, that this disorder had always been deemed of the spasmodic kind, and that the good effects produced by the *extractum thebaicum* must probably be owing to the relaxing and resolving faculty of that medicine, he directed a blister to be applied between the shoulders, the whole length of the spine; the jaw to be anointed with the *oleum lateritium;* and a purge consisting of the *tinctura sacra*, *tinctura jalappæ*, and the *syrupus de rhamno cathartico*, to be given him. This was repeated three several times afterwards, at the distance of three or four days between each dose. On the intermediate days, he was ordered the *oleum succini*, the fetid gum, and the *oleum amygdalinum*. Of the first he took 30 drops, of the gum 20 grains, and of the last four ounces, in 24 hours. By these means, and these only, the convulsions soon ceased; and he grew daily better and better, till at the end of a fortnight he was able to walk about his room, and in less than three weeks became in all respects well, some small weakness in the parts only excepted. The jaw was relieved first, after that the spine, and last of all the legs. A pain and uneasiness in the places affected, neither of which he had felt before, were the forerunners of his approaching amendment.

From all this it seems reasonable to conclude, either that there is no certain remedy for tetanus in all cases, or that the medicines which prove effectual in one constitution will fail in another. Thus, it is possible, that in cases where opium proves ineffectual, mercury may be a remedy; and, on the contrary, where mercury fails, opium may be effectual; and even where both are ineffectual, the antispasmodics recommended by Dr Carter may be of use. It is therefore necessary for physicians to be extremely careful to observe the effects of the first doses of their remedies: for if the symptoms show not the least appearance of remission after a large dose of opium, it is improbable that it can be cured by a repetition of the medicine; and as no time can be lost with safety, it will then be proper to apply mercurial ointment, or whatever else may be judged proper.—In the Edinburgh Medical Commentaries we have an account of the cold bath being used as a remedy, by Dr Thomas Cochrane, at that time physician at Nevis. The patient was an East Indian boy, who had been gored by a cow, and afterwards exposed to a rainy damp air for some hours. Dr Cochrane ascribes his cure to the cold bath, which was applied by dashing the water upon his body. But as the patient at the same time got laudanum, at first in the quantity of 200 drops a-day, and afterwards in still larger doses; and had besides his throat and shoulders anointed with warm oil of turpentine, was bled, and had lenient clysters and laxatives; it is by no means easy to say what share the cold bath had in his cure. Dr Cochrane, however, says he has heard of some cases being treated successfully by cold water and cinchona

cinchona in St Euſtatia and St Kitt's, and in another letter mentions his having uſed the cold bath in other caſes of tetanus with ſucceſs. But ſince Dr Cochrane's publication, a more full and ſatisfactory account of the benefit of this practice has been communicated in a paper publiſhed by Dr Wright, in the ſixth volume of the London Medical Obſervations. Dr Wright gives a particular account of ſix caſes, in which the beſt effects were obtained from daſhing cold water upon the patient; and he obſerves, that ſince he firſt uſed this method of cure he never failed in one inſtance to effect a recovery, and that in a ſhorter time than by any other method hitherto propoſed. This practice has on ſome occaſions been adopted by practitioners in Britain, although here the diſeaſe is a much leſs frequent occurrence. It has particularly been employed with ſucceſs by Dr Currie of Liverpool; and we hope that ſtill more extenſive practice will confirm the benefit to be derived from it, although not in every inſtance, yet in many caſes of this affection. We are, however, ſorry to ſay that we have of late heard of ſeveral caſes in which it has been tried in Britain, and which, notwithſtanding the uſe of it, had a fatal termination.

Very lately a different mode of cure in this affection has been recommended by Dr Ruſh, profeſſor of medicine in Philadelphia, in a paper entitled Obſervations on the Cauſe and Cure of Tetanus, publiſhed in the ſecond volume of the Tranſactions of the American Philoſophical Society. Dr Ruſh, viewing tetanus as being a diſeaſe occaſioned by relaxation, thinks the medicines indicated to cure it are ſuch only as are calculated to remove this relaxation, and to reſtore tone to the ſyſtem. On this ground he recommends the liberal uſe of wine and cinchona; and tells us, that he has employed them with ſucceſs in actual practice. When the diſeaſe ariſes from an wound of any particular place, he recommends ſtimulants to the part affected; ſuch as dilatation of the wound, and filling it with oil of turpentine. How far this practice will be confirmed by more extenſive experience, we cannot take upon us to determine. We may only obſerve, that a very contrary practice has been recommended as highly ſucceſsful by ſome practitioners in Spain, where tetanic affections are a very frequent occurrence in conſequence of ſlight accidents. There gentle emollients are ſtrongly recommended, particularly immerſing the wounded part in tepid oil for the ſpace of an hour or ſo at a time, and repeating this application at ſhort intervals. By this mode many caſes, after very alarming appearances had taken place, are ſaid to have been completely and ſpeedily removed. While the practice is very ſimple, it appears at the ſame time in many reſpects very rational, and may perhaps be conſidered as well deſerving a trial in the firſt inſtance.

Among other remedies employed in tetanus it has been ſaid that the ſpaſms have ſometimes been allayed by a ſtrong electric ſhock. And in obſtinate caſes electricity or galvaniſm certainly well deſerve a trial.

Genus XLIX. TRISMUS.

280 The *Locked Jaw.*

Triſmus, *Sauv.* gen. 117. *Lin.* 124. *Sag.* gen. 223.
Capiſtrum, *Vog.* 208.

Sp. I. *Trismus nascentium.* 281

Locked Jaw in children under two months old.

Triſmus naſcentium, *Sauv.* ſp. 1. *Heiſter Comp.* Med. Pract. cap. xv. § 10. *Cleghorn* on the Diſeaſes of Minorca, Introd. p. 33. *Hofer.* in Act. Helvet. tom. i. p. 65.

This diſtemper is ſo cloſely connected with the tetanus, that it ought rather to be accounted a ſymptom of the tetanus than a primary diſeaſe. And nothing need now be added to what has been ſaid reſpecting tetanus.

Sp. II. The *Trismus* from *Wounds* or *Cold.* 282

Triſmus traumaticus, *Sauv.* ſp. 2. *Lond. Med. Obſ.* vol. i. art. 1, 7. Vol. ii. 34. Vol. iii. 31. Vol. iv. 7.
Angina ſpaſmodica, *Sauv.* ſp. 18. *Zwingeri*, Act. Helvet. tom. iii. p. 319.
Convulſio à nervi punctura, *Sauv.* ſp. 2.
Triſmus catarrhalis, *Sauv.* ſp. 15. *Hillary's* Barbadoes, 221. *Lond. Med. Obſ.* vol. iv. 7.

The internal remedies proper in all caſes of the locked jaw, from whatever cauſe it may proceed, have been already mentioned under Tetanus: the external treatment of wounded parts which may give occaſion to it belongs to the article Surgery. But of this alſo we have offered ſome obſervations under the head of Tetanus; and, indeed, triſmus may be conſidered as being merely an incipient tetanus, or rather a ſlight degree of that diſeaſe.

Genus L. CONVULSIO.

Convulsions. 283

Convulſio, *Sauv.* gen. 128. *Lin.* 142. *Vog.* 191. *Sag.* gen. 235.
Convulſio univerſalis, *Sauv.* ſp. 11.
Hieranoſos, *Lin.* 144. *Vog.* 190.
Convulſio habitualis, ſp. 12.
Convulſio intermittens, *Sauv.* ſp. 16.
Convulſio hemitotonos, *Sauv.* ſp. 15.
Convulſio abdominis, *Sauv.* ſp. 10.
Convulſio ab inanitione, *Sauv.* ſp. 1.
Convulſio ab onaniſmo, *Sauv.* ſp. 13.
Scelotyrbe feſtinans, *Sauv.* ſp. 2.

Deſcription. When convulſions attack only particular parts of the body, they are generally attended with ſome kind of paralyſis at the ſame time, by which means the affected parts are alternately convulſed and relaxed; a permanent convulſion, or unnatural contraction of particular muſcles, is called a *ſpaſm* or *cramp.* Theſe partial convulſions may attack almoſt any part of the body; and are not unfrequently ſymptomatic, in fevers, the cholera morbus, &c. The involuntary ſtartings of the tendons, the picking of the bedclothes, &c. in acute diſeaſes are all of them convulſive diſorders. Convulſions, even when moſt generally extended, differ from epilepſy in not being attended with any mental affection or abolition of ſenſe, and not followed by the ſame torpid ſtate.

Cauſes. Convulſions, not only of particular parts, but alſo over the whole body, often take place from cauſes not very evident. Sometimes they ſeem to depend

pend on a certain delicacy or irritability of the nervous ſyſtem, which is framed with ſuch exquiſite ſenſibility as to be ſtrongly affected by the ſlighteſt cauſes. Delicate women are often ſubject to hyſterical convulſions, and alſo hyponchondriac people. Convulſions, however, often take their riſe from wounds, irritations of the ſtomach and inteſtines by worms, poiſons, violent cathartics and emetics, &c.; and very often they are ſymptomatic, as in dentition, the ſmallpox, and many kinds of fevers.

Prognoſis. Except in ſome few caſes, convulſive diſorders are always to be dreaded; but leſs in young people than in ſuch as are advanced in life. Thoſe which attack girls under the age of puberty, will generally ceaſe on the appearance of the menſes; and boys have likewiſe a chance of being relieved as they advance in life: but in grown-up people, unleſs the cauſe be very evident, a cure is hardly to be expected, eſpecially after the diſeaſe has been of long continuance.

Cure. The treatment is very much the ſame with that of epilepſy, afterwards to be conſidered: but a recovery is moſt frequently obtained by the removal of the exiſting cauſe.

284 Genus LI. CHOREA.

St Vitus's Dance.

Scelotyrbe, *Sauv.* gen. 136. *Sag.* 243.
Chorea, *Lin.* 139.
Scelotyrbe chorea Viti, *Sauv.* ſp. 1.
Chorea St Viti, *Sydenh.* Sched. Monit.

Deſcription. This diſeaſe ſhows itſelf firſt by a kind of lameneſs or inſtability of one of the legs, which the patients draw after them in a ridiculous manner: nor can they hold the arm of the ſame ſide ſtill for a moment; for if they lay it on their breaſt, or any other part of their body, it is immediately forced away by a convulſive motion. If they be deſirous of drinking, they uſe a number of odd geſticulations before they can bring the cup to their mouths, becauſe their arms are drawn this way and that by the convulſions which affect them.

Cauſes, &c. The general cauſe of St Vitus's dance is a debility of the ſyſtem; and hence we find it attacks only weakly boys, and more eſpecially girls, when under the age of puberty. But the particular cauſes determining the muſcles to be affected in ſuch and ſuch a manner are entirely unknown.

Prognoſis. As this diſorder ſcarce ever attacks any perſons but ſuch as are under the age of puberty, there is almoſt a certain proſpect of its being then cured, though generally the diſorder is eaſily removed before that time.

Chorea, however, in ſome inſtances, proves an obſtinate affection; but is hardly in any inſtance attended with danger.

Cure. It has hitherto been almoſt univerſally the common practice to treat this diſeaſe with antiſpaſmodics and tonics, particularly opium, hyoſciamus, valerian, cinchona, preparations of iron, zinc, and copper, and cold bathing; and under the uſe of theſe the diſeaſe has, in general, been removed. But Dr James Hamilton, ſenior phyſician to the Royal Infirmary of Edinburgh, in a treatiſe which he has lately publiſhed on the uſe of purgative medicines, has recommended a very different practice in this diſeaſe, the uſe, viz. of briſk cathartics: theſe he adviſes to be repeated daily for ſome time. The great object, however, which he has in view, is not to evacuate from the ſyſtem, but to produce a thorough and complete evacuation of the inteſtinal canal. He finds, that by the firſt doſes, large quantities of black-coloured matter are diſcharged; and he recommends that the uſe of the purgatives ſhould be perſiſted in till the ſtools aſſume a natural appearance. In confirmation of the utility of this practice, he has related ſeveral caſes in which it produced a ſpeedy and complete cure; and equal ſucceſs has attended this practice when directed by ſeveral others. There can therefore be no heſitation in recommending it at leaſt in every obſtinate inſtance of chorea.

Genus LII. RAPHANIA. 285

Raphania, *Lin.* 155. *Vog.* 143. *Lin.* Amœn. Acad. vol. vi.
Convulſio raphania, *Sauv.* ſp. 7.
Eclampſia typhodes, *Sauv.* ſp. 1. *Sennert.* de febr. l. iv. cap. 16. *Gregor. Horſt.* Oper. tom. ii. l. viii. obſ. 22. *Brunner* in Ephem. Germ. D. iii. A. ii. obſ. 224. *Williſch.* ibid. cent. vii. obſ. 13. *Wepfer.* de Affect. Capitis, obſ. 120. *Breſlauer* Sammlung 1717, Julio, Septembri, et Decembr. ibid. 1723, Januar. A. N. C. vol. vii. obſ. 41. *Bruckmann.* Comb. Norimb. 1743, p. 50.

Deſcription. According to Sauvages, this diſtemper begins with a laſſitude of the limbs, tranſient colds and ſhiverings, pain of the head, and anxieties of the præcordia. Then come on ſpaſmodic ſtartings of the fingers and feet; alſo of the tendons and muſcles, conſpicuous below the ſkin. The diſeaſe is attended with heat, fever, delirium, ſtupor, conſtriction of the breaſt, ſuffocating dyſpnœa, loſs of voice, horrid convulſions of the limbs, preceded by a formication, or ſenſation as of ants or other ſmall inſects creeping on the parts. In this ſtate of the diſeaſe, the convulſive paroxyſms are attended with moſt violent pains in the limbs, vomiting, or diarrhœa, with the paſſing of worms, thirſt, and in young people an unnatural hunger. It continues from ten days to three months. About the eleventh or twentieth day, ſome are relieved by copious ſweats, or purple exanthemata: while others fall into a tabes, with ſtupor, or ſtiffneſs of the joints.

Cauſes, &c. This diſeaſe is frequently epidemic in Suabia and other parts of Germany; where it is ſaid to be produced by ſeeds of radiſhes, which are often mixed with rye in that country; and from this ſuppoſed cauſe the diſeaſe takes its name. It is alſo, however, a very common opinion, that this diſeaſe depends on the rye uſed in diet being of a bad quality, and particularly containing a large proportion of what is called *ſpurred rye.*

Cure. In this affection, the cure, as far as it has yet been diſcovered, is very much the ſame with that of epilepſy, the diſeaſe next to be conſidered. But from what has been ſaid of the advantages derived from the uſe of purgatives in chorea, analogy would lead us to make a trial of them alſo in caſes of raphania.

286 ## GENUS LIII. EPILEPSIA.

FALLING-SICKNESS.

Epilepſia, *Sauv.* gen. 134. *Lin.* 143. *Vog.* 188. *Sag.* gen. 24. *Boerh.* 1071. *Hoffm.* III. 9. *Junck.* 54.
Eclampſia, *Sauv.* gen. 133. 180. *Sag.* gen. 240.

287 Sp. I. The *CEREBRALIS*, or *Epilepſy* depending on an affection of the *Brain.*

Epilepſia plethorica, *Sauv.* ſp. 1.
Eclampſia plethorica, *Sauv.* ſp. 7.
Epilepſia cachectica, *Sauv.* ſp. 2.

288 Sp. II. The *SYMPATHICA*, or *Sympathetic Epilepſy*, with a ſenſation of ſomething riſing from a certain part of the body towards the head.

Epilepſia ſympathica, *Sauv.* ſp. 8.
Epilepſia pediſymptomatica, *Sauv.* ſp. 6.

289 Sp. III. The *OCCASIONALIS*, or *Epilepſy* ariſing from various irritating cauſes.

Epilepſia traumatica, *Sauv.* ſp. 13.
Eclampſia traumatica, *Sauv.* ſp. 9.
Epilepſia à dolore, *Sauv.* ſp. 10.
Epilepſia rachialgica, *Sauv.* ſp. 14.
Eclampſia à doloribus, *Sauv.* ſp. 4.
 a, Rachialgica.
 b, Ab otalgia.
 c, A dentitione.
Eclampſia parturientium, *Sauv.* ſp. 3.
Eclampſia verminoſa, *Sauv.* ſp. 2.
Eclampſia ab atropa, *Sauv.* ſp. 11.
Eclampſia ab œnanthe, *Sauv.* ſp. 12.
Eclampſia à cicuta, *Sauv.* ſp. 13.
Eclampſia à coriaria, *Sauv.* ſp. 14.
Epilepſia exanthematica, *Sauv.* ſp. 11.
Epilepſia cachectica, *Sauv.* ſp. 2.
Epilepſia ſtomachica, *Sauv.* ſp. 3.
Eclampſia à ſaburra, *Sauv.* ſp. 5.
Epilepſia à pathemate, *Sauv.* ſp. 7.
Eclampſia ab inanitione, *Sauv.* ſp. 8.
Epilepſia neophytorum, *Sauv.* ſp. 15.

Deſcription. The epilepſy often attacks ſuddenly, and without giving any warning: but more frequently is preceded by a pain in the head, laſſitude, ſome diſturbance of the ſenſes, unquiet ſleep, unuſual dread, dimneſs of ſight, a noiſe in the ears, palpitation of the heart, coldneſs of the joints; and in ſome there is a ſenſation of formication, or a cold air, &c. aſcending from the lower extremities towards the head. In the fit, the perſons fall ſuddenly to the ground (whence the name of the *falling-ſickneſs*), frequently with a violent cry. The thumbs are ſhut up cloſe in the palms of the hands, and are with difficulty taken out; the eyes are diſtorted, ſo that nothing but the whites are to be ſeen; all ſenſation is ſuſpended, inſomuch, that by no ſmell, noiſe, or otherwiſe, nor even by pinching the body, can they be brought to themſelves; they foam at the mouth, with a hiſſing kind of noiſe; the tongue is frequently lacerated by the teeth, and there is a violent convulſive motion of the arms and legs. Sometimes, however, the limbs, inſtead of being agitated by convulſive motions, are all ſtiff, and the patients are as immoveable as a ſtatue. In children, the penis is erected; and in young men there is an emiſſion of the ſemen, and the urine is often thrown out to a conſiderable diſtance. At length there is a remiſſion of the ſymptoms, and the patients recover after a longer or ſhorter interval; when they complain of a pain, torpor, or heavineſs of the head, with a laſſitude of all the joints.

Cauſes, &c. The diſſection of epileptic ſubjects has ſhown a variety of morbid appearances, which may be ſuppoſed to have contributed to the diſeaſe; ſuch as, indurations in the brain or meninges; caries of the internal ſurface of the cranium; projections of the bony ſubſtance of the ſame, preſſing upon the brain; collections of ſerum or purulent matter, and earthy concretions within the ſkull; beſides many others which are recorded by Bonetus, Morgagni, and Lieutaud. But often the cauſes are impoſſible to be diſcovered; for even in thoſe who have died of the diſeaſe, the brain and all other parts of the nervous ſyſtem have been apparently ſound. The diſeaſe will attack ſtrong as well as weak people; and in thoſe who are ſubject to it, any conſiderable exceſs in drinking, a ſurfeit, violent paſſion, or venery, &c. will certainly bring on a fit. Some have epileptic paroxyſms returning periodically after conſiderable intervals; and the diſeaſe has been thought to have ſome dependence on the phaſes of the moon.

Prognoſis. If the epilepſy comes on before the time of puberty, there are ſome hopes of its going off at that time. But it is a bad ſign when it attacks about the 21ſt year, and ſtill worſe if the fits grow more frequent; for then the animal functions are often deſtroyed, as well as thoſe of the mind, and the patient becomes ſtupid and fooliſh. Sometimes it will terminate in melancholy or madneſs, and ſometimes in a mortal apoplexy or palſy. It has ſometimes, however, been obſerved, that epilepſies have been removed by the appearance of cutaneous diſeaſes, as the itch, ſmallpox, meaſles, &c. While the diſeaſe is recent, therefore, we are not to deſpair of a cure; but if it be of long ſtanding, or hereditary, there is very little reaſon to expect that it can be removed.

Cure. From the ſymptoms occurring in epilepſy, which conſiſts of involuntary convulſive motions, and an affection of the mental powers, there is reaſon to conclude that the fit immediately depends on the induction of ſome peculiar action of the brain; but that convulſions may enſue from this cauſe, it would ſeem neceſſary that there ſhould alſo occur a peculiar diſpoſition to action in the moving fibres. On this ground, then, we may ſuppoſe the cure to be chiefly expected on one of two principles; either by our being able to prevent the peculiar action of the brain, or to remove the diſpoſition to action in the moving fibres. The firſt is chiefly to be accompliſhed by the removal of irritating cauſes, by preventing their influence from being propagated to the brain, when they are applied to remote parts; or by counteracting their influence, from inducing in the brain a ſtate of action different from that to which they give riſe. The ſecond end is chiefly to be obtained by diminiſhing the mobility of the nervous energy, and by ſtrength-

ening

Spasmi. ening the tone of the moving fibres. It must, however, be allowed, that in all convulsive disorders, excepting those which are cured by nature about the time of puberty, the cure by artificial means is very difficult. Numberless specifics have been recommended, but all of them have failed of answering the expectation. When the cause can be discovered, that must be removed. In other cases, the cold bath, valerian root, castor, musk, opium, the fetid gums, cinchona, with the whole tribe of nervous and antispasmodic medicines, have been recommended: but none of these, or indeed any combination of them, have been found generally useful; though the slighter, or symptomatic cases, may often be removed by them.

Of late the *calx* or *oxide*, improperly called the *flowers*, of zinc, have obtained such reputation in convulsive disorders as to be received into the Edinburgh Pharmacopœia under the title of *oxidum zinci*. They were proposed by Dr Gaubius as an antispasmodic, in his *Adversaria;* and their efficacy has since been confirmed by various observations. In an inaugural dissertation published by Dr Hart at Leyden, the medical virtues of the flowers of zinc are considered. He observes, that they have long been used externally, chiefly for inflammations of the eyes from acrid lymph. Glauber first proposed the internal use of them; and Gaubius discovered them to be the remedy of a celebrated empiric Luddemannus, which he styled his *luna fixata*. After this he exhibited them with success in convulsive and spasmodic diseases. Dr Hart supposes, that they act either as absorbents, or as possessing a specific virtue: but is a strong advocate for their efficacy, on whatever principles they may operate; and, in favour of his opinion, relates seven cases in which they proved successful. A girl of 17 years of age was seized with a slight *chorea* from a fright; and when the disease had continued six days, she began to take the flowers of zinc, by which her disorder was removed in less than three weeks. Her cure required only 16 grains of the zinc. In a few months the complaints returned, from the same cause; and were removed by four grains of the medicine divided into 10 doses. A boy of about four years old, labouring under a real epilepsy, suspected to be hereditary, was cured by a grain of the flowers of zinc taken every day for some time.—A man 50 years old, thrown into convulsions from a violent passion, was cured by a grain of the calx taken every two hours. The disease had gone off upon venesection and the use of some other remedies; but returned again in two weeks, when it was finally removed by the zinc. The two last cases are related from Dr Gaubius, who affirms that he has used the flowers of zinc in cases of the chincough, hysteric hiccough, and spasmus cynicus; that they frequently did more than other medicines, but were by no means successful in every case. The other cures mentioned by Dr Hart are similar to those above mentioned. But it does not appear that he ever saw a confirmed epilepsy cured by this medicine.

In the first volume of the Edinburgh Medical Commentaries, we have an account by Mr Benjamin Bell, of a man afflicted with a confirmed epilepsy, who was considerably relieved by the flowers of zinc.

In a young man labouring under the epilepsy, in whom the fits were preceded by an *aura epileptica*, or sensation like air arising from the inside of the knee-joint, the disease was also relieved, but not cured. Epilepsia.

Dr Percival relates some cases of epilepsy which seem to have been cured by the flowers of zinc; and in other cases, where the disease was not entirely removed by it, the spasms were nevertheless much mitigated. He did not observe that it promoted any evacuation; excepting that in some, upon being first taken, it occasioned a little sickness, which went off with a stool. He adds, that those apothecaries who do not prepare this medicine themselves, are in great danger of being imposed upon, as it is sometimes a mere corrosion of the zinc by an acid, and even imperfectly washed.

The good effects of the oxide of zinc as an antispasmodic are also attested by Dr Haygarth of Chester and Dr White of York. The former gives a test of their goodness which may be of use to those who do not prepare them, namely, that the true flowers of zinc, when strongly heated, become yellow, but reassume their white colour on being allowed to cool. The latter gives a case of hieranosos, or strange convulsions of almost all the muscles of the body, cured by zinc, after a number of other remedies had failed. But, although from these and other respectable authorities, there can be no doubt that zinc has often been successful in epilepsy; yet it is equally certain, that in many others it has had a fair trial, without producing any benefit.

In Dr Home's clinical experiments and histories, also, oxide of zinc is mentioned as having been found serviceable upon trial in the Royal Infirmary of Edinburgh. Of the other principal remedies which have been recommended for the epilepsy and other convulsive disorders allied to it, we have the following account by the same author.

1. *The cold-bath* was tried in one who had a convulsive disorder of one side, but the symptoms were rendered much worse by it.

2. *Venesection.* Not to be depended on in convulsions.

3. *Electricity.* In two convulsive cases was of no service.

4. *Epispastics.* Do not seem to be powerful antispasmodics.

5. *Valerian.* In nine convulsive cases, for which this remedy has been reckoned almost a specific, it not only made no cure, but could scarcely be reckoned to do any good. Dr Home supposes that it acts as a bitter tonic, something like the *serpentaria Virginiana*. Though much used at present, he tells us it has always appeared to him a weak, often a hurtful, medicine.

6. *Musk.* Six convulsive patients treated with large doses of this remedy, were neither cured nor in the least relieved.

7. *Castor* seems to be unworthy of the confidence formerly put in it. It is indeed possessed of a sedative power, and therefore may be useful in spasmodic feverish cases.

8. *Asafœtida* has considerable antispasmodic powers, but is not always successful. It heats and quickens the pulse; and is therefore improper in cases attended with inflammation. It disagrees with some from a peculiarity of constitution; exciting pain in the stomach, and

Spasmi. and vomiting: but this can be known only after the exhibition of the medicine.

9. *Cinchona.* Of seven spasmodic cases, six were either cured or mitigated. An epilepsy of eight years standing was very much relieved by taking the bark for a month, and one of two years standing by taking it for ten days. But the medicine is of a heating nature, and therefore is not to be employed in cases attended with inflammatory symptoms.

10. *Peony root* was given to two epileptic patients without the least success.

11. *Viscus quercinus*, or missletoe, was given in the quantity of two scruples five times a-day to an epileptic patient, without success.

12. *Extractum hyosciami* was given to an epileptic patient, to one afflicted with the hemitotonos, and to one who laboured under the hysteric affection, without the least good effect.

13. *Folia aurantiorum* were exhibited with the like bad success. Five drams of the powdered leaves were taken at once without any sensible effect.

14. *Cardamine pratensis*, in three epileptic cases, was not attended with any success.

15. *Opium* did no good.

16. *Ammoniaretum cupri* made no cure in four cases of epilepsy in which it was tried.

That in many cases all these remedies have been employed without success, is not to be denied: and indeed it may with confidence be asserted, that a great majority of cases of epilepsy are incurable by any remedy that has yet been discovered. At the same time, as there is incontrovertible evidence that some of them have succeeded at least in certain cases, the more powerful may always be considered as deserving a fair trial. The ammoniaretum cupri, in particular, seems well entitled to the attention of practitioners; for though it be a medicine of great activity, yet under prudent administration it may be employed even with very young subjects without any hazard; and in several inveterate cases, which had obstinately resisted other medicines, it has brought about a complete recovery.

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Genus LIV. PALPITATIO.

Palpitation of the Heart.

Palpitatio, *Sauv.* gen. 130. *Lin.* 132. *Vog.* 213. *Sag.* 237. *Hoffm.* III. 83. *Junck.* 33.

The palpitation of the heart is sometimes so violent, that it may be heard at a considerable distance. It may proceed from a bad conformation of the heart itself, or some of the large vessels. It may also be occasioned by wounds or abscesses in the heart; or it may proceed from polypous concretions or ossifications of that viscus, or from plethora, fear, or spasmodic affections of the nervous system. When it proceeds from diseases of the heart or large vessels, it is absolutely incurable. In spasmodic cases, the remedies above related may be used. If the patient be plethoric, bleeding will probably remove the disorder, at least for the present.

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Genus LV. ASTHMA.

Asthma, *Sauv.* gen. 145. *Lin.* 161. *Vog.* 268. *Sag.* gen. 282.

Asthma convulsivum, et spasmodico-flatulentum, *Hoffm.* III. 94. Asthma.

Asthma spasticum, *Junck.* tab. 51.

Sp. I. *Spontaneous Asthma.*

Asthma humidum, *Sauv.* sp. 1. Flatulentum, *Floyer* on the Asthma, chap. i.

Asthma convulsivum, *Sauv.* sp. 2. *Willis* Pharm. rat. P. II. sect. i. cap. 12.

Asthma hystericum, *Sauv.* sp. 3. *Floyer* on the Asthma, chap. i.

Asthma stomachicum, *Sauv.* sp. 8. *Floyer*, Scheme of the species of Asthma. Periodic Asthma, 6.

Orthopnœa spasmodica, *Sauv.* sp. 3.

Orthopnœa hysterica, *Sauv.* sp. 4.

Sp. II. The *Exanthematic Asthma.*

Asthma exanthematicum, *Sauv.* sp. 11.

Asthma cachecticum, *Sauv.* sp. 13.

Sp. III. The *Plethoric Asthma.*

Asthma plethoricum, *Sauv.* sp. 15.

The asthma is a chronic disease, which may continue to give very great distress, at intervals, for a considerable number of years. Sir John Floyer, when he wrote his celebrated treatise, had laboured under repeated paroxysms for thirty years.

The common distinction is into *humid* and *dry*; the former is accompanied with an expectoration of mucus or purulent matter, but the latter is not. In the genuine humoral asthma, the patients are obliged to lean forward; the inspiration is short and spasmodic; and the expiration very slow.

Asthmatic persons have generally some warning of the attack, from a languor, loss of appetite, oppression, and swelling of the stomach from flatulence, which precede the fit; but it is usually in the middle of the night that the violent difficulty of breathing comes on.

The duration of the paroxysm is uncertain, as it will sometimes terminate in three or four hours, while at other times it will continue for as many days; nay, it has been known to last three weeks without intermission. While it subsists, the patient is in very great distress, not being able to lie in bed, nor scarcely to speak or expectorate, so great is the difficulty of breathing; and yet, notwithstanding all this apparent interruption to the free passage of the blood through the lungs, an inflammation here seldom or never supervenes a fit of the asthma. As the paroxysm wears off, and the breathing becomes free, there is more or less of an expectoration of mucus; and the urine, from being pale and limpid, becomes high coloured, and lets fall a copious sediment.

In order to obtain relief in the fit, we must sometimes bleed, unless extreme weakness or old age should forbid, and repeat it according to the degrees of strength and fulness; a purging clyster, with a solution of asafœtida, must be immediately injected; and if the violence of the symptoms should not speedily abate, it will be proper to apply a blistering plaster to the neck or breast.

In the height of the paroxysm, an emetic might be followed

Spaſmi.

followed by dangerous ſymptoms, as it would increaſe the accumulation of blood in the veſſels of the head; but vomiting will often prevent a fit of the aſthma, eſpecially if the ſtomach ſhould chance to be loaded with any ſort of ſaburra. A very ſtrong infuſion of roaſted coffee has been found to give eaſe in an aſthmatic paroxyſm.

Sir John Pringle ſays it is the beſt abater of the paroxyſms of the periodic aſthma that he has ſeen. The coffee ought to be of the beſt Mocco, newly burnt, and made very ſtrong immediately after grinding it. He commonly ordered an ounce for one diſh; which is to be repeated freſh after the interval of a quarter or half an hour; and which is to be taken without milk or ſugar. The medicine in general is mentioned by Muſgrave in his treatiſe *de Arthritide anomala*; but he firſt heard of it from a phyſician in Litchfield, who had been informed by the old people of that place, that Sir John Floyer, during the latter part of his life, kept free from, or at leaſt lived eaſy under, his aſthma, from the uſe of very ſtrong coffee. This diſcovery, it ſeems, he made after the publication of his book upon that diſeaſe. Dr Percival ſays he has frequently directed coffee in the aſthma with great ſucceſs.

In the intervals of the fit, perſons ſubject to the aſthma, eſpecially the humid ſpecies, ſhould take emetics from time to time. An infuſion of tobacco is an emetic that has been ſaid to be very ſerviceable in ſome aſthmatic caſes; but its operation is both ſo diſtreſſing and ſo dangerous, that it will never probably be introduced into common uſe as an emetic. Smoking or chewing the ſame has been known to prevent the frequency and ſeverity of the paroxyſms. Aſthmatic patients may alſo uſe the *lac ammoniaci*, with a due proportion of *oxymel ſcilliticum* and *vinum antimoniale*, with a view to promote expectoration; or the gum ammoniac, and others of ſimilar virtues, may be formed into pills, and combined with ſoap, as mentioned for the dyſpnœa pituitoſa; or a maſs may be compoſed of aſafœtida and balſam of Tolu, with ſyrup of garlic; and theſe pills may be waſhed down by a medicated wine, impregnated with ſquills, horſe-radiſh root, and muſtard ſeed; or a ſtrong bitter infuſion, with a little antimonial wine.

In ſome caſes crude mercury will be found ſerviceable; in others flowers of ſulphur, made into an electuary with honey or ſyrup of garlic; and if, notwithſtanding the uſe of theſe things, a coſtive habit ſhould prevail, it will be neceſſary, from time to time, to give a few grains of pills of aloes and myrrh, ſoap and aloes, or a maſs of equal parts of rhubarb, ſcammony, and ſoap.

The *dry* or *ſpaſmodic aſthma*, during the extreme violence of the fit, is beſt relieved by opiates; and ſometimes very large doſes are required. But in order to obtain permanent relief, nothing is found to anſwer better than ipecacuanha in ſmall doſes. Three, five, eight, or ten grains, according to the ſtrength and conſtitution of the patient, given every other day, have been productive of the happieſt effects; acting ſometimes as an evacuant, pumping up the viſcid phlegm; at others, as an antiſpaſmodic or ſedative. Iſſues are generally recommended in both ſpecies, and will often be found uſeful.

Changes of weather are uſually felt very ſenſibly by aſthmatic people, who in general cannot live with tolerable eaſe in the atmoſphere of large cities; though we ſhall ſometimes meet with patients who agree better with this air, which is ſo replete with groſs effluvia of various kinds, than with the pureſt that can be found in country ſituations. And ſome are found who breathe with the moſt eaſe in a crowded room, with a fire and candles.

Dyſpnœa.

A light diet of meats that are eaſy of digeſtion, and not flatulent, is requiſite for aſthmatic people; and the exerciſe of riding is often highly ſerviceable.

When the aſthma is found to depend on ſome other diſeaſe, whether it be the gout or an intermittent fever, or when it proceeds from the ſtriking in of ſome cutaneous eruption, regard muſt always be had to the primary diſeaſe: thus, in the *aſthma arthriticum*, ſinapiſms to the feet, or bliſtering, will be abſolutely neceſſary, in order, if poſſible, to bring on a fit of the gout. And when the dregs of an ague give riſe to an aſthma, which is termed *febriculoſum*, and invades at regular intervals, we muſt have recourſe to the Peruvian bark. The *aſthma exanthematicum* will require bliſters or iſſues, to give vent to the acrid matters which were repelled from the ſurface of the body; and courſes of ſulphureous waters, goats whey, and ſweetening diet drinks, or perhaps mercurial alteratives, in order to correct the ſharpneſs of the juices.

Genus LVI. DYSPNOEA. 292

Habitual DIFFICULTY *of* BREATHING.

Dyſpnœa, *Sauv.* gen. 144. *Lin.* 160. *Vog.* 267. *Sag.* 251. *Junck.* 32.

Sp. I. The *Catarrhal* DYSPNOEA. 293

Aſthma catarrhale, *Sauv.* ſp. 16.
Aſthma pneumonicum, *Willis* Pharm. rat. P. II. ſect. i. cap. 12.
Aſthma pituitoſum, *Hoffm.* III. ſect. ii. cap. 2. § 3.
Aſthma pneumodes, *Sauv.* ſp. 17.

This is readily known by the ſymptoms of pneumonia and catarrh attending it, and to the removal of theſe ſymptoms the care of the phyſician muſt be principally directed.

Sp. II. The *Dry* DYSPNOEA. 294

Dyſpnœa à tuberculis, à hydatibus, &c. *Sauv.* ſp. 2, 4, 5, 20.
Orthopnœa à lipomate, *Sauv.* ſp. 18.

This is generally accompanied with a phthiſis pulmonalis; but Sauvages mentions one ſpecies of phthiſis to which the dry dyſpnœa ſeems more particularly to belong. The patients fall away by degrees, and have a great difficulty of breathing, continual thirſt, and little or no ſpitting. When opened after death, their lungs are found not to be ulcerated, but ſhrivelled and contracted as if they had been ſmoke-dried. Goldſmiths and chemiſts are ſaid to be ſubject to this diſeaſe by reaſon of the vapours they draw in with their breath. Sauvages doth not mention any particular remedy. Shortneſs of breath ariſing from *tubercles*, as they are termed, or a ſcirrhous enlargement of the lymphatic glands which are diſperſed through the lungs, is commonly

Spasmi. monly found in scrophulous habits, and may be distinguished by the concomitancy of those external swellings and appearances which particularly mark the scrophula. This species of dyspnœa generally ends in a phthisis. Courses of goats whey, and of sea water, have been known to do service; but it must be confessed, that a perfect cure is seldom obtained. Issues are of use in these cases, as they appear to prevent the ill effects of over fulness, if it should happen at any time to supervene.

295 Sp. III. *DYSPNOEA* from *Changes* in the *Weather*. (*Sauv.* sp. 12.).

This seems to be a disease entirely spasmodic, and the antispasmodics already related are accordingly indicated.

296 Sp. IV. The *DYSPNOEA* from *Earthy Substances* formed in the *Lungs*.

Sauvages mentions this disease as much more common in brutes than in the human race: but Dr Cullen mentions his having seen some instances of it; and we have several accounts by different authors of calculous matters being coughed up by people labouring under a dyspnœa, and threatened with consumpton. In three cases of this kind which fell under Dr Cullen's inspection, there was no appearance of earthy or stony concretions in any other part of the body. The calcareous matter was coughed up frequently with a little blood, sometimes with mucus only, and sometimes with pus. In one of these cases, an exquisite phthisis came on, and proved mortal: in the other two the symptoms of phthisis were never fully formed; and after some time, merely by a milk diet and avoiding irritation, the patients entirely recovered.

Sauvages also greatly recommends milk in these cases, and soap for dissolving the concretions. The reason why brutes are more subject to these pulmonary calculi than mankind, is, that they very seldom cough, and thus the stagnating mucus or lymph concretes into a kind of gypseous matter.

297 Sp. V. The *Watery DYSPNOEA*.

Dyspnœa pituitosa, *Sauv.* sp. 1.
Orthopnœa ab hydropneumonia, *Sauv.* sp. 12.

This may arise from too great a defluxion of mucus on the lungs, or from an effusion of serum, as is mentioned under the pneumonia. The treatment of the disease may be gathered from what has been already said under the heads of Pneumonia, Catarrh, Empyema, &c.

298 Sp. VI. The *DYSPNOEA* from *Corpulency*.

Orthopnœa à pinguedine, *Sauv.* sp. 6.

There have been many instances of suffocation and death occasioned by too great corpulency. These fatal effects, however, may be almost always avoided, if the persons have resolution to persist in an active and very temperate course of life; avoiding animal food, much sleep, and using a great deal of exercise. In the third volume of the Medical Observations, however, there is an extraordinary instance of internal obesity which neither showed itself externally, nor could be removed by any medicines.

Pertussis. Other species of dyspnœa have been considered under PHTHISIS. It is frequently symptomatic of diseases of the heart and large vessels, or swellings of the abdomen, &c.

GENUS LVII. PERTUSSIS.

CHINCOUGH. 299

Pertussis, *Sydenham*, Ed. Leid. p. 200, 311, 312. *Huxham* de aëre, ad ann. 1732.
Tussis convulsiva, sive ferina, *Hoffm.* III. 111.
Tussis ferina, *Sauv.* sp. 10. *Sag.* sp. 10.
Tussis convulsiva, *Sauv.* sp. 11. *Sag.* sp. 11.
Amphimerina tussiculosa, *Sauv.* sp. 13.

Description. This disease comes on at first like a common cold; but is from the beginning attended with a greater degree of dyspnœa than is common in catarrh; and there is a remarkable affection of the eyes, as if they were swelled, and a little pushed out of their sockets. By degrees the fits of coughing become longer and more violent, till at last they are plainly convulsive, so that for a considerable time the patient cannot respire, and when at last he recovers his breath, inspiration is performed with a shrill kind of noise like the crowing of a cock. This kind of inspiration serves only as an introduction to another convulsive fit of coughing, which is in like manner followed by another inspiration of the same kind; and thus it continues for some time, very often till the patient vomit, which puts an end to the paroxysm at that time. These paroxysms are attended with a violent determination of the blood towards the head, so that the vessels become extremely turgid, and blood not unfrequently flows from the mouth and nose. The disease is tedious, and often continues for many months. It is not commonly attended with fever, unless at the commencement.

Causes, &c. The chincough is an infectious disorder, and very often epidemic: but the nature of the contagion is not understood; at least it is no farther understood than that of smallpox, measles, or similar epidemics. We well know that it is from a peculiar and specific contagion alone that this disease, as well as the others above mentioned, can arise. But with regard to the nature of any of them, we are totally in the dark. It generally attacks children, or adults of a lax habit, making its attack frequently in the spring or autumn; at the same time, when this contagion is introduced into any town, village, or neighbourhood, it will rage epidemically at any season. Those alone are affected with this disease who had never before been subjected to it. For in this affection, as well as in smallpox, having had the disease once, gives defence against future contagion. Every individual, however, does not seem to be equally readily affected with this contagion; like other contagious diseases occurring only once in a lifetime, it may naturally be expected to be more frequent among children than at any other period of life. But many, though frequently exposed to contagion, are yet not affected with the disease: and those children who live upon unwholesome watery food, or breathe unwholesome air, are most liable to its attacks, or at least suffer most

moſt from them. In general it has been concluded, that whatever weakens the ſolids, or tends to bring on a diſſolution of the fluids, prediſpoſes to this diſeaſe, and increaſes its ſeverity.

Prognoſis. The chincough is not very often fatal. During one epidemic, however, it is often obſerved to be much more dangerous and more ſevere than during another. This is alſo remarked with regard even to particular periods of the ſame epidemic; and it is alſo obſerved, that on certain families this diſeaſe is much more ſevere than on others. Its danger, however, is ſtill more connected with the period of life at which it occurs. In children under two years of age it is moſt dangerous; and kills them by producing convulſions, ſuffocation, inflammation, and ſuppuration of the brain or in the lungs, ruptures, and incurvation of the ſpine. In pregnant women it will produce abortion; and in adults inflammations of the lungs, and all the conſequences of pneumonia, more frequently than in children. From a long continuance of the diſeaſe patients will become aſthmatic, ricketty, and ſcrofulous. It is generally reckoned a good ſign when a fit terminates by vomiting; for in this diſeaſe there ſeems to be a great increaſe of the ſecretion of mucus, and the vomiting affords great relief.

Cure. Pertuſſis is one of thoſe diſeaſes which, after the contagion has exerted its influence, can be terminated only by running a certain courſe: but it is much leſs limited in its courſe than ſmallpox and meaſles, and often it runs on to a very great length, or at leaſt it is very difficult to diſtinguiſh certain ſequelæ of this diſeaſe from the diſeaſe itſelf. And when it exiſts in the former of theſe ſtates, it admits of an artificial termination. In the treatment of this affection, therefore, the objects at which a practitioner chiefly aims, are, in the firſt place, the obviating urgent ſymptoms, and forwarding the natural termination of the diſeaſe; and ſecondly, the inducing an artificial termination. With theſe intentions various practices are employed on different occaſions. The moſt approved remedies are vomits, purges, bleeding, and the attenuating pectorals; for the other kinds generally do hurt: but large evacuations of any kind are pernicious. In the Medical Obſervations, vol. iii. Dr Morris recommends caſtor and cinchona: but in caſes attended with any degree of inflammation, the latter muſt certainly do hurt, and the former will generally be inſignificant. Dr Butter, in a diſſertation expreſsly on the ſubject, relates 20 caſes of it cured by the extract of hemlock. He directs half a grain daily for a child under ſix months old; one grain for a child from ſix months to two years; afterwards allowing half a grain for every year of the patient's age till he be 20: beyond that period, he directs ten grains to be given for the firſt day's conſumption, gradually increaſing the doſe according to the effect. If the patient have not two ſtools daily, he adviſes magneſia or the *ſulphas potaſſæ cum ſulphure*, to be added to the hemlock mixture. By this method he ſays the peculiar ſymptoms of the diſeaſe are removed in the ſpace of a week; nothing but a ſlight cough remaining. The uſe of hemlock, however, has by no means become univerſal in conſequence of this publication, nor indeed has this remedy been found equally ſucceſsful with others who have given it a fair trial.

The remedy moſt to be depended upon in this diſeaſe is change of air. The patient, as ſoon as the diſeaſe is fully formed, ought to be removed to ſome other part of the country: but there is no occaſion for going to a diſtant place; a mile or two, or frequently a ſmaller diſtance, will be ſufficient; and in this new habitation, the frequency of the cough is almoſt inſtantly diminiſhed to a moſt ſurpriſing degree. After remaining there for ſome time, however, the cough will often be obſerved to become again more frequent, and the other ſymptoms increaſed. In this caſe, another change of air, or even a return to the former habitation, becomes neceſſary. Manifeſt benefit has even been derived by changing a patient from one room of a houſe to another. But although change of air has thus been advantageous, it muſt alſo be remarked, that when it has been had recourſe to at very early periods it has often done miſchief, particularly by aggravating the febrile and inflammatory ſymptoms. If the diſeaſe be attended with fever, bleeding and other antiphlogiſtic remedies are proper. Dr Buchan recommends an ointment made of equal parts of garlic and hog's lard applied to the ſoles of the feet; but if it have any effect, it is probably merely as an *emplaſtrum calidum*. It ought to be put on a rag and applied like a plaſter. Opiates may ſometimes be uſeful, but in general are to be avoided. They are chiefly ſerviceable where the cough is very frequent, with little expectoration. In theſe caſes benefit has ſometimes alſo been derived from ſulphuric ether, and ſometimes from the tincture of cantharides. An almoſt inſtantaneous termination has on ſome occaſions been put to this diſeaſe by exciting a high degree of fear, or by inducing another febrile contagion: But the effects of both are too uncertain and too dangerous to be employed in practice.

Genus LVIII. PYROSIS. 300

The Heart-Burn.

Pyroſis, *Sauv.* gen. 200. *Sag.* 158.
Soda, *Lin.* 47. *Vog.* 154.
Scotis, the Water-Brash.
Pyroſis Suecica, *Sauv.* ſp. 4.
Cardialgia ſputatoria, *Sauv.* ſp. 5.

This diſeaſe, whether conſidered as primary or ſymptomatic, has already been fully treated under Dyspepsia.

Genus LIX. COLICA.

The Colic. 301

Colica, *Sauv.* gen. 204. *Lin.* 50. *Vog.* 160. *Sag.* 162. *Junck.* 106.
Colica ſpaſmodica et flatulenta, *Hoffm.* II. 284.
Rachialgia, *Sauv.* gen. 211. *Sag.* 168.
Ileus, *Sauv.* gen. 252. *Vog.* 162. *Sag.* gen. 187. Iliaca, *Lin.* 185.
Dolor et ſpaſmus iliacus, *Hoffm.* II. 263.
Paſſio iliaca, *Junck.* 107.

Sp. I. *The Spaſmodic Colic.*

Colica flatulenta, pituitoſa, &c. *Sauv.* ſp. 1, 2, 5, 6, 7. 302
Ileus

Spafmi. Colica.

Ileus phyfodes, volvulus inflammatorius, &c. *Ejufd.* fp. 1. 3. 5. 7. 8. 9.

Defcription. The colic is chiefly known by a violent pain in the abdomen, commonly about the umbilical region. The pain refembles various kinds of fenfations, as of burning, twifting, boring, a ligature drawn very tight, &c. The belly is generally coftive, though fometimes there is a violent evacuation of bilious matters upwards and downwards. In thefe cafes the difeafe is fometimes accompanied from the beginning with a weak and intermitting pulfe, cold fweats, and fainting. In fome the difeafe comes on gradually, beginning with an habitual coftivenefs; and if purgatives be taken, they do not operate. The pain comes on generally after a meal, and foon occafions naufea and vomiting. Sometimes the difeafe is attended with pyrexia, violent thirft, and a full pulfe; the vomiting becomes more violent, and excrementitious matters are thrown up with the moft exquifite pain and tenfion of the abdomen; and hiccough comes on, which continues obftinately; till at laft a ceffation of pain and fetid breath indicate a mortification of the inteftines and approaching death. Sometimes the periftaltic motion of the inteftines is fo totally inverted, that all their contents are evacuated by the mouth, and even clyfters will be vomited; which conftitutes that difeafe commonly called the *iliac paffion.*

Caufes, &c. Colics may arife from any fudden check given to perfpiration, as by violent cold applied to any part of the body, efpecially to the lower extremities and abdomen. Very frequently they are occafioned by auftere, acid, or indigeftible aliments taken into the ftomach. By any of thefe, a violent colic, or indeed an iliac paffion, may be occafioned; for Dr Cullen juftly obferves, that this laft, though commonly accounted a different fpecies of difeafe, differs from colic in no other way than in being in every refpect in a much higher degree. In thofe who have died of this difeafe and been diffected, the inteftines have fometimes been found twifted; but more commonly there hath been an *introfufception* of the inteftine, that is, one part of the gut feems to have entered within the other. In the Edinburgh Medical Effays, vol. iii. we have a differtation on the ufe of the warm bath in the bilious colic, in which the author derives the diforder from a fpafmodic conftriction of the inteftine occafioned by the acrimony of the bile. By this, he fays, the inteftine is not only contracted into an unufual narrownefs, but the fides of it have been found, upon diffection, fo clofely joined, that no paffage could be made downwards more than if they had been ftrongly tied by a ligature. The formation of the *introfufceptio* he explains by quoting a paffage from Peyerus, who made the following experiment on a frog. Having irritated the inteftine of the animal in feveral different places, he obferved it to contract at thofe places moft violently, and to protrude its contents upwards and downwards wherever the relaxed ftate of the part would permit; by which means the contents were heaped together in different parts. Hence fome parts of the inteftine being dilated much more than enough, by reafon of the great quantity of matter thrown into them, formed a kind of fack which readily received the conftricted part into it. If this happen in the human body, there is the greateft danger of a mortification; becaufe the part which is conftricted, and at any rate difpofed to inflammation, has that difpofition very much increafed by its confinement within the other, and by the preffure of the contents of the alimentary canal from the ftomach downwards upon it. An iliac paffion may alfo arife from the ftrangulation of part of the inteftine in a hernia; and even a very fmall portion of it thus ftrangulated may occafion a fatal difeafe. In the Medical Obfervations, vol. iv. however, we have an account of an iliac paffion arifing from a very different caufe, which could neither have been fufpected nor cured by any other way than the operation of *gaftrotomy*, or opening the abdomen of the patient, in order to remove the caufe of the diforder. The patient, a woman of about 28 years of age, died after fuffering extreme torture for fix days. The body being opened, fome quantity of a dirty coloured fluid was found in the cavity of the abdomen. The jejunum and ileum were greatly diftended with air. A portion of the omentum adhered to the mefentery, near that part where the ileum terminates in the cæcum. From this adhefion, which was clofe to the fpine, there ran a ligamentous cord or procefs about two inches and a half long, unequally thick, in fome places not thicker than a packthread; which by its other extremity adhered to the coats of the ileum, about two inches above the cæcum. This cord formed a circle with the mefentery, large enough to admit a hen's egg to pafs through it. The cord had formed a noofe (in a manner difficult to be explained), which included a doubling of about two inches of the lower end of the ileum, and was drawn fo tight, that it not only put a ftop to the paffage of every thing through the bowels, and brought on a gangrene of the ftrangulated part, but it had even cut through all the coats of the inteftine on the oppofite fide to the mefentery, and made an aperture about an inch long. In the Memoirs of the Academy of Surgery are mentioned feveral fimilar cafes.

Prognofis. The colic is never to be reckoned void of danger, as it may unexpectedly terminate in an inflammation and gangrene of the inteftines. Thofe fpecies of it which are attended with purging muft be confidered as much lefs dangerous than thofe in which the vomiting is very violent. The iliac paffion, or that attended with the vomiting of feces, is always to be accounted highly dangerous; but if the paffage through the inteftines be free, even though their periftaltic motion fhould be inverted, and clyfters evacuated by the mouth, there is much more hope of a cure, than when the belly is obftinately coftive, and there is fome fixed obftruction which feems to bid defiance to all remedies.

Cure. In the cure of the fpafmodic colic, the recovery muft ultimately depend on producing a refolution of the fpafmodic affection. In order to accomplifh this, it is in general neceffary to evacuate the contents of the inteftines, and to remove morbid irritability exifting in that part of the fyftem. But in order to preferve the life of the patient from the moft imminent hazard, it is ftill more neceffary to prevent and remove thofe inflammatory affections which often occur in this difeafe. As the chief danger in colics arifes from an inflammation and confequent mortification of the

the inteſtines, it is eſſentially neceſſary, in the firſt place, to diminiſh the tendency to a pyrexia, if there ſhould happen to be any. This is accompliſhed by bleeding, emollient injections, warm bathing, and cooling medicines taken inwardly. Dr Porter ſtrongly recommends the warm bath in thoſe colics attended with violent evacuations of bile. He ſuppoſes it to do ſervice by relaxing the conſtriction of the inteſtines, and thus preventing or removing the introſuſceptio. In the mean time opiates may be given to eaſe the pain, while every method is tried, by cathartics and glyſters of various kinds to procure a ſtool. In obſtinate caſes, where ſtimulating cathartics have proved ineffectual, the milder kinds, ſuch as manna, ſenna, oleum ricini, &c. will ſometimes ſucceed; but when every thing of this kind fails, recourſe muſt be had to ſome of the more extraordinary methods. Some have recommended the ſwallowing of leaden bullets, on a ſuppoſition that by their weight they would force through the obſtruction; but theſe ſeem much more likely to create than to remove an obſtruction. It is impoſſible they can act by their gravity, becauſe the inteſtines do not lie in a ſtraight line from the pylorus to the anus; and though this were actually the caſe, we cannot ſuppoſe that the weight of a leaden bullet could prove very efficacious in removing either a ſpaſmodic conſtriction or an obſtruction from any other cauſe. But when we conſider not only that the inteſtines conſiſt of a great multitude of folds, but that their periſtaltic motion (by which only the contents are forced through them) is inverted, the futility of this remedy muſt be evident. It might rather be ſuppoſed to aggravate the diſeaſe; as the lead, by its preſſure, would tend to fix the introſuſception more firmly, or perhaps puſh it ſtill farther on. The ſame thing may be ſaid of quickſilver: not to mention the pernicious conſequences to be apprehended from ſwallowing large quantities of this mineral, even if it ſhould prove efficacious in relieving the patient for the preſent. There are, however, ſome late caſes on record, particularly one by Mr William Perry, publiſhed in the ſixteenth volume of the Edinburgh Medical Commentaries, in which the hydrargyrus, ſwallowed in great quantities, was attended with the happieſt effects, after every other remedy had been tried in vain.

Another method has been propoſed, in the Medical Eſſays, for relieving the miſerable patients in this diſorder, which in many caſes has been known to do ſervice. The patient is to be taken out of bed, and made to walk about on the cold floor of a damp apartment. At the ſame time, baſons of cold water are to be daſhed on his feet, legs, and thighs; and this muſt be continued for an hour or longer, if a ſtool be not procured before that time, though this will generally be the caſe much ſooner. The exerciſe does not at all impair the patient's ſtrength, but rather adds to it; and ſome very remarkable inſtances are adduced in the 6th volume of the Medical Eſſays, where this proved effectual after all other medicines had failed. In one perſon the diſeaſe had come on with a habitual coſtiveneſs, and he had been for a week tormented with the moſt violent pain and vomiting, which could be ſtopped neither by anodynes nor any other medicines, the ſharpeſt clyſters being returned unaltered, and all kinds of purgatives thrown up ſoon after they were ſwallowed; but by the

above-mentioned method, a ſtool was procured in 35 minutes, and the patient recovered. In ſome others the coſtiveneſs had continued for a much longer time.—Other remedies are, the blowing air into the inteſtines by means of a bellows, and the injecting clyſters of the ſmoke of tobacco. But neither of theſe ſeem very capable of removing the diſeaſe. They can affect only the parts below the obſtruction; while, to cure the diſeaſe, it is neceſſary that the obſtructed parts themſelves ſhould be reached by the medicine, and therefore we have not many well-atteſted inſtances of their ſucceſs. In ſome obſtinate caſes, however, benefit has certainly been derived from tobacco-ſmoke injections, and likewiſe from injections of tepid water to the extent of ſeveral pounds. For putting in practice theſe modes of cure, a particular apparatus has been contrived; and in caſes even apparently deſperate, neither ſhould be neglected. The cold water gives a general and very conſiderable ſhock to the ſyſtem, checks the perſpiration, and thus drives the humours inward upon the inteſtines, by which they receive a much more effectual ſtimulus than can be ſuppoſed to ariſe from any kind of clyſter. But when all methods have failed, the only chance the patient can have for life is by a manual operation.

In thoſe colics which are attended with faintings, &c. from the beginning, and which generally attack hyſteric women and other debilitated perſons, all kinds of evacuations are pernicious; and the cure is to be attempted by anodynes and cordials, which will ſeldom fail of ſucceſs. Even there alſo, however, it is neceſſary that the belly ſhould be moved; and for this purpoſe injections, containing a ſolution of aſafœtida, which operate powerfully as antiſpaſmodics, are preferable to moſt other modes of cure.

Sp. II. COLICA PICTONUM. *The Colic of Poictou.* 303

Rachialgia Pictonum, *Sauv.* ſp. 1.
Rachialgia metallica, *Sauv.* ſp. 3.
Colica Pictonum *Citeſii.*

Another cauſe to which violent colics are frequently to be aſcribed, and which often gives occaſion to them where it is very little ſuſpected, is lead, or ſome ſolution or fume of it, received into the body. To this cauſe is evidently owing the colics to which plumbers, lead-miners, and ſmelters of lead are ſubject. To the ſame cauſe, though not ſo apparent at firſt ſight, are we to aſcribe the Devonſhire colic, where lead is received into the body diſſolved in cyder, the common drink of the inhabitants of that country. This has been proved by experiment; for lead has been extracted from cyder in quantity ſufficient to produce pernicious effects on the human body. The colic of Poictou, and what is called the *dry belly-ach* in the Weſt Indies, are of the ſame nature: for which reaſon we give the following general deſcription of the ſymptoms of all theſe diſeaſes.

The patient is generally firſt ſeized with an acute pain at the pit of the ſtomach, which extends itſelf down with griping pains to the bowels. Soon after there is a diſtenſion, as with wind; and frequent retchings to vomit, without bringing up any thing but ſmall quantities of bile and phlegm. An obſtinate coſtiveneſs follows, yet ſometimes attended with a teneſmus, and

Spaſmi. and the bowels ſeem to the patient as if they were drawn up towards the back; at other times they are drawn into hard lumps, or hard rolls, which are plainly perceptible to the hand on the belly. Sometimes the coats of the inteſtines ſeem to be drawn up from the anus and down from the pylorus towards the navel. When a ſtool is procured by artificial means, as clyſters, &c. the feces appear in little hard knots like ſheep's dung, called *ſcybala*, and are in ſmall quantity. There is, however, uſually an obſtinate coſtiveneſs; the urine is diſcharged in ſmall quantity, frequently with pain and much difficulty. The pulſe is generally low, though ſometimes a little quickened by the violence of the pain; but inflammatory ſymptoms very ſeldom occur. The extremities are often cold, and ſometimes the violence of the pain cauſes cold clammy ſweats and fainting. The mind is generally much affected, and the ſpirits are ſunk. The diſeaſe is often tedious, eſpecially if improperly treated, inſomuch that the patients will continue in this miſerable ſtate for twenty or thirty days ſucceſſively; nay, inſtances have been known of its continuing for ſix months. In this caſe the pains at laſt become almoſt intolerable: the patient's breath acquires a ſtrong fetid ſmell like excrements, from a retention of the feces, and an abſorption of the putrid effluvia from them by the lacteals. At laſt, when the pain in the bowels begins to abate, a pain comes on in the ſhoulder-joints and adjoining muſcles, with an unuſual ſenſation and tingling along the ſpinal marrow. This ſoon extends itſelf from thence to the nerves of the arms and legs, which become weak; and that weakneſs increaſes till the extreme parts become paralytic, with a total loſs of motion, though a benumbed ſenſation often remains. Sometimes, by a ſudden metaſtaſis, the brain becomes affected, a ſtupor and delirium come on, and the nervous ſyſtem is irritated to ſuch a degree as to produce general convulſions, which are frequently followed by death. At other times, the periſtaltic motion of the inteſtines is inverted, and a true iliac paſſion is produced, which alſo proves fatal in a ſhort time. Sometimes the paralytic affection of the extremities goes off, and the pain of the bowels returns with its former violence; and on the ceſſation of the pain in the inteſtines, the extremities again become paralytic; and thus the pain and palſy will alternate for a very long time.

Cure. Various methods have been attempted for removing this terrible diſeaſe. The obſtinate coſtiveneſs which attends it, made phyſicians at firſt exhibit very ſtrong purgatives and ſtimulating clyſters. But theſe medicines, by increaſing the convulſive ſpaſms of the inteſtines, were found to be pernicious. Balſam of Peru, by its warm aromatic power, was found to ſucceed much better; and Dr Sydenham accordingly preſcribed it in the quantity of 40 drops twice or thrice a-day taken on ſugar. This, with gentle purgatives, opiates, and ſome drops of the hotter eſſential oils, continued to be the medicine commonly employed in this diſeaſe, till a ſpecific was publiſhed by Dr Lionel Chalmers of South Carolina. This receipt was purchaſed by Dr Chalmers from a family where it had long been kept a ſecret. The only unuſual medicine in this receipt, and on which the efficacy of it chiefly if not wholly depends, is ſulphate of copper. Colica. This muſt be diſſolved in water, in the quantity of one grain to an ounce, and the doſe of the ſolution is a wine-glaſsful given faſting for nine ſucceſſive mornings. For the firſt four or five days this medicine diſcharges much æruginous bile both ways; but the excretions of this humour leſſen by degrees; and before the courſe be ended, it has little other effect than to cauſe ſome degree of ſqueamiſhneſs, or promote a few bilious ſtools, or perhaps may not move the patient at all. At the time of uſing this medicine the patients ſhould live upon broth made of lean meat, gruel, or panada: but about the ſeventh or eighth day, they may be allowed bread and boiled chicken. Here the copper ſeems to do ſervice by its tonic power; and for the ſame reaſon, alum, recommended by Dr Percival, moſt probably cures the diſeaſe. He ſays he has found this very efficacious in obſtinate affections of the bowels, and that it generally proves a cure in the ſlighter caſes of the colica pictonum. It was given to the quantity of fifteen grains every fourth, fifth, or ſixth hour; and the third doſe ſeldom failed to mitigate the pain, and ſometimes entirely removed it. Among purgative medicines the *oleum ricini* is found to be the moſt efficacious. Mercury alſo, particularly under the form of calomel, has often been employed with ſucceſs. And much benefit has been derived from combining the calomel with opium. From this combination there is often obtained, in the firſt inſtance, an alleviation of the pain, and afterwards a free diſcharge by the belly.

Sp. III. The Colic from *Coſtiveneſs*. 304

Colica ſtercorea, *Sauv.* ſp. 3.
Ileus à fæcibus induratis, *Sauv.* ſp. 2.

For the treatment of this ſpecies, ſee above.

Sp. IV. The *Accidental* Colic.

Colica Japonica,—accidentalis,—lactentium,—à veneno, *Sauv.* ſp. 10. 14. 18. 20.
Cholera ſicca auriginoſa, à fungis venenatis, *ejuſd.* ſp. 2.

When colics ariſe from acrid poiſonous matter taken into the ſtomach, the only cure is either to evacuate the poiſon itſelf by vomiting, or to ſwallow ſome other ſubſtance which may decompound it, and thus render it inactive. The moſt common and dangerous ſubſtances of this kind are corroſive mercury and arſenic. The former is eaſily decompounded by alkaline ſalts; and therefore a ſolution of lixivial ſalt, if ſwallowed before the poiſon has time to induce a mortification of the bowels, will prove a certain cure. Much more uncertain, however, is the caſe when arſenic is ſwallowed, becauſe there is no certain and ſpeedy ſolvent of that ſubſtance yet known. Milk has been recommended as efficacious; and lately a ſolution of *hepar ſulphuris*. The latter may poſſibly do ſervice; as arſenic unites readily with ſulphur, and has its pernicious qualities more obtunded by that than by any other known ſubſtance: but indeed, even the ſolvent powers of this medicine are ſo weak, that its effects as well as thoſe of others muſt be very uncertain.

Some kinds of fungi, when ſwallowed, are apt to produce colics attended with ſtupor, delirium, and convulſions; and the ſame ſometimes happens from eating a large

Spasmi.

large quantity of the shell-fish known by the name of muscles (the MYTILUS). Some of the fungi, doubtless, may have an inherent poisonous quality; but generally they as well as the muscles act on a different principle. Their pernicious effects happen most commonly when they are taken on an empty stomach; and are then supposed to be occasioned by their adhering so close to its coats, that it cannot exert its powers, and the whole system is thrown into the utmost disorder. The malady may therefore be very easily prevented; but when once it has taken place, it cannot be removed till either vomiting be excited, or the stomach has recovered itself in such a manner as to throw off the adhering matter.

305 Sp. V. COLIC of *New-born Infants* from a *Retention* of the *Meconium*. (*Sauv.* sp. 19.).

This disorder would be prevented were children allowed immediately to suck their mothers, whose milk at first is purgative. But as this is not commonly done, the child is frequently troubled with colics. These, however, may be removed by a few grains of ipecacuanha, or a drop or two of antimonial wine. By these means the stomach is cleansed by vomiting, and the belly is generally loosened; but if this last effect does not happen, some gentle purge will be necessary.

306 Sp. VI. COLIC from a *Callosity* of the *Colon*.

It is often impossible to discover this distemper before the patient's death; and though it should, it does not admit of a cure.

307 Sp. VII. The COLIC from *Intestinal Calculi*. (*Sauv.* sp. 10. 15.).

When certain indigestible bodies, such as cherry-stones, plum-stones, small pieces of bones, &c. are swallowed, they frequently prove the basis of calculi, formed by an accretion of some kind of earthy matter; and being detained in some of the flexures of the intestines, often occasion very violent colics. These calculi do not discover themselves by any peculiar symptoms, nor do they admit of any particular method of cure. In the Medical Essays we have an instance of colics for six years, occasioned by calculi of this kind. The concretions were at last passed by stool; and their passage was procured by causing the patient drink a large quantity of warm water, with a view to promote the evacuation of bile, a redundancy of which was supposed to be the cause of her disorder.

308 GENUS LX. CHOLERA, the CHOLERA MORBUS.

Cholera, *Sauv.* 253. *Lin.* 186. *Vog.* 110. *Sag.* 188. *Hoffm.* II. 165.
Diarrhœa cholerica, *Junck.* 112.

309 Sp. I. The *Spontaneous CHOLERA*, coming on without any manifest cause.

Cholera spontanea, *Sauv.* sp. 1. *Sydenh.* sect. iv. cap. 2.
Cholera Indica, *Sauv.* sp. 7.

Cholera.

Sp. II. The *Accidental CHOLERA*, from acrid matter taken inwardly. 310

Cholera crapulosa, *Sauv.* sp. 11.
Cholera à venenis, *Sauv.* sp. 4, 5.

The cholera shows itself by excessive vomiting and purging of bilious matters, with violent pain, inflation and distension of the belly. Sometimes the patients fall into universal convulsions; and sometimes they are affected with violent spasms in particular parts of the body. There is a great thirst, a small and unequal pulse, cold sweats, fainting, coldness of the extremities, and hiccough; and death frequently ensues in twenty-four hours.

In this disease, as a great quantity of bile is deposited in the alimentary canal, particularly in the stomach, the first object is to counteract its influence, and to promote an easy discharge of it. It is next necessary to restrain that increased secretion of bile, by which a fresh deposition in the alimentary canal would otherwise be soon produced. And, in the last place, measures must often be employed to restore a sound condition to the alimentary canal, which is frequently much weakened by the violence of the disease.

On these grounds, the cure of this distemper is effected by giving the patient a large quantity of warm water, or very weak broth, in order to cleanse the stomach of the irritating matter which occasions the disease, and injecting the same by way of clyster, till the pains begin to abate a little. After this, a large dose of laudanum is to be given in some convenient vehicle, and repeated as there is occasion. But if the vomiting and purging have continued for a long time before the physician be called, immediate recourse must be had to the laudanum, because the patient will be too much exhausted to bear any further evacuations. Sometimes the propensity to vomit is so strong, that nothing will be retained, and the laudanum itself thrown up as soon as swallowed. To settle the stomach in these cases, Dr Douglas, in the Medical Essays, recommends a decoction of oat-bread toasted as brown as coffee; and the decoction itself ought to be of the colour of weak coffee. He says he does not remember that this decoction was ever vomited by any of his patients. An infusion of mint-leaves or good simple mint-water is also said to be very efficacious in the same case.

The tincture of opium is sometimes retained when given in conjunction with a portion of the sulphuric acid properly diluted. But when it cannot be retained in a fluid form by the aid of any addition, it will sometimes sit upon the stomach when taken in a solid state.

After the violence of the disease is overcome, the alimentary canal, and the stomach in particular, requires to be braced and strengthened. With this view recourse is often had with advantage to different vegetable bitters, particularly to the use of the colombo root; which, while it strengthens the stomach, is also observed to have a remarkable tendency in allaying a disposition to vomiting, which often remains for a considerable time after the cholera may be said to be overcome.

GENUS

311 Genus LXI. DIARRHOEA.

Looseness.

Diarrhœa, *Sauv.* gen. 253. *Lin.* 187. *Vog.* 105. *Sag.* gen. 189. *Junck.* 112.
Hepatirrhœa, *Sauv.* gen. 246.
Cholerica, *Lin.* 190.
Cœliaca, *Sauv.* gen. 255. *Lin.* 189. *Vog.* 109. *Sag.* gen. 199.
Lienteria, *Sauv.* gen. 256. *Lin.* 188. *Sag.* gen. 191. *Vog.* 108.
Pituitaria, et leucorrhois, *Vog.* 111. 112.

312 Sp. I. The *Feculent DIARRHOEA.*

Diarrhœa stercorosa et vulgaris, *Sauv.* sp. 1. 2.

This is occasioned by too great a quantity of matter thrown into the alimentary canal; and what is discharged has not the appearance of excrements, but is much whiter, and of a thinner consistence. Voracious people who do not sufficiently chew their food, gormandizers, and even those who stammer in their speech, are said to be liable to this disease. In slighter cases it is removed without any medicine, or by a dose of rhubarb; but where the matters have acquired a putrid taint, the disorder may be much protracted and become dangerous. In this case lenient and antiseptic purgatives are to be made use of, after which the cure is to be completed by astringents.

313 Sp. II. *Bilious DIARRHOEA.*

(*Sauv.* sp. 8.).

This distemper shows itself by copious stools of a very yellow colour, attended with gripes and heat of the bowels, thirst, bitterness, and dryness of the mouth, yellowness of the tongue, and frequently follows an intermitting or bilious fever. When the fever is gone, the diarrhœa is to be removed by acidulated and cooling drinks, with small doses of nitre.

314 Sp. III. The *Mucous DIARRHOEA.*

Diarrhœa lactentium, *Sauv.* sp. 19.
Dysenteria Parisiaca, *Sauv.* sp. 3.
Diarrhœa ab hypercatharsi, *Sauv.* sp. 16.
Dysenteria à catharticis, *Sauv.* sp. 12.
Pituitaria, *Vog.* 111.
Leucorrhois, *Vog.* 112.
Diarrhœa pituitosa, *Sauv.* sp. 4.
Cœliaca mucosa, *Sauv.* sp. 3.
Diarrhœa serosa, *Sauv.* sp. 10.
a. Diarrhœa urinosa.

This kind of diarrhœa, besides the matters usually excreted, is attended with a copious dejection of the mucus of the intestines with great pain; while the patient daily pines away, but without any fever.—Persons of all ages are liable to it, and it comes on usually in the winter-time; but is so obstinate, that it will sometimes continue for years. In obstinate loosenesses of this kind, vomits frequently repeated are of the greatest service. It is also very beneficial to keep the body warm, and rub the belly with stimulating ointments; at the same time that astringent clysters, rhubarb, and stomachic medicines, are to be exhibited. Starch clysters are very often efficacious.—Some kinds of looseness are contagious; and Sir John Pringle mentions a soldier who laboured under an obstinate diarrhœa, who infected all those that used the same privy with himself. In the looseness which frequently followed a dysentery, the same author tells us that he began the cure with giving a vomit of ipecacuanha, after which he put the patients on a course of astringents. He used a mixture of three drachms of extract of logwood, dissolved in an ounce and a half of spirit of cinnamon, to which was added seven ounces of common water, and two drachms of tincture of catechu. Of this the patient took two spoonfuls once in four or five hours, and sometimes also an opiate at bed-time. He recommends the same medicine in obstinate diarrhœas of all kinds. A decoction of simarauba bark was also found effectual, when the dysenteric symptoms had gone off. Dr Huck, who used this article in North America, also recommends it in diarrhœas. Two or three ounces of the simarauba are to be boiled in a pound and a half of water to a pound, and the whole quantity taken throughout the day. He began with the weakest decoction; and, when the stomach of the patient could easily bear it, he then ordered the strongest: but at the same time he acknowledges, that, unless the sick found themselves sensibly better within three days from the time they began the medicine, they seldom afterwards received any benefit from it. But when all astringents have failed, Sir John Pringle informs us, he hath known a cure effected by a milk and farinaceous diet; and he thinks in all cases the disorder would be much more easily removed, if the patients could be prevailed on to abstain entirely from spirituous liquors and animal food. If the milk by itself should turn sour on the stomach, a third part of lime-water may be added. In one case he found a patient receive more benefit from good butter-milk than from sweet-milk. The chief drinks are decoctions of barley, rice, calcined hartshorn, toast and water, or milk and water.

Sp. IV. The *COELIAC PASSION.* 315

Cœlica chylosa, *Sauv.* sp. 1.
Cœlica lactea, *Sauv.* sp. 4.

There are very great differences among physicians concerning the nature of this disease. Sauvages says, from Aretæus, it is a chronic flux, in which the aliment is discharged half digested. It is attended with great pains of the stomach, resembling the prickling of pins; rumbling and flatus in the intestines; white stools, because deprived of bile, while the patient becomes weak and lean. The disease is tedious, periodical, and difficult to be cured. Sauvages adds, that none of the moderns seem to have observed the disease properly; that the excrements indeed are white, on account of a deficiency of the bile, but the belly is bound as in the jaundice. Dr Cullen says there is a dejection of a milky liquid of the nature of chyle; but this is treated by Vogel as a vulgar error. He accuses the moderns of copying from Aretæus, who mentions white fæces as a symptom of the distemper; from whence authors have readily fallen into the notion that they never appeared of any other colour in persons

persons labouring under the cœliac passion. This error quickly produced another, which has been very generally received; namely, that the chyle was thrown out of the lacteals by reason of some obstruction there, and thus passed along with the excrements; of which he says there is not the least proof, and agrees with Aretæus that the whiteness is only occasioned by the want of bile. He endeavours to prove at length, that the cœliac passion can neither be occasioned by an obstruction of the lacteals, nor of the mesenteric glands; though he owns that such as have died of this disease and were dissected, had obstructions in the mesenteric glands; but he denies that all those in whom such obstructions occur, are subject to the cœliac passion. He considers the distemper as arising from a cachexy of the stomachic and intestinal juices; and directs the cure to be attempted by emetics, purgatives, antiseptics, and tonics, as in other species of diarrhœa.

316 Sp. V. The LIENTERY.

Lienteria spontanea, *Sauv.* sp. 2.

The lientery, according to Sauvages, differs from the cœliac passion only in being a slighter species of the disease. The aliment passes very quickly through the intestines, with scarce any alteration. The patients do not complain of pain, but are sometimes affected with an intolerable hunger. The cure is to be attempted by stomachics and tonics, especially the Peruvian bark. This disease is most common at the earlier periods of life; and then rhubarb in small quantities, particularly when combined with magnesia, is often productive of the best effects.

317 Sp. VI. The *Hepatic FLUX.*

Hepatirrhœa intestinalis, *Sauv.* sp. 2.

The hepatic diarrhœa is by Sauvages described as a flux of bloody serous matter like the washings of flesh, which percolates through the coats of the intestines by means of the anastomosing vessels. It is the cœliac passion of Trallianus; and which, according to Sauvages, rarely, if ever, occurs as a primary disease. It has, however, been observed to follow an inflammation of the liver, and then almost always proves fatal.

318 GENUS LXII. DIABETES.

A profuse Discharge of URINE.

Diabetes, *Sauv.* gen. 263. *Lin.* 197. *Vog.* 115. *Sag.* gen. 199. *Junck.* 99. *Dobson*, Med. Observat. vol. v. p. 298. *Home's* Clinical Experiments, sect. xvi.
Diuresis, *Vog.* 114.

319 Sp. I. The DIABETES with *sweet Urine.*

Diabetes Anglicus, *Sauv.* sp. 2. *Mead* on Poisons, Essay I. Ejusdem Monita Med. cap. ix. sect. 2. *Dobson* in Lond. Med. Observ. vol. v. art. 27. *Myers* Diss. inaug. de Diabete, Edinb. 1779.
Diabetes febricosus, *Sauv.* sp. 7. *Sydenh.* Ep. resp. ad R. Brady.

Sp. II. DIABETES with *insipid Urine.* 320

M. Lister Exerc. Medicin. II. de Diabete.
Diabetes legitimus, *Sauv.* sp. 1. *Aretæus* de Morb. diuturn. lib. ii. cap. 2.
Diabetes ex vino, *Sauv.* sp. 5. *Ephem. Germ.* D. I. A. II. Observ. 122.

Description. The diabetes first shows itself by a dryness of the mouth and thirst, white frothy spittle, and the urine in somewhat larger quantity than usual. A heat begins to be perceived in the bowels, which at first is a little pungent, and gradually increases. The thirst continues to augment by degrees, and the patient gradually loses the power of retaining his urine for any length of time. It is remarkable, that though the patients drink much, the quantity of urine always exceeds what is drank. In Dr Home's Clinical Experiments we have an account of two patients labouring under this disease: one of them drank between 10 and 12 English pints a-day without being satisfied. The quantity was greater in the forenoon than in the afternoon. In the other the case was reversed. He drank about four pints a-day, and more in the afternoon than the forenoon. The former discharged from 12 to 15 pints of urine in the day: the latter, 11 or 12; so that his urine always exceeded his drink by eight or at least seven pints. When the urine is retained a little while, there is a swelling of the loins, feet, and scrotum; in this disease the strength gradually decays; the skin is dry and shrivelled; œdematous swellings arise in various parts of the body, but afterwards subside without relieving the disease in the least; and the patient is frequently carried off by convulsions.

The most singular phenomenon in this disease is, that the urine seems to be entirely or very much divested of an animal nature, and to be largely impregnated with a saccharine matter scarce distinguishable from that obtained from the sugar-cane. This discovery was first made by Dr Dobson of Liverpool, who made some experiments on the urine of a person labouring under a diabetes, who discharged 28 pints of urine every day, taking during the same time from 12 to 14 pounds of solid and liquid food. Some of this urine being set aside, fell into a spontaneous effervescence, changed first into a vinous liquor, and afterwards into an acetous one, before it became putrid and offensive. Eight ounces of blood taken from the same patient, separated into crassamentum and serum; the latter being sweet to the taste, but less so than the urine. Two quarts of the urine, evaporated to dryness, left a white cake weighing four ounces two drams and two scruples. This cake was granulated, and broke easily between the fingers: it smelled sweet like brown sugar; neither could it by the taste be distinguished from sugar, except that it left a slight sense of coolness on the tongue. The experiment was repeated after the patient was recovered to such a degree as to pass only 14 pints of urine a-day. There was now a strong urinous smell during the evaporation; and the residuum could not be procured in a solid form, but was blackish, and much resembled very thick treacle. In Dr Home's patients, the serum of the blood had no preternatural sweetness; in one of them the crassamentum was

Spasmi. was covered with a thick inflammatory crust. In one of these patients the urine yielded an ounce and a half, and in the other an ounce, of saccharine matter from each pound. It had, however, an urinous smell, and a saline taste mixed with the sweet one; and the urine of one fermented with yeast, we are told, into "tolerable small-beer." Both these patients had a voracious appetite, and perpetual gnawing sense of hunger; as had also Dr Dobson's patient. The insipid urine of those affected with diabetes has not been examined by physicians with sufficient accuracy to enable us to speak with confidence of its contents.

Causes. These are exceedingly obscure and uncertain; spasms of the nervous system, debility, and every thing inducing it, but especially strong diuretics and immoderate venery, have been accused of bringing on the diabetes. It has, however, occurred in persons where none of these causes could be suspected; nor have the best physicians been able to determine it.—Dissections have only shown that the kidneys were in an enlarged and lax state. In one of Dr Home's patients who died, they smelled sour; which showed that the urine peculiar to diabetes came from the kidneys, and was not sent directly from the intestines by a retrograde motion of the lymphatics, as some imagine.

Prognosis. The diabetes is rarely cured, unless when taken at the very beginning, which is seldom done; and in a confirmed diabetes the prognosis must therefore be unfavourable.

Cure. As there is reason to believe that in this affection the morbid secretion of urine, which is both preternatural in point of quantity and of quality, arises from a morbid diminution of tone in the kidney, the great object in the cure must be the restoration of due tone to the secreting vessels of the kidney. But as even this diminished tone would not give rise to the peculiar vitiated secretion without a morbid sensibility of that organ, it is necessarily a second object to remove this morbid sensibility. But besides this, the morbid secretion of urine may also be counteracted both by a diminution of the determination of fluids to the kidney, and by preventing the occurrence of superfluous water in the general mass of blood.

On these grounds the principal hopes of a cure in this distemper are from astringent and strengthening medicines. Dr Dobson's patient was relieved by the following remedies; which, however, were frequently varied, as none of them produced their good effects for any length of time: Cinchona in substance, with small doses of rhubarb; decoction of the bark, with the acid elixir of vitriol; the cold infusion of the bark, of which he drank from a quart to two quarts daily; Dover's powder; alum-whey; lime-water; antimonials combined with *tinctura thebaica.* The warm bath was used occasionally when the skin was remarkably hot and dry, and the patient complained of restlessness and anxiety. The tincture of cantharides was likewise tried; but he could never take more than 25 drops for a dose, without exciting great uneasiness in his bowels. The body was kept constantly open, either with rhubarb or the infusion of senna joined with rhubarb. His common drinks were rice-water, barley-water, lime-water, and milk; lime-water alone; sage, balm, or mint tea; small-beer, simple water, and water acidulated with the sulphuric acid. In seven months, these remedies, in whatever manner varied, made no further progress in removing the disease. In Dr Home's patients, all these medicines, and many others, were tried without the least good effect; insomuch that he uses this remarkable expression: "Thus, these two patients have exhausted all that experience had ever recommended, and almost all that theory could suggest; yet in both cases, the disease has resisted all the means of cure used." It is remarkable, that though septics were given to both, in such quantity as evidently to produce a putrescency in the *primæ viæ*, the urine remained unaltered both in quantity and quality. Diabetes.

But although this disease be frequently in its nature so obstinate as to resist every mode of cure, yet there can be no doubt that particular remedies have succeeded in different cases. Dr Brisbane relates several cases cured by the use of tincture of cantharides: and Dr M'Cormick has related some in the 9th volume of the Edinburgh Medical Commentaries, which yielded to Dover's powder after a variety of other remedies had been tried in vain.

But of all the modes of cure lately proposed, that which has been most celebrated, is the treatment recommended by Dr Rollo of the Royal Artillery. In a valuable work lately published, entitled *Cases of the Diabetes Mellitus*, he has recorded two remarkable examples of the good effects of a peculiar regimen in this disease. He considers diabetes as being a disease not of the kidney but of the alimentary canal, and as arising from the formation of an uncommon quantity of sugar. He therefore strictly forbids the use of every article of diet which can furnish sugar, even of bread; and by a diet consisting entirely of animal and alkalescent food his patients were much benefited. The experience of some other practitioners has to a certain degree confirmed the observations of Dr Rollo. But we are sorry to add, that we have met with many other instances of diabetes mellitus, in which a diet consisting solely of animal food, had a fair trial, without producing any material benefit. And we may conclude with observing, that the cure of diabetes still remains to be discovered. As allaying the excessive thirst, and producing a temporary restoration of urinous smell, or the urea which it ought naturally to contain, we have found nothing equal in efficacy to a large proportion of fat meat, such as pork steaks or butter.

Genus LXIII. HYSTERIA. 321

Hysterics.

Hysteria, *Sauv.* gen. 135. *Lin.* 126. *Vog.* 219. *Sag.* gen. 242.
Malum hystericum, *Hoffm.* III. 50. *Junck.* 36.
Affectio hysterica, *Willis* de Morb. Convulsiv. cap. 5. 10. 11. *Sydenham* Diss. Epist. ad G. Cole, *Whytt* on Nervous Disorders.

Description. The hysteria is a convulsive disease, which comes on at uncertain intervals, sometimes longer and sometimes shorter, but at no stated time. The paroxysms commonly begin with a languor and debility of the whole body; yawning, stretching, and restlessness. A sense of coldness also in the extremities, almost always precedes, and for the most part remains during the whole time of, the paroxysm. To this some-times

Spasmi. times succeeds a sense of heat; and the two sensations alternate with each other in different parts of the body. The face is sometimes flushed and sometimes pale: and sometimes the paleness and flushing come alternately. There is a violent pain in the head; the eyes become dim, and pour out tears; there is a rumbling and inflation of the intestines; a sensation is felt like that of a globe ascending from the lower part of the abdomen or hypogastrium, which sometimes seems to roll along the whole alimentary canal. It ascends to the stomach, sometimes suddenly, sometimes slowly; and there produces a sense of inflation and weight, together with anxiety, nausea, and vomiting. At last it comes up to the throat, where it produces a sense of suffocation, and difficulty of breathing or swallowing. During this time there are the most violent pains both in the external and internal parts of the abdomen; the muscles are convulsed; the umbilicus is drawn inwards; and there are frequently such spasms of the intestines, that neither clysters can be injected, nor even flatus pass downwards. Sometimes the paroxysm remits after these symptoms have continued for a certain time, but more frequently the patients fall into fainting fits; sometimes they lie without motion, as if they were in a deep sleep; sometimes they beat their breasts violently and continually with their hands, and sometimes they are seized with general convulsions, and the disease puts on the appearance of an epilepsy. In some patients the extremities become cold and stiff, and the body has the appearance of one in a catalepsy. Sometimes a most violent beating pain takes place in some part of the head, as if a nail was driven into it, and all visible objects seem to turn round; grievous pains attack the loins, back, and bladder, and the patients discharge a surprising quantity of urine as limpid as water; which last is one of the surest signs of the disease. The mind is very much affected as well as the body. Sometimes the patients are tormented with vain fears: sometimes they will laugh, at other times cry immoderately; and sometimes their temper becomes so peevish and fretful, that they cannot enjoy a moment's quiet. The appearances which take place in this affection are indeed so much varied, that they can hardly be enumerated: they may, however, with propriety, be divided into hysteric fits, which very much resemble those of epilepsy, excepting that they are not attended with an abolition of the internal senses; and hysteric symptoms, such as the *globus hystericus*, *clavus hystericus*, and the like, which are chiefly known to constitute a part of this disease from being observed to alternate with fits.

Causes, &c. The general cause of hysteria is thought by the best physicians to consist in a too great mobility and irritability of the nervous system, and of consequence the disease may be brought on by whatever debilitates and renders the body irritable. Hence it most frequently attacks females of a weak and lax habit of body, though there are some instances of men also attacked by it. It generally comes on between the time of puberty and the age of 35, and makes its attacks during the time of menstruation more frequently than at any other. It also more frequently seizes barren women and young widows, than such as are bearing children.

Prognosis. Though the appearance of this disease be so very terrible, it seldom proves mortal unless by wrong treatment: but notwithstanding this, it is extremely difficult of cure, and rarely admits of any thing else than being palliated; for though it should seem to be conquered by medicine for a time, it very quickly returns, and that from the slightest causes. Hysteria.

Cure. The ends principally to be aimed at in the cure of this disease are, in the first place, the removal of particular convulsive or spasmodic affections immediately producing various appearances in the disease, whether under the form of proper hysteric fits, or merely of what may be called hysteric symptoms; and in the second place, the prevention of the return of symptoms after they have been removed, by the employment of proper remedies during those intervals from complaints which patients often have when labouring under this affection.

The most powerful remedy hitherto discovered in hysteric cases is opium, or the tincture of it. By this commonly the most violent paroxysms are stopped, though it be insufficient to accomplish a radical cure. In Dr Home's Clinical Experiments we find an instance of a cure performed by venesection, though this remedy has been generally condemned in hysterical cases. Asafœtida seems to stand next in virtue to opium; though with some it disagrees, and occasions pains in the stomach and vomiting. Sulphuric æther will also frequently remove an hysteric fit: but its effects are of short duration; and if it do not effect a cure soon after its exhibition, no service is to be expected either by perseverance in the use of it or by increasing the dose; and with some constitutions it disagrees to such a degree as to occasion convulsions. If the patient be seized with a violent fit, so that she can swallow nothing, which is frequently the case, it will be proper to apply some strong volatile alkali to her nose; or if that be not at hand, the vapour of burning feathers is sometimes very efficacious. In some instances benefit is derived from the sudden application of cold water to the face or hands; but still more frequently the application of water in a tepid state, particularly the warm pediluvium, is found to be of very great service in bringing about a favourable termination of different violent hysteric symptoms. A plaster of galbanum and asafœtida will also prove serviceable: but it must be remembered, that none of these things will prevent the return of the disease; and therefore a radical cure is to be attempted by exercise, cinchona, chalybeates, mineral waters, and other tonics; but particularly, where the state of the patient is such as to be able to bear it, by the use of the cold bath, which, where it does not disagree with the constitution, is often of the greatest service in preventing returns of this affection.

In hysteria as well as in chorea Dr Hamilton has found, that in some instances very great benefit has been obtained from copious evacuations of the alimentary canal, by cathartics frequently repeated.

Genus LXIV. HYDROPHOBIA. 322

The *Dread* of Water.

Hydrophobia, *Sauv.* gen. 231. *Lin.* 86. *Vog.* 30. *Sag.* gen. 343. *Boerh.* 1138. *Junck.* 124. *Mead* on Poisons. *Dessault* sur la rage. *Sauv.* diss. sur la

Spafmi.

la rage. *James* on canine madnefs. *Dalby*, Virtues of cinnabar and mufk againft the bite of a mad dog. *Nugent* on the hydrophobia. *Choifel*, Nouvelle methode pour le traitement de la rage. *Journal de Medicine*, paffim. *Medical Obf. and Inquiries*, vol. iii. art. 34. vol. v. art. 20. 26. and App. *Med. Tranfact.* vol. ii. art. 5. 12. and 15. *Heyfham*, Diff. inaug. de rab. canin. Edinb. 1777. *Parry*, Diff. inaug. de rab. contagiof. five canin. Edinb. 1778. *Andry*, Recherches fur la rage, 1778. *Vaughan*, Cafes of hydrophobia, fecond edit. 1778. *Arnold*, Cafe of hydrophobia, 1795.

323 Sp. I. *HYDROPHOBIA Rabiofa*, or Hydrophoby confequent on the *Bite* of a *Mad Animal*.

Hydrophobia vulgaris, *Sauv.* fp. 1.

It is the opinion of fome, that Dr Cullen has done wrong in employing the term *hydrophobia* as a generic name, under which canine madnefs is included: and it muft be allowed, that the dread of water, while it is not univerfal, is alfo a fymptom occurring only late in the difeafe, at leaft in the greater part of cafes. Perhaps his arrangement would have been lefs exceptionable, if, following Linnæus, he had adopted *rabies* as a generic term, and had diftinguifhed this particular fpecies by the epithet of *canina*, *contagiofa*, or the like. Difputes, however, about names, are in general not very important; and it is fufficient to obferve, that the affection now to be treated of is canine madnefs, or that difeafe which arifes from the bite of a mad animal.

Defcription. This difeafe commonly does not make its attack till a confiderable time after the bite. In fome few inftances it has commenced in feven or eight days from the accident; but generally the patient continues in health for 20, 30, or 40 days, or even much longer. The bite, if not prevented, will in general be healed long before that time, frequently with the greateft eafe; though fometimes it refifts all kinds of healing applications, and forms a running ulcer which difcharges a quantity of matter for many days. It has been faid, that the nearer the wounded place is to the falivary glands, the fooner the fymptoms of hydrophobia appear. The approach of the difeafe is known by the cicatrix of the wound becoming high, hard, and elevated, and by a peculiar fenfe of prickling at the part; pains fhoot from it towards the throat: fometimes it is furrounded with livid or red ftreaks, and feems to be in a ftate of inflammation; though frequently there is nothing remarkable to be obferved about it. The patient becomes melancholy, loves folitude, and has ficknefs at ftomach. Sometimes the peculiar fymptom of the difeafe, *the dread of water*, comes on all at once. We have an inftance of one who, having taken a vomit of ipecacuanha for the ficknefs he felt at his ftomach, was feized with the hydrophobia in the time he was drinking the warm water. Sometimes the difeafe begins like a common fore throat; and the forenefs daily increafing, the hydrophobic fymptoms fhow themfelves like a convulfive fpafm of the mufcles of the fauces. In others, the mind feems to be primarily affected, and they are fubject to defpondency and melancholy for fome time prior to any dread of water. And when that dread commences, it is with an evident mental affection. Dr James, in his Treatife on Canine Madnefs, mentions a boy fent out to fill two bottles with water, who was fo terrified by the noife of the liquid running into them, that he fled into the houfe crying out that he was bewitched. He mentions alfo the cafe of a farmer, who, going to draw fome ale from a cafk, was terrified to fuch a degree at its running into the veffel, that he ran out in a great hafte with the fpigot in his hand. But in whatever manner this fymptom comes on, it is certain that the moft painful fenfations accompany every attempt to fwallow liquids. Nay, the bare fight of water, of a looking-glafs, of any thing clear or pellucid, will give the utmoft uneafinefs, or even throws the patient into convulfions.

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With regard to the affection of the mind itfelf in this difeafe, it does not appear that the patients are deprived of reafon. Some have, merely by the dint of refolution, conquered the dread of water, though they never could conquer the convulfive motions which the contact of liquids occafioned: while this refolution has been of no avail; for the convulfions and other fymptoms increafing, have almoft always deftroyed the unhappy patients.

In this difeafe there feems to be an extreme fenfibility and irritability of the nervous fyftem. The eyes cannot bear the light, or the fight of any thing white; the leaft touch or motion offends them, and they want to be kept as quiet and in as dark a place as poffible. Some complain of the coldnefs of the air, frequently when it is really warm. Others complain of violent heat; and have a great defire for cold air, which yet never fails to increafe the fymptoms. In all there is a great flow of vifcid faliva into the mouth; which is exceedingly troublefome to the patients, as it has the fame effect upon their fauces that other liquids have. This therefore they perpetually blow off with violence, which in a patient of Dr Fothergill's occafioned a noife not unlike the hollow barking of a dog, and which he conjectures might have given rife to the common notion that hydrophobous patients bark like dogs. They have an infatiable thirft; but are unable to get down any drink, except with the utmoft difficulty; though fometimes they can fwallow bread foaked in liquids, flices of oranges, or other fruits. There is a pain under the *fcrobiculus cordis*, as in the tetanus; and the patients mournfully point to that place as the feat of the difeafe. Dr Vaughan is of opinion that it is this pain, rather than any difficulty in fwallowing, which diftreffes the patient on every attempt to drink. The voice is commonly plaintive and mournful; but Dr Vaughan tells us there is a mixture of fiercenefs and timidity in the countenance which he cannot defcribe, but by which he could know a hydrophobous perfon without afking any queftions.

In this diftemper, indeed, the fymptoms are fo various, that they cannot be enumerated; for we will feldom read two cafes of hydrophobia which do not differ very remarkably in this refpect. Some feem to have at times a furious delirium, and an inclination to fpit at or bite the byftanders; while others fhow no fuch inclination, but will even fuffer people to wipe the infide of their mouths with the corner of a handkerchief in order to clear away the vifcid faliva which is

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is ready to suffocate them. In some male patients there is an involuntary erection of the penis, and emission of the semen; and the urine is forced away by the frequent return of the spasms. In a letter from Dr Wolf of Warsaw to Henry Baker, F. R. S. dated Warsaw Sept. 26th, 1767, we have the following melancholy account of the cases of five persons who died of the hydrophobia: "None of them quite lost their right senses; but they were all talking without intermission, praying, lamenting, despairing, cursing, sighing, spitting a frothy saliva, screeching, sometimes belching, retching, but rarely vomiting. Every member is convulsed by fits, but most violently from the navel up to the breast and œsophagus. The fit comes on every quarter of an hour; the fauces are not red, nor the tongue dry. The pulse is not at all feverish; and when the fit is over nearly like a sound pulse. The face grows pale, then brown, and during the fit almost black; the lips livid; the head is drowsy, and the ears tingling; the urine limpid. At last they grow weary; the fits are less violent, and cease towards the end; the pulse becomes weak, intermittent, and not very quick; they sweat, and at last the whole body becomes cold. They compose themselves quietly as if to get sleep, and so they expire. The blood drawn a few hours before death appears good in every respect. A general observation was, that the lint and dressings of the wounds, even when dry, were always black, and that when the pus was very good in colour and appearance." In one of Dr Wolf's patients who recovered, the blood stunk intolerably as it was drawn from a vein; and one of Mr Vaughan's patients complained of an intolerable fetid smell proceeding from the wounded part, though nobody but himself could perceive it. In general, the violent convulsions cease a short time before death; and even the hydrophobia goes off, so that the patients can drink freely. But this does not always happen; for Mr Vaughan mentions the case of a patient, in whom, "when he had in appearance ceased to breathe, the spasmus cynicus was observable, with an odd convulsive motion in the muscles of the face; and the strange contrariety which took place in the action of these produced the most horrid assemblage of features that can well be conceived. Of this patient also it was remarkable, that in the last hours of his life he ceased to call for drink, which had been his constant request; but was perpetually asking for something to eat."

The hydrophobia seems to be a symptom peculiar to the human race; for the mad animals which communicate the infection, do not seem to have any dread of water. Dr Wolf, in the letter above quoted, says in general, that cattle bit at the same time and by the same animal (a mad wolf) which bit the persons whoses cases he related, died nearly with the same frightful raging as the men; but says nothing of their having any hydrophobia: nay, Dr James and some others assert, that the hydrophobia is not always an attendant on rabies canina in the human race; and indeed it is certain that the disease has proved mortal after this terrible symptom has been removed. With regard to the symptoms of madness in dogs, they are very equivocal; and those particularly enumerated by some authors, are only such as might be expected in dogs much heated or agitated by being violently pursued and struck. One symptom indeed, if it could be depended upon, would determine the matter; namely, that all other dogs avoid and run away from one that is mad; and even large dogs will not attack one of the smallest size who is infected with this disease. Upon this supposition they point out a method of discovering whether a dog who has been killed was really mad or not; namely, by rubbing a piece of meat along the inside of his mouth, and then offering it to a sound dog. If the latter eats it, it is a sign the dog was not mad; but if the other rejects it with a kind of howling noise, it is certain that he was. Dr James tells us, that among dogs the disease is infectious by staying in the same place; and that after a kennel has been once infected, the dogs put into it will be for a considerable time afterwards in danger of going mad also. A remedy for this, he says, is, to keep geese for some time in the kennel. He rejects as false the opinion that dogs when going mad will not bark; though he owns that there is a very considerable change in their bark, which becomes hoarse and hollow.

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Of all the accounts that have been published on the characteristics of rabies in dogs, the best is to be found in Dr Arnold's late treatise: the characteristics there mentioned are given on the authority of Mr Meynell, a gentleman who has paid particular attention to this subject. From Mr Meynell's observations it appears, that most of the characteristics which have been commonly mentioned, are mere vulgar errors; and, according to him, the best marks are from their peculiar dull look, and the peculiar sound which they utter. "Mad dogs (says Mr Meynell) never bark, but occasionally utter a most dismal and plaintive howl, expressive of extreme distress, and which, they who have once heard it, can never forget; so that dogs may be known to be going mad without being seen, when only this dismal howl is heard.

Causes, &c. In no disease whatever are we more at a loss to discover the causes than in the hydrophobia. In dogs, foxes, and wolves, it seems to come on spontaneously; though this is contested by some authors. It is said, that the causes commonly assigned, viz. heat, feeding upon putrid flesh, want of water, &c. are not sufficient for producing the distemper. It does not appear that madness is more frequent among dogs in the warm than in the cold climates; nay, in the island of Antigua, where the climate is very hot, and the water very scarce, this distemper has never, it is said, been observed. As to putrid aliment, it seems natural for dogs to prefer this to any other, and they have been known to subsist upon it for a long time without any detriment. For these reasons, they think the disease arises from a specific contagion, like the smallpox and measles among the human race, which, being once produced by causes unknown, continues to be propagated by the intercourse which dogs have with each other, as the diseases just mentioned continue to be propagated among the human race.

With regard to the immediate cause among mankind, there is not the least doubt that the hydrophobia is occasioned by the saliva of the mad animal being mixed with the blood. It does not appear that this can operate through the cuticula; but, when that is rubbed off, the smallest quantity is sufficient to communicate

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When we attempt to investigate the nature of the cause of the hydrophobia by dissections, our inquiries are commonly disappointed. In two bodies opened by Dr Vaughan, there was not the least morbid appearance; in the very fauces, where we might have expected that the disease would have shown itself most evidently, there was not the least appearance even of inflammation. The stomach, intestines, diaphragm, œsophagus, &c. were all in a natural state: neither do we find in authors of credit any certain accounts of morbid appearances in the bodies of hydrophobous persons after death. Dr Vaughan therefore concludes, that the poison acts upon the nervous system; and is so wholly confined to it, that it may be doubted whether the qualities of the blood are altered by it or not; and that it acts upon the nerves by impairing and disturbing their functions to such a degree as speedily to end in a total extinction of the vital principle. As to the difficulty in swallowing generally believed to accompany the dread of water, he treats it as a misrepresentation, as well as that the œsophagus with the muscles subservient to deglutition are especially concerned in this disease. The principal foundation of the evil, he thinks, rests on a morbid sensibility both of the external and internal fauces. For the sight of a liquid, or the application of any substance to the internal fauces, but more especially of a fluid, instantly excites the most painful feelings. Nay, the same symptoms are produced by touching the external fauces with a fluid, or by the contact of cold air with these parts; and nearly in as great a degree. But a solid or fluid substance being conveyed into the œsophagus, the transit into the stomach is accomplished with little or no impediment; so that in fact the difficulty is surmounted before the patient is engaged in the action of swallowing. Nor is the excruciating pain, which never fails to be the companion of every attempt to drink, felt in the *fauces* and *throat*: it is, he says, at the *scrobiculus cordis*; to which the sufferer applies his hand. From this last circumstance, therefore, from the presence of the *risus sardonicus*, from the muscles of the abdomen being forcibly contracted, and from the sense of suffocation which seems to threaten the patient with immediate death, Dr Vaughan has been led to think that in the hydrophobia a new sympathy was established between the fauces, the diaphragm, and the abdominal muscles.

Prognosis. When a person is bit, the prognosis with regard to the ensuing hydrophobia is very uncertain. All those who are bit do not fall into the disease; Hydrophobia. nay, Dr Vaughan relates, that out of 30 bit by a mad dog, only one was seized with the hydrophobia. During the interval betwixt the bite and the time the disease comes on, there are no symptoms by which we can judge whether it will appear or not. When once it has made its appearance, the prognosis is exceedingly fatal, though there are certainly some well authenticated cases of complete recovery, particularly one recorded by Dr Arnold.

Prevention and Cure. It has been generally allowed by practitioners, that though the hydrophobia may be prevented, yet it can seldom if ever be cured after it has made its appearance. The most essential part of the treatment therefore depends on the proper use of means of prevention. The great objects to be aimed at in prevention, are, in the first place, the complete removal of the contagious matter as soon as possible; or, secondly, means of destroying it at the part, where there is even the slightest reason to believe that it has not been completely removed. Of all the means of removal, the complete cutting out the part to which the tooth has been applied, is unquestionably the most to be depended upon. This practice, therefore, should be had recourse to as soon as possible. The sooner it can be accomplished, the better. But it has been observed, that as a peculiar sensation at the part affected always precedes the accession of the disease, even when it takes place at a late period after the bite, there is good ground for believing that the removal of the part may be of advantage even after a considerable interval. But besides removal of the contagious matter, by cutting away the part to which it is attached, this should also be attempted by careful and long-continued washing. This may be done, in most instances, before a proper opportunity can be had of having recourse to the knife. Cold water should particularly be poured upon the wound from a considerable height, that the matter may be washed away with some force. Even after removal by the knife, careful washing is still a necessary and proper precaution. And after both these, to prevent as far as can be the possibility of any contagious matter lurking about the wounded part, it should not be allowed to heal, but a discharge of matter should be supported for the space of several weeks, by ointment with cantharides, or similar applications. By these means there is at least the best chance of removing the matter at a sufficiently early period. And this mode of prevention seems to be of more consequence than all others put together which have hitherto been discovered. But besides removal, prevention may also be obtained by the destruction of the contagious matter at the part; and where there is the least reason to think that a complete removal has not been obtained, this should always be had recourse to. With this intention the actual cautery and burning with gun-powder have been employed. And the action of fire is probably one of the most powerful agents that can be used for this purpose. But recourse has also been had to washing both with acids and with alkalies. Of the former kind, vinegar has been chiefly used, but more may probably be expected from the latter; and particularly from the caustic alkali, so far diluted that it can be applied with safety: for from its influence as a solvent of animal mucus, it gives the

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the best chance of a complete removal of the matter, independent of any influence in changing its nature. It has been thought also, that oil applied to the part may be of service. But if recourse be had to it, more active measures should at least be previously employed; and even then, some are of opinion that it is of advantage to increase the activity of the unctuous matter by combining it with mercury.

On these grounds, and by these means, we are inclined to think that the action of this contagion on the system, after it has been applied by the bite of a rabid animal, may be most effectually prevented. But after this action has once taken place, no remedy has yet been discovered on which much dependence can be put. A very great variety of articles indeed have at different periods been held forth as infallible, both in the prevention and cure of this affection; but their reputation has, perhaps, universally been founded on their being given to people, who, though really bit by a mad dog, were yet not infected with the contagion. And this happily, either from the tooth being cleaned in making the bite, or not being covered with contagious matter, is by no means an unfrequent occurrence. Mankind, however, even from the earliest ages, have never been without some boasted specific, which has been held forth as an infallible remedy for this affection till fatal experience demonstrated the contrary. Dr Boerhaave has given a pretty full catalogue of those specifics from the days of Galen to his own time; and concludes, that no dependence is to be put in any of them. It is now, therefore, altogether unnecessary to take notice of burnt crabs, the hyæna's skin, mithridate with tin, liver of the rabid animal, or a variety of other pretended remedies for this disease, proved by experience to be totally inefficacious. But although no greater confidence is perhaps to be put in specifics of modern date, it will be proper that these should be mentioned.

Bathing in cold water, especially in the sea, and drinking sea-water for a certain time, have been prescribed, and by some accounted a certain preventive. When this was known to fail, a long course of antiphlogistic regimen, violent submersion in water, even to danger of drowning, and keeping the wounded place open with cauteries, were recommended.—To this extreme severity Dr Mead objected; and in his treatise on this subject endeavours to show, that in all ages the greatest success has been reaped from diuretics, for which reason he proposes the following powder: "Take ash-coloured ground-liverwort, half an ounce; black-pepper, two drams: reduce them separately to powder, then mix them together." This powder was first published in the Philosophical Transactions, by Mr Dampier, in whose family it had been kept as a secret for many years. But this medicine which was inserted in former editions of the London and Edinburgh pharmacopœias, under the name of *Pulvis Antilyssus*. has long lost its credit.

There is a famous East India medicine, composed of 24 grains of native and as much factitious cinnabar, made into a powder with 16 grains of musk. This is called the *Tonquin* medicine, and must be taken in a tea cupful of arrac or brandy; and it is said to secure the patient for 30 days, at the expiration of which it is to be repeated; but if he has any symptoms of the disease, it must be repeated in three hours, which is said to be sufficient for a cure. The first dose is to be taken as soon after the bite as possible.

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Another celebrated remedy is Palmarius's powder, composed of the leaves of rue, vervain, sage, polypody, wormwood, mint, mugwort, balm, betony, St John's-wort, and lesser centaury. These herbs must be gathered in their prime, dried separately in the shade, and then powdered. The dose is a dram, or a dram and a half, taken every day.

A remedy which might promise to be more efficacious than any of those hitherto mentioned is mercury. This has been recommended in frictions, and to be taken inwardly in the form of calomel and turbith mineral, in order if possible to raise a slight salivation, on which the efficacy was thought to depend. Besides this, venesection, opium, cinchona, and camphor, have been tried in very large quantities; the warm bath; and, in short, every thing which human invention could suggest; but with how little success, can be judged from many well authenticated cases.

Dr Wolf, after detailing a number of interesting cases, makes the following observations.—"Thus we see, that the mercury, the acids, the musk, the feeding on the most famous herbs, the sweating, the *cura antiphlogistica*, &c. are no specifics."

The following case by Dr Raymond of Marseilles shows the inefficacy of mercury even as a *preventive*. —On the 19th of July 1765, Mr Boyer, aged 25, of a bloated cachectic habit, was bit by a mad dog in the inferior part of the leg: the wound extended half way round, bled freely, and was like a great scratch. The patient's legs had been swelled for a considerable time before the accident; and there were also two ulcers in the other leg. Some hours after the accident, the actual cautery was applied to the wound. The doctor was not present at this operation; but the part around the bite was rubbed with mercurial ointment immediately after, and the eschar was dressed with the same ointment. The eschar was separated on the first day, but the dressing was continued till the wound was cicatrised. The second day a bolus of four grains of turbith and eight grains of camphor was exhibited. This procured a considerable evacuation both by vomit and stool, and a spitting also came on. The third day the bitten leg was rubbed with mercurial ointment: in the space of a month the frictions were repeated five times on both legs, three drams of mercurial ointment being used in each friction. During the same time the bolus was five times repeated; and this treatment kept up a slight salivation to the 40th day. The evening of the third day he took the *Tonquin medicine*, called also *Sir George Cobb's powder*, in a bolus; which vomited him briskly. This powder was repeated seven or eight times in the month, generally with the same effect. During the first seven or eight days he got four times, in the morning, a dram of the *anagallis flore puniceo*, fresh gathered and powdered. The 41st day, the turbith bolus was prescribed for the seventh time: he was bathed in the sea, and continued the bathing for two days more. On the 74th he was seized with the distemper; and died on the 76th, seemingly suffocated or strangled, his mouth covered with slaver, and his

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his face bloated. He lost his senses not above half a quarter of an hour before his death. The pulse was quiet the whole time.

Another instance is mentioned by the same author, of a pregnant woman bit by the same dog and on the same day with Mr Boyer, who was never seized with the distemper. She was treated in much the same manner with him, and salivated a little more. But she was bit through a shamoy leather shoe, which must necessarily have cleaned the animal's teeth of the poisonous saliva before they reached her skin, and to this we are naturally led to ascribe her safety. One of Dr Wolf's patients also was a pregnant woman, and was not seized with the distemper. Perhaps women in a state of pregnancy may be less liable to this distemper than others; but it is more probable that the contagion was not communicated.

The same author tells us, "there are many examples of the inefficacy of mercurial frictions. A surgeon of Marseilles treated a girl about 12 years of age bit by a mad dog, with mercurial frictions; applying them as in the *lues venerea*: yet she died of the hydrophobia on the 55th day. Her wound was not cauterized."

In the following case all the most powerful remedies were tried.—In the afternoon of the 29th of Aug. 1777, Dr Vaughan was called to a boy of eight years of age labouring under a hydrophobia. He had been bit on the wrist by a cat about a month before; of which the marks remained, but without any ulcer, or even the smallest appearance of inflammation. About the middle of the day before Dr Vaughan saw him, he began to complain of a pain in the part bitten, which ascended up the arm, and affected the temple on that side; soon after which he swallowed liquids with reluctance and difficulty. He was put into the warm bath for three quarters of an hour, during which time he was easier: he had a clyster of five ounces of fresh broth, and 30 drops of laudanum, injected immediately after his coming out of it: a liniment consisting of three drams of strong mercurial ointment with the same quantity of oil of amber, was rubbed upon the shoulders and back; two pills of a grain of flowers of zinc, and half a grain of *cuprum ammoniacum*, were taken every three or four hours; and a medicated atmosphere was prepared for him, by burning gum ammoniac in his room. As these remedies were not attended with any good effect, each dose of pills was ordered to contain two grains of *cuprum ammoniacum*, the same quantity of opium, three grains of flowers of zinc, and ten grains of asafœtida; whilst a solution of that fetid gum, with a dram of laudanum, was administered as a clyster. These pills, though repeated every four hours, afforded not the smallest relief, nor did they show the least action on the frame. At last the doctor resolved to put in practice the desperate remedy mentioned by Van Helmont, of throwing the patient into cold water, and keeping him there till he is almost drowned. With this view a large tub of cold water, well saturated with common salt, was prepared, into which the poor boy was plunged over head and ears, and there held until he ceased to struggle. He was then taken out again, and the same operation repeated until he became so quiet that the doctor was under apprehensions that a total extinction of life would take place. He was then wrapped up in a blanket and put to bed, and he remained more quiet than he had formerly been; but all his former restlessness soon returned, his pulse sunk, and he died about two o'clock in the morning.

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Another celebrated antidote against the poison of a mad dog has been known for some years by the name of the *Ormskirk medicine*. The true composition of this is kept a secret by the proprietors: however, it has been analysed, and the following composition published by Dr Heysham as perfectly similar to it in all respects.

"Take half an ounce of chalk, three drams of Armenian bole, 10 grains of alum, one dram of elecampane in powder; mix them all together, and add six drops of oil of anise."

They must certainly be very credulous who can put confidence in such an insignificant medicine as a preservative against the hydrophobia: however, there is a possibility that there may be some unknown ingredient in the genuine powder: for it is difficult to analyse powders after the ingredients are thoroughly mixed together. The efficacy of the medicine therefore must depend on the virtues of that unknown ingredient, if any such there be. The following cases, however, too well determine that it is not *infallible*, as was at first pretended. In all probability, as well as many others, its reputation also is solely rested on its being exhibited in many cases where no contagion was communicated to the person bit, and while of course no disease could take place.

On the 14th of February 1774, Mr Bellamy of Holborn, aged 40, was bit by a cat affected with rabies, which was killed the same morning. The following day he took the celebrated Ormskirk medicine, sold by Hill and Berry in Hill-Street, Berkeley-Square, and conformed in every respect to the directions given by the vender. A servant maid, who was bitten in the leg before her master was bitten, likewise took the same remedy. About the middle of April Mr Bellamy complained of a pain in his right knee, which he supposed to be rheumatic, and which continued and increased till the 7th of June, when he got some pills of calomel, ipecacuanha, and *pil. sapon.* from an apothecary, with Huxham's tincture of the bark in small doses. In six days more he had a titillation in the urethra, a contraction of the scrotum and penis to a degree of pain, and an emission of semen after making water, to which he had frequent calls. The medicines were discontinued; and on the 16th of that month the hydrophobia came on, and Dr Fothergill was called. Six ounces of blood were taken from his arm, and a bolus of a scruple of native cinnabar and half a scruple of musk was given every four hours. The distemper manifestly increased through the day. In the evening a clyster was injected, and several times repeated during the night; he had been put into the warm bath, and two drams of strong mercurial ointment rubbed into his legs and thighs by himself. He was greatly relieved by the warm bath while he continued in it, but the symptoms returned with increased violence in the night. The next day being greatly worse, he was blooded to as great a quantity as he could bear, had the warm bath and clysters repeated, and half an ounce of mercurial ointment rubbed into his thighs and legs. Pills of opium were prescribed, but he did not take them. He died the

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the same night, at half an hour after 12. This patient was a man of great resolution, and could in part conquer his aversion at water. He seemed to have totally forgot the accident of the bite: and casually said, that he thought this disorder resembled the hydrophobia, without supposing that he was afflicted with that distemper at the time.—The bite on the girl's leg refused to heal, baffled the art of a young surgeon who attempted to cure it, and continued a running ulcer for a long time. She did not fall into the hydrophobia. Hence Dr Fothergill thinks it probable, that keeping the wounds made by the teeth of mad animals open for a long time, would probably be of service as a preventive; but in some of Dr Wolf's patients these artificial drains appear not to have been attended with success.

On the 16th of November 1773, Thomas Nourse, a strong healthy boy of 14, was admitted into the Leicester infirmary; having been that day month bitten by a mad fox-hound. The wound was a large lacerated one on the cheek, and bled very freely on being inflicted. The day after he was bit he went to the sea, where he was dipped with all the severity usually practised under so disagreeable an operation. The *Ormskirk medicine* was also administered with all due care. It was bought of the person in Leicester who is deputed by the proprietor to sell it for him. A common adhesive plaster was applied to the part after sea-bathing; and in the course of a month, without any further trouble, the wound was healed; excepting a small portion, somewhat more than an inch in length, and in breadth about one-tenth. This yielded no discharge, and was quite in a cicatrizing state. Five days before his admission into the infirmary, he began to complain of a tightness over his temples, and a pain in his head: in two days the hydrophobia began to appear; and at its commencement he complained of a *boiling heat* in his stomach, which was continually ascending to the fauces. The disease was pretty strong when he came to the infirmary. He got a bolus of a scruple of musk with two grains of opium; then a composition of 15 grains of musk, one of turbith mineral, and five grains of opium, was directed to be taken every third hour; an ounce of the stronger mercurial ointment was to be rubbed on the cervical vertebræ and shoulders, and an embrocation of two ounces of laudanum, and half an ounce of *acetum saturninum*, was directed to be applied to the throat. But by this last he was thrown into convulsions, and the same effect followed though his eyes were first covered with a napkin. The embrocation was therefore changed for a plaster of three drams of powdered camphor, half an ounce of opium, and six drams *confectio Damocritis*. By these medicines the disease seemed to be somewhat suspended, but the symptoms returned with violence in the evening. His medicine was repeated at seven; and at eight five grains of opium were exhibited without musk or turbith. At nine, another ounce of mercurial ointment was rubbed upon the shoulders, and half an ounce of laudanum with six ounces of mutton-broth was injected into the intestines, but to no purpose. A larger dose of opium was then given, but with as little effect as the former, and he died the same night.

In the month of September 1774, a farmer, aged 25, was bit by a mad dog, whose teeth made a slight wound in the fore finger of the left hand. He was dipped, as usual, in the sea; and drank the sea-water for some time on the spot, which operated briskly as a purge. He continued well till the 6th of June following, when he first felt a pain in that hand and arm; for which he bathed in a river that evening, supposing that it had been a rheumatic complaint. The next day he was sick; and in the evening was seized with a violent vomiting, which continued all that night and till the middle of the next day, when it was succeeded by the hydrophobia. He was treated with the warm bath; had a purgative clyster injected; and as soon as it had operated, a second was given, consisting of four ounces of oil, and half an ounce of laudanum; half an ounce of strong mercurial ointment was rubbed on the fauces, and the part was afterwards covered with the *cataplasma è cymino*, to which was added an ounce of opium. An embrocation was applied to the region of the stomach with continued friction, consisting of half an ounce of spirit of sal ammoniac, ten drams of olive oil, six drams of oil of amber, and ten drams of laudanum. Two ounces of strong mercurial ointment were rubbed upon the shoulders and back; and as a further means of inducing a ptyalism speedily, he received the smoke of cinnabar into the mouth by throwing a dram of that substance now and then upon a hot iron: he was also directed to take every four hours a bolus of 15 grains of musk, three grains of turbith mineral, and four grains of opium. He was easier while in the warm bath, and during the application of the ointment; but died the same night about two o'clock.

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Many other instances might be adduced of the inefficacy of this pretended specific: which will, it is hoped, create a due degree of caution in those to whom they who are so unfortunate as to be bit by a mad animal may commit themselves. Another remedy may also be mentioned as having had the reputation of being sometimes successful in this disease; which is chiefly employed in different parts of India, particularly in the territory of Tanjore. The medicine to which we now allude contains indeed several articles which are altogether unknown in our materia medica: but it contains at least one very powerful substance well known to us, viz. arsenic. This medicine, known by the name of the Snake Pills, as being principally employed against the bite of the most venomous snakes, is directed to be prepared in the following manner:

Take white arsenic, of the roots of nelli navi, of nevi visham, of the kernels of the ner valum, of pepper, of quicksilver, each an equal quantity. The quicksilver is to be rubbed with the juice of the wild cotton till the globules are perfectly extinguished. The arsenic being first levigated, the other ingredients, reduced to a powder, are then to be added, and the whole beat together with the juice of the wild cotton to a consistence fit to be divided into pills.

Though these pills are principally used against the bite of the cobra de capello, yet they are said also to be successful in the cure of other venomous bites; and, for the prevention of rabies canina, one is taken every morning for some length of time. Of this remedy European practitioners have, we believe, as yet no experience; and if, in the accounts transmitted

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by East India practitioners, it cannot be said that we have authentic evidence of its want of success, it can as little be pretended that there is indubitable evidence of its efficacy in any instance; and it is by no means improbable, that it will be found equally inefficacious with others at one time considered as infallible.

Of the great variety of remedies which have had their day of reputation, there is not one which has not possessed the credit, some time or other, of preventing the noxious effects arising from the bite of a mad dog. A more adequate experience has with all of them discovered the deception. It was above observed, that rabies is by no means the infallible consequence of being bit by a mad animal; and that of between 20 and 30 persons who were bit by the dog which gave the fatal wound to one of Dr Vaughan's patients, not one felt the least ill effect but himself. "In the above number (says the doctor) were some who took the Ormskirk medicine; others went to the salt water; and a part of them used no remedy, who yet fared equally well with the most attentive to their injury. The same thing has often happened before; and much merit, I doubt not, has been attributed to the medicine taken, from that celebrated one of *Sir George Cobb* down to the *infallible* one which my good *Lady Bountiful's* receipt-book furnishes."

From all that has been said, the reader will judge how far the hydrophobia is capable of being subdued by any of the medicinal powers which have yet been tried. Some eminent physicians assert that it is totally incurable; and allege that the instances recorded by different authors of its cure have not been the genuine kind, but that which comes on spontaneously, and which is by no means so dangerous. Indeed two of Dr Wolf's patients recovered, where the disease seems to have been perfectly genuine: but in these the poison seemed to vent itself partly on some other place besides the nervous system. In one the blood was evidently infected, as it had an abominable fœtor; and the other had a violent pain and swelling in the belly. In all the others, it seemed to have attacked only the nervous system; which perhaps has not the same ability to throw off any offending matter as the vascular system.

There is, however, a possibility that the prodigious affections of the nerves may arise only from a vitiated state of the gastric juices; for it is well known, that the most terrible convulsions, nay the hydrophobia itself, will arise from an affection of the stomach, without any bite of a mad animal. This seems to be somewhat confirmed from one of Dr Wolf's patients, who, though he vomited more than 50 times, yet still threw up a frothy matter, which was therefore evidently secreted into the stomach, just as a continual vomiting of a bilious matter shows a continual and extraordinary secretion of bile. Dr Wolf himself adopts this hypothesis so far as to say, that perhaps the *serum* may become frothy; but in blood drawn from a vein not the least fault appears either in the serum or crassamentum. He affirms, however, that the duodenum appears to be one of the parts first and principally affected; and as it is not inflamed, it would seem that the affection it sustains must arise from the vitiated state of its juices.

Be this as it will, however, in the hydrophobia, the stomach seems totally, or in a great measure, to lose the power which at other times it possesses. Two grains of *cuprum ammoniacum* were repeatedly given to a child of eight years of age without effect; but this dose would occasion violent vomiting in a strong healthy man. Something or other therefore must have prevented this substance from acting on the nervous coat of the stomach; and this we can only suppose to have been the exceedingly disordered state of the gastric juice, which occasioned such violent irritation through the whole body, that the weaker stimulus of the medicine was entirely lost. It would seem proper therefore to consider the stomach in hydrophobic cases as really containing a poisonous matter, which could not be expelled by vomiting, because it is renewed as fast as evacuated. The indication therefore must be, to change its nature by such medicines as are certainly more powerful than the poison; and this indication will naturally lead us to think of large doses of alkaline salts. These, it is certain, will destroy any animal substance with which they come in contact, and render even the poison of serpents inactive. By exhibiting a few doses of them, larger no doubt than what could be safely done on other occasions, we would be certain to change the state of the stomachic juices; and thus might free the patient from those intolerable spasms which always occasion death in such a short time. Dr Wolf seems inclined to think that volatile alkalies were of service; but the above hypothesis would incline us to use rather the fixed kind. At any rate, it seems vain for physicians to trust much to the power of opium, mercury, musk, or cinnabar, either singly or combined in any possible way. Cinchona has also failed, and the most celebrated specifics have been found ineffectual. Alkalies are the next most powerful remedies which the *materia* medica affords, and they cannot be more unsuccessful than the others have generally been.

Another remedy which seems adapted to change the nature of the gastric juices is ardent spirits. In one of Dr Wolf's patients two bottles of brandy seem to have effected a cure. The oil mixed with it was of no efficacy in other cases, and the opium and turbith seem not to have been exhibited till the worst was past. In this case the disease seems to have attacked the vascular as well as the nervous system.

In all the patients the warm bath seems to have been a palliative, and a very powerful one, and as such it ought never to be omitted, though we can by no means trust to it as a radical cure; and the above histories abundantly show, that though the warm bath and opium may palliate for a short time, the cause on which the spasms depend is still going on and increasing, till at last the symptoms become too strong to be palliated even for a moment by any medicine however powerful. At any rate, the above-mentioned hypothesis suggests a new indication, which, if attended to, may perhaps lead to useful discoveries. In cases where putrescent bile is abundantly secreted, columbo root and vegetable acids are recommended to change the nature of the poison which the body is perpetually producing in itself. Where corrosive mercury has been swallowed, alkaline salt is recommended to destroy the poison which nature cannot expel by vomiting; and why

Spaſmi. why ſhould not ſomething be attempted to deſtroy the poiſon which the ſtomach ſeems to ſecrete in the hydrophobia, and which nature attempts to expel, though in vain, by violent efforts to vomit?

But whatever plan may be purſued in the hopes of curing this dreadful malady after any of the ſymptoms have made their appearance, we ought, in every inſtance, to direct our immediate care to *prevention*, as being perhaps the only real ground of hope: And the moſt certain and efficacious way of preventing the ill conſequences, is inſtantly (if it can be done) to cut out the piece that happens to be bitten. Dr James, indeed, ſays, that he would have little opinion of cutting or cauterizing, if ten minutes were ſuffered to elapſe from the receiving of the bite before the operation was performed. But in an inaugural diſſertation lately publiſhed at Edinburgh by Dr Parry, the author is of opinion that exciſion will be of uſe a conſiderable time after the bite is received. He adopts this opinion from what happens in the ſmallpox, where the blood does not ſeem to receive the infection till ſome days after inoculation has been performed. A ſecond inflammation, he tells us, then takes place, and the infection is conveyed into the blood. In like manner, when the hydrophobous infection is about to be conveyed into the blood, according to him, the wound, or its cicatrix, begins again to be inflamed; and it is this ſecond inflammation which does all the miſchief. Exciſion, or the cautery, will therefore be effectual any time between the bite and the ſecond inflammation of the wound. Without implicitly truſting to this doctrine, however, or conſidering it as in any degree aſcertained in what manner the poiſon diffuſes itſelf, by what marks its progreſs may be known, or how ſoon the ſyſtem may be irremediably tainted with its malignity, it is undoubtedly ſafeſt not to loſe unneceſſarily a moment's time in applying the knife. This, or a dilation of the wound if it be ſmall, Dr Vaughan conſiders as the only prophylactics that can be depended upon. In the latter caſe, he directs to fill the wound with gunpowder, and ſet fire to it; which would produce a laceration of the part, and poſſibly the action of ignited powder upon the poiſon may have its uſe. In all caſes, likewiſe, after theſe practices have been employed, the wound ſhould be prevented from healing for ſome length of time.

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Hydrophobia ſpontanea, *Sauv.* ſp. 2.

This diſeaſe very much reſembles the former, ſo that it has undoubtedly been often miſtaken for it. It has been known to come on from an inflammation of the ſtomach, where it was cured by repeated and large bloodletting; in hyſteria, where it was cured by opium, muſk, or other antiſpaſmodics; and in putrid fevers, where it was cured by evacuating the inteſtinal canal of the putrid matters by repeated clyſters. A very good method of diſtinguiſhing the two is, that in the ſpontaneous hydrophobia the patient is much more delirious than in the genuine ſpecies. In the inſtance mentioned in the Medical Eſſays of this ſymptom attending the inflammation of the ſtomach, the patient *raved in the moſt extraordinary manner.* Dr Raymond ſays he remembers a ſpontaneous hydrophobia *attended with madneſs*; and in almoſt all the caſes of hydrophobia which are ſaid to have been cured, the patient was very delirious. Dr Nugent's patient was very frequently delirious, and dreaded *dogs* as well as water. In the Medical Tranſactions a caſe is communicated by W. Wrightſon ſurgeon in Sedgefield, Durham, of *canine madneſs* ſucceſsfully treated. This madneſs indeed came on after the bite of a dog ſaid to be mad: but it appeared only four days after the accident happened, and was attended with ſymptoms very unlike any of thoſe above mentioned; for he ſuddenly ſtarted up in a fit of delirium, and ran out of the houſe, and after being brought in, caught hold of the hot bars of the grate which held the fire: Whereas, in the true hydrophobia, the patients dread the fire, light, or any thing which makes a ſtrong impreſſion on the ſenſes. It is probable, therefore, that this was only a ſpontaneous hydrophobia, eſpecially as it readily yielded to veneſection, 30 drops of laudanum, and pills of a grain and a half of opium given every three hours, ſome boluſes of muſk and cinnabar, &c. while in ſome of the former caſes as much opium was given to a boy as would have deprived of life the ſtrongeſt healthy man had he ſwallowed it; and yet this amazing quantity produced ſcarcely any effect. This patient alſo dreaded the ſight of a dog.

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ORDER IV. VESANIÆ. 325

Paranoiæ, *Vog.* Claſs IX.
Deliria, *Sauv.* Claſs VIII. Ord. III. *Sag.* Claſs XI. Ord. III.
Ideales, *Lin.* Claſs V. Ord. I.

GENUS LXV. AMENTIA. 326

FOLLY, or *Idiotiſm.*

Amentia, *Sauv.* gen. 233. *Vog.* 337. *Sag.* 346.
Moroſis, *Lin.* 106.
Stupiditas, Moroſis, Fatuitas, *Vog.* 336.
Amneſia, *Sauv.* gen. 237. *Sag.* 347.
Oblivio, *Lin.* 107. *Vog.* 338.
Memoriæ debilitas, *Junck.* 120.

GENUS LXVI. MELANCHOLIA. 327

MELANCHOLY *Madneſs.*

Melancholia, *Sauv.* gen. 234. *Lin.* 71. *Vog.* 332. *Sag.* 347. *Boerh.* 1089. *Junck.* 121.
Dæmonomania, *Sauv.* gen. 236. *Sag.* 348.
Dæmonia, *Lin.* 69.
Veſania, *Lin.* 70.
Paraphobia, *Lin.* 75.
Athymia, *Vog.* 329.
Delirium melancholicum, *Hoffm.* III. 251.
Erotomania, *Lin.* 82.
Noſtalgia, *Sauv.* gen. 226. *Lin.* 83. *Sag.* 338. *Junck.* 125.
Melancholia nervea, *Cl. Lorry* de melancholia, P. I.

GENUS LXVII. MANIA. 328

RAVING or FURIOUS *Madneſs.*

Mania, *Sauv.* gen. 235. *Lin.* 68. *Vog.* 331. *Sag.* 349. *Boerh.* 1118. *Junck.* 122. *Battie* on Madneſs.
Paraphroſyne, *Lin.* 66.

Amentia,

Vesaniæ. Mania.

Amentia, *Lin.* 67.
Delirium maniacum, *Hoffm.* III. 251.

Although these distempers may be considered as distinct genera, yet they are so nearly allied, and so readily change into each other, that it sufficiently justifies the treating all of them together.

The distinguishing characteristic of madness, according to Dr Battie, is a *false perception;* and under this general character may be comprehended all kinds of what is called *madness*, from the most silly stupidity and idiotism to the must furious lunacy. Frequently the different kinds of madness are changed into each other by the casual excitement of some passion: thus, an idiot may become furiously mad, by being put in a violent passion; though this does not so often happen as the change of melancholy into the raving madness, and *vice versa.*

It is a very surprising circumstance, that mad people are not only less liable to be seized with infectious disorders than those who are in perfect health; but even when labouring under other diseases, if the patients chance to be seized with madness, they are sometimes freed from their former complaints. Of this kind Dr Mead relates two very remarkable instances.

On the other hand, it has been known, that an intermittent fever, supervening upon madness of long standing, has proved a cure for the madness; the senses having returned when the fever terminated. Dr Monro saw two instances of this himself; and mentions it as an observation made also by his predecessor in the care of Bethlehem hospital.

Another remarkable circumstance is, that immoderate joy, long continued, as effectually disorders the mind as anxiety and grief. For it was observable in the famous South Sea year, when so many immense fortunes were suddenly gained, and as suddenly lost, that more people had their heads turned, from the prodigious flow of unexpected riches, than from the entire loss of their whole substance.

Mad people, especially of the melancholic kind, sometimes obstinately persevere in doing things which must excite great pain; whence it should seem as if their minds were troubled with some distracting notions, which make them patiently bear the present distress, lest more severe tortures should be inflicted; or possibly they may think, that, by thus tormenting the body, they render themselves more acceptable to the divine Being, and expiate the heinous sins of which they may imagine themselves to have been guilty.

It is, however, also highly probable that their feelings differ exceedingly from what they are in a natural state; at least they are every day observed to endure, apparently without the smallest uneasiness, watching, hunger, and cold, to an extent which in a state of health would not only be highly distressing, but to the greater part of individuals would even prove fatal. And this resistance of hunger, cold, and sleep, affords perhaps the best test for distinguishing cases of real insanity, from cases where the disease is only feigned, and appearances of it put on, to answer particular purposes; at least where this power of resistance is present, we have good reason to conclude that the affection is not feigned.

Cure. Although we be well acquainted with many of the remote causes of this disease, some of the principal of which have already been mentioned, yet we are still so ignorant of the influence of these upon the system, as giving a derangement of the mental faculties, that no general principles on which the cure may be conducted, can with any confidence be pointed out.

It may, however, be observed, that while some remedies seem to operate by producing an artificial termination of this complaint, many others have effect only as aiding a natural termination. And where a recovery from this disease does take place, it most frequently happens in consequence of a natural convalescence. All the species and degrees of madness which are hereditary, or that grow up with people from their early youth, are out of the power of physic; and so, for the most part, are all maniacal cases of more than one year's standing, from whatever source they may arise. Very often mere debility, the dregs of some particular disease, such as an ague, the small-pox, or a nervous fever, shall occasion different degrees of foolishness or madness. In these cases, the cure must not be attempted by evacuations; but, on the contrary, by nourishing diet, clear air, moderate exercise, and the use of wine: whereas, in almost all the other maniacal cases, which arise from different sources, and which come on in consequence of intemperate living, violent passions, or intense thinking, it is generally held, that evacuations of every kind are necessary, unless the constitution of the patient be such as absolutely forbids them.

Blood is most conveniently drawn either from the arm or jugulars; and if the weakness be such as renders it improper to take away much blood, we may apply cupping-glasses to the occiput.

Vomiting, in weakly people, must be excited by the vinum ipecacuanhæ; but in the more robust by emetic tartar or antimonial wine: the most efficacious cathartics are the infusion or tincture of black hellebore, or infusion of senna quickened with tincture of jalap; but if there be suppression of the menses, or of an habitual hæmorrhoidal discharge, then aloetic purges will be more proper; and in some instances cooling saline purgatives, such as lixiviated tartar, are of great service. In general, mad people require very large doses, both of the emetics and cathartics, before any considerable operation ensues.

Dr Monro assures us, that the evacuation by vomiting is infinitely preferable to any other: the prodigious quantity of phlegm with which the patients in this disease abound, he says, is not to be overcome but by repeated emetics; and he observes, that the purges have not their right effect, or do not operate to so good purpose, until the phlegm be broken and attenuated by frequent emetics. He mentions the case of a gentleman who had laboured under a melancholy for three years, from which he was relieved entirely by the use of vomits and a proper regimen. Increasing the discharge by urine, is also of the greatest moment, especially when any degree of fever is present. The cutaneous discharges are also to be promoted; for which purpose the hot bath is of the highest service in maniacal cases. Hoffman asserts, that he has seen numerous instances, both of inveterate melancholy and raging madness, happily cured by means of warm bathing;

bleeding

Veſaniæ. bleeding and nitrous medicines having been premiſed. Camphor has alſo been highly commended; but, if we can believe Dr Locker of Vienna, not very deſervedly. Having found very good effects from a ſolution of this medicine in vinegar, he took it for granted that all the ſucceſs was owing to the camphor; therefore, in order to give it a fair trial, he ſelected ſeven patients, and gave it in large doſes of half a dram twice a-day. This was continued for two months, and the doctor was ſurpriſed to find that only one of his patients received any benefit. He then returned the other ſix back to the camphorated julep made with vinegar, and in a few weeks four of them recovered the uſe of their reaſon. This inclined him to think that the virtue depended ſolely on the vinegar, and accordingly he began to make the trial. Common vinegar was firſt given: but after a little while he fixed on that which had been diſtilled, and gave about an ounce and a half of it every day; the patients having been previouſly prepared by bleeding and purging, which was repeated according as it was found neceſſary. He gives a liſt of eight patients who were cured by this method; ſome in ſix weeks, others in two months, and none of them took up more than three months in perfecting the cure. He does not indeed give the ages of the patients, nor mention the circumſtances of the caſes; he only mentions the day on which the uſe of the vinegar was begun and the day on which they were diſcharged; and he adds, that they all continued well at the time of his writing.

Dr Locker informs us, that this medicine acts chiefly as a ſudorific; and he obſerved, that the more the patients ſweated, the ſooner they were cured: it was alſo found to promote the menſtrual diſcharge in ſuch as had been obſtructed, or had too little of this ſalutary evacuation.

Both reaſon and experience ſhow the neceſſity of confining ſuch as are deprived of their ſenſes; and no ſmall ſhare of the management conſiſts in preventing them from hurting either themſelves or others. It has ſometimes been uſual to chain and to beat them: but this is both cruel and abſurd; ſince the contrivance called the *ſtrait waiſtcoat* anſwers every purpoſe of reſtraining the patients without hurting them.

Theſe waiſtcoats are made of ticken, or ſome ſuch ſtrong ſtuff; are open at the back, and laced on like a pair of ſtays; the ſleeves are made tight, and long enough to cover the ends of the fingers, where they are drawn cloſe with a ſtring like a purſe mouth, by which contrivance the patient has no power of his fingers; and when laid on his back in bed, and the arms brought acroſs the cheſt, and faſtened in that poſition by tying the ſleeve ſtrings round the waiſt, he has no uſe of his hands. A broad ſtrap of girth-web is then carried acroſs the breaſt, and faſtened to the bedſtead, by which means the patient is confined on his back; and if he ſhould be ſo outrageous as to require further reſtraint, the legs are ſecured by ligatures to the foot of the bed; or they may be ſecured by being both put into one bag not very wide, which may be more eaſily fixed than the feet themſelves, at leaſt without giving pain.

It is of great uſe in practice to bear in mind, that all mad people are cowardly, and can be awed even by the menacing look of a very expreſſive countenance; and when thoſe who have charge of them once impreſs them with the notion of fear, they eaſily ſubmit to any thing that is required. The phyſician, however, ſhould never deceive them in any thing, but more eſpecially with regard to their diſtemper: for as they are generally conſcious of it themſelves, they acquire a kind of reverence for thoſe who know it; and by letting them ſee that he is thoroughly acquainted with their complaint, he may very often gain ſuch an aſcendant over them that they will readily follow his directions. Mania.

It is a more difficult matter to manage thoſe whoſe madneſs is accompanied either with exceſſive joy or with great dejection and deſpondency, than thoſe who are agitated with rage: and all that can be done is to endeavour to excite contrary ideas, by repreſſing the immoderate fits of laughter in the one kind by chiding or threatening (taking care, however, not abſolutely to terrify them, which can never be done without danger, and has often added to the miſery of the unhappy ſufferer); and diſpelling the gloomy thoughts in the other, by introducing pleaſing concerts of muſic, or any other ſpecies of entertainment which the patients have been known to delight in while they had the uſe of their reaſon. Upon the whole, in the cure of inſanity, more is perhaps to be effected by moral than by medical treatment. And this moral treatment ſhould be as gentle as is conſiſtent with ſafety. Chains, bolts, and ſeverity of every kind are to be avoided as much as poſſible. But while great benefit is often derived from company and amuſement, ſo alſo, on the other hand, ſolitary confinement is in not a few caſes productive of the beſt effects.

Though bliſtering the head has generally been directed, Dr Mead ſays he has oftener found it to do harm than ſervice: but he recommends iſſues in the back; and adviſes to keep the head always cloſe ſhaved, and to waſh it from time to time with warm vinegar. Opium has by many been forbidden in maniacal caſes, from a ſuppoſition that it always increaſes the diſturbance; but there are inſtances where large doſes of this medicine have been found to prove a cure, and perhaps if it were tried oftener we ſhould find powerful effects from it: there certainly cannot much harm enſue from a few doſes, which may be immediately diſuſed if they ſhould be found to exaſperate the diſeaſe.

The diet of maniacal patients ought to be perfectly light and thin: their meals ſhould be moderate; but they ſhould never be ſuffered to live too low, eſpecially while they are under a courſe of phyſic: they ſhould be obliged to obſerve great regularity in their hours: even their amuſements ſhould be ſuch as are beſt ſuited to their diſpoſition. After the diſeaſe appears to be ſubdued, chalybeate waters and the cold bath will be highly proper to ſtrengthen their whole frame and ſecure them againſt a relapſe.

Genus LXVIII. ONEIRODYNIA. 329

Uneasiness in Sleep.

Somnium, *Vog.* 339.
Somnambuliſmus, *Sauv.* gen. 221. *Lin.* 77. *Sag.* 333.
Hypnobataſis, *Vog.* 340.

Noctambulatio,

Noctambulatio, *Junck.* 124.
Ephialtes, *Sauv.* gen. 138. *Lin.* 163. *Sag.* 245.
Incubus, *Vog.* 221. *Junck.* 50.

The greatest uneasiness which people feel in sleep is that commonly called the *incubus* or *night-mare*. Those seized with it seem to have a weight on their breasts and about their præcordia. Sometimes they imagine they see spectres of various kinds which oppress or threaten them with suffocation. Neither does this uneasiness continue only while they are asleep; for it is some time after they awake before they can turn themselves in their beds or speak; nay, sometimes, though rarely, the distemper has proved mortal.—The incubus rarely seizes people except when the stomach is oppressed with aliments of hard digestion, and the patient lies on his back. It is to be cured by eating light suppers, and raising the head high; or, if it become very troublesome, antispasmodic medicines are to be administered, and the body strengthened by chalybeates. The same method is to be followed by those who are subject to walking in their sleep; a practice which must necessarily be attended with the greatest danger: and somnambulism may justly be considered as merely a different modification of this disease. Accordingly Dr Cullen has distinguished the one by the title of *oneirodynia activa*, and the other by that of *oneirodynia gravans*.

330 ## Class III. CACHEXIÆ.

Cachexiæ, *Sauv.* Class X. and Class VIII. *Sag.* Class III.
Deformes, *Lin.* Class X.

331 ### Order I. MARCORES.

Macies, *Sauv.* Class X. Order I. *Sag.* Class III. Order I.
Emaciantes, *Lin.* Class X. Order I.

332 ### Genus LXIX. TABES.

Wasting of the *Body*.

Tabes, *Sauv.* gen. 275. *Lin.* 209. *Vog.* 306. *Sag.* 100.

This disorder is occasioned by the absorption of pus from some ulcer, external or internal, which produces an hectic fever. The primary indication therefore must be to heal the ulcer, and thus take away the cause of the disease. If the ulcer cannot be healed, the patient will certainly die in an emaciated state. But the proper treatment of the tabes proceeding from this cause, falls to be considered under the head of *Ulcer* in Surgery, and likewise under the genera Siphylis, Scrofula, Scorbutus, &c. diseases in which ulcers are at least a very common symptom.

333 ### Genus LXX. ATROPHIA.

Nervous Consumption.

Description. This affection consists principally in a wasting of the body, without any remarkable fever, cough, or difficulty of breathing; but attended with want of appetite and a bad digestion, whence the whole body grows languid, and wastes by degrees.—Dr Cullen, however, asserts, that some degree of fever, or at least of increased quickness of the pulse, always attends this disease.

Causes. Sometimes this distemper will come on without any evident cause. Sometimes it will arise from passions of the mind; from an abuse of spirituous liquors; from excessive evacuations, especially of the semen, in which case the distemper has got the name of *tabes dorsalis*. It may arise from mere old age, or from famine.

Prognosis. This distemper, from whatever cause it may arise, is very difficult to cure, and often terminates in a fatal dropsy.

Cure. The general principles on which the treatment of this disease is to be regulated, very much depend on the cause by which it is induced; and it is unnecessary to add, that this must be removed as far as possible. Next to this, the disease is most effectually combated by the introduction of nutritious aliment into the system, and by obtaining the proper assimilation and digestion of this. With the first of these intentions, recourse must be had to the diet which is most nutritious, and at the same time of easiest digestion. But from the condition of the stomach commonly attending this disease, it is necessary that small quantities only should be taken at a time, and that it should be frequently repeated. With the second intention, stomachic and nervous medicines are the articles chiefly at least to be depended upon in this case. The Peruvian bark, sulphuric acid, and chalybeates, are excellent; and these should be conjoined with gentle exercise, as far as the strength and other circumstances of the patient will admit. In that species of the distemper occasioned by venereal excesses, it is so essentially necessary to abstain from them, that without it the best remedies will prove altogether useless.

Order II. INTUMESCENTIÆ. 334

Intumescentiæ, *Sauv.* Class X. Ord. II. *Sag.* Class III. Ord. II.
Tumidosi, *Lin.* Class X. Ord. II.

Genus LXXI. POLYSARCIA. 335

Corpulency.

Polysarcia, *Sauv.* gen. 279. *Lin.* 213. *Vog.* 540. *Sag.* 160. Steatites, *Vog.* 390.

In a natural and healthy state, the fat, or animal oil, is not allowed to diffuse itself throughout the cellular interstices at large, but is confined to the places where such an oily fluid is necessary, by a particular apparatus of distinct vesicles. But in some constitutions the oily part of the blood appears to exceed the requisite proportion, and easily separates from the other constituent parts; or there is an uncommon tendency to the separation of oily matter. In these cases it is apt to accumulate in such quantities, that we may suppose it to burst those vesicles which were originally destined to hinder it from spreading too far; or almost every cell of the membrana adiposa, many of which are in ordinary cases altogether empty, may be completely filled and distended with fat.

The increase of the omentum particularly, and the accumulation

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accumulation of fat about the kidneys and meſentery, ſwell the abdomen, and obſtruct the motions of the diaphragm; whence one reaſon of the difficulty of breathing which is peculiar to corpulent people; while the heart, and the large veſſels connected with it, are in like manner ſo encumbered, that neither the ſyſtaltic nor ſubſultory motion can be performed with ſufficient freedom, whence weakneſs and ſlowneſs of the pulſe: but when the whole habit is in a manner overwhelmed with an oily fluid, the enlargement of the cellular interſtices will neceſſarily interrupt the general diſtribution and circulation throughout the nervous and vaſcular ſyſtems; impeding the action of the muſcular fibres, and producing inſenſibility, ſomnolency, and death.

Theſe caſes are the more deplorable, as there is but little proſpect of a cure. For the animal oil is of too groſs a nature to be eaſily taken up by abſorption; and we know, that when fluids are accumulated in the cellular ſyſtem, there are only two ways in which they can be carried off or eſcape; namely, by the abſorbents, which take their riſe from the cellular interſtices, and through the pores of the ſkin by tranſudation.

Another misfortune is, that the diſeaſe ſteals on ſo imperceptibly, that it becomes inveterate before people begin to think of purſuing the proper means of relief.

In this diſeaſe the cure muſt turn upon two points: Firſt, on preventing the farther depoſition of fat, by avoiding the introduction of ſuperfluous aliment, particularly of fatty matters, into the ſyſtem; and, ſecondly, on promoting and forwarding the abſorption of fat. On theſe grounds, beſides what may be done by proper regimen, a variety of articles have been recommended in the way of medicine.

Soap has been propoſed as a remedy to melt down and facilitate the abſorption of the fat in corpulent people; and Dr Fleming ſome years ago publiſhed a little treatiſe, wherein he recommends this medicine, and relates the caſe of a gentleman who is ſaid to have received conſiderable benefit from it. But perhaps the ſoap leys would be more powerful, and might be more eaſily taken ſheathed, in the manner directed when uſed as a diſſolvent of the ſtone.

Lieutaud adviſes to take *acetum ſcilliticum* in ſmall doſes, with frequent purging and briſk exerciſe. But it will ſeldom happen that the patients will be found ſufficiently ſteady to perſiſt in any of theſe courſes, it being the nature of the diſorder to render them irreſolute and inattentive to their condition. Therefore the principal uſe of rules muſt be with a view to prevention; and perſons who are diſpoſed to corpulency ſhould take care in time to prevent it from becoming an abſolute diſeaſe, by uſing a great deal of exerciſe, not indulging in ſleep, and abridging their meals, eſpecially that of ſupper. Salted meats are leſs fattening than ſuch as are freſh; and drinking freely of coffee is recommended to corpulent people.

But Dr Fothergill obſerves, that a ſtrict adherence to vegetable diet reduces exuberent fat more certainly than any other means that he knows; and gives two caſes in which this regimen ſucceeded remarkably well. The famous Dr Cheyne brought himſelf down in this way, from a moſt unwieldy bulk to a reaſonable degree of weight; as he himſelf informs us. It deſerves, however, to be remarked, that every practice for the removal or prevention of fatneſs muſt be uſed with great caution and prudence: for not a few, anxious to prevent this affection, have had recourſe to a regimen and to medicine which have proved fatal. This has particularly ariſen from the exceſſive uſe of acids, probably operating by entirely deſtroying the action of the chylopoietic viſcera.

Pneumatoſis.

Genus LXXII. PNEUMATOSIS. 336

Emphysema, or *Windy Swelling*.

Pneumatoſis, *Sauv.* gen. 280. *Vog.* 391. *Sag.* 107.
Emphyſema, *Sauv.* gen. 13. *Lin.* 288. *Vog.* 392.
Leucophlegmatia, *Lin.* 214.

The emphyſema ſometimes comes on ſpontaneouſly; but more frequently is occaſioned by wounds of the lungs, which, giving vent to the air, that fluid inſinuates itſelf into the cellular texture, and often blows it up to a ſurpriſing degree. It muſt be obſerved, however, that it is only in caſes of laceration of the lungs where this diſeaſe can take place; for in a ſimple wound, the effuſion of blood always prevents the air from getting out. The cure is to be accompliſhed by ſcarifications and compreſſes; but in ſome caſes only by the paracenteſis of the thorax. When air introduced from the lungs is collected in a conſiderable quantity in the cavity of the thorax, the operation of the paracenteſis is perhaps the only means of cure. Upon an opening being thus made, the air ſometimes ruſhes out with incredible violence; and the patient receives at leaſt immediate relief from circumſtances the moſt diſtreſſing imaginable. In ſome inſtances it is followed even by a complete cure.

Genus LXXIII. TYMPANITES. 337

Tympany.

Tympanites, *Sauv.* gen. 291. *Lin.* 219. *Vog.* 316. *Sag.* 118. *Boerh.* 226. *Junck.* 87.
Affectio tympanitica, *Hoffm.* III. 339.
Meteoriſmus, *Sauv.* gen 292.

This is an inflation of the abdomen, and is of two kinds: 1. That in which the flatus is contained in the inteſtines, in which the patient has frequent exploſions of wind, with a ſwelling of the belly commonly unequal. 2. When the flatus is contained in the cavity of the abdomen; in which caſe the ſwelling is more equal, and the belly ſounds when ſtruck, without any conſiderable emiſſion of flatus. Of theſe two, however, the former diſeaſe is by much the moſt common; inſomuch, that many, even extenſively engaged in practice, have never met with an inſtance of true abdominal tympanites. In both caſes the reſt of the body falls away.

Cauſes, &c. The tympany ſometimes takes place in thoſe who have been long troubled with flatulencies in the ſtomach and inteſtines. It happens frequently to women after abortion; to both ſexes after the ſuppreſſion of the hæmorrhoids; and ſometimes from tedious febrile diſorders injudiciouſly treated.

Prognoſis. This diſeaſe is generally very obſtinate, and for the moſt part proves fatal by degenerating in-

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to an afcites. Sometimes, if the patient be healthy and ftrong, the difeafe may terminate favourably, and that the more readily if it has followed from fome diforder. A hectic confumption, dry cough, and emaciated countenance in a tympany, with a fwelling of the feet, denote approaching death in a very fhort time.

Cure. With a view to the prevention of this affection, it is neceffary, in the firft place, to avoid, as far as it can be done, caufes giving rife to an uncommon extrication of air, by preferving the proper tone of the alimentary canal. After the affection has taken place, the indications are, firft, to expel the air already extricated and confined in different cavities; and, fecondly, to prevent further accumulation. On thefe grounds different remedies are employed. The cure, however, is principally attempted by carminative, refolvent, and ftomachic medicines, gentle laxatives, and at laft tonics, efpecially chalybeates. In the Edinburgh Medical Effays, vol. i. we have a very remarkable hiftory of a tympany by Dr Monro fenior. The patient was a young woman of 22 years of age, who fell into the diftemper after a tertian ague, in which fhe was badly treated. She became a patient in the Edinburgh Infirmary the 24th of March 1730; took feveral purgatives, and fome dofes of calomel; ufed the warm bath; and had an antihyfteric plafter applied over the whole belly, but with very little effect. She was monftroufly diftended, infomuch that the fkin feemed to be in danger of burfting: her breathing was much ftraitened: but the fwelling fometimes gradually decreafed without any evacuation. The returns and degree of this fwelling were very uncertain; and when the belly was moft detumefied, feveral unequal and protuberant balls could be felt over the whole abdomen, but efpecially at its fides. Her ftomach was good, fhe had no thirft, and her urine was in proportion to the quantity fhe drank. She was very coftive, had her menfes at irregular periods, but no œdematous fwellings appeared in the feet or any where elfe. In this fituation fhe continued from the time of her admiffion till the 21ft of June, during which interval fhe had only menftruated twice. Throughout this fpace of time, the following circumftances were obferved, 1. Several times, upon the falling of the fwelling, fhe complained of a headach; once of pains throughout all her body, once of a giddinefs, twice of a naufea and vomiting, and the laft time threw up green bile; and once her ftomach fwelled greatly, whilft the reft of the abdomen fubfided. 2. During the flowing of the menfes fhe did not fwell, but became very big upon their ftopping. 3. Blood-letting and emetics, which were made ufe of for fome accidental urgent fymptoms, had no very fenfible effect in making the tympany either better or worfe. 4. She never had paffage of wind either way, except a little belching fome days before the monthly evacuation.

Some time before the laft eruption of the menfes, the purgatives were given more fparingly; and antihyfterics of the ftrongeft kinds, fuch as afafœtida, oleum corn. cerv. &c. mixed with foap, were given in large dofes, accompanied with the hotter antifcorbutics as they are called, as horferadifh and ginger-root infufed in ftrong-ale with fteel. The patient was ordered to ufe frequent and ftrong frictions to all the trunk of her body and extremities, and to ufe moderate exercife. Immediately before the menfes began to flow, clyfters of the fame kind of medicines were injected. The menfes were in fufficient quantity; but as foon as they ceafed, her belly increafed in its circumference four inches and a half, but foon fubfided. She then complained of pains, which a gentle fweat carried off. Borborygmi were for the firft time obferved on the fame day, June 25th; and having taken fome *tinctura facra* at night, fhe paffed a fmall quantity of blood next day by ftool. This was the firft appearance of the return of the hæmorrhoids, to which fhe had been formerly fubject.

Phyfometra.

The two following days her faponaceous, antihyfteric, and antifcorbutic medicines being ftill continued, fhe had fuch explofions of wind upwards and downwards, that none of the other patients would remain in the fame room, nay fcarce on the fame floor with her. Her belly became lefs and fofter than it had been from the firft attack of the difeafe; her medicines, with a dofe of fyrup of buckthorn at proper intervals, ftill were continued, only the proportion of fteel was increafed; her flatulent difcharge went on fuccefsfully, and fhe gradually recovered her former health.

Genus LXXIV. PHYSOMETRA. 332

Windy Swelling of the Uterus.

Phyfometra, *Sauv.* gen. 290. *Sag.* 119.
Hyfterophyfe, *Vog.* 317.

The treatment of this is not different from that of the tympany. It is however, upon the whole, a very rare difeafe; and when it takes place, very feldom if ever admits of a cure.

Genus LXXV. ANASARCA. 333

Watery Swelling over the Whole Body.

Anafarca, *Sauv.* gen. 281. *Lin.* 215. *Vog.* 313. *Sag.* 108. *Boerh.* 1225. *Hoffm.* III. 322. *Junck.* 87. *Monro* on the Drofpy. *Millman* Animadverfiones de hydrope 1779.
Phlegmatia, *Sauv.* gen. 282.
Angina aquofa, *Boerh.* 791.

In this difeafe the feet firft begin to fwell, efpecially in the evening, after exercife, and when the patient has ftood or fat long; this fwelling rifes frequently to the thighs. By lying in bed, the fwelling becomes lefs, or even almoft difappears. In the progrefs of the difeafe, the fwelling often rifes to the hips, loins, and belly, and at laft covers the whole body. This difeafe, befides the other fymptoms afterwards mentioned under Ascites, is attended with a remarkable difficulty of breathing. In the cure of this, as well as other fpecies of dropfy, the general intentions are, firft, the evacuation of the water already effufed either by natural or artificial outlets: and, fecondly, the prevention of frefh accumulation, which is chiefly to be expected from fupporting a due action of the abforbents, and from keeping up a proper difcharge by the ferous excretories.

The remedies employed with thefe intentions are much the fame with what are employed againft the more

more important genus of aſcites. Only it may be here noticed, that in anaſarca it has by many been recommended to ſcarify the feet and legs. By this means the water is often diſcharged: but the operator muſt be cautious not to make the inciſions too deep; they ought barely to penetrate through the ſkin; and ſpecial care muſt be taken, by ſpirituous fomentations and proper digeſtives, to prevent a gangrene. Dr Fothergill obſerves, that the ſafeſt and moſt efficacious way of making theſe drains is by the inſtrument uſed for cupping, called a *ſcarificator;* and he always orders it to be ſo applied as to make the little wounds tranſverſely; as they not only diſcharge better, but are alſo longer in healing, than when made longitudinally.

Notwithſtanding every precaution, however, gangrene will often enſue; and it is upon the whole a much ſafer practice to evacuate the water by the natural outlets, the valvular lymphatic abſorbents; and with this intention emetics and cathartics, but particularly diuretics, are often employed with ſucceſs.

340 ## Genus LXXVI. HYDROCEPHALUS.

Water in the Head.

External or *Chronic HYDROCEPHALUS.*

Hydrocephalus, *Sauv.* gen. 285. *Lin.* 216. *Boerh.* 1217.
Hydrocephalum, *Vog.* 384.

This differs from the hydrocephalus formerly treated of at ſome length under the title of Apoplexia Hydrocephalica, chiefly in the water being collected in the external parts of the head, whereas the former is entirely within the ſkull. In the fifth volume of the Medical Obſervations we have an account of a very extraordinary caſe of this kind. The patient was a child only of a few days old, and had a tumor on his head about the ſize of a common tea-cup, which had the appearance of a bladder diſtended with water; near the apex was a ſmall opening, through which a bloody ſerum was diſcharged. In other reſpects the child was healthy. No application was uſed but a piece of linen dipt in brandy. The tumor continued to increaſe for many months; at the end of which time the membrane containing the water appeared equally thick with the other part of the ſcalp, except at one place about the ſize of a ſhilling, which continued thin, and at times appeared as if it would burſt. He remained in this ſituation for about 17 months, when the circumference of the head was 20 inches, the baſe $16\frac{1}{2}$, the middle $18\frac{1}{2}$, and from the baſe to the apex near $8\frac{1}{2}$. The water was then drawn off, and the child died in two days. Almoſt all other caſes of this diſtemper have proved fatal; the ſutures of the ſkull generally give way, and the whole external part of the head is equally enlarged: but in the inſtance juſt now given there was a deficiency of part of the bones. Although, however, in ſome inſtances, where the head is thus enlarged to an enormous ſize, the water is exterior to the brain, and therefore entitled to the appellation of hydrocephalus exterior, yet much more frequently in thoſe inſtances where there is a manifeſt ſeparation of the bones of the cranium at the ſutures, the water is ſtill contained within the ventricles; and accordingly the diſeaſe may be much more properly diſtinguiſhed into the *acute* and *chronic* hydrocephalus, than as is commonly done into the *internal* and *external.* Although the latter be much ſlower in its progreſs, ſometimes ſubſiſting even for years, yet it is equally difficult of cure with the former, and very often it proves fatal in a few days if the water be drawn off by an artificial opening, which may be very eaſily performed by a mere puncture with a common lancet, without either pain or any immediate hazard from the operation itſelf, although the water be lodged in the ventricles; for theſe are diſtended to an enormous ſize, and the ſubſtance of the brain almoſt totally deſtroyed, ſo that hardly any thing is to be punctured but membrane.

Genus LXXVII. HYDRORACHITIS. 341

Spina Bifida.

Hydrorachitis, *Sauv.* gen. 287. *Morgagn.* de ſed. XII. 9. *et ſeq.*
Spinola, *Lin.* 289.
Spina bifida, *Vog.* 386.

This diſeaſe, which conſiſts in a ſoft tumor on the lumbar vertebræ, attended with a ſeparation of the vertebræ themſelves, though generally conſidered as approaching to the nature of rachitis, is commonly referred to the article Surgery, which may be conſulted with regard to this affection.

Genus LXXVIII. HYDROTHORAX. 342

Dropsy of the Breast.

Hydrothorax, *Sauv.* gen. 150. *Vog.* 311. *Boerh.* 1219.

This affection, particularly with reſpect to its cauſes, is in many circumſtances ſimilar to other kinds of dropſy, particularly to aſcites. But from the ſituation of the water, which is here depoſited in the cavity of the thorax, it may naturally be ſuppoſed that ſome peculiar ſymptoms will occur. Beſides the common ſymptoms of dropſy, paleneſs of the countenance, ſcarcity of urine, and the like, this diſeaſe is, in ſome inſtances, attended with a fluctuation of water within the breaſt; which, when it does occur, may be conſidered as a certain diſtinguiſhing mark of this affection. But beſides this, it is alſo diſtinguiſhed by the remarkable affections of circulation and reſpiration with which it is attended.

The breathing is peculiarly difficult, eſpecially in a recumbent poſture; and in many inſtances patients cannot breathe with tolerable eaſe, unleſs when ſitting erect, or even ſtooping ſomewhat forwards. The pulſe is very irregular, and has often remarkable intermiſſions. But the diſeaſe has been thought to be principally characterized by a ſudden ſtarting from ſleep, in conſequence of an almoſt inexpreſſible uneaſy ſenſation referred to the breaſt, and attended with ſtrong palpitation, which may probably ariſe from an affection either of circulation or of reſpiration.

That theſe ſymptoms are common attendants of this diſeaſe, is undeniable; and they are certainly the beſt characteriſtics of this affection with which we are yet acquainted: but it muſt be allowed that they are preſent in ſome caſes where there is no water in the breaſt; and

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and that in other inftances where the difeafe exifts, they are either altogether wanting, or occur only to a very flight degree. Certain diagnoftics, therefore, of this difeafe ftill remain to be difcovered.

When hydrothorax is prefent, from the affection of the vital functions with which it is attended, it may readily be concluded that it is a dangerous difeafe, and in many inftances it proves fatal. The cure, as far as it can be accomplifhed, is obtained very much on the fame principles as in other dropfies. Here, however, probably from the uncertainty of the diagnoftics, the artificial abftraction of water, by paracentefis of the thorax, is lefs frequently had recourfe to than in afcites; though in fome inftances, after other means have failed, it has been faid not only to give relief of fymptoms highly urgent, particularly dyfpnœa, but even to produce a complete cure. Benefit is often obtained from an artificial difcharge of water by the application of blifters to the breaft: but in this, as well as other dropfies, a difcharge is chiefly effected by the natural outlets, particularly from the ufe of cathartics and diuretics. In this fpecies of dropfy, more perhaps than in any other, recourfe has been had to the ufe of the digitalis purpurea, or foxglove, fo ftrongly recommended as a diuretic by Dr Withering in his treatife refpecting the ufe of it. There can be no doubt that this article, though fometimes productive of inconvenience from the diftreffing ficknefs and fevere vomiting which it not unfrequently excites, though ufed even but in fmall dofes, often operates as a powerful diuretic, and produces a complete evacuation of water, after other articles have failed. From the effects mentioned above, however, as well as from its influence on the pulfe, which it renders much flower, it is neceffary that it fhould be employed with great caution, and in fmall dofes. A dram of the dried leaves of the digitalis, macerated for four hours in half a pint of warm water, forms an infufion which may be given in dofes of an ounce, and the dried powder of the leaves in dofes of one or two grains: thefe dofes may be gradually increafed, and repeated twice or oftener in the day; but this requires to be done with great caution, left fevere vomiting, or other diftreffing fymptoms, fhould take place.

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Genus LXXIX. ASCITES.

Dropsy of the *Abdomen*.

Afcites, *Sauv.* gen. 288. *Lin.* 217. *Vog.* 314. *Sag.* gen. 115. *Boerh.* 1226. *Hoffm.* III. 322. *Junck.* 87. *Dr Monro* on the Dropfy, 1765. *Milman*, Animadverfiones de Hydrope, 1779.

Defcription. This difeafe affumes three different forms: 1. When the water immediately wafhes the inteftines. 2. When it is interpofed between the abdominal mufcles and peritonæum. Or, 3. When it is contained in facs and hollow veficles: in which cafe it is called the *encyfted dropfy*. Some phyficians of great reputation have afferted, that the water was often placed within the duplicature of the peritonæum: but this is alleged by Dr Milman to be a miftake, as that membrane is looked upon by the beft anatomifts to be fingle; and he thinks that the above-mentioned phyficians have been led into this error from obferving the water collected in the cellular fubftance of the peritonæum.

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In the beginning of an afcites the patient becomes languid, breathlefs, and has an averfion to motion: his belly fwells; and, when ftruck, the found of fluctuating water is perceptible; there is a difficulty of breathing when the belly is preffed. There is an almoft continual thirft, which in the progrefs of the difeafe becomes very urgent; the urine is thick, in fmall quantity, and high coloured. The pulfe is fmall and frequent; and as the belly fwells, the other parts wafte away. A fever at laft arifes, which, conftantly increafing, in the end carries off the patient. Thefe fymptoms are moft urgent where the waters are in immediate contact with the inteftines; in the other kinds the reft of the body is lefs wafted; nor is there fo great thirft or difficulty of breathing.

Caufes, &c. The immediate caufe of dropfy is a greater effufion of ferum by the exhalant arteries than the abforbents take up. This may be occafioned either by too great a quantity of liquid thrown out by the former, or by an inability of the latter to perform their office. This commonly happens in people whofe bodies are of a weak and lax texture, and hence women are more fubject to this malady than men; chlorotic girls efpecially are very apt to become dropfical.

Sometimes, however, this difeafe is occafioned by a debility of the vital powers, by great evacuations of blood, or by acute difeafes accidentally protracted beyond their ufual period; and although this caufe feems very different from a laxity of fibres, yet the dropfy feems to be produced in a fimilar manner by both. For the vital powers being debilitated by either of thefe caufes, naturally bring on a certain debility and laxity of the folids; and, on the other hand, a debility of the folids always brings on a debility of the vital powers; and from this debility of the vital powers in both cafes it happens, that thofe humours which ought to be expelled from the body are not difcharged, but accumulate by degrees in its cavities. There, is, however, this difference between the two kinds of dropfy arifing from thefe two different caufes: That in the one which arifes from laxity the folid parts are more injured that in that which arifes from a debility of the vital powers. In the former, therefore, the water feems to flow out from every quarter, and the body fwells all over. But when the difeafe is occafioned by a debility of the vital powers, though the folids be lefs difeafed, yet the power of the heart being much diminifhed, and the humours fcarce propelled through the extreme veffels, the thin liquids, by which in a healthy ftate the body is daily recruited, are carried by their own weight either into the cavities or into the cellular texture. Hence thofe aqueous effufions which follow great evacuations of blood, or violent loofeneffes, begin in the more depending parts of the body, gradually afcending, till they arrive at the cavity of the abdomen, or even the thorax.

But another and much more fufficient caufe for the production of dropfy is an obftruction of the circulation; and this may take place from polypi in the heart or large veffels, and hard fwellings in the abdomen. Inftances have been obferved of a dropfy arifing from fteatomatous tumors in the omentum, and many more from a fcirrhous liver or fpleen, and from an infarction

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tion and obstruction of the mesenteric glands, by which means the lymph coming from the extremities is prevented from arriving at the heart. Scirrhosity of the liver, the most common cause of ascites, probably operates by augmenting effusion, in consequence of its preventing the return of the venous blood, the greater part of the veins from the abdomen going to the formation of the vena portarum.

Lastly, Whatever, either within or without the vessels, contracts or shuts up their cavities, produces a more copious and easy transmission of the thin humours through the exhalant arteries, at the same time that it prevents their return by the absorbent veins. This has been established by experiment: For Lower having perforated the right side of the thorax in a dog, tied the *vena cava*, and sewed up the wound. The animal languished for a few hours, and then died. On dissection, a great quantity of serum was found in the abdomen, as if he had long laboured under an ascites. In like manner, having tied the jugular veins of another dog, a surprising swelling took place in those parts above the ligatures, and in two days the animal died. On dissection, all the muscles and glands were vastly distended, and quite pellucid, with limpid serum. From these experiments, and some cases of the disease mentioned by different authors, it appears, that when the veins are obstructed so that they cannot receive the arterial blood, the serum is separated as by a filtre into the more open cavities and laxer parts of the body, while the thicker part stagnates and is collected in the proper blood-vessels.

The too great tenuity of the humours is very frequently accused as the cause of dropsy, and many authors have asserted that dropsy might arise merely from a superabundance of water in the blood. For this, some experiments are quoted, from which they would infer, that when a great quantity of aqueous fluid is introduced into the blood, the superfluous fluid ought by no means to pass through the extremities of the sanguiferous arteries into the veins in the common course of circulation, but by being effused into the cavities should produce a dropsy. But this can only happen when the vital powers are very much diminished; for, in a natural state, the superfluous quantity is immediately thrown out by the skin or the kidneys: and agreeable to this we have an experiment of Schultzius, who induced a dropsy in a dog by causing him drink a great quantity of water; but he had first bled him almost *ad deliquium*, so that the vital powers were in a manner oppressed by the deluge of water. In this manner do those become hydropic who are seized with the disease on drinking large quantities of water either when wearied with labour, or weakened by some kinds of diseases. Dr Fothergill relates an instance of a person who, being advised to drink plentifully of barley-water, in order to remove a fever, rashly drunk 12 pounds of that liquor every day for a month, and thus fell into an almost incurable dropsy. But if this quantity had been taken only during the prevalence of the fever, he would, in all probability, have suffered no inconvenience, as may be inferred from what has been related concerning the *dieta aquea* used by the Italians.

It is moreover evident from experiments, that, in a healthy state, not only water is not deposited in the cavities, but that if it is injected into them it will be absorbed, unless some laxity of the solids has already taken place. Dr Musgrave injected into the right side of the thorax of a dog four ounces of warm water; whence a difficulty of breathing and weakness immediately followed. But these symptoms continually lessened, and in the space of a week the animal seemed to be in as good health as before. Afterwards he injected 16 ounces of warm water into the left cavity of the thorax in the same dog; the same effects followed, together with great heat, and strong pulsation of the heart; but he again recovered in the space of a week. Lastly, He injected 18 ounces of water into one side of the thorax, and only six into the other: the same symptoms followed, but vanished in a much shorter time; for within five days the dog was restored to perfect health. During this time, however, he observed that the dog made a greater quantity of urine than usual.

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The remote causes of dropsy are many and various. Whatever relaxes the solids in such a manner as to give an occasion of accumulation to the serous fluids, disposes to the dropsy. A lazy indolent life, rainy wet weather, a swampy or low soil, and every thing which conduces to vitiate the viscera, or insensibly to produce obstructions in them, paves the way for a dropsy. Hence those are ready to fall into the disease who use hard and viscid aliments, such as poor people in some countries who use coarse brown bread, and children who are fed with unwholesome aliments; and the same thing happens to those who drink immoderately of spirituous liquors.

Prognosis. When the dropsy arises from a scirrhus of the liver or spleen, or any of the other viscera, the prognosis must always be unfavourable, and also when it arises from disorders of the lungs. Neither is the case more favourable to those in whom the small vessels are ruptured, and pour out their liquids into the cavity of the abdomen. Those certainly die who have polypi in the vessels, or tumors compressing the veins and vessels of the abdomen. A dropsy arising from obstructions in the mesenteric glands is likewise difficult to cure, whether such obstructions arise from a bad habit of body, or from any other cause; if we can, however, by any means remove the disease of the glands, the dropsy soon ceases. But in those who fall into dropsy without any disease preceding, it is not quite so dangerous; and even though a disease has preceded, if the patient's strength be not greatly weakened, if the respiration be free, and the person be not affected with any particular pain, we may entertain great hopes of a cure. But where a great loss of blood is followed by a fever, and that by a dropsy, the patients almost always die, and that in a short time: those, however, are very frequently cured who fall into this disease without any preceding hæmorrhage.

Cure. In the cure of this disease authors chiefly mention two indications: 1. To expel the effused water; and, 2. To prevent its being again collected. But before we proceed to speak of the remedies, it is necessary to take notice, that by the laws of the animal economy, if a great evacution of a fluid takes place in any part of the body, all the other fluids in the body are directed towards that part, and those which lie, as it were, lurking in different parts will be immediated absorbed, and thrown out by the same passage. Hence the humours which in hydropic persons

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sons are extravasated into the different cavities of the body will be thrown into the intestines, and evacuated by purgatives; or by diuretics will be thrown upon the kidneys, and evacuated by urine. It is, however, not only necessary to excite these evacuations in order to remove this malady, but they must be assiduously promoted and kept up till the abundant humour is totally expelled. For this reason Sydenham has advised purgatives to be administered every day, unless, either through the too great weakness of the body, or the violent operation of the purgative, it shall be necessary to interpose a day or two now and then; because if any considerable intervals be allowed to take place between the exhibition of the purgatives, an opportunity is given to the waters of collecting again. In this method, however, there is the following inconvenience, that, when the waters are totally evacuated, the strength is at the same time so much exhausted, that the distemper commonly returns in a very short time. Hence our chief hopes of curing a dropsy consist in gently evacuating the waters by means of diuretics. But the efficacy of these is generally very doubtful. Dr Freind has long ago observed, that this part of medicine is of all others the most lame and imperfect; but a French physician, Mr Bacher, lately discovered, as he alleges, a method of making the diuretics much more successful. His reputation became at last so great, that the French king thought proper to purchase his secret for a great sum of money. The basis of his medicine was the black hellebore root, the malignant qualities of which he pretended to correct in the following manner: A quantity of the dried roots of black hellebore were pounded, and then put into a glazed earthen vessel, and afterwards sprinkled with spirit of wine. They were suffered to stand for twelve hours, stirring them about twice or thrice during that space of time. They were then sprinkled again, and at last good Rhenish wine was poured on till it stood six fingers above the roots. The mixture was frequently agitated with a wooden spatula; and as the wine was imbibed by the roots, more was poured on, so as to keep it always at the same height for 48 hours. The whole was then put on the fire and boiled for half an hour, after which the decoction was violently pressed out; the same quantity of wine was added as at first, and the mixture boiled as before. After the second expression the woody residuum was thrown away as useless. Both the strained liquors were then mixed together with two parts of boiling water to one of the decoction. The whole is afterwards evaporated in a silver vessel to the consistence of a syrup. One part of the extract is again mixed with two parts of boiling water, and the whole inspissated as before.—By this means, says he, the volatile nauseous acrid particles are separated by evaporation, and the fixed ones remain corrected and prepared for medicinal uses; adding, towards the end, a ninth part of old brandy, and evaporating to the consistence of turpentine. Mr Bacher reasons a good deal on the way in which this process corrects the medicine; but tells us, that notwithstanding the improvement, his pills will not have the desired effect unless properly made up. For forming them, they ought to be mixed with matters both of an inviscating and indurating nature; yet so prepared that it will be readily soluble in the stomach, even of a person much debilitated. For answering these purposes, he chose myrrh and carduus benedictus, and he gives the following receipt for the formation of his pills:—

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"Take of the extract of hellebore prepared as above directed, and of solution of myrrh, each one ounce; of powdered carduus benedictus, three drams and a scruple. Mix them together, and form into a mass, dividing it into pills of a grain and a half each." To these pills Mr Bacher gives the name of the *pilulæ tonicæ*, from an idea, that, while they evacuate the water, they at the same time act as tonics; and thus, from augmenting the action of the lymphatics, prevent the return of the disease. And if both these intentions could be effectually answered by the use of the same remedy, it would unquestionably be of great importance in practice.

The effects of these pills were, we are told, very surprising. Dr Daignan relates that he gave them to eighteen hydropic patients at once; and these he divided into three classes, according to the degree of the disease with which they were affected. The first class contained those who laboured under an anasarca following intermittent fevers. The second class contained those who had an anasarca, together with some degree of ascites, arising from tedious febrile disorders. All these were cured; but these two classes consisted of such cases as are most easily removed. But the third contained six who were seized with a most violent anasarca and ascites, after being much weakened by tedious disorders, and of consequence in whom the disease was very difficult to be cured. Even of these, however, four were cured, and the other two died. The body of one of these being dissected, both sides of the cavity of the thorax were found to be full of a blackish-red water. The lungs were unsound; there was a polypous concretion in the right ventricle of the heart: the liver and spleen were hard, and of a preternatural bulk; and the glands of the mesentery were obstructed and infarcted. In the other, the liver and pancreas were scirrhous, and the spleen very hard.

The same medicines were given to De Horne to eight persons, six of whom had both an anasarca and ascites, but the other two only an ascites. Four of these recovered; three died without being freed from the dropsy; one in whom the dropsy was cured died in a short time after, having for some time before his death become speechless.

By these patients ten of the pills were taken at once; and the same dose repeated to the third time, with an interval of an hour betwixt each dose. At first they proved purgative, and then diuretic: by which last evacuation they finally cured the disease. But though Mr Bacher was firmly of opinion that his pills cured the dropsy by reason of the above-related correction, yet it is certain that, in the hands of other practitioners, these very pills have failed, unless they also made use of the same regimen recommended by that physician; while, on the other hand, it is also certain, that different medicines will prove equally efficacious in dropsical cases, provided this regimen is made use of.

For a great number of ages it has been recommended to dropsical patients to abstain as much as possible from drink, and thus to the torments of their disease was added that of an intolerable thirst; and how great this torment was, we may understand from an example of a friend of King Antigonus, who, having been

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been closely watched both by order of the physicians and also of the king, was so unable to bear the raging thirst occasioned by his disease, that he swallowed his own excrements and urine, and thus speedily put an end to his life. Dr Milman shows at great length the pernicious tendency of this practice. He maintains that it is quite contrary to the sentiments of Hippocrates and the best ancient physicians. He asserts, that unless plenty of diluting drink be given, the best diuretics can have no effect. He condemns also in the strongest terms the practice of giving dropsical patients only dry, hard, and indigestible aliments. These would oppress the stomach even of the most healthy; and how much more must they do so to those who are already debilitated by labouring under a tedious disorder! By what means also are these aliments to be dissolved in the stomach when drink is withheld? In this disease the saliva is viscid, and in small quantity; from whence it may be reasonably conjectured, that the rest of the fluids are of the same nature, and the gastric juices likewise depraved. Thus the aliments lie long in the stomach; and if the viscera were formerly free of obstructions, they are now generated; the strength fails; perspiration and other excretions are obstructed; the viscid and pituitous humours produced by these kinds of food float about the præcordia, and increase the disease, while the surface of the body becomes quite dry. Nay, so much does this kind of diet conspire with the disease, that 100 pounds of fluid will sometimes be imbibed in a few days by hydropic persons who take no drink. Even in health, if the body from any cause becomes dry, or deprived of a considerable part of its juices, as by hunger, labour, &c. it will imbibe a considerable quantity of moisture from the air; so that we must impute the above-mentioned extraordinary inhalation, in part at least, to the denial of drink, and to the nature of the aliment given to the sick. The following is the account given by Sir Francis Milman of his practice in the Middlesex hospital.

If the patient be not very much debilitated, he is sometimes treated with the purging waters, and a dose of jalap and calomel alternately. On the intermediate days he gets a saline mixture, with 40 or 60 drops of *acetum scilliticum* every sixth hour; drinking with the purgatives oat-gruel and some thin broths. That he might the better ascertain what share the liquids given along with the medicines had in producing a copious flow of urine, he sometimes gave the medicines in the beginning of the distemper without allowing the drink: but though the swellings were usually diminished a little by the purgatives, the urine still continued scanty, and the patients were greatly weakened. Fearing, therefore, lest, by following this course, the strength of the sick might be too much reduced, he then began his course of diuretic medicines, giving large quantities of barley water with a little *sal diureticus;* by which means, sometimes in the short space of 48 hours after the course was begun, the urine flowed out in very large quantity: but as saline drinks are very disagreeable to the taste, a drink was composed purposely for hydropic persons, of half an ounce of supertartrite of potash, dissolved in two pounds of barley-water, made agreeably sweet with syrup, adding one or two ounces of French brandy.

To this composition Sir Francis Milman was induced by the great praises given to supertartrite of potash by some physicians in hydropic cases. In the *Acta Bononiensia*, 15 cases of hydropic patients are related who were cured only by taking half an ounce of cream of tartar daily. But it is remarkable, that by these very patients the cream of tartar was taken for 20, 30, nay 40 days, often without any perceptible effect; yet when dissolved in a large quantity of water, it showed its salutary effects frequently within as many hours, by producing a plentiful flow of urine. This liquor is now the common drink of hydropic patients in the hospital above mentioned, of which they drink at pleasure along with their medicines.

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Among purgative medicines Sir Francis Milman recommends the *radix senekæ;* but says the decoction of it, according to the Edinburgh Pharmaeopœia is too strong, as he always found it excite vomiting when prepared as there directed, and thus greatly to distress the patients: but when only half an ounce or six drams of the root are used to a pound of decoction, instead of a whole ounce as directed by the Edinburgh college, he finds it an excellent remedy; and though it may sometimes induce a little vomiting, and frequently a nausea, yet it seldom failed to procure nine or ten stools a-day, and sometimes also proved diuretic. But we must take care not to be too free in the use of seneka, or any other purgative, if the patients be very weak; and therefore, after having used purgatives for some time, it will be proper to depend upon diuretics entirely for perfecting the cure; and of the success of this method our author gives some very remarkable instances. But he observes, that after the dropsy is removed, the patients will sometimes die without any evident cause; and of this it is proper that the physicians should be aware. It is remarkable with what ease a flux of urine is induced in those who have a scirrhous liver; while, on the other hand, in one who had the mesenteric glands obstructed, along with a scirrhosity of the liver and vitiated state of the lungs, the most powerful diuretics proved ineffectual. In some cases Sir Francis Milman thinks the kidneys may be so pressed with the weight of the water, as to be unable to perform their office. With regard, however, to diuretics in general, it may be remarked, that the operation of none of them can be certainly depended upon. In particular constitutions, and at particular times, one will be observed to succeed, after another, though commonly much more powerful, has been tried in vain. Accordingly various articles of this kind are often used in succession. Recourse is particularly often had to the root of taraxacum, of colchicum, and of squills; the latter, especially when combined with calomel, is often found to be a very powerful diuretic. And indeed mercury in different forms, probably from acting as a deobstruent, is often of very great use in dropsical complaints. Among other diuretics, the lactuca virosa has of late been highly extolled by Dr Collins of Vienna, and the nicotiana tabaccum by Dr Fowler of York: but neither has been extensively introduced into practice, although we have known some instances in which the latter, in particular, has been used with great advantage.

The water having been drawn off, we are to put the patient on a course of strengtheners; such as cinchona, with some of the warm aromatics, and a due proportion of

Intumescentiæ. of rhubarb infused in wine and chalybeates. Gentle exercise, and frictions on the belly, with such a course of diet as shall be light and nourishing, are also to be enjoined: and it may be observed, that the use of tonic medicines is by no means to be delayed till a complete evacuation of the water can be obtained. On the contrary, by alternating, and even combining the use of evacuants and tonics, the influence of both is often very much promoted.

When the patient can by no other means be relieved, the operation of paracentesis must be had recourse to, which is described under the article SURGERY.

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GENUS LXXX. HYDROMETRA.

DROPSY of the *Uterus*.

Hydrometra, *Sauv.* gen. 289. *Sag.* 116. *Boerh.* 1224.

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GENUS LXXXI. HYDROCELE.

DROPSY of the *Scrotum*.

Oscheocele, *Sauv.* gen. 41. *Vog.* 388.
Oscheophyma, *Sag.* 44.
Hydrops scroti, *Vog.* 389.
Hydrops testium, *Boerh.* 1227.

For the treatment of these two diseases, we may refer the reader to what has already been said of other species of dropsy, particularly Ascites. But both are chiefly to be combated by chirurgical operation, especially the latter, in which it seldom fails to produce a complete cure.

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GENUS LXXXII. PHYSCONIA.

SWELLING of the *Belly*.

Physconia, *Sauv.* gen. 283. *Vog.* 325. *Sag.* gen. 110.
Hyposarca, *Lin.* 218.

This disease may arise from a variety of causes, as from a swelling of the liver, spleen, kidneys, uterus, omentum, ovarium, mesentery, intestines, &c. and sometimes it arises merely from fat. In the former cases, as the viscera are generally scirrhous and indurated, the distemper is for the most part incurable; neither is the prospect much better where the disease is occasioned by a great quantity of fat.

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GENUS LXXXIII. RACHITIS.

The *RICKETS*.

Rachitis, *Sauv.* gen. 294. *Lin.* 212. *Vog.* 312. *Sag.* gen. 120. *Boerh.* 1480. *Hoffm.* III. 487. *Zeviani* della Rachitide. *Glisson* de Rachitide.

Description. This is one of the diseases peculiar to infancy. It seldom attacks children till they are nine months, nor after they are two years old; but it frequently happens in the intermediate space between these two periods. The disease shows itself by a flaccid tumor of the head and face, a loose flabby skin, a swelling of the abdomen, and falling away of the other parts, especially of the muscles. There are protuberances of the epiphyses of the joints; the jugular veins swell, while the rest decrease; and the legs grow crooked. If the child has begun to walk before he be seized with this disease, there is a slowness, debility, and tottering in his motion, which soon brings on a constant desire of sitting, and afterwards of lying down; insomuch that nothing at last is moveable but the neck and head. As they grow older, the head is greatly enlarged, with ample sutures; the thorax is compressed on the sides, and the sternum rises up sharp, while the extremities of the ribs are knotty. The abdomen is protuberant, and the teeth black and carious. In such patients as have died of this disease, all the solids appear soft and flaccid, and the fluids dissolved and mucous. Rachitis.

Causes. The rickets may proceed from scrophulous or venereal taints in the parents, and may be increased by those of the nurse. It is likewise promoted by feeding the child with aqueous and mucous substances, crude summer fruits, fish, unleavened farinaceous aliment, and too great a quantity of sweet things.—Sometimes it follows intermittent fevers and chronic disorders; and in short, is caused by any thing which tends to debilitate the body, and induce a viscid and unhealthy state of the juices.

Prognosis. The rickets do not usually prove fatal by themselves, but if not cured in time, they make the person throughout life deformed in various ways; and often produce very pernicious disorders, such as carious bones in different parts of the body.

Cure. This is to be effected by mild cathartics, alteratives, and tonics, such as are used in other diseases attended with a debility of the system and a vitiated state of the blood and juices. In the Western islands of Scotland, the medicine used for the cure of the rickets is an oil extracted from the liver of the skate-fish. The method of application is as follows: First, the wrists and ankles are rubbed with the oil in the evening: this immediately raises a fever of several hours duration. When the fever from the first rubbing subsides, the same parts are rubbed again the night following; and repeatedly as long as the rubbing of these parts continues to excite the fever.—When no fever can be excited by rubbing the wrists and ankles alone, they are rubbed again along with the knees and elbows. This increased unction brings on the fever again; and is practised as before, till it no longer has that effect. Then the vertebræ and sides are rubbed, along with the former parts; and this unction, which again brings on the fever, is repeated as the former. When no fever can be any longer excited by this unction, a flannel shirt dipped in the oil is put upon the body of the patient: this brings on a more violent and sensible fever than any of the former unctions; and is continued till the cure be completed, which it commonly is in a short time.

A German physician, Dr Strack, has lately published a paper, in which he recommends the filings of iron as a certain remedy in the rickets. This disease, he observes, in general begins with children when they are about 16 months old. It is seldom observed with children before they be one year old, and seldom attacks them after they pass two; and it is very generally worse where it begins early than where it begins late.

For

Impetigines.

For effecting a cure, it is, he affirms, a matter of the utmost consequence to be able to distinguish, very early, whether a child will be afflicted with rickets or not. And this, he assures us, may be determined by the following symptoms: Paleness and swelling of the countenance; and in that part of the cheeks which should naturally be red, a yellow colour approaching to that of sulphur. When that is the case, he directs that a medicine should be immediately had recourse to which will retard the further progress of the disease, and remove what has already taken place. For this purpose, he advises that five grains of the filings of iron, and as much rhubarb, should be rubbed up with ten grains of sugar, and given for a dose every morning fasting, and every evening an hour before supper. But if considerable looseness should be produced, it will be necessary, at first, to persist in the use of one dose only every day.

After a month's continuance in this course, according to Dr Strack, there in general ensues a keen appetite for food, quick digestion, and a copious flow of urine; by means of which the fulness of the face and yellowness of the complexion are by degrees removed, while the natural colour of the countenance and firmness of the body in general are gradually restored. This practice, he assures us, has never failed of success in any one instance; not even in those children born of parents greatly afflicted with the rickets.

In addition to the use of chalybeates, great benefit is often also obtained in this disease from the use of the cold bath; which under prudent administration, is perhaps one of the most effectual remedies for this complaint with which we are yet acquainted.

Mr Bonhome of Paris, in a late treatise on the subject of rachitis, has endeavoured to prove, that the disease arises from a peculiar acid, and in the cure he particularly recommends phosphate of soda, phosphate and muriate of lime; but above all other articles alkaline lotions. The efficacy of these remedies, however, is not yet confirmed by experience. And we may conclude with observing, that both in the prevention and cure nothing has been found so successful as cold bathing.

When the bones of rickety children begin to bend, they may sometimes be restored to their natural shape by compresses, bolsters, and proper supports. See the article SURGERY.

348 ORDER III. IMPETIGINES.

Impetigines, *Sauv.* Class X. Ord. V. *Sag.* Class III. Ord. V.

349 GENUS LXXXIV. SCROPHULA.

KING'S EVIL.

Scrophula, *Sauv.* gen. 285. *Vog.* 397. *Sag.* 121.
Struma, *Lin.* 284.

Description. This disease shows itself by hard, scirrhous, and often indolent tumors, which arise by degrees in the glands of the neck, under the chin, armpits, and different parts of the body, but most commonly in the neck, and behind the ears. In process of time, the cellular substance, ligaments of the joints, and even the bones themselves, are affected. In scrophula the swellings are much more moveable than those of the scirrhous kind; they are generally softer, and seldom attended with much pain; they are tedious in coming to suppuration; are very apt to disappear suddenly, and again to rise in some other part of the body. We may likewise mention as characteristic circumstances of this disease, a remarkable softness of the skin, a kind of fulness of the face, generally with large eyes, and a very delicate complexion.

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Causes. A variety of causes have been mentioned as tending to produce scrophula, viz. a crude indigestible food; bad water; living in damp, low situations; its being an hereditary disease, and in some countries endemic, &c. But whatever may in different circumstances be the exciting or predisposing causes of the scrophula, the disease itself either depends upon, or is at least much connected with, a debility of the constitution in general, and probably of the lymphatic system in particular, the complaint always showing itself by some affections of the latter. And that debility has at least a considerable influence in its production is probable, not only from the manifest nature of some of the causes said to be productive of scrophula, but likewise from such remedies as are found most serviceable in the cure, which are all of a tonic invigorating nature.

Prognosis. The scrophula is a distemper which often eludes the most powerful medicines, and therefore physicians cannot with any certainty promise a cure. It is seldom, however, that it proves mortal in a short time, unless it attacks the internal parts, such as the lungs, where it frequently produces tubercles that bring on a fatal consumption. When it attacks the joints, it frequently produces ulcers, which continue for a long time, and gradually waste the patient; while in the mean time the bones become foul and corroded, and death ensues after a long scene of misery. The prognosis in this respect must be regulated entirely by the nature of the symptoms.

Cure. It was long supposed that scrophula depended upon an acid acrimony of the fluids; and this, it is probable, gave rise to the use of burnt sponge, different kinds of soap, and other alkaline substances, as the best remedies for acidity. But although a sourness of the stomach and *primæ viæ* does no doubt frequently occur in these complaints, yet this symptom seems to be entirely the consequence of that general relaxation which in scrophula so universally prevails, and which does not render it in the least necessary to suppose a general acescency of the fluids to take place; as the one very frequently, it is well known, even in other complaints, occurs without the least suspicion of any acid acrimony existing in the other. This is also rendered very probable from the indolent nature of scrophulous tumors, which have been known to subsist for years without giving any uneasiness; which could not have been the case, if an acid, or any other acrimony, had prevailed in them.

In the treatment of scrophula, different morbid conditions, existing in different parts, require, according to circumstances, various means of cure: but, upon the whole, the remedies directed may be considered as used with a view either to the tumours, to the ulcerations, or to the general state of the system.

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Gentle mercurials are sometimes of use as resolvents in scrophulous swellings; but nothing has such considerable influence as a frequent and copious use of cinchona. Cold bathing too, especially in the sea, together with frequent moderate exercise, is often of singular service here; as is likewise change of air, especially to a warm climate.

In the scrophulous inflammation of the eyes, or ophthalmia strumosa, the cinchona has also been given with extraordinary advantage: and we meet with an instance of its having cured the gutta rosacea in the face; a complaint which it is often difficult to remove, and which is extremely disagreeable to the fair sex.

From the various cases related of tumefied glands it appears, that when the habit is relaxed and the circulation weak, either from constitution or accident, cinchona is a most efficacious medicine, and that it acts as a resolvent and discutient. It will not, however, succeed in all cases; but there are few in which a trial can be attended with much detriment. Dr Fothergill observes, that he has never known it avail much where the bones were affected, nor where the scrophulous tumor was so situated as to be accompanied with much pain, as in the joints, or under the membranous coverings of the muscles; for when the disease attacks those parts, the periostæum seldom escapes without some injury, by which the bone will of course be likewise affected. Here cinchona is of no effect: instead of lessening, it rather increases the fever that accompanies those circumstances: and, if it do not really aggravate the complaint, it seems at least to accelerate the progress of the disease.

Various are the modes in which cinchona is administered: Dr Fothergill makes use of a decoction, with the addition of some aromatic ingredients and a small quantity of liquorice root, as a form in which a sufficient quantity may be given without exciting disgust. But where it is easily retained in the stomach in substance, perhaps the best form of exhibiting it is that of powder; and in this state it is often advantageously conjoined with powder of cicuta, an article possessing very great deobstruent powers.

The powder, however, soon becomes disagreeable to very young patients; and the extract seems not so much to be depended upon as may have been imagined. In making the extract, it is exposed to so much heat, as must have some effect upon its virtues, perhaps to their detriment. In administering it, likewise, if great care be not taken to mix it intimately with a proper vehicle, or some very soluble substance, in weak bowels it very often purges, and thereby not only disappoints the physician, but injures the patient. A small quantity of the *cortex Winteranus* added gives the medicine a grateful warmth; and a little liquorice, a few raisins, gum arabic or the like, added to the decoction before it be taken from the fire, by making the liquor viscid enables it to suspend more of the fine particles of the bark; by which process the medicine is not only improved in efficacy, but at the same time rendered less disagreeable.

In indolent swellings of the glands from viscid humours, sea water has been strongly recommended by Dr Russel.

Dr Fothergill also acquaints us, that the cicuta even by itself is not without a considerable share of efficacy in removing scrophulous disorders. He mentions the case of a gentlewoman, about 28 years of age, afflicted from her infancy with scrophulous complaints, severe ophthalmies, glandular swellings, &c. cured by the *extractum cicutæ* taken constantly for the space of a year. He observes, however, that when given to children, even in very small doses, it is apt to produce spasmodic affections; for which reason he rarely exhibits it to them when very young, or even to adults of very irritable habits.

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Dr Fothergill gives several other instances of the success of cicuta in scrophulous cases, and even in one which seemed to be not far removed from a confirmed phthisis; but owns that it seldom had such good effects afterwards: yet he is of opinion, that where there are symptoms of tubercles forming, a strumous habit, and a tendency to phthisis, the cicuta will often be serviceable. It is anodyne, corrects acrimony, and promotes the formation of good matter. With regard to the quality of the medicine, he observes, that the extract prepared from hemlock before the plant arrives at maturity, is much inferior to that which is made when the hemlock has acquired its full vigour, and is rather on the verge of decline: just when the flowers fade, the rudiments of the seeds become observable, and the habit of the plant inclines to yellow; this, he thinks, is the proper time to collect the hemlock. It has then had the full benefit of the summer heat; and the plants that grow in exposed places will generally be found more active than those that grow in the shade. The less heat it undergoes during the preparation, the better. Therefore, if a considerable quantity of the dry powder of the plant gathered at a proper season be added, less boiling will be necessary, and the medicine will be the more efficacious. But let the extract be prepared in what manner soever it may, provided it be made from the genuine plant, at a proper season, and be not destroyed by boiling, the chief difference observable in using it is, that a larger quantity of one kind is required to produce a certain effect than of another. Twenty grains of one sort of extract have been found equal in point of efficacy to thirty, nay near forty, of another; yet both of them made from the genuine plant, and most probably prepared with equal fidelity. To prevent the inconveniences arising from this uncertainty, it seems always expedient to begin with small doses, and proceed step by step till the extract produces certain effects, which seldom fail to arise from a full dose. These effects are different in different constitutions. But, for the most part, a giddiness affecting the head, and motions of the eyes, as if something pushed them outwards, are first felt; a slight sickness, and trembling agitation of the body; a laxative stool or two. One or all of these symptoms are the marks of a full dose, let the quantity in weight be what it will. Here we must stop till none of these effects be felt; and in three or four days advance a few grains more. For it has been supposed by most of those who have used this medicine to any good purpose, that the cicuta seldom procures any benefit, though given for a long time, unless in as large a dose as the patient can bear without suffering any of the inconveniences above mentioned. There is however reason to believe, that its effects, as a discutient, are in no degree dependent on its narcotic powers: and

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and we are inclined to think, that recourse is often had to larger doses than are necessary; or at least that the same benefit might be derived from smaller ones continued for an equal length of time.

Patients commonly bear a greater quantity of the extract at night than at noon, and at noon than in the morning. Two drams may be divided into thirty pills. Adults begin with two in the morning, two at noon, and three or four at night, with directions to increase each dose, by the addition of a pill to each, as they can bear it.

But, after all, the best form under which the cicuta can, we think, be exhibited, is that of powder from the leaves. This, either under the form of powder or made into pills, may be given at first to the extent of four or five grains, and the dose gradually rising till it amount to 15 or 20 grains twice or thrice a-day. Given to this extent, particularly when conjoined with cinchona, it has often been found of great service in scrophulous cases. At the same time it must be allowed, that such patients, after resisting every mode of cure, will have in some instances a spontaneous recovery in the progress of life, probably from the system acquiring additional vigour.

Different mineral waters, particularly the sulphureous ones, as those of Harrowgate, Moffat, and Gillsland, have been much recommended in scrophula, and sometimes productive of benefit. Recourse has sometimes also been had with advantage to zinc, iron, and barytes, particularly muriate of barytes. But as well as in rachitis, no remedy has been found more efficacious in scrophula than cold bathing, especially sea-bathing.

350 Genus LXXXV. SIPHYLIS.

Lues Venerea, or *French Pox*.

Siphylis, *Sauv.* gen. 3086. *Lin.* 6. *Vog.* 319. *Sag.* 126.

Lues venerea, *Boerh.* 1440. *Hoffm.* III. 413. *Junck.* 96. *Astruc* de Lue Venerea.

Dr Astruc, who writes a very accurate history of the lues venerea, is fully convinced that it is a new disease, which never appeared in Europe till some time between the years 1494 and 1496, having been imported from America by the companions of Christopher Columbus; though this opinion is not without its opponents. Dr Sanches in particular has contended with much learning and ability, that it appeared in Europe at an earlier period: But it is at least certain that it was altogether unknown to the medical practitioners of Greece and Rome, and that it was a very common disease in America when the Europeans first visited that country. But at whatever period it may have been introduced into Europe, or from whatever source it may have been obtained, there can be no doubt that, as well as smallpox or measles, siphylis depends on a peculiar specific contagion; on a matter *sui generis*, which is alone capable of inducing this disease.

The venereal infection, however, cannot, like the contagious miasmata of the smallpox and some other diseases, be carried through the air, and thus spread from place to place: for unless it is transmitted from the parents to the children, there is no other way of contracting the disease but from actual contact with the infectious matter. Thus, when a nurse happens to labour under the disease, the infant that she suckles will receive the infection; as, on the other hand, when the child is infected, the nurse is liable to receive it: and there have even been instances known of lying-in women being infected very violently, from having employed a person to draw their breasts who happened to have venereal ulcers in the throat. It may be caught by touching venereal sores, if the cuticle be abraded or torn: and in this way accoucheurs and midwives have sometimes been infected severely. Dr Macbride says, the most inveterate pox he ever saw was caught by a midwife, who happened to have a whitlow on one of her fingers when she delivered a woman ill of the lues venerea.

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But by far the most ready way of contracting this disease is by coition, the genital parts being much more bibulous than the rest of the body. When the disorder is communicated, the places where the morbific matter enters are generally those where it first makes its appearance; and as coition is the most usual way of contracting it, so the first symptoms commonly appear on or near the pudenda.

The patient's own account will, for the most part, help us to distinguish the disease: but there are sometimes cases wherein we cannot avail ourselves of this information, and where, instead of confessing, the parties shall conceal all circumstances; while, on the other hand, there are now and then people to be met with, who persuade themselves that symptoms are venereal, which in reality are owing to some other cause: and therefore it is of the utmost importance to inform ourselves thoroughly of the nature of those symptoms and appearances which may be considered as pathognomic signs of lues venerea.

In the first place, when we find that the local symptoms, such as chancres, buboes, phymosis, and the like, do not give way to the usual methods; or when these complaints, after having been cured, break out again without a fresh infection; we may justly suspect that the virus has entered the whole mass of fluids: but if at the same time ulcers break out in the throat, and the face is deformed by callous tubercles, covered with a brown or yellow scab, we may be assured that the case is now become a confirmed lues, which will require a mercurial course.

When eruptions of the furfuraceous and superficial kind are venereal, they are not attended with itching; and the scale being picked off, the skin appears of a reddish brown, or rather copper colour, underneath; whereas leprous eruptions are itchy, throw off a greater quantity of scales, and rise in greater blotches, especially about the joints of the knees and elbows. Venereal tubercles or pustules are easily distinguished from carbuncles of the face, by not occupying the cheeks or the nose, nor as having a purulent apex, but are covered at top, either with a dry branny scurf like the superficial eruptions just now mentioned, or else with a hard dry scab of a tawney yellow hue; they particularly break out among the hair or near to it, on the forehead or on the temples.

Venereal ulcers affecting the mouth are distinguishable from those which are scorbutic, in the following manner: 1. Venereal ulcers first affect the tonsils, fauces

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ces and uvula; then the gums, but these very rarely: on the contrary, scorbutic ulcers affect the gums first of all; then the fauces, tonsils, and uvula. 2. Venereal ulcers frequently spread to the nose; scorbutic ones almost never. 3. Venereal ulcers are callous in the edges; scorbutic ones are not so. 4. Venereal ulcers are circumscribed, and, for the most part, are circular, at least they are confined to certain places; scorbutic ones are of a more irregular form, spread wider, and frequently affect the whole mouth. 5. Venereal ulcers are for the most part hollow, and generally covered at bottom with a white or yellow slough; but scorbutic ones are more apt to grow up into loose fungi. 6. Venereal ulcers are red in their circumference, but scorbutic ones are always livid. 7. Venereal ulcers frequently rot the subjacent bones, the scorbutic ones seldom or never. 8. And lastly, Venereal ulcers are generally combined with other symptoms which are known to be venereal; scorbutic ones with the distinguishing signs of the scurvy, such as difficult breathing, listlessness, swelling of the legs, rotten gums, &c.

Another strong sign of the confirmed lues is often afforded from certain deep-seated nocturnal pains, particularly of the shins, arms, and head. As for any superficial wandering pains that have no fixed seat, and which affect the membranes of the muscles, and ligaments of the joints, they, for the most part, will be found to belong to the gout or rheumatism, and can never be considered as venereal, unless accompanied with some other evident signs; but with regard to the pains that are deeply-seated, and always fixed to the same place, and which affect the middle and more solid part of the ulna, tibia, and bones of the cranium, and rage chiefly and with greatest violence in the forepart of the night, so that the patient can get no rest till morning approaches, these may serve to convince us that the disease has spread itself throughout the whole habit, whether they be accompanied with other symptoms of the lues or not. *Gummata* in the fleshy parts, *nodes* in the periosteum, *ganglia* upon the tendons, *tophi* upon the ligaments, *exostoses* upon the bones, and *fici* at the verge of the anus, are all of them signs of the confirmed lues: these are hard indolent swellings; but as they sometimes arise independently of any venereal infection, and perhaps may proceed from a scrophulous taint, unless they be accompanied or have been preceded by some of the more certain and evident symptoms of the lues, we must be cautious about pronouncing them venereal. When these swellings are not owing to the siphylitic virus, they are very seldom painful, or tend to inflame and suppurate, whereas those that are venereal usually do, and if they lie upon a bone generally bring on a caries.

These carious ulcers are most commonly met with upon the ulna, tibia, and bones of the cranium; and when accompanied with nocturnal pains, we can never hesitate about declaring their genuine nature. Frequent abortions, or the exclusion of scabby, ulcerated, half-rotten, and dead foetuses, happening without any manifest cause to disturb the foetus before its time, or to destroy it in the womb, may be reckoned as a sign that at least one of the parents is infected.

These then are the principal and most evident signs of the confirmed lues. There are others which are more equivocal, and which, unless we can fairly trace them back to some that are more certain, cannot be held as signs of the venereal disease: Such are, 1. Obstinate inflammations of the eyes, frequently returning, with great heat, itching, and ulceration of the eyelids. 2. A singing and hissing noise in the ears, with ulcers or caries in the bones of the meatus auditorius. 3. Obstinate headachs. 4. Obstinate cutaneous eruptions, of the itchy or leprous appearance, not yielding to the milder methods of treatment. 5. Swellings of the bones; and, 6. Wandering and obstinate pains. None of these symptoms, however, can be known to be venereal, except they happen to coincide with some one or other of the more certain signs.

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It may, perhaps, be considered as a singularity in this disease, that the diagnosis is often more difficult in the advanced than in the early periods of the affection. That is, with those who have been certainly subjected to siphylis, it is often very difficult to say whether certain symptoms, remaining after the ordinary modes of cure have been employed, be siphylitic or not. Very frequently, as appears from the sequel, nocturnal pains, ulcerations, and the like, remaining after a long course of mercury has been employed, are in no degree of a venereal nature, but are in reality to be considered as consequences rather of the remedy than of the disease; and are accordingly best removed by nourishing diet, gentle exercise, and tonics. But as long as any symptoms of any kind remain, it is often impossible to convince some patients that they are cured; and it is often impossible for a physician with certainty to affirm that the disease is altogether overcome.

Upon the whole, we are first to distinguish and consider the several symptoms apart; and then, by comparing them with each other, a clear judgment may be formed upon the general review.

Prognosis. Being thoroughly convinced that the case is venereal, we are to consider, first of all, whether it be of a longer or shorter date; for the more recent it is, it will, *cæteris paribus*, be less difficult to remove. But there are other circumstances which will assist us in forming a prognostic as to the event. As,

1. The age of the patient. This disorder is more dangerous to infants, and old people, than to such as are in the flower and vigour of life, in whom some part of the virus may be expelled by exercise, or may be subdued in some degree by the strength of the constitution.

2. The sex. Though women are for the most part weaker than men, and therefore should seem less able to resist the force of any disease, yet experience shows that this is easier borne by them than by men; perhaps owing to the menstrual and other uterine discharges, by which a good portion of the virus may be carried off immediately from the parts where it was first applied; for it is observable, that whenever these discharges are obstructed, or cease by the ordinary course of nature, all the symptoms of this disease grow worse.

3. The habit of body. Persons who have acrid juices will be liable to suffer more from the venereal poison than such as have their blood in a milder state; hence, when people of a scorbutic or scrophulous habit contract venereal disorders, the symptoms are always remarkably violent, and difficult to cure. And for

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for the same reasons, the confirmed lues is much more to be dreaded in a person already inclined to an asthma, phthisis, dropsy, gout, or any other chronic distemper, than in one of a sound and healthy constitution. For as the original disease is increased by the accession of the venereal poison, so the lues is aggravated by being joined to an old disorder. The more numerous the symptoms, and the more they affect the bones, the more difficult the cure. Of all combinations the union of siphylis with scrophula is perhaps the most difficult to overcome: but if the acrimony should seize on the nobler internal parts, such as the brain, the lungs or the liver, then the disease becomes incurable, and the patient will either go off suddenly in an apoplectic fit, or sink under a consumption.

Cure. Viewing this disease as depending on a peculiar contagious matter introduced into the system, and multiplied there, it is possible to conceive that a cure may be obtained on one of three principles; either by the evacuation of the matter from the system, by the destruction of its activity, or by counteracting its influence in the system. It is not impossible that articles exist in nature capable of removing this complaint on each of these grounds: but we may venture at least to assert, that few such are yet discovered. Notwithstanding numbers of pretended infallible remedies for siphylis, mercury is perhaps the only article on which dependence is placed among European practitioners; and with regard to its mode of operation, all the three different opinions pointed out have been adopted and supported by different theorists.—But although many ingenious arguments have been employed in support of each, we are, upon the whole, inclined to think it more probable that mercury operates by destroying the activity of the venereal virus, than that it has effect either by evacuating it, or by exciting a state of action by which its influence is counteracted. Some practitioners have affirmed, that the disease may be totally extirpated without the use of mercury; but, excepting in slight cases, it appears from the most accurate observations, that this grand specific is indispensable; whether it be introduced through the pores of the skin, in the form of ointments, plasters, washes, &c.; or given by the mouth, disguised in the different shapes of pills, troches, powders, or solutions.

Formerly it was held as a rule, that a salivation ought to be raised, and a great discharge excited. But this is now found to be unnecessary: for as mercury probably acts by some specific power in subduing and correcting the venereal virus, all that is required is to throw in a sufficient quantity of the medicine for this purpose; and if it can be diverted from the salivary glands so much the better, since the inconveniences attending a spitting are such as we should always wish to avoid.

Mercury, when combined with any saline substance, has its activity prodigiously increased; hence the great variety of chemical preparations which have been contrived to unite it with different acids.

Corrosive sublimate, or the murias hydrargyri corrosivus, is one of the most active of all the mercurial preparations, insomuch as to become a poison even in very small doses. It therefore cannot safely be given in substance; but must be dissolved in order to render it capable of a more minute division. We may see, by looking into Wiseman, that this is an old medicine, though seldom given by regular practitioners. How it came to be introduced into so remote a part of the world as Siberia, is not easily found out; but Dr Clerc, author of the *Histoire Naturelle de l'Homme Malade*, assures us, that the sublimate solution has been in use there time out of mind.

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It appears to have been totally forgotten in other places, until of late years, when Baron Van Swieten brought it into vogue; so that at one period, if we may credit Dr Locker, they used no other mercurial preparation at Vienna. The number of patients cured by this remedy alone in the hospital of St Mark, which is under the care of this gentleman, from 1754 to 1761, inclusive, being 4880.

The method of preparing the solution is, to dissolve as much sublimate in any kind of ardent spirit (at Vienna they use only corn brandy) as will give half a grain to an ounce of solution. The dose to a grown person is one spoonful mixed with a pint of any light ptisan or barley water, and this is to be taken morning and evening: the patients should keep principally in a warm chamber, and lie in bed to sweat after taking the medicine; their diet should be light; and they ought to drink plentifully throughout the day, of whey, ptisan, or barley water. If the solution does not keep the belly open, a mild purge must be given from time to time; for Locker observes, that those whom it purges two or three times a-day, get well sooner than those whom it does not purge: he also says, that it very seldom affects the mouth, but that it promotes the urinary and cutaneous discharges. This course is not only to be continued till all the symptoms disappear, but for some weeks longer. The shortest time in which Locker used to let the patients out was six weeks; and they were continued on a course of decoction of the woods for some weeks after they left off the solution.

This method has been introduced both in Britain and Ireland, though by no means to the exclusion of others; but it appears, that the solution does not turn out so infallible a remedy, either in these kingdoms, or in France, as they say it has done in Germany. It was seldom if ever found to perform a radical cure, and the frequent use of it proved in many cases highly prejudicial. It has therefore been succeeded in practice, even at Vienna, by mercury exhibited in other forms; and, among these, by a remedy first recommended by Dr Plenck, and since improved by Dr Saunders; consisting of mercury united with mucilage of gum arabic, which is said to render its exhibition perfectly mild and safe. For particulars, we refer to Dr Saunders's treatise.

But a late French writer, supposed to be Dr Petit, in a small book, entitled, *A parallel of the different methods of treating the venereal disease*, insists, that there is neither certainty nor safety in any other method than the repeated frictions with mercurial ointment.

If, therefore, it is determined to have recourse to the mercurial frictions, the patient may with advantage be prepared by going into the warm bath some days successively; having been previously blooded if of a plethoric habit, and taking a dose or two of some proper cathartic.

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The patient being fitted with the neceſſary apparatus of flannels, is then to enter on the courſe.

If he be of a robuſt habit and in the prime of life, we may begin with two drams of the *unguentum hydrargyri fortius*, (Ph. Lond.) which is to be rubbed in about the ankles by an aſſiſtant whoſe hands are covered with bladders: then having intermitted a day, we may expend two drams more of the ointment, and reſt for two days; after which, if no ſoreneſs of the mouth comes on, uſe only one dram; and at every ſubſequent friction aſcend till the ointment ſhall reach the trunk of the body; after which the rubbings are to be begun at the wriſts, and from thence gradually extended to the ſhoulders. In order to prevent the mercury from laying too much hold of the mouth, it muſt be diverted to the ſkin, by keeping the patient in a conſtant perſpiration from the warmth of the room, and by drinking plentifully of barley-water, whey, or ptiſan; but if, nevertheleſs, the mercury ſhould tend to raiſe a ſpitting, then, from time to time, we are either to give ſome gentle cathartic, or order the patient into a vapour or warm bath; and thus we are to go on, rubbing in a dram of the ointment every ſecond, third, or fourth night, according as it may be found to operate; and on the intermediate days either purging or bathing, unleſs we ſhould chooſe to let the ſalivation come on; which, however, it is much better to avoid, as we ſhall thus be able to throw in a larger quantity of mercury.

It is impoſſible to aſcertain the quantity of mercury that may be neceſſary to be rubbed in, as this will vary according to circumſtances: but we are always to continue the frictions, for a fortnight at leaſt, after all ſymptoms of the diſeaſe ſhall have totally diſappeared; and when we have done with the mercury, warm bathing, and ſudorific decoctions of the woods, are to be continued for ſome time longer.

This is a general ſketch of the methods of treatment for the confirmed lues; but for a complete hiſtory of the diſeaſe, and for ample directions in every ſituation, we refer to Aſtruc, and his abridger Dr Chapman.—We have to add, however, that a method of curing this diſeaſe by mercurial fumigation has been lately recommended in France, but it ſeems not to meet with great encouragement. One of the moſt recent propoſals for the cure of the venereal diſeaſe is that of Mr Clare, and conſiſts in rubbing a ſmall quantity of mercury under the form of the *ſubmurias hydrargyri*, or *calomel* as it is commonly called, on the inſide of the cheek; by which means it has been ſuppoſed that we will not only avoid the inconveniences of unction, but alſo the purgative effects that are often produced by this medicine when taken into the ſtomach. But after all, the introduction of mercury under the form of unction, as recommended by the lateſt and beſt writers in Britain on the venereal diſeaſe, Dr Swediaur, Mr John Hunter, and others, is ſtill very generally preferred to any mode that has yet been propoſed.

Where, after a long trial of mercury, diſtreſſing ſymptoms ſtill remain, particularly obſtinate ulcerations and ſevere pains, benefit has often been derived from the uſe of opium: but there is little reaſon to believe, as has been held by ſome, that of itſelf it affords an infallible cure of this diſeaſe; at leaſt we are inclined to think, that all the facts hitherto brought in ſupport of the cure of ſiphylis by opium are at the utmoſt very doubtful.

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The ſame obſervation may perhaps be made with regard to another remedy which has of late been highly extolled in ſiphylis, viz. the nitric acid. This article ſeems to have been firſt introduced both againſt affections of the liver and venereal complaints by Dr Scott of Bombay. It has ſince been highly extolled by Dr Beddoes and other writers in Britain. And there are many well authenticated caſes on record in which it has produced a cure. But it is very rarely preferable to mercury; and it is chiefly uſeful when, from ſome peculiarity of conſtitution, mercury cannot be exhibited.

In obſtinate ulcerations, remaining probably after the venereal virus has been overcome, and reſiſting the uſe of mercury, a complete cure has in many inſtances been obtained from the uſe of the root of the mezereon, the daphne mezereum of Linnæus. This article has been chiefly employed under the form of decoction; and it now appears that it is the baſis of an article at one time highly celebrated in venereal complaints, under the title of *Liſbon diet drink*. But, upon the whole, theſe ſequelæ of this diſeaſe are perhaps more readily overcome by country air, gentle exerciſe, and nouriſhing diet, particularly a milk diet, than by the uſe of any medicine whatever. It muſt indeed be allowed, that for combating different ſequelæ, various practices accommodated to the nature of theſe will on particular occaſions be requiſite. But into the conſideration of theſe we cannot here propoſe to enter.

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Scurvy.

Scorbutus, *Sauv.* gen. 391. *Lin.* 223. *Vog.* 318. *Sag.* 127. *Boerh.* 1148. *Hoffm.* III. 369. *Junck.* 91. *Lind* on the Scurvy. *Hulme* de Scorbuto. *Rouppe* de Morbis Navigantium.

Deſcription. The firſt indication of the ſcorbutic diatheſis is generally a change of colour in the face, from the natural and healthy look to a pale and bloated complexion, with a liſtleſſneſs, and averſion from every ſort of exerciſe; the gums ſoon after become itchy, ſwell, and are apt to bleed on the ſlighteſt touch; the breath grows offenſive; and the gums, ſwelling daily more and more, turn livid, and at length become extremely fungous and putrid, as being continually in contact with the external air; which in every caſe favours the putrefaction of ſubſtances diſpoſed to run into that ſtate, and is indeed in ſome reſpects abſolutely requiſite for the production of actual putridity.

The ſymptoms of the ſcurvy, like thoſe of every other diſeaſe, are ſomewhat different in different ſubjects, according to the various circumſtances of conſtitution; and they do not always proceed in the ſame regular courſe in every patient. But what is very remarkable in this diſeaſe, notwithſtanding the various and immenſe load of diſtreſs under which the patients labour, there is no ſickneſs at the ſtomach, the appetite keeps up, and the ſenſes remain entire almoſt to the very laſt: when lying at reſt, ſcorbutic patients make no complaints, and feel little diſtreſs or pain; but the

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the moment they attempt to rise or stir themselves, then the breathing becomes difficult, with a kind of straitness or catching, and great oppression, and sometimes they have been known to fall into a syncope. This catching of the breath upon motion, with the loss of strength, dejection of spirit, and rotten gums, are held as the essential or distinguishing symptoms of the disease. The skin is generally dry, except in the very last stage, when the patients become exceedingly subject to faintings, and then it grows clammy and moist: in some it has an anserine appearance: but much oftener it is smooth and shining; and, when examined, is found to be spread over with spots, not rising above the surface, of a reddish, bluish, livid or purple colour, with a sort of yellow rim round them. At first these spots are for the most part small, but in time they increase to large blotches. The legs and thighs are the places where they are principally seen: more rarely on the head and face. Many have a swelling of the legs, which is harder, and retains the impression of the finger longer than the common dropsical or truly œdematous swellings. The slightest wounds and bruises, in scorbutic habits, degenerate into foul and untoward ulcers; and the appearance of these ulcers is so singular and uniform, that they are easily distinguished from all others. Scorbutic ulcers afford no good digestion, but give out a thin and fetid ichor mixed with blood, which at length has the appearance of coagulated gore lying caked on the surface of the sore, not to be separated or wiped off without some difficulty. The flesh underneath these sloughs feels to the probe soft and spongy, and is very putrid. Neither detergents nor escharotics are here of any service; for though such sloughs be with great pains taken away, they are found again at the next dressing, where the same sanguineous putrid appearance always presents itself. Their edges are generally of a livid colour, and puffed up with excrescences of proud flesh arising from below the skin. As the violence of the disease increases, the ulcers shout out a soft bloody fungus, which often rises in a night's time to a monstrous size; and although destroyed by cauteries, actual or potential, or cut away with the knife, is found at next dressing as large as ever. It is a considerable time, however, before these ulcers, bad as they are, come to affect the bones with rottenness. These appearances will always serve to assure us that an ulcer is scorbutic; and should put us on our guard with respect to the giving mercurials, which are very generally pernicious in these cases.

Scorbutic people, as the disease advances, are seldom free from pains; though they have not the same seat in all, and often in the same person shift their place. Some complain of universal pain in all their bones; but most violent in the limbs, and especially the joints: the most frequent seat of their pain, however, is some part of the breast. The pains of this disease seem to arise from the distraction of the sensible fibres by the extravasated blood being forced into the interstices of the periosteum and of the tendinous and ligamentous parts; whose texture being so firm, the fibres are liable to higher degrees of tension, and consequently of pain.

The states of the bowels are various: in some there is an obstinate costiveness; in others a tendency to a flux, with extremely fetid stools: the urine is also rank and fetid, generally high coloured; and, when it has stood for some hours, throws up an oily scum on the surface. The pulse is variable; but most commonly slower and more feeble than in the time of perfect health. A stiffness in the tendons, and weakness in the joints of the knees, appear early in the disease: but as it grows more inveterate, the patients generally lose the use of their limbs altogether; having a contraction of the flexor tendons in the ham, with a swelling and pain in the joint of the knee. Some have their legs monstrously swelled, and covered over with livid spots or ecchymoses; others have had tumours there; some, though without swelling, have the calves of the legs and the flesh of the thighs quite indurated. As persons far gone in the scurvy are apt to faint, and even expire, on being moved and brought out into the fresh air, the utmost care and circumspection are requisite when it is necessary to stir or remove them.

Scorbutic patients are at all times, but more especially as the disease advances, extremely subject to profuse bleedings from different parts of the body; as from the nose, gums, intestines, lungs, &c. and likewise from their ulcers, which generally bleed plentifully if the fungus be cut away. It is not easy to conceive a more dismal and diversified scene of misery than what is beheld in the third and last stage of this distemper; it being then that the anomalous and more extraordinary symptoms appear, such as the bursting out of old wounds, and the dissolution of old fractures that have been long united.

Causes. The term *scurvy* has been indiscriminately applied, even by physicians, to almost all the different kinds of cutaneous foulness; owing to some writers of the last century, who comprehended such a variety of symptoms under this denomination, that there are few chronic distempers which may not be so called, according to their scheme: but the disease here meant is the true putrid scurvy, so often fatal to seamen, that with many it has got the name of sea-scurvy, though it be a disease frequently occurring on shore, as was experienced by the British garrisons of Boston, Minorca, and many other places. Indeed no disease is perhaps more frequent or more destructive to people pent up in garrisons without sufficient supplies of sound animal food and fresh vegetables. It is sometimes known to be endemic in certain countries, where the nature of the soil, the general state of the atmosphere, and the common course of diet, all combine in producing that singular species of corruption in the mass of blood which constitutes the scorbutic diathesis; for the appearances, on dissecting scorbutic subjects, sufficiently show that the scurvy may, with great propriety, be termed a disease of the blood.

Dr Lind has, in a postscript to the third edition of his treatise on the scurvy, given the result of his observations drawn from the dissection of a considerable number of victims to this fatal malady; from which it appears that the true scorbutic state, in an advanced stage of the distemper, consists in numerous effusions of blood into the cellular interstices of most parts of the body, superficial as well as internal; particularly the gums and the legs; the texture of the former being almost entirely cellular, and the generally dependent state of the latter rendering these parts, of all others in the whole body, the most apt to receive and

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and retain the ſtagnant blood, when its craſis comes to be deſtroyed; and when it loſes that glutinous quality which, during health, hinders it from eſcaping through the pores in the coats of the blood-veſſels or through exhalant extremities.

A dropſical indiſpoſition, eſpecially in the legs and breaſt, was frequently, but not always, obſerved in the ſubjects that were opened, and the pericardium was ſometimes found diſtended with water: the water thus collected was often ſo ſharp as to ſhrivel the hands of the diſſector; and in ſome inſtances, where the ſkin happened to be broken, it irritated and feſtered the wound.

The fleſhy fibres were found ſo extremely lax and tender, and the bellies of the muſcles in the legs and thighs ſo ſtuffed with the effuſed ſtagnating blood, that it was always difficult, and ſometimes impoſſible, to raiſe or ſeparate one muſcle from another. He ſays that the quantity of this effuſed blood was amazing; in ſome bodies it ſeemed that almoſt a fourth part of the whole maſs had eſcaped from the veſſels; and it often lay in large concretions on the perioſteum, and in ſome few inſtances under this membrane immediately on the bone. Notwithſtanding this diſſolved and depraved ſtate of the external fleſhy parts, the brain always appeared perfectly ſound, and the viſcera of the abdomen, as well as thoſe in the thorax, were in general found quite uncorrupted. There were ſpots indeed, from extravaſated blood, obſerved on the meſentery, inteſtines, ſtomach, and omentum; but theſe ſpots were firm, and free from any mortified taint; and, more than once, an effuſion of blood, as large as a hand's-breadth, has been ſeen on the ſurface of the ſtomach; and what was remarkable, that very ſubject was not known while living to have made any complaint of ſickneſs, pain, or other diſorder, in either ſtomach or bowels.

Theſe circumſtances and appearances, with many others that are not here enumerated, all prove to a demonſtration a putreſcent, or at leaſt a highly depraved ſtate of the blood: and yet Dr Lind takes no ſmall pains to combat the idea of the ſcurvy's proceeding from animal putrefaction; a notion which, according to him, "may, and hath miſled phyſicians to propoſe and adminiſter remedies for it altogether ineffectual."

He alſo, in the preface to his third edition, talks of the miſchief done by an attachment to deluſive theories. He ſays, "it is not probable that a remedy for the ſcurvy will ever be diſcovered from a preconceived hypotheſis, or by ſpeculative men in the cloſet, who have never ſeen the diſeaſe, or who have ſeen at moſt only a few caſes of it;" and adds, "that though a few partial facts and obſervations may, for a little, flatter with hopes of greater ſucceſs, yet more enlarged experience muſt ever evince the fallacy of all poſitive aſſertions in the healing art."

Sir John Pringle, however, is of a very different opinion. He "is perſuaded, after long reflection, and the opportunities he has had of converſing with thoſe who to much ſagacity had joined no ſmall experience in nautical practice, that upon an examination of the ſeveral articles which have either been of old approved, or have of late been introduced into the navy, it will appear, that though theſe means may vary in form and in mode of operating, yet they all ſome way contribute towards preventing putrefaction; whether of the air in the cloſer parts of a ſhip, of the meats, of the water, of the clothes and bedding, or of the body itſelf."

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What Dr Lind has above advanced is the more remarkable, as, in the two former editions of his book, he embraced the hypotheſis of animal putrefaction being the cauſe of the ſcurvy; and if theſe effuſions of blood, from a deſtruction of its craſis and the diſſolved ſtate of the muſcular fibres, together with the rotten condition of the mouth and gums, do not betray putreſcency, it is hard to ſay what does, or what other name we ſhall beſtow on this peculiar ſpecies of depravation which conſtitutes the ſcurvy.

The blood, no doubt, derives its healthy properties, and maintains them, from the due ſupplies of wholeſome food; while the inſoluble, ſuperfluous, effete, and acrid parts, are carried off by the ſeveral diſcharges of ſtool, urine, and perſpiration.

Our ſenſes of taſte and ſmell are ſufficient to inform us when our food is in a ſtate of ſoundneſs and ſweetneſs, and conſequently wholeſome; but it is from chemiſtry that we muſt learn the principles on which theſe qualities chiefly depend

Experiments of various kinds have proved, that the ſoundneſs of animal and vegetable ſubſtances depends very much, if not entirely, on the preſence of their aërial principle. Rottenneſs is never obſerved to take place without an emiſſion of fixed air from the putrefying ſubſtance: and even when putrefaction has made a conſiderable progreſs, if aërial acid can be transferred, in ſufficient quantity, from ſome other ſubſtance in a ſtate of efferveſcence or fermentation, into the putrid body, the offenſive ſmell of this will be deſtroyed. If it be a bit of rotten fleſh with which the experiment is made, the firmneſs of its fibres will be found in ſome meaſure reſtored.

The experiments of Dr Hales, as well as many others made ſince his time, ſhow that an aërial principle is greatly connected with, and remarkably abundant in, the gelatinous parts of animal bodies, and in the mucilage or farina of vegetables. But theſe are the parts of our food which are moſt particularly nutritive; and Dr Cullen, whoſe opinion on this as on every other medical ſubject muſt be allowed of the greateſt weight, affirms, in his Lectures on the Materia Medica, that the ſubſtances on which we feed are nutritious only in proportion to the quantities of oil and ſugar which they reſpectively contain. This oil and ſugar are blended together in the gelatinous part of our animal food, and in the mucilaginous and farinaceous part of eſculent vegetables; and, while thus intimately combined, are not perceivable by our taſte, though very capable of being developed and rendered diſtinct by the power of the digeſtive organs; for in conſequence of the changes produced during digeſtion, the oily and the ſaccharine matter become manifeſt to our ſenſes, as we may ſee and taſte in the milk of animals, which is chiefly chyle a little advanced in its progreſs toward ſanguification; the oil is obſerved to ſeparate ſpontaneouſly, and from which a quantity of actual ſugar may be obtained by a very ſimple proceſs.

Thus much being premiſed, we can now readily comprehend

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comprehend how the blood may come to lose those qualities of smoothness, mildness, and tenacity which are natural to it. For if, in the first place, the fluids, and organs subservient to digestion, should be so far distempered or debilitated that the nutritious parts of the food cannot be properly developed, the blood must be defrauded of its due supplies; which will also be the case if the aliment should not originally contain enough of oily and saccharine matter, or should be so circumstanced, from being dried or salted, as to hinder the ready extrication of the nutritious parts; or, lastly, if the natural discharges should be interrupted or suspended, so that the superfluous, acrid, and effete fluids are retained in the general mass; in all these instances the blood must of necessity run into proportionate degrees of depravation.

And hence we may understand how it may possibly happen, that when persons are greatly weakened by some preceding disorder, and at the same time debarred the use of proper bodily exercise, the scorbutic diathesis should take place, even though they enjoy the advantages of pure air and wholesome diet. But these are solitary cases, and very rarely seen; for whenever the scurvy seizes numbers, and can be considered as an epidemic disease, it will be found to depend on a combination of the major part, or perhaps all, of the following circumstances:

1. A moist atmosphere, and more especially if cold be joined to this moisture. 2. Too long cessation from bodily exercise, whether it be from constraint, or a lazy slothful disposition. 3. Dejection of mind. 4. Neglect of cleanliness, and want of sufficient clothing. 5. Want of wholesome drink, either of pure water or fermented liquors. And, 6. Above all, the being obliged to live continually on salted meats, perhaps not well cured, without a due proportion of the vegetables sufficient to correct the pernicious tendency of the salt, by supplying the bland oil and saccharine matter requisite for the purposes of nutrition.

These general principles respecting the causes and nature of scurvy, seem to afford a better explanation of the phenomena of the disease than any conjectures respecting it that have hitherto been proposed. It must, however, be allowed, that Dr Lind is by no means the only writer who is disposed to consider this disease as not referable to the condition of the circulating fluids. In a late ingenious treatise on this subject by Sir F. Milman, he strenuously contends, that the primary morbid affection in this complaint is a debilitated state of the solids arising principally from want of aliment. But his arguments on this subject, as well as those of Dr Lind, are very ably answered by a still later writer on this subject, Dr Trotter, who has drawn his observations respecting it from very extensive experience, and who considers it as clearly established, by incontrovertible facts, that the proximate cause of scurvy depends on some peculiar state of the blood.—That this disease does not depend on a debilitated state of the solids, is demonstratively proved from numerous cases where every possible degree of debility occurs in the solids without the slightest appearance of scurvy. Dr Trotter, in the second edition of his Observations on the Scurvy, from the result of farther observation and later discoveries in chemistry, has attempted, with much ingenuity, to prove that the morbid condition of the blood, which takes place in scurvy, arises from the abstraction of vital air, or, as it is now generally called, *oxygene;* and this opinion, though still, perhaps, in some particulars requiring farther confirmation, is, it must be allowed, supported by many plausible arguments.

Prevention and Cure. The scurvy may be prevented, by obviating and correcting those circumstances in respect of the non-naturals which were mentioned as contributing to the disease, and laid down as causes. It is, therefore, a duty highly incumbent on officers commanding at sea, or in garrisons, to use every possible precaution; and, in the first place, to correct the coldness and moisture of the atmosphere by sufficient fires: in the next, to see that their men be lodged in dry, clean, and well ventilated births or apartments: thirdly, to promote cheerfulness, and enjoin frequent exercise, which alone is of infinite use in preventing the scurvy: fourthly, to take care that the clothing be proper, and cleanliness of person strictly observed: fifthly, to supply them with wholesome drink, either pure water or sound fermented liquors; and if spirits be allowed, to have them properly diluted with water and sweetened with melasses or coarse sugar: and lastly, to order the salted meats to be sparingly used, or sometimes entirely abstained from; and in their place, let the people live on different compositions of the dried vegetables; fresh meat and recent vegetables being introduced as often as they can possibly be procured.

A close attention to these matters will, in general, prevent the scurvy from making its appearance at all, and will always hinder it from spreading its influence far. But when these precautions have been neglected, or the circumstances such that they cannot be put in practice, and the disease has actually taken place, our whole endeavour must be to restore the blood to its original state of soundness: and happily, such is the nature of this disease, that if a sufficiency of new matter, of the truly mild nutritious sort, and particularly such as abounds with vital air, such as recent vegetables, or different acid fruits, can be thrown into the circulation while the fleshy fibres retain any tolerable degree of firmness, the patient will recover; and that in a surprisingly short space of time, provided a pure air, comfortable lodgings, sufficient clothing, cleanliness, and exercise, lend their necessary aid.

This being the case, the plan of treatment is to be conducted almost entirely in the dietetic way; as the change in the mass of blood, which it is necessary to produce, must be brought about by things that can be received into the stomach by pints or pounds, and not by those which are administered in drops or grains, drams or ounces. For here, as there is no disorder of the nervous system, we have no need of those active drugs which are indispensably necessary in febrile or nervous diseases; the scorbutic diathesis being quite opposite to that which tends to produce a fever or any species of spasmodic disorders; nay, Dr Lind says, he has repeatedly found, that even the infection of an hospital fever is long resisted by a scorbutic habit.

It will now naturally occur to the reader, what those alimentary substances must be which bid the fairest

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The four juices of lemons, oranges, and limes, have been generally held as antiscorbutics in an eminent degree, and their power ascribed to their acid; from an idea that acids of all kinds are the only correctors of putrefaction. But the general current of practical observations shows, and our experiments confirm it, that the virtue of these juices depends on their *aerial principle*; accordingly, while perfectly recent and in the mucilaginous state, and especially if mixed with wine and sugar, the juices of any one of these fruits will be found a most grateful and powerful antiscorbutic.

Dr Lind observing, "that the lemon juice, when given by itself undiluted, was apt, especially if overdosed, to have too violent an operation, by occasioning pain and sickness at the stomach, and sometimes a vomiting; found it necessary to add to it wine and sugar. A pint of Madeira wine, and two ounces of sugar, were put to four ounces and a half of juice, and this quantity was found sufficient for weak patients to use in 24 hours: such as were very weak sipped a little of this frequently according as their strength would permit; others who were stronger took about two ounces of it every two hours; and when the patients grew still stronger, they were allowed eight ounces of lemon juice in 24 hours."

While this very pleasant mixture, which is both a cordial and an antiseptic, may be had, it would be needless to think of prescribing any other; but when the fresh juice cannot be procured, we must have recourse to such other things as may be obtained. But the various modes of combining and administering these, so as to render them perfectly agreeable to the stomach, must always be regulated by circumstances, and therefore it will be in vain to lay down particular directions; since all that we have to do is, to fix on such fruits and other fresh vegetables as can be most conveniently had and taken, and contrive to give them in those forms, either alone or boiled up with flesh meat into soups, which will allow the patients to consume the greatest quantities.

The first promising alteration from such a course is usually a gentle diarrhœa; and if, in a few days, the skin becomes soft and moist, it is an infallible sign of recovery; especially if the patient gain strength, and can bear being stirred or carried into the open air without fainting.

But if the belly should not be loosened by the use of the fresh vegetables, nor the skin become soft and moist, then they must be assisted by stewed prunes, or a decoction of tamarinds with supertartrite of potash, in order to abate the costiveness; and by drinking a little decoction of the woods, and warm bathing, in order to relax the pores of the skin; for nothing contributes more to the recovery of scorbutic patients than moderate sweating. Scorbutus.

With regard to particular symptoms, antiseptic mouth waters, composed of a decoction of cinchona and infusion of roses, with a solution of myrrh, must be used occasionally, in order to cleanse the mouth, and give firmness to the spongy gums. Swelled and indurated limbs, and stiffened joints, must be bathed with warm vinegar, and relaxed by the steam of warm water, repeatedly conveyed to them, and confined to the parts by means of close blankets: ulcers on the legs must never be treated with unctuous applications nor sharp escharotics; but the dressing should consist of lint or soft rags, dipt in a strong decoction of cinchona.

This disease at no time requires, or indeed bears, large evacuations, either by bleeding or purging; and as has been already mentioned, the belly must only be kept open by the fresh vegetables or the mildest laxatives. But we are always to be careful that scorbutic persons, after a long abstinence from greens and fruits, be not permitted to eat voraciously at first, lest they fall into a fatal dysentery.

All, however, that has now been laid down as necessary towards the cure, supposes the patients to be in situations where they can be plentifully furnished with all the requisites; but unhappily these things are not to be procured at sea, and often deficient in garrisons: in order therefore, that a remedy for the scurvy might never be wanting, Dr Macbride, in the year 1762, first conceived the notion, that the *infusion of malt*, commonly called *wort*, might be substituted for the common antiscorbutics; and it was accordingly tried.

More than three years elapsed before any account arrived of the experiments having been made: at length, ten histories of cases were received, wherein the wort had been tried, with very remarkable success; and this being judged a matter of great importance to the seafaring part of mankind, these were immediately communicated to the public in a pamphlet, under the title of *An historical account of a new method of treating the scurvy at sea*.

This was in 1767; but after that time a considerable number of letters and medical journals, sufficient to make up a small volume, were transmitted to Dr Macbride, particularly by the surgeons of his majesty's ships who had been employed of late years for making discoveries in the southern hemisphere. Certain it is, that in many instances it has succeeded beyond expectation. In others it has fallen short: but whether this was owing to the untoward situation of the patients, or inattention on the part of the persons who were charged with the administration of the wort, not preparing it properly, or not giving it in sufficient quantity, or to its own want of power, must be collected from the cases and journals themselves.

During Captain Cook's third voyage, the most remarkable, in respect of the healthiness of the crew, that ever was performed, the wort is acknowledged to have been of singular use.

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In a letter which this very celebrated and successful circumnavigator wrote to Sir John Pringle, he gives an account of the methods pursued for preserving the health of his people; and which were productive of such happy effects, that he performed "a voyage of three years and 18 days, through all the climates from 52° north to 71° south, with the loss of one man only by disease, and who died of a complicated and lingering illness, without any mixture of scurvy. Two others were unfortunately drowned, and one killed by a fall; so that out of the whole number 118 with which he set out from England, he lost only four."

He says, that much was owing to the extraordinary attention of the admiralty, in causing such articles to be put on board as either by experience or conjecture were judged to tend most to preserve the health of seamen: and with respect to the wort, he expresses himself as follows:

"We had on board a large quantity of *malt*, of which was made *sweet wort*, and given (not only to those men who had manifest symptoms of the scurvy, but to such also as were, from circumstances, judged to be most liable to that disorder) from one or two to three pints in the day to each man, or in such proportion as the surgeon thought necessary, which sometimes amounted to three quarts in the 24 hours: this is without doubt one of the best sea antiscorbutic medicines yet found out; and if given in time, will, with proper attention to other things, I am persuaded, prevent the scurvy from making any great progress for a considerable time: but I am not altogether of opinion that it will cure it, in an advanced state, at sea."

On this last point, however, the captain and his surgeon differ; for this gentleman positively asserts, and his journal (in Dr Macbride's possession) confirms it, that the infusion of malt did effect a cure in a confirmed case, and at sea.

The malt being thoroughly dried, and packed up in small casks, is carried to sea, where it will keep sound, in every variety of climate, for at least two years: when wanted for use, it is to be ground in a hand mill, and the infusion prepared from day to day, by pouring three measures of boiling water on one of the ground malt; the mixture being well mashed, is left to infuse for 10 or 12 hours, and the clear infusion then strained off. The patients are to drink it in such quantities as may be deemed necessary, from one to three quarts in the course of the 24 hours: a panada is also to be made of it, by adding biscuit, and currants or raisins; and this palatable mess is used by way of solid food. This course of diet, like that of the recent vegetables, generally keeps the bowels sufficiently open; but in cases where costiveness nevertheless prevails, gentle laxatives must be interposed from time to time, together with diaphoretics, and the topical assistants, fomentations and gargles, as in the common way of management.

Captain Cook was also provided with a large stock of *sour krout;* (cabbage leaves cut small, fermented and stopped in the second stage of fermentation, and afterwards preserved by a due quantity of salt). A pound of this was served to each man, twice a-week, while they were at sea. Sour krout, since the trial made of it on board Captain Cook's ships, has been extensively used by direction of the British government in many other situations, where scorbutus has prevailed; and it has been found to be highly serviceable both in preventing and in curing the disease. It was particularly found, during the late American war, to be highly beneficial to the British troops besieged in Boston, who were at that time entirely fed on salt provisions sent from England, and among whom true scorbutus was very fatal till the sour krout arrived. The scurvy at one period broke out among them with very alarming appearances; but by the seasonable arrival of a quantity of sour krout, it was effectually overcome. Care, however, must be bestowed, that this article be properly prepared and properly kept. When due attention is paid to these particulars, it may be preserved in good condition for many months; and is considered both by sailors and soldiers as a very acceptable addition to their salt provisions. But when served out to them in a putrid state, it is not only highly disagreeable to the taste, but probably also pernicious in its effects.

Among other means of preventing scurvy, Captain Cook had also a liberal supply of *portable soup;* of which the men had generally an ounce, three days in the week, boiled up with their pease; and sometimes it was served to them oftener; and when they could get fresh greens, it was boiled up with them, and made such an agreeable mess, that it was the means of making the people eat a greater quantity of greens than they would otherwise have done. And what was still of further advantage, they were furnished with sugar in lieu of butter or oil, which is seldom of the sweetest sort; so that the crew were undoubtedly great gainers by the exchange.

In addition to all these advantages of being so well provided with every necessary, either in the way of diet or medicine, Captain Cook was remarkably attentive to all the circumstances respecting cleanliness, exercise, sufficient clothing, provision of pure water, and purification of the air in the closer parts of the ship.

From the effect of these different means, as employed by Captain Cook, there can be little doubt that they will with due attention be sufficient for the prevention and cure of the disease, at least in most situations: but besides these, there are also some other articles which may be employed with great advantage.

Newly brewed spruce beer made from a decoction of the tops of the spruce fir and melasses, is an excellent antiscorbutic; it acts in the same way that the wort does, and will be found of equal efficacy, and therefore may be substituted. Where the tops of the spruce fir are not to be had, this beer may be prepared from the essence of spruce as it has been called, an article which keeps easily for a great length of time. But in situations where neither the one nor the other can be had, a most salutary mess may be prepared from oatmeal, by infusing it in water, in a wooden vessel, till it ferments, and begins to turn sourish; which generally happens, in moderately warm weather, in the space of two days.—The liquor is then strained off from the grounds, and

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and boiled down to the consistence of a jelly, which is to be eaten with wine and sugar, or with butter and sugar.

Nothing is more commonly talked of than a *land scurvy*, as a distinct species of disease from that which has been now described; but no writer has yet given a description so clear as to enable us to distinguish it from the various kinds of cutaneous foulness and eruption, which indeed are vulgarly termed *scorbutic*, but which are akin to the itch or leprosy, and for the most part require mercurials. These, however, are very different diseases from the true scorbutus, which, it is well known, may prevail in certain situations on land as well as at sea, and is in no degree to be attributed to sea air.

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Genus LXXXVII. ELEPHANTIASIS.

Elephantiasis, *Sauv.* gen. 302. *Vog.* 321. *Sag.* gen. 128.
Elephantia Arabum, *Vog.* 322.

The best account of this disease is that by Dr Heberden, published in the first volume of the Medical Transactions. According to him, frequently the first symptom is a sudden eruption of tubercles, or bumps of different sizes, of a red colour, more or less intense (attended with great heat and itching), on the body, legs, arms, and face; sometimes in the face and neck alone, at other times occupying the limbs only; the patient is feverish; the fever ceasing, the tubercles remain indolent, and in some degree scirrhous, of a livid or copper colour, but sometimes of the natural colour of the skin, or at least very little altered; and after some months they not unfrequently ulcerate, discharging a fetid ichorous humour in small quantity, but never laudable pus.

The features of the face swell and enlarge greatly; the part above the eyebrows seems inflated; the hair of the eyebrows falls off, as does the hair of the beard; but Dr Heberden has never seen any one whose hair has not remained on his head. The *alæ nasi* are swelled and scabrous; the nostrils patulous, and sometimes affected with ulcers, which, corroding the cartilage and *septum nasi*, occasion the nose to fall. The lips are tumid; the voice is hoarse; which symptom has been observed when no ulcers have appeared in the throat, although sometimes both the throat and gums are ulcerated. The ears, particularly the lobes, are thickened, and occupied by tubercles. The nails grow scabrous and rugose, appearing something like the rough bark of a tree; and the distemper advancing, corrodes the parts gradually with a dry sordid scab or gangrenous ulcer; so that the fingers and toes rot and separate joint after joint. In some patients the legs seem rather posts than legs, being no longer of the natural shape, but swelled to an enormous size, and indurated, not yielding to the pressure of the fingers; and the superficies is covered with very thin scales, of a dull whitish colour, seemingly much finer, but not so white as those observed in the *lepra Græcorum*. The whole limb is overspread with tubercles, interspersed with deep fissures; sometimes the limb is covered with a thick moist scabby crust, and not unfrequently the tubercles ulcerate. In others the legs are emaciated, and sometimes ulcerated; at other times affected with tubercles without ulceration. The muscular flesh between the thumb and forefinger is generally extenuated.

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The whole skin, particularly that of the face, has a remarkably shining appearance, as if it was varnished or finely polished. The sensation in the parts affected is very obtuse, or totally abolished; so that pinching, or puncturing the part, gives little or no uneasiness; and in some patients, the motion of the fingers and toes is quite destroyed. The breath is very offensive; the pulse in general weak and slow.

The disease often attacks the patient in a different manner from that above described, beginning almost insensibly; a few indolent tubercles appearing on various parts of the body or limbs, generally on the legs or arms, sometimes on the face, neck, or breast, and sometimes in the lobes of the ears, increasing by very slow degrees, without any disorder, previous or concomitant, in respect of pain or uneasiness.

To distinguish the distemper from its manner of attacking the patient, Dr Heberden styles the first by *fluxion* and the other by *congestion*. That by fluxion is often the attendant of a crapula, or surfeit from gross foods; whereby, perhaps, the latent seeds of the disorder yet dormant in the mass of blood are excited; and probably from frequent observations of this kind (the last meal being always blamed), it is, that, according to the received opinion, either fish, (the tunny, mackarel, and shell-fish, in particular), melons, cucumbers, young garden-beans, or mulberries, eaten at the same meal with butter, cheese, or any preparation of milk, are supposed to produce the distemper, and are accordingly religiously avoided.

Violent commotions of the mind, as anger, fear, and grief, have more than once been observed to have given rise to the disorder; and more frequently, in the female sex, a sudden suppression of an accustomed evacuation, by bathing the legs and feet in cold water at an improper season.

The disorder by fluxion is what is the oftenest endeavoured to be remedied by timely application; that by congestion, not being so conspicuous, is generally either neglected or attempted to be concealed, until perhaps it be too late to be cured, at least unless the patients would submit to a longer course of medicine and stricter regimen of diet than they are commonly inclined to do.

Several incipient disorders by fluxion have been known to yield to an antiphlogistic method, as bleeding, refrigerant salts in the saline draughts, and a solution of crystals of tartar in water, for common drink, (by this means endeavouring to precipitate part of the peccant matter, perhaps too gross to pass the pores by the kidneys); and when once the fever is overcome, cinchona combined with sassafras, is the remedy principally to be relied on. The only topical medicine prescribed by Dr Heberden, was an attenuating embrocation of brandy and alkaline spirit. By the same method some confirmed cases have been palliated. But, excepting in one patient, Dr Heberden never saw or heard of a confirmed elephantiasis radically cured. He adds, however, that he never met with another patient possessed of prudence and perseverance enough to prosecute the cure as he ought.

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Genus LXXXVIII. LEPRA.

The *Leprosy*.

Lepra, *Sauv.* gen. 303. *Lin.* 262. *Sag.* 129.
Lepra *Græcorum*, *Vog.* 320.

This diftemper is but little known to phyficians in the weftern parts of Europe. Wallis tells us, that it firft begins with red pimples, or puftules, breaking out in various parts of the body. Sometimes they appear fingle; fometimes a great number arife together, efpecially on the arms and legs; as the difeafe increafes, frefh pimples appear, which, joining the former, make a fort of clufters; all which enlarge their borders, and fpread in an orbicular form. The fuperficies of thefe puftules are rough, whitifh, and fcaly; when they are fcratched the fcales fall off, upon which a thin ichor oozes out, which foon dries and hardens into a fcaly cruft. Thefe clufters of puftules are at firft fmall and few; perhaps only three or four in an arm or leg, and of the fize of a filver penny. But if the difeafe be fuffered to go on, they become more numerous, and the clufters increafe to the fize of a crown-piece, but not exactly round. Afterwards the affection increafes to fuch a degree, that the whole body is covered with a leprous fcurf. The cure of this diftemper is very much the fame with that of the Elephantiasis. Here, however, recourfe is frequently had to antimonial and mercurial medicines, continued for a confiderable length of time. In conjunction with thefe, warm bathing, particularly the vapour bath, has often been employed with advantage.

Although what can ftrictly be called lepra is now, at leaft, a very rare difeafe in this country, yet to this general head may be referred a variety of cutaneous affections which are here very common, and which in many inftances prove very obftinate. Thefe appear under a variety of different forms; fometimes under that of red puftules; fometimes of white fcurfs; fometimes of ulcerations; and not unfrequently a tranfition takes place from one form to another, fo that they cannot be divided into different genera from the external appearance. Thefe affections will often yield to the remedies already mentioned; but where antimonials and mercurials either fail, or from different circumftances are confidered as unadvifeable, a cure may fometimes be effected by others. In particular cafes, purging mineral waters, the decoction of cinchona, the infufion of the œnanthe crocata, and various others, have been employed with fuccefs. Different external applications alfo have fometimes been employed with advantage. An article ufed in this way, known under the name of Gowland's lotion, with the compofition of which we are unacquainted, has been much celebrated, and has been faid to be employed with great fuccefs, particularly againft eruptions on the face and nofe.

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Genus LXXXIX. FRAMBOESIA.

The *Yaws*.

Frambœfia, *Sauv.* gen. 125. *Sag.* 125.

Defcription. The defcription which is given of this

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diftemper by the anonymous author of a paper in the 6th volume of the Edinburgh Medical Effays, (art. 76.) differs, in fome circumftances, from one that Sauvages received from M. Virgile, an eminent furgeon of Montpelier, who practifed twelve years in the ifland of St Domingo; and therefore he diftinguifhes the *frambœfia* into two fpecies, *Guineenfis* and *Americana*.

The *frambœfia Guineenfis* is faid by the firft-mentioned writer to be fo common on the coaft of Guinea and other parts of Africa, that it feldom fails to attack each individual of both fexes, one time or other, in the courfe of their lives; but moft commonly during childhood or youth. "It makes its appearance in little fpots on the cuticle, level with the fkin, at firft no larger than a pin's head, which increafe daily, and become protuberant like pimples: foon after the cuticle frets off, and then, inftead of finding pus or ichor, in this fmall tumor, only white floughs or fordes appear, under which is a fmall red fungus, growing out of the cutis, increafing gradually to very different magnitudes, fome lefs than the fmalleft wood ftrawberry, fome as big as a rafpberry, and others exceeding in fize even the largeft mulberries; which berries they very much refemble, being knobbed as thefe are." Thefe protuberances, which give the name to the difeafe, appear on all parts of the body: but the greateft numbers, and the largeft fized, are generally found in the groins, and about the pudenda or anus, in the armpits, and on the face: when the yaws are very large, they are few in number; and when remarkably numerous, they are lefs in fize. The patients, in all other refpects, enjoy good health, do not lofe their appetite, and feem to have little other uneafinefs than what the fores occafion.

M. Virgile defcribes the fpecies of yaws that is common among the negroes of St Domingo, and which Sauvages has termed *frambœfia Americana*, as beginning from an ulcer that breaks out indifcriminately in different parts of the body, though moft commonly on the legs; at firft fuperficial, and not different from a common ulcer in any other circumftance faving its not healing by the ufual applications; fooner or later, numerous fungous excrefcences break out on the furface of the body, as before defcribed, like little berries, moift, with a reddifh mucus. Befides thefe, the foles of the feet and palms of the hands become raw, the fkin fretting off, fo as to leave the mufcles bare; thefe excoriations are fometimes moift with ichor and fometimes dry, but always painful, and confequently very diftreffing. They are mentioned alfo by the author of the article in the Medical Effays; and both he and M. Virgile obferve, that there is always one excrefcence, or yaw, of an uncommon fize, which is longer in falling off than the others, and which is confidered as the *mafter-yaw*, and fo termed. An ingenious inaugural differtation on the fubject of the yaws was lately publifhed at Edinburgh by Dr Jonathan Anderfon Ludford, now phyfician in Jamaica. The author of that differtation confiders Dr Cullen as improperly referring frambœfia to the clafs of cachexiæ. He thinks that this difeafe ought rather to be referred to the exanthemata; for, like the fmallpox, he tells us, it has its acceffion, height, and decline. It begins with fome degree of fever either more or lefs violent; it may be propagated by inoculation; and it attacks the

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Dr Ludford conſiders the yaws as being in every inſtance the conſequence of contagion, and as depending on a matter *ſui generis*. He ſuppoſes no peculiar prediſpoſition from diet, colour, or other circumſtances, as being in any degree neceſſary. He views the diſeaſe as chiefly ariſing from contact with the matter, in conſequence of ſleeping in the ſame bed, waſhing in the ſame veſſel with the infected, or the like. In ſhort, the yaws may be communicated by any kind of contact; nay, it is even believed that flies often convey the infection, when, after having gorged themſelves with the virulent matter by ſucking the ulcers of thoſe who are diſeaſed, they make punctures in the ſkin of ſuch as are ſound, and thus inoculate them; in conſequence of which the diſorder will ſoon appear.

Prognoſis. The yaws are not dangerous, if the cure be ſkilfully managed at a proper time; but if the patient has been prematurely ſalivated, or has taken any quantity of mercury, and if his ſkin has been ſuddenly cleared, the cure will be very difficult, if not impracticable.

Cure. In attempting the cure of this diſeaſe, the four following indications are chiefly to be held in view:

1. To ſupport the ſtrength of the patient.
2. To promote excretion by the ſkin.
3. To correct the vitiated fluids.
4. To remove and counteract the injuries done either to the conſtitution in general, or to particular parts, by the diſeaſe.

With the firſt of theſe intentions, a liberal diet, conſiſting of a conſiderable quantity of animal food, with a conſiderable proportion of wine, and gentle exerciſe, are to be employed: but the cure is principally to be effected by mercurial ſalivation, after the virulent matter has been completely thrown out to the ſurface of the body by ſudorifics. The following are the particular directions given on this head by the author of the article in the Medical Eſſays. The yaws being an infectious diſeaſe, as ſoon as they begin to appear on a negro, he muſt be removed to a houſe by himſelf; or, if it is not certain whether the eruption be the yaws or not, ſhut him up ſeven days, and look on him again, as the Jews were commanded to do with their lepers, and in that time you may in moſt caſes be certain.

As ſoon as you are convinced that it is the yaws, give a bolus of flowers of ſulphur, with camphor and theriaca. Repeat this bolus every night for a fortnight or three weeks, or till the yaws come to the height; that is, when they neither increaſe in ſize or number: then throw your patient into a gentle ſalivation with calomel given in ſmall doſes, without farther preparation; five grains repeated once, twice, or thrice a-day, is ſufficient, as the patient can bear it. If he ſpits a quart in 24 hours, it is enough. Generally, when the ſalivation is at this height, all the yaws are covered with dry ſcaly cruſts or ſcabs; which, if numerous, look terribly. Theſe fall off daily in ſmall white ſcales; and in ten or twelve days leave the ſkin ſmooth and clean. Then the calomel may be omitted, and the ſalivation permitted to go off ſpontaneouſly. A dram of corroſive ſublimate diſſolved in an ounce of rum or brandy, and the ſolution daubed on the yaws, will, it is ſaid, in general clear the ſkin in two days time. Frambœſia.

After the ſalivation, ſweat the patient twice or thrice in a frame or chair with ſpirits of wine; and give an alterative electuary of æthiops and gum guaiac. He may likewiſe uſe the decoction of guaiacum and ſaſſafras fermented with melaſſes, for his conſtant drink while the electuary is taking, and a week or a fortnight after the electuary is finiſhed.

The maſter yaw muſt be conſumed an eighth or a tenth part of an inch below the ſkin, with *Mercur. corroſ. rub. et alum. uſt. part. æqual.* and digeſted with *Ung. baſil. flav.* ℥j. and *mercur. corroſ. rub.* ʒj. and cicatrized with lint preſſed out of ſpirits of wine, and with the ſulphate of copper.

After the yaws are cured, ſome patients are afflicted with carbuncles in their feet; which ſometimes render them incapable of walking, unleſs with pain. The method of cure is, by bathing and paring to deſtroy the cuticle, and then proceed as in the maſter-yaw. The gentle eſcharotics are to be preferred; and all imaginable care is to be taken to avoid the tendons and perioſteum.

To children under ſix or ſeven years old, at the proper time of ſalivating, when the yaws are come to their full growth, give a grain or two of calomel in white ſugar, once a day, once in two days, or once in three days, ſo as only to keep their mouths a little ſore till the yaws dry, and, falling off in white ſcales, leave the ſkin clean. This ſucceeds always, but requires a longer time than in adults.

In St Domingo they are ſalivated by unction; but it does not appear that ſucceſs always followed this practice. It is alſo uſual in that iſland to give the ſolution of corroſive ſublimate along with a decoction of ſarſaparilla. Twelve ounces of this root, and 12 pounds of the coarſeſt ſugar, macerated for 15 days in 12 quarts of water, is mentioned as a ſpecific, and ſaid to be the preſcription of an Engliſh phyſician; the doſe is four ounces every ſixth hour.

GENUS XC. TRICHOMA. 355

The *PLICA POLONICA*, or *Plaited Hair*.

Trichoma, *Sauv.* gen. 311. *Sag.* 137.
Plica, *Lin.* 312.
Plica ſive Rhopaloſis, *Vog.* 323.

This diſorder is only met with in Poland and Lithuania, and conſiſts of ſeveral blood-veſſels running from the head into the ends of the hairs; which cleave together, and hang from the head in broad flat pieces, generally about an ell in length, but ſometimes they are

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five or ſix yards long; one patient has more or leſs of theſe, up to 20, and ſometimes 30. They are painful to the wearer, and odious to every ſpectator. At the approach of winter an eruptive fever happens to many in theſe countries: the eruptions principally infeſt the head, and when at the height an ichorous humour flows from them. In this ſtate they are too tender to admit of being touched, and the matter running down the hairs mats them together; the ſkin by degrees, breaking, the ramifications of the capillary veſſels following the courſe of the hair, or prolonged out of the ſkin, are increaſed to a vaſt length.

No method of relief is yet known; for if the diſcharge be checked, or the veſſels cut off, the conſequence is an increaſe of more miſerable ſymptoms, and in the end death. Sennertus ſays, when all the morbid matter is thrown out of the body the plicæ fall off ſpontaneouſly. He further obſerves, that the only ſafe practice in this caſe is, to ſolicit the peccant matter to the hairs, to which it naturally tends; and that this is beſt anſwered by lotions of bear's-breech. Some ſay that a decoction of the herb club-moſs, and its ſeeds, with which the head is to be waſhed, is a ſpecific.

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The *JAUNDICE*.

Icterus, *Lin.* 224. *Vog.* 306. *Boerh.* 918. *Junck.* 90.
Aurigo, *Sauv.* gen. 306. *Sag.* 132.
Cachexia icterica, *Hoffm.* III. 301.

Deſcription. The jaundice firſt ſhows itſelf by a liſtleſſneſs and want of appetite, the patient becomes dull, oppreſſed, and generally coſtive. Theſe ſymptoms have continued but a very ſhort time, when a yellow colour begins to diffuſe itſelf over the *tunica albuginea*, or white part of the eye, and the nails of the fingers; the urine becomes high coloured, with a yellowiſh ſediment capable of giving a yellow tinct to linen; the ſtools are whitiſh or gray. In ſome there is a moſt violent pain in the epigaſtric region, which is conſiderably increaſed after meals. Sometimes the patient has a continual propenſity to ſleep; but in others there is too great watchfulneſs; and ſometimes the pain is ſo great, that though the patient be ſleepy he cannot compoſe himſelf to reſt. The pains come by fits; and moſt women who have had the jaundice and born children, agree, that they are more violent than labour-pains. As the diſeaſe increaſes, the yellow colour becomes more and more deep; an itching is felt all over the ſkin; and even the internal membranes of the viſcera, the bones, and the brain itſelf, become tinged, as hath been ſhown from diſſections, where the bones have been found tinged ſometimes for years after the jaundice has been cured.

In like manner, all the ſecretions are affected with the yellow colour of the bile, which in this diſeaſe is diffuſed throughout the whole maſs of fluids. The ſaliva becomes yellowiſh and bitter; the urine exceſſively high coloured, in ſuch a manner as to appear almoſt black; nay, the blood itſelf is ſometimes ſaid to appear of a yellow colour when drawn from a vein; yet Dr Heberden ſays, that he never ſaw the milk altered in its colour, even in caſes of very deep jaundice. In proceſs of time the blood begins to acquire a tendency to diſſolution and putrefaction; which is known by the patient's colour changing from a deep yellow to a black or dark yellow. Hæmorrhages enſue from various parts of the body, and the patients frequently die of an apoplexy; though in ſome the diſeaſe degenerates into an incurable dropſy; and there have not been wanting inſtances of ſome who have died of the dropſy after the jaundice itſelf had been totally removed.

Icterus.

Cauſes. As the jaundice conſiſts in a diffuſion of the bile throughout the whole ſyſtem, it thence follows, that whatever may favour the diffuſion is alſo to be reckoned among the cauſes of jaundice. Many diſputes have ariſen concerning the manner in which the bile is introduced into the blood; but it is now generally agreed that it is taken up by the lymphatics of the gall-bladder and biliary ducts. Hence, a jaundice may ariſe from any thing obſtructing the paſſage of the bile into the duodenum, or from any thing which alters the ſtate of the lymphatics in ſuch a manner as to make them capable of abſorbing the bile in its natural ſtate. Hence the jaundice may ariſe from ſcirrhi of the liver or other viſcera preſſing upon the biliary ducts, and obſtructing the paſſage of the bile; from flatus diſtending the duodenum, and ſhutting up the entrance of the ductus communis choledochus into it; from the ſame orifice being plugged up by viſcid bile, or other ſordes; but by far the moſt frequent cauſe of jaundice is the formation of calculi, or more properly biliary concretions: for although they were long conſidered as being of a calcareous nature, yet more accurate experiments have now demonſtrated, that they conſiſt principally of a ſebaceous matter; accordingly, while they are ſo light as to ſwim in water, they are alſo highly inflammable. Theſe are found of almoſt all ſizes, from that of a ſmall pea to that of a walnut, or bigger: they are of different colours; and ſometimes appear as if formed in the inward part by cryſtallization, but of lamellæ on the outer part; though ſometimes the outward part is covered with rough and ſhining cryſtals, while the inward part is lamellated. Theſe enter into the biliary ducts, and obſtruct them, cauſing a jaundice, with violent pain for ſome time; and which can be cured by no means till the concretion is either paſſed entirely through the ductus communis or returned into the gall-bladder. Sometimes, in the opinion of many celebrated phyſicians, the jaundice is occaſioned by ſpaſmodic conſtrictions of the biliary ducts; but this is denied by others, and it is not yet aſcertained whether theſe ducts are capable of being affected by ſpaſm or not, as the exiſtence of muſcular fibres in them has not with certainty been diſcovered. It cannot, however, be denied, that violent fits of paſſion have often produced jaundice, ſometimes temporary, but frequently permanent. This has been by ſome deemed a ſufficient proof of the ſpaſmodic contraction of the ducts; but their opponents ſuppoſed, that the agitation occaſioned by the paſſion might puſh forward ſome biliary concretion into a narrow part of the duct, by which means a jaundice would certainly be produced, till the concretion was either driven backward or forward into the duodenum altogether. But even ſuppoſing the ducts themſelves to be incapable of ſpaſm, yet there can be no doubt that by a ſpaſm of the inteſtines biliary concretions may be retained in the ducts; and

Impetigines.

and indeed it is principally where the duct entering obliquely into the inteftine forms as it were a fpecies of valve that thefe concretions are retained.

In a very relaxed ftate of the body there is alfo an abforption of the bile, as in the yellow fever; and indeed in all putrid diforders there is a kind of yellowifh tinct over the fkin, though much lefs than in the true jaundice. The reafon of this is, that in thefe diforders there is ufually an increafed fecretion of bile, commonly of a thinner confiftence than in a healthy ftate, while the orifices of the lymphatics are probably enlarged, and thus ready to abforb a fluid fomewhat thicker than what they ought to take up in a healthy ftate; but thefe diforders are of fhort duration in comparifon with the real jaundice, which fometimes lafts for many years. Thefe affections, however, cannot with propriety in any cafe be confidered as real inftances of jaundice; for, to conftitute that difeafe, bile muft not only be prefent in the blood, but wanting in the alimentary canal.

It is obfervable, that women are more fubject to jaundice than men, which probably arifes from their more fedentary life; for this, together with fome of the depreffing paffions of the mind, is found to promote the acceffion of the difeafe, if not abfolutely to produce it. Pregnant women alfo are frequently attacked by the jaundice, which goes off after their delivery.

Prognofis. As jaundice may arife from many different caufes, fome of which cannot be difcovered during the patient's life, the prognofis muft on this account be very uncertain. The only cafes which admit of a cure are thofe depending upon biliary concretions, or obftructions of the biliary ducts by vifcid bile; for the concretions are feldom of fuch a fize that the ducts will not let them pafs through, though frequently not without extreme pain. Indeed this pain, though fo violent, and almoft intolerable to the fick perfon, affords the beft prognofis; as the phyfician may readily affure his patient that there is great hope of his being relieved from it. The coming on of a gentle diarrhœa, attended with bilious ftools, together with the ceffation of pain, are figns of the difeafe being cured. We are not, however, always to conclude, becaufe the difeafe is not attended with acute pain, that it is therefore incurable; for frequently the paffage of a concretion through the biliary ducts is accompanied only with a fenfation of flight uneafinefs.

Cure. The great object to be aimed at in the cure of jaundice is unqueftionably the removal of the caufe which obftructs the paffage of bile into the inteftines: But before this can be accomplifhed, practices are often neceffary for alleviating urgent fymptoms; which may be done fometimes by fupplying the want of bile in the alimentary canal, fometimes by affording an exit for bilious matter from the general mafs of blood, but moft frequently by obviating the effects of diftention and obftruction to the circulation in the fyftem of the liver.

The meafures to be employed for the removal of the obftruction muft depend very much on the nature of the obftructing caufe.

When the jaundice arifes from indurated fwellings or fc'r hi of the vifcera, it is abfolutely incurable; nevertheless, as thefe cannot always be difcovered, the phyfician ought to proceed in every cafe of jaundice as if it arofe from calculi. The indications here are, 1. To diffolve the concretions; and, 2. To prevent their formation a fecond time. But unhappily the medical art has not yet afforded a folvent for biliary concretions. They cannot even be diffolved when tried out of the body either by acids or alkalies, or any thing but a mixture of oil of turpentine and fpirit of wine; and thefe fubftances are by far too irritating to be given in fufficient quantity to affect a concretion in the biliary ducts. Boerhaave obferves, that difeafes of the liver are much more difficult to cure than thofe in any other part of the body; becaufe of the difficulty there is in getting at the part affected, and the tedious and roundabout paffage the blood has to it. The juice of common grafs has indeed been recommended as a fpecific in the jaundice, but on no good foundation. Gliffon obferves, that black cattle are fubject to biliary concretions when fed with hay or dried ftraw in winter, but are cured by the fucculent grafs in the fpring; and Van Swieten tells a ftrange ftory of a man who cured himfelf of the juandice by living almoft entirely on grafs, of which he devoured fuch quantities, that the farmers were wont to drive him out of their fields; but other practitioners have by no means found this in any degree effectual. The only method of cure now attempted in the jaundice is to expel the concretion into the inteftines; for which vomits and exercife are the principal medicines. The former are juftly reckoned the moft efficacious medicines, as they powerfully fhake all the abdominal and thoracic vifcera; and thus tend to diflodge any obftructing matter that may be contained in them. But if there be a tendency to inflammation, vomits muft not be exhibited till bleeding has been premifed. We muft alfo proceed with caution if the pain be very fharp; for in all cafes where the difeafe is attended with violent pain, it will be neceffary to allay it by opiates before the exhibition of an emetic. There is alfo danger, that, by a continued ufe of vomits, a concretion which is too large to pafs, may be fo impacted in the ducts that it cannot even be returned into the gall-badder, which would otherwife have happened. In all cafes, therefore, if no relief follows the exhibition of the fecond or third emetic, it will be prudent to forbear their farther ufe for fome time.

Icterus.

Of all kinds of exercife, that of riding on horfeback is moft to be depended upon in this difeafe. It operates in the fame manner with vomits, namely, by the concuffion it gives to the vifcera; and therefore the cautions neceffary to be obferved in the ufe of vomits are alfo neceffary to be obferved in the ufe of riding. Cathartics alfo may be of fervice, by cleanfing the *primæ viæ*, and foliciting a difcharge of the bile into the inteftines; but they muft not be of too draftic a nature, elfe they may produce incurable obftructions, by bringing forward conerctions that are too large to pafs. Anodynes and the warm bath are ferviceable by their relaxing quality; and there can be no doubt, that, from acting as powerful antifpafmodics, they often give an opportunity for the difcharge of concretions by very flight caufes, when they would otherwife be firmly retained. Soap has been fuppofed to do fervice as

Dysæsthesiæ. as a solvent; but this is now found to be a mistake, and it acts in no other way than as a relaxant or as a gentle purgative.

But when all means of relief fail, as in cases of scirrhus, we can then only attempt to palliate the symptoms, and preserve the patient's life as long as possible. This is best accomplished by diuretics; for thus a great quantity of bilious matter is evacuated, and the system is freed from the bad consequences which ensue on its stagnation in the habit. But even this is by no means equal to the common evacuation by stool; nor can all the attempts to supply the want of bile in the intestines by bitters and other stomachics restore the patient to his wonted appetite and vigour. If the pain be very violent, we must on all occasions have recourse to opiates; or if the blood has acquired a tendency to dissolution, it must be counteracted by proper antiseptics.

If the disease goes off, its return must be prevented by a course of tonic medicines, particularly the cinchona and antiseptics: but we can by no means be certain that the jaundice will not return, and that at any interval; for there may be a number of concretions in the gall-bladder, and though one has passed, another may very quickly follow, and produce a new fit of jaundice; and thus some people have continued to be affected with the distemper, at short intervals, during life.

In the East Indies, mercury has been lately recommended as exceedingly efficacious in disorders of the liver, especially those which follow intermitting and remitting fevers. Dr Monro, in his Observations on the means of preserving the health of soldiers, acquaints us, that he has seen some icteric cases which, he thought, received benefit from taking a few grains of the submurias hydrargyri at night, and a purge next morning; and this repeated two or three times a-week.

Infants are subject to a temporary jaundice, commonly called the *gum*, soon after birth; the cause of which is not well understood. It differs remarkably from the common jaundice; as, in the latter, the disease is first discoverable in the white of the eyes; but though the skin of infants in the gum is all over yellow, their eyes always remain clear. The disorder goes off spontaneously, or by the use of a gentle purgative or two.

357 Class IV. LOCALES.

Vitia, *Sauv.* Class I. *Lin.* Class XI. *Vog.* Class X. *Sag.* Class I.
Plagæ, *Sag.* Class II.
Morbi organici Auctorum.

358 Order I. DYSÆSTHESIÆ.

Dysæsthesiæ, *Sauv.* Class VI. Ord. I. *Sag.* Class IX. Ord. I.

359 Genus XCII. CALIGO.

The *Cataract.*

Caligo, *Sauv.* gen. 153. *Vog.* 288. *Sag.* gen. 259.
Cataracta, *Lin.* 109.

A *cataract* is an obstruction of the pupil, by the interposition of some opaque substance which either diminishes or totally extinguishes the sight. It is generally an opacity in the crystalline humour. In a recent or beginning *cataract*, the same medicines are to be used as in the *gutta serena*; and they will sometimes succeed. But when this does not happen, and the cataract becomes firm, it must be couched, or rather extracted; for which operation, see Surgery.—Dr Buchan says he has resolved a recent cataract by giving the patient some purges with calomel, keeping a poultice of fresh hemlock constantly upon the eye, and a perpetual blister on the neck.

There is, however, but little reason to suppose that these practices will frequently succeed. A resolution can only be effected here by an absorption of the opaque matter; and where this is possible, there is perhaps a better chance of its being effected by the agency of the electric fluid than by any other means. For this purpose electricity is chiefly applied under the form of the *electric aura*, as it has been called; but even this is very rarely successful.

Genus XCIII. AMAUROSIS. 360

The *Gutta Serena.*

Amaurosis, *Sauv.* gen. 155. *Lin.* 110. *Vog.* 238. *Sag.* 261.
Amblyopia, *Lin.* 108. *Vog.* 236.

Amaurosis. A *gutta serena* is an abolition of the sight without any apparent cause or fault in the eyes. In every case it depends on an affection of some part of the optic nerve. But the affections which may produce this disease are of different kinds. When it is owing to a decay or wasting of the optic nerve, it does not admit of a cure; but when it proceeds from a compression of the nerves by redundant humours, these may be in some measure drained off, and the patient relieved. For this purpose, the body must be kept open with the laxative mercurial pills. If the patient be young, and of a sanguine habit, he may be bled. Cupping with scarifications on the back part of the head will likewise be of use. A running at the nose may be promoted by volatile salts, stimulating powders, &c. But the most likely means of relieving the patient, are issues or blisters kept open for a long time on the back part of the head, behind the ears, or on the neck; which have been known to restore sight even after it had been for a considerable time lost.—Should these fail, recourse must be had to a mercurial salivation; or, what will perhaps answer the purpose better, 12 grains of the corrosive sublimate mercury may be dissolved in an English pint and a half of brandy, and a table spoonful of it taken twice a-day, drinking half a pint of the decoction of sarsaparilla after it.—Of late electricity has been much celebrated as efficacious, when no other thing could do service; and here it has in some degree the same chance of success as in other cases of insensibility, depending on an affection of the nerves, in some of which it has certainly in particular cases been of use.

In the amaurosis, Dr Porterfield observes, that it is of the utmost consequence to know of how long standing the disease has been; which is not always easily done if one eye only be affected. This is a very essential

Dyſæſtheſiæ. tial point; becauſe an amauroſis of long ſtanding is altogether incurable. Mr Boyle mentions the caſe of a man who had a cataract for ſeveral years without knowing it himſelf, though others did. He diſcovered it at laſt by happening to rub his ſound eye, and was ſurpriſed to find himſelf in the dark. When a perſon, therefore, has a gutta ſerena only in one of the eyes, he may think that the eye has but lately loſt the power of ſight; though this perhaps has been the caſe for ſeveral years. On the other hand, he may imagine that a recent diſeaſe of this kind is really of long ſtanding. But by inquiring at what time he firſt became ſubject to miſtakes in all actions that require the diſtance to be exactly diſtinguiſhed, as in pouring liquor into a glaſs, ſnuffing a candle, or threading a needle, we may diſcover the age of the diſeaſe, and thence be aſſiſted to form a more juſt prognoſtic with reſpect to its cure. Dr Porterfield gives an inſtance of his conjecturing in this manner concerning the caſe of a young lady who had diſcovered a loſs of ſight in one of her eyes only the day before. The diſeaſe was thought to be of long ſtanding; but as the doctor found that ſhe had only been ſubject to miſtakes of the kind above mentioned for about a month, he drew a favourable prognoſtic, and the diſeaſe was cured.

361 Genus XCIV. DYSOPIA.

Depraved Vision.

Amblyopia, *Sauv.* gen. 154. *Sag.* 258.

There are ſeveral ſpecies referred to this genus by Dr Cullen, viz.

1. *Dyſopia* Tenebrarum; 2. *Dyſopia* Luminis.—The former of theſe is properly the *nyctalopia*, or night-blindneſs, of ancient authors. But amongſt both the Greek and Latin writers, there is a direct oppoſition in the uſe of this word *nyctalopia;* ſome ſaying it ſignifies "thoſe who *cannot* ſee by night," and others expreſs by it "thoſe who cannot ſee during the day, but during the *night*."—The difference in the account of this diſorder, as to its appearing in the night or in the day, is reconciled by conſidering it as of the intermitting kind: the difference then will conſiſt in the different times of its approach; ſo it may be called *periodical blindneſs*. Intermittents appearing in a variety of modes, and the ſucceſs of cinchona in ſome inſtances of this ſort of blindneſs, both favour the opinion of its being an intertermittent diſeaſe of the eyes; and this view has accordingly been taken of it by ſome late writers, particularly in ſome papers in the London Medical Obſervations, and Medical Tranſactions.

3. *Dyſopia Proximorum* (*Preſbytia*), or the defect of thoſe who *ſee only at too great diſtance.* 4. *Dyſopia Dissitorum* (*Myopia*), or the defect of thoſe who are *ſhortſighted.*—Theſe are diſorders which depend on the original ſtructure or figure of the eye, therefore admit of no cure. The inconveniences ariſing from them may, however, be in ſome meaſure remedied by the help of proper glaſſes. The former requires the aid of a convex, and the latter of a concave glaſs.

5. *Dyſopia Lateralis;* a defect by which objects cannot be viewed diſtinctly but in an oblique poſition.—Thus, in viewing an object placed on the left, they turn their face and eyes to the right, and *vice verſa.*—This diſorder may proceed from various cauſes both natural and accidental, ſome of which admit of no remedy. If it be occaſioned by a partial adheſion of the eyelids, the hand of the ſurgeon is required: if by a tranſverſe poſition of the pupil, ſome mechanical contrivance is neceſſary. If it be owing to an *albugo* covering part of the pupil, or to a film rendering a portion of the cornea opaque, the remedies for theſe affections are to be here applied. Paracuſis.

Genus XCV. PSEUDOBLEPSIS. 362

Imaginary Vision of Objects which do not exiſt.

Suffuſio, *Sauv.* gen. 217. *Sag.* 329.
Phantaſma, *Lin.* 73. *Sag.* 289.

This very often takes place when the body is diſeaſed, and then the patient is ſaid to be delirious. Sometimes, however, in theſe caſes, it does not amount to delirium; but the perſon imagines he ſees gnats or other inſects flying before his eyes; or ſometimes, that every thing he looks at has black ſpots in it, which laſt is a very dangerous ſign. Sometimes alſo ſparks of fire appear before the eyes; which appearances are not to be diſregarded, as they frequently precede apoplexy or epilepſy. Sometimes, however, people have been affected in this manner during life without feeling any other inconvenience. Such a diſorder can rarely if ever be cured.

Genus XCVI. DYSECOEA. 363

Deafness, or *Difficulty of Hearing.*

Genus XCVII. PARACUSIS. 364

Depravation of Hearing.

Paracuſis, *Sauv.* gen. 159. *Sag.* 265.
Syrigmus, *Sauv.* gen. 219. *Sag.* 231.

The functions of the ear may be injured by wounds, ulcers, or any thing that hurts its fabric. The hearing may likewiſe be hurt by exceſſive noiſe; violent colds in the head; fevers; hard wax, or other ſubſtances ſticking in the cavity of the ear; too great a degree of moiſture or dryneſs of the ear. Deafneſs is very often the effect of old age, and is incident to moſt people in the decline of life. Sometimes it is owing to an original fault in the ſtructure or formation of the ear itſelf. When this is the caſe it admits of no cure; and the unhappy perſon not only continues deaf, but generally likewiſe dumb, for life.

When deafneſs is the effect of wounds or ulcers of the ears, or of old age, it is not eaſily removed. When it proceeds from cold applied to the head, the patient muſt be careful to keep his head warm, eſpecially in the night; he ſhould likewiſe take ſome gentle purges, and keep his feet warm, and bathe them frequently in lukewarm water at bedtime. When deafneſs is the effect of a fever, it generally goes off after the patient recovers. If it proceed from dry wax ſticking in the ears, it may be ſoftened by dropping oil into them; afterwards they muſt be ſyringed with warm milk and water.

If deafneſs proceeds from dryneſs of the ears, which may

Dysæsthesiæ. may be known by looking into them, half an ounce of the oil of ſweet almonds, and the ſame quantity of camphorated ſpirit of wine, or tincture of aſafœtida, may be mixed together, and a few drops of it put into the ear every night at bedtime, ſtopping them afterwards with a little wool or cotton. Some, inſtead of oil, put a ſmall ſlice of the fat of bacon into each ear, which is ſaid to anſwer the purpoſe very well.—When the ears abound with moiſture, it may be drained off by an iſſue or ſeton, which ſhould be made as near the affected parts as poſſible.

Some, for the cure of deafneſs, recommend the gall of an eel mixed with ſpirit of wine, to be dropped into the ear; others, equal parts of Hungary water and ſpirit of lavender. Etmuller extols amber and muſk; and Brookes ſays, he has often known hardneſs of hearing cured by putting a grain or two of muſk into the ear with cotton wool. Where, however, an application with conſiderable ſtimulant power is neceſſary, camphorated oil, with the addition of a few drops of volatile alkaline ſpirit, may be conſidered as one of the beſt. It is proper, however, to begin with a ſmall quantity of the alkali, increaſing it as the ear is found to bear it. In ſome inſtances, where deafneſs depends on a ſtate of inſenſibility in the nerves, electricity, particularly under the form either of ſparks, or of the electric aura, has been employed with great ſucceſs. Great benefit has alſo in ſome caſes been derived from galvaniſm. But theſe and other applications muſt be varied according to the cauſe of the diſorder.

Though ſuch applications may ſometimes be of ſervice, yet they much oftener fail, and frequently they do hurt. Neither the eyes nor ears ought to be tampered with; they are tender organs, and require a very delicate touch. For this reaſon, what we would chiefly recommend in deafneſs, is to keep the head warm. From whatever cauſe this diſorder proceeds, this is always proper; and more benefit has often been derived from it alone, in the moſt obſtinate caſes of deafneſs, than from any medicines whatever.

365 Genus XCVIII. ANOSMIA.

Defect of Smelling.

Anoſmia, *Sauv.* gen. 156. *Lin.* 113. *Vog.* 248. *Sag.* 262.

Cauſes. Morbid affections in the ſenſe of ſmelling, may be conſidered with reſpect to their cauſes, as ariſing from one of two ſources; either from ſome organic affection of the parts here principally concerned, or from a mere atonic ſtate of the parts without any obvious affection. The ſenſe of ſmelling may be diminiſhed or deſtroyed by various diſeaſes of the parts; as, the moiſture, dryneſs, inflammation or ſuppuration of that membrane which lines the inſide of the noſe, commonly called the *olfactory membrane;* the compreſſion of the nerves which ſupply this membrane, or ſome fault in the brain itſelf at their origin. A defect, or too great a degree of ſolidity, of the ſmall ſpongy bones of the upper jaw, the caverns of the forehead, &c. may likewiſe impair the ſenſe of ſmelling. It may alſo be injured by a collection of fetid matter in thoſe caverns, which keeps conſtantly exhaling from them. Few things are more hurtful to the ſenſe of ſmelling than taking great quantities of ſnuff.

Ageuſtia.

Cure. When the noſe abounds with moiſture, after gentle evacuations, ſuch things as tend to take off irritation and coagulate the thin ſharp ſerum may be applied; as the oil of aniſe mixed with fine flour, camphire diſſolved in oil of almonds, &c. The vapours of amber, frankincenſe, gum-maſtic, and benzoin, may likewiſe be received into the noſe and mouth. For moiſtening the mucus when it is too dry, ſome recommend ſnuff made of the leaves of marjoram, mixed with oil of amber, and aniſeed; or a ſternutatory of calcined ſulphate of zinc, 12 grains of which may be mixed with two ounces of marjoram-water and filtrated. The ſteam or vapour of vinegar thrown upon hot iron received up the noſtrils is likewiſe of uſe for ſoftening the mucus, opening obſtructions, &c.

If there be an ulcer in the noſe, it ought to be dreſſed with ſome emollient ointment, to which, if the pain be very great, a little laudanum may be added. If it be a venereal ulcer, it is not to be cured without mercury. In that caſe, the ſolution of the corroſive ſublimate in brandy may be taken, as directed in the gutta ſerena. The ulcer ought likewiſe to be waſhed with it; and the fumes of cinnabar may be received up the noſtrils.

If there be reaſon to ſuſpect that the nerves which ſupply the organs of ſmelling are inert or want ſtimulating, volatile ſalts, ſtrong ſnuffs, and other things which occaſion ſneezing, may be applied to the noſe. The forehead may likewiſe be anointed with balſam of Peru, to which may be added a little of the oil of amber.

Genus XCIX. AGEUSTIA. 366

Defect of Tasting.

Ageuſtia, *Sauv.* gen. 157. *Sag.* 263.
Ageuſtia, *Lin.* 114.
Apogeuſis, *Vog.* 449.

Cauſe. This diſeaſe alſo may ariſe either from an organic affection, or an atonic ſtate of the parts. The taſte may be diminiſhed by cruſts, filth, mucus, aphthæ, pellicles, warts, &c. covering the tongue; it may be depraved by a fault of the ſaliva, which, being diſcharged into the mouth, gives the ſame ſenſation as if the food which the perſon takes had really a bad taſte; or it may be entirely deſtroyed by injuries done to the nerves of the tongue and palate. Few things prove more hurtful either to the ſenſe of taſting or ſmelling than obſtinate colds, eſpecially thoſe which affect the head.

Cure. When the taſte is diminiſhed by filth, mucus, &c. the tongue ought to be ſcraped, and frequently waſhed with a mixture of water, vinegar, and honey, or ſome other detergent. When the ſaliva is vitiated, which ſeldom happens unleſs in fevers or other diſeaſes, the curing of the diſorder is the cure of this ſymptom. To relieve it, however, in the mean time, the following practices may be of uſe: if there be a bitter taſte, it may be taken away by vomits, purges, and other things which evacuate bile: what is called a *nidorous taſte*, ariſing from putrid humours, is

Dyſorexiæ. is corrected by the juice of citrons, oranges, and other acids: a ſalt taſte is cured by plentiful dilution with watery liquors: an acid taſte is deſtroyed by abſorbents and alkaline ſalts, as powder of oyſter-ſhells, ſalt of wormwood, &c.

When the ſenſibility of the nerves which ſupply the organs of taſte is diminiſhed, the chewing of horſe-radiſh, and of other ſtimulating ſubſtances, will help to recover it.

367 Genus C. ANÆSTHESIA.

Defect of the Senſe of FEELING.

Sauv. gen. 161. *Lin.* 218. *Vog.* 267.

Cauſes, &c. This ſenſe may be hurt by any thing that obſtructs the nervous ſyſtem, or prevents its being regularly conveyed to the organs of touching, as preſſure, extreme cold, &c. It may likewiſe be hurt by too great a degree of ſenſibility, when the nerve is not ſufficiently covered by the cuticle or ſcarf-ſkin, or where there is too great a tenſion of it, or it is too delicate. Whatever diſorders the functions of the brain and nerves, hurts the ſenſe of touching. Hence it appears to proceed from the ſame general cauſes as palſy and apoplexy, and requires nearly the ſame method of treatment.

In a *ſtupor*, or defect of touching, which ariſes from an obſtruction of the cutaneous nerves, the patient muſt firſt be purged; afterwards ſuch medicines as excite the action of the nerves, or ſtimulate the ſyſtem, may be uſed. For this purpoſe, the ſpirit of hartſhorn, either by itſelf or combined with eſſential oils, horſe-radiſh, &c. may be taken inwardly; the diſordered parts, at the ſame time, may be frequently rubbed with freſh nettles or ſpirit of ſal ammoniac. Bliſters and ſinapiſms applied to the parts will likewiſe be of uſe; and alſo warm bathing, eſpecially in the natural hot baths.

368 Order II. DYSOREXIÆ.

Sect. I. *APPETITUS ERRONEI.*

Moroſitates, *Sauv.* Claſs VIII. Order II. *Sag.* Claſs XIII. Order II.
Pathetici, *Lin.* Claſs V. Order II.
Hyperæſtheſes, *Vog.* Claſs VII.

369 Genus CI. BULIMIA.

Insatiable Hunger, or *Canine Appetite.*

Bulimia, *Sauv.* gen. 223. *Lin.* 79. *Sag.* gen. 335.
Bulimus, *Vog.* 296.
Addephagia, *Vog.* 297.
Cynorexia, *Vog.* 298.

This diſeaſe is commonly owing to ſome fault in the ſtomach, by which the aliments are thrown out too ſoon; and unleſs the perſon be indulged in his deſire for eating, he frequently falls into fainting fits. Sometimes it is attended with ſuch a ſtate of the ſtomach, that the aliment is rejected by vomit almoſt immediately after being ſwallowed; after which the appetite for food returns as violent as ever. But there are many circumſtances which ſeem to render it probable that it more frequently ariſes from a morbid condition of the ſecreted fluid poured into the ſtomach, by means of which the aliment is diſſolved. Bulimia. When the activity of this fluid is morbidly increaſed, it will both produce too ſudden a ſolution of the ſolid aliment, and likewiſe operate as a powerful and peculiar ſtimulus to the ſtomach, giving an uneaſy ſenſation, ſimilar to that which takes place in natural hunger. Such things are proper for the cure as may enable the ſtomach to perform its office: chalybeates and other tonics will generally be proper. In ſome, brandy drunk in a morning has been uſeful; and frequent ſmoking tobacco has relieved others. Oil, fat meat, pork, opiates, and in ſhort every thing which in a ſound perſon would be moſt apt to pall the appetite, may alſo be uſed as temporary expedients, but cannot be expected to perform a cure. In ſome, the pylorus has been found too large; in which caſe the diſeaſe muſt have been incurable.

Genus CII. POLYDIPSIA. 370

Excessive Thirst.

Polydipſia, *Sauv.* gen. 224. *Lin.* 80. *Vog.* 275. *Sag.* 336.

This is almoſt always ſymptomatic; and occurs in fever, dropſy, fluxes, &c. The cure is very generally obtained only by the removal of the primary diſeaſe; and it is beſt palliated by the gradual introduction of diluents: But when theſe are contraindicated, it may often be ſucceſsfully obviated by ſuch articles taken into the mouth as have effect in augmenting the flow of ſaliva.

Genus CIII. PICA. 371

Longing, or *Falſe Appetite.*

Pica, *Sauv.* gen. 222. *Sag.* 334.
Citta, *Lin.* 78.
Allotriophagia, *Vog.* 299.
Malacia, *Vog.* 300.

The pica is alſo very generally ſymptomatic of other diſeaſes, as of worms, chloroſis, pregnancy, &c.; and is therefore chiefly to be combated by the removal of the primary affection. It may, however, be obſerved, that peculiar longings occurring in certain diſeaſes, as for example in fevers, often point out a natural cure. The indulgence of ſuch appetites to a moderate degree is ſeldom productive of any inconvenience, and often followed by the beſt conſequences.—Hence there are ſome practitioners who think that ſuch craving ſhould very generally be indulged; particularly when the patient can aſſign no reaſon whatever for ſuch particular longings, but is merely prompted by an uncommon and inexplicable deſire.

Genus CIV. SATYRIASIS. 372

Satyriaſis, *Sauv.* gen. 228. *Lin.* 81. *Sag.* 340.

Satyriaſis is a violent deſire of venery in men, even ſo that reaſon is depraved by it. The pulſe is quick, and the breathing ſhort; the patient is ſleepleſs, thirſty, and

Dyforexiæ. and loathes his food; the urine is evacuated with difficulty, and a fever foon comes on. Thefe fymptoms, however, are probably not fo much the confequence of fatyriafis, as merely concomitant effects refulting from the fame caufe. And indeed this affection is moft frequently the concomitant of a certain modification of infanity. The nature and caufe of this affection are in moft inftances very little afcertained; but as far as we are acquainted with the treatment, it agrees very much with the affection next to be mentioned, which, of the two, is the moft common occurrence.

373 GENUS CV. NYMPHOMANIA.

FUROR UTERINUS.

Nymphomania, *Sauv.* 229. *Sag.* 341.
Satyriafis, *Lin.* 81.

The *furor uterinus* is in moft inftances either a fpecies of madnefs or a high degree of hyfterics. Its immediate caufe is a preternatural irritability of the uterus and pudenda of women (to whom the diforder is proper), or an unufual acrimony of the fluids in thefe parts.—Its prefence is known by the wanton behaviour of the patient: fhe fpeaks and acts with unreftrained obfcenity; and as the diforder increafes, fhe fcolds, cries, and laughs, by turns. While reafon is retained, fhe is filent, and feems melancholy, but her eyes difcover an unufual wantonnefs. The fymptoms are better and worfe until the greateft degree of the diforder approaches, and then by every word and action her condition is too manifeft.—In the beginning a cure may be hoped for; but if it continue, it degenerates into a mania.—In order to the cure, blood-letting is commonly recommended in proportion to the patient's ftrength. Camphor in dofes of 15 or 20 grains, with nitre, and fmall dofes of the tincture of opium, fhould be repeated at proper intervals. Some venture to give cerufa acetata in dofes from three to five grains. Befides bleeding, cooling purges fhould alfo be repeated in proportion to the violence of fymptoms, &c. What is ufeful in maniacal and hypochondriac diforders, is alfo ufeful here, regard being had to fanguine or phlegmatic habits, &c. When the delirium is at the height, give opiates to compofe; and ufe the fame methods as in a phrenitis or a mania. Injections of barley-water, with a fmall quantity of hemlock-juice, according to Riverius, may be frequently thrown up into the uterus: this is called *fpecific*; but matrimony, if poffible, fhould be preferred. For although this cannot be reprefented as a cure for the difeafe when in an advanced ftate, yet there is reafon to believe that it has not unfrequently prevented it where it would otherwife have taken place.

374 GENUS CVI. NOSTALGIA.

Vehement DESIRE *of* REVISITING *one's* COUNTRY.

Noftalgia, *Sauv.* gen. 226. *Lin.* 83. *Sag.* 338.

This is to be reckoned a fpecies of melancholy; and unlefs it be indulged, it very commonly proves not only incurable but even fatal. Although it cannot be confidered as altogether peculiar to any nation, yet it is obferved to be much more frequent with fome than with others; and it has particularly been remarked among Swifs foldiers in the fervice of foreign ftates. Noftalgia.

SECT. II. *APPETITUS DEFICIENTES.*

Anepithymiæ, *Sauv.* Clafs VI. Ord. II. *Sag.* IX. Ord. II.
Privativi, *Lin.* Clafs VI. Order III.
Adynamiæ, *Vog.* Clafs VI.

GENUS CVII. ANOREXIA. 375

Want of APPETITE.

Anorexia, *Sauv.* gen. 162. *Lin.* 116. *Vog.* 279. *Sag.* 268.

The anorexia is fymptomatic of many difeafes, but feldom appears as a primary affection; and it is very generally overcome only by the removal of the affection on which it depends.

GENUS CVIII. ADIPSIA. 376

Want of THIRST.

Adipfia, *Sauv.* gen. 163. *Lin.* 117. *Vog.* 281. *Sag.* 269.

This by Dr Cullen is reckoned to be always fymptomatic of fome diftemper affecting the *fenforium commune.*

GENUS CIX. ANAPHRODISIA. 377

Impotence to VENERY.

Anaphrodifia, *Sauv.* gen. 164. *Sag.* 270.
Atecnia, *Lin.* 119.
Agenefia, *Vog.* 283.

For this, fee the article IMPOTENCE in the alphabetical order.

ORDER III. DYSCINESIÆ. 378

GENUS CX. APHONIA. 379

Lofs of VOICE.

Aphonia, *Sauv.* gen. 166. *Lin.* 115. *Vog.* 253. *Sag.* 272.

The lofs of voice may proceed from various caufes. If one of the recurrent nerves, which are formed by the *par vagum* and the *nervus acceſſorius*, and reach the larynx, be cut, the perfon is capable of only as it were a half-pronunciation; but if both be cut, the fpeech and voice are both loft. The lofs of fpeech happening in hyfteric patients is alfo called *aphonia;* but more properly that lofs of fpeech is thus named which depends on fome fault of the tongue.

Since the motion of any part is deftroyed, or leffened at leaft, by the interception of the nervous fluid in its paffage thither, and fince the nerves deftined for the motion of the tongue arife principally from the fifth pair, it appears that the feat of this diforder is in the fifth pair of nerves, and that the immediate caufe is

Dyscinesiæ. is a diminution or total destruction of the nervous power in them. Hence a palsy of the tongue, which is either antecedent or subsequent to hemiplectic or apoplectic disorders, demand our utmost attention.

If an aphonia appears alone, it generally bespeaks an approaching hemiplegia or apoplexy; but if it succeed these disorders, and is complicated with a weak memory and a sluggishness of the mental powers, it threatens their return. That aphony usually terminates the best which proceeds from a stagnation of serous humours compressing the branches of the fifth pair of nerves, which run to the tongue; but it is no less afflictive to the patient, and is very obstinate of cure.

Other causes of this disorder are, the striking in of eruptions on the skin, a congestion of blood in the fauces and tongue, obstructed periodical evacuations in plethoric habits, spasmodic affections, worms, a crumb of bread falling into the larynx, fear, too free an use of spirituous liquors; also whatever destroys the ligaments which go from the arytænoid to the thyroid cartilages, will destroy the voice.

The *prognostics* vary according to the cause. That species which is owing immediately to spasms, soon gives way on the removal of them. If a palsy of the tongue be the cause, it is very apt to return, though relieved, but often continues incurable.

In order to the *cure*, we must endeavour first to remove whatever obstructs the influx of the nervous fluid into the tongue, and secondly to strengthen the weak parts. These general intentions, in all cases, being regarded, the particular causes must be removed by remedies accommodated to each.

If worms be the cause, antispasmodics may give present relief; but the cure depends on the destruction or expulsion of the animals themselves. In case of a congestion of blood about the head, bleeding and nitrous medicines are to be used.—That species of aphony which remains after the shock of an hemiplegia or apoplexy, requires blisters to be applied to the nape of the neck; if spasmodic constrictions about the fauces and tongue be the cause, external paregorics are of the greatest service, anodyne antispasmodics may be laid under the tongue, and the feet bathed in warm water; carminative clysters also are useful.—When a palsy of the tongue produces this complaint, evacuations, according to the patient's habit, must be made, and warm nervous medicines must be externally applied, and internally administered; blisters also should be placed between the shoulders.—In case of repelled cuticular eruptions, sudorifics should be given, and the patient's drink should be warm. The spiritus ammoniæ succinatus, or vinum antimonii, may be employed either in combination with other articles, or by themselves, and given at proper distances of time, in the patient's drink, or on a bit of sugar.—Sometimes the serum flows so rapidly to the fauces and adjacent parts, in a salivation, as to deprive the patient of all power to speak; in this case diaphoretics and laxatives, with a forbearance of all mercurials, are the speediest remedies.

380 GENUS CXI. MUTITAS.

DUMBNESS.

Mutitas, *Sauv.* gen. 165. *Vog.* 257. *Sag.* 271.

Mutitas. Dumb people are generally born deaf; in which case the distemper is incurable by medicine: though even such people may be taught not only to read and write, but also to speak and to understand what others say to them. From some observations on the method in which this has been accomplished, we may refer the reader to the article DUMBNESS, in the alphabetical order. But in these cases, admitting of cure in the manner above alluded to, the dumbness proceeds principally, if not solely, from the deafness. For when it proceeds from a defect of any of the organs necessary for speech, the tongue for instance, it is always incurable; but if it arise from a palsy, the medicines applicable in that case will sometimes restore the speech.

GENUS CXII. PARAPHONIA. 381

Change in the Sound of the VOICE.

Paraphonia, *Sauv.* gen. 168.
Cacophonia, *Sag.* 274.
Raucedo, *Lin.* 146.
Raucitas, *Vog.* 252.
Asaphia, &c. *Vog.* 250, 251, 254, 255, 256.

The voice may be changed from various causes. In males it becomes much more hard about the time of puberty; but this can by no means be reckoned a disease. In others it proceeds from a catarrh, or what we call a *cold;* it arises also from affections of the nose and palate, as polypi, ulcers, &c. in which case the cure belongs properly to SURGERY. In some it arises from a laxity of the *velum pendulum palati* and glottis, which makes a kind of snoring noise during inspiration. The cure of this last case is to be attempted by tonics and such other medicines as are of service in diseases attended with laxity.

GENUS CXIII. PSELLISMUS. 382

Defect in PRONUNCIATION.

Psellismus, *Sauv.* gen. 167. *Lin.* 139. *Sag.* 273.
Traulotis, &c. *Vog.* 258, 259, 260, 261.

Of this disease (if such it may be called), there are many different kinds. Some cannot pronounce the letter S; others labour under the same difficulty with R, L, M, K, &c.; while some who can with sufficient ease pronounce all the letters, yet repeat their words, or the first syllables of them, in such a strange manner, that they can scarce be understood. Very frequently these defects arise entirely from habit, and may then be got the better of by those who have the resolution to attempt it; as we are told that Demosthenes the celebrated orator got the better of a habit of stammering by declaiming with pebbles in his mouth. Sometimes, however, pronunciation may be impeded by a wrong conformation of the tongue or organs of speech; and then it cannot by any pains whatever be totally removed.

GENUS CXIV. STRABISMUS. 383

SQUINTING.

Strabismus, *Sauv.* gen. 116. *Lin.* 304. *Vog.* 514. *Sag.* 222.

Dyscinesiæ.

Description. This disease shows itself by an uncommon contraction of the muscles of the eye; whereby the axis of the pupil is drawn towards the nose, temples, forehead, or cheeks, so that the person cannot behold an object directly.

Causes, Prognosis, &c. I. This disease may proceed from custom and habit; while in the eye itself, or in its muscles, nothing is preternatural or defective.

Thus children by imitating those that squint, and infants by having many agreeable objects presented to them at once, which invite them to turn one eye to one and the other eye to another, do frequently contract a habit of moving their eyes differently, which afterwards they cannot so easily correct. Infants likewise get a custom of squinting by being placed obliquely towards a candle, window, or any other agreeable object capable of attracting their sight: for though, to see the object, they may at first turn both eyes towards it; yet, because such an oblique situation is painful and laborious, especially to the most distant eye, they soon relax one of the eyes, and content themselves with examining it with the eye that is next it; whence arises a diversity of situation and a habit of moving the eyes differently.

In this case, which may admit of a cure if not too much confirmed, it is evident, that objects will be seen in the same place by both eyes, and therefore must appear single as to other men; but because, in the eye that squints, the image of the object to which the other eye is directed falls not on the most sensible and delicate part of the retina, which is naturally in the axis of the eye, it is easy to see that it must be but faintly perceived by this eye. Hence it is, that while they are attentive in viewing any object, if the hand be brought before the other eye, this object will be but obscurely seen, till the eye change its situation and have its axis directed to it; which change of situation is indeed very easy for them, because it depends on the muscles of the eyes, whose functions are entire; but, by reason of the habit they have contracted of moving their eyes differently, the other eye is at the same time frequently turned aside, so that only one at a time is directed to this object.

II. The *strabismus* may proceed from a fault in the first conformation, by which the most delicate and sensible part of the retina is removed from its natural situation, which is directly opposite to the pupil, and is placed a little to a side of the axis of the eye; which obliges such people to turn away the eye from the object they would view, that its picture may fall on this most sensible part of the organ.

When this is the case, the disease is altogether incurable, and the phenomena that arise therefrom differ in nothing from the phenomena of the former case, excepting only that here, 1. The object to which the eye is not directed will be best seen; which is the reverse of what happens when this disease arises barely from habit and custom. 2. No object will appear altogether clear and distinct: for all objects to which the eye is directed, by having their image painted in the retina at the axis of the eye, where it is not very sensible, will be but obscurely seen; and objects that are placed so far to a side of the optic axis as is necessary for making their image fall on the most sensible and delicate part of the retina, must appear a little confused, because the several pencils of rays that come therefrom fall too obliquely on the crystalline to be accurately collected in so many distinct points of the retina; though it must be acknowledged, that this confusion will, for the most part, be so small as to escape unobserved.

Strabismus.

III. This disease may proceed from an oblique position of the crystalline, where the rays that come directly to the eye from an object, and that ought to converge to the point of the retina, which is in the axis of the eye, are, by reason of the obliquity of the crystalline, made to converge to another point on that side of the visual axis where the crystalline is most elevated; and therefore the object is but obscurely seen, because its image falls not on the retina at the axis of the eye, where it is most sensible: But the rays that fall obliquely on the eye, will after refraction, converge to this most sensible part of the retina; and, by converging there, must impress the mind with a clear idea of the object from whence they came. It is for this reason that the eye never moves uniformly with the other, but turns away from the object it would view, being attentive to the object to which it is not directed. When this is the case, it is in vain to expect any good from medicine.

The symptoms which naturally arise from it are, 1. The object to which the eye is directed will be but faintly seen, because its image falls on the retina where it is not very sensible. 2. The object to which the eye is not directed, by having its image painted on the retina at the axis of the eye, will be clearly perceived. But, 3. This same object must appear somewhat indistinct, because the pencils of rays that flow from it are not accurately collected in so many distinct points in the retina, by reason of their oblique incidence on the crystalline. 4. It must be seen, not in its proper place, but thence translated to some other place situated in the axis of vision. And, 5. Being thus translated from its true place, where it is seen by the other eye that does not squint, it must necessarily appear double; and the distance between the places of its appearance will be still greater, if the crystalline of the other eye incline to the contrary side.

IV. This disease may arise from an oblique position of the cornea; which, in this case, is generally more arched and prominent than what it is naturally.

When the eye has this conformation, no object to which it is directed can be clearly seen, because its image falls not on the retina at the axis of the eye; and therefore the eye turns aside from the object it would view, that its image may fall on the most sensible part of the retina.

When the strabismus proceeds from this cause, the prognostic and the phænomena that attend it will be much the same as in the case immediately preceding; from which nevertheless it may be distinguished by the obliquity of the cornea, which is manifest to the senses, and if the cornea be also more arched and prominent than what it is naturally, which is commonly the case, the eye will also be short-sighted.

V. This want of uniformity in the motions of our eyes, may arise from a defect, or any great weakness or

Dyſcinesiæ. Strabiſmus.

or imperfection, in the fight of both or either of the eyes; and this, according to Dr Porterfield, is the moſt common cauſe of this diſeaſe. The prognoſtic in this caſe is the ſame with that of the diſeaſe from which it proceeds.

VI. Another cauſe from which the ſtrabiſmus may proceed, lies in the muſcles that move the eye. When any of thoſe muſcles are too ſhort or too long, too tenſe or too lax, or are ſeized with a ſpaſm or paralyſis, their equilibrium will be deſtroyed, and the eye will be turned towards or from that ſide where the muſcles are faulty.

In this caſe, the diſeaſe frequently yields to medicine, and therefore admits of favourable prognoſtic; excepting only when, by a fault in the firſt conformation, any of the muſcles are longer or ſhorter than their antagoniſt; in which caſe, if ever it ſhould happen, no medicine can be of any uſe.

As to what concerns the optical phænomena, they are the ſame here as in caſe firſt: only when the diſeaſe commences not till, by cuſtom and habit, the uniform motion of the eyes has been rendered neceſſary, all objects do for ſome time appear double; but in time they appear ſingle.

Laſtly, This want of uniformity in the motions of our eyes may proceed from a preternatural adheſion or attachment to the eyelids: of this we have an inſtance in Langius. And that the ſame thing may alſo be occaſioned by a tumor of any kind within the orbit, preſſing the eye aſide, and reſtraining it from following the motions of the other, is ſo evident, that inſtances need not be brought to prove it. Here alſo the caſe may admit of a favourable prognoſtic; and as for what concerns the optical phænomena, they muſt be the ſame as in the caſe immediately preceding.

The *cure*, in confirmed caſes, is to be effected by mechanical contrivances, by which the perſon may be obliged to look ſtraight upon objects, or not ſee them at all; or at leaſt that he may ſee with uneaſineſs and confuſedly when he ſquints. In the 68th volume of the Philoſophical Tranſactions we have an account of a confirmed caſe of ſquinting of a very uncommon kind. The patient was a boy of five years old, and viewed every object which was preſented to him with but one eye at a time. If the object was preſented on his right ſide, he viewed it with his left eye; and if it was preſented on his left ſide, he viewed it with his right eye. He turned the pupil of that eye which was on the ſame ſide with the object in ſuch a direction that the image of the object might fall on that part of the bottom of the eye where the optic nerve enters it. When an object was held directly before him, he turned his head a little to one ſide, and obſerved it with but one eye, viz. that moſt diſtant from the object, turning away the other in the manner above deſcribed; and when he became tired of obſerving it with that eye, he turned his head the contrary way, and obſerved it with the other eye alone, with equal facility; but never turned the axis of both eyes on it at the ſame time. He ſaw letters which were written on bits of paper, ſo as to name them with equal eaſe, and at equal diſtances, with one eye as with the other. There was no perceptible difference in the diameters of the iriſes, nor in the contractility of them after having covered his eyes from the light. Theſe obſervations were carefully made by writing ſingle letters on ſhreds of paper, and laying wagers with the child that he could not read them when they were preſented at certain diſtances and in certain directions.

As from theſe circumſtances it appeared that there was no defect in either eye, which is frequently the caſe with perſons who ſquint, and hence that the diſeaſe was ſimply a depraved habit of moving his eyes, the diſeaſe ſeemed capable of a cure. A paper gnomon was made for this purpoſe, and fixed to a cap; and when this artificial noſe was placed over his real noſe, ſo as to project an inch between his eyes, the child, rather than turn his head ſo far to look at oblique objects, immediately began to view them with that eye which was next to them. But having the misfortune to loſe his father ſoon after this method was begun to be followed, the child was neglected for ſix years, during which time the habit was confirmed in ſuch a manner as ſeemed to leave little room to hope for a cure. The ſame phyſician, however, being again called, attempted a ſecond time to remove the deformity by a ſimilar contrivance. A gnomon of thin braſs was made to ſtand over his noſe, with a half circle of the ſame metal to go round his temples: theſe were covered with black ſilk, and by means of a buckle behind his head, and a croſs piece over the crown of his head, this gnomon was worn without any inconvenience, and projected before his noſe about two inches and a half. By the uſe of this machine he ſoon found it leſs inconvenient to view all oblique objects with the eye next to them than the eye oppoſite to them.

After this habit was weakened by a week's uſe of the gnomon, two bits of wood, about the ſize of a gooſe quill, were blackened all but a quarter of an inch at their ſummits; theſe were frequently preſented to him to look at, one being held on one ſide the extremity of his black gnomon, and the other on the other ſide of it. As he viewed theſe, they were gradually brought forwards beyond the gnomon, and then one was concealed behind the other: by theſe means, in another week, he could bend both his eyes on the ſame object for half a minute together; and by continuing the uſe of the ſame machine, he was in a fair way of being cured when the paper was written.

Dr Darwin, who writes the hiſtory of the above caſe, adds, that all the other ſquinting people he had occaſion to attend, had one eye much leſs perfect than the other: theſe patients, ſays he, are certainly cureable by covering the beſt eye many hours in a day; as by a more frequent uſe of the weak eye, it not only acquires a habit of turning to the objects which the patient wiſhes to ſee, but gains at the ſame time a more diſtinct viſion; and the better eye at the ſame time ſeems to loſe ſomewhat in both theſe reſpects, which alſo facilitates the cure.

Genus CXV. CONTRACTURA. 354

Contractions of the Limbs.

Contractura, *Sauv.* gen. 119. *Lin.* 299. *Sag.* 225.
Obſtipitas, *Sauv.* gen. 11.

Caput

Apocenoses.

Caput obstipum, *Vog.* 513.
Digitium, *Vog.* 221.

The contraction of various muscles of the body is generally the consequence of some other disease, as the rheumatism, gout, scurvy, or palsy, especially that species of the latter which follows the *colica Pictonum.* It is exceedingly difficult of cure; though the warm medicinal waters are much recommended, and have sometimes done great service. Of late electricity has been found to perform surprising cures in this way.

385 ORDER IV. APOCENOSES.

Apocenoses, *Vog.* Class II. Ord. II.
Fluxus, *Sauv.* Class IX. *Sag.* Class V.
Morbi evacuatorii, *Lin.* Class IX.

386 GENUS CXVI. PROFUSIO.

FLUX of BLOOD.

Profusio, *Lin.* 239.
Hæmorrhagia, *Vog.* 81. *Boerh.* 218.

The disease commonly known by the name of *bloody flux*, is the putrid or contagious dysentery, a disease which has already been treated of. But independent of the discharge of blood which then takes place, hæmorrhagy may take place from the alimentary canal as well as from other parts of the system. In such instances, however, if we except the place from which the discharge occurs, the phenomena are very much the same as in menorrhagia, hæmoptysis, and other hæmorrhagies already treated of; while the disease is to be combated on the same principles and by the same remedies.

387 GENUS CXVII. EPHIDROSIS.

Excessive SWEATING.

Ephidrosis, *Sauv.* gen. 258. *Sag.* gen. 194.
Sudor, *Lin.* 208.
Hydropedesis, *Vog* 121.

This is generally symptomatic; and occurs in almost all fevers, but especially in the latter stages of the hectic. Sometimes it is a primary disease arising merely from weakness; and then easily admits of a cure by the use of the cinchona, the cold bath, and other tonics.

388 GENUS CXVIII. EPIPHORA.

FLUX of the LACHRYMAL HUMOUR.

Epiphora, *Sauv.* gen. 259. *Lin.* 172. *Vog.* 99. *Sag.* 195.

This by Sauvages is described as an involuntary effusion of tears without any remarkable itching, heat, or pain. It follows long continued ophthalmias; or it may be occasioned by immoderate study, or any thing that weakens the eyes: hence it comes on about the age of 50 years, when the eyesight naturally becomes weak. It in general grows worse in the winter-time, and is very hard to cure. Some authors recommend purgatives, and blisters on the nape of the neck, in order to draw off the abundant humours; but as the disease evidently proceeds from weakness, it would rather seem proper to pursue a contrary method. Sauvages recommends to the patients to abstain from study, wine, and salted meats; and also to avoid smoke or wind, and at night to foment the eyes with an infusion of four cloves in two ounces of proof-spirit.—Hungary water, rose water with sulphate of zinc dissolved in it, &c. have also been recommended.

Ptyalismus.

GENUS CXIX. PTYALISMUS. 389

SALIVATION.

Ptyalismus, *Sauv.* gen. 261. *Lin.* 176. *Vog.* 103. *Sag.* 197.

A salivation is often symptomatic, but rarely a primary disease. Dr Cullen is of opinion, that when the latter happens to be the case, it arises from laxity; and then is to be cured by astringents and tonics. In the Medical Transactions we have the following account of a salivation brought on by a foreign substance irritating one of the parotid glands.

In the month of April 1751, a young lady about the age of 16 years, of a delicate habit, but subject to no particular complaints, perceived the beginning of a disease which afterwards proved most obstinate and loathsome, viz. an incessant spitting. The quantity of this discharge was different at different times, varying from one pint to two pints and a half in 24 hours. As to its quality, it seemed to be no other than the ordinary secretion of the salival glands. By so large and constant an evacuation, her strength became extremely impaired, and the most efficacious medicines had proved useless. She had taken large quantities of cinchona, both alone and combined with preparations of iron: and afterwards the fetid gums, opium, amber, alum, and the Neville-Holt water, had in succession been given her. In the mean time an exact regimen had been prescribed: she had been ordered to ride constantly; and to confine herself to a mucilaginous diet, such as veal, calves feet, &c. Likewise a gentle opening medicine had now and then been interposed. The disease still continued unaltered, she had afterwards tried the *tinctura saturnina;* and had, at the same time, been encouraged to chew cinchona, and to swallow the saliva. But all these attempts had been vain; and after she had taken some or other of the medicines above mentioned until the end of September 1753, namely, above two years, it appeared to her physician, Sir George Baker, unreasonable to expect relief in such a case from any internal medicines whatever.

He now conceived a suspicion, that some extraneous body having accidentally found its way into the *meatus auditorius*, might possibly be the cause of this extraordinary secretion, by keeping up a continued irritation in the parotid glands. With this view he examined her ears, and extracted from them a quantity of fetid wool. How, or when, it came thither, no account could be given.

To this substance he attributed the beginning of the salivation, notwithstanding that the disease did not immediately abate on the removal of the wool; as it appeared to be no improbable supposition that the discharge

charge might be continued by the force of habit, though the original cauſe no longer remained.

It ſeemed, therefore, expedient to introduce ſome other habit, in the place of the increaſed ſecretion of ſaliva; which habit might afterwards be gradually left off. With this intention, he prevailed on the patient to chew perpetually a little dry bread, and to ſwallow it with her ſpittle. In a few weeks, it became neceſſary for her to chew the bread only at certain hours in the day; and thus, after two months, ſhe became entirely free from a moſt diſguſtful and tedious diſorder.

It is worthy of obſervation, that, at firſt, the ſwallowing of ſo much ſaliva frequently occaſioned a nauſea; and that then, for a few hours, ſhe was obliged to ſpit it out as uſual; and that during the greateſt part of the time, when ſhe chewed the bread, ſhe had a ſtool or two every day more than common.

390 Genus CXX. ENURESIS.

An involuntary Flux *of* Urine.

Enureſis, *Sauv.* gen. 264. *Lin.* 195. *Vog.* 113. *Sag.* 200.

This is a diſtemper which frequently affects children, otherwiſe healthy, when aſleep; and is extremely diſagreeable. Often it is merely the effect of lazineſs, and may be driven off by proper correction; but ſometimes it proceeds from an atony or weakneſs of the ſphincter of the bladder. Many ridiculous cures have been preſcribed for it, and among the reſt fieldmice dried and powdered. Tonics are frequently of uſe; but ſometimes the diſtemper proves obſtinate, in ſpite of every thing we can uſe. In the London Medical Obſervations we find bliſters much recommended in this diſeaſe when applied to the region of the os ſacrum. A girl of 13 years of age had been ſubject to an enureſis for four years. She could retain her water but a very little while in the day-time, but it flowed continually in the night. She had taken Peruvian bark and elixir of vitriol in conſiderable quantities; alſo valerian and the volatile julep, without effect. She was ſeverely threatened, as the phyſician ſuſpected it might ariſe from a bad habit; but this producing no effect, a bliſter was applied to the os ſacrum, which in 24 hours totally removed the diſeaſe. A man aged 32, having been ſeized with an incontinence of urine and palſy of the lower extremities in conſequence of taking a quack medicine, was cured of the incontinence of urine in 24 hours by one bliſter, and of the palſy itſelf by another. A woman of 50 having been ſeized with an enureſis and paralytic affection of the right thigh and leg in conſequence of a ſprain, was cured of both by a ſingle bliſter. Several other caſes are mentioned, by which the power of bliſters in removing this diſtemper ſeems to exceed that of every other medicine whatever.

391 Genus CXXI. GONORRHOEA.

Gonorrhœa, *Sauv.* gen 208. *Lin.* 200. *Vog.* 118. *Sag.* 204.

The gonorrhœa is a flux of viſcid matter of various colours, from the urethra in men and the vagina in women. It commonly proceeds from coition with a perſon infected with the venereal diſeaſe, and is one of the moſt common forms under which that diſeaſe ſhows itſelf.

Deſcription. The firſt ſymptoms of the diſeaſe in men are commonly a ſenſation at the end of the penis not unlike a flea-bite, together with a fulneſs of the lips of the urethra, and ſome degree of tenſion in the penis, the urinary canal feeling as if tightened, and the urine flowing in a ſmall and unequal ſtream: a little whitiſh mucus is to be ſeen about the orifice of the urethra, and oozing from it when ſlightly preſſed, eſpecially if the preſſure be made on the ſpot where the ſoreneſs is moſt felt. The diſcharge ſoon increaſes in quantity, and varies in its colour according to the degree of inflammation. The patient feels a ſenſation of heat and pain in evacuating his urine, particularly at certain ſpots of the urethra, and above all towards its orifice; and the involuntary erections to which he is ſubjected from the ſtimulus, particularly when warm in bed, occaſion a diſtortion or curvature of the penis, attended with exquiſite pain. When the inflammation is violent, the glans appears tumid and tranſparent, the tenſion extends through the whole of the penis, the perinæum is affected with ſwelling and redneſs, and even the loins, buttocks, and anus, ſympathize and afford a very uneaſy ſenſation. Sometimes the prepuce inflames about the end of the penis, and cannot be drawn back, occaſioning what is called a *phymoſis;* at other times, as in the *paraphymoſis*, it remains in an inflamed ſtate below the glans, ſo that it cannot be drawn forwards; and, if the ſtricture and inflammation be violent, may terminate in gangrene. Now and then, eſpecially when there is a phymoſis, we may perceive a hard chord extending along the back of the penis. This is an inflamed lymphatic, and may be conſidered as a prelude to a bubo. When, however, a bubo does appear, almoſt univerſally ſome ulceration is previouſly to be diſcovered about the præputium, or glans penis; which gives ground to preſume that ſome other contagious matter beſides that of gonorrhœa may have been applied to the urethra. For it is certain that matter capable of communicating the contagion of gonorrhœa to a female, is often copiouſly applied to the whole glans penis of a male for ſeveral days together, without giving either ulceration or bubo.

In mild caſes, the ſeat of the diſeaſe is in the urethra, not far from its orifice; but it frequently happens that the virus inſinuates itſelf much higher up, ſo as to affect Cowper's glands, the proſtate, and parts very near to the neck of the bladder.

In the generality of caſes, the inflammation goes on increaſing for ſeveral days, commonly for a week or a fortnight; after which the ſymptoms begin to abate; and the running, when left to itſelf, gradually leſſens in quantity, and becomes whiter and thicker, till at length it totally ſtops. The colour of the mucus, however, is by no means a certain guide in theſe caſes: for in many patients it is of a yellowiſh, and ſometimes of a greeniſh hue to the very laſt; but in general it becomes more conſiſtent towards the cloſe of the diſeaſe.

In women, the external parts of generation being fewer and more ſimple, the diſeaſe is leſs complicated than

Apocenoses. than in men. Sometimes the vagina only is affected; and when this happens, the symptoms are very trifling: but in general it comes on with an itching and sensation of heat as in the other sex; and is attended with inflammation of the nymphæ, inside of the *labia*, *clitoris*, *carunculæ myrtiformes*, the orifice and sometimes the whole of the *meatus urinarius*. Very often the deep-seated glands of the vagina are affected, and it is sometimes difficult to distinguish the discharge of a gonorrhœa from that of the fluor albus.

Causes, &c. Many ingenious arguments have of late been advanced to prove, that the gonorrhœa and the lues venerea are different affections, originating from two distinct species of virus; and this controversy still, perhaps, remains to be decided by future facts. Certain it is, that in 19 of 20 cases of gonorrhœa, no symptom whatever of siphylis appears; and that the disease readily admits of cure without having recourse to those remedies which are universally requisite for combating the contagion of siphylis. It is by no means wonderful, that in some cases both contagions, supposing them different, should be communicated at the same time. Nay, cases are by no means rare, where the contagion of itch, though essentially different from both, has been communicated with either. But as undeniable proof that the contagion in both cases is precisely the same, it has been alleged by some, that the matter of a chancre introduced into the urethra will generate a gonorrhœa, and that the discharge from a gonorrhœa will produce chancre, bubo, and every other symptom of siphylis. On the other hand, however, it is contended, that when experiments of this nature are conducted with the greatest accuracy, the matter of siphylis uniformly produces siphylis, and that of gonorrhœa, gonorrhœa only. Without pretending to decide on which of these experiments the greatest dependence is to be put, we may only observe, that while an almost inconceivably small portion of siphylitic matter applied to the glans penis, from connection with an infected female, infallibly produces siphylis if it be not speedily removed, the matter of gonorrhœa, in every instance of that disease, is applied to the whole surface of the glans penis for many days together without producing almost any bad effect whatever. From this, therefore, there is ground for inferring, either that it is not capable of being absorbed, or that if absorbed it is innocent.

But while there have been disputes with regard to the peculiar nature of the matter in gonorrhœa, there have also been controversies with respect to the source from whence it is derived. While some suppose it to be principally purulent matter arising from ulcerations, others assert that no such ulceration is ever produced in the urethra by gonorrhœa. They contend that the increased secretion in these cases is exactly similar to what happens in the catarrh. But the comparison will by no means hold good in every particular: in the latter the whole membrane of the nose is equally irritated; whereas in the gonorrhœa, only particular parts of the urethra seem to be affected. The disease, in the generality of cases, seldom extends more than an inch and a half along that canal, and in many is confined (at least in the beginning) to a small spot about an inch from the extremity of the glans. The discharge is produced from that part of the urethra where Gonorrhœa. the pain is felt; and the patient, when he voids his urine, feels no smarting till it reaches the inflamed spot: but as the disorder increases, the inflammation affects a greater number of points, just in the same manner as chancres affect different parts of the glans. It might be supposed that dissection would at once clear up this matter, and put an end to the dispute; but this is far from being the case. Dr Simmons has seen several urethras opened in persons who had a gonorrhœa at the time of their death: in three of them the surface of the urethra, as in the cases related by Morgagni, appeared for some way down of a slight red colour, and in all of them was covered with mucus; but without any appearance of ulceration, except in two dissections at Paris, in which most of the gentlemen present were convinced that they saw evident marks of it: but Dr Simmons says that the appearances were to him not sufficiently satisfactory to enable him to decide with certainty on the subject. On the other hand, when we consider that the discharge in a gonorrhœa is sometimes tinged with blood, and that when this happens a little blood vessel is no doubt ruptured, we can have no reason to doubt that an ulceration may, and sometimes does, happen in these cases; especially as we often observe an excoriation near the orifice of the urethra. It is certain, that wherever there is considerable inflammation, there will be danger of ulceration. Besides, from a neglected or badly-treated gonorrhœa, we often see fistulas *in perineo*, and other ulcers of the urethra, penetrating through its substance, and affording a passage to the urine. And there can be no doubt that slight ulcerations of this canal often occur, and are afterwards perfectly obliterated, in a similar manner to what happens in the papillæ of the tongue, the tonsils, &c. Such an obliteration will the more readily take place in a part like the urethra, defended with mucus, and not exposed to the air, which is known to have no little effect in hardening a cicatrix.

But whether ulcers take place or not, whether the virus of gonorrhœa be precisely of the same kind with that which gives siphylis, or of a different kind, there is reason from the phenomena of the disease to conclude, that the matter first acts by mixing with the mucus at the extremity of the urethra; and that from thence it is propagated upwards, particularly where the excretories of mucus are most numerous; and that on the parts to which it is applied, it operates as a peculiar irritating cause. The consequences of this irritation will be inflammation and an increased secretion of mucus; and so far the complaint will be local. In ninety-nine cases of an hundred, a local affection of this kind constitutes the whole of the disease; and of this inflammation, ulcerations within the urethra, strictures, and other local affections, may be the consequence. But whether a disease of the habit ever takes place, unless when the contagion of siphylis is communicated with that of gonorrhœa, still remains to be determined by future observations and experiments.

Nothing can be more variable than the period at which the disease makes its appearance after infection. Perhaps, at a medium, we may place it between the 4th and 14th day: but in some cases it happens within

Apocenoses. 24 hours; and in others, not before the end of five or even six weeks: neither of these extremes, however, are common.

From what has been said of the manner in which the contagious matter in gonorrhœa acts, and of the influence it exerts on those parts with which it comes in contact, it follows, that the prevention of gonorrhœa must depend on the removal of the contagious matter, as soon as that can be done; and where this is either altogether neglected or not properly accomplished, that the cure must depend on counteracting the inflammation which this contagious matter excites, and the consequences which result from it.

The first of these intentions may be most certainly and most easily accomplished by careful lotion of all the parts to which the contagious matter has any chance of being applied. These parts, at least on the first application of the matter, are readily accessible: for even in men there is no reason to believe that it at first penetrates to any extent in the urethra. This washing of the parts should be performed as soon as possible; because then the matter is both most accessible and least involved with mucus: but although washing cannot be accomplished at an early period, it should not be neglected afterwards; for from the disease uniformly commencing, even when it does not appear till a considerable time after the application of the contagious matter, with a peculiar sense of titillation at the external parts, particularly in men at the extremity of the urethra, there is reason to believe that the contagious matter attached to the mucus may remain latent there for a very considerable time. For the purpose of washing, with a view to the prevention of this disease, recourse may be had to almost any watery fluid, provided it be not so stimulant as to produce bad effects from injuring the parts. Pure water, properly applied, is perhaps one of the best lotions; but there can be no doubt that its power in removing the contagious matter may be somewhat increased by such additions as render it a more powerful solvent of mucus. With this intention, one of the most powerful additions is the vegetable alkali, either in its mild or caustic state. In the latter state it is the most active, but in the former it is most safe; and the *carbonas potassæ* of the Edinburgh pharmacopœia, to the extent of half a dram, dissolved in six or eight ounces of water, is one of the best lotions that can be employed. The purpose of removing the contagion may often also be effectually answered from washing with water impregnated with soap; for there the alkali, though in a caustic state, is prevented from exerting any disagreeable effects, in consequence of its being combined with oily matters.

With the view of preventing gonorrhœa, some have advised, that the alkali either in its mild or caustic state, properly diluted with water, should be injected into the urethra: and there can be no doubt, that by this means the contagious matter, when it has entered the urethra, may be removed. A removal may also be effected by the injection of a weak solution of corrosive sublimate, which seems to act not by dissolving the mucus but by producing an augmented secretion. But at a very early period of the disease, injections are probably unnecessary; and if it has made any considerable progress, they are dangerous: for from the augmented sensibility of the part, even very gentle ones are apt to excite a high degree of inflammation.

Gonorrhœa.

There are practitioners who, supposing that the body possesses powers to expel the virus, and that the disease has a certain period to run through its several stages of progress, acmè, and decline, are for leaving the cure to nature; or at least content themselves with assisting her by an antiphlogistic regimen, gentle evacuations, and the like.

That in many cases the disorder admits of a natural cure, there can be no doubt; the increased secretion of mucus carrying off the virus faster than it is formed, till at length the infection is wholly removed: But it is equally certain, that in every case, by the application of suitable remedies to the inflamed part, we may shorten the duration of the complaint, and abridge the sufferings of the patient, with the same certainty and safety as we are enabled to remove the effects of an ophthalmia or any other local inflammation, by proper topical applications. General remedies, such as occasional blood-letting, a cooling diet, the liberal use of diluting liquors, and mild purges, are by all allowed to be useful, and even necessary. Astruc was of opinion that in these cases blood-letting ought to be repeated five or six times; and there are still many practitioners who depend much on repeated evacuations of this sort for a removal of the inflammation. But there is, perhaps, not one case in ten in which it is at all requisite; and this small number of cases will consist only of the strong and plethoric: in such, when the chordee is frequent and painful, and the pulse hard and full, the loss of from eight to twelve ounces of blood will be beneficial, but it will be seldom necessary to repeat the operation. The inflammation in these cases is kept up by the local stimulus of the virus and the urine; and all that we can expect from venesection is to moderate the pain and the frequency of erection. In persons of a delicate habit, and of an irritable fibre, the evacuation will do no good; but if repeated will certainly be liable to do harm, by increasing irritability, and of course rendering the patient more susceptible of stimulus.

The utility, and even the necessity, of a cooling regimen, are sufficiently obvious; wine and spirituous liquors, spiceries, a fish-diet, much animal-food, and salted and high-seasoned dishes of every sort, will constantly add to the complaint. The patient should eat meat only once a-day, and that sparingly. He should abstain from hot suppers. Milk, mild vegetables, and fruit, should constitute the principal part of his diet while the inflammatory symptoms continue. Every thing that tends to excite the venereal imagination should be studiously avoided; for whatever promotes erections of the penis will increase the inflammation, and of course add fuel to the disease. For the same reasons much walking or riding on horseback will be hurtful, from the irritation kept up in the perinæum by such means. Violent exercise of any kind, or any thing that is liable to increase the heat and the momentum of the blood, will of course be improper.

The drinking freely of mild, cooling, mucilaginous liquors, such as linseed-tea, orgeat, whey, milk and water, almond emulsion, and the like, will be extremely useful, by diluting the urine, and preventing its salts from stimulating the urethra. When the heat and pain in making water are very considerable, mucilaginous substances

Apocenoses. substances are found to have the best effect, particularly the gum tragacanth. It is a common practice to give equal quantities of this gum or gum-arabic and nitre, and to dissolve nitre in the patient's drink, with a view to lessen the inflammation. But in these cases nitre is always improper: it is known to be a powerful diuretic, its chief action being upon the urinary passages; so that the stimulus it occasions will only serve to increase the evil it is intended to alleviate. Supertartrite of potash, on account of its diuretic quality, will be equally improper. Our view here is not to promote a preternatural flow of urine; for the virus, being insoluble in water, cannot easily be washed away by such means; but our object ought to be, to render the urine that is secreted as mild and as little stimulating as possible.

Mild purges, which constitute another material part of the general remedies, are no doubt extremely useful when exhibited with prudence; but it is well known that the abuse of purgative medicines in this disease has been productive of numerous evils. Formerly it was a pretty general practice to give a large dose of calomel at bed time, three or four times a-week; and to work it off the next morning with a strong dose of the *pilulæ cocciæ*, or some other drastic purge. This method was persevered in for several weeks: in consequence of which the patient often found himself troubled with an obstinate gleet, and perhaps his constitution materially injured; the effect of such a method being (especially in irritable habits) to weaken the stomach and bowels, and lay the foundation of hypochondrial complaints. Violent purging likewise often occasions strangury, and other troublesome symptoms.

The cathartics employed in these cases should be gentle; such as Rochelle salt, manna, tartarised alkali, and the like. They should be given only in a dose sufficient to procure two or three stools, and be repeated only every two or three days. The daily use of the purgative electuaries that are still given by some practitioners, serves only to keep up a continual irritation on the bladder, and of course to prolong the inflammation.

The topical remedies that are used consist chiefly of different sorts of injections, the ingredients of which are extremely various; but their modes of operation may in general be referred to their mucilaginous and sedative, or to their detergent, stimulating, and astringent qualities. In the hands of skilful practitioners, great advantages may doubtless be derived from the use of these remedies; but, on the other hand, the improper and unseasonable administration of them may prove a source of irreparable mischief to the patient.

We know that mucilaginous and oily injections will tend to allay the local inflammation; and that a sedative injection, such as a solution of opium, will lessen the irritability of the parts, and of course produce a similar effect; the utility of such applications is therefore sufficiently obvious.

A detergent injection, or one that will act upon the mucus of the urethra, increase the discharge of it, wash it away, and with it the venereal virus that is blended with it, can only be used as a prophylactic before the symptoms of infection have made their appearance. But great circumspection is necessary in the use of this kind of injection. If it be too weak, it can be of no efficacy; and if it be too strong, it may prove dangerous to the patient. A suppression of urine has Gonorrhœa. been brought on by the improper use of an injection of this kind. When the symptoms of inflammation have once made their appearance, the stimulus of such an injection must be extremely hazardous. Excoriation of the urethra has but too often been produced by remedies of this sort in the hands of adventurous and unskilful practitioners.

While the inflammation of the urethra continues, every thing that stimulates it must be hurtful. If the injection excites a painful sensation in the urethra, as is but too often the case, it will be liable to produce swelled testicles, difficulty in making water, excoriation, and other effects of increased inflammation: if, by its astringency, the running be checked before the virus that excited the discharge be properly subdued, the patient will be exposed to fresh dangers; and perhaps to a variety of local complaints, such as obstructions in the urethra, and abscesses *in perinæo*, which are well known to be sometimes owing to applications of this sort improperly managed.

When the inflammation has subsided, gently stimulating and astringent injections may be used with safety, and with considerable advantage: for as the inflammation is at first excited by the stimulus of the venereal virus, so when the former begins to lessen, we may be assured that the activity of the latter has abated in proportion; and, in general, when the inflammatory symptoms are entirely removed, it will be found, that the mucus is no longer of an infectious nature, but is merely the effect of an increased secretion and of relaxation. Mild astringents will therefore serve to brace and strengthen the vessels secreting mucus, and in this way will lessen the discharge, and greatly promote the cure. It is certain, that in the greater number of cases, a gonorrhœa, which if treated by internal remedies alone, would continue for five or six weeks, or longer, may, when judiciously treated with injections, be cured in a fortnight, and very often in less time. The great aim, therefore, of the practitioner ought to be at first to make use of such injections only as will tend to lubricate the surface of the urethra, and to counteract and destroy the stimulus of the virus: as the inflammation abates, he may add some gently astringent preparation to a mucilaginous and sedative injection; taking care that its astringency be suited to the state of the disease, and to the irritability of the patient. Amongst a great variety of substances, mercury in different forms is one of those that is the most frequently employed in injections. All these mercurial injections have more or less of astringency; and, according to Dr Simmons, it is solely to this property that we are to ascribe their effects; for the idea of their correcting the venereal virus was originally introduced, and has, he thinks, been continued, upon mistaken principles.

Calomel, mixed with the mucus discharged in a gonorrhœa, has no more power in destroying the infectious properties of that mucus than ceruse or any other preparation would have. A diluted solution of sublimate injected into the urethra, will, like a solution of verdigrise, or blue vitriol, or any other styptic, constringe the mouths of the lacunæ; but this is all that it will do, for it will never lessen the infectious nature of the virus. The same thing may be observed of crude

Apocenoses. crude mercury extinguished by means of mucilage, or of mercurial ointment, blended with the yolk of an egg, and which, when thrown up into the urethra, will act nearly in the same manner as balsam of copaiva, or any other stimulating injection. The stimulus of mercury, however, has often been found of considerable efficacy; and in women, when the vagina only was affected, after washing the parts well, the cure has been accomplished by rubbing them repeatedly with mercurial ointment.

As the gonorrhœa is only a local affection, it may be inferred, that the internal use of mercury is unnecessary towards the cure. Very often indeed this complaint may be removed without having recourse to mercurials. Sometimes patients have been met with whose general health has been greatly impaired by a long continued use of mercury in such cases, while the original disease, the gonorrhœa, was rendered much worse by it. In some it has degenerated into a gleet, that was cured with extreme difficulty; in others it has brought on a variety of distressing symptoms. In cases of gonorrhœas, therefore, whenever mercury is administered, it ought to be, not with a view to expedite the cure, but merely to obviate the dangers of syphilis. When the infection is apparently slight, and the inflammation and the symptoms trifling, we may proceed without the assistance of mercury, especially if the patient be of a weak, relaxed, and irritable habit, likely to be injured by mercurial medicines. On the other hand, when the discharge is violent, the inflammation considerable, or the seat of the disease high up in the urethra, it is perhaps the most prudent plan to give mercurials in small doses, and in such forms as seem the best adapted to the constitution of the patient.

The *pilulæ hydrargyri*, as prepared according to the receipts inserted in the last edition either of the London or Edinburgh Pharmacopœias, in both of which the mercury is rendered active merely by triture, may perhaps be considered as one of the mildest and most efficacious forms under which mercury can be exhibited by the mouth. Its efficacy will depend on its not irritating the bowels, and thus passing off by stool; care must likewise be taken to prevent its affecting the mouth. Of the chemical preparations of mercury, the mildest and least irritating is calomel. It may be given from gr. iss. to gr. iii. at bed-time, occasionally interposing a mild purgative to prevent it from salivating; but in general the mercurial pill just mentioned is to be preferred.

When there is no chancre nor bubo, no appearance in short of syphilitic infection, it would be improper to administer corrosive sublimate, the mercurius calcinatus, or any other of the more acrid preparations of mercury.

After a gonorrhœa proceeding from venereal causes has been removed, another kind of running without pain, called the *gonorrhœa mucosa*, or *gleet*, sometimes remains. Sometimes it arises from a constriction and excoriation of the urethra, and frequently it is the effect of an enlargement and diseased state of the prostate. In each of these cases, as the gleet is the effect of irritation, the cure will depend on the removal of the local disease that occasions it. But there is another species of gleet that seems to depend chiefly on relaxation. It is in general free from infection, and is most common in those who have had long and frequent gonorrhœas. It is likewise often the effect of a debilitated habit, from severe purging, or a long continued use of mercurials. A discharge of this kind is more frequent in women than in men; or, at least, the fluor albus, after a gonorrhœa, will often be mistaken for a gleet. Obstipatio.

When there is no reason to suspect remaining contagion, astringent injections will be of the greatest service. It will be necessary, at the same time, to attend to the health of the patient, by employing cinchona, chalybeate waters, cold bathing, and such other remedies as will tend to strengthen the system: and indeed by the use of these, particularly by the cinchona, such runnings are often successfully combated in those who from apprehension of dangerous consequences cannot be prevailed upon to employ injections. When there is no tendency to inflammation, the balsam of copaiva may be prescribed with advantage in large doses. Dr Simmons says he once saw a complaint of this sort removed by applying a blister to the perinæum, after it had resisted a variety of other remedies. In the Medical Observations also we have an account of a gleet and incontinence of urine removed at once by a blister to the os sacrum. In general, however, the other methods above mentioned will be sufficient to remove it, though sometimes it will continue for a long time in spite of all our endeavours to check it.—Other kinds of gonorrhœa, in which the semen itself is ejected, especially during sleep, may be cured by tonics and a mild cooling regimen.

Order V. EPISCHESES. 392

Genus CXXII. OBSTIPATIO. 393

Costiveness.

Obstipatio, *Lin.* 166. *Vog.* 128. *Sag.* 221.

Costiveness is sometimes occasioned by debility in dyspeptic persons, sometimes it is the effect of rigidity, and sometimes it is symptomatic of the colic. It may proceed from an affection of the liver; drinking rough red wines, or other astringent liquors; too much exercise, especially on horseback: it may likewise proceed from a long use of cold insipid food, which does not sufficiently stimulate the intestines. Sometimes it is owing to the bile not descending to the intestines, as in the jaundice; and at other times it proceeds from diseases of the intestines themselves, as a palsy, spasms, tumors, &c.

Excessive costiveness is apt to occasion pains of the head, vomiting, colics, and other complaints of the bowels. It is peculiarly hurtful to hypochondriac and hysteric persons, as it generates wind and other distressing symptoms.

Persons who are generally costive should live upon a moistening and laxative diet; as roasted or boiled apples, pears, stewed prunes, raisins, gruels, with currants, butter, honey, sugar, and such like. Broths with spinage, leeks, and other soft pot-herbs, are likewise proper. Rye-bread, or that which is made of a mixture of wheat and rye together, ought to be eaten. No person troubled with costiveness should eat white bread alone, especially that which is made of fine flour.

Epiſcheſes. flour. The beſt bread for keeping the belly ſoluble is what in ſome parts of England they call *meſlin*. It is made of a mixture of wheat and rye, and is very agreeable to thoſe who are accuſtomed to it.

Coſtiveneſs is increaſed by keeping the body too warm, and by every thing that promotes the perſpiration; as wearing flannel, lying too long in bed, &c. Intenſe thought, and a ſedentary life, are likewiſe hurtful. All the ſecretions and excretions are promoted by moderate exerciſe without doors, and by a gay, cheerful, ſprightly temper of mind.

The drink ſhould be of an opening quality. All ardent ſpirits, auſtere and aſtringent wines, as port, claret, &c. ought to be avoided. Malt liquor that is fine and of a moderate ſtrength is very proper. Butter-milk, whey, and other watery liquors, are likewiſe proper, and may be drank in turns, as the patient's inclination directs.

Thoſe who are troubled with coſtiveneſs ought, if poſſible, to remedy it by diet, as the conſtant uſe of medicines for that purpoſe is attended with many inconveniences, and often with bad conſequences. In time the cuſtom becomes neceſſary, and generally ends in a total relaxation of the bowels, indigeſtion, loſs of appetite, waſting of the ſtrength, and death.

The learned Dr Arbuthnot adviſes thoſe who are troubled with coſtiveneſs to uſe animal oils, as freſh-butter, cream, marrow, fat broths, &c. He likewiſe recommends the expreſſed oils of mild vegetables, as olives, almonds, piſtaches, and the fruits themſelves; all oily and mild fruits, as figs; decoctions of mealy vegetables; theſe lubricate the inteſtines; ſome ſaponaceous ſubſtances which ſtimulate gently, as honey, hydromel, or boiled honey and water, unrefined ſugar, &c. are uſeful.

The doctor obſerves, that ſuch lenitive ſubſtances are proper for perſons of dry atrabiliarian conſtitutions, who are ſubject to aſtriction of the belly and the piles, and will operate when ſtronger medicinal ſubſtances are ſometimes ineffectual; but that ſuch lenitive diet hurts thoſe whoſe bowels are weak and lax. He likewiſe obſerves, that all watery ſubſtances are lenitive; and that even common water, whey, ſour milk, and butter-milk, have that effect:—That new milk, eſpecially aſſes milk, ſtimulates ſtill more when it ſours on the ſtomach; and that whey, turned ſour, will purge ſtrongly:—That moſt part of fruits are likewiſe laxative; and that ſome of them, as grapes, will throw ſuch as take them immoderately, into a cholera morbus, or incurable diarrhœa.

When the body cannot be kept open without medicine, gentle doſes of rhubarb may be taken twice or thrice a-week. This is not near ſo injurious to the ſtomach as aloes, jalap, or the other draſtic purgatives ſo much in uſe. Infuſions of ſenna and manna may likewiſe be taken, or half an ounce of tartariſed alkali diſſolved in water gruel. About the ſize of a nutmeg of lenitive clectuary taken twice or thrice a-day, generally anſwers the purpoſe very well.

394 ## Genus CXXIII. ISCHURIA.

Suppression of *Urine*.

Iſchuria, *Sauv.* gen. 293. *Lin.* 167. *Vog.* 129. *Sag.* 212. *Home's* Clinical Experiments, ſect. xv.

Iſchuria. This diſeaſe is diſtinguiſhed into various ſpecies, according as the ſeat of it is in the kidneys, the ureters, the bladder, or the urethra; and hence theſe ſpecies are named *renalis*, *ureterica*, *veſicalis*, and *urethralis*.

1. *Iſchuria renalis*, or a ſuppreſſion of urine from an 395
affection of the kidneys, happens but rarely; however, Dr Home in his Clinical Experiments deſcribes ſuch a caſe. In the end of December 1774, a man of a full habit, aged 35, was ſeized with ſhivering, coldneſs, and ſevere cough. Three days after, his urine appeared high-coloured, was paſſed with pain, and in ſmall quantity. About the 8th of January 1775, he was attacked with violent pains in the ſmall of his back, over the whole abdomen, and in the ankles, with pain in the region of the liver when preſſed. A general ſwelling was afterwards obſerved all over the body, but chiefly in the ankles and abdomen, which laſt was tenſe and hard. Theſe were attended with vomiting, bad appetite, and conſiderable thirſt. When he entered the clinical ward (January 21ſt), the cough, ſickneſs, and vomiting, had gone off, but the ſuppreſſion of urine remained. The little which he made was paſſed with his ſtools, ſo that Dr Home ſaw it but once; and then it was pale, and had a white powder at bottom. The pains and ſwellings which retained the impreſſion of the finger, continued; he had a headach, and a very ſlow pulſe, beating only 48 ſtrokes in a minute. He had taken a great many diuretic medicines before his admiſſion. The day after his reception, he was ſeized with a ſpontaneous diarrhœa, which continued during the remainder of his life. Cryſtals of tartar were exhibited in doſes of half an ounce each morning; at bed-time he took 20 drops of tincture of opium with a ſcruple of nitre, and continued this courſe for eight days without any increaſe of urine. The ſtronger and heating diuretics were then tried, as an infuſion of juniper berries and pills of garlic; but they were attended with no manifeſt advantage. Whenever the pulſe became ſo ſtrong that he could bear bleeding, eight ounces of blood were taken away, which was ſizy. This was thrice repeated; he appeared eaſier after each bleeding, his pulſe bore it well, and the ſwellings and other ſymptoms abated. The heating diuretics, in this ſtate, were given up, and a mixture of vinegar and nitre was ſubſtituted in their place, in each doſe of which, taken every two hours, there was a ſcruple of nitre. Fomentations were applied to the region of the kidneys, and camphorated oil was afterwards rubbed on the part. He was ordered the ſemicupium, which, from a deficiency of water in the hoſpital at that time, he got only once; and which then ſeemed to have a good effect, as he paſſed a gill of urine when he was in it. Notwithſtanding this, however, the diſeaſe continually gained ground; he became comatoſe, delirious, and died ten days after his admiſſion. On diſſection, the kidneys were found of an irregular form; ſome watery veſicles appeared on their ſurface, containing black gritty particles like fine ſand; and the lower part of the right kidney was conſiderably inflamed. The pylorus, part of the duodenum, and a conſiderable part of the ſmall inteſtines, were much inflamed. In the abdomen were found about five pounds of fluid, and in the cavities of the thorax about half a pound. The

Epifcheses. The lungs were a little inflamed, and full of fmall tubercles on their furface and in their fubftance: the heart was large, and a polypus in each ventricle. About fix ounces of fluid were found in the pericardium: in the brain nothing preternatural appeared, except about an ounce of water in each ventricle.

Dr Home feems to have been at a lofs for the remote caufe of this fuppreffion of urine, which manifeftly had its immediate origin from the kidneys having loft the power of performing their functions. He thinks the inflammation which appeared in the right kidney was fcarce fufficient to have occafioned the diftemper, as the other would have fupplied its place: for which reafon alfo he thinks that the ifchuria was owing to a general affection of the fyftem; and that it was of an arthritic nature, the patient having been troubled with complaints of that kind for a long time before.

396 2. The *ifchuria ureterica* is alfo a rare difeafe, unlefs the obftruction proceeds from a ftone or clot of blood ftopping up the paffage. Gravel or ftones, indeed, are very frequently formed in the kidneys; and, by falling into the ureters, occafion an ifchuria, with violent pain, and fymptoms more or lefs urgent in proportion to the fize and fhape of the ftones. Sometimes it is attended with coldnefs of the extremities, naufea, vomiting, and fpaftic conftriction of the præcordia, a difficulty of making water, conftipation of the belly, difficulty of breathing, ftupor of the thigh, retraction of the tefticle, inquietude, lofs of ftrength, fyncope, and convulfion fits. When the violent pain has continued for feveral days and nights without intermiffion, and has brought the patient exceeding low, and the fuppreffion of urine is complete, with coldnefs of the extremities and convulfions of the tendons, death is at hand. Nor is it a good fign when the ftone continues long in the ureter; for then the appetite decays, a naufea and retching to vomit fupervene, and the patient is confumed with a hectic heat. Sometimes the pain is attended with an inflammation of the ftomach and inteftines; and fometimes the difeafe ends in a dropfy of the breaft, or lethargy, which foon carry off the patient.

The indications of cure are, to exclude the ftone as eafily as poffible, and prevent the breeding of others. If the patient be of a fanguineous temperament, Sydenham recommends to take away ten ounces of blood from the affected fide; and then to give the patient a gallon of poffet-drink in which two ounces of marfhmallow roots have been boiled, injecting at the fame time an emollient glyfter. After the poffet drink has been vomited up, and the clyfter returned, give a pretty large dofe of an opiate. But if the patient be old or weak, or fubject to nervous affections, bleeding may be omitted, efpecially if his urine at the beginning of the fit be coffee-coloured, and mixed with gravel; but as to other things, the cure is the fame.—Huxham highly recommends an emollient bath prepared of a decoction of marfhmallow root, lintfeed, fœnugreek feed, and flowers of chamomile, to which may be added a few white poppy feeds. By the ufe of this bath he fays he has feen the moft cruel fit of the gravel fuddenly ended, when neither copious bleeding nor opiates had the leaft effect. Mild diuretics are alfo of fervice. Hoffman recommends dulcified fpirit of nitre as proper to relax the fpaftic ftricture. It is to be taken with fuitable diftilled waters and fyrup of poppies; or in broth, with a few fpoonfuls of oil of fweet almonds. Turpentine glyfters are alfo accounted very ferviceable; and may be prepared with ten ounces of a decoction of chamomile, with half an ounce of turpentine diffolved in the yolk of an egg, and about as much honey. The *fal diureticus*, or *acetis potaffæ*, is much efteemed by fome, when taken along with an opiate. But when the ftone is too big to pafs, Arbuthnot recommends a cool and diluent diet to hinder the further growth of it. Whey, infufion of lintfeed, decoction of marfhmallows, and gently refolving diuretics, are alfo proper. To put a ftop to the vomiting, the compound tincture of benzoin, formerly named *balfamum traumaticum*, has fometimes been ufed with fuccefs, when almoft every other means have failed. Ifchuria.

3. The *ifchuria veficalis* may arife from a ftone in the bladder; and this indeed is the moft common caufe of it: but there are certain cafes, in which, though the ufual quantity of urine, or perhaps more, be paffed, the patient dies from the retention of a ftill greater quantity in the bladder. Of this Dr Home gives the following inftances. A man of 58 years of age, of a ftrong fpare habit, and never fubject to the gravel, had, during the winter of 1777, a cough with expectoration, which went off in the beginning of 1778. About the 17th of February 1778 he felt fome difficulty in paffing his urine, and much pain about the region of the bladder. He continued in this way for ten days, after which he became eafier on application of fome medicines. The abdomen then fwelled, and he had pains in his loins and thighs. On the 3d of March he was admitted into the clinical ward: his abdomen was then fwelled and tenfe; and an evident fluctuation was felt, which fome that touched him thought was fonorous and produced by wind. A tumor was difcovered between the navel and fpine of the os ilium on the left fide, which gave him much pain, efpecially when preffed. This tumor became more eafily felt after the fwelling of the abdomen decreafed, feemed round, and very near as large as the head of a child. It appeared very much on the left fide, even when the patient lay on the right, and it then became dependent. He paffed urine frequently, and rather more than in health, as it was computed at four pints a-day. It was always clear, and of a light colour. His body had a ftrong difagreeable fmell; his fkin was dry, belly bound, and his appetite entirely gone, fo that he had hardly taken any food for 12 days. His legs fwelled flightly for fome days in the evening. His pulfe was generally regular, fometimes flower than natural, and fometimes a little quicker; being once felt at 64, and another time at 92. He was often feized, efpecially after eating or drinking, with hiccough; which increafed and lafted till his death. On the 20th day of his difeafe, after fome dofes of fquills, the general fwelling of his abdomen fell, became much fofter, and more diftinctly difcovered the fwelling of the left fide. The next day a vomiting came on; he became delirious, and died the day following. The body being opened, it appeared that the tumor which was fo diftinctly felt on the left fide of the abdomen, was owing to a diftenfion of the bladder with urine. Its fundus reached to about the divifion of the aorta into the 397

Epiſcheſes. the iliacs; it entirely filled the pelvis, and contained between five and ſix pounds of urine of a pale colour. On examining the external ſurface, its neck, and the beginning of the urethra, were found to be ſurrounded with a ſcirrhoſity, which impeded the evacuation of the urine. The bladder itſelf was much thickened, but not more in one part than another. The ureters entered naturally; but were much thickened in their upper half near the kidney. The kidneys were ſomewhat enlarged; particularly the left, which had ſeveral watery veſicles on its external ſurface. Theſe organs were not in their uſual ſituation; but lay cloſe on each ſide of the ſpine, and very near the aorta: ſo that the renal veſſels were very ſhort. What was very ſingular, the lower end of each aroſe over the ſpine, and they were united together by their membranes, the aorta paſſing beneath the union. The bladder had preſſed conſiderably on this part; and the peritoneum covering them was conſiderably thicker than natural. The lungs adhered every where to the pleura, and in ſome places very firmly: they were of a looſe texture and black colour; and the veins of the lower extremities were turgid with blood. It does not appear that this patient got any medicines farther than a few dried ſquills, which diminiſhed the ſwellings and brought off much wind. He alſo got a mixture of muſk, and afterwards of opium, for his hiccough; but without ſucceſs. His diſeaſe was miſtaken for an aſcites; and the catheter was not tried: but in another caſe the uſe of this inſtrument was apparently of more ſervice than any internal medicines. This laſt patient was about 90 years of age, and laboured under ſymptoms very ſimilar to thoſe already mentioned. When admitted into the clinical ward, he had the hypogaſtric region ſwelled, and difficulty of paſſing his water; but without pain, vomiting, or hiccough. He had loſt all appetite; was thirſty, and coſtive. His pulſe was 110, and weak. In the evening about three Engliſh pints of pale clear urine were drawn off by means of the catheter: the next day all the ſymptoms were gone off or abated. After this he continued to paſs ſome urine, ſometimes voluntarily, ſometimes involuntarily and inſenſibly; but ſo much always remained behind, that his bladder was conſtantly full, unleſs when the urine was drawn off, which was done twice every day. The urine was ſometimes pale, ſometimes of a deep red colour; and once there was ſome blood mixed with it, which perhaps might have been occaſioned by the catheter. About the ſixth day the urine was very putrid, with much purulent like matter at the bottom, and was paſſed with more pain. About the 11th, the putrid ſmell went off. The next day all the urine paſſed inſenſibly except what was drawn off; and an hiccough, though not very ſevere, had come on. In this way he continued without fever, though frequently troubled with the hiccough, eſpecially during thoſe nights in which the urine had not been drawn off. A month after admiſſion, the bladder, with the aſſiſtance of the catheter, was almoſt entirely, though inſenſibly evacuated, and the hiccough had left him; he had no other complaint but that of voiding his urine inſenſibly, the natural effect of a ſcirrhous bladder, and which was probably incurable. With this patient the hot bath and mercurials were tried, in order to ſoften the ſcirrhoſity of the bladder, but without effect. Iſchuria.

398 4. The *iſchuria urethralis* ariſes from ſome tumor obſtructing the paſſage of the urethra, and thus hindering the flow of urine. It is no uncommon diſtemper, and often follows a gonorrhœa. Dr Home gives us an example of this alſo.—The patient was a man of 60 years of age, who had laboured under a gonorrhœa ſix months before, and which was ſtopped by ſome medicines in two or three days. He felt, ſoon afterwards, a difficulty in paſſing his urine, which gradually increaſed. About 10 days before his admiſſion into the clinical ward, it was attended with pains in the glans, and *ardor urinæ;* he had paſſed only about eight ounces the day before his admiſſion, and that with very great difficulty; and the hypogaſtric region was ſwelled and pained. On introducing the catheter, three pounds of urine were drawn off, by which the pain and ſwelling were removed. The inſtrument required force to make it paſs the neck of the bladder, and blood followed the operation: and the finger, introduced into the anus, felt a hard tumor about its neck. He was treated with mercurial pills and ointment, by which the ſwelling about the neck of the bladder ſoon began to decreaſe; but at the ſame time a ſwelling of the right teſticle appeared. He was vomited with four grains of turbith-mineral, the *ſubſulphas hydrargyri flavus* of the preſent pharmacopœia, which operated gently; and here Dr Home obſerves, that though theſe vomits are little uſed, from a miſtaken notion of their ſeverity, he never ſaw them operate with more violence than other vomits, or than he could have wiſhed. The ſwelling diminiſhed in conſequence of the emetic and ſome external applications; and the cure was completed by bleeding and a decoction of mezereon root.

Genus CXXIV. DYSURIA. 399

Difficulty of discharging urine.

Dyſuria, *Sauv.* gen. 265. *Lin.* 57. *Vog.* 164. *Sag.* 213.
Stranguria *auctorum.*

A difficulty of making water may ariſe from many different cauſes; as from ſome acrid matter in the blood, cantharides, for inſtance; and hence a ſtrangury very often ſucceeds the application of bliſters. In many caſes it ariſes from a compreſſion of ſome of the neighbouring parts; of the uterus, for inſtance, in a ſtate of pregnancy. Or it may ariſe from a ſpaſmodic affection of the bladder, or rather its ſphincter; or from an inflammation of theſe parts, or others near them. Hence the diſeaſe is diſtinguiſhed into ſo many ſpecies, the cure of which is to be attempted by remedies indicated by their different cauſes.

But the moſt common, as well as the moſt dangerous ſpecies is that ariſing from a calculous concretion, or

Stone in the Bladder. 400

Dyſuria calculoſa, *Sauv.* ſp. 12.

The ſigns of a ſtone in the bladder are, pain, eſpecially about the ſphincter; and bloody urine, in conſequence

quence of riding or being jolted in a carriage; a sense of weight in the *perinæum;* an itchiness of the *glans penis;* slimy sediment in the urine; and frequent stoppages in making water: a *tenesmus* also comes on while the urine is discharged: but the most certain sign is, when the stone is felt by the finger introduced into the anus, or by sounding.

Causes, &c. It is not easy to say what the particular causes are which occasion the apparently earthy particles of the fluids to run together, and form those calculous concretions which are found in different parts of the body, and especially in the organs for secreting and discharging the urine.

The gout and stone are generally supposed to have some affinity, because gouty people are for the most part afflicted with the gravel. But perhaps this is in part owing to their long confinement, and to lying on the back, which people who labour under the gout are often obliged to submit to; since the want of exercise, and this posture, will naturally favour the stagnation of gross matters in the kidneys: besides, there are many instances of people severely afflicted with the stone for the greatest part of a long life, who have never had the least attack of the gout.

There is, however, good reason for believing, that some farther connection takes place between the two diseases; and when treating of the gout we have already given some account of the opinion of an ingenious anonymous author, who has endeavoured to prove, that both the one and the other depend on a peculiar acid, the concreting, lithic, or uric acid, which is always present in blood; and which may be precipitated from thence by various causes, such as the introduction of other acids, or the like. When thus precipitated, he supposes it to produce the whole phenomena of both diseases. The objections we formerly stated to his theory of gout, do not equally militate against that of calculus; and it is at least certain, from the best chemical analysis, that what are commonly called *urinary calculi*, and have been considered as entirely an earthy matter, consist principally of acid in a solid state united only with a small proportion of earth or mucus. We may, therefore, whether this hypothesis be altogether well founded or not, justly view lithiasis as depending, in a great measure, on the separation of an acid from the blood.

Whatever may be the particular cause of the disposition to *lithiasis*, the kidneys appear to be the most likely places for particles to concrete or run together, because of the great quantity of blood which passes through the renal arteries, and which comes immediately from the heart, fraught with various newly-received matters, that have not undergone much of the action of the vessels, and therefore cannot as yet be supposed to be thoroughly assimilated.

Anatomists who have carefully examined the kidneys in the human subject, particularly M. Bertin, inform us, that there are two sets of *tubuli uriniferi;* the one continued directly from the extremities of the renal artery, and the other springing from that vesicular texture which is conspicuous in the kidneys.

It is in this vesicular part of the kidney that we presume the particles of the concreting matter first stagnate and coalesce: for it is hardly to be supposed, that such solid matters could be allowed to stop in the extremities of the renal arteries, since the blood, and the urine separated from it, must flow through these vessels with great degrees of force and velocity; but in the intermediate vesiculæ the particles may lie, and there attracting each other, soon come to acquire sensible degrees of magnitude, and thus become sand or gravel. As long as this sand or gravel formed in the vesicular part of the kidney lies quiet, there will be no pain or uneasiness, until the concretions become large enough to press either on the adjoining *tubuli*, or on the blood-vessels; then a sense of weight, and a kind of obtuse pain in the loins, will be felt. But when the small pieces of concreting matter shall be dislodged and washed off by the force of the circulating fluids, or loosened by some spasmodic action of the moving fibres in these parts, they will in their passage create pain, raise different degrees of inflammation, or perhaps lacerate some blood vessels, and cause bloody urine. When these little concretions happen to be detained in the pelvis of the kidney, or any other place where a flow of urine continually passes, they soon increase in size, and become calculi, from the constant accession of particles, which are attracted by the original bit of sand, which thus becomes the nucleus of a stone.

It is an opinion which Hippocrates first advanced, and which has been almost universally adopted by his followers, and has remained till lately uncontroverted, that the stone and gravel are generated by the use of hard water. From the quality, which the waters of certain springs possess, of depositing a large earthy sediment, either in the aquæducts through which they are conveyed, or in the vessels in which they are boiled or preserved, it was conjectured, that in passing through the kidneys, and especially whilst retained in the bladder, they would let fall their grosser particles, which by the continued apposition of fresh matter, connected by the animal gluten, and compacted by the muscular action of that organ, would in time form a calculus sufficiently large to produce a train of the most excruciating symptoms. And this reasoning *à priori* has been supposed to be confirmed by facts and experience; for not to mention the authority of Hippocrates, Dr Lister has observed, that the inhabitants of Paris are peculiarly subject to the stone in the bladder. Nicholas de Blegny has related the history of one who was dissected at Paris, in whom the pylorus, a great part of the duodenum, and the stomach itself, were found incrustated with a stony matter, to the thickness of a finger's breadth. And it is well known, that the water of the river Seine, with which that city is supplied, is so impregnated with calcareous matter, as to incrustate, and in a short time to choke up, the pipes through which it runs. But on the other hand it is objected, that the human calculus is of animal origin, and by chemical analysis appears to bear very little analogy to the stony concretions of water: and though it be allowed, that more persons are cut for the stone in the hospitals at Paris than in most other places; yet upon inquiry it is found, that many of those patients come from different provinces, and from towns and villages far distant from the Seine.

Dr Percival conjectures, that though this disease may chiefly depend upon a peculiar disposition to concrete in

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in the animal fluids, which in many inſtances is hereditary, and in no inſtance can with certainty be imputed to any particular cauſe; yet hard water is at leaſt negatively favourable to this diatheſis, by having no tendency to diminiſh it. The urine of the moſt healthy perſon is generally loaded with an apparently terreous matter, capable in favourable circumſtances of forming a calculus; as is evident from the thick cruſt which it depoſits on the ſides of the veſſels in which it is contained. And it ſeems as if nature intended by this excretion to diſcharge all the ſuperfluous ſalts of the blood, together with thoſe earthy particles, which are either derived from our aliment, and fine enough to paſs through the lacteals, though inſuperable by the powers of circulation, or which ariſe from the abraſion of the ſolids, or from the diſſolution of the red globular part of our fluids. Now water, whether uſed as nature preſents us with it, or mixed with wine, or taken under the form of beer or ale, is the great diluter, vehicle, and menſtruum, both of our food, and of the ſaline, earthy, and excrementitious parts of the animal juices. And it is more or leſs adapted to the performance of theſe offices, in proportion to its degree of purity. For it muſt appear evident to the moſt ordinary underſtanding, that a menſtruum already loaded, and perhaps ſaturated with different contents, cannot act ſo powerfully as one which is free from all ſenſible impregnation. Nor is this reaſoning founded upon theory alone; for it is obſerved, that Malvern water, which iſſues from a ſpring in Worceſterſhire, remarkable for its uncommon purity, has the property of diſſolving the little ſabulous ſtones which are often voided in nephritic complaints. And the ſolution too, which is a proof of its being complete, is perfectly colourleſs. Hence this water is drunk with great advantage in diſorders of the urinary paſſages. And during the uſe of it, the patient's urine is generally limpid, and ſeldom depoſits any ſandy ſediment. Yet notwithſtanding this appearance of tranſparency, it is certainly at ſuch times loaded with impurities, which are ſo diluted and diſſolved as not to be viſible. For it is attended with a ſtrong and fetid ſmell, exactly reſembling that of aſparagus. Hoffman mentions a pure, light, ſimple water in the principality of Henneberg, in Germany, which is remarkable for its efficacy in the ſtone and gravel; and a water of ſimilar virtues was diſcovered not many years ago in the Black foreſt, near Oſterod, which upon examination did not afford a ſingle grain of mineral matter. Indeed it is worthy of obſervation, that moſt of the ſprings which were formerly held in great eſteem, and were called *holy wells*, are very pure, and yield little or no ſediment.

Dr Percival informs us that a gentleman of Mancheſter, who had been long ſubject to nephritic complaints, and often voided ſmall ſtones, was adviſed to refrain from his own pump water, which is uncommonly hard, and to drink conſtantly the ſoft water of a neighbouring ſpring; and that this change alone, without the uſe of any medicine, has rendered the returns of his diſorder much leſs frequent and painful. A lady alſo, much affected with the gravel, was induced by the peruſal of the firſt edition of Dr Percival's Eſſay, to try the effect of ſoft water; and by the conſtant uſe of it remained two years entirely free from her diſorder.

Dyſuria.

In nephritic caſes, diſtilled water would be an excellent ſubſtitute for Malvern water, as the following experiment evinces.

Two fragments of the ſame calculus, nearly of equal weight, were immerſed, the one in three ounces of diſtilled water, the other in three ounces of hard pump-water. The phials were hung up cloſe together in a kitchen-chimney, at a convenient diſtance from the fire. After 14 days maceration, the calculi were taken out, and carefully dried by a very gentle heat. The former, viz. that which had been immerſed in diſtilled water, was diminiſhed in its weight a grain and a half; the latter had loſt only half a grain.

It is the paſſage of theſe calculi from the kidneys down into the bladder, which occaſions the pain, vomiting, and other ſymptoms, that conſtitute what is uſually termed a *fit of the gravel* or *ſtone*.

When an inflammation is actually raiſed, the diſeaſe is known by the name of *nephritis*, and has been already treated of.

As ſoon as the ſtone paſſes through the ureter, and falls into the bladder, the pain and other nephritic ſymptoms ceaſe; and every thing will remain quiet, either till the ſtone be carried into the urethra, or until it has remained long enough in the bladder to acquire weight ſufficient to create new diſtreſs.

If a ſtone happen to be ſmooth and of a roundiſh form, it may lie in the bladder and acquire conſiderable bulk before it can be perceived by the patient; but when it is angular, or has a rugged ſurface, even though it may be ſmall in ſize, yet it ſeldom fails to raiſe pain, and occaſion bloody urine, or the diſcharge of a ſlimy fluid, with teneſmus, and difficulty in making water.

There have been various attempts made to diſſolve the ſtone; and there are certainly ſome articles which have this effect when applied to them out of the body; but the almoſt total impoſſibility of getting theſe conveyed to the kidneys, renders it extremely doubtful whether a ſolvent ever will be diſcovered. Of all the articles employed for this purpoſe, no one perhaps has had greater reputation than fixed alkaline ſalt in its cauſtic ſtate, particularly under the form of the *lixivium cauſticum*, or *aqua potaſſæ*, as it is now called: but this being of a very acrid nature, it requires to be well ſheathed by means of ſome gelatinous or mucilaginous vehicle. Veal-broth is as convenient as any for this purpoſe; and accordingly it is uſed by theſe who make a ſecret of the cauſtic alkali as a ſolvent of calculus.

Mr Blackrie, who has taken much pains in this inquiry, has proved very ſatisfactorily, that Chittrick's noſtrum is no other than ſoap-lees given in veal-broth, which the patients ſend every day to the doctor, who returns it mixed up with the medicine, in a cloſe veſſel ſecured by a lock.

It is not every caſe, however, that either requires or will bear a courſe of the cauſtic alkali. Some calculi are of that ſoft and friable nature, that they will diſſolve even in common water; and there are caſes wherein it appears that the conſtant uſe of ſome very ſimple decoction or infuſion of an inſignificant vegetable, has brought away large quantities of earthy matter, in flakes which apparently have been united together in layers to form a ſtone. Dr Macbride aſ-

Epifchefes. fures us, that a decoction of raw coffee, only 30 berries in a quart of water, boiled till it acquired a deep greenifh colour, taken morning and evening to the quantity of eight or ten ounces, with ten drops of fweet fpirit of nitre, had the powerful effect of bringing away, in the courfe of about two months, as much earthy matter in flakes as filled a large tea-cup. The patient was far advanced in years; and, before he began this decoction, had been reduced to great extremities by the continuance of pain and other diftreffing fymptoms: he was purged occafionally with *oleum ricini.*

Very lately the alkali in a mild ftate, and in a different form, has been much ufed by many calculous patients, and with great advantage, under the form of what is called *alkaline aërated water*, the aqua fupercarbonatis potaffæ of the prefent edition of the Edinburgh Pharmacopœia. For the introduction of this medicine, or at leaft for its extenfive ufe, we are chiefly indebted to the ingenious phyfician Dr William Falconer of Bath. He has lately publifhed an account of the *Aqua Mephitica Alkalina*, or folution of fixed alkaline falt, faturated with fixable air, in calculous diforders; which contains a number of cafes ftrongly fupporting the benefit to be derived from it. But whether the good effects obtained in thefe inftances are to be explained from its operating as a folvent of calculus, feems to be extremely doubtful. There are indeed cafes in Dr Falconer's treatife, of patients in whom, after ufing it for a confiderable time, no ftone could be detected by founding, although it had been difcovered in that way before they began the employment of it. But in many inftances, the relief has been fo fudden, that it may be concluded, that, notwithftanding the eafe obtained, the calculus ftill remained. In fuch cafes, it probably removed from the urine that quality by which it gives to the calculus frefh accretions, producing that roughnefs of its furface by which it is chiefly capable of acting as a ftimulus. For the diftreffing fymptoms refulting from ftone are chiefly to be attributed to the inflammatory and fpafmodic affections which it induces; and when its furface is leaft capable of operating as a ftimulus, thefe of courfe will be leaft confiderable. It is therefore not improbable, that this remedy produces relief, by preventing frefh additions being made to the calculus.

An infufion of the feeds of *daucus fylveftris* fweetened with honey, is another fimple and much celebrated remedy; it has been found to give confiderable eafe in cafes where the ftomach could not bear any thing of an acrid nature. The leaves of the *uva urfi* were ftrongly recommended by the late celebrated De Haen; and this, whatever its way of operating may be, feems to have been productive of good effects in fome inftances. There is no reafon to believe that it has any influence in diffolving calculus; and indeed it feems to be chiefly ufeful in thefe inftances where ulcerations take place in the urinary paffages.

In the Edinburgh Medical Commentaries, vol. iii. we have an account of a method ufed by the inhabitants of Arabia Petræa for curing the ftone, to which they are very much fubject, and which the author (an Englifh gentleman of experience and candour) affirms he has feen frequently performed with fuccefs. By means of a catheter, they inject into the bladder a weak ley of alkali with the purified fat of a fheep's tail, and a proper quantity of opium, all put together. Their catheters are made of gold; and in performing the operation they introduce them quite into the bladder; fo that the compofition is fafely conveyed to the ftone without hurting any other part. But when a ftone is fituated in the kidney, they have no method of cure.

Dyfuria.

If this method of curing by injection could be fafely practifed, it would no doubt have the advantage over that of taking alkalies by the mouth, where the medicine is not only much weakened, but the conftitution of the patient runs the rifk of being greatly injured. But from fome experiments mentioned in the fecond volume of the Medical Tranfactions, and ftill more from the chemical analyfis of urinary concretions, lately publifhed by Fourcroy and other modern chemifts, it appears that the human calculi are very different from one another in their natures. Some, for inftance, will eafily yield to an alkaline menftruum, and very little to an acid; while others are found to refift the alkali, and yield to the acid; and fome are of fuch a compact nature, that they yield neither to acids nor alkalies. An attention, however, to the fragments, fcales, or films, which the ftone may caft off, and alfo to the contents and fediment of the urine, may lead to the difcovery of what folvent is proper, or whether the ftone can be diffolved by any. To ufe either alkalies or acids improperly may be hurtful; though there may be fuch kinds of calculi as demand the alternate ufe of acids and alkalies; nay, there may be found calculi of oppofite kinds in the fame fubject.

In fuch cafes as will not allow us to think of diffolving the ftony concretions, and where the only object is to palliate and procure eafe from time to time, little more can be done than to keep the bowels open occafionally by fome gentle cathartic, and wafh off as much of the loofe gravelly matter and flime as can be removed by fuch mild diuretic infufions and decoctions as fhall be found to pafs freely and fit well on the ftomach. Perfons afflicted with the ftone fhould be careful in refpect of their diet, and ftudioufly avoid all heavy and flatulent food, as well as high fauces that are apt to turn rancid. For the fame reafon, butter and acids are to be fhunned; for thefe often create heart-burning, and every thing that offends the ftomach raifes the nephritic pain; fuch is the fympathy that obtains between the digeftive and the uropoietic organs.

There have been furgeons bold enough to entertain an idea of cutting even into the kidney, in order to extract a ftone: this, however, except in cafes where an abfcefs has been formed, and nature points out the way, is both very uncertain and very hazardous. But cutting into the bladder for the fame purpofe, is an ancient and well known operation, and often crowned with fuccefs. A defcription, however, of this operation belongs to the article SURGERY, to which we refer; and here fhall only make this remark, that a furgeon fhould never begin his operation, until he and his affiftants are perfectly fatisfied, from actually feeling the ftone, that there is one in the bladder; becaufe it has fometimes happened, that when the incifion has been made, no ftone could be found: and the patient having died in confequence of the operation, and the body

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When a dysuria proceeds from any acrimonious matter thrown into the blood, it may be readily cured by bleeding, emollient clysters, cooling and diluting drinks with gum arabic or gum tragacanth, linseed tea, or the warm bath. When it arises from inflammations of the bladder or parts adjoining to it, we are to regard it only as a symptomatic affection; and the remedies used to remove the primary disease will also remove the dysuria. Sometimes it may arise from an ulcer of the bladder; in which case it is generally incurable; a mild nutritious diet will, however, protract the patient's life; and even render that life tolerable, by alleviating symptoms.

401 Genus CXXV. DYSPERMATISMUS.

Difficult Emission *of* Semen.

Dyspermatismus, *Sauv.* gen. 260.
Sterilitas, *Lin.* 171. *Sag.* 211.
Agenesia, *Vog.* 283.

This impediment proceeds generally from obstructions in the urethra, either by tumors in itself, or in the cavernous bodies of the penis; in which case the treatment is the same as in the ischuria urethralis; sometimes it is owing to a kind of epileptic fit which seizes the man in the venereal act; and sometimes the semen, when ejected from the proper receptacles, is again absorbed, or flows into the bladder, and is expelled along with the urine. The last case it is very difficult, or even impossible, to cure; as proceeding from scirrhi, or other indissoluble tumors of the verumontanum, or the neighbouring parts. It is also, in general, incurable. In some it proceeds merely from too violent an erection; in which case emollient and relaxing medicines will be of service; and we have an example of a cure performed by means of these in the first volume of the Edinburgh Medical Essays.

402 Genus CXXVI. AMENORRHOEA.

Suppression *of the* Menses.

Amenorrhœa, *Vog.* 130.
Dysmenorrhœa, *Lin.* 168. *Sag.* 218.

This obstruction, with many other symptoms, as dyspepsia, yellowish or greenish colour of the skin, unusual appetites, &c. constitutes the *chlorosis* already treated of, a disease which seldom or never appears without a suppression of the menses. In Dr Hume's Clinical Experiments we find the virtues of several emmenagogues set forth in the following manner. Chalybeates seldom or never succeeded: they were always found more useful in diminishing the evacuation when too violent, than in restoring it when deficient. The tincture of black hellebore proved successful only in one of nine or ten cases, though given to the length of four tea-spoonfuls a-day, which is double the quantity recommended by Dr Mead. Compression of the crural artery, recommended by Dr Hamilton in the Physical and Literary Essays, vol. ii. proved successful only in one of six cases. From the effects produced by this compression, it has the strongest appearance of loading the uterus with blood; from the sensations of the patient it produces the same effects as the approach of the menses, and has every appearance in its favour; yet does not succeed. Dr Hume supposes that the uterus is most frequently in too plethoric and inflammatory a state; in which case, this remedy will do more hurt than in a state of inanition; however, he owns, that in the case in which it did succeed, the patient was plethoric and inflammatory. Venesection is recommended as an excellent remedy; the doctor gives three instances of its success, and says he could give many more. It acts by removing the plethoric state of the uterus, relaxing the fibres, and giving the vessels full play; so that their action overcomes all resistance, and the evacuation takes place. It is of no great moment from whence the blood is taken: the saphænic vein has been supposed to empty the uterus most; but it is difficult to get the proper quantity from it, and the quantity of the discharge cannot be so well measured. The powder of savine is a most powerful remedy; and proved successful in three cases out of four in which it was tried. It was given to the quantity of half a dram twice a-day. It is a strong topical stimulus, and seems improper in plethoric habits. Madder-root, according to Dr Hume, is a very powerful medicine in this disease; and proved successful in 14 out of 19 cases in which it was tried, being sometimes exhibited in the quantity of two scruples, or a dram, four times a-day. It has scarcely any sensible effects; never quickens the pulse, or excites inflammatory symptoms: on the contrary, the heat, thirst, and other complaints abate; and sometimes these symptoms are removed, though the disease be not cured; but when it succeeds, the menses appear from the third to the 12th day.

Amenorrhœa.

We have now considered all those diseases enumerated in Dr Cullen's Nosology, the cure of which is to be attempted chiefly by internal medicines. The other genera either require particular manual operations, or a very considerable use of external applications; and therefore more properly fall under the article Surgery. To this, therefore, we shall refer the genera which fall under the three last orders of the class of locales, viz. the *tumores*, *ectopiæ*, and *dialyses*; and we shall add, by way of Appendix, a few observations on some important affections to which Dr Cullen has not given a place in his system, or which practitioners in general are not agreed in referring to any one particular genus which he has mentioned.

APPENDIX.

APPENDIX.

ANGINA PECTORIS.

493 Dr Heberden was the firſt who deſcribed this diſeaſe, though it is an extremely dangerous, and, by his account, not very rare affection. It ſeizes thoſe who are ſubject to it when they are walking, and particularly when they walk ſoon after eating, with a moſt diſagreeable and painful ſenſation in the breaſt, which ſeems to threaten immediate deſtruction: but the moment they ſtand ſtill, all the uneaſineſs vaniſhes. In all other reſpects the patients at the beginning of this diſorder are well, and have no ſhortneſs of breath; from which the *angina pectoris* is totally different. After it has continued ſome months, the fits will not ceaſe inſtantaneouſly on ſtanding ſtill; and it will come on not only when the patients are walking, but when they are lying down, and oblige them to riſe up out of bed every night for many months together. In one or two very inveterate caſes, it has been brought on by the motion of a horſe or carriage, and even by ſwallowing, coughing, going to ſtool, ſpeaking, or by any diſturbance of mind. The perſons affected were all men, almoſt all of whom were above 50 years of age, and moſt of them with a ſhort neck and inclining to be fat. Something like it, however, was obſerved in one woman, who was paralytic; and one or two young men complained of it in a ſlight degree. Other practitioners have obſerved it in very young perſons.

When a fit of this ſort comes on by walking, its duration is very ſhort, as it goes off almoſt immediately upon ſtopping. If it comes on in the night, it will laſt an hour or two. Dr Heberden met with one in whom it once continued for ſeveral days; during all which time the patient ſeemed to be in imminent danger of death. Moſt of thoſe attacked with the diſtemper died ſuddenly: though this rule was not without exceptions; and Dr Heberden obſerved one who ſunk under a lingering illneſs of a different nature.

The *os ſterni* is uſually pointed to as the ſeat of this malady. It ſeems as if it was under the lower part of that bone, and at other times under the middle or upper part, but always inclining more to the left ſide; and in many caſes there is joined with it a pain about the middle of the left arm, which appears to be ſeated in the biceps muſcle.

The appearance of Dr Heberden's paper in the Medical Tranſactions very ſoon raiſed the attention of the faculty, and produced other obſervations from phyſicians of eminence; particularly Dr Fothergill, Dr Wall of Worceſter, Dr Haygarth of Cheſter, and Dr Percival of Mancheſter. It alſo induced an unknown ſufferer under the diſeaſe to write Dr Heberden a very ſenſible letter, deſcribing his feelings in the moſt natural manner; which, unfortunately, in three weeks after the date of this anonymous epiſtle, terminated in a ſudden death, as the writer himſelf had apprehended.

The youngeſt ſubject that Dr Fothergill ever ſaw afflicted with this diſorder was about 30 years of age; and this perſon was cured. The method that ſucceeded with him was a courſe of pills, compoſed of the maſs of gum pill, ſoap, and native cinnabar; with a light chalybeate bitter: this was continued for ſome months, after which he went to Bath ſeveral ſucceſſive ſeaſons, and acquired his uſual health: he was ordered to be very ſparing in his diet; to keep the bowels open; and to uſe moderate exerciſe on horſeback, but not to take long or fatiguing walks.

The only ſymptom in this patient that is mentioned, was a ſtricture about the cheſt, which came on if he was walking up hill or a little faſter than ordinary, or if he was riding at a very briſk trot; for moderate exerciſe of any kind did not affect him: and this uneaſy ſenſation always obliged him to ſtop, as he felt himſelf threatened with immediate death if he had been obliged to go forward.

It is the ſharp conſtrictive pain acroſs the cheſt which (according to Dr Fothergill's obſervation) particularly marks this ſingular diſeaſe; and which is apt to ſupervene upon a certain degree of muſcular motion, or whatever agitates the nervous ſyſtem.

In ſuch caſes as fell under the inſpection of Dr Fothergill, he very ſeldom met with one that was not attended with an irregular and intermitting pulſe; not only during the exacerbations, but often when the patient was free from pain and at reſt: but Dr Heberden obſerves, that the pulſe is, at leaſt ſometimes, not diſturbed; and mentions his having once had an opportunity of being convinced of this circumſtance, by feeling the pulſe during the paroxyſm.

But no doubt theſe varieties, as well as many other little circumſtances, will occur in this diſeaſe, as they do in every other, on account of the diverſity of the human frame; and if thoſe which in general are found to predominate and give the diſtinguiſhing character be preſent, they will always authoriſe us in giving the name to the diſeaſe: thus, when we find the conſtrictory pain acroſs the cheſt, accompanied with a ſenſe of ſtrangling or ſuffocation; and ſtill more, if this pain ſhould ſtrike acroſs the breaſt into one or both arms; we ſhould not heſitate to pronounce the caſe an *angina pectoris*.

As to the nature of this diſeaſe, it appears to be purely ſpaſmodic: and this opinion will readily preſent itſelf to any one who conſiders the ſudden manner of its coming on and going off; the long intervals of perfect eaſe; the relief afforded by wine and ſpirituous cordials; the influence which paſſionate affections of the mind has over it; the eaſe which comes from varying the poſture of the head and ſhoulders, or from remaining quite motionleſs; the number of years for which it will continue, without otherwiſe diſordering health; its bearing ſo well the motion of a horſe or carriage, which circumſtance often diſtinguiſhes ſpaſmodic pains from thoſe which ariſe from ulcers; and, laſtly, its coming on for the moſt part after a full meal, and in certain patients at night, juſt after the firſt ſleep, at which time the incubus, convulſive aſthma, and other diſeaſes, juſtly attributed to the diſordered func-

 tions

Angina Pectoris.

tions of the nerves, are peculiarly apt to return or to be aggravated.

From all these circumstances taken together, there can be little doubt that this affection is of a spasmodic nature: but though it should be admitted, that the whole distress in these cases arise from spasm, it may not be so easy to ascertain the particular muscles which are thus affected.

The violent sense of strangling or choking, which shows the circulation through the lungs to be interrupted during the height of the paroxysm; and the peculiar constrictive pain under the sternum, always inclining (according to Dr Heberden's observation) to the left side; together with that most distressing and alarming sensation, which, if it were to increase or continue, threatens an immediate extinction of life; might authorise us to conclude that the heart itself is the muscle affected: the only objection to this idea is, that the pulse is not always interrupted during the paroxysm. The appearances in two of the dissections, favour the opinion that the spasm affects the heart; as in one subject the left ventricle was found as empty of blood as if it had been washed; and in another, the substance of the heart appeared whitish, not unlike a ligament; as it should seem, in both cases, from the force of the spasm squeezing the blood out from the vessels and cavities.

If this hypothesis be allowed, we must conclude that the spasm can only take place in an inferior degree, as long as the patient continues to survive the paroxysm; since an affection of this sort, and in this part, of any considerable duration or violence, must inevitably prove fatal: and accordingly, as far as could be traced, the persons who have been known to labour under this disease have in general died suddenly.

The dissections also show, that whatever may be the true seat of the spasm, it is not necessary for the bringing of it on, that the heart, or its immediate appendages, should be in a morbid state; for in three out of the six that have as yet been made public, these parts were found in a sound state.

On opening the body of the poor gentleman who wrote the letter to Dr Heberden, "upon the most careful examination, no manifest cause of his death could be discovered; the heart, in particular, with its vessels and valves, were all found in a natural condition."

In the case communicated by Dr Percival to the publishers of the Edinburgh Medical Commentaries, "the heart and aorta descendens were found in a sound state." And in Dr Haygarth's patient, "on opening the thorax, the lungs, pericardium, and heart, appeared perfectly sound." Not to mention Dr Fothergill's patient (R. M.), in whose body the only morbid appearance about the heart was a small white spot near the apex. Thus the cause, whatever its nature might have been, was at too great a distance, or of too subtile a nature, to come under the inspection of the anatomist. But there was a circumstance in two of the subjects that is worthy of remembrance; and which shows that the crasis of the blood, while they were living, must have been greatly injured, namely, its not coagulating, but remaining of a cream-like consistence, without any separation into serum and crassamentum.

From all that we have seen hitherto published, it does not appear that any considerable advances have been made towards the actual cure of this anomalous spasm.

The very judicious and attentive Dr Heberden (to whom the public are highly indebted for first making the disorder known) confesses, that bleedings, vomits, and other evacuations, have not appeared to do any good: wine and cordials taken at bed-time, will sometimes prevent or weaken the fits; but nothing does this so effectually as opiates: in short, the medicines usually called *nervous* or *cordial*, such as relieve and quiet convulsive motions, and invigorate the languishing principle of life, are what he recommends.

Dr Wall mentions one patient, out of the 12 or 13 that he had seen, who applied to him early in the disease, and was relieved considerably by the use of antimonial medicines joined with the fetid gums: he was still living at the time the doctor wrote his paper, (November 1772), and going about with tolerable ease. Two were carried off by other disorders; all the rest died suddenly.

Dr Fothergill's directions are chiefly calculated with the view to prevent the disorder from gaining ground, and to alleviate present distress. Accordingly he enjoins such a kind of diet as may be most likely to prevent irritability: in particular, not to eat voraciously: to be very abstemious in respect to every thing heating; spices, spirits, wines, and all fermented liquors: to guard most scrupulously against passion, or any vehement emotions; and to make use of all the usual means of establishing and preserving general health: to mitigate excesses of irritability by anodynes; or pains, if they quicken the circulation: to disperse flatulencies when they distend the stomach, by moderate doses of carminatives; amongst which, perhaps, simple peppermint water may be reckoned one of the safest. But since obesity is justly considered as a principal predisposing cause, he insists strongly on the necessity of preventing an increase of fat, by a vegetable diet, and using every other practicable method of augmenting the thinner secretions.

These were the only means recommended by the practitioners mentioned above for opposing this formidable disease: but Dr Smyth of Ireland has, we are told, discovered that it may be certainly cured by issues, of which Dr Macbride gives the following instance.

"*A. B.* a tall well-made man; rather large than otherwise; of healthy parents, except that there had been a little gout in the family; temperate; being very attentive to the business of his trade (that of a watchmaker), led a life uncommonly sedentary; had, from his boyhood upwards, been remarkably subject to alarming inflammations of his throat, which seized him, at least, once in the course of the year; in all other respects well.

"In 1767, (then 48 years of age), he was taken, without any evident cause, with a sudden and very dispiriting throbbing under the sternum. It soon afterwards increased, and returned upon him every third or fourth week, accompanied with great anxiety, very laborious breathing, choking, a sensation of fulness and distension in the head, a bloated and flushed countenance, turgid and watery eyes, and a very irregular and unequal pulse. The paroxysm invaded, Angina Pectoris.

vaded, almoft conftantly, while he was fitting after dinner: now and then he was feized with it in the morning, when walking a little fafter than ufual; and was then obliged to ftop, and reft on any object at hand. Once or twice it came on in bed; but did not oblige him to fit up, as it was then attended with no great difficulty in breathing. In the afternoon fits, his greateft eafe was from a fupine pofture; in which he ufed to continue motionlefs for fome hours, until, quite fpent and worn out with anguifh, he dropt into a flumber. In the intervals between thefe attacks, which at length grew fo frequent as to return every fourth or fifth day, he was, to appearance, in perfect health.

"Thus matters continued for more than two years; and various antifpafmodics were ineffectually tried for his relief. In 1769, there fupervened a very fharp conftrictory pain at the upper part of the fternum, ftretching equally on each fide, attended with the former fymptoms of anxiety, dyfpnœa, choking, &c. and with an excruciating cramp, as he called it, that could be covered with a crown-piece, in each of his arms, between the elbow and the wrift, exactly at the infertion of the pronator teres; the reft of the limb was quite free. The fits were fometimes brought on, and always exafperated, by any agitation of mind or body. He once attempted to ride on horfeback during the paroxyfm; but the experiment was near proving fatal to him. The difference of feafon or weather made no impreffion upon him. Still, in the intervals, his health was perfectly good; except that his eyes, which before his illnefs were remarkably ftrong and clear, were now grown extremely tender: and that his fight was much impaired. He had no flatulency of ftomach, and his bowels were regular.

"In this fituation, February 22. 1770, he applied to me for affiftance. I had feen, I believe, eight or ten of thefe frightful cafes before. Two of the patients dropt dead fuddenly. They were men between 40 and 50 years of age, and of a make fomewhat flefhy. The fate of the others I was not informed of; or, at leaft cannot now recollect.

"Having found the total inefficacy of blifters and the whole clafs of nervous medicines in the treatment of this anomalous fpafm, I thought it right to attempt the correcting or draining off of the irritating fluid in the cafe now before us. To this purpofe, I ordered a mixture of lime-water with a little of the compound juniper-water, and an alterative proportion of Huxham's antimonial wine: I put the patient on a plain, light, perfpirable diet; and reftrained him from all vifcid, flatulent, and acrimonious articles. By purfuing this courfe, he was foon apparently mended; but after he had perfifted regularly in it for at leaft two months, he kept for fome time at a ftand. I then ordered a large iffue to be opened on each of his thighs. Only one was made. However, as foon as it began to difcharge, his amendment manifeftly increafed. The frequency and feverity of the fits abated confiderably: and he continued improving gradually, until, at the end of 18 months he was reftored to perfect health: which he has enjoyed, without the leaft interruption, till now, except when he has been tempted (perhaps once in a twelvemonth) to tranfgrefs rules, by making a large meal on falted meat, or indulging himfelf in ale or rum-punch, each of which never failed to diforder him from the beginning of his illnefs: and even on thefe occafions, he has felt no more than the flighteft motion of his former fufferings; infomuch that he would defpife the attack, if it did not appear to be of the fame ftock with his old complaint. No other caufe has had the leaft ill effect on him.

"Though rum was conftantly hurtful, yet punch made with a maceration of black currants in our vulgar corn-fpirit, is a liquor that agrees remarkably well with him.

"He never took any medicine after the iffue began to difcharge; and I have directed that it fhall be kept open as long as he lives. The inflammations of his throat have difappeared for five years paft; he has recovered the ftrength and clearnefs of his fight; and his health feems now to be entirely re-eftablifhed."

Dr Macbride, in a letter to Dr Duncan, publifhed in the Edinburgh Medical Commentaries, gives the following additional obfervations on this difeafe.

"Within thefe few weeks I have, at the defire of Dr Smyth, vifited, three or four times, a very ingenious man who keeps an academy in this city, of about 34 years of age, who applied to the doctor for his advice in January laft.

"I fhall give you his fymptoms as I had them from his own mouth, which appear to me to mark his cafe to be an angina pectoris, and as deplorable as any that I have read of. It was ftrongly diftinguifhed by the exquifite conftrictory pain of the fternum, extending to each of his arms as far as the infertion of the deltoid mufcle, extreme anxiety, laborious breathing, ftrangling, and violent palpitation of the heart, with a moft irregular pulfe. The paroxyfms were fo frequent, that he fcarcely ever efcaped a day, for fix or feven years, without one. They were ufually excited by any agitation of mind or body, though flight. He had clear intervals of health between the fits. The diftemper feems hereditary in him, as he fays his father was affected in the fame manner fome years previous to his death. He has a ftrong gouty taint, which never fhowed itfelf in his limbs; and he has led a life of uncommon fedentarinefs, from intenfe application to mathematical ftudies, and attention of mind, and paffion, even from his boyifh years. Thefe circumftances may, perhaps, account for his having been taken with this difeafe at fo early an age as 17.

"A large iffue was immediately opened in each of his thighs. In a month afterwards he began to mend, and has gone on improving gradually. He can now run up ftairs brifkly, as I faw him do no later than yefterday, without hurt; can bear agitation of mind; and has no complaint, excepting a flight oppreffion of the breaft, under the fternum, which he feels fometimes in a morning, immediately after dreffing himfelf, and which he thinks is brought on by the motion ufed in putting on his clothes; though for a complete week preceding the day on which I faw him laft, he told me that he had been entirely free from all uneafinefs, and was exulting that he had not had fuch an interval of eafe for thefe laft feven years.

"Doctor Smyth alfo fhowed me, in his *adverfaria*, the cafe of a gentleman who had been under his care in 1760, which he had forgotten when my book went

Puerperal Fever

went to the preſs, and which he was reminded of the other day by a viſit from his patient. It was a genuine angina pectoris, brought on by a very ſedentary life, and great vexation of mind, clearly marked by the exquiſite pain under the ſternum, that extended acutely to the upper extremities, particularly along the left arm, together with the other ſymptoms of dyſpnœa, anxiety, palpitation of the heart, &c. recited in the caſe above. The diſorder went off in 1762, by large ſpontaneous diſcharges from the piles, but returned upon him ſeverely in 1765. Iſſues in his thighs were then recommended to him, but not made. But, whether it was by the perſuaſion of ſome friend, or of his own accord, he went into a courſe of James's powder, in ſmall alterative doſes, combined with a little caſtor and aſafœtida. This he perſiſted in for about ſix weeks; in the meanwhile, he had large acrimonious gleetings from the ſcrotum, and a plentiful diſcharge of ichor from the anus.—From this time he began to find his complaints grow leſs and leſs diſtreſſing, and he has now been totally free from them for ſix years paſt."

404 The PUERPERAL, or CHILDBED FEVER.

This ſpecies of fever, as its name imports, is peculiar to women in childbed; and is uſually the moſt fatal of all the diſorders to which the ſex is liable. But, notwithſtanding the prevalence of it in all ages, its real nature has remained, to the preſent time, a ſubject of much diſpute and uncertainty. The critical period of its invaſion, when febrile commotions are apt to be excited by various accidents, and the equivocal ſymptoms which accompany it, have even afforded room for queſtioning whether it be a primary or a ſecondary diſeaſe. Some writers have conſidered it as proceeding entirely from an inflammation of the uterus; others have imagined it to be the conſequence of an obſtruction to the ſecretion of the milk; while the greater number has been inclined, for reaſons equally if not more plauſible, to impute it to a ſuppreſſion of the lochia. If we examine this fever attentively, however, according to its natural courſe, and independently of all the accidental concomitant ſymptoms with which it is not eſſentially connected, we may ſafely pronounce it to be a primary diſeaſe of a particular nature, and perhaps not the neceſſary conſequence of any of the cauſes above mentioned

This fever is moſt generally incident to women within 48 hours after delivery, though it may ſupervene on the fourth or fifth day, and ſometimes conſiderably later. It is preceded, like other fevers, by a rigor, which is commonly violent; and when happening during the time of labour, may be confounded with the pains of parturiency. In its earlier ſtage it is attended with the ſigns of inflammation. A great pain is felt in the back, hips, and the region of the uterus; which, in the part laſt mentioned, is accompanied with the ſenſe of heat and throbbing. A ſudden change in the quality or quantity of the lochia now alſo takes place; the patient is frequently troubled with a teneſmus; and the urine, which is very high-coloured, is diſcharged in ſmall quantity and with pain. At the firſt attack of the fever, the woman is generally ſeized with a vomiting of porraceous matter, as in the *cholera morbus*, to which diſeaſe it then bears a ſtrong reſemblance.—But inſtead of this ſymptom, there is ſometimes only a nauſea, or loathing at the ſtomach, with a diſagreeable taſte in the mouth. The belly ſwells to a conſiderable bulk, and becomes ſuſceptible of painful ſenſations from the ſlighteſt impreſſion. The tongue is generally dry, though ſometimes moiſt, and covered with a thick browniſh fur. When the fever has continued a few days, the ſymptoms of inflammation uſually ſubſide, and the diſeaſe acquires a more putrid form. At this period, if not at the very beginning of the diſorder, a bilious or putrid diarrhœa, of a dangerous and obſtinate nature, ſupervenes, and accompanies it through all its future progreſs; each motion to ſtool being preceded by a temporary increaſe, and followed by an alleviation of pain. The patient uſually nauſeates all kind of food and drink, except what is cold and acidulated. A brown or blackiſh ſordes, the conſequence of putrid exhalations, adheres to the edges of the teeth; a troubleſome hiccough is at length produced, which greatly exaſperates the pains of the abdomen; petechiæ or vibices alſo appear, with ſometimes a miliary eruption, but which produces no mitigation of the diſeaſe. Through the whole courſe of the fever, the patient is affected with great anxiety and dejection of ſpirits.

Such in general is the courſe of the puerperal fever: the ſymptoms of which, however, may be often varied, according to the conſtitution of the patient, the degree of the diſeaſe, and its earlier or later invaſion. When the woman is naturally weak, or her ſtrength has been greatly reduced by immoderate evacuations after delivery; when the diſeaſe is violent, and immediately follows that period; its progreſs and termination are proportionably rapid and fatal. In ſuch unfortunate circumſtances, many have been known to expire within 24 hours from the firſt attack of the diſeaſe; nay, there are ſome inſtances where the rigor has concluded the ſcene. The cataſtrophe, however, is moſt generally ſuſpended for ſome days; and the number of theſe is variable, though the 11th from the commencement of the fever may juſtly be fixed as the period which is uſually deciſive. In whatever ſtage of the diſeaſe an unfavourable termination may happen, it would ſeem as if the commencement of the patient's recovery were not marked by any critical revolution of the fever, as depending on an alteration of the humours; but that the cure is gradually effected, either by a ſpontaneous vomiting, or a long-continued diſcharge by ſtool of that porraceous matter, the exiſtence of which in the ſtomach is uſually evinced at the firſt attack of the diſeaſe. The moſt unfavourable prognoſtic, therefore, ariſes from ſuch a weakneſs of the patient as renders her unable to ſupport ſo tedious an evacuation as that by which the fever is overcome. When the lochia return to their former ſtate, when the ſwelling and tenderneſs of the abdomen abate, and there is a moiſture on the ſkin, we have reaſon to hope for a happy termination of the diſeaſe.

Though the puerperal fever may generally be aſcertained from the deſcription which has been given, and chiefly by that remarkable tenderneſs of the abdomen which particularly diſtinguiſhes it: yet, as ſome of its ſymptoms may be confounded with thoſe ariſing from other diſeaſes, and which require a different method of

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of cure, it will be proper to mention here the circumstances by which it may be known with greater certainty.

The pains of the abdomen, attending the childbed fever, may be distinguished from those called *after-pains*, by their uninterrupted continuance through the course of the disease, though sometimes they suffer exacerbations; whereas, in the latter, they often totally intermit. They are also distinguishable by the absence of fever with concomitant symptoms in the one, and their evident existence in the other.

Many circumstances evince a dissimilarity between the puerperal and miliary fevers, notwithstanding the symptoms of anxiety and oppression are common to both; insomuch that the nature of the approaching disease may be ascertained at the very commencement of its attack. In the puerperal fever the rigor is more violent, of longer duration, and not interrupted, as it is in the other. The pulse is fuller and stronger; the skin is more hot; and the tongue, whether moist or dry, though generally the latter, is not of a white, but brownish appearance; and the urine is also higher coloured. Eruptions, which are critical in miliary fevers, procure no mitigation of the puerperal fever, and cordials generally increase it.

When the original attack of the puerperal fever happens to coincide with the febrile commotion which is excited in childbed women by the milk, the nature of it may at first be misapprehended; but the concomitant symptoms, and greater violence of the disease, must in a short time dissipate such an error.

From all the most accurate accounts of this disease, and from the period at which it generally commences, there seems reason to conclude, that it owes its rise more immediately to accidents after delivery. For it is allowed that it may follow a labour under the best and most favourable circumstances, though endeavours to dilate the os internum are supposed frequently to produce it. The more immediate causes generally assigned by authors are a stoppage of perspiration, the too free use of spices, and the neglect of procuring stools after delivery; sudden frights, too hasty a separation of the placenta, and binding the abdomen too tight. The putrid appearance, however, which this disease so soon assumes, affords ground to suspect that the predisposing cause of it is a vitiated state of the humours; for it is generally observed to be most prevalent in an unhealthy season, and among women of a weakly and scorbutic constitution. But from its prevalence in some particular hospitals, while others in the same city are entirely free from it, there can be little doubt that it is often communicated by contagion from one female to another. This opinion is corroborated also by many other circumstances; particularly by the means by which it has been removed from hospitals. It would seem, however, that this contagion does not act on the female system without a certain predisposition, and that this predisposition is induced by those changes to which the female habit is subjected in consequence of delivery.

Within these few years this fever has been treated of by several writers, most of whom have differed from each other in their sentiments of the nature of the disease. The first in the order of publication is Dr Denman, who seems to be of opinion, that it may derive its origin either from a redundancy or too great acrimony of the bile, the secretion of which appears to be much interrupted in the time of gestation. In Dr Manning's treatise on this fever, he mentions its being highly probable that such a cause contributes greatly to produce the disease, especially where the putrid tendency of the humours is increased by unwholesome air and diet.

It has likewise been the fate of the puerperal fever, that no disease has more divided the sentiments of physicians in regard to the method of cure. The apparent indications and contra-indications of bleeding, and other remedies, arising from the complication of inflammatory and putrid symptoms; the equivocal appearance of the vomiting and purging, as whether they be critical or symptomatical; and the different causes whence symptoms similar to each other may arise in pregnant women; all these circumstances concur to involve the subject in great obscurity and indecision. If we carefully attend to the several characteristics of the disease, however, so as to be able to distinguish it from every other puerperal complaint, and observe at the same time the usual manner of its declension, our judgment may be guided in the method of cure by the salutary efforts of nature. But, in order to obtain a clearer view of the genuine indications, it will be proper to consider them under the several lights in which they have been generally agitated by authors.

One of the most essential points to be ascertained in the cure of the childbed fever, respects the propriety of bleeding. A free use of the lancet has been generally regarded as the most successful expedient in practice; and there are some instances of critical hæmorrhages which would seem to confirm its utility. But Dr Denman thinks we may safely affirm from experience, that for one who will be benefited by large bleeding, a much greater number will be injured, and that even almost irretrievably. Nor can this seem surprising, when we consider the situation of childbed women. In most, the evacuations consequent upon delivery are sufficient to diminish any undue superabundance of the fluids; and if, as frequently happens, the disease be produced by too hasty a separation of the placenta, the consequence of which is generally a very copious discharge of blood, we can never suppose that nature will be assisted in overcoming the febrile commotion, by the farther evacuation of the vital fluid, through the defect of which she is now rendered unequal even to the ordinary support of the animal œconomy. We may appeal to every practical physician, how much he has known the pulse to sink, and what a train of nervous symptoms he has observed to succeed an excess of the discharge above mentioned. Besides, it is an axiom in physic, that a remedy which cures any disorder, will always prove sufficient to prevent it; and therefore, if bleeding were the proper cure in the childbed fever, the disease ought to have been prevented by a large evacuation of blood, when that happened previous to its attack. Experience, however, in this, as in all other diseases, is the only unerring guide we can follow; and whoever regulates his practice by fact and observation, will be convinced that bleeding, especially in a larger quantity, is, in general, very far from being attended with success. Bleeding is

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is seldom proper, except in women of plethoric constitutions, and in whom the signs of inflammation rise high. Nor even in such patients ought it to be repeated without great caution, and the existence of strong indications. Bleeding, when used in proper circumstances, may unquestionably palliate the fever; but that it often shortens the duration of it, appears to be a matter of much doubt. On this account the practice becomes still more suspicious and exceptionable, when we consider that by venesection improperly used the patient's strength may be so far reduced as not to support the tedious looseness by which the disease is generally carried off. Though bleeding, however, ought in general to be used with great caution, there are certainly many cases in which it is both necessary and advantageous.

The genuine nature and effects of the looseness in this disease, is another controverted point of the highest importance, and which merits the most attentive inquiry. Physicians, observing that women who die of the puerperal fever are generally molested with that evacuation, have been induced to consider this symptom as of the most dangerous and fatal tendency; and what, therefore, we should endeavour by every means to restrain. In this opinion, however, they would seem to have been governed by too partial an observation of facts. For experience certainly authorises the assertion, that more women appear to have recovered of the childbed fever, through the intervention of a diarrhœa, than have been destroyed by that cause. If it also be considered, that purging is usually almost the only sensible evacuation in the more advanced state of the disease, and is that which accompanies it to its latest period, we shall have the strongest reason to think that it is critical rather than symptomatical, and ought therefore to be moderately supported, instead of being unwarily restrained. Nay, the advantage which is found to attend vomiting as well as purging in the earlier stage of the disease, would seem to evince that the matter discharged by these evacuations is what chiefly foments the disease. Emetics and purgatives, therefore, in the opinion of Dr Manning, are the only medicines on which any rational dependence is to be placed in this fever; at least, they are certainly such as are found the most successful. It is an established rule in practice, to prescribe a vomit at the beginning of every fever attended with any nausea or loathing of the stomach, and where there is not any reason to apprehend an inflammation of that organ. Nor does the state of childbed women afford the smallest ground for prohibiting our recourse to the same expedient in answering a similar indication.

It is so seldom a physician is called during the rigor preceding the puerperal fever, that he has few opportunities of trying the effects of remedies in that early state of the disease. When such occur, however, we should endeavour as much as possible to abate and shorten that period, as the succeeding fever is generally found to bear a proportion to the violence and duration of it. For this purpose, warm diluting drinks should be plentifully used, with a small quantity of volatile spirits or brandy. When Dr Manning apprehended such an accident, he sometimes ordered the nurse to give immediately a dish or two of warm sack-whey; taking care that it was not too strong, which is a caution that ought always to be remembered: for though a free use of the more cordial and spirituous kinds of liquors might perhaps soon abate the rigor, there is danger to be feared from their influence on the approaching fever, especially in women of a strong and healthy constitution. In all cases, warm applications to the extremities, such as heated bricks, towels, or toasted grains in a linen bag, may be used with perfect safety, and some advantage.

When the hot fit is advanced, the first thing Dr Manning orders is some emollient injection, as chicken-water, or water and milk, which ought to be frequently repeated through the course of the disease. These prove beneficial, not only by promoting the discharge from the intestines, which seems in fact to be the solution of the disease; but also by acting as a kindly fomentation to the uterus and adjacent parts. With this intention they are particularly serviceable when the lochia are suppressed. Great care, however, is requisite in administering them, on account of the tenderness and inflammatory disposition, which at that time render the parts in the pelvis extremely susceptible of pain.

The next step in the method of cure ought to be to promote the discharge of the morbid matter both by the stomach and intestines. This intention may be answered by a remedy prescribed by Dr Denman—Two grains of tartrite of antimony rubbed up with a scruple of the powder of lapilli cancrorum.

Of a powder thus prepared, Dr Denman gives from two to six grains, and repeats it as circumstances require. If the first dose do not procure any sensible operation, he repeats it in an increased quantity at the end of two hours, and proceeds in that manner; not expecting any benefit but from its sensible evacuation.

Should the disease be abated, but not removed, (which sometimes happens), by the effect of the first dose, the same medicine must be repeated, but in a less quantity, till all danger be over. But if any alarming symptoms remain, he does not hesitate one moment to repeat the powder, in the same quantity as first given; though this be seldom necessary, if the first dose operates properly.

It is to be observed, says Dr Denman, that as the certainty of cure depends upon the proper repetition of the medicine, the method of giving it at stated hours does not appear eligible. If the first dose produce any considerable effect by vomiting, procuring stools, or plentifully sweating, a repetition of the medicine in a less quantity will seldom fail to answer our expectations; but great judgment is required in adapting the quantity first given to the strength of the patient and other circumstances. We are not to expect that a disease which from the first formation carries so evident marks of danger, should instantly cease, even though a great part of the cause be removed.

Frequent doses of the saline draughts ought also to be given, which not only promote the evacuation by the intestines, but likewise increase the salutary discharges of urine and perspiration. These medicines are particularly serviceable in subduing the remains of the fever, after its violence has been broken by the more efficacious remedies above mentioned; but when they are used even in the decline of the disease, gentle laxatives of rhubarb and magnesia, as advised by Dr Denman,

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Denman, ought to be frequently interpofed, fince, as he juftly obferves, without ftools we can do little fervice.

Although the difcharge by the inteftines appears to have the moft falutary effect in this difeafe; yet when the ftomach has not been properly unloaded of offenfive matter, though a great naufea and ficknefs had indicated the expediency of fuch an evacuation at the beginning of the fever, the continuance of the loofenefs is fometimes fo long protracted as in the end to prove fatal. In this alarming ftate of the difeafe, when the ftools are very frequent and involuntary, and all appearances threaten danger, Dr Denman fays, that a clyfter of chicken-water injected every one, two, or three hours, or as often as poffible without fatiguing the patient too much, with a cordial diaphoretic draught taken every fix hours, has produced better effects than could be expected.

While thefe medicines are employed, we fhould endeavour to mitigate the pains of the belly by relaxing applications. During the courfe of the difeafe, the patient ought to drink freely of diluting liquors, and abftain from every thing of a heating quality, unlefs great faintnefs fhould indicate the ufe of a fmall quantity of fome cordial medicine.

Such is the practice recommended in this difeafe by Dr Denman. We fhall now take a curfory view of the fentiments of fucceeding writers on this fubject.

According to Dr Hulme, the proximate caufe of the puerperal fever is an inflammation of the inteftines and omentum; for the confirmation of which opinion he appeals to diffections. He fuppofes the chief predifponent caufe of the difeafe to be the preffure of the gravid uterus againft the parts above mentioned. The omentum, fays he, in the latter ftage of pregnancy, muft either be flat, which is its natural fituation, or be rumpled or carried up by the gravid uterus in folds or doublings. When the latter is the cafe, which he obferves is probably not feldom, the danger of a ftrangulated circulation will be greater.

Mr White, who has alfo written on this difeafe, judicioufly remarks, that were Dr Hulme's hypothefis well founded, the diforder ought rather to take place before delivery, and be immediately removed at that period: That it would likewife moft generally happen to women at their firft labour, when the abdominal mufcles are lefs yielding, and the pains more violent; the contrary of which is moft frequently experienced to be the cafe.

It alfo deferves to be remarked, that, upon Dr Hulme's fuppofition, we cannot account for the difeafe being more common and fatal in large towns and in hofpitals, than in the country and private practice, while other inflammatory diforders are more endemic among thofe who live in the latter than the former fituation. Even admitting the friction of the inteftines and omentum againft the uterus to be as violent as Dr Hulme fuppofes, is it not highly improbable, that any inflammation could be occafioned by the preffure of fuch foft fubftances upon each other? Or, were this effect really produced, ought not the puerperal fever to be more common and fatal after the moft laborious deliveries? But this obfervation is not fupported by experience.

Dr Hulme, in favour of his own hypothefis, alleges that it gives a fatisfactory anfwer to the queftion, "Why all lying-in women have been, and ever will be, fubject to this difeafe?" In this propofition, however, the doctor fuppofes fuch an univerfality of the difeafe as is not confirmed by obfervation. It is affirmed upon undoubted authority, that in many parts of Britain the puerperal fever is hardly known; whereas, were it really produced by the caufes he affigns, it would be equally general and unavoidable.

But how peculiar foever this author's fentiments are in refpect of the proximate caufe of this difeafe, they have not led him to any method of cure different from the eftablifhed practice. On this fubject Dr Hulme divides his obfervations into two parts; comprehending under the former the more fimple method of treatment, and under the latter the more complex. He fets out with remarking, that the patient being generally coftive at the beginning of the difeafe, an emollient opening clyfter will often give immediate relief; but if this fhould not prove effectual, recourfe muft be had to cathartics. Thofe which he found anfwer his purpofe beft, were the *fal catharticus amarus*, the *oleum ricini*, emetic tartar, and antimonial wine. When the bowels have been fufficiently cleared and the pain abates, he advifes encouraging a gentle diaphorefis by medicines which neither bind the body nor are heating; fuch as fmall dofes of ipecacuan, emetic tartar, and antimonial wine, combined with an opiate in a moderate dofe, and given once or twice in the courfe of 24 hours; adminiftering the faline draughts in the intermediate fpaces. If, preceding or during this courfe, a ficknefs at ftomach or vomiting attend, he advifes affifting the efforts of nature, by drinking plentifully of chamomile tea, warm water, or any other diluting liquor. He concludes with recommending a cooling regimen, reft of body, and tranquillity of mind; prohibiting all kinds of bandage upon the abdomen, and enjoining particular attention to the ftate of the bowels, which ought to be kept gently open for fome time, even after the diforder feems to be gone off, till the patient be quite out of danger.

So much for the fimple treatment: we now proceed to the fecond part, where he defcribes the method of practice when the difeafe is in its more irregular and complicated ftate.

When a diarrhœa accompanies the difeafe, he obferves that it ought by no means to be checked, but fupported, by ordering the patient to drink plentifully of mild aperient liquors. If the pain of the hypogaftric region be attended with ftitches in the fides or over the pit of the ftomach, and a pulfe that refifts the finger pretty ftrongly, he remarks that bleeding would then be highly neceffary: declaring, however, his opinion, that, in the puerperal fever, bleeding is to be confidered only as a fecondary means of relief, though the firft in point of time; that it ought to be advifed with great caution; and that the greateft dependence is always to be placed upon evacuations by ftool.

Mr White imputes the puerperal fever to a putrefcent difpofition of the humours, contracted during pregnancy, and fomented by the hot regimen commonly ufed by women in childbed. In conformity to this opinion, the chief means which he recommends for preventing the difeafe is a cool regimen and free circula-

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tion of air, which he evinces to be of the greateſt importance. In reſpect of bleeding, he informs us, that, upon the ſtricteſt inquiry, he cannot find that thoſe who have bled the moſt copiouſly have had the greateſt ſucceſs, either in private or hoſpital practice. He even ſeems to queſtion the propriety of this evacuation in any caſe; but approves of emetics, cathartics, and clyſters, for cleanſing the *primæ viæ*, and likewiſe of ſuch medicines and diet as will correct the putrid humours: adding, that an upright poſture and free ventilation are at all times uſeful, and abſolutely neceſſary, both for the prevention and cure of the diſeaſe.

Another writer who treats of the childbed fever is Dr Leake, who has publiſhed the reſult of his obſervations on this diſeaſe from April 1768 to the autumn of the year 1770; but chiefly from December 1769 to May 1770, during which period the childbed fever prevailed much about London.

Dr Leake tells us that this fever generally commenced the evening of the ſecond or morning of the third day after delivery, with a rigor or ſhivering fit. Sometimes it invaded ſoon after delivery; and at other times though rarely, it has ſeized ſo late as the fifth or ſixth day. Now and then it ſeemed to be occaſioned by catching cold, or by errors in diet; but oftener by anxiety of mind. Sometimes the thirſt was great; though the tongue had, in general, a better appearance at the beginning than is common in other fevers. It was ſeldom ever black or very foul: but, as the diſeaſe advanced, became white and dry, with an increaſe of thirſt; and at laſt was of a browniſh colour towards the root, where it was ſlightly covered with an inſpiſſated mucus. The loſs of ſtrength was ſo great and ſudden, that few of the patients could turn in bed without aſſiſtance, even ſo early as the firſt or ſecond day after the attack. The lochia, from firſt to laſt, were not obſtructed, nor deficient in quantity; neither did the quality of this diſcharge ſeem to be in the leaſt altered from its natural ſtate; a preſumption, ſays the author, that the uterus was not at all affected. Of this he was convinced by making a conſiderable preſſure above the pubes with the hand, which did not occaſion pain; but when the ſame degree of preſſure was applied higher, between the ſtomach and umbilical region, it became almoſt intolerable. A perfect criſis ſeldom if ever happened in this fever, which he imputes to the great oppreſſion of the vital powers, whereby they were rendered unable to produce ſuch an event. When the diſeaſe proved mortal, the patient generally died on the 10th or 11th day from the firſt attack. In thoſe who died of the fever, the omentum was found ſuppurated; an inflammation of which part, or of the inteſtines, Dr Leake concludes to be the proximate cauſe of the diſeaſe.

In conſequence of this idea of the cauſe of the diſeaſe, Dr Leake affirms that veneſection is the only remedy which can give the patient a chance for life. But, though it be the principal reſource to be depended upon at the beginning of the fever, he obſerves that it will ſeldom prove of ſervice after the ſecond or third day; and if directed yet later, will only weaken and exhauſt the patient; when, matter having begun to form in the omentum, the progreſs of the diſeaſe can no longer be prevented by that evacuation. At this period the blood begins to be tainted by the abſorption of the purulent fluid; and the fever, from being inflammatory, is changed into a putrid nature.

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After bleeding in ſuch a quantity as the ſymptoms require, he adviſes that the corrupted bile be evacuated and corrected as ſoon as poſſible; that the diarrhœa, when exceſſive, be reſtrained by emollient anodyne clyſters and gentle ſudorifics, or even by opiates and mild aſtringents, when the patient's ſtrength begins to ſink under the diſcharge; and, laſtly, that where the ſigns of the putrefaction or intermiſſion take place, antiſeptics and the cinchona may be adminiſtered.

The great uniformity of the ſymptoms in all Dr Leake's patients might authoriſe an opinion, that the fever which he deſcribes was in a great meaſure a diſeaſe *ſui generis*, and depended much upon the conſtitution of the air preceding and during the period in which the fever prevailed.

Dr Kirkland has alſo made judicious obſervations on this ſubject, He rejects the opinion that the puerperal fever is a diſeaſe *ſui generis*, and ariſes always from the ſame cauſe. The particular ſituation of childbed women, he acknowledges, occaſions a ſimilarity in the appearance of all the febrile ſymptoms: but he affirms that the ſame kind of fever may be produced by various cauſes; for inſtance, by an inflammation of the uterus or abdomen, by putrid blood or other matter, and putrid miaſms. The ſymptoms, he obſerves, will vary according to the time of ſeizure. If the fever happen in three or four days after delivery, all the ſymptoms uſual to the ſituation of the patient will make their appearance; but if it do not invade till the milk has been ſecreted, and the lochial diſcharge be nearly finiſhed, the ſymptoms, if the breaſts are properly drawn, will, for the moſt part, be thoſe only which are common to that kind of diſorder by which the fever has been produced.

With reſpect to the cure of puerperal fevers, Dr Kirkland adviſes the antiphlogiſtic method when they ariſe from inflammation; but when this method fails of ſucceſs, and a diarrhœa ſupervenes, the diſeaſe has changed its nature, having become more or leſs putrid, and requires a very different treatment.

His obſervations relative to the management of the diarrhœa merit attention. No one, ſays he, would purge and bleed to cure the colliquative fever ariſing from the abſorption of matter in large wounds; and yet the only difference is, that in the puerperal fever the matter abſorbed from the uterus, &c. acts with more violence, becauſe the blood is commonly thinner and the habit in a more irritable ſtate. We ſee, continues he, that abſorbed matter purges as effectually as if any purging medicine had been given by the mouth; and may we not therefore do harm by additional purging, when there has been a large evacuation, eſpecially as purges in this caſe are incapable of entirely removing the *fomes morbi*?

He conſiders cinchona as the principal remedy, as ſoon as the pulſe ſinks, the heat is leſſened, and the ſtomach will bear it. If this increaſe the diarrhœa beyond moderation, he joins with it ſmall doſes of laudanum; but if the diarrhœa ſhould entirely ſtop without the fever going off, in place of laudanum he adviſes a proper quantity of rhubarb. Should the diarrhœa, notwithſtanding the uſe of the medicines propoſed, become

Puerperal Fever. come fo violent as to endanger the patient, he agrees with Mr White in recommending the columbo root, which is a warm cordial, and removes the irritability of the ftomach and inteftines more powerfully than any other bitter he knows.

Of this difeafe alfo, as it appeared in Derbyfhire and fome of the adjacent provinces, an account has been publifhed by Dr Butter. Concerning the caufes and nature of the difeafe, he obferves, that pregnancy feems to add much to the natural fenfibility of the female conftitution; becaufe at this period women are often fubject to a train of nervous fymptoms, which never moleft them at other times. During geftation likewife, the appetite is for the moft part keen, while the digeftion appears to be impaired; and this weaknefs is increafed not only by improper food, of which the woman is frequently defirous, but alfo by the inactivity attending her fituation. To thefe circumftances, it is added, that the inteftinal paffage being interrupted by the uterine preffure, coftivenefs generally prevails. From the feveral obfervations here enumerated, Dr Butter concludes, that the proximate caufe of the puerperal fever is a fpafmodic affection of the firft paffages, with a morbid accumulation in their cavity; and upon this fuppofition he endeavours to account for the various fymptoms of the difeafe.

In treating of the method of cure, he lays down two indications; the former of which is to promote two, three, or four ftools daily, in a manner fuited to the ftrength of the patient, till fuch time as they refume a natural appearance. The fecond indication is to relieve all uneafy fymptoms, fuch as heat, thirft, headach, &c.

With refpect to the opinion entertained by Dr Butter of the caufe of the puerperal fever, it nearly coincides with that of Mr White. But however plaufible it may appear, we are not entirely fatisfied that a difeafe attended with fo peculiar fymptoms as the puerperal fever can depend principally upon an irritability, which is not reftricted either to the pregnant or puerperal ftate.

The late Dr Thomas Young profeffor of midwifery in the univerfity of Edinburgh, although he publifhed nothing on the fubject of the puerperal fever, wrote a very ingenious differtation refpecting it, which was read in the Philofophical Society of Edinburgh. In that differtation, after giving a very accurate account of the fymptoms of the difeafe, which coincides very nearly with the account given by others, he endeavours to fhow, that the *puerperal fever*, ftrictly fo called, is in every inftance the confequence of contagion; but he contends, that the contagious matter of this difeafe is capable only of producing its effect, in confequence of a peculiar predifpofition given by delivery and its confequences. In fupport of this doctrine, he remarks, that for many years the difeafe was altogether unknown in the lying-in ward of the Royal Infirmary at Edinburgh; but that after it was once accidentally introduced into the hofpital, almoft every woman was in a fhort time after delivery attacked with it; although prior to her delivery, fhe may have lain, even for weeks together, not only in the fame ward with the infected, but even in the very next bed. He remarks, that it was only eradicated from the hofpital in confequence of the wards being entirely emptied, thoroughly ventilated, and new painted. After thefe proceffes, puerperal females in the hofpital remained as free from this difeafe as formerly. The puerperal fever, according to Dr Young, has very generally a ftrong tendency to the typhoid type; although he allows, that in the beginning it is not unfrequently attended with inflammatory fymptoms, and even with topical inflammation, particularly in the inteftinal canal. On this idea, he confiders the puerperal fever as admitting of the fame variety of treatment with other affections depending on contagion, in which fometimes an inflammatory, fometimes a putrefcent tendency, prevails; fuch, for example, as fmallpox or eryfipelas. But from the prevailing putrefcent tendency in this affection, he confiders the free accefs of cool air, with the liberal ufe of antifeptics, as being very generally requifite.

It deferves to be remarked, that though the feveral writers who treat of this fubject have conducted their method of cure conformably to their particular idea of the caufe of the difeafe, refpecting which their fentiments are very different, they feem to have been equally fuccefsful in the treatment of their patients. Indeed the feveral writers differ lefs from each other in their method of cure than might be expected, where fo great an oppofition of theoretical fentiment prevails. For after endeavouring to eftablifh indications correfpondent to their particular fyftems, thofe who contend for the expediency of promoting the inteftinal difcharge, diffuade not from having recourfe to phlebotomy when the difeafe is attended with inflammatory fymptoms; while, on the other hand, the moft ftrenuous advocates for bleeding admit the utility of the former evacuation. It appears, therefore, that a due regulation of the alvine difcharge is neceffary through the whole courfe of the fever, but venefection only fometimes.

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405 Worms. Thofe infefting the human body are chiefly of three kinds: the *afcarides*, or fmall round and fhort white worms; the *teres*, or round and long worm; and the *tænia*, or tape-worm.

406 The *afcarides* have ufually their feat in the rectum.—The *teretes* or *lumbrici* are about a fpan long, round and fmooth: they are feated for the moft part in the upper fmall inteftines; but fometimes they are lodged alfo in the ftomach, and in any part of the inteftines, even to the rectum.—The tape-worms are from two to forty feet long, according to the teftimony of Platerus; they generally poffefs the whole tract of the inteftines, but efpecially the ileum: they very much refemble a tape in their appearance, whence the name of *tape worm*: but another fpecies of this genus, from the refemblance of each joint to a gourd feed, has the name of the *gourd-worm*. 407

In the Medical Tranfactions, vol. i. Dr Heberden gives a very accurate account of the fymptoms produced by the *afcarides*, from an eminent phyfician who was troubled with them all his life. They brought on an uneafinefs in the rectum, and an almoft intolerable itching in the anus; which fenfations moft ufually came on in the evening, and prevented fleep for feveral hours. They were attended with heat, fometimes fo confiderable as to produce a fwelling in the rectum

both

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both internally and externally; and if theſe ſymptoms were not ſoon relieved, a teneſmus was brought on, with a mucous dejection. Sometimes there was a griping pain in the lower part of the abdomen, a little above the *os pubis*. If this pain was very ſevere, a bloody mucus followed, in which there were often found aſcarides alive. They were alſo ſometimes ſuſpected of occaſioning diſturbed ſleep, and ſome degree of headach.

On this caſe Dr Heberden obſerves, that the general health of the patient did not ſeem to have ſuffered from the long continuance of the diſeaſe, nor the immediate inconveniences of the diſorder itſelf to have increaſed. "It is (ſays he) perhaps univerſally true, that this kind of worms, though as difficult to be cured as any, yet is the leaſt dangerous of all. They have been known to accompany a perſon through the whole of a long life, without any reaſon to ſuſpect that they had haſtened its end. As in this caſe there was no remarkable ſickneſs, indigeſtion, giddineſs, pain of the ſtomach, nor itching of the noſe, poſſibly theſe ſymptoms, where they have happened to be joined with the aſcarides, did not properly belong to them, but aroſe from ſome other cauſes. There is indeed no one ſign of theſe worms, but what in ſome patients will be wanting."

The above-mentioned patient uſed purging and irritating clyſters with very little ſucceſs. One dram and a half of tobacco was infuſed in ſix ounces of boiling water; and the ſtrained liquor being given as a clyſter, occaſioned a violent pain in the lower part of the abdomen, with faintneſs and a cold ſweat: this injection, though retained only one minute, acted as a ſmart purge, but did little or no good. Lime-water was alſo uſed as a clyſter; which brought on a coſtiveneſs, but had no good effect. Six grains of ſalt of ſteel were diſſolved in ſix ounces of water, and injected. This clyſter in a few minutes occaſioned an aching in the rectum, griped a little without purging, and excited a teneſmus. Some few aſcarides were brought off with it; but all of them were alive. The uneaſy ſenſation in the rectum did not abate till ſome warm milk was thrown up. Whenever the teneſmus or mucous ſtools were thought worth the taking notice of, warm milk and oil generally gave immediate relief. If purging was neceſſary, the lenient purges, ſuch as manna with oil, were, in this particular caſe, made uſe of: rhubarb was found too ſtimulating.—But, in general, the moſt uſeful purge, and which therefore was moſt uſually taken, was cinnabar and rhubarb, of each half a drachm: this powder ſeldom failed to bring away a mucus as tranſparent as the white of an egg, and in this many aſcarides were moving about. The cinnabar frequently adhered to this mucus, which did not come off in large quantities, when a purge was taken without cinnabar. Calomel did no more than any other purge which operates briſkly would have done; that is, it brought away aſcarides, with a great deal of mucus. Oil given as a clyſter ſometimes brought off theſe animalcules: the oil ſwam on the ſurface of the mucus, and the aſcarides were alive and moving in the mucus itſelf, which probably hindered the oil from coming in contact with them and killing them.

Dr Heberden alſo obſerves, that mucus or ſlime is the proper neſt of the aſcarides, in which they live, and is perhaps the food by which they are nouriſhed; and it is this mucus which preſerves them unhurt, though ſurrounded with many other liquors, the immediate touch of which would be fatal. It is hard to ſatisfy ourſelves by what inſtinct they find it out in the human body, and by what means they get at it; but it is obſervable in many other parts of nature, as well as here, that where there is a fit ſoil for the hatching and growth of animals and vegetables, nature has taken ſufficient care that their ſeeds ſhould find the way thither. Worms are ſaid to have been found in the inteſtines of ſtill-born infants. Purges, by leſſening this ſlime, never fail to relieve the patient: and it is not unlikely, that the worms which are not forced away by this quickened motion of the inteſtines, may, for want of a proper quantity of it, languiſh, and at laſt die; for if the aſcarides are taken out of their mucus, and expoſed to the open air, they become motionleſs, and apparently die in a very ſhort time. Dr Heberden ſuppoſes that the kind of purge made uſe of is of ſome conſequence in the cure of all other worms as well as aſcarides; the animals being always defended by the mucus from the immediate action of medicines; and that therefore thoſe purges are the beſt which act briſkly, and of which a repetition can be moſt eaſily borne. Purging waters are of this ſort, and jalap eſpecially for children; two or more grains of which, mixed with ſugar, are moſt eaſily taken, and may be repeated daily.

From Dr Heberden's obſervations, we may eaſily ſee why it is ſo difficult to deſtroy theſe animals; and why anthelmintics, greatly celebrated for ſome kinds, are yet ſo far from being ſpecifics in the diſeaſe. As the worms which reſide in the cavities of the human body are never expoſed to the air, by which all living creatures are invigorated, it is evident, that in themſelves they muſt be the moſt tender and eaſily deſtructible creatures imaginable, and much leſs will be requiſite to kill them than any of our common inſects. The moſt pernicious ſubſtances to any of the common inſects are oil, cauſtic fixed alkali, lime, and lime-water. The oil operates upon them by ſhutting up the pores of their bodies; the lime-water, lime, and cauſtic alkali, by diſſolving their very ſubſtance. In the caſe of inteſtinal worms, however, the oil can have very little effect upon them, as they are defended from it by the moiſture and mucus of the inteſtines; the like happens with lime-water: and therefore it is neceſſary that the medicine ſhould be of ſuch a nature as to deſtroy both mucus and inſects together; for which purpoſe the cauſtic fixed alkali is at once ſafe and efficacious; nor is it probable that any caſe of worms whatever could reſiſt the proper uſe of this medicine. A very large doſe of any ſalt indeed will alſo deſtroy the mucus and deſtroy the worms; but it is apt to inflame and excoriate the ſtomach and inteſtines, and thus to produce worſe diſtempers than that which it was intended to cure. Dr Heberden gives the following remarkable caſe of a patient cured of worms by enormous doſes of common ſalt, after trying many other remedies in vain. In February 1757, the patient was ſeized with uncommon pains in his ſtomach, attended with nauſea, vomiting, and conſtipation of bowels, and an almoſt total loſs of ſleep and appetite:

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He foon became much emaciated, and could neither ftand nor walk upright; his belly grew fmall and hard, and clofely retracted, infomuch that the fternum covered the navel, and the latter could fcarce be difcovered or felt by the finger: his urine was always milky, and foon depofited a thick white fediment; his excrements were very hard and lumpy, refembling thofe of fheep, only of a brown colour; nor had he ever a ftool without fome medicine or other to procure it. In this fituation he continued four years; during which time he had been in an infirmary, attended by eminent phyficians, but was difmiffed as incurable. At laft he was advifed by a neighbour to drink falt and water, as he faid he knew one cured by it who had for many years been afflicted with the fame kind of pains in the belly and ftomach. As his diftemper was now almoft infupportable, he willingly tried the experiment. Two pounds of common falt were diffolved in as little water as poffible, all which he drank in lefs than an hour. Soon afterwards he found himfelf greatly oppreffed at the ftomach, grew extremely fick, and vomited violently; on the fourth ftraining he brought up about half a pint of fmall worms, part afcarides, and the reft refembling thofe worms which are called the *botts*, and frequently met with in the ftomach of horfes, but much fmaller, and about the fize of a grain of wheat. The falt foon began to operate downwards, and he had five or fix very copious fetid ftools, tinged with blood; and in them difcharged near an equal quantity of the fame kind of worms he had vomited. Being greatly fatigued with the violence of the operations, he fell into a calm fleep, which lafted two hours, during which he fweated profufely, and awoke much refrefhed. Inftead of his ufual pains, he now only complained of a rawnefs and forenefs of his gullet, ftomach, and bowels, with an almoft unquenchable thirft; to allay which, he drank large quantities of cold water, whey, butter-milk, or whatever he could get. The urine he now paffed was fmall in quantity, and rendered with very great difficulty, being highly faturated with the falt, from whence arofe a moft troublefome dyfuria and ftrangury. However, thefe fymptoms gradually abated by a free ufe of the liquors above mentioned; and on the third morning he was fo well recovered, that he took two pounds more of falt, diffolved in the like quantity of water. The effects were nearly fimilar to the former; only that moft of the worms were now burft, and came away with a confiderable quantity of flime and mucus. The drought, ftrangury, &c. returned with their former violence, but foon yielded to the old treatment. He fweated very copioufly for three days, flept eafily, and by that time could extend his body freely: on the fifth day he left his bed, and, though very weak, could walk upright; his ftrength and appetite foon returned, and he became robuft and well.

The anthelmintic medicines which have been recommended by one perfon or other, are in a manner innumerable; but the principal are,

1. *Quickfilver*. This is very efficacious againft all kinds of worms, either taken in the form of calomel or corrofive fublimate. Even the crude metal boiled in water, and the water drunk, has been recommended as an almoft certain cure. But this, it is evident, can receive no impregnation from the mercury. If, therefore, it have any effect, it muft be from fome for gn and accidental impregnation. In moft inftances there can be no objection to mercury, but only that it is not endowed with any attenuating quality whereby the mucus in which thefe infects refide can be diffolved. It therefore fails in many cafes, though it will moft certainly deftroy worms where it can get at them.

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2. *Powder of tin*. This was for fome time celebrated as a fpecific, and indeed we may reafonably expect good effects from it; as by its weight and grittinefs it rubs off the mucus and worms it contains from the coats of the inteftinal canal, in which cafe they are eafily evacuated by purgatives. In order to produce any confiderable effects, it muft be given in a large dofe.

3. *Geoffræa inermis*, or *cabbage bark*. This remedy is ufed by the inhabitants of Jamaica. The firft account of it which appeared in this country was publifhed in the Phyfical and Literary Effays, vol. ii. by Mr Duguid furgeon in that ifland. He acquaints us, that the inhabitants of Jamaica, young and old, white and black, are much infefted with worms, efpecially the long round fort; the reafon of which, he thinks, is the quantity of fweet vifcid vegetables which they eat. On diffecting a child of feven months old, who died of vomiting and convulfions, twelve large worms were found; one of them filled the *appendix vermiformis*, and three of them were entwified in fuch a manner as to block up the *valvula Tulpii*, fo that nothing could pafs from the fmall to the great guts.—The cabbage bark, however, he tells us, is a fafe and effectual remedy, and the moft powerful vermifuge yet known; and that it it frequently brings away as many worms by ftool as would fill a large hat. He owns that it has fometimes violent effects; but this he afcribes to the negroes who make the decoction (in which form the bark is ufed) too ftrong, and not to the remedy itfelf.

Mr Anderfon, furgeon in Edinburgh, has alfo given an account of this bark and its operation, in a letter to Dr Duncan, publifhed in the Edinburgh Medical Commentaries, volume iv. p. 84. From this account it appears, that there are two different kinds of cabbage bark; the one much paler than the other: the pale kind operates much more violently than the other. It often occafions loofe ftools, great naufea, and fuch like fymptoms, attended with great uneafinefs in the belly: in one or two inftances it was fufpected of inducing fyncope. The darker coloured kind refembles the caffia lignea, though it is of a much coarfer texture. This kind, Mr Anderfon thinks, may be exhibited in any cafe where an anthelmintic is neceffary; the dangerous fymptoms might have followed either from the ufe of the firft kind, or from an over-dofe of the fecond. The ufual method of preparing the medicine is by boiling two ounces and a half of the bark in two quarts of water to a pint and a half. Of this a tea-fpoonful may be given at firft in the morning, gradually increafing the quantity till we come to four or five table-fpoonfuls in a day. When exhibited in this manner, Mr Anderfon informs us, that he never faw it produce any violent fymptoms, and has experienced the beft effects from it as an anthelmintic. After the ufe of this decoction for eight

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or nine mornings successively, a dose of jalap with calomel must be given, which seldom fails to bring away the worms, some dead, some alive. If at any time the decoction produce more than one or two loose stools, a few drops of liquid laudanum may be given; and, in general, Mr Anderson gave 15 or 20 drops of the spirit of lavender with each dose.

In a letter from Dr Rush, professor of chemistry at Philadelphia, to Dr Duncan of Edinburgh, the following account is given of another preparation of this medicine. "It has long (says he) been a complaint among physicians, that we have no *vermifuge* medicine which can be depended upon. Even calomel fails in many cases where there are the most pathognomonic signs of worms in the bowels. But this complaint, it is hoped, is now at an end. The physicians of Jamaica have lately found, that the *cabbage-bark*, as it is called in the West Indies, made into a syrup with brown sugar, is an infallible antidote to them. I have used above 30 pounds of it, and have never found it fail in one instance. The syrup is pleasant; it sometimes pukes, and always purges, the first or second time it is given."

The most accurate botanical description of the geoffrœa inermis, or the tree furnishing the worm bark, as it has often been called, is that which was published some years ago in the Philosophical Transactions by Dr Wright, formerly physician at Jamaica, now of Edinburgh, who also highly extolls this remedy as an anthelmintic.

Notwithstanding these encomiums, however, the cabbage bark has not come into general use in Britain. But diseases from the *teretes*, or *lumbrici* as they are often called, the species of worm against which this bark is employed, much less frequently occur in Britain than in some other countries. When they do occur, in almost every instance they readily yield to more gentle and safe anthelmintics; and the worms may not only be expelled by calomel, but by the vegetable bitters; as the powder of the artemisia santonica, or the like.

4. *Couhage*, or *cow-itch*. This is the *Dolichos urens* or *pruriens* of Linnæus; and the principles on which it acts have been already explained under the article Dolichos. It is somewhat similar to the powder of tin, but bids fair for being more efficacious. It might at first appear to occur as objections to this medicine, that by the hairs of it entangling themselves with one another, calculi might be formed in the intestines, or obstructions equally bad; or if the sharp points and hooks with which it abounds were to adhere to the nervous coats of the intestines themselves, they might occasion a fatal irritation, which could not be removed by any means whatever. But from the experience of those who have employed it extensively in practice, it would appear, that these objections are entirely theoretical: and that it may be employed with perfect safety. The spiculæ, gently scraped off from a single pod, and mixed with syrup or melasses, are taken for a dose in the morning fasting. This dose is repeated in this manner for two or three days without any sensible operation; but even a very slight purgative taken afterwards has been found to discharge an almost incredible quantity of worms. And according to Dr Bancroft, who has given a very particular account of its use in his Natural History of Guiana, it is one of the safest and most certain anthelmintics yet discovered; but, as well as the bark of the *Geoffræa*, it has hitherto been very little used in Britain, probably from its not being necessary.

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5. *Indian pink.* This plant, which is the *Spigelia marilandica* of Linnæus, is also an American plant, and was first recommended in the Edinburgh Physical and Literary Essays by Dr Garden of Charlestown in South Carolina. He is of opinion that a vomit ought always to precede the use of it; and informs us, that half a dram of it purges as briskly as the same quantity of rhubarb. At other times he has known it produce no effect on the belly though given in very large quantity: In such cases it becomes necessary to add a grain or two of sweet mercury, or some grains of rhubarb; but then it is less efficacious than when it proves purgative without addition. The use of it, however, in small doses, is by no means safe; as it frequently produces giddiness, dimness of sight, convulsions, &c. The addition of a purgative, indeed, prevents these effects; but at the same time, as already observed, it diminishes the virtue of the medicine. The doctor therefore recommends large doses, as from them he never knew any other effect than the medicine's proving emetic or violently cathartic. The dose is from 12 to 60 or 70 grains of the root in substance, or two, three, or four drams of the infusion, twice a-day. This medicine has also had its day, and is now very far from being considered as a specific.

The long round worms seem to be the most dangerous which infest the human body, as they often pierce through the stomach and intestines, and thus bring on a miserable death. The common symptoms of them are nausea, vomiting, looseness, fainting, slender intermitting pulse, itching of the nose, and epileptic fits. By the consumption of the chyle they produce hunger, paleness, weakness, costiveness, tumor of the abdomen, eructations, and rumbling of the intestines; but it is from the perforation of the intestines that the disease proves so frequently fatal. A child may be known to have worms from his cold temperament, paleness of the countenance, livid eyelids, hollow eyes, itching of the nose, voracity, startings, and grinding of the teeth, in sleep; and more especially by a very fetid breath. Very frequently, however, they are voided by the mouth and anus, in which case there is no room for doubt. In the Medical Commentaries, vol. ii. we have an account of the intestines being perforated by a worm, and yet the patient recovered. The patient was a woman troubled with an inflammation in the lower part of the abdomen. The pain was so violent, that for six days she slept none at all; the tumor then broke, discharged upwards of a pound of thin watery sanies, immediately after which the excrements followed. The next day she was extremely low; her pulse could scarcely be felt; the extremities were cold; and there was a considerable discharge from the wound, which had already begun to mortify. She got a decoction of cinchona with wine, which alleviated the symptoms; but in removing the mortified parts a worm was found among them nine inches long, and as thick as an eagle's quill. By proper applications, the discharge of excrements ceased, and she recovered perfect health. She was sensible of no accident giving rise to the

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the inflammation; so that in all probability it arose entirely from the worm itself.

The *tænia*, or *tape-worm* as it is called, is one of those most difficult to be removed from the human body. It is of two kinds, *tænia solium* and *tænia lata;* for a description of which see the article TÆNIA.—The reason of its being so difficult to cure is, that though portions of it are apt to break off and be discharged, it is endowed with a power of reproduction, so that the patient is little or nothing better. The symptoms occasioned by it are not different from those above described. A specific against the *tænia lata* has been lately so much celebrated in France, that the king thought proper to purchase it from the proprietor (Madame Nouffer), and the account of it has been translated into English by Dr Simmons. The patients are required to observe no particular regimen till the day before they take the specific. That day they are to take nothing after dinner till about 7 o'clock; after which, they are to take the following soup: "Take a pint and a half of water, two or three ounces of good fresh butter, and two ounces of bread cut into thin slices: add to this salt enough to season it, and then boil it to the consistence of panada." About a quarter of an hour after this, they take a biscuit and a glass of white wine, either pure or mixed with water; or even water alone, if they have not been accustomed to wine. If the patient has not been to stool that day, (which, however, is not usual with patients in this way), the following clyster is to be injected. "Take a small quantity of the leaves of mallows, and boil them in a sufficient quantity of water, mixing with it a little salt, and when strained off add two ounces of olive oil." Next morning, about eight or nine hours after the supper above mentioned, the specific is to be taken. This is no other than two or three drams of the root of male fern, *polypodium filix mas* of Linnæus, gathered in autumn, and reduced to fine powder. It is to be taken in any distilled water, or in common water. This medicine is apt to occasion a nausea: to avoid which, Madame Nouffer allows her patients to chew any thing that is agreeable, but forbids any thing to be swallowed; or they may smell to vinegar, to check the sickness: but if, notwithstanding this, the specific be thrown up, a fresh dose must be swallowed as soon as the sickness is gone off, and then they must try to sleep. About two hours after this the following bolus is to be taken. "Take of the panacea of mercury 14 times sublimed, and select resin of scammony, each ten grains; of fresh and good gamboge six or seven grains: reduce each of these substances separately into powder, and then mix them with some conserve into a bolus." This composition is to be swallowed at two different times, washing it down with one or two dishes of weak green-tea, after which the patient must walk about his chamber. When the bolus begins to operate, he is to take a dish of the same tea occasionally, until the worm be expelled; then, and not before, Madame Nouffer gives him broth or soup, and he is directed to dine as is usual after taking physic. After dinner he may either lie down or walk out, taking care to conduct himself discreetly, to eat but little supper, and to avoid every thing that is not of easy digestion.

The cure then is complete; but it is not always effected with the same quickness in every subject. He who has not kept down the whole bolus, or who is not sufficiently purged by it, ought to take, four hours after it, from two to eight drams of Epsom salt dissolved in boiling water. The dose of this salt may be varied according to the temperament and other circumstances of the patient.

If the worm should not come away in a bundle, but in the form of a thread (which particularly happens when the worm is involved in much tenacious mucus), the patient must continue to sit upon the close-stool without attempting to draw it away, drinking at the same time warm weak tea: sometimes this alone is not sufficient, and the patient is obliged to take another dose of purging salt, but without varying his position till the worm be wholly expelled.

It is unusual for patients who have kept down both the specific and purging dose, not to discharge the worm before dinner-time. This, however, sometimes happens when the dead worm remains in large bundles in the intestines, so that the fæces becoming more limpid towards the end of the purging, pass by it without drawing it with them. The patient may in this case eat his dinner; and it has been observed, that the food, joined to the use of a clyster, has brought about the expulsion of the worm.

Sometimes the worm is brought away by the action of the specific alone, before the patient has taken the purging bolus: when this happens, Madame Nouffer gives only two-thirds of it, or substitutes the salt in its stead.

Patients must not be alarmed by any sensation of heat or uneasiness they may feel during the action of the remedy, either before or after a copious evacuation, or just as they are about to void the worm. These sensations are transitory, and go off spontaneously, or by the assistance of the vapour of vinegar drawn in at the nose.

They who have vomited both the specific and bolus, or who have kept down only a part of them, sometimes do not void the worm that day. Madame Nouffer therefore directs them to take again that night the soup, the wine and biscuit; and if circumstances require it, the clyster. If the worm do not come away during the night, she gives them early the next morning another dose of the specific, and, two hours afterwards, six drams or an ounce of purging salt, repeating the whole process of the preceding day; excepting the bolus, which she suppresses.

She observes, that very hot weather diminishes in some degree the action of her remedy; she therefore prefers the month of September for administering it; but as she has not been always able to choose the season, and has been sometimes obliged to undertake the cure of patients in the hottest days of summer, she then gave her specific very early in the morning; and with this precaution she saw no difference in its effects.

On the day appointed for the trial of this medicine before the commissioners nominated by the king of France, it was exhibited to five different persons; but only one of them was certainly known to have the *tænia lata* by having discharged parts of it before. That person was cured; the second voided a potion of the *tænia solium;* the third some *ascarides*, with a part of the *tænia solium;* the fourth and fifth voided no worms; but

but the laſt conſidered much of the viſcid ſlime he voided to be worms in a diſſolved ſtate.

This trial was thought ſufficient to aſcertain the efficacy of the medicine, and further trials were made by thoſe to whom the ſecret was communicated. The firſt voided two tænia, after much vomiting and 18 or 20 ſtools; the ſecond had no vomiting, but was as violently purged, and diſcharged two worms; the third had 20 copious ſtools during the night, and diſcharged the worm in the morning; and the fifth was affected in much the ſame manner. Some others who were not relieved, were ſuppoſed not to have a tænia.

This ſpecific, however, is not to be conſidered as a new diſcovery; the efficacy of fern in caſes of tænia having been known long ago. Theophraſtus preſcribes its root, in doſes of four drams, given in water ſweetened with honey, as uſeful in expelling flat worms.—Dioſcorides orders it in the ſame doſe, and adds, that its effects are more certain when it is mixed with four oboli (40 grains) of ſcammony or black hellebore; he particularly requires that garlic ſhould be taken before hand. Pliny, Galen, Oribaſius, and Aëtius, aſcribe this ſame virtue to fern; and are followed in this by Avicenna, and the other Arabian phyſicians. Dorſtenius, Valerius Cordus, Dodonæus, Mathiolus, Dalechampius, who commented on Dioſcorides, or copied him in many things, all mention the fern-root as a ſpecific againſt the tænia. Sennertus, and Burnet after him, recommended in ſimilar caſes an infuſion of this plant, or a dram of its powder, for young perſons, and three drams for adults. Simon Paulus, quoted by Ray and Geoffroy, conſiders it as the moſt efficacious of all poiſons againſt the flat worm, and as being the baſis of all the ſecret remedies extolled by empirics in that diſeaſe, Andry prefers diſtilled fern-water to the root in powder, or he employs it only in the form of an opiate, or mixed with other ſubſtances.

Theſe are not the only authors who have mentioned the tænia; many others have deſcribed this worm, the ſymptoms it excites, and the treatment proper to expel it. Almoſt all of them mention the fern-root, but at the ſame time they point out other remedies as poſſeſſing equal efficacy. Amongſt theſe we find the bark of the root of the mulberry-tree, the juice of the *auricula murus*, the roots of *chamæleon niger*, ginger, zedoary; decoctions of mugwort, ſouthernwood, wormwood, penny-royal, origanum, hyſſop, and in general all bitter and aromatic plants, &c. Some of them direct the ſpecific to be ſimply mixed and taken in wine or honey and water; others join to it the uſe of ſome purgative remedy, which they ſay adds to its efficacy. Oribaſius, Sylvius, &c. diſtinguiſh the ſpecific that kills the worm, from the purgative that evacuates it, and direct them to be given at different times. Sennertus gives a very ſatisfactory reaſon for adopting this method. If we give, ſays he, the purgative medicine and the ſpecific at the ſame time, the latter will be haſtily carried off before it can have exerted its powers on the worm: whereas, if we give the ſpecific firſt, and thus weaken the worm, it will collect itſelf into a bundle, and, being brought away by means of the purge, the patient will be cured. The cure will be more ſpeedy if the *primæ viæ* have been previouſly lubricated. Theſe precautions are all of them eſſential to the ſucceſs of the remedy, nor are they neglected by Madame Nouffer in her method of treatment. The panada and injection ſhe preſcribes the night before, to lubricate the inteſtines, and prepare the *primæ viæ*. The fern root, taken in the morning, kills and detaches the worm; of this the patients are ſenſible by the ceſſation of the pain in the ſtomach, and by the weight that is felt in the lower belly. The purgative bolus adminiſtered two hours after this, procures a complete evacuation; it is compoſed of ſubſtances that are at once purgative and vermifuge, and which, even when adminiſtered alone, by different phyſicians, ſometimes ſucceeded in expelling the worm. If this purgative appear to be too ſtrong, the reader is deſired to recollect, that it produced no ill effects in either of the caſes that came under the obſervation of the phyſicians appointed to make the trials; and that in one of thoſe caſes, by diminiſhing the doſe, they evidently retarded the evacuations.—Regard however, they obſerve, is to be had both to the age and the temperament of the patient, and the treatment ſhould always be directed by a prudent and experienced phyſician, who may know how to vary the proportions of the doſe as circumſtances may require. If the purgative be not of ſufficient ſtrength, the worm, after being detached by the ſpecific, remains too long a time in the inteſtines, and becoming ſoon corrupted, is brought away only in detached portions: on the other hand, if the purgative be too ſtrong, it occaſions too much irritation, and evacuations that cannot fail to be inconvenient.

Madame Nouffer's long experience has taught her to diſtinguiſh all theſe circumſtances with ſingular adroitneſs.

This method of cure is, as we have ſeen, copied in a great meaſure from the ancients: it may be poſſible to produce the ſame effects by varying the remedies; but the manner of applying them is by no means indifferent: we ſhall be always more certain of ſucceſs if the inteſtines be previouſly evacuated, and if the ſpecific be given ſome time before the purgative bolus. It is to this method that Madame Nouffer's conſtant ſucceſs is attributed.

Her remedy has likewiſe ſome power over the *tænia ſolium*; but as the rings of this worm ſeparate from each other more eaſily than thoſe of the *tænia lata*, it is almoſt impoſſible for it to be expelled entire. It will be neceſſary therefore to repeat the treatment ſeveral times, till the patient ceaſe to void any portions of worms. It muſt likewiſe be repeated, if, after the expulſion of one *tænia ſolium*, another ſhould be generated in the inteſtinal canal. This laſt caſe is ſo rare, that it has been ſuppoſed that no perſon can have more than one of theſe worms; and for this reaſon it has been named *ſolitary worm*, which, being once removed, could never be renewed or replaced by a ſecond: but experience has proved, that this notion is an ill-founded prejudice; and we know that ſometimes theſe worms ſucceed each other, and that ſometimes ſeveral of them exiſt together. Two living tæniæ have frequently been expelled from the ſame patient. Dr De Haen relates an inſtance of a woman who voided 18 tæniæ at once. In theſe caſes the ſymptoms are uſually more alarming; and the appetite becomes exceſſive, becauſe theſe worms derive all their nouriſhment from the chyle. If too auſtere and ill-judged a regimen deprives

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deprives them of this, they may be expected to attack even the membranes of the inteſtines themſelves. This evil is to be avoided by eating frequently.

Such are the precautions indicated in this diſeaſe. The ordinary vermifuge remedies commonly procured only a palliative cure, perhaps becauſe they were too often improperly adminiſtered. But the efficacy of the preſent remedy, in the opinion of the French phyſicians, ſeems to be ſufficiently confirmed by experience. To the above account, however, it ſeems proper to ſubjoin the following obſervations by Dr Simmons.

"A Swiſs phyſician, of the name of *Herrenſchwand*, more than 20 years ago, acquired no little celebrity by diſtributing a compoſition of which he ſtyled himſelf the *inventor*, and which was probably of the ſame nature as Madame Nouffer's. Several very eminent men, as Tronchin, Hovius, Bonnet, Cramer, and others, have written concerning the effects of this remedy. It ſeems that Dr Herrenſchwand uſed to give a powder by way of preparation, the night before he adminiſtered his ſpecific. Nothing could be ſaid with certainty concerning the compoſition either of one or the other. The treatment was ſaid ſometimes to produce moſt violent effects, and to leave the patients in a valetudinary ſtate. Dr De Haen was diſſuaded by his friends from uſing it, becauſe it diſordered the patients too much. It will be readily conceived, now that we are acquainted with Madame Nouffer's method, that theſe effects were occaſioned wholly by the purgative bolus. It is not ſtrange, that reſin of ſcammony or jalap, combined with *mercurius dulcis* and gamboge, all of them in ſtrong doſes, ſhould in many ſubjects occaſion the greateſt diſorders. It ſeems likely, however, that much of the ſucceſs of the remedy depends on the uſe of a draſtic purge. Some of the ancients who were acquainted with the virtues of the fern root, obſerved that its efficacy was increaſed by ſcammony. Reſinous purges, eſpecially when combined with mercury, have often been given with ſucceſs in caſes of *tænia*. Dr De Haen ſaw a worm of this ſort five ells long expelled by the reſin of jalap alone. Dr Gaubius knew a woman who had taken a variety of anthelmintic remedies without any effect, though ſhe had voided a portion of *tænia* an ell and a half long previous to the uſe of theſe medicines: but at length, after taking a purge of ſingular ſtrength, ſhe voided the worm entire. Many other inſtances of the ſame kind are to be met with in authors. Other remedies have occaſionally been given with ſucceſs. In Sweden, it has been a practice to drink ſeveral gallons of cold water, and then to take ſome draſtic purge. Boerhaave ſays, that he himſelf ſaw a *tænia* meaſuring 300 ells expelled from a Ruſſian by means of the ſulphate of iron.

From ſome late accounts, there is reaſon to believe that Dr Herrenſchwand's remedy for *tænia* does not ſo exactly agree with that of Madame Nouffer as Dr Simmons ſeems to imagine. According to the account given us by a gentleman who had his information from Dr Herrenſchwand himſelf, it conſiſts entirely of gamboge and fixed vegetable alkali.

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Of many poiſons we have already treated, but there are ſome of which nothing has hitherto been ſaid. Among the moſt fatal of theſe are the bites and ſtings of ſerpents, ſcorpions, &c. According to Dr Mead, the ſymptoms which follow the bite of a viper are, an acute pain in the place wounded, with a ſwelling, at firſt red, but afterwards livid, which by degrees ſpreads farther to the neighbouring parts; with great faintneſs, and a quick, low, and ſometimes interrupted pulſe; great ſickneſs at ſtomach, with bilious convulſive vomitings, cold ſweats, and ſometimes pains about the navel. Frequently a ſanious liquor runs from the ſmall wound, and little puſtules are raiſed about it: the colour of the whole ſkin in leſs than an hour is changed yellow, as if the patient had the jaundice. Theſe ſymptoms are very frequently followed by death, eſpecially if the climate be hot, and the animal of a large ſize. This is not, however, the caſe with all kinds of ſerpents. Some, we are aſſured, kill by a fatal ſleep; others are ſaid to produce an univerſal hæmorrhage and diſſolution of the blood; and others an unquenchable thirſt. But of all the ſpecies of ſerpents hitherto known, there is none whoſe bite is more expeditiouſly fatal than that of the rattleſnake. Dr Mead tells us, that the bite of a large ſerpent of this kind killed a dog in a quarter of a minute; and to the human ſpecies they are almoſt equally fatal. Of this ſerpent it is ſaid, that the bite makes the perſon's ſkin become ſpotted all over like the ſkin of the ſerpent; and that it has ſuch a motion as if there were innumerable living ſerpents below it. But this is probably nothing more than a diſſolution of the blood, by which the ſkin becomes ſpotted as in petechial fevers, at the ſame time that the muſcles may be convulſed as in the diſtemper called *hieranoſos*, which was formerly thought to be the effect of evil ſpirits: but it is even not improbable that obſervers have been ſomewhat aided by fancy and ſuperſtition when they thought that they detected ſuch appearances.

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It has juſtly appeared ſurpriſing to philoſophers, how ſuch an inconſiderable quantity of matter as the poiſon emitted by a viper at the time of biting ſhould produce ſuch violent effects. But all inquiries into this matter muſt neceſſarily be uncertain; neither can they contribute any thing towards the cure. It is certain that the poiſon produces a gangrenous diſpoſition of the part itſelf, and likewiſe ſeemingly of the reſt of the body; and that the original quantity of poiſon continues ſome time before it exerts all its power on the patient, as it is known that removing part of the poiſonous matter by ſuction will alleviate the ſymptoms. The indications of cure then are three: 1. To remove the poiſonous matter from the body: Or, 2. If this cannot be done, to change its deſtructive nature by ſome powerful and penetrating application to the wound: And, 3. To counteract the effects of that portion already received into the ſyſtem.

The poiſonous matter can only be removed from the body by ſucking the wound either by the mouth, or by means of a cupping glaſs; but the former is probably the more efficacious, as the ſaliva will in ſome meaſure dilute and perhaps obtund the poiſon. Dr Mead directs the perſon who ſucks the wound to hold warm oil in his mouth, to prevent inflammation of the lips and tongue: but as bites of this kind are moſt likely to happen in the fields, and at a diſtance from houſes, the want of oil ought by no means to retard the operation, as the delay of a few minutes might prove

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prove of the moſt fatal conſequence; and it appears from Dr Mead's experiments, that the taking the poiſon of a viper into the mouth undiluted, is attended with no worſe conſequences than that of raiſing a ſlight inflammation. A quick exciſion of the part might alſo be of very great ſervice.

The only way of anſwering the ſecond indication is, by deſtroying the poiſoned part by a red-hot iron, or the application of alkaline ſalts, which have the power of immediately altering the texture of all animal ſubſtances to which they are applied, provided they are not covered by the ſkin; and as long as the poiſon is not totally abſorbed into the ſyſtem, theſe muſt certainly be of uſe.

To anſwer the third indication, Dr Mead recommends a vomit of ipecacuanha, encouraged in the working with oil and warm water. The good effects of this, he ſays, are owing to the ſhake which it gives to the nerves, whereby the irregular ſpaſms into which their whole ſyſtem might be drawn are prevented. After this the patient muſt go to bed, and a ſweat muſt be procured by cordial medicines; by which the remaining effects of the poiſon will be carried off.

It has been confidently aſſerted by many, that the American Indians are poſſeſſed of ſome ſpecific remedy by which they can eaſily cure the bite of a rattleſnake. But Mr Cateſby, who muſt have had many opportunities of knowing this, poſitively denies that they have any ſuch medicine. They make applications indeed, and ſometimes the patient recovers; but theſe recoveries he aſcribes to the ſtrength of nature overcoming the poiſon, more than to the remedies made uſe of. He ſays, they are very acute in their prognoſtics whether a perſon that is bit will die or not; and when they happen to receive a bite in certain parts of the body, when the teeth of the animal enter a large vein, for inſtance, they quietly reſign themſelves to their fate, without attempting any thing for their own relief. Indeed, ſo violent and quick is the operation of this poiſon, that unleſs the antidote be inſtantly applied, the perſon will die before he can get to a houſe. It would ſeem therefore eligible for thoſe who are in danger of ſuch bites, to carry along with them ſome ſtrong alkaline ley, or dry alkaline ſalt, or both, which could be inſtantly clapt on the wound, and by its diſſolving power would deſtroy both the poiſon and the infected parts. Strong cordials alſo, ſuch as ardent ſpirits, volatile alkali, &c. might poſſibly excite the languid powers of nature, and enable her to expel the enemy, which would otherwiſe prove too powerful. This ſeems to be ſomewhat confirmed from the account we have in the Philoſophical Tranſactions of a gentleman bit by a rattleſnake, who was more relieved by a poultice of vinegar and vine-aſhes put to his wound than any thing elſe. The vine aſhes being of an alkaline nature, muſt have ſaturated the vinegar, ſo that no part of the cure could be attributed to it: on the other hand, the aſhes themſelves could not have been ſaturated by the ſmall quantity of acid neceſſary to form them into a poultice; of conſequence they muſt have operated by their alkaline quality.—Soap ley, therefore, or very ſtrong ſalt of tartar, may reaſonably be thought to be the beſt external application, not only for the bites of vipers, but of every venomous creature; and in fact we find *dry ſalt* univerſally recommended both in the bites of ſerpents and of mad dogs. Dr Mead recommends the fat of vipers immediately rubbed into the wound; but owns that it is not ſafe to truſt to this remedy alone.

Diſeaſes of Children.

Some years ago the volatile alkali was ſtrongly recommended by M. Sage of the French academy, as a powerful remedy againſt the bite of the viper: and, by a letter from a gentleman in Bengal to Dr Wright, it would appear that this article, under the form of the *eau de luce*, which is very little if any thing different from the *ſpiritus ammoniæ ſuccinatus* of the London Pharmacopœia, has been employed with very great ſucceſs againſt this affection in the Eaſt Indies: but from the trials made with it by the abbé Fontana, publiſhed in his Treatiſe on the Poiſon of the Viper, it would appear that it by no means anſwered his expectation; and the efficacy of this, as well as of the ſnake pills mentioned under the article HYDROPHOBIA, ſtill requires to be confirmed by further experience.

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This is a diſtemper not very common, but it has been obſerved by the ancient phyſicians, and is deſcribed by Hippocrates under the name of *morbus niger*. It ſhows itſelf by a vomiting and purging of black tar-like matter, which Hippocrates, Boerhaave, and Van Swieten, ſuppoſed to be occaſioned by atra bilis. But Dr Home, in his Clinical Experiments, endeavours to ſhew that it is owing to an effuſion of blood from the meſeraic veſſels, which, by its ſtagnation and corruption, aſſumes that ſtrange appearance. The diſeaſe, he ſays, frequently follows hæmorrhage; and thoſe of a ſcorbutic habit are moſt ſubject to it. It is an acute diſeaſe, and terminates ſoon; yet it is not attended with any great degree of fever. In one of Dr Home's patients the criſis happened on the eighth day by diarrhœa; in another, on the 14th, by ſweat and urine; and a third had no evident critical evacuation.

As to the cure, Dr Home obſerves, that bleeding is always neceſſary where the pulſe can bear it; nor are we to be deterred from it by a little weakneſs of the pulſe, more than in the enteritis. Emetics are hurtful, but purgatives are uſeful. But the moſt powerful medicine for checking this hæmorrhage is the ſulphuric acid: and, that this might be given in greater quantity, he mixed it with mucilage of gum arabic; by which means he was enabled to give double the quantity he could otherwiſe have done. The cold bath was tried in one inſtance, but he could not determine whether it was of any ſervice or not. The cure was completed by exerciſe and cinchona.

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Dr Buchan obſerves, that from the annual regiſters of the dead, it appears that about one half of the children born in Great Britain die under twelve years of age; and this very great mortality he attributes in a great meaſure to wrong management. The particulars of this wrong management enumerated by him are,

1. Mothers not ſuckling their own children. This, he owns, it is ſometimes impoſſible for them to do; but

but where it can be done, he affirms that it ought never to be omitted. This, he fays, would prevent the unnatural cuftom of mothers leaving their own children to fuckle thofe of others; on which he paffes a moft fevere cenfure, and indeed fcarce any cenfure can be fevere enough upon fuch inhumanity. Dr Buchan informs us, "He is fure he fpeaks within bounds, when he fays not one in a hundred of thefe children live who are thus abandoned by their mothers." For this reafon he adds, that no mother fhould be allowed to fuckle another's child till her own be fit to be weaned. A regulation of this kind would fave many lives among the poorer fort, and would do no harm to the rich; as moft women who make good nurfes are able to fuckle two children in fucceffion upon the fame milk.

2. Another fource of the difeafes of children is the unhealthinefs of parents: and our author infifts that no perfon who labours under an incurable malady ought to marry.

3. The manner of clothing children tends to produce difeafes. All that is neceffary here, he fays, is to wrap the child in a foft loofe covering; and the foftnefs of every part of the infant's body fufficiently fhows the injury which muft neceffarily enfue by purfuing a contrary method.

4. A new-born infant, inftead of being treated with fyrups, oils, &c. ought to be allowed to fuck the mother's milk almoft as foon as it comes into the world. He condemns the practice of giving wines and fpirituous liquors along with the food foon after birth; and fays, that if the mother or nurfe has a fufficient quantity of milk, the child will need little or no other food before the third or fourth month. But to this it may reafonably be objected, not only that the nurfing would thus be very fevere on the mother; but if the child be left thus long without other food, it will not eafily relifh that food for fome time, and its ftomach is apt to be eafily hurt by a flight change of diet after it has been long accuftomed to one thing. The human fpecies are unqueftionably fitted by nature for a mixed aliment, both from the vegetable and animal kingdom. And the analogy of other animals belonging to the clafs of mammalia for whom milk is equally provided at the earlieft periods of life, would lead us to the conclufion, that mixed aliment is well fitted for the human fpecies even in the earlieft periods of infancy. The lamb is no fooner dropt than, by natural inftinct, it crops the grafs as well as it fucks its mother. And the ftomach in the human fpecies, immediately after birth, can digeft other food as well as milk. Neither can it be fhown, that the ftrongeft and moft healthy infants are thofe which get no other food but the mother's milk during the firft months of their life. In fact, children are evidently of a weak and lax habit of body, fo that many of their difeafes muft arife from that caufe; all directions which indifcriminately advife an antiphlogiftic regimen for infants as foon as they come into the world, muft of neceffity be wrong. Many inftances in fact might be brought to fhow, that by the prepofterous method of ftarving infants, and at the fame time treating them with vomits and purges, they are often hurried out of the world. Animal food indeed, particularly under the form of broths, is exceffively agreeable to children, and they ought to be indulged with it in moderation. This will prove a much better remedy for thofe acidities with which children are often troubled, than magnefia alba, crabs eyes, or other abforbents, which have the moft pernicious effects on the ftomachs of thefe tender creatures, and pall the appetite to a furprifing degree. The natural appetites of children are indeed the beft rule by which we can judge of what is proper or improper for them. They muft no doubt be regulated as to the quantity; but we may be affured that what a child is very fond of will not hurt it, if taken in moderation. When children are fick, they refufe every thing but the breaft; and if their diftemper be very fevere, they will refufe it alfo, and in this cafe they ought not to be preffed to take food of any kind; but when the ficknefs goes off, their appetite alfo returns, and they will require the ufual quantity of food.

According to Dr Armftrong, *inward fits*, as they are called, are in general the firft complaint that appears in children; and as far as he has obferved, moft, if not all infants, during the firft months, are more or lefs liable to them. The fymptoms are thefe: The child appears as if it was afleep, only the eyelids are not quite clofed; and if you obferve them narrowly, you will fee the eyes frequently twinkle, with the white of them turned up. There is a kind of tremulous motion in the mufcles of the face and lips, which produces fomething like a fimper or a fmile, and fometimes almoft the appearance of a laugh. As the diforder increafes, the infant's breath feems now and then to ftop for a little; the nofe becomes pinched; there is a pale circle about the eyes and mouth, which fometimes changes to livid, and comes and goes by turns; the child ftarts, efpecially if you attempt to ftir it though ever fo gently, or if you make any noife near it. Thus difturbed, it fighs, or breaks wind, which gives relief for a little, but prefently it relapfes into the dozing. Sometimes it ftruggles hard before it can break wind, and feems as if falling into convulfions; but a violent burft of wind from the ftomach, or vomiting, or a loud fit of crying, fets all to rights again. As the child increafes in ftrength, thefe fits are the more apt to go off fpontaneoufly and by degrees; but in cafe they do not, and if there is nothing done to remove them, they either degenerate into an almoft conftant drowfinefs, (which is fucceeded by a fever and the thrufh), or elfe they terminate in vomitings, four, curdled, or green ftools, the watery gripes, and convulfions. The thrufh indeed very often terminates in thefe laft fymptoms. As thefe complaints naturally run into one another, or fucceed one another, they may be confidered, in a manner, as only different ftages of the fame difeafe, and which derive their origin from the fame caufe. Thus, the inward fits may be looked upon as the firft ftage of the diforder; the fever, and thrufh (when it happens), as the fecond; the vomitings, four, curdled, green or watery ftools, as the third; and convulfions, as the laft.

As to the caufe of thefe complaints, he obferves, that in infants the glandular fecretions, which are all more or lefs glutinous, are much more copious than in adults. During the time of fucking, the glands of the mouth and fauces being fqueezed by the contraction of the mufcles, pour forth their contents plentifully; which afterwards mixing with the mucus of the gullet

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and ſtomach, render the milk of a ſlimy conſiſtence, by which means it is not ſo readily abſorbed into the lacteals; and as in moſt infants there is too great an acidity in the ſtomach, the milk is thereby curdled, which adds to the load; hence ſickneſs and ſpaſms, which, being communicated by ſympathy to the nerves of the gullet and fauces, produce the convulſive motions above deſcribed, which go commonly by the name of *inward fits*. The air, likewiſe, which is drawn in during ſuction mixing with the milk, &c. in the ſtomach, perhaps contributes towards increaſing the ſpaſms above mentioned. Dr Armſtrong is the more induced to attribute theſe fits to the cauſes now aſſigned, that they always appear immediately after ſucking or feeding; eſpecially if the child has been long at the breaſt, or fed heartily, and has been laid down to ſleep without having firſt broken wind. Another reaſon is, that nothing relieves them ſo ſoon as belching or vomiting; and the milk or food they throw up is generally either curdled, or mixed with a large quantity of heavy phlegm. If they be not relieved by belching or vomiting, the fits ſometimes continue a good while, and gradually abate, according as the contents of the ſtomach are puſhed into the inteſtines; and as ſoon as the former is pretty well emptied, the child is waked by hunger, cries, and wants the breaſt; he ſucks, and the ſame proceſs is repeated.—Thus, ſome children for the firſt weeks are kept almoſt always in a doze, or ſeemingly ſo; eſpecially if the nurſes, either through lazineſs or want of ſkill, do not take care to rouſe them when they perceive that it is not a right ſleep, and keep them awake at proper intervals. This dozing is reckoned a bad ſign amongſt experienced nurſes; who look upon it as a forerunner of the thruſh, as indeed it often is; and therefore, when it happens, we ought to be upon our guard to uſe the neceſſary precautions for preventing that diſorder.

For theſe diſorders, the only remedy recommended by Dr Armſtrong is antimonial wine, given in a few drops according to the age of the infant. By this means the ſuperabundant mucus will no doubt be evacuated; but at the ſame time we muſt remember, that this evacuation can only *palliate*, and not cure the diſeaſe. This can only be effected by tonics; and, when from inward fits and other ſymptoms it appears that the tone of the ſtomach is very weak, a decoction of cinchona, made into a ſyrup, will readily be taken by infants, and may be ſafely exhibited from the very day they come into the world, or as ſoon as their bowels are emptied of the meconium by the mother's milk or any other means.

Dr Clarke obſerves, that *fractures* of the *limbs* and *compreſſions* of the *brain*, often happen in difficult labours; and that the latter are often followed by convulſions ſoon after delivery. In theſe caſes, he ſays, it will be adviſable to let the navel-ſtring bleed two or three ſpoonfuls before it be tied. Thus the oppreſſion of the brain will be relieved, and the diſagreeable conſequences juſt mentioned will be prevented. But if this has been neglected, and fits have actually come on, we muſt endeavour to make a revulſion by all the means in our power; as by opening the jugular vein, procuring an immediate diſcharge of the urine and meconium, and applying ſmall bliſters to the back, legs, or behind the ears. The ſemicupium, too, would ſeem to be uſeful in this caſe, by driving the oppreſſive load of fluids from the head and upper parts.

It ſometimes happens after a tedious labour, that the child is ſo faint and weak as to diſcover little or no ſigns of life. In ſuch a caſe, after the uſual cleanſing, the body ſhould be immediately wrapped in warm flannel, and briſkly toſſed about in the nurſe's arms, in order, if poſſible, to excite the languid circulation. If this fail, the breaſt and temples may be rubbed with brandy or other ſpirits; or the child may be provoked to cry, by whipping, or other ſtimulating methods, as the application of onion, or ſalt and ſpirit of hartſhorn, to the mouth and noſtrils. But after all theſe expedients have been tried in vain, and the recovery of the child abſolutely deſpaired of, it has ſometimes been happily revived by introducing a ſhort catheter or blowpipe into the mouth, and gently blowing into the lungs at different intervals. Such children, however, are apt to remain weak for a conſiderable time, ſo that it is often no eaſy matter to rear them; and therefore particular care and tenderneſs will be required in their management, that nothing may be omitted which can contribute either to their preſervation or the improvement of their ſtrength and vigour.

All the diſorders which ariſe from a *retention* of the *meconium*, ſuch as the *red gum*, may eaſily be removed by the uſe of gentle laxatives; but the great ſource of mortality among children is the *breeding* of their *teeth*. The uſual ſymptoms produced by this are fretting; reſtleſſneſs; frequent and ſudden ſtartings, eſpecially in ſleep; coſtiveneſs; and ſometimes a violent diarrhœa, fever, or convulſions. In general, thoſe children breed their teeth with the greateſt eaſe, who have a moderate laxity of the bowels, or a plentiful flow of ſaliva during that time.

In mild caſes, we need only, when neceſſary, endeavour to promote the means by which nature is obſerved to carry on the buſineſs of dentition in the eaſieſt manner. For this purpoſe, if a coſtiveneſs be threatened, it muſt be prevented, and the body kept always gently open; the gums ſhould be relaxed by rubbing them frequently with ſweet oils, or other ſoftening remedies of that kind, which will greatly diminiſh the tenſion and pain. At the ſame time, as children about this period are generally diſpoſed to chew whatever they get into their hands, they ought never to be without ſomething that will yield a little to the preſſure of their gums, as a cruſt of bread, a wax candle, a bit of liquorice root, or ſuch like; for the repeated muſcular action, occaſioned by the conſtant biting and gnawing at ſuch a ſubſtance, will increaſe the diſcharge from the ſalivary glands, while the gums will be ſo forcibly preſſed againſt the advancing teeth, as to make them break out much ſooner, and with leſs uneaſineſs, than would otherwiſe happen. Some likewiſe recommend a ſlice of the rind of freſh bacon, as a proper maſticatory for the child, in order to bring moiſture into its mouth, and facilitate the eruption of the teeth by exerciſing the gums. If theſe means, however, prove ineffectual, and bad ſymptoms begin to appear, the patient will often be relieved immediately by cutting the inflamed gum down to the tooth, where a ſmall white point ſhows the latter to be coming forward. When the pulſe is quick, the ſkin hot and dry, and the child of a ſufficient age and ſtrength, emptying the veſſels by bleeding,

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ing, especially at the jugular, will frequently be necessary here, as well as in all other inflammatory cases; and the belly should be opened from time to time by emollient, oily, or mucilaginous clysters. But, on the contrary, if the child be low, sunk, and much weakened, repeated doses of the spirit of hartshorn, and the like reviving medicines, ought to be prescribed. Blisters applied to the back, or behind the ears, will often be proper in both cases. A prudent administration of opiates, when their use is not forbid by costiveness or otherwise, is sometimes of great service in difficult teething, as, by mitigating pain, they have a tendency to prevent its bad effects, such as a fever, convulsions, or other violent symptoms; and often they are absolutely necessary, along with the testaceous powders, for checking an immoderate diarrhœa.

When cathartics are necessary, if the child seems too tender and weak to bear their immediate operation, they should be given to the nurse; in which case they will communicate so much of their active powers to the milk as will be sufficient to purge the infant. This at least certainly holds with regard to some cathartics; such, for example, as the infusion of senna, particularly if a very weak infusion be employed, and not used to such an extent as to operate as a purgative to the nurse.

As most young children, if in health, naturally sleep much, and pretty soundly, we may always be apt to suspect that something is amiss when they begin to be subject to *watching* and *frights;* symptoms which seldom or never occur but either in consequence of some present disorder not perceived, or as the certain forerunners of an approaching indisposition. We should immediately, therefore, endeavour to find out the cause of watchfulness, that we may use every possible means to remove or prevent it; otherwise the want of natural rest, which is so very prejudicial to persons of all ages, will soon reduce the infant to a low and emaciated state, which may be followed by a hectic fever, diarrhœa, and all the other consequences of weakness. These symptoms, being always the effects of irritation and pain, may proceed, in very young infants, from crudities or other affections of the *primæ viæ* producing flatulencies or gripes; about the sixth or seventh month, they may be owing to that uneasiness which commonly accompanies the breeding of the teeth; and after a child is weaned, and begins to use a different kind of food, worms become frequently an additional cause of watchings and disturbed sleep. Hence, to give the necessary relief on these occasions, the original complaint must first be ascertained from the child's age and other concomitant circumstances, and afterwards treated according to the nature of the case. Women and nurses are too apt to have recourse to opiates in the watchings of children, especially when their own rest happens to be much disturbed by their continual noise and clamour. But this practice is often prejudicial, and never ought to have place when the belly is in the least obstructed.

There is no complaint more frequent among children than that of worms, the general symptoms of which have been already enumerated; but it must be observed, that all the symptoms commonly attributed to worms, may be produced by a foulness of the bowels. Hence practitioners ought never to rest satisfied with administering to their patients such medicines as are possessed only of an anthelmintic quality, but to join them with those which are particularly adapted for cleansing the *primæ viæ;* as it is uncertain whether a foulness of the bowels may not be the cause of all the complaints. This practice is still the more advisable, on account of viscid humours in the intestines affording lodgement to the ova of worms; which, without the convenience of such a receptacle, would be more speedily discharged from the body.

The difficulty of curing what is called a *worm fever*, arises, according to Dr Musgrave, from its being frequently attributed to worms, when the cause of the disorder is of a quite different nature. He does not mean to deny that worms do sometimes abound in the human body, nor that the irritation caused by them does sometimes produce a fever; but he apprehends these cases to be much more uncommon than is generally imagined, and that great mischief is done by treating some of the disorders of children as worm cases, which are really not so. Dr Hunter is of the same opinion on this point. He has, we are told, dissected great numbers of children who have been supposed to die of worm fevers, and whose complaints were of course treated as proceeding from worms, in whom, however, there appeared, upon dissection, to be not only no worms, but evident proofs of the disorder's having been of a very different nature.

The *spurious worm fever*, as Dr Musgrave terms it, has, in all the instances he has seen of it, arisen evidently from the children having been indulged with too great quantities of fruit. Every sort of fruit eaten in excess will probably produce it; but an immoderate use of cherries seems to be the most common cause of it. The approach of this disorder has a different appearance, according as it arises from a habit of eating fruit in rather too large quantities, or from an excessive quantity eaten at one time. In the former case, the patient gradually grows weak and languid: his colour becomes pale and livid; his belly swells and grows hard; his appetite and digestion are destroyed; his nights grow restless, or at least his sleep is much disturbed with startings, and then the fever soon follows, in the progress of which, the patient grows comatose, and at times convulsed; in which state, when it takes place to a high degree, he often dies. The pulse at the wrist, though quick, is never strong or hard; the carotids, however, beat with great violence, and elevate the skin so as to be distinctly seen at a distance. The heat is at times considerable, especially in the trunk; though at other times, when the brain is much oppressed, it is little more than natural. It is sometimes accompanied by a violent pain of the epigastric region, though more commonly the pain is slight, and terminates in a coma; some degree of pain, however, seems to be inseparable from it, so as clearly to distinguish this disorder from other comatose affections.

When a large quantity of fruit has been eaten at once, the attack of the disorder is instantaneous, and its progress rapid; the patient often passing, in the space of a few hours, from apparently perfect health, to a stupid, comatose, and almost dying state. The symptoms of the fever, when formed, are in both cases nearly the same; except that, in this latter sort, a little purulent matter is sometimes discharged, both by vomit

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mit and ſtool, from the very firſt day. The ſtools, in both caſes, exhibit ſometimes a kind of curd reſembling curdled milk, at other times a floating ſubſtance is obſerved in them; and ſometimes a number of little threads and pellicles, and now and then a ſingle worm.

Strong purgatives, or purges frequently repeated, in this diſorder, are greatly condemned by Dr Armſtrong, as they in general not only aggravate the ſymptoms already preſent, but are ſometimes the origin of convulſions. Bloodletting is not to be thought of in any ſtage of the diſorder.

Although frequent purging, however, be not recommended, yet a ſingle vomit and purge are adviſed in the beginning of the diſorder, with a view to evacuate ſuch indigeſted matter and mucus as happens to remain in the ſtomach and bowels. Theſe having operated properly, there is ſeldom occaſion for repeating them; and it is ſufficient, if the body be coſtive, to throw up, every ſecond or third day, a clyſter, compoſed of ſome grains of aloes, diſſolved in five or ſix ounces of infuſion of chamomile.

The principal part of the cure, however, depends upon external applications to the bowels and ſtomach; and as the cauſe of the diſorder is of a cold nature, the applications muſt be warm, cordial, and invigorating; and their action muſt be promoted by conſtant actual heat.

When any nervous ſymptoms come on, or remain after the diſorder is abated, they are eaſily removed by giving a pill with a grain or two of aſafœtida once or twice a-day.

The diagnoſtics of worms are very uncertain; but, even in real worm caſes, the treatment above recommended would, it is imagined, be much more efficacious than the practice commonly had recourſe to. As worms either find the conſtitution weakly, or very ſoon make it ſo, the frequent repetition of purges, particularly mercurials, cannot but have a pernicious effect. Bear's-foot is ſtill more exceptionable, being in truth to be ranked rather among poiſons than medicines. Worm ſeed and bitters are too offenſive to the palate and ſtomach to be long perſiſted in, though ſometimes very uſeful. The powder of coralline creates diſguſt by its quantity; and the infuſion of pink root is well known to occaſion now and then vertiginous complaints and fits.

Fomenting the belly night and morning with a ſtrong decoction of rue and wormwood, is much recommended. It is a perfectly ſafe remedy, and, by invigorating the bowels, may therefore have ſome influence in rendering them capable of expelling ſuch worms as they happen to contain. After the fomentation, it is adviſed to anoint the belly with a liniment, compoſed of one part of eſſential oil of rue, and two parts of a decoction of rue in ſweet oil. It is, however, a matter of great doubt whether theſe external applications, in conſequence of the articles with which they are impregnated, exert any influence on the worms themſelves.

The diet of children diſpoſed to worms ſhould be warm and nouriſhing, conſiſting in part at leaſt of animal food, which is not the worſe for being a little ſeaſoned. Their drink may be any kind of beer that is well hopped, with now and then a ſmall draught of porter or negus. A total abſtinence from butter is not ſo neceſſary, perhaps, as is generally imagined. Poor cheeſe muſt by all means be avoided; but ſuch as is rich and pungent, in a moderate quantity, is particularly ſerviceable. In the ſpurious worm fever, the patient ſhould be ſupported occaſionally by ſmall quantities of broth; and, at the cloſe of it, when the appetite returns, the firſt food given ſhould be of the kinds above recommended.

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The diet here recommended will, perhaps, be thought extraordinary, as the general idea is at preſent, that, in the management of children, nothing is ſo much to be avoided as repletion and rich food. It is no doubt an error to feed children too well, or to indulge them with wine and rich ſauces; but it is equally an error to confine them to too ſtrict or too poor a diet, which weakens their digeſtion, and renders them much more ſubject to diſorders of every kind, but particularly to diſorders of the bowels. In regard to the ſpurious worm fever, if it be true that acid fruits too plentifully eaten are the general cauſe of it, it follows as a conſequence, that a warm nutritious diet, moderately uſed, will moſt effectually counteract the miſchief, and ſooneſt reſtore the natural powers of the ſtomach. Beſides, if the diſorder does not readily yield to the methods here directed, as there are many examples of its terminating by an inflammation and ſuppuration of the navel, it is highly adviſeable to keep this probability in view, and, by a moderate allowance of animal food, to ſupport thoſe powers of nature, from which only ſuch a happy criſis is to be expected.

Beſides theſe, many other diſeaſes might here be mentioned, which, if not peculiar to infants, are at leaſt peculiarly modified by the infant ſtate. But into details reſpecting theſe we cannot propoſe to enter. It is ſufficient to ſay, that due regard being paid to age and conſtitution, the cure is to be conducted on the ſame general principles as in the adult ſtate.

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During the progreſs of ſcience in Europe this ſubject has not been altogether neglected. But we may ſafely venture to aſſert, that even from many enlightened governments it has hitherto claimed much leſs attention than its importance merits. At the Britiſh univerſities this has been too much the caſe. It is indeed true, that for near 20 years a few lectures on this ſubject have been delivered at the univerſity of Edinburgh, by the profeſſor of the inſtitutions of medicine. But he could by no means conſider the ſubject on that extenſive ſcale which its importance merited. And he had often expreſſed his regret, that, as in ſeveral of the foreign univerſities, a profeſſorſhip had not been inſtituted for the expreſs purpoſe of giving a courſe of lectures on medical juriſprudence. That defect, however, in medical education at Edinburgh is now ſupplied. When that able and upright ſtateſman Lord Grenville, to whom every thing that regarded the laws of his country was an object of peculiar attention, was at the head of his majeſty's councils, a regius profeſſorſhip of juridical and political medicine was eſtabliſhed in the univerſity of Edinburgh by a royal warrant. And

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And there is every reaſon to hope, that this appointment will be attended with many effects highly beneficial to the nation.

A ſhort view of the extent and importance of this ſubject will, we preſume, not be unacceptable to the intelligent reader.

Whatever aid the ſcience of medicine can contribute towards the good of the ſtate, and the execution of its laws, has been by the Germans denominated State Medicine; a new, but not improper, appellation, for that branch of knowledge which many writers have termed Medical Juriſprudence.

It comprehends both medical police and juridical medicine. The former conſiſts of the medical precepts which may be of uſe to the legiſlature or to the magiſtracy. The latter is the aggregate of all the information, afforded by the different branches of medicine, which is neceſſary for elucidating doubtful queſtions in courts of law.

Although there are ſome traces of juridical medicine in the Juſtinian code; ſuch as determining the real period of birth, with a view to prevent the impoſition of ſpurious children: it properly originated with the code of laws enacted by the emperor Charles V. under the name of *Conſtitutio criminalis Carolina;* in which it is ordained, that the opinions of phyſicians ſhould be taken, with regard to the danger of wounds, child-murder, murder, poiſoning, procured abortion, concealed pregnancy, &c. Theſe directions, and the impoſſibility which was found of determinating many queſtions by ſimply legal means, induced ſome legiſlators to enjoin, that all tribunals and judges ſhould procure from ſworn phyſicians, appointed to this office, their opinions concerning all the ſubjects to be mentioned hereafter.

Since that time, it has been treated ſyſtematically by many learned men; ſuch as Fortunatus Fidelis, Zacchias, Alberti, Hebenſtreit, Haller, Ludwig, Plenck; and laſtly, in the moſt maſterly manner, by Metzger. Numberleſs diſſertations have been written on all its parts; and among thoſe who contributed to its advancement, we may reckon Ambroſe Parry, Bohn, Butener, Morgagni, Camper, and Gruner. Collections of caſes, illuſtrating its principles, have been made by Amman, Daniel, Bucholz, Pyl, Scherf and Metzger. Theſe are only a few of the principal writers who have attended to this ſcience: to enumerate more would be unneceſſary.

From its very nature, it is evident how neceſſary a knowledge of this ſcience muſt be to every medical practitioner, who is liable to be called upon to illuſtrate any queſtion comprehended under it before a court of juſtice. On his anſwers, the fate of the accuſed perſon muſt often depend; both judge and jury regulating their deciſion by his opinion. On the other hand, while he is delivering his ſentiments, his own reputation is before the bar of the public. The acuteneſs of the gentlemen of the law is univerſally acknowledged; the verſatility of their genius, and the quickneſs of their apprehenſion, are rendered almoſt inconceivable, by conſtant exerciſe. It is their duty to make every poſſible exertion for the intereſt of their client, and they ſeldom leave unnoticed any inaccurate or contradictory evidence. How cautious muſt, then, a medical practitioner be, when examined before ſuch men, when it is their duty to expoſe his errors, and magnify his uncertainties, till his evidence ſeem contradictory and abſurd? How often muſt he expoſe himſelf to ſuch ſevere criticiſm, if he be not maſter of the ſubject on which he is giving evidence, and have not arranged his thoughts on it according to juſt principles? On the other hand, he may deſerve and gain much credit, by ſo public a diſplay of judgment and profeſſional knowledge.

Some acquaintance with this part of medical ſcience muſt be uſeful at leaſt, and ſometimes neceſſary, to judges and lawyers. They will thus be enabled to eſtimate how much they may depend on the opinion of any phyſician, and will know how to direct their queſtions, ſo as to arrive at the truth, and avoid being miſled by his partiality or favourite opinions. To the lawyer who conducts the defence of an accuſed perſon, in a criminal caſe, it is almoſt indiſpenſable; without it, he cannot do juſtice to the cauſe of his client.

Before criminal courts, the queſtions which occur moſt generally are, reſpecting

1. The cauſe of death, as aſcertained from the examination of the body.
2. The ſufficiency of the ſuppoſed cauſe to have produced death.
3. Probable event of wounds, contuſions, &c.
4. The importance of the part injured.
5. Suppoſed child-murder; whether ſtill-born or not.
6. Whether death accidental or intended.
7. Abortion; its having occurred,
8. Spontaneouſly, from habit; accidentally, from external violence or paſſions of the mind; or intentionally, from the introduction of a ſharp inſtrument, uſe of certain drugs, &c.
9. Rape; its being attempted or conſummated; recent or previous defloration.
10. The reſponſibility of the accuſed for his actions.

Before civil courts the queſtions generally regard,

1. The ſtate of mind; madneſs, melancholy, idiotiſm.
2. Pregnancy; concealed, pretended.
3. Parturition; concealed, pretended, retarded, premature.
4. The firſt-born of twins.
5. Diſeaſes; concealed, pretended, imputed.
6. Age and duration of life.

Before conſiſtorial courts, the ſubjects inveſtigated are,

1. Impotence; general, relative, curable, incurable.
2. Sterility; curable, relatively incurable, abſolutely incurable.
3. Uncertainty of ſex; hermaphrodites.
4. Diſeaſes preventing cohabitation; venereal diſeaſe, leproſy, &c.

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Of incomparably greater conſequence, and more widely extended influence, is the ſecond diviſion of this ſubject. It regards not merely the welfare of individuals, but the proſperity and ſecurity of nations. It is perhaps the moſt important branch of general police; for its influence is not confined to thoſe whom accidental circumſtances bring within its ſphere, but extends over the whole population of the ſtate.

Many

Medical Police.

Many of its principles have been long acknowledged, and confidered as neceffary confequences of medical and political truths; and fome few of them have acquired the authority of laws. But it was referved for the philanthropic Frank, to collect the whole into one vaft and beneficent fyftem, and to feparate it from juridical medicine; in the old fyftems of which, it was neglected, or mentioned only in a few fhort paragraphs. His enlarged mind perceived at once, and fully vindicated its importance. The very name of Medical Police, is now fufficient to attract the attention of legiflators and of magiftrates, and to make them defirous of becoming acquainted with its principles, and anxious to fee them carried into execution. In fact, its influence is already vifible in the countries where it is cultivated. If the principles of medical police were feparated from the profeffional part of medicine, and communicated in a form generally intelligible, in what country have we reafon to expect more beneficial effects from its influence than this? Where is the fpirit of patriotifm and benevolence fo prevalent? What nation is more generous in its public inftitutions. Where does the individual facrifice a part of his wealth fo willingly for the benefit of the community? It feems only neceffary to prove that an undertaking will be of advantage to the ftate, to have it carried into inftant execution. But, can medical knowledge be more ufefully employed than in pointing out the means of preferving or improving health; of fupplying healthy nourifhment to the poor, epecially in times of fcarcity; of oppofing the introduction of contagious difeafes, and of checking their progrefs; of fecuring to the indigent the advantages intended by their benefactors; of rearing the orphan to be the fupport of the nation which has adopted him; and of diminifhing the horrors of confinement to the poor maniac and the criminal? Thefe good effects are not to be promoted fo much by rigid laws, as by recommendation and example. Nor can it be reafonably objected to a fyftem of medical police, that it is a pleafing dream, which flatters the imagination, but the execution of which is in reality impracticable. As well might we entirely throw afide the rules of humanity, becaufe no one is able to obferve them all; or live without laws, becaufe no exifting code is unexceptionable.

Medical police may be defined,—The application of the principles deduced from the different branches of medical knowledge, for the promotion, prefervation and reftoration of general health.

The effects to be expected from it are the general welfare of the ftate, and increafe of healthy population; and are to be attained by means of public inftitutions, exprefs laws, and popular inftruction. Inftructing the people, and convincing them of the propriety of certain precautions and attentions, in regard to their own and the general ftate of health, are neceffary to fecure the good effects of our public inftitutions and regulations; to obtain refpect and obedience in many things, to which no exprefs law can be adapted; and, to induce them to forego what may be prejudical to the fafety of the community, and of themfelves.

Public medical inftitutions and laws, muft be adapted to the country for which they are intended. Many local circumftances, national character, habits of life, prevalent cuftoms and profeffions, fituation, climate, &c. make confiderable varieties neceffary. And many inftitutions, many a law which would be highly beneficial to the public health, in fome circumftances, would be ufelefs, impracticable, and even hurtful, in others. Thefe caufes and their effects, muft, therefore, be particularly attended to.

The principal authors who have writen on this fubject, are Alberti, Heifter, Plaz, Frank, Huffty, Metzger, and Hebenftreit; to whom we may add Howard and Rumford

The fubjects which it comprehends, cannot be claffed very regularly or fyftematically. Its views will be different, according to occafional and temporary caufes; and its interference may fometimes be advantageoufly extended beyond what may feem the ftrict limits of a branch of the medical profeffion.

Medical Police relates to

The Situation of Places of Abode. Conftruction of houfes.

Air. Means of counteracting its impurity—Its various impregnations.

Water. Its neceffity and purity.

Food. Its various kinds—Comparative quantities of nourifhment afforded by them—Cheaper kinds, which may be fafely fubftituted in times of fcarcity—Bread—Animal food—Butcher meat—Fifh—Vegetables—Veffels Cookery; Healthy; Œconomical.

Drink. Beer—Ale—Porter—Cyder—Spirituous liquors—Wine—Warm drinks—Adulterations of thefe liquors—Hurtful additions—Veffels.

Fire and Light.

Clothing.

Cleanliness.

Professions. Manufacturers—Mechanics—Soldiers—Sailors—Men of letters.

Healthy Propagation.

Pregnant and Puerperal Women.

New-Born Infants. Regifters of birth.

Physical Education.

Prevention of Accidents. From poifon—Hurtful Effluvia—Maniacs—Rabid animals.

Restoration of the Apparently dead. Humane Societies—Care of the dying—Danger of too early—too late burial—Places of interment—manner of conducting it—Bills of mortality.

Contagious and Epidemic diseases. Plague—Putrid fever—Dyfentery—Smallpox—Inoculation—Extirpation of them—Leprofy—Itch and pox—Precautions to be taken, to prevent their introduction, to diminifh their violence, to deftroy their caufe, and to counteract their effects.

Management of Public Institutions in which many people are collected under the care of the public.

Hofpitals for the Indigent:

1. Lying-in Hofpitals.
2. Foundling ditto.
3. Orphan ditto.
4. Hofpitals for Education.

5. Aged

5. Aged.
6. Blind.
7. Maimed.

Military Hoſpitals :
Priſoners of War.
Lazarettoes.
Work-houſes.
Priſons.

Hoſpitals for the Sick.
Maniacs.
Convaleſcents.
Incurables.

Obſervations on the MEANS *of preſerving* HEALTH.

Having now treated of all the moſt important diſeaſes to which the human body is ſubjected, we ſhall conclude the article MEDICINE, with a few obſervations on the means of preſerving health, both for the general management of valetudinarians, and of thoſe alſo who wiſh to obtain long life and good health by avoiding the cauſes of thoſe diſeaſes which the human ſpecies often bring upon themſelves. On this ſubject much has been written at almoſt every period of medicine. And we may refer thoſe readers who wiſh for a full and extenſive view of this intereſting ſubject to a very elaborate work lately publiſhed by Sir John Sinclair, Bart. entitled the Code of Health and Longevity. Here we cannot propoſe to give even an abridged view of this extenſive inquiry ; but muſt content ourſelves with offering only a very few general obſervations.

413 I. RULES *for the Management of* VALETUDINARIANS.

THAT part of the medical ſyſtem which lays down rules for the preſervation of health, and prevention of diſeaſes, termed *Hygieina*, is not to be ſtrictly underſtood as if it reſpected only thoſe people who enjoy perfect health, and who are under no apprehenſions of diſeaſe, for ſuch ſeldom either deſire or attend to medical advice ; but is rather conſidered as relating to valetudinarians, or ſuch as, though not actually ſick, may yet have ſufficient reaſon to fear that they will ſoon become ſo : hence it is that the rules muſt be applied to correct morbific diſpoſitions, and to obviate various particulars which were ſhown to be the remote or poſſible cauſes of diſeaſes.

From the way in which the ſeveral temperaments are commonly mentioned by ſyſtematic writers, it ſhould ſeem as if they meant that every particular conſtitution might be referred to one or other of the four ; but this is far from being the caſe, ſince by much the greater number of people have temperaments ſo indiſtinctly marked, that it is hard to ſay to which of the temperaments they belong.

When we actually meet with particular perſons who have evidently either,

1. Too much ſtrength and rigidity of fibre, and too much ſenſibility ;

2. Too little ſtrength, and yet too much ſenſibility ;

3. Too much ſtrength, and but little ſenſibility ; or,

4. But little ſenſibility joined to weakneſs ;

we ſhould look on ſuch perſons as more or leſs in the valetudinary ſtate, who require that theſe morbific diſpoſitions be particularly watched, leſt they fall into thoſe diſeaſes which are connected with the different temperaments.

People of the firſt-mentioned temperament being liable to ſuffer from continued fevers, eſpecially of the inflammatory ſpecies, their ſcheme of preſerving health ſhould conſiſt in temperate living, with reſpect both to diet and exerciſe ; they ſhould ſtudiouſly avoid immoderate drinking, and be remarkably cautious leſt any of the natural diſcharges be checked. People of this habit bear evacuations well, eſpecially bleeding : they ought not, however, to loſe blood but when they really require to have the quantity leſſened ; becauſe too much of this evacuation would be apt to reduce the conſtitution to the ſecond-mentioned temperament, in which ſtrength is deficient, but ſenſibility redundant.

Perſons of the ſecond temperament are remarkably prone to ſuffer from painful and ſpaſmodic diſeaſes, and are eaſily ruffled ; and thoſe of the ſofter ſex who have this delicacy of habit, are very much diſpoſed to hyſterical complaints. The ſcheme here ſhould be, to ſtrengthen the ſolids by moderate exerciſe, cold bathing, cinchona, and chalybeate waters ; particular attention ſhould conſtantly be had to the ſtate of the digeſtive organs, to prevent them from being overloaded with any ſpecies of ſaburra which might engender flatus, or irritate the ſenſible membranes of the ſtomach and inteſtines, from whence the diſorder would ſoon be communicated to the whole nervous ſyſtem. Perſons of this conſtitution ſhould never take any of the draſtic purges, or ſtrong emetics ; neither ſhould they loſe blood but in caſes of urgent neceſſity. But a principal ſhare of management, in theſe extremely irritable conſtitutions, conſiſts in avoiding all ſudden changes of every ſort, eſpecially thoſe with reſpect to diet and clothing, and in keeping the mind as much as poſſible in a ſtate of tranquillity : hence the great advantages which people of this frame derive from the uſe of medicinal waters drank on the ſpot, on account of that freedom from care and ſerious buſineſs of every kind, which generally obtains in all the places planned for the reception of valetudinarians.

The third-mentioned temperament, where there is an exceſs of ſtrength and but little ſenſibility, does not ſeem remarkably prone to any diſtreſſing or dangerous ſpecies of diſeaſe ; and therefore it can hardly be ſuppoſed that perſons ſo circumſtanced will either of themſelves think of any particular ſcheme of management, or have recourſe to the faculty for their inſtructions : ſuch conſtitutions, however, we may obſerve, bear all kinds of evacuations well, and ſometimes require them to prevent an over-fulneſs, which might end in an oppreſſion of the brain or ſome other organ of importance.

But the fourth temperament, where we have weakneſs joined to want of ſenſibility, is exceedingly apt to fall into tedious and dangerous diſeaſes, ariſing from a defect of abſorbent power in the proper ſets of veſſels, and from languor of the circulation in general : whence corpulency, dropſy, jaundice, and different degrees of ſcorbutic affection. In order to prevent theſe, or any other ſpecies of accumulation and depravation of the animal fluids, the people of this conſtitution ſhould uſe a generous courſe of diet, with briſk exerciſe, Means of preserving Health.

exercise, and be careful that none of the secretions be interrupted, nor any of the natural discharges suppressed. These constitutions bear purging well, and often require it; as also the use of emetics, which are frequently found necessary to supply the place of exercise, by agitating the abdominal viscera, and are of service to prevent the stagnation of bile, or the accumulation of mucous humours, which hinder digestion, and clog the first passages. The free use of mustard, horse-radish, and the like sort of stimulating dietetics, is serviceable in these torpid habits.

When the general mass of fluids is increased beyond what is conducive to the perfection of health, there arises what the writers term a *plethora*, which may prove the source of different diseases; and therefore, when this overfulness begins to produce languor and oppression, care should be taken in time to reduce the body to a proper standard, by abridging the food and increasing the natural discharges, using more exercise, and indulging less in sleep.

But in opposite circumstances, where the fluids have been exhausted, we are to attempt the prevention of further waste by the use of strengthening stomachics, nourishing diet, and indulgence from fatigue of body or mind.

Vitiated fluids are to be considered as tainted either with the different kinds of general acrimony, or as betraying signs of some of the species of morbific matter which give rise to particular diseases, such as calculus, scurvy, &c.

During the state of infancy, we may sometimes observe a remarkable acidity, which not only shows itself in the first passages, but also seems to contaminate the general mass of fluids. As it takes its rise, however, from weak bowels, our views, when we mean to prevent the ill consequences, must be chiefly directed to strengthen the digestive organs, as on their soundness the preparation of good chyle depends; and hence small doses of rhubarb and chalybeates (either the natural chalybeate waters mixed with milk, or the *murias ammoniæ et ferri* in doses of a few grains, according to the age of the child), are to be administered; and the diet is to be so regulated as not to add to this acid tendency: brisk exercise is likewise to be enjoined, with frictions on the stomach, belly, and lower extremities.

Where the fluids tend to the putrescent state, which shows itself by fetid breath, sponginess and bleeding of the gums, a bloated look and livid cast, the diet then should be chiefly of fresh vegetables and ripe fruits, with wine in moderation, due exercise, and strengthening bitters.

Where acrimony shows itself by itching eruptions, uncommon thirst, and flushing heats, nothing will answer better than such sulphureous waters as the Harrowgate and Moffat, at the same time using a course of diet that shall be neither acrid nor heating.

So far with respect to those kinds of morbific matter which do not invariably produce a particular species of disease: but there are others of a specific nature, some of which are generated in the body spontaneously, and seem to arise from errors in diet, or other circumstances of ill management with respect to the animal economy; and hence it is sometimes possible, to a certain degree if not altogether, to prevent the ill consequences. Thus, there are instances where returns of the gout have been prevented by adhering strictly to a milk diet.

Means of preserving Health.

The rheumatism has also been sometimes warded off by wearing a flannel shirt, or by using the cold bath without interruption.

Calculus may be retarded in its progress, and prevented from creating much distress, by the internal use of soap and lime-water, by soap-lees taken in milk or in veal-broth, or by the use of aërated alkaline water, which may perhaps be considered as being both more safe and more efficacious, and at the same time more pleasant, than any of the other practices.

The scurvy may be prevented by warm clothing and perseverance in brisk exercise, by drinking wine or cyder, and eating freely of such vegetable substances as can be had in those situations where this disease is most apt to show itself.

In constitutions where there is an hereditary disposition to the scrophula, if early precautions be taken to strengthen the solids by cold bathing, a nourishing course of diet, and moderate use of wine, the constitution which gives rise to the disease will probably be prevented from producing any very bad effects.

The other kinds of morbific matter, which are of the specific nature, are received into the body by infection or contagion.

The infection of a putrid fever or dysentery is best prevented by immediately taking an emetic on the first attack of the sickness or shivering; and if that do not completely answer, let a large blister be applied between the shoulders: by this method the nurses and other attendants on the sick in the naval hospitals have often been preserved. As to other infectious morbific matter, we must refer to what has already been said when treating of hydrophobia, poisons, gonorrhœa, &c.

The ill effects which may arise from the different species of saburra, are to be obviated, in general, by the prudent administration of emetics, and carefully abstaining from such kinds of food as are known to cause the accumulation of noxious matters in the first passages.

Crude vegetables, milk, butter, and other oily substances, are to be avoided by persons troubled with a sourness in the stomach; brisk exercise, especially riding, is to be used, and they are to refrain from fermented liquors: the common drink should be pure water; or water with a very little of some ardent spirit, such as rum or brandy. Seltzer and Pyrmont waters are to be drunk medicinally; and aromatic bitters, infusions, or tinctures, acidulated with sulphuric acid, will be found serviceable, in order to strengthen the fibres of the stomach, and promote the expulsion of its contents, thereby preventing the too hasty fermentation of the alimentary mixture. In order to procure immediate relief, magnesia alba, or *creta præparata*, will seldom fail; the magnesia, as well as the chalk, may be made into lozenges, with a little sugar and mucilage; and in that form may be carried about and taken occasionally by people afflicted with the acid saburra.

In constitutions where there is an exuberance or stagnation of bile, and a troublesome bitterness in the mouth, it is necessary to keep the bowels always free, by taking occasionally small doses of pure aloes, *oleum ricini*, Means of preserving Health.

ricini, ſupertartrite of potaſs, ſome of the common purging ſalts, or the natural purging waters.

When there is a tendency to the empyreumatic and rancid ſaburra, people ſhould carefully avoid all the various kinds of thoſe oily and high-ſeaſoned articles of diet generally termed *made-diſhes*, and eat ſparingly of plain meat, without rich ſauches or much gravy; and in theſe caſes the moſt proper drink is pure water.

414 II. RULES *for thoſe who enjoy perfect* HEALTH.

THERE can be no doubt, that, in general, temperance is the true foundation of health; and yet the ancient phyſicians, as we may ſee in the rules laid down by Celſus, did not ſcruple to recommend indulgence now and then, and allowed people to exceed both in eating and drinking; but it is ſafer to proceed to exceſs in drink than in meat; and if the debauch ſhould create any extraordinary or diſtreſſing degree of pain or ſickneſs, and a temporary fever ſhould enſue, there are two ways of ſhaking it off, either to lie in bed and encourage perſpiration, or to get on horſeback, and by briſk exerciſe reſtore the body to its natural ſtate. The choice of theſe two methods muſt always be determined by the peculiar circumſtances of the parties concerned, and from the experience which they may before have had which agrees beſt with them.

If a perſon ſhould commit exceſs in eating, eſpecially of high-ſeaſoned things, with rich ſauces, a draught of cold water, acidulated with ſulphuric acid, will take off the ſenſe of weight at the ſtomach, and aſſiſt digeſtion by moderating and keeping within bounds the alimentary fermentation, and thus preventing the generation of too much flatus. The luxury of ices may be here of real ſervice at the tables of the great, as producing ſimilar effects with the cold water acidulated. Perſons in theſe circumſtances ought not to lay themſelves down to ſleep, but ſhould keep up and uſe gentle exerciſe until they are ſenſible that the ſtomach is unloaded, and that they no longer feel any oppreſſive weight about the præcordia.

If a man be obliged to faſt, he ought, if poſſible, during that time, to avoid laborious work: after ſuffering ſevere hunger, people ought not at once to gorge and fill themſelves; nor is it proper, after being overfilled, to enjoin an abſolute faſt: neither is it ſafe to indulge in a ſtate of total reſt immediately after exceſſive labour, nor ſuddenly fall hard to work after having been long without motion: in a word, all changes ſhould be made by gentle degrees; for though the conſtitution of the human body be ſuch that it can bear many alterations and irregularities without much danger, yet, when the tranſitions are extremely ſudden, there is a great riſk of producing ſome degree of diſorder.

It is alſo the advice of Celſus to vary the ſcenes of life, and not confine ourſelves to any ſettled rules: but as inaction renders the body weak and liſtleſs, and exerciſe gives vigour and ſtrength, people ſhould never long omit riding, walking, or going abroad in a carriage. Fencing, playing at tennis, dancing, or other ſimilar engagements, which afford both exerciſe and amuſement, as each ſhall be found moſt agreeable or convenient, are to be uſed in turn, according to the circumſtances and tendency to any particular ſpecies of diſeaſe. But when the weakneſs of old age ſhall have rendered the body incapable of all theſe, then dry frictions with the fleſh-bruſh will be very requiſite to preſerve health, by accelerating the flow of humours through the ſmalleſt orders of veſſels, and preventing the fluids from ſtagnating too long in the cellular interſtices of the fleſhy parts.

Sleep is the great reſtorer of ſtrength; for, during this time, the nutritious particles appear to be chiefly applied to repair the waſte, and replace thoſe that have been abraded and waſhed off by the labour and exerciſe of the day; but too much indulgence in ſleep has many inconveniencies, both with reſpect to body and mind, as it blunts the ſenſes, and encourages the fluids to ſtagnate in the cellular membrane; whence corpulency, and its neceſſary conſequences languor and weakneſs.

The proper time for ſleep is the night, when darkneſs and ſilence naturally bring it on: ſleep in the daytime, from noiſe and other circumſtances, is in general not ſo ſound or refreſhing; and to ſome people is really diſtreſſful, as creating an unuſual giddineſs and languor, eſpecially in perſons addicted to literary purſuits. Cuſtom, however, frequently renders ſleep in the day neceſſary; and in thoſe conſtitutions where it is found to give real refreſhment, the propenſity to it ought to be indulged, particularly in very advanced age.

With regard to the general regimen of diet, it has always been held as a rule, that the ſofter and milder kinds of aliment are moſt proper for children and younger ſubjects: that grown perſons ſhould eat what is more ſubſtantial; and old people leſſen their quantity of ſolid food, and increaſe that of their drink both of the diluent and cordial kind.

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Spina

Medicis.

MEDICIS, Cosmo de, was born in the year 1389, and was in the prime of life, at the death of his father Giovanni. His conduct was distinguished for urbanity and kindness to the superior ranks of his fellow-citizens, and by a constant attention to the wants of the lower class, whom his munificence abundantly relieved. His prudence and moderation, however, could not repress the ambitious designs of the rival families, the Florentines and Medici; for in 1433, Rinaldo de Albizi, at the head of a formidable party, carried the appointment of the magistracy. On returning from his country seat he was seized upon by his adversaries, and committed to prison. The conspirators not agreeing as to the proper method of dispatching their prisoner, one Peruzzi recommended poison, which was heard by Cosmo, who refused to take any other sustenance than a small portion of bread. In this dismal situation he remained four days, shut up from all his kindred and friends, where he soon expected to be numbered with the dead. But the man employed to take him off, unexpectedly proved his friend. Malavolta, the keeper of the prison, relented, and declared that he had no just reason to be alarmed, as he hesitated not to eat of every thing that was brought him.

His brother Lorenzo, and his cousin Averardo, raised a considerable body of men in Romagna and other districts; and being joined by the commander of the republican forces, they marched to Florence to relieve him. A decree was obtained from the magistracy, by which he was banished to Padua for ten years, his brother to Venice for five, and several of their relations shared a similar fate. Padua was in the dominions of Venice, and he received a deputation from the senate before he reached it, promising him their protection and assistance in whatever he should desire. He rather experienced the treatment of a prince than of an exile, as they entertained the highest expectations from his great commercial knowledge. From this period his life may be considered as one continued scene of uninterrupted prosperity, and his family received education equal to that of the greatest potentates. In his public and private charities he was almost unbounded, and perhaps possessed more wealth than any single individual in Europe at that period. In his promotion of science and encouragement of learned men he was truly exemplary, and from this source he acquired the greatest honour and esteem.

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His fostering hand protected the arts as well as the sciences; and architecture, sculpture, and painting, all flourished under his powerful protection. The countenance he showed to these arts was not such as their professors generally receive from the great; for the sums of money which he expended on pictures, statues, and public buildings, appear almost incredible. When he approached the period of his mortal existence, his faculties were still unimpaired; and 20 days before he died, he requested Ficino to translate from the Greek the treatise of Xenocrates on death. He died on the 1st of August 1464, at the age of 75, and gave strict injunctions, that his funeral should be conducted with as much privacy as possible. By public decree he was honoured with the title of *Pater Patriæ*, an appellation which was inscribed on his tomb, and was declared by competent judges, to be founded in real merit.

Medici, *Lorenzo de*, stiled, with great propriety, the Magnificent, was the grandson of Cosmo, and about 16 years of age at his decease. In 1469 his father died, and he succeeded to his authority as if it had constituted a part of his fortune. In the year 1474, Lorenzo incurred the displeasure of the pope for the opposition he

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he made to some of his encroachments on the petty princes of Italy, and for this reason he deprived him of the office of treasurer of the Roman see, which he conferred on one Pazzi, connected with a Florentine family, the interest of which he thus secured, and intended to sacrifice Lorenzo and Juliano to his private revenge. Their assassination was fixed for Sunday, April 26. 1478, and the cathedral was the place in which a monster of an archbishop had resolved to murder them by the instigation of the pope. When the people saw one of their favourites (Juliano) expiring, and the other (Lorenzo) covered with blood, their rage was not to be expressed in language. The interference of the magistrates was finally victorious, who had the courage and virtue to hang the archbishop from one of the windows, arrayed in his pontifical robes, which made Florence resound with the acclamation—Medici, Medici! down with their enemies!

Lorenzo was delivered from that part of the cathedral to which he had fled for refuge, and was triumphantly carried home, where his wounds were attended to by men of ability. His friends in the mean time pursued the conspirators, and spared none who happened to fall in their way. In a word, the generality of them were either hanged or decapitated, and very few had the good fortune to escape their uncommon vigilance. Much to the honour of Lorenzo, he exerted all his influence to prevent the indiscriminate massacre of his cruel enemies, and restrain the just indignation of the people, begging that they would trust the magistrates with the punishment of the guilty; and the respect in which he was held had the most astonishing effect in restraining the vengeance of popular indignation.

No sooner had hostilities ceased between Pope Sextus and the Florentine republic, than Lorenzo began to develope plans for securing the internal peace and tranquillity of Italy, by which the highest honour has been conferred on his political life. But the life of this great man was again brought into imminent danger by the intrigues of Cardinal Riario, and some Florentine exiles, who determined to assassinate him in the church of the Carmeli, on the festival of the Ascension 1481; but the plot was happily discovered, the conspirators were executed, and after this Lorenzo very seldom went abroad without being surrounded by a number of friends in whom he could securely confide.

When we attentively examine the character of Lorenzo, it will not perhaps appear astonishing, that Italy, Christendom, and even the Mahometans themselves, conferred upon him the most flattering approbation. Even Prince Mirandola chose Florence as the place of his residence entirely upon his account, and there ended his mortal career. To a most engaging person Lorenzo added almost every other accomplishment. He was the favourite of the ladies, the envy of his own sex, and the admiration of all. He was declared to be unrivalled in chivalry, and one of the most eminent orators that the world in any age has produced. According to the opinion of his contemporaries, he was even superior to Julius Cæsar himself, except as a general, yet he would also have proved a most consummate commander had not peace been always the darling of his soul. We recollect a memorable passage in the Rambler, which may here be appositely introduced. A great man condescending to do little things, is like the sun in his western declination; he remits his splendor, but retains his magnitude, and pleases more though he dazzles less. To such little things did Lorenzo frequently submit, often seeking pleasure in his nursery, and spending hours there in all the frivolous pranks of childish diversion. The gravity of his life, if contrasted with its levity, must make him appear as a composition of two different persons, incompatible, and, as it were, impossible to be joined the one with the other.

Such were the love and veneration of the citizens for Lorenzo, that the physician who attended him on his deathbed, terrified to return to Florence, left the house in a state of distraction, and plunged himself into a well. When Ferdinand king of Naples was informed of his death, he cried out, "This man has lived long enough for his own glory, but too short a time for Italy." He died on the 8th of April 1492, amidst a number of his weeping friends, who appeared deeply conscious of such an irreparable loss.

Medicis, *John de*, on account of his bravery and knowledge in military affairs, was surnamed the *Invincible*. He was the son of John, otherwise called *Jourdain*, de Medicis. His only son Cosmo I. styled the *Great*, was chosen duke of Florence after the murder of Alexander de Medicis, A. D. 1537. He first carried arms under Laurence de Medicis against the duke of Urbino, afterwards under Pope Leo X. Upon the death of Leo, he entered into the service of Francis I. which he quitted to follow the fortune of Francis Sforza duke of Milan. When Francis I. formed an alliance with the pope and the Venetians against the emperor, he returned to his service. He was wounded in the knee at Governola, a small town in the Mantuan territory, by a musket ball; and being carried to Mantua, he died the 29th of November 1526, aged 28. Brantome relates, that when his leg was to be cut off, and when he was informed that he needed some person to support him, "Proceed without fear (said he), I need nobody!" and he held the candle himself during the operation. This anecdote is also mentioned by Varchi. John de Medicis was above the middle stature, strong, and nervous. His soldiers, to express their affection for him and their concern for his loss, assumed a mourning dress and standards, which gave the name of *the black band* to the Tuscan troops whom he commanded.

Medicis, *Laurence* or *Laurenein de*, was descended from a brother of Cosmo the Great, and affected the name of *popular*. In 1537, he killed Alexander de Medicis, whom Charles V. had made duke of Florence, and who was believed to be the natural son of Laurence de Medicis duke of Urbino. He was jealous of Alexander's power, and disguised this jealousy under the specious pretext of love to his country. He loved men of learning, and cultivated literature. His works are, 1. *Lamenti*, Modena, 12mo. 2. *Acidosio Commedia*, Florence 1595, 12mo. He died without issue.

Medicis, *Hypolitus de*, natural son of Julian de Medicis and a lady of Urbino, was early remarkable for the brilliancy of his wit and the graces of his person. Pope Clement VII. his cousin, made him cardinal in 1529, and sent him as legate into Germany to the court of Charles V. When that prince went into Italy, Medicis, yielding to his warlike disposition, appeared

appeared in the drefs of an officer, and advanced before the emperor, followed by feveral refpectable gentlemen of the court. Charles, naturally fufpicious, and afraid that the legate intended to do him fome ill offices with the pope, fent after him and caufed him to be apprehended. But when he underftood that it was a mere fally of humour in the young cardinal, he fet him at liberty in a few days. The character which Medicis obtained by the happy fuccefs of this appointment was of effential fervice to him. He was confidered as one of the Supports of the Holy See; and a little before Clement's death, when the corfair Barbaroffa made a defcent into Italy to the great terror of Rome, which was only defended by 200 of the pope's guards, Medicis was defpatched to protect the coafts from the fury of the barbarians. On his arrival at the place of deftination, he was fortunate enough to find that Barbaroffa had withdrawn himfelf at that critical moment; which allowed him to claim the honour of the retreat without expofing his perfon or his army. When he returned to Rome, he was of great fervice in the election of Paul III. who neverthelefs refufed to make him legate to Ancona, though that office had been promifed to him in the conclave. Enraged alfo that the pope had beftowed the principality of Florence on Alexander de Medicis, fuppofed to be the natural fon of Laurence duke of Urbino, he was prompted by his ambition to believe that he might fucceed to that dignity by the deftruction of Alexander. He entered into a confpiracy againft him, and determined to carry him off by a mine; but the plot was difcovered before he had accomplifhed his purpofe. Octavian Zanga, one of his guards, was arrefted as his chief accomplice. Hypolitus de Medicis, apprehenfive for his own fafety, retired to a caftle near Tivoli. On his road to Naples, he fell fick at Itri in the territory of Fondi, and died Auguft 13. 1535, in his 24th year, not without fufpicion of being poifoned. His houfe was an afylum for the unfortunate, and frequently for thofe who were guilty of the blackeft crimes. It was open to men of all nations; and he was frequently addreffed in twenty different languages. He had a natural fon named *Afdrubal de Medicis*, who was a knight of Malta. This anecdote proves that his manners were more military than ecclefiaftic. He wore a fword, and never put on the habit of cardinal except on occafions of public ceremony. He was wholly devoted to the theatre, hunting, and poetry.

Medicis, *Alexander de*, firft duke of Florence in 1530, was natural fon of Laurence de Medicis, furnamed the *Younger*, and nephew of Pope Clement VII. He owed his elevation to the intrigues of his uncle and to the arms of Charles V. This prince having made himfelf mafter of Florence after an obftinate fiege, conferred the fovereignty of this city on Alexander, and afterwards gave him in marriage Margaret of Auftria his natural daughter. According to the terms of capitulation granted to the Florentines, the new duke was to be only hereditary doge, and his authority was tempered by councils; which left them at leaft a fhadow of their ancient liberty. But Alexander, who felt himfelf fupported by the emperor and the pope, was no fooner in poffeffion of his new dignity, than he began to govern like a tyrant; being guided by no law but his own caprice, indulging the moft brutal paffions, and making light of difhonouring families, and of violating even the afylum of the cloifters to gratify his luft. Among the confidants of his debauchery was a relation of his own, Laurence de Medicis. This young man, who was only 22 years of age, at the inftigation of Philip Strozzi, a zealous republican, conceived the defign of affaffinating Alexander, and thereby of delivering his country from oppreffion. From the moment when he firft became attached to him, he tried to gain his confidence, for no other reafon but that he might the better have it in his power to take away his life. A confiderable time elapfed before he found fuch an opportunity as he defired. At length, under pretence of procuring the duke a *tête à tête* with a lady of whom he was deeply enamoured, he brought him alone and unattended into his chamber, and put him under his bed. He went out, under pretence of introducing the object of his paffion; and returned along with an affaffin by profeffion, to whom alone he had entrufted his defign, only to ftab him. This cruel fcene happened on the night betwixt the 5th and 6th of January 1537. Alexander was only 26 years of age. The Florentines derived no advantage from this crime of Laurence, for they failed in their attempt to recover their liberty. The party of the Medicis prevailed, and Alexander was fucceeded by Cofmo: whofe government, it muft be confeffed, was as juft and moderate, as that of his predeceffor had been violent and tyrannical. Laurence de Medicis fled to Venice, to fome of the leaders of the malecontents at Florence, who had taken refuge there; but not thinking himfelf in fufficient fecurity, he went to Conftantinople, whence he returned fome time after to Venice. He was there affaffinated in 1547, ten years after the duke's murder, by two foldiers, one of whom had formerly been in Alexander's guards: And thefe foldiers were generous enough to refufe a confiderable fum of money, which was the price put upon his head.

Medicis, *Cofmo de*, grand duke of Tufcany, joined Charles V. againft the French, after trying in vain to continue neutral. As a reward for his fervices, the emperor added to the duchy of Tufcany Piombino, the ifle of Elba, and other ftates. Cofmo foon after received from Pope Pius IV. the title of *grand duke;* and had it not been oppofed by all the princes of Italy, this pontiff, who was entirely devoted to Cofmo, becaufe he had thought proper to acknowledge him to be of his houfe, would have conferred on him the title of *king*. There never was a more zealous patron of learning. Ambitious of imitating the fecond Cæfar, he like him, was fond of learned men, kept them near his perfon, and founded for them the univerfity of Pifa. He died in 1574, at the age of 55, after governing with equal wifdom and glory. In 1562 he inftituted the military order of St Stephen. His fon, Francis Mary who died in 1587, was the father of Mary of Medicis, the wife of Henry the Great and of Ferdinand I. who died in 1608.

MEDIETAS linguæ, in *Law*, fignifies a jury, or inqueft impanelled, of which the one half are natives of this land and the other foreigners. This jury is never ufed except where one of the parties in a plea is a ftranger and the other a denizen. In petit treafon, murder,

murder, and felony, foreigners are allowed this privilege; but not in high treafon, becaufe an alien in that cafe fhall be tried according to the rules of the common law, and not by a *medietas linguæ*. A grand jury ought not in any cafe to be of a *medietas linguæ*; and the perfon that would have the advantage of a trial in this way, is to pray the fame, otherwife it will not be permitted on a challenge of the jurors.

MEDIMNUS, in Grecian antiquity, a meafure of capacity. See MEASURE.

MEDINA TALNARI, a famous town of Arabia Petræa, between Arabia Deferta and Arabia the Happy; celebrated for being the burial-place of Mahomet. It ftands at a day's journey from the port of Iambo. It is of moderate fize, furrounded by wretched walls, and fituated in the midft of a fandy plain. It belongs to the fcherif of Mecca, although it had of late times a particular fovereign of the family of Dacii Barkad. At prefent the government is confided by the fcherif to a vizir, who muft be taken from the family of the fovereign. Before Mahomet, this city was called *Iathreb*; but it got the name of *Medinet en Nebbi*, "the City of the Prophet," after Mahomet, being driven from Mecca by the Koreifchites, had taken refuge there, and paffed in it the reft of his days. The tomb of Mahomet at Medina is refpected by Muffulmans, but they are under no obligation to vifit it for the purpofes of devotion. The caravans of Syria and Egypt alone, which on their return from Mecca pafs near Medina, go a little out of their way to fee the tomb. It ftands in a corner of the great fquare, whereas the Kaba is fituated in the middle of that at Mecca. That the people may not perform fome fuperftitious worfhip to the relics of the prophet, they are prevented from approaching the tomb by grates, through which they may look at it. It confifts of a piece of plain mafon work in the form of a cheft, without any other monument. The tomb is placed between two others, where the afhes of the two firft caliphs repofe. Although it is not more magnificent than the tombs of the greater part of the founders of mofques, the building that covers it is decorated with a piece of green filk ftuff embroidered with gold, which the pacha of Damafcus renews every feven years. It is guarded by 40 eunuchs, who watch the treafure faid to be depofited there. It is feated in a plain abounding with palm trees, in E. Long. 57. 10. N. Lat. 25. See (*Hiftory of*) ARABIA.

MEDINA Celi, an ancient town of Spain, in Old Caftile, and capital of a confiderable duchy of the fame name; feated near the river Xalon, in W. Long. 2. 9. N. Lat. 41. 15.

MEDINA de-las-Torres, a very ancient town of Spain, in Eftremadura, with an old caftle, and the title of a duchy. It is feated on the confines of Andalufia, at the foot of a mountain near Bajadoz.

MEDINA-del-Campo, a large, rich, and ancient town of Spain, in the kingdom of Leon. The great fquare is very fine, and adorned with a fuperb fountain. It is a trading place, enjoys great privileges, and is feated in a country abounding with corn and wine. W. Long. 4. 20. N. Lat. 41. 22.

MEDINA-del-rio-Secco, an ancient and rich town of Spain, in the kingdom of Leon, with the title of a duchy: feated on a plain, remarkable for its fine paftures. E. Long. 4. 33. N. Lat. 42. 8.

MEDINA, SIR JOHN, an eminent painter, was fon of Medina de l'Afturias, a Spanifh captain who fettled at Bruffels, where the fon was born in 1660. He was inftructed in painting by Du Chatel; under whofe direction he made great progrefs; and applying himfelf to the ftudy of Rubens, made that eminent mafter his principal model. He painted both hiftory and portrait; and was held in extraordinary efteem by moft of the princes of Germany, who diftinguifhed his merit by feveral marks of honour. He married young, and came into England in 1686, where he drew portraits for feveral years with great reputation; as he painted thofe fubjects with remarkable freedom of touch, a delicate management of tints, and ftrong refemblance of the perfons. The earl of Leven encouraged him to go to Scotland, and procured him a fubfcription of 500l. worth of bufinefs. He went, carrying a large number of bodies and poftures, to which he painted heads. He returned to England for a fhort time; but went back to Scotland, where he died, and was buried in the churchyard of the Grayfriars at Edinburgh in 1711, aged 52. He painted moft of the Scotch nobility. Two fmall hiftory pieces, and the portraits of the profeffors, in the Surgeons Hall at Edinburgh, were alfo painted by him. At Wentworth caftle is a large piece containing the firft duke of Argyll and his fons, the two late dukes John and Archibald, in Roman habits; the ftyle Italian, and fuperior to moft modern performers. The duke of Gordon prefented Sir John Medina's head to the great duke of Tufcany for his collection of portraits done by the painters themfelves; the duke of Gordon too was drawn by him, with his fon the marquis of Huntley and his daughter Lady Jane, in one piece. Medina was knighted by the duke of Queenfberry, lord high commiffioner; and was the laft knight made in Scotland before the union. The prints in the octavo edition of Milton were defigned by him; and he compofed another fet for Ovid's Metamorphofes, but they were never engraved.

MEDINE, an Egyptian piece of money of iron filvered over, and about the fize of a filver threepence.

MEDIOLANUM, an ancient city, the capital of the Infubres, built by the Gauls on their fettlement in that part of Italy; a *municipium*, and a place of great ftrength; and a feat of the liberal arts; whence it had the name of *Novæ Athenæ*. Now *Milan*, capital of the Milanefe, fituated on the rivers Olana and Lombro. E. Long. 9. 30. N. Lat. 45. 25.

MEDIOLANUM Aulercorum, in *Ancient Geography*, a town of Gallia Celtica, which afterwards took the name of the *Eburovicum Civitas* (Antonine); corrupted to *Civitas Ebroicorum*, and this laft to *Ebroica*; whence the modern appellation *Evreux*, a city of Normandy. E. Long. 1. 12. N. Lat. 49. 21.

MEDIOLANUM Gugernorum, in *Ancient Geography*, a town of Gallia Belgica; now the village *Moyland*, not far from Cologne.

MEDIOLANUM Ordovicum, in *Ancient Geography*, a town of Britain, now *Llan Vethlin*, a market town of Montgomeryfhire in Wales.

MEDIOLANUM Santonum, in *Ancient Geography*, which afterwards taking the name of the people, was called

Mediolanum || Medium.

called *Santonica Urbs;* alſo *Santones* and *Santoni:* A town of Aquitaine. Now *Saintes*, capital of Saintonge in Guienne, on the river Charente.

MEDIOMATRICI, anciently a territory of Belgica. Now the dioceſe of Metz.

MEDITATION, an act by which we conſider any thing cloſely, or wherein the ſoul is employed in the ſearch or conſideration of any truth. In our religion, it is uſed to ſignify a conſideration of the objects and grand truths of the Chriſtian faith.

Myſtic divines make a great difference between *meditation* and *contemplation:* the former conſiſts in diſcurſive acts of the ſoul, conſidering methodically and with attention the myſteries of faith and the precepts of morality; and is performed by reflections and reaſonings, which leave behind them manifeſt impreſſions on the brain. The pure contemplative have no need of meditation, as ſeeing all things in God at a glance, and without any reflection. When a man, therefore, has once quitted meditation, and is arrived at contemplation, he returns no more; and, according to Alvarez, never reſumes the oar of meditation, except when the wind of contemplation is too weak to fill his ſails.

MEDITERRANEAN, ſomething encloſed within land; or that is remote from the ocean.

MEDITERRANEAN is more particularly uſed to ſignify that large ſea which flows between the continents of Europe and Africa, entering by the ſtraits of Gibraltar, and reaching into Aſia, as far as the Euxine ſea and the Palus Mæotis.

The Mediterranean was anciently called the *Grecian ſea* and the *Great ſea.* It is now cantoned out into ſeveral diviſions, which bear ſeveral names. To the weſt of Italy it is called the *Liguſtic* or *Tuſcan ſea;* near Venice, the *Adriatic;* towards Greece, the *Ionic* and *Ægean;* between the Helleſpont and the Boſphorus, the *White ſea*, as being very ſafe; and beyond, the *Black ſea*, its navigation being dangerous.

The Britiſh trade carried on by means of the Mediterranean ſea is of the laſt conſequence to Great Britain; and the permanent preſervation thereof depends on the poſſeſſion of the town and fortification of Gibraltar.

The counterfeiting of Mediterranean paſſes for ſhips to the coaſt of Barbary, &c. or the ſeal of the admiralty office to ſuch paſſes, is felony without benefit of clergy. Stat. 4. Geo. II. c. 18.

MEDITRINALIA, a Roman feſtival in honour of the goddeſs Meditrina, kept on the 30th of September. Both the deity and the feſtival were ſo called *à medendo*, becauſe on this day they began to drink new wine mixed with old by way of medicine. The mixture of wines, on this feſtival, was drank with much form and ſolemn ceremony.

MEDITULLIUM, is uſed by anatomiſts for that ſpongy ſubſtance between the two plates of the *cranium*, and in the interſtices of all laminated bones. See ANATOMY, N° I. II.

MEDIUM, in *Logic*, the mean or middle term of a ſyllogiſm, being an argument, reaſon, or conſideration, for which we affirm or deny any thing; or, it is the cauſe why the greater extreme is affirmed or denied of the leſs in the concluſion.

MEDIUM, in *Arithmetic*, or *arithmetical medium* or *mean*, called in the ſchools *medium rei;* that which is equally diſtant from each extreme, or which exceeds the leſſer extreme as much as it is exceeded by the greater, in reſpect of quantity, not of proportion; thus 9 is a medium betwixt 6 and 12.

Medium || Meduſa.

Geometrical MEDIUM, called in the ſchools *medium perſonæ*, is that where the ſame ratio is preſerved between the firſt and ſecond as between the ſecond and third terms, or that which exceeds in the ſame ratio or quota of itſelf, as it is exceeded: thus 6 is a geometrical medium between 4 and 9.

MEDIUM, in *Philoſophy*, that ſpace or region through which a body in motion paſſes to any point: thus æther is ſuppoſed to be the medium through which the heavenly bodies move; air, the medium wherein bodies move near our earth; water, the medium wherein fiſhes live and move; and glaſs is alſo a medium of light, as it affords it a free paſſage. That denſity or conſiſtency in the parts of the medium, whereby the motion of bodies in it is retarded, is called the *reſiſtance of the medium;* which, together with the force of gravity, is the cauſe of the ceſſation of the motion of projectiles.

Subtle or *Æthereal MEDIUM.* Sir Iſaac Newton conſiders it probable, that, beſide the particular aërial medium, wherein we live and breathe, there is another more univerſal one, which he calls an *æthereal medium;* vaſtly more rare, ſubtle, elaſtic, and active, than air, and by that means freely permeating the pores and interſtices of all other mediums, and diffuſing itſelf through the whole creation; and by the intervention hereof he thinks it is that moſt of the great phenomena of nature are effected. See ÆTHER, ELECTRICITY, FIRE, &c.

MEDIUM, in optics, any ſubſtance through which light is tranſmitted.

MEDLAR, ſee MESPILUS, BOTANY *Index.*

MEDULLA OSSIUM, or *MARROW of the bones.* See ANATOMY, N° 5.

MEDULLA cerebri and *cerebelli*, denotes the white ſoft part of the brain and cerebellum, covered on the outſide with the cortical ſubſtance, which is of a more dark or aſhy colour. See ANATOMY, N° 131—133.

MEDULLA oblongata, is the medullary part of the brain and cerebellum, joined in one; the fore part of it coming from the brain, and the hind part from the cerebellum. See ANATOMY, N° 134.

It lies on the baſis of the ſkull, and is continued through the great perforation thereof into the hollow of the vertebræ of the neck, back, and loins; though only ſo much of it retains the name *oblongata* as is included within the ſkull. After its exit thence it is diſtinguiſhed by the name of *medulla ſpinalis. Ibid.* N° 135.

MEDUSA, in fabulous hiſtory, one of the three Gorgons, daughter of Phorcys and Ceto. She was the only one of the Gorgons who was ſubject to mortality. She is celebrated for her perſonal charms and the beauty of her locks. Neptune became enamoured of her, and obtained her favours in the temple of Minerva. This violation of the ſanctity of the temple provoked Minerva; and ſhe changed the beautiful locks of Meduſa, which had inſpired Neptune's love, into ſerpents, the ſight of which turned the beholders into ſtones: but Perſeus, armed with Mercury's axe, with which he killed Argus, cut off Meduſa's head, from whoſe blood ſprang Pegaſus and Chryſaor, together with the innumerable

ſerpents

serpents that infest Africa. The conqueror placed Medusa's head on the ægis of Minerva, which he had used in his expedition; and the head still retained the same petrifying powers as before.

MEDUSA, a genus of vermes, belonging to the order of mollusca. See HELMINTHOLOGY *Index*.

MEDWAY, a river of England, rises in the Weald of Sussex, and entering Kent near Ashurst, runs by Tunbridge, and thence continues its course towards Maidstone. It is navigable for large ships to Rochester bridge, and thence for vessels and barges to Maidstone, the tide flowing up to that town. The distance between the mouth of this river, where the fort at Sheerness is erected, and Rochester bridge, is between 16 and 18 miles. In this part of the river, the channel is so deep, the banks so soft, and the reaches so short, that it is one of the best and safest harbours in the world; and ships of 80 guns ride afloat at low water, within musket shot of Rochester bridge. Nor is there a single instance upon record, that any of the royal navy ever suffered here by storms, except in the dreadful tempest which happened in November 1703, when the Royal Catherine was sunk and lost. On the shore of this river are two castles, one at Upnor, which guards two reaches of the river, and is supposed to defend all the ships which ride above, between that and the bridge; on the other side of the river is Gillingham castle, built for the same purpose, and well furnished with cannon, which commands the river. Besides these, there is a platform of guns at a place called the Swam, and another at Cockhamwood. But the principal fortification on this river is the castle at Sheerness.

MEEREN, or MEER, JOHN VANDER, called the *Old*, an esteemed painter, was born in 1627. He chose for his subjects sea-pieces, landscapes, and views of the sea and its shores; which he painted with great truth, as he had accustomed himself to sketch every scene after nature. The situations of his landscapes are agreeably chosen, frequently they are solemn, and generally pleasing. The forms of his trees are easy and natural, his distances well observed, and the whole scenery has a striking effect, by a happy opposition of his lights and shadows. He also painted battles in an agreeable style, as they showed good composition, were touched with spirit, and had a great deal of transparence in the colouring. He died in 1690.

MEEREN, or MEER, *John Vander*, called *De Jonghe*, an eminent landscape painter, is supposed to have been the son of the old John Vander Meer, and of whom he learned the first rudiments of the art; but being in his youth deprived of his instructor before he had made any great progress, he became a disciple of Nicholas Berghem, and was accounted the best of those who were educated in the school of that admired master. In the manner of his master, he painted landscapes and cattle; and his usual subjects are cottages, with peasants at their rural occupations and diversions. It is observed of him, that he very rarely introduced cows, horses, or any other species of animals, except goats and sheep; the latter of which are so highly finished, that one would imagine the wool might be felt by the softness of its appearance. His touch is scarce perceptible, and yet the colours are admirably united. He died in 1688. The genuine works of this Vander Meer bear a very high price, and are esteemed even in Italy, where they are admitted into the best collections; but the scarcity of them has occasioned many moderate copies after his works to be passed on the undiscerning for real originals.

MEGALE POLIS, in *Ancient Geography*, dividedly (Ptolemy, Pausanias), or conjunctly *Megalopolis*, (Strabo): A town of Arcadia, built under the auspices of Epaminondas, after the battle of Leuctra; many inconsiderable towns being joined together in one great city, the better to withstand the Spartans. It was the greatest city of Arcadia, according to Strabo.

MEGALESIA, and MEGALENSES LUDI, feasts and games in honour of Cybele or Rhea the mother of the gods, kept on the 12th of April by the Romans, and famous for great rejoicings and diversions of various sorts. The Galli carried the image of the goddess along the city, with sound of drums and other music, in imitation of the noise they made to prevent Saturn from hearing the cries of his infant son Jupiter, when he was disposed to devour him.

MEGARA, in *Ancient Geography*, a noble city, and the capital of the territory of Megaris, which for many years carried on war with the Corinthians and Athenians. It had for some time a school of philosophers, called the *Megarici*, successors of Euclid the Socratic, a native of Megara. Their dialect was the Doric; changed from the Attic, which it formerly had been, because of Peloponnesian colonists who settled there.

Megara was situated at a distance from the sea. Its port was called *Nisæa*, from Nisus son of Pandion the second, who obtained Megaris for his portion, when the kingdom of Athens was divided into four lots by his father. He founded the town, which was eighteen stadia or two miles and a quarter from the city, but united with it, as the Piræus with Athens, by long walls. It had a temple of Ceres. "The roof (says Pausanias) may be supposed to have fallen through age." The site (as Dr Chandler informs us*) is now covered with rubbish, among which are standing some ruinous churches. The place has been named from them *Dode Ecclesiais*, "The Twelve Churches;" but the number is reduced to seven. The acropolis or citadel, called also *Nisæa*, was on a rock by the sea side. Some pieces of the wall remain, and a modern fortress has been erected on it, and also on a lesser rock near it.

* *Travels in Greece*, p. 192.

The village Megara (continues the doctor) consists of low mean cottages pleasantly situated on the slope of a brow or eminence indented in the middle. On each side of this vale was an acropolis or citadel; one named Caria; the other from Alcathous, the builder of the wall. They related, that he was assisted by Apollo, who laid his harp aside on a stone, which, as Pausanias testifies, if struck with a pebble returned a musical sound. An angle of the wall of one citadel is seen by a windmill. The masonry is of the species called Incertum. In 1676 the city wall was not entirely demolished, but comprehended the two summits, on which are some churches, with a portion of the plain toward the south. The whole site, except the hills, was now green with corn, and marked by many heaps of stones, the collected rubbish of buildings. A few inscriptions are found, with pedestals fixed in the walls and inverted; and also some maimed or mutilated

Megara, Megaris.

mutilated ſtatues. One of the former relates to Atticus Herodes, and is on a pedeſtal which ſupported a ſtatue erected to him when conſul, A. D. 143. by the council and people of Megara, in return for his benefactions and good will toward the city. In the plain behind the ſummits, on one of which was a temple of Minerva, is a large baſin of water, with ſcattered fragments of marble, the remains of a bath or of a fountain, which is recorded as in the city, and remarkable for its ſize and ornaments, and for the number of its columns. The ſpring was named from the local nymphs called Sithnides.

The ſtone of Megara was of a kind not diſcovered any where elſe in Hellas; very white, uncommonly ſoft, and conſiſting entirely of cockle ſhells. This was chiefly uſed; and, not being durable, may be reckoned among the cauſes of the deſolation at Megara, which is ſo complete, that one ſearches in vain for veſtiges of the many public edifices, temples, and ſepulchres, which once adorned the city.

Megara was engaged in various wars with Athens and Corinth, and experienced many viciſſitudes of fortune. It was the only one of the Greek cities which did not reſlouriſh under their common benefactor Hadrian; and the reaſon aſſigned is, that the avenging anger of the gods purſued the people for their impiety in killing Anthemocritus, a herald, who had been ſent to them in the time of Pericles. The Athenian generals were ſworn on his account to invade them twice a-year. Hadrian and Atticus were followed by another friend, whoſe memory is preſerved by an inſcription on a ſtone lying near a church in the village:—“This too is the work of the moſt magnificent count Diogenes ſon of Archelaus, who regarding the Grecian cities as his own family, has beſtowed on that of the Megarenſians one hundred pieces of gold towards the building of their towers, and alſo one hundred and fifty more, with two thouſand two hundred feet of marble toward re-edifying the bath; deeming nothing more honourable than to do good to the Greeks, and to reſtore their cities.” This perſon is not quite unnoticed in hiſtory. He was one of the generals employed by the emperor Anaſtaſius on a rebellion in Iſauria. He ſurpriſed the capital Claudiopolis, and ſuſtained a ſiege with great bravery, A. D. 494.

Megara retains its original name. It has been much infeſted by corſairs; and in 1676 the inhabitants were accuſtomed, on ſeeing a boat approach in the day time or hearing their dogs bark at night, immediately to ſecrete their effects and run away. The vaiwode or Turkiſh governor, who reſided in a forſaken tower above the village, was once carried off. It is no wonder, therefore, that Niſæa has been long abandoned. The place was burned by the Venetians in 1687.

Megara, in *Ancient Geography*, formerly called *Hybla*, a town towards the eaſt coaſt of Sicily; extinct in Strabo's time, though the name Hybla remained on account of the excellence of its honey. It was a colony of Megareans from Greece. *Riſus Megaricus* denotes a horſe laugh.

MEGARIS, in *Ancient Geography*, the country of the Megareans, is deſcribed as a rough region, like Attica; the mountain called *Oneian* or the Aſinine, now *Macriplayi* or “the long Mountain,” extending through it towards Bœotia and Mount Cithæron. It belonged to Ionia or Attica, until it was taken by the Peloponneſians in the reign of Codrus, when a colony of Dorians ſettled in it. This territory had Attica to the eaſt, Bœotia to the north and weſt, and the iſthmus of Corinth to the ſouth.

Megaris || Mela.

Megaris, a ſmall iſland in the Tuſcan ſea, joined to Naples by a bridge, now called *Caſtello dell'Ovo.*

MEGASTHENES, a Greek hiſtorian in the age of Seleucus Nicanor, about 300 years before Chriſt. He wrote about the oriental nations, and particularly the Indians. His hiſtory is often quoted by the ancients. What now paſſes as his compoſition is ſpurious.

MEGIDDO, in *Ancient Geography*, a town of Galilee, recited (Joſhua xvii. 11.) among the cities of Manaſſeh, in the tribe of Iſſachar or Aſſer, on the weſt ſide of Jordan; famous for the defeat of Ahaziah and Joſiah, who periſhed there (2 Kings xxiii. 29.): near it was an open plain, fit for drawing up an army in battle array. It was ſituated to the north, contrary to its poſition in the common maps. The Canaanites, being tributary to the Iſraelites, dwelt in it, Joſhua xvii.—It was rebuilt by Solomon, 1 Kings ix.

MEIBOMIUS, the name of ſeveral learned Germans.—*John Henry Meibomius* was profeſſor of phyſic at Helmſtadt, where he was born, and at Lubec; he wrote the Life of Mæcenas, publiſhed at Leyden in 4to, 1653, with ſeveral other learned works. *Henry*, his ſon, was born at Lubec in 1638; became profeſſor of phyſic at Helmſtadt; and, beſides works in his own profeſſion, publiſhed *Scriptores rerum Germanicarum*, 3 vols folio, 1688; a very uſeful collection, firſt begun by his father.—*Marcus Meibomius*, of the ſame family, publiſhed a collection of ſeven Greek authors who had written upon ancient muſic, with a Latin verſion by himſelf, dedicated to Queen Chriſtina of Sweden, who invited him to her court. But ſhe engaging him one day to ſing an air of ancient muſic, while ſomebody was ordered to dance to it, the immoderate mirth which this occaſioned in the ſpectators ſo diſguſted him, that he immediately left the court of Sweden. His edition of the Greek mythologiſts, and notes upon Diogenes Laërtius in Menage's edition, ſhow him to have been a man of learning; but he ſuffered no little raillery for his attempt to correct the Hebrew text of the Bible, by a kind of metre he fancied he had found out in thoſe ancient writings.

MEISSEN, a conſiderable town of Germany, in the electorate of Saxony, and in the margravate of Miſnia, with a caſtle. It formerly belonged to the biſhop, but is now ſecularized, and the inhabitants are Lutherans. In this place is a famous manufactory of porcelain. E. Long. 13. 27. N. Lat. 51. 19.

MEL, Honey, in the *Materia Medica*. See Honey.

MELA, Pomponius, an ancient Latin writer, was born in the province of Bætica in Spain, and flouriſhed in the reign of the emperor Claudius. His three books of Coſmography, or *De ſitu orbis*, are written in a conciſe, perſpicuous, and elegant manner; and have been thought worthy of the attention and labours of the ableſt critics. Iſaac Voſſius gave an edition of them in 1658, 4to, with very large and copious notes. To this edition is added, *Julii Honorii oratoris excerptum coſmographiæ*, firſt publiſhed from the manuſcript, and

and *Æthici cosmographia*. Gronovius afterwards published another edition with illustrations by medals. In his last edition are added five books, *De Geographia*, written by some later author; by Jornandes, as Fabricius conjectures.

MELÆNE, or BLACK FLUX, in *Medicine*. See MEDICINE, N° 409.

MELALEUCA, a genus of plants belonging to the polydelphia class. See BOTANY *Index*.

MELAMPODIUM, a name given to black hellebore. See HELLEBORUS, BOTANY *Index*.

MELAMPODIUM, a genus of plants belonging to the syngenesia class; and in the natural method ranking under the 49th order, *Compositæ*. See BOTANY *Index*.

MELAMPUS, in fabulous history, a celebrated soothsayer and physician of Argos, son of Amythaon and Idomenea or Dorippe. He lived at Pylos in Peloponnesus. His servants once killed two large serpents who had made their nests at the bottom of a large oak; and Melampus paid so much regard to their remains, that he raised a burning pile and burned them upon it. He also took particular care of their young ones, and fed them with milk. Some time after this, the young serpents crept to Melampus as he slept on the grass near the oak; and, as if sensible of the favours of their benefactor, they wantonly played around him, and softly licked his ears. This awoke Melampus, who was astonished at the sudden change which his senses had undergone. He found himself acquainted with the chirping of the birds, and with all their rude notes, as they flew around him. He took advantage of this supernatural gift, and soon made himself perfect in the knowledge of futurity, and Apollo also instructed him in the art of medicine. He had soon after the happiness of curing the daughters of Prœtus, by giving them hellebore, which from that circumstance has been called *melampodium;* and, as a reward for his trouble, he married the eldest of these princesses. The tyranny of his uncle Neleus, king of Pylos, obliged him to leave his native country; and Prœtus, to show himself more sensible of his services, gave him part of his kingdom. About this time the personal charms of Pero, the daughter of Neleus, had gained many admirers; but the father promised his daughter only to him who brought into his hands the oxen of Iphiclus. This condition displeased many; but Bias, who was also one of her admirers, engaged his brother Melampus to steal the oxen and deliver them to him. Melampus was caught in the attempt, and imprisoned; and nothing but his services as a soothsayer and physician to Iphiclus would have saved him from death. All this pleaded in the favour of Melampus; but when he had taught the childless Iphiclus how to become a father, he not only obtained his liberty, but also the oxen; and with them he compelled Neleus to give Pero in marriage to Bias. A severe distemper, which had rendered the women of Argos insane, was totally removed by Melampus; and Anaxagoras, who then sat on the throne, rewarded his merit by giving him part of his kingdom, where he established himself, and where his posterity reigned during six successive generations. He received divine honours after death, and temples were raised to his memory.

MELAMPYRUM, COW-WHEAT, a genus of plants belonging to the didynamia class; and in the natural method ranking under the 40th order, *Personatæ*. See BOTANY *Index*.

MELANCHOLY, a kind of delirium attended with gloomy thoughts, heaviness, and sorrow. See MEDICINE, N° 327.

MELANCTHON, PHILIP, born at Bretten in the Palatinate in 1495, was one of the wisest and most able men of his age among the reformers, though of a mild temper, and disposed to accommodate rather than to inflame disputes. In his youth he made an admirable progress in learning, and was made Greek professor at Wittenberg in 1509. Here his lectures upon Homer, and the Greek text of St Paul's Epistle to Titus, drew to him a great number of auditors, and entirely effaced the contempt to which his low stature and mean appearance had exposed him. Melancthon reduced the sciences to systems; and acquired such reputation, that he had sometimes 2500 auditors. He soon entered into an intimate friendship with Luther, who taught divinity in the same university; and in 1519 they went together to Leipsic, to dispute with Eccius. The following years he was continually engaged in various employments; he composed several books; he taught divinity; took several journeys, in order to found colleges and visit churches; and in 1530 drew up a confession of faith, which goes by the name of the *Confession of Augsburg*, because it was presented to the emperor at the diet held in that city. All Europe was convinced that he was not, like Luther, backward to accommodate the differences between the various sects of Christians. He hated religious disputes, and was drawn into them only through the necessity of the part he was called to act in the world; and therefore would have sacrificed many things to have produced an union among the Protestants. For this reason, Francis I. the French king, wrote to desire him to come and confer with the doctors of the Sorbonne, in order to agree with them about putting an end to all controversies; but though Luther endeavoured to persuade the elector of Saxony to consent to that journey, and though Melancthon himself desired it, that prince, whether he distrusted Melancthon's moderation, or was afraid of quarrelling with the emperor Charles V. would never grant his permission. The king of England also in vain desired to see him. Melancthon, in 1529, assisted at the conferences of Spires. In 1541, he was at the famous conferences at Ratisbon. In 1543, he went to meet the archbishop of Cologne to assist him in introducing the reformation into his diocese; but that project came to nothing: and in 1548, he assisted at seven conferences on the subject of the interim of Charles V. and wrote a censure on that interim, and all the writings presented at these conferences. He was extremely affected at the dissensions raised by Flaccus Illyricus. His last conference with those of the Roman communion was at Worms, in 1557. He died at Wittenberg in 1560, and was interred near Luther. Some days before he died, he wrote upon a piece of paper the reasons which made him look upon death as a happiness; and the chief of them was, that it "delivered him from theological persecutions." Nature had given Melancthon a peaceable temper, which was but ill suited to the time he was to live in. His moderation served only to be his cross. He was like a lamb in the midst of wolves. Nobody liked his mildness; it looked as if he was lukewarm; and even Luther himſelf was ſometimes angry at it.

Melancthon was a man in whom many good as well as great qualities were wonderfully united. He had great parts, great learning, great ſweetneſs of temper, moderation, contentedneſs, and the like, which would have made him very happy in any other times but thoſe in which he lived. He never affected dignities, or honours, or riches, but was rather negligent of all theſe things; too much ſo in the opinion of ſome, conſidering he had a family; and his ſon-in-law Sabinus, who was of a more ambitious temper, was actually at variance with him upon this very account. Learning was infinitely obliged to him on many accounts; on none more than this, that, as already obſerved, he reduced almoſt all the ſciences which had been taught before in a vague irregular manner into ſyſtems. Conſidering the diſtractions of his life, and the infinity of diſputes and tumults in which he was engaged, it is aſtoniſhing how he could find leiſure to write ſo many books. Their number is prodigious, inſomuch that it was thought neceſſary to publiſh a chronological catalogue of them in the year 1582. His works indeed are not correct, and he himſelf owned it: but as he found them uſeful, he choſe rather to print a great number, than to finiſh only a few: "which however (as Bayle ſays), was poſtponing his own glory to the advantage of others." His conſtitution was very weak, and required great tenderneſs and management; which made Luther, as hot and zealous as he was, blame him for labouring too earneſtly in the vineyard.

MELANIPPIDES, in fabulous hiſtory, a Greek poet about 520 years before Chriſt. His grandſon of the ſame name, flouriſhed about 60 years after at the court of Perdiccas the Second, of Macedonia. Some fragments of their poetry are ſtill extant.

MELANTERIA, an old term in *Natural Hiſtory*, which ſeems to have been applied to copper pyrites.

The Greeks uſed it externally as a gentle eſcharotic and a ſtyptic, as an ingredient in their ointments for old ulcers, and alſo to ſprinkle in the form of powder on freſh wounds, in order to ſtop the hæmorrhage.

MELASSES. See MOLASSES.

MELASTOMA, the AMERICAN GOOSEBERRY-TREE, a genus of plants belonging to the decandria claſs; and in the natural method ranking under the 17th order, *Calycanthemæ*. See BOTANY *Index*.

MELCHA, a ſmall village of Barbary, ſituated abut 10 miles from the city of Tunis, built on the ruins of Carthage, ſome of which are ſtill viſible.

MELCHITES, in church hiſtory, the name given to the Syriac, Egyptian, and other Chriſtians of the Levant. The Melchites, excepting ſome few points of little or no importance, which relate only to ceremonies and eccleſiaſtical diſcipline, are in every reſpect profeſſed Greeks; but they are governed by a particular patriarch, who reſides at Damas, and aſſumes the title of *patriarch of Antioch*. They celebrate maſs in the Arabian language. The religious among the Melchites follow the rule of St Baſil, the common rule of all the Greek monks. They have four fine convents diſtant about a day's journey from Damas, and never go out of the cloiſter.

MELCHISEDEC, or MELCHIZEDEK, king of Salem, and prieſt of the Moſt High. The ſcripture tells us nothing either of his father, or of his mother, or of his genealogy, or of his birth, or of his death. And in this ſenſe he was a figure of Jeſus Chriſt, as St Paul affirms, who is a prieſt for ever, according to the order of Melchiſedec, and not according to the order of Aaron, whoſe original, life, and death, are known. When Abraham returned from purſuing the four confederate kings, who had defeated the kings of Sodom and Gomorrah, and had taken away Lot, Abraham's nephew, along with them (Gen. xiv. 17, 18, 19, &c.) Melchiſedec came to meet Abraham as far as the valley of Shaveh, which was afterwards named the King's valley, preſented him with the refreſhment of bread and wine (or he offered bread and wine in ſacrifice to the Lord, for he was a prieſt of the moſt high God), and bleſſed him. Abraham, being deſirous to acknowledge in him the quality of prieſt of the Lord, offered him the tythes of all he had taken from the enemy. After this time, there is no mention made of the perſon of Melchiſedec; only the Pſalmiſt (cx. 4.) ſpeaking of the Meſſiah, ſays, "Thou art a prieſt for ever after the order of Melchiſedec." St Paul, in his epiſtle to the Hebrews, unfolds the myſtery which is concealed in what is ſaid of Melchiſedec in the Old Teſtament. See Heb. v. 6—10. An infinite nnmber of difficulties and ſcruples have been ſtarted upon the ſubject of Melchiſedec.—St Jerome thought that Salem, of which Melchiſedec was king, was not Jeruſalem, but the city of Salem near Scythopolis, where they ſtill pretended to ſhow the ruins of the palace of this prince. The greatneſs and extent of theſe ruins are a ſufficient proof of the magnificence of this ancient building. He thinks it was at this city of Salem or Shalem, that Jacob arrived after his paſſage over Jordan, at his return from Meſopotamia (Gen. xxxiii. 18.). Some believe that Salem, where Melchiſedec reigned, is the ſame as Salim ſpoken of in the goſpel of St John, chap. iii. 23. From the time of Epiphanes, there were names invented for the father and mother of Melchiſedec. To his father was given the name of Heraclas or Heracles, and to his mother that of Aſhtaroth or Aſtaria. It is generally agreed on by the learned, that when the apoſtle ſays, he was "without father and without mother," no more is meant, than that he is introduced into the hiſtory of Abraham without acquainting us who he was, or whence he came, where he lived or when he died. Nevertheleſs, ſome have taken St Paul's words literally, and contended that he was not of human but divine nature. Origen and Didymus took him to be an angel; and the author of the Queſtions upon the Old and New Teſtaments pretends, that he was the Holy Ghoſt, who appeared to Abraham in a human form. The Arabic Catena upon the ninth chapter of Geneſis, makes Melchiſedec to be deſcended from Shem by his father, and from Japheth by his mother. Heraclas or Heraclim his father, was, they ſay, ſon or grandſon of Phaleg, and ſon of Heber; and his mother, named Salathiel, was daughter of Gomer ſon of Japheth. Cedrenus and others derive Melchiſedec from an Egyptian ſtock. They ſay his father was called Sidon or Sida, and was the founder of the city of Sidon, the capital of Phœnicia. Suidas ſays he was of the curſed race of Canaan; for which reaſon the ſcripture does not mention his genealogy. The Jews and Samaritans believed Melchiſedec to be the ſame

same with the patriarch Shem; which opinion has been followed by a great number of modern writers. M. Jurieu has undertaken to prove that he is the same as Cham or Ham. It would be endless to set down all the opinions upon this matter: therefore we shall only add, that Peter Cunæus and Peter du Moulin have asserted, that Melchisedec who appeared to Abraham was the Son of God, and that the patriarch worshipped him and acknowledged him for the Messiah.

About the beginning of the third century arose the heresy of the Melchisedecians, who affirmed that Melchisedec was not a man, but a heavenly power, superior to Jesus Christ: for Melchisedec, they said, was the intercessor and mediator of the angels, but Jesus Christ was so only for men, and his priesthood only a copy of that of Melchisedec, who was the Holy Ghost.

We shall only beg leave to add here one opinion more concerning Melchisedec, which is that of the learned Heidegger, who, as the author of the *Hist. Patriar.* thinks, has taken the right method of explaining the accounts of Moses and the apostle Paul relating to this extraordinary person. He supposes a twofold Melchisedec; the one historical, whereof Moses gives an account in the 14th chapter of Genesis, as that he was king as well as high priest of Jerusalem; the other allegorical, whom St Paul describes, and this allegorical person is Jesus Christ.

As the history of this prince and priest is so little known, it is no wonder, as Selden observes, that many fabulous accounts have been invented of him; of which the following may suffice as a specimen. Eutychus patriarch of Alexandria relates, that the body of Adam having been embalmed according to his order, was deposited in a cave under a mountain of the children of Seth; but that Adam before his death had commanded that they should take away his remains from that place, and transport them to the middle of the earth: that Noah, to follow the orders of his ancestors, had preserved the bodies of Adam and all the patriarchs with him in the ark: that finding himself near his death, he ordered his son Shem to take the body of Adam, to furnish himself with bread and wine for his journey, to take with him Melchisedec the son of Phaleg, and to go to the place in which an angel would show them where to bury the first man: that Noah added this order, "Command Melchisedec to fix his residence in that place, and to live unmarried all his lifetime, because God has chosen him to do service in his presence; command him, that he build no temple, nor shed the blood of birds, nor four-footed beasts, or any other animal; and that he offer no other oblations to God but bread and wine." This is the reason, according to this author, why Melchisedec, when he met Abraham, brought forth only bread and wine.

A Greek author, under the name of Athanasius, relates, that Melchisedec was the son of an idolatrous king called Melchi and of a queen called Salem.—Melchi, having resolved to offer a sacrifice to the gods, sent his son Melchisedec to fetch him seven calves. In the way the young prince was enlightened by God, and immediately returned to his father, to demonstrate to him the vanity of his idols. Melchi, in wrath, sent him back to fetch the victims. While he was absent, the king sacrificed his eldest son, and a great many other children, to his gods. Melchisedec returning, and conceiving great horror at this butchery, retired to Mount Tabor, where he lived seven years, without clothes, and fed only on wild fruits. At the end of seven years, God appeared to Abraham, bid him go up to Mount Tabor, where he should find Melchisedec. He ordered him to clothe him, and to ask his blessing; which Abraham having done, Melchisedec anointed him with oil, and they came down together from the mountain.

MELCOMB-REGIS, a town of Dorsetshire, in England, 130 miles from London, is situated at the mouth of the river Wey, by which it is parted from Weymouth. It appears from the name to have been anciently the king's demesne, and from the records to have paid quit-rent to the crown all along after King Edward I. till it was bought off by the inhabitants before they were united to Weymouth. It lies on the north side of the haven, on a peninsula surrounded by the sea on all sides except on the north. The streets are broad and well paved, and many of the houses large and high. It sent members to parliament in the reign of King Edward I. before Weymouth had that privilege. It was by parliament appointed a staple in the reign of Edward III. In the next reign the French burnt it; and it was thereby rendered so desolate, that the remaining inhabitants prayed and obtained a discharge from customs. On account of its quarrels with Weymouth, in the reign of Henry VI. its privileges as a port were removed to Pool: but in that of Queen Elizabeth they were restored to it by act of parliament, which was confirmed in the next reign, on condition that Melcomb and Weymouth should make but one corporation, and enjoy their privileges in common; and to this was owing the flourishing state of both. In the two reigns last mentioned, a wooden bridge with seventeen arches was built from hence to Weymouth; to which, as well as its church, the chief contributors were certain citizens of London; and upon its decay it was rebuilt in 1770. Here is a good market place and town-hall, to which the members of the corporation of Weymouth come to attend public business, as the inhabitants do to its church for public worship. For several years past the sea has retired from it on the east, the priory formerly being bounded by the sea; but there is now a street beyond it, from which it is several paces to the high water mark. The priory was situated in the east part of the town, in Maiden street, whose site occupied about an acre, now covered with tenements. On the south side are the remains of the chapel, now converted into a malt house. Near it are the remains of an ancient building, formerly a nunnery. Here are three meeting houses, and a workhouse for the poor. The church, which is in the middle of the town, has a wooden turret for a bell, and had been an old chapel. It was rebuilt in 1605, and made parochial, and is a handsome fabric, with a beautiful altarpiece painted and given by Sir James Thornhill. The port, which generally goes by the name of Weymouth, is said to be the best frequented in the county, and is defended by Sandford and Portland castles. The markets for both towns are Tuesdays and Fridays, but there are no fairs. Melcomb-regis is reckoned larger, more thriving, and

and populous than Weymouth. They are now one corporation and borough, confifting of a mayor, recorder, two bailiffs, an uncertain number of aldermen, and twenty-four capital burgeffes. Whoever has been a mayor is ever after an alderman. They fend four burgeffes to parliament, who are elected by fuch as have freeholds, whether they are inhabitants or not; the number of voters is near 700. Every elector, as in London, has the privilege of voting for four perfons, who when chofen are returned, in two diftinct indentures, as the burgeffes of Weymouth and the burgeffes of Melcomb-regis.

MELDÆ, in *Ancient Geography*, a town of Gallia Celtica, (called *Meldorum Civitas* in the Notitia), on the Matrona. Now *Meaux*, a city of Champagne, on the Marne, in France.

MELEAGER, in fabulous hiftory, a celebrated hero, fon of Oeneus king of Calydonia, by Althæa daughter of Theftius. The Parcæ were prefent at the moment of his birth, and predicted his future greatnefs. Clotho faid that he would be brave and courageous; Lachefis foretold his uncommon ftrength and valour: and Atropos faid that he fhould live as long as that firebrand, which was on the fire, remained entire and unconfumed. Althæa no fooner heard this, than fhe fnatched the ftick from the fire, and kept it with the moft jealous care, as the life of her fon totally depended upon its prefervation. The fame of Meleager increafed with his years; he fignalized himfelf in the Argonautic expedition, and afterwards delivered his country from the neighbouring inhabitants, who made war againft his father at the inftigation of Diana, whofe altars Oeneus had neglected. But Diana punifhed the negligence of Oeneus by a greater calamity. She fent a huge wild boar, which laid wafte all the country, and feemed invincible on account of its immenfe fize. It became foon a public concern: all the neighbouring princes affembled to deftroy this terrible animal: and nothing is more famous in mythological hiftory, than the hunting of the Calydonian boar. The princes and chiefs that affembled, and which are mentioned by mythologifts, were Meleager fon of Oeneus, Idas and Lynceus fons of Apharcus, Dryas fon of Mars, Caftor and Pollux fons of Jupiter and Leda, Pirithous fon of Ixion, Thefeus fon of Ægeus, Anceus and Cepheus fons of Lycurgus, Admetus fon of Pheres, Jafon fon of Æfon, Peleus and Telamon fons of Æcus, Iphicles fon of Amphitryon, Eurytrion fon of Actor, Atalanta daughter of Schœneus, Iolas the friend of Hercules, the fons of Theftius, Amphiaraus fon of Oileus, Protheus, Cometes, the brothers of Althæa, Hippothous fon of Cercyon, Leucippus, Adraftus, Ceneus, Philcus, Echion, Lelex, Phœnix fon of Amyntor, Panopeus, Hyleus, Hippafus, Neftor, Menœtius the father of Patroclus, Amphicides, Laërtes the father of Ulyffes, and the four fons of Hippocoon. This troop of armed men attacked the boar, and it was at laft killed by Meleager.—The conqueror gave the fkin and the head to Atalanta, who had firft wounded the animal. This irritated the reft, and particularly Toxeus and Plexippus the brothers of Althæa, and they endeavoured to rob Atalanta of the honourable prefent. Meleager defended her, and killed his uncles in the attempt. Meantime the news of this celebrated conqueft had already reached Calydon, and Althæa went to the temple of the gods to return thanks for the victory which her fon had gained: But being informed that her brothers had been killed by Meleager, fhe in a moment of refentment threw into the fire the fatal ftick on which her fon's life depended, and Meleager died as foon as it was confumed. Homer does not mention the firebrand; whence fome have imagined that this fable is pofterior to that poet's age. But he fays, that the death of Toxeus and Plexippus fo irritated Althæa, that fhe uttered the moft horrible curfes and imprecations upon her fon's head.

MELEAGER, a Greek poet, the fon of Eucrates, was born at Seleucia in Syria, and flourifhed under the reign of Seleucus VI. the laft king of Syria. He was educated at Tyre; and died in the ifland of Coos, anciently called Merope. He there compofed the Greek epigrams called by us the *Anthologia*. The difpofition of the epigrams in this collection was often changed afterwards, and many additions have been made to them. The monk Planudes put them into the order they are in at prefent, in the year 1380.

MELEAGRIS, the TURKEY; a genus of birds belonging to the order of gallinæ. See ORNITHOLOGY *Index*.

MELES, the BADGER. See URSUS, MAMMALIA *Index*.

MELES, in *Ancient Geography*, a fine river running by the walls of Smyrna in Ionia, with a cave at its head, where Homer is faid to have written his poems. And from it Homer takes his original name *Melefigenes*, given him by his mother Critheis, as being born on its banks. (Herodotus).

MELETIANS, in ecclefiaftical hiftory, the name of a confiderable party who adhered to the caufe of Meletius bifhop of Lycopolis, in Upper Egypt, after he was depofed, about the year 306, by Peter bifhop of Alexandria, under the charge of his having facrificed to the gods, and having been guilty of other heinous crimes; though Epiphanius makes his only failing to have been an exceffive feverity againft the lapfed. This difpute, which was at firft a perfonal difference between Meletius and Peter, became a religious controverfy; and the Meletian party confifted in the fifth century, but was condemned by the firft council of Nice.

MELIA, AZADERACH, or the *Bead Tree*, a genus of plants, belonging to the decandria clafs; and in the natural method ranking under the 23d order, *Trihilatæ*. See BOTANY *Index*.

MELIANTHUS, HONEY-FLOWER, a genus of plants belonging to the didynamia clafs; and in the natural method ranking under the 24th order, *Corydales*. See BOTANY *Index*.

MELIBOEA, in *Ancient Geography*, an ifland of Syria, at the mouth of the Orontes; which before it falls into the fea, forms a fpreading lake round it. This ifland was famous for its purple dye. Thought to be a colony of Theffalians; and hence Lucretius's epithet, *Theffalicus*.

MELICA, ROPEGRASS, a genus of the digynia order, belonging to the triandria clafs of plants; and in the natural method ranking under the 4th order, *Gramina*. See BOTANY *Index*.

MELICERES, in *Surgery*, a kind of encyfted tumour,

mour, ſo called when their contents are of the conſiſtence of honey. See TUMOUR, SURGERY *Index*.

MELICERTA, MELICERTES, or *Melicertus*, in fabulous hiſtory, a ſon of Athamas and Ino. He was ſaved by his mother from the fury of his father, who prepared to daſh him againſt a wall as he had done his brother Learchus. The mother was ſo terrified that ſhe threw herſelf into the ſea with Melicerta in her arms. Neptune had compaſſion on the misfortunes of Ino and her ſon. He changed them both into ſea deities. Ino was called *Leucothoë* or *Matuta;* and Melicerta was known among the Greeks by the name of *Palæmon*, and among the Latins by that of *Portumnus*. Some ſuppoſe that the Iſthmian games were inſtituted in honour of Melicerta.

MELILLA, an ancient town of Africa, in the kingdom of Fez, and in the province of Garet. It was taken by the Spaniards in 1469, but returned back to the Moors. W. Long. 2. 9. N. Lat. 35. 20.

MELILOT. See TRIFOLIUM, BOTANY and AGRICULTURE *Index*.

MELINDA, a kingdom on the eaſt coaſt of Africa, ſituated according to ſome, between the third and fourth degree of ſouth latitude; though there is great diſagreement among geographers as to its extent. It is allowed by all, however, that the coaſts are very dangerous; being full of rocks and ſhelves, and the ſea at ſome ſeaſons very liable to tempeſts. The kingdom of Melinda is for the moſt part rich and fertile; producing almoſt all the neceſſaries of life except wheat and rice, both which are brought thither from Cambaya and other parts; and thoſe who cannot purchaſe them make uſe of potatoes in their ſtead, which are here fine, large, and in great plenty. They likewiſe abound with great variety of fruit trees, roots, plants, and other eſculents, and with melons of exquiſite taſte. They have alſo great plenty of veniſon, game, oxen, ſheep, hens, geeſe, and other poultry, &c. and one breed of ſheep whoſe tails weigh between 30 and 40 pounds. The capital city is alſo called *Melinda*.

MELINUM, in *Natural Hiſtory*, the name of an earth famous in the earlieſt ages of painting, being the only white of the great painters of antiquity; and, according to Pliny's account, one of the three colours with which alone they performed all their works. From the deſcription given of this earth it ſeems to be aluminous, tolerably pure, and in a ſtate of minute diviſion.

MELISSA, in fabulous hiſtory, a daughter of Meliſſus king of Crete, who with her ſiſter Amalthæa fed Jupiter with the milk of goats. She firſt found out the means of collecting honey; whence it has been fabled that ſhe was changed into a bee, as her name is the Greek word for that inſect.

MELISSA, *Baum*, a genus of plants, belonging to the didynamia claſs; and in the natural method ranking under the 42d order, *Verticillatæ*. See BOTANY *Index*.

MELISSUS of SAMOS, a Greek philoſopher, was the ſon of Rhagines and the diſciple of Parmenides; and lived about 440 B. C. He pretended that the univerſe is infinite, immoveable, and without a vacuum. Themiſtocles was among his pupils.

MELITE, in *Ancient Geography*, an iſland referred to Africa by Scylax and Ptolemy; but nearer Sicily, and allotted to it by the Romans: commended for its commodious harbours; for a city well built, with artificers of every kind, eſpecially weavers of fine linen; all owing to the Phœnicians, the firſt coloniſts. Now *Malta;* remarkable for St Paul's ſhipwreck. See MALTA.

MELITE, *Melita*, or *Melitina Inſula;* an iſland on the coaſt of Illyricum in the Adriatic. The *Catuli Melitæi* (Pliny) were famous. Now *Melede*, the name of the iſland Samos. See SAMOS.

MELITE, in *Ancient Geography*, a town of Ionia, ſtruck out of the number of Ionian towns on account of the arrogance of the people, and Smyrna admitted in lieu of it. The ſituation is not ſpecified.

MELITENSIS TERRA, the *Earth of Malta:* an earth of which there are two very different kinds; the one of which is a bole, the other a marl. The latter is that known by medical authors under this name; the former is the Malta earth now in uſe; but both being brought from the ſame place, are confuſedly called by the ſame name. The Malteſe marl, which is the *terra Melitenſis* of medical authors, is a looſe, crumbly, and light earth, of an unequal and irregular texture; and, when expoſed to the weather, ſoon falls into fine ſoft powder: but when preſerved and dried, it becomes a looſe, light maſs, of a dirty white colour, with a grayiſh caſt: it is rough to the touch, adheres firmly to the tongue, is very eaſily crumbled to powder between the fingers, and ſtains the hands. Thrown into the water, it ſwells, and afterwards moulders away into a fine powder. It ferments very violently with acids. Both kinds are found in great abundance in the iſland of Malta, and the latter has been much eſteemed as a remedy againſt the bites of venomous animals. The other has ſupplied its place in the German ſhops; and is uſed there as a cordial, ſudorific, and aſtringent.

MELITO (canonized), biſhop of Sardis in Lydia, in the ſecond century; remarkable for the apology he preſented to the emperor Aurelius, in favour of the Chriſtians; on which Euſebius and the other ancient eccleſiaſtical writers beſtow great praiſes: but that apology and all Melito's other works are loſt.

MELITUS, a Greek orator and poet, the accuſer of Socrates. The Athenians, after the death of Socrates, diſcovering the iniquity of the ſentence they had paſſed againſt that great philoſopher, put Melitus to death, 400 B. C.

MELLER, a lake of Sweden, 80 miles long, and 30 broad; on which ſtands the city of Stockholm.

MELLI, with the country of the Mundingoes, in Africa. The country formerly called *Melli*, now chiefly inhabited by the Mundingoes, who ſtill retain pretty much of the character aſcribed to the people of Melli, lies to the ſouth of the river Gambia; on the weſt it borders on the kingdom of Kabo; on the ſouth it has *Melli*, properly ſo called, and the mountains that part it from Guinea; and on the eaſt it extends to the kingdom of Gago. With a great part of this country we are little acquainted, as is the caſe with regard to moſt of the inland territories of Africa; but towards the ſea coaſt this country is a little better known.

The firſt place of note we meet with is Kachao, a Portugueſe colony, ſituated on the river of St Domingo, which falls into the ſea about 26 leagues below this town.—About 26 leagues above Kachao, on the ſame

same side of the river, is another trading town called *Farini*, where, in the months of October and November, there is some trade in wax and ivory.—Bot is a village near the mouth of the river Gesves, where most of the traders buy rice; which is in great plenty there, and very good.—Gesves is a village on a river of the same name, on which the Portuguese have a factory. At Gesves one may trade yearly for 250 slaves, 80 or 100 quintals of wax, and as many of ivory. Near the mouth of the river of Gesves is a village called *Kurbali*, where there is a considerable trade for salt; here are also some slaves and ivory. Rio Grande, or the Great River, runs about 10 or 12 leagues to the south of the river of Gesves. About 80 leagues from the mouth of it is a nation of negroes, who are considerable traders in ivory, rice, millet, and some slaves. They are called *Analons*. Over against the mouth of Rio Grande is a cluster of islands called *Bissago Isles;* the most considerable of which is Cassagut, being about six leagues long and two broad; its soil is very good, and produces millet, rice, and all kinds of pulse, besides orange and palm trees, and many others. This island, with those of Carache, Canabac, and La Gallina, are the only ones where the Europeans may trade with some security. They trade, however, sometimes at the other islands, but they must be extremely cautious; and yet after all their precautions, they will be robbed and murdered if they venture to go ashore. The river Nunho runs 16 leagues to the south of Rio Grande; it is very considerable, and comes from a vast distance inland. One may buy here 300 quintals of ivory and 100 slaves a-year. Rice grows here admirably well, and is very cheap. There are everywhere sugar canes which grow naturally; and plants of indigo, which might turn to good account. The trade is carried on here from March till August. In the river of Sierra Leone, the late Royal African Company of England had, in the year 1728, two islands; the one, called *Tasso*, a large flat island, near three leagues in circumference, in which the company's slaves had a good plantation; the rest of the island is covered with wood, among which are silk cotton trees of an unaccountable size. The other island is *Bense*, whereon stood a regular fort. It was formerly the residence of one of the English chiefs.

MELLITE, or Honey-stone, a mineral substance, composed of a peculiar acid and alumina. See Mellite, Mineralogy *Index*.

MELMOTH, William, Esq. a learned member of Lincoln's Inn, was born in 1666. In conjunction with Mr Peere Williams, Mr Melmoth was the publisher of Vernon's Reports, under an order of the court of chancery. He had once an intention of printing his own Reports; and a short time before his death advertised them at the end of those of his coadjutor Peere Williams, as then actually preparing for the press. They have, however, not yet made their appearance. But the performance for which he justly deserves to be held in perpetual remembrance is, "The Great Importance of a Religious Life;" concerning which it may be mentioned to the credit of the age, that notwithstanding many large editions had before been circulated, 42,000 copies of this useful treatise have been sold in the last 18 years. It is a somewhat singular circumstance, that the real author of this most admirable treatise should never before have been publicly known (it having been commonly attributed to the first earl of Egmont, and particularly by Mr Walpole in his Catalogue); which is the more surprising, as the author is plainly pointed out in the following short character prefixed to the book itself: It may add weight, perhaps, to the reflections contained in the following pages, to inform the reader, that the author's life was one uniform exemplar of those precepts which, with so generous a zeal, and such an elegant and affecting simplicity of style, he endeavours to recommend to general practice. He left others to contend for modes of faith, and inflame themselves and the world with endless controversy: it was the wiser purpose of his more ennobled aim, to act up to those clear rules of conduct which revelation hath graciously prescribed. He possessed by temper every moral virtue; by religion every Christian grace. He had a humanity that melted at every distress; a charity which not only thought no evil, but suspected none. He exercised his profession with a skill and integrity which nothing could equal but the disinterested motive that animated his labours, or the amiable modesty which accompanied all his virtues. He employed his industry, not to gratify his own desires; no man indulged himself less: not to accumulate useless wealth; no man more disdained so unworthy a pursuit: it was for the decent advancement of his family, for the generous assistance of his friends, for the ready relief of the indigent. How often did he exert his distinguished abilities, yet refuse the reward of them, in defence of the widow, the fatherless, and him that had none to help him! In a word, few have ever passed a more useful, not one a more blameless life; and his whole time was employed either in doing good, or in meditating it. He died on the 6th day of April 1743, and lies buried under the cloister of Lincoln's Inn Chapel. MEM. PAT. OPT. MER. FIL. DIC." The son, by whom this character is drawn, is William Melmoth, Esq. the celebrated translator of Pliny and of Cicero's Letters; and author of those which pass under the name of *Sir Thomas Fitzosborne*.

MELOCHIA, Jews Mallow, a genus of plants belonging to the monadelphia class; and in the natural method ranking under the 37th order, *Columniferæ*. See Botany *Index*.

MELODUNUM, in *Ancient Geography*, a town of the Cenones in Gallia Celtica, above Lutetia; now *Melun*, in the Isle of France, on the Seine.

MELODY, in music, a succession of sounds ranged in such a manner, according to the laws of rhythmus and modulation, that it may form a sentiment agreeable to the ear. Vocal melody is called *singing;* and that which is performed upon instruments may be termed *symphonic melody*.

The idea of rhythmus necessarily enters into that of melody. An air is not an air but in proportion as the laws of measure and quantity are observed. The same succession of sounds is susceptible of as many different characters, as many different kinds of melody, as the various ways by which its emphatic notes, and the quantities of those which intervene, may be diversified; and the change in duration of the notes alone, may disguise that very succession in such a manner that it cannot be known. Thus, melody in itself is nothing; it is the rhythmus or measure which determines it, and there can be no air without time. If then we abstract measure

measure from both, we cannot compare melody with harmony; for to the former it is essential, but not at all to the latter.

Melody, according to the manner in which it is considered, has a relation to two different principles. When regarded only as agreeable to the proportions of sound and the rules of modulation, it has its principle in harmony; since it is a harmonical analysis, which exhibits the different gradations of the scale, the chords peculiar to each mode, and the laws of modulation, which are the sole elements that compose an air. According to this principle, the whole power of melody is limited to that of pleasing the ear by agreeable sounds, as the eye may be pleased with an agreeable assemblage of suitable colours. But when considered as an imitative art, by which we may affect the mind with various images, excite different emotions in the heart, inflame or soothe the passions; by which, in a word, we produce different effects upon our moral faculties, which are not to be effectuated by the influence of external sense alone, we must explore another principle for melody: for in our whole internal frame there appears to be no power upon which either harmony alone, or its necessary results, can seize, to affect us in such a manner.

What then is the second principle? It is as much founded on nature as the first; but, in order to discover its foundation in nature, it will require a more accurate though simpler observation, and a more exquisite degree of sensibility in the observer. This principle is the same which varies the tone of the voice, when we speak, according as we are interested in what we say, and according to the different emotions which we feel in expressing it. It is the accent of languages which determines the melody of every nation; it is the accent which determines us to employ the emphasis of speaking while we sing, and to speak with more or less energy according as the language which we use is more or less accented. That language whose accents are the most sensible, ought to produce a more passionate and more lively melody; that which has little accentuation, or none at all, can only produce a cold and languid melody, without character and without expression. These are the true principles: in proportion as we depart from them, when we speak of the power of music upon the human heart, we shall become unintelligible to ourselves and others: our words will be without meaning.

If music does not impress the soul with images but by melody, if from thence it obtains its whole power, it must follow, that all musical sounds which are not pleasing by themselves alone, however agreeable to harmony they may be, is not an imitative music; and, being incapable, even with its most beautiful chords, either to present the images of things, or to excite the finer feelings, very soon cloys the ear, and leaves always the heart in cold indifference. It follows likewise, that notwithstanding the parts which harmony has introduced, and which the present taste of music so wantonly abuses, wherever two different melodies are heard at the same time, they counteract each other, and destroy the effects of both, however beautiful each may be when performed alone: from whence it may be judged with what degree of taste the French composers have introduced in their operas the miserable practice of accompanying one air with another, as well in singing, which is the native expression of pathos and sentiment, as in instrumental performances; which is the same thing as if whimsical orators should take it in their heads to recite two orations at the same time, that the elegance of each might derive more force from the other.

So much for Rousseau. The translator, however, has reason to fear, that the causes by which national melody is diversified and characterized, are more profound and permanent than the mere accentuation of language. This indeed may have great influence in determining the nature of the rhythmus, and the place of emphatic notes; but very little in regulating the nature of the emphasis and expression themselves. If Rousseau's principle be true in its full extent, he must of necessity acknowledge, that an air which was never set or intended for words, however melodious, cannot be imitative; he must likewise confess, that what is imitative in one nation cannot be such in another: nor can it be denied, upon his hypothesis, that the recitative, which is formed upon the mode of speaking, is the most forcible of all melodies; which is absurd. His other observations are at once judicious and profound. Though it is impossible to exhibit the beauty and variety of harmony by playing the same melody at the same time upon different keys, admitting those keys to form among themselves a perfect chord, which will of consequence preserve all the subsequent notes in the same intervals; yet this perfect harmony would by no means be uniformly pleasing to the ear. We must therefore of necessity introduce less perfect chords to vary and increase the pleasure, and these chords in any complex system of music must of necessity produce dissonances. It then becomes the business of the composer to be careful that these discords may arise as naturally from, and return as naturally to perfect harmony as possible. All these causes must inevitably vary the melody of the different parts; but still, amidst all these difficulties, the artist ought to be zealous in preserving the melody of each as homogeneous with the others as possible, that the result of the whole may be in some measure uniform. Otherwise, by counteracting each other, the parts will reciprocally destroy the effects one of another.

MELOE, a genus of insects of the order of coleoptera. See ENTOMOLOGY *Index*.

MELON, a species of CUCUMIS, in the Linnæan system. See BOTANY and GARDENING *Index*.

Water MELON. See ANGURIA, BOTANY *Index*.

MELOS, in *Ancient Geography*, an island between Crete and Peloponnesus, about 24 miles from Scyllæum. It is about 60 miles in circumference, and of an oblong figure. It enjoyed its independence for about 700 years before the time of the Peloponnesian war. This island was originally peopled by a Lacedæmonian colony, 1116 years before the Christian era. For this reason the inhabitants refused to join the rest of the island and the Athenians against the Peloponnesians. This refusal was severely punished. The Athenians took Melos, and put to the sword all such as were able to bear arms. The women and children were made slaves, and the island left desolate. An Athenian colony repeopled it, till Lysander reconquered it and reestablished the original inhabitants in their possessions.

MELOTHRIA, a genus of plants belonging to the triandria claſs; and in the natural method ranking under the 34th order, *Cucurbitaceæ*. See BOTANY *Index*.

MELPOMENE, in *Fabulous Hiſtory*, one of the muſes, daughter of Jupiter and Mnemoſyne. She preſided over tragedy. Horace has addreſſed the fineſt of his odes to her, as to the patroneſs of lyric poetry. She was generally repreſented as a young woman with a ſerious countenance. Her garments were ſplendid; ſhe wore a buſkin, and held a dagger in one hand and in the other a ſceptre and crown.

MELROSE, a town of Scotland, in the county of Selkirk, and on the confines of Tweedale, ſeated on the ſouth ſide of the river Tweed; with an ancient abbey, now in ruins. W. Long. 2. 32. N. Lat. 55. 32.

This abbey was founded by King David I. in 1136. He peopled it with Ciſtertians brought from Rivale abbey in Yorkſhire, and dedicated it to the Virgin Mary. At the reformation James Douglas was appointed commendator, who took down much of the building, in order to furniſh materials for a large houſe to himſelf, which ſtill remains, and is dated 1590. Nothing is left of the abbey excepting a part of the cloiſter walls elegantly carved; but the ruins of the church are of moſt uncommon beauty. Part is at preſent uſed for divine ſervice, the reſt uncovered; but every part does great honour to the architect.—Alexander II. was buried beneath the great altar, and it is alſo the place of interment of the Douglaſes and other potent families.—Its ſituation is extremely pleaſant.

MELT OF FISHES. In the melt of a living cod there are ſuch numbers of thoſe animalcules ſaid to be found in the ſemen of all male animals, that in a drop of its juice no larger than a grain of ſand, there are contained more than 10,000 of them; and conſidering how many ſuch quantities there are in the whole melt of one ſuch fiſh, it is not incredible, that there are more animals in one melt of it than there are living men at one time upon the face of the earth. However ſtrange and romantic ſuch a conjecture muſt appear, a ſerious conſideration and calculation will make it very evident. An hundred ſuch grains of ſand as thoſe juſt mentioned will make about an inch in length; therefore in a cubic inch there will be a million of ſuch ſands; and if there be 10,000 animals in each of thoſe quantities, there muſt be in the whole 150,000 millions, which is a number vaſtly exceeding that of mankind, even ſuppoſing the whole as populous as Holland.

MELTING CONE, in eſſaying, an hollow cone of braſs or caſt iron, into which melted metalline ſubſtances are thrown, in order to free them from their ſcoriæ. When a ſmall quantity of matter is melted, it will be ſufficient to rub the inſide of the cone with greaſe; but when the quantity is large, eſpecially if it contains any thing ſulphureous, this caution of tallowing the moulds is not ſufficient. In this caſe the eſſayer has recourſe to a lute reduced to thin pap with water, which effectually prevents any injury to the cone.

MELTON MOUBRAY, a town of Leiceſterſhire, 108 miles from London. It is a large well-built place, in a fertile ſoil; with a market on Tueſday, the moſt conſiderable for cattle of any in this part of the iſland. It is almoſt encompaſſed with a little river called the *Eye*, over which it has two fine bridges; and has a large handſome church, with a free ſchool. Here are frequent horſe races, and three fairs in the year.

MELVIL, SIR JAMES, deſcended from an honourable Scots family, being the third ſon of the laird of Kaeth, was born about the middle of the 16th century. He went to France very young, in the capacity of page to Queen Mary, then married to the dauphin; and on the death of her huſband, followed her to Scotland, where he was made gentleman of her chamber, and admitted a privy counſellor. She employed him in her moſt important concerns, till her unhappy confinement in Lochleven, all which he diſcharged with the utmoſt fidelity; and, from his own accounts, there is reaſon to conclude, that, had ſhe taken his advice, ſhe might have avoided many of her misfortunes. When ſhe was priſoner in England, ſhe recommended him ſtrongly to her ſon James; with whom he continued in favour and employment until the death of Queen Elizabeth: James would then have taken him to England; but Melvil, now grown old, was deſirous of retiring from buſineſs, and in his retirement he drew up the memoirs of his paſt life for the uſe of his ſon. Theſe Memoirs were accidentally found in Edinburgh caſtle in the year 1660, though nobody knew how they came to be depoſited there; and were publiſhed in folio in 1683.

MEMBERS, in *Anatomy*, the exterior parts, ariſing from the trunk or body of an animal, like the boughs from the trunk of a tree.

MEMBER, in *Architecture*, denotes any part of a building; as a frieze, cornice, or the like.

MEMBER is ſometimes alſo uſed for moulding.

MEMBER, in *Grammar*, is applied to the parts of a period or ſentence.

MEMBER, is alſo uſed to denote ſome particular order or rank in a ſtate or government: thus we ſay, "member of a corporation, member of parliament, member of the council," &c.

MEMBRANE, MEMBRANA, in *Anatomy*, a ſimilar part of an animal body; being a thin, white, flexible, expanded ſkin, formed of ſeveral ſorts of fibres interwoven together, and ſerving to cover or wrap up certain parts of the body. See ANATOMY *paſſim*.

MEMEL, or MEMMEL; a town of Pruſſia, ſituated on the northern extremity of the Curiſche Haf, an inlet of the ſea about 70 miles in length, which is here joined to the Baltic by a narrow ſtrait.—It is an ill built town, with narrow dirty ſtreets; but remarkable for its extenſive commerce, being provided with the fineſt harbour in the Baltic. In 1784, 996 ſhips, amongſt which were 500 Engliſh, arrived here. The imports chiefly are, ſalt, iron, and ſalted herrings; the exports, which greatly exceed the imports, are amber, corn, hemp, flax, and particularly timber. An Engliſh conſul reſides here. The trade increaſed greatly on account of the high duties laid on the imports of Riga. E. Long. 21. 25. N. Lat. 55. 50.

MEMNON, in fabulous hiſtory, a king of Ethiopia, ſon of Tithonus and Aurora. He came with a body of 10,000 men to aſſiſt his uncle Priam, during the Trojan war. He behaved with great courage, and killed Antilochus, Neſtor's ſon. The aged father challenged

lenged the Ethiopian monarch; but Memnon refused it on account of the venerable age of Nestor, and accepted that of Achilles. He was killed in the combat, in the sight of the Grecian and Trojan armies. Aurora prayed to Jupiter to grant her son such honours as might distinguish him from other mortals. The god consented; and immediately a numerous flight of birds issued from the burning pile on which the body was laid, and dividing themselves into two separate bodies, fought with such fury, that above half of them fell down in the fire as victims to appease the manes of Memnon. These birds were called *Memnonides;* and it has been observed by some of the ancients, that they never failed to return yearly to the tomb of Memnon in Troas, and repeat the same bloody engagement in honour of the hero from whom they received their name. The Ethiopians or Egyptians, over whom Memnon reigned, erected a celebrated statue to the honour of their monarch. This statue had the wonderful property of uttering a melodious sound every day at sunrising, like that which is heard at the breaking of the string of a harp when it is wound up. This was effected by the rays of the sun when they fell upon it. At the setting of the sun, and in the night, the sound was lugubrious. This is supported by the testimony of the geographer Strabo, who confesses himself ignorant whether it proceeded from the basis of the statue, or the people that were then around it. This celebrated statue was dismantled by order of Cambyses when he conquered Egypt; and its ruins still astonish modern travellers by their grandeur and beauty.

MEMNON of Rhodes, one of the generals of Darius king of Persia, advised the prince to lay waste the country, in order to deprive Alexander the Great's army of support, and afterwards to attack Macedon; but this counsel was disapproved by Darius's other generals. Memnon behaved at the passage of the Granicus like an experienced general. He afterwards defended the city of Miletum with great courage; seized the islands of Chio and Lesbos; spread terror throughout all Greece; and would have put a stop to the conquests of Alexander, if he had not been prevented by death. Barsina, Memnon's widow, was taken prisoner with Darius's wife, and Alexander had a son by her named *Hercules*.

MEMOIRS, in matters of literature, a species of history, written by persons who had some share in the transactions they relate; answering to what the Romans called *Commentarii.*—The journals of the proceedings of a literary society, or a collection of matters transacted therein, are likewise called *Memoirs*.

MEMORY, a faculty of the mind, which presents to us ideas or notions of what is past, accompanied with a persuasion that the things themselves were formerly real and present. What we distinctly remember to have perceived, we as firmly believe to have happened, as what is now present to our senses.

The opinions of philosophers concerning the means by which the mind retains the ideas of past objects, and how those ideas carry with them evidence of their objects having been actually perceived, shall be laid before our readers in another place: (see METAPHYSICS, Part I. chap. ii.). At present we shall throw together some observations on the memory, which, being of a practical rather than of a speculative nature, cannot be admitted into the article where the nature of the faculty itself is discussed.

"When we remember with little or no effort, it is called *remembrance* simply, or *memory*, and sometimes *passive memory* *. When we endeavour to remember what does not immediately (and as it were) of itself occur, it is called *active memory*, or *recollection*. A ready recollection of our knowledge, at the moment when we have occasion for it, is a talent of the greatest importance. The man possessed of it seldom fails to distinguish himself in whatever sort of business he may be engaged." It is indeed evident, that when the power of retention is weak, all attempts at eminence of knowledge must be vain; for "memory is the primary and fundamental power †, without which there could be no other intellectual operation. Judgment and ratiocination suppose something already known, and draw their decisions only from experience. Imagination selects ideas from the treasures of remembrance, and produces novelty only by varied combinations. We do not even form conjectures of distant, or anticipations of future events, but by concluding what is possible from what is past."

* *Beattie's Elements of Moral Science.*

† *Idler.*

Of a faculty so important, many rules have been given for the regulation and improvement; of which the first is, that he who wishes to have a clear and distinct remembrance, should be temperate with respect to eating, drinking, and sleep. The memory depends very much upon the state of the brain; and therefore whatever is hurtful to the latter, must be prejudicial to the former. Too much sleep clouds the brain, and too little overheats it; therefore either of these extremes must of course hurt the memory, and ought carefully to be avoided. Intemperance of all kinds, and excess of passion, have the same ill effects; so that we rarely meet with an intemperate person whose memory is at once clear and tenacious.

"The liveliest remembrance is not so vivid as the sensation that produced it ‡; and ideas of memory do often, but not always, decay more and more, as the original sensation becomes more and more remote in time. Those sensations and those thoughts have a chance to be long remembered which are lively at first; and those are likely to be most lively which are most attended to, or which are accompanied with pleasure or pain, with wonder, surprise, curiosity, merriment, and other lively passions. The art of memory, therefore, is little more than the art of attention. What we wish to remember we should attend to, so as to understand it perfectly, fixing our view particularly upon its importance or singular nature, that it may raise within us some of the passions above mentioned. We should also disengage our minds from all other things, that we may attend more effectually to the object which we wish to remember. No man will read with much advantage who is not able at pleasure to evacuate his mind, or who brings not to his author an intellect defecated and pure, neither turbid with care, nor agitated with pleasure. If the repositories of thought are already full, what can they receive? If the mind is employed on the past or the future, the book will be held before the eyes in vain.

‡ *Beattie's Elements,* &c. and *Idler.*

"It is the practice of many readers, to note in the margin of their books the most important passages §, the

§ *Elements of Moral Science.*

the ſtrongeſt arguments, or the brighteſt ſentiments. Thus they load their minds with ſuperfluous attention, repreſs the vehemence of curioſity by uſeleſs deliberation, and by frequent interruption break the current of narration or the chain of reaſon, and at laſt cloſe the volume and forget the paſſages and the marks together. Others are firmly perſuaded, that nothing is certainly remembered but what is tranſcribed; and they, therefore, paſs weeks and months in transferring large quotations to a common-place-book. Yet, why any part of a book which can be conſulted at pleaſure ſhould be copied, we are not able to diſcover. The hand has no cloſer correſpondence with the memory than the eye. The act of writing itſelf diſtracts the thoughts; and what is read twice, is commonly better remembered than what is tranſcribed. This method, therefore, conſumes time, without aſſiſting the memory. But to write an abridgment of a good book may ſometimes be a very profitable exerciſe. In general, when we would preſerve the doctrines, ſentiments, or facts, that occur in reading, it will be prudent to lay the book aſide, and put them in writing in our own words. This practice will give accuracy to our knowledge, accuſtom us to recollection, improve us in the uſe of language, and enable us ſo thoroughly to comprehend the thoughts of other men, as to make them in ſome meaſure our own."

"Our thoughts have for the moſt part a connection *; ſo that the thought which is juſt now in the mind, depends partly upon that which went before, and partly ſerves to introduce that which follows.—Hence we remember beſt thoſe things of which the parts are methodically diſpoſed and mutually connected. A regular diſcourſe makes a more laſting impreſſion upon the hearer than a parcel of detached ſentences, and gives to his rational powers a more ſalutary exerciſe: and this may ſhow us the propriety of conducting our ſtudies, and all our affairs, according to a regular plan or method. When this is not done, our thoughts and our buſineſs, eſpecially if in any degree complex, ſoon run into confuſion."

* *Idler.*

As the mind is not at all times equally diſpoſed for the exerciſe of this faculty, ſuch ſeaſons ſhould be made choice of as are moſt proper for it. The mind is ſeldom fit for attention preſently after meals; and to call off the ſpirits at ſuch times from their proper employment in digeſtion, is apt to cloud the brain, and prejudice the health. Both the mind and body ſhould be eaſy and undiſturbed when we engage in this exerciſe, and therefore retirement is moſt fit for it: and the evening, juſt before we go to reſt, is generally recommended as a very convenient ſeaſon, both from the ſtillneſs of the night, and becauſe the impreſſions will then have a longer time to ſettle before they come to be diſturbed by the acceſſion of others proceeding from external objects; and to call over in the morning what has been committed to the memory overnight, muſt, for the ſame reaſon, be very ſerviceable. For, to review thoſe ideas while they continue freſh upon the mind, and unmixed with any others, muſt neceſſarily imprint them more deeply.

Some ancient writers ſpeak of an artificial memory, and lay down rules for attaining it. Simonides the poet is ſaid firſt to have diſcovered this, or at leaſt to have given the occaſion for it. The ſtory they tell of him is this: Being once at a feaſt, he recited a poem which he had made in honour of the perſon who gave the entertainment. But having (as is uſual in poetry) made a large digreſſion in praiſe of Caſtor and Pollux; when he had repeated the whole poem, his patron would give him but half the ſum he had promiſed, telling him he muſt get the other part from thoſe deities who had an equal ſhare in the honour of his performance. Immediately after, Simonides was told that two young men were without, and muſt needs ſpeak with him. He had ſcarcely got out of the houſe, when the room where the company was fell down, killed all the perſons in it, and ſo maſhed the bodies, that, when the rubbiſh was thrown off, they could not be known one from another: upon which Simonides recollecting the place where every one had ſat, by that means diſtinguiſhed them. Hence it came to be obſerved, that to fix a number of places in the mind in a certain order, was a help to the memory: As we find by experience, that, upon returning to places once familiar to us, we not only remember them, but likewiſe many things we both ſaid and did in them. This action therefore of Simonides was afterwards improved into an art; and the nature of it is this: They bid you form in your mind the idea of ſome large place or building, which you may divide into a great number of diſtinct parts, ranged and diſpoſed in a certain order. Theſe you are frequently to revolve in your thoughts, till you are able to run them over one after another without heſitation, beginning at any part. Then you are to impreſs upon your mind as many images of living creatures, or any other inſenſible objects which are moſt likely to affect you, and be ſooneſt revived in your memory. Theſe, like characters in ſhorthand, or hieroglyphics, muſt ſtand to denote an equal number of other words, which cannot ſo eaſily be remembered. When therefore you have a number of things to commit to memory in a certain order, all that you have to do is, to place theſe images regularly in the ſeveral parts of your building. And thus they tell you, that, by going over ſeveral parts of the building, the images placed in them will be revived in the mind; which of courſe will give you the things or words themſelves in the order you deſire to remember them. The advantage of the images ſeems to be this; that, as they are more like to affect the imagination than the words for which they ſtand, they will for that reaſon be more eaſily remembered. Thus, for inſtance, if the image of a *lion* be made to ſignify *ſtrength*, and this word *ſtrength* be one of thoſe I am to remember, and is placed in the porch; when, in going over the ſeveral parts of the building, I come to the porch, I ſhall ſooner be reminded of that image than of the word *ſtrength*. Of this artificial memory, both Cicero and Quintilian ſpeak; but we know not of any modern orator that has ever made uſe of it. It ſeems indeed to have been a laborious way of improving the memory, if it ſerves that end at all, and fitter for aſſiſting us to remember any number of unconnected words than a continual diſcourſe, unleſs ſo far as the remembrance of one word may enable us to recollect more. It is, however, in alluſion to it, that we ſtill call the parts of a diſcourſe

places

Memory, Mnemonica.

places or *topics*, and say, *in the first place, in the second place*, &c.

But, doubtless, the most effectual way to gain a good memory, is by constant and moderate exercise of it; for the memory, like other habits, is strengthened and improved by daily use. It is indeed hardly credible, to what a degree both active and passive remembrance may be improved by long practice. *Scaliger* reports of himself, that in his youth he could repeat above 100 verses, having once read them; and *Bertheus* declares, that he wrote his *Comment upon Claudian* without consulting the text. To hope, however, for such degrees of memory as these, would be equally vain as to hope for the strength of *Hercules*, or the swiftness of *Achilles*. "But there are clergymen who can get a sermon by heart * in two hours, though their memory, when they began to exercise it, was rather weak than strong: And pleaders, with other orators who speak in public and *extempore*, often discover, in calling instantly to mind all the knowledge necessary on the present occasion, and every thing of importance that may have been advanced in the course of a long debate, such powers of retention and recollection as, to the man who has never been obliged to exert himself in the same manner, are altogether astonishing. As habits, in order to be strong, must be formed in early life, the memories of children should, therefore, be constantly exercised; but to oblige them to commit to memory what they do not understand, perverts their faculties, and gives them a dislike to learning." In a word, those who have most occasion for memory, as orators and public speakers, should not suffer it to lie idle, but constantly employ it in treasuring up and frequently reviving such things as may be of most importance to them; for by these means it will be more at their command, and they may place greater confidence in it upon any emergency."

* Idler.

"Men complain of nothing more frequently than of deficient memory †: and indeed every one finds, that after all his efforts, many of the ideas which he desired to retain have slipped irretrievably away; that acquisitions of the mind are sometimes equally fugitive with the gifts of fortune; and that a short intermission of attention more certainly lessens knowledge than impairs an estate. To assist this weakness of our nature, many methods besides those which we have mentioned have been proposed; all of which may be justly suspected of being ineffectual: for no art of memory, however its effects may have been boasted or admired, has been ever adopted into general use; nor have those who possessed it appeared to excel others in readiness of recollection or multiplicity of attainments." The reader who is desirous to try the effect of those helps, may have recourse to a treatise entitled *A new Method of Artificial Memory*; but the true method of memory is attention and exercise.

† Elements of Moral Science.

MNEMONICA, or the art of memory, as it was called by the ancients, has been lately revived and studied in Germany and France. In some notices concerning this subject which we have seen, it is observed that this science is more intimately connected with the Egyptian hieroglyphics than is generally thought, and that this connection may help to explain them. In Germany this art has been revived by M. Aretin; and a pupil of his, M. Kaestner has been permitted to teach the new doctrine at Leipsic, but on the express condition of not allowing his hearers to write down his lectures. This seems to be a singular, and we may add a silly prohibition. The following account is given of this art in a letter from Paris in the beginning of 1807. "During my residence, says the writer, in this metropolis I heard a great deal of a new method of *mnemonique*, or of a method to assist and fix our memory, invented by Gregor de Feinaigle. Notwithstanding the simplicity with which he announced his lectures in the papers, I could not determine myself to become a pupil of his, as I thought to find a quack or mountebank, and to be laughed at by my friends for having thrown away my cash in such a foolish manner. Perhaps I should hesitate to this moment about the utility of this newly invented method to assist our natural memory, had I not had the pleasure of dining at his excellency's the count of Metternich, the Austrian ambassador, who followed, with all his secretaries, the whole course of lectures: they all spoke very advantageously of it, likewise several other persons of the first rank I met there: in consequence of this I was inserted into the list of pupils, and I follow, at this moment, the lectures. All I can tell you about this method is, it is a very simple one, and easy to be learned, adapted to all ages and sexes: all difficulties in such sciences as require an extraordinary good memory, for instance, the names and epochs in history, are at once overcome and obviated. There is not one branch of science to which this method cannot be applied. It is easy to be perceived that such an invention cannot pass without some critique, and even sarcasms, in the public prints: some of them were very injurious, and plausible enough to mislead the public, who, knowing nothing of the method, are always more ready to condemn than to assist. Mr Feinaigle, to answer all these critics at once, adopted a method not less public for Paris than the public papers, but less public for the rest of Europe: he gave, the 22d of last month, a public exhibition to about 2000 spectators, in which he did not appear at all, only about 12 or 15 of his pupils: each of them made such an application of the method as his situation in life required. The principal parts were the following: history, about names and years; geography, with respect to longitude, latitude, number of inhabitants, square miles, &c. &c.; grammar in various languages, about different editions of the same work; pandects, their division, and title of each book, title, &c.; different systems of botany, poetry, arithmetic, &c. &c. At last one desired the company to give him one thousand words, without any connection whatsoever, and without numeric order; for instance, the word *astronomer*, for N° 62; *wood*, for N° 188; *lovely*, for N° 370; *dynasty*, for N° 23; *David*, for N° 90, &c. &c. till all the numbers were filled; and he repeated the whole (notwithstanding he heard these words without order, and but once), in the numerical order; or he told you what word was given against any one number, or what number any one word bore. It is still more striking, but certainly, likewise, more difficult, to retain as many numbers however great they may be. For words and numbers I could venture myself, with the greatest safety, as far as one hundred of each; and I am sure, after having

Mnemonia, Memphis. having fixed them once, which is done in lefs than ten minutes, I could repeat them to you at any period, without ever thinking any more of them *."

Feinaigle afterwards delivered lectures on the fame fubject to crowded audiences in London, Edinburgh, Glafgow, &c.; but we do not find that any of his pupils received improvement from his inftructions, and very few of them could give any account of his method.

* Phil. Mag. 28. 93.

MEMPHIS, an ancient city, and the royal refidence of the kings in the Higher Egypt; diftant from the Delta to the fouth 15 miles, according to Pliny. Called alfo *Moph*, and *Noph*, in fcripture.

Though this city is now fo completely ruined, that authors greatly difagree concerning its fituation; yet Strabo informs us that in his time it was the moft magnificent in Egypt, next to Alexandria, and called the capital of the country; and there was an entire temple of Ofiris, where the Apis or facred ox was kept and worfhipped. In the fame place was an apartment of the mother of the ox; a very magnificent temple of Vulcan; a large circus or fpace for fighting bulls; and a great coloffus in the middle of the city, which was thrown down. There was likewife a temple of Venus, and a Serapium in a very fandy place, where the wind heaps up hills of fand very dangerous to travellers; together with a number of fphinxes, the heads of fome of them only being vifible. In the front of the city there were many lakes; and it contained a number of palaces, at that time in ruins. Thefe buildings formerly ftood upon an eminence: they lay along the fide of the hill, ftretching down to the lakes and groves, 40 ftadia from the city. On a mountain in the neighbourhood, there was a great number of pyramids, with the fepulchres of the kings. From this defcription, Mr Bruce concludes that the celebrated capital of Egypt ftood in the place where the villages of Metrahenny are now fituated; in oppofition to Dr Shaw's opinion, who thinks it was fituated at Geeza or Gifa.

M. Savary has alfo fhown, that Gifa was not the fituation of the ancient Memphis, which ftood, he fays, on the fpot where the village of Memph now ftands. Large heaps of rubbifh are ftill to be feen there; but the Arabs have tranfported to Cairo the columns and remarkable ftones, which they have difpofed, without tafte and without order, in their mofques and public buildings. This city extended as far as Saccara; and was almoft wholly encompaffed by lakes, part of which are ftill fubfifting. It was neceffary to crofs them to convey the dead to the fepulchre of their fathers. The tombs, hewn out of the rock, were clofed up with ftones of a proportionable fize, and covered with fand. Thefe bodies embalmed with fo much care, preferved with fo much refpect, are torn from the monuments they repofe in, and fold without decency to ftrangers by the inhabitants of Saccara. This place is called *the plain of mummies*. There too we find *the well of the birds*, into which one defcends by means of a rope. It leads to fubterraneous galleries, filled with earthen vafes containing the facred birds. They are rarely met with entire, becaufe the Arabs break them in hopes of finding idols of gold. They do not conduct travellers into the places where they have found more precious articles. They even clofe them up carefully, referving to themfelves fome fecret paffages by which they defcend. In a journey into Egypt made by the duke de Chaulnes, he advanced very far into thefe winding labyrinths, fometimes crawling, and fometimes fcrambling on his knees. Informed by Mr Edward Wortley Montague, who has carefully vifited Egypt, he arrived at one of thofe paffages which had an opening fhut up from without by branches of the date tree interwoven, and covered with fand. He remarked there fome hieroglyphics *in relievo*, executed in the higheft perfection. But the Arabs refifted every offer he made them to permit him to take drawings of them, or to mould them, in order to preferve their form. The duke de Chaulnes is of opinion that thefe hieroglyphics, fculptured with fo much art that the objects they reprefent may be difcovered at the firft fight, might poffibly furnifh the key of the others, whofe contours are fimply expreffed, and form a fort of alphabet of this unintelligible language. Several pyramids are diftinguifhable along the mountains which bound Saccara on the weft, the greateft part of which appear as lofty as thofe of Gifa. See PYRAMIDS.

Memphis || Menander.

MENAGE (Fr.), denotes a collection of animals; whence we have derived the word *menagery*.

MENANDER, an ancient Greek poet, was born at Athens in the fame year with Epicurus, which was the third of the 109th Olympiad. His happinefs in introducing the new comedy, and refining an art which had been fo grofs and licentious in former times, quickly fpread his name over the world. Pliny informs us, that the kings of Egypt and Macedon gave a noble teftimony of his merit, by fending ambaffadors to invite him to their courts, and even fleets to bring him over; but that Menander was fo much of a philofopher, as to prefer the free enjoyment of his ftudies to the promifed favours of the great. Of his works, which amounted to above 100 comedies, we have had a double lofs, the originals being not only vanifhed, but the greateft part of them, when copied by Terence, having unfortunately perifhed by fhipwreck before they faw Rome. Yet the four plays which Terence borrowed from him before that accident happened, are ftill preferved in the Roman habit; and it is chiefly from Terence that moft people form their judgment of Menander, the fragments that remain of him not being fufficient to enable them to do it. The ancients have faid high things of Menander; and we find the old mafters of rhetoric recommending his works as the true patterns of every beauty and every grace of public fpeaking. Quintilian declares, that a careful imitation of Menander only, will fatisfy all the rules he has laid down in his inftitutions. It is in Menander that he would have his orator fearch for a copioufnefs of invention, for a happy elegance of expreffion, and efpecially for that univerfal genius which is able to accommodate itfelf to perfons, things, and affections.—But Julius Cæfar has left the loftieft as well as the jufteft praife of Menander's works, when he calls Terence only a *Half-Menander*. For while the virtues of the Latin poet are fo defervedly admired, it is impoffible we fhould raife a higher notion of excellency than to conceive the great original ftill fhining with half its luftre unreflected, and preferving an equal part of its graces, above the power of the beft copier in the world. Menander died in the 3d year of the 122d Olympiad,

Olympiad, as we are taught by the ſame old inſcription from which we learn the time of his birth. His tomb, in Pauſanias's age, was to be ſeen at Athens, in the way from the Piræus to the city, cloſe by the honorary monument of Euripides. Quintilian, in his judgement of Afranius the Roman comedian, who imitated him, cenſures Menander's morals as much as he commends his writings; and his character, according to Suidas, is, that he was a very "mad fellow after women." Phædrus has given him the gait and dreſs of a moſt affected fop:

"Unguento delibutus, veſtitu adfluens,
"Veniebat greſſu delicatulo et languido."
Lib. v. fab. 2.

MENANDRIANS, the moſt ancient branch of Gnoſtics; thus called from Menander their chief, ſaid by ſome, without ſufficient foundation, to have been a diſciple of Simon Magus, and himſelf a reputed magician.

He taught, that no perſon could be ſaved, unleſs he were baptiſed in his name; and he conferred a peculiar ſort of baptiſm, which would render thoſe who received it immortal in the next world: exhibiting himſelf to the world, with the phrenſy of a lunatic more than the founder of a ſect, as a promiſed ſaviour. For it appears by the teſtimonies of Irenæus, Juſtin, and Tertullian, that he pretended to be one of the æons ſent from the pleroma, or eccleſiaſtical regions, to ſuccour the ſouls that lay groaning under bodily oppreſſion and ſervitude; and to maintain them againſt the violence and ſtratagems of the dæmons that hold the reins of empire in this ſublunary world. As this doctrine was built upon the ſame foundation with that of Simon Magus, the ancient writers looked upon him as the inſtructor of *Menander*. See SIMONIANS.

MENASSEH BEN ISRAEL, a celebrated rabbi, born in Portugal about the year 1604, was the ſon of Joſeph Ben Iſrael, and followed his father into Holland. Here he was educated by Rabbi Iſaac Uziel, under whom he in a ſhort time made ſuch progreſs in the Hebrew tongue, that at 18 years of age he ſucceeded him in the ſynagogue of Amſterdam. In this poſt he continued ſeveral years, and married Rachel of the family of the Abarbanels, whom the Jews imagine to be deſcended from King David. He afterwards went to his brother Ephraim, a rich merchant, who had ſettled at Baſil; by whoſe advice he entered into trade. Some time after, the hopes of a more agreeable ſettlement induced him to come into England, under the protectorſhip of Cromwell; who gave him a very favourable reception, and one day entertained him at his table with ſeveral other learned divines. However, he ſoon after paſſed into Zealand; and died at Middleburg about the year 1657. The Jews at Amſterdam obtained his body, and interred it at their expence. He was of the ſect of the Phariſees; had a lively wit, a ſolid judgment, great learning, and all the virtues that can adorn private life. He wrote many works in Hebrew, Latin, Spaniſh, and Engliſh. The principal of thoſe publiſhed in Latin, are, 1. His *Conciliator;* a learned and curious work, in which he reconciles thoſe paſſages of Scripture which ſeem to contradict each other. 2. *De reſurrectione mortuorum.* 3. *De termino vitæ.* 4. *Diſſertatio de fragitate humana, ex lapſu Adami, deque Divino in bono opere auxilio.* 5. *Spes Iſrael.* Dr Thomas Pococke has written his life in Engliſh.

MENDELSHON, MOSES, that is, *Moſes the ſon of Mendel*, a Jew of Berlin, and one of the moſt celebrated writers in Germany, died there in the year 1785 at the age of 57. His fourth attempt as an author was ſoon after 1767, by a work entitled *Jeruſalem;* in which, beſides other bold and unjuſtifiable opinions, he maintains, that the Jews have a revealed law but not a revealed religion; that opinions are not ſubjects of revelation; and that the only religion of the Jewiſh nation is that of nature. He acquired great honour by his *Phædon*, or "Diſcourſes on the Immateriality and Immortality of the Soul," tranſlated into the French 1773, 8vo; in which he unfolds this important truth, the great foundation of all morality, with the wiſdom of an enlightened philoſopher and the charms of an elegant writer. In conſequence of this excellent work, he was ſtyled the *Jewiſh Socrates* by ſome of the periodical writers; but he wanted the firmneſs and courage of the Grecian philoſopher. His timidity, and even puſillanimity, defects too common in ſpeculative men, prevented him from being of any eſſential ſervice to his nation; of which he might have become the benefactor by being the reformer. The pliancy of his character, his ſoft, modeſt, and obliging diſpoſition, gained him the eſteem alike of the ſuperſtitious and of the incredulous. After all, he could never procure admiſſion to the Berlin ſociety, or to the converſation of the king of Pruſſia. At his death he received from his nation thoſe honours which are commonly paid to their firſt rabbins. Contrary to an imprudent cuſtom prevalent among the Jews of burying their dead before ſunſet, his interment was delayed till 24 hours after he expired. Though Mendelſhon was deſcended from a reſpectable family, he was very poor. In early life he entered into a counting-houſe of his own nation, wherein he greatly recommended himſelf by his capacity and integrity in buſineſs: But philoſophy and literature ſoon became his principal occupation; and to the famous Leſſing he was indebted for counſels which, without diverting his attention from thoſe purſuits that were neceſſary to his ſubſiſtence, accelerated his progreſs in his literary career. Even after the death of his benefactor, Mendelſhon retained for him the ſincereſt regard and the moſt lively gratitude. Notwithſtanding the very ſtrict regimen which he obſerved, he ſurvived him only a few years; for his feeble frame and weak conſtitution were gradually and inſenſibly undermined by intenſe application to ſtudy.

MENDEZ PINTO, FERDINAND, was born at Montemor-o-velho in Portugal, and was at firſt ſervant to a Portugueſe gentleman. In expectation of making a fortune, he embarked for India in 1537. His veſſel being taken by the Turks on his paſſage, he was carried to Mocka, and ſold to a Greek renegado, and afterwards to a Jew, in whoſe poſſeſſion he continued till he was redeemed by the governor of Ormus, a Portugueſe fort. The governor procured him an opportunity of going out to India, agreeable to his firſt deſign. During a reſidence of twenty-one years in that country, he was witneſs to very important tranſactions, and experienced many ſingular adventures. He returned to Portugal in 1558, where he enjoyed the re-

Mendez, Mendicants.

ward of his labours, after having been thirteen times a ſlave and ſixteen times ſold. A very curious account of his travels was written by himſelf, and publiſhed at Liſbon, A. D. 1614, in folio. This work was tranſlated into French by Bernard Figuier, a Portugueſe gentleman, and printed at Paris 1645, in 4to. It is written in a very intereſting manner, and in a ſtyle more elegant than might have been expected from a man whoſe whole life was ſpent in the camp and in ſlavery. It elucidates a great variety of particulars relating to the geography, hiſtory, and manners of the inhabitants of China, Japan, Pegu, Siam, Achem, Java, &c. Many of his facts appeared fabulous, but their truth has been ſince aſcertained. M. de Surgi compiled an intereſting hiſtory from the moſt ſingular facts in Mendez Pinto's relation, which he publiſhed in the *Viciſſitudes de la Fortune*, Paris, 2 vols. 8vo.

MENDICANTS, or Begging Friars, ſeveral orders of religious in Popiſh countries, who having no ſettled revenues, are ſupported by the charitable contributions they receive from others.

This ſort of ſociety began in the 13th century; and the members of it, by the tenor of their inſtitution, were to remain entirely deſtitute of all fixed revenues and poſſeſſions; though in proceſs of time their number became a heavy tax upon the people. Innocent III. was the firſt of the popes who perceived the neceſſity of inſtituting ſuch an order; and accordingly he gave ſuch monaſtic ſocieties, as made a profeſſion of poverty, the moſt diſtinguiſhing marks of his protection and favour. They were alſo encouraged and patronized by the ſucceeding pontiffs, when experience had demonſtrated their public and extenſive uſefulneſs. But when it became generally known, that they had ſuch a peculiar place in the eſteem and protection of the rulers of the church, their number grew to ſuch an enormous and unwieldy multitude, and ſwarmed ſo prodigiouſly in all the European provinces, that they became a burden, not only to the people, but to the church itſelf. The great inconvenience that aroſe from the exceſſive multiplication of the mendicant orders was remedied by Gregory X. in a general council, which he aſſembled at Lyons in 1272. For here all the religious orders that had ſprung up after the council held at Rome in 1215, under the pontificate of Innocent III. were ſuppreſſed; and the extravagant multitude of mendicants, as Gregory called them, were reduced to a ſmaller number, and confined to the four following ſocieties or denominations, viz. the Dominicans, the Franciscans, the Carmelites, and the Augustins or hermits of St Auguſtin.

As the pontiffs allowed theſe four mendicant orders the liberty of travelling wherever they thought proper, of converſing with perſons of every rank, of inſtructing the youth and multitude wherever they went; and as thoſe monks exhibited, in their outward appearance and manner of life, more ſtriking marks of gravity and holineſs than were obſervable in the other monaſtic ſocieties, they aroſe all at once to the very ſummit of fame, and were regarded with the utmoſt eſteem and veneration through all the countries of Europe. The enthuſiaſtic attachment to theſe ſanctimonious beggars went ſo far, that, as we learn from the moſt authentic records, ſeveral cities were divided or cantoned out into four parts, with a view to theſe four orders; the firſt part being aſſigned to the Dominicans, the ſecond to the Franciſcans, the third to the Carmelites, and the fourth to the Auguſtins. The people were unwilling to receive the ſacraments from any other hands than thoſe of the mendicants, to whoſe churches they crowded to perform their devotions, while living, and were extremely deſirous to depoſit there alſo their remains after death: nor did the influence and credit of the mendicants end here; for we find in the hiſtory of this and of the ſucceeding ages, that they were employed not only in ſpiritual matters, but alſo in temporal and political affairs of the greateſt conſequence, in compoſing the differences of princes, concluding treaties of peace, concerting alliances, preſiding in cabinet councils, governing courts, levying taxes, and other occupations, not only remote from, but abſolutely inconſiſtent with, the monaſtic character and profeſſion. However, the power of the Dominicans and Franciſcans greatly ſurpaſſed that of the other two orders: inſomuch that theſe two orders were, before the Reformation, what the Jeſuits have been ſince that happy and glorious period, the very ſoul of the hierarchy, the engines of the ſtate, the ſecret ſprings of all the motions of the one and the other, and the authors and directors of every great and important event, both in the religious and political world. By very quick progreſſion their pride and confidence arrived at ſuch a pitch, that they had the preſumption to declare publicly, that they had a divine impulſe and commiſſion to illuſtrate and maintain the religion of Jeſus; they treated with the utmoſt inſolence and contempt all the different orders of the prieſthood; they affirmed, without a bluſh, that the true method of obtaining ſalvation was revealed to them alone; proclaimed, with oſtentation, the ſuperior efficacy and virtue of their indulgencies; and vaunted beyond meaſure their intereſt at the court of heaven, and their familiar connexions with the Supreme Being, the Virgin Mary, and the ſaints in glory. By theſe impious wiles, they ſo deluded and captivated the miſerable, and blinded the multitude, that they would not intruſt any other but the mendicants with the care of their ſouls. They retained their credit and influence to ſuch a degree, towards the cloſe of the 14th century, that great numbers of both ſexes, ſome in health, others in a ſtate of infirmity, and others at the point of death, earneſtly deſired to be admitted into the mendicant order, which they looked upon as a ſure and infallible method of rendering heaven propitious. Many made it an eſſential part of their laſt wills, that their bodies after death ſhould be wrapped in old ragged Dominican or Franciſcan habits, and interred among the mendicants. For ſuch was the barbarous ſuperſtition and wretched ignorance of this age, that people univerſally believed they ſhould readily obtain mercy from Chriſt, at the day of judgment, if they appeared before his tribunal aſſociated with the mendicant friars.

About this time, however, they fell under an univerſal odium; but being reſolutely protected againſt all oppoſition, whether open or ſecret, by the popes, who regarded them as their beſt friends and moſt effectual ſupports, they ſuffered little or nothing from the efforts of their numerous adverſaries. In the 15th century,

century, besides their arrogance, which was excessive, a quarrelsome and litigious spirit prevailed among them, and drew upon them justly the displeasure and indignation of many. By affording refuge at this time to the Beguins in their order, they became offensive to the bishops, and were hereby involved in difficulties and perplexities of various kinds. They lost their credit in the 16th century by their rustic impudence, their ridiculous superstitions, their ignorance, cruelty, and brutish manners. They discovered the most barbarous aversion to the arts and sciences, and expressed a like abhorrence of certain eminent and learned men, who endeavoured to open the paths of science to the pursuits of the studious youth, recommended the culture of the mind, and attacked the barbarism of the age in their writings and discourse. Their general character, together with other circumstances, concurred to render a reformation desirable, and to accomplish this happy event.

Among the number of mendicants are also ranked the Capuchins, Recollects, Minims, and others, who are branches or derivations from the former.

Buchanan tells us, the mendicants in Scotland, under an appearance of beggary, lived a very luxurious life; whence one wittily called them, not *Mendicant* but *Manducant* friars.

MENE, a Chaldean word, which signifies "he has numbered or counted;" being one of the three words that were written upon the wall by the hand that appeared to Belshazzar, the last king of Babylon, the night that he was put to death. See BELSHAZZAR.

MENECRATES, a physician of Syracuse, who flourished about 360 B. C. is famous for his skill in his profession, but much more for his vanity. He would always be followed by some of the patients he had cured, and with whom he previously stipulated that they should follow him wherever he went. One appeared with the attributes of Hercules, another with those of Apollo, and others again with those of Mercury or Æsculapius; while he, clad in a purple robe, with a golden crown on his head, and a sceptre in his hand, presented himself, to the admiration of the public, under the name of *Jupiter*, and travelled through different countries escorted by these counterfeit deities. He once wrote the following letter to the king of Macedon: Menecrates Jupiter to Philip, greeting. Thou reignest in Macedonia, and I in medicine; thou givest death to those who are in good health, I restore life to the sick; thy guard is composed of Macedonians; the gods themselves constitute mine." Philip answered him in a word, that he wished him restored to reason. Learning some time after that he was in Macedon, Philip sent for him, and invited him to an entertainment. Menecrates and his companions were placed on rich and lofty couches; before which was an altar, covered with the first fruits of the harvest; and, whilst an excellent repast was served up to the other guests, perfumes and libations only were offered to these new gods, who, unable to endure the affront, hastily left the palace, in which they never more made their appearance.

MENEDEMUS, a Greek philosopher, born at Erythreum, was the son of Calisthenes, and one of Phedo's followers. He was in the greatest esteem, and enjoyed several important posts, in his own country. He several times defended Erythreum with great bravery, and died of grief when Antigonus became master of it. A person one day saying to him, "It is a great happiness to have what we desire," he replied, "It is a much greater to desire nothing but what we have." He flourished about 300 B. C.

MENELAUS, the son of Atreus, and the brother of Agamemnon, reigned at Sparta, when Paris deprived him of his wife Helen. This rape occasioned the famous war of Troy. See HELEN.

MENELAUS, a mathematician in the reign of the emperor Trajan, wrote three books on the *Sphere*, which have been published by Father Marsenne.

MENES, born at This, a town of Thebais in Upper Egypt, was the founder of the Egyptian empire. He had three sons, viz. Athotis, who ruled after him, at This and Thebes; Curudes, who in Lower Egypt founded the kingdom of Heliopoli, which afterward was the kingdom of Diospoli; and Necherophes, who reigned at Memphis. It is thought this Menes reigned 117 years after the birth of Phaleg, son of Heber, which was the very year of the dispersion of the people throughout the whole earth. In building Memphis, he stopped the Nile near it, by the invention of a causeway 100 furlongs broad, and caused it to run through the mountains.

MENIALS, domestic or household servants, who live under their lord or master's roof.

MENINGES, or MENYNGES, in *Anatomy*, a name given to the dura and pia mater of the brain. See ANATOMY, Nº 129.

MENINX, an island in the Mediterranean, to the west of the Syrtis Minor. Supposed by Strabo and Polybius to be Homer's country of the Lotophagi; and hence Ptolemy and Eratosthenes denominate the island *Lotophagitis*, with a cognominal town *Meninx*. It was the country of Vibius Gallus the emperor, and of Volusianus. Now called *Gerbi* and *Zarbi*.

MENIPPUS, a cynic philosopher of Phœnicia. He was originally a slave, but obtained his liberty with a sum of money, and became one of the greatest usurers at Thebes. He grew so desperate from the continual reproaches and insults to which he was daily exposed on account of his meanness, that he destroyed himself. He wrote 13 books of satires, which have been lost.

MENIPPEAN (*satira MENIPPEA*), a kind of satire consisting of prose and verse intermixed. It is thus called from Menippus a cynic philosopher who delighted in composing satirical letters, &c. In imitation of him, Varro also wrote satires under the title of *Satiræ Menippeæ:* whence this sort of composition is also denominated *Varronian satire*.

Among the moderns there is a famous piece under this title first published in 1594, against the chiefs of the league, called also the *Catholicon* of Spain. It is esteemed a masterpiece for the time.

MENISCUS, in *Optics*, a glass or lens, concave on one side and convex on the other; sometimes also called *lunula*. See OPTICS.

MENISPERMUM, MOONSEED, a genus of plants belonging to the diœcia class, and in the natural method ranking under the 11th order, *Sarmentaceæ*. See BOTANY *Index*.

MENNITH, or MINNITH, Judges xi. 33. a town

 near

Meunith, Mennonites.

near Heshbon (Jerome), in Arabia Petræa; in a district named *Ecosipolis*, or *twenty-towns*, (Cellarius). There is also a Minnith mentioned Ezekiel xxvii. as being in a good wheat country: but whether the same with the foregoing is uncertain; though some think that the first Minnith lay in the country of Ammon, (Wells).

MENNONITES, a sect in the United Provinces, in most respects the same with those in other places called *Anabaptists*.

They had their rise in 1536, when Menno Simon, a native of Friesland, who had been a Romish priest, and a notorious profligate, resigned his rank and office in the Romish church, and publicly embraced the communion of the Anabaptists.

Menno was born at Witmarsum, a village in the neighbourhood of Bolswert in Friesland, in the year 1505, and died in 1561 in the duchy of Holstein, at the country seat of a certain nobleman not far from the city of Oldesloe, who, moved with compassion by a view of the perils to which Menno was exposed, and the snares that were daily laid for his ruin, took him with certain of his associates into his protection, and gave him an asylum. The writings of Menno, which are almost all composed in the Dutch language, were published in folio at Amsterdam in the year 1651. About the year 1637, Menno was earnestly solicited by many of the sect with which he connected himself, to assume among them the rank and functions of a public teacher; and as he looked upon the persons who made this proposal to be exempt from the fanatical phrensy of their brethren at Munster, (though according to other accounts they were originally of the same stamp, only rendered somewhat wiser by their sufferings), he yielded to their entreaties. From this period to the end of his life, he travelled from one country to another with his wife and children, exercising his ministry, under pressures and calamities of various kinds, that succeeded each other without interruption, and constantly exposed to the danger of falling a victim to the severity of the laws. East and West Friesland, together with the province of Groningen, were first visited by this zealous apostle of the Anabaptists; from whence he directed his course into Holland, Guelderland, Brabant, and Westphalia, continued it through the German provinces that lie on the coasts of the Baltic sea, and penetrated as far as Livonia. In all these places his ministerial labours were attended with remarkable success, and added to his sect a prodigious number of followers. Hence he is deservedly considered as the common chief of almost all the *Anabaptists*, and the parent of the sect that still subsists under that denomination. Menno was a man of genius, undirected by a very sound judgment; he possessed a natural and persuasive eloquence, and such a degree of learning as made him pass for an oracle in the estimation of the multitude. He appears, moreover, to have been a man of probity, of a meek and tractable spirit, gentle in his manners, pliable and obsequious in his commerce with persons of all ranks and characters, and extremely zealous in promoting practical religion and virtue, which he recommended by his example as well as by his precepts. The plan of doctrine and discipline drawn up by Menno was of a much more mild and moderate nature than that of the furious and fanatical ANABAPTISTS, whose tumultuous proceedings have been recited under that article, but somewhat more severe, though more clear and consistent than the doctrine of the wiser branches of that sect, who aimed at nothing more than the restoration of the Christian church to its primitive purity. Accordingly he condemned the plan of ecclesiastical discipline that was founded on the prospect of a new kingdom, to be miraculously established by Jesus Christ on the ruins of civil government and the destruction of human rulers, and which had been the fatal and pestilential source of such dreadful commotions, such execrable rebellions, and such enormous crimes. He declared publicly his dislike of that doctrine, which pointed out the approach of a marvellous reformation in the church by the means of a new and extraordinary effusion of the Holy Spirit. He expressed his abhorrence of the licentious tenets, which several of the Anabaptists had maintained, with respect to the lawfulness of polygamy and divorce; and finally, considered as unworthy of toleration those fanatics who were of opinion that the Holy Ghost continued to descend into the minds of many chosen believers, in as extraordinary a manner as he did at the first establishment of the Christian church, and that he testified this peculiar presence to several of the faithful by miracles, predictions, dreams, and visions of various kinds. He retained indeed the doctrines commonly received among the Anabaptists, in relation to the baptism of infants, the *millennium*, or 1000 years reign of Christ upon earth, the exclusion of magistrates from the Christian church, the abolition of war, and the prohibition of oaths enjoined by our Saviour, and the vanity as well as the pernicious effects of human science. But while Menno retained these doctrines in a general sense, he explained and modified them in such a manner as made them resemble the religious tenets that were universally received in the Protestant churches; and this rendered them agreeable to many, and made them appear inoffensive even to numbers who had no inclination to embrace them. It however so happened, that the nature of the doctrines considered in themselves, the eloquence of Menno which set them off to such advantage, and the circumstances of the times, gave a high degree of credit to the religious system of this famous teacher among the Anabaptists, so that it made a rapid progress in that sect. And thus it was in consequence of the ministry of Menno, that the different sorts of Anabaptists agreed together in excluding from their communion the fanatics that dishonoured it, and in renouncing all tenets that were detrimental to the authority of civil government, and by an unexpected coalition formed themselves into one community.

Though the Mennonites usually pass for a sect of Anabaptists, yet M. Herman Schyn, a Mennonite minister, who has published their history and apology, maintains, that they are not Anabaptists either in principle or by origin. However, nothing can be more certain than this fact, viz. that the first Mennonite congregations were composed of the different sorts of Anabaptists, of those who had been always inoffensive and upright, and of those who, before their conversion by the ministry of Menno, had been seditious fanatics: besides, it is alleged, that the Mennonites

nites do actually retain, at this day, some of those opinions and doctrines, which led the seditious and turbulent Anabaptists of old to the commission of so many and such enormous crimes: such particularly is the doctrine concerning the nature of Christ's kingdom, or of the church of the New Testament, though modified in such a manner as to have lost its noxious qualities, and to be no longer pernicious in its influence.

The Mennonites are subdivided into several sects; whereof the two principal are the *Flandrians* or FLEMINGIANS, and the WATERLANDIANS. The opinions, says Mosheim, that are held in common by the Mennonites, seem to be all derived from this fundamental principle, that the kingdom which Christ established upon earth is a visible church or community, into which the holy and just alone are to be admitted, and which is consequently exempt from all those institutions and rules of discipline that have been invented by human wisdom, for the correction and reformation of the wicked. This principle, indeed, was avowed by the ancient Mennonites, but it is now almost wholly renounced: nevertheless, from this ancient doctrine, many of the religious opinions that distinguish the Mennonites from all other Christian communities, seem to be derived: in consequence of this doctrine, they admit none to the sacrament of baptism but persons that are come to the full use of their reason; they neither admit civil rulers into their communion, nor allow any of their members to perform the functions of magistracy; they deny the lawfulness of repelling force by force, and consider war, in all its shapes, as unchristian and unjust; they entertain the utmost aversion to the execution of justice, and more especially to capital punishments; and they also refuse to confirm their testimony by an oath. The particular sentiments that divided the more considerable societies of the Mennonites are the following: The rigid Mennonites, called the *Flemingians*, maintain with various degrees of rigour, the opinions of their founder Menno, as to the human nature of Christ, alleging that it was produced in the womb of the Virgin by the creating power of the Holy Ghost; the obligation that binds us to wash the feet of strangers, in consequence of our Saviour's command; the necessity of excommunicating and avoiding, as one would do the plague, not only avowed sinners, but also all those who depart, even in some light instances pertaining to dress, &c. from the simplicity of their ancestors; the contempt due to human learning, and other matters of less moment. However this austere system declines, and the rigid Mennonites are gradually approaching towards the opinions and discipline of the more moderate or *Waterlandians*.

The first settlement of the Mennonites, in the United Provinces, was granted them by William prince of Orange, towards the close of the 16th century; but it was not before the following century that their liberty and tranquillity were fixed upon solid foundations, when, by a confession of faith published in the year 1626, they cleared themselves from the imputations of those pernicious and detestable errors that had been laid to their charge. In order to appease their intestine discords, a considerable part of the Anabaptists of Flanders, Germany, and Friesland, concluded their debates in a conference held at Amsterdam, in the year 1630, and entered into the bonds of fraternal communion, each reserving to themselves a liberty of retaining certain opinions. This association was renewed and confirmed by new resolutions, in the year 1649; in consequence of which, the rigorous laws of Menno and his successors were, in various respects, mitigated and corrected.

MENOLOGY, MENOLOGIUM, (from μην, *month*, and λογος, *discourse*), is much the same as martyrology, or calendar, in the Latin.

The Greek menologium is divided into the several months in the year; and contains an abridgment of the lives of the saints, with a bare enumeration of the names of such whose lives were never written. The Greeks have various menologies; and the Romans tax them with inserting divers heretics in their menologies as saints.—Baillet treats of them at large.

MENSA, in law books, a term that includes in it all patrimony, and necessaries for livelihood.

MENSALS, MENSALIA, in church history, such livings as were formerly united to the tables of religious houses, and hence called *mensal benefices*. See the article BENEFICE.

MENSES, CATAMENIA, in *Medicine*, the monthly evacuations from the uterus of women not with child or not giving suck. They are so called from *mensis* "month," the period wherein they return. They are also called *flowers*, *courses*, &c. By the Jewish law a woman was unclean while the menstrual blood flowed; and the man who touched her, and the moveables she had touched, were declared unclean.—Lev. xv. See MIDWIFFERY and MEDICINE.

MENSORES, among the Romans, were harbingers, whose business it was to go before the emperor, and fix upon lodgings for him when he travelled into any of the provinces. They also marked out encampments, and assigned every regiment its post.

Mensores were also land-surveyors, architects, or appraisers of houses and public buildings. The distributors of provisions in the army were called *mensores frumentarii*. And mensores was also an appellation given to servants who waited at table.

MENSURATION.

EVERY branch of the mathematics which has for its object the comparison of geometrical quantities, and the determination of their proportions to each other, may be comprehended under the general name *Mensuration*. So that, taking the term in its most extensive sense, whatever is delivered in this work under the titles GEOMETRY, TRIGONOMETRY, CONIC SECTIONS, part of ALGEBRA, and a very considerable portion of FLUXIONS, may be considered as constituting particular branches of this general theory.

The

Tables of Measures.

The term mensuration, however, is also frequently used in a less extensive sense, and is applied to a system of rules and methods by which numerical measures of geometrical quantities are obtained. And it is to this limited view of the subject that we propose to confine our attention in the present treatise. In general, it will only be necessary to give the practical rules, as we have already explained their foundation when treating of GEOMETRY, CONIC SECTIONS, and FLUXIONS; but, in addition to the rules, in a few instances, we shall give their demonstrations.

In all practical applications of mathematics it is necessary to express magnitudes of every kind by numbers. For this purpose a line of some determinate length, as one inch, one foot, &c. is assumed as the measuring unit of lines, and the number expressing how often this unit is contained in any line, is the numerical value or measure of that line.

A surface of some determinate figure and magnitude is assumed as the measuring unit of surfaces, and the number of units contained in any surface is the numerical measure of that surface, and is called its *area*. It is usual to assume, as the measuring unit of surfaces, a square, whose side is the measuring unit of lines.

A solid of a determinate figure and magnitude is in like manner assumed as the measuring unit of solids, and the number of units contained in any solid is its solidity or content. The unit of solids is a cube, each of whose edges is the measuring unit of lines, and consequently each of its faces the measuring unit of surfaces.

A right angle is conceived to be divided into 90 equal angles; and one of these, called an angle of one degree, is assumed as the measuring unit of angles.

The measures generally employed in the application of mensuration to the common affairs of life, and their proportions to each other, are expressed in the following tables.

Table of Lineal Measures.

12 Inches	=	1 Foot.
3 Feet	=	1 Yard.
6 Feet	=	1 Fathom.
$5\frac{1}{2}$ Yards	=	1 Pole, Rod, or Perch.
40 Poles	=	1 Furlong.
8 Furlongs	=	1 Mile.
3 Miles	=	1 League.
$69\frac{1}{6}$ Miles nearly	=	1 Degree.
360 Degrees	=	The earth's circumference.

Note. An inch is supposed equal to three barley-corns in length.

4 Inches	=	1 Hand, or handsbreadth.
5 Feet	=	1 Geometrical Pace.
4 Poles or 66 Feet 100 Links each $7\frac{92}{100}$ Inches	=	1 English chain.
74 Feet	=	1 Scots chain.

Table of Square Measures.

144 Square Inches	=	1 Foot square.
9 Square Feet	=	1 Yard.
$30\frac{1}{4}$ Square Yards	=	1 Pole.
40 Square Poles	=	1 Rood.
4 Roods or 160 Square Poles	=	1 Acre.
10 Square Chains or 100,000 Square Links	=	1 Acre.
640 Square Acres	=	1 Square Mile.

Note. The Scots acre is to the English acre as 100,000 to 78,694.

Table of Solid Measures.

1728 Cubic Inches	=	1 Cubic Foot.
27 Cubic Feet	=	1 Cubic Yard.

Note,	282 Cubic inches make	1 Ale Gallon.
	231	1 Wine Gallon.
	2150.42	a Winchester Bushel.
	105 Cubic inches	1 Scots Pint.
	The Wheat Firlot contains	$21\frac{1}{4}$ Scots Pints.
	The Barley Firlot	31 Scots Pints.

SECTION I.

OF THE MENSURATION OF RIGHT LINES AND ANGLES.

Of Right Lines and Angles.

THE rules by which certain of the sides or angles of a triangle are to be found, when other sides and angles are given, might be considered as belonging to this part of mensuration. But as these are fully investigated and explained in the article PLANE TRIGONOMETRY, it is not necessary to deliver them also here. Referring therefore to that article, we shall employ the remainder of this section in the application of trigonometry to the mensuration of heights and distances.

Mensuration of Heights and Distances.

By the application of geometry the measurement of lines, which, on account of their position or other circumstances, are inaccessible, is reduced to the determination of angles, and of other lines which are accessible, and admit of being measured by methods sufficiently obvious.

A line considered as traced on the ground may be measured with rods or a Gunter's chain of 66 feet; but more expeditiously with measuring tapes of 50 or 100 feet. By these, if the ground be tolerably even, and the direction of the line be traced pretty correctly, a distance may, by using proper care, be measured within about 3 inches of the truth in every 50 feet, so that the error may not exceed the 200th part of the whole line.

Vertical angles may be measured with a quadrant furnished with a plummet and sights in the manner indicated by fig. 1. and fig. 2. If an angle of elevation is to be measured, as the angle contained by a horizontal line AC, and a line drawn from A to B the top of a tower, hill, or other eminence; or to a celestial body, as a star, &c.; the centre of the quadrant must be fixed at A, and the instrument moved about A, in the vertical plane, till to an eye placed at G the object B be seen through the two sights D, *d*. Then will the arch EF, cut off by the plumb-line AF, be the measure of the angle CAB.

Plate CCCXXXIII.

An angle of depression CAB (fig. 2.) is to be measured exactly in the same manner, except that here the eye

eye is to be placed at A the centre of the inſtrument, and the meaſure of the angle is the arch EF.

But the moſt convenient inſtrument of any for obſerving angles, whether vertical or horizontal, is the *Theodolite*. This inſtrument is varieuſly conſtructed, ſo as to admit of being ſold at a higher or lower price, according to the degree of accuracy the purchaſer may wiſh to attain in his obſervations with it. An inſtrument of this kind is repreſented in fig. 3. Its principal parts are, 1. A teleſcope and its level CC, D. 2. The vertical arc BB. 3. The horizontal limb and compaſs AA. The limb is generally about 7 inches in diameter. 4. The ſtaff with its parallel plates E.

The teleſcope CC in the beſt inſtruments is generally of the achromatic kind, in order to obtain a larger field and greater magnifying power. In the focus of the eye glaſs are two very fine hairs or wires, at right angles to each other, whoſe interſection is in the plane of the vertical arc. The object glaſs may be moved to different diſtances from the eye glaſs by turning the milled nut *a*, and thus may be accommodated to the eye of the obſerver and diſtance of the object. The ſcrews for moving and adjuſting the croſs hairs, are ſunk a little within the eye tube. On the outſide of the teleſcope are two metal rings which are ground perfectly true. Theſe are to lie on the ſupporters *e*, *e*, called Y's, which are fixed to the vertical arc. The vertical arc BB is firmly fixed to a long axis which is at right angles to the plane of the arc. This axis is ſuſtained by, and moveable on, the two ſupporters, which are fixed firmly to the horizontal plate. On the upper part of the vertical arc are the two Y's for holding the teleſcope; the inner ſides of theſe are ſo framed as to be tangents to the cylindric rings of the teleſcope, and therefore bear only on one part. The teleſcope is confined to the Y's by two loops which turn on a joint, and may therefore be readily opened and turned back when the two pins are taken out.

One ſide of the vertical arc is graduated to half degrees, which are ſubdivided to every minute of a degree by a *nonius*. It is numbered each way; from 0 to 90° towards the eye end for angles of altitude, and from 0 to 50° towards the object end for angles of depreſſion. On the other ſide of the vertical arc are two ranges of diviſions, one for taking the upright height of timber in 100th parts of the diſtance between the inſtrument and tree whoſe height is to be meaſured; and the other for reducing hypothenuſal lines to ſuch as are horizontal.

The vertical arc is cut with teeth or a rack, and may be moved regularly, and with eaſe, by turning the milled nut *b*.

The compaſs is fixed to the upper horizontal plate, its ring is divided into 360°, and the bottom of the box is divided into four parts or quadrants, each of which is ſubdivided to every 10°. The magnetic needle is ſupported in the middle of the box upon a ſteel pin finely pointed, and there is a wire trigger for throwing the needle off the point when not in uſe.

The horizontal limb AA conſiſts of two plates, one moveable on the other, the outermoſt edge of the upper plate is chamfered to ſerve as an index to the degrees on the lower. The upper plate, together with the compaſs, vertical arc, and teleſcope, are eaſily turned round by a pinion fixed to the ſcrew *c*; *d* is a nut for fixing the index to any part of the limb, and thereby rendering it ſecure, while the inſtrument is moved from one ſtation to another. The horizontal limb is divided into half degrees, and numbered from the right hand towards the left; the diviſions are ſubdivided by the nonius ſcale to every minute of a degree.

On the upper plate, towards the nonius, are a few diviſions ſimilar to thoſe on the vertical arc, giving the 100th parts, for meaſuring the diameter of trees, buildings, &c.

The whole inſtrument fits on the conical ferril of a ſtrong braſs-headed ſtaff, with three ſubſtantial wooden legs. The top or head of the ſtaff conſiſts of two braſs plates E, parallel to each other: four ſcrews paſs through the upper plate and reſt on the lower plate; by the action of theſe the horizontal limb may be ſet truly level, and for this purpoſe a ſtrong pin is fixed to the outſide of the plate, and connected with a ball that fits into a ſocket in the lower plate; the axis of the pin and ball are ſo framed as to be perpendicular to the plate, and conſequently to the horizontal limb.

There are three adjuſtments neceſſary before the inſtrument is applied to the menſuration of angles. In the firſt place, care muſt be taken that the line of collimation (that is, the line of viſion paſſing through the croſs hairs) be exactly in the centre of the cylindric rings round the teleſcope; in the next place, that the level be parallel to this line; and, laſtly, the horizontal limb muſt be ſo ſet, that when the vertical arc is at *zero*, and the upper part moved round, the bubble of the level will remain in the middle of the open ſpace.

When theſe adjuſtments are made, and the inſtrument is to be applied to practice, the lower plate of the horizontal limb AA being ſuppoſed to remain unmoved and parallel to the horizon, the teleſcope is to be directed ſucceſſively to the different objects, whoſe angular poſitions are to be determined, by means of the pinions at *c* and *b*; (the former of which turns the upper part of the inſtrument round in a horizontal plane, and the latter turns the arc BB in a vertical plane). Then, the angle which a line paſſing through the axis of the teleſcope and any object makes with the horizon, will be indicated by the arc of the vertical circle between 0° and the index engraved on the nonius ſcale H fixed to the upper plate of the horizontal limb of the inſtrument. Alſo, the horizontal angle contained by two vertical planes conceived to paſs through any two objects and the centre of the inſtrument, will be ſhewn by the arc of the lower plate of the horizontal limb over which the index engraved on the upper plate has paſſed by the direction of the teleſcope being changed from the one object to the other.

Having thus explained ſhortly the nature of the inſtruments by which acceſſible lines and angles are to be meaſured, and the manner of applying them, we ſhall now ſhew, by a few examples, how to find from theſe other lines which cannot be determined by a direct meaſurement.

Example 1. Having meaſured AE, a diſtance of 200 feet in a direct horizontal line from the bottom of a tower, the angle BCD, contained by the horizontal line CD: and a line drawn from C to the top of the tower, Fig. 4.

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tower, was meaſured by a quadrant, or theodolite placed at C, and found to be $47^\circ\ 30'$. The centre C of the inſtrument was five feet above the line AE at its extremity E. It is required hence to determine AB the height of the tower.

In the right-angled triangle CBD we have given the ſide CD=200 feet, and the angle C=$47^\circ\ 30'$. And ſince by the rules of PLANE TRIGONOMETRY,

rad. : tan. BCD :: DC : DB;

By employing the logarithmic tables (ſee LOGARITHMS), and proceeding as is taught in PLANE TRIGONOMETRY, we ſhall find DB = 218.3 feet. To which add DA=EC=5 feet, the height of the inſtrument, and we have AB=223.3 feet, the height of the tower.

Fig. 5. *Ex.* 2. Suppoſe a cloud, or balloon C, is ſeen at the ſame time by two obſervers at A and B, and that theſe ſtations are in the ſame vertical plane with the object C, and on the ſame ſide of it. Alſo ſuppoſe that its angles of elevation, viz. the angles A and B are 35° and 64°, and that AB, the diſtance between the obſervers, is 880 feet. It is required hence to determine CD the height of the object, alſo AC, BC its diſtances from the two obſervers.

In the triangle CAB there are given the outward angle CBD=64°, and one of the inward angles A=35°; hence the other inward angle ACB, which is their difference, is given, and $=64^\circ-35^\circ=29^\circ$.

Now in the triangle CAB

Sin. ACB : ſin. A :: AB : BC,
and ſin. ACB : ſin. B :: AB : AC.

From theſe proportions, by actual calculation, BC will be found =1041 feet, and AC=1631 feet.

Again, in the right-angled triangle BCD

rad. : ſin. B :: BC : CD,

Hence CD will be found =936 feet.

Fig. 6. *Ex.* 3. Wanting to know the breadth CD of a river, and alſo the diſtance of an object A cloſe by its ſide from another object C on its oppoſite ſide, a baſe AB of 400 yards was meaſured along the bank. Then, by means of a theodolite, the angles CBA and CAB were meaſured, and found to be $37^\circ\ 40'$ and $59^\circ\ 15'$ reſpectively. It is required thence to determine the breadth CD, and the diſtance AC between the objects A and C.

This example differs from the laſt only by the given angles, and diſtances required, lying in a horizontal inſtead of a vertical plane.

In the triangle ABC we have the baſe AB, alſo the angles A and B, and conſequently the angle C given. And by Plane Trigonometry,

Sin. ACB : ſin. B :: AB : AC.

Hence AC is found to be 246.2 yards.

Alſo, in the right-angled triangle ACD,

rad. : ſin. A :: AC : CD.

Hence CD is found to be 211.6 yards.

Ex. 4. At B the top of a tower which ſtood on a hill near the ſea ſhore, the angle of depreſſion of a ſhip at anchor (viz. the angle HBS), was $4^\circ\ 52'$; and at R, the bottom of the tower, its depreſſion (namely, the angle NRS) was $4^\circ\ 2'$. Required AS the horizontal diſtance of the veſſel; and alſo RA, the height of the bottom of the tower above the level of the ſea, ſuppoſing RB the height of the tower itſelf to be 54 feet. Fig. 7.

From the angle BSA=HBS=$4^\circ\ 52'$, ſubtract the angle RSA=NRS=$4^\circ\ 2'$, and there remains the angle BSR=$50'$. Alſo, from the angle HBA=90° ſubtract HBS=$4^\circ\ 52'$, and there remains SBR=$85^\circ\ 8'$.

In the triangle SBR,

Sin. BSR : ſin. SBR :: BR : SR;

Hence SR is found. Again, in the triangle SRA,

rad. : ſin. RSA :: SR : AR,
and rad. : coſ. RSA :: SR : AS.

From the firſt of theſe proportions we find AR=260 feet; and from the ſecond, AS=3690 feet.

Ex. 5. To meaſure the height of an obeliſk CD, ſtanding on the top of a declivity, two ſtations at A and B were taken, one at the diſtance of 40, and the other at the diſtance of 100 feet from the centre of its baſe, which was in a ſtraight line with the ſtations. At the nearer ſtation A, a line drawn from it to the top of the obeliſk was found to make an angle of 41° with the plane of the declivity; and at B, the more remote ſtation, the like angle was found to be $23^\circ\ 45'$. Hence it is required to find the height of the obeliſk. Fig. 8.

From the angle CAD = 41°, ſubtract the angle B = $23^\circ\ 45'$, and there remains the angle BCA = $17^\circ\ 15'$.

In the triangle BCA,

Sin. BCA : ſin. B :: AB : AC. Hence AC=81.49 feet.

And in the triangle ACD,

$AC+AD : AC-AD :: \tan.\frac{1}{2}(D+C) : \tan.\frac{1}{2}(D-C)$.

Hence $\frac{1}{2}(D-C)=42^\circ\ 24'\frac{1}{2}$, which, ſubtracted from $\frac{1}{2}(D+C)$, gives the angle ACD=$27^\circ\ 5'\frac{1}{2}$.

Laſtly, in the triangle ACD,

Sin. ACD : ſin. A :: AD : DC.

Hence DC, the height required, will be found to be 57.62 feet.

Ex. 6. Wanting to know the diſtance between two inacceſſible objects H and M, a baſe AB of 670 yards was meaſured in the ſame plane with the objects, and the following angles were taken at its extremities. Fig. 9.

At A $\begin{cases} BAM=40^\circ\ 16' \\ MAH=57\ \ 40 \end{cases}$ At B $\begin{cases} ABH=42^\circ\ 22' \\ HBM=71\ \ \ 7 \end{cases}$

Hence it is required to determine HM, the diſtance between the objects.

In the triangle HAB we have the angle HBA=$42^\circ\ 22'$, the angle HAB (=HAM+MAB)= 97°

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$97^\circ\ 56'$, and therefore the remaining angle $AHB = 39^\circ\ 42'$. We have alſo the ſide $AB = 670$ yards. Hence, by this proportion,

Sin. AHB : ſin. HBA :: AB : AH.

we find $AH = 706.8$ yards.

Again, in the triangle MAB we have the angle $MAB = 40^\circ\ 16'$, the angle ABM $(= ABH + HBM) = 113^\circ\ 29'$, and therefore the angle $AMB = 26^\circ\ 15'$. Hence from the proportion,

Sin. AMB : ſin. ABM :: AB : AM

we get $AM = 1389.4$.

In the triangle HAM, beſides the angle $HAM = 57^\circ\ 40'$ we have now the ſides $AH = 706.8$, and $AM = 1389.4$ yards, to find the remaining ſide HM. Therefore, proceeding according to the rules of trigonometry, we ſtate this proportion,

$AM + AH : AM - AH ::$ tan. $\frac{1}{2}(AHM + AMH)$: tan. $\frac{1}{2}(AHM - AMH.)$

Hence we find half the difference of the angles AHM and AMH to be $30^\circ\ 36'$, which taken from $61^\circ\ 10'$, half the ſum, leaves $30^\circ\ 34'$ for AMH the leaſt of the two angles. Laſtly, from the proportion

Sin. HMA : ſin. HAM :: HA : HM,

we get $HM = 1174$ yards, the anſwer to the queſtion.

Fig. 10. *Ex.* 7. There are three objects A, B, C, whoſe diſtances aſunder are known to be as follows; namely, from A to B $106\frac{1}{2}$, from A to C 202, and from B to C 131 fathoms. Now to determine the diſtance of D a fourth object, or ſtation, from each of the other three, the angle ADB was meaſured with a theodolite, or other ſuitable inſtrument; and found to be $13^\circ\ 30'$, and the angle CDB was found $29^\circ\ 50'$. Hence it is required to determine the diſtances DA, DB, and DC, ſuppoſing DB the leaſt of the three.

Let a circle be deſcribed about the points A, D and C; and let DB be produced to meet the circle again in E, and draw AE, CE.

In the triangle AEC there are given the ſide $AC = 202$ fathoms, the angle ACE (= ADE. Geom. Sect. II. Theor. 15.) $= 13^\circ\ 30'$, and the angle CAE $(= CDE) = 29^\circ\ 50'$. Hence (by Trigon.) we ſhall have $AE = 68.716$ fathoms.

In the triangle ABC, all its ſides are given, and hence the angle BAC will be found $= 35^\circ\ 35'\ 54''$; to this, add the angle CAE, and the ſum is the angle $EAB = 65^\circ\ 25'\ 54''$.

In the triangle ABE, we have given $AB = 106.5$ $AE = 68.716$, the angle $BAE = 65^\circ\ 25'\ 54''$; hence we ſhall have the angle $ABE = 38^\circ\ 43'\ 41''$, and the angle $AEB = 75^\circ\ 51'\ 25''$.

In the triangle ADE we have the ſide $AE = 68.716$, the angle $ADE = 13^\circ\ 30'$, and the angle $AED = 75^\circ\ 51'\ 25''$. Hence we have $AD = 285.43$ fathoms, which is one of the diſtances required.

In the triangle ABD we have $AB = 106.5$, the angle $ADB = 13^\circ\ 30'$, the angle DAB $(= ABE - ADB)$ $25^\circ\ 13'\ 45''$. Hence BD, another of the diſtances ſought, will be found $= 194.45$ fathoms.

Laſtly, In the triangle ADC, there is given $AC = 202$, the angle ADC $(= ADB + BDC) = 43^\circ\ 20'$, the angle DCA $(= DEA) = 75^\circ\ 51'\ 25''$. Hence we get $DC = 256.97$ fathoms, which is the remaining diſtance ſought.

Ex. 8. From a ſhip at ſea a point of land was obſerved to bear E. by S. and after ſailing N. E. 12 miles, the ſame point was found to bear S. E. by E. How far was the laſt obſervation made from the point of land? Fig. 11.

Let A be the firſt poſition of the ſhip, B the ſecond, and C the point of land. In the triangle ABC we have given the angle $A = 5$ points or $56^\circ\ 15'$, the angle $B = 9$ points, or $101^\circ\ 15'$, and the angle $C = 2$ points or $22^\circ\ 30'$. Alſo the ſide $AB = 12$ miles. Hence (by Trigon.) the ſide BC is readily found to be 26.073 miles.

There are various other inſtruments and methods by which the heights or diſtances of objects may be found. One of the moſt ſimple inſtruments, both in reſpect of its conſtruction and application, is a ſquare, ABCD, made of ſome ſolid material, and furniſhed with two ſights on AB, one of its edges, and a plummet faſtened to A, one of its angles, and having the two ſides BC, CD, which contain the oppoſite angle divided into 10, or 100, or 1000 equal parts. Fig. 12.

To meaſure any altitude HK with this inſtrument. Let it be held in ſuch a poſition that K, the top of the object may be ſeen through the ſights on its edge AB, while its plane is perpendicular to the horizon; then the plummet will cut off from the ſquare a triangle ſimilar to that formed by the horizontal line AI, the vertical line IK, and the line AK drawn from the eye to the top of the object. Fig. 13.

If the line of the plummet paſs through D the oppoſite angle of the ſquare, then the height KI will be equal to AI, the diſtance of the eye from the vertical line to be meaſured. If it meet AD, the ſide of the ſquare next the eye, in ſome point E between A and D, then the triangles ABE, AIK, being ſimilar, and the angle ABE equal to the angle AKI, we have AE : AB :: AI : IK. Let us now ſuppoſe $AD = AB$ to be divided into 1000 equal parts; then the length of AE will be expreſſed by a certain number of theſe parts; thus the proportion of AE to AB, and conſequently that of AI to IK will be given; therefore if AI be determined by actual meaſurement, we may from the above proportion immediately find IK.

If again the line of the plummet meet DC the ſide of the ſquare oppoſite to the ſights in F, then, in the ſimilar triangles AIK, BCF, the angle AKI is equal to BFC; thus we have BC : CF :: AI : IK. Hence IK is determined as before, and in each caſe by adding HI the height of the eye, we ſhall have HK the whole height required.

SECTION II.

MENSURATION OF PLANE FIGURES.

Problem I.

To find the area of a parallelogram, whether it be a ſquare, a rectangle, a rhombus, or a rhomboid.

Rule

Of Plane Figures.

Rule I.

Multiply the length by the perpendicular breadth, and the product will be the area.

This rule is demonſtrated in Geometry, Sect. IV. Theor. 5.

Fig. 14. *Ex.* 1. Required the area of a ſquare ABCD, whoſe ſide AB is $10\frac{1}{2}$ inches.

Here $10\frac{1}{2} \times 10\frac{1}{2}$ or $10.5 \times 10.5 = 110.25$ ſquare inches is the area required.

Fig. 15. *Ex.* 2. Required the area of a rectangle EFGH, whoſe length EF is 13.75 chains, and breadth FG is 9.5 chains.

Here $13.75 \times 9.5 = 130.625$ ſquare chains is the area, which, when reduced to acres, &c. is 13 *ac.* 0 *ro.* 10 *po.*

Fig. 16. *Ex.* 3. Required the area of a parallelogram KLMN, whoſe length KL is 37 feet, and perpendicular breadth NO is $5\frac{1}{4}$ or 5.25 feet.

In this example the area is $37 \times 5.25 = 194.25$ ſquare feet, or 21.583 ſquare yards.

Rule II.

As radius,
To the ſine of any angle of the parallelogram,
So is the product of the ſides including the angle,
To the area of the parallelogram.

To ſee the reaſon of this rule it is only neceſſary to obſerve, that in the parallelogram KLMN, the perpendicular breadth NO is a fourth proportional to *radius*, *ſine* of the angle K, and the oblique line KN, (Trigonometry), and is therefore equal to $\frac{\textit{ſin. } K}{\textit{rad.}} \times KN$; therefore the area of the figure is $\frac{\textit{ſin. } K}{\textit{rad.}} \times KN \times KL$, which expreſſion is the ſame as the reſult obtained by the above rule.

Ex. Suppoſe the ſides KL and KN are 36 feet, and 25.5 feet, and the angle K is 58°, required the area.

Here it will be convenient to employ the table of logarithms given at the end of the article Logarithms. The operation may ſtand thus,

log. rad.	10.00000
log. ſin. 58°	9.92842
log. $(36 \times 25.5) =$ log. 36 + log. 25.5	2.96284
log. of area	2.89126

area = 778.5 ſquare feet.

Problem II.

Having given any two ſides of a right-angled triangle, to find the remaining ſide.

Rule.

1. When the ſides about the right angle are given, to find the hypothenuſe.

Add together the ſquares of the ſides about the right angle, and the ſquare root of the ſum will be the hypothenuſe.

2. When the hypothenuſe and one of the ſides about the right angle is given, to find the other ſide.

From the ſquare of the hypothenuſe ſubtract the ſquare of the given ſide, and the ſquare root of the remainder will be the other ſide.

This rule is deduced from Theor. 13. Sect. IV. Geometry.

Example 1. In a right-angled triangle ABC, the ſides AB and AC, about the right angle, are 33 feet and 56 feet; what is the length of the hypothenuſe BC? Fig. 17.

Here $33^2 + 56^2 = 3136 + 1089 = 4225$,
and $\sqrt{(4225)} = 65$ feet, = the hypothenuſe BC.

Ex. 2. Suppoſe the hypothenuſe BC to be 65 feet, and AB one of the ſides about the right angle to be 33 feet; what is the length of AC the other ſide?

Here $65^2 - 33^2 = 4225 - 1089 = 3136$;
and $\sqrt{(3316)} = 56$ feet = the ſide AC.

Problem III.

To find the area of a triangle.

Rule I.

Multiply any one of its ſides by the perpendicular let fall upon it from the oppoſite angle, and half the product will be the area.

The truth of this rule is proved in Geometry, Sect. IV. Theor. 6.

Example. What is the area of a triangle ABC, whoſe baſe AC is 40, and perpendicular BD is 14.52 chains.

The product of the baſe by the perpendicular, or 40×14.52, is 580.8 ſquare chains, the half of which, or 290.4 *ſq. ch.* = 29 *ac.* 0 *r.* 6.4 *po.* is the area of the triangle. Fig. 18.

Rule II.

As radius,
To the ſine of any angle of a triangle,
So is the product of the ſides including the angle
To twice the area of the triangle.

This rule follows immediately from the ſecond rule of Prob. I. by conſidering that the triangle KNL (fig. 16.) is half the parallelogram KNML.

Example. What is the area of a triangle ABC, whoſe two ſides AB and AC are 30 and 40, and the included angle A is 28° 57′? Fig. 18.

Operation by Logarithms.

log. rad.	10.00000
log. $(30 \times 40) =$ log. 30 + log. 40.	3.07918
log. ſin. 28° 57′	9.68489
log. of twice area	2.76407

twice area = 580.85
area 290.42

Rule

Of Plane Figures.

RULE III.

When the three ſides are given, add together the three ſides, and take half the ſum. Next, ſubtract each ſide ſeverally from the ſaid half ſum, thus obtaining three remainders. Laſtly, multiply the ſaid half ſum, and thoſe three remainders all together, and extract the ſquare root of the laſt product for the area of the triangle.

This practical rule is deduced from the following geometrical theorem. *The area of a triangle is a mean proportional between two rectangles, one of which is contained by half the perimeter of the triangle, and the exceſs of half the perimeter above any one of its ſides; and the other is contained by the exceſſes of half the perimeter above each of the other two ſides.* As this theorem is not only remarkable, but alſo of great utility in menſuration, we ſhall here give its demonſtration.

Fig. 19. Let ABC then be any triangle; produce AB, any one of its ſides, and take BD, and B d, each equal to BC; join CD and C d, and through A draw a line parallel to BC, meeting CD and C d produced in E and e; thus the angle AED will be equal to the angle BCD, (GEOMETRY, Sect. I. Theor. 21.), that is, to the angle BDC or ADC, (Sect. I. Theor. 11.); and hence AE=AD (Sect. I. Theor. 12.); and in like manner, becauſe the angle A e d is equal to the angle BC d, that is, to the angle B d C, or A d e, therefore A e=A d.

On A as a centre, at the diſtance AD or AE, deſcribe a circle meeting AC in F and G; and on the ſame centre, with the diſtance A d or A e, deſcribe another circle meeting AC in f and g, and draw BH and B h perpendicular to CD and C d. Then, becauſe BD, BC, B d are equal, the point C is in the circumference of a circle, of which D d is the diameter, therefore CD and C d are biſected at H and h (Sect. II. Theor. 6.) and the angle DC d is a right angle, (Sect. II. Theor. 17.), and hence the figure CHB h is a rectangle, ſo that B h = CH = $\frac{1}{2}$CD, and BH= C h= $\frac{1}{2}$ C d.

Join BE, and B e, then the triangle BAC is equal to each of the triangles BEC, B e C (Sect. IV. Theor. 2. Cor. 2.); but the triangle BEC is equal to $\frac{1}{2}$ EC × BH (Sect. IV. Theor. 2.), that is to $\frac{1}{4}$ EC × C d; and in like manner the triangle B e C is equal to $\frac{1}{2}$ e C × B h, that is to $\frac{1}{4}$ e C × CD, therefore the triangle ABC is equal to $\frac{1}{4}$ EC × C d, and alſo to $\frac{1}{4}$ e C × CD.

Now ſince CD : C d :: CE × CD : CE × C d } Sect. IV.
and alſo CD : C d :: C e × CD : C e × C d } Theor. 3.

Therefore CE × CD : CE × C d :: C e × CD : C e × C d; that is, becauſe CE × CD = FC × CG, and C e × C d = fC × C g (Sect. IV. Corollaries to Theor. 28. and 29.).

$$FC\times CG : CE\times Cd : Ce\times CD : fC\times Cg;$$

which laſt proportion (by taking one-fourth of each of its terms, and ſubſtituting the triangle ABC for its equivalent values $\frac{1}{4}$ CE × C d and $\frac{1}{4}$ C e × CD) gives us

$$\tfrac{1}{2}FC\times\tfrac{1}{2}CG : trian.\ ABC :: trian.\ ABC : \tfrac{1}{2}fC\times\tfrac{1}{2}Cg.$$

Now, if it be conſidered that the radius of the circle DGE is AB+BC, and that the radius of the circle g d e is AB—BC, it will readily appear that, putting $2s$ for the perimeter of the triangle ABC, we have

$$FC\ (=AB+BC+AC)=2s$$
$$CG\ (=AB+BC-AC)=2s-2\,AC,$$
$$fC\ (=AC+\{AB-BC\})=2s-2\,BC,$$
$$gC\ (=AC-\{AB-BC\})=2s-2\,AB.$$

Put now a, b, c for the ſides AC, BC, and AB reſpectively, then $\frac{1}{2}$ FC=s, $\frac{1}{2}$ GC=$s-a$, $\frac{1}{2}fC=s-b$, $\frac{1}{2}Cg=s-c$; thus the laſt proportion becomes

$$s\times(s-a) : trian.\ ABC :: trian.\ ABC : (s-b)\times(s-c),$$

which concluſion, when expreſſed in words at length, is evidently the proportion to be demonſtrated.

And as a mean proportional between two quantities is found by taking the ſquare root of the product, it follows that the area of the triangle ABC, which is a mean between $s\times(s-a)$ and $(s-b)\times(s-c)$, is equal to

$$\sqrt{\{s\times(s-a)\times(s-b)\times(s-c)\}}$$

which formula, when expreſſed in words at length, gives the preceding rule.

Example. Required the area of a triangle whoſe three ſides are 24, 36, and 48 chains reſpectively.

Here 24+36+48=108 = the ſum of the three ſides.

And $\frac{108}{2}$=54= half that ſum.

Alſo 54 — 24 = 30, the firſt remainder; 54—36=18, the ſecond remainder; and 54—48=6, the third remainder.

The product of the half ſum and remainders is

$$54\times30\times18\times6=174960.$$

And the ſquare root of this product is

$$\sqrt{(174960)}=418.28 \text{ ſq. ch. the area required.}$$

PROBLEM IV.

To find the area of a trapezoid.

RULE.

Add together the two parallel ſides, then multiply their ſum by the perpendicular breadth, or diſtance between them, and half the product will be the area.

This rule is demonſtrated in GEOMETRY, Sect. IV. Theor. 7.

Example. Required the area of the trapezoid AB CD, whoſe parallel ſides AB and DC are 7.5. and 12.25 chains, and perpendicular breadth DE is 15.4 chains. Fig. 20.

The ſum of the parallel ſides is 7.5+12.25=19.75; which multiplied by the breadth is

$$19.75\times15.4=304.15;$$

and half this product is

$$\frac{304.15}{2}=152.075\ \textit{ſq. ch.} = 15\ \textit{ac.}\ 33.2\ \textit{po.}$$

the area required.

Of Plane Figures.

PROBLEM V.

To find the area of any trapezium.

RULE.

Divide the trapezium into two triangles by a diagonal, then find the areas of these triangles, and add them together.

Note. If two perpendiculars be let fall on the diagonal from the other two opposite angles, the sum of these perpendiculars being multiplied by the diagonal, half the product will be the area of the trapezium. The reason of this rule is sufficiently obvious.

Fig. 21. *Example.* In the trapezium ABCD the diagonal AC is 42, and the two perpendiculars BE, DF are 16 and 18: What is its area?

Here the sum of the perp. is $16+18=34$, which multiplied by 42, and divided by 2 gives

$$\frac{34\times 42}{2}=714 \text{ the area.}$$

PROBLEM VI.

To find the area of an irregular polygon.

RULE.

Draw diagonals dividing the proposed polygon into trapeziums and triangles; then find the areas of all these separately, and add them together for the content of the whole polygon. The reason of this rule, and the manner of applying it, are sufficiently obvious.

PROBLEM VII.

To find the area of a regular polygon.

RULE.

Multiply the perimeter of the polygon, or sum of its sides, by the perpendicular drawn from its centre on one of its sides, and take half the product for the area.

This rule is only in effect resolving the polygon into as many triangles as it has sides, by drawing lines from its centre to all its angles, then taking the sum of their areas for the area of the figure.

Fig. 22. *Example.* Required the area of a regular pentagon ABCDE, whose side AB, or BC, &c. is 25 feet, and perpendicular HK is 17.2 feet.

Here $25\times 5=125=$the perimeter,
And $125=17.2=2150$,
And its half $1075=$the area required.

Note. If only the side of the polygon be given, its perpendicular may be found by the following proportion.

As radius,
To the tan. of half the angle of the polygon,
So is half the side of the polygon,
To the perpendicular.

And here, as well as in all other trigonometrical calculations, we may employ the table of logarithmic sines and tangents given in the article LOGARITHMS.

The angle of the polygon, that is, the angle contained by any two of its adjacent sides, will be found from this theorem, *The sum of all its interior angles is equal to twice as many right angles, wanting four, as it has sides*, which is demonstrated in Theor. 25. Sect. I. GEOMETRY.

PROBLEM VIII.

To find the diameter and circumference of a circle, the one from the other.

RULE I.

As 7 is to 22, so is the diameter to the circumference, nearly.

As 22 is to 7, so is the circumference to the diameter, nearly.

RULE II.

As 113 is to 355, so is the diameter to the circumference, nearly.

As 355 is to 113, so is the circumference to the diameter, nearly.

RULE III.

As 1 is to 3.1416, so is the diameter to the circumference, nearly.

As 3.1416 is to 1, so is the circumference to the diameter, nearly.

Note. The result obtained by the first rule, which is the least accurate of the three, will not differ from the true answer by so much as its 2400th part. But that obtained by the second rule, which is the most accurate, will not differ by so much as its 10000000th part.

The proportion of the diameter of a circle to its circumference is investigated in GEOMETRY, Sect. VI. Prop. 6. Also in FLUXIONS, § 137 and § 140. The manner of finding the first and second rules, and others of the same kind, is explained in ALGEBRA, Sect. XXI. But it is impossible to express exactly, by finite numbers, the proportion of the diameter of the circle to its circumference.

Example. 1. To find the circumference of a circle whose diameter is 20.

By the first rule,

$$7 : 22 :: 20 : \frac{20\times 22}{7}=62\tfrac{6}{7} \text{ the answer.}$$

Or by the third rule $3.1416\times 20=62.832$ the answer.

Ex. 2. The circumference of a circle is 10 feet, what is its diameter?

By the second rule

$$355 : 113 :: 10 : \frac{113\times 10}{355}=3.1831 \text{ the answer.}$$

PROBLEM IX.

To find the length of any arch of a circle.

RULE I.

As 180 is to the number of degrees in the arch, so is 3.1416 times the radius to its length.

To see the reason of this rule it is only necessary to consider, that 3.1416 times the radius is (by last rule) equal to half the circumference, or to an arch of 180°, and that the length of an arch is proportional to the number of degrees it contains.

Example.

Of Plane Figures.

Fig. 23. *Example.* Required the length of the arch AEB, whose chord AB is 6, the radius AC or CB being 9. Draw CD perpendicular to the chord, then CD will bisect the chord in D, and the arch in E. Now in the right-angled triangle ACD, there is given the hypothenuse AC=9, and the side AD=3; hence, by trigonometry, the angle ACE will be found to contain $19^{\circ}\ 28'\ \frac{3}{10}=19.471$ degrees. The double of this, or 38.942, is the number of degrees in the whole arch AEB. Then by the rule

$$180 : 38.942 :: 9 \times 3.1416 : \frac{9 \times 3.1416 \times 38.942}{180}$$

$=6.11701$ the answer.

Rule II.

From 8 times the chord of half the arch subtract the chord of the whole arch, and $\frac{1}{3}$ of the remainder will be the length of the arch nearly.

This rule may be demonstrated briefly thus. Let a denote an arch of a circle; then from the series expressing the sine of an arch in terms of the arch, (see Fluxions, § 70. *Ex.* 3. also Trigonometry) we have, putting rad. = 1,

$$\text{Sin. } \tfrac{1}{2}a=\tfrac{1}{2}a-\frac{a^3}{48}+\frac{a^5}{3840}-, \&c.$$

Therefore, if the arch a be small, so that a^5 is a very small quantity, then

$$\text{Sin. } \tfrac{1}{2}a=\tfrac{1}{2}a-\frac{a^3}{48} \text{ nearly.}$$

In like manner we have

$$\text{Sin. } \tfrac{1}{4}a=\tfrac{1}{4}a-\frac{a^3}{384} \text{ nearly.}$$

By means of the two last equations exterminate the quantity a^3, and the resulting equation is

$$16 \text{ sin. } \tfrac{1}{4}a - 2 \text{ sin. } \tfrac{1}{2}a = 3a.$$

But $16 \text{ sin. } \frac{1}{4}a = 8 \text{ chord } \frac{1}{2}a$, and $2 \text{ sin. } \frac{1}{2}a = \text{chord } a$.

Therefore $8 \text{ chord } \frac{1}{2}a - \text{chord } a = 3a$.

Here we have supposed the radius of the circle to be unity; but the same must evidently be true, whatever be the radius of the circle.

Fig. 23. *Example.* Suppose as before, that the chord AB is 6, and the radius AC is 9. Then $CD=\sqrt{(CA^2-AD^2)}$ $=\sqrt{72}=8.4852814$, and $DE=9-8.4852814=0.5147186$,

and hence $AE=\sqrt{(AD^2+DE^2)}=3.043836$.

Then by the rule

$$\frac{3.043836\times 8-6}{3}=6.116896$$

is the length of the arch, nearly the same as before.

Problem X.

To find the area of a circle.

Rule I.

Multiply half the circumference by half the diameter, and the product will be the area.

Rule II.

Multiply the square of the diameter by .7854, and the product will be the area.

The first of these rules has been demonstrated in Geometry, Sect. VI. Prop. 3. And the second rule is deduced from the first, as follows. It appears from Prop. 6. Sect. VI. Geometry, that the diameter of a circle being unity, its circumference is 3.1416 nearly; therefore, by the first rule, its area is $1\times 3.1416\div 4$ $=.7854$. But circles are to one another as the squares of their diameters, (Prop. 4.) therefore, putting d for the diameter of any circle, $1 : d^2 :: .7854 : .7854\, d^2$ = the area of the circle whose diameter is d.

Example. What is the area of a circle whose diameter is 7.

By the second rule $7\times 7\times .7854=38.4846$ the area.

By the first rule $7\times 3.1416=$ the circumference.

Then $\frac{7\times 3.1416\times 7}{4}=7\times 7\times .7854$ the area, the same as before.

Problem XI.

To find the area of any sector of a circle.

Rule I.

Multiply the radius by half the arch of the sector, and the product will be the area, as in the whole circle.

Rule II.

As 360 is to the degrees in the arc of the sector, so is the area of the whole circle to the area of the sector.

The first of these rules follows easily from the rule for the whole area, by considering that the whole circumference is to the arch of the sector, as the whole area to the area of the sector, that is,

circum. : arch of sect. :: rad. $\times \frac{1}{2}$ circum. : area of sect.

Hence area of sect. = rad. $\times \frac{1}{2}$ arch of sect.

The second rule is too obvious to need any formal proof.

Example. To find the area of a circular sector ACB whose arch AEB contains 18 degrees, the diameter being 3 feet. Fig. 23.

1. By the first rule.

First $3.1416\times 3=9.4248$ the circum.

And $360 : 18 :: 9.4248 : .47124$ the arch of sect.

Then $.47124\times 3\div 4=.35343$ the area.

2. By the second rule.

First $.7854\times 3^2=7.0686$ the area of the circle.

Then $360 : 18 :: 7.0686 : .35343$ the area.

Problem

Problem XII.

To find the area of a ſegment of a circle.

Rule I.

Find the area of the ſector having the ſame arch with the ſegment by the laſt problem. Find alſo the area contained by the chord of the ſegment and the two radii of the ſector. Then take the ſum of theſe two for the anſwer when the ſegment is greater than a ſemicircle, or take their difference when it is leſs than a ſemicircle. As is evident by inſpection of the figure of a ſegment.

Fig. 23. *Example.* To find the area of the ſegment AEBDA, its chord AB being 12, and the radius AC or BC 10.

Firſt, as AC : AD :: rad. : ſin. $36^\circ\ 52'\frac{1}{5} = 36.87$ degrees, the degrees in the angle ACE or arch AE. And their double, or $73.74 =$ the degrees in the whole arch AEB.

Now $.7854 \times 400 = 314.16$ the area of the whole circle.

Therefore $360^\circ : 73.74 :: 314.16 : 64.3504 =$ area of the ſector CAEB.

Again $\sqrt{(CA^2 - AD^2)} = \sqrt{(100-36)} = \sqrt{64} = 8 = DC$.

Therefore $AD \times DC = 6 \times 8 = 48 =$ area of the triangle.

Hence ſector ACBA — triangle ACB $= 16.3504$ the area of ſeg. AEBDA.

Problem XIII.

To find the area of any ſegment of a parabola, that is the ſpace included by any arch of a parabola, and the ſtraight line joining its extremities.

Rule.

Multiply the baſe of the ſegment by its height, and take $\frac{2}{3}$ of the product for the area.

This rule is demonſtrated in Prop. 12. Part I. Conic Sections.

Fig. 24. *Example.* The baſe AB of a parabolic ſegment ACB is 10, and its altitude CD, (that is, the greateſt line that can be drawn in the ſegment perpendicular to the baſe AB) is 4: What is its area?

$$\text{Here } 10 \times 4 \times \tfrac{2}{3} = \frac{80}{3} = 26\tfrac{2}{3} \text{ the area.}$$

Problem XIV.

To find the area of an ellipſe.

Rule.

Multiply the product of the two axes by the number .7854 for the area of the ellipſe.

For the area of an ellipſe is equal to the area of a circle whoſe diameter is a mean proportional between the axes of the ellipſe, (Conic Sections, Part II. Prop. 22.) that is, to the area of a circle, the ſquare of whoſe diameter is equal to the product of the axes. But by Prob. X. the area of a circle is equal to the ſquare of the diameter multiplied by .7854; therefore the area of an ellipſe is equal to the product of the axes multiplied by the ſame number .7854.

Example. If the axes of an ellipſe, ABCD, be 35 and 25. What is the area? Fig. 25.

$$35 \times 25 \times .7854 = 687.225 \text{ the area.}$$

Note. As to hyperbolic areas, the mathematical reader will find formulas for their exact menſuration in Fluxions, § 152. Ex. 4. and 5.

Problem XV.

To find nearly the area of a figure bounded by any curve line $A\,a\,a''\,a''$, &c. P, and a ſtraight line BQ and AB, PQ two other ſtraight lines drawn from the extremities of the curve perpendicular to BQ.

Rule.

Let BQ, the baſe of the figure, be divided into any even number of equal parts by the perpendiculars $b\,a$, $b'\,a'$, $b''\,a''$, &c. which meet the curve in the points a, a', a'', &c. Fig. 26.

Let F and L denote the firſt and laſt perpendiculars AB and PQ.

Let E denote the ſum of all the remaining even perpendiculars, viz. $a\,b$, $a''\,b''$, $a''''\,b''''$, the ſecond, fourth, ſixth, &c.

Let R denote the ſum of the remaining perpendiculars, viz. $a'\,b'$, $a'''\,b'''$, &c.

And put D for Bb, or bb', &c. the common diſtance between the perpendiculars.

Then the area of the figure will be nearly equal to

$$\tfrac{1}{3}D \times (F + L + 4\,E + 2\,R);$$

and the approximation will be ſo much the more accurate according as the number of perpendiculars is the greater.

Demonſtration. Join the tops of the firſt and third perpendiculars by the line A a' meeting the ſecond perpendicular in E, and draw CD through a ſo as to form the parallelogram A a' DC; then the ſpace bounded by the curve line A $a\,a'$ and the three ſtraight lines AB, B b', $b'\,a'$ will be made up of the trapezoid AB $b'\,a'$, and the ſpace bounded by the arch A $a\,a'$ and its chord A a'. Now if the arch A $a\,a'$ be ſmall, this laſt ſpace will be nearly two-thirds of the parallelogram AD, for it will be nearly equal to the area contained by the ſtraight line A a', and an arch of a parabola paſſing through the points A, a, a', and having $a\,b$ for a diameter, which area is $\frac{2}{3}$ of its circumſcribing parallelogram. (Conic Sections, Part I. Prop. 12.). Therefore the ſpace A $a\,a'\,b'$ BA will be nearly equal to the ſum of the trapezoid AB $b'\,a'$ and $\frac{2}{3}$ of the parallelogram AD, which ſum is evidently equal to $\frac{1}{3}$ of the trapezoid AB $b'\,a'$, together with $\frac{2}{3}$ of the trapezoid CB b' D.

Of Plane Figures.

CBb'D. Now the area of the trapezoid AB$b'a'$ is $\frac{AB+a'b'}{2}\times Bb'$ (GEOMETRY, Sect. IV. Theor. 7.) $=\frac{AB+a'b'}{2}\times 2Bb$; and in like manner the area of the trapezoid CBb'D is $\frac{CB+Db'}{2}\times Bb'=ab\times 2Bb$; therefore the area of the figure A$a\,a'\,b'$ B is nearly

$$\tfrac{1}{3}\times\frac{AB+a'b'}{2}\times 2Bb+\tfrac{2}{3}\times ab\times 2Bb$$

$$=\tfrac{1}{3}(AB+4ab+a'b')Bb.$$

In the very same way it may be shewn that the area of the figure $a'\,a''\,a'''\,b'''\,b'$ is nearly

$$\tfrac{1}{3}(a'b'+4a''b''+a'''b''')\times Bb,$$

and that the area of the figure $a'''\,a^{iv}$ PQb''' is nearly

$$\tfrac{1}{3}(a'''b'''+4a^{iv}b^{iv}+PQ)\times Bb.$$

Therefore, the area of the whole figure bounded by the curve line AP, and the straight lines AB, BQ, QP, is nearly equal to the sum of these three expressions, namely to

$$\tfrac{1}{3}Bb\times\left\{\begin{array}{c}AB+PQ\\+4(ab+a''b''+a^{iv}b^{iv})\\+2(a'b'+a'''b''')\end{array}\right\}$$

as was to be demonstrated.

Fig. 27. *Example* 1. Let it be required to find the area of the quadrant ABC, whereof the radius AC=1.

Let AC be bisected by the perpendicular DE, and let CD be divided into four equal parts by the perpendiculars mn, pq, rs. Now because CA=1, therefore CD$=\frac{1}{2}$, C$r=\frac{3}{8}$, C$p=\frac{1}{4}$, C$m=\frac{1}{8}$. Hence DE $=\sqrt{(EC^2-CD^2)}=\sqrt{(1-\frac{1}{4})}=\frac{1}{2}\sqrt{3}$; and in like manner $rs=\frac{1}{8}\sqrt{55}$, $pq=\frac{1}{4}\sqrt{15}$, $mn=\frac{1}{8}\sqrt{63}$. Therefore

$$\begin{array}{ll}F+L=1+\frac{1}{2}\sqrt{3} & =1.8660\\ 4E=\frac{1}{2}\sqrt{55}+\frac{1}{2}\sqrt{63} & =7.6767\\ 2R=\frac{1}{2}\sqrt{15} & =1.9365\end{array}$$

The sum	11.4792
Multiply by $\frac{1}{3}$ D =	$\frac{1}{24}$
The product is	.4783
Subtract the triangle CDE =	.2165
There remains the sector CBE =	.2618
The triple of which is the quadrant ABC =	.7854

Fig. 28. *Ex.* 2. To find the area of the hyperbola FDM, of which the abscifs FM=10, the semiordinate MD=12, and semitransverse CF=15.

Let FM be divided into five equal parts by the semiordinates HI, mn, pq, rs. Thus CH=17, Cm=19, Cp=21, Cr=23, CM=25. Now, since from the nature of the curve, $\sqrt{(CM^2-CF^2)}$: MD :: $\sqrt{CH^2-CF^2)}$: HI (CONIC SECTIONS, Part III. Prop. 19. and GEOMETRY, Sect. IV. Theor. 12.), that is, in numbers, 20 : 12 :: 8 : HI, therefore HI$=\frac{24}{5}$. In like manner we find $mn=\frac{6}{5}\sqrt{34}$, $pq=\frac{18}{5}\sqrt{6}$, and $rs=\frac{12}{5}\sqrt{19}$. Therefore

$$\begin{array}{lcl}F+L(=HI+MD) & = & 16.8\\ 4E(=4mn+4rs) & = & 68.8399\\ 2R(=2pq) & = & 17.6363\end{array}$$

The figure HIDM $=103.2762\times\frac{2}{3}=68.8508$

to which adding FIH, considered as a portion of a parabola, we have 75.245 for the area of the hyperbola.

OF LAND SURVEYING.

THE instruments most commonly employed in land surveying are the Chain, the Plane Table, and Cross.

A statute acre of land being 160 square poles, the chain is made 4 poles, or 66 feet in length, that 10 square chains, (or 100,000 square links) may be equal to an acre. Hence each link is 7.92 inches in length.

The plane table is used for drawing a plan of a field, and taking such angles as are necessary to calculate its area. It is of a rectangular form, and is surrounded by a moveable frame, by means of which a sheet of paper may be fixed to its surface. It is furnished with an index by which a line may be drawn on the paper in the direction of any object in the field, and with scales of equal parts by which such lines may be made proportional to the distances of the objects from the plane table when measured by the chain, and its frame is divided into degrees for observing angles.

The cross consists of two pair of sights set at right angles to each other upon a staff having a pike at the bottom to stick into the ground. Its use is to determine the points where a perpendicular drawn from any object to a line will meet that line; and this is effected by finding by trials a point in the line, such that the cross being fixed over it so that one pair of the sights may be in the direction of the line, the object from which the perpendicular is to be drawn may be seen through the other pair; then the point thus found will be the bottom of the perpendicular, as is evident.

A theodolite may also be applied with great advantage to land-surveying, more especially when the ground to be measured is of great extent.

In addition to these, there are other instruments employed in surveying, as the perambulator, which is used for measuring roads and other great distances. Levels, with telescopic or other sights, which are used to determine how much one place is higher or lower than another. An offsett-staff for measuring the offsetts and other short distances. Ten small arrows, or rods of iron or wood, which are used to mark the end of every chain length. Pickets or staves with flags to be set up as marks or objects of direction; and lastly, scales, compasses, &c. for protracting and measuring the plan upon paper.

The observations and measurements are to be regularly entered as they are taken, in a book which is called the Field-book, and which serves as a register of all that is done or occurs in the course of the survey.

To

Of Plane Figures.

To Measure a Field by the Chain.

Fig. 29. Let $AmBCDq$ represent a field to be measured. Let it be resolved into the triangles AmB, ABD, BCD, AqD. Let all the sides of the large triangles ABD, BCD, and the perpendiculars of the small ones AmB, AqD from their vertices m, q be measured by the chain, and the areas calculated by the rules delivered in this section, and their amount is the area of the whole. But if, on account of the curvature of its sides the field cannot be wholly resolved into triangles, then, either a straight line may be drawn over the curve side, so that the parts cut off from the field, and those added to it, may be nearly equal. Or, without going beyond the bounds of the field, the curvilineal spaces may be measured by the rule given in Prob. XV. of this section.

To Measure a Field with the Plane Table.

Fig. 30. Let the plane table be fixed at F, about the middle of the field ABCDE, and its distances FA, FB, FC, &c. from the several corners of the field measured by the chain. Let the index be directed from any point assumed on the paper to the points A, B, C, D, &c. successively, and the lines Fa, Fb, Fc, drawn in these directions. Let the angles contained by these lines be observed, and the lines themselves made proportional to the distances measured. Then their extremities being joined, there will be formed a figure $abcde$ similar to that of the field; and the area of the field may be found by calculating the areas of the several triangles of which it consists.

To Plan a Field from a given Base Line.

Fig. 31. Let two stations A, B be taken within the field, but not in the same straight line with any of its corners; and let their distance be measured. Then the plane table being fixed at A, and the point a assumed on its surface directly above A, let its index be directed to B, and the straight line ab drawn along the side of it to represent AB. Also, let the index be directed from a to an object at the corner C, and an indefinite straight line drawn in that direction, and so of every other corner successively. Next, let the plane table be set at B, so that b may be directly over B, and ba in the same direction with BA, and let a straight line be drawn from b in the direction BC. The intersection of this line with the former, it is evident, will determine the point C, and the triangle abc on the paper will be similar to ABC in the field. In this manner all the other points are to be determined, and these being joined there will be an exact representation of the field.

If the angles at both stations were observed, as the distance between them is given, the area of the field might be calculated from these data, but the operation is too tedious for practice. It is usual therefore to measure such lines in the figure that has been constructed as will render the calculation easy.

SECTION III.

MENSURATION OF SOLIDS.

Problem I.

To find the surface of a right prism, or cylinder.

Of Solids.

Rule.

Multiply the perimeter of the end by the length or height of the solid, and the product will be the surface of all its sides; to which add also the area of the two ends of the prism when required.

The truth of this rule will be evident, if it be considered that the sides of a right prism are rectangles, whose common length is the same as the length of the solid, and their breadths taken all together make up the perimeter of the ends of the prism. And as a cylinder may be considered as the limit of all the prisms which can be inscribed in or circumscribed about its base; so the surface of the cylinder will be the limit of the surfaces of these prisms, and the expression for that limit is evidently the product of the circular base by its height. Or a cylinder may be considered as a prism of an indefinitely great number of sides.

Ex. 1. What is the surface of a cube, the length of its side AB being 20 feet? Fig. 32.

Here	$4\times20=$	80 the perim. of end.
And	$80\times20=$	1600 the four sides.
And	$2\times20\times20=$	800 the top and bottom.
The sum		$2400=$ the area or surface.

Ex. 2. What is the convex surface of a cylinder whose length AB is 20 feet, and the circumference of its base 3 feet? Fig. 33.

Here $3\times20=60$ feet, the answer.

Problem II.

To find the surface of a right pyramid or cone.

Rule.

Multiply the perimeter of the base by the slant height or length of the side, and half the product will evidently be the surface of the sides, or the sum of the areas of all the triangles which form it. To which add the area of the end or base, if required.

Note. Here a cone is considered as a pyramid of an indefinitely great number of sides.

Ex. 1. What is the upright surface of a triangular pyramid, ABCD, the slant height, AE, being 20 feet, and each side of the base 3 feet? Fig. 34.

Here $\frac{3\times3\times20}{2}=90$ feet, the surface.

Ex. 2. Required the convex surface of a cone, the slant height AB being 50 feet, and the diameter of its base $8\frac{1}{2}$ feet. Fig. 35.

Here $8.5\times3.1416=$ circum. of base.

And $\frac{8.5\times3.1416\times50}{2}=667.59$, the answer.

PROBLEM

Of Solids.

PROBLEM III.

To find the ſurface of the fruſtum of a right pyramid or cone, being the lower part, when the top is cut off by a plane parallel to the baſe.

RULE.

Add together the perimeters of the two ends, and multiply their ſum by the ſlant height, and take half the product for the anſwer.

The truth of this rule will be evident if it be conſidered that the ſides of the fruſtum are trapezoids, whoſe parallel ſides bound its top and baſe, and whoſe common breadth is its ſlant height.

Fig. 36. *Example.* How many ſquare feet are in the ſurface of a fruſtum AG of a ſquare pyramid, whoſe ſlant height RE is 10 feet; alſo each ſide of the greater end AC is 3 feet 4 inches, and each ſide of the leſſer end EG 2 feet 2 inches.

Here $3\frac{1}{3}\times 4 = 13\frac{1}{3}$ the per. of gr. end.

And $2\frac{1}{6}\times 4 = 8\frac{2}{3}$ the per. of leſs end.

And their ſum is 22 feet.

Therefore $\frac{22\times 10}{2} = 110$ feet, is the anſwer.

PROBLEM IV.

To find the ſolid content of any priſm or cylinder.

RULE.

Find the area of the baſe or end of the figure, and multiply it by the height or length, and the product will be the area.

This rule follows immediately from Theor. 11. Sect. VIII. and Theor 2. Sect. IX. GEOMETRY.

Fig. 32. *Ex.* 1. What is the ſolid content of a cube AG, the length of whoſe ſide is 24 inches?

Here $24\times 24 = 576$ ſq. inches, the area of the end.

And $576\times 24 = 13824$ cub. inches is the ſolidity.

Fig. 33. N° 2. *Ex.* 2. Required the content of a triangular priſm, whoſe length AD is 20 feet, and the ſides of its triangular baſe ABC are 3, 4, and 5 feet.

Firſt, the area of the triangular baſe is found by Rule 3. of Prob. 3. Sect. II. to be

$\sqrt{(6\times 3\times 2\times 1)} = 6$ ſq. feet.

Therefore $6\times 20 = 120$ cub. feet the ſolidity.

Ex. 3. The Wincheſter buſhel is a cylinder $18\frac{1}{2}$ inches in diameter, and eight inches deep. How many cubic inches does it contain?

By Prob. 10. of Sect. II. the area of its baſe is

$$.7854\times 18.5^2 = 268.803 \text{ ſq. inches;}$$

Therefore $268.803\times 8 = 2150.424$ is the ſolid content.

PROBLEM V.

To find the ſolid content of any pyramid or cone.

RULE.

Find the area of the baſe, and multiply that area by the height, and one-third of the product will be the content of the ſolid.

This rule is demonſtrated in Theor. 16. Sect. VIII. and Theor. 3. Sect. IX. GEOMETRY.

Ex. 1. What is the content of a triangular pyramid ABCD, whoſe perpendicular height AF is 30 feet, and each ſide of its baſe BCD is three feet. Fig. 34.

Firſt, the area of the baſe, as found by Rule 3. of Prob. 3. Sect. II. is

$$\sqrt{(4.5\times 1.5\times 1.5\times 1.5)} = 3.89711.$$

Therefore $\frac{3.89711\times 30}{3} = 38.9711$ cub. feet is the ſolid content.

Ex. 2. What is the ſolid content of a cone, the radius BC of its baſe being nine inches, and its height AC 15 feet. Fig. 35.

Here $.7854\times \frac{3^2}{2^2} = 1.76715$ is the area of the baſe in ſquare feet.

And $\frac{1.76715\times 15}{3} = 8.8357$ cub. feet is the ſolid content.

PROBLEM VI.

To find the ſolidity of the fruſtum of a cone or pyramid.

RULE.

Add into one ſum the areas of the two ends, and the mean proportional between them, that is, the ſquare root of their product, and one-third of that ſum will be a mean area, which being multiplied by the perpendicular height or length of the fruſtum will give the content.

Demonſtration. Let PABCD be any pyramid, and AG a fruſtum of it contained between ABCD its baſe, and EFGH, a plane parallel to the baſe. Put a for the ſide of a ſquare equal to AC the baſe of the fruſtum; b for the ſide of a ſquare equal to EG its top; h for LM the height of the fruſtum, and c for PL the height of the part of the pyramid above the fruſtum. Then a^2 is the area of the baſe of the fruſtum; b^2 is the area of its top; $\frac{1}{3}a^2(h+c)$ is the ſolid content of the whole pyramid; (GEOM. Sect. VIII. Theor. 16.) $\frac{1}{3}b^2c$ is the content of its upper part; and therefore Fig. 36.

$$\tfrac{1}{3}\left\{a^2(h+c)-b^2c\right\}$$

is the ſolid content of the fruſtum itſelf. Now the baſe and top of the fruſtum being ſimilar figures, (Sect. VIII. Theor.

Of Solids.

Theor. 13.) their areas are to one another as the squares of AB and EF their homologous sides, (Sect. IV. Theor. 27.). But AB : EF :: BP : PF (Sect. VII. Theor. 7. and Sect. IV. Theor. 20.) :: PM : PL, (Sect. VII. Theor. 14.); therefore the area of the base of the frustum is to the area of its top as $PM^2 : PL^2$, that is, $a^2 : b^2 :: (h+c)^2 : c^2$, and consequently $a : b :: h+c : c$; hence $ac = bh + bc$, and $c = \frac{bh}{a-b}$, and $h+c = \frac{ah}{a-b}$. Let these values of c and $h+c$ be now substituted in the preceding expression for the content of the frustum, and it will become, by proper reduction,

$$\tfrac{1}{3} h \frac{a^3 - b^3}{a-b}.$$

Let the numerator of the fractional part of this formula be actually divided by its denominator, and we shall obtain for the area of the frustum this more simple expression,

$$\tfrac{1}{3} h\, (a^2 + ab + b^2),$$

which formula, when expressed in words, is the rule. And as a cone may be considered as the limit of all the pyramids that can be inscribed in it, when the number of sides is conceived indefinitely increased, it is evident that the rule will apply alike to the cone and pyramid.

Ex. 1. Required the solidity of the frustum of a hexagonal pyramid, the side of whose greater end is four feet, and that of its lesser end is three feet, and its height nine feet.

First, by Prob. 7. Sect. II. the area of the base of the frustum is found to be 41.569, and the area of its lesser end 23.383 square feet. And the mean proportional between these is

$$\surd\,(41.569 \times 23.383) = 31.177.$$

Hence the mean area is

$$\tfrac{1}{3}(23.383 + 41.569 + 31.177) = 32.043.$$

And the solid content of the frustum is

$$32.043 \times 9 = 288.387 \text{ cubic feet.}$$

Ex. 2. What is the solidity of the frustum of a cone, the diameter of the greater end being five feet, that of the lesser end three feet, and the altitude nine feet.

Here the area of the greater end is (by Prob. 10. Sect. II.) $5^2 \times .7854$, and the area of the lesser end is $3^2 \times .7854$, and the mean proportional between them is $\surd\,(5^2 \times 3^2 \times .7854^2) = 5 \times 3 \times .7854$; therefore the mean area is

$$\frac{.7854}{3} \times (5^2 + 3^2 + 5 \times 3) = 12.8282.$$

And the content of the frustum

$$12.8282 \times 9 = 115.4538 \text{ cub. feet.}$$

Problem VII.

To find the surface of a sphere, or of any segment or zone of it.

Of Solids.

Rule.

Multiply the circumference of the sphere by the height of the part required, and the product will be the curve surface, whether it be a segment, a zone, or the whole sphere.

Note. The height of the whole sphere is its diameter.

The truth of this rule has been already shown in the article Fluxions, § 165. It may however be deduced from principles more elementary, by reasoning as follows. Let PCQ be a semicircle, and ABCDE several successive sides of a regular polygon inscribed in it. Fig. 37.
Conceive the semicircle to revolve about the diameter PQ as an axis, then the arch ABCDE will generate a portion of the surface of a sphere, and the chords AB, BC, CD, &c. will generate the surfaces of frustums of cones; and it is easy to see that the number of chords may be so great that the surface which they generate shall differ from the surface generated by the arch ACE by a quantity which is less than any assigned quantity. Bisect AB in L, and draw AF, LM, BG, CH, &c. perpendicular to PQ. For the sake of brevity, let *circ.* AF denote the circumference of a circle whose radius is AF. Then because AF, BG, LM, are to each other respectively as *circ.* AF, *circ.* BG, *circ.* LM (Geom. Sect. VI. Prop. 4.), and because $\frac{1}{2}$ (AF + BG) = LM, therefore $\frac{1}{2}$ (*circ.* AF + *circ.* BG) = *circ.* LM. Now the area of the surface generated by the chord AB is $\frac{1}{2}$ (*circ.* AF + *circ.* BG) × AB, (Prob. 3.) therefore the same area is also equal to (*circ.* LM) × AB. Draw AO parallel to FG, and draw LN to the centre of the circle. Then the triangles AOB, LMN are manifestly similar; therefore AB : AO :: NL : LM :: *circ.* NL : *circ.* LM; and hence AO × *circ.* NL = AB × *circ.* LM. But this last quantity has been proved equal to the surface generated by AB, therefore the same surface is equal to AO × *circ.* NL, or to FG × *circ.* NL, that is, to the rectangle contained by FG and the circumference of a circle inscribed in the polygon. In the same way it may be shown that the surfaces generated by BC, CD, DE, are respectively equal to GH × *circ.* LN, HI × *circ.* LN, IK × *circ.* LN. Therefore the whole surface generated by the chords AB, BC, CD, DE, &c. is equal to (FG + GH + HI + IK) × *circ.* LN = FK × *circ.* LN. Conceive now the number of chords between A and E to be indefinitely increased; then, observing that the limit of the surface generated by the chords is the surface generated by the arch ABCDE, and that the limit of NL is NP, the radius of the generating circle, it follows that the spherical surface or zone generated by the arch ACE is equal to the product of the circumference of the sphere by FK the height of the zone.

Ex. 1. What is the superficies of a globe whose diameter is 17 inches?

First $17 \times 3.1416 = 53.4072$ inches = the circum.

Then $53.4072 \times 17 = 907.9224$ sq. inches = 6.305 square feet the answer.

Ex. 2. What is the convex surface of a segment 8 inches in height cut off from the same globe?

Here

Of Solids.

Here $53.4072 \times 8 = 427.2576$ sq. inches $= 2.967$ sq. feet the anſwer.

PROBLEM VIII.

To find the ſolidity of a ſphere.

RULE I.

Multiply the area of a great circle of the ſphere by its diameter, and take $\frac{2}{3}$ of the product for the content.

RULE II.

Multiply the cube of the diameter by the decimal .5236 for the content.

The firſt of theſe rules is demonſtrated in GEOMETRY, Sect. IX. Theor. 6. And the ſecond is deduced from the firſt, thus: put d for the diameter of the ſphere, then $d^2 \times .7854$ is the area of a great circle of the ſphere, and by the firſt rule $\frac{2}{3}d \times d^2 \times .7854 = d^3 \times .5236$ is its content.

Example. What is the content of a ſphere whoſe diameter is 6 feet?

Anſwer $6^3 \times .5236 = 113.0976$ cub. feet.

PROBLEM IX.

To find the ſolid content of a ſpherical ſegment.

RULE.

From 3 times the diameter of the ſphere take double the height of the ſegment, then multiply the remainder by the ſquare of the height, and the product by the decimal .5236 for the content.

This rule has been inveſtigated in FLUXIONS, § 163. But it may be proved in a more elementary manner by means of the following axiom. *If two ſolids be contained between two parallel planes; and if the ſections of theſe ſolids by a third plane parallel to the other two, at any altitude, be always equal to one another, then the ſolids themſelves are equal. Or more generally thus. If two ſolids between two parallel planes be ſuch, that any ſections of them by a third plane parallel to the other two have always to each other the ſame given ratio, then the ſolids themſelves are to one another in that ratio.* We have given this propoſition in the form of an axiom for the ſake of brevity, but its truth may be ſtrictly demonſtrated, as has been done when treating of pyramids and the ſphere, in GEOMETRY, Sect. 8. and 9.

Fig. 38. Let us now ſuppoſe ABE to be a quadrant; C the centre of the circle; AFEC a ſquare deſcribed about the quadrant; and CF the diagonal of the ſquare. Suppoſe the figures to revolve about AC as an axis, then the quadrant will generate a hemiſphere, the triangle ACF will generate a cone, and the ſquare AE a cylinder. Let theſe three ſolids be cut by a plane perpendicular to the axis, and meeting the plane of the ſquare, in the line DHBG; and join CB. Then, becauſe CDB is a right-angled triangle, a circle deſcribed with CB as a radius is equal to two circles deſcribed with CD and DB as radii (GEOMETRY, Sect. VI. Prop. 4. Cor. 2.). But CB=DG, and ſince CA=AF, therefore CD=DH; therefore the circle deſcribed with the radius DG, is equal to the ſum of the circles deſcribed with the radii DH, DB; that is, the ſection of the cylinder at any altitude, is equal to the correſponding ſections of the ſphere and cone taken together. Conſequently, by the foregoing axiom, the cylinder is equal to the hemiſphere and cone taken together, and alſo the ſegment of the cylinder between the planes AF, DG is equal to the ſum of the ſegments of the hemiſphere and cone contained between the ſame planes. Put 2CE, or 2AF, the diameter of the circle, $=d$, and AD, the height of the ſpherical ſegment, $=h$. Then $AC=\frac{1}{2}d$ and $2CA-2AD=2CD=d-2h$. Let n denote the number .7854. Then the area of the baſe common to the conic fruſtum AH, and cylinder AG, is $n\,d^2$, (Sect. II. Prob. 10.), and the area of the top of the fruſtum is $n\,(d-2h)^2$, and the mean proportional between theſe areas is $n\,(d-2h)\,d$. Therefore the ſolid content of the fruſtum is (by Prob. 6. of this ſect.)

$$\frac{1}{3}\left\{n\,d^2+n\,(d-2\,h)^2+n\,d\,(d-2\,h)\right\}\times h.$$

$$=n\,d^2\,h-2\,n\,d\,h^2+\tfrac{4}{3}\,n\,h^3.$$

Now the ſolid content of the cylinder is $n\,d^2\,h$: (Prob. 1.) Therefore the ſolid content of the ſpherical ſegment, (which is equal to the difference between the cylinder AG and conic fruſtum AH) is equal to

$$n\,d^2\,h-(n\,d^2\,h-2\,n\,d\,h^2+\tfrac{4}{3}\,n\,h^3),$$

that is, to $2\,n\,d\,h^2-\frac{4}{3}\,n\,h^3$, or to

$$\frac{2\,n}{3}(3\,d-2\,h)\,h^2,$$

which expreſſion, if it be conſidered that $\frac{2\,n}{3}$ or $\frac{2\times.7854}{3}$ is equal to .5236, is evidently the ſame as that given by the rule.

Example. In a ſphere whoſe diameter is 21, what is the ſolidity of a ſegment whoſe height is 4.5 inches?

Firſt $3\times21-2\times4.5=54$.

Then $54\times4.5\times4.5\times.5236=572.5566$ inches, the ſolidity required.

PROBLEM X.

To find the ſolid content of a paraboloid, or ſolid, produced by the rotation of a parabola about its axis.

RULE.

Multiply the area of the baſe by the height, and take half the product for the content.

To demonſtrate this rule, let AGC and BHD be two equal ſemi-parabolas lying in contrary directions, and having their vertices at the extremity of the line AB. Let AD, BC be ordinates to the curves. Complete the rectangle ABCD, and conceive it to revolve about AB as an axis; then the rectangle will generate a cylinder, the radius of whoſe baſe will be AD, and the two ſemi-parabolas will generate two equal paraboloids having the ſame baſe and altitude as the cylinder. Let a plane be drawn perpendicular to the axis, and let FHGE be the common ſection of this plane and the Fig. 39.

generating

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generating figure. Let P denote the parameter of the axis. Then since

$$EG^2 = P \times AE,$$
$$\text{and } EH^2 = P \times EB,$$
$$EG^2 + EH^2 = P \times AB = CB^2.$$

Hence it appears, as in the demonſtration of the preceding rule, that of the ſolids deſcribed by ADCB, ACB, ADB between the ſame parallel planes, the ſection of the cylinder at any altitude is equal to the correſponding ſections of the paraboloids taken together. Conſequently (by the Axiom) the cylinder is equal to both the paraboloids taken together; hence each is half a cylinder of the ſame baſe and altitude agreeing with the rule.

The ſame thing is alſo proved in FLUXIONS, § 163.

Example. If the diameter of the baſe of a paraboloid be 10 and its height 12 feet; what is its content?

Here $10 \times .7854 = 7.854$ the area of the baſe.

And $\frac{1}{2} \times 7.854 \times 12 = 47.124$ cub. feet is the ſolidity.

PROBLEM X.

To find the ſolid content of a fruſtum of a paraboloid.

RULE.

Add together the areas of the circular ends, then multiply that ſum by the height of the fruſtum, and take half the product for its ſolid content.

To prove this rule put A and a for the greater and leſſer ends of the fruſtum, and h for its height; alſo let c denote the height of the portion cut off from the complete paraboloid, ſo as to form the fruſtum. Then, by the laſt problem, the content of the complete paraboloid is $\frac{1}{2}$ A $(h+c)$, and the content of the part cut off is $\frac{1}{2}\, a\, c$, therefore the content of the fruſtum is

$$\tfrac{1}{2}\left\{A(h+c) - a c\right\} = \tfrac{1}{2}\left\{A\, h + c(A - a)\right\}$$

But from the nature of the parabola, $c : h+c :: a : A$;

hence $A\, c = a\, h + a\, c$ and $c = \dfrac{a\, h}{A - a}$.

Let this value of c be ſubſtituted inſtead of it in the above expreſſion for the content of the fruſtum, and it becomes

$$\tfrac{1}{2}(A\, h + a\, h) = \tfrac{1}{2} h(A + a),$$

and hence is derived the rule.

Example. Required the ſolidity of the fruſtum of a paraboloid, the diameter of the greater end being 58, and that of the leſſer end 30, and the height 18.

Firſt, (by Prob. 10. Sect. II.) we find the areas of the ends to be $58^2 \times .7854$, and $30^2 \times .7854$; therefore their ſum is $(58^2 + 30^2) \times .7854 = 4264 \times .7854$. And the content of the figure is $\frac{1}{2} \times 4264 \times .7854 \times 18 = 30140.5104$, the anſwer.

PROBLEM XI.

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To find the ſolid content of a parabolic ſpindle or ſolid generated by the rotation of AEB an arc of a parabola, about AB an ordinate to the axis. Fig. 40.

RULE.

Multiply the area of the middle ſection by the length, and take $\frac{8}{15}$ of the product for the content of the ſolid.

For the inveſtigation of this rule we muſt refer the reader to FLUXIONS, § 163. *Ex.* 2.

Example. The length of the parabolic ſpindle AEBeA is 60, and the middle diameter Ee 34; what is the ſolidity?

Here $34^2 \times .7854$ is area of the middle ſection.

Therefore $34^2 \times .7854 \times 60 \times \frac{8}{15} = 29053.5168$ is the ſolidity required.

PROBLEM XII.

To find the ſolid content of the fruſtum of a parabolic ſpindle, one of the ends of the fruſtum paſſing through the centre of the ſpindle.

RULE.

Add into one ſum eight times the ſquare of the diameter of the greater end, and three times the ſquare of the leſſer end, and four times the product of the diameters; multiply the ſum by the length, and the product multiplied by .05236, or $\frac{1}{15}$ of .7854, will be the content.

For, referring the reader to FLUXIONS, § 163. Ex. 2. as before, and ſubſtituting h for $AC = \frac{1}{2} b$, but, in other reſpects, retaining the figure and notation, we have this general expreſſion for the ſegment APp,

$$\frac{\pi x^3}{a^2}\left(\frac{4\, h^2}{3} - h\, x + \frac{x^2}{5}\right),$$

which, when $x = h$ gives $\dfrac{8\, \pi\, h^5}{15\, a^2}$ for the value of the ſemi-ſpindle. From this quantity let the former be ſubtracted, and there will remain

$$\frac{8\, \pi\, h^5}{15\, a^2} - \frac{\pi x^3}{a^2}\left(\frac{4\, h^2}{3} - h\, x + \frac{x^2}{5}\right)$$

for the content of the fruſtum. In this expreſſion let z be put inſtead of $h - x$ or CD, and, denoting CE the radius of the greater end of the ſpindle by d, let $\dfrac{h^2}{d}$ be ſubſtituted inſtead of its value a. Then we ſhall have the content of the fruſtum otherwiſe expreſſed by

$$\frac{\pi\, d^2\, z}{h^4}\left\{h^4 - \frac{2\, h^2\, z^4}{3} + \frac{z^4}{5}\right\}$$

which value, by putting $h\sqrt{\dfrac{d-y}{d}}$ in its two laſt terms

inſtead

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instead of z, is changed to

$$\pi z \times \frac{8d^2+4dy+3y^2}{15},$$

and hence is derived the preceding rule.

Example. Suppose the diameter of the greater end to be 8, and the diameter of the lesser end 6, and the length 10, required the content?

First $8\times 8^2+3\times 6^2+4\times 8\times 6=812$.

Then, $812\times 10\times .05236=425.1632$, the content.

PROBLEM XIII.

To find the solid content of a spheroid, or solid generated by the rotation of an ellipse about either axis.

RULE.

Multiply continually together the fixed axis, and the square of the revolving axis, and the number .5236 or $\frac{1}{6}$ of 3.1416, and the last product will be the solidity.

Fig. 41. For, let the semiellipse ADB, and semicircle AEB, revolve about the same fixed axis AB, and thus generate a spheroid and sphere. Let CD the revolving semiaxis of the ellipse meet the circle in E, and draw QP any ordinate to the fixed axis meeting the circle in R. Then, from the nature of the ellipse $PQ^2 : PR^2 :: CD^2 : CE^2$ or CA^2 (CONIC SECTIONS, Part II. Prop. 11. Cor. 3.). Hence it follows, (GEOMETRY, Sect. VI. Prop. 4.), that every section of the spheroid is to the corresponding section of the sphere in the same given ratio, namely, that of the square of the revolving axis to the square of the fixed axis; therefore (Axiom in the dem. of Prob. 9.) the whole spheroid is to the whole sphere in the same ratio. That is, (because the content of the sphere is $AB^3\times .5236$) $AB^2 : (2CD)^2 :: AB^3\times .5236$: (the cont. of spheroid). Hence the content of the spheroid is $AB\times(2CD)^2\times .5236$.

Ex. 1. What is the solid content of an oblong spheroid, or solid generated by the rotation of an ellipse about its greater axis, the axes being 50, and 30?

Here $50\times 30^2\times .5236=23562$, the content.

Ex. What is the solid content of an oblate spheroid, or solid generated by the rotation of an ellipse about its lesser axis, the two axes being as before.

Here $30\times 50^2\times .5236=39270$ the answer.

PROBLEM XIV.

To find the solid content of the frustum of a spheroid, its ends being perpendicular to the fixed axis, and one of them passing through the centre.

RULE.

To the area of the less end add twice that of the greater, multiply the sum by the altitude of the frustum, and $\frac{2}{3}$ of the product will be the content.

Note. This rule will also apply to the sphere.

Demonstration. Let ABE be a quadrant of an ellipse, C its centre, CAFE its circumscribed rectangle, and CF its diagonal. Draw any straight line DG parallel to CE, meeting AC, CF, ABE and EF in D, H, B, and G. Then by CONIC SECTIONS, Part II. Prop. 11. — Fig. 42.

$$CE^2 \text{ or } AF^2 : DB^2 :: CA^2 : CA^2-CD^2,$$

and by sim. tr. $AF^2 : DH^2 :: CA^2 : CD^2$.

Therefore (GEOMETRY, Sect. III. Theor. 8.),

$$AF^2 : DB^2+DH^2 :: CA^2 : CA^2;$$
$$\text{Hence } DB^2+DH^2=AF^2=DG^2.$$

Conceive now the figure to revolve about AC as an axis, so that the elliptic quadrant may generate the half of a spheroid, the rectangle AE a cylinder, and the triangle ACF a cone; then it is evident (as was shown in the case of the sphere in Prob. 9.) that every section of the first of these solids by a plane perpendicular to the axis is equal to the difference of the sections of the other two, and consequently that the frustum of the spheroid between CE and DG is equal to the difference between the cylinder having DG or CE for the radius of its base, and CD for its altitude, and the cone having DH for the radius of its base, and DC for its altitude.

Put n for the number 3.1416, then (Prob. 4.) the content of the cylinder is $4n\times DG^2\times CD$, and (Prob. 5.) the content of the cone is $\frac{4}{3}n\times DH^2\times CD$, and therefore the content of the frustum of the spheroid is

$$4n\times CD\,(DG^2-\tfrac{1}{3}DH^2).$$

But it was shewn that $DH^2=DG^2-DB^2$; therefore the content of the frustum is also equal to

$$\tfrac{4}{3}n\times CD\,(2\,CE^2+DB^2),$$

and hence is derived the rule.

Ex. Suppose the greater end of the frustum to be 15, the less end 9, and the length 10 inches, required the content?

The area of the greater end is $15^2\times .7854$, and the area of the less $9^2\times .7854$, therefore the content is

$.7854\,(9^2+2\times 15^2)\times\frac{10}{3}=1390.158$ cubic inches.

PROBLEM XV.

To find the solid content of a hyperboloid, or solid generated by the rotation of a hyperbola about its transverse axis.

RULE.

As the sum of the transverse axis and the height of the solid is to the sum of the said transverse axis and $\frac{2}{3}$ of the height, so is half the cylinder of the same base and altitude to the solidity of the hyperboloid.

Demonstration. Let BAb be a hyperbola, Aa its transverse axis, C its centre, CF, Cf its asymptotes, FAf a tangent at its vertex. Draw FE parallel to CA, and draw any straight line parallel to Ff, meeting the asymptotes in H and h, the curve in B and b, the axis in D, and the line FE in G. Then, because $AF^2=BH\times hB$ (CONIC SECTIONS, Part III. Prop. 11.) and — Fig. 43.

Of Solids. and $HB \times hB = DH^2 - DB^2$ (GEOMETRY, Sect. IV. Theor. 12.), therefore $AF^2 = DH^2 - DB^2$, and $DB^2 = HD^2 - DG^2$. Hence it appears, that if the figure be conceived to revolve about CA as an axis, so that the hyperbolic arc AB may generate a hyperboloid, the triangle DCH a cone, and the rectangle DAFG a cylinder, any section of the first of these solids by a plane Hh, perpendicular to the axis, will be equal to the difference of the sections of the other two by the same plane. Therefore the hyperboloid BAb is equal to the difference between the conic frustum $FHhf$ and the cylinder $FGgf$. Let Aa the transverse axis be denoted by p, Ff = its conjugate axis by q, AD the height of the solid by h, Bb its base by b. Then, because by similar triangles, &c.

$$CA : CD :: Ff : Hh :: Ff^2 : Ff \times Hh,$$

therefore $Ff \times Hh = \frac{CD}{CA} \times Ff^2 = \frac{(\frac{1}{2}p+h)\,q^2}{\frac{1}{2}p} = q^2 + \frac{2hq^2}{p}$.

Now $Ff^2 = q^2$, and Hh^2 $(= Bb^2 + Ff^2) = b^2 + q^2$, therefore putting n for .7854, we have (by Prob. 6.) the content of the conic frustum $FHhf$ equal to

$$\frac{nh}{3}\left(q^2+b^2+q^2+q^2+\frac{2hq^2}{p}\right) = \frac{nh}{3}\left(3q^2+b^2+\frac{2hq^2}{p}\right);$$

from this subtract nhq^2, the expression for the content of the cylinder $FGgf$, and there will remain

$$\frac{nh}{3}\left(b^2+\frac{2hq^2}{p}\right)$$

for the content of the hyperboloid. But from the nature of the hyperbola

$$Aa^2 : Ff^2 :: AD \times Da : BD^2,$$

that is, $p^2 : q^2 :: (p+h)\,h : \frac{1}{4}b^2$;

therefore $\frac{2hq^2}{p} = \frac{pb^2}{2(p+h)}$; and hence the content of the hyperboloid is also equal to

$$\frac{nh}{3}\left(b^2+\frac{pb^2}{2(p+h)}\right) = \frac{nhb^2}{2} \times \frac{p+\frac{2}{3}h}{p+h}.$$

Now if it be considered that the quantity nhb^2 is the expression for the content of a cylinder whose base is b and height h, it will appear evident, that this last formula is the same as would result from the foregoing rule.

Ex. Suppose the height of the hyperboloid to be 10, the radius of its base 12, and its transverse axis 30. What is its content?

1. Because a cylinder of the same base and altitude is $24^2 \times .7854 \times 10$, therefore, we have the proportion,

$$40 : \frac{110}{3} :: \frac{24^2 \times .7854 \times 10}{2} :$$

$$\frac{24^2 \times .7854 \times 10 \times 110}{40 \times 3 \times 2} = 2073.456,$$ the content of the solid as required.

Of GAUGING.

GAUGING treats of the measuring of casks, and other things falling under the cognizance of the officers of the excise, and it has received its name from a gauge or rod used by the practitioners of the art. Of Gauging.

From the way in which casks are constructed, they are evidently solids of no determinate geometrical figure. It is, however, usual to consider them as having one or other of the four following forms:

1. The middle frustum of a spheroid.
2. The middle frustum of a parabolic spindle.
3. The two equal frustums of a paraboloid.
4. The two equal frustums of a cone.

We have already given rules by which the content of each of these solids may be found in cubit feet, inches, &c. But as it is usual to express the contents of casks in gallons, we shall give the rules again in a form suited to that mode of estimating capacity. Observing that in each case the lineal dimensions of the cask are supposed to be taken in inches.

PROBLEM I.

To find the content of a cask of the first, or spheroidal variety.

RULE.

To the square of the head diameter add double the square of the bung diameter, and multiply the sum by the length of the cask. Then let the product be multiplied by $.0009\frac{1}{4}$, or divided by 1077 for ale gallons, or multiplied by $.0011\frac{1}{3}$ or divided by 882 for wine gallons.

The truth of this rule may be proved thus. Put B for FG, the bung diameter, H for AH the head diameter, and L for AD, the length of the cask, then (by Prob. 14.) the content of the cask is $(2B^2+H^2)L \times \frac{.7854}{3}$, which being divided by 282 (the cubic inches in an ale gallon) gives $(2B^2+H^2)L \times .000928371$, or $(2B^2+H^2) \times \frac{1}{1077.157} \times L$, for the content in ale gallons. And being divided by 231, (the cubic inches in a wine gallon) gives $(2B^2+H^2) \times .00113333\,L$, or $(2B^2+H^2) \times \frac{1}{882.355} \times L$, for the content in wine gallons. Fig. 44.

Ex. Suppose the bung and head diameters to be 32 and 24, and the length 40 inches. Required the content?

Here $(2 \times 32^2 + 24^2) \times 40 \times .0009\frac{1}{4} = 97.44$ ale gallons, is the content required.

And $(2 \times 32^2 + 24^2) \times 40 \times .0011\frac{1}{3} = 118.95$ wine gallons is the same content.

PROBLEM II.

To find the content of a cask of the second, or parabolic spindle form.

RULE.

To the square of the head diameter add double that of the bung diameter, and from the sum take $\frac{2}{5}$, or $\frac{4}{10}$ of

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of the ſquare of the difference of the ſaid diameters. Then multiply the remainder by the length, and the product multiplied, or divided by the ſame numbers as in the rule to laſt problem, will give the content.

For by Problem 12. the content in inches is

$$\frac{8B^2+4BH+3H^2}{15}\times .7854\,L;$$

and this formula may be otherwiſe expreſſed thus,

$$\left\{2B^2+H^2-\tfrac{2}{5}(B-H)^2\right\}\times\frac{.7854}{3}\times L,$$

and hence is derived the rule, the multipliers or diviſors being evidently the ſame as in laſt problem.

Ex. The dimenſions of a caſk being the ſame as in laſt problem; required the contents.

Anſwer, $(2\times 32^2+24^2-\frac{2}{5}\times 8^2)\times 40\times .0009\frac{1}{4}=96.49$ the content in ale gallons.

And $10393.6\times .0011\frac{1}{3}=117.79$ the content in wine gallons.

Problem III.

To find the content of a caſk of the third or paraboloidal variety.

Rule.

To the ſquare of the bung diameter add the ſquare of the head diameter, and multiply the ſum by the length; then, if the product be multiplied by .0014, or divided by 718, the reſult will be the content in ale gallons; or if it be multiplied by .0017, or divided by 588, the reſult will be the content in wine gallons.

For by Problem 10. the content in inches is $\frac{1}{2}(B^2+H^2)\times .7854\,L$; and this expreſſion being divided by 282 gives $(B^2+H^2)\times .00139255\,L$ or $(B^2+H^2)\times\frac{1}{718.105}\times L$ for the content in ale gallons; and divided by 231 gives $(B^2+H^2)\times .0017\,L$ or $(B^2\times H^2)\times\frac{1}{588.233}$ for the content in wine gallons.

Ex. Suppoſe the dimenſions of a caſk, as before; required the content.

Anſwer, $(32^2+24^2)\times 40\times .0014=89.1$ the content in ale gallons.

And $64000\times .0017=108.8$ the content in wine gallons.

Problem IV.

To find the content of a caſk of the fourth or conical variety.

Rule.

To three times the ſquare of the ſum of the diameters add the ſquare of the difference of the diameters; multiply the ſum by the length; and multiply the reſult by $.00023\frac{1}{3}$, or divide it by 4308, for the content in ale gallons; or multiply the reſult by $.0028\frac{1}{3}$, or divide it by 3529, for the content in wine gallons.

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For by Problem 6. the content in inches is $\frac{1}{3}(B^2+BH+H^2)\times .7854\,L$, which expreſſion is equivalent to

$$\left\{3(B+H)^2+(B-H)^2\right\}\times\frac{.7854}{12}L.$$

Now $\frac{.7854}{12}$ divided by 282 gives $.00023209=\frac{1}{4308.628}$ the multiplier for ale gallons, and divided by 231 gives $.00028333=\frac{1}{3529.42}$ the multiplier for wine gallons.

Ex. Suppoſing the dimenſions of a caſk as before, What is its content?

Anſwer, $(3\times 56^2+8^2)\times 40\times .00023\frac{1}{3}=87.93$ the content in ale gallons.

And $378880\times .00028\frac{1}{3}=107.35$, is the content in wine gallons.

As theſe four forms of caſks are merely hypothetical, it may reaſonably be expected that ſome degree of uncertainty will attend the application of the rules to actual meaſurement. The following rule, however, given by Dr Hutton in his excellent treatiſe on menſuration will apply equally to any caſk whatever. And as the ingenious author obſerves, that its truth has been proved by ſeveral caſks which have been actually filled with a true gallon-meaſure after their contents were computed by it, we preſume that it is more to be depended upon in practice than the others.

Rule.

Add into one ſum 39 times the ſquare of the bung diameter, 25 times the ſquare of the head diameter, and 26 times the product of the diameters; multiply the ſum by the length, and the product by .00034; then the laſt product divided by 9 will give the wine gallons, and divided by 11 will give the ale gallons.

In inveſtigating this rule the ingenious author aſſumed as a hypotheſis, that one-third of a caſk at each end is nearly the fruſtum of a cone, and that the middle part may be taken as the middle fruſtum of a parabolic ſpindle. This being ſuppoſed, let AB and CD be the two right-lined parts, and BC the parabolic part; produce AB and DC to meet in E, and draw lines as in the figure. Let L, B, and H denote the ſame as before. Then, ſince AB has the ſame direction as EB at B, ABE will be a tangent to a parabola BF, and therefore $FI=\frac{1}{2}EI$. But $BI=\frac{1}{3}AK$, and hence, by ſim. triangles $EI=\frac{1}{3}EK$; conſequently $FI=\frac{1}{2}EI=\frac{1}{6}EK=\frac{1}{5}FK=\frac{1}{10}(B-H)$; ſo that the common diameter $BL=FG-2FI=B-\frac{1}{5}(B-H)=\frac{1}{5}(4B+H)$, which call c. Now by the rules for parabolic ſpindles and conic fruſtums we obtain (putting n for .7854) Fig. 44.

$$\frac{8B^2+4BC+3C^2}{15}\times\frac{Ln}{3}=\frac{328B^2+44BH+3H^2}{25\times 45}\times Ln$$ for the parabolic or middle part; and $$\frac{C^2+CH+H^2}{3}\times\frac{2Ln}{3}=\frac{160B^2\times 280BH+310H^2}{25\times 45}\times Ln$$ for the two ends,

Of Gauging.

ends, and the sum of these two gives after proper reduction $(39B^2+26BH+25H^2)\times\frac{Ln}{90}$, nearly, for the content in inches. And the quantity $\frac{n}{90}$ or $\frac{.7854}{90}$ being divided by 231 gives $\frac{.00034}{9}$ the multiplier for wine gallons; and since 231 is to 282 as 9 to 11 nearly, $\frac{.00034}{11}$ will be the multiplier for ale gallons as in the rule.

Ex. Suppose a cask to have the same dimensions as in the four former rules; required the content.

Here $(39\times32^2+26\times32\times24+25\times24^2)\times40\times.00034=1010.5$; which being divided by 9 and by 11 we obtain 112.3 wine gallons or 91.9 ale gallons for the content required.

Menstrual || Mentz.

MENSTRUAL, or MENSTRUOUS, in *Physiology*, is applied to the blood which flows from women in their ordinary monthly purgations. See MIDWIFERY and MEDICINE *Index*.

MENSTRUUM, in *Chemistry*, any body which in a fluid or subtilized state is capable of interposing its small parts betwixt the small parts of other bodies, so as to divide them subtly, and form a new uniform compound of the two.

MENTHA, MINT, a genus of plants belonging to the didynamia class, and in the natural method ranking under the 42d order, *Verticillatæ*. See BOTANY *Index*.

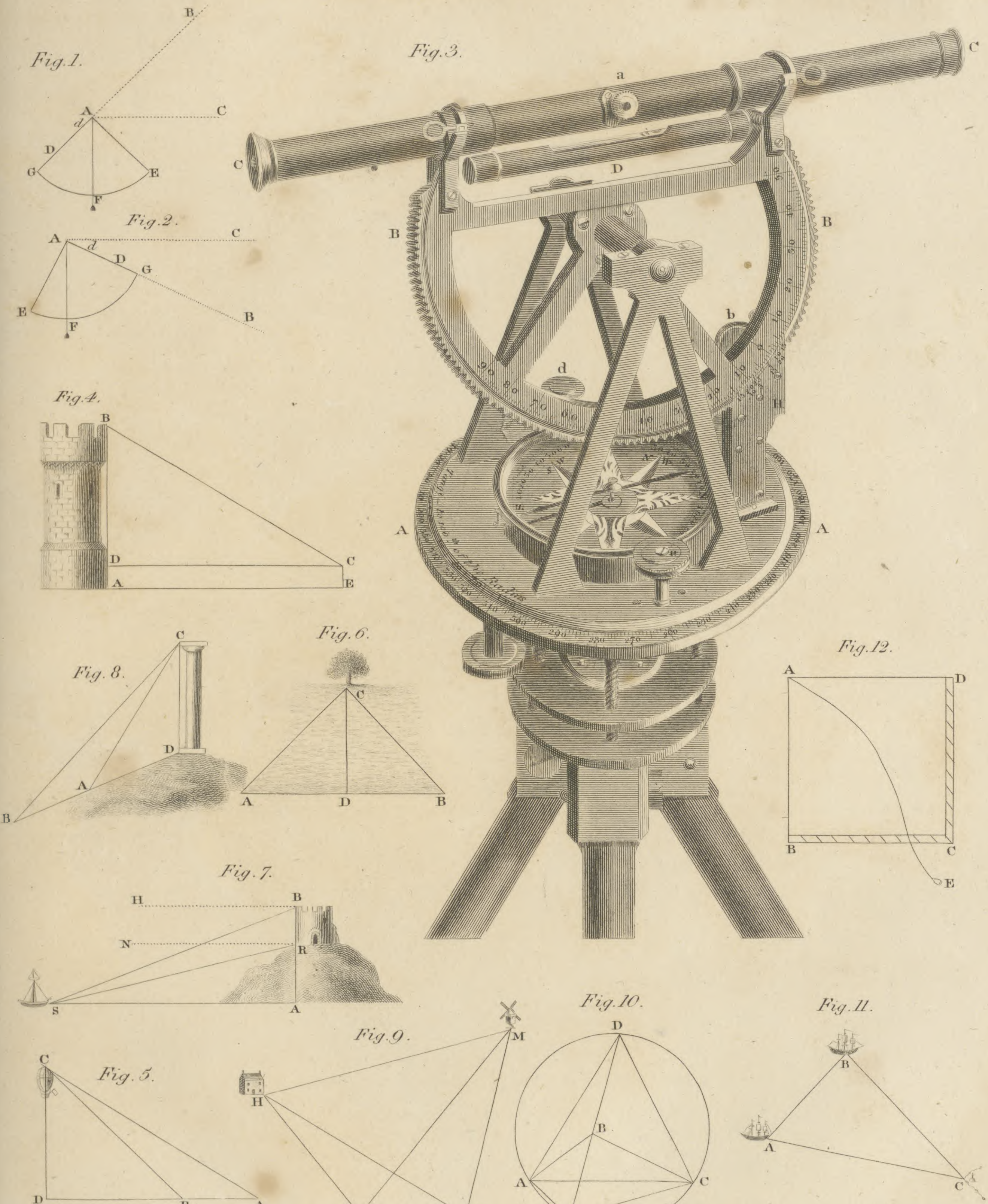
MENTOR, in fabulous history, a faithful friend of Ulysses; a son of Hercules; a king of Sidonia, who revolted against Artaxerxes Ochus, and afterwards was restored to favour by his treachery to his allies, &c. *Diod.* 16. An excellent artist in polishing cups and engraving flowers on them. *Plin.* 33. c. 11.—*Mart.* 9. ep. 60. v. 16.

MENTZ, an archbishopric and electorate in Germany. It lies on the banks of the river Maine, between the electorate of Triers on the west, the Palatinate on the south, Franconia on the east, and the Wetterau on the north. It is about 60 miles in length from north-east to south-west, and about 50 in breadth. A considerable part of the elector's revenue arises from the toll on the Rhine and Maine, and from the tax on the excellent wines produced in this country. The chief towns of any trade are, 1. Mentz; (see the next article). In its neighbourhood is Hockheim, so celebrated for good wines, that the best Rhenish is from thence called *old Hock*. It is a pretty village, containing about 300 families; and belongs to the chapter of Mentz, the dean of which enjoys the revenue of it; in a good year he makes from twelve to fifteen thousand guilders of his wine. He and the Augustins of Mentz and Francfort have the exclusive enjoyment of the best Hockheimer wine, of which, in good years, a piece, consisting of 100 measures, sells for from 900 to 1000 guilders from the press. "This (says the Baron Riesbeck) is certainly one of the dearest wines in the world. Having a desire to taste it on the spot, we were obliged to pay a rixdollar; it was, however, of the best vintage in this century, viz. that of 1766. Nor should we have had it, but for an advocate of Mentz, to whom the hostess meant to shew favour. This was the first German wine I had met with which was entirely without any sour taste: it was quite a perfume to the tongue; whereas the other wine of Hockheim, let it be as good as it may, is not quite clear of vinegar; though for this also, if it has any age, you are forced to pay a guilder and a half." 2. Bingen is a pleasant town, which stands in the district called *Rhinegau*. This town, which, together with the toll on the Rhine, is worth about 30,000 guilders, belongs to the chapter of Mentz, is extremely beautiful, and contains about 4500 inhabitants. A great part of the corn which is carried into the Rhinegau from the neighbouring Palatinate, comes through this place, which, on the other hand, supplies the Palatinate with drugs, and various foreign commodities. This traffic alone would make the place very lively; but, besides this, it has very fruitful vineyards. The hill, at the foot of which it lies, and one side of which is made by the gullet through which the Nahe runs into the Rhine, forms another steep rock behind this gullet parallel to the Rhine and the golden Rudesheimer mountain; it therefore enjoys the same sun as this does, which makes the Budesheimer wine that grows on it little inferior to the Rudesheimer. See RUDESHEIM. The rising grounds about it produce wines that are esteemed preferable to those of Baccharac, so much in vogue heretofore.—3. Elfeld, five miles west from Mentz, is a strong fortified town, on the north side of the Rhine, and the chief of the Rhinegau.—Here is Rudesheim, a place noted for the growth of the best wines in these parts. 4. Weisbaden lies between six and seven leagues from Francfort, and about five or six miles north of Mentz; it is the metropolis of a country belonging to the branch of Nassau-Saarbrak, and is famous for its mineral waters.

According to Riesbeck, the see of Mentz is indebted for its increase of riches to St Boniface, who may be called, with great justice, the apostle of the Germans. It was this man, an Englishman by birth, who in the time of Charlemagne baptized Witikind and the other brave Saxons who had so long resisted baptism with their swords, and spread the empire of the vicar of Jesus Christ as far as the northern and eastern seas. He it was who introduced the Roman liturgy into Germany, and made the savage inhabitants abstain from eating horse's flesh. He raised the papal power to a higher pitch than it had been raised in any other country in Christendom; and, in recompence of his services, the pope made all the new founded bishoprics in the north of Germany subject to the see of Mentz, which Boni-

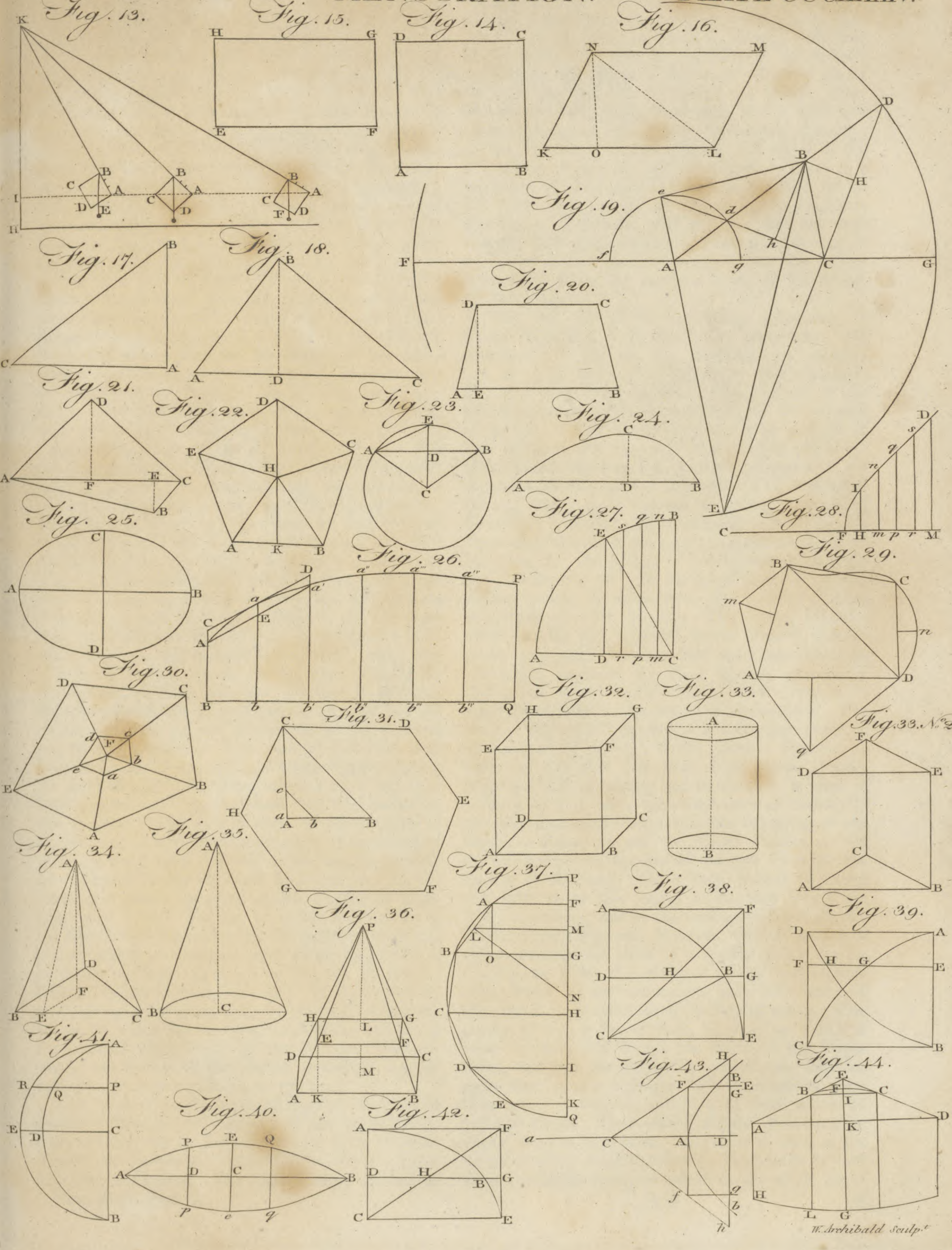
face

MENSURATION. PLATE CCCXXXIII.



E. Mitchell sculp.t

MENSURATION. *PLATE CCCXXXIV.*



Mentz.

face had chosen for his residence. The provinces, the most considerable in the whole papal dominions, all Suabia, Franconia, Bohemia, and almost all Saxony, with a part of Switzerland, Bavaria, and the Upper Rhine, belong to this diocese. Though the reformation, and revenge of the kings of Bohemia, have lessened it one-third, it still contains the archbishopric of Sprengel, and eleven bishoprics, most of which are the most considerable of Germany, as Wurtzburg, Paderborn, Hildesheim, Augsburg, &c. When the building of the papal monarchy was completed by Gregory VII. the archbishops of Mentz became powerful enough to be at the head of the empire. In the 13th and 14th centuries, they were so eminent as to be able to make emperors without any foreign assistance; and it was to one of them that the house of Hapsburg was indebted for its first elevation. Since the boundaries of the two powers have been more accurately ascertained, and the temporal has so much got the better of the spiritual, the power and influence of the archbishops of this place have of course been much reduced; still, however, they are possessed of very important prerogatives, which they might exert with much more efficacy than they do, were it not that various circumstances have rendered them too dependent on the emperors. They are still the speakers in the electoral college, have the appointment of the diets under the emperors, and may order a re-examination of the proceedings of the imperial courts. These high privileges are, however, too much subject to the controul of the house of Austria; nor are their spiritual powers any longer what they once were. Their suffragan bishops have taken it into their heads that all bishops are alike as to power, and that the title of archbishop only entitles its possessor to the first place amongst brothers who are equal. The temporals, however, which are still annexed to this chair, make him who sits in it rich amends for the diminution of his spiritual and political splendor. Though he does not absolutely possess the largest, yet he certainly has the richest and most peopled domain of any ecclesiastical potentate in Germany. The country, it is true, does not contain more than 125 German miles square, whereas the archbishopric of Saltzburg contains 240; but then Saltzburg has only 250,000 inhabitants, whereas Mentz has 320,000. The natural riches of the territory of Mentz, and its advantageous situation, make a subject of Mentz much richer than one of Saltzburg, the greatest part of which is only inhabited by herdsmen. In the territory of Mentz there are 40 cities; in that of Saltzburg only seven. The tax on vessels which go down the Rhine of itself produces 60,000 guilders, or 6000l. a-year, which is nearly as much as all the mines of Saltzburg put together, excepting only the salt mine at Halle. The tax on wine, here and in the country round, produces the court above 100,000 guilders, or 10,000l. a-year, in which sum we do not reckon the customs of the countries which lie at a greater distance. Upon the whole, the income of the present archbishop may be valued at 1,700,000 guilders, or 170,000l.

If the lands of the elector lay all together, they would produce a sufficiency of corn and all the prime necessaries of life; but as several parts of them lie wide asunder, the people are compelled to purchase a great deal from foreigners. The capital itself, as well as the adjacent Rhinegau, depends on the Palatinate for its corn, notwithstanding the great abundance of that and every other species of grain in its own possessions in Wetterau. The noblest production of the elector's territory on the Rhine is the wine, which is almost the only true Rhenish. Connoisseurs, indeed, allow the wines of Neirstein, Baccarach, and a very few other places out of this country, to be true Rhenish: but they do not give this name to the wines of the Palatinate, of Bardon, and of Alsatia. There is a great deal of wine made in the countries which lie on the south and west of the Rhine, at Laubenheim, Bodenheim, Budesheim, and Bingen; but the true Rhenish, that which inspires so many who are and so many who are not poets, comes only from the Rhinegau, which lies on the northern banks of the Rhine. See RHINEGAU.

The civil list of the archbishop (according to Baron Riesbeck), is by much too immoderate and expensive. "He has his ministers, his counsellors of state, and eighty or ninety privy counsellors of various denominations. The expence of this establishment is very disproportionate to the revenue of the state. This is owing to the large number of poor nobility, who can only accept of employments of this kind. Ignorance of the true principles of government are the causes of this evil. The consequences are, that a great number of persons, who might be usefully employed, live in idleness. Even the military establishment of the country appears to me more calculated for the purpose of feeding a hungry nobility than for real use. At the accession of the present elector, though the whole army only consisted of 2200 men, there were six generals. The regular establishment paid for and supported by the country is 8000 men; but though there are only 2000 men kept up, the money expended for their support, particularly that given to numberless useless officers, might be made use of more for the benefit of the country. The army of the archbishop consists of a German guard of 50 men and 25 horses, a Swiss guard, a squadron of hussars of 130 men (the most useful troops, as they purge the land of robbers and murderers), a corps of artillery of 104 men, three regiments of infantry of 600 men each, and some companies belonging to the armies of Franconia and the Upper Palatinate. Of the fortifications of the capital we may say much the same as of the army. Were they, indeed, improved and kept up as they ought to be, they would vie with Luxemburg, and be the most powerful of all the barriers against France. It is true, that the nature of the ground does not allow of a regular plan; but for single parts, I have seen no place of the same capabilities, where greater advantages have been taken of the ground for the erection of the several works. The beauty, as well as size of them, is indeed an object of great wonder; but though the circle of the Upper Rhine, and even the empire in general, has laid out great sums on the building these fortifications, parts of them are not finished, and parts of them are ready to fall to pieces. Their extent, indeed, would require a great army to man them. But this, as well as the maintaining and keeping them up, is evidently beyond the power of this court, or indeed of the whole circle of

Mentz. of the Upper Rhine united. They are, therefore, alſo to be looked upon as one of the things which ſerve more for magnificence than real uſe."

MENTZ, a conſiderable town of Germany, in the circle of the Lower Rhine, and capital of the electorate of the ſame name, is ſituated on the Rhine near its confluence with the Maine, 20 miles north-weſt of Worms, 15 weſt of Francfort, and 75 eaſt of Triers, in E. Long. 8. 20. N. Lat. 40. 51. This city claims a right to the invention of the art of printing: (ſee *Hiſtory of* PRINTING). Here is a very beautiful quay along the river, defended by ſeveral works well fortified with cannon. That part of the city which extends towards the river is moſt populous. The beſt vineyards for Rheniſh wine being in this neighbourhood, Mentz has a flouriſhing trade in that commodity more particularly; and its commerce is the briſker, by reaſon that all the merchandiſe which paſſes up and down the Rhine ſtops in its harbour to change bottoms.

The northern part of the city, in which the archbiſhop reſides, is full of very regular buildings. Here are three regular ſtreets, called the *Blerchen*, which run parallel to each other from the banks of the Rhine to 600 yards within the city, and are cut almoſt regularly by very pretty croſs ſtreets. The archbiſhop's palace has a moſt commanding view of theſe ſtreets, the Rhine, and the Rhinegau. There are alſo ſome good buildings in the old part of the city. The market of beaſts is extremely well worth ſeeing; and you here and there meet with other agreeable ſpots. The market in the middle of the town, though not regular, is one of the prettieſt places in Germany. The cathedral is well worth notice. It is an immenſe large old Gothic building, the ſpire of which was ſtruck with lightning about 20 years ago, and entirely laid in aſhes. As it was made of a foreſt of wood, it burned 14 hours before it was entirely conſumed. To prevent theſe accidents for the future, the chapter had the preſent one built to the ſame height in ſtone, an undertaking which coſt them 40,000 guilders or 4000l. It is a great pity (Baron Rieſbeck obſerves) that it is overloaded with ſmall ornaments: and a ſtill greater, that this wonderful edifice is ſo choked up with ſhops and houſes as to be hardly more than half viſible. As, however, houſes and ſhops are very dear in this part of the town, one cannot be very angry with the chapter for chooſing rather to make the moſt of its ground, than to ſhow off the church to the beſt advantage. The rent of a ſhop and a ſingle room to live in is 150 guilders or 15l. per annum in this part of the town. There is hardly another church in Germany of the height and length of this cathedral; and the inſide of it is decorated with ſeveral magnificent monuments of princes and other great perſonages. Beſides the cathedral, the city of Mentz contains ſeveral other churches in the modern ſtyle, very well worth ſeeing. St Peter's, and the Jeſuit's church, though both too much loaded with ornament, are among this number. The church of the Auguſtins, of which the inhabitants of Mentz are ſo proud, is a maſterpiece of bad taſte; but that of Ignatius, though little is ſaid about it, would be a model of the antique, if here likewiſe there had not been too much ornament laviſhed. Upon the whole, the palaces of the nobleſſe want that noble ſimplicity which alone conſtitutes true beauty and magnificence. In another century the externals of the city will be quite changed. The late prince built a great deal, and the preſent has a taſte for the ſame ſort of expence. The monks and governors of hoſpitals alſo have been forced to rebuild their houſes; ſo that when a few more ſtreets are made broader and ſtraighter, the whole will have no bad appearance. The inhabitants, who together with the garriſon amount to 30,000, are a good kind of people, and, like all the catholics of Germany, make great account of a good table. Their faces are intereſting, and they are not deficient either in wit or activity.

There are few cities in Germany beſides Vienna which contain ſo rich and numerous a nobility as this does: there are ſome houſes here which have eſtates of 100,000 guilders, or 10,000l. a-year. The counts of Baſſenheim, Schonborn, Stadion, Ingelheim, Elz, Oſtein, and Walderdorf, and the lords of Dahlberg, Breitenbach, with ſome others, have incomes of from 30,000 to 100,000 guilders. Sixteen or eighteen houſes have from 15,000 to 30,000 guilders annual revenue. The nobility of this place are ſaid to be ſome of the oldeſt and moſt untainted in Germany. There are amongſt them many perſons of extraordinary merit, who join uncommon knowledge to all the duties of active life. Upon the whole, they are far ſuperior to the greater part of the German nobility. Their education, however, is ſtill too ſtiff. The firſt miniſter of the court was refuſed admittance into their aſſemblies for not being ſufficiently noble; and they think they degrade themſelves by keeping company with bourgeois.

The clergy of this place are the richeſt in Germany. A canonry brings in 3500 Rheniſh guilders in a moderate year. The canonry of the provoſt brings him in 40,000 guilders a-year; and each of the deaneries is worth 2600 guilders. The income of the chapter altogether amounts to 300,000 guilders. Though it is forbidden by the canons of the church for any one to have more than a ſingle prebend, there is not an eccleſiaſtic in this place who has not three or four; ſo that there is hardly a man amongſt them who has not at leaſt 8000 guilders a-year. The laſt provoſt, a count of Elz, had prebends enough to procure him an income of 75,000 guilders. Excluſive of the cathedral, there are ſeveral other choirs in which the canonries bring in from 1200 to 1500 guilders a-year. To give an idea of the riches of the monaſteries of this place, Baron Rieſbeck informs us, that at the deſtruction of the Jeſuits, their wine, which was reckoned to ſell extremely cheap, produced 120,000 rixdollars. A little while ago the elector aboliſhed one Carthuſian convent and two nunneries, in the holy cellars of which there was found wine for at leaſt 500,000 rixdollars. "Notwithſtanding this great wealth (continues our author), there is not a more regular clergy in all Germany. There is no dioceſe, in which the regulations made by the council of Trent have been more ſtrictly adhered to than they have here; the archbiſhops having made a particular point of it both at the time of the reformation and ever ſince. One thing which greatly contributes to keep up diſcipline is the not ſuffering any prieſt to remain in the country who

who has not fixed and ſtated duties, and a revenue annexed to them. Moſt of the irregularities in Bavaria, Auſtria, and other countries, ariſe from abbés who are obliged to ſubſiſt by their daily induſtry and any maſſes which they can pick up. Theſe creatures are entirely unknown here. The theological tenets of this court are alſo much purer than thoſe of any other eccleſiaſtical prince in Germany. I was pleaſed to ſee the Bible in the hands of ſo many common people, eſpecially in the country. I was told that the reading of it was not forbidden in any part of the dioceſe; only perſons were enjoined not to read it through, without the advice of their confeſſors. For a long time ſuperſtition has been hunted through its utmoſt receſſes; and though it is not quite poſſible to get entirely clear of pilgrimages and wonder-working images, you will meet with no prieſt bold enough to exorciſe or to preach ſuch nonſenſe as we hear in the pulpits of other German churches."

Though the trade of this place has been conſtantly on the increaſe for theſe 18 or 20 years paſt, yet it is by no means what it ought to be from the ſituation and other advantages. The perſons here who call themſelves merchants, and who make any conſiderable figure, are in fact only brokers, who procure their livelihood at the expence of the country or territory round, or who act for the merchants of Francfort. A few toy-ſhops, five or ſix druggiſts, and four or five manufacturers of tobacco, are all that can poſſibly be called traders. There is not a banker in the whole town; and yet this country enjoys the ſtaple privilege, and commands by means of the Maine, Necker, and Rhine, all the exports and imports of Alſatia, the Palatinate, Franconia, and a part of Suabia and Heſſe, as far as the Netherlands. The port too is conſtantly filled with ſhips, but few of them contain any merchandiſe belonging to the inhabitants of the place. The French took it by ſurpriſe in October 1792; it ſurrendered to the king of Pruſſia in 1793; the French made a fruitleſs attack upon it in 1795; it was relieved from a blockade by the Auſtrians in 1796, and the French got poſſeſſion of it in October 1797.

MENTZEL, Christian, born at Fruſtenwall in the Mittel-mark, is celebrated for his ſkill in medicine and botany, in purſuit of which he travelled through many countries. He had correſpondents in the moſt diſtant parts of the world. He died A. D. 1701 about the 79th year of his age. He was a member of the academy *des Curieux de la Nature*. His works are, 1. *Index nominum plantarum*, printed at Berlin in folio, 1696; and reprinted with additions in 1715, under the title of *Lexicon plantarum polyglotton univerſale*. 2. A Chronology of China, in German, printed at Berlin 1696, in 4to. The following manuſcripts of his compoſition are preſerved in the royal library at Berlin. 1. *Sur l' Hiſtoire Naturelle du Braſil*, in four volumes folio. 2. *Sur les Fleurs et les Plantes du Japon*, with coloured plates, two vols folio.

MENUS, in *Ancient Geography*, a river of Germany; now the *Maine*, riſing in Franconia, and running from eaſt to weſt into the Rhine at Mentz.

MENUTHIAS, in *Ancient Geography*, an iſland adjoining to the north-eaſt of the promontory Praſum of Ethiopia beyond Egypt. Some take it to be *Madagaſcar*, or the iſland *St Laurence*. Iſaac Voſſius will have it to be *Zanzibar;* Madagaſcar being at a greater diſtance from the continent than the ancients ever failed to, whereas Menuthias was nearer: yet though Zanzibar be nearer the continent, it is however nearer the equator than Ptolemy's Menuthias, placed in ſouth latitude $12\frac{1}{2}$ degrees.

MENYANTHES, Marsh-trefoil, or *Bogbean;* a genus of plants belonging to the pentandria claſs; and in the natural method ranking under the 21ſt order, *Preciæ*. See Botany *Index*.

MENZIKOFF, Alexander, was originally an apprentice to a paſtry-cook near the palace of Moſcow; but by a fortunate circumſtance was drawn from that ſituation in early life, and placed in the houſehold of Peter the Great. Having made himſelf maſter of ſeveral languages, and being formed for war and for buſineſs, he firſt rendered himſelf agreeable, and afterwards became neceſſary to his maſter. He aſſiſted Peter in all his projects; and was rewarded for his ſervices with the government of Ingria, the rank of prince, and the title of *major-general*. He ſignalized himſelf in Poland in 1708 and 1709; but in 1713 he was accuſed of embezzling the public money, and fined in 300,000 crowns. The czar remitted the fine; and having reſtored him to favour, gave him the command of an army in the Ukraine in 1719, and ſent him as his ambaſſador into Poland in 1722. Conſtantly employed about the means of preſerving his influence after the death of his maſter, who was then evidently on the decline, Menzikoff diſcovered the perſon to whom the czar intended to leave the ſucceſſion. The emperor was highly offended, and his penetration coſt him the principality of Pleſcoff. Under the czarina Catherine, however, he was higher in favour than ever; becauſe, on the death of the czar in 1725, he was active in bringing different parties in Ruſſia to agree to her ſucceſſion. This princeſs was not ungrateful. In appointing her ſon-in-law Peter II. to be her ſucceſſor, ſhe commanded him to marry the daughter of Menzikoff, and gave the czar's ſiſter to his ſon. The parties were actually betrothed: and Menzikoff was made duke of Cozel and grand ſteward to the czar. But this ſummit of elevation was the prelude to his fall. The *Dolgoroukis*, favourites of the czar, had influence enough to procure his baniſhment, together with that of his family, to one of his own eſtates at the diſtance of 250 leagues from Moſcow. He had the imprudence to leave the capital with the ſplendor and magnificence of a governor going to take poſſeſſion of his province. His enemies took advantage of this circumſtance to inflame the indignation of the czar. At ſome diſtance from Moſcow he was overtaken by a detachment of ſoldiers. The officer who commanded them made him alight from his chariot, which he ſent back to Moſcow; and placed him and his whole family in covered waggons, to be conducted into Siberia, in the habit of peaſants. When he arrived at the place of his deſtination, he was preſented with cows and ſheep big with young, and poultry, without knowing from whom he received the favour. His houſe was a ſimple cottage; and his employment was to cultivate the ground, or to ſuperintend its cultivation. New cauſes of ſorrow were added to the ſeverities of exile. His wife died in the journey; he had the misfortune to loſe one

one of his daughters by the smallpox; and his other two children were seized with the same disease, but recovered. He sunk under his misfortunes, November 2. 1729; and was buried beside his daughter, in a little chapel which he had built. His misfortunes had inspired him with sentiments of devotion, which, amid the splendor of his former situation, he had altogether neglected. His two surviving children enjoyed greater liberty after the death of their father. The officer permitted them to attend public worship on Sundays by turns. One day when his daughter was returning from the village, she heard herself accosted by a peasant from the window of a cottage, and, to her great surprise, recognised in this peasant the persecutor of her family, Dolgorouki; who, in his turn, had fallen a sacrifice to the intrigues of the court. She communicated this intelligence to her brother, who could not behold, without emotion, this new instance of the vanity and instability of honours and power. Young Menzikoff and his sister were soon after recalled to Moscow by the czarina Ann; and left Dolgorouki in possession of their cottage. He was made captain of the guards, and received the fifth part of his father's possessions. His sister was appointed maid of honour to the empress, and afterwards married to great advantage.

MENZINI, Benedict, a celebrated Italian poet, born at Florence, was professor of eloquence at the college Della Sapienza at Rome, where he died in 1704. He wrote, 1. The art of poetry. 2. Satires, elegies, hymns, and the Lamentations of Jeremiah. 3. *Academia Tusculana*, a work in verse and prose, which passes for his masterpiece.

MEOTIS, or Palus Meotis, a sea of Turkey, which divides Europe from Asia; extending from Crim Tartary to the mouth of the river Don or Tanais.

MEPHITIC, a name expressing any kind of noxious vapour; but generally applied to that species of vapour called *fixed air*. See Carbonic Acid, Chemistry *Index*.

MEPHITIS fanum, a temple erected to the goddess Mephitis, near Lacus Amsancti; who was worshipped also at Cremona. Figuratively, *Mephitis* denotes a noisome or pestilential exhalation, (Virgil).

MEQUINEZ, or Miquinez, the northern capital of the Morocco empire, stands at the extremity of the province of Beni Hassen, 80 leagues north from the city of Morocco (which is the southern imperial city), and 20 to the east of Sallee and the ocean. Maknassa, its founder, built it first at the bottom of a valley; but Muley Ismael extended it considerably over the plain that lies to the west of the valley. It is surrounded with well cultivated fields and hills, adorned with gardens and olive plantations, and abundantly watered with rivulets. Accordingly, fruits and kitchen stuffs thrive here exceedingly, and even the superior urbanity of the inhabitants announces the temperature of the climate. The winter indeed is very inconvenient, on account of the dirtiness of the town, the streets not being paved, and the soil being slimy.

Mequinez is surrounded with walls; the palace itself is fortified with two bastions, on which formerly some small guns were mounted. Muley Ismael, and Muley Abdallah, often in this city resisted the efforts of the Brebes, the sworn enemies of their tyranny. To the west are seen some walls of circumvallation, six feet in height, which were probably mere intrenchments for the infantry; the attacks of the Brebes being only sudden and momentary inroads, which did not require a long defence. There is at Mequinez, as well as at Morocco, a walled and guarded suburb for the Jews. The houses are neater here than at Morocco. The Jews here are more numerous; and they can turn their industry to greater account, because the Moors in this city are more polished, and (being nearer to Europe) more visited, than those in the southern parts. Near the Jewry, there is another enclosed and separate quarter, called the *Negro town*. It was built by Muley Ismael, for the accommodation of those black families which composed his soldiery. This town is now uninhabited, as are all those destined for the same use through the rest of the empire.

At the south-east extremity of the city stands the palace of the emperor, which was built by Muley Ismael. The space occupied by this palace is very great; it includes several gardens, elegantly disposed, and well watered. There is a large garden in the centre, surrounded by a vast and pretty regular gallery resting on columns, which communicates with the apartments. Those of the women are very spacious, and have a communication with a large chamber which looks into the garden. As you pass from one apartment to another, you find at intervals regular courts paved with square pieces of black and white marble; in the middle of these courts is a marble basin, from the centre of which rises a *jet d'eau*, and the water falls down into this basin. These fountains are numerous in the palace; they are useful for domestic purposes, and they serve for the ablutions, which the scruples of the Mahometans have exceedingly multiplied. The palaces of the Moorish kings are large, because they are composed only of one range of apartments; these are long and narrow, from 18 to 20 feet high; they have few ornaments, and receive the light by two large folding doors, which are opened more or less as occasion requires. The rooms are always lighted from a square court in the centre, which is generally encompassed with a colonnade.

The Moors here are more courteous than those in the southern parts; they are civil to strangers, and invite them into their gardens, which are very neat. The women in this part of the empire are beautiful; they have a fair complexion, with fine black eyes, and white teeth. I have sometimes seen them taking the air on the terraces; they do not hide themselves from Europeans, but retire very quickly on the appearance of a Moor.

MERA-de-Asta, formerly a large town of Andalusia, seated on the river Guadaleta, between Arcos and Xeres de la Frontera; but now only a large heap of ruins. Here the Arabs conquered Roderick the last king of the Goths, and by that victory became masters of Spain in 713.

MERCATOR, Gerard, one of the most celebrated geographers of his time, was born at Ruremonde in 1512. He applied himself with such industry to geography and mathematics, that he is said to have frequently forgot to eat and drink. The emperor Charles V. had a particular esteem for him, and the duke of Juliers made him his cosmographer. He composed

composed a chronology, some geographical tables, an atlas, &c. engraving and colouring the maps himself. He died in 1594. His method of laying down charts is still used, and bears the name of *Mercator's charts*.

MERCATOR, *Nicholas*, an eminent mathematician in the 17th century, was born at Holstein in Denmark; and came to England about the time of the restoration, where he lived many years. He was fellow of the Royal Society; and endeavoured to reduce astrology to rational principles, as appeared from a MS. of his in the possession of William Jones, Esq. He published several works, particularly *Cosmographia*. He gave the quadrature of the hyperbole by an infinite series; which was the first appearance in the learned world of a series of this sort drawn from the particular nature of the curve, and that in a manner very new and abstracted.

MERCATOR's Sailing, that performed by Mercator's chart. See NAVIGATION.

MERCATORUM FESTUM, was a festival kept by the Roman merchants on the 15th of May, in honour of Mercury, who presided over merchandise. A sow was sacrificed on the occasion, and the people present sprinkled themselves with water fetched from the fountain called *aqua Mercurii;* the whole concluding with prayers to the god for the prosperity of trade.

MERCHANT, a person who buys and sells commodities in gross, or deals in exchanges; or that traffics in the way of commerce, either by importation or exportation. Formerly every one who was a buyer or seller in the retail way was called a *merchant*, as they still are both in France and Holland; but here shopkeepers, or those who attend fairs or markets, have lost that appellation.

Previous to a person's engaging in a general trade, and becoming an universal dealer, he ought to treasure up such a fund of useful knowledge as will enable him to carry it on with ease to himself, and without risking such losses as great ill-concerted undertakings would naturally expose him to. A merchant should therefore be acquainted with the following parts of commercial learning: 1. He should write properly and correctly. 2. Understand all the rules of arithmetic that have any relation to commerce. 3. Know how to keep books of double and single entry, as journals, a leger, &c. 4. Be expert in the forms of invoices, accounts of sales, policies of insurances, charter-parties, bills of lading, and bills of exchange. 5. Know the agreement between the money, weights, and measures of all parts. 6. If he deal in silk, woollen, linen, or hair manufactures, he ought to know the places where these different sorts of merchandises are manufactured, in what manner they are made, what are the materials of which they are composed, and from whence they come, the preparations of these materials before working up, and the places to which they are sent after their fabrication. 7. He ought to know the lengths and breadths which silk, woollen, or hair stuffs, linen, cottons, fustians, &c. ought to have according to the several statutes and regulations of the places where they are manufactured, with their different prices, according to the times and seasons; and if he can add to his knowledge the different dyes and ingredients which form the various colours, it will not be useless. 8. If he confines his trade to that of oils, wines, &c. he ought to inform himself particularly of the appearances of the succeeding crops, in order to regulate his disposing of what he has on hand; and to learn as exactly as he can what they have produced when got in, for his direction in making the necessary purchases and engagements. 9. He ought to be acquainted with the sorts of merchandise found more in one country than another, those which are scarce, their different species and qualities, and the properest method for bringing them to a good market either by land or sea. 10. To know which are the merchandises permitted or prohibited, as well on entering as going out of the kingdoms or states where they are made. 11. To be acquainted with the price of exchange, according to the course of different places, and what is the cause of its rise and fall. 12. To know the customs due on importation or exportation of merchandises, according to the usage, the tariffs, and regulations, of the places to which he trades. 13. To know the best manner of folding up, embaling, or tunning, the merchandises for their preservation. 14. To understand the price and condition of freighting and insuring ships and merchandise. 15. To be acquainted with the goodness and value of all necessaries for the construction and repairs of shipping, the different manner of their building; what the wood, the masts, cordage, cannons, sails, and all requisites, may cost. 16. To know the wages commonly given to the captains, officers, and sailors, and the manner of engaging with them. 17. He ought to understand the foreign languages, or at least as many of them as he can attain to; these may be reduced to four, viz. the Spanish, which is used not only in Spain but on the coast of Africa, from the Canaries to the Cape of Good Hope: the Italian, which is understood on all the coasts of the Mediterranean, and in many parts of the Levant: the German, which is understood in almost all the northern countries; and the French, which is now become almost universally current. 18. He ought to be acquainted with the consular jurisdiction, with the laws, customs, and usages of the different countries he does or may trade to; and in general all the ordinances and regulations both at home and abroad that have any relation to commerce. 19. Though it is not necessary for a merchant to be very learned, it is proper that he should know something of history, particularly that of his own country; geography, hydrography, or the science of navigation; and that he be acquainted with the discoveries of the countries in which trade is established, in what manner it is settled, of the companies formed to support those establishments, and of the colonies they have sent out.

All these branches of knowledge are of great service to a merchant who carries on an extensive commerce; but if his trade and his views are more limited, his learning and knowledge may be so too: but a material requisite for forming a merchant is, his having on all occasions a strict regard to truth, and his avoiding fraud and deceit as corroding cankers that must inevitably destroy his reputation and fortune.

Trade is a thing of so universal a nature, that it is impossible for the laws of Britain, or of any other nation, to determine all the affairs relating to it; therefore

fore all nations, as well as Great Britain, ſhow a particular regard to the law-merchant, which is a law made by the merchants among themſelves: however, merchants and other ſtrangers are ſubject to the laws of the country in which they reſide. Foreign merchants are to ſell their merchandiſe at the port where they land, in groſs, and not by retail; and they are allowed to be paid in gold or ſilver bullion, in foreign coin or jewels, which may be exported. If a difference ariſes between the king and any foreign ſtate, the merchants of that ſtate are allowed ſix months time to ſell their effects and leave the kingdom; during which time they are to remain free and unmoleſted in their perſons and goods. See the articles COMMERCE, and *Mercantile Law*.

MERCHET (MERCHETUM), a fine or compoſition paid by inferior tenants to the lord, for liberty to diſpoſe of their daughters in marriage. No baron, or military tenant, could marry his ſole daughter and heir, without ſuch leave purchaſed from the king, *pro maritanda filia*. And many of our ſervile tenants could neither ſend their ſons to ſchool, nor give their daughters in marriage, without expreſs leave from the ſuperior lord. See Kennet's Gloſſary *in Maritagium*. See alſo MARCHET, under which word it is ſtated, and very generally underſtood, that this was a right claimed by the lord of the manor in the time of the feudal ſyſtem of paſſing the firſt night after marriage with his female villain. According to Mr Aſtle, the mercheta was a compact between the lord and his vaſſal for the redemption of an offence committed by the vaſſal's unmarried daughter; and alſo a fine paid by a ſokeman or a villain to his lord for permiſſion to marry his daughter to a free man; and in caſes where the vaſſal gave away his daughter without having obtained this licenſe, he ſubjected himſelf to a heavier fine.

MERCIA, the name of one of the ſeven kingdoms founded in England by the Saxons. Though the lateſt formed, it was the largeſt of them all, and grew by degrees to be by far the moſt powerful. On the north it was bounded by the Humber and the Merſey, which ſeparated it from the kingdom of Northumberland; on the eaſt by the ſea, and the territories of the Eaſt Angles and Saxons; on the ſouth by the river Thames; and on the weſt by the rivers Severn and Dee. It comprehended well nigh 17 of our modern counties, being equal in ſize to the province of Languedoc in France; very little, if at all, leſs than the kingdom of Arragon in Spain; and ſuperior in ſize to that of Bohemia in Germany.

Penda is regarded as its firſt monarch; and the kingdom is thought to derive its name from the Saxon word *merc*, which ſignifies "a march, bound, or limit," becauſe the other kingdoms bordered upon it on every ſide; and not from the river Merſey, as ſome would perſuade us. Penda aſſumed the regal title A. D. 626, and was of the age of 50 at the time of his acceſſion; after which he reigned near thirty years. He was of a moſt furious and turbulent temper, breaking at different times with almoſt all his neighbours, calling in the Britons to his aſſiſtance, and ſhedding more Saxon blood than had been hitherto ſpilled in all their inteſtine quarrels. He killed two kings of Northumberland, three of the Eaſt Angles, and compelled Kenwall king of the Weſt Saxons to quit his dominions. He was at length ſlain, with moſt of the princes of his family, and a multitude of his ſubjects, in a battle fought not far from Leeds, by Oſwy king of Northumberland. This battle, which the Saxon chronicle tells us was fought at Winwidfield, A. D. 655, made a great change in the Saxon affairs, which the unbridled fury of Penda had thrown into great confuſion. He had the year before killed Anna king of the Eaſt Angles in battle, whoſe brother Ethelred notwithſtanding took part with Penda. On the other hand, Penda, the eldeſt ſon of Penda, to whom his father had given the ancient kingdom of the Mid Angles, had two years before married the natural daughter of King Oſwy, and had been baptized at his court. At that time it ſhould ſeem that Oſwy and Penda were upon good terms; but after the latter had conquered the Eaſt Angles, he reſolved to turn his arms againſt the kingdom of Northumberland. Oſwy by no means had provoked this rupture; on the contrary, Bede tells us that he offered large ſums of money, and jewels of great value, to purchaſe peace: theſe offers being rejected, he was reduced to the neceſſity of deciding the quarrel by the ſword. The river near which the battle was fought overflowing, there were more drowned than killed. Amongſt theſe, as the Saxon chronicle ſays, there were thirty princes of the royal line, ſome of whom bore the title of *kings*; and alſo Ethelred king of the Eaſt Angles, who fought on the ſide of Penda againſt his family and country.

His ſon Penda, who married the daughter of that conqueror became a Chriſtian, and was not long after murdered, as is ſaid, by the malice of his mother. His brother Wolther becoming king of Mercia, embraced in proceſs of time the faith of the goſpel, and proved a very victorious and potent monarch; and is, with no fewer than ſeven of his immediate ſucceſſors, commonly ſtyled *king of the Anglo-Saxons*, though none of them are owned in that quality by the Saxon chronicle. But though poſſibly none of them might enjoy this honour, they were undoubtedly very puiſſant princes, maintaining great wars, and obtaining many advantages over the ſovereigns of other Saxon ſtates, and eſpecially the Eaſt Angles, whom they reduced. The extent of the Mercian territories was ſo ample as to admit, and ſo ſituated as to require, the conſtituting ſubordinate rulers in ſeveral provinces; to whom, eſpecially if they were of the royal line, they gave the title of *kings*; which occaſions ſome confuſion in their hiſtory. Beſides the eſtabliſhing epiſcopal ſees and convents, the Saxon monarchs took other methods for improving and adorning their dominions; and as Mercia was the largeſt, ſo theſe methods were moſt conſpicuous therein. Coventry, as being ſituated in the centre, was uſually, but not always, the royal reſidence. Penda, who was almoſt continually in a ſtate of war, lived as his military operations directed, in ſome great town on the frontiers. Wolfher built a caſtle or fortified palace for his own reſidence, which bore his name.—Offa kept his court at Sutton Walls near Hereford.

In each of the provinces there reſided a chief magiſtrate; and if he was of the royal blood, had uſually the title of *king*. Penda, at the time he married Oſwy's daughter, had the title of *king of Leiceſter*.—

Ethelred

Ethelred made his brother Merowald king of Hereford; who, dying without iſſue, bequeathed it to his younger brother Mercelm. The like honours were ſometimes conferred upon the princeſſes; and hence, in Mercia eſpecially, we occaſionally read of *vice-queens*. By theſe means the laws were better executed, the obedience of the ſubjects more effectually ſecured, and the ſplendour of theſe reſidences conſtantly kept up and augmented.

At length the crown devolving ſometimes on minors and ſometimes on weak princes, inteſtine factions alſo prevailing, the force of this hitherto mighty kingdom began ſenſibly to decline. This falling out in the days of Egbert, the moſt prudent as well as the moſt potent monarch of the Weſt Saxons, he took advantage of theſe circumſtances; and having encouraged the Eaſt Angles to make an attempt for the recovery of their independence, he, in a conjuncture every way favourable to his deſign, broke with the Mercians, and after a ſhort war obliged them to ſubmit. But this was not an abſolute conqueſt, the kings of Mercia being allowed by him and his ſucceſſors to retain their titles and dominions, till the invaſion of the Danes put an end to their rule, when this kingdom had ſubſiſted above 250 years; and when the Danes were afterwards expelled by the Weſt Saxons, it ſunk into a province, or rather was divided into many.

MERCURIAL, ſomething conſiſting of, or relating to, mercury.

MERCURIALIS, Dogs Mercury; a genus of plants belonging to the diœcia claſs; and in the natural method ranking under the 38th order, *Tricoccæ*. See Botany *Index*.

MERCURIFICATION, in metallurgic chemiſtry, the obtaining the mercury from metallic minerals in its fluid form. See Chemistry and Mineralogy *Index*.

MERCURY, or Quicksilver. See Chemistry and Mineralogy *Index*.

Mercury, in the heathen mythology. See Hermes.

Moſt of the actions and inventions of the Egyptian Mercury have likewiſe been aſcribed to the Grecian, who was ſaid to be the ſon of Jupiter and Maia, the daughter of Atlas. No one of all the heathen divinities had ſo many functions allotted to him as this god: he had conſtant employment both day and night, having been the common miniſter and meſſenger of the whole Pantheon; particularly of his father Jupiter, whom he ſerved with indefatigable labour, and ſometimes, indeed, in a capacity of no very honourable kind. Lucian is very pleaſant upon the multitude of his avocations; and, according to the confeſſion of the emperor Julian, Mercury was no hero, but rather one who inſpired mankind with wit, learning, and the ornamental arts of life, than with courage. The pious emperor, however, omits ſome of his attributes; for this god was not only the patron of trade, but alſo of theft and fraud.

Amphion is ſaid, by Pauſanias, to have been the firſt that erected an altar to this god; who, in return, inveſted him with ſuch extraordinary powers of muſic (and maſonry), as to enable him to fortify the city of Thebes in Bœotia, by the mere ſound of his lyre. Horace gives us the beſt part of his character:

Thou god of wit, from Atlas ſprung,
Who by perſuaſive pow'r of tongue,
And graceful exerciſe, refin'd
The ſavage race of human kind,
Hail! winged meſſenger of Jove,
And all th' immortal pow'rs above.
Sweet parent of the bending lyre,
Thy praiſe ſhall all its ſounds inſpire.
Artful and cunning to conceal
Whate'er in ſportive theft you ſteal,
When from the god who gilds the pole,
E'en yet a boy, his herds you ſtole;
With angry voice the threat'ning power
Bade thee thy fraudful prey reſtore;
But of his quiver too beguil'd,
Pleas'd with the theft, Apollo ſmil'd.
You were the wealthy Priam's guide,
When ſafe from Agamemnon's pride,
Through hoſtile camps, which round him ſpread
Their watchful fires, his way he ſped.
Unſpotted ſpirits you conſign
To bliſsful ſeats and joys divine;
And, pow'rful, with thy golden wand,
The light, unbodied crowd command;
Thus grateful does thy office prove
To gods below, and gods above. Francis.

This ode contains the ſubſtance of a very long hymn to Mercury, attributed to Homer. Almoſt all the ancient poets relate the manner in which the Grecian Mercury diſcovered the lyre; and tell us that it was an inſtrument with ſeven ſtrings; a circumſtance which makes it eſſentially different from that ſaid to have been invented by the Egyptian Mercury, which had but three. However, there have been many claimants beſides Mercury to the ſeven-ſtringed lyre. See Lyre.

His moſt magnificent temple was on Mount Cylene, in Arcadia. He is deſcribed by the poets as a fair beardleſs youth, with flaxen hair, lively blue eyes, and a ſmiling countenance. He has wings fixed to his cap and ſandals, and holds the caduceus (or ſtaff ſurrounded with ſerpents, with two wings on the top), in his hand; and is frequently repreſented with a purſe, to ſhow that he was the god of gain. The animals ſacred to him, were the dog, the goat, and the cock. In all the ſacrifices offered to him, the tongues of the victims were burnt; and thoſe who eſcaped imminent danger ſacrificed to him a calf with milk and honey.

Mercury, ☿ in *Aſtronomy*. See Astronomy *Index*.

This planet is brighteſt between his elongations and ſuperior conjunction, very near to which laſt he can generally be ſeen. He becomes inviſible ſoon after he has found his elongation, going towards his inferior conjunction; and becomes viſible again a few days before his next elongation. The brightneſs of this planet alters ſometimes very conſiderably in 24 hours. It has been obſerved when leſs than three degrees diſtant from the ſun, and may, perhaps, ſometimes be ſeen even in conjunction with it.

Mercury and Venus appear brighteſt and moſt beautiful in the oppoſite parts of their orbits: the firſt, be-tween

tween his elongations and superior conjunction; and the other, between her elongations and inferior conjunction. Therefore, Venus is seen in great perfection as a crescent, particularly in her inferior conjunction, whilst Mercury is seldom seen in such perfect phases. Mercury should be always observed on or near the meridian. When farthest from the sun, he always appears with a very faint light; and when he has a great south declination, or the atmosphere is not perfectly clear, he seldom can be seen in those parts of his orbit, where he only begins to recover his brightness, or where it is much diminished. He has frequently been seen on the meridian even with a small telescope and small power; and it appears from the above statement that he may be obscured in a clear day rather more than half his orbit, or near one hundred and fourscore days in the year.

MERCURY, in *Heraldry*, a term used in blazoning by planets, for the purple colour used in the arms of sovereign princes.

MERCY, a virtue that inspires us with compassion for our brethren, and which inclines us to give them assistance in their necessities. Mercy is also taken for those favours and benefits that we receive either from God or man, particularly in the way of forgiveness of injuries or of debts. Nothing can be more beautiful than the description of mercy given us by Shakespeare, in the pleading between Portia and the Jew:

Por. Then must the Jew be merciful.
Shy. On what compulsion must I? tell me that.
Por. The quality of mercy is not strain'd;
It droppeth as the gentle rain from heav'n
Upon the place beneath. It is twice bless'd:
It blesseth him that gives, and him that takes.
'Tis mightiest in the mightiest; it becomes
The throned monarch better than his crown:
The sceptre shows the force of temporal power,
The attribute to awe and majesty,
Wherein doth sit the dread and fear of kings;
But mercy is above this scepter'd sway,
It is enthroned in the hearts of kings;
It is an attribute to God himself,
And earthly power doth then show likest God's,
When mercy seasons justice. Therefore, Jew,
Though justice be thy plea, consider this,
That in the course of justice none of us
Should see salvation. We do pray for mercy;
And that same prayer doth teach us all to render
The deeds of mercy. *Merchant of Venice*, act iv.

MERCY-SEAT, or PROPITIATORY, in Jewish antiquity, the covering of the ark of the covenant.—The Hebrew name of this cover, which we translate mercy-seat, is *Capporeth* (Exod. xxv. 17. 22.), from *Cappor*, which signifies *to cover*, *to shut up*, *to expiate*, *to pay*. This cover was of gold, and at its two ends were fixed the two cherubims of the same metal, which by their wings extended forwards, seemed to form a throne for the majesty of God, who in scripture is represented to us as sitting between the cherubims, and the ark itself was as it were his footstool. It was from hence that God gave his oracles to Moses, or to the high priest that consulted him, (Exod. xxv. 22. Numb. vii. 89.).

MERETRIX, among the Romans, differed from the *prostibula*. The *prostibulæ* were common courtesans, with bills over their doors, signifying their profession, and were ready at all times to entertain customers; whereas the *meretrices* entertained none but at night.—The *meretrices* differed in their dress from the *matrons*; the former wore the *toga* and short *tunics*, like those of the men: the latter wore the *palla* and the *stola* of such a length as to reach to their feet.

MERGANSER. See MERGUS.

MERGUS, a genus of birds of the order of anseres. See ORNITHOLOGY *Index*.

MERIAN, MARIA SIBYLLA, a celebrated paintress, born at Frankfort in 1647, was the daughter of Matthias Merian, a noted engraver and geographer.—As she showed a very early fondness for painting, she was instructed by Abraham Mignon; from whom she learned great neatness of handling and delicacy of colour. Her genius particularly led her to paint reptiles, flowers, and insects, which she designed after nature, and studied every object with a most curious and inquisitive observation; so that her works rose every day more and more into reputation. Frequently she painted her subjects in water colours on vellum, and finished an astonishing number of designs, as she was equally indefatigable in her work and in her inquiries into the curiosities of nature. She drew the flies and caterpillars in all the variety of changes and forms in which they successively appear from their quiescent state till they become butterflies; and also drew frogs, toads, serpents, ants, and spiders, after nature, with extraordinary exactness and truth. She even undertook a voyage to Surinam, to paint those insects and reptiles which were peculiar to that climate; and at her return to her own country published two volumes of engravings after her designs, which are well known to the curious. She died in 1717. Her daughter Dorothea Henrietta Graff, who painted in the same style, and had accompanied her mother to Surinam, published a third volume collected from the designs of Sibylla; which complete work has been always admired by the learned, as well as by the professors of painting.

MERIDA, a strong town of Spain, in Estremadura, built by the Romans before the birth of Christ. Here are some fine remains of antiquity, particularly a triumphal arch, but which is considerably decayed. It is seated in an extensive and fertile plain, 47 miles east of Elva, and 45 south by east of Alcantara. W. Long. 6. 4. N. Lat. 38. 42.

MERIDA, a town of North America, in New Spain, and capital of the province of Yucatan, where the bishop and the governor of the province reside. It is inhabited by Spaniards and native Americans; is 30 miles south of the sea, and 120 north-east of Campeachy. W. Long. 89. 25. N. Lat. 20. 15.

MERIDA, a town of South America, in the kingdom of New Granada, seated in a country abounding with all kinds of fruits, 130 miles north-east of Pampeluna. W. Long. 71. 0. N. Lat. 8. 30.

MERIDEN, or MIREDEN, a town of Warwickshire, 97 miles from London on the London road, near Coventry. It is pleasantly situated, though in a wet clayey situation, and is not ill built. The church stands on an elevated spot, and contains some good monuments. There is an inn here, about half way from

from St Clement's foreſt to Coventry, one of the fineſt in this part of England, being built like a nobleman's ſeat.

MERIDIAN, in *Geography*, a great circle ſuppoſed to be drawn through any part on the ſurface of the earth, and the two poles; and to which the ſun is always perpendicular at noon. See GEOGRAPHY.

In aſtronomy, this circle is ſuppoſed to be in the heavens, and exactly perpendicular to the terreſtrial one. See ASTRONOMY.

MERIDIANI, in antiquity, a name which the Romans gave to a kind of gladiators who entered the arena about noon after the beſtiarii (who fought in the morning againſt beaſts) had finiſhed. They were thus called from *meridies*, i. e. *noon*, the time when they exhibited their ſhows. The meridiani were a ſort of artleſs combatants, who fought man with man, ſword in hand. Hence Seneca takes occaſion to obſerve, that the combats of the morning were full of humanity compared with thoſe which followed.

MERIDIONAL DISTANCE, in *Navigation*, the ſame with departure, or eaſting and weſting; being the difference of longitude between the meridian under which the ſhip now is, and any other meridian which ſhe was under before.

MERIDIONAL parts, miles, or minutes, in *Navigation*, are the parts by which the meridians in a Mercator's chart do increaſe, as the parallels of latitude decreaſe.

MERIONETHSHIRE, a county of North Wales, is bounded on the north by Caernarvonſhire and Denbighſhire; on the eaſt by Montgomeryſhire; on the weſt by St George's channel, or the Iriſh ſea; and on the ſouth by the river Dyffl, which parts it from Cardiganſhire; extending 40 miles in length and 36 in breadth. It is divided into ſix hundreds, in which are four market towns, 37 pariſhes, about 5787 houſes, and 29,506 inhabitants in 1801. It lies in the dioceſe of Bangor, and ſends one member to parliament. The air is very ſharp in winter, on account of its many high barren mountains; and the ſoil is as bad as any in Wales, it being very rocky and mountainous. However, this county feeds large flocks of ſheep, many goats, and large herds of horned cattle, which find pretty good paſture in the valleys. Beſides theſe, among their other commodities may be reckoned Welch cotton, deer, fowl, fiſh, and eſpecially herrings, which are often taken on this coaſt in great plenty.

MERIT, ſignifies *deſert*. This term is more particularly applied to ſignify the moral goodneſs of the actions of men, and the rewards to which thoſe actions entitle them.

MERLIN, AMBROSE, a famous Engliſh poet and reputed prophet, flouriſhed at the end of the 5th century. Many ſurpriſing and ridiculous things are related of him. Several Engliſh authors have repreſented him as the ſon of an incubus, and as tranſporting from Ireland to England the great ſtones which form Stonehenge on Saliſbury plain. Extravagant prophecies and other works are alſo attributed to him, on which ſome authors have even written commentaries.

MERLIN. See FALCO, ORNITHOLOGY *Index*.

MERLON, in *Fortification*, is that part of a parapet which is terminated by two embraſures of a battery.

MERLUCIUS, the HAKE. See GADUS, ICHTHYOLOGY *Index*.

MERMAID, or MERMAN, a ſea-creature frequently talked of, ſuppoſed half human and half a fiſh.

However naturaliſts may doubt of the reality of *mermen* or *mermaids*, we have teſtimony enough to eſtabliſh it; though, how far theſe teſtimonies may be authentic, we cannot take upon us to ſay. In the year 1187, as Lary informs us, ſuch a monſter was fiſhed up in the county of Suffolk, and kept by the governor for ſix months. It bore ſo near a conformity with man, that nothing ſeemed wanting to it but ſpeech. One day it took the opportunity of making its eſcape; and plunging into the ſea, was never more heard of. *Hiſt. de Angleterre*, P. I. p. 403.

In the year 1430, after a huge tempeſt, which broke down the dikes in Holland, and made way for the ſea into the meadows, &c. ſome girls of the town of Edam in Weſt Frieſland, going in a boat to milk their cows, perceived a mermaid embarraſſed in the mud, with a very little water. They took it into their boat, and brought it with them to Edam, dreſſed it in woman's apparel, and taught it to ſpin. It fed like one of them, but could never be brought to offer at ſpeech. Some time afterwards it was brought to Haerlem, where it lived for ſome years, though ſtill ſhowing an inclination to the water. Parival relates, that they had given it ſome notion of a Deity, and that it made its reverences very devoutly whenever it paſſed by a crucifix. *Delices de Hollande*.

In the year 1560, near the iſland of Manaar, on the weſtern coaſt of the iſland of Ceylon, ſome fiſhermen brought up, at one draught of a net, ſeven mermen and mermaids; of which ſeveral Jeſuits, and among the reſt F. Hen. Henriques and Dimas Boſquez, phyſicians to the viceroy of Goa, were witneſſes. The phyſician, who examined them with a great deal of care, and made diſſection thereof, aſſerts, that all the parts both internal and external were found perfectly conformable to thoſe of men. See the *Hiſt. de la compagnie de Jeſus*, P. II. T. iv. N° 276. where the relation is given at length.

We have another account of a merman, ſeen near the great rock called *Diamond*, on the coaſt of Martinico. The perſons who ſaw it, gave in a preciſe deſcription of it before a notary. They affirmed that they ſaw it wipe its hand over its face, and even heard it blow its noſe.

Another creature of the ſame ſpecies was caught in the Baltic in the year 1531, and ſent as a preſent to Sigiſmund king of Poland, with whom it lived three days, and was ſeen by all the court. Another very young one was taken near Rocca de Sintra, as related by Damian Goes. The king of Portugal and the grand maſter of the order of St James, are ſaid to have had a ſuit at law to determine which party theſe monſters belong to.

In Pontopidan's Natural Hiſtory of Norway, alſo, we have accounts of mermaids; but not more remarkable or any way better atteſted than the above, to which we have given a place, merely to ſhew how far the folly and extravagance of credulity have been carried by weak minds.

MERNS, MEARNS, or KINCARDINESHIRE, a county of Scotland. See KINCARDINESHIRE.

MERODACH was an ancient king of Babylon, who was placed among the gods, and worshipped by the Babylonians. Jeremiah (chap. l. 2.), speaking of the ruin of Babylon, says, " Babylon is taken, Bel is confounded, Merodach is broken in pieces; her idols are confounded, her images are broken in pieces." We find certain kings of Babylon, in whose names that of Merodach is contained: for example, Evil-merodach and Merodach-baladan. Evil-merodach was the son of Nebuchadnezzar the Great, and had for his successor the wicked Belshazzar. Merodach-baladan, son of Baladan king of Babylon, having heard that Hezekiah had been cured miraculously (Isa. xxxix.), and that the sun had gone backwards to give him an assurance of his recovery, sent him presents, and made him him compliments upon the recovery of his health. Ptolemy calls him *Mardoc-empadus*; and says, that he began to reign at Babylon 26 years after the beginning of the era of Nabonassar, that is, in the year of the world 2283.

MEROE, in *Ancient Geography*, an island of Ethiopia beyond Egypt, in the Nile; with a cognominal town, the metropolis of the Ethiopians.

The Jesuits have endeavoured to prove, that the province of Gojam in Abyssinia is the Meroë of the ancients; but this is strongly contested by Mr Bruce, who is of opinion, that it must be looked for somewhere between the source of the Nile and its union with the Atbara. The latter, he thinks, is very plainly the Astaboras of the ancients; and Pliny says, that this stream encloses the left side of Meroë as the Nile does the right, in which case we must suppose him looking southward from Alexandria, otherwise the words would not apply.

We are told by Diodorus Siculus, that Meroë had its name from a sister of Cambyses king of Persia, who died there in the expedition undertaken by that prince against the Ethiopians. His army perished with hunger and thirst in the deserts beyond Meroë, which could not have happened if they had reached Gojam, the latter being one of the most plentiful countries in the world. A further proof that Gojam cannot be the ancient Meroë is, that the latter was enclosed between the rivers Nile and Astaboras, while Gojam is almost entirely surrounded by the Nile. If the ancients were acquainted with Gojam, they must also have been acquainted with the fountains of the Nile, which we certainly know they were not. Pliny says that Meroë, the most considerable of all the islands of the Nile, was called *Astaboras*, from the name of its left channel, which cannot be supposed any other than the junction of the Nile and Atbara. He informs us moreover, that the sun was vertical twice in the year, viz. when proceeding northward he entered the 18th degree of Taurus, and when returning he came to the 14th degree of Leo; but this could never be the case with Gojam, which lies in about 10 degrees north latitude.

Again, the poet Lucan describes Meroë by two circumstances which cannot apply to any other than the peninsula of Atbara. One is, that the inhabitants were black; which was the case with the Gymnosophists and first inhabitants, and which has been the case with all the rest down to the Saracen conquest: but the inhabitants of Gojam, as well as the other Abyssinians, are fair, at least greatly different in complexion from the blacks; they are also long-haired, and nobody imagined that they ever had philosophers or science among them, which was eminently the case with the ancient inhabitants of Meroë. The other circumstance is, that the ebony tree grew in the island of Meroë, which at this day grows plentifully in the peninsula of Atbara, and part of the province of Kuara, but not in Gojam, where the tree could not subsist on account of the violent rains which take place during six months of the year. Mr Bruce mentions another circumstance quoted from the poet Lucan, which likewise tends to prove the identity of Meroë and Atbara; viz. that though there are many trees in it, they afford no shade This our traveller found by experience, when returning from Abyssinia through Atbara. " The country (says he) is flat, and has very little water. The forests, though thick, afforded no sort of shade, the hunters for the sake of their sport, and the Arabs for destroying the flies, having set fire to all the dry grass and shrubs; which passing with great rapidity in the direction of the wind from east to west, though it had not time to destroy the trees, did yet wither, and occasion every leaf that was upon them to fall, unless in those spaces where villages had been, and where water was. In such spots a number of large spreading trees remained full of foliage; which, from their great height and being cleared of underwood, continued in full verdure, loaded with large, projecting, and exuberant branches. But even here the pleasure that their shade afforded was very temporary, so as to allow us no time for enjoyment. The sun so near the zenith, changed his azimuth so rapidly, that every few minutes I was obliged to change the carpet on which I lay, round the trunk of the tree to which I had fled for shelter; and though I lay down to sleep perfectly screened by the trunk or branches, I was presently awakened by the violent rays of a scorching sun, the shade having passed beyond me. In all other places, though we had travelled constantly in a forest, we never met with a tree that could shade us for a moment, the fire having deprived them of all their leaves." The heat of Atbara is excessive, the thermometer having been observed at $119\frac{1}{2}°$: two of Mr Bruce's company died of thirst, or at least of the consequences of drinking after extreme thirst. The inhabitants live in the greatest misery, and are continually in danger from the neighbouring Arabs, who, by destroying and burning their corn, are able to reduce them to a starving condition. Notwithstanding all their disadvantages, however, they have a manufacture of coarse cotton towels, of a size just sufficient to go round the waist, which pass current as money throughout the whole country.

MEROM, in *Ancient Geography*. The waters of Merom, at which place Jabin and the other confederate kings met to fight (Joshua xi. 5.), are generally supposed by the learned to be the lake Semechon, which lies between the head of the river Jordan and the lake Gennesareth; since it is agreed on all hands, that the city Hazor, where Jabin reigned, was situated upon this lake. But others think that the waters of Merom or Merome were somewhere about the brook Kishon, since there is a place of that name mentioned in the account of the battle against Sisera (Judg. v. 21.). And it is more rational to think, that the confederate kings advanced as far as the brook Kiſhon, and to a paſs which led into the country, to hinder Joſhua from penetrating it, or even to attack him in the country where he himſelf lay encamped, than to imagine that they waited for him in the midſt of their own country; leaving all Galilee at his mercy, and the whole tract from the brook Kiſhon to the lake Semechon.

MEROPE, in *Fabulous Hiſtory*, one of the Atlantides. She married Siſyphus the ſon of Æolus, and like her ſiſters was changed into a conſtellation after death. It is ſaid that in the conſtellation of the Pleiades the ſtar of Merope appears more dim and obſcure than the reſt, becauſe ſhe, as the poets obſerve, married a mortal, while her ſiſters married ſome of the gods or their deſcendants.

MEROPS, in *Fabulous Hiſtory*, a king of the iſland of Cos, who married Clymene, one of the Oceanides. He was changed into an eagle, and placed among the conſtellations. Alſo a celebrated ſoothſayer of Pereoſus in Troas, who foretold the death of his ſons Adraſtus and Amphius, who were engaged in the Trojan war. They ſlighted their father's advice, and were killed by Diomedes.

MEROPS, a genus of birds belonging to the order of picæ. See ORNITHOLOGY *Index*.

MEROVINGIAN CHARACTER, derives its name from Meroüée, the firſt king of France of that race, which reigned 333 years, from Pharamond to Charles Martel. This race is ſaid by ſome to have terminated in Childeric III. A. D. 751. There are many MSS. in the French libraries ſtill extant in this character.

MEROZ, in *Ancient Geography*, a place in the neighbourhood of the brook Kiſhon, whoſe inhabitants refuſing to come to the aſſiſtance of their brethren when they fought with Siſera, were put under an anathema (Judges v. 23.) "Curſe ye Meroz, ſays the angel of the Lord; curſe ye bitterly the inhabitants thereof: becauſe," &c. Some have thought that Meroz is the ſame as Merus or Merom; and this F. Calmet thinks the moſt probable opinion in this matter. Others will have it, that Meroz was a mighty man, who dwelt near the Kiſhon, and not caring to come to the aſſiſtance of Barak and Deborah, was excommunicated by the angel of the Lord by the ſound of 400 trumpets. The angel of the Lord, according to ſome, was Barak, the general of the Lord's army; but according to others he was the high prieſt for the time being, or a prophet.

MERSA, a town of Barbary, pleaſantly ſituated about 11 miles from the city of Tunis, and two from Melcha the ſite of ancient Carthage. The bey has here two country houſes, one of them very coſtly work, built by Haſſan Bey ſurnamed the *Good*. From theſe are orange gardens reaching almoſt to the ſea-ſhore; on the edge of which is a famous well of ſweet water, eſteemed the beſt and lighteſt in the kingdom. Cloſe to this is a coffeehouſe, whither numbers of people from the neighbouring places reſort to drink coffee, and a glaſs of this natural luxury ſo peculiarly enjoyed in the eaſtern countries. In the middle of the court is a large mulberry tree, under the ſhade of which they ſit and ſmoke and play at cheſs; inhaling the comfortable ſea breeze that refreſhes this delightful ſpot. The water is drawn up by a camel with the Perſian wheel.

There are the remains of an ancient port, or cothon, (ſuppoſed to be an artificial one), built by the Carthaginians after Scipio had blocked up the old port, nothing but the turret or lighthouſe being left.

MERS or MERSE, a county of Scotland, called alſo *Berwickſhire*. This laſt name it derives from the town of Berwick, which was the head of the ſhire before it fell into the hands of the Engliſh, and obtained the appellation of *Mers* or *March*, becauſe it was one of the borders towards England. See BERWICK, *County of*.

MERSENNE, MARIN, in Latin *Merſennus*, a learned French author, born at Oyſé, in the province of Maine, anno 1588. He ſtudied at La Fleche at the ſame time with Des Cartes; with whom he contracted a ſtrict friendſhip, which laſted till death. He afterwards went to Paris, and ſtudied at the Sorbonne; and in 1611 entered himſelf among the Minims. He became well ſkilled in Hebrew, philoſophy, and mathematics. He was of a tranquil, ſincere, and engaging temper; and was univerſally eſteemed by perſons illuſtrious for their birth, their dignity, and their learning. He taught philoſophy and divinity in the convent of Nevers, and at length became ſuperior of the convent; but being willing to apply himſelf to ſtudy with more freedom, he reſigned all the poſts he enjoyed in his order, and travelled into Germany, Italy, and the Netherlands. He wrote a great number of excellent works; the principal of which are, 1. *Queſtiones celeberrimæ in Geneſim.* 2. *Harmonicorum libri.* 3. *De ſonorum natura, cauſis, et effectibus.* 4. *Cogitata phyſico-mathematica.* 5. *La verité des Sciences.* 6. *Les queſtions inouies.* He died at Paris in 1648. He had the reputation of being one of the beſt men of his age. No perſon was more curious in penetrating into the ſecrets of nature, and carrying all the arts and ſciences to their utmoſt perfection. He was in a manner the centre of all the men of learning, by the mutual correſpondence which he managed between them. He omitted no means to engage them to publiſh their works; and the world is obliged to him for ſeveral excellent diſcoveries, which, had it not been for him, would perhaps have been loſt.

MERSY, a river of England, which runs through the counties of Lancaſter, York, and Cheſter, and empties itſelf into the Iriſh ſea at Liverpool. By means of inland navigation, it has communication with the rivers Dee, Ribble, Ouſe, Trent, Derwent, Severn, Humber, Thames, Avon, &c.; which navigation, including its windings, extends above 500 miles, in the counties of Lincoln, Nottingham, York, Lancaſter, Weſtmoreland, Cheſter, Stafford, Warwick, Leiceſter, Oxford, Worceſter, &c.

MERSEY Iſland, an iſland of Eſſex, at the mouth of the Coln, ſouth of Colcheſter. It was ſeized by the Danes in the reign of King Alfred, for their winter quarters. It had eight pariſhes, now reduced to two, viz. Eaſt and Weſt Merſey. There was formerly a blockhouſe on the iſland.

MERULA, or *Blackbird*. See TURDUS, ORNITHOLOGY *Index*.

MERUS, in *Ancient Geography*, a mountain of the Hither India, hanging over the city Nyſſa, built by Bacchus, and ſituated between the rivers Cophen and Indus. The name, denoting the *thigh*, gave riſe to the fable of Bacchus being inſerted into Jupiter's thigh, and being

being born twice; because in this mountain he and his army are said to have been preserved, when disease and pestilence raged in the plains below.

MESARAIC VESSELS, in the general sense, are the same with MESENTERIC.

In common use, mesaraic is more frequently applied to the veins, and mesenteric to the arteries, of the mesentery. See ANATOMY.

MESCHED, a considerable town of Persia, and in the province of Chorassan; fortified with several towers, and famous for the magnificent sepulchre of Iman Risa, of the family of Ali, to whom the Persians pay great devotion. It is seated on a mountain near this town, on which are fine turquoise stones; in E. Long. 59. 25. N. Lat. 37. 0.

MESEMBRYANTHEMUM, FIG-MARIGOLD, a genus of plants belonging to the icosandria class; and in the natural method ranking under the 13th order, *Succulentæ*. See BOTANY *Index*.

MESENTERIC, or MESARAIC, an epithet given to two arteries arising from the descending aorta, and proceeding to the mesentery. See MESENTERY.

MESENTERITIS, or *Inflammation of the* MESENTERY. See MEDICINE *Index*.

MESENTERY, MESENTERIUM, (formed of μεσος, *middle*, and εντερον, *intestine*), in anatomy, a fatty membranous body, thus called as being placed in the middle of the intestines, which it connects to one another. See ANATOMY, N° 94.

MESHES *of NETS*, the openings or interstices between the threads.

MESN, or MESNE, a term in law, signifying him who is lord of a manor, and so hath tenants holding of him; yet he himself holds of a superior lord.

The word is properly derived from *maisne*, *quasi minor natu*; because his tenure is derived from another, from whom he holds.

MESN also denotes a writ, which lieth where there is lord mesn and tenant; and the tenant is distrained for services due from the mesn to the superior lord.

This is in the nature of a writ of right; and in this case the tenant shall have judgment to be acquitted or indemnified by the mesne lord; and if he makes default therein, or does not appear originally to the tenant's writ, he shall be forejudged of his mesnalty, and the tenant shall hold immediately of the lord paramount himself.

MESOCHRI, were musicians among the ancients, who presided in concerts, and by beating a wooden desk regularly with their feet, directed the measure of the music. For the purpose of beating time, they wore wooden clogs, called by the ancients *crupezia*, which occasioned the sound to be better heard.

MESOCOLON, in *Anatomy*, that part of the mesentery, which, having reached the extremity of the ileum, contracts and changes its name. See ANATOMY, N° 94.

MESOLOGARITHMS, according to Kepler, are the logarithms of the co-sines and co-tangents; the former of which were called by Baron Napier *anti-logarithms*, and the latter *differentials*.

MESOPOTAMIA, the ancient name of the province of DIARBECK, in Turkey in Asia. It is situated between the rivers Euphrates and Tigris; having Assyria on the east, Armenia on the north, Syria on the west, and Arabia Deserta with Babylonia on the south. The Hebrews called it *Padan-aram*, (Gen. xxviii. 2. &c.) and *Aram Naharaim* (title of Psalm lx.) or Aram *of the two rivers*, because it was first peopled by Aram father of the Syrians, and is situated between the two rivers already mentioned. This country is much celebrated in Scripture, as being the first dwelling of men both before and after the deluge; and because it gave birth to Phaleg, Heber, Terah, Abraham, Nahor, Sarah, Rebekah, Rachel, Leah, and to the sons of Jacob. Babylon was in the ancient Mesopotamia, till, by vast labour and industry, the two rivers of the Tigris and Euphrates were united into one channel. The plains of Shinar were in the same country. Often they gave it the name of Mesopotamia (Deut. xxiii. 4. &c.) and sometimes that of Syria, (Hosea xii. 12.). Balaam son of Beor was of Mesopotamia, Deut. xxiii. 4. Chushan-rishathaim king of Mesopotamia kept the Hebrews in subjection some time after the death of Joshua, Judg. iii. 8.

MESOPTERYGIUS, a term applied to such fishes as have only one back-fin, which is situated in the middle of the back.

MESPILUS, the MEDLAR, a genus of plants belonging to the icosandria class; and in the natural method ranking under the 36th order, *Pomaceæ*. See BOTANY *Index*.

MESS, in a military sense, implies a number of soldiers, who, by laying away a certain proportion of their pay towards provisions, mess together: six or eight is generally the number of each mess. Experience proves, that nothing contributes more to the health of a soldier, than a regular and well chosen diet, and his being obliged every day to boil the pot: it corrects drunkenness, and in a great measure prevents gaming, and thereby desertion.

MESSALINA, VALERIA, a daughter of Messala Barbatus. She married the emperor Claudius, and disgraced herself by her cruelties and incontinence. Her husband's palace was not the only seat of her lasciviousness, but she prostituted herself in the public streets, and few men there were at Rome who could not boast of having enjoyed the favours of the impure Messalina. Her extravagancies at last irritated her husband, who commanded her to appear and answer all the accusations which were brought against her: upon which she attempted to destroy herself; and when her courage failed, one of the tribunes who had been sent to her despatched her with his sword. It is in speaking of her debaucheries and lewdness that Juvenal says,

Et lassata viris, necdum satiata, recessit.

Her name has become a common appellation to denote a woman of shameless and inordinate lust.

MESSANA, in *Ancient Geography*, the first town of Sicily on crossing over from Italy, situated on the strait now called the *Faro*, (Italicus). Anciently called *Zancle*, according to Diodorus Siculus, from King Zanclus; or, according to others, from the Sicilian term *Zanclon*, denoting a sickle, alluding to the curvity of the coast; a name appropriated by the poets; and hence *Zanclæi*, the people, (Herodotus, Pausanias).

The

Messana || Messenia.

The other name *Messana* is from the *Messenii* of Peloponnesus, (Strabo). Thucydides ascribes its origin to Anaxilas the Messenian, tyrant of Rhegium, who received all comers, calling the town after the name of his country. The Greeks always call it *Messene;* the Romans *Messena* constantly, to distinguish it from *Messene* of Peloponnesus. Now MESSINA, lately ruined by earthquakes.

MESSENA, or MESSENE, an inland town, and the capital of Messenia, a country of Peloponnesus; erroneously placed by Ptolemy on the coast. It was built by Epaminondas, who recalled all the Messenian exiles, and gave the town the name of *Messene*. A place vying in point of strength and situation with Corinth, according to Strabo; and therefore Demetrius Phalereus advised Philip, father of Perseus, that if he wanted to have Peloponnesus in his power, he should make himself master of these two towns, as thus he would have the ox by both horns.

MESSENGERS, are certain officers chiefly employed under the direction of the secretaries of state, and always in readiness to be sent with all kinds of despatches foreign and domestic. By virtue of the secretaries warrants, they also take up persons for high treason, or other offences against the state. The prisoners they apprehend are usually kept at their own houses, for each of which they are allowed 6s. 8d. per day by the government: and when they are sent abroad, they have a stated allowance for their journey, viz. 30l. for going to Paris, Edinburgh, or Dublin; 25l. for going to Holland; and to other places in the same proportion; part of which money is advanced for the expence of their journey. Their standing salary is 45l. per annum; and their posts, if purchased, are esteemed worth 300l. But these sums have now probably been increased. The messengers wait 20 at a time, monthly, and are distributed as follows, viz. four at court, five at one secretary's office, five at another, two at the third for North Britain, three at the council office, and one at the lord chamberlain's of the household.

MESSENGERS, in Scotland. See LAW, Part III.

MESSENGERS of the Exchequer, are four officers who attend the exchequer, in the nature of pursuivants, and carry the lord treasurer's letters, precepts, &c.

MESSENGER of the Press, a person who, by order of the court, searches printing-houses, booksellers shops, &c. in order to discover the printers or publishers of seditious books, pamphlets, &c.

MESSENIA, a country in the south of Peloponnesus, mostly maritime, situated between Elea to the west, and Laconia to the east. Anciently a part of Laconia under Menelaus, and called *Messene* by Homer; interpreted by the scholiast, *Messenæa Regio*. *Messenii*, the people, reduced to a state of slavery and subjection by the Spartans; *Messenius*, the epithet.

This country is famous in history, on account of the resistance made by the Messenians against the Spartans, and the exploits of their hero Aristomenes. The first hostilities commenced about the year 652 B. C. on what occasion is uncertain. Though the Messenians were inferior in the knowledge of the art of war to the Spartans; yet, by keeping for some time on the defensive, they improved so much, that in three years time they found themselves in a capacity of giving battle to their enemies in the open field; nor did they appear to be in any degree inferior either in courage or conduct: the war was therefore protracted, with various success, on both sides. At last, both consulted the oracle at Delphi; and received for answer, "that whoever should first dedicate 100 tripods in the temple of Jupiter at Ithome, a strong hold of the Messenians, should be masters of the country." The inhabitants of Messenia, on hearing this, having no money to make the tripods of brass, fell to cutting them out in wood; but before this could be accomplished, a Spartan having got into the city by stratagem, dedicated 100 little tripods of clay: which threw the Messenians into such despair, that they at last submitted to the Spartans.

Messenia.

The new subjects of Sparta were treated with the utmost barbarity by these cruel tyrants; so that a new war commenced under Aristomenes, a man of unconquerable valour, and enthusiastically fond of liberty. He perceived that the Argives and Arcadians, who were called the *allies* of the Lacedæmonians, adhered to them only through fear of their power; but that in reality they hated them, and wished to revenge the injuries they had done them. To these Aristomenes applied; and receiving an answer conformable to his wishes, he engaged his countrymen unanimously to take up arms. About a year after the revolt began, and before either party had received any auxiliaries, the Spartans and Messenians met at a village called *Deræ*, where an obstinate engagement ensued. Aristomenes was conceived to have performed more than mortal achievements: in gratitude therefore, respect being also had to his royal descent, his countrymen unanimously saluted him *king;* which title he modestly waved, alleging, that he took up arms to set them free, and not to make himself great: he consented, however, to accept the title of *general*, with a power of doing whatsoever he thought requisite for the service of the public. Knowing well the superstition of the age in which he lived, he resolved to intimidate the Spartans, by showing them what he was sure they would take for an ill omen. Disguising himself therefore, he went privately to the city, where, in the night, he hung up a shield on the wall of the temple of Minerva, with this inscription: *Aristomenes dedicates this, out of the spoils of the Spartans, to the goddess.* It was easily perceived that this war would be both long and bloody; the Lacedæmonians therefore sent deputies to Delphi, to inquire of the oracle concerning its event: the answer they received was, *That it behoved the Spartans to seek a leader from Athens.* The Athenians naturally envious of the Spartans, granted their request indeed, but in such a manner as manifested their spite; for they sent them for a general Tyrtæus, a schoolmaster and poet, lame of one foot, and who was suspected to be a little out of his wits. But here their skill failed them; for this captain, notwithstanding his despicable appearance, proved of great consequence to Sparta, teaching them how to use good, and how to bear up under ill fortune.

In the mean time, Aristomenes had drawn together a mighty army, the Eleans, Argives, Sicyonians, and Arcadians, having sent troops to his assistance; the Spartans in this, as in the former war, having no ally but Corinth. The Spartan kings, according to the custom

Messenia. custom of their city, no sooner took the field, than, notwithstanding their inferiority in number, they offered the enemy battle, which Aristomenes readily accepted. It was long, obstinate, and bloody; but in the end the Messenians were victorious, and the Lacedæmonians put to flight with a great slaughter. It is scarce to be conceived how much the Spartans were struck with this defeat: they grew weary of the war, dissatisfied with their kings, diffident of their own power, and in a word sunk into a state of general uneasiness and want of spirit. It was now that the Athenian general convinced them, that he was capable of fulfilling all the promises of the oracle; he encouraged them by his poems, directed them by his counsels, and recruited their broken armies with chosen men from among the Helotes. Aristomenes, on the other hand, acted with no less prudence and vigour. He thought it not enough to restore the reputation of the Messenians, if he did not also restore their wealth and power: he therefore taught them to act offensively against their enemies; and, entering the territories of Sparta, he took and plundered Pharæ, a considerable borough in Laconia, putting all such as made any resistance to the sword, carrying off at the same time an immense booty. This, however, was an injury which the Spartans could not brook with patience; they therefore sent immediately a body of forces to overtake the Messenians, which accordingly they did: but Aristomenes routed these pursuers, and continued to make a mighty slaughter of them, till such time as he was disabled by having a spear thrust in his side, which occasioned his being carried out of the battle. His cure, which took up some time, being finished, he resolved to carry the war even to the gates of Sparta; and to that purpose raised a very great army; but, whether he found his design impracticable, or was really diverted by some dream, he gave out, that Castor and Pollux, with their sister Helena, had appeared to him, and commanded him to desist. A short time after this retreat, going with a small party to make an incursion, and attempting to take prisoners some women who were celebrating religious rites near Egila, a village in Laconia, those zealous matrons fell upon him and his soldiers with such fury, that they put them to flight, and took him prisoner: however, he soon afterwards made his escape, and rejoined his forces. In the third year of the war, the Spartans with a great force entered Messenia, whither Aristocrates king of Arcadia was come, with a great body of troops to the assistance of his allies: Aristomenes therefore made no difficulty of fighting when the Spartans approached; but they entering privately into a negociation with Aristocrates, engaged him with bribes and promises to betray his confederates. When the battle began, the deceitful Arcadian represented to the forces under his command the mighty danger they were in, and the great difficulty there would be of retreating into their own country, in case the battle should be lost: he then pretended, that the sacrifices were ominous; and, having terrified his Arcadians into the disposition of mind fittest to serve his purpose, he not only drew them off from both wings, but, in his flight, forced through the Messenian ranks, and put them too in confusion. Aristomenes and his troops, however, drew themselves into close order, that they might defend themselves the best they could: and indeed they had need of all their valour and skill; for the Lacedæmonians, who expected this event, immediately attacked and surrounded them on all sides. Fortune was, on this occasion, too powerful either for the courage or the conduct of the Messenians; so that, notwithstanding their utmost efforts, most of their army were cut to pieces, and amongst them the chief of their nobility. Aristomenes, with the poor remains of his shattered forces, retired as well as he could; and, perceiving that it was now impossible to maintain the war against the Lacedæmonians upon equal terms, he exhorted his countrymen to fortify Mount Era, and to make the best dispositions possible for a long defence. He likewise placed garrisons in Pylus and Methone on the sea coasts; and to these three places he gathered all the inhabitants, leaving the rest of Messenia to the mercy of the Spartans. They, on the other hand, looked on the war as now in a manner finished; for which reason they divided the lands among their citizens, and caused them to be carefully cultivated, while they besieged Era. But Aristomenes quickly convinced them that the war was far from being over: he chose out of all the Messenians 300 men, with whom he ravaged all the adjacent country: carried off a prodigious booty; and, when Messenia could no longer supply the wants of his garrison, penetrated into Laconia, and bore away corn, wine, cattle, and whatever else was necessary to the subsistence of his countrymen shut up in Era: so that at last the Spartans were constrained to issue a proclamation, forbidding the cultivation, not only of the Messenian territory in their hands, but also of Laconia in its vicinity; whereby they distressed themselves more than their enemies, inducing at last a famine in Sparta itself, which brought with it its usual attendant, sedition. Here again all things had gone wrong, if the wisdom of the poet Tyrtæus had not supported the Spartan courage; nor was it without much difficulty that he influenced them to continue the blockade of Era, and to maintain a flying camp for the security of the country.

Aristomenes, in spite of all these precautions, committed terrible depredations with his small corps of 300 men. Amongst other places which he plundered, the city of Amyclæ was one; from whence he carried not only a great quantity of riches, but also many carriages laden with provisions. The kings of Sparta lying with their troops in its neighbourhood, as soon as they heard of this expedition, marched after Aristomenes with the utmost diligence; and, as the Messenians were encumbered with their booty, came up with them before they could reach Era. In this situation of things, Aristomenes, prompted rather by despair than prudence, disposed his troops in order of battle; and, notwithstanding they were so few, made a long and vigorous resistance against the whole Lacedæmonian army. At length, however, numbers prevailed: the greatest part of the Messenians were slain on the spot; and Aristomenes, with about 50 of his men who survived the slaughter, were taken prisoners; that chief having received so many wounds, that he was senseless when they carried him away. The Lacedæmonians expressed the loudest joy at the sight of this illustrious captive; who for so many years, by his single abilities, had

Meſſenia. had enabled his exhauſted country to defend itſelf againſt the whole force of Sparta. When he was recovered of his wounds, they decreed him and all his fellow priſoners to be thrown together into a deep cavern, which was the common puniſhment of the loweſt kind of offenders. This judgment was executed with the utmoſt ſeverity, excepting that Ariſtomenes had leave to put on his armour. Three days he continued in this diſmal place, lying upon and covered over with dead bodies. The third day, he was almoſt famiſhed through want of food, and almoſt poiſoned with the ſtench of corrupted carcaſes, when he heard a fox gnawing a body near him. Upon this he uncovered his face, and perceiving the fox juſt by him, he with one hand ſeized one of its hind legs, and with the other defended his face, by catching hold of its jaw when it attempted to bite him. Following as well as he could his ſtruggling guide, the fox at laſt thruſt his head into a little hole; and Ariſtomenes then letting go his leg, he ſoon forced his way through and opened a paſſage to the welcome rays of light, from which the noble Meſſenian had been ſo long debarred. Feeble as he was, Ariſtomenes wrought himſelf an outlet with his nails; and travelling by night with all the expedition he could, at length arrived ſafe at Era, to the great joy and amazement of his countrymen. When this news was firſt blazed abroad, the Spartans would have had it paſs for a fiction; but Ariſtomenes ſoon put the truth of it out of doubt, by falling on the poſts of the Corinthians, who, as allies of the Spartans, had a conſiderable body of troops before Era. Moſt of their officers, with a multitude of private men, he ſlew; pillaged their camp; and, in ſhort, did ſo much miſchief, that the Spartans under the pretence of an approaching feſtival, agreed to a ceſſation of arms for 40 days, that they might have time to bury their dead. On this occaſion, Ariſtomenes for the ſecond time celebrated the *hecatomphonia*, or the ſacrifice appointed for thoſe who had killed 100 of the enemy with their own hands. He had performed the ſame before and after his ſecond battle; and he lived to do it a third time: which muſt appear wonderful to the reader, when he is informed, that, notwithſtanding this truce, certain Cretan archers in the ſervice of the Spartans ſeized Ariſtomenes as he was walking without the walls, and carried him away a priſoner. There were nine of them in all: two of them immediately flew with the news to Sparta, and ſeven remained to guard their prize, whom they bound, and conducted to a lone cottage inhabited only by a widow and her daughter. It ſo fell out that the young woman dreamt the night before that ſhe ſaw a lion without claws, bound, and dragged along by wolves; and that ſhe having looſed his bonds, and given him claws, he immediately tore the wolves to pieces. As ſoon as Ariſtomenes came into the cottage, and her mother who knew him, had told her who he was, ſhe inſtantly concluded that her dream was fulfilled; and therefore plied the Cretans with drink, and when they were aſleep, took a poniard from one of them, cut the thongs with which Ariſtomenes was bound, and then put it into his hands. He preſently verified her viſion, by putting all his guards to death; and then carried her and her mother to Era, where, as a reward for her ſervice, he married the young woman to his ſon Gorgus, then about 18 years of age. Meſſenia.

When Era had held out near eleven years, it fell into the hands of Sparta by an accident: the ſervant of one Empiramus, a Spartan commander, driving his maſter's cattle to drink at the river Neda, met frequently with the wife of a Meſſenian whom he engaged in an amour. This woman gave him notice, that her huſband's houſe was without the wall; ſo that he could come to it without danger, when the good man was abroad; and ſhe likewiſe gave him intelligence when her huſband was upon duty in the garriſon. The Spartan failed not to come at the time appointed; but they had not been long in bed before the huſband returned, which put the houſe into great confuſion; the woman, however, ſecured her gallant; and then let in her huſband, whom ſhe received in appearance with great joy, inquiring again and again by what exceſs of good fortune ſhe was bleſſed with his return. The innocent Meſſenian told her, that Ariſtomenes being detained in his bed by a wound, the ſoldiers knowing that he could not walk the rounds, had a grant to retire to their houſes, to avoid the inclemency of the ſeaſon. The Spartan no ſooner heard this, than he crept ſoftly out of doors, and haſtened away to carry the news to his maſter. It ſo happened, that the kings were at this time abſent from the camp, and Empiramus had the chief command of the army. As ſoon as he received this information, he ordered his army to begin its march, though it rained exceſſively, and there was no moon light. The fellow guided them to the ford, and managed matters ſo well that they ſeized all the Meſſenian poſts: yet, after all, they were afraid to engage; darkneſs, and high wind, heavy rain, together with the dread of Ariſtomenes, keeping them quiet in the places they had ſeized. As ſoon as it was light the attack began; and Era had been quickly taken, if only the men had defended it; but the women fought with ſuch fury, and by their mingling in the fray, brought ſuch an acceſſion of numbers, as made the event doubtful. Three days and two nights this deſperate engagement laſted: at laſt, all hopes of preſerving the city being loſt, Ariſtomenes drew off his wearied troops. Early in the fourth morning, he diſpoſed the women and children in the centre, the Meſſenian youth in the front and rear, the leſs able men in the main body: himſelf commanded the van; the rear-guard was brought up by Gorgus and Manticlus, the former the ſon of Ariſtomenes, the latter of Theocles, a Meſſenian of great merit, who fell with much glory in this attack, fighting valiantly in the cauſe of his country. When all things were ready, Ariſtomenes cauſed the laſt barrier to be thrown open; and, brandiſhing his ſpear, marched directly towards the Spartan troops, in order to force a paſſage. Empiramus, perceiving his intent, ordered his men to open to the right and left, and fairly gave them a paſſage; ſo that Ariſtomenes marched off in triumph, as it were, to Arcadia.

The Arcadians, when they heard that Era was taken, were very deſirous of ſuccouring their old confederates in this deep diſtreſs: they therefore entreated their king Ariſtocrates to lead them into Meſſenia.

Messenia. But he, corrupted by the Lacedæmonians, persuaded them that it was too late; that the Messenians were all cut off; and that such a step would only expose them to the fury of the conquerors. When the thing appeared to be otherwise, and it was known that Aristomenes was on the frontiers of Arcadia, they went in crowds to carry him provisions, and to testify their readiness to afford him and those under his command all the assistance in their power. Aristomenes desired to be heard before a general assembly; which being accordingly convoked, he there opened one of the boldest and best laid schemes recorded in history: he said, that he had yet 500 undaunted soldiers, who, at his command, would undertake any thing; that it was very probable most of the Spartans were employed in pillaging Era, and that therefore he determined to march and surprise Sparta; which appeared so sensible, that all the assembly loudly commended his great capacity and unshaken courage. Aristocrates, however, took care to betray him; having, by various pretences, retarded the execution of the project. The Arcadians, who began to suspect him, waited for and surprised the messengers as they came back. They took the letters from them, and read them openly in the assembly. The purport of them was, that they acknowledged his great kindness both now and in the battle; and promised, that the Lacedæmonians would be grateful. As soon as the letters were read, the Arcadians fell to stoning their king, frequently calling upon the Messenians to assist them; which, however, they did not, waiting for Aristomenes's order; who, far from triumphing in this spectacle, stood still, with his eyes fixed on the ground, which he wet with his tears, his soul pierced with sorrow to see a crowned head so shamefully and so deservedly put to death. The Arcadians afterwards erected a monument over him, with an inscription to perpetuate his infamy. As for the Messenians under the command of Gorgus and Manticlus, they passed over into Sicily; where they founded the city of Messene, one of the most famous in the island. Aristomenes remained, however, in Greece; where he married all his daughters, except the youngest, to persons of great rank. A prince of Rhodes, inquiring of the oracle at Delphi whom he should espouse, that his subjects might be happy under his posterity, was directed to marry the daughter of the most worthy of the Greeks; which answer was immediately understood to point at the virgin daughter of Aristomenes. Her therefore he demanded, and received; Aristomenes accompanying him back to his dominions, where he formed a scheme of uniting the Lydians and Medes against the Spartans, resolving with this view to go into Media, and to the court of Sardis; but while he meditated these great things, death surprised him, and thereby freed Lacedæmon from the most formidable enemy she ever had.

MESSIAH, a word signifying one *anointed*, or installed into an office by unction. It was usual among the Jews to anoint kings, high priests, and sometimes prophets, at the designation or installment of them, to signify emblematically the mental qualifications necessary for discharging these offices. Saul, David, Solomon, and Joash, kings of Judah, received the royal unction. Aaron and his sons received the sacerdotal, and Elisha the disciple of Elijah received the prophetic unction.—The name MESSIAH, *Anointed* or *Christ* (Χριστος), was given to the kings and high priests of the Jews. The patriarchs and prophets are also called by the name of *Messiahs*, or the *Lord's anointed*. See 1 Sam. xii. 3, 5. 1 Chron. xvi. 22. Ps. cv. 15.

But this name MESSIAH was principally and by way of eminence given by the Jews to their expected great deliverer, whose coming they still vainly wait; and is a name the Christians apply to *JESUS Christ*, in whom the prophecies relating to the Messiah were accomplished. The sum of these prophecies is, That there should be a glorious person named *Messiah*, descended from Abraham, Isaac, and Jacob, who should be born at Bethlehem, of a virgin of the family of David, then in its decline, before the Jews ceased to be a people, while the second temple was standing, and about 500 years after Ezra's time; who, though appearing in mean circumstances, should be introduced by a remarkable forerunner, whose business it should be to awaken the attention and expectation of the people. That this illustrious person called *Messiah* should himself be eminent for the piety, wisdom, and benevolence of his character, and the miraculous works he should perform: yet that, notwithstanding all this, he should be rejected and put to death by the Jews; but should afterwards be raised from the dead, and exalted to a glorious throne, on which he should through all generations continue to rule, at the same time making intercession for sinners. That great calamities should for the present be brought on the Jews for rejecting him; whereas the kingdom of God should by his means be erected among the Gentiles, and disperse itself even unto the ends of the earth; wherever it came, destroying idolatry, and establishing true religion and righteousness. In a word, That this glorious person should be regarded by all who believed in him as a divine teacher, an atoning sacrifice, and a royal governor? by means of whom God would make a covenant with his people, very different from that made with Israel of old; in consequence of which they should be restored to, and established in, the divine favour, and fixed in a state of perpetual happiness. See *JESUS Christ*, and CHRISTIANITY.

The Jews, as was already observed, still wait for the coming of the *Messiah*, being impressed with the notion of a temporal *Messiah*, who is to be a mighty conqueror, and to subdue all the world. Most of the modern rabbins, according to Buxtorf, believe that the *Messiah* is already come, but that he keeps himself concealed, and will not manifest himself because of the sins of the Jews. Some of the Jews, however, in order to reconcile those prophecies that seem to contradict each other as to the character and condition of the *Messiah*, have had recourse to the hypothesis of two *Messiahs*, who are yet to succeed each other; one in a state of humiliation and suffering; the other of glory, splendor, and power. The first, they say, is to proceed from the tribe of Ephraim, who is to fight against Gog, and to be slain by Annillus, Zech. xii. 10. The second is to be of the tribe of Judah, and

Messiah, Messina.

and lineage of David, who is to conquer and kill Annillus, and restore the kingdom of Israel, reigning over it in the highest glory and felicity.

Jesus Christ asserts himself the *Messiah.* In St John iv. 25. the Samaritan woman says to Jesus, *I know that when* Messiah *comes, who is called the* Christ, *he will tell us all things. Jesus answered her, I that speak to thee am he.*

There are several impostors, who have endeavoured to pass for *Messiahs*, as Christ himself predicted. J. Lent, a Dutchman, has written a history *De Pseudomessiis* "Of False Messiahs." The first he mentions was one Barcochab, who appeared under the empire of Adrian. The last was Rabbi Mordecai, who began to be talked of in 1682. A little before him, viz. in 1666, appeared Sabbethai Sebi, who was taken by the Turks, and turned Mahometan.

MESSINA, an ancient, large, handsome, and strong city of Sicily, and in the Val di Demona, with a citadel, several forts, a fine spacious harbour, and an archbishop's see. It is seated on the sea side, 110 miles east of Palermo, 260 south by east of Rome, and 180 south-east of Naples. E. Long. 15. 50. N. Lat. 38. 10. The public buildings and the monasteries were numerous and magnificent, and it contained about 60,000 inhabitants; the harbour is one of the safest in the Mediterranean, and extremely deep; the viceroy of Sicily resides here six months in the year; and it was a place of great trade in silk, oil, fruit, corn, and excellent wine, especially since it was declared a free port. This city in the beginning of the year 1783 suffered most dreadfully by the earthquakes which shook great part of Calabria and Sicily to their foundations, overturned many rich and populous towns, and buried thousands in their ruins: (see CALABRIA, and EARTHQUAKE, GEOLOGY *Index*).—The following account of Messina, as it stood before the above period, is extracted from Mr *Swinburne's Travels in Sicily.*

A large chain of mountains presses upon the shore, and part of the city stands upon elevated ground. The mountains are many of them nobly wooded; the hills before them finely chequered with groves and fields. As the town runs in a sweep along the edge of a declivity, every building of consequence is seen to advantage, while the less noble parts are hidden by the Palazzata. This is a regular ornamental range of lofty houses, with 19 gates, answering to as many streets: it follows the semicircular bend of the port for one mile and five poles, and would have been the handsomest line of buildings in Europe had the design been completed; but a considerable part of the extent is not finished, except merely in the front wall, and that seems to be in a very ruinous condition. Philibert Emmanuel of Savoy, viceroy of Sicily, in 1622, began this princely work. Before it is a broad quay, decorated with statues and fountains; ships of any burden can moor close to the parapet in great depth of water. At the west extremity is a small fort and a gate; the other end is closed by the governor's house and the citadel, a modern pentagonal fortress, built on the point where the isthmus or *braccio di San Raniero* issues from the main land. On this slip of low ground, which with the Palazzata forms the circular harbour of Messina, is placed the lighthouse *(lazaretto)*, and on the point the old castle of St Salvatore. The circumference of the port is four miles: it probably owes its formation to an earthquake, which opened an immense chasm, and then filled it with water. Near the lighthouse is a kind of whirlpool in the sea, shown as the Charybdis of the ancients.

Messina.

The inner part of Messina is dirty, though it contains a considerable number of neat churches and large substantial dwellings. The cathedral is Gothic, enriched with Saracenic mosaics on the altars and shrines; the front of the high altar is particularly splendid: Gagini has embellished the pulpit and some tombs with excellent specimens of his art.—In the treasury of this church is preserved the palladium of Messina, a letter from the Virgin Mary to its citizens (A). This is the title upon which the Messinese build their pretensions

(A) The story is as follows: After St Paul had made some stay at Messina (a circumstance of his travels unnoticed by St Luke), the Messinese prevailed upon him to return to Jerusalem with an embassy of four persons sent by the city to the Virgin Mary. Their excellencies were graciously received by her, and brought back a letter written with her own hand in the Hebrew tongue, which St Paul translated into Greek. By the irruption of the Saracens this invaluable treasure was lost, and utterly forgotten till the year 1467, when Constantine Lascaris, a refugee Greek, found a copy of it, and turning it into Latin, made it known to the citizens, and then to all the Catholic world. Its authenticity is now so well established at Messina, that Regna the historian candidly acknowledges, that whoever was to confess even a doubt on the subject in that city would be treated as an infidel.

This curious epistle is conceived in these terms:—Maria Virgo, Joachim filia, Dei humillima Christi Jesu crucifixi mater, ex tribu Judæ, stirpe David, Messanensibus omnibus salutem, et Dei Patris Omnipotentis benedictionem. Vos omnes fide magna legatos ac nuncios per publicum documentum ad nos misisse constat. Filium nostrum Dei genitum Deum et hominem esse fatemini, et in cœlum post suam resurrectionem ascendisse, Pauli apostoli electi prædicatione mediante viam veritatis agnoscentes. Ob quod vos et ipsam civitatem benedicimus, cujus perpetuam protectricem nos esse volumus. Anno filii nostri XLII. Indict. I. III. Nonas Junii, luna XXVII. feria V. ex Hyerosolymis.

Thus translated:—"The Virgin Mary, daughter of Joachim, most humble mother of God, Jesus Christ crucified, of the tribe of Juda and the family of David, health and the blessing of God the Father Almighty to all the people of Messina. Out of the abundance of your faith, you have, in consequence of a public deliberation, sent a deputation to me; and since you acknowledge that my Son is both God and man, and that he ascended into heaven after his resurrrection, as you have learned from the preaching of St Paul the apostle, I

Messina. pretensions to pre-eminence over the whole island, nay over the whole world; to its virtues and patronage they attribute every piece of good fortune, and to their own unworthiness all sinister events that have befallen them. The authenticity of this epistle has been seriously impugned, and of course vigorously defended by many Sicilian divines and disputators.

There is another church in this city that deserves particular notice, not so much on account of its architecture or ornaments, as for its being the last refuge of the Greek liturgy, which was once the predominant service of the island, but gradually abolished by different conquerors. It is dedicated to the Virgin Mary de Grapheo, or of the *Letter*, which denomination may perhaps have furnished Lascaris with the idea of his letter. It is known at present by the name of *la Cattolica*. According to the Greek canons, the entrance of monastic churches was reciprocally forbidden to each sex, and the cathedrals were the only places of worship where a daily sacrifice was offered up by the bishop and clergy, and where both men and women were present at the same time, but in different parts of the church. From this general admittance the building acquired the title of *Catholic* or *universal*.

Messina is all paved with lava, cut into large flags of two feet square: a material which the vicinity of lavas renders it easy to procure, and which being very hard resists friction better than any other.

During a series of ages, notwithstanding the various revolutions and calamities to which it has been exposed, this city has still maintained its original situation; while most other cities have shifted their ground more or less from the place where they were first founded. But its situation enjoys advantages which have still tempted such of its inhabitants as escaped from the ravages of war and the desolation of earthquakes to prefer it to every other spot, however delightful or secure. It is of very ancient origin; it has been under many different races of monarchs; and its name has been repeatedly changed: It has been at different times called *Zancle*, *Mamertina*, *Messana*. Its first name *Zancle*, which in the old language of Sicily meant, "a fickle;" alluding, as some authors suppose, to the form of the port; or, according to others, to the fertility of the country. Allured by the advantages of its situation, the Cumæans, a commercial and enterprising people, invaded the island and drove the Siculi from this settlement; they were in their turn overpowered by a band of Samian adventurers, who made way for a colony of citizens of Messene, and under these masters it changed its name to *Messana*. Their government was of short duration; for in the 289th year before Christ it was destroyed by the Mamertines, a warlike unprincipled nation inhabiting the south part of Bruttium. These soldiers being received into Messana on their return to Italy from Syracuse, where they had served as mercenaries in the army of Agathocles, took an opportunity of massacring the inhabitants and usurping their possessions. The city was now called *Mamertina*; and, in order to support themselves against the resentment of the Sicilian powers, the Mamertines implored the protection of the Romans, who, eager to extend their dominion beyond the limits of Italy, and jealous of the growing power of Carthage, made no scruple to succour these assassins with a consular army. This step brought on the first Punic war. The Mamertines reaped no other fruit from the alliance but a more honourable degree of slavery; for such was the real nature of their connexion with Rome, whatever name it might be disguised under. Messina.

Messina was, however, always distinguished by particular attentions and favours from the senate; and, excepting a short period during the wars of the triumvirate, appears to have tasted all the sweets of Roman prosperity, without partaking of the bitter draughts of adversity. Its fate, in the ruin of the empire, was similar to that of the rest of Sicily. In 829 Messina fell into the hands of the Saracens, but obtained very honourable terms of capitulation; for half the city was left to the Christians, where they were to be governed by their own laws, and profess their own religion undisturbed. In the other resided the bey of one of the five provinces into which the Arabian conquerors had divided the island. Notwithstanding this indulgence, Messina was the first to cast off the yoke in 1037, when George Maniaces landed an army of Greeks and Normans on the shore of the Faro. It afterwards held out against the whole Mussulman force, till the feeble state of a distracted empire shut out all hopes of assistance from Constantinople. This unfortunate city then opened its gates to the army of the caliph, and felt very severely the weight of his resentment, but it did not long groan under the yoke; for in less than 20 years Roger the Norman took it by surprise and delivered it from Mahometan oppression. During the crusade our Richard Cœur de Lion and Philip Augustus king of France wintered here in their way to Palestine; a sojourn marked by continual quarrels, conflagration, and bloodshed. The Messinese were particularly tardy in entering into the national conspiracy of 1282, but afterwards exceeded the rest of the insurgents in deeds of cruelty: This, and the importance of their situation, singled them out for the first objects of Charles's vengeance. He invested their city very closely, and declared so openly his determination to refuse all terms whatever to the besieged, that they saw no hopes of safety but in an obstinate defence. Their courage, perseverance, and sufferings, were excessive; at length their strength and resources began to fail rapidly, and every circumstance seemed to denounce their speedy destruction, when Roger Lauria appeared off the harbour with the Arragonian fleet, forced the king to retire with precipitation across the

I give my blessing to you and all your city, and agree to become your protectress. In the 42d year of my Son, the 1st of the Indiction, the 3d day of June, and the 27th of the moon, at Jerusalem."

Not to dwell upon the astronomical blunders in these dates, let it suffice to observe, that Lascaris was not aware that Denis the Little, a Syrian monk in the 6th century, was the first who made use of the era that commences at our Saviour's birth.

Messina. the straits, and in his sight defeated and destroyed his naval armament. Robert, grandson of Charles I. also made a fruitless attack; but in the disturbed reign of Frederic III. Messina was delivered up to Louis king of Naples and his consort Queen Joan, who entered it in triumph. In a few years it returned to its former possessors. The year 1672 was remarkable for the revolt of the Messinese.—They threw off the Spanish yoke, and swore allegiance to Louis XIV. king of France. They were for some time vigorously assisted by the French; but before the Spaniards had gained the least advantage to excite any hopes of recovering so valuable a possession, Louis found himself necessitated from motives of political interest to desert his new subjects, and leave them to the mercy of their old incensed masters. The horror of being thus abandoned, and the chastisement inflicted by Spain, broke the fierce spirit of the Messinese; they were still stunned with the remembrance and effects of this blow, when the plague in 1743 was introduced from the Levant, and swept away more than half the inhabitants. From this chain of calamities, the opulence, trade, and population of Messina, have been gradually sinking; and unless very favourable circumstances happen, will every year fall lower. The number of its inhabitants does not now exceed 30,000.

The following particulars are added from M. Houel, who visited this city since the late earthquakes, which completed its destruction.

On the front of the cathedral there is a square, which, though not regular, is far from being mean. This was not the largest square in Messina before its overthrow; but it was the most elegant, the most splendidly adorned, and the best frequented. There stands in this square an equestrian statue of Charles II. of Spain, in bronze, which has been spared by the earthquake. It stands on a marble pedestal, in the middle of the square. Opposite to this statue is an elegant marble fountain, ornamented with a variety of figures, representing men and other animals, all of them spouting out water in great abundance; which used, in summer, to spread an agreeable and refreshing coolness over the square, that induced company to assemble here. Seven streets terminated here. The cathedral forms a part of the square. It is dedicated to the blessed Virgin; the occasion of which has been already mentioned.

There is an anniversary feast celebrated in Messina, which is called *the feast of the Letter*. A lock of the Virgin's hair, which she sent to the Messenians at the same time with the letter, is carried through the city in procession in a crystal vessel. She made also a present of her picture to the Messenian deputies. It is placed over the tabernacle. None but the canons of the cathedral are permitted to touch, or take up on their shoulders, the silver shrine in which the crystal vessel with the Virgin's hair is deposited. Eight of those canons, with mitres on their heads, bear this shrine in the procession. The canopy suspended over it is supported by six senators in their robes. The picture and the hair is shown to strangers. This procession, and the other religious ceremonies of this festival, are followed by horse races. The spirits of the people being already elevated by their religious exercises, they engage with amazing eagerness in these and the other diversions with which they are accompanied: a tumultuous joy reigns over the city; and the evening concludes with illuminations and fireworks. The ships in the harbour pay the citizens the compliment of entertaining them with a discharge of their guns on the occasion.

Through a square called the *Square of the Great Hospital*, runs a large and impetuous torrent, the *Porte delle Legni*. It is precipitated from those lofty mountains which overlook this city on the south side. The channel which it has cut out for itself is at times entirely full. It would, on such occasions, overflow the square and other parts of the city, were it not confined by walls which have been built on both sides to prevent such accidents.—Another stream of a similar origin, called the *Torrent of La Bocetta*, runs through another part of the city, it is also confined within walls to prevent it from overflowing.

The *Square of St John of Malta* is one of the largest in Messina. In the middle of this square is a fine marble fountain, ornamented with a variety of sculptured figures and jets d'eau. Beside the fountain there used to stand a large reservoir for horses to drink out of.

In the time of the annual festivals, there used to be exhibited on the water of the reservoir a galley, or rather a fictitious representation of a galley, with galley-slaves, soldiers, officers, and a commander on board, all in arms, and the galley properly equipped as a ship of war. This galley was decorated with great art; and by night the masts, and every other suitable part, were hung with lamps, which illumined it in a very splendid manner. Every thing around was so artificially disposed, that when the fireworks were played off, the spectator was led to think, though he perceived only one galley, that the noise which he heard was produced by a naval combat; and that the other ships were concealed from his view by the smoke occasioned by the guns and fireworks. This, when properly conducted, was a noble spectacle. The senate repaired thither from the cathedral, attended with a guard and a numerous company. In one carriage sat six senators, the governor of the city, and sometimes the archbishop. It was exceedingly large, and drawn by six white horses very richly harnessed. Other carriages followed, with the train who attended the governor and the senators.

Almost all festivals owe their origin to some extraordinary event, or some singular story either true or false. It is said, that when the splendor with which the feast of the *Assumption de la Bara* was celebrated at Messina, first began to attract foreigners to the city, on that occasion such crowds repaired thither as to alarm the inhabitants with the fears of a famine: But one year, when the number of strangers was greater than usual at the time of this festival, the magistrates were very much at a loss how to supply them with provisions; and at length, every other resource failing, no hopes of relief remained but from the kindness of the Blessed Virgin. Fervent prayers were addressed to their patroness: and next morning by day-break three brigantines appeared entering the harbour with full sails. They proved to be loaded with corn. It was eagerly purchased: and the people of the city hasted to appease their hunger. But when they came after refreshing

Messina. refreshing themselves to pay the corn merchants their money, neither ships nor merchants could be found. After their first emotions of surprise had subsided, they naturally concluded that such a seasonable supply must undoubtedly be a present from the Virgin, who, being pleased with the zeal of her Messenian votaries, and desirous to prevent the concourse of strangers who attended the festival from diminishing, had interposed in this miraculous manner to save them from the distresses of famine. A new festival was celebrated in gratitude to their generous benefactress. Three small vessels of silver were made, and dedicated to the Virgin in memory of the event; and these are at present used as lamps in the cathedral. The senate likewise decreed, that the clergy should pay annually a small tax, to be laid out in constructing a small galley to swim on the fountain, and in defraying the expences of the fireworks. The profits of the clergy are so considerable on the occasion of the festival, that they may be supposed to pay the tax with great cheerfulness.

In Messina, as in the other cities of Sicily, the women wrap themselves in a large black mantle above the rest of their dress. The stuffs are richer or plainer according to rank and circumstances. People who are not rich enough to have fine clothes of their own, hire them at so much an hour. There are women who make a livelihood by lending out their clothes. The mantle covers the wearer from head to foot.—It reduces the old and the young, the ill-shaped and the handsome, pretty much to an equality in point of appearance. This must naturally appear very unfavourable to the influence of beauty. But yet, on proper occasions, at church or in a public walk, the ladies of Messina find means to open and adjust the mantle so as to display all their beauties of face and shape, and to attract the affections of lovers, perhaps more powerfully than if their dress were suited to display their charms in a more ostentatious manner.

Between Messina and the tower of Faro there stands a small church called the *Madona of the Grotto*. It was anciently a temple of a round structure, and ornamented with columns like the temple of the sun at Rome. Modern columns now supply the place that was occupied by the ancient. There are large niches in the rock adjoining to the temple, which are thought to be of equal antiquity. These contain no sculptured figures; but in Pagan times they might possibly contain some.

Messina being situated between Mount Ætna and the gulf of Charybdis, and being likewise at no great distance from the volcanoes of Lipari and Stromboli, must have been in all ages liable to suffer by earthquakes. Such terrible events, however, appear to have been more unfrequent in ancient than in modern times, and have actually alarmed the present age oftener than any other. In the year 1693 a fourth part of the cities of Scily was destroyed by an earthquake. Messina merely felt the shock; all its buildings, however, suffered. In the year 1742 it suffered another equally violent. A plague which followed in 1743 retarded the repairs necessary after the earthquake. In the year 1780 this city continued, for more than six months, to suffer from new earthquakes.

Were the state of the elements, previous to these dreadful events, carefully examined, it might perhaps be found to undergo certain changes which might be considered as prognosticating them. Messina.

The autumn of the year 1782 was unusually cold and rainy. Fahrenheit's thermometer was often as low as 56 degrees. The succeeding winter was dry; and the mercury never fell under 25 degrees: And, what is uncommon in that season, storms were now and then observed to arise from the west. The pilots in the channel observed that the tides no longer rose at the usual periods, and the gulf of Charybdis raged with extraordinary fury.

On the 5th of February 1783, the air was heavy and calm; the sky obscured with thick clouds, and the atmosphere seemingly all in a flame. About half after twelve at noon, the earth began to shake with a dreadful noise. The shocks continually increased, and became at length so violent as to open the ground, and to overturn in two or three minutes a considerable part of the buildings.

A long white cloud appeared to the north-west; and soon after another, very dark, in the same quarter of the heavens. The latter in a moment spread over the whole horizon, and deluged the city with rain and hail, accompanied with dreadful claps of thunder. The inhabitants fled in the utmost terror to the fields and the ships in the harbour.

From mid-day till five in the afternoon the earthquake continued almost without interruption. The shocks then became somewhat less frequent. The cries of the dying; the shrieks of those who were half buried under the ruins; the wild terror with which others, who were still able, attempted to make their escape; the despair of fathers, mothers, and husbands, bereft of those who were dearest to them; then formed altogether a scene of horror, such as can but seldom occur in the history of the calamities of the human race. Amid that awful scene, instances of the most heroic courage and the most generous affection were displayed. Mothers, regardless of their own safety, rushed into every danger to snatch their children from death. Conjugal and filial affection prompted deeds not less desperate and heroic. But no sooner did the earthquake cease, than the poor wretches who had escaped began to feel the influence of very different passions. When they returned to visit the ruins, to seek out the situation of their fallen dwellings, to inquire into the fate of their families, to procure food and collect some remains of their former fortunes—such as found their circumstances the most wretched became suddenly animated with rage, which nothing but wild despair could inspire. The distinction of ranks, and the order of society were disregarded, and property eagerly violated. Murder, rapine, and lawless robbery, reigned among the smoking ruins.

About one in the morning another shock of the earthquake was felt, which overturned most of the houses that were still standing. Most of those whom want, or avarice, or humanity, still detained among the ruins, now shared the same fate with their friends whom the former shocks had buried under them.

The succeeding day scarce alleviated the distress of this dismal night: the few wretches who still survived found themselves destitute of every necessary. At length order was in some degree re-established; and in two

two days after every perfon was fupplied at leaft with fome fmall portion of the neceffaries for fubfiftence.

None yet thought of returning to take up their abode among the ruins. The common people fixed their refidence on the plain of Porto Salvo, near the town of Salleo. The nobles, magiftrates, and merchants, took up their abode on another plain, on the other fide of the ftream Porto de Legno; the foldiers at Terra Nuova.

Some violent fhocks which were again felt on the 7th of February and the 28th of March completed the deftruction of the city. The corn magazines, however, efcaped without damage; and the public ovens and the aqueducts were but little injured. From thefe facts it may perhaps be inferred, that had not the houfes of Meffina been, in general, haftily built at the firft, and afterwards carelefsly repaired, fewer of them would have been overthrown by the earthquake.

The neighbouring villages having fuffered but little, were the firft to relieve the remaining inhabitants of Meffina in their diftrefs. Maltefe gallies for fome days fupplied neceffaries to the poor and the fick with a generofity which merits the higheft praife. They brought furgeons and whatever was needful for the cure of the wounded. The fupplies fent by the king of France were refufed, for what reafon we know not. What money was needed for the fupport of the people was taken from the treafury of the city of Meffina; for what the king of Naples fent was feized and fpent by the garrifon.

It is faid that not more than 800 or 900 perfons perifhed by this earthquake. The fea during that convulfion of the land was flightly agitated in the harbour. Farther out the fea was more violently agitated; but none of the fhips in the harbour were dafhed to pieces. The waters rofe fo high as to be injurious in a very confiderable degree to Pharo, as well as along the coaft of Scylla and Bagnara.

This earthquake was not of a momentary duration, like that by which Lifbon was deftroyed, and like many others; for more than fixty days, from the 5th of February to the beginning of April, Meffina continued to be fhaken, and in that time felt more than 200 fhocks; and even after that period the alarm was again and again renewed. Not only the magiftrates, the foldiers, and the people, but the priefts likewife, with their tabernacle and altar, retired to the barracks. The nuns, too, deferted their cloifters, and fought a retreat without the walls. Some of them confined themfelves to the gardens of their convents; others mixed indifcriminately with the people.

The chief damage which the public buildings within the city fuffered was the fall of the dome of the church of Purgatory. Only the walls were left ftanding; and even thefe had fuffered confiderably. One half of the fteeple of the cathedral was beaten to the ground. The magazines of Porto Franco were likewife very much fhattered. The fort of St Salvator, being built on an artificial foundation, the fide next the fea is there fallen down; but on the other fide, where it is founded on a rock, it has ftood unmoved by all the fhocks of the earthquake.

On the 5th of February, when the earthquake was more violent than at any time afterwards, a ftrong fmell of fulphur was felt. The earth was affected fomewhat in the fame way as if it had been borne upon a fluid; and feemed to reel with the fhocks much like a fhip toffed with the waves. This tremulous motion was felt all over Sicily; but towards Pharo it became weaker. On the following days the fky was cloudy; the mountains of Sicily and the fhores of Calabria continued covered with a thick fog like fmoke. North and north-eaft winds raged with the moft violent impetuofity.

The difaftrous year of this earthquake was fcarce concluded, the chafms which it had opened in the ground were ftill yawning, and the poor inhabitants of the adjacent country ftill trembled with terror, when the elements again renewed their fury to ravage this miferable land.

On Tuefday the 6th of January 1784, about funrife, the wind began to blow foftly from the north-eaft. The fea gradually fwelled, rofe beyond its bed with rapid impetuofity, overflowed the quay of Meffina, and lafhed with its billows the ruins of the Palazzata. It loofened and difplaced many of the ftones of the mole, fpread over the whole ftreet, and attacked the pedeftals of the ftatues which had been fpared by the earthquake, and ftill ftood firm among the ruins. The fame furious wind which fwelled the fea in fo extraordinary a manner, ravaged the whole coaft from Meffina all the way to Syracufe.

MESSUAGE, Messuagium, in *Law*, a dwelling-houfe, with fome land adjoining affigned for its ufe. By the name of *meffuage* may a garden, fhop, mill, cottage, chamber, cellar, or the like, pafs.—In Scotland, *meffuage* denotes what is called in England the *manor-houfe*, viz. the principal dwelling-houfe within any barony.

MESOPORPHYRON, a name given by the Greeks to the Roman *laticlave*; becaufe that garment, being edged on each fide, where it opened before, with purple, appeared when clofed with two purple ftripes down the middle. The fame term was alfo applied to the *anguftíclave*.

META, in the Roman circus, was a pile of ftones of a pyramidical form, intended as a boundary of the *ftadium*, or chariot courfe.—When the meta was paffed the feventh time, the race was concluded. The greateft art and management were required in avoiding the meta, and yet going as near it as poffible. If they went too near, they were in the greateft danger of breaking the chariot to pieces; and if they took too large a circuit in the turn, they gave their rivals an opportunity of getting within them, befides lofing a great deal of ground. The boundary of the Grecian *ftadium*, or courfe, was called τεγος, τερμα, γραμμη and ανρα γραμμη; to which laft name Horace probably alludes, in calling death "*ultima linea rerum.*"

The *metæ* at Rome were firft of wood, afterwards of ftone; but the emperor Claudius made them of gold, or rather gilded them. In the Roman circus there were two *metæ*, one at the entrance of the courfe, and and the other at the end of it. An egg was placed upon the top of the *metæ*.

METACARPUS, or Metacarpium, (from μετα, *behind*, and καρπος, *hand*), in *Anatomy*, that part of the hand between the wrift and the fingers. See Anatomy, N° 55.

METAGITNION, the fecond month of the Athenian year, anfwering to the latter part of our July and the

the beginning of Auguſt, and ſo called from *metagitnia*, a feſtival in honour of Apollo, which was kept in it. The Bœotians called this month *panemus*, and the Syracuſans, *carnius*.

METAL, in *Natural Hiſtory*, is a ſubſtance which is diſtinguiſhed from others by its ductility, malleability, tenacity, opacity, &c. for an account of which, ſee CHEMISTRY.

METAL, in *Heraldry*. There are two metals uſed in heraldry, by way of colours, viz. gold and ſilver, in blazon called *or* and *argent*.

In the common painting of arms theſe metals are repreſented by white and yellow, which are the natural colours of thoſe metals. In engraving, gold is expreſsed by dotting the coat, &c. all over; and ſilver, by leaving it quite blank.

It is a general rule in heraldry, never to place metal upon metal, or colour upon colour: ſo that if the field be of one of the metals, the bearing muſt be of ſome colour; and if the field be of any colour, the bearing muſt be one of the metals.

METALEPSIS. See ORATORY, N° 59.

METALLISATION, is defined to be the natural proceſs by which metals are formed in the bowels of the earth.

METALLURGY, in a more general ſenſe, comprehends the whole art of working metals, from the ſtate of ore to the utenſil; and in this ſenſe, eſſaying, ſmelting, refining, parting, ſmithery, gilding, &c. are only branches of metallurgy. But in a more limited ſenſe it includes only the operations which are followed in ſeparating metals from their ores. For an account of theſe proceſſes, ſee ORES, *Reduction of;* and for the practical branches, ſee GILDING, PARTING, PURIFYING, REFINING, SMITHERY.

METAMORPHOSIS, in general, denotes the changing of ſomething into a different form; in which ſenſe it includes the transformation of inſects, as well as the mythological changes related by the ancient poets.

Mythological metamorphoſes were held to be of two kinds, apparent and real: thus, that of Jupiter into a bull, was only apparent; whereas that of Lycaon into a wolf, was ſuppoſed to be real.

Moſt of the ancient metamorphoſes include ſome allegorical meaning, relating either to phyſics or morality; ſome authors are even of opinion that a great part of the ancient philoſophy is couched under them; and Lord Bacon and Dr Hooke have attempted to unriddle ſeveral of them.

METAPHOR, in *Rhetoric*. See ORATORY, N° 54.

METAPHOR *and Allegory*, in poetry.—A metaphor differs from a ſimile, in form only, not in ſubſtance: in a ſimile the two ſubjects are kept diſtinct in the expreſſion, as well as in the thought; in a metaphor, the two ſubjects are kept diſtinct in the thought only, not in the expreſſion. A hero reſembles a lion, and upon that reſemblance many ſimilies have been raiſed by Homer and other poets. But inſtead of reſembling a lion, let us take the aid of the imagination, and feign or figure the hero to be a lion; by that variation the ſimile is converted into a metaphor; which is carried on by deſcribing all the qualities of a lion that reſemble thoſe of the hero. The fundamental pleaſure here, that of reſemblance, belongs to the thought. An additional pleaſure ariſes from the expreſſion: the poet, by figuring his hero to be a lion, goes on to deſcribe the lion in appearance, but in reality the hero; and his deſcription is peculiarly beautiful, by expreſſing the virtues and qualities of the hero in new terms, which, properly ſpeaking, belong not to him, but to the lion. This will better be underſtood by examples. A family connected with a common parent, reſembles a tree, the trunk and branches of which are connected with a common root; but let us ſuppoſe, that a family is figured, not barely to be like a tree, but to be a tree; and then the ſimile will be converted into a metaphor, in the following manner:

Edward's ſev'n ſons, whereof thyſelf art one,
Were ſev'n fair branches, ſpringing from one root;
Some of theſe branches by the deſt'nies cut:
But Thomas, my dear lord, my life, my Glo'ſter,
One flouriſhing branch of his moſt royal root,
Is hack'd down, and his ſummer leaves all faded,
By Envy's hand and Murder's bloody axe.
Richard II. act i. ſc. 3.

Figuring human life to be a voyage at ſea.

There is a tide in the affairs of men,
Which, taken at the flood, leads on to Fortune:
Omitted, all the voyage of their life
Is bound in ſhallows and in miſeries.
On ſuch a full ſea are we now afloat:
And we muſt take the current when it ſerves,
Or loſe our ventures. *Julius Cæſar*, act iv. ſc. 5.

Figuring glory and honour to be a garland of flowers:

Hotſpur.——————————Wou'd to heav'n,
Thy name in arms were now as great as mine!
Pr. Henry. I'll make it greater ere I part from thee;
And all the budding honours on thy creſt
I'll crop, to make a garland for my head.
Firſt Part of Henry IV. act v. ſc. 9.

Figuring a man who hath acquired great reputation and honour to be a tree full of fruit:

——————————Oh, boys, this ſtory
The world may read in me; my body's mark'd
With Roman ſwords; and my report was once
Firſt with the beſt of note. Cymbeline lov'd me;
And when a ſoldier was the theme, my name
Was not far off; then was I as a tree,
Whoſe boughs did bend with fruit. But in one night,
A ſtorm or robbery, call it what you will,
Shook down my mellow hangings, nay, my leaves;
And left me bare to wither.
Cymbeline, act iii. ſc. 3.

"Bleſt be thy ſoul, thou king of ſhells, ſaid Swaran of the dark-brown ſhield. In peace, thou art the gale of ſpring; in war, the mountain-ſtorm. Take now my hand in friendſhip, thou noble king of Morven."
Fingal.

"Thou dwelleſt in the ſoul of Malvina, ſon of mighty Oſſian. My ſighs ariſe with the beam of the eaſt: my tears deſcend with the drops of night. I was a lovely tree in thy preſence, Oſcar, with all my branches round me: but thy death came like a blaſt from the deſert,

desert, and laid my green head low; the spring returned with its showers, but no leaf of mine arose."

Fingal.

An *allegory* differs from a metaphor; and a *figure of speech* differs from both. A metaphor is defined above to be an act of the imagination, figuring one thing to be another. An allegory requires no such operation, nor is one thing figured to be another: it consists in choosing a subject having properties or circumstances resembling those of the principal subject: and the former is described in such a manner as to represent the latter: the subject thus represented is kept out of view: we are left to discover it by reflection; and we are pleased with the discovery, because it is our own work. (See the word ALLEGORY).

Quintilian gives the following instance of an allegory.

O navis, referent in mare te novi
Fluctus. O quid agis? fortiter occupa portum.
Horat. lib. i. ode 14.

and explains it elegantly in the following words: "Totusque ille Horatii locus, quo navim pro republica, fluctuum tempestates pro bellis civilibus, portum pro pace atque concordia, dicit."

In a *figure of speech*, there is no fiction of the imagination employed, as in a metaphor; nor a representative subject introduced, as in an allegory. This figure, as its name implies, regards the expression only, not the thought; and it may be defined, the using a word in a sense different from what is proper to it.—Thus youth, or the beginning of life, is expressed figuratively by *morning of life*: morning is the beginning of the day; and in that view it is employed to signify the beginning of any other series, life especially, the progress of which is reckoned by days. See *FIGURE of Speech.*

Metaphor and *allegory* are so much connected, that it seemed proper to handle them together: the rules particularly for distinguishing the good from the bad, are common to both. We shall therefore proceed to these rules, after adding some examples to illustrate the nature of an *allegory*, which, with a view to this article, was but slightly illustrated under its proper name.

Horace, speaking of his love to Pyrrha, which was now extinguished, expressed himself thus:

————————Me tabulâ sacer
Votivâ paries indicat uvida
Suspendisse potenti
Vestimenta maris Deo. *Carm.* lib. i. ode 5.

Again:
Phœbus volentem prælia me loqui,
Victas et urbes, increpuit, lyra
Ne parva Tyrrhenum per æquor
Vela darem. *Carm.* lib. iv. ode 15.

Queen. Great lords, wise men ne'er sit and wail their loss,
But cheerly seek how to redress their harms.
What though the mast be now blown overboard,
The cable broke, the holding anchor lost,
And half our sailors swallowed in the flood!
Yet lives our pilot still. Is't meet that he
Should leave the helm, and, like a fearful lad,
With tearful eyes add water to the sea,
And give more strength to that which hath too much;
While in his moan the ship splits on the rock,
Which industry and courage might have sav'd?
Ah, what a shame! ah, what a fault were this!
Third Part of Henry VI. act v. sc. 5.

Oroonoko. Ha! thou hast rous'd
The lion in his den; he stalks abroad,
And the wide forest trembles at his roar.
I find the danger now. *Oroonoko,* act iii. sc. 2.

"My well beloved hath a vineyard in a very fruitful hill. He fenced it, gathered out the stones thereof, planted it with the choicest vine, built a tower in the midst of it, and also made a wine press therein; he looked that it should bring forth grapes, and it brought forth wild grapes. And now, O inhabitants of Jerusalem, and men of Judah, judge, I pray you, betwixt me and my vineyard. What could have been done more to my vineyard, that I have not done? Wherefore, when I looked that it should bring forth grapes, brought it forth wild grapes? And now go to, I will tell you what I will do to my vineyard: I will take away the hedge thereof, and it shall be eaten up; and break down the wall thereof, and it shall be trodden down. And I will lay it waste: it shall not be pruned, nor digged, but there shall come up briars and thorns: I will also command the clouds that they rain no rain upon it. For the vineyard of the Lord of hosts is the house of Israel, and the men of Judah his pleasant plant." *Isaiah* v. 1.

The rules that govern metaphors and allegories are of two kinds. The construction of these figures comes under the first kind: the propriety or impropriety of introduction comes under the other.—To begin with rules of the first kind; some of which coincide with those already given for similes; some are peculiar to metaphors and allegories.

In the first place, It has been observed, that a simile cannot be agreeable where the resemblance is either too strong or too faint. This holds equally in metaphor and allegory; and the reason is the same in all. In the following instances, the resemblance is too faint to be agreeable.

Malcolm. ————But there's no bottom, none,
In my voluptuousness: your wives, your daughters,
Your matrons, and your maids, could not fill up
The cistern of my lust. *Macbeth,* act iv. sc. 4.

The best way to judge of this metaphor, is to convert it into a simile: which would be bad, because there is scarce any resemblance between lust and a cistern, or betwixt enormous lust and a large cistern.

Again:

He cannot buckle his distemper'd cause
Within the belt of rule. *Macbeth,* act v. sc. 2.

There is no resemblance between a distempered cause and any body that can be confined within a belt.

Again:

Steep me in poverty to the very lips.
Othello, act iv. sc. 9.

Poverty

Metaphor. Poverty here muſt be conceived a fluid, which it reſembles not in any manner.

Speaking to Bolingbroke baniſhed for ſix years:

The ſullen paſſage of thy weary ſteps
Eſteem a ſoil, wherein thou art to ſet
The precious jewel of thy home return.
Richard II. act ii. ſc. 6.

Again:

Here is a letter, lady,
And every word in it a gaping wound
Iſſuing life-blood.
Merchant of Venice, act iii. ſc. 3.

Tantæ *molis* erat Romanam condere gentem.
Æneid. i. 37.

The following metaphor is ſtrained beyond all endurance: Timur bec, known to us by the name of *Tamerlane the Great*, writes to Bajazet emperor of the Ottomans in the following terms:

"Where is the monarch who dares reſiſt us? where is the potentate who doth not glory in being numbered among our attendants? As for thee, deſcended from a Turcoman ſailor, ſince the veſſel of thy unbounded ambition hath been wreck'd in the gulf of thy ſelf-love, it would be proper, that thou ſhouldſt take in the ſails of thy temerity, and caſt the anchor of repentance in the port of ſincerity and juſtice, which is the port of ſafety; leſt the tempeſt of our vengeance make thee periſh in the ſea of the puniſhment thou deſerveſt."

Such ſtrained figures, as obſerved above, are not unfrequent in the firſt dawn of refinement; the mind in a new enjoyment knows no bounds, and is generally carried to exceſs, till taſte and experience diſcover the proper limits.

Secondly, Whatever reſemblance ſubjects may have, it is wrong to put one for another, where they bear no mutual proportion. Upon comparing a very high to a very low ſubject, the ſimile takes on an air of burleſque: and the ſame will be the effect where the one is imagined to be the other, as in a metaphor; or made to repreſent the other, as in an allegory.

Thirdly, Theſe figures, a metaphor eſpecially, ought not to be crowded with many minute circumſtances; for in that caſe it is ſcarcely poſſible to avoid obſcurity. A metaphor above all ought to be ſhort: it is difficult, for any time, to ſupport a lively image of a thing being what we know it is not; and for that reaſon, a metaphor drawn out to any length, inſtead of illuſtrating or enlivening the principal ſubject, becomes diſagreeable by overſtraining the mind. Here Cowley is extremely licentious. Take the following inſtance.

Great and wiſe conqu'ror, who where'er
Thou com'ſt, doſt fortify and ſettle there!
Who canſt defend as well as get;
And never hadſt one quarter beat up yet;
Now thou art in, thou ne'er will part
With one inch of my vanquiſh'd heart;
For ſince thou took'ſt it by aſſault from me
'Tis garriſon's ſo ſtrong with thoughts of thee,
It fears no beauteous enemy.

For the ſame reaſon, however agreeable long allegories may at firſt be by their novelty, they never afford any laſting pleaſure: witneſs the *Faëry Queen*, which with great power of expreſſion, variety of images, and melody of verſification, is ſcarce ever read a ſecond time.

In the fourth place, The compariſon carried on in a ſimile, being in a metaphor ſunk by imagining the principal ſubject to be that very thing which it only reſembles; an opportunity is furniſhed to deſcribe it in terms taken ſtrictly or literally with reſpect to its imagined nature. This ſuggeſts another rule, That in conſtructing a metaphor, the writer ought to make uſe of ſuch words only as are applicable literally to the imagined nature of his ſubject: figurative words ought carefully to be avoided; for ſuch complicated figures, inſtead of ſetting the principal ſubject in a ſtrong light, involve it in a cloud, and it is well if the reader, without rejecting by the lump, endeavour patiently to gather the plain meaning, regardleſs of the figures:

A ſtubborn and unconquerable flame
Creeps in his veins, and drinks the ſtreams of life.
Lady Jane Gray, act i. ſc. 1.

Copied from Ovid:

Sorbent avidæ præcordia flammæ.
Metamorph. lib. ix. 172.

Let us analyze this expreſſion. That a fever may be imagined a flame, we admit: though more than one ſtep is neceſſary to come at the reſemblance: a fever, by heating the body, reſembles fire; and it is no ſtretch to imagine a fever to be a fire: again, by a figure of ſpeech, flame may be put for fire, becauſe they are commonly conjoined; and therefore a fever may be termed a *flame*. But now admitting a fever to be a flame, its effects ought to be explained in words that agree literally to a flame. This rule is not obſerved here; for a flame drinks figuratively only, not properly.

King Henry to his ſon Prince Henry:

Thou hid'ſt a thouſand daggers in thy thoughts,
Which thou haſt whetted on thy ſtony heart
To ſtab at half an hour of my frail life.
Second Part Henry IV. act iv. ſc. 11.

Such faulty metaphors are pleaſantly ridiculed in the *Rehearſal*:

Phyſician. Sir, to conclude, the place you fill has more than amply exacted the talents of a wary pilot; and all theſe threatening ſtorms, which, like impregnate clouds, hover o'er our heads, will, when they once are graſp'd but by the eye of reaſon, melt into fruitful ſhowers of bleſſings on the people.

"*Bayes.* Pray mark that allegory. Is not that good?

"*Johnſon.* Yes, that graſping of a ſtorm with the eye is admirable. Act ii. ſc. 1.

Fifthly, The jumbling different metaphors in the ſame ſentence, beginning with one metaphor and ending with another, commonly called a *mixt metaphor*, ought never to be indulged.

K. Henry.

K. Henry. ———Will you again unknit
This churliſh knot of all-abhorred war,
And move in that obedient orb again,
Where you did give a fair and natural light?
Firſt Part Henry VI. act v. ſc. 1.

Whether 'tis nobler in the mind, to ſuffer
The ſtings and arrows of outrageous fortune;
Or to take arms againſt a ſea of troubles,
And by oppoſing end them.
Hamlet, act iii. ſc. 2.

In the ſixth place, It is unpleaſant to join different metaphors in the ſame period, even where they are preſerved diſtinct: for when the ſubject is imagined to be firſt one thing and then another in the ſame period without interval, the mind is diſtracted by the rapid tranſition; and when the imagination is put on ſuch hard duty, its images are too faint to produce any good effect:

At regina gravi jamdudum ſaucia cura,
Vulnus alit venis, et cæco carpitur igni.
Æneid. iv. 1.

————Eſt mollis flamma medullas
Interea, et tacitum vivit ſub pectore vulnus.
Æneid. iv. 66.

Motum ex Metello conſule civicum,
Bellique cauſas, et vitia, et modos,
Ludumque fortunæ, graveſque
Principum amicitias, et arma
Nondum expiatis uncta cruoribus,
Periculoſæ plenum opus aleæ,
Tractas, et incedis per ignes
Subpoſitos cineri doloſo.
Horat. Carm. lib. ii. ode 1.

Rebus anguſtis animoſus atque
Fortis adpare: ſapienter idem
Contrahes vento nimium ſecundo
Turgida vela. *Hor. Carm.* lib. ii. ode 10.

The following is a miſerable jumble of expreſſions, ariſing from an unſteady view of the ſubject, between its figurative and natural appearance:

But now from gath'ring clouds deſtruction pours,
Which ruins with mad rage our halcyon hours:
Miſts from black jealouſies the tempeſt form,
Whilſt late diviſions reinforce the ſtorm.
Diſpenſary, canto iii.

To thee the world its preſent homage pays,
The harveſt early, but mature the praiſe.
Pope's Imitation of Horace, book ii.

Oui, ſa pudeur ne'ſt que franche grimace,
Qu'une ombre de vertu qui garde mal la place,
Et qui s'evanouit, comme l'on peut ſavoir,
Aux rayons du ſoleil qu'une bourſe vait voir.
Moliere, L'Etourdi, act iii. ſc. 2.

Et ſon feu, de pourvû de ſenſe et de lecture,
S'éteint à chaque pas, faut de nourriture.
Boileau, L'Art Poetique, chant. iii. l. 319.

Dryden, in his dedication of the tranſlation of *Juvenal*, ſays, "When thus, as I may ſay, before the uſe of the loadſtone, or knowledge of the compaſs, I was ſailing in a vaſt ocean, without other help than the pole-ſtar of the ancients, and the rules of the French ſtage among the moderns," &c.

"There is a time when factions, by the vehemence of their own fermentation, ſtun and diſable one another." *Bolingbroke.*

This fault of jumbling the figure and plain expreſſion into one confuſed maſs, is not leſs common in allegory than in metaphor.

In the laſt place, It is ſtill worſe to jumble together metaphorical and natural expreſſion, ſo as that the period muſt be underſtood in part metaphorically, in part literally; for the imagination cannot follow with ſufficient eaſe changes ſo ſudden and unprepared: a metaphor begun and not carried on, hath no beauty; and inſtead of light there is nothing but obſcurity and confuſion. Inſtances of ſuch incorrect compoſition are without number: we ſhall, for a ſpecimen, ſelect a few from different authors. Speaking of Britain,

——This precious ſtone ſet in the ſea,
Which ſerves it in the office of a wall,
Or as a moat defenſive to a houſe,
Againſt the envy of leſs happier lands.
Richard II. act ii. ſc. 1.

In the firſt line Britain is figured to be a precious ſtone: in the following line, Britain, diveſted of her metaphorical dreſs, is preſented to the reader in her natural appearance.

Theſe growing feathers pluck'd from Cæſar's wing,
Will make him fly an ordinary pitch,
Who elſe would ſoar above the view of men,
And keep us all in ſervile fearfulneſs.
Julius Cæſar, act i. ſc. 1.

Take the following examples:

————Heu! quoties fidem,
Mutatoſque Deos flebit, et aſpera
Nigris æquora ventis
Emirabitur inſolens,
Qui nunc te fruitur credulus aureâ:
Qui ſemper vacuam, ſemper amabilem
Sperat, neſcius auræ
Fallacis. *Horat. Carm.* lib. i. ode 5.

Pour moi ſur cette mer, qu'ici bas nous courons,
Je ſonge à me pourvoir d'eſquif et d'avirons,
A regler mes deſires, à prévenir l'orage,
Et ſauver, s'il ſe peut, ma Raiſon du naufrage.
Boileau, epitre 5.

Lord Halifax, ſpeaking of the ancient fabuliſts: "They (ſays he) wrote in ſigns, and ſpoke in parables: all their fables carry a double meaning: the ſtory is one, and entire; the characters the ſame throughout; not broken or changed, and always conformable to the nature of the creature they introduce. They never tell you, that the dog which ſnapped at a ſhadow, loſt his troop of horſe; that would be unintelligible. This is his

Metaphor. his (Dryden's new way of telling a ſtory, and confounding the moral and the fable together." After inſtancing from the Hind and Panther, he goes on thus: "What relation has the hind to our Saviour? or what notion have we of a panther's bible? If you ſay he means the church, how does the church feed on lawns, or range in the foreſt? Let it be always a church, or always a cloven-footed beaſt; for we cannot bear his ſhifting the ſcene every line."

A few words more upon allegory. Nothing gives greater pleaſure than this figure, when the repreſentative ſubject bears a ſtrong analogy, in all its circumſtances, to that which is repreſented: but the choice is ſeldom ſo lucky; the analogy being generally ſo faint and obſcure, as to puzzle and not pleaſe. An allegory is ſtill more difficult in painting than in poetry: the former can ſhow no reſemblance but what appears to the eye; the latter hath many other reſources for ſhowing the reſemblance. And therefore, with reſpect to what the abbé du Bos terms *mixt allegorical compoſitions*, theſe may do in poetry; becauſe, in writing, the allegory can eaſily be diſtinguiſhed from the hiſtorical part: no perſon, for example, miſtakes Virgil's Fame for a real being. But ſuch a mixture in a picture is intolerable; becauſe in a picture the objects muſt appear all of the ſame kind, wholly real or wholly emblematical. For this reaſon, the hiſtory of Mary de Medicis, in the palace of Luxembourg, painted by Rubens, is unpleaſant by a perpetual jumble of real and allegorical perſonages, which produce a diſcordance of parts, and an obſcurity upon the whole: witneſs, in particular, the tablature repreſenting the arrival of Mary de Medicis at Marſeilles; where, together with the real perſonages, the Nereids and Tritons appear ſounding their ſhells: ſuch a mixture of fiction and reality in the ſame group is ſtrangely abſurd. The picture of Alexander and Roxana, deſcribed by Lucian, is gay and fanciful; but it ſuffers by the allegorical figures. It is not in the wit of man to invent an allegorical repreſentation deviating farther from any ſhadow of reſemblance, than one exhibited by Louis XIV. anno 1664; in which an enormous chariot, intended to repreſent that of the ſun, is dragged along, ſurrounded with men and women, repreſenting the four ages of the world, the celeſtial ſigns, the ſeaſons, the hours, &c. a monſtrous compoſition, and yet ſcarcely more abſurd than Guido's tablature of Aurora.

In an allegory, as well as in a metaphor, terms ought to be choſen that properly and literally are applicable to the repreſentative ſubject: nor ought any circumſtance to be added that is not proper to the repreſentative ſubject, however juſtly it may be applicable properly or figuratively to the principal. The following allegory is therefore faulty:

> Ferus et Cupido,
> Semper ardentes acuens ſagittas
> Cote *cruentâ*. *Horat.* lib. ii. ode 8.

For though blood may ſuggeſt the cruelty of love, it is an improper or immaterial circumſtance in the repreſentative ſubject: water, not blood, is proper for a whetſtone.

We proceed to the next head, which is, to examine in what circumſtances theſe figures are proper, in what improper. This inquiry is not altogether ſuperſeded by what is ſaid upon the ſame ſubject in the article COMPARISON; becauſe, upon trial, it will be found, that a ſhort metaphor or allegory may be proper, where a ſimile, drawn out to a greater length, and in its nature more ſolemn, would ſcarcely be reliſhed. Metaphor.

And, in the firſt place, A metaphor, like a ſimile, is excluded from common converſation, and from the deſcription of ordinary incidents. Secondly, In expreſſing any ſevere paſſion that totally occupies the mind, metaphor is unnatural.

The following example, of deep deſpair, beſide the highly figurative ſtyle, has more the air of raving than of ſenſe:

> *Caliſta.* Is it the voice of thunder, or my father?
> Madneſs! confuſion! let the ſtorm come on,
> Let the tumultuous roar drive all upon me,
> Daſh my devoted bark; ye ſurges, break it:
> 'Tis for my ruin that the tempeſt riſes.
> When I am loſt, ſunk to the bottom low,
> Peace ſhall return, and all be calm again.
> *Fair Penitent*, act v.

The following metaphor is ſweet and lively; but it ſuits not the fiery temper of Chamont, inflamed with paſſion: parables are not the language of wrath venting itſelf without reſtraint:

> *Chamont.* You took her up a little tender flow'r,
> Juſt ſprouted on a bank, which the next froſt
> Had nipp'd; and with a careful loving hand,
> Tranſplanted her into your own fair garden,
> Where the ſun always ſhines: there long ſhe flouriſh'd,
> Grew ſweet to ſenſe, and lovely to the eye;
> Till at the laſt a cruel ſpoiler came,
> Cropt this fair roſe, and rifled all its ſweetneſs,
> Then caſt it like a loathſome weed away.
> *Orphan*, act iv.

The following ſpeech, full of imagery, is not natural in grief and dejection of mind.

> *Gonſalez.* O my ſon! from the blind dotage
> Of a father's fondneſs theſe ills aroſe.
> For thee I've been ambitious, baſe, and bloody:
> For thee I've plung'd into this ſea of ſin;
> Stemming the tide with only one weak hand,
> While t'other bore the crown (to wreathe thy brow),
> Whoſe weight has ſunk me ere I reach'd the ſhore.
> *Mourning Bride*, act v. ſc. 6.

There is an enchanting picture of deep diſtreſs in Macbeth, where Macduff is repreſented lamenting his wife and children, inhumanly murdered by the tyrant. Stung to the heart with the news, he queſtions the meſſenger over and over: not that he doubted the fact, but that his heart revolted againſt ſo cruel a misfortune. After ſtruggling ſome time with his grief, he turns from his wife and children to their ſavage butcher: and then gives vent to his reſentment, but ſtill with manlineſs and dignity:

> O, I could play the woman with mine eyes,
> And braggart with my tongue. But, gentle Heav'n!
> Cut ſhort all intermiſſion; front to front
> Bring thou this fiend of Scotland and myſelf;

Within my ſword's length ſet him. If he 'ſcape,
Then Heav'n forgive him too.

Metaphorical expreſſion, indeed, may ſometimes be uſed with grace where a regular ſimile would be intolerable: but there are ſituations ſo ſevere and diſpiriting, as not to admit even the ſlighteſt metaphor. It requires great delicacy of taſte to determine with firmneſs, whether the preſent caſe be of that nature: perhaps it is; yet who could wiſh a ſingle word of this admirable ſcene altered?

But metaphorical language is proper when a man ſtruggles to bear with dignity or decency a misfortune however great; the ſtruggle agitates and animates the mind:

Wolſey. Farewell, a long farewell to all my greatneſs;
This is the ſtate of man: to day he puts forth
The tender leaves of hope; to-morrow bloſſoms,
And bears his bluſhing honours thick upon him;
The third day comes a froſt, a killing froſt,
And when he thinks, good eaſy man, full ſurely
His greatneſs is a-ripening, nips his root,
And then he falls as I do. *Henry VIII.* act iii. ſc. 6.

METAPHRAST, a tranſlator, or perſon who renders an author into another form or another language, word for word.

METAPHYSICS.

1 Definition.

METAPHYSICS has been defined, by a writer deeply read in the ancient philoſophy, "The ſcience of the principles and cauſes of all things exiſting." This definition, we think, extremely proper: and hence it is, that *mind* or intelligence, and eſpecially the *ſupreme intelligence*, which is the cauſe of the univerſe, and of every thing which it contains, is the principal ſubject of this ſcience; and hence, too, the ſcience itſelf received its name. Ariſtotle, indeed, who, of all the ancient metaphyſicians whoſe works have come down to us, was unqueſtionably the greateſt, calls this ſcience THE FIRST PHILOSOPHY, as being not only ſuperior, but alſo prior in the order of nature, to the whole circle of the other arts and ſciences. But, "what is firſt to nature, is not firſt to man." Nature begins with *cauſes*, which produce *effects*. Man begins with *effects*, and by them aſcends to *cauſes*. Thus all human ſtudy and inveſtigation proceed of neceſſity in the reverſe of the natural order of things, from *ſenſible* to *intelligible*, from *body* the effect, to *mind*, which is both the firſt and the final cauſe. Now PHYSICS being the name given by the Stagyrite to the philoſophy of body, ſome of his interpreters, from this neceſſary courſe of human ſtudies, called that of mind METAPHYSICS, implying by that term, not only that its ſubject is more ſublime and difficult, but alſo that the ſtudy of it would be moſt properly and ſucceſsfully entered upon AFTER THAT OF PHYSICS. To this name, which, though it has ſometimes been treated with ridicule, is abundantly ſignificant, the followers of Ariſtotle were led by their maſter, who, to the books in which he pretends to elevate the mind above things corporeal to the contemplation of God and things ſpiritual, prefixed the Greek words μετα τα φυσικα (A).

2 Diviſion of the ſcience into

The ſcience of Metaphyſics has been divided, according to the objects which it conſiders, into ſix principal parts, which are called, 1. *Ontology;* 2. *Coſmology;* 3. *Anthropoſophy;* 4. *Pſychology;* 5. *Pneumatology;* and, 6. *Metaphyſical theology.*

1. That part of the ſcience which is named *ontology*, inveſtigates and explains the nature and eſſence of all beings, as well as the qualities and attributes that eſſentially appertain to them. Hence it has been ſaid that ontology ſhould proceed in its operations from the moſt ſimple ideas; ſuch as do not admit of any other qualities of which they may be compounded. Theſe ſimple ideas are of *being*, of *eſſence*, of *ſubſtance*, of *mode*, of *exiſtence* as well with regard to time as place, of a *neceſſary cauſe* of *unity;* the idea of *negation;* the difference between a *being* that is *ſimple* or *compound*, *neceſſary* or *accidental*, *finite* or *infinite;* the ideas of *eſſential* and *abſtract properties*, ſuch as of the *greatneſs*, *perfection*, and *goodneſs* of *beings*, &c. The buſineſs therefore of ontology, is to make us acquainted with every kind of being in its nature and eſſential qualities, which diſtinguiſh it from all other beings. This knowledge being once eſtabliſhed on ſimple principles, juſt conſequences may thence be drawn, and thoſe things proved after which the metaphyſician inquires, and which is the buſineſs of his ſcience to prove. 3 Ontology;

It is eaſy to conceive, that even a clear knowledge of beings, and their eſſential properties, would be ſtill defective and uſeleſs to man, if he did not know how to determine and fix his ideas by proper denominations, and conſequently to communicate his perceptions to thoſe whom he would inſtruct, or againſt whom he is obliged to diſpute. To render our ideas therefore intelligible to others, we muſt have determinate words or denominations for each being, and the qualities of each being; and ontology teaches us thoſe terms which are ſo neceſſary to fix our ideas, and to give them the requiſite perſpicuity and preciſion, that when we endeavour to extend the ſphere of

(A) ΤΩΝ ΜΕΤΑ ΤΑ ΦΥΣΙΚΑ. Cujus inſcriptionis hæc ratio eſt, quod in hoc opere ea tractantur quorum theoria poſterior eſt doctrinæ naturali ſaltem quoad nos, qui à corporum cognitione rerumque caducarum in ſubſtantiarum immaterialium atque immortalium contemplationem provehimur.

Du Val. Synopſ. Doctr. Peripat.

Diviſions of the ſcience. of our knowledge, we may not waſte our time in diſputes about words.

4 Coſmology; 2. Metaphyſics, having, in as ſolid a manner as poſſible, explained and eſtabliſhed the principles above mentioned, continues its inquiries to the ſecond part, which is called *coſmology*, and examines into the eſſence of the world and all that it contains; its eternal laws; of the nature of matter; of motion; of the nature of tangible bodies, their attributes and adjuncts; and of all that can be known by reaſoning and experience. It is alſo in coſmology that the metaphyſicians of this ſchool examine the Leibnitzian ſyſtem; that is, whether God, in creating the world, muſt neceſſarily have created the beſt world; and if this world be ſo in fact. In this manner they purſue the argument, from conſequence to conſequence, to its laſt reſort, frequently with very little advantage to truth and ſcience.

5 Anthropoſophy; 3. *Anthropoſophy*, or the knowledge of man, forms the third branch of metaphyſics. It is ſubdivided into two parts. The firſt, which conſiſts in the knowledge of the exterior parts of the human frame, belongs not to this ſcience, but to Anatomy and Phyſiology. The buſineſs of the metaphyſician is here to aſcertain the nature of thoſe powers by which all the motions eſſential to life are produced; and to diſcover, if poſſible, whether they be corporeal or ſpiritual. This inquiry leads at the ſame time to

6 Pſychology; 4. *Pſychology;* which conſiſts in the knowledge of the intellectual ſoul in particular; concerning which the moſt profound, the moſt ſubtle, and moſt abſtract reſearches, have been made that human reaſon is capable of: and concerning the ſubſtance of which, in ſpite of all theſe efforts, it is yet extremely difficult to ſupport any poſitive opinion with concluſive or probable arguments.

7 Pneumatology; 5. The fifth part of metaphyſics is called *pneumatology*. By this term, which has not been long in uſe, metaphyſicians mean the knowledge of all ſpirits, *angels*, &c. It is eaſy to conceive what infinite art is neceſſary to give an account of that, of which nothing poſitive can ever be known in the preſent ſtate of human exiſtence. But the metaphyſician of this ſchool readily offers to ſhow us, "what is the idea of a ſpirit; the effective exiſtence of a ſpirit; what are its general qualities and properties; that there are rational ſpirits, and that theſe rational ſpirits have qualities that are founded in the moral attributes of God:" for this is in ſo many words what is attempted to be taught in pneumatology.

8 Metaphyſical theology. 6. *Metaphyſical theology*, which Leibnitz and ſome others call *theodicy*, is the ſixth and laſt branch of the ſcience of metaphyſics. It teaches us the knowledge of the exiſtence of God; to make the moſt rational ſuppoſitions concerning his divine eſſence, and to form a juſt idea of his attributes and perfections, and to demonſtrate them by abſtract reaſoning. Theodicy differs from natural theology, in as much as this laſt borrows, in fact, from theodicy proofs and demonſtrations to confirm the exiſtence of a ſupreme Being: but after having ſolidly eſtabliſhed that great truth, by extending its conſequences natural theology teaches us what are the relations and connexions that ſubſiſt between the ſupreme Being and men, and what are the duties which reſult from theſe relations.

We have briefly mentioned theſe diviſions of the ſcience, becauſe they were once prevalent in the ſchools. The greater part of them, however, appears to us to be not only ſuperfluous, but ſuch as can ſerve no other purpoſe than to perplex the mind. The only beings of which we know any thing are mind and body; and we have no reaſon to think that there are any other beings in the univerſe. Of bodies indeed there are various kinds, endowed with different properties: and it is extremely probable, that of minds endowed with different powers, the variety may be equally great. Our own minds we know to be united in one ſyſtem with bodies by which they perform all their operations; and we can demonſtrate that there is another Mind, which is independent of all body, and is the cauſe of all things. Between theſe there may be numberleſs orders of minds; but their energies are wholly unknown to us, and therefore they can never become the objects of ſcience. Diviſions of the Science. 9 This diviſion uſeleſs and improper.

Mind and body therefore, *i. e.* the minds and bodies which we know to exiſt, together with their powers and properties, eſſential and accidental, can alone be the ſubjects of rational inquiry. We may inquire into the eſſence of mind and the eſſence of body, and endeavour to aſcertain in what reſpects they differ. We may examine the nature of different bodies, in order to diſcover whether all bodies, however modified, have not ſomething in common; and we may conſider the properties, relations, and adjuncts of bodies, and endeavour to diſtinguiſh thoſe which are accidental from ſuch as appear to be ſo neceſſary that without them body itſelf could not exiſt. Of minds we cannot make the ſame compariſon. In this part of the ſcience we have not ſufficient data for an accurate and complete induction: we can only examine the powers of our own mind; and by probable analogy make ſome eſtimate of the powers of ſuperior minds, as obſervation will help us to gueſs at the powers of thoſe which are placed beneath us in the ſcale of exiſtence.

If this be ſo, Coſmology, as diſtinguiſhed from Ontology, cannot properly be a branch of Metaphyſics. For if mind and body, with their ſeveral powers, properties, and adjuncts, compoſe the univerſe, it is obvious, that when we have aſcertained, as well as we are able, the eſſence of mind and the eſſence of body, together with the powers and properties of each, and have traced them all to the firſt cauſe, we have done every thing in the ſcience of the univerſe, if we may uſe the expreſſion, which belongs to the province of the metaphyſician. The particular laws of motion on the earth and in the planetary ſyſtem belong to the natural philoſopher and aſtronomer.

In like manner, Anthropoſophy, Pſychology, or Pneumatology, if they be not words expreſſive of diſtinctions where there is no difference, ſeem to be at leaſt very needleſsly disjoined from each other. Of the nature of ſpirits we can know nothing but from contemplating the powers of our own minds; and the body of man is in the province, not of the metaphyſician, but of the anatomiſt and phyſiologiſt. Anthropoſophy, pſychology, and pneumatology, if they be uſed to denote our knowledge of all minds except the Supreme, are words of the ſame import; for of no created minds except our own can we acquire ſuch knowledge as deſerves the name of ſcience.

Ontology

Divisions of the Science.

Ontology has fometimes been defined the fcience of *being in the abftract;* but in the courfe of our inquiries it will be feen, that *being in the abftract* is a phrafe without meaning. Confidered as the fcience of *real beings* and their *properties*, Ontology is a very fignificant word, of the fame import with Metaphyfics, comprehending in itfelf the knowledge of the nature of all things exifting. Or if it be thought proper to make a diftinction between ontology and theology, the former branch of the fcience will teach the knowledge of body and created minds, whilft it is the province of the latter to demonftrate the exiftence and attributes of that mind which is uncreated.

10 Another propofed.

Body and mind, therefore, with their properties, adjuncts, and powers, comprehend the whole fubject of the fcience of metaphyfics: and as we are earlier acquainted with body than with mind, the natural order of conducting our inquiries feems to be, to begin with the former, and thence proceed to the latter. It is obvious, however, that if we would purfue thefe inquiries with any hopes of fuccefs, we muft firft trace human knowledge from its fource, afcertain the nature of truth, and fhow what kind of evidence on each topic to be treated ought to enforce conviction. In this view of the fcience, metaphyfics appears to be divided into three parts; the firft treating *of human underftanding;* the fecond, *of body with its adjuncts;* and the third, *of mind with its powers.*

11 Idea and notion explained.

Previous to the entering upon fuch inquiries, fome philofophers of great merit have thought it expedient to explain the terms which they might have occafion to ufe. Their conduct is judicious and worthy of imitation; for the objects of metaphyfics being, for the moft part, fuch as fall not under the cognizance of the fenfes, are liable to be differently apprehended by different men, if the meanings of the words by which they are expreffed be not afcertained with the utmoft precifion. We intend, however, to ufe very few words but in the common acceptation; and we therefore hope, that as terms of fcience are explained under different words in the Dictionary, to which references are made, we have little or no occafion for fwelling the article by previous definitions. There are indeed two words which have given rife to much ufelefs difputation, which yet cannot be banifhed from fpeculative philofophy, and which it will therefore be proper here to define. The words to which we allude are *idea* and *notion.* Thefe are very generally confidered as fynonymous; but we think that much logomachy might have been avoided by affigning to each a determinate fignification. We know not any philofopher who made much ufe of the word *idea* before Plato; but with his myfterious doctrine concerning ideas we have here nothing to do: our prefent bufinefs is to afcertain the precife meaning of the word, which is evidently derived from ειδω to *fee*, as the word *notion* is from "nofco, novi, *notum*," and that from γινωσκω to *know* or *underftand.* In the original fenfe of the two words, therefore, *notion* is more comprehenfive than *idea*, becaufe we *know* many things which cannot be *feen.* We have not a doubt, but that at firft the word *idea* was employed to denote only thofe forms of external objects which men contemplate in their imaginations, and which are originally received through the fenfe of *fight.* Its fignification was afterwards extended to the relicts of every fenfation, of touch, tafte, found, and fmell, as well as of fight; and at laft it was confounded with *notion*, which denotes the mental apprehenfion of whatever may be known. In our ufe of the word *idea*, except when we quote from others, we fhall employ it only to denote that appearance which abfent objects of fenfe make in the memory or imagination (B); and by the word *notion* we fhall denote our apprehenfion or knowledge of fpirits, and all fuch things as, though they be the objects of fcienec, cannot be perceived by the external fenfes. Having faid this, we proceed to our inquiries, beginning with that into human underftanding.

PART I. OF HUMAN UNDERSTANDING.

Preliminary Obfervations on the ORIGIN *of our* IDEAS *and* NOTIONS.

12 No innate ideas or notions in the human mind.

THAT the mind of man has no innate ideas or notions, but comes into the world ignorant of every thing, is a truth which fince the days of Locke has been very little difputed. In the firft book of his Effay on the Human Underftanding, that acute philofopher has demonftrated, that the rudiments or firft principles of all our knowledge are communicated to us by fenfation; and he has compared the mind, previous to the operation of external objects upon the fenfes, to a *tabula rafa* or fheet of white paper. To repeat his arguments would fwell the article to no purpofe. There is not a man capable of attending to his own ideas, who

(B) In thus reftricting the meaning of the word *idea*, we have the honour to agree with the great Englifh Lexicographer.—"He was particularly indignant againft the almoft univerfal ufe of the word *idea* in the fenfe of *notion* or *opinion*, when it is clear that *idea* can only fignify fomething of which an image may be formed in the mind. We may have an *idea* or *image* of a mountain, a tree, or a building; but we cannot furely have an *idea* or *image* of an *argument* or *propofition.* Yet we hear the fages of the law delivering their *ideas* upon the queftion under confideration; and the firft fpeakers in Parliament entirely coinciding in the *idea*, which has been fo ably ftated by an honourable member; or reprefenting an *idea* as unconftitutional, and fraught with the moft dangerous confequences to a great and free country. This Johnfon called *modern cant.*" *Bofwell's Life of Johnfon.*

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who can entertain a doubt in what manner he received them. Without the ſenſe of ſight, we could never have known colours; nor ſound, without hearing; nor hardneſs, ſoftneſs, ſmoothneſs, pain, or bodily pleaſure, without touch; nor odours, without ſmell, &c.

Self-evident as theſe facts are, objections have been ſtarted to the inferences drawn from them; and Locke has been accuſed of advancing principles ſubverſive of all diſtinction between truth and falſehood, and favourable of courſe to univerſal ſcepticiſm.—"The firſt book of his Eſſay, which with ſubmiſſion (ſays Dr Beattie*) I think the worſt, tends to eſtabliſh this dangerous doctrine, that the human mind, previous to education and habit, is as ſuſceptible of one impreſſion as of another: a doctrine which, if true, would go near to prove that truth and virtue are no better than human contrivances; or at leaſt that they have nothing permanent in their nature, but may be as changeable as the inclinations and capacities of men; and that there is no ſuch thing as common ſenſe in the world. Surely this is not the doctrine which Mr Locke meant to eſtabliſh." We are ſo thoroughly ſatisfied that it is not, that we cannot help wondering how ſuch inferences could, by a man of learning, genius, and candour, be drawn from any thing which is to be found in the Eſſay on the Human Underſtanding.

*Eſſay on the Nature and Immutability of Truth.

But the Doctor thinks Mr Locke's "ſimile of the mind to white paper one of the moſt unlucky alluſions that could have been choſen; becauſe the human ſoul, when it begins to think, is not extended, nor of a white colour, nor incapable of energy, nor wholly unfurniſhed with ideas, nor as ſuſceptible of one impreſſion or character as of any other:" and it has been obſerved by another objector†, that "on a ſheet of white paper you may write that ſugar is bitter; wormwood ſweet; fire and froſt in every degree pleaſing and ſufferable: that compaſſion and gratitude are baſe; treachery, falſehood, and envy, noble; and that contempt is indifferent to us."

† *J. Uſher, author of* Clio. See *a vol. of Fugitive Pieces printed for J. Davies, London,* 1774.

13
Objections anſwered.

All this is true; but we apprehend it is not to the purpoſe. Mr Locke has no where expreſſed himſelf in ſuch a manner as to lead us to ſuppoſe that he believed the ſoul to be extended or coloured; or, when it begins to think, incapable of energy, and wholly unfurniſhed with ideas: but he certainly did believe, that it begins not to think the firſt inſtant of its exiſtence, and that it *acquires* all the ideas of which it is ever poſſeſſed. We may undoubtedly write upon a piece of white paper that ſugar is bitter, and that wormwood is ſweet; but how the capacity of paper to receive the ſymbols of falſe propoſitions ſhould make Mr Locke's compariſon improper or dangerous, we cannot comprehend. Mr Uſher indeed ſays, that it is improper on this account, "that no human art or induſtry is able to make thoſe impreſſions upon the mind: in reſpect of them, the mind diſcovers not a paſſive capacity, but reſiſts them with the force of fate." Does it indeed? does the mind reject the idea of ſugar or of bitterneſs, of contempt or of indifference? May not any man have the *idea* of ſugar and at the ſame time the *idea* of bitterneſs, and compare the one with the other in his mind, as well as the word *ſugar* may be written beſide the word *bitter*, and connected with it on the ſame piece of paper? In all this we perceive nothing that is impoſſible or even difficult. The mind cannot indeed be made to feel that ſugar has the ſame taſte with wormwood; but who ever thought that it could? Not Mr Locke, we ſhall be bold to ſay; nor does his ſimile give the ſmalleſt countenance to ſuch an abſurdity. The author of the Eſſay on the Human Underſtanding underſtood his ſubject too well to imagine that either truth or falſehood could be communicated to paper, or that paper is capable of comparing ideas. Paper is capable of receiving nothing but lines or figures; and it paſſively receives whatever lines or figures we may chooſe to inſcribe on it: yet if a pen be carried over it in a circular direction, the figure impreſſed will not be a ſquare; juſt as, to the mind of one eating ſugar, the taſte communicated is not that of wormwood.

Origin of Ideas and Notions.

On a piece of paper a circle may be deſcribed, and cloſe beſide it a ſquare: in like manner an agreeable ſenſation may be communicated to the mind, and immediately afterwards a ſenſation that is diſagreeable. Theſe two ſenſations, or the ideas which they leave behind them, may be compared together; and it is certainly true that no art or induſtry can make them appear ſimilar in the mind: but is it not equally true, that no art or induſtry can make the circle and the ſquare ſimilar on the paper? The paper is ſuſceptible of any ſort of plain figures, and the mind is equally ſuſceptible of any ſort of ideas or ſenſations; but figures diſſimilar cannot be made to coincide, neither can diſcordant ideas be made to agree. Again, one may write upon paper, that "a circle *is* a ſquare," and likewiſe that "a circle *is not* a ſquare;" and both theſe propoſitions may be communicated to the mind by the organs of ſight or of hearing. The paper receives the *words* expreſſive of the falſe as well as thoſe expreſſive of the true propoſition; and the mind receives the *ideas* and *relations* ſignified by the one cluſter of words as well as thoſe ſignified by the other: but in the mind the *idea* of a ſquare is *different* from that of a circle, and on the paper the *figure* of a ſquare is *different* from the *figure* of a circle. The great difference between the mind and the paper is, that *the former* is *conſcious* of its ideas, and *perceives* their agreement or diſagreement; whereas the paper is *not* conſcious of the figures drawn upon it, nor perceives any thing about them. But ſtill thoſe figures are what they are; they either agree or diſagree on the paper, as well as the ideas either agree or diſagree in the mind. It is not in the power of the mind to alter the *ideas* of the ſquare and the circle, not in the power of the paper to alter the *forms* of theſe figures.

It appears then, that the principles of Mr Locke, and the compariſon by which he illuſtrates them, have no more tendency to ſubvert the difference between truth and falſehood, right and wrong, than the paſſiveneſs of paper has to ſubvert the difference between a ſtraight line and a crooked, a circle and a ſquare: and with a view to eſtabliſh the doctrine of innate ideas and inſtinctive principles of knowledge, we might with as much propriety aſk, Whether it be poſſible to imagine that any mode of manufacture could make paper of ſuch a nature, as that a pen drawn over it in a circular direction would leave the figure of a ſquare? as that, "Whether it be poſſible to imagine, that any courſe of education could ever bring a rational creature to believe that two and two are equal to three."

The

Origin of Ideas and Notions.

The mind being thus, as we may ſay, originally white paper, void of all characters, without ideas or notions of any kind, the firſt queſtion which we have to conſider is, Whence and in what manner it derives the materials of all its knowledge? To this queſtion the only anſwer which can be given is, That it derives them from obſervation and experience; from obſervation, either employed upon external objects of ſenſe, or turned inwardly upon its own operations. Our ſenſes, converſant about particular external objects, convey into the mind ſeveral diſtinct perceptions; ſuch as thoſe of *colour*, *figure*, *heat*, *cold*, *bitterneſs*, *ſweetneſs*, and all thoſe things which are uſually called *ſenſible qualities*. The notions, ideas, or whatever elſe they may be called which are acquired in this manner, may be called *ſenſible knowledge*; and the ſource of that knowledge is termed *ſenſation*.

14 [...]ut all derived from ſenſation and reflection.

The other fountain from which experience furniſhes the underſtanding with knowledge, is that attention which we are capable of giving to the operations of our own minds when employed about thoſe ideas which were originally ſuggeſted by objects of ſenſe. Theſe operations, when the ſoul comes to reflect on them, furniſh us with a ſet of notions entirely different from the ideas of ſenſe; ſuch as the notions of *perception*, *thinking*, *doubting*, *believing*, *reaſoning*, *knowing*, *willing*, and all the different energies and paſſions of our own minds. Of theſe operations we are always conſcious when we are awake: but it requires, as ſhall be ſhown afterwards, no inconſiderable effort to ſet them, as it were, at a diſtance, to reflect on them and conſider what they are; but when we have made this effort, we acquire notions as diſtinct, and perhaps more important, than thoſe ideas which we receive through the medium of the ſenſes.

Senſation and reflection then furniſh mankind with the firſt materials of all their knowledge. The mind ſeems not to have ideas or notions of any kind which it did not receive by one or other of theſe ways. By means of the ſenſes it perceives external objects; and by that power which it has of turning its attention upon itſelf, it diſcovers the nature and manner of its own operations.

Although the knowledge which we acquire from *reflection* be of equal importance, and perhaps of greater certainty than that which we receive through the medium of the ſenſes, it comes into the mind at a much later period; both becauſe it is impoſſible that the faculties of the mind ſhould operate without materials, and becauſe it is much more difficult to attend to theſe operations even while they are going on, than to the objects of ſenſe which ſolicit our attention. It is for this reaſon pretty late before children have any notions whatever of the operations of their own minds; and of the greater part of theſe operations the bulk of mankind have no clear or accurate notions during their whole lives. On the other hand, every human being is ſo ſurrounded with bodies, which perpetually and variouſly affect his ſenſes, that a variety of ſenſible ideas force an entrance even into the minds of children. In order therefore to trace the procedure of the underſtanding, and to aſcertain the extent and limits of human knowledge, it ſhould ſeem that we muſt begin with conſidering the external ſenſes, that we may diſcover the manner in which we receive knowledge by means of them, the objects of that knowledge, and its certainty. It is to be obſerved, however, that though we conſider the mind as poſſeſſed of many powers or faculties, and inquire firſt into the nature of that faculty which we conceive to be firſt exerted, this is done merely for the ſake of proceeding in our ſubject with method and perſpicuity. The mind is one ſimple and undivided being; and in every mental energy it is the whole mind, and not any part or portion of it, that is energetic. On this account, it is impoſſible to explain even the nature of ſenſation and perception to him who knows not what is meant by *will* and *underſtanding*; but to every one who is acquainted with the common import of theſe words, and who has read the ſhort ſyſtem of LOGIC inſerted in this Work, we hope that our theory of perception will be intelligible and convincing.

Of Senſation.

CHAP. I. *Of* SENSATION *and* PERCEPTION.

SECT. I. *Of Senſation.*

15 Senſation by five organs.

THE Supreme Being, who made us and placed us in this world, has given us ſuch powers of mind as he ſaw to be ſuited to our ſtate and rank in his creation. He has given us the power of perceiving many objects around us; but that power is limited in various ways; and particularly in this, that without the organs of the ſeveral ſenſes we perceive no external object. The ſenſes, as every one knows, are five in number, and each communicates its proper ſenſation. It is by the eyes alone that we ſee, by the ears that we hear, by the noſe that we ſmell, and by the tongue and palate that we taſte; the ſenſe of feeling or touch is ſpread over the whole body, for we feel equally by our hands and by our feet, &c. To the powers of perception by the ſenſes it is neceſſary not only that we have all the organs enumerated, but that we have them alſo in a ſound and natural ſtate. There are many diſorders of the eye which cauſe total blindneſs, as well as others which impair without deſtroying the power of viſion. The ſame thing is true of the organs of all the other ſenſes.

All this is ſo well known from experience, that it needs no proof; but it may be worth while to obſerve, that it is known from experience only *. For any thing that we know to the contrary, our Creator might have endowed us with the power of perception by a thouſand organs of ſenſe, all different from thoſe which we poſſeſs; and it is certain that he himſelf perceives every thing more perfectly than we do without bodily organs. For it is to be obſerved, that the organs of ſenſe are different from the being which is ſentient.—It is not the eye which ſees, nor the ear which hears; theſe are only the organs by which we ſee and hear. A man cannot ſee the ſatellites of Jupiter but by means of a teleſcope, nor hear a low voice but by means of an ear trumpet. Does he from this conclude that it is the teleſcope which ſees thoſe ſatellites, or the trumpet which hears that voice? Such a concluſion would be evidently abſurd. It is no leſs abſurd to conclude that it is the eye which ſees, or the ear which hears. The teleſcope and the trumpet are artificial organs of ſight and of hearing, of which the eye and the ear are natural organs; but the natural organs ſee and hear as little as the artificial.

* *Reid's Eſſays on the Intellectual Powers of Man.*

16 Theſe organs themſelves not ſentient, but

17 Inſtruments of ſenſation.

That this is the caſe with reſpect to the eye and the ear, Of Sensation.

ear, is so obvious, that, as far as we know, it has never been denied. But with respect to the senses of touch, taste, and smell, the truth at first view appears not so evident. A celebrated writer has observed*, that "after the utmost efforts, we find it beyond our power to conceive the flavour of a rose to exist in the mind: we are necessarily led to conceive that pleasure as existing in the nostrils, along with the impression made by the rose upon that organ (c); and the same will be the result of experiments with respect to every feeling of taste, touch, and smell. Touch (he says), affords the most satisfactory evidence, and philosophy detects the delusion." To detect this delusion requires, indeed, no great depth in philosophy; for it is so far from being true that we are necessarily led otherwise than by association, of which the laws shall be explained afterwards, to conceive the pleasure or pain of touch as existing at that part of our body upon which the impression is made, that as every man must have observed, children previous to experience cannot distinguish the precise place of their bodies which is affected by the touch of any external object. Nay, we believe it will be found upon trial, that if a full grown man, with all the experience of age to guide him, be pricked with a pin on any part of his body which he has seldom handled, and never seen, he will not readily nor at first put his finger upon the wound, nor even come very *near* to the wound. This, however, he would certainly and infallibly do were the sense of touch necessarily conceived as existing at the organ. To these observations objections may perhaps be made, which we cannot stay to obviate; but the following, we think, will admit of none. We appeal to every man who has experienced that particular sensation of touch which Scaliger dignified with the name of a sixth sense, whether, whilst those sensations were new to him, he was necessarily led to conceive them as existing at any particular organ. If he was not, it follows undeniably that the organs of sensation are different from the being which is sentient; that it is not the eye which sees, the ear which hears, the nostrils which smell, the tongue which tastes, nor any part of the body which feels; and that it is by experience that we learn to associate our several sensations with those organs upon which the impressions are made.

* *Elements of Criticism.*

It is, however, certain that we receive no sensation from external objects, unless when some impression is made upon the organ of sense, either by the immediate application of the object itself, or by some medium which passes between the object and the organ †. In two of our senses, viz. *touch* and *taste*, there must be an immediate application of the object to the organ. In the other three the sensation is occasioned by the impression of some medium passing from the object to the organ. The effluvia of bodies drawn into the nostrils with the breath are the medium of smell; the undulations of the air are the medium of hearing; and the rays of light passing from visible objects to the eye are the medium of sight. These are facts known from experience to hold universally both in men and in brutes. It is likewise a law of our nature perfectly known to all who know any thing of anatomy, that in order to actual sensation the impressions made upon the external organs must be communicated to the nerves, and from them to the brain. First, The object, either immediately, or by some medium, makes an impression upon the organ; the organ serves only as a medium, by which the impression is communicated to the nerves; and the nerves serve as a medium to carry it on to the brain. Here the corporeal part ends; at least we can trace it no farther. The rest is all intellectual.

† *Reid's Essays on the Intellectual Powers of Man*, and *Hartley's Observations on Man.*

18 The brain and nerves necessary to sensation.

The proof of these impressions upon the nerves and brain in sensation is this, that from many observations and experiments it is found, that when the organ of any sense is perfectly sound, and has the impression made upon it by the object ever so strongly, yet if the nerve which serves that organ be cut or tied hard, there is no sensation; and it is well known that disorders in the brain deprive us of sensation, while both the organ and its nerve are sound.

19 Process of nature in sensation.

There is sufficient reason, therefore, to conclude, that in sensation the object produces some change in the organ; that from the organ the change proceeds to the nerve, and from the nerve to the brain. Hence it is that we have positive sensations, from negative objects, or mere nonentities, such as *darkness*, *blackness*, and *vacuity*. For, sensation resulting from changes in the brain, whatever produces any change must of course occasion a new sensation: but it is obvious, that the mere absence of any impression, by the removal of the object which produced it, must as necessarily cause a change in the organ, nerves, and brain, as the presence of a new impression from a new object. To these changes, or that which *immediately* produces them, we give the name of *impressions*; because we know not how, in a general manner, to express more properly any change produced by an external cause without specifying the nature of that cause. Whether it be pressure, or attraction, or repulsion, or vibration, or something unknown, for which we have no name, still it may be called an impression.

Sir Isaac Newton was perhaps the first who supposed that the rays of light falling upon the bottom of the eye excite vibrations in the *tunica retina*; and that those vibrations being propagated along the solid fibres of the optic nerves into the brain, cause the actual sensation of seeing. This hypothesis was adopted by Dr Hartley, applied to the other senses, and shown to be

(c) Another eminent writer thinks on this subject very differently, and in our opinion much more justly.—"Suppose (says Dr Reid) a person who never had this sense (viz. *smell*) before, to receive it all at once, and to smell a rose; can he perceive any similitude or agreement between the smell and the rose? or indeed between it and any other object whatever? Certainly he cannot. He finds himself affected in a new way, he knows not why, or from what cause. He is conscious that he is not the cause of it himself; but he cannot from the nature of the thing determine whether it be caused by body or spirit; by something near, or by something at a distance. He cannot give it a *place* any more than he can give a place to melancholy or joy; nor can he conceive it to have any existence but when it is smelled." *Inquiry into the Human Mind*, ch. 2. sect. 2.

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be at least as probable as any which has yet been invented to account for the perception of external objects by means of the organs of sense. Be this as it may, experience informs us, that whatever be the nature of those impressions and changes which are made by external objects upon the senses, nerves, and brain, we have without them no actual sensation, and of course perceive nothing *ab extra*. Hence it has been supposed, that the mind is wholly passive in sensation, and that sensation is *necessarily* produced by those impressions. But this we believe to be a mistake. Every man who has been attentive to his own thoughts and actions, must know instances of impressions having been certainly made upon his organs of sense without producing any sensation, or suggesting to his mind the perception of the particular objects by which the impressions were caused. He whose mind is intensely employed in any particular pursuit, may have his eyes open upon an object which he does not see; or he may not hear the sound of a clock striking within two yards of him: Nay, we will venture to affirm, that there is hardly one reader of this article to whom such absences of sensation have not often occurred. Now, as there is no reason to suppose, that in the one case the undulations of the air, caused by the striking of the clock, did not reach his ears, or that in the other the rays of light, reflected from the object, did not fall upon his eyes, which were open to receive them; the only reason which can be assigned for his not having, in these instances, had audible and visible sensations, is, that his mind was so engaged in something else as not to pay to the vibrations in his brain that attention, if we may so say, without which impressions *ab extra* can produce no sensation. There are, indeed, some impressions on the organs of sense so violent and so sudden, as to force themselves upon the mind however employed. Such are those made on the ear by thunder, and on the eye by strong light. In these cases, sensation is involuntary and unavoidable; whence we conclude, not that in such instances the mind is passive or destitute of energy, but that by the violent agitation given to the brain, it is roused from its reverie, and compelled to give attention. It appears, therefore, that in sensation the mind exerts some kind of energy; for in nothing but in the sentient being itself can we seek for the cause why, when all external circumstances are the same, organical impressions sometimes produce sensations and sometimes not; and that cause can only be the energy of the mind; what kind of energy we pretend not to say.

20
In sensation the mind is partly active.

Sect. II. *Of Perception by the Senses.*

21
[D]ifficult to [ac]count for [th]e percep[ti]on of ob[je]cts.

How the correspondence is carried on between the thinking principle within us and the material world without us, has always, as Dr Reid observes, been found a very difficult problem to those philosophers who consider themselves as obliged to account for every phenomenon in nature. It is, indeed, a problem of which we expect not to see a complete solution. A few steps beyond the vulgar we may certainly go; but the nature of that connexion by which the mind and body are united, will probably remain for ever unknown. One question, however, which has employed much of the attention of philosophers, both ancient and modern, appears to be not wholly unanswerable. It is, Whether by means of our senses we perceive external objects mediately or immediately; or in other words, Whether sensation and perception be one and the same thing, or two things succeeding each other? On this subject, till of late, there appears to have been in the main a great uniformity in the sentiments of philosophers, notwithstanding their variations respecting particular points. Of some of the most eminent of them, we shall give the opinions as we find them collected by one * who is well acquainted with their writings, who is thoroughly qualified to estimate their respective merits, and who cannot be suspected of partiality to that theory which we feel ourselves compelled to adopt.

* Dr Reid in his *Essays on the Intellectual Powers of Man.*

22
The hypothesis of Plato;

"Plato illustrates our manner of perceiving external objects thus: He supposes a dark subterraneous cave, in which men lie bound in such a manner as that they can direct their eyes only to one part of the cave. Far behind there is a light, of which some rays come over a wall to that part of the cave which is before the eyes of our prisoners. A number of men variously employed pass between them and the light, whose shadows are seen by the prisoners, but not their persons themselves. In this manner did that philosopher conceive that by our senses we perceive not things themselves, but only the shadows of things; and he seems to have borrowed his notions on this subject from the disciples of Pythagoras.

23
Of Aristotle;

"If we make due allowance for Plato's allegorical genius, his sentiments with respect to sensation and perception correspond very well with those of the Peripatetics. Aristotle, the founder of that school, seems to have thought, that the soul consists of two or three parts, or rather that we have three souls—the vegetable, the animal, and the rational. The animal soul he held to be a certain *form* of the body, which is inseparable from it, and perishes at death. To this soul the senses belong; and he defines a sense to be that which is capable of receiving the sensible forms, or species of objects, without any of the matter of them; as wax receives the form of the seal without any of its matter. Of this doctrine it seems to be a necessary consequence, that bodies are constantly sending forth, in all directions, as many different kinds of forms without matter as they have different sensible qualities. This was accordingly maintained by the followers of Aristotle, though not, as far as we know, taught by himself. They disputed concerning the nature of these forms or species, whether they were real beings or nonentities: but of matter and form we shall have occasion to speak afterwards.

24
Of Des Cartes;

"After Aristotle had kept possession of the schools for more than a thousand years, his authority, which had often supplied the place of argument, was called in question by Lord Bacon and others. Des Cartes, however, was the first philosopher who, convinced of the defects of the prevailing system, attempted to form another entirely new: but on the nature of perception by means of the senses he differs little or nothing from those who had preceded him in that department of science. He denies, indeed, and refutes by solid reasoning, the doctrine which maintains that *images*, *species*, or *forms* of external objects, come from the objects themselves, and enter into the mind by the avenues

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avenues of the ſenſes. But he takes it for granted, as all the old philoſophers had done, that what we immediately perceive muſt be either in the mind itſelf, or in the brain, in which the mind is immediately preſent. The impreſſions made upon our organs, nerves, and brain, can be nothing, according to his philoſophy, but various modifications of extenſion, figure, and motion. There can be nothing in the brain like *ſound* or *colour*, *taſte* or *ſmell*, *heat* or *cold*. Theſe are ſenſations in the mind, which by the laws of the union of the ſoul and body, are raiſed on occaſion of certain traces in the brain; and although he ſometimes gives the name of ideas to theſe traces, he does not think it neceſſary that they ſhould be perfectly like the things which they repreſent, any more than that words and ſigns ſhould reſemble the things which they ſignify.

"According to this ſyſtem it would appear, that we perceive not external objects *directly* by means of our ſenſes; but that theſe objects, operating either mediately or immediately upon the organs of ſenſe, and they again upon our nerves and brain, excite in the mind certain ſenſations; whence we *infer* the exiſtence of external objects from our ſenſations of which they are the cauſe. Perception of external objects, therefore, according to Des Cartes, is not one ſimple original act of the mind, but may be reſolved into a proceſs of reaſoning from effects to cauſes."

25 Of Malebranche.

The doctrines of Malebranche, Locke, and Hartley, reſpecting perception, differ not eſſentially from that of Des Cartes. Malebranche, indeed, ſuppoſes, that external objects are not themſelves the cauſes of perceptions; but that the Deity, being always preſent to our minds more intimately than any other being, does, upon occaſion of the impreſſions made upon our organs of ſenſe, diſcover to us, as far as he thinks proper, and according to fixed laws, his own ideas of the object: and thus, according to him, we ſee all things in God, or in the divine ideas. He agrees, however, with Des Cartes and the ancient philoſophers, in conſidering it as a truth which it is impoſſible to refute, that we perceive not the objects without us, the ſun, moon, and ſtars, &c. becauſe it is not likely that the ſoul ſallies out of the body, and takes a walk, as it were, through the heavens to contemplate theſe objects. She ſees them not therefore by themſelves; and the immediate object of the mind, when it ſees the ſun, is not the ſun itſelf, but ſomething which is intimately united to the mind, and is that which he calls an *idea*.

26 Of Locke.

Locke, ſpeaking of the reality of our knowledge, ſays: "It is evident the mind knows not things immediately, but only by the intervention of the *ideas* it has of them. Our knowledge, therefore, according to him, is real only ſo far as there is a conformity between our ideas and the things which they repreſent." The manner of our perceiving external objects he illuſtrates by the following ſimilitude: "Methinks the underſtanding is not much unlike a cloſet wholly ſhut from light, with only ſome little opening left, to let in external viſible reſemblances or ideas of things without. Would the pictures coming into ſuch a dark room but ſtay there, and lie ſo orderly as to be found upon occaſion, it would very much reſemble the underſtanding of a man in reference to all objects of ſight, and the ideas of them *." He has elſewhere † defined an *idea* thus: "Whatſoever the mind perceives in itſelf, or is the immediate object of perception, thought, or underſtanding, that I call an *idea*; and the power to produce any idea in our mind, I call *quality* of the ſubject wherein the power is." He likewiſe thinks it "eaſy to draw this obſervation, that the ideas of what he calls primary qualities of bodies, viz. *extenſion*, *ſolidity*, *figure*, *mobility*, &c. are reſemblances of theſe qualities as they really exiſt in the bodies themſelves."

* *Eſſay on the Underſtanding*, book ii. chap. 11.

† Book ii. chap. 8.

This unguarded expreſſion, which affirms that ideas in the mind are the reſemblances of external things, has brought upon Mr Locke much undeſerved ridicule. That on this and other occaſions he uſes the word *idea* with too great latitude, and that he often confounds ideas with ſenſations, and even with the cauſes of ſenſation, muſt be admitted by his warmeſt admirers: but we believe, that by an attentive reader, who peruſes his whole work, and compares ſuch paſſages as are obſcure with thoſe which are clearer, his meaning may always be diſcovered, and with reſpect to ſenſation and perception will generally be found juſt. That by calling the ideas of primary qualities reſemblances of the qualities themſelves, he meant nothing more than that bodies in all poſſible ſtates impreſs the ſenſes, nerves, and brain, in ſuch a manner as to produce in the mind certain ſenſations, between which and thoſe impreſſions there is an inſeparable, though unknown, connection, is evident from the account which he gives of the manner of perception. "Our ſenſes (ſays he), converſant about particular ſenſible objects, do convey into the mind ſeveral diſtinct perceptions of things according to thoſe various ways in which theſe objects affect them: and thus we come by thoſe ideas we have of *yellow*, *white*, *heat*, *cold*, *ſoft*, *hard*, *bitter*, *ſweet*, and all thoſe which we call ſenſible qualities; which when I ſay the ſenſes convey into the mind, I mean, they from external objects convey into the mind what produces thoſe perceptions." And as bodies can act only by impulſe, he adds, that "thoſe perceptions can be produced only by an impreſſion made upon the ſenſes, and ſome motion thence continued by our nerves to the brain or ſeat of perception."

27 Of Hartley.

Dr Hartley was the pupil of Locke and Newton; and has, in a more ſatisfactory manner than all who had preceded or have ſince followed him, explained the material part of the proceſs of perception. His principles we ſhall have occaſion, during the courſe of the article, to develope pretty fully. For our preſent purpoſe it is ſufficient to ſay, that all his obſervations and arguments evidently ſuppoſe, that nothing diſtant from the mind can be perceived in the immediate act of ſenſation; but that the apparently immediate perception of external objects is an inſtance of early and deep-rooted aſſociation.

28 Of Hume.

In this ſentiment Mr Hume agrees with his predeceſſors; but he obſcures his philoſophy, and miſleads his reader, by confounding ſenſations with the impreſſions from which they proceed. "Every one (ſays he †) will allow, that there is a conſiderable difference between the perceptions of the mind, when a man feels the pain of exceſſive heat, or the pleaſure of moderate warmth, and when he afterwards recals to his memory this ſenſation, or anticipates it by his imagination."

† *Inquiry concerning Human Underſtanding*, ſect. iii.

tion." The leſs forcible and lively of theſe perceptions he with great propriety calls *ideas;* but it is either hrough wilful perverſeneſs, or confuſion of intellect, that he chooſes to call the others *impreſſions.* Senſation and perception are cauſed by *impreſſions;* but they are no more impreſſions themſelves, than the pain occaſioned by the ſtroke of a bludgeon is the ſtroke itſelf, or the bludgeon with which it was ſtruck. But more of this afterwards.

29
Agreement of philoſophers, and the reaſon of it.

Thus far, then, that we perceive not external objects *directly*, but infer their exiſtence from certain ſenſations excited in our minds by the operation of theſe objects upon our *ſenſes*, *nerves*, and *brain*, ſeems to have been the opinion of every philoſopher from Pythagoras † to Mr Hume. For an opinion ſo univerſal, and at the ſame time ſo contrary to the perſuaſion of the multitude, ſome cogent reaſon muſt have been aſſigned. That reaſon has been given by many philoſophers, but by none with greater perſpicuity than Dr Porterfield, in his Eſſay concerning the Motion of the Eyes. "How body acts upon the mind, or mind upon body (ſays he), I know not; but this I am very certain of, that nothing can act, or be acted upon, where it is not: and therefore our mind can never perceive any thing but its own proper modifications, and the various ſtates of the ſenſorium to which it is preſent. So that it is not the external ſun and moon, which are in the heavens, that our mind perceives, but only their image or repreſentation impreſſed on the ſenſorium. How the ſoul of a ſeeing man ſees thoſe images, or how it receives thoſe ideas from ſuch agitations in the ſenſorium, I know not; but I am ſure it can never perceive the external bodies themſelves to which it is not preſent."

† See *Moſheim's edition of Cudworth's Intellectual Syſtem*, where the opinions of the philoſophers of antiquity are more faithfully collected than in any other work with which we are acquainted.

This reaſoning appears to have force; and, perhaps, the unanimous agreement of thinking men in all ages has ſtill greater force; yet the doctrine which prevailed ſo long, and which to Locke appeared ſo evident as to need no proof, has been ſince called in queſtion by ſome eminent philoſophers of our own country; who, though they allow that we cannot perceive external objects but by means of the ſenſes, yet affirm that they are the objects themſelves which we perceive directly; and that in perception there is no aſſociation which can be reſolved into a proceſs of reaſoning from ſenſations the effects, to external objects the cauſes. Dr Reid, who was perhaps the firſt, and is unqueſtionably the ableſt of this claſs of philoſophers, had expreſſed himſelf on the ſubject as follows:

"If we attend to the ACT of our mind, which we call the perception of an external object of ſenſe, we ſhall find in it theſe three things: *Firſt*, Some conception or notion of the object perceived. *Secondly*, A ſtrong and irreſiſtible conviction and belief of its preſent exiſtence. And, *Thirdly*, That this conviction and belief are immediate, and not the effect of reaſoning ‡." To the firſt and ſecond of theſe propoſitions, we are perſuaded that Des Cartes and Locke would readily have aſſented; nor do we imagine that they would have denied the third, had the author allowed that this ſtrong and irreſiſtible conviction is the conſequence of an early and deep-rooted aſſociation reſolvable into a proceſs of reaſoning. This, however, the learned profeſſor does not allow; for he repeatedly affirms, that it is inſtinctive and original, and that "the conſtitution of our power of perception determines us to hold the exiſtence of what we diſtinctly perceive as a firſt principle, from which other truths may be deduced, but it is deduced from none." With this view of the matter, he could with no propriety attempt to ſupport his own opinion by argument; but to the reaſonings of Dr Porterfield and others in defence of the Carteſian theory, he replies in the following words: "That nothing can act immediately where it is not, I think muſt be admitted (D); for I agree with Sir Iſaac Newton, that power without ſubſtance is inconceivable. It is a conſequence of this, that nothing can be acted upon immediately where the agent is not preſent; let this, therefore, be granted. To make the reaſoning concluſive, it is farther neceſſary, that when we perceive objects, either they act upon us, or we act upon them. This does not appear ſelf-evident, nor have I ever met with any proof of it †."

‡ *Eſſays on the Intellectual Powers of Man*, Eſſay ii. ch. 5.

Of the profundity of Dr Reid's underſtanding, we have the moſt firm conviction; nor is there any metaphyſician, ancient or modern, from whom we differ with greater reluctance: but we cannot help thinking this a very raſh aſſertion, as his own works appear to us to afford complete proof, that, in perception, the mind both acts and is acted upon. Let us attend, however, to the reaſons which, on this occaſion, induced

† *Eſſays on the Intellectual Powers of Man*, Eſſay ii. chap. 14.

(D) One of the moſt celebrated of Dr Reid's followers thinks otherwiſe. "That no diſtant ſubject can act upon the mind, is a propoſition (ſays Lord Kames) which undoubtedly requires evidence; for it is not inſtinctively certain: And, therefore, till the propoſition be demonſtrated, every man may without ſcruple rely upon the conviction of his ſenſes, that he hears and ſees things at a diſtance." But his Lordſhip ought to have known, that Locke and Berkeley, the two philoſophers whom he was combating, have no where called in queſtion the conviction of their ſenſes. They do not, indeed, admit, that the external organs are themſelves percipient, or that by means of them the mind can *immediately* perceive diſtant objects; but they have no where denied, that through the *medium* of them the mind comes to the knowledge of external exiſtence. And the reaſons which they aſſign for this twofold opinion are, that in perception they experience action or the effects of action, which is not their own; and that it is an intuitive truth, that nothing can act where it is not preſent. "But admitting (ſays his Lordſhip) that no being can act but where it is, is there any thing more ſimple or more common, than the acting upon ſubjects at a diſtance by intermediate means? This holds in fact with reſpect both to ſeeing and hearing." It certainly does, and with reſpect to the other ſenſes likewiſe; but it is the very thing for which Locke and Berkeley would have contended, had any man in their days preſumed to call it in queſtion. It is the very foundation of their ſyſtem; and if it be granted, nothing can be more evident, than that external exiſtence is not the *immediate* object of perception. See *Appendix to Elements of Criticiſm.*

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ced him to think, that in perception there is no action either of the object on the mind or of the mind on the object.

"When we say, that one being acts upon another, we mean, that some power or force is exerted by the agent which produces, or has a tendency to produce, a change in the thing acted upon. If this be the meaning of the phrase, as I conceive it is, there appears no reason for asserting, that in perception, either the object acts upon the mind or the mind upon the object. An object, in being perceived, does not act at all. I perceive the walls of the room where I sit; but they are perfectly inactive, and therefore act not upon the mind. To be perceived, is what logicians call an external denomination, which implies neither action nor quality in the object perceived."

3° We think unsuccessfully; and

This last sentence we pretend not to understand. Substance without qualities is to us inconceivable, and certainly is no object of perception; for Dr Reid himself has told us, and told us truly, that "the objects of perception are the various qualities of bodies." That an object in being perceived does not act at all, is directly contrary to what the ingenious author has taught us, both in his *Inquiry* and in his *Essays*, viz. that "it is a law of our nature that we perceive not external objects, unless certain impressions be made by the object upon the organ, and by means of the organ upon the nerve and brain;" for if the external object in being perceived make impressions, it is certainly not true that it acts not at all. It is indeed readily acknowledged, that when one perceives the walls of the room where he sits, these walls do not act immediately upon the organs of sight; but it does not, therefore, follow, that they are perfectly inactive; for it is known to all mankind, that from every point of the wall which is seen, rays of light are reflected to the eye; that those rays make upon the *retina tunica* an impression, which is conveyed by the optic nerve to the brain; and that this impression on the brain is one of the immediate causes of vision. In what *particular manner* it causes vision, we shall never be able to discover, till we know more of the laws which unite mind and body, and by which one of these is qualified to act upon the other; but because we know not the *manner* of this operation, to affirm that there is no operation at all seems to be as absurd as it would be to affirm, because we perceive no necessary connexion between a stroke and the sensation of sound, that the sound of a musical string is not caused by the stroke of a plectrum. That God might have given us powers of perception of a different kind from those which we possess, there can be no doubt; but with what we might have been, we have no concern. As we are, we know perfectly that the eye is an instrument of vision, because without it nothing can be seen: we know also that the retina and optic nerves are equally necessary; because if they be disordered, vision is still wanting; we know likewise, that the brain is necessary to all perception; because, when it is disordered, thinking either entirely ceases, or is proportionably disturbed. And, lastly, We are not more certain of our own existence, than that *actual perception* takes not place but when the object makes an impression upon some organ of sense; for when no rays of light fall upon the eye, we see nothing; when no sapid body is applied to the tongue and palate, we taste nothing; and if we could be removed from every thing solid, we would feel nothing. These are conclusions which cannot be controverted. They are admitted equally by the philosopher and by the plain unlettered man of common sense; nor are they rendered one whit less certain by our not being able to go a step farther, so as to discover in what *manner* the brain or the affections of it can be the immediate instrument of sensation and perception. For (as Dr Reid, in the spirit of true philosophy, observes ‡), in the operations of mind, as well as in those of bodies, we must often be satisfied with knowing that certain things are connected and invariably follow one another, without being able to discover the chain that goes between them. It is to such connexions that we give the name of *laws of nature*; and when we say that one thing produces another by a law of nature, this signifies no more than that one thing which we call in popular language *the cause*, is constantly and invariably followed by another which we call *the effect*; and that we know not *how* they are connected.

‡ *Inquiry into the Human Mind*, 4th edit. p. 258.

In the preceding section we have observed, that in sensation the mind exerts some energy; and therefore, as on every hypothesis perception is a consequence of sensation, it follows, that in perception the mind cannot be wholly inactive. Dr Reid, in his Essays on the Intellectual Powers of Man, seems to affirm that it is. "I see no reason (says he) to believe, that in perception the mind acts upon the object. To perceive an object is one thing, to act upon it is another: Nor is the last at all included in the first. To say that I act upon the wall by looking at it, is an abuse of language, and has no meaning." This is indeed true; it would be a great abuse of language to say, that by looking at the wall a man acts upon it; but we do not believe that any man ever said or supposed such a thing. The philosophers, whose opinion he is combating, might argue in this manner. We are conscious that in perception the mind is active; nothing can act immediately where it is not; the mind cannot act immediately upon external existence: external existence therefore is not the immediate object of that energy which is exerted in perception. As Dr Reid affirms that external existence is the immediate object of perception, he must deny the first proposition in this argument; for *if it* be granted, as we have just seen that in his reply to Dr Porterfield he admits the second, the laws of reasoning will compel him to admit the third. To say, that in perception the mind acts not upon *external* objects, is a truth in which all mankind are agreed; and it is the very principle from which his antagonists infer, that the conviction of the present existence of external objects is not an original and instinctive consequence of sensation, but an early and deep-rooted association which may be resolved into a process of reasoning. His meaning, therefore, must be, that in perception the mind *acts not at all:* but this is directly contrary to his definition of perception, which he calls an ACT of the mind: it is likewise contrary to his theory of perception, as it is detailed in *the Inquiry into the Human Mind on the principles of Common Sense.* We are there taught, with equal elegance and perspicuity, "that an impression made by an external object upon the organ, nerves, and brain,

is

Of Perception.

is followed by a *sensation*, and that this sensation is followed by the perception of the object." We are likewise taught, that "although the Peripatetics had no good reason to suppose an active and passive intellect, they yet came nearer the truth, in holding the mind to be, in sensation, partly passive and partly active, than the moderns in affirming it to be purely passive. Sensation, imagination, memory, and judgment, have by the vulgar, in all ages, been considered as acts of the mind. The manner in which they are expressed in all languages shows this: for when the mind is much employed in them, we say, it is very active; whereas, if they were impressions only, we ought to say that the mind is very passive." All this is undeniable; but if sensation necessarily precede perception, and if in sensation the mind be active, what becomes of the assertion, that in perception it acts not at all? Indeed we may appeal to the common sense of mankind, whether any thing can be perceived without some mental energy of the percipient. For when the impressions made on the external senses are faint, in order to be conscious of them an evident exertion is requisite, not of the organ only, but also of the mind, as in perceiving very remote objects and sounds; but when the impressions are stronger, the perception is involuntary and unavoidable, as has been already explained in the preceding section.

31 herefore ie old the-y of per-ption to prefer-d to his.

It being thus certain that in perception the mind both acts and is acted upon, and it being universally acknowledged that nothing can act where it is not, we feel ourselves compelled to admit with the Cartesians, that in perception the conviction of the present existence of external objects is not original and instinctive, but the consequence of an early and unavoidable association of certain sensations with the causes which produce them. In this opinion we are still more confirmed by the well-known fact, that particular pressures upon the organ, nerves, and brain, excite not only sensations, but even perceptions of objects apparently external, when no such objects are within the reach of our senses. Thus §, if a man in the dark press either corner of his eye with his finger, he will see a circle of colours like those in the feather of a peacock's tail, though no such external object be before him, and though the room be so dark that nothing external could possibly be seen. Again, If a burning coal be nimbly moved round in a circle, with gyrations continually repeated, the whole circumference of the circle will at once appear on fire, though it is certain that there can be really no fire but one portion of that circumference, equal in length to the diameter of the coal. These are facts known to all mankind; and they are perfectly irreconcileable with the supposition, that the perception of external objects by the sense of sight is original and instinctive; but they are at once accounted for, if it be true that rays of light falling from external objects upon the *retina tunica* agitate the optic nerves and brain, and that such agitations excite sensations in the mind which experience has taught us to refer to external objects, as, under God, their ultimate cause.

§ *Hartley's bserva-ons on lan.*

But though we have declared ourselves to be in this instance Cartesians, we do not admit all the absurdities which have sometimes been imputed to that system of perception. We do not believe that external objects are perceived by means of images of them in the mind or the brain; nor do we think that Des Cartes or Locke has anywhere affirmed that they are, otherwise than by an expression obviously figurative, denoting, not that the actual shapes of things are delineated in the brain or upon the mind, but only that impressions of some kind or other are conveyed to the brain by means of the organs of sense and their corresponding nerves; and that between these impressions and the sensations excited in the mind, there is a real, and in our present state a necessary, though unknown, connexion.

33 That theory fairly stated, and

Upon the whole, we think that there is good evidence for believing, that in perception the process of nature is as follows: *First*, If the object be not in contact with the organ of sense, there must be some medium which passes between them; as, in vision, the rays of light; in hearing, the vibrations of elastic air; and in smelling, the effluvia of the body smelled; otherwise we have neither sensation nor perception. *Secondly*, There must be some action or impression upon the organ of sense, either by the immediate application of the object, as in the two senses of touch and taste; or by the medium that goes between them, as in the other three senses. *Thirdly*, The nerves which go from the brain to the organ, must receive some impression by means of that which was made upon the organ; and by means of these nerves that impression must be carried to the brain. *Fourthly*, The impression made upon the organ, nerves, and brain, rouses the dormant energy of the mind; and this double action of the mind and the object produces a sensation. And, *lastly*, As we know by experience that the mind alone cannot, by any exertion of its own, produce one sensation, and are intuitively certain that nothing can begin to exist without a cause, we infer from the existence of any new sensation the existence of some other cause than the internal energy of the mind, from which that sensation proceeds; and this cause experience teaches us to be the external object. This process is carried on so rapidly, and the several parts of it, by being continually repeated, are so closely associated, that except by a reflex act of the mind we distinguish them not from one another, and therefore we denominate the whole *perception*.

33 Shown to differ little from Dr Reid's.

It is with extreme diffidence that we advance a doctrine which Dr Reid has controverted; but he differs from us only in the last stage § of the process, where he supposes sensation and perception to be two simple and independent acts of the mind. Yet he sometimes expresses himself, as if he thought, as we do, that in perception the belief of the present existence of external objects is rather the result of experience than an instinctive persuasion. Thus, speaking of the perception which we have in smelling a rose, he says §, "Perception has always an external object, and the object of my perception in this case is that quality in the rose which I discern by the sense of smell. Observing that the agreeable sensation is raised when the rose is near, and ceases when it is removed, I am led by my nature [we think *by experience* would have been more proper] to conclude some quality to be in the rose, which is the cause of this sensation. This quality in the rose is the object perceived; and that act of my mind, by which I have the conviction and belief

§ See *Inquiry into the Human Mind*, 4th edit. p. 383.

§ *Essays on the Intellectual Powers of Man*, Essay ii. chap. 15. and 21.

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lief of this quality, is what in this case I call perception. Again (he says) that "three of our senses, viz. smell, taste, and hearing, originally give us only certain sensations, and a conviction that these sensations are occasioned by some external object. We give a name to that quality of the object by which it is fitted to produce such a sensation, and connect that quality with the object and with its other qualities. Thus we learn, that a certain sensation of smell is produced by a rose; and that quality in the rose by which it is fitted to produce this sensation we call the *smell of the rose*. Here it is evident that the sensation is original. The perception that the rose has that quality which we call its *smell*, is acquired."

To this doctrine no Cartesian could possibly object; for it is the very account which Des Cartes himself would have given of perception by the organ of smell, as it resolves such a perception into an early association between a certain sensation and that external quality from which we know by experience that the sensation proceeds. Indeed this excellent author repeatedly affirms, that every different perception is conjoined with a sensation which is proper to it; and that the one is the sign, and the other the thing signified. He likewise doubts *, whether children, from the time that they begin to use their senses, make a distinction between things which are only conceived or imagined, and things which really exist. But if the conviction of the present existence of external objects were in perception *instinctive*, we cannot see how there could be room for such a doubt; for the mere senses of children are as perfect as those of full grown men; and they know well the difference between actually sucking their nurses and only thinking of that operation, though they be not capable of expressing that difference in language.

* *Essays on the Intellectual Powers of Man.*

34 Both theories afford intuitive evidence that something exists besides the perception and the sensation.

But if in perception our conviction of the present existence of external objects be not instinctive, what, it may be asked, is the evidence that such objects really exist? This question we shall partly answer in the following section, and more completely when we come to examine Berkeley's theory of the non-existence of matter: but from what has been said already, it is sufficiently evident, that every sensation compels us to believe in the present existence of something different from ourselves, as well as from our sensations.

Sect. III. *Of the Objects of each Sense respectively.*

35 Touch, the sense by which we perceive heat and cold, &c.

Hitherto we have considered sensation and perception in general, and shown that it is not by instinct that we perceive the existence of external objects. This will appear more clearly, if we can ascertain the precise nature of that information which each sense affords us: and in order to this, we shall begin with the sense of *touch*, not only because it is that which is certainly first exercised, but also because there is a meaning in which all the others may be resolved into it.

36 The nature of heat and cold, which are perceived immediately.

By means of touch we perceive many things, of which the chief are, heat and cold, hardness and softness, roughness and smoothness, extension, figure, solidity, and motion. Of these perceptions, some are immediate; and others, as we are persuaded, early associations, which may be resolved into a process of reasoning. The perceptions of heat and cold are immediate. When a person for the first time in his life approaches the fire, he feels heat; and when he is first exposed to the frost, he feels cold. What are heat and cold, and where do they reside? They are obviously the reverse of each other; but are they external objects, or mere sensations in the mind? They are undoubtedly sensations which have no existence but when they are felt. To every man not altogether a stranger to these speculations, this proposition is self-evident; but to the bulk of the people it appears an extravagant paradox. To make it plain, however, to the meanest capacity, it is sufficient to observe, that at a certain distance the fire has no perceptible influence upon any person; if that distance be lessened, we feel an agreeable warmth; approach a little nearer, and the warmth becomes disagreeable; and still nearer, it will rise to pain. No man supposes the pain inflicted by a sword to exist in the sword, or anywhere else but in a sentient being. It is equally absurd to suppose pain to exist in fire, or anywhere else but in a sentient being. But that which at one distance is pain, at another is only agreeable warmth; and since warmth and pain are only different degrees of the same feeling, it is equally absurd to suppose the one as the other in the fire. What then is the object of sense when we feel heat? There is obviously no object beyond the present sensation.

37 Their external causes.

But has the sensation of heat no cause independent of us? Undoubtedly it has, and experience teaches us that the cause is in the fire. We know that we cannot produce the sensation of heat in ourselves by any mental energy of our own; and we are intuitively certain, that nothing can begin to exist without some cause. A man on the top of a mountain covered with snow, may imagine or remember what he felt when in the neighbourhood of fire, and thus have in his mind what is called an *idea* of heat; but that idea will not warm him (E) like the actual sensation, which no exertion of his own can in such circumstances produce. When he leaves the mountain, however, and approaches the fire, he feels the sensation actually produced, and produced as often as he makes the experiment. He is, therefore, under the necessity of inferring, that in the fire there is some power or quality which, acting either mediately or immediately upon his sense of touch, excites the feeling which is called *heat*. What that power is, we shall perhaps never be able to discover; but it is self-evident, that it is neither heat nor the resemblance of

(E) ——Who can hold a fire in his hand,
By thinking on the frosty Caucasus?
Or cloy the hungry edge of appetite,
By bare imagination of a feast?
Or wallow naked in December's snow,
By thinking on fantastic summer's heat?
Oh no! the apprehension of the good
Gives but the greater feeling to the worse.
K. Richard II.

bjects of he reſpec- ve Senſes. of heat, though in vulgar language it is known by that name.

The ſame reaſoning holds good with reſpect to cold. There is at certain times, and in certain countries, ſome power in the air which congeals water and cauſes cold; but that power is as different from the ſenſation of cold, as the power of fire is different from the ſenſation of heat, or the point of a ſword from a fleſh wound.

38 he perceptions of xtenſion nd figure, c. not immediate.

By the ſenſe of touch we perceive extenſion, figure, ſolidity, &c. but we do not perceive them *immediately* as we perceive heat and cold; for extenſion, figure, and ſolidity, are not ſenſations. Thoſe perceptions then muſt be acquired; and more clearly to aſcertain the manner in which we acquire them, let us ſuppoſe a man from his birth deſtitute of the ſenſe of ſight and the power of local motion, but poſſeſſed of intellect and every other faculty which we enjoy.—Such a perſon, it is obvious, would be capable of every ſenſation and perception which is *original* to us, except the perception of colours; but we doubt whether it would be poſſible to give him perceptions of extenſion, figure, and ſolidity. Let us try; and as he cannot move a ſingle limb or member of himſelf, let us ſuppoſe a ſolid ſubſtance of ſmall dimenſions to be gently preſſed againſt any part of his body; what would ſuch preſſure communicate to him? We think it could communicate nothing but a new ſenſation, to which, as it is neither pleaſing nor painful, no name has hitherto been given, except the general one of *feeling*. This ſenſation he would not know whether to refer to an external or internal cauſe; or rather he could have no notion whatever of an external cauſe, though he would at the ſame time be conſcious that the new ſenſation was not excited by any energy of his own will. Were the preſſure to be gradually increaſed till it roſe to pain, our blind man would ſtill be conſcious of nothing but a ſenſation, which could not lead him to the notion of extenſion, figure, or ſolidity, becauſe mere ſenſations cannot be conceived as either ſolid or extended. Let us next ſuppoſe the preſſure to be applied ſucceſſively to different parts of his body; he would now indeed be conſcious of ſucceſſive ſenſations, but he could not aſſign to them either extenſion or *place*: for it has been already ſhown that the external parts of the body are not themſelves ſentient; and it ſhall be ſhown afterwards, that to a man who has never perceived motion, place is abſolutely inconceivable. Laſtly, Let us ſuppoſe the dimenſions of the preſſing ſubſtance to be greatly enlarged: what would then follow? nothing, we apprehend, but an increaſe of pain: for though his whole body were preſſed *ab extra*, the preſſure could affect the individual being which is ſentient, not more extenſively, but only more violently. It appears, therefore, that a man blind from his birth, and deſtitute of the power of local motion, could never be made to perceive extenſion, figure, or ſolidity.

39 ow they re acquired.

Let us now ſuppoſe this man to receive by a miracle the uſe of his limbs, and to be ſuddenly prompted, by ſome inſtinctive impulſe, to ariſe and walk. So long as he met with no obſtacle in his way, he would not, we apprehend, acquire by this exerciſe any correct notions of extenſion or figure; but were a ſtone or log of wood of conſiderable dimenſions to be laid acroſs his uſual walk, the caſe would ſoon be altered. He would feel himſelf interrupted in his courſe, and he would at the ſame inſtant recognize his wonted ſenſations of touch. After being twice or thrice thus interrupted, he would learn from experience that the interruption or reſiſtance proceeded from the ſame cauſe which in this inſtance communicated to him the ſenſation of feeling; and were he to run his hand along the ſurface of the log or ſtone, he would perceive the reſiſtance and the ſenſation continued. As every effect muſt have an adequate cauſe, this continued reſiſtance would compel him to believe the continuity of ſomething external in every direction in which he felt his hand reſiſted; but ſuch continuity of being is all that is meant by the word extenſion. At the very ſame time, and by the very ſame means, he would gradually acquire the perception of figure; for by running his hand in every direction over the ſurface of the obſtacle which oppoſed him, he would ſoon perceive it on all ſides limited; but the limits of extenſion is a phraſe of preciſely the ſame import with figure. It appears, therefore, that without the power of local motion, men could never, by the ſenſe of touch, acquire the notions of extenſion and figure; and the ſame will be found to be the caſe with reſpect to hardneſs and ſoftneſs.

Objects of the reſpective Senſes.

40 Hardneſs and ſoftneſs, how perceived.

When we preſs our hand gently againſt a ſtock or a ſtone, we feel a ſenſation which is neither painful nor pleaſing. When we preſs it more violently, the ſenſation becomes painful, and we experience in the object a reſiſtance which we have not power to overcome. When we preſs butter or pomatum very gently, we have a ſenſation in all reſpects ſimilar to that which we felt when we gently touched the ſtock or the ſtone. But when we preſs the butter with violence, we feel no pain, and experience little reſiſtance; for the parts of which it is compoſed give way before the hand, though the parts of the ſtock or the ſtone remained fixed and immoveable. That the parts of one body ſhould thus reſiſt a preſſure to which the parts of another ſo readily yield, muſt proceed from ſome difference in the texture of the two bodies: for by the ſenſe of touch we perceive the effects to be different; and are therefore certain that they muſt proceed either from different cauſes, or from the ſame cauſe operating with different degrees of force. That particular texture which makes the parts of a ſtone reſiſt the preſſure of touch, we call hardneſs; and the texture which makes the parts of butter or pomatum give way to touch, we call ſoftneſs. But what hardneſs and ſoftneſs are in themſelves, touch cannot inform us; for they are neither ſenſations, nor ſimilar to ſenſations. We acquire, however, by experience, ſo complete notions of hardneſs and ſoftneſs, that every one who underſtands the Engliſh language perfectly knows the meaning of theſe words as ſoon as he hears them; and when he is told that one body is hard and another ſoft, he knows with abſolute certainty that the meaning of the aſſertion is, that the parts of the body which is ſaid to be hard are held together by ſome unknown cauſe operating forcibly, and that the parts of the other are held together by the ſame or a ſimilar cauſe operating with leſs force.

41 Roughneſs and ſmoothneſs.

We acquire the notions of roughneſs and ſmoothneſs in the very ſame way and by the very ſame means that we

Objects of the respective Senses.

we acquire ideas of extension and figure. To describe the process at large would certainly be superfluous; for if what we have said concerning our perceptions of extension and figure be just and intelligible, every one will, without farther assistance, discover for himself how he perceives roughness and smoothness. *Motion* shall be considered among the adjuncts of body; but in order to understand what body itself is, it will be necessary, before we dismiss the sense of touch, to inquire how we come by the notion of solidity.

42 Solidity, what; and how perceived.

Solidity is one of those notions, or, in the language of Locke, one of those ideas, which are commonly said to be acquired by the sense of touch. That touch gives the first hint towards our notion of solidity, is certainly true; but that hint must be afterwards improved by the intellect, or we never could have an adequate knowledge of what is meant when any thing is said to be absolutely solid. We know by experience, that we can at pleasure open and shut our empty hand without meeting with any resistance. We know likewise, that when we grasp an ivory ball of three or four inches diameter, no force which we can exert will bring together the several parts of the hand, which were easily brought together when we grasped nothing. In this way do we acquire our first notion of solidity; for that word denotes nothing more in this instance than the power or property of the ball, by which our fingers are excluded from the place which it occupies. Solidity differs from hardness in this respect, that hardness results from the strong cohesion of the parts of a hard body, which renders it difficult to change the places of those parts, as they respect one another; whereas solidity respects the whole mass, and is as essential a quality of water as of adamant. A drop of water, indeed, placed between two plane surfaces of marble, will not like adamant preclude their contact; because the parts of a drop of water, cohering but loosely to one another, give way to the pressure, and escape in every lateral direction. But if a drop of water be confined on all sides, as in a globe of gold, we know from experience that no force will bring the sides of the globe together without forcing the water through the pores of the metal; and hence we infer solidity to be essential to every corporeal substance.

Thus then it appears that of the objects perceived by touch not one is *immediately* perceived except heat, cold, and other sensations. The sensations, as they are not excited by any internal energy of our own, lead us indeed to something external as their cause; and by comparing the different sensations with each other, and observing what effects their external causes have upon our own motions, we are naturally led to conceive these causes as extended, figured, solid, hard or soft, rough or smooth, &c.; but it is obvious that this conception is the result of experience, and a process of mental reasoning.

43 Nothing but mere sensations the object of smell,

On the senses of taste, smell, and hearing, it is needless to say much. The immediate objects of these are confessedly sensations which have no existence but when they are perceived; though experience teaches us to refer them all to external objects as their respective causes. With respect to smell, this has been made sufficiently evident in the preceding section, and it is not less evident with respect to taste and hearing.

44 Taste, and

Certain bodies applied to the tongue and palate, and moistened with the saliva, excite certain sensations which we call tastes. These sensations, however, are not in the bodies; nor can they have any existence but in a sentient being. They are produced in consequence of impulses on the nerves of the tongue and palate, exciting certain agitations in the brain; but the sensation itself is neither impulse nor agitation. Some substances excite tastes which are agreeable, and others such as are disagreeable; and there are not a few which excite no taste at all. Bodies, which applied to the tongue and palate of one man produce tastes that are agreeable, applied to the same organs of another man give him tastes which are disagreeable; and we have all experienced, that the same substance, which, when the organs are sound, excites a sweet or pleasant taste, has, when the organs were disordered, excited a taste which was bitter or unpleasant. These facts, which cannot be controverted, afford the fullest evidence, if evidence were wanted, that taste, as we feel it, is no quality of bodies, nor has any existence out of the mind.

The organ of hearing is the *ear*, and its object is sound. It is well known, that sound is produced by certain vibrations of the air striking the tympanum of the ear, and that these vibrations are caused by the sonorous body. Sound, however, is not vibration, nor the idea of sound the idea of vibration. Sound considered by itself is a mere sensation, which can have no existence but in a sentient being. We know by experience, that it is caused by something external; but we know likewise that the effect has no resemblance to the cause. Previous to experience we could not refer sound to any external cause; far less could we discern whether it proceeded from an object above us or below us, on our right hand or on our left. It appears to us self-evident, that if a man born deaf were suddenly made to hear, he would consider his first sensation of sound as originating wholly within himself. Between that sensation and the sensations of touch, taste, smell, and sight, there is no resemblance; nor are there any relations among them, which, previous to experience, could induce him to trace them all to external objects as their several causes. Our deaf man might have learned to refer all his other sensations to their true causes, in some such way as we have described under the sense of touch; but sound would be something so new to him, and so totally different from touch, taste, and smell, that he could attribute it to nothing external. 45 Hearing.

46 It is by experience that we distinguish different sonorous bodies by their respective sounds.

Experience, however, would soon teach him, that the ear is its organ, and the sonorous body its cause; and he would in time learn to distinguish one sound, that of a trumpet for instance, from another, suppose the sound of a bell; and to attribute each to its proper cause, even when neither the trumpet nor the bell was perceived by his other senses. With respect to sounds which we have been accustomed to hear, this is done so instantaneously, that some philosophers have imagined it to be the effect of an instinctive principle in our nature, totally different from experience, and independent of reason. But the fact is not so. Long before we are capable of making sensation and perception objects of reflection, we have heard the sound produced by the ringing of a bell, and seen the object which produced the sound so often, that, when we hear a similar

sound

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sound again, we instantly refer it to a *bell*, though we see not the bell from which it proceeds: but this is the effect of habit, and not of instinct. Had we never perceived a bell while ringing by either of our senses of sight or touch, we could not by the sense of hearing acquire any notion of the figure or texture of the body from which the cause of the sound proceeds, though we had heard that sound every day of our lives. It is, indeed, by experience only that we learn to distinguish by the ear whether a sonorous body be before or behind us, on our right hand or on our left; for we find it always difficult to say from what precise quarter a strange sound proceeds; and this difficulty would be heightened to impossibility, had not all sounds something in common. Dr Sparrman relates, that when he first heard the roaring of a lion, he did not know on what side of him to apprehend danger, as the sound seemed to proceed from the ground, and to enclose a circle of which he and his companions stood in the centre. The same thing has happened to every man, when the sound was such as he had never heard before; even though it was neither so loud nor so terrific as the roaring of a lion in a desert wilderness: but with respect to sounds which we are daily hearing on each side of us, we soon learn to distinguish with tolerable accuracy whether they be before or behind us, above or below, on our right hand or on our left. All this, however, is the effect, not of instinct, but of experience improved into habit.

47
Sight originally perceives nothing but colours, which are mere sensations.

Sight is justly considered as the noblest and most comprehensive of all our senses. The reason is obvious: for when a full grown man opens his eyes, he perceives houses, trees, rivers, the earth, sun, and moon, &c. and to each of these objects belong figure, extension, colour, &c. which are all perceived instantly by means of this sense. Yet it is certain, that the sense of sight does not originally communicate to us so many perceptions; and there is abundant evidence, that an infant cannot at first, or for some weeks after its birth, distinguish by vision one object from another. *Colour* is the proper object of sight, and for some time its only object; but colour as perceived by us is a mere sensation, which can have no existence but in a sentient being. If this proposition stood in need of proof, we might observe that there are men, and even whole families, who possess the sense of sight in a degree of perfection sufficient for all the purposes of life, and yet cannot distinguish certain colours from each other; blue, for instance, from green, or perhaps from red: and there is no man who can distinguish between some particular shades of blue and green by the feeble light of a candle. Were colours the real qualities of body, this mistake of one for another could never be experienced. No man who possesses the sense of touch ever confounded hardness with softness, a sphere with a cube, or an ell with an inch. The reason is, that hardness and softness, figure and extension, are the qualities of things external; whereas colour being a mere sensation, is nothing but an affection or modification of the sentient being. But it is obvious, that sentient beings, according as they differ from one another, may be differently affected by the same external cause; so that one man may perceive that to be green which all other men perceive to be blue. The immediate external cause of the sensation of colour, is the rays of light reflected from the body, which in common language is said to be coloured. These rays falling upon the pupil of the eye, are refracted differently, according as their incidence is more or less oblique, into points on the retina, where they form a picture of the external object; and from the picture, by means of the optic nerve, is communicated to the brain some impulse or agitation, which produces vision or the pereeption of colour. As rays of light are corporeal substances, it is obvious that they can act upon body only by impulse; but between impulse and the various sensations of *red*, *green*, *blue*, &c. there is no resemblance. For the laws of reflection and refraction, and for the structure of the eye, see Optics and Anatomy. That which we have to inquire into at present is, how we learn, by means of the sense of sight, to perceive the figure, magnitude, motion, and distance of external objects, or indeed to distinguish one object from another.

A ray of light proceeding, as all rays do, in a straight line, must, however great its length, affect the eye, retina, and optic nerve, as if it were a single point. From this obvious and undeniable fact, Bishop Berkeley predicted *, that a man born blind, who should be suddenly made to see, would at first perceive nothing without him, would distinguish neither the distance, size, figure, nor situation, of external objects; that he would only see in his eyes themselves, or, to speak more properly, would only experience new modifications in his mind, until joining *touch* to *sight*, he formed thus a communication with the external world, and learned, by the simultaneous exercise of the two senses, that natural language in which the *visible* is the sign of the *tangible*. This truth, which was discovered by the bishop merely by contemplating in his own mind the nature of sensation and the known laws of optics, after having been laughed at for more than 20 years as one of the many dreams of a visionary genius, was completely confirmed by the case of the famous patient whom Cheselden cured of a cataract; and that too, though the cataract does not produce total blindness: which makes it evident, that the first visual perceptions of the patient after his recovery could not be wholly new and unmixed. It may indeed be confirmed at any time by a simple experiment made upon an infant. For several weeks after birth, a child shuts not its eyes upon the sudden approach of an object to them, nor shows the least symptom of distinguishing one distance from another; and it is easy by a little attention to observe, how it gradually learns to distinguish objects at greater and greater distances. Indeed colour, or the immediate object of sight, being a mere sensation or affection of the mind, can have no natural relation whatever to any thing external.

* *Essay towards a new Theory of Vision.*

48
Perception of distance by sight, how acquired.

It is plain, therefore, that distance is in its own nature imperceptible to the eye, and yet it is often perceived by sight. How is this done? We think, in the following manner. Distance is one mode of extension, which, we have already seen, is perceived by means of touch. Of short distances, our first ideas are doubtless acquired by the stretching out and drawing back of our arms; and those ideas are soon so connected with certain sensations which we have in actual vision, that the latter instantly suggests the former. Thus,

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Thus, it is a fact known by experience, that when we look at a near object with both eyes, according as it approaches or recedes from us, we alter the disposition of our eyes, by lessening or widening the interval between the pupils. This disposition or turn of the eyes, is attended with a sensation of which every man is conscious at the time of vision; and this sensation seems to us to be that which in this case suggests the idea of greater or less distance to the mind. Not that there is any natural or *necessary* connexion between the sensation of which we are conscious, and greater or less distance; for the sensation is wholly internal, and the distance is external. But because the mind has, by constant *experience*, found the different sensations occasioned by different dispositions of the eyes to correspond to different degrees of distance in the object, there has grown a habitual or customary connexion between those sensations and the notions of greater or less distance. So that the mind no sooner perceives the sensation arising from the different turn it gives the eyes in order to bring the *pupils* nearer or farther asunder, than it is instantly impressed with a certain notion of the distance which was wont to be connected with that sensation. Again, An object placed at a certain distance from the eye, to which the breadth of the pupil bears a sensible proportion, being made to approach nearer, is seen more confusedly; and the nearer it is brought, the confusion is always the greater. The reason of all this is known to every optician: but it being constantly experienced by those who never dipt into optics, there arises in the mind of every man a habitual connexion between the several degrees of confusion and distance, the greater confusion still implying the less distance, and the less confusion the greater distance. It is of no avail to say, that between confused vision and distance, great or small, there is no necessary connection: for there is as little connexion between a blush in the face and the mental feeling of shame; and yet no sooner does a man of observation perceive that particular colour in the face of another, than it suggests to him the notion of that feeling or passion with which he has constantly observed it accompanied.

In these ways, however, we perceive only small distances. Of distances more remote our judgment is formed from other data; and happily these data are not far to seek. It is a fact known to every man who is not totally ignorant of the science of optics, that a greater number of rays fall upon the eye when reflected from a body near at hand, than can fall from the same body at a distance; and as those rays operate by impulse, it is self-evident that the impression must be stronger, and of course the sensation or colour more vivid, when the body is near than when it is distant. Now having acquired the notion of the true distance of objects by motion and the sense of touch, and finding by uniform experience, that as they are near or far off, the sensation or colour which they excite in the mind through the organ of vision is more or less vivid, those degrees of sensation come to be so closely associated with the respective distances of the object, that the one instantly suggests the other.

49 How figure is perceived by sight.

It is just so that we perceive figure by sight. Having experienced by the sense of touch that one surface is a square and another a circle, that one body is a cube and another a sphere; and finding our sense of sight differently affected by the square and the circle, by the cube and the sphere; these different affections come to be so closely connected in our minds with the figures of the respective bodies, that long before we are capable of reasoning on the subject the one is never present to us without suggesting the other. Nay, so complete in this case is the connexion or association, that we cannot even in idea abstract the colour from the figure; though it is certain that colour is a mere sensation, and figure an external quality; that colour alone is immediately perceivable by the eye, and the notion of figure suggested by the colour. We are aware that it has been affirmed, and affirmed with great vehemence, that figures of two dimensions are immediately perceived by the eye, and perceived with greater accuracy than by the sense of touch. But they who insist upon this doctrine affirm likewise, contrary to experience and the clearest reasoning, that the immediate objects of sight are external, and that colour is a quality of bodies. In the arguments too by which they support their hypothesis, they seem to confound sight as an affection of the mind, with the picture on the bottom of the eye, as if the retina were the sentient being; whereas the retina and picture are no more than instruments of sensation. It is indeed a fact, that the picture has the same figure nearly with the plane of the object which is presented to the eye; as when the object is a sphere, the picture is a circle variously shaded in colour. It is likewise a fact, that the picture is enlarged in proportion as the object is brought near, and diminished as it is carried to a distance. But these facts are known only to persons skilled in optics; and therefore it is evident, that though calculations may be raised from them by mathematicians to determine the distance and figure of external objects, they cannot possibly be the data from which distance and figure are inferred by the vulgar, who know not that such pictures on the retina exist. Besides all this, it is universally known, that a painter, by laying on his colours properly, can make a plain square surface appear to the eye in certain positions as an oblong or as a cube, and a plain circular surface as a concave or a convex hemisphere. But not one of these things could possibly be done, were figure, or indeed any thing else than colour, the immediate object of vision.

As we see distance and figure, so we see magnitude; and we see both in the same way that we see shame or anger in the looks of a man. The impression made upon the bottom of the eye by rays reflected from a large magnitude, must necessarily be different from the impression made by rays reflected from a magnitude that is less. This is self-evident; and since the impression *ab extra* is in some way or other the cause of that sensation, which is all of which we are originally conscious in vision, it is obvious that the sensation, like every other effect, must correspond to the cause from which it proceeds. Being therefore conscious of different sensations; and having, at an earlier period than we distinctly remember, learned by experience to refer them to different magnitudes; no sooner is each sensation excited than it suggests the notion, or, if you please, the perception, of that magnitude with which it is connected. So completely is this association fixed in the mind, that when we look at a known object, its real 50 Magnitude.

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real magnitude appears to be as inftantly obferved as its colour, whilft we hardly attend at all to the particularity of the fenfation by which the magnitude is fuggefted. It is, indeed, cuftomary with writers on optics to diftinguifh between tangible and vifible magnitude, as if any kind of magnitude were the immediate object of vifion : but this is not fo : for magnitude is fomething external, whereas the immediate object of vifion is a mere fenfation. What has introduced into fcience this mode of fpeaking is the following fact, that as we approach a diftant object it appears to the eye larger and larger every ftep, and lefs and lefs as we recede from it ; whereas the tangible magnitude of an object is always the fame. The reafon of this apparent change of magnitude to the eye, according to the diftance at which any particular object is viewed, is, that from a near object rays of light fall in greater numbers and more diverging than from the fame object viewed at a diftance. This of courfe alters the nature of the vifible fenfation : each common fenfation is in the mind clofely linked with a particular notion of magnitude ; and by the exercife of fight and touch we have learned from experience, that the particular fenfation caufed by diverging rays muft be referred to a larger magnitude than that which is caufed by parallel rays proceeding from the fame diftance.

51 Vifible fenfations a kind of natural language.

Upon the whole, then, we think ourfelves entitled to conclude, that the proper and original objects of vifion conftitute an univerfal language of the Author of Nature, by which we are inftructed how to regulate our actions, in order to attain thofe things that are neceffary to the prefervation and well-being of our bodies, as alfo to avoid whatever may be hurtful or deftructive to them. It is principally by the information of this language that we are guided in all the tranfactions and concerns of life : And the manner in which it fignifies and marks to us the objects which are at a diftance, is fimilar to that of languages and figns of human appointment, which do not fuggeft the things fignified by any likenefs or identity of nature, but only by a habitual connexion, which experience has made us to obferve, between them. This language of the eye, like the language of the tongue, fuggefts by one fenfation what may be refolved into a variety of perceptions. A tree is compofed of a trunk, branches, leaves ; it has colour, figure, fize ; and all thefe things are at once fuggefted to the mind by the two words *fpreading oak*. Juft fo it is with refpect to vifion : the fenfation received by the eye fuggefts at once the *trunk*, *branches*, *leaves*, *colour*, *figure*, and *fize* of the oak, and fuggefts them all as the qualities of one object.

Chap. II. *Of* Retention *and* Ideas.

52 Senfations and perceptions remain for a very fhort time after the removal of their objects.

From the experiment with the burning coal mentioned in N° 31. it is apparent, the fenfations excited through the eye, together with their correfponding perceptions, remain in the mind for a fhort time after the external exciting caufe is removed. The fame thing appears from another experiment which was firft made by Sir Ifaac Newton, and which every man may repeat for his own fatisfaction. It is univerfally known *, that a proper mixture of the feven original colours, *red*, *yellow*, *green*, *blue*, &c. conftitutes that uniform appearance which we call *white*. But when thefe colours are made to pafs in a rapid confecution before the eye, they excite the very fame perception as when they are properly mixed, which is a fatisfactory proof that the impreffion made by each feparate colour remains in the brain until a revolution of all the colours be completed ; for nothing but the impreffion of all the colours at *once* can produce the fenfation and perception of *white*. Indeed no perfon capable of paying the proper attention to thefe things, can keep his eye fixed upon a luminous object, and afterwards fhut it, without experiencing that the fenfation and perception remain for fome time after the external object is fhut out, and that they go off gradually till they leave behind them the mental appearance, which is properly called an *idea* of the object.

* *Hartley on Man.*

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The fame continuance of the fenfation after the removal of its caufe is equally obfervable in the fenfe of hearing ; for every found which we hear is reflected by the neighbouring bodies ; and therefore confifts in reality of a variety of founds fucceeding each other at different diftances of time, according to the diftances of the feveral reflecting bodies. Yet this caufes no confufion or apparent complexity of found, unlefs when the diftance of the reflecting bodies is very confiderable, as in fpacious buildings.

With refpect to the continuance of the fenfation of touch, doubts have been ftarted ; but for thefe there is as little room as for doubting the continuance of the fenfations of feeing and hearing. The continuance of heat after the heating body is removed, and of the fmart of a wound after the inftant of infliction, are proofs that every fenfation of touch does not vanifh with its caufe. A man unufed to the motion of a fhip or a coach, after having been a day at fea or on the road, feels or imagines he feels the rolling of the fhip or the jolting of the coach after he is in bed and actually at reft. Of thefe facts we know not what other account can be given, than that the agitation in the brain, which is the immediate caufe of the fenfation of touch, remains for fome time after the external caufe of the agitation is removed.

As to the fenfes of tafte and fmell, Dr Hartley feems to think that there is no clear and direct evidence for the continuance of their fenfations after their proper objects are removed : but in this inftance the ingenious author does not do juftice to his own theory. Let any man eat onions, garlic, or any other thing of a very pungent tafte, and immediately wafh his mouth with frefh water, fo that he may be fure no part of the fapid body remains on his tongue or palate. According to this doctrine, the tafte of the onion or garlic fhould inftantly vanifh with its object ; but the fact is otherwife. Whoever fhall make the experiment, will find the fenfation to remain a confiderable time ; not indeed in its original force, but weakened no more than what it muft neceffarily be by the introduction of a new fenfation excited by the water. It is more difficult to afcertain the permanency of fmell : but analogy inclines us to believe, that in this particular it refembles the other fenfes, though we know not how to direct the reader to an experiment which will give him abfolute conviction.

Whether the caufe of thefe continued fenfations, after the removal of their objects, be in the brain alone, in

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in the mind alone conſidered as an immaterial being, or in both together, is of very little importance; becauſe, taking the mind and its internal organs as one *metaphyſical whole* *, it matters not to our preſent inquiry, where this retentive power reſides, as long as it can be proved to exiſt within us: for it ſeems evident, that what has the faculty of retaining a ſenſation when no longer acted upon by the object which excited it, muſt alſo have a power to preſerve the veſtiges of that ſenſation even after the ſenſation itſelf ſhall be entirely obliterated. This is in fact the caſe with the mind. When an object which we have once perceived is moſt remote from our thoughts, we are certain that there is within us a capacity, diſpoſition, tendency, or power, by which a repreſentation of that object may be at any time revived and preſented to the intellect. Thus the ſame inherent power of the mind and its internal organs, which retains a ſenſation and perception in the abſence of the object by which they were excited, can alſo reproduce that perception, or bring into the view of the intellect ſomething exactly ſimilar to it. The reproduction will not indeed be ſo lively as the original perception when accompanied with its correſponding ſenſation, becauſe ſenſation and actual perception are affected by a double cauſe, the action of the external object upon the organ, nerves, and brain, and the correſponding energy of the mind or ſentient principle; whereas, in the reproduction, the mind ſeems to act ſolely by its own power, and certainly without the aſſiſtance of external objects. This reproductive power is commonly called *memory*. By many of the ancient philoſophers, and by *M. Schwab*, with one or two others among the moderns, it is called *imagination*. We do not chooſe either to revive antiquated modes of expreſſion, or to introduce innovations of our own; but as we cannot diſapprove of the ancient phraſeology, after the definitions which the reader will by and by find of *imagination*, *memory*, and *recollection*, as given by Mr Harris, we have prefixed to this chapter the general title of *retention*, which comprehends them all.

53 Hence we have that power or faculty called *memory*.

* See *An Eſſay on the Reduction of the Faculties of the Mind, by M. Schwab.*

54 The opinions of philoſophers reſpecting memory.

When one recals an object of ſight by the power of memory, it appears to him preciſely the ſame as in the original ſurvey, only leſs diſtinct, and with a conviction (which is perhaps the reſult of experience) that the real object is not immediately before him. How is an object recalled by the power of memory? Does the man endeavour to form in his mind a picture or repreſentative image of the object? Let us liſten to the anſwers given by different philoſophers to this queſtion.

55 The Peripatetics and Platoniſts

The ſentiments of the Peripatetics, as expreſſed by *Alexander Aphrodiſienſis*, one of the earlieſt commentators on *Ariſtotle*, are thus tranſlated by Mr Harris in his Hermes.—"Now, what fancy or imagination is, we may explain as follows: We may conceive to be formed within us, from the operation of the ſenſes about ſenſible objects, ſome impreſſion (as it were), or picture in our original ſenſorium, being a relict of that motion cauſed within us by the external object; a relict which, when the external object is no longer preſent, remains, and is ſtill preſerved, being as it were its image; and which, by being thus preſerved, becomes the cauſe of our having memory. Now ſuch a ſort of relict, (and as it were) impreſſion, they call *fancy* or *imagination* (E)." A paſſage from ALCINOUS *of the doctrines of Plato*, as rendered into Engliſh by Dr Reid †, ſhows that, in this theory, as in that of perception, the Platoniſts agreed with the Peripatetics. "When the form or type of things is imprinted on the mind by the organs of the ſenſes, and ſo imprinted as not to be deleted by time, but preſerved firm and laſting, its preſervation is called *memory*."

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† *Eſſays on the Intellectual Powers of Man.*

Mr Harris, who was deeply read in the ancient philoſophy, and who conſidered the authority of Ariſtotle and Plato as ſuperſeding all reaſoning and all inquiry, after juſtly obſerving, that if the ſoul had no other faculties than the ſenſes, it could never acquire the leaſt idea of *time*, thus expreſſes himſelf on the ſubject before us: "But, happily for us, we are not deſerted here. We have, in the firſt place, a faculty called *imagination* or *fancy*; which, however, as to its *energies* it may be ſubſequent to ſenſe, yet is truly prior to it both in *dignity* and *uſe*. This it is which *retains the fleeting forms of things*, when things themſelves are gone, and *all ſenſation* is at an end. That this faculty, however connected with ſenſe, is ſtill perfectly different, may be ſeen from hence. We have an *imagination* of things that are gone and extinct; but no ſuch things can be made objects of *ſenſation*. We have an eaſy command over the objects of our *imagination*, and can call them forth in almoſt what manner we pleaſe; but our *ſenſations* are neceſſary when their objects are preſent, nor can we controul them but by removing either the objects or ourſelves. As wax would not be adequate to its buſineſs of ſignature, had it not a power to retain, as well as receive; the ſame holds of the SOUL, with reſpect to *ſenſe* and *imagination*. SENSE is its *receptive* power: IMAGINATION its *retentive*. Had it ſenſe without imagination, it would not be as wax but as water; where, though all impreſſions may be inſtantly made, yet as ſoon as made they are entirely loſt. Thus then, from a view of the two powers taken together, we may call SENSE (if we pleaſe), *a kind of tranſient imagination*; and IMAGINATION, on the contrary, *a kind of permanent ſenſe*."

56 diſtinguiſh properly between imagination and memory, &c.

Great part of the office which is here given to imagination, is in common Engliſh attributed to memory; but between theſe two faculties, as well as between them and recollection, the author accurately diſtinguiſhes thus:—"When we view ſome *relict* of ſenſation repoſed within us, *without thinking of its riſe*, or *referring it to any ſenſible object*, this is FANCY OR IMAGINATION. When we view ſome ſuch *relict*, and *refer it withal to that ſenſible object which in time paſt was its*

(E) The original is as follows: Τι τοινυν εστιν ἡ φαντασια ὡδε αν γνωρισαιμεν δει νοειν εν ημιν απο των ενεργειων των περι τα αισθητα, οιον τυπον τινα αναζωγραφημα εν τω πρωτω αισθητηριω, εγκαταλειμμα τι της υπο του αισθητου γινομενης κινησεως, ὁ και μηκετι του αισθητου παροντος, υπομενει τε και σωζεται, ον ὡσπερ εικων τις αυτου, ον και της μνημης ημιν σωζομενον αιτιον γινεται το τοιουτον εγκαταλειμμα, και τον τοιουτον ὡσπερ τυπον, φαντασιαν καλουσιν. *Alex. Aphrod. de Anima*, p. 135. *Edit. Ald.*

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its cauſe and original, this is MEMORY. Laſtly, the *road which leads to memory through a ſeries of ideas however connected, whether rationally or caſually*, this is recollection."

57 Objections to their theory.

Of this theory we ſhall only remark, that if we could underſtand the words *picture* and *form* in a metaphorical ſenſe, as candour obliges us to underſtand Locke's *images* in the mind, the doctrine of *Alexander Aphrodiſienſis* would be very little wide of the truth. Experience teaches us that memory as well as perception depends upon the ſtate of the brain; and as it is undeniable, that when a man to-day contemplates an object which he perceived yeſterday, or at any former period, he has a view of it in all reſpects ſimilar to the original perception, only fainter and leſs diſtinct, it is extremely probable, that an impreſſion, *ab extra*, which produces a ſenſation and perception, leaves behind it ſome *tendency* in the brain, to vibrate as in the actual ſenſation, and that this *tendency* is carried into *effect* by the internal energy of the mind itſelf. But in the Peripatetic philoſophy, *pictures* and *forms* in the *ſenſorium* were conſidered as real things, and by no means as metaphorical expreſſions. This is evident from their being conſtantly compared to the impreſſion of a ſeal upon wax, and from their converting the *materia prima* from ſomething, which can neither be ſeen nor felt, into viſible and tangible body, of which we ſhall treat afterwards. Now it being certain that on a being immaterial, no corporeal *form* can be impreſſed, and repeated diſſections having ſhown that no ſuch forms are in fact impreſſed on the brain, this whole theory is at once overturned.

58 Locke's doctrine concerning memory.

Modern philoſophers having denied that there are real *images* or *forms* in the mind during the immediate act of perception, cannot conſiſtently with themſelves admit ſuch images in the act of retention, or when thoſe things which were formerly objects of perception are recalled to the mind by the power of memory. Mr Locke's doctrine is, "that the mind retains theſe ſimple ideas which it firſt received from ſenſation or reflection, two ways: firſt, by keeping the idea, which is brought into it, for ſome time actually in view, which is called CONTEMPLATION: and ſecondly, by the power which we have to revive again in our minds thoſe ideas, which, after imprinting, have diſappeared, or have been, as it were, laid out of ſight; as when we conceive heat or light, yellow or ſweet, the object being removed. This (he ſays) is MEMORY; which is, as it were, the ſtorehouſe of our ideas *.

To explain this more fully, he immediately adds the following obſervation:—"But our ideas being nothing but actual perceptions in the mind, which ceaſe to be any thing when there is no perception of them, this laying up of our ideas in the repoſitory of the memory, ſignifies no more than this, that the mind has a power in many caſes, to revive perceptions which it has once had, with this additional perception annexed to them, that it has had them before. And in this ſenſe it is, that our ideas are ſaid to be in our memories, when indeed they are actually nowhere; but only there is an ability, in the mind, when it will, to revive them again, and, as it were, paint them anew on itſelf, though ſome with more ſome with leſs difficulty, ſome more lively and others more obſcurely. And thus it is, by the aſſiſtance of this faculty, that we are ſaid to have all thoſe ideas in our underſtandings, which, though we do not actually contemplate them, yet we can bring in ſight, and make appear again, and be the objects of our thoughts, without the help of thoſe ſenſible qualities which firſt imprinted them there."

* *Eſſay*, book ii. chap. 10.

To attempt a defence of the accuracy of this language would be vain; but as the author's meaning is ſufficiently obvious, his expreſſions may be eaſily and certainly corrected. Had Locke ſaid—"But our ideas being nothing but ſcenes or appearances in the mind, which ceaſe to be any thing when there is no perception of them, this laying up of our ideas in the repoſitory of the memory ſignifies no more but this, that the mind has a power, in many caſes, to revive ſcenes which it has once viewed, with this additional perception annexed to them, that it has viewed them before;" there would have been no room for the many petulant remarks which have been made upon the paſſage.

59 objected to.

But againſt this account of memory, a much heavier charge has been brought than that which regards the propriety of the language. It has been ſaid, that the additional perception, which, according to Locke, attends the revival of our ideas by the power of memory, "would be a fallacious perception, if it led us to believe that we had them before, ſince they cannot have two beginnings of exiſtence: nor can we believe them to have two beginnings of exiſtence; we can only believe that we had formerly ideas or perceptions very like to them, though not identically the ſame." Let us examine this queſtion ſomewhat narrowly: for if it be really true, that in the ſenſe in which the word *ſame* is here uſed, we cannot twice contemplate the ſame idea, all confidence in memory would ſeem to be at an end.

60 The objection obviated.

Suppoſe a man to ſtand on ſome of the riſing grounds about Edinburgh, the Caltonhill for inſtance, and from that eminence to view the glorious proſpect of the coaſt of Fife, the ocean, the frith of Forth, and the little iſlands ſcattered in the frith. Let him go away, and return next day to the ſame place, and look the ſame way: we would aſk whether he has the ſame *view* or *perception* which he had the day before? The man muſt ſurely be very captious who would ſay that he has not: and yet it is certain that the energy of mind by which he perceives on one day cannot be identically the ſame with that by which he perceived on another; nor are the rays of light which fall upon his eyes on the ſecond day, identically the ſame with thoſe which fell upon his eyes and occaſioned viſion on the firſt day. Let the ſame man now ſhut his eyes, and contemplate the various objects at which he had been juſt looking. They will appear to him in all reſpects the ſame as when viewed by means of his organs of ſight, only fainter and leſs diſtinct, with this additional conviction, that the immediate objects of his preſent contemplation are not real external things, but *ideas* or *mental repreſentations* of thoſe things which had ſo lately been the objects of his ſight. Let him think no more about the matter for ſome days, and then exert his powers of memory. We have no heſitation to ſay, that in the ſenſe of the word *ſame*, as uſed by Mr Locke, the very ſame ideas will recur

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recur and be present to his intellect which were present to it at the former contemplation. The second energy of memory or imagination, or whatever it may be called, is not indeed identically the same with the first; nor is that agitation or motion, or whatever other affection of the brain is necessary to memory, identically the same at the second time as at the first: but the mind exerting itself in the very same manner at the one time as at the other, produces the same kind of agitation in the brain, and is itself affected in the very same way at the second as at the first exertion. Whence it follows, that the second *ideal scene* will be as much the same with the first, as the second *actual perception* is the same with the first; and the two ideal scenes, and the two actual perceptions, are respectively said to be the same with each other, only because they impress the mind with a conviction that they were occasioned by the same external objects.

But though we think Locke's doctrine, with respect to memory, may be thus easily vindicated from the charge of fallaciousness, we must acknowledge that to us it appears not to be of much value. It teaches nothing, but that the mind has a power to retain ideas of those objects which it formerly perceived, and in many instances to recal them as occasion may require. But these are truths known to all mankind, to the clown as well as to the philosopher.

61 The opinion of Hume.

Philosophers in general have paid less regard to the retentive faculties of the mind than to its original powers of perception. Perhaps they imagined, that as memory depends upon perception, and in some respects appears to resemble it, a competent knowledge of the nature of the former faculty would lead to that of the second. Be this as it may, Mr Hume, who was at some pains to detail his notions of perception, has in his Philosophical Essays only dropt concerning memory and imagination a few hints, so loosely thrown together, that, if he had not elsewhere expressed himself with more precision, it would have been difficult to discover his real meaning. According to him, that which is commonly called the *perception of an external object*, is nothing but a strong impression upon the mind; and that which is called the *remembrance of a past object*, is nothing but a present impression or idea weaker than the former. Imagination is an idea weaker than the idea or impression which he calls *memory*. This seems to be a wonderful abuse of language. Impressions are not perceptions; and, if possible, they can still less be called *ideas*, which are but secondary perceptions. It is likewise far from being true, that an idea of imagination has necessarily less vivacity than an idea of memory. We have seen Mr Hume, and have at the present moment an idea of his form and dress: we can likewise imagine to ourselves a centaur; and though a centaur was never seen, and therefore cannot be *an impression repeated by memory*, our idea of the monster is much more lively and distinct than that of the philosopher.

62 Of Dr Reid.

Dr Reid having observed of memory *, that it is by it we have an immediate knowledge of things past; that it must have an object; that in this respect it agrees with perception, but differs from sensation, which has no object but the feeling itself; and that every man can distinguish the thing remembered from the remembrance of it—proceeds to inquire what memory is. And, "First (says he), I think it appears that memory is an original faculty given us by the Author of our being, of which we can give no account but that we are so made. The knowledge (continues he) which I have of things past by my memory, seems to me as unaccountable as an immediate knowledge would be of things to come (F); and I can give no reason why I should have the one and not the other, but that such is the will of my Maker. I find in my mind a distinct conception and a firm belief of a series of past events; but how this is produced I know not. I call it *memory*; but this is only giving a name to it; it is not an account of its cause. I believe most firmly what I distinctly remember; but I can give no reason of this belief. It is the inspiration of the Almighty which gives me this understanding. When I believe the truth of a mathematical axiom or of a mathematical proposition, I see that it must be so: every man who has the same conception of it sees the same. There is a necessary and an evident connexion between the subject and the predicate of the proposition; and I have all the evidence to support my belief which I can possibly conceive. When I believe that I washed my hands and face this morning, there appears no necessity in the truth of the proposition. It might be or it might not be. A man may distinctly conceive it without believing it at all. How then do I come to believe it? I remember it distinctly. This is all I can say. This remembrance is an act of my mind. Is it impossible that this act should be, if the event had not happened? I confess I do not see any necessary connexion, between the one and the other. If any man can show such a necessary connexion, then I think that belief which we have of what we remember will be fairly accounted for: but if this cannot be done, that belief is unaccountable; and we can say no more but that it is the result of our constitution. Our original faculties are all unaccountable: Of these memory is one. He only who made them comprehends fully how they are made, and how they produce in us not only a conception, but a firm belief and assurance, of things which it concerns us to know."

* *Essays on the Intellectual Powers of Man.*

On this account of memory we shall make no remarks. There is a certain sense of the words, in which every thing which the author has said on the subject is undoubtedly

(F) If memory depends upon the state of the brain as it has been affected in past perceptions, this appears to us a strange position. Perhaps the excellent author means nothing more, than that it is as unaccountable to us, that impressions on the brain should cause perception, and the vestiges of those impressions should cause remembrance, as how the mind might not perceive things to come without the intervention of impressions on the brain. If this be his meaning, no man will controvert it: for it is impossible to discover the nature of that relation which subsists between an impression and perception; but that there is such a relation, we know from experience.

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undoubtedly juſt; and it would be very uncandid to take his words in any other ſenſe. But though memory, as it is the reſult of that conſtitution which was given us by God, and not the offspring of habit or human contrivance, is unqueſtionably an original faculty; and though it is therefore impoſſible to account for it ſo fully as to ſilence every inquiry which may be made, yet we could wiſh that Dr Reid had beſtowed a little more pains upon it, in order to diſcover if poſſible in what reſpects it reſembles or differs from perception. He has well obſerved, that there are laws of nature by which the operations of the mind are regulated, as well as laws of nature which govern the material ſyſtem. As the latter are the ultimate concluſions which the human faculties can reach in the philoſophy of bodies, ſo the former are the ultimate concluſions which we can reach in the philoſophy of minds. The more general that theſe laws are in both caſes, the more uſeful they are and the more ſatisfactory: for as they are themſelves inexplicable, the fewer they are in number, and the more comprehenſive each, the fewer will thoſe phenomena be for which we can give no account. Thus, as we know not what makes the planets tend to the centre of the ſun, or heavy bodies tend to the centre of the earth, we can give no other account of theſe phenomena, but that, as they appear to be of the ſame kind, it is reaſonable to conclude that they proceed from ſimilar cauſes. What the cauſe is of this tendency of bodies towards each other, we know not. We call it *gravitation*, and employ it to account for all phenomena of the ſame kind. In like manner it is univerſally allowed, that as we know not how mind and matter operate upon each other, there is ſomething in perception wholly unaccountable. That perception follows ſenſation; and that there is no ſenſation which is not occaſioned by ſome affection of the brain, proceeding from ſome impreſſion *ab extra;* we have the evidence of experience: but how a particular affection of the brain ſhould excite a ſenſation in the mind, we know not; though we may here, as in the corporeal ſyſtem, attribute ſimilar effects to the ſame or ſimilar cauſes. Thus, if when we exert an act of memory we have the ſame appearance of things as in the original act of perception, the rules of philoſophizing authorize us to refer both phenomena to the ſame general law; juſt as they authorize us to refer the motion of the planets and of projectiles to the ſame general law. On the other hand, if we perceive no ſimilarity between memory and perception, we have made no progreſs in the philoſophy of mind; for in that caſe we have diſcovered two phenomena proceeding from two cauſes totally different from each other, and both inexplicable. Although we ſcarcely hope to throw any light upon a ſubject which Dr Reid has not attempted to illuſtrate, we ſhall ſtate a few facts reſpecting the memory, and ſubmit to the reader the concluſions to which we think theſe facts lead.

63 The appearance of ſenſible objects when recalled by the power of memory.

1. Objects once perceived by the ſenſes, when recalled to the mind by the power of memory, appear preciſely the ſame as in the original perception, only leſs diſtinct *. For example, having ſeen yeſterday a ſpreading oak growing on the bank of a river, and having heard a ſhepherd play, and handled a ſquare ſtone, we endeavour to recal to our mind theſe objects which are now abſent. How is this operation performed? Do we endeavour to form in our minds pictures of them or repreſentative images? or, does our intellect ſurvey the types or forms which, according to Ariſtotle, thoſe objects left in the imagination when originally perceived? Neither of theſe things is done. We conceive ourſelves as ſtanding in the ſame place where we ſtood yeſterday; upon which we have perceptions of the objects ſimilar in all reſpects to the perceptions which we had when we employed our eyes, our ears, and our hands. The tree appears, as it were, before us; faint indeed, but attended with all the objects which we obſerved around it yeſterday: we ſeem to hear the ſound of the pipe confuſedly, and at a diſtance; to move our hands over the ſtone, and to feel the ſame ſurfaces and the ſame angles which we felt in the original perception. In this recollection we are not conſcious of pictures or images more than in the original ſurvey. The perceptions ſeem to be of the tree and river themſelves, of the ſound itſelf, and of the ſtone itſelf, exactly as at the firſt; and yet we are ſatisfied that in the act of remembrance we perceive no ſuch object as a *real* tree, pipe, or ſtone. That theſe are facts, every man muſt be convinced who attends to the energies of his own mind when exerting the powers of retention: and therefore it is, in our opinion, with no impropriety that Mr Harris ſays, we may call SENSE, if we pleaſe, *a kind of tranſient imagination;* and IMAGINATION, on the contrary, *a kind of permanent ſenſe;* for if theſe two faculties, as far as the mind or intellect is concerned, be not the ſame, they ſeem to reſemble each other much.

* *Appendix to Elements of Criticiſm.*

64 What ideas remain longeſt in the memory.

2. The *primary* perception of a *viſible* object is more complete, lively, and diſtinct, and remains longer in the *ſenſorium*, than that of any other object. We know likewiſe by experience, that an *idea* or *ſecondary* perception of a viſible object is as much more complete, lively, and diſtinct, than the idea of any other object, as was the *primary* perception; and that we remember things which we have ſeen for a longer time than ſounds which we have heard, or than tangible objects which we have only handled. Yet there ſeems to be a conſtant decay of all our ideas, even of thoſe which are ſtruck (G) deepeſt and in minds the moſt retentive; ſo that if they be not frequently renewed by repeated exerciſe of the ſenſes, or by reflection on thoſe objects which at firſt occaſioned them, the print (G) wears out,

(G) Theſe expreſſions, which mention ideas as things which are *deep ſtruck*, and as *prints which wear out*, are the expreſſions of Locke. We hope it is needleſs to warn our readers, that they are uſed by us, as they were by him, in a metaphorical ſenſe. On theſe ſubjects it is impoſſible to write without metaphor; which, while the meaning is obvious, no man will condemn, who reflects that the words of language were not invented by metaphyſicians, and are for the moſt part *literally* ſignificant only of ſenſible objects.

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out, and at laſt there remains nothing to be ſeen. Concerning ideas, it is eaſy to remark, that thoſe remain longeſt and cleareſt in the memory which are derived from two or more ſenſes, eſpecially if the ſenſe of ſight be one of the number, or which are ofteneſt refreſhed by a return of the objects which produced them. Hence a man has a longer and more diſtinct remembrance of what he has ſeen than of what he has only heard, of what he has both ſeen and felt than of what he has only ſeen; and the ideas which we have of heat and cold, of hunger and thirſt, and of all thoſe things which moſt frequently affect our ſenſes, are extremely clear, and are never quite loſt whilſt the mind retains any ideas at all.

65 Memory a kind of habit.

3. Memory appears to be a kind of habit, which is not always in exerciſe with regard to things we remember, but is ready to ſuggeſt them when there is occaſion. The moſt perfect degree of this habit is, when the thing preſents itſelf to our remembrance ſpontaneouſly, and without labour, as often as there is occaſion A ſecond degree is, when the thing is forgotten for a longer or ſhorter time, even when there is occaſion to remember it, and yet at laſt ſome incident, ſuch as a violent paſſion *, which agitates the whole mind and ſenſorium, tumbles the idea, as it were, out of its dark corner, and brings it into view without any ſearch. A third degree is, when we caſt about and ſearch for what we would remember, and after ſome labour find it out. This ſearching faculty of the ſoul is by Ariſtotle called *αναμνησις*, by Dr Reid and others *reminiſcence*, and by Mr Harris *recollection*. Should it be ſaid, that what we *will* to remember we muſt already conceive, as we can will nothing of which we have not a conception; and that, therefore, a *will* to remember a thing, ſeems to imply that we remember it already—we anſwer, with Dr Reid, that when we will to remember a thing, we muſt indeed remember ſomething relating to it; but we may have no poſitive idea or conception of the thing itſelf, but only of the relation which it bears to that other thing which we do remember. Thus, one remembers that a friend charged him with a commiſſion to be executed at ſuch a place, but he has forgotten what the commiſſion was. He applies himſelf to diſcover it; and *recollects* that it was given by *ſuch a perſon*, upon *ſuch an occaſion*, in conſequence of ſuch a *converſation*: and thus by a train of thought he is led to the very thing which he had forgotten and wiſhed to remember. To this operation it is not always neceſſary that the relations between the various ideas which the mind turns over be very cloſe, or have their foundation in nature; for a caſual connexion is often ſufficient. Thus, from ſeeing a garment, we think of its owner; thence of his habitation; thence of woods; thence of timber; thence of ſhips; thence of admirals; thence of cannons, iron, furnaces, and forges," &c.

* *Reid's Eſſays on the Intellectual Powers of Man, Locke's Eſſay*, &c. and *Harris's Hermes.*

66 In recollection one idea ſuggeſts another, and why

That, in the proceſs of recollection, one idea ſhould ſuggeſt another, may be eaſily accounted for. When, in perception, our minds are expoſed to the influence of external objects, all the parts and properties, and even the accidental variable adjuncts of theſe objects, are perceived by full-grown men at the ſame time; ſo that the whole group makes but one impreſſion upon our organs of ſenſe, and conſequently upon the mind. By theſe means all the parts of the ſimultaneous impreſſion *, and conſequently of the perception occaſioned by that impreſſion, are ſo intimately aſſociated or linked together, that the idea of any one of them recurring at any future period, generally introduces the ideas of all the reſt. But as the neceſſary parts and properties of any thing are more cloſely linked together, and occur more frequently than any particular variable adjuncts, it is obvious, that by the idea of any one of theſe properties, the idea of the reſt, and of the object itſelf, will be more readily introduced than by the idea of any variable adjunct. It ſeems, however, to be certain, that we have no power of calling up any idea at pleaſure, but only ſuch as have a connexion, either in nature or by means of former aſſociations, with thoſe that are at any time preſent to the mind. Thus the ſight, or the idea, of any particular perſon, generally enables us to recollect his name, becauſe his name and his perſon have been conſtantly aſſociated together. If that fail to introduce the name, we are at a loſs and cannot recollect it at all till ſome other aſſociated circumſtance help us. In naming a number of words in a ſentence, or lines in a poem, the end of each preceding word or line being connected with the beginning of the word or line which ſucceeds it, we can eaſily repeat them in that order; but we are not able to repeat them backwards with any eaſe, nor at all till after many fruitleſs efforts. By frequent trials, however, we acquire at laſt a facility in doing it, as may be found by making the experiment on the names of number from one to twenty. It is, indeed, probable, that in the wildeſt flights of *fancy*, no ſingle idea occurs to us but ſuch as had a connexion with ſome other idea, perception, or notion, previouſly exiſting in the mind, as ſhall be ſhown more fully in a ſubſequent chapter.

* *Hartley on Man.*

67 Memory depends on the ſtate of the brain.

4. " Memory appears to depend entirely or chiefly upon the ſtate of the brain †. For diſeaſes, concuſſions of the brain, ſpirituous liquors, and ſome poiſons, impair or deſtroy it; and it generally returns again with the return of health, from the uſe of proper medicines and methods. It is obſervable, too, that in recovering from concuſſions and other diſorders of the brain, it is uſual for the perſon to recover the power of remembering the then preſent common incidents for minutes, hours, and days, by degrees; alſo the power of recalling the events of his life preceding his illneſs. At length he recovers this laſt power perfectly; and at the ſame time forgets almoſt all that paſt in his illneſs, even thoſe things which at firſt he remembered for a day or two. Now the reaſon of this ſeems to be, that upon a perfect recovery the brain recovers its natural ſtate, and all its former affections and tendencies; but that ſuch affections or tendencies as took place during the preternatural ſtate, i. e. during the patient's illneſs, are obliterated by the return of the natural ſtate." All this we are induced to believe; becauſe, though it is a fact incontrovertible, that in certain diſeaſes the memory is impaired, and recovers its vigour with the return of health, it is not conceivable that the mind itſelf ſhould ſuffer any change by diſeaſes, concuſſions, or ſpirituous liquors, &c.

† *Hartley on Man.*

From theſe facts we are ſtrongly inclined to conclude,

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clude, that the power of the *mind*, or *immaterial* (H) *principle*, by which it remembers paſt events, differs not from that by which it perceives preſent objects. In

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External objects operating on the ſenſes leave ſome permanent effect in the brain.

perception, impreſſions are made upon the organs of ſenſe, which are communicated to the brain; and, by ſome unknown means, occaſion ſenſations which are followed by the perception of the external object. When by the power of memory we recal paſt objects of ſenſe, the mind has the ſame view of them as in the original perception, except that they appear fainter, leſs diſtinct, and generally more diſtant. We have, therefore, reaſon to conclude, that in the act of remembrance the brain is affected in the ſame way, though not ſo forcibly, as in perception. That memory depends as much as perception upon the ſtate of the brain, is confirmed by daily experience; and therefore there cannot be a doubt but that external objects, operating upon the ſenſes, nerves, and brain, leave ſome permanent effect behind them. What that effect preciſely is we cannot know, and we need not deſire to know; but that they leave *ſome* effect we have as good evidence as that the planets are moved round the ſun by forces of the ſame kind with thoſe by which projectiles are moved on the earth. Could we ſuppoſe that they leave real *prints* or *impreſſions* behind them, which we confeſs to be very little probable, memory would ſeem to be nothing but the perceptive power of the mind turned to thoſe impreſſions. If the permanent effect of impreſſions by external objects be, as Dr Hartley ſuppoſes, only a tendency in the brain to vibrate as in the original perception, remembrance will reſult from the mind's operating upon the brain as in actual perception; and the reaſon that ideas of memory are fainter than perceptions of ſenſe, is, that the former are produced by a ſingle, and the latter by a double, operation.

69
Why the memory advances to perfection, and then gradually decays.

This theory appears to be greatly confirmed by the following well known facts, that children ſoon commit to their memory any thing which they underſtand, and as ſoon forget it; that the powers of memory gradually advance to perfection, and then gradually decay; and that old men remember more diſtinctly what they perceived in their youth, than what they perceived a year ago. For if the memory belonged wholly to the pure intellect, and had no dependence upon the brain, it is not eaſy to conceive how it ſhould advance towards a ſtate of perfection and afterwards decay. A being which is unextended and indiviſible, can ſuffer no change either in its eſſence or in its faculties: the ideas which it had once retained, it would retain for ever. But if memory be occaſioned by ſome relict of ſenſe left in the brain, it is eaſy to ſee how all thoſe changes ſhould take place: and therefore, though we have the weight of Dr Reid's authority againſt us, we cannot help thinking that Ariſtotle was in the right, when he imputed the ſhortneſs of memory in children to this cauſe, that their brain is too moiſt and ſoft to retain impreſſions made upon it; and that he was likewiſe in the right, when he imputed the defect of memory in old men to the hardneſs and rigidity of the brain, which hinders it from receiving any durable impreſſion.

Another argument to prove, that in remembrance the mind acts upon ſomething left in the brain by the impreſſions of ſenſe, is this, that nothing can act but where it is preſent. The truth of this axiom is acknowledged by Dr Reid, and we believe by all mankind except Dr Prieſtley and one or two others, whoſe paradoxes we ſhall conſider afterwards. Now it is confeſſed, that in recollection at leaſt the mind is active; and therefore it muſt act, *not* upon an object which has now perhaps no exiſtence, and certainly no immediate exiſtence, *but* upon ſomething left by that object in the brain or ſenſorium, to which the mind is intimately preſent.

70
By what means we never confound memory with perception.

But if this be ſo, we may be aſked how it comes to paſs that men never confound memory with perception, nor fancy that they perceive things which they only remember? If perception be an inference drawn from certain ſenſations excited by an impreſſion on the brain, and if remembrance reſult from the mind's operating upon relicts of thoſe impreſſions, one would think it natural to ſuppoſe, that in both caſes we have actual perceptions, though in the one caſe the perception muſt be more vivid and diſtinct than in the other. To this we anſwer, That previous to all experience, perception and memory are very probably confounded; and that we believe a man brought into the world with all his faculties in their full *natural* perfection, would not inſtantly be able to diſtinguiſh what he remembered from what he perceived. This we know to be the caſe with reſpect to imagination, a faculty which ſtrongly reſembles memory; for in dreams, and ſometimes even in waking reveries, we fancy that we actually perceive things which it is certain we can only imagine. A very ſhort experience, however, would enable this newly created man to make the proper diſtinction between remembrance and perception. For let us ſuppoſe him to be brought into a dark room, and ſoon afterwards a candle to be introduced. The candle would give him a viſible ſenſation, though not at firſt the perception of an external object. Let the candle after ſome time be carried out: the man would retain a viſible *idea*, which he might confound with the actual ſenſation. But if, whilſt this idea remained in his mind, the candle were brought back, he would inſtantly feel a difference between the real ſenſation and the idea, when both were together preſent to his mind. And having, in ſome ſuch manner as we have already deſcribed, acquired the power of perceiving external objects by means of his ſenſes, he would ſoon diſcover, without any effort of his own, the difference between actual perceptions and the ideas treaſured up in his memory.

 The

(H) Through the whole of this and the preceding chapters, we have taken it for granted, that the ſentient principle in man is not material. This is the *common*, and, as ſhall be ſhown afterwards, the moſt *probable* opinion: but whether it be abſolutely certain or not, makes no difference on the theories of ſenſation and perception. Theſe are obviouſly neither figure nor motion, and therefore not ſubject to the laws which govern the material world.

Retention and Ideas.

71 The order of succession in which objects recur to the memory.

The only remaining difficulty which seems to encumber this theory of remembrance, is, to account for the order of succession in which objects recur to the memory, and to which we give the name of *time*.—But this difficulty will vanish when we have ascertained what *time* is. At present it is sufficient to observe, that our perceptions of external objects remain a certain space of time in the mind; that this time is different, according to the strength and other circumstances of the impression which occasioned the perception; and that traces of those perceptions, i. e. *ideas*, may be recalled after the intervention of other trains of ideas, and at very different intervals. If one look upon a house, and then shut his eyes, the impression which it made upon his mind will not instantly vanish: he can contemplate the house almost as long as he pleases; and, by the help of various associated circumstances, he may recal the idea several years afterwards, and refer it to the original perception.

72 Brutes have memory, and

Before we dismiss the subject of retention, it may not be improper to take notice of the retentive powers of inferior animals. Aristotle, Locke, Dr Reid, and almost every philosopher of eminence both among the ancients and moderns, have maintained, that inferior animals have memory as well as men; and indeed we do not perceive how the fact can be denied of the more perfect animals, and those with whose operations we are best acquainted. A dog knows his master again after a long absence; a horse will trace back a road which he has but once travelled, often with more accuracy than his rider; and it is well known that many species of singing birds have a capacity to learn tunes from the human voice, and that they repeat the notes again and again, approaching nearer and nearer to perfection, till at last they sing the tune correctly. These phenomena can be accounted for only by supposing, that in the brains of the several animals traces are left by perception, of the same kind with those which perception leaves in the brain of man, and which are the cause or occasion of his remembrance. With respect to this point, the learned author of *Ancient Metaphysics* differs from his master Aristotle. He allows that brutes have imagination, but denies that they have memory: for (says he) "memory necessarily implies a sense of *time*, and what is *first* and *last*; but brutes have no idea of time, or of first and last; and it is certain that they have not consciousness or reflection, by which only they could review their own operations. At the same time he admits, that imagination in the brute serves the purpose of memory in us; for whenever he sees the object that is painted on his *phantasia*, he knows it again, but without any perception of the time when he first saw it." But that a brute, when he sees the object which is painted on his phantasia, should know it *again* without referring it to a former perception, is plainly impossible. The recognisance of any thing consists in a consciousness of its having been perceived before; and nothing more than such recognisance is essential to memory. The author's mistake seems to lie in supposing that memory necessarily implies a sense of some determinate portion of past time; but we surely remember many things of which we can only say that we have formerly perceived them, without being able to ascertain the precise period at which we had such perceptions. A child has the use of memory sooner than he acquires the faculty of speech; but he must have spoken and even reasoned before he can have an accurate notion of time, which, as shall be shown afterwards, arises from comparing the fleeting succession of our own ideas with the permanence of ourselves and other objects. The author's distinction between memory and imagination seems to be on all accounts improper. Aristotle has said, and said truly, that there is memory of *ideas* as well as of sensible objects; meaning by ideas general conceptions or propositions: but this reviver of his philosophy is inclined to say, "that *memory* is only of *ideas*, consequently belongs only to man; and that *imagination* is only of sensible objects, and consequently belongs both to man and brute."—But surely man *remembers* what he has *seen* and *felt* as well as what he has *conceived* or *thought*; and if imagination and memory be properly distinguished by Mr Harris, the reverse of this writer's doctrine must be true, viz. that imagination belongs only to *man*, and memory of sensible objects both to *man* and *brute*.—We can contemplate in imagination the idea of a *centaur* or a *golden mountain*; but we cannot be said to remember them, for they were never perceived. That a dog can contemplate in his imagination the idea of a *centaur* or of a *golden mountain*, we have not the least reason to suppose; but were he not capable of viewing relicts of sense reposed with him, and referring them to their original causes, he could not possibly recognise his master after a day's absence.

73 the power of recollection.

Dr Reid and the same author agree with Aristotle, in thinking it probable that brutes have not reminiscence, or the power of recollection; but there are many well-attested facts which seem to prove the contrary. We shall mention one which fell under our own observation. One of the persons concerned in this work was, when a young man, absent for five months from the house of his father. Upon his return, a dog of that species which is commonly called the *shepherd's cur*, and which had been in the possession of his father only a few months before his departure, gazed at him for a few minutes as at any other stranger. The animal then began to walk round him with looks which soon attracted his notice. This made him call the dog by the name which he bore in the family, and stretch out his hand to caress him, when the creature instantly leaped upon him with all that appearance of attachment which these animals so commonly exhibit upon the return of their master after a few days absence. If this was not recollection, we should be glad to know what it was, for we cannot distinguish it from recollection in men. Indeed, if dogs and some other animals possess, as Aristotle, Locke, and others, allow them to possess, the power of memory, and something of ratiocination; and if, as Dr Reid expressly says*, "they expect events in the same order and succession in which they happened before;" it is not conceivable that they can be wholly destitute of reminiscence, or the power of recollection.

74 Memory capable of improvement.

That memory is a faculty of the first importance, cannot be denied; since it is obvious, that, without the power of retaining the ideas and notions which we receive by the senses and other faculties, we never could make any progress in the acquisition of knowledge, but should begin every day, nay every hour, in the same

* *Essays on the Intellectual Powers of Man.*

Of ſimple Apprehenſion and Conception.

ſame ſtate of ignorance in which we are born. That it is a faculty capable of improvement by exerciſe, and that there are ſome methods of exerciſe better adapted for this purpoſe than others, has been ſhown elſewhere. See MEMORY.

CHAP. III. *Of* SIMPLE APPREHENSION *and* CONCEPTION.

75 Ideas of ſenſation the firſt materials of human knowledge.

THE ideas received into the mind by the ſenſes, and treaſured up in the memory and imagination, are the original materials of human knowledge. It is by comparing thoſe ideas with one another, or by analyzing them into their firſt principles, that we acquire all our knowledge in mathematics and philoſophy, and indeed all the knowledge which regulates our conduct through life. It muſt, therefore, be of importance to trace the progreſs of the mind in her various operations upon theſe materials; beginning, as ſhe certainly begins, with that which is moſt ſimple, and proceeding regularly to thoſe which are more complex and difficult.

76 Simple apprehenſion of ideas

Now the firſt operation of the mind about her ideas appears plainly to be that which logicians term *ſimple apprehenſion*. Having yeſterday obſerved a *tree* or any other object, if we contemplate the idea of that tree to-day as it remains in the imagination, without comparing it with any other idea, or referring it to any external object, we perform the operation which is called *ſimple apprehenſion*. We conſider ſimple apprehenſion as an *operation*, becauſe the mind in the apprehenſion of her own ideas is certainly active; ſhe turns them, as it were, round and round, and views them on every ſide.

77 different from conception.

Simple apprehenſion is a phraſe which is commonly taken to be of the ſame import with the word *conception;* and in the ordinary affairs of life no confuſion can ariſe from an indiſcriminate uſe of the two words: but in this article we think it expedient to employ the phraſe *ſimple apprehenſion*, to denote the view or contemplation of thoſe ideas only which the mind by ſenſation has actually received from external objects; and the word *conception* to denote the view, not only of thoſe ideas, but alſo of ſuch as the mind fabricates to herſelf. Thus, a man may *conceive* a centaur, but we would not chooſe to ſay that he may *apprehend* a centaur: not that there is any impropriety, perhaps, in this laſt expreſſion; but as there is certainly a difference between *apprehending* the idea of what has been ſeen or felt, and *conceiving* that which never exiſted, perſpicuity requires that theſe different operations be expreſſed by different names.

78 In what ſenſe it is true that we can conceive objects which never exiſted

We have ſaid that the mind may conceive what never exiſted: and every man may eaſily ſatisfy himſelf that what we have ſaid is true: but though this has been frequently called the creative power of the mind, it has in fact no reſemblance to *creation*. The materials of all our moſt complex and fantaſtic conceptions are furniſhed to our hands by ſenſation and reflection; nor can we form one ſimple idea which was not originally received by ſome of our ſenſes from external objects, or, as ſhall be ſhown afterwards, one intellectual notion which was not acquired by reflecting on the operations of our own minds. To explain the proceſs of fantaſtic conception, it is to be obſerved, that in every ſenſible object we perceive at once ſeveral things, ſuch as *colour*, *figure*, *extenſion* and *motion* or *reſt*, &c. Theſe are the objects of different ſenſes: but they are not, at leaſt by full-grown men, perceived in ſucceſſion, but all at once; whence it comes to paſs that the memory, or the imagination, retains not ſeveral diſtinct and disjointed ideas, but the idea of *one coloured*, *figured*, and *extended object*. But when we compare various objects, or the ideas of various objects, together, we find that in ſome reſpects they agree and in others diſagree; i. e. that ſeveral objects affect ſome of our ſenſes in the ſame way, and other ſenſes differently. Thus one globe is black, and another white; one black ſubſtance is circular and hard, and another ſquare and ſoft. In the firſt inſtance, the two globes affect our ſenſe of touch in the ſame way, and our ſenſe of ſeeing differently; in the ſecond, the two black ſubſtances affect our ſenſe of ſight in the ſame way, and our ſenſe of touch differently.

From obſerving this difference among objects by means of the different ſenſations received from them, the mind learns to analyze its original ideas, which are copies of thoſe ſenſations, into their firſt principles, and to combine thoſe principles in ſuch a manner as to form complex ideas of objects which were never actually perceived by the ſenſes. Of the ſimple and unmixed principles which compoſe thoſe complex ideas, there is not indeed one which was not originally received by ſome ſenſe; ſo that the whole difference between complex ideas fabricated by the mind, and thoſe which are the relicts of ſenſation, conſiſts in the order in which the conſtituent ſimple ideas of each are put together. Thus, no man ever ſaw a mountain of pure gold; and therefore the idea of ſuch a mountain can be in no human mind as a relict of ſenſation; but we have all ſeen pieces of gold of different ſizes, and we have all ſeen mountains; and nothing is more eaſy than to *conceive* a piece of gold extended on all ſides to the ſize of a mountain, and riſing out of the earth. Again, Though no perſon ever ſaw a centaur, yet it is eaſy to *conceive* the upper parts of a man joined to the breaſt and ſhoulders of a horſe. In theſe inſtances, the complex conceptions are of things which it is in the higheſt degree probable never had a real exiſtence, and which it is certain we never *perceived* as exiſting: but the ſimple ideas of which they are compoſed are the relicts of actual ſenſations; for every one has perceived as really exiſting the body of a horſe and the upper parts of a man, and when conceiving a centaur he only perceives them to exiſt united. That we have not in the imagination one ſimple and unmixed idea which was not left there as a relict of ſenſe, every man will be convinced who ſhall try to conceive a ſimple colour or taſte which is totally different from all the colours and taſtes, and all the ſhades and varieties of them, which he has received by ſenſation; but his ſimple ideas, though all received from without, he may put together in numberleſs manners, differing from any order in which he has ever actually perceived the qualities of external objects exiſting.

79 This power of conception limited to poſſible exiſtence.

Yet even this power of the mind is limited. It is impoſſible to put together a number of *contrary* and *inconſiſtent* ideas, in ſuch a manner as to form of them one complex conception. No man, for inſtance, can

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conceive a thing to be at once white and black, round and ſquare, hard and ſoft, in motion and at reſt.— Hence it is a maxim among philoſophers almoſt univerſally received, that though we can conceive many things which never *actually* exiſted, yet we can form no ideas but of ſuch things as *might poſſibly exiſt*. A centaur never exiſted, but it may be conceived; for it is by no means impoſſible that the head of a man might be joined to the body of a horſe: but black ſnow cannot be *conceived;* for in the complex idea denoted by the word *ſnow* whiteneſs is an eſſential part, and nothing can be conceived to be both black and white at the ſame time. From this undoubted fact, that we cannot conceive impoſſible exiſtence, the power of conception has by ſome writers in certain inſtances been made a teſt of truth. "In every idea is implied (ſays Dr Price *) the poſſibility of the exiſtence of its object; nothing being clearer, than that there can be no idea of an impoſſibility, or conception of what cannot exiſt." "It is an eſtabliſhed maxim in metaphyſics (ſays Hume), that whatever the mind conceives, includes the idea of poſſible exiſtence; or, in other words, that nothing we imagine is abſolutely impoſſible †." In a word, it has been admitted by all philoſophers, from Pythagoras to Dr Reid, to be an axiom as evident and undeniable as any in Euclid, that whatever we can diſtinctly conceive is poſſible, though many things may be poſſible, nay may really exiſt, of which we can form no conception.

* *Review of the principal Queſtions and Difficulties in Morals.*

† *Eſſays.*

80 The ſingular opinion of Dr Reid reſpecting our power of conception

This axiom has been denied by the author of the Eſſays on the Intellectual Powers of Man; who affirms, that any two ſides of a triangle may be conceived to be equal to the third," as diſtinctly as "any two ſides of a triangle may be conceived to be greater than the third." This aſſertion from ſuch a man ſurpriſed us as much as any paradox which we ever read: for nothing is more certain, than that *we* ourſelves can form no conception of a triangle of which two of the ſides are only equal to the third. We can, indeed, reſolve the propoſition into its different parts, and form the diſtinct and independent ideas of a *triangle*, *two ſides*, and *one ſide;* and we can likewiſe form the general notion of *equality:* but to combine theſe ideas and this notion into one individual complex conception, we find to be abſolutely impoſſible. A man who knows nothink of triangles, if ſuch a man there be, might *believe* Dr Reid that it is a figure of which one of its ſides is equal to the other two; but ſuch a perſon would have no *conception* of the *figure itſelf*, but only a confidence in the doctor's veracity.

81 controverted.

What is it to *conceive* a corporeal thing to exiſt? Is it not to fancy that we view it on all ſides, as what may be ſeen, or felt, or ſmelt, or taſted? The doctor, indeed, repeatedly reprobates as the ſource of much error the notion of ideas as images in the mind; and if ideas be taken as real material figures, he is certainly in the right: But we appeal to the common ſenſe of mankind, whether every perſon who diſtinctly *conceives a triangle*, is not at the time conſcious that his mind is affected in a manner ſimilar, though not ſo forcibly, as when he actually views a triangle with his eyes? What other men may feel, they know beſt; but we are as certain that this is the caſe with reſpect to ourſelves, as we are certain of our own exiſtence. That this affection of the mind is occaſioned by ſome agitation in the brain, of the ſame kind with that which occaſions actual perception, is highly probable; but whatever be the cauſe, the fact is undeniable.

The doctor's words, indeed, taken by themſelves, would lead one to think, that by *conception* he means in this caſe nothing more than the underſtanding of the terms of a propoſition: but if that be his meaning, there was no room for controverſy; as the great philoſophers *Cudworth*, *Clarke*, *Price*, and *Hume*, whoſe opinion he is combating, would have been as ready as himſelf to allow, that when a man is thoroughly maſter of any language, he will find no difficulty in underſtanding the meaning of any particular words in that language, however abſurdly theſe words may be put together. When Dr Price ſays, that "in every idea is implied the poſſibility of the exiſtence of its object, nothing being clearer than that there can be no idea of impoſſibility or conception of what cannot exiſt," his meaning evidently is, that we cannot mentally contemplate or fancy ourſelves viewing any thing corporeal, which we might not actually view with our eyes, or perceive by ſome other ſenſe (K). This is the true meaning of *conception*, which is ſomething very different from underſtanding the ſeparate meaning of each word in a propoſition.

The learned profeſſor, however, appeals to the practice of mathematicians for the truth of his opinion: and if they be on his ſide, we muſt give up the cauſe; for in no ſcience have we ſuch clear ideas, or ſuch abſolute certainty, as in mathematical reaſonings. But it is to be obſerved, that the word *conception* is with

(K) Dr Price may be thought by ſome to have contradicted in this paſſage what he had aſſerted in a former. He is a ſtrenuous advocate for abſtract and general ideas even of material objects; but thoſe among the moderns who contend the moſt zealouſly for theſe, contend for them only as conceptions of the mind which can have no poſſible exiſtence out of it. Were this likewiſe the opinion of Dr Price, he would certainly have fallen into a direct contradiction; but this is not his opinion. His notion of abſtract ideas ſeems to be the ſame with that of Plato, who conſiders ideas not only as the poſſibilities of exiſtence but as things actually exiſting from eternity, uncreated and independent even of the Supreme Mind That Dr Price carries the matter thus far, we are unwilling to believe; but he certainly conſiders general ideas as real exiſtences independent of *our* minds, though the immediate objects of our underſtanding. That in this notion he is miſtaken, we ſhall endeavour to prove in the next chapter. It is enough for our preſent purpoſe to have ſhown that he does not contradict himſelf; and that he might with great propriety affirm on his own principles, as well as upon the principles of thoſe who admit not of univerſal ideas, that in every idea is implied the poſſibility of its object.

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with no propriety applied to *abſtract truth*, but to *real* or *poſſible* exiſtence; nor can we be ſaid to conceive diſtinctly a *real* or *poſſible* object, unleſs we be able to turn it round and round, and view it on all ſides.—The faculties which are converſant about *abſtract truth* are the judgment and the reaſon; and truth itſelf conſiſts in the agreement, as falſehood does in the diſagreement, of two or more ideas or terms compared together. If thoſe ideas about which the judgment is to be made can be immediately brought together, without the intervention of a third idea, it is impoſſible that we ſhould *judge*, or, if Dr Reid will have it ſo, *conceive* that to be *true* which is *really falſe*. If the two ideas cannot be immediately brought together, it is impoſſible that we ſhould form any *judgment* or *conception* at all about their *agreement* or *diſagreement*: but we may *ſuppoſe* or *admit*, for the ſake of argument, that they agree or diſagree; and if that ſuppoſition conduct to a manifeſt abſurdity, we then *know* that the ſuppoſition was falſe. It is, therefore, perfectly agreeable to the maxim of Price and Hume, that mathematicians ſhould in many caſes prove ſome things to be poſſible and others impoſſible, which without demonſtration would not have been believed; becauſe if the ideas compared cannot be immediately brought together, no *judgment* previous to the demonſtration can be formed of the truth or falſehood of the propoſition; and if it concern not real or poſſible exiſtence, it is a propoſition with which *conception* has nothing to do.

"But (ſays Dr Reid) it is eaſy to *conceive*, that, in the infinite ſeries of numbers and intermediate fractions, ſome one number, integral or fractional, may bear the ſame ratio to another as the ſide of a ſquare bears to its diagonal." We are ſo far from thinking this an eaſy matter, that if the word *conceive* be taken in the ſenſe in which is is uſed by the philoſophers whoſe opinion he is combating, we muſt confeſs that we can form no adequate conception at all of an infinite ſeries. When we make the trial, we can only bring ourſelves to *conceive* the real numerical figures 1, 2, 3, &c. or the fractional parts $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, &c.; and even here our *conception* reaches but a ſmall way. We have reaſon to believe, that minds of a larger graſp can conceive at once more of the ſeries than we can; and that the Supreme Mind conceives the whole of it, if the whole of a mathematical infinity be not a contradiction in terms: but ſurely no man will ſay that he can conceive an infinite ſeries as he conceives a centaur, and have an adequate and diſtinct view of it at once. If, by conceiving that in an infinite ſeries ſome one number may bear the ſame ratio to another that the ſide of a ſquare bears to its diagonal, the doctor only means that ſuch a *ſuppoſition* may be made, his obſervation is not to the purpoſe for which it is brought; for the queſtion is not about our power to make ſuppoſitions of this kind, but about our power to raiſe in our imaginations an adequate and diſtinct mental view of poſſible or impoſſible exiſtence. "To ſuppoſe (ſays Johnſon), is to advance by way of argument or illuſtration, without maintaining the truth of the poſition." In this ſenſe a man may *ſuppoſe* that in an infinite ſeries there may be ſome one number which bears the ſame ratio to another that the ſide of a ſquare bears to its diagonal: but ſuch a ſuppoſition contains in it nothing that is *poſitive*, which conception always does; it is only admitting, for the ſake of argument, a poſition, of the truth or falſehood of which the perſon who makes the ſuppoſition knows nothing.—He is only talking of ratios as a blind man may talk of colours. A man born blind may be made to comprehend many of the laws of optics, and may make ſuppoſitions about colours, and reaſon from ſuch ſuppoſitions to a certain extent, as clearly and juſtly as one who ſees; but will any perſon ſay that a man blind from his birth can conceive *red* or *green?* It is much the ſame with reſpect to an infinite ſeries. We can follow ſuch a ſeries ſo far, and may know the ratio by which it increaſes or decreaſes, and reaſon from what we know with the utmoſt certainty: but no man ever *conceived the whole of an infinite ſeries* as he conceives an individual object; nor can any reaſonings upon the nature of it be applied to the queſtion of conceiving impoſſible exiſtence.

But "mathematicians often require us (ſays Dr Reid) to conceive things that are impoſſible, in order to prove them to be ſo. This is the caſe in all their demonſtrations *ad abſurdum*. Conceive (ſays Euclid) a right line drawn from one point of the circumference of a circle to another, to fall without the circle. I conceive this, I reaſon from it, until I come to a conſequence that is manifeſtly abſurd, and from thence conclude that the thing which I conceived is impoſſible." If it be indeed true, that Euclid deſires his readers to conceive a mathematical circle with a line drawn from one point of its circumference to another, and that line lying without the circle—if he really deſires them to form ſuch a complex conception as this, we have no heſitation to affirm, that he requires them to do what is manifeſtly impoſſible. The writer of this article has not in his cuſtody any copy of the Elements in the original Greek, and therefore cannot ſay with certainty what are Euclid's words, nor is it of much importance what they be; for on a queſtion which every man may decide for himſelf, by looking into his own mind, the authority of Euclid is nothing.—The propoſition to which the doctor refers, is the ſecond of the third book; and, in the edition of Simpſon, is expreſſed thus: "If any two points be taken in the circumference of a circle, the ſtraight line which joins them ſhall fall within the circle." Every mathematician who can form an adequate conception of a circle and a ſtraight line, perceives the truth of this propoſition inſtantly, for it reſults neceſſarily from his conception; but he who has not an adequate conception of a circle, *may* ſtand in need of a demonſtration to ſhow him the truth: for it is to be obſerved, that demonſtration does not *make truth;* it only points it out to thoſe who cannot perceive it intuitively, juſt as a microſcope does not make the hairs on a mite's back, but only brings them within the field of viſion.

Were a man who never examined a mite through a microſcope, and who has no adequate ideas of the inſect kingdom, to be aſked whether there be hairs on a mite's back? he would probably anſwer that he did not know, but he could *conceive* no ſuch hairs. In like manner, were a man who has no adequate conception of a mathematical circle, to be aſked whether a ſtraight line, which joins any two contiguous points in the circumference, could lie *without* the circle? he would probably

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bably anſwer that he did not know. Now it is to be remembered, that the reader of the Elements can have no very adequate conception of a circle when he comes to the ſecond propoſition of the third book. The definition of a circle was indeed given him in the introduction to the firſt book; but of that definition he has hitherto had occaſion to make very little uſe, ſo that his idea of a circle will be little more accurate than that of an illiterate clown, who has no other idea of the figure than what he takes from a halfpenny or a ſhilling. Dr Reid himſelf has elſewhere † well obſerved, that "when a youth of moderate parts begins to ſtudy Euclid, every thing at firſt is new to him. His apprehenſion is unſteady; his judgment is feeble, and reſts partly upon the evidence of the thing, and partly upon the authority of his teacher: but every time he goes over the definitions, the axioms, the elementary propoſitions, more light breaks in upon him; the language becomes familiar, and conveys clear and ſteady conceptions." In this ſtate he certainly is when he reads for the firſt time the ſecond propoſition of the third book: his conception of a circle can then be neither clear nor ſteady. Our young geometrician, however, muſt allow, that the propoſition is either true or falſe; and if he has read the preceding books with any advantage, he muſt have clear and ſteady conceptions of angles and triangles, and be able to demonſtrate many of their properties. "Well (ſays Euclid), though you have no adequate conception of a circle, you are well acquainted with plane angles and triangles, and many of their properties: let us ſuppoſe, if that be poſſible, that my propoſition is falſe, and I will ſhow you that the ſuppoſition is abſolutely inconſiſtent with what you know to be demonſtrable or ſelf-evident truth." This is all which Euclid can be ſuppoſed to require, when, in the words of his excellent tranſlator, he ſays, "If it (viz. the ſtraight line) do not fall within (the circle), let it fall, if poſſible, without." He could not poſſibly deſire a man who has an adequate idea of a circle, to form the poſitive and complex conception of that figure, with a ſtraight line touching two points of the circumference, and yet lying on the outſide of the circumference; becauſe all his figures and lines are mere conceptions, and not real material things; and ſuch a requeſt would have been the ſame thing as if he had ſaid, Conceive what cannot be conceived (L).

† See *Lord Kame's Sketches of the Hiſtory of Man;* Appendix to the firſt Sketch on the Sciences.

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We have inſiſted the longer on this point, becauſe we think it of the higheſt importance: for were it indeed true, that we could conceive impoſſible exiſtence, the conſequences would be very melancholy. Theſe conſequences it is needleſs to enumerate. Our readers will perceive, that if we could put together inconſiſtent ideas of ſenſible objects, and view them ſo united as one conſiſtent whole, nothing is clearer than that our faculties would be contrived to deceive us, and we would be doomed to cheerleſs and univerſal ſcepticiſm.

Chap. IV. *Of* Abstraction *and* general Ideas.

82 Every ſenſible object and every idea are individual.

Every ſenſible object is an individual, and differs in many reſpects from every other object. As ſuch it is perceived by the ſenſes; and ideas being nothing more than relicts of ſenſation preſerved in the imagination or memory, every idea muſt of courſe be an individual, as much as the object to which it refers. But all ſcience, whether mathematical, moral, or metaphyſical, is converſant about general truths; and if truth conſiſt, as we have already obſerved, and ſhall more fully evince afterwards, in the agreement or coincidence of ideas, how, it may be aſked, can general truth reſult from the compariſon of particular ideas? To get rid of this difficulty, many philoſophers, both ancient and modern, pretend that the mind is furniſhed with *general ideas*, from a compariſon of which reſult general propoſitions applicable to many individuals. Philoſophers, indeed, have differed in opinion reſpecting the ſource of thoſe ideas, ſome of the ancients deriving them immediately from the Supreme Mind to the human, whilſt almoſt all the moderns ſay that they are framed by abſtraction, and therefore call them *abſtract ideas*.

83 The doctrine of abſtract ideas ſtated, and

The doctrine of *abſtract* ideas has been ſo fairly ſtated, and, in our opinion, ſo completely overturned, by Biſhop Berkeley, that we ſhall content ourſelves with abridging what he has ſaid on the ſubject, and obviating

(L) Principal Campbell, treating of the commonly received doctrine of abſtraction, and having ſhown, that though Locke has in one paſſage of his immortal work expreſſed himſelf on the ſubject in terms unintelligible, his ſentiments on the whole differed little from thoſe of Berkeley and Hume, adds, "Some of the greateſt admirers of that eminent philoſopher ſeem to have overlooked entirely the preceding account of his ſentiments on this ſubject; and, through I know not what paſſion for the paradoxical (I ſhould rather ſay the impoſſible and unintelligible), have ſhown an amazing zeal for defending the propriety of the haſty expreſſions which appear in the paſſages formerly referred to. Has not the mind of man (ſay they) an unlimited power in moulding and combining its ideas? The mind, it muſt be owned, hath an unlimited power in moulding and combining its ideas. It often produces wonderful forms of its own out of the materials originally ſupplied by ſenſe; forms indeed of which there is no exemplar to be found in nature:—centaurs and griffins,

Gorgons and hydras, and chimeras dire.

But ſtill it muſt not attempt abſolute impoſſibilities, by giving to its creature contradictory qualities. It muſt not attempt to conceive the ſame thing to be black and white at the ſame time; to be no more than three inches long, and yet not leſs than three thouſand; to conceive two or more lines to be both equal and unequal; the ſame angle to be at once acute, obtuſe, and right;" or we may add, the two ſides of a triangle to be not greater than the third. See *Philoſophy of Rhetoric*, vol. ii. p. 108, &c.

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obviating ſome cavils which have lately been urged againſt his reaſoning. "It is agreed on all hands (ſays that learned and ingenious prelate *), that the qualities or modes of things do never really exiſt each of them apart by itſelf and ſeparated from all others; but are mixed, as it were, and blended together, ſeveral in the ſame object. But, we are told the mind being able to conſider each quality ſingly, or abſtracted from thoſe other qualities with which it is united, does by that means frame to itſelf abſtract ideas. For example: There is perceived by ſight an object extended, coloured, and moved: this mixed or compound idea, the mind reſolving into its ſimple conſtituent parts, and viewing each by itſelf excluſive of the reſt, does frame the abſtract ideas of extenſion, colour, and motion. Not that it is poſſible for colour or motion to exiſt without extenſion; but only that the mind can frame to itſelf by *abſtraction* the idea of colour excluſive of extenſion, and of motion excluſive of both colour and extenſion. Again, The mind having obſerved, that in the particular extenſions perceived by ſenſe, there is ſomething common and alike in all, and ſome other things peculiar, as this or that figure or magnitude, which diſtinguiſh them from one another; it conſiders apart, or ſingles out by itſelf, that which is common, making thereof a moſt abſtract idea of extenſion, which is neither line, ſurface, nor ſolid, nor has any figure or magnitude, but is an idea entirely preſcinded from all theſe. So likewiſe the mind, by leaving out of the particular colours perceived by ſenſe that which diſtinguiſhes them one from another, and retaining that only which is common to all, makes an idea of colour in abſtract, which is neither red, nor blue, nor white, nor any other determinate colour. And as the mind frames to itſelf abſtract ideas of qualities or modes, ſo does it by the ſame preciſion or mental ſeparation attain abſtract ideas of the more compounded beings, which include ſeveral coexiſtent qualities. For example: The mind having obſerved that *Peter*, *James*, and *John*, reſemble each other in certain common agreements of ſhape and other qualities, leaves out of the complex or compounded idea it has of *Peter*, *James*, and any other particular man, that which is peculiar to each, retaining only what is common to all, and ſo makes an abſtract idea wherein all the particulars equally partake, abſtracting entirely from and cutting off all thoſe circumſtances and differences which might determine it to any particular exiſtence. After this manner, it is ſaid, we come by the abſtract idea of *man*, or, if you pleaſe, humanity or human nature, in which, it is true, there is included colour, becauſe there is no man but has ſome colour; but then it can be neither *black*, nor *white*, nor any *particular* colour, becauſe there is no one particular colour wherein all men partake. So likewiſe there is included ſtature; but then it is neither tall ſtature, nor low ſtature, nor middle ſtature, but ſomething abſtracted from all theſe; and ſo of the reſt. Moreover, there being a great variety of other creatures that partake in ſome parts, but not all, of the complex idea of *man;* the mind, leaving out thoſe parts which are peculiar to man, and retaining thoſe only which are common to all the living creatures, frameth the idea of *animal;* which abſtracts not only from all particular men, but alſo from all birds, beaſts, fiſhes, and inſects. The conſtituent parts of that abſtract idea of animal, are body, life, ſenſe, and ſpontaneous motion. By *body*, is meant body without any particular ſhape or figure, there being no one ſhape or figure common to all animals, without covering either of hair or feathers or ſcales, &c. and yet not naked; hair, feathers, ſcales, and nakedneſs, being the diſtinguiſhing properties of particular animals, and for that reaſon left out of the *abſtract idea*. Upon the ſame account, the ſpontaneous motion muſt be neither walking, nor flying, nor creeping: it is nevertheleſs motion; but what that motion is, it is not eaſy to conceive.

84 controverted; and

"Whether others have this wonderful faculty of *abſtracting their ideas* (continues the biſhop), they beſt can tell; for myſelf, I find indeed that I have a faculty of imagining or repreſenting to myſelf the ideas of thoſe particular things which I have perceived, and of variouſly compounding and dividing them. I can imagine a man with two heads, or the upper parts of a man joined to the body of a horſe. I can conſider the hand, the eye, the noſe, each by itſelf abſtracted or ſeparated from the reſt of the body. But then, whatever hand or eye I imagine, it muſt have ſome particular ſhape, and ſome particular colour.—Likewiſe the idea of man that I frame to myſelf, muſt be either of a white, or a black, or a tawney, a ſtraight or a crooked, a tall or a low, or a middle-ſized man. I cannot by any effort of thought conceive the abſtract idea above deſcribed. To be plain, I own myſelf able to abſtract in one ſenſe, as when I conſider ſome particular parts or qualities ſeparated from others with which, though they are united in ſome objects, yet it is poſſible they may really exiſt without them. But I deny that I can abſtract one from another, or conceive ſeparately thoſe qualities which it is impoſſible ſhould exiſt ſo ſeparated; or that I can frame a general notion by abſtracting from particulars in the manner aforeſaid; and there are grounds to think moſt men will acknowledge themſelves to be in my caſe."

85 ſhown to be abſurd.

To think this, there are indeed ſuch good grounds, that it is probable ſome of our readers, little converſant with the writings of modern metaphyſicians, are by this time diſpoſed to ſuſpect, that the biſhop in his zeal may have miſrepreſented the doctrine of *abſtraction;* as no man in his ſenſes, who is not perverted by ſome darling hypotheſis, can ſuppoſe himſelf capable of tagging together ſuch monſtrous inconſiſtencies, as magnitude which is neither large nor ſmall, and colour which is neither white, red, green, nor black, &c. But that the ingenious prelate, in his account of this proceſs of *lopping* and *pruning*, as Mr Harris contemptuouſly, but moſt properly, terms it, has not exaggerated in the ſmalleſt degree, is apparent from the following account of *abſtraction* given by Mr Locke. "*Abſtract ideas* (ſays that writer) are not ſo obvious or eaſy to children, or the yet unexerciſed mind, as particular ones. If they ſeem ſo to grown men, it is only becauſe by conſtant and familiar uſe they are made ſo; for when we nicely reflect upon them, we ſhall find that general ideas are fictions and contrivances of the mind that carry difficulty with them, and do not ſo eaſily offer themſelves as we are apt to imagine. For example, does it not require ſome pains and ſkill to form the general idea of a triangle

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triangle (which is yet none of the most abstract, comprehensive, and difficult)? for it must be neither oblique nor rectangle, neither equilateral, equicrural, nor scalenon, but *all and none of these at once*. In effect, it is something imperfect that cannot exist, an idea wherein some parts of several different and *inconsistent* ideas are put together." "Surely (to use the words of Principal Campbell *) the bare *mention* of this hypothesis is equivalent to a confutation of it, since it really confutes itself." But if any man has the faculty of framing in his mind such an idea of a triangle as is here described, it would be vain in us to dispute with him; for we are possessed of no such faculty, and therefore would fight on unequal terms. All we have to desire is, that the reader would fully and certainly inform himself whether he has such an idea or not; and this can be no hard task to perform. What is more easy for any one than to look a little into his own thoughts, and there try whether he has, or can attain to have, an idea of *colour* separated from all *extension*; of *extension*, which is neither *great* nor *small*; of *taste*, which is neither *sweet* nor *bitter*, nor *acid*, nor *agreeable*, nor *disagreeable*; or the general idea of a triangle, which is neither *oblique* nor *rectangle*, *equicrural*, *equilateral*, nor *scalenon*, *but all and none of these at once* (M)?

* *Philosophy of Rhetoric.*

86
Abstract conceptions the same with abstract ideas.

Dr Reid having denied that there are or can be in the mind any *ideas* of sensible objects, rejects of course the doctrine of *abstract general ideas*, whilst he maintains in fact the same thing, only substituting the word *conception* for the word *idea*. "What hinders me (says he) from attending to the whiteness of the paper before me, without applying that colour to any other object?" We know nothing indeed which can hinder any man from performing this operation, which is daily and hourly performed by infants; but will the doctor say, that he can attend to colour, or conceive it, abstracted from the paper and every other surface? We are persuaded he will not, though he immediately adds, the "whiteness of this individual object is an *abstract conception*." Now we should rather have thought, that, consistent with his own notions of colour, he would have called the whiteness of the paper a *concrete quality*, and his own conception of it a *particular* and *concrete conception*. If he conceives the whiteness as separated from the paper, it is no longer the whiteness of that individual object: and he must either conceive it as abstracted from *all* objects, which is plainly impossible: or he must conceive it as inhering in some other object, and then neither the quality of whiteness, nor his conception of it, is abstract in general, but concrete and particular. He affirms, however, "that in abstraction, strictly so called, he can perceive nothing that is difficult either to be understood or practised." This is going much farther into the doctrine than Mr Locke went; for he owned that there was much difficulty in it. Let us see how it becomes so easy to Dr Reid. "What can be more easy (says he) than to distinguish the different attributes which we know to belong to a subject? In a man, for instance, to distinguish his size, his complexion, his age, his fortune, his birth, his profession, and twenty other things that belong to him." All this indeed, and much more, we can do with the utmost ease; but this is not abstraction, strictly so called, nor any thing like abstraction. We distinguish the size, the complexion, the age, &c. of the man, from *one another*: but still we conceive them all as *his* qualities; nor is it possible, at least for us, *to abstract them from him*, without conceiving them as the qualities of some *other* man; so that *our* conceptions are all concrete and particular. "It ought likewise to be observed (says the professor), that attributes may with perfect ease be distinguished and *disjoined* in our conception, which cannot be *actually separated* in the subject." They may be so in his conception, but certainly not in ours; for *we* can conceive nothing which may not actually exist. "Thus (continues he) I can in a body distinguish its solidity from its extension, and its weight from both. In extension, I can distinguish length, breadth, and thickness; yet none of these can be separated from the body, or from one another. It is therefore *certain*, that attributes, which in their nature are absolutely inseparable from their subject, and from one another, may be disjoined in our conception; one *cannot exist* without the other, but one *can be conceived* without the other." So far is this from being a matter of *certainty*, that in every possible sense in which we can understand the word *conception*, it appears to us as evidently *false*, as that *three* and *two* are equal to *nine*. It is indeed not difficult to distinguish *in* a body its solidity from its extension, and its weight from both: but can we distinguish them *out* of the body? or, to speak in plain language, can we conceive *solidity* as separated from *all extension* and *all weight*? Unless this can be done, and by *us* it cannot be done, there is no *abstraction strictly so called*. It is indeed easy to conceive *solidity* or *extension* abstracted from *any one* individual object: but how is it done? Why by transferring your attention to some other *individual object*. Thus, we can easily conceive *solidity* or *extension* separated from a guinea, for instance; but it is only by transferring our thoughts to another body, *a piece of silver*, or a *ball of lead*, &c. and our conceptions in both cases are *particular* and *concrete*.

As we think this opinion of Dr Reid's respecting ABSTRACTION both ill-founded and of dangerous consequences, we have expressed our dissent from it in strong terms; and in doing so we have only followed the example set us by himself when dissenting from the theories of Hume and Berkeley. But we are so thoroughly

(M) "If such an extraordinary faculty (abstraction) were possible, I cannot for my part conceive what purpose it could serve. An idea hath been defined by some logicians, the form or resemblance of a thing in the mind; and the whole of its power and use in thinking is supposed to arise from an exact conformity to its archetype. What then is the use or power of that idea, to which there neither is nor can be any archetype in nature, which is merely a creature of the brain, a monster that bears not the likeness of any in the universe?" *Philosophy of Rhetoric*, vol. ii. p. 110.

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roughly convinced that the doctor's acuteneſs is ſuperior to our own (M), that we are not without our fears that we may have miſtaken his meaning. We are conſcious that we have not wilfully miſrepreſented it; and to enable our readers to judge for themſelves between him and us, we ſhall lay before them his definition of *general conceptions* in his own words.

87
Terms, how they are

* Eſſay on the Intellectual Powers of Man.

That there are in every language *general terms*, is known to all mankind; for ſuch are all ſubſtantives, proper names excepted; and all adjectives. But "it is impoſſible (ſays the doctor*) that words can have a general ſignification, unleſs there be conceptions in the mind of the ſpeaker and of the hearer, of *things* (N) that are *general*. It is to ſuch that I give the name of *general conceptions*: and it ought to be obſerved, that they take this denomination, not from the act of the mind in conceiving, which is an individual act; but from the object or thing conceived, which is general." Now, whatever is conceived, muſt be either *external* to the mind, or *preſent* with it. But the doctor himſelf acknowledges, "That all the objects we perceive are individuals. Every object of ſenſe, of memory, or of *conſciouſneſs*, is an individual object. All the good things we enjoy or deſire, and all the evils we feel or fear, muſt come from individuals; and I think I may venture to ſay, that every creature which God has made in the heavens above, or in the earth beneath, or in the waters under the earth, is an individual." If this be ſo, and no man can call it in queſtion, it is obvious that we can have no *general* conception of any thing *external*. The *act* of conceiving is *an individual act*; and therefore the only thing which can be *general*, muſt be ſomething preſent with the mind, and different from the *mere act of conceiving*: But what can this be, if not what Berkeley and others call an *idea*? and how can we have an *idea* of which we are not *conſcious*? yet every thing of which we are conſcious Dr Reid himſelf acknowledges to be an *individual*.

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of general ſignification.

But if the doctrine generally received reſpecting abſtract ideas be ſo very abſurd as it has appeared in our repreſentation, how comes it to be ſo prevalent among the acuteſt philoſophers? To this we anſwer, that thoſe philoſophers have certainly in this inſtance been impoſed upon by the ſtructure of language. Every adjective and every ſubſtantive, proper names excepted, are words of general ſignification; and all ſcience is converſant about general truth; but as words are ſaid to be ſignificant, not of things, but of ideas; and as truth reſults from the agreement or coincidence of ideas; it has been haſtily ſuppoſed, that without general ideas there could have been neither general terms nor general truth. This is plauſible, but it is not ſolid. Every object which affects our ſenſes is an individual object; but we perceive that two or more objects which affect ſome of our ſenſes very differently, affect others of them in preciſely the ſame way. Thus, the paper upon which one writes, the ſnow which he perceives from his window, and the milk which he may uſe at breakfaſt, affect his ſenſes of touch and taſte very differently, but they preſent the ſame appearances to his eye. This diverſity in the one caſe he believes to proceed from different powers or qualities in the ſeveral objects; and the ſameneſs of appearance in the other, from ſimilar qualities in theſe objects. To the ſimilar qualities, though he can frame no idea of them abſtracted from every individual object, he gives one common name; and calls every object which preſents the ſame appearance to his eye that ſnow does, a *white* object; where the word *white* does not ſtand for an abſtract idea, but for a quality inherent in one or more objects. Hence the origin of adjectives in language, which denote more than can be expreſſed by any claſs of ſubſtantives; for every adjective, beſides the power of a name, includes in itſelf the force of a conjunction. See GRAMMAR.

The other claſs of general terms comprehends ſubſtantives; of which the origin is as follows: The objects about which we have occaſion to ſpeak or write are ſo numerous and ſo fluctuating, that if every individual had a proper name, a complete language could never be formed. But as there are not perhaps in nature two objects that appear to us ſimilar in all reſpects, ſo are there not in nature two objects which affect *all* our ſenſes differently. The mind, therefore, either actually perceiving two or more objects at once, or contemplating the *ideas* left by two or more objects in the memory, perceives, by its intellective power, in what reſpects they agree and in what they diſagree. If the agreement be ſtriking, and in more qualities than one, it combines the ſeveral individuals into one claſs or ſpecies, giving to the whole a common name, which equally denotes the ſpecies and every individual belonging to it. Thus, obſerving that Peter, James, and John, agree in having the ſame erect form, in walking on two legs, in having hands, &c. and in being endowed with reaſon, we combine theſe three, and all other individuals which we perceive to agree in the ſame ſtriking and important qualities, into one ſpecies, to which we give the name of *man*—a word which equally denotes the whole ſpecies and every individual of it. Again, Contemplating ſeveral figures, which all agree in the circumſtance of being bounded by three ſtraight lines meeting one another ſo as to form three angles, we call the whole claſs of figures and each individual by the name of *triangle*—though it may be impoſſible to contemplate any number of triangles without perceiving that all the angles of one are acute; that one angle of another is a right angle; and that in the third there is one angle obtuſe; but the word *triangle*, unleſs it is limited in its ſignification by the addition of an adjective, is equally expreſſive of an acute-angled triangle, a right-angled triangle, and an obtuſe-angled triangle. By thus arranging individuals according to their moſt conſpicuous qualities, we may combine all the objects exiſting into ſo many claſſes or ſpecies, which ſhall be afterwards known by as many names; but of each ſpecies we neither have, nor can have,

(M) Notwithſtanding this declaration, which is made with the greateſt ſincerity, we do not apprehend that we are guilty of preſumption when we examine the doctor's opinions. Berkeley and Hume were certainly as acute as any metaphyſician who has ſucceeded them; yet their opinions have been canvaſſed without ceremony, and to much advantage. *Aliquando bonus dormitat Homerus.*

(N) He tells us ſoon afterwards, that there are *no things general*. How is the one paſſage to be reconciled with the other?

Of Abſtraction and general Ideas.

have, any other idea than that of a multitude of ſimilar individuals.

As our acquaintance with nature enlarges, we diſcover reſemblances, ſtriking and important, between one ſpecies and another, which naturally begets the notion of a higher claſs called a *genus*. From comparing man with beaſts, birds, fiſhes, and reptiles, we perceive that they are all alike poſſeſſed of life, or a principle of ſenſation and action, and of an organized body: hence we rank them all under a higher claſs or genus, to which we give the name of *animal;* which equally denotes the whole *genus*, each ſpecies comprehended under the *genus*, and every *individual* of every *ſpecies*. Thus, *animal*, is a *genus ; man, beaſt, bird*, are ſo many *ſpecies* comprehended under that *genus ;* and *Peter, James*, and *John*, are *individuals* of the ſpecies *man*. *Peter, James*, and *John*, are proper names, denoting each an *individual ; man, beaſt, bird*, are *ſpecific* terms, denoting each a *whole ſpecies* compriſing many *individuals ;* and *animal* is a *general term*, becauſe it denotes a *whole genus*, comprehending under it *ſeveral ſpecies*, of which each conſiſts of *many individuals ;* and the general term denotes either the whole *genus*, all the *ſpecies*, or any *individual* of all the ſpecies. This is the whole myſtery of *abſtraction :* they are merely *terms*, that in ſtrictneſs of ſpeech are *general* and *abſtract ;* and even thoſe are general only as *ſigns*, of which the full ſignification cannot always be repreſented by any conceivable *idea*.

89 Names and ideas often uſed as mere ſigns,

"It is a received opinion (ſays Biſhop Berkeley), that language has no other end but the communicating of our ideas, and that every ſignificant name ſtands for an idea. This being ſo ; and it being withal certain, that names, which yet are not thought altogether inſignificant, do not always mark out particular conceivable ideas ; it is ſtraightway concluded that they ſtand for abſtract notions. That there are many names in uſe amongſt ſpeculative men, which do not always ſuggeſt to others determinate particular ideas, is what nobody will deny : and a little attention will diſcover, that it is not neceſſary, even in the ſtricteſt reaſonings, that ſignificant names, which ſtand for ideas, ſhould every time they are uſed excite in the underſtanding the ideas they are made to ſtand for. In reading and diſcourſing, names are for the moſt part uſed as letters in algebra ; in which, though a particular quantity be marked by each letter, yet to proceed right, it is not requiſite that in every ſtep each letter ſuggeſt to our thoughts that particular quantity it was appointed to ſtand for." The ſame thing is true of ideas, which as well as names are often uſed merely as ſigns repreſenting a whole claſs ; and on that account they may be called *general*, though every idea is in itſelf ſtrictly particular. Thus, "An idea, which conſidered in itſelf is particular, becomes general by being made to repreſent or ſtand for all other particular ideas of the ſame ſort. To make this plain by an example, ſuppoſe a geometrician is demonſtrating the method of cutting a line in two equal parts : He draws, for inſtance, a black line of an inch in length : this, which in itſelf is a particular line, is nevertheleſs, with regard to its ſignification, general ; ſince, as it is there uſed, it repreſents all particular lines whatſoever : ſo that what is demonſtrated of it is demonſtrated of all lines, or, in other words, of a line in general. And as that particular line becomes general by being made a ſign, ſo the *name* line, and the *idea* of a line in the imagination, either of which taken abſolutely is particular, by being ſigns are made general likewiſe. And as the former owes its generality, not to its being the ſign of an abſtract or general line, but of all particular right lines that may poſſibly exiſt ; ſo the latter, the name and the idea, muſt be thought to derive their generality from the ſame cauſe, namely, the various particular lines which each of them indifferently denotes." Again, When one demonſtrates any propoſition concerning triangles, it is to be ſuppoſed that he has in view to demonſtrate an univerſal truth ; yet the particular triangle which he conſiders muſt be either equilateral, iſoſceles, or ſcalenon ; for a plain triangle, which is none of theſe, can neither exiſt nor be conceived. But whether it be of this or that ſort is of no importance, as any of them may equally ſtand for and repreſent all rectilineal triangles, and on that account be denominated *univerſal*.

This doctrine reſpecting names and ideas being uſed merely as *ſigns*, has been adopted by almoſt every ſubſequent philoſopher ; and by Principal Campbell it has been illuſtrated with perſpicuity and acuteneſs every way worthy of the author of the Diſſertation on Miracles. "In confirmation of this doctrine (ſays he *), it may be obſerved, that we really think by *ſigns*, as well as ſpeak by them. All the truths which conſtitute ſcience, which give exerciſe to reaſon, and are diſcovered by philoſophy, are general ; all our ideas, in the ſtricteſt ſenſe of the word, are particular. All the particular truths about which we are converſant are properly hiſtorical, and compoſe the furniture of memory. Nor do I include under the term *hiſtorical* the truths which belong to natural hiſtory ; for even theſe too are general. Now, beyond particular truth or hiſtorical facts, firſt perceived and then remembered, we ſhould never be able to proceed one ſingle ſtep in thinking any more than in converſing, without the uſe of ſigns.

* *Philoſophy of Rhetoric.*

"When it is affirmed that *the whole is equal to all its parts*, there cannot be an affirmation which is more perfectly intelligible, or which commands a fuller aſſent. If, in order to comprehend this, I recur to ideas, all that I can do is to form a notion of ſome individual whole, divided into a certain number of parts of which it is conſtituted ; ſuppoſe of the year, divided into the four ſeaſons. Now all that I can be ſaid to diſcern here is the relation of equality between this particular whole and its component parts. If I recur to another example, I only perceive another particular truth. The ſame holds of a third and of a fourth. But ſo far am I, after the perception of ten thouſand particular ſimilar inſtances, from the diſcovery of the univerſal truth, that if the mind had not the power of conſidering things as ſigns, or particular ideas as repreſenting an infinity of others, reſembling in one circumſtance though totally diſſimilar in every other, I could not ſo much as conceive the meaning of an univerſal truth. Hence it is that *ſome ideas*, to adopt the expreſſion of Berkeley, *are particular in their nature, but general in their repreſentation*."

90 which, though particular in themſelves, ſerve to demonſtrate general truths ; becauſe

But if in univerſal propoſitions, ideas particular in themſelves be uſed only as the ſigns of others, it may be demanded, how we can know any propoſition to be true of all the ideas which are repreſented by the ſign ?

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sign? For example, having demonstrated that the three angles of an isosceles rectangular triangle are equal to two right ones, how can we conclude that this affection therefore agrees to all other triangles which have neither a right angle nor two equal sides? To this question Bishop Berkeley and Principal Campbell give the following answer: Though the idea we have in view whilst we make the demonstration be that of an isosceles rectangular triangle, whose sides are of a determinate length, we may yet be certain that the demonstration extends to all other rectilineal triangles of what sort or bigness soever; for this plain reason, that neither the equality nor determinate length of the sides, nor the right angle, are at all concerned in the demonstration. It is true, the idea or diagram we have in view includes all these particulars; but then there is not the least mention made of them in the proof of the proposition. It is not said the three angles are equal to two right angles, *because* one of them is a *right angle*, or because the sides comprehending it are of equal length; which sufficiently shows that the right angle might have been oblique and the sides unequal; and for all that the demonstration have held good. In every one of Euclid's theorems, a particular triangle, and a particular parallelogram, and a particular circle, are employed as signs to denote all triangles, all parallelograms, and all circles. When a geometrician makes a diagram with chalk upon a board, and from it demonstrates the property of a straight-lined figure, no spectator ever imagines that he is demonstrating a property of nothing else but that individual white figure, five inches long, which is before him.—Every one is satisfied that he is demonstrating a property of all of that order, whether more or less extensive, of which it is both an example and a sign; all the order being understood to agree with it in certain characters, however different in other respects. Nay, what is more, the mind with the utmost facility extends or contracts the representative power of the sign as the particular occasion requires. Thus the same equilateral triangle will with equal propriety serve for the demonstration, not only of a property of all equilateral triangles, but of a property of all isosceles triangles, or even of a property of all triangles whatever. Nay, so perfectly is this matter understood, that if the demonstrator in any part should recur to some property belonging to the particular figure he hath constructed, but not essential to the kind mentioned in the proposition, and which the particular figure is solely intended to represent, every intelligent observer would instantly detect the fallacy: So entirely for all the purposes of science doth a particular serve for a whole species or genus. Now, why one *visible* individual should in our reasonings serve without the smallest inconvenience as a sign for an infinite number, and yet one *conceivable* individual, or a particular idea of imagination, should not be adapted to answer the same end, it will, we imagine, be utterly impossible to say (N).

It must, however, be confessed, that there is a considerable difference in kind, between *ideas* used as signs and the *general* terms of any language. Amongst all the individuals of a species, or even of the highest genus, there is still a natural connexion, as they agree in the specific or generic character; and when the mind makes use of any positive idea as the sign of the species or genus, that idea appears in the imagination as an exact resemblance of some one individual. But the connexion which subsists between words and things, or even between words and ideas, is in its origin arbitrary; and yet its effect upon the mind is much the same with that of the natural connexion between ideas and things. For having often had occasion to observe particular words used as signs of particular things, and specific terms used as signs of a whole species, we contract a habit of associating the sign with the thing signified, insomuch that either being presented to the mind necessarily introduces or occasions the apprehension of the other. Custom in this instance operates precisely in the same manner as natural resemblance in the other; so that certain sounds, and the ideas of things to which they are not naturally related, come to be as thoroughly linked in our conceptions as the ideas of things and things themselves. Nay, so completely are they linked together, that we often use, through long chains of reasoning, certain sounds or words, without attending at all to the ideas or notions of which they are signs. "I believe (says the author of *A Treatise on Human Nature*), that every one who examines the situation of his mind in reasoning will agree with me, that we do not annex distinct and complete ideas to every term we make use of; and that in talking of *government*, *church*, *negotiation*, *conquest*, we seldom spread out in our minds all the simple ideas of which the compound notions signified by these terms are composed. It is, however, observable, that notwithstanding this imperfection, we may avoid talking nonsense on these subjects, and may perceive any repugnance among the ideas as well as if we had a full comprehension of them." This remark generally holds true; but then it is to be observed, that all the words used as signs, and which yet do not denote any one conceivable determinate *idea*, must be capable of definition. Thus, in matters that are perfectly familiar, in simple narration, or in moral observations on the occurrences of life, a man of common understanding may be deceived by specious falsehood, but is hardly to be gulled by downright nonsense or a repug-

 nance

(N) Were it possible to frame an *abstract general idea* of a triangle, which is neither equilateral, isosceles, nor scalenon, even *that idea* must be used merely as a sign as much as any particular triangle whatever; and the question might still be asked, How we can know any proposition to be true of all the triangles represented by the sign? For example: having demonstrated that the three angles of an ideal triangle, which is neither equilateral, isosceles, nor scalenon, are equal to two right angles, how can we conclude that this affection agrees to triangles which are equilateral, &c.? To this question it is not easy to conceive what answer could be given other than that of Berkeley and Campbell, in the case of using particular and conceivable triangles as signs.

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nance of ideas. Almost all the possible applications of the terms (in other words, all the acquired relations of the signs) have become customary to him. The consequence is, that an unusual application of any of them is instantly detected: this detection breeds doubt, and this doubt occasions an immediate recourse to *definition*; which, proceeding through species and genera, resolves complex terms into others less complex, till it ends at last in simple ideas and relations, which can neither be defined nor misunderstood (o). See Logic.

91 It is not the *matter* but the *power* of the sign that is regarded by the mind.

Thus then we see, that though there are no ideas, properly speaking, general and abstract, a man may, by *terms* and *particular* ideas, used as *signs*, arrive at the knowledge of general truth. In neither case is it the *matter*, if we may be allowed the expression, but the *power* of the sign that is regarded by the mind. We find, that even in demonstrative reasonings, signs the most arbitrary, or mere symbols, may be used with as little danger of error as ideas or natural signs. The operations both of the algebraist and arithmetician are strictly of the nature of demonstration. The one employs as *signs* the letters of the alphabet, the other certain numerical characters. In neither of these arts is it necessary to form ideas of the quantities and sums signified; in some instances it is even impossible without resolving the quantity or sum into parts, in a manner analogous to definition; and then the mind comprehends not the whole quantity or number at once, but the several parts of which it is composed, which it connects (P) by the relation of junction or addition. Yet without this resolution, the equations and calculations carried on by means of the letters and figures significant of the whole quantity or the whole sum, are not the less accurate or convincing. And so much for *abstraction*, *generalization*, and the power of *signs*, whether *natural* or artificial.

Chap. V. *Of the* Association *of* Ideas.

92 A continued train of thought in the mind.

Every man whilst awake is conscious of a continued train of thought spontaneously arising in his mind and passing through it; nor could a single now or instant be pitched upon in which some idea is not present in his memory or imagination. No one idea, however, unless detained by a voluntary exertion of the mind, or unless productive of intense pleasure or pain, remains long in the imagination; but each hastens off the stage to make way for another, which takes its turn and is succeeded by a third, &c. We are not to imagine that this train of thought is altogether fortuitous and incoherent. "It is evident (says Mr Hume*), that there is a principle of connexion between different thoughts or ideas of the mind; and that, in their appearance to the memory or imagination, they introduce each other with a certain degree of method and regularity. In our more serious thinking or discourse this is so observable, that any particular thought which breaks in upon the regular track or chain of ideas is immediately remarked and rejected. Even in our wildest and most wandering reveries, nay, in our very dreams, we shall find, if we reflect, that the imagination ran not altogether at adventures, but that there was still a connexion upheld among the different ideas which succeeded each other. Were the loosest and freest conversation to be transcribed, there would immediately be observed something which connected it in all its transitions: Or, where this is wanting, the person who broke the thread of discourse might still inform you, that there had secretly revolved in his mind a succession of thoughts, which had gradually led him from the subject of conversation. Among different languages, even where we cannot suspect the least connexion or communication, it is found, that words expressive of ideas the most compounded, do yet nearly correspond to each other; a certain proof that the simple ideas comprehended in the compound ones, were bound together by some universal principle, which had an equal influence on all mankind."

* *Essays.*

93 Principles of association.

That these observations are well founded, every man may be satisfied by looking attentively into his own thoughts; but when the author reduces the principles of this association of ideas to *three*, viz. *resemblance*, *contiguity* in time and place, and *cause* or *effect*, he certainly contracts them within too narrow a compass. That these principles often serve to connect ideas, will not indeed be denied. A picture leads our thoughts to the original: the mention of one apartment in a building introduces an inquiry or discourse concerning the others: and if we think of a wound, we can hardly forbear reflecting on the pain which follows it. But surely ideas sometimes succeed each other without *resemblance*, without *contiguity* in time or in place, and without being connected by the relation of a *cause* to its *effect*. Besides all this, there are other associations than of *ideas*. Ideas are associated with passions and emotions, and passions and emotions are associated together. A particular idea is associated with a proper name, and often with the general name of the species. General conceptions, such as those which Mr Locke calls mixed modes (see Mode), are associated with signs both audible and visible, and signs are associated with each other. Surely virtue, as it consists in action and intention, does not resemble the *sound* virtue, is not *contiguous* to it in time or in place, and is neither its *cause* nor its *effect*; nor is it conceivable, that the arbitrary signs of different things should have any natural relation to one another.

But were the enumeration complete, the bare mention of these principles does not account for the phenomena:

(o) For a farther view of this subject, see some excellent observations on the common doctrine concerning abstraction by Professor Dugald Stewart of Edinburgh. *Elements of the Philosophy of the Human Mind.*

(P) No man, we think, will pretend that he can perceive at one view a million of individual men, or that he can imagine or conceive at once a million of ideal men: yet he may divide the million into parts, which, in the one case may be easily viewed, and in the other may be easily conceived, in succession. Thus, 100+100+100, &c.

Association of Ideas

nomena: For, granting the fact, it may still be asked, Why does a picture lead our thoughts to the original; or the mention of one apartment in a building introduce an inquiry concerning the others? To these questions our author has given no answer; nor are we acquainted with any writer who can be said to have attempted it, except Dr Hartley and his ingenious editor. There may be some of our readers whom the names of these men will prejudice against their theory; but, doubtless, the greater part are willing to adopt truth, or to examine an ingenious speculation, from whatever quarter it comes. To such as feel themselves otherwise disposed, we beg leave to say, that if they allow the name of *Priestley* to disgust them at what follows, they will furnish him with a new proof of the truth of the doctrine which they reject.

94 How they operate.

That *ideas* should be associated together, seems to be inevitable from the manner in which the mind acquires them. All our ideas, properly speaking, are of sensible objects, and by far the greater part of them of *visible* objects. But every sensible object conveys at once various sensations and perceptions to the mind, which appear not only united in fact, but inseparable in imagination. Thus, when a man looks at any particular object, a tree for instance, he perceives the *trunk*, *branches*, *leaves*, *size*, *shape*, and *colour*, &c. of the whole at *once*: he does not first perceive the *figure* of the trunk, then its *size*, then its *colour*, then the *branches*, &c. all in succession; but a perception of the *whole* is conveyed to the mind by one simultaneous impression (Q). We have already seen, that the senses, in fact, convey nothing to the mind but their respective sensations; and that the perception of the external object instantly follows the sensation. We have likewise seen, that sensation is occasioned by some impression, concussion, or vibration, given to the nerves and brain, and by them communicated to the mind or percipient being. We have likewise seen, that memory depends as much upon the brain as original sensation, and is always attended or occasioned by similar concussions or vibrations, &c. These are facts proved by universal experience, and which, we believe, no thinking man has ever called in question. It follows, therefore, that every actual sensation must leave some effect in the brain, either an actual print, which seems to be impossible, or a tendency to vibrate or be agitated in the same way as when the original impression was made. This being the case, it is natural to conclude, that when any part of the original perception is revived in the memory, the whole perception should be revived at once, so as that we cannot have an idea of the trunk of a tree without perceiving the ideas of the branches associated with it. This is indeed not merely natural, but the contrary seems to be impossible; for as the original agitation or vibration was occasioned by the whole tree, it is evident, that whatever effect or tendency that agitation or vibration left behind it, must be left by the whole vibration, and therefore be equally related to the whole tree.

But no object stands single in nature. When we view a tree, or any thing else, we always notice, however transiently, the field where it grows and the objects around it. These too leave effects in the brain at the same time that the tree does so; and therefore make their appearance with it in the memory or imagination: but if the tree was the object to which we principally attended during the actual sensation, the idea of it will be much more vivid than the idea of its adjuncts, and remain much longer in the imagination or memory; because the original sensation by which it was perceived, was struck much deeper than the sensations by which its adjuncts were perceived. All this must be intelligible to every one who attends to what we have already said of sensation, perception, and memory.

Thus we see why a picture leads our thoughts to the original, and why the mention of one apartment in a building introduces an inquiry concerning the others. It is not merely because the picture *resembles* the original, and because the apartments of a building are *contiguous*. Between a plain surface, variously coloured and shaded, and the contour of the human face, there is certainly very little real resemblance, as any man may be convinced who places his eye within six inches of a good picture. But the painter, having by his skill in perspective, contrived to lay his colours on the plain canvas in such a manner as that they reflect the same rays of light with the original, provided the spectator stand at the proper distance; these rays proceeding from the picture fall upon the eye in the same direction, and therefore give to the nerves and brain the very same impulse which was given by the original. When one apartment of a building is mentioned, we inquire concerning the others from the very same cause that, when we think of the trunk of a tree which we have seen, we cannot avoid thinking likewise of its branches.

95 Association gives meaning to the words of language;

But the principle of association takes place among things not naturally connected, as the apartments of a

(Q) This is certainly the case with adults, but it may be doubted whether it be so with very young children. It has been shown already, that the sensation communicated by the eye from any visible object, has not the least resemblance to that object; and that in looking at a tree or any thing else, a full-grown man pays not the least attention to the appearance which the tree really makes to his eye; nay, that he is not even conscious of that appearance farther than as it consists in colour. It is by the sense of touch only that we acquire ideas of figure, even of plain figure; and we imagine that we perceive them by the eye only because different figures, as distinguishable by touch, are so closely associated with their corresponding visible sensations, that long before we are capable of inquiry, these two things are inseparable in the imagination. It is otherwise with children, who, when they first begin to distinguish objects by the sense of sight, appear to do it, with great deliberation, as if they first felt the proper sensation of light and colour so or so modified, and afterwards acquired, by something like a mental inference, a notion of the figure at which they are looking.

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a building and a ſubſtance and its attributes and adjuncts. It is aſſociation which is the original ſource of all the general or complex conceptions which we have, and which even gives meaning to the words of every language. Between ſounds conſidered in themſelves, and things, or the ideas of things, every one knows that there is no natural connexion; yet the idea of every known object is in the mind of every man ſo ſtrictly aſſociated with the name that it bears in its native tongue, that the preſence of the one always ſuggeſts the other. It cannot indeed be otherwiſe, if we attend to the manner in which a child learns to affix a meaning to the words which he hears.—A child knows his mother and nurſe, and indeed almoſt every viſible object in the family, long before he acquires the power of articulation. The impreſſions made by theſe objects, and repeated daily and hourly on his brain, every one of which excites a ſenſation, muſt ſoon become ſo deep as not to be eaſily effaced. Numbers of them too are aſſociated together, ſo that the preſence of one introduces the other. It has been already obſerved, that ideas of ſight are the moſt vivid and the moſt laſting; but the child hearing the ſame ſound often repeated, even that ſound comes in time to leave in his memory a permanent idea. He then hears the ſound *nurſe*, for inſtance, uttered at the time when he is looking earneſtly at the perſon of the nurſe, with whom he is well acquainted, and to whom he is ſtrongly attached; and having the two ideas repeatedly excited together, they ſoon become ſo aſſociated, that the one neceſſarily excites the other: the *word nurſe* calls into view the *idea* of the *woman* treaſured up in his imagination.

But we need not have recourſe to children for the proof of our aſſertion. It is obvious that the name of every ſimple and uncompounded idea can be ſignificant only by aſſociation. Of a complex conception the name may be made intelligible by a definition; but ſimple ideas cannot be defined, and between ideas and ſounds there is no natural connexion, ſo as that the one previous to aſſociation ſhould ſuggeſt the other. Even of complex conceptions and mixed modes, the meaning of the names is generally acquired by aſſociation; for though it is certainly true, that all ſuch names are capable of definition, they are yet uſed with ſufficient propriety by thouſands who know not what a definition is. Were a plain unlettered man aſked to define virtue, it is not probable that he could do it ſo as to make himſelf underſtood; yet having ideas of the *practice of juſtice, charity, fortitude*, &c. ſtrictly aſſociated in his mind with the *word virtue*, he may know the general meaning of that word as well as the moſt acute grammarian or the moſt profound philoſopher.

An *alms* is a donation to a poor man; but a child who never heard of this definition knows perfectly what an *alms* is, from having often ſeen his parents give money to a beggar, and call what they were doing by the name *alms*. The ſound of the word, after having ſeen the firſt alms given, will excite in his mind an idea of the *individual* object who received it, and of the *action* of him by whom it was given; but after having ſeen ſeveral poor men relieved, he comes to aſſociate with the word *alms* any thing given to any perſon who needs it or appears to be in want.

So completely does this aſſociation take place between ideas or cluſters of ideas, and the words by which they are expreſſed, that even men of letters hear and underſtand perfectly many words without reviewing in their minds all the ideas and relations of which they are the ſigns. It has been already obſerved, that in talking of *government, church, negotiation, conqueſt*, we ſeldom ſpread out in our minds all the ſimple ideas of which the compound notions ſignified by theſe terms are compoſed; and we now add, that the terms may be uſed with ſufficient propriety, and be perfectly underſtood by thoſe who never attempted to analyze the notions of which they are ſignificant into their primary and conſtituent parts. Every man has read numberleſs details of the tranſactions of one court with another: he has heard ſuch tranſactions univerſally called by the term *negotiation*. The term and the tranſactions ſignified by it are ſo cloſely aſſociated in his mind, that they are in a manner inſeparable: and by this aſſociation he knows the meaning of the term better than he could have done by the moſt complete definition; which, perhaps, he would find it difficult to give, or even to comprehend.

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and is the ſource of our firſt notions of virtue.

We have ſaid that the *meaning* of the word *virtue* is acquired by aſſociation, by having often heard that ſound applied to certain *actions*; but it is extremely probable, that the very *notion* of virtue, ſimple and uncompounded as it appears to be, is acquired in the very ſame manner. The *firſt* rudiments of the notions of *right* and *wrong* and *obligation* ſeem to be acquired by a child when he finds himſelf checked and controuled by ſuperior power. At firſt he feels nothing but mere *force*, and conſequently has no notion of any kind of reſtraint but that of neceſſity. He finds he cannot have his will, and therefore he ſubmits. Afterwards he attends to many circumſtances which diſtinguiſh the commands of a *father*, or of a *maſter*, from thoſe of any other perſon. Notions of *reverence, love, eſteem*, and *dependence*, are connected with the idea of him who gives thoſe commands; and by degrees the child experiences the peculiar *advantages* of filial ſubjection. He ſees alſo that all his companions, who are noticed and admired by others, obey their parents; and that thoſe who are of a refractory diſpoſition are univerſally diſliked. Theſe and other circumſtances now begin to alter and modify the notion of mere neceſſity, till by degrees he conſiders the commands of a parent as ſomething that *muſt not* be reſiſted or diſputed, even though he has a power of doing it; and all theſe ideas coaleſcing, form the notions of *moral right* and *moral obligation*, which are eaſily transferred from the commands of a parent to thoſe of a magiſtrate, of God, and of conſcience. This opinion of the gradual formation of the ideas of moral right and wrong, from a great variety of elements aſſociated together, perfectly accounts for that prodigious diverſity in the ſentiments of mankind reſpecting the objects of moral obligation; nor do we ſee that any other hypotheſis can account for the facts. If the notion of moral obligation were a ſimple uncompounded idea, ariſing from the view of certain actions or ſentiments; or were it acquired, as it certainly might be, by a chain of reaſoning from the nature of God and the nature of man; why ſhould it not in the one caſe be as invariable as the perception of colours or ſounds, and in the other

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other as our judgments of mathematical or physical truths? But though the shape and colour of a flower appear the same to every human eye; though every man of common understanding knows, that if a billiard ball be struck by another, it will move from its place with a velocity proportioned to the force of the impulse; and though all mankind who have but dipt into mathematics, perceive that any two sides of a triangle must be greater than the third side; yet one man practises as a moral duty what another looks upon with abhorrence, and reflects on with remorse. Now a thing that varies with education and instruction, as moral sentiments are known to do, certainly has the appearance of being generated by a series of different impressions and associations in some such manner as we have endeavoured to describe. Let not any man imagine that this account of the origin of moral sentiments endangers the cause of virtue; for whether those sentiments be instinctive or acquired, their operation is the very same, and in either case their rectitude must often be tried by the test of reason, so that the interests of virtue are equally safe on this as on any other scheme. See *MORAL Philosophy*.

97 It ought, therefore, to be attended to in the education of youth.

This principle of association has so great an influence over all our actions, passions, reasonings, and judgments, that there is not perhaps any one thing which deserves more to be looked after in the education of youth. Some of our ideas—such as those of a substance and its attributes, a genus and the species contained under it, a species and its several individuals, have a real connexion with each other in nature. These it is the office of our reason to trace out and to hold together in that union and order in which nature presents them to the view of the mind; for such associations constitute perhaps the greatest part of necessary and of useful truths. But there are others formed by custom and caprice, which are too often the sources of error, superstition, vice, and misery—of errors the more dangerous, and of vice the more deplorable; that if the associations have been long formed without an attempt to dissolve them, they generally become at last too strong to be broken by the most vigorous effort of the best-disposed mind. Thus, let a foolish maid * amuse or rather frighten children with stories of ghosts appearing in the dark, let her repeat these fictions till they have made a deep impression on the young minds, and the notion of ghosts will in time become so closely associated with the idea of darkness, that the one shall always introduce the other; and it may not be in the power of the children, after they have become men, and are convinced in their judgments of the falsehood and absurdity of the tales which originally frightened them, to separate entirely the notion of ghosts from the idea of darkness, or with perfect ease to remain alone in a dark room. Again, Let the idea of *infallibility* be annexed to any person or society, and let these two inseparably united constantly possess the mind; and then one body in ten thousand places at once shall, unexamined, be swallowed for an incontrovertible fact, whenever that infallible person or society dictates or demands assent without inquiry.

* *Locke's Essay*, and his *Conduct of the Understanding*.

Some such wrong and unnatural combinations of ideas will be found to establish the irreconcilable opposition that we find between different sects in philosophy and religion; for we cannot imagine every individual of any sect to impose wilfully on himself, and knowingly to reject truth offered by plain reason. That which leads men of sincerity and good sense blindfold, will be found, when inquired into, to be some early and wrong association. Ideas independent and of no alliance to one another, are by education, custom, and the constant din of their party, so linked together in their minds, that they can no more be separated from each other than if they were but one idea: and they operate upon the judgment as if they really were but one. This gives sense to jargon, the force of demonstration to absurdities, and consistency to nonsense: it is the foundation of the greatest and most dangerous errors in the world; for as far as it obtains, it hinders men from seeing and examining.

98 The principle of association operates in our perception of external objects;

Before we dismiss the subject of association, it may be proper to inquire, how far it is agreeable to the account which we have given of the manner in which external objects are perceived by means of the senses, and the ideas of such objects retained in the memory. —It has been proved, we think, by arguments unanswerable, that by the organs of sense nothing is conveyed immediately to the mind but sensations which can have no resemblance to external objects, and that the perception of an object may be resolved into a process of reasoning from effects to causes.—But children, it will be said, do not reason from effects to causes, and yet they soon acquire the faculty of perceiving and distinguishing the objects with which they are surrounded. This is an undoubted truth; and it can be accounted for only by the principle of association. A child has as much the use of his senses as a full-grown man. By his eye he has the sensation of colour; by his nose, that of smell; by his ear he has the sensation of sound; and by his hand he feels heat and cold, resistance and bounded resistance. Every object which is presented to him, impresses his mind with various sensations: and these sensations combined together are probably all that he perceives for some years; for there is no reason to imagine that a boy of one or two years old has the slightest notion of what we mean by solidity, hardness, softness, or indeed of that which is termed *substance*. Yet when two or more objects are present, he may easily distinguish the one from the other, because the sensations excited by the one must differ from those excited by the other, as much as the real qualities of the one are different from the real qualities of the other; and by distinguishing between his own sensations, he in effect distinguishes between the objects which produce these sensations. His sensations too being frequently excited, leave behind them ideas in his memory or imagination; and those ideas, from having been imprinted together and never separated, become in time so closely associated, that whenever one of them is called into view, the others necessarily make their appearance with it. Thus a child has a set of combined sensations excited in his mind by the presence of his nurse; he has a different cluster excited, suppose by the presence of his mother. These are often repeated, and leave deep traces behind them; so that when the mother or the nurse makes her appearance, she is immediately recognised as a known object; or, to speak more correctly, the child feels the very same sensations

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tions which he has felt before, from which he has experienced pleaſure, and of which he has the ideas treaſured up in his memory or imagination. A ſtranger, on the other hand, muſt affect him with a ſet of new ſenſations, and of courſe will be diſtinguiſhed from a known object as accurately as if the child were poſſeſſed of the notions of ſolidity, ſubſtance, qualities, and diſtance. A man born blind, who knew not that ſuch things as fire and ſnow had ever exiſted, would yet diſtinguiſh the one from the other the moment that he ſhould be brought within their influence. He could not indeed apply their names properly, nor ſay which is the fire and which is the ſnow, nor would he at firſt have any notion of either of them as a real, external, and diſtant object; but he would certainly diſtinguiſh his own ſenſations, the ſenſation of heat from that of cold. It is juſt ſo with a child: At firſt he perceives nothing but different ſenſations. Theſe he can diſtinguiſh; and as they are cauſed by different objects, in diſtinguiſhing between the ſenſations he will appear to diſtinguiſh between the objects themſelves. In a ſhort time, however, he acquires, by the following proceſs, ſome inaccurate notions of diſtance. He looks, for inſtance, earneſtly in his nurſe's face, and at the ſame time touches her cheek perhaps by accident. He repeats this operation frequently, till the ſenſation communicated by his eye comes to be aſſociated with that of his touch, and with the extending of his arm; and being all treaſured up as aſſociated ideas in the memory, the ſight of his nurſe makes him ever afterwards ſtretch out his hands with a deſire to touch her. All this while there is not the ſlighteſt probability that the child has any notion of *ſubſtance*, or *qualities*, or of any thing beyond his own *ſenſations*, and the means by which he has experienced, that ſenſations which are pleaſant may be obtained, and that ſuch as are painful may be avoided. The preciſe time at which a child begins to think of external things we cannot pretend to aſcertain; but we are perſuaded that it is later than many perſons imagine, and certainly not till he has made conſiderable progreſs in the exerciſe of reaſon. Prior to that period the things which men know to be bodies, are known to children only as ſenſations and ideas ſtrongly bound together by the tie of aſſociation.

99 and ſeems to diſtinguiſh memory from imagination;

But if aſſociation be of ſuch importance in the act of ſenſation, it is of ſtill greater in that of retention; for it ſeems to conſtitute the whole difference that there is between imagination and memory. By many of the ancient, as well as by ſome modern philoſophers, theſe two faculties ſeem to have been confounded with each other; but between them there is certainly a great difference, though they likewiſe reſemble each other in ſome reſpects. An idea of memory, conſidered by itſelf, makes the very ſame appearance to the intellect as an idea of imagination. We contemplate both as if they were actual, though faint and diſtant perceptions: but the one is attended with the conviction, that it is the idea of an object which has really been perceived at ſome period of paſt time; whilſt the other is attended with no conviction, except that the idea itſelf is actually preſent to the mind. Mr Hume has ſaid, that ideas of memory differ from thoſe of imagination only in being more vivid and diſtinct; but certainly this is not always the caſe. An idea of imagination has ſometimes been taken for a real perception, which an idea of memory can never be. The difference between theſe two kinds of ideas, we are perſuaded, ariſes chiefly, if not wholly, from aſſociation. Every idea of memory is aſſociated with many others, and thoſe again with others down to the very moment of the energy of remembrance; whereas ideas of imagination are either the voluntary creatures of the fancy at the moment of their appearance, in which caſe we ſhould call them conceptions; or they are ideas which we have actually received from ſenſation, but which, on account of ſome link being broken in the vaſt chain of aſſociation, we cannot refer to any real objects. What gives probability to this conjecture is, that ideas often appear in the mind which we know not whether to refer to the memory or imagination, nothing being more common than to hear a perſon ſay, I have in my head the idea of ſuch or ſuch an object; but whether I remember or only imagine the object, I am very uncertain. Afterwards, however, by turning the idea over and over in the mind, he finds other ideas make their appearance, till at laſt cluſters of them come into view, and aſſociate ſo cloſely with the principal idea, which was the object of doubt, as to convince the judgment that it is an idea of memory.

100 and to be the ground of our belief of what we remember.

It has been aſked, Why we believe what we diſtinctly remember? and to that queſtion it has been ſuppoſed that no anſwer can be given. But it appears to us, that aſſociation is the ground of belief in this as it will be found to be in other inſtances; and that a man believes he waſhed his hands and face in the morning, becauſe the idea of that operation is ſo ſtrongly linked in his mind to the whole train of ideas which have ariſen in it through the day, that he cannot ſeparate the firſt from the laſt, that which was a ſenſation in the morning from the ſenſations which are preſent at the inſtant of remembrance. As thoſe ideas are aſſociated by nature, each muſt paſs in review in its proper order; ſo that in ſo ſhort a ſpace of time there is no danger, and hardly a poſſibility, of taking the firſt for the laſt, or the laſt for the firſt. Nay more, we will venture to hazard an opinion, that every paſt event of a man's life, which he diſtinctly remembers, is tied by the chain of aſſociation to his preſent perceptions. That this is poſſible is certain, ſince it is not difficult to conceive how it may be done. The principal events of a ſingle day may ſurely be ſo linked together as to be all diſtinctly reviewed in a cluſter of ideas on the morrow. Of theſe events ſome one or other muſt be the moſt important, which will therefore make its appearance as an idea more frequently than the reſt, and be more cloſely aſſociated with the events of next day. Some event of that day will, for the ſame reaſon, be more cloſely aſſociated with it than the others; and theſe two, dropping perhaps all the reſt of their original companions, will paſs on together to the third day, and ſo on through weeks, and months, and years. In the compaſs of a year, ſeveral things muſt occur to make deep impreſſions on the mind. Theſe will at firſt be aſſociated together by events of little importance, like the occurrences of a ſingle day. Whilſt theſe feeble chains, however, continue unbroken, they will be ſufficient to link the one

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one important event to the other, and to bring them both into view at the same time, till at last these two, from appearing so often together, will in time unite of themselves, and the intermediate ideas be completely effaced. Thus may two or three important events of one year be associated with such a number of similar events of another year, so that the ideas of the one shall always introduce to the mind the ideas of the other; and this chain of association may pass from the earliest event which we distinctly remember through all the intermediate years of our lives down to the instant when memory is exerted.

To this account of memory it may perhaps be objected, that it gives us no distinct notion of time. Every thing that is remembered is necessarily believed to have been present in some portion of past time; but association brings into view nothing but a series of events. This objection will be seen to have no weight when we have inquired into the nature of time, and ascertained what kind of a thing it is. It will then perhaps appear, that duration itself, as apprehended by us, is not distinguishable from a series of events; and that if there were no train of thought passing through our minds, nor any motion among the objects around us, time could have no existence. Meanwhile, whatever become of this opinion, we beg leave to observe, that our theory of remembrance is perfectly consistent with the commonly received notions respecting time; and indeed, that it is the only theory which can account for numberless phenomena respecting past duration. It is universally allowed, that if motion, or a succession of events, do not constitute time, it is the only thing by which time can be measured. Now it is a fact which no man will deny, that the distance of time from the present *now* or instant to the earliest period which he distinctly remembers, appears to his view extremely short, much shorter than it is said to be in reality; and that one year, when he looks forward, appears longer than two, perhaps longer than ten, when he looks backward. Upon our principles this fact is easily accounted for. We remember nothing which is not linked by a chain of associations with the perceptions of the present moment; and as none but a few of the most important events of our lives can be linked together in this manner, it hence follows, that events which, in the order of succession, were far *distant* from each other, must thus be brought *together* in the memory, and the whole chain be contracted within very short limits. But when we figure to ourselves a series of future events, we employ the active power of fancy instead of the passive capacity of retention; and can therefore bring within the compass of one periodical revolution of the sun a longer series of imaginary events succeeding each other, than is preserved of real events in our memory from the earliest period of our existence: So perfectly does our theory accord with this well known fact. On the other hand, if memory be an original faculty of the mind totally independent of association, and of which no other account is to be given than that it necessarily commands our belief, why is it a faculty which, with regard to duration, thus uniformly deceives us? and how comes it to pass, that to a man whose memory is tenacious, who has read much, seen many countries, and been engaged in various occurrences, any determinate portion of past time always appears longer than to another man whose memory is feeble, and whose life has been wasted in ease and idleness? To these questions we know not what answer can be given upon any other principle than that which makes the evidence of memory depend upon association. But if we remember nothing but what is linked to the perception or idea which is present with us at the time of remembrance, and if duration be measured by the succession of events, it is obvious that any portion of past time must necessarily appear longer to him who has many ideas associated in the mind than to him who has but few.

101 The importance of association in the philosophy of the human mind.

There is not perhaps a single fact of greater importance in the philosophy of the human mind than the *association of ideas*; which, when thoroughly understood, accounts for many of those phenomena which some late writers of name have, with injury to science and with danger to morality, attributed to a number of distinct and independent instincts. It is for this reason that we have considered it so minutely, and dwelt upon it so long; and in addition to what we have said on the subject, we beg leave to recommend to our more philosophical readers the diligent study of Hartley's Observations on Man (R). In that work we think several things are taken for granted which require proof; and some which, we are persuaded, have no foundation in nature: but, with all its defects, it has more merit than any other treatise on the sensitive part of human nature with which we are acquainted.

Chap. VI. *Of* Consciousness *and* Reflection.

102 Consciousness, what it is, and what are its objects.

Sensation, remembrance, simple apprehension, and conception, with every other actual energy or passion of the mind, is accompanied with an inward feeling or perception of that energy or passion; and that feeling or perception is termed *consciousness*. *Consciousness* is the perception of what passes in a man's own mind at the *instant* of its passing there; nor can we *see*, *hear*, *taste*, *smell*, *remember*, *apprehend*, *conceive*, employ our faculties in any manner, enjoy any pleasure, or suffer any pain, without being *conscious* of what we are doing, enjoying, or suffering. *Consciousness* is only of things *present* *; and to apply it to things *past*, is to confound *consciousness* with memory or *reflection*. One cannot say that he is conscious of what he has seen or heard and now remembers: he is only conscious of the act of remembrance; which, though it respects a past event, is itself a present energy. It is likewise to be observed, that consciousness is only of things in the mind or conscious being, and not of things external. It is improper in any person to say that he is *conscious* of

* Reid's *Essays on the Intellectual Powers of Man.*

(R) Since this was written, Mr Stewart's *Elements of the Philosophy of the Human Mind* have been published; in which the reader will find many excellent remarks on the nature and influence of the associating principle.

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of the table before him; he perceives it, he *sees* it, and he may with great propriety say that he is *conscious* he perceives or sees it; but he cannot say that he is conscious of the table itself, for it is only his immediate energy of perception that can be the object of consciousness. All the operations of our minds are attended with consciousness; which is the only evidence that we have or can have of their existence. Should a man take it into his head to think or to say that his consciousness may deceive him, and to require a proof that it cannot, we know of no proof that can be given him: he must be left to himself as a man that denies first principles, without which there can be no reasoning. Every attempt to prove this point, or to set it in a clearer light, would only serve to render it more dark and unintelligible. I *think*, I *feel*, I *exist*, are first truths, and the basis of all human knowledge.

103 Des Cartes's argument from consciousness for his own existence.

This has given rise to the question, whether Des Cartes did not fall into an absurdity when, inferring his own existence from his actual thought, he said, *Cogito, ergo sum.* This argument has been called a pitiful sophism, and a *petitio principii*; because, before a man take it for granted that he thinks, he must also, it is said, take it for granted that he exists, since there cannot be thought where there is no existence. Now it must be confessed, that if Des Cartes pretended by this argument to give us a fresh conviction of our own existence, his endeavours were useless and puerile; because a man capable of being convinced by the arguments of another, must have a previous conviction of his own existence: but the argument itself is certainly neither a sophism nor a *petitio principii*. Those * who defend Des Cartes assert, and there is no reason to doubt the truth of their assertion, that his only view in urging such an argument was not to prove the truth of our existence, but to exhibit the order of that process by which we arrive at the knowledge of the fact; and this he has very clearly done by analyzing the truth into its first principles. A stone exists as well as the human mind; but has the stone any knowledge of its own existence? No man will say that it has; neither should we have any knowledge of ours, did we think as little as the stone. We certainly *might* exist without thinking, as it is probable we do in very sound sleep; and in that state our existence might be known to other beings, but it could not possibly be known to ourselves: for the only things of which the mind is conscious, or has immediate knowledge, are its own operations. I *exist* is therefore a legitimate inference from the proposition I *think*; and the observation that it is so may be useful to show us the procedure of the mind in the acquisition of knowledge; but it has little merit as an argument, and still less as a discovery, though, being strictly true and just, it should never have been exposed to ridicule.

* See *Buffier's First Truth.*

104 Reflection, what it is, and how different from consciousness.

It is to be observed, that we are conscious of many things to which we give very little attention. We can hardly attend to several things at the same time; and our attention is commonly employed about that which is the *object* of our thought, and rarely about the thought itself. It is in our power, however, when we come to the years of understanding, to give attention to our own thoughts and passions, and the various operations of our minds. And when we make these the objects of our attention, either while they are present, or when they are recent and fresh in our memory, we perform an act of the mind which is properly called *reflection*. This *reflection* ought to be distinguished from *consciousness* *; with which it is confounded sometimes by Locke, and often by the learned author of Ancient Metaphysics. All men are *conscious* of the operations of their own minds at all times while they are awake, nor does it appear that brutes can be wholly destitute of consciousness; but there are few men who *reflect* upon the operations of their minds, or make them the objects of thought; and it is not probable that any species of brutes do so.

* *Reid's Essays on the Intellectual Powers of Man.*

From infancy, till we come to the years of understanding, we are employed solely about sensible objects. And although the mind is conscious of its operations, it does not attend to them; its attention is turned solely to the objects about which these operations are employed. Thus, when a man is angry, he is *conscious* of his passion; but his *attention* is turned to the *person* who offended him and the *circumstances* of the *offence*, while the *passion of anger* is not in the least the object of his attention. The difference between *consciousness* and *reflection*, is like the difference between a superficial view of an object which presents itself to the eye, while we are engaged about something else, and that attentive examination which we give to an object when we are wholly employed in surveying it. It is by consciousness that we immediately acquire all the knowledge which we have of mental operations; but attentive reflection is necessary to make that knowledge accurate and distinct. *Attention* is a voluntary act; it requires some exertion to begin and continue it; and by great exertion it may be continued for a considerable time; but *consciousness* is involuntary, and of no continuance, changing with every thought. The power of reflection upon the operations of their own minds does not at all appear in children. Men must have come to some ripeness of understanding before they are capable of it. Of all the powers of the human mind it seems to be the last that unfolds itself. Most men seem incapable of acquiring it in any considerable degree; and many circumstances conspire to make it to all men an exercise of difficulty. The difficulty, however, must be conquered, or no progress can be made in the science of our own or of other minds.

105 All our notions of mental energies got by reflection.

All the notions which we have of mind and of its operations are got by reflection; and these notions are by Mr Locke called *ideas of reflection*. This term we think extremely ill chosen; and we believe it has been the source of much error and confusion among Locke's followers. A man, by attending to the operations of his own mind, may have as distinct *notions* of remembrance, of judgment, of will, of desire, as of any object whatever: but if the secondary perception of a sensible object, that appearance which it has to the mind when viewed in the memory or imagination, be properly called an *idea*, it is certain that of the operations of the mind itself there can be no ideas; for these operations, when reflected on, make no appearance without their objects either in the memory or in the imagination. Nothing is more evident, in fact, than that we have no *ideas*, in the original and proper meaning of the word, but of sensible objects upon which the mind exerts its first operations. Of these operations we have indeed a consciousness;

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consciousness; but abstracted from their objects we cannot frame of them any idea or resemblance. We are *conscious* to ourselves of *thinking*, *willing*, *remembering*, *discerning*, *reasoning*, *judging*, &c. but let any one look into himself, and try whether he can there find any *idea* of *thinking* or *willing*, &c. entirely separate and abstracted from the *object* of thought or will. Every man who has seen a tree or house, will find in his mind ideas of these objects, which he can contemplate by themselves, independent of every thing else; but no man can contemplate the *idea* of thinking or desiring without taking into view the thing thought on or desired. It is plain, therefore, that the energies of *thinking*, *willing*, and *desiring*, with all their various modifications, are not themselves *ideas*, or capable of *communicating* ideas to be apprehended, as the ideas of bodies are apprehended by the pure intellect. They are the *actions* and *workings* of the *intellect itself* upon ideas which we receive from the objects of sense, and which are treasured up in the memory or imagination for the very purpose of furnishing the intellect with materials to work upon. Between *ideas* and the *energies of thinking* there is as great and as obvious a difference as there is between a *stone* and the *energies* of him by whom it is cast. Ideas are the passive subjects; the energies of thinking are the operations of the agents. Ideas are relicts of sensation, and have a necessary relation to things external; the energies of thinking are relicts of nothing, and they are wholly and originally internal.

106 Our knowledge of the operations of intellect immediate, and not by the intervention of ideas.

That we can in no sense of the word be said to have *ideas* of the operation of the intellect, will be still more evident, if we consider by what means we acquire the knowledge which we have of those operations. It has been already observed, that when our thoughts are employed upon any subject, though we are conscious of thinking, yet our *attention* is commonly employed upon the *object* of our thought, and not upon the *thought* itself; and that if we would give attention to our thoughts and passions, we must do it by a reflex act of the mind, whilst the act of thinking is still recent and fresh in our memory. Thus, if a man wishes to know what perception is, it is not the time to make the inquiry while he is looking at some rare or beautiful object; for though he is *conscious* of the energy of perceiving, the *object* of perception employs all his *attention*. But the time to make this inquiry is either when the object has become familiar to him, or presently after it is removed from his sight. In the former case, he can look upon it without emotion, pay attention to every step in the process of perception, and be immediately conscious what perception is. In the latter case, by turning his attention inwards, and reflecting on what he did or felt when the object was before him, he will find clear and vivid ideas of every thing which he perceived by his sense of sight; but he will find no *idea* of the act of *seeing* or *perceiving*. On the contrary, if he be capable of sufficient attention, he will observe that his intellect is employed in the very same manner upon the *ideas* that it was upon the original *sensations*; and of that employment, and the manner of it, he will be equally conscious as he was of the original energy exerted in sensation. There is indeed this difference between the two, without which reflection could make no discoveries, that the most vivid ideas being still faint when compared with actual sensations, the intellect is not so wholly engrossed by them, as it was by the original objects, nor is it so rapidly carried from idea to idea as it was from sensation to sensation. It is thus at leisure to attend to its own operations, and to know what they are; though to form *ideas* of them as separate from their objects, is absolutely impossible. Every man capable of paying attention to what passes within himself when he sees, hears, and feels, &c. may have very accurate *notions* of *seeing*, *hearing*, and *feeling* &c. but he cannot have *ideas* of them as he has of the *objects* of *sight*, *hearing*, and *touch*.

The same is the case with respect to the exertion of our reasoning faculties. A man must have distinct and clear *ideas* to reason upon, but he can have no *idea* of reasoning itself, though he must be conscious of it, and by attention may know what it is. When a man sits down to study for the *first time* a proposition in the Elements of Euclid, he certainly employs his reasoning faculty, and is conscious that he is doing so; but his attention is wholly turned to the diagram before him, and to the several ideas which the diagram suggests. Afterwards, when he has mastered the proposition, he may go over it again, with a view to discover what reasoning is; but he will not find he has any *idea* of reasoning as he has of the diagram. He will only exert that faculty a second time, and perceive one truth linked to and depending upon another in such a manner that the whole taken together forms a complete demonstration. In a word, the operations of our own minds, when attention is paid to them, are known immediately by consciousness; and it is as impossible that we should have ideas of them, as that a living man should be a picture upon canvas. He who attends to what passes in his own mind when he perceives, remembers, reasons, or wills, must know by consciousness what these operations are, and be capable of forming very accurate notions of them, as connected with their objects; and he who does not attend to what passes in his own mind will never acquire any notions of them, though he were to read all that has been written on the subject from the days of Pythagoras to those of Dr Reid.

107 There are things which we know partly by sensation and partly by reflection, &c.

As we acquire ideas of external objects by means of our senses; and notions of perceiving, remembering, reasoning, and willing, &c. by reflecting on the operations of our own minds; so there are other things of which we acquire notions, partly by sensation, partly by reflection, and partly by means of that faculty of which it is the more peculiar office to compare ideas and to perceive truth. Such are *substance*, *body*, *mind*, with their several qualities, adjuncts, and relations; the knowledge of which, as has been already observed, constitutes what in strictness of speech is termed the science of *metaphysics*. These shall be considered in order, after we have investigated the nature of truth, and inquired into the several sources of evidence; but there is one notion, about the origin and reality of which there have been so many disputes, which in itself is of so great importance, and which will be so intimately connected with all our subsequent inquiries, that it may not be improper to consider it here.—The notion to which we allude is of POWER.

108 Our notion of power how acquired.

Among the objects around us we perceive frequent changes, and one event regularly succeeding another.

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Gold thrown into the fire is changed from a solid to a fluid body. Water exposed to a certain degree of cold is changed from a fluid to a solid body. Night succeeds to day, and summer succeeds to winter. We are conscious of new sensations in ourselves every hour. We are likewise conscious of reasoning, willing, and desiring; and we know that by an exertion of will we can rise or sit, stand still or walk, call one idea into view, and dismiss others from our contemplation. Experience teaches us, that it is not occasionally, but always, that gold is changed into a fluid, by being thrown into the fire, and water into a solid body by being exposed to a certain degree of cold; that night succeeds to day, and summer to winter. These changes have regularly taken place since the creation of the world; and it has never once been observed that water was made solid by fire, or gold rendered liquid by cold. Were we not assured by experience that our own voluntary motions are produced by exertions of our minds, of which we are conscious, and that without such exertions those motions would never have taken place, we should probably have considered the liquefaction of gold as an event equally independent of fire, though uniformly conjoined with it, as night is independent of day, and day of night. But having experienced that we can move or not move our bodies as we please; that when it is our will to sit, we never get up to walk; and that when we wish to walk, we always do it except prevented by external violence: having likewise experienced, that by a thought, by some internal and inexplicable exertion of our minds, we can call up in our memory or imagination one idea and dismiss others from our mental view; we are led to believe with the fullest conviction, that all those motions of our bodies which in common language are termed *voluntary*, and that succession of ideas which follows a conscious exertion of the mind, depend upon ourselves. In other words, we are necessitated to believe that we have a *power* to move or not move our bodies in many cases, and a *power* to turn our attention to one idea in preference to others.

It is thus that we acquire the notion of *power* in ourselves, which we easily transfer to other objects. Knowing that the various motions of our bodies thus effected proceed from power, we are naturally led to inquire whether the changes which we perceive in other bodies may not proceed from *power* likewise, i. e. from something analogous to that power, of the exertions of which we are conscious in ourselves Now uniform experience teaching us that gold is liquefied by being thrown into the fire, and that water is made solid by being exposed to cold; we infer with the utmost certainty that there are *powers* in fire and cold to produce these changes, and that without the exertion of such *powers* these changes would not be produced. We cannot indeed say of external powers, as we can of our own, in what substance they inhere. We know with the utmost certainty that the voluntary motions of our hands, &c. are produced by a power not inherent in the hands but in the mind, for of the exertion of that power we are conscious; but we do not know whether the power which liquefies gold be inherent in that sensible object which we call *fire*, or in something else to which fire is only an instrument. We learn by observation, that the minute particles of fire or heat insinuate themselves between the particles of gold, and, if we may use the expression, tear them asunder; but whether they do this in consequence of a *power* inherent in themselves, or only as instruments impelled by another *power*, is a question which *observation* cannot enable us to answer.

Were we not conscious of the exertion of our own powers, it seems not conceivable that we could ever have acquired any notion of power at all; for power is not an object of sense, nor, independent of its operations, is it indeed an object of consciousness. In external operations, all that we perceive is *one thing*, in which we suppose the *power* to reside, followed by another, which is either the *change* or that on which the change is *produced;* but the exertion of the power itself we do not perceive. Thus we perceive gold, after it has been some time in the fire, converted from a solid to a fluid body; but we perceive not by our senses either the power or the energy of the power which operates to this conversion. In the exercise of our own powers, the case is otherwise. When a man puts his hand to his head, and afterwards thrusts it into his bosom, he not only perceives by his senses the change of position, but is also conscious of the energy or exertion by which the change was produced.

"Suppose (says Mr Hume *) a person, though endowed with the strongest faculties of reason and reflection, to be brought on a sudden into this world; he would indeed immediately observe a continual succession of objects, and one event following another, but he would not be able to discover any thing farther. He would not at first by any reasoning be able to reach the idea of cause and effect; since the particular powers by which all natural operations are performed never appear to the senses. The impulse of one billiard ball is attended with motion in the second. This is the whole that appears to the *outward* senses. The mind feels no sentiment or *inward* impression from this succession of objects; consequently there is not, in any single particular instance of cause and effect, any thing which can suggest the idea of power or necessary connexion. From the first appearance of an object, we never can conjecture what effect will result from it; but, were the power or energy of any cause discoverable by the mind, we could foresee the effect even without experience; and might at first pronounce with certainty concerning it by the mere dint of thought and reasoning. It is impossible, therefore, that the idea of power can be derived from the contemplation of bodies in single instances of their operations; because no bodies ever discover any power which can be the original of this idea."

* *Essays.*

There is a sense in which this reasoning is unquestionably just. A man who had never been conscious of exerting power in himself, would certainly not acquire the notion of power from observing a continual succession of external objects. The impulse of one billiard ball being followed by the motion of another, would no more lead him to the notion of power in the former, than the succession of night to day would lead him to the notion of a power in light to produce darkness. When Mr Hume says, "that from the *first* appearance of an object *we* can never conjecture what effect

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fect will reſult from it," he uſes language that is ambiguous, and utters an aſſertion which is either true or falſe according to the ſenſe in which it is underſtood. If it be meant, that after having reflected on the operations of our own minds, and learned by experience that motion is communicated by impulſe from one ball of ivory to another, we could not conjecture whether a ſimilar effect would be produced by the impulſe of balls made of other hard bodies which we had never before ſeen, the aſſertion is manifeſtly falſe. A man who had but once ſeen motion communicated in this manner from one *ivory* ball to another, would certainly conjecture that it might be communicated from one *wooden* ball to another; and if he had ſeen it repeatedly communicated from one ball to another of different ſubſtances, he would infer, with the utmoſt confidence, that it might be communicated from ball to ball of whatever ſubſtance compoſed, provided that ſubſtance be hard, or of a ſimilar texture with the balls to the impulſe of which he had formerly paid attention. If by this ambiguous phraſe the author only means, as is probably the caſe, that from the firſt appearance of an object to which we had never before obſerved any thing in any reſpect ſimilar, we could not conjecture what effect would reſult from it; or if his meaning be, that a man ſuddenly brought into the world, who had never acquired ſuch a notion of power as may be had from attention to the energies and operations of our own minds, would not, by obſerving an effect to reſult from one body, conjecture from the firſt appearance of another ſimilar body what effect would reſult from it; in either of theſe caſes his aſſertion is certainly true, and tends to prove, that without the conſciouſneſs of the operations of our own minds we could never acquire a notion of power from the changes perceived by our ſenſes in external objects.

109 Mr Hume attempts to prove that we can have no notion whatever of power.

But Mr Hume, not contented with denying, which he might juſtly do, that we could ever have derived the idea of power merely from obſerving the continual ſucceſſion of external objects, labours hard to prove that we have no notion of power at all, and that when we uſe the word *power*, we do nothing more than utter an inſignificant ſound. To pave the way for the arguments by which ſo extravagant a paradox is to be ſupported, he lays it down as a "propoſition which will not admit of much diſpute, that all our ideas are nothing but copies of our impreſſions; or, in other words, that it is impoſſible for us to *think* of any thing that we have not antecedently *felt* either by our external or internal ſenſes." As this propoſition, however, will admit, it ſeems, of *ſome* diſpute, he takes care, before he applies it to the purpoſe of demoliſhing all power, to ſupport it by two arguments. "Firſt (ſays he), when we analyze our thoughts or ideas, however compounded or ſublime, we always find that they reſolve themſelves into ſuch ſimple ideas as were copied from a precedent feeling or ſentiment. Thoſe who would aſſert, that this poſition is not univerſally true nor without exception, have only one, and that an eaſy, method of refuting it; by producing that idea, which, in their opinion, is not derived from this ſource. Secondly, If it happen, from a defect of the organ, that a man is not ſuſceptible of any ſpecies of ſenſation, we always find that he is as little ſuſceptible of the correſpondent ideas. A blind man can form no notion of colours, a deaf man of ſounds. And though there are few or no inſtances of a like deficiency in the mind, where a perſon has never felt, or is wholly incapable of a ſentiment or paſſion that belongs to his ſpecies; yet we find the ſame obſervation to take place in a leſs degree. A man of mild manners can form no idea of inveterate revenge or cruelty; nor can a ſelfiſh heart eaſily conceive the heights of friendſhip and generoſity."

110 His reaſoning ſophiſtical.

As theſe propoſitions are the engines by which all power is baniſhed from the world, it may not be improper, before we proceed to inquire by what means they perform ſo arduous a taſk, to conſider their own inherent ſtrength; for if they be weak in themſelves, their work, however dexterouſly they may be employed, can have no ſtability. We have already noticed the perverſeneſs of this writer's language, when it confounds *ſenſations* with *impreſſions*; but here it is ſtill more perverſe, for paſſions, ſentiments, and even *conſciouſneſs*, are ſtyled *impreſſions*. When ſenſations are confounded with impreſſions, the effect is only miſtaken for the cauſe, it being univerſally known that ſenſations proceed from impreſſions made upon the organs of ſenſe. When conſciouſneſs is confounded with an impreſſion, one thing is miſtaken for another, to which it is univerſally known to have neither reſemblance nor relation. But, not to waſte time upon theſe fallacies, which, though dangerous if admitted, are yet too palpable to impoſe upon a reader capable of the ſlighteſt attention, let us examine the propoſitions themſelves. The moſt important, and that for the ſake of which alone the others are brought forward, is, that it is impoſſible for us to *think* of any thing that we have not immediately *felt*, either by our external or internal ſenſes." Did Mr Hume then never *think* of a mathematical *point*, or a mathematical *line?* Neither of theſe things is capable of being *felt* either by making an impreſſion upon the organs of ſenſe or as an object of conſciouſneſs; and therefore it is impoſſible that he ſhould ever have had ideas of them ſuch as he doubtleſs had of ſenſible objects; yet in the moſt proper ſenſe of the word *think* (s), he certainly thought of both points and lines; for he appears to have made conſiderable progreſs in the ſcience of geometry, in which he could not have proceeded a ſingle ſtep without a perfect knowledge of theſe things, on which the whole ſcience is built. It is not therefore true, that our thoughts or ideas, when analyzed, always reſolve themſelves into ſuch ſimple ideas as were copied from a precedent feeling or ſentiment; for every mathematical figure of which we can think reſolves itſelf into a point and motion; and a point having

(s) *Thinking*, in the propriety of the Engliſh tongue, ſignifies that ſort of operation of the mind about its ideas wherein the mind is active; where it, with ſome degree of voluntary attention, conſiders any thing.— *Locke.*

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having no parts and no magnitude, cannot possibly be the object of feeling to any of our senses. If, therefore, ideas alone be the objects of thought, we have refuted Mr Hume's position by the very method which he himself lays down; for we have produced an idea which is not derived either from a precedent feeling or a precedent sentiment. By sentiment, we suppose to be here meant that which by other philosophers is denominated consciousness; and of consciousness it is undeniable that nothing is the object but the actual energies of our own minds.

111 Things of which we can have no *ideas* may themselves be the objects of thought

But ideas are not the only objects of thought. We have already given our reasons for restricting the word *idea* to that appearance which an object of sense, when reflected on, makes either in the memory or imagination. Such was undoubtedly its original signification; and had it never been used to denote other and very different objects, much error and perplexity would have been avoided, which now disgrace the science of metaphysics. Things may *themselves* be the objects of thought; and when that is the case, to think of their *ideas*, were it possible to do so, would be worse than useless; for we may certainly know a man better by looking at himself than by looking at his picture. Of things which are *themselves* the objects of thought, we have either a *direct* or a *relative* knowledge. We know directly the actual operations of our own minds by the most complete of all evidence, that of consciousness; and we have a *relative* notion of mathematical points and lines: but neither of mental energies nor of these external things (T) can we possibly have any *idea*.

112 We have only relative notions of some things,

It is well observed by Dr Reid*, that our notions both of body and mind are nothing more than relative. "What is body? It is, say philosophers, that which is extended, solid, and divisible. Says the querist, I do not ask what the properties of body are, but what is the thing itself? let me first know directly what body is, and then consider its properties. To this demand I am afraid the querist will meet with no satisfactory answer; because our notion of body is not direct, but relative to its qualities. We know that it is something extended, solid, and divisible, and we know no more. Again, If it should be asked, what is mind? It is that which thinks. I ask not what it does, or what its properties are, but what it is? To this I can find no answer; our notion of mind being not direct, but relative to its operations, as our notion of body is relative to its qualities (U)."

* *Essay on the Active Powers of Man.*

113 about which, however, we can reason with the utmost precision;

Our notion of a mathematical point is of the very same kind. What is a point? It is, says Euclid, that which hath no parts and no magnitude. Replies the querist, I ask not either what it has or what it has not, let me first know what it is? To this second question, it might perhaps be answered, that a mathematical point is that which by motion generates a line. But, rejoins the querist, I am not inquiring what it generates; give me a direct idea of the point itself? or, if that cannot be done, as surely it cannot, tell me what its offspring a line is? A line, says Euclid, is length without breadth. I have no idea, replies the querist, of length without breadth. I never felt an *impression* from a sensible object which did not suggest length, breadth, and thickness, as inseparably united; and I can have no idea which is not the *copy* of a *former impression*. To assist the querist's conception, it may be said that lines are the boundaries of a superficies, and that superficies are the boundaries of a solid body; but of a solid body every man has a clear and direct idea, in the most proper sense of the word. Here then are several things, viz. points, lines, and superficies, of not one of which is it possible to form a direct notion; and yet we know them so thoroughly, from the relation which they bear to other subjects, that we can reason about them with a precision and certainty which only the mathematical sciences admit.

114 And such is power.

The great advantage of these sciences above the moral, Mr Hume himself expressly admits: but he attributes it to a wrong cause, when he says it consists in this, that the "ideas of the former being *sensible* are always clear and determinate;" for we see that the notion of a point or of a line is merely relative, and cannot possibly be the copy of a sensation, or, in his language, of a sensible impression. If then we have clear and determinate notions of points and lines, and may reason about them without ambiguity, as he acknowledges we may, what is there to hinder us from having an equally clear and determinate notion of power, or from reasoning about it with as little ambiguity (V): Why, says he, we are not conscious of power. And to prove this position, which needs no proof,

(T) By calling mathematical points and lines external things, we do not mean to attribute to them any corporeal existence. We know well that they are merely creatures of the mind, and that if there were no mind, they could have no existence. But twenty men may at the same instant have a notion of the same lines and the same points; and therefore these lines and points have an existence independent of, and external to, any *one* mind, at least to any one *human* mind. The objects, however, of which a man is conscious, are in no sense whatever external, for they are present to no human mind but his own.

(U) The opinions of philosophers concerning corporeal and spiritual substances shall be considered more fully hereafter. In quoting from Dr Reid on another subject, we have been obliged to anticipate his opinion, which will be found to be not more modest than just.

(V) "There are some things of which we can have both a direct and relative conception. I can directly conceive ten thousand men, or ten thousand pounds, because both are objects of sense, and may be seen. But whether I see such an object, or directly conceive it, my notion of it is indistinct; it is only that of a great multitude of men, or of a great heap of money; and a small addition or diminution makes no perceptible change in the notion I form in this way. But I can form a relative notion of the same number of men or of pounds by attending to the relations which this number has to other numbers greater or less. Then I perceive that the relative notion is distinct and scientific; for the addition of a single man, or a single pound, or even of

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proof, he makes many observations that, however just, might certainly have been spared. Of these one is, that "a man suddenly struck with a palsy in the leg or arm, or who had now lost these members, frequently endeavours at first to move them, and employ them in their usual offices. Here he is as much conscious of power to command such limbs, as a man in perfect health is conscious of power to actuate any member which remains in its natural state and condition. But consciousness never deceives. Consequently, neither in the one case nor in the other are we ever conscious of any power." This is true; we never are conscious of any power; but we are frequently conscious of actual energies: and the man who, after being suddenly struck with a palsy, endeavours in vain to move his leg or arm, is as conscious of energy as he who in health makes the attempt with success. Nor let it be imagined that his consciousness deceives him; for, as Mr Hume justly observes, consciousness never deceives. He is certain of the *energy*, but finds by experience that the *instrument* of this energy has suddenly become disordered and unfit for its usual office. In this and this alone consists the difference between the paralytic and the man whose limbs are sound. The one may be as conscious of energy as the other, and his consciousness may be equally infallible. What then is this energy? Mr Hume will not say that it is an *idea*, for it is not the copy of any antecedent impression; besides, he has somewhere allowed that ideas are never active. Is it then a substance? Impossible! for it is not permanent: and we believe no man will venture to affirm, or even to suppose, that the same substance can be repeatedly annihilated, and as often created. Is it then the occasional exertion of some substance? This must be the truth; for no other supposition remains to be made. If so, that substance must be possessed of *power*; for a capacity of exerting actual energy is all that is meant by the word *power*. —"Wherever there is a *capability* of energy or exertion, there must be *power*; for though there can be no exertion without power, there may be power that is not exerted *. Thus a man may have *power* to speak when he is silent; he may have power to rise and walk when he sits still. But though it be one thing to *speak* and another to have the *power* of speaking, we always conceive of the power as something which has a certain relation to the effect; and of every power we form our notion by the effect which it is able to produce. Nor is it only in speaking and moving his limbs that a man is conscious of energy. There is as much energy, though of a different kind, in *thinking* as in *acting*. Hence the powers of the human mind have been divided into active and speculative. By the former we move the body; and by the latter we see, hear, remember, distinguish, judge, reason, and perform upon our notions and ideas every other operation which is comprehended under the general word *to think*."

* *Reid's Essays on the Active Powers of Man.*

115 Locke's passive power an improper expression.

Mr Locke † has introduced into his theory of power another distinction than that which we have made between active and speculative powers. Observing by our senses, under which on this occasion memory is certainly included, various changes in objects, we collect, says he, a possibility in one object to be changed, and in another a possibility of making that change, and so come by that idea which we call power. Thus we say that fire has a power to melt gold, and that gold has a power to be melted. The first he calls *active*, the second *passive*, power. But to say that the *possibility* of being changed is *power*, seems to be a very improper mode of speaking, and such as may lead to consequences which the excellent author certainly held in abhorrence. It tends to make unwary readers imagine that the passive subject is as necessary to the existence of power, as the active being of which power is an attribute; but if the universe had a beginning, and if its Creator be immutable, two propositions which Mr Locke firmly believed, there certainly was power when there was no change, nor any thing existing which was capable of change. He owns, indeed, that active power is more properly called power than the other; but we see no propriety at all in passive power. "It is (in the language of Dr Reid) a powerless power, and a contradiction in terms."

† *Essay*, book ii. chap. 21.

116 Just observations of the same author respecting power as belonging to body or mind.

But though Locke here uses improper terms, he has other observations with which we have the honour fully to agree, and which lead to consequences the reverse of that impiety which seems to follow from the notion of *passive* power. He observes, that "we have from body no idea at all of thinking, nor any idea of the beginning of motion. A body at rest affords us no idea of any active power to move; and when it is set in motion itself, that motion is rather a passion than an action in it. For when the ball obeys the stroke of a billiard stick, it is not any action of the ball, but a passion: also, when by impulse it sets another ball in motion that lay in its way, it only communicates the motion it had received from another, and loses in itself so much as the other received; which gives us but a very obscure idea of an active power of moving in body, whilst we observe it only to transfer, but not to produce any motion. So that it seems to me, we have from the observation of the operation of bodies by our senses but a very imperfect obscure idea of

of a penny, is easily perceived. In like manner, I can form a direct notion of a polygon of a thousand equal sides and equal angles. This direct notion cannot be more distinct when conceived in the mind, than that which I get by sight when the object is before me; and I find it so indistinct that it has the same appearance to my eye, or to my *direct* conception, as a polygon of a thousand and one, or of nine hundred and ninety-nine sides. But when I form a *relative* conception of it, by attending to the relation it bears to polygons of a greater or less number of sides, my notion of it becomes distinct and scientific, and I can demonstrate the properties by which it is distinguished from all other polygons. From these instances it appears, that our relative conceptions of things are not always less distinct, nor less fit materials for accurate reasoning, than those that are direct; and that the contrary may happen in a remarkable degree."

Reid's Essays on the Active Powers of Man.

Of Consciousness and Reflection.

of active power, since they afford us not any idea in themselves of the power to begin any action either of motion or thought." He thinks it evident, however, "that we find in ourselves a power to begin or forbear, continue or end, several actions of our minds and motions of our bodies, barely by a thought or preference of the mind ordering, or, as it were, commanding, the doing or not doing such or such a particular action. This power which the mind has thus to order the consideration of any idea, or the forbearing to consider it, or to prefer the motion of any part of the body to its rest, and *vice versa* in any particular instance, is that which we call *will*. The actual exercise of that power, by directing any particular action, or its forbearance, is that which we call *volition* or *willing*.

117 Whence it follows, that only such beings as have will and understanding can possess real power.

According to Mr Locke, therefore, the only clear notion or idea we have of power, is taken from the power which we find in ourselves to give certain motions to our bodies, or certain directions to our thoughts; and this power in ourselves can be brought into action only by willing or volition. This is exactly our doctrine; where we have endeavoured to prove, that without the consciousness of actual energy in ourselves, we never could have acquired any notion at all of power from observing the changes which take place among external objects. But if this be so, if the *power*, of which alone we know any thing, can be brought into action only by willing or volition, and if will necessarily implies some degree of understanding, as in us it certainly does, it comes to be a question of the first importance, whether any being which possesses not will and understanding can be possessed of real power, or be the efficient cause of any action. This question we feel ourselves compelled to answer in the negative. If *we* had not will, and that degree of understanding which will necessarily implies, it is evident that we could exert no power, and consequently could have none: for power that cannot be exerted is no power. It follows also, that the power, of which alone we can have any distinct notion, can be only in beings that have understanding and will. Power to produce any effect, implies power not to produce it; and we can conceive no way in which power may be determined to one of these rather than the other in a being that has not will. We grow from infancy to manhood; we digest our food, our blood circulates, our heart and arteries beat; we are sometimes sick and sometimes in health: all these things must be done by the power of some agent, but they are not done by our power. And if it be asked how we know this? the answer is, because they are not subject to our will. This is the infallible criterion by which we distinguish what is our doing from what is not; what is in our power from what is not. Human power can be exerted only by will: and we are unable to conceive any active power to be exerted without will. If, therefore, any man affirms that a being may be the efficient cause of an action which that being can neither conceive nor will, he speaks a language which we do not understand. If he has a meaning, he must take the words *power* and *efficiency* in a sense very different from ours; for the only distinct notion, indeed the only notion which we can form, of real efficiency, is a relation between the cause and the effect similar to that between us and our voluntary actions. It seems therefore most probable, that such beings only as have some degree of understanding and will can possess active power, and that inanimate beings must be merely passive. Nothing which we perceive without us affords any good ground for ascribing active power to any inanimate being; and we can as little conceive such a being possessed of power as we can conceive it capable of feeling pain. On the other hand, every thing which we discover in our own constitution, leads us to think that active power cannot be exerted without will and intelligence: and to affirm that it can, is to affirm what to us at least is a contradiction in terms.

118 An objection obviated.

To this reasoning, which is Dr Reid's *, and which to us appears unanswerable, we have heard it objected, that a man born blind has the same evidence for the non-existence of colour that is here urged for the impossibility of power being exerted without will and understanding. If the objection had not been made by a very acute man, we should have deemed it altogether unworthy of notice; for between the two cases supposed to be similar there is hardly any analogy. A man born blind has no notion whatever of colour. If you describe it to him in the best manner you can, and refer it to any of the senses which he possesses; if you say that it is the object of feeling, and that by feeling it one may perceive things at the distance of many miles; the blind man has reason to say that you are uttering a proposition which he knows with the utmost certainty cannot possibly be true. But if you tell him that colour is the object of the sense of sight, a sense which he possesses not; that it has not the least resemblance to the objects of the other senses; and that persons endowed with the sense of sight perceive coloured objects at the distance of many miles; the blind man cannot know whether what you say be true or false, because he has no idea or conception of the things of which you speak. This is not the case with respect to power; for every man who has reflected on the operations of his own mind has a very distinct notion of power, and knows perfectly, that to the actual exertion of the only power which he can conceive, will and understanding are necessary. Should it be said that there may be power altogether different from that of which we have a distinct conception, we think it sufficient to reply, that of a thing which cannot be conceived nothing can be either affirmed or denied: that activity exerted without will and understanding ought not to be called an exertion of *power*, because power is the name already appropriated to the attribute of a being by which he can do certain things if he wills; that as we can form no notion of a real efficient cause which has not will and understanding, so we have no reason to believe that such a cause anywhere exists; and to say that power, such as we can conceive, may be exerted without will and understanding, is as great an absurdity as to say that there may be velocity without space.

* See *Essays on the Active Powers of Man*.

But if active power, in its proper meaning, requires a subject endowed with will and intelligence, what shall we say of those active powers which philosophers teach us to ascribe to matter, the powers of corpuscular attraction, magnetism, electricity, gravitation, and others? These powers, as they are called, shall be considered when we treat of the nature and source of corporeal

Of Truth. poreal motion. In the mean time, it is sufficient to observe, that whatever the agents may be in the operations of nature, whatever the manner of their agency or the extent of their power, they depend upon the First Cause, and are all under his controul.

Chap. VII. *Of* Truth, *and the different* Sources *of* Evidence.

Sect. I. *Of Truth.*

By pursuing these inquiries in the order which to us appears most natural, we are now led to the contemplation of those faculties of the human mind of which *truth* is properly the object. But what is *truth?* This was a famous question among the Greek sophists; which had been so often agitated, and to which so many absurd answers had been given, that it came at last to be doubted by men of the world whether a satisfactory answer could be given, or indeed whether the matter was worthy of investigation. It is well known, that among the ancient philosophers there was a sect called from their principles *Sceptics*, and from their founder *Pyrrhonians*, who openly avowed their opinion that *truth*, like virtue, is nothing but a name; that all things are equally true, or rather equally doubtful; and that it is in vain for man to hope for certainty in any inquiry in which he can be engaged. Such scepticism as this no modern philosopher has professed; but many have had enough of it to make sober men hesitate about defining truth, and even insinuate that of truth no definition can be given. This surely is a mistake. If truth cannot be defined, it still wanders at large and in disguise, and vain must be the pursuit of every man who endeavours to obtain it; he is pursuing he knows not what.

119 Truth defined.

So obvious and so solid is this reflection, that almost every philosopher of merit who has lately written on the nature of evidence has begun his work, if not with a formal definition, with something at least equivalent to a definition of the object of his pursuit. To repeat all these definitions could serve no other purpose than to swell this article to a disproportioned bulk, and to perplex perhaps the mind of the reader. We shall therefore content ourselves with that which is given by Mr Wollaston. "Those propositions (says he) are true which represent things as they are: or truth is the conformity of those words or signs by which things are expressed to the things themselves." Notwithstanding the objections of a very learned and acute writer (w), this is the best definition of *truth* which we have met with in any language. It is concise

(w) Dr Tatham having asked with a contemptuous air, How imperfect and illogical is the definition of truth given by Wollaston? proceeds, though not to define, to describe or characterize it himself. "Truth (says he) is of the nature and essence of God, like him *incomprehensible* in the whole, and *ineffable* in its sublimer parts. For these and other reasons it cannot admit of an *adequate definition*. And who, in the beginning of his researches, should presume to define that which, after all his longest and best conducted labours, he can only hope partially, and often imperfectly, to comprehend; and of which an important part can neither be *directly* expressed nor *directly* understood? We may indeed esteem ourselves highly favoured by the Author and Finisher of all truth, if, at the end of our researches, we shall be able any way to understand, to define, and to apply, a few particular portions and detachments of it, and to guard them from ERROR and corruption. When upon a solemn occasion the question was put to our Lord by a Roman governor, *What is* TRUTH? though it was what he fully and perfectly knew, and what he came purposely and professedly to teach, he did not define it. He knew that definition was never the best method of instruction; and that in its common use and application it was seldom the friend of truth. Philosophically viewed, words do not constitute truth; they are only the vocal instruments by which it is communicated, or the written signs by which it is recorded. By an inquirer, therefore, things are to be examined rather than words defined. By a teacher, things are to be conveyed by words in some form or other, which are doubtless to be explained to the understanding, if not sufficiently understood before. But *explanation* is one thing, and *definition* quite another. Explanation is the *first* office of a teacher: Definition, if it be good, is the *last* of the inquirer, after the truth be found; and is then the most *advantageously* employed by the teacher, when his previous instructions have prepared him for it. GOD is a mind, and TRUTH is consequently an *attribute* of MIND. To the SUN, declaring at his rising a marvellous instrument, He by whom all things were made hath delegated the power of enlightening the *material* system: whilst he hath reserved to HIMSELF the office which is more suitable to his nature, of giving light and knowledge, by his eternal TRUTH, to the *mind* of man. But whether he acts through the instrumentality of his creatures, or more *immediately* from himself, he is uniform and consistent in his operations; so that one part of his divine economy is always illustrative of another. As the SUN sheds his *light* over the material creation to be apprehended by the eye, TRUTH is the *light* shed down from heaven to be apprehended by the intellect, given to illumine every subject, natural and moral, corporeal and spiritual, so far as they are qualified by their different natures to convey it to the human mind, or rather perhaps so far as the human mind is qualified to receive it from them." *The Chart and Scale of Truth*, vol. i.

This passage, of which some parts are certainly not remarkable for perspicuity, seems to be descriptive, not of *truth* in the common acceptation of the word, but of *all knowledge* human and divine, of which indeed no adequate definition can be given. *Truth*, as here used, seems to be opposed to *ignorance*; as used by Mr Wollaston and others, it is opposite to *falsehood*. In this last sense it may certainly be *explained*, if not defined; and if the learned lecturer will allow that Mr Wollaston has given a good *explanation* of the word *truth* as opposed to *falsehood*, we shall not quarrel with him or any man about the propriety of an expression. We have called it a *definition* of truth; because it was so called by the author from whom it is taken.

Of Truth. ciſe and perſpicuous. It comprehends all kinds of truth, as well that which is merely mental, the ſubject of ſilent contemplation, as that which is communicated either by written language or by the living voice: and it makes truth itſelf immutable, as depending not upon the arbitrary conſtitution of this or that individual, or even of the whole human race (x), but upon the nature of things as eſtabliſhed by their Almighty Creator.

120 Every propoſition either true or falſe.

According to this definition, every propoſition which can be expreſſed or apprehended is neceſſarily either true or falſe, whether its truth or falſehood be perceived or not either by him who hears or by him who utters it. All propoſitions are either affirmative or negative; but before any thing can with certainty be affirmed or denied of another, we muſt know thoſe things as they are in themſelves, as well as the eſtabliſhed uſe of the ſigns by which they are expreſſed. He who affirms or denies without this knowledge, ſpeaks at random, and has no diſtinct meaning.

121 Every human faculty concerned in the acquiſition of truth.

Every faculty which we poſſeſs is in ſome way or other an inſtrument of knowledge; for we know by our ſenſes, by our memory, and by our intellect. Every one of our faculties, therefore, is concerned in the acquiſition of truth, and furniſhes the mind with the materials of propoſitions. Theſe propoſitions are indeed of various kinds; but they are all certainly true or certainly falſe, though the *certainty* of the truth or falſehood of every one it is not always in our power to perceive.

122 Diverſity of belief affects not the truth of what is believed.

When a man affirms that red is a quality inherent in a ſoldier's coat, he utters a propoſition which every one of the vulgar firmly believes to be true, but which every philoſopher knows to be falſe. This diverſity of belief, however, affects not the truth of the propoſition itſelf. All mankind know that it is either true or falſe, independent of them or their perceptions; and it is eaſy, by a few optical experiments and by an explanation of terms, to convince them all, that what they have agreed to call *red* is no quality inherent in external objects, but only a ſenſation cauſed by the impulſe of certain rays of light reflected from certain objects to the eye of the percipient. The contrariety therefore in this caſe of vulgar to philoſophical belief, does not reſult from any ambiguity in the nature of truth itſelf, but from the different means of perception which the clown and the philoſopher poſſeſs.

Of Truth. Again, Were a man looking at a red and a green object, to affirm that they are both of the ſame colour, he would affirm what in one ſenſe may be true, what in another is undoubtedly falſe, and what in a third may be either true or falſe. If it be his meaning that the two objects give to him the ſame ſenſation, he may know with the utmoſt certainty that what he ſays is true; if he mean that they affect all mankind preciſely as they affect him, he utters what all mankind with the moſt abſolute certainty know to be falſe; if he mean that the texture of the two bodies (that particular diſpoſition of parts on their ſurfaces which makes them reflect certain rays of light and abſorb others) is exactly ſimilar, ſo as that the one muſt reflect the very ſame kind of rays with the other, he utters what all mankind muſt *believe* to be falſe, though ſtill it is *poſſible* that what he affirms may be true. This diverſity of belief affects not the truth itſelf. The two objects are what they are by whomſoever perceived, or whether perceived or not; the rays of light reflected by each are what they are, whether they fall upon this, upon that, or upon any eye; and the ſenſation communicated to this ſingular man is certainly what he is conſcious it is, as thoſe of the reſt of mankind are with equal certainty what they are conſcious of. This being the caſe, it is obvious and undeniable, that the organs of ſight in this individual of the human race are ſomehow differently formed from thoſe of other men: and the only queſtion which can occaſion a doubt in the mind of the ſceptic is, whether his or their eyes be ſo formed as to repreſent things falſely? for that by the one or the other things are falſely repreſented, is as evident as that two contradictory propoſitions cannot both be true. Now, though, for any thing we know it is certainly poſſible, as to us it appears not to imply any contradiction, that the eyes of but one man are formed in a manner ſuitable to their objects, whilſt the eyes of all other men are formed to deceive them; yet the contrary is ſo highly probable, that no man really doubts of it any more than he doubts whether three and two be equal to five.

123 Why ſome truths are ſaid to be abſolutely and others morally certain.

This laſt propoſition is indeed ſaid to expreſs a truth abſolutely certain, whilſt the former expreſſes a truth which is called morally certain: not that there is any difference or degrees of certainty in the nature of truths themſelves; the only difference is in our power of perceiving them. That three and two are equal to five, is

(x) Dr Beattie, in his elegant eſſay, has given a definition of truth very different from this, though it is poſſible that his meaning may be the ſame with Mr Wollaſton's. "I account that to be *truth* (ſays he) which the conſtitution of our nature determines us to believe; and that to be *falſehood* which the conſtitution of our nature determines us to diſbelieve." But if truth be really *immutable*, as he teaches or wiſhes to teach, it muſt depend upon the nature of things, and not upon the inſtinctive impulſe of any particular conſtitution. It is always difficult, often impoſſible, to diſtinguiſh between the conſtitution of our nature, as it came from the hand of God, and the ſame conſtitution as it is moulded by arbitrary and capricious aſſociations of our own. A ſincere member of the church of Rome certainly believes the doctrine of tranſubſtantiation. How he may do ſo we have already ſhown. Were all mankind ſincere members of that church, it would be ſaid and thought, "that the conſtitution of human nature determines men to believe tranſubſtantiation:" a doctrine which, though it is rejected by millions, Pere Buffier has laboured hard to reconcile with common ſenſe. Yet it is certain that the ſame body cannot be in different places at the ſame time; and that therefore tranſubſtantiation muſt be falſe, though believed by all mankind. Our *believing* any thing does not make it true, nor our *diſbelieving* any thing make it falſe. We muſt, indeed, *act* according to our belief; but in every inſtance truth and falſehood would have been what they are, though we had never exiſted.

Of Truth.

is said to be an absolute truth; because we perceive the whole of it as it is in itself, and are convinced that every intelligence from the highest to the lowest who understands the terms in which it is expressed perceives it as we do: whereas of *moral* or *physical* truths, as they are called, we only perceive a part, and may therefore mistake for want of evidence. Thus, in the case of the two objects exhibiting the same colour to one man, whilst they exhibit different colours to all other men, could we see into the objects themselves, and comprehend them immediately with our intellect as we comprehend our own ideas, it might, and no doubt would, appear as palpable a contradiction to say that the particular disposition of the parts on their surfaces, which reflect the rays of light, are the same in both, as it is now to affirm that three and two are not equal to five. Between truth and falsehood there is no medium. All truths are in *themselves* equally certain; and to the Supreme Being, who knows the nature of every thing more fully and intimately than we know our own ideas, they all *appear* equally certain: but yet we may without absurdity speak of *probable* truth as well as of *certain* truth, provided always that we make the difference to result, not from the nature of things, but from the power of our understanding, which comprehends the one kind of truth wholly and the other only partially.

124 Why some truths are said to be eternal and necessary, whilst others are considered as temporary and contingent.

There is another division made of truth into that which is eternal and necessary, and that which is temporary and contingent. Though we do not approve of applying the epithets *temporary* and *eternal* to any thing but real existences, yet as this manner of speaking has been used by all philosophers, we shall give instances of each kind of truth, and endeavour to ascertain in what the distinction consists. "The three angles of a plain triangle are equal to two right angles," is a proposition expressive of a necessary and eternal truth. "The world exists," is a contingent and temporary truth. Here it is obvious, that if both these propositions be true, there is no distinction between them, so far as mere *truth* is concerned; for truth admits not of degrees of comparison. It is however said, that the first proposition depends not upon time, or will, or any thing else; and that the Supreme Being himself could not make it false: whereas it is certainly possible, that he who created the world could annihilate it, and thus reduce what is now a truth to an absolute falsehood. This difference between the two propositions is thought a sufficient ground for calling the former a *necessary* and *eternal* truth, and the latter a *temporary* and *contingent* truth. But is the difference itself real? In the present instance we cannot think that it is: for if the right angles and triangles, which constitute the materials of the former proposition, be real corporeal things, they may be annihilated as well as the rest of the world; and then the truth of the proposition will cease, for there can be neither equality nor inequality between nonentities. If the angles and triangles be merely ideas in the mind of a rational being, it is not to be denied that the proposition must be true, independent of all *will*, whenever those ideas exist, i. e. whenever right angles and triangles are *thought upon*; but if all reasonable creatures were to be annihilated, and the Supreme Being never to think of triangles, the proposition would unquestionably cease to be either true or false. The world may indeed be annihilated; but it certainly is not annihilated whilst any one creature exists to contemplate even that which is called *necessary* and *eternal* truth: and therefore whilst any truth exists in a mind not divine, it must be necessarily true that the world exists; for the individual being by which truth is perceived would then constitute the whole world.

But if in a somewhat different manner we compare the former of these propositions with this, "The solar system consists of the sun and at least seven primary planets," we shall at once perceive the difference between necessary and contingent truths. Both propositions we know to be true at this moment: but there is this difference between them, that a plain triangle can neither actually exist at any period of duration, nor be conceived by any one mind divine or human, of which the three internal angles are not precisely equal to two right angles; whereas the solar system may easily be conceived, and might certainly have been formed, with a smaller number of primary planets rolling round the central fire. This needs no proof; as it is well known, that till very lately we conceived the system to consist of the sun and only six primary planets; and it has been already shown, that whatever we can positively conceive may possibly exist. Thus, then, every proposition, of which the contrary is clearly and distinctly perceived to be impossible, is a *necessary* truth; and it may likewise be said to be *eternal*, because at every period of duration it must of necessity when thought upon be perceived to be true: On the other hand, every proposition of which the contrary may be clearly and distinctly conceived, is, if true, only a *contingent* truth, because its contrary might have existed; and it may likewise be called *temporary*, because what might have been false in time past may yet be false in time future.

125 Truth perceived by our rational faculties, which are commonly said to be two, *reason* and *judgment*.

Though all our faculties (our senses, our memory, and our intellect), furnish materials for propositions, and are therefore all subservient to the investigation of truth; yet the perception of truth, as it is in itself, is commonly ascribed to our rational faculties; and these have by Locke and others been reduced to two—reason and judgment. The former is said to be conversant about certain truths, the latter chiefly about probabilities.

126 To which some philosophers have added a third faculty, viz. *common sense*.

Some late philosophers of great merit, dissatisfied with this analysis of the intellect, have added to reason and judgment a third faculty, to which they have given the name of *common sense*, and of which the proper object is such truths as neither admit nor stand in need of evidence. By *common sense* they mean, "that degree of judgment which is common to men with whom we can converse and transact business." Whether the introduction of such a term into metaphysics was proper or improper, we do not think it of importance to inquire. According to this definition of it, which is Dr Reid's, it differs not from the *reason* (Y) and *judgment* of Locke; agreeing with the former when its

(Y) This is expressly acknowledged by Dr Reid. "It is absurd (says that able and candid writer) to conceive

Of Intuitive Evidence and Demonstration.

its object is certain truth, and with the latter when it is conversant about probabilities. Nothing indeed is more evident, than that in the assent of the mind to every proposition, some energy of the judgment is exerted; and upon every proposition not self-evident, reasoning of some kind or other must be employed to procure that assent. Instead therefore of perplexing ourselves and our readers with various analyses of the human understanding, or rather with various names to what after all is perhaps but one individual power, it will surely be of more importance to the cause of truth to examine the different sources of evidence by which the assent of the reason, or judgment, or common sense, is determined.

Under the article LOGIC it was observed, that *intuition*, *experience*, and *testimony*, are each a sufficient *ground of judgment;* but they are not the only grounds. *Consciousness* is certainly one source of evidence, perhaps the most complete of any; and, in a low degree, *analogy* is another. Of *consciousness* we have already treated, but of *analogy* we have yet said nothing: and though we might (for an account of *intuition*, *experience*, and *testimony*) refer our readers to the article LOGIC, where they are accurately though concisely explained, we shall, without repeating what has been already said, add a few words on each, as well to complete the present article as to supply the deficiencies of the former.

SECT. II. *Of Intuitive Evidence and Demonstration.*

127 Intuitive evidence, what.

INTUITIVE evidence is that which arises from the comparison of two or more ideas or notions when their agreement or disagreement is perceived immediately, without the intervention of any third idea or notion. Of this kind is the evidence of these propositions: One and four make five *; things equal to "the same thing are equal to one another; the whole is greater than any of its parts;" and in a word, all the axioms in arithmetic and geometry. All these are in reality propositions in which the subject and predicate appear upon comparison to be nothing more than the same thing taken in different views or expressed by different terms. In fact, they are all in some respect reducible to this axiom, "Whatever is, is." We do not say that they are deduced from it; for they have in themselves that original and intrinsic evidence which makes them, as soon as the terms are understood, to be perceived intuitively. And if they be not thus perceived, no deduction of reason will ever confer on them any additional evidence. But though not deduced from the general axiom, they may be considered as particular exemplifications of it; inasmuch as they are all implied in this, that the properties and relations of our clear and adequate ideas can be no other than what the mind clearly perceives them to be.

* Campbell's Philosophy of Rhetoric.

128 Every demonstration a series of propositions intuitively evident.

It may perhaps be thought, that if axioms were propositions perfectly identical, it would be impossible by their means to advance a single step beyond the simple ideas first perceived by the mind. And it would indeed be true, that if the predicate of the proposition were nothing but a repetition of the subject under the same aspect, and in the same or synonymous terms, no conceivable advantage could be made of it for the furtherance of knowledge. Of such propositions as these, for instance, "seven are seven, eight are eight, the three angles of a triangle are the three angles of a triangle, two right angles are two right angles," it is manifest that we could never avail ourselves for the improvement of science: But when the thing, though in effect coinciding, is considered under a different aspect; when that which is single in the subject is divided in the predicate, and conversely; or when what is a whole in the one is regarded as a part of something else in the other; such propositions lead to the discovery

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conceive that there can be any opposition between reason and common sense. It is indeed the first-born of reason; and as they are commonly joined together in speech and in writing, *they are inseparable in their nature.* We ascribe to reason two offices or two degrees: the first is to judge of things self-evident; the second to draw conclusions that are not self-evident from those that are. The first of these is the province, and the sole province of common sense; and therefore it *coincides with reason in its whole extent*, and is only *another name* for one branch or one degree of reason." Pere Buffier talks nearly the same language; but Dr Beattie expresses himself very differently. "That there is a real and essential difference between these two faculties; that common sense cannot be accounted for by being called the *perfection of reason*, nor reason by being resolved into *common sense;* will appear (he thinks) from the following remarks: 1. We are conscious, from internal feeling, that the energy of understanding, which perceives intuitive truth, is different from that other energy which unites a conclusion with a first principle by a gradual chain of intermediate relations. 2. We cannot discern any necessary connexion between reason and common sense." Nay, he says, "That we often find men endued with the one who are destitute of the other:" and he instances dreams and certain kinds of madness where this is the case; adding, that a man who believes himself made of glass, shall yet reason very justly concerning the means of preserving his supposed brittleness from flaws and fractures." Surely these are strange remarks. Dreams and madness have hitherto been supposed to originate in the imagination, or, as it was denominated by the ancient philosophers, the *phantasia:* and when the ideas or forms which are there treasured up are disarranged or absurdly compounded, a dreaming sane man or a waking madman, if he reason at all, must reason from absurd principles: not, however, through any defect of common sense, but from a disorder in that region of the brain, upon which the phantasia more immediately depends. Of his first remark, we can only say, that to us it appears to be the reverse of truth. In every proposition which admits of demonstration, *we* are conscious that the conclusion is united with the first principle by a repetition of the very same energy of the understanding which perceives intuitive truth. That this is the case in every one of Euclid's demonstrations, we appeal to every mathematical reader; and why it must be so, we shall by and by endeavour to evince.

Of Intuitive Evidence and Demonstration.

discovery of innumerable and apparently remote relations. It is by the aid of ſuch ſimple and elementary principles that the arithmetician and the algebraiſt proceed to the moſt aſtoniſhing diſcoveries. Nor are the operations of the geometrician eſſentially different: for to this claſs belong all propoſitions relating to number and quantity; that is, all which admit of mathematical demonſtration. If the truth of a mathematical propoſition be not ſelf-evident; in other words, if the ſubject and predicate do not appear at firſt ſight to be different names for the ſame thing, another term muſt be found that ſhall be ſynonymous to them both. Thus, to prove that the three internal angles of a rightlined triangle are equal to two right angles, I produce the baſe of the triangle; and by a very ſhort proceſs I diſcover that the exterior angle ſo formed is equal to the two interior and oppoſite angles. By a proceſs equally plain and ſhort, I perceive that the exterior angle and the interior adjacent angle are equal to two right angles: But I have already ſeen, that the exterior angle is neither more nor leſs than the two interior and oppoſite angles under a different aſpect; whence it appears that the three internal angles of the triangle are nothing elſe than two right angles under a different aſpect. In a word, all demonſtration is founded on firſt principles or primary truths, which neither admit nor ſtand in need of proof, and to which the mind is compelled to give its aſſent by a bare intuition of the ideas or terms of which theſe primary truths are compoſed. Nothing is ſuſceptible of demonſtration, in the rigid ſenſe of the word, but general, neceſſary, and eternal truths; and every demonſtration is built upon intuition, and conſiſts in a ſeries of axioms or propoſitions of the very ſame kind with the firſt principle or truth from which the reaſoning proceeds. That propoſitions formerly demonſtrated are taken into the ſeries, doth not in the leaſt invalidate this account; inaſmuch as theſe propoſitions are all reſolvable into axioms, and are admitted as links in the chain; not becauſe neceſſary, but merely to avoid the uſeleſs prolixity which frequent and tedious repetitions of proofs formerly given would occaſion. But it is obvious that ſuch truths only as reſult from the compariſon of ideas and notions are neceſſary; and of courſe that ſuch truths only are capable of ſtrict demonſtration. The truths which relate to real exiſtences are all contingent, except that which affirms the exiſtence of the Supreme Being, the Parent of all truth.

The mathematical ſciences, categorical logic, and that part of metaphyſics which demonſtrates the being of God, are therefore the only branches of human knowledge which admit of ſtrict demonſtration. The longeſt demonſtration in the mathematical ſciences may be traced to this general and neceſſary truth, "Whatever is, is," or to ſome particular exemplification of it: the longeſt train of categorical ſyllogiſms terminates in this general principle, "What is affirmed or denied of a whole *genus*, may be affirmed or denied of all the *ſpecies*, and all the *individuals* belonging to that genus:" and the metaphyſical demonſtration of the being of God reſts upon this foundation, "Whatever had a beginning, had a cauſe." That theſe are truths abſolutely certain, which can neither be proved nor called in queſtion, every man may be ſatisfied, merely by attending to the ideas or notions which the terms of each propoſition expreſs. The two firſt are merely identical propoſitions, of the truth of which no man has ever pretended to doubt; and though the laſt is not identical, it is a neceſſary and ſelf-evident truth, as its contrary implies, that in the ſame thing there is power and no power, change and no change, action and inaction, at the ſame inſtant.

129 It is by intuition that we acquire all our notions of relation.

Before we diſmiſs the ſubject of intuition, it may not be improper to obſerve, that it is by this faculty or power of the mind contemplating its ideas, and comparing one idea with another, that we acquire all our notions of relation: ſuch as *identity* and *diverſity*, *reſemblance*, *coexiſtence*, relations of *ſpace* and *time*, relations of *quantity* and *number*, of a *cauſe* to its *effect*, and many more which it would be uſeleſs as well as tedious to enumerate.

Sect. III. *Of Experience and Analogy.*

130 Experience, the reſult of repeated obſervations.

It has been juſt obſerved, that intuition and demonſtration are applicable only to general and neceſſary propoſitions, of which the contrary are not only falſe, but abſurd and impoſſible. The great buſineſs of life, however, is with facts and contingent truths, which admit not of demonſtration, but reſt upon other evidence. The ſenſes, external and internal, are the inlets to all our knowledge of facts; and the memory is the ſtorehouſe where that knowledge is preſerved. Of what a man ſees or feels, he can at the inſtant of ſeeing or feeling entertain no doubt; and whilſt the ideas of what he has ſeen or felt, with all their aſſociated circumſtances, remained vivid and diſtinct in his memory, he is conſcious that he poſſeſſes ſo much real knowledge. But all our knowledge, as it is derived from the ſenſes, is of particular facts or particular truths; and the man who has in certain circumſtances obſerved one particular phenomenon, for the exiſtence of which he perceives no *neceſſity*, has not ſufficient ground to conclude, that in ſimilar circumſtances ſimilar phenomena will always occur. Milton, who ſurpaſſed the greater part of his cotemporaries in philoſophical ſcience almoſt as far as he has ſurpaſſed all ſucceeding poets in the ſublimity of his genius, repreſents Adam, when firſt falling aſleep, as under apprehenſions that he was about to ſink into his original ſtate of inſenſibility:

———————"Gentle ſleep
"Firſt found me, and with ſoft oppreſſion ſeiz'd
"My drouſed ſenſe, untroubled; though I thought
"I then was paſſing to my former ſtate
"Inſenſible, and forthwith to diſſolve."

Apprehenſions ſimilar to theſe would take place in his mind when he firſt perceived that darkneſs had overſpread the earth. In his circumſtances, he could have no ground to expect that the ſun when once ſet would riſe again to relume the world, as he had not then experienced the alternate ſucceſſion of light and darkneſs, and probably knew not whence light proceeds. After ſome time, however, having obſerved day and night regularly to ſucceed each other, theſe two appearances, or the ideas of them, would be ſo aſſociated in his mind, that each ſetting ſun would ſuggeſt the idea of next ſunriſing, and lead him to expect that glorious

glorious event with the utmoſt confidence. He would then conſider the alternate ſucceſſion of day and night as a law of nature, which might be affirmed in a propoſition expreſſive of a certain truth.

131 Is the only evidence that we have for all the general truths in phyſics, even thoſe which we think intuitively certain.

This continued obſervation of the ſame event happening in the ſame or ſimilar circumſtances, is what we call *experience;* and it is the only evidence which we have for all the general truths in phyſics, even for thoſe which we are apt to think intuitively certain *. Thus, that *milk* is white, and that *gold* is yellow, are ſuppoſed to be univerſal and neceſſary truths: but for any thing that we know, they may be particular truths; and they are certainly contingent, as the contrary to either of them may be ſuppoſed without abſurdity. We have indeed always obſerved the milk of animals of every ſpecies *white;* and therefore the idea of *white* becomes a neceſſary part of our *idea* of the ſubſtance milk, of which we call whiteneſs an eſſential property. This, however, reſpects only the milk of thoſe animals with which we are acquainted. But ſince the milk of all the animals with which we are acquainted, or of which we have heard, is white, we can have no reaſon to ſuſpect that the milk of any new and ſtrange animal is of any other colour. Alſo, ſince, wherever there has been the ſpecific gravity, ductility, and other properties of *gold*, the colour has always been *yellow;* we conclude that theſe circumſtances are neceſſarily united, though by ſome unknown bond of union, and that they will always go together.

* *Campbell's Philoſophy of Rhetoric;* and *Prieſtley's Remarks on the Drs Reid,* &c.

132 Difference between experience and analogy.

The proper proof, therefore, of ſuch univerſal propoſitions as "milk is white," "that gold is yellow," or, "that a certain degree of cold will freeze water," conſiſts in what is called an induction of *particular facts* of preciſely the ſame nature. Having found, by much and various experience, that the ſame events never fail to take place in the ſame circumſtances, the *expectation* of the ſame conſequences from the ſame previous circumſtances is neceſſarily generated in our minds; and we can have no more ſuſpicion of a different event than we can ſeparate the *idea* of *whiteneſs* from that of the other properties of *milk*. When the previous circumſtances are preciſely the ſame, we call the proceſs of proof by the name of *induction*, and expect the event from *experience:* but if they be not preciſely the ſame, but only bear a conſiderable reſemblance to the circumſtances from which any particular appearance has been found to reſult, we call the argument *analogy;* and it is ſtronger in proportion to the degree of reſemblance in the previous circumſtances. Thus the milk of all the cows that we have ſeen, or upon which we have made the experiment, having been found nouriſhing, we confidently expect that the milk of all other cows will prove nouriſhing likewiſe; and this confidence of expectation is the reſult of uniform experience. But if, from having found the milk of all the animals with which we are acquainted to be nouriſhing, however different the nature of theſe animals; we infer that the milk of any ſtrange animal will likewiſe be nouriſhing; the inference is drawn by analogy, and by no means carries with it the conviction of experience. A proof from *real* experience can leave no doubt in the mind (z); an argument from analogy always muſt. In the one caſe, we only infer that two events of preciſely the ſame nature, and in preciſely the ſame circumſtances, have been produced by the ſame kind of cauſe; in the other, we infer that two events ſimilar in moſt reſpects, though for any thing that we know diſſimilar in others, have been produced by the ſame kind of cauſe; and it is obvious that between theſe caſes the difference is great.

Thus, after having obſerved that all the projectiles to which we have paid any attention—a ſtone thrown from the hand, a ball from a gun, and an arrow from a bow—deſcribe a certain curve, and are impelled in that curve by two powers acting in different lines of direction which form with each other a certain angle, we infer that all projectiles which on the ſurface of the earth deſcribe the ſame curve are impelled by the ſame or ſimilar powers acting in the ſame or ſimilar lines of direction. This inference is the reſult of experience, and carries with it the fulleſt conviction to the mind. But when, from having obſerved that the curves deſcribed by the planets are of the ſame kind with thoſe deſcribed by projectiles on the earth, Sir Iſaac Newton inferred that theſe vaſt bodies are impelled in their orbits by forces of the very ſame kind, and acting in the ſame manner with the forces which impel a ball from a cannon or an arrow from a bow, his argument was founded only on analogy; and even that

133 The evidence of analogy inferior to that of experience.

(z) We ſay from *real* experience; becauſe what is often taken for *experience*, and to human eyes has that appearance, is in fact nothing more than *analogy*. Thus a phyſician may have preſcribed to ninety-nine patients labouring under the ſame diſeaſe the ſame remedy, and always with the ſame ſucceſs. If ſo, he will think that he has experience of its utility, and will preſcribe it again with the fulleſt confidence. Yet in this caſe he may be diſappointed; for though the medicine be the ſame and the diſeaſe the ſame, there may be ſomething in the conſtitution of the hundredth patient ſo different from that of the ninety-nine, that what was ſalutary to them may be pernicious to him. This does not detract from the evidence of experience; it only ſhows, that the circumſtances of the caſe in which the medicine failed were different from thoſe in which it ſucceeded. In ſuch concluſions as are founded on a complete induction and uniform experience, every man expects the event with the laſt degree of aſſurance, and regards his paſt experience as a full *proof* of the future exiſtence of that event: In other caſes, where experience has been variable—or apparently variable—he knows that the induction has been incomplete, and therefore proceeds with caution. He weighs the oppoſite experiments; takes as complete a view as he can of the circumſtances in which they were made; conſiders which ſide is ſupported by the greater number of experiments, and inclines to that ſide with doubt and heſitation. And when at laſt he fixes his judgment, the evidence exceeds not what is called *probability*. All probability, then, ſuppoſes an oppoſition of experiments and obſervations, where the one ſide is found to overbalance the other, and to produce a degree of evidence proportioned to the ſuperiority.

Of Testimony.

that analogy is very remote. We know by experience that all projectiles which fall under our immediate cognizance are of the very same kind and in the very same circumstances; that every one of them has a tendency, from whatever cause, to the centre of the earth, and is preserved from falling by the force of projection; we know likewise that they are all moved through the medium of the atmosphere, which at the surface of the earth is considerably dense, and that a dense medium must occasion much resistance: But we do not *know* that the planets have a tendency to the centre of the sun, that they are preserved from falling into that luminary by a projectile force, or whether they move through a *medium* or *in vacuo*; so that we are not *certain* that the motion of the planets is perfectly similar to that of terrestrial projectiles in any other circumstance than the form of the curve which they all describe; and from this single case of coincidence no inference can be drawn which carries to the mind absolute conviction.

When a man reasons from *experience*, he infers, that what has uniformly happened hitherto, will happen always in the very same circumstances; or that what is known to be the cause of *various phenomena of the same kind* is the cause of every other phenomenon in *all respects* similar to these. Such an inference is founded on the united and complete evidence of sense, memory, and reason. When a man reasons from *analogy* he infers, that what has *generally* happened hitherto, will happen again in circumstances *nearly similar*; or that what is known to be the cause of various phenomena of the same kind, is the cause of other phenomena in *some respects* similar to these. This inference is likewise founded on the united evidence of sense, memory, and reason: but here the evidence of sense is not complete, and it can be strengthened only by finding more facts of the same or of a similar nature.

Sect. IV. *Of Testimony.*

134 Mankind ready to believe the testimony of each other.

THE last source of evidence which we proposed to consider is *testimony*, or the report of men concerning events which have fallen under the observation of their senses. That we are all ready to believe the information which we receive from the testimony of our fellow creatures is undeniable; and indeed without such belief every man's knowledge of facts and events would be confined to those only of which he himself had been a personal witness. In that case, no man who had not travelled would believe that there are such cities as Rome and Constantinople; and no man whatever could now believe that such heroes as Hannibal and Cæsar had ever existed.

Between words and things there is no natural connexion; and though we are all accustomed to give to things the names by which they are known in the language that we speak, and to express their mutual relations by the words appropriated for that purpose; yet it is obviously impossible to denote one thing by the name of another, and to express by words relations that have no existence. This being the case, it may be asked upon what principle we give credit to human testimony? To this question various answers have been given, which have produced much controversy on one of the most important subjects which can employ the mind of man.

135 The reason assigned by Hume for this propensity

"We may observe (says Mr Hume *), that there is no species of reasoning more common, more useful, and even necessary to human life, than that which is derived from the testimony of men and the reports of eye-witnesses and spectators. This species of reasoning perhaps one may deny to be founded on the relation of cause and effect. I shall not dispute about a word. It will be sufficient to observe, that our assurance in any argument of this kind is derived from no other principle than our observation of the veracity of human testimony, and of the usual conformity of facts to the reports of witnesses. It being a general maxim that no (A) objects have any discoverable connexion together, and that all the inferences which we can draw from one to another are founded merely on our experience of their constant and regular conjunction; it is evident that we ought not to make an exception to this maxim in favour of human testimony, whose connexion with any event seems in itself as little necessary as any other. Were not the memory tenacious to a certain degree; had not men commonly an inclination to truth, and a principle of probity; were they not sensible to shame when detected in falsehood: Were not these, I say, discovered by *experience* to be qualities inherent in human nature, we should never repose the least confidence in human testimony. And as the evidence derived from witnesses and human testimony is founded on past experience, so it varies with the experience, and is regarded either as *a proof* or *probability*, according as the conjunction between any particular kind of report and any kind of object has been found to be constant or variable. There are a number of circumstances to be taken into consideration in all judgments of this kind; and the ultimate standard by which we determine all disputes that may arise concerning them, is always derived from experience and observation. The reason why we place any credit in witnesses and historians, is not derived from any *connexion* which we perceive *à priori* between testimony and reality, but because we are accustomed to find a conformity between them. But when the fact attested is such a one as has seldom fallen under our observation, here is a contest of two opposite experiences; of which the one destroys the other as far as it goes, and the superior can only operate on the mind by the force which remains. The very same principle of experience which gives us a certain degree of assurance in the testimony of witnesses, gives us also, in this case, another degree of assurance against the fact which they endeavour to establish; from which contradiction there necessarily arises a counterpoise, and mutual destruction of belief and authority."

* *Essay on Miracles.*

136 confuted, and

This account of the origin of faith in testimony has been

(A) Is there then no discoverable connexion between a tree and the field in which it grows; between a man and his clothes; between an author and his work; between a sceptic and paradoxes? Surely all these are correlates, and necessarily suggest the ideas of each other.

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been controverted with much success by the Doctors Campbell and Reid. "That the evidence of testimony is derived solely from experience (says the former of these writers *), is at least not so incontestable a truth as Mr Hume supposes it; that, on the contrary, testimony hath a natural and original influence on belief antecedent to experience, will, I imagine, easily be conceived. For this purpose, let it be remarked, that the earliest assent which is given to testimony by children, and which is previous to all experience, is, in fact, the most unlimited; that by a gradual experience of mankind, it is gradually contracted, and reduced to narrower bounds. To say, therefore, that our diffidence in testimony is the result of experience, is more philosophical, because more consonant to truth, than to say that our faith in testimony has this foundation. Accordingly, youth, which is unexperienced, is credulous; age, on the contrary, is distrustful. Exactly the reverse would be the case were this author's doctrine just." This is a complete confutation of the reasoning of Mr Hume: but in order to prevent all cavilling, it is to be wished that the very acute author had explained more fully what he means by saying, that testimony hath a *natural* and *original* influence on belief; for these words may be taken in different senses, in one of which what he affirms is true, and in another false.

* *Dissertation on Miracles*, and *The Philosophy of Rhetoric*.

Dr Campbell's omission is amply supplied by Dr Reid, who gives † the following account of testimony, and of the credit which it obtains. "The wise and beneficent Author of nature, who intended that we should be social creatures, and that we should receive the greatest and most important part of our knowledge by the information of others, hath, for these purposes, implanted in our nature two principles that tally with each other. The first of these principles is a propensity to speak truth, and to use the signs of language so as to convey our real sentiments. This principle has a powerful operation even in the greatest liars; for where they lie once, they speak truth a hundred times. Truth is always uppermost, and is the natural issue of the mind. It requires no art or training, no inducement or temptation, but only that we yield to a natural impulse. Lying, on the contrary, is doing violence to our nature, and is never practised even by the worst men without some temptation. Speaking truth is like using our natural food, which we would do from appetite, although it answered no end; but lying is like taking physic, which is nauseous to the taste, and which no man takes but for some end which he cannot otherwise attain.—When we are influenced by any motive, we must be conscious of that influence, and capable of perceiving it upon reflection. Now, when I reflect upon my actions most attentively, I am not conscious that in speaking truth I am influenced on ordinary occasions by any motive moral or political. I find that truth is always at the door of my lips, and goes forth spontaneously if not held back. It requires neither good nor bad intention to bring it forth, but only that I be artless and undesigning. There may indeed be temptations to falsehood, which would be too strong for the natural principle of veracity, unaided by principles of honour or virtue; but where there is no such temptation, we speak truth by *instinct*. By this instinct, a real connexion is formed between our words and our thoughts; and thereby the former become fit to be signs of the latter, which they could not otherwise be."

† *Inquiry into the Human Mind*, &c.

Such is the account which Dr Reid gives of the truth of human testimony: and he adds, that there is another original principle implanted in us by the Supreme Being, to tally with it, viz. a disposition to confide in the veracity of others, and to believe what they tell us. "This (he says) is the counterpart to the former; and as that may be called the *principle of veracity*, we shall, for the want of a more proper name, call this the *principle of credulity*. It is unlimited in children, until they meet with instances of deceit and falsehood; and retains a very considerable degree of strength through life."

It is ever with extreme reluctance that we controvert the opinions of this able writer; and that reluctance cannot be lessened in the present instance, when we are conscious that great part of what he says is unanswerable. That truth is always at the door of the lips; that it requires no effort to bring it forth; that in ordinary cases men speak truth uninfluenced by any motive moral or political; that the greatest liars speak truth a hundred times where they lie once; and that lying is never practised by the worst men without some temptation, are positions which daily experience renders it impossible to question: But notwithstanding this, we do not think that truth is spoken by an *instinctive* principle; because it is inconceivable that instinct should teach the use of arbitrary and artificial signs, such as the words of every language undoubtedly are; or that between such signs and ideas any *instinctive* connexion should ever be formed. "Truth (as we have defined it) is the conformity of those words or signs by which things are expressed to the things themselves;" and things themselves are what they are, independent of us, our instincts, and perceptions. When we have precise and adequate ideas of objects, and when those ideas are related to one another as the objects themselves are related, we are in possession of mental truth; and in this case there is a *real* and *natural* connexion between the signs and the things signified: for we cannot frame original and simple ideas which have no archetype in nature; nor can *one* object, distinctly perceived, generate in our minds the ideas that are generated by *other* objects. Here external things are the objects, and ideas are the signs, which, when they are in conformity to the things signified by them, constitute truth.

137 The true reason assigned.

But in human testimony, the ideas in the mind of the speaker are the things signified, and the words of language are signs by which they are expressed; and when these things and signs are in conformity to each other, the words uttered express so much truth.—Now, though in this case there is no *natural* connexion between the sign and the thing signified, yet it is obvious, that without a violent effort of the speaker to the contrary they must always be in conformity with each other; because, in every language, there are words appropriated for the purpose of denoting every idea and relation which can be expressed; and in the mind of every man these ideas, relations, and *words*, have been constantly associated from the time that he learned to speak. So intimate is this association, and so impossible to be broken, that whoever will pay sufficient attention to

Of Teſtimony.

to the operations of his own mind, will find that he *thinks* as well as *ſpeaks* in ſome language; and that in cogitation he ſuppoſes and runs over, ſilently and habitually, thoſe ſounds which in ſpeaking he actually utters (B). If this be ſo, it is impoſſible that a man without ſome effort ſhould ever ſpeak any thing but truth: for the *ideas* of what he has ſeen or heard, &c. are not of his manufacture; they are generated by external objects; and till they be effaced from the memory, they muſt always, by the law of aſſociation, make their appearance there with all their mutual relations, and in their proper dreſs. In the very act of learning to ſpeak, we neceſſarily learn to ſpeak the *truth*: for were we not to employ words exactly as they are employed by thoſe with whom we converſe, our language (if language it might be called) would be unintelligible: and we could neither declare our wants nor aſk relief with any hopes of ſucceſs. *Children* beginning to ſpeak, may indeed utter untruths without any motive, and merely from miſtake; becauſe the ideas and words of children have neither been long nor cloſely aſſociated: but it is impoſſible that a *man*, however wicked, ſhould habitually and without motives lie on ordinary occaſions, unleſs the fundamental principles of his nature have been totally altered; unleſs his brain has been diſordered by diſeaſe; unleſs his ideas have been diſarranged, and all his original aſſociations broken.

We know indeed by woful experience, that immoral men occaſionally utter falſehoods with a view to deceive. But on theſe occaſions they are influenced by ſome motive either of hope or terror: the falſehood is always uttered with an effort: and ſo ſtrong is the aſſociation between words and ideas, that the truth will at times break out in ſpite of all their endeavours to ſuppreſs it; ſo that the end or middle of a falſe narrative, if it be of any length, is commonly inconſiſtent with the beginning. We entertain a ſuſpicion concerning any matter of fact, when thoſe who relate it contradict each other—when they are but few in number, or of doubtful character—when they have an intereſt in what they affirm—when they deliver their teſtimony with heſitation—or, on the contrary, with too violent aſſeverations; becauſe theſe are circumſtances which we have generally experienced to accompany falſe witneſs. It is likewiſe with reluctance that we admit a narrative of events entirely different from every thing which hitherto we have ſeen or heard; becauſe we may not be certain that the narrator is not under ſome influence to deceive us in matters concerning which we have nothing but his teſtimony on which to ground our judgment. But in every caſe where the fact recorded is in itſelf poſſible, and attributed to an adequate cauſe; where a competent (C) number of witneſſes had ſufficient means of information, and are certainly under no inducement to deceive; teſtimony is complete evidence, however extraordinary the fact may be; becauſe no fact which is known to have an adequate cauſe can be ſo incredible, as that a number of men of ſound underſtandings ſhould act contrary to the fundamental principles of human nature, or be able, if ſo diſpoſed, to diſſolve aſſociations which had been formed in the mind of each from his infancy, and form new ones, all agreeing exactly with one another, but all contrary to truth.

PART II. OF BODY WITH ITS ADJUNCTS.

Chap. I. *Of the* Composition *of* Bodies; *or, of* Matter *and* Form.

HITHERTO we have contemplated only the powers of our minds by which we acquire a ſtock of ideas, and the various operations of the intellect upon thoſe ideas, as treaſured up in the memory or imagination. In the courſe of the inquiry we have found, that every idea and notion which we have was ſuggeſted by ſomething independent of us; and in order to diſcover what thoſe things are, we have inveſtigated the nature of each ſenſe, as it is by the ſenſes only that we have any communication with the external world. By touch we perceive heat and cold, hardneſs and ſoftneſs, figure, ſolidity, motion, and extenſion; by the organ of ſmell, we perceive odours; by the tongue and palate, taſtes; by the ear, ſounds; and by the ſight colours. We have likewiſe ſeen, that heat and cold, odours, taſtes, ſounds, and colours, are mere ſenſations which have no exiſtence but while they are perceived. On the other hand, hardneſs and ſoftneſs, figure and ſolidity, motion and extenſion, are neither ſenſations, nor like ſenſations; but are conceived to be ſomething external

(B) This ſeems to have been *Plato*'s opinion; for he calls *thinking* λογον ον αυλη προς αυλην ἡ ψυχη δι εξερχεται περι ων αν σκοπη, "the language by which the ſoul explains itſelf to itſelf when it conſiders any thing." And *Plotinus* ſays, Ὁ εν Φωνη λογος μιμημα του εν ψυχη, "the vocal words are an imitation of thoſe of the ſoul." To ſay that vocal words are an imitation of thoſe of the ſoul, is to ſpeak inaccurately, and to reverſe the proceſs of aſſociation; but it affords ſufficient evidence, that in the opinion of Plotinus men think as well as ſpeak in words.

(C) Should it be aſked what number we call competent, we beg leave to ſay, that it will be greater or leſs according to circumſtances. In caſes where they are not liable to the deceptions of ſenſe, two men of integrity and intelligence deſerve equal credit with two thouſand; but where there is particular occaſion for good organs, whether of ſight, hearing, or touch, the greater the number the greater is our ſecurity. To this muſt be added, that as one man is influenced by that which to another would be no motive, a great number of witneſſes concurring in the ſame teſtimony is always an additional ſecurity that they are not under the influence of any latent bias.

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ternal and independent of our faculties, which may operate in a deſert wilderneſs as well as in a populous city, though, for want of ſentient beings to operate upon, it cannot in the wilderneſs produce the ſame effects as in the city.

138 Of things perceived by the ſenſes the greater part always united.

Of things perceived by the ſenſes we find the greater part always united; for when a man perceives a piece of ſealing wax, if he makes uſe of all his ſenſes, he perceives at once, cold, taſte, colour, hardneſs, roughneſs or ſmoothneſs, figure, ſolidity, motion or reſt, and extenſion. That the powers or qualities, which in this inſtance produce the ſenſations of heat or cold, taſte, odour, and colour, are ſo united to the hardneſs, figure, ſolidity, and extenſion of the wax, as that they cannot exiſt alone, is evident; becauſe it is impoſſible to remove any one of theſe things, or to conceive it removed, without removing with it all the reſt. What then is the bond of this union? Do theſe things neceſſarily accompany one another, ſo as that one of them cannot exiſt without bringing all the reſt along with it? No; there is no neceſſary connexion among them; for by the operation of fire the wax may be rendered liquid, when the *hardneſs* and *cold* are gone, though every thing elſe remains the ſame, or nearly the ſame, as it was before. By a ſtill further operation of fire the appearance may be entirely changed; and that which was formerly a piece of hard red wax, may be reduced to ſmoke and aſhes, in which there is neither hardneſs, colour, odour, nor figure; at leaſt there is not in the ſmoke and aſhes *ſuch* hardneſs, colour, odour, or figure, as was in the wax. The ſolidity and extenſion, however, remain; for we perceive aſhes and ſmoke to be extended and ſolid as much as wax or an adamant; nor is it poſſible to do any thing with the wax, or with any other ſenſible object, which ſhall deprive it of extenſion or ſolidity.

139 Some of theſe things termed *accidents*, and why.

Thus, then, extenſion and ſolidity may exiſt and be perceived, when ſeparated from hardneſs, colour, and odour; but none of theſe can exiſt, or be conceived to exiſt, independent of extenſion and ſolidity. Hardneſs, colour, odour, taſte, and figure, or the things which ſuggeſt theſe notions to us, have with great propriety been termed accidents or qualities; becauſe they cannot exiſt or be conceived to exiſt by themſelves, but require for their ſupport one common ſubject. Extenſion and ſolidity can exiſt independent of them; but they cannot exiſt independent of ſolidity and extenſion.

140 Things perceived by the ſenſes, qualities which inhere in a ſubject called *matter*.

Is then ſolidity the baſis of theſe qualities, ſo that they neceſſarily reſult from it? No; there are many things ſolid and extended which are neither hard, nor coloured, nor odorous, nor ſapid; which could not be if theſe qualities were the neceſſary effect of ſolidity. Beſides, all mankind conceive of ſolidity and extenſion as qualities of ſomething elſe; for we never ſay that ſolidity is extended or coloured, or hard or odorous, but that ſomething ſolid has theſe qualities: whence it is evident that we conſider ſolidity as a quality itſelf. In what then does ſolidity and all the other ſenſible qualities inhere, ſince they cannot exiſt ſeparately, and do not ſupport each other? This is a queſtion which modern philoſophers pretend not to anſwer: but ſome of the ancients were not ſo modeſt. Ariſtotle and his followers reſolved every bodily ſubſtance into *matter* and *form*, making matter the baſis or *ſubſtratum*, and under form comprehending all ſenſible qualities.

As attempts have been lately made to revive this philoſophy, it may not be improper to give a ſhort view of the doctrine of *matter* and *form*, if it were only to diſcover whether the ſpeculations of Ariſtotle and his adherents on this ſubject deſerve to be preferred to thoſe of Newton and Locke.

The moſt perſpicuous, and by far the moſt elegant writer among the moderns who has adopted the ancient philoſophy, is Mr Harris; and leſt we ſhould be accuſed by others of doing injuſtice to a ſubject above the reach of ordinary comprehenſion, we ſhall tranſcribe ſo much of what he has ſaid of *matter* and *form* in his Philoſophical Arrangements as ſeems neceſſary to make our readers underſtand his meaning as far as it is intelligible.

141 The Peripatetic doctrine concerning matter;

"Matter (ſays this writer) is that elementary conſtituent in compoſite ſubſtances which appertains in *common* to them all, without diſtinguiſhing them from one another. Every thing generated or made, whether by nature or art, is generated or made out of ſomething elſe; and this ſomething elſe is called its ſubject or matter. Such is iron to the ſaw; ſuch is timber to the boat. Now this *ſubject* or *matter* of a thing being *neceſſarily previous* to that thing's exiſtence, is *neceſſarily different* from it, and *not the ſame*. Thus iron, as iron, is not a ſaw; and timber, as timber, is not a boat. Hence, then, one character of every *ſubject* or *matter*, that is, the character of *negation* or *privation*. [He means *negation* or privation of what is to be made out of it].

142 which is deſcribed as deſtitute of every attribute or quality,

"Again, Though the *ſubject* or *matter* of a thing be not that thing, *yet*, were it incapable of becoming ſo, it could not be called its ſubject or matter. Thus iron is the *ſubject* or *matter* of a ſaw; becauſe, though *not* a ſaw, it may ſtill *become* a ſaw. On the contrary, timber is *not* the ſubject or matter of a ſaw; becauſe it not only (as timber) is no ſaw, but can never be made one from its very nature and properties. Hence, then, beſides *privation*, another character of every *ſubject* or *matter*, and that is the character of *aptitude* or *capacity*. [He means aptitude or capacity to be that which is made out of it].

"Again, When one thing is the *ſubject* or *matter* of *many* things, it implies a *privation* of them all, and a *capacity* to them *all*. Thus iron being the ſubject or matter of the ſaw, the axe, and the chiſſel, implies *privation* and *capacity* with reſpect to *all three*. Again, We can change a ſaw into a chiſſel, but not into a boat; we can change a boat into a box, but not into a ſaw. The reaſon is, there can be no change or mutation of one thing into another where the two changing beings do not participate the ſame matter (D). But even here, were the boat to moulder and turn to earth,

(D) In a note he ſays: This reaſoning has reference to what the ancients called υλη προσεχης, *the immediate matter*, in oppoſition to υλη πρωτη, *the remote* or *primary matter*.

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earth, and that earth by natural process to metallize and become iron; through such progression as this we might suppose even the boat to become a saw. Hence therefore it is, that *all change* is by immediate or mediate participation of the *same matter*. Having advanced thus far, we must be careful to remember, first, that every *subject* or *matter* implies, as such, *privation* and *capacity*; and next, that *all change* or *mutation* of beings into one another is *by means of their participating the same common matter*. This we have chosen to illustrate from works of art, as falling more easily under human cognizance and observation. It is, however, no less certain as to the productions of nature, though the superior subtlety in these renders examples more difficult. The question then is, whether in the world which we inhabit, it be not admitted from experience, as well as from the confession of all philosophers, that substances of every kind (E), whether natural or artificial, either immediately or mediately, pass into one another: and whether, in that case, there must not be some one *primary matter* common to *all things*. I say some *one primary matter*, and that common to *all things*, since without some *such* matter, *such mutation* would be wholly impossible. But if there be some *one primary matter*, and that *common to all things*, this *matter* must imply, not (as particular and subordinate matters do) a *particular* privation and a *particular* capacity, but, on the contrary, *universal* privation and *universal* capacity. If the notion of such a being appear strange and incomprehensible, we may farther prove the *necessity* of its existence from the following considerations: Either there is no such general change as here spoken of; which is contrary to fact, and would destroy the sympathy and congeniality of things: Or, if there be, there must be a matter of the character *here* established; because without it (as we have said) such change would be *impossible*. Add to this, however hard *universal* privation may appear, yet had the *primary matter*, in its proper nature, any one particular attribute, so as to prevent its *privation* from being unlimited and universal, such *attribute would run through all things*, and be conspicuous in all. If it were white, all things would be white; if circular, they would be circular; and so as to other attributes; which is contrary to fact. Add to this, that the *opposite* to such attribute could *never* have existence, unless it were possible for the same thing to be at *once* and in the same instance both white and black, circular and rectilineal, &c. since this inseparable attribute would necessarily be *every where*; because the *matter*, which implies it, is itself *every where*, at least may be found in all things that are generated and perishable.

143 and to be apprehended only by abstraction and analogy.

"Here then we have an idea (such as it is) of that singular being υλη πρωτη, the *primary matter*; a being which those philosophers who are immerged in sensible objects know not well how to admit, though they cannot well do without it; a being which flies the perception of every *sense*, and which is at best, even to the *intellect*, but a negative object, no otherwise *comprehensible* than either by *analogy* or *abstraction*. We gain a glimpse of it by *abstraction*, when we say that the *first manner* is *not* the lineaments and complexion which make the beautiful face, *nor yet* the *flesh* and *blood* which make those lineaments and that complexion; *nor yet* the liquid and solid aliments which make that flesh and blood; *nor yet* the simple bodies of earth and water which make those various aliments; but *something*, which being *below* all these, and supporting them all, is yet *different* from them all, and essential to their existence. We obtain a sight of it by *analogy*, when we say, that as is the brass to the statue, the marble to the pillar, the timber to the ship, or any one *secondary matter* to any one *peculiar form*; so is the *first* and *original matter* to all *forms in general*."

Such is the doctrine of the Peripatetics concerning the *primary matter* or the basis of bodily substances. We forbear to make any remarks upon it till we have seen what they say of *form*, the other essential part of every body; for what is meant by *matter* and *form* will be most completely seen when they are viewed together.

144 The Peripatetic doctrine concerning form.

"FORM (says the same elegant writer) *is that elementary constituent in every composite substance, by which it is* DISTINGUISHED, CHARACTERIZED, *and known, from every other*. But to be more explicit: The *first* and most simple of all *extensions* is a *line*: this, when it exists, united with a *second* extension, makes a *superficies*; and these two existing together with a *third*, make a *solid*. Now this *last* and *complete* EXTENSION we call the *first* and *simplest* FORM; and when this *first* and *simplest form* accedes to the *first* and *simplest matter*, the union of the two produces *body*; which is for that reason defined to be *matter triply extended*. And thus we behold the rise of *pure* and original *body* (F). It must be remembered, however, that *body*, under this character, is something *indefinite and vague*, and scarcely to be made an *object* of *scientific contemplation*. It is necessary to this end that its extension should be *bounded*; for as yet we have treated it without such regard. Now, the *bound* or *limit* of *simple body* is *figure*; and thus it is that *figure*, with regard to *body*, becomes the next *form* after *extension*.

145 The three original forms which, added to matter, constitute body physical.

"But though the *boundary* of body by *figure* is one step towards rendering it *definite* and *knowable*, yet is not this sufficient for the purposes of nature. It is necessary *here*, that not only its *external* should be duly bounded, but that a suitable regard should likewise be had to its *internal*. This *internal adjustment*, disposition, or *arrangement* (denominate it as you please), is called ORGANIZATION, and may be considered as the *third* form which appertains to body. By its accession we behold the rise of BODY PHYSICAL or NATURAL; for every such body is some way or other *organized*. And thus may we affirm, that these *three*, that is to say, extension,

(E) He must mean only bodily substances; for it is not admitted by such philosophers as make a distinction between mind and body, that the one ever passes into the other.

(F) "Original body (he says), when we look *downward*, has reference to the *primary matter*, its substratum: when we look *upwards*, it becomes itself a *matter* to *other things*; to the *elements*, as commonly called, air, earth, water, &c. and in consequence to all the variety of *natural productions*."

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extension, *figure*, and *organization*, are the *three original forms* to *body physical* or *natural*; *figure* having respect to its *external*, *organization* to its *internal*, and *extension* being common both to one and to the other. It is more than probable, that from the variation in these *universal* and (as I may say) *primary forms*, arise most of those *secondary* forms usually called *quantities sensible*, because they are the proper objects of our several sensations. Such are roughness and smoothness, hardness and softness; the tribes of colours, savours, odours; not to mention those powers of character more *subtle*, the powers electric, magnetic (G), medicinal, &c.

"Here therefore we may answer the question, how *natural* bodies are *distinguished*. Not a single one among them consists of *materials in chaos*, but of materials wrought up after the most exquisite manner, and that conspicuous in their *organization*, or in their *figure*, or in *both*.—As therefore every *natural body* is distinguished by the *differences* just described, and as these *differences* have nothing to do with the *original matter*, which being everywhere similar can afford no distinction at all; may we not here infer the expediency of ESSENTIAL FORMS, that every *natural substance* may be essentially *characterized*? These *forms*, though they differ from matter, can yet *never subsist without it*; but *united* with it, they help to produce every *composite* being, that is to say, in other words, every *natural substance*, in the visible world. It must be remembered, however, that it is the FORM in this union which is the *source of all distinction*. It is by *this* that the *ox* is distinguished from the *horse*, not by that grass on which they subsist, the *common matter* to both. To which also may be added, that as figures and sensible qualities are *the only objects of our sensations*, and these are all *parts of natural form*; so therefore (contrary to the sentiment of the vulgar, who dream of nothing but of matter) *it is form, which is in truth the whole that we either hear, see, or feel*; nor is *mere matter* any thing better than an *obscure imperfect being*, knowable only to the *reasoning faculty* by the two methods already explained, I mean that of *analogy* and that of *abstraction*. Here therefore we conclude with respect to *sensible forms*, that is to say, *forms immerged in matter* and *ever inseparable* from it. In *these* and *matter* we place the ELEMENTS OF NATURAL SUBSTANCE."

If this extract appear long, let it be remembered that it contains the fullest and most perspicuous detail which is to be found in the English language, of a doctrine of which the author of *Ancient Metaphysics* supposes Locke to have been ignorant; and for which ignorance he affects to treat the English philosopher with supercilious contempt. Had Locke really been ignorant of the ancient doctrine of *matter* and *form*, it is probable that most people will be of opinion, that the *contempt* expressed by his censurer might have been spared; but if it should appear, that, as far as this theory is intelligible, it differs not, except in words, from the doctrine laid down in the *Essay concerning Human Understanding*, what shall we think of that zeal for ancient phrases, which had influence sufficient to make one respectable philosopher pour contempt upon another who was an ornament to his country?

146 Matter cannot be destitute of solidity.

What Mr Harris has said of *matter* and *form* respecting works of art, is sufficiently intelligible, and extremely just. Nor should we object to the account which he gives of the origin of natural body, if he had not divested his first matter of every power and every quality, solidity and extension not excepted. But though we can suppose body divested of any one particular figure and of every sensible quality, such as colour, odour, tastes, &c. and the *substratum* or *basis* or *matter* of it still to remain, yet it seems impossible to conceive it divested of *solidity* without supposing it totally annihilated. Nay, if we have any just notion at all of solidity, it is evidently inseparable from the substratum of body, whatever that substratum be; and indeed though Mr Harris divests his first matter of every attribute, the argument by which he proves the necessary existence of such a being does not require its privation to be so universal. "Had the *primary matter* (says he), in its proper nature, any one particular attribute, so as to prevent its privation from being unlimited and universal, *such attribute would run through all things* and be conspicuous in all." This indeed is obvious and undeniable: but *solidity* and *extension* do in *fact* run through *all things* into which the *substratum* or *matter* of body is ever formed or ever can be conceived to be formed; and therefore there is no necessity for supposing the first matter divested of these attributes (H).

Mr Harris says, that both Timæus and Plato drop expressions

(G) That it is from the *extension*, *figure*, and *organization* of bodies, that their *medicinal* powers arise, seems to be undeniable; for medicines operate by contact: but it is not so clear that the same *forms*, to use the author's language, are the source of *magnetical* powers. If the magnet be surrounded with an atmosphere extending to a certain distance, such may be the case; but if not, the author's conjecture must be ill founded. See MAGNETISM.

(H) Nor does it appear that it was divested of them by all the ancient philosophers. We learn from Cudworth, that "the atomical physiology, the most ancient perhaps of any, teaches that body is nothing else but διαστατὸν ἀντίτυπον, *extended bulk*; and that nothing is to be attributed to it but what is included in the nature and idea of it, viz. greater or less magnitude, with divisibility into parts, figure, and position, together with motion or rest, but so as that no part of body can ever move itself. And consequently, this philosopher supposes, that there is no need of any thing else besides the simple elements of magnitude, figure, site, and motion, (which are all clearly intelligible, or different modes of extended substance), to solve the corporeal phenomena by; and therefore not of any substantial *forms* distinct from the matter; nor of any other qualities really existing in the bodies without, besides the results or aggregates of those simple elements, and the disposition of the insensible parts of bodies in respect of figure, site, and motion; nor of any intentional *species* or *shows* propagated from the objects to our senses: nor lastly, of any other kind of motion or action really distinct from

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expressions as if they considered *matter* to be *place*; but place, as will be seen afterwards, can be the basis of nothing. He likewise quotes a passage from Ammonius on the predicaments, in which it is said "that there never was in *actuality* either matter without body, or body without quality;" and we appeal to our readers if it be not absolutely impossible to contemplate such a being even in *idea*. To the question, Whether the first matter has a separate existence by itself, distinct from all the qualities of body, the author of *Ancient Metaphysics* answers thus:—"We have no idea of it existing separately, because we find no such thing in nature, from which we draw all our ideas; but whether there may not be such a thing existing in the regions of infinite space, as *matter* without *form* and *dimensions*; is what I think no man can take upon him to decide." But with all submission, if a man cannot decide this question with the utmost certainty, his three ponderous volumes are nothing better than useless paper: for the subject of them is things *existing*; and concerning existence we know nothing with greater certainty, than that a being of which nothing positive can be affirmed, cannot possibly have any existence.

147 Some first matter common to all bodies;

That, in the world which we inhabit, bodily substances of every kind, whether natural or artificial, either immediately or mediately pass into one another, is a truth which cannot be denied: and therefore it follows, that there must be some one primary matter common to all things. In modern philosophy this primary matter is considered as solid, and as the *substratum* of all bodies; and all those things which, in the language of Mr Harris, are comprehended under the appellation of *form*, are called *qualities*: so that on this subject the ancient and modern philosophy differ in nothing but in the latter using the word *qualities* instead of the word *form*; and defining the first matter to be, a *solid* substance every where the same," whilst the ancient philosophy considers it as void of solidity.

148 of the nature of which, all men are equally ignorant.

Of the nature of this first matter all philosophers are equally ignorant: for, as Mr Harris says, it is in truth *form*; or, as modern philosophers would say, they are in truth *qualities*, which are the whole that we either hear, or see or feel, or of which we have either idea or conception. Mr Locke says expressly, "that if any one will examine himself concerning his notion of pure substance in general, he will find that he has no other idea of it at all, but only a supposition of he knows not what support of such qualities as are capable of producing simple ideas in us."

149 How we know that the things immediately perceived are qualities.

But how, it has been asked, do we know that the things which we perceive are qualities, and cannot exist without a subject? We answer, Because every one of them, except solidity, may be changed or destroyed, and the subject in which they inhere still remain. Thus, though wax may be melted or burnt, and be no longer a hard red substance of such a figure and such a smell, the matter which supported the hardness, figure, colour, and smell, still remains; for melted wax or ashes is as much a solid substance as is that which may be used for the sealing of letters, &c.

It has been said that solidity (1) is the *substratum* of body;

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from local motion (such as generation and alteration), they being neither intelligible as modes of extended substance, nor any way necessary: Forasmuch as the forms and qualities of bodies may well be conceived to be nothing but the result of those simple elements of magnitude, figure, site, and motion, variously compounded together; in the same manner as syllables and words in great variety result from the different combinations and conjunctions of a few letters, or the simple elements of speech; and the corporeal parts of sensation, and particularly that of vision, may be solved only by local motion of bodies, that is, either by corporeal effluvia (called *simulacra*, *membranæ*, and *exuviæ*), streaming continually from the surface of the objects, or rather, as the later and more refined atomists conceived, by pressure made from the object to the eye, by means of light in the medium. So that ως δια βακτηριας του ταθεντος αερος το βλεπομενον αναγγελλεται, the sense taking cognizance of the object by the subtle interposed medium, that is tense and stretched (thrusting every way from it upon the optic nerves), doth by that, as it were by a staff, touch it. Again, Generation and corruption may be sufficiently explained by concretion and secretion, or local motion, without substantial forms and qualities. And lastly, Those sensible ideas of light and colours, heat and cold, sweet and bitter, as they are distinct things from the figure, site, and motion of the insensible parts of bodies, seem plainly to be nothing else but our own fancies, passions, and sensation, however they be vulgarly mistaken for qualities in the bodies without us. *Cudworth's Intellectual System*, Book i. chap. 1.

This, as will be seen by and by, is the philosophy of Newton, Locke, and all their followers: and that it is the genuine philosophy of the ancient atomists, we may safely take the word of the author whom we have quoted; for no modern has been more conversant with their writings, more completely master of their language, or has given their sense with greater accuracy. Those authors, therefore, who in their zeal for ancient metaphysics would explode the physiology of Newton and Locke, and substitute in its place the Aristotelian doctrine of *matter* and *form*, belie their own pretences; for the theory which they would banish is more ancient than that which they introduce, and we appeal to our readers if it be not more intelligible.

(1) The philosophers of most eminence who have maintained this opinion are, *Dr Watts*; the author of the *Procedure, Extent, and Limits, of the Human Understanding*; and *Dr Law*, late bishop of Carlisle, who in a note upon *King's Origin of Evil* gives the opinion of the triumvirate in the following words:—"We find by experience, that a thing will always exhibit the same appearances in some respects, though it admit of changes in others: or, in Mr Locke's language, that certain numbers of simple ideas go constantly together, whereas some others do not. The former of these we call the *substance*, thing, or being, itself; the latter are termed its modes or *accidents*. Thus the substance of *body*, as far as we know of it, consists in solidity and extension; which being necessarily finite, it also becomes capable of division, figure, and motion. These are its original inseparable qualities,

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body; and men have been probably led into this notion from a conviction that such *substratum*, whatever it be, is and must be solid; but that solidity is only a quality inseparable from the first matter, and not that matter itself, must be evident from this consideration, that solidity is the same in all bodies, and incapable of producing by itself any other effect than that of excluding from the place occupied by it every other solid substance. It could not of itself be the *substratum* of colour, taste, or smell, otherwise all bodies would be coloured, sapid, and odorous; and as, according to all our notions of it, it is incapable of any change, it could not by itself be so modified as to excite in us these sensations.

150 Our notion of matter relative and obscure.

The things then immediately perceived by us, or of which we have any adequate idea or conception, are only qualities which must belong to a subject; and all that we know about this subject is, that it is that to which such qualities belong. From this it is evident, that our notion of matter, as distinguished from its qualities, is a relative * and obscure notion, and must remain obscure till men have other faculties. In this the philosopher seems to have no advantage above the vulgar: for as they perceive colour, and figure, and motion, by their senses, as well as he does; and as both are equally certain that there is a subject of those qualities; so the notions which both have of this subject are equally obscure; or, to speak more properly, they have no *positive* notion of it at all. When a philosopher calls it the *first matter*, a *substratum* or a *subject* of *inhesion*, those learned words convey no meaning but what every man understands and expresses, by saying in common language, that it is a thing extended, solid, and moveable.

* *Reid's Essays on the Intellectual Powers of Man.*

They are therefore *qualities*, or in the language of ancient philosophy, *forms* alone, about which, in corporeal substance, we can reason with precision and certainty; and it is sufficient for all the purposes of life that we have of them an adequate knowledge. For as the *first matter* or original *substratum* of all bodies seems to be the same, though we know not what it is; and as one body is distinguished from another only by its *qualities* or *powers*; a knowledge of the nature of these is all that can be necessary to direct our conduct with respect to the various objects with which we are surrounded.

151 Qualities primary and

Qualities thus considered in bodies, are, first, such as are utterly inseparable from the body, in what state soever it is; such as in all the changes and alterations which it suffers, and under all the force which can be employed upon it, it constantly keeps. Thus, in the instance already given, a stick of sealing wax may, by the operations of fire, be rendered liquid or reduced to smoke and ashes; and when it has undergone these changes, it has lost many of the sensible qualities which it had when a long round substance fit for the purpose of sealing letters; but other qualities which were then perceivable in it still remain: for not only liquid wax, but every particle of smoke and ashes, is solid and extended, as well as the hardest or largest body; and every such particle has likewise some figure, and is capable of motion or rest. Again, If a grain of wheat or any other corporeal substance, be divided into two parts, and each part be again divided without end, still the smallest particle of it will be solid, extended, of some figure, and capable of further division. *Solidity*, *extension*, *divisibility*, and *motion* or *rest*, are therefore qualities inseparable from *body*, and have on that account been with great propriety called its *original* or *primary qualities*.

152 secondary.

There are other qualities, which in truth are nothing in the bodies themselves, but powers arising from the magnitude, figure, texture, and motion, of their insensible parts to produce in us various sensations; such are *colours*, *sounds*, *tastes*, and *odours*. These have been denominated *secondary qualities*; and to them may be added

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lities, which constitute the thing, and seem not to depend on any thing else as a *subject*. But a particular figure, motion, &c. are only accidents or modes of its existence; which do not necessarily attend it, though they themselves cannot be supposed to exist without it. The substance of *spirit* consists in the powers of thinking and acting, which likewise admit of various modifications. This seems to be all that we can learn concerning the nature of things from observation and experience. To inquire into the *manner* how these, which we call *properties*, exist together, or to attempt to explain the *cause*, ground, or reason, of their union, is in vain. To assign the word *substance* for a representation of it, is saying nothing: it is setting a mere word for what we have neither any idea of nor occasion for. Indeed if we consider these primary qualities as needing something to inhere in, we are obliged to seek for something to support them: and by the same way of reasoning, we may seek for something else to support that other something, and so on; and at last shall find no other support for the whole but the cause which produced it." "Dr Watts (continues the Bishop) is of opinion, that it is introducing a needless *scholastic* notion into the real nature of things, and then fancying it to have a real existence:" (*Logic*, p. 14.). The author of the *Procedure*, *Extent*, &c. affirms, "That as far we directly know the essential properties of any substance, so far we have a *direct* knowledge of the substance *itself*: and if we had a direct knowledge of *all* the essential properties of any substance, we should have an *adequate* knowledge of that substance; for surely, if there be any meaning in words, the knowing any thing of the essential properties of a thing is knowing *so much* of its very substance."

That the substance of body consists in *solidity* and *extension*, and nothing more; and that these depend not upon any thing else as a *subject*; cannot be true: for *solidity*, in our conception, is nothing but *impenetrability*; but whoever uses the word *impenetrability*, certainly means that there is *something* impenetrable. That there is some real thing or being different from solidity and extension, which impresses us with the notion that it is solid and extended, is self-evident to all mankind: if it be not matter, these conceptions must be communicated to us by the immediate agency of the Deity, which seems to have been the real opinion of the Bishop of Carlisle. But this differs not from the theory of Berkeley, which we shall consider by and by.

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added a third ſort, which are univerſally allowed to be barely *powers*, though they are in fact as much real qualities in the ſubject as thoſe we have juſt mentioned. Thus the power in fire to produce by its primary qualities a new colour or conſiſtency in wax or clay, is as much a quality in the fire as the power which it has to produce in us a new ſenſation of warmth or burning. That *colours*, *taſtes*, *ſounds*, and *odours*, as they are perceived by us, are mere ſenſations, has been already proved: and that the powers in the bodies which produce theſe ſenſations are not, like *ſolidity* and *extenſion*, inſeparable from the body to which they may belong, is evident; becauſe a piece of *red* wax may be reduced to *black* aſhes; and becauſe by pounding an almond we may change its clear white colour into a dirty hue, and its pleaſant taſte into one that is oily and rancid; and a ſingle rent through the body of a bell deſtroys its ſound.

The primary qualities of body have a real exiſtence independent of us and of every other creature. Thus the particular *bulk*, *number*, *figure*, and *motion*, of the *parts* of *fire* or *ſnow* are *really in the fire or ſnow*, whether any man's ſenſes perceive them or not; and therefore theſe may be called *real qualities*, becauſe they really exiſt in the bodies: But *light*, *heat*, *whiteneſs*, or *cold* (as they are perceived by us), are no more *really in fire or ſnow*, than ſickneſs is in *tartar* or pain in a *ſword*. Take away the ſenſations of them: let not the eyes ſee light or colours, nor the ears hear ſounds; let not the palate taſte nor the noſe ſmell; and all colours, taſtes, odours, and ſounds, as they are ſuch particular ſenſations, vaniſh and ceaſe, and are reduced to their cauſes, *i. e.* to the bulk, figure, and motion of the parts of the body.

153 Bodily qualities are of three ſorts.

The qualities then that are in bodies, rightly conſidered, are of three ſorts. 1. The *bulk*, *figure*, *number*, *ſituation*, and *motion* or *reſt*, of their *ſolid* parts. Of theſe, as they are in themſelves, we have clear and diſtinct notions. We know that they are in the body whether we perceive them or not, and we call them *primary* or *eſſential qualities*. 2. The power that is in any body, by reaſon of its internal texture and inſenſible primary qualities, to operate upon our ſenſes in a peculiar manner, producing in us the different ſenſations of *colours*, *ſounds*, *taſtes*, or *ſmells*, &c. Theſe we have called *ſecondary qualities*, but they are often termed *ſenſible qualities*. 3. The *power* that is in any body, by reaſon of the particular conſtitution of its primary qualities, to make ſuch a *change* in the *bulk*, *figure*, *texture*, and *motion* of *another body*, as to make it operate on our ſenſes differently from what it did before. Thus, the ſun has a power to make wax white, and fire to make lead fluid. Theſe are univerſally called *powers*; but we have no ſuch notions of them as we have of the *primary qualities* of bodies. We know that they exiſt, but we know not what they are. It has indeed been diſcovered, that the ſenſation of ſmell is occaſioned by the effluvia of bodies*; that of ſound by their vibration. The diſpoſition of bodies to reflect a particular kind of light occaſions the ſenſation of colour; and the operation of the minute parts of bodies upon the nerves of the tongue and palate is the cauſe of taſtes. Very curious diſcoveries have been made of the nature of heat and its manner of operating, and an ample field ſtill remains. We are likewiſe intuitively certain, that body can operate upon body only by impulſe; but how certain impulſes upon certain organs ſhould produce ſenſations in us to which there is nothing ſimilar in the impelling body, is equally unknown to the clown and the philoſopher.

* *Reid's Eſſays on the Intellectual Powers of Man*, and *Locke's Eſſay*, &c.

154 The doctrine of the ancient atomiſts reſpecting qualities.

Such is the diſtinction which in modern philoſophy is made between primary and ſecondary qualities; but it is a diſtinction which was likewiſe well known to that ſect of ancient philoſophers who were denominated *atomiſts*. At the head of theſe were Thales and Pythagoras (K); and we may infer from Ariſtotle, that the ſect comprehended almoſt all the phyſiologiſts who taught before himſelf and Plato: for he ſays†, Δημοκριτος και οἱ πλειστοι των φυσιολογων ατοπωτατον τι ποιουσι, παντα γαρ τα αισθητα απτα ποιουσι, και εις σχηματα αναγουσι τους χυμους: "Democritus, and *moſt* of the *phyſiologiſts*, fall into a great abſurdity; for they make all ſenſe to be touch, and reſolve ſenſible qualities into the figures of inſenſible atoms." And he adds, that "the former phyſiologiſts (without exception) ſaid not well, that there is no black and white without the ſight, nor bitter and ſweet without the taſte." He elſewhere ‡ tells us, that thoſe philoſophers explained generation and alteration without forms and qualities, by figures and local motion." Δημοκριτος και Λευκιππος ποιησαντες τα σχηματα την αλλοιωσιν και την γενεσιν εκ τουτων ποιουσι διακρισει μεν και συγκρισει γενεσιν και φθοραν ταξει δε και θεσει αλλοιωσιν. "Democritus and Leucippus having made figures (or variouſly figured atoms) the firſt principles, make generation and alteration out of theſe; namely, generation

† *Lib. de Senſu et Senſibili*, cap. 4.

‡ *De Generatione et Corruptione*, lib. i. cap. 2.

(K) This is denied by Biſhop Warburton, who thinks nothing better ſettled than that Democritus and Leucippus were the authors of the atomic phyſiology. We highly reſpect the learning and ingenuity diſplayed in the Divine Legation of Moſes; but on this point we are convinced that its author is miſtaken. Strabo expreſsly affirms, that Moſchus the Phœnician was the author of the atomic phyſiology; and Cudworth has proved, by arguments which to us are perfectly ſatisfactory, that Thales and Pythagoras were both atomiſts, and that they derived the doctrine from Phœnicia or Egypt. They did not, indeed, ſpeculate in phyſics, but delivered their doctrines as they had received them from tradition, and they referred all motion to mind as its cauſe. Leucippus and Democritus, we believe, were the firſt ſpeculative atomiſts: but though they refined upon, and perhaps improved, the mere mechanical part of the phyſiology of their maſters, they unhappily dropt the better part of it; and, baniſhing mind from their ſyſtem of the univerſe, they became materialiſts and atheiſts. With the ſober and pious part of philoſophers this brought the atomic theory into diſrepute; and Plato and Ariſtotle, who were theiſts, when they oppoſed that theory, always pointed their arguments againſt Leucippus and Democritus, which is probably what led the learned Biſhop to conſider theſe atheiſts as the authors of the atomic phyſiology.

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tion together with corruption from the concretion and secretion of them, but alteration from the change of their order and position." By the atomic physiologists the name of *quality* was generally applied only to those things which we have called *secondary qualities*. The *primary* being considered as *essential* to *matter*, were seldom, if ever, called *qualities*. That the atoms, which they held to be the first principles of bodies, were figured, solid, extended, and moveable, is apparent not only from the short view of their system which we have given from Cudworth, but likewise from the passages which we have just quoted from Aristotle: but the question debated between them and their antagonists was, whether those atoms had *smell*, *taste*, and *colour*; or, as it was commonly expressed, whether they had *qualities*? Democritus, Leucippus, and the other atomists, we see, maintained that they had not; and the following account of the doctrine of Protagoras, another philosopher of that school, shows, that on this subject at least the ancient advocates for the atomic system reasoned as justly as any of the moderns, and much more justly than the Peripatetics and Platonists by whom they were opposed. Plato having in his Theœtetus first said in general that the philosophy of Protagoras made all things to consist of a commixture of atoms and local motion, represents his doctrine concerning colours in particular, after this manner: "First, As to that which belongs to the sight, you must conceive what is called a white or black colour, not to be any thing absolutely existing either without your eyes or within your eyes; but black and white, and every other colour, is caused by different motions made upon the eye, from objects differently modified; so that it is nothing either in the agent or patient absolutely, but something which arises from between them both (L)." From this passage it is plain, that Protagoras thought of colours exactly as Mr Locke thought, that they are not *real qualities* existing in bodies, but merely sensations excited in our minds; and indeed he is presently after represented as having called them τινα εν ημιν φασματα, *certain fancies* or *appearances in us*. But there is in the Theœtetus another passage, in which a fuller account is given of the atomic philosophy, to this purpose: "The principle upon which all these things depend is this, That the whole universe (M) is motion of atoms and nothing else: which motion is considered two ways, and is accordingly called by two names, *action* and *passion*. From the mutual congress, and, as it were, attrition of these together, are begotten innumerable offsprings, which though infinite in number, yet may be reduced to two general heads, *sensibles* and *sensations*, which are both generated at the same time. The *sensations* are *seeing*, *hearing*, and the like; and the corresponding *sensibles* are *colours*, *sounds*, &c. Wherefore, when the eye and its proper object meet together, both the αισθητον and the αισθησις, the *sensible idea* of white and black, and the *sensation* of seeing, are generated together, neither of which would have been produced if those two had not met. The like is to be conceived of all other *sensibles*, as hot and cold, &c. None of these are absolute things in themselves, or real qualities in external objects; but they are begotten from the mutual congress of agent and patient, and that by motion. So that neither the agent has any such thing in it before its congress with the patient, nor the patient before its congress with the agent. But the agent and patient meeting together, and begetting *sensation* and *sensibles*, both the object and the sentient are forthwith made to be so and so qualified; as when honey is tasted, the sensation of tasting, and the quality of sweetness, are begotten together, though the sensation be vulgarly attributed to the taster, and the quality of sweetness to the honey." The conclusion of all which is summed up thus, ουδ εν ειναι αυτο καθ' αυτο, αλλα τινι αιει γιγνεσθαι: "Not one of these sensible things is any thing absolutely in the object without, but they are all generated or made relative to the sentient (N)."

The language of ancient philosophy was defective in precision; terms were used vaguely and improperly, so that the meaning of the author is often to be collected only from the context. When Protagoras is here made to say, that when the agent and patient meet together, both the object and the sentient are forthwith made to be so and so *qualified*; as when honey is tasted, the sensation of tasting and the *quality* of sweetness are begotten together; it could not be his meaning, that any real change is made upon the external object merely by our tasting it, but only that the actual sensation and the sensible *idea* of sweetness are produced at once; just as he had said before, that the sensible idea of white or black, and the sensation of seeing, are generated together. If his words be thus interpreted they express a noble truth; and the whole passage shows, that the ancient atomic theory differed not from the theory of Des Cartes, Newton, and Locke, being the most rational, as well as the earliest system of physics with which we have any acquaintance. By divesting body of *essential forms* distinct from matter and motion, and by giving to the first matter extension and solidity, it renders the corporeal world intelligible; and accounts for those appearances

(L) Υπολαβε τοινυν ουτωσι κατα τα ομματα πρωτον, ὁ δε καλεις χρωμα λευκον μη ειναι αυτο ἑτερον τι εξω των σων ομματων, μηδ' εν τοις ομμασι, αλλα μελαν τε και λευκον και ὁτιουν αλλο χρωμα εκ της προσβολης των ομματων προς την προσηκουσαν φοραν φανειται γεγενημενον και ὁ δε εκαστον ειναι φαμεν χρωμα, ουτε το προσβαλλον ουτε το προσβαλλομενον αλλα μεταξυ τι εκαστω ιδιον γεγονος.

(M) Protagoras was a follower of Leucippus and Democritus in every thing, and of course an atheist.—This, however, does not hinder him from having been a correct physiologist with respect to the composition of body; and as such only is he quoted by us. It is, indeed, melancholy to think, that there was hardly a sect of ancient philosophers in which there were not many atheists.

(N) Αρχη δε εξ, ἡς α νυν δη ελεγομεν παντα ηρτηται ἡ δε αυτων, ὡς το παν κινησις ην και αλλο παρα τουτο ουδεν της δε κινησεως δυο ειδη, πληθει μεν απειρον, ἑκατερον, δυναμιν δε το μεν ποιειν εχον, το δε πασχειν, &c.—See the *Theœtetus*; see also *Cudworth's Intellectual System*, book i. chap. 1.

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pearances which are called secondary qualities, in a manner perfectly satisfactory. Aristotle indeed opposed the atomic philosophy, and had influence enough to bring it into disrepute for many ages; but when he insisted that the two constituent principles of body are *matter* and *form*, both independent of all sentient beings, and which may be conceived as existing distinct from each other, he substituted for a simple and sublime theory an absurd and incomprehensible fiction.

Chap. II. *Of the* Essences *of* Bodies.

155 The essences of bodies result,

Having treated of the substance, qualities, and powers of body, we may seem to have exhausted this part of our subject; but there is still more to be done. Metaphysicians, ancient and modern, have introduced another term into the science, to denote that which distinguishes one species or sort of bodies from all other species or sorts; and this term we shall briefly explain. Gold is apparently different from lead, and from every other species of metal; a horse is apparently different from an ox, and from every other species of animals; and all animals apparently differ from all vegetables, as vegetables differ from metals.

156 according to the Peripatetics and Platonists, from essential forms;

It is only with the *bodies*, not the minds of animals, that we are at present concerned: and we have seen that all bodies are composed of the same matter.—What then is it that makes different bodies exhibit to us such different appearances; or, in other words, how come they to be possessed of such different qualities and powers? It is (say the followers of Plato and Aristotle) from their having different *essential forms*, by which every natural substance is essentially characterized; for of every animal, vegetable, or metal, &c. there is a *form* conceived, as existing before the individuals in which it is incorporated, from which result all the properties of that animal, vegetable, or metal, such as *figure*, *size*, *colour*, and the other qualities perceptible by our senses: but this *internal and essential form* itself, from which all other forms result, is not perceptible by our senses, nor even by our understanding directly and immediately, nor otherwise than by the analogy formerly mentioned. These essential forms, we are told, mean something, which, though different from matter, can yet never subsist without it; something which, united with it, helps to produce every *composite* being, that is to say, in other words, every natural substance in the visible world.

157 but these forms have no existence.

This assertion Mr Harris submits with deference to his contemporaries; because (says he) "I speak perhaps of spectres as shocking to some philosophers as those were to Æneas which he met in his way to hell—*Terribiles visu formæ.*" The elegant author's unwillingness to frighten his contemporaries, was a proof of his amiable and benevolent disposition; but he needed not to have suffered from any such apprehension. Those spectres, apparently so dreadful, had long before been laid to rest by the incomparable Cudworth, who has demonstrated, that *essential forms* different from matter and motion, as they have no real existence, had no place in the most ancient philosophy; and that the different appearances or sensible qualities which different bodies exhibit, are the result of the different contexture of their insensible parts. Thus, gold and lead are composed of the same primary matter, but the atoms or minute parts of that matter are in the one substance differently combined from what they are in the other; and this different combination is the sole cause that gold is specifically heavier than lead, more ductile, and of a different colour, &c. For the very same reason, iron is harder than either gold or lead, specifically lighter, and possessed of many other sensible qualities which are not found in either of these substances. One vegetable differs from another externally in size, colour, taste, smell, rapidity of growth, and proportion of parts, &c.: but all vegetables are composed of the same matter; and the external difference which prevails among them is the result of a different structure and motion of their insensible parts. The same is to be said of the differences which prevail among the bodies of animals; they all result from internal organization and motion, and from nothing else, whatever be the immediate cause of that motion.

158 The real essences of bodies unknown to us.

This particular internal texture and motion of insensible parts, is that which makes one sort of bodies differ externally from every other sort of bodies; and it is by modern metaphysicians called the *real essence* of bodies. Thus, that internal texture of minute parts, which makes gold of a bright yellow, extremely ductile, specifically heavier than all other metals, and soluble in *aqua regia*, is the real essence of gold; but what that essence is in itself no man can tell, as we perceive only the qualities which result from it. We are, however, certain, that it is different from the real essences of lead and iron, because it produces different effects from those which are produced by these essences; and different effects are never produced in the same circumstances by the same cause.

159 Nominal essences, what they are,

We have called the internal texture and motion of the insensible parts of bodies, their *real essences*, to distinguish them from other *essences* which are only *nominal*, and with which we are perfectly acquainted, because they are the fabrication of our own minds.—Thus, a beautiful bright yellow, a certain specific gravity, extreme ductility, and solubility in *aqua regia*, are the qualities by which we distinguish gold from all other metals. Of these qualities we frame a sort of general conception, which we call the *essence* of gold; and every substance in which we find this essence, we class under the specific name gold. For though it is obvious that our conceptions cannot be the *real essences* of things external, yet are they sufficient guides to these essences, as we know that bodies which, being all formed of the same matter, have the very same sensible qualities, must likewise have the same internal organization or texture of parts, because it is only in that organization or texture that one body can differ from another.—And so much for bodily substance, qualities, and essences.

Chap. III. *Of the* Existence *of* Matter.

160 Berkeley attempts to demonstrate that matter has no existence.

We have endeavoured to prove, that all corporeal substances consist of minute atoms, solid and extended; and that the sensible qualities of every body result from the combination and motion of the atoms of which that body is composed. The celebrated Berkeley, bishop of Cloyne, Of the Existence of Matter

Cloyne, however, attempted to demonſtrate that theſe atoms have no real exiſtence; and that the very ſuppoſition of a ſolid, extended, and inert ſubſtance, being the archetype of our ideas, involves in it an abſurdity and contradiction.

It is univerſally allowed, that all our knowledge of matter is derived through the ſenſes, either immediately in the very act of ſenſation, or mediately by an aſſociation which is reſolvable into a proceſs of reaſoning. According to the principles which we have ſtated, and laboured to eſtabliſh, matter itſelf is no immediate object of the ſenſes; and as theſe are the principles upon which the biſhop erected his demonſtration, it will be incumbent upon us to conſider his theory, becauſe it has been repreſented as in the higheſt degree pernicious, and as leading to univerſal ſcepticiſm.

161 The view of his theory given by his antagoniſts.

The author of the *Eſſay on the Nature and Immutability of Truth*, repreſents Berkeley as teaching us, "that external objects (that is, the things which we take for external objects) are nothing but ideas in *our* minds; in other words, that they are in *every reſpect* different from what they appear to be; that matter exiſts not but in *our* minds; and that independent on *us* and *our* faculties, the earth, the ſun, and the ſtarry heavens, have no exiſtence at all; that a lighted candle hath not *one* of *thoſe qualities* which it *appears to have*; that it is not white nor luminous, nor round, nor diviſible, nor extended; but that, for any thing we know, or can ever know to the contrary, it may be an Egyptian pyramid, the king of Pruſſia, a mad dog, the iſland of Madagaſcar, Saturn's ring, one of the Pleiades, or nothing at all." With reſpect to the conſequences of this theory, he affirms, that "it is ſubverſive of man's moſt important intereſts, as a moral, intelligent and percipient being; and not only ſo, but alſo, that if it were univerſally and ſeriouſly adopted, the diſſolution of ſociety, and the deſtruction of mankind, would neceſſarily enſue within the compaſs of a month."

The diſſolution of ſociety and the deſtruction of mankind are indeed diſmal conſequences—enough to make a man ſhudder in his cloſet. But do they really flow from Berkeley's ſyſtem? They certainly do, if it be the aim of that ſyſtem to prove that a candle has not any one quality which it appears to have, and that it may be a *mad dog*; for ſhould all philoſophers, by ſome means or other, become converts to the theory of Berkeley, as we know that the biſhops Sherlock, Smalridge, and others, actually did, the diſſolution of ſociety and the deſtruction of mankind would indeed be inevitable. The ſcribbling race, by uſing mad dogs for candles, would all become infected with the hydrophobia; and having their natural irritability augmented by the canine rabies, they would bite and tear till not a human being were left alive.

162 A view of his theory given by himſelf.

But to drop this ludicrous ſtyle, ſo unſuitable to philoſophical inveſtigation and calm inquiry, we beg leave to affirm, that the theory of Berkeley is here totally and groſsly miſrepreſented, and that not one of thoſe dangerous conſequences which flow from that miſrepreſentation can be fairly deduced from any thing taught in *The Principles of Human Knowledge* and the *Dialogues on the Exiſtence of Matter*. So far is Berkeley from teaching that external things are nothing but ideas in *our* minds, and that they are in every reſpect different from what they appear to be, that he teaches the very reverſe of this in the plaineſt language poſſible. "I am of a vulgar caſt (ſays he), ſimple enough to believe my ſenſes, and leave things as I find them. It is my opinion, that the real things are thoſe very things I ſee and feel and perceive by my ſenſes. That a thing ſhould really be perceived by my ſenſes, and at the ſame time not really exiſt, is to me a plain contradiction. When I deny ſenſible things an exiſtence out of the mind, I do not mean *my* mind in particular, but *all* minds. Now it is plain they have an exiſtence exterior to my mind, ſince I find them by experience to be independent of it. There is therefore ſome other mind wherein they exiſt during the intervals between the times of my perceiving them; as likewiſe they did before my birth, and would do after my annihilation. And as the ſame is true with regard to all other finite created ſpirits, it neceſſarily follows there is an *omnipotent eternal mind*, which knows and comprehends all things, and exhibits them to our view in ſuch a manner, and according to ſuch rules, as he himſelf hath ordained, and are by us termed the laws of nature."

So far is Berkeley from teaching that, independent on *us* and *our* faculties, the earth, the ſun, and the ſtarry heavens, have no exiſtence at all, and that a lighted candle has not one of thoſe qualities which it appears to have, that he over and over affirms the direct contrary; that the univerſe has a real exiſtence in the mind of that infinite God, in whom, according to the ſcriptures, we all live, and move, and have our being; that a lighted candle has not only all thoſe qualities which it appears to have, but that, with reſpect to us, it has nothing elſe; that ſo far from being continually deceived by our ſenſes, we are never deceived by them; and that all our miſtakes concerning matter are the reſult of falſe inferences from true ſenſations.

The biſhop makes the ſame diſtinction that we have made between ideas and notions; reſtraining the uſe of the former term to denote the relicts of ſenſation, and employing the latter to denote our knowledge or conception of ſpirits and all ſuch objects as are not perceived by ſenſe. He likewiſe affirms, that we can have no *idea* of an external inert ſubſtance; becauſe an idea can be like nothing but another idea, or the ſenſation of which it is a relict: and as all mankind admit that ideas and ſenſations can have no exiſtence but in the mind of a percipient being, he therefore infers that we can have no *idea* of any thing exiſting unperceived, and by conſequence can have no idea of matter in the philoſophical ſenſe of that word. Solidity, extenſion, diviſibility, motion, figure, colour, taſte, and all thoſe things which are uſually called qualities primary and ſecondary, being according to him mere ideas, can have no exiſtence but in a mind perceiving them; but ſo far is he from ſuppoſing their exiſtence to depend upon the perception of our minds, that he ſays expreſsly, "When in broad day-light I open my eyes, it is not in my power to chooſe whether I ſhall ſee or no, or to determine what particular objects ſhall preſent themſelves to my view; and ſo likewiſe as to the hearing and other ſenſes, the ideas imprinted on them are not creatures of my will. There is therefore ſome other will or ſpirit that produces them.

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them. The question between the materialists and me is not, Whether things have a real existence out of the mind of *this* or *that* person? but, Whether they have an absolute existence, distinct from being perceived by *God*, and exterior to *all minds?* I assert, as well as they, that since we are affected from without, we must allow powers to be without in a being distinct from ourselves. So far we are agreed. But then we differ as to the kind of this powerful being. I will have it to be spirit; they matter, or I know not what third nature. Thus I prove it to be spirit: From the effects I see produced, I conclude there are actions; and because actions, volitions (for I have no notion of any action distinct from volition); and because there are volitions, there must be a will. Again, The things I perceive must have an existence, they or their archetypes, out of my mind: but being ideas, neither they nor their archetypes can exist otherwise than in an understanding: there is therefore an understanding. But will and understanding constitute in the strictest sense a mind or spirit. The powerful cause, therefore, of my ideas is, in strict propriety of speech, a spirit."

163 That theory, however improbable, certainly possible, and

This is a faithful abstract of Berkeley's theory given in his own words. Matter, according to him, cannot be the *pattern* or *archetype* of ideas, because an idea can resemble nothing but another idea, or the sensation of which it is a relict. Matter, he thinks, cannot be the *cause* of ideas; for every cause must be active, and matter is defined to be inert and incapable of action. He therefore infers, that all our sensations of what we call the qualities of body are the effect of the immediate agency of the Deity upon our minds; and that corporeal substance has no existence, or at least that we have no evidence of its existence. That such may *possibly* be the origin of our sensations, no man will deny who reflects upon the infinite power and wisdom of the Agent from whom they are said to proceed. Dr Reid himself, the ablest of all Dr Berkeley's opponents, frankly acknowledges that no man "can show, by any good argument, that all our sensations might not have been as they are, though no body or quality of body had ever existed."

164 in its consequences harmless.

In its consequences we do not perceive that this theory can be hurtful either to religion, to virtue, or to the business of common life; for it only explodes the notion of a substratum, which, though it may have a real existence, was never thought of by the generality of mankind in any nation under heaven. Dr Beattie indeed affirms, that in "less than a month after the non-existence of matter should be universally admitted, he is certain there could not, without a miracle, be one human creature alive on the face of the earth." But this assertion must be the consequence of his mistaking Berkeley's non-existence of matter for the non-existence of sensible objects, the reality and existence of which the bishop never denied. On the contrary, he expresly says, "We are sure that we really see, hear, feel; in a word, that we are affected with sensible impressions; and how are we concerned any farther? I *see* this cherry, I *feel* it, I *taste* it; and I am sure *nothing* cannot be seen, or felt, or tasted: it is therefore *real*. Take away the sensations of softness, moisture, redness, tartness, and you take away the cherry." All this is equally true and equally conceivable, whether the combined sensations which indicate to us the existence of the cherry be the effect of the immediate agency of God or of the impulse of matter upon our minds; and to the lives of men there is no greater danger in adopting the former than the latter opinion.

165 A consequence of Berkeley's theory; which

But it has been said, that Berkeley's doctrine necessarily leads to scepticism in religion, as the same kind of reasoning which he employs to prove the non-existence of matter, operates equally against the existence of mind, and consequently against the possibility of a future state of rewards and punishments. "The rational issue of this system (we are told) is scepticism with regard to every thing excepting the existence of our ideas and their necessary relations. For ideas being the only objects of thought, and having no existence but when we are conscious of them, it necessarily follows, that there is no object of our thought which can have a continued and permanent existence. Body and spirit, cause and effect, time and space, to which we were wont to ascribe an existence independent of our thought, all are turned out of existence by this short dilemma: Either those things are ideas of sensation or reflection, or they are not: If they are ideas of sensation or reflection, they can have no existence, but when we are conscious of them: If they are not ideas of sensation or reflection, they are words without any meaning."

This sophism was advanced as a consequence from Berkeley's principles by Mr Hume; and upon these principles it has been deemed unanswerable by subsequent philosophers of great merit. But is it really a part of Berkeley's system, or can it be fairly inferred from the principles on which that system is built? These questions it is fit that Berkeley should answer for himself: and we shall venture to assert, that his answer will be perfectly satisfactory to every reader who attends to the distinction, which, after the bishop, we have stated between ideas and notions.

166 that author foresaw and

Though we believe this dangerous inference from Berkeley's principles is commonly attributed to Hume as its author, it did not escape the sagacity of the bishop himself. In the third dialogue, *Hylas*, who pleads for the existence of matter, thus objects to the reasoning of his antagonist. "Notwithstanding all you have said, to me it seems, that according to your own way of thinking, and in consequence of your own principles, it should follow, that you are only a system of floating ideas, without any substance to support them. Words are not to be used without a meaning. And as there is no more meaning in spiritual substance than in material substance, the one is to be exploded as well as the other."

167 obviated, but

To this *Philonus* answers: "How often must I repeat, that I know or am *conscious* of my own being; and that I myself am not my ideas, but somewhat else; a thinking active principle, that perceives, knows, wills, and operates about ideas: I know that I, one and the same self, perceive both colours and sounds; that a colour cannot perceive a sound, nor a sound a colour; that I am therefore one independent principle, distinct from colour and sound; and, for the same reason, from all other sensible things and inert ideas. But I am not in like manner *conscious* either of the existence or essence of matter. Farther, I know what

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what I mean, when I affirm that there is a ſpiritual ſubſtance or ſupport of ideas; i. e. that a ſpirit knows and perceives ideas. But I do not know what is meant, when it is ſaid that an unperceiving ſubſtance hath inherent in it, and ſupports, either ideas or the archetypes of ideas. In the very notion or definition of material ſubſtance there is included a manifeſt repugnance and inconſiſtency. But this cannot be ſaid of the notion of ſpirit. That ideas ſhould exiſt in what doth not perceive, or be produced by what doth not act, is repugnant. But it is no repugnancy to ſay, that a perceiving thing ſhould be the ſubject of ideas, or an active being the cauſe of them. That I, who am a ſpirit or thinking ſubſtance, exiſt, I know as certainly as I know that my ideas exiſt. I know likewiſe what I mean by the terms *I* and *myſelf*; and I know this immediately or intuitively; though I do not perceive it as I perceive a triangle, a colour, or a ſound. Ideas are things inactive and perceived; and ſpirits a ſort of beings altogether different from them, by which they are perceived. I do not, therefore, ſay, that my ſoul is an idea, or like an idea. However, taking the word *idea* in a large ſenſe, my ſoul may be ſaid to furniſh me with an idea, that is, an image or likeneſs of God, though indeed extremely inadequate. For all the notion I have of God is obtained on reflecting on my own ſoul, heightening its powers, and removing its imperfections. I have, therefore, though not an inactive idea, yet in myſelf ſome ſort of an active thinking image of the Deity. And though I perceive him not by ſenſe, yet I have a notion of him, or know him, by reflection and reaſoning. My own mind and my own ideas I have an immediate knowledge of; and by the help of theſe do immediately apprehend the *poſſibility* of the exiſtence of other ſpirits and ideas. Farther, from my being, and from the dependency I find in myſelf and my ideas, I do by an act of reaſon *neceſſarily* infer the exiſtence of a God, and of all created things in the mind of God. It is granted that we have neither an immediate evidence, nor a demonſtrative knowledge, of the exiſtence of *other finite ſpirits*; but it will not therefore follow, that ſuch ſpirits are on a footing with material ſubſtances: if, to ſuppoſe the one be inconſiſtent, and if it be not inconſiſtent to ſuppoſe the other; if the one can be inferred by no argument, and there is a probability of the other; if we ſee ſigns and effects indicating diſtinct finite agents like ourſelves, and ſee no ſign nor ſymptom whatever that leads to a rational belief of matter. I ſay, laſtly, that I have a *notion* of ſpirit, though I have not, ſtrictly ſpeaking, an *idea* of it. I do not perceive it as an idea, or by means of an idea; but know it by reflection. Whereas, I neither perceive matter objectively as I do an idea, nor know it as I do myſelf by a reflex act; neither do I mediately apprehend it by ſimilitude of the one or the other, nor yet collect it by reaſoning from that which I know immediately. All which makes the caſe of matter widely different from that of the Deity and all ſpirits.

Thus far we think Berkeley's theory tenible, and its conſequences harmleſs. That by the immediate agency of the Deity all our ſenſations *might* be what they are, though matter had no exiſtence, we think he has proved by arguments unanſwerable; and we are likewiſe of opinion, that by admitting the evidence of ſenſe, conſciouſneſs, and reaſon, in their fulleſt extent, and by diſtinguiſhing properly between thoſe things of which we have *ideas* and thoſe of which we have *notions*, he has ſufficiently ſecured the exiſtence of ſpirits or percipient beings, and obviated the irreligious ſophiſtry of Hume before it was conceived by that author. But the good biſhop ſtops not here. Not ſatiſfied with proving that all our ſenſations lead us immediately to the Deity, and that, for aught we know, matter, as defined by philoſophers, may have no ſeparate exiſtence, he proceeds farther, and endeavours to prove that matter cannot poſſibly exiſt. This appears even in the extracts which we have quoted from his book, in which he talks of the repugnance and inconſiſtency of the notion. In this part of his ſyſtem, we think he errs greatly, and advances an opinion altogether inconſiſtent with his own juſt principles.

168 Not ſatiſfied with this, he endeavours to prove the exiſtence of matter impoſſible.

169 His reaſoning

The repugnance of which he ſpeaks, ariſes ſolely from conſidering ſolidity and extenſion as relicts of ſenſation, or ideas of the ſame kind with thoſe of heat and cold, taſtes and ſounds. "Light and colours, heat and cold, extenſion and figures; in a word, the things we ſee and feel; what are they (ſays his lordſhip), but ſo many ſenſations, notions, ideas, or impreſſions, on ſenſe? and is it poſſible to ſeparate even in thought any of theſe from pereeption? Some there are who make a diſtinction betwixt *primary* and *ſecondary* qualities: by the former, they mean extenſion, figure, motion, reſt, ſolidity or impenetrability, and number: by the latter, they denote all other ſenſible qualities, as colours, ſounds, taſtes, and ſo forth.—The ideas we have of theſe they acknowledge not to be the reſemblances of any thing exiſting without the mind, or unperceived; but they will have our ideas of the primary qualities to be patterns or images of things which exiſt without the mind, in an unthinking ſubſtance which they call *matter*. But it is evident that extenſion, figure, and motion, are only ideas exiſting in the mind; that without extenſion ſolidity cannot be conceived; that an idea can be like nothing but another idea; and that conſequently neither they nor their archetypes can exiſt in an unperceiving ſubſtance. Hence it is plain, that the very notion of what is called *matter* or *corporeal ſubſtance*, involves a contradiction in it."

170 fallacious.

This account of extenſion and ſolidity affords a ſtriking inſtance how much the moſt vigorous and upright mind is liable to be warped by prejudice in behalf of a darling theory, and how apt the cleareſt underſtanding is to be blinded by the equivocal uſe of terms. That Biſhop Berkeley poſſeſſed a vigorous and perſpicaeious mind, his moſt vehement antagoniſts are eager to admit; and that his intentions were good, is known to all Europe. Yet by the equivocal uſe of the word *idea*, which the writings of Locke had then introduced into the language of philoſophy, he has here ſuffered himſelf to loſe ſight of a very proper and accurate diſtinction, which, ſo far as we know, was among the moderns firſt made by himſelf between *ideas* and *notions*. According to the biſhop, "we have a *notion* of power and a *notion* of ſpirits, but we can have no *idea* either of the one or the other; for all ideas being paſſive

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passive and inert, they cannot represent unto us by way of image or likeness that which acts. Such is the nature of *spirit* or that which acts, that it cannot be of itself perceived, but only by the effects which it produceth. It must be owned, however, that we have some *notion* of soul, spirit, and the operations of the mind, such as willing, loving, hating, inasmuch as we know or understand the meaning of these words."

Now we beg leave to affirm, that what is here said of spirits, and of which we readily admit the truth, is equally true of material or solid substances. We have no *ideas* of solidity and extension, because these things are not originally impressed upon the senses; but we have very distinct though relative *notions* of them, for they are clearly perceived by the effects which they produce. That this is at least possible, we have the acknowledgement of Bishop Berkeley himself: for he "freely owns, that from a cause, effect, operation, sign, or other circumstance, there may reasonably be inferred the existence of a thing not immediately perceived; and that it were absurd for any man to argue against the existence of that thing, from his having no direct and positive notion of it." This is exactly the case with respect to solid substances. These substances we do not immediately perceive; but we infer their existence from effects, signs, and other circumstances, and we have of them very clear though relative notions. Thus a man can open and shut his empty hand; but when he grasps an ivory ball of three or four inches diameter, he feels, that though the same power be exerted, his hand cannot then be shut. He is conscious that there is no change in himself; and being intuitively certain that every effect must have a cause, he infers with the utmost confidence, that the cause which prevents his hand from shutting is in the ball; or, in other words, that the thing which communicates to his eye the sensation of colour, and impresses upon his hand a sensation of touch, must be solid or impenetrable. Solidity, however, is not the sensation itself; it is only the cause of the sensation; and therefore it is so far from being an idea in our minds, that we are conscious our notion of it is of a thing totally different from all our ideas, of a thing external, at least to our minds. Indeed the notion itself is not positive; it is only relative, and inferred from the effects which are produced on our senses. That it is the *same* thing which communicates to the eye the sensation of colour, and has the power of resisting the compression of our hand, is evident: because, when the ball is thrown away, the resistance as well as the actual sensation vanish at once.

171 The idea of colour and the notion of solidity not naturally inseparable.

From this fact, which a less acute man would think a proof that the resistance was not occasioned by the immediate agency of the Supreme Being, but by the impenetrability of a solid substance of small dimensions, the bishop argues thus against the *possibility* of such a substance: "They who assert that figure, motion, and the rest of the primary or original qualities, do exist without the mind in unthinking substances, do at the same time acknowledge, that colours, sounds, heat, cold, and such like secondary qualities, do not; which they tell us are sensations existing in the mind alone, that depend on and are occasioned by the different size, texture, and motion, of the minute particles of matter. This they take for an undoubted truth, which they can demonstrate beyond all exception. Now if it be certain, that those original qualities are inseparably united with the other sensible qualities, and not even in thought capable of being abstracted from them, it plainly follows, that they exist only in the mind. But I desire any one to reflect and try whether he can by any abstraction of thought conceive the extension and motion of a body, without all other sensible qualities. For my own part, I see evidently that it is not in my power to frame an idea of a body extended and moved, but I must withal give it some colour or other sensible quality, which is acknowledged to exist only in the mind. In short, extension, figure, and motion, abstracted from all qualities, are inconceivable. Where, therefore, the other sensible qualities are, there must be these also, to wit, in the mind, and no where else."

In this reasoning, though plausible, there is an unintended fallacy. It is indeed true, that we cannot contemplate in imagination a solid substance without conceiving it to have some colour; but there is sufficient reason to believe, that this union of colour and solidity in our minds is not the effect of nature as it operates at first upon our senses, but merely the consequence of early and deep-rooted association. Bishop Berkeley himself has taught us, that the objects of sight are not at a distance; and that if a man born blind were suddenly made to see, he would conceive the objects of his sight as existing either in his eye or in his mind. This is a truth which no man will controvert who has dipt into the science of optics, or who has even paid the slightest attention to the perceptions of infants; and if so, it follows, that to a man born blind and suddenly made to see, colour and solidity would not appear united. Were such a person to lay hold of an ivory ball and raise it to the elevation of his eye, he would perceive whiteness as a new sensation existing in his eye or his mind, but he would feel resistance at the extremity of his arm. He would not have the least reason to conclude, that this whiteness was inseparably united to the cause of this resistance; and he would, in fact, draw no such conclusion, till experience had taught him, that by removing the ball or cause of resistance from his hand, he at the same time removed the sensation from his eye. After repeated experiments, he would indeed discover, that the cause of colour to the eye, was likewise by some means or other the cause of resistance to the hand; and he would so associate these in his mind, that the one would never afterwards make its appearance as an idea or a notion without bringing the other along with it. The whole difficulty, therefore, in this case, is to break an early and deep-rooted association; for it is plain that the associated ideas were not originally united, and that solidity and colour were at first conceived as separate.

If the reader perceive not the force of this reasoning, we beg leave to recommend to him the following experiment, which, if we mistake not, will carry conviction to his judgment, that in the last-quoted passage Bishop Berkeley has argued fallaciously, and that extension and colour are not *inseparably* united as ideas in the mind. Let him go into a dark room, containing a number of spherical bodies of various colours; let him take one of them into his hand;

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and he will instantly *feel* resistance, and have a *notion* of extension and solidity; but will he likewise have the *idea* of colour inseparably united with this notion? The bishop says he will: and if so, it must be the idea of some *particular* colour; for his lordship has taught us, that the *abstract* and *general* idea of colour, which is neither *red*, nor *green*, nor *blue*, &c. cannot possibly be formed. The man, then, we shall suppose, whilst he feels resistance, conceives the resisting body to be *green*; and holding it still in his hand, walks into the light of day. The *resistance*, and consequently the *cause* of resistance, remains unchanged; but what becomes of the inseparable union of those with colour, when the body, upon being actually seen, proves to be *black*, i. e. to have no colour at all?—It appears, therefore, undeniable, that solidity and colour are not united in nature; that the one is an essential quality of something external to us, of which we have no *idea*, but a very distinct though relative *notion*; and that the other is an actual sensation in our minds, caused by the impression of something external on the organ of sense, which leaves behind it in the memory or imagination a positive and direct *idea* that exists no where else.

172 Matter exists, but

Solid substance, therefore *may* exist; for though it is not immediately perceived by the senses, and is a thing of which we can have no *idea*, we acquire a clear and distinct *notion* of it, by the very same means which Bishop Berkeley thinks sufficient to give us distinct notions of power and of spirits; and, therefore, that notion can involve in it no contradiction. Still, however, we would not say with Dr Beattie, "that we could as easily believe, that two and two are equal to ten; or, that whatever is, is not; as that matter has no separate existence:" for it is certainly *possible*, that the Supreme Being, without the instrumentality of matter, could communicate to our minds all the sensations and notions from which we infer the reality of solid substance. All that we contend for, as having the evidence of demonstration, is the *possibility* of solid and extended substance; and if the thing be *possible*, the general voice of mankind proclaims its *probability*.—We are *conscious* of our actual sensations, and we know by *experience* that they are caused by something distinct from ourselves. When a man grasps an ivory ball, he *feels* that he cannot shut his hand, and he knows that the resistance which prevents him proceeds *not* from *himself*. Thus far all mankind are agreed. But Bishop Berkeley says, that the resistance proceeds immediately from the Supreme Being or some other spirit; whilst we, without pretending that his scheme is impossible, think it more natural to suppose that the man's hand is kept from shutting by the resistance of a solid substance of four inches diameter; of which substance, though we have no *idea* of it, we have as distinct a *notion* as Berkeley had of spirits. From one or other of these causes this effect must proceed; and it is of little importance to life or happiness which of them be the true cause, since it is with the effect only that we are immediately concerned. Still, however, a philosopher would choose to adopt the easiest and most natural side of every alternative; which, if our notion of solidity be just, is certainly, in the present case, the existence of matter.

After treating so largely of the composition of bodies, and showing the general agreement of metaphysicians, ancient and modern, with respect to the notion of their solidity, it will appear strange to the less philosophical part of our readers, that we should now express a doubt of that notion's being well-founded.—We have ourselves no doubt, but on the contrary are fully convinced, that solidity is essential to matter. This, however, has of late been denied by philosophers of great merit. Dr Priestley, after Mr Mitchell and Father Boscovich, affirms that matter is *not solid* or impenetrable to other matter; and that it has, in fact, no properties but those of *attraction* and *repulsion* *. The proofs of this position, which appears so paradoxical, he draws from optical experiments, from electricity, and from the effects of heat and cold upon substances usually conceived to be solid.

173 is by some philosophers denied to be solid.

The appearances from which the solidity of matter is inferred, are nothing more, he says, than superficial appearances, and therefore have led to superficial and false judgments, which the *real appearances* will not authorize. "*Resistance*, on which alone our opinion concerning the solidity or impenetrability of matter is founded, is never occasioned by *solid matter*, but by something of a very different nature, viz. a *power of repulsion*, always acting at a real, and in general an assignable distance, from what we call the body itself. When I press my hand against the table, I naturally imagine that the obstacle to its going through the table, is the *solid matter* of which it consists; but a variety of philosophical considerations demonstrate that it generally requires a much greater power of pressure than I can exert to bring my fingers into actual contact with the table. Electrical appearances show that a considerable weight is requisite to bring into seeming contact even the links of a chain hanging freely in the air, they being kept asunder by a repulsive power belonging to a very small surface, so that they do not actually touch, though they are supported by each other. It has been shown, from optical considerations, that a drop of water rolls upon a cabbage leaf without ever coming into actual contact with it; and indeed all the phenomena of *light* are most remarkably unfavourable to the hypothesis of the solidity or impenetrability of matter. When light is reflected back from a body on which it seems to strike, it was natural to suppose that this was occasioned by its impinging against the *solid parts* of the body; but it has been demonstrated by Sir Isaac Newton, that the rays of light are always reflected by a *power of repulsion* acting at some distance from the body. Again, When part of a beam of light has overcome this power of repulsion, and has entered any transparent substance, it goes on in a right line, provided the medium be of a uniform density, without the least interruption, and without a single particle being reflected, till it comes to the opposite side, having met with no solid particles in its way, not even in the densest transparent substances, as glass, crystal, or diamond; and when it is arrived at the opposite side, it is solely affected by the laws of attraction and repulsion.

174 The arguments used in support of this hypothesis.

"Nay, that the component particles of the hardest bodies themselves do not actually touch one another, is demonstrable from their being brought nearer together by cold, and by their being removed farther from each other by heat. The power sufficient to overcome these

* *Disquisitions on Matter and Spirit, and Correspondence with Dr Price.*

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these internal forces of repulsion, by which the ultimate particles of bodies are prevented from coming into actual contact, is what no person can pretend to compute. The power requisite to break their cohesion, or to remove them from the sphere of each other's attraction, may in some measure be estimated; but this affords no *data* for ascertaining the force that would be necessary to bring them into actual contact, which may exceed the other almost infinitely."

From these facts, Dr Priestley infers, that the mutual resistance of bodies proceeds in all cases from powers of repulsion acting at a distance from each body: that the supposition of the *solidity* or *impenetrability* of matter is destitute of all support whatever; and that matter itself is nothing but powers of attraction and repulsion, and several spheres of them, one within another. As other philosophers have said, "Take away solidity, and matter vanishes;" so he says expressly, "Take away attraction and repulsion, and matter vanishes."

To illustrate this strange notion, "Suppose (says he) that the Divine Being, when he created *matter*, only fixed certain *centres of various attractions and repulsions*, extending indefinitely in all directions, the whole effect of them to be upon each other, these centres approaching to, or receding from each other, and consequently carrying their peculiar spheres of attraction and repulsion along with them, according to certain definite circumstances. It cannot be denied that these spheres may be diversified infinitely, so as to correspond to all the kinds of bodies that we are acquainted with, or that are possible. For all effects in which bodies are concerned, and of which we can be sensible by our eyes, touch, &c. may be resolved into attraction or repulsion. A compages of these centres, placed within the spheres of each other's attraction, will constitute a body that we term *compact*; and two of these bodies will, on their approach, meet with a repulsion or resistance sufficient to prevent one of them from occupying the place of the other, without a much greater force than we are capable of employing; so that to us they will appear perfectly hard.

"As in the constitution of all actual bodies that we are acquainted with, these centres are placed so near to each other, that in every division that we can make we still leave parts which contain many of these centres; we, reasoning by analogy, suppose that every particle of matter is infinitely divisible; and the *space* it occupies is certainly so. But, strictly speaking, as those centres which constitute any body are not absolutely infinite, it must be naturally possible to come by division to one single centre, which could not be said to be divisible, or even to occupy any portion of space, though its sphere of action should extend ever so far; and had only *one* such centre of attraction, &c. existed, its existence could not have been known, because there would have been nothing on which its action could have been exerted; and there being no *effect*, there could not have been any ground for supposing a *cause*."

In answer to this reasoning against the solidity of matter, Dr Priestley was frequently asked by his candid and masterly antagonist *, "What it is that attracts and repels, and that is attracted and repelled?" But to the question he was never able to give a satisfactory answer. Indeed, how could he have been able? for, as Dr Price argues, "Exclusive of attraction and repulsion, he affirms matter to be absolutely nothing; and therefore, though we were to allow it the power of attracting and repelling, yet as it is nothing but this power, it must be the power of nothing, and the very idea of it be a contradiction."

If there be any class of truths intuitively certain, that class comprehends the two following propositions: POWER CANNOT BE WITHOUT A SUBJECT; and NOTHING CAN ACT WHERE IT IS NOT. If, therefore, there be powers of attraction and repulsion, (which shall be considered afterwards in the Chapter of MOTION), there must be a subject of those powers; and if matter, whether solid or unsolid, be the subject, it cannot possibly attract or repel at a *distance*. Sir Isaac Newton, in his letters to Dr Bentley, calls the notion that matter possesses an innate power of attraction, or that it can act upon matter at a distance, and attract and repel by its own agency, "an absurdity into which, he thought, no one could possibly fall." Hence it follows, that the appearances from which Dr Priestley infers the penetrability of matter must be fallacious appearances, since they contradict an intuitive and necessary truth. The facts which he instances are, indeed, such as would make most other men suspicious of fallacy, and in his reasonings from them he sometimes takes for granted the truth to be proved. The links of a chain used for electrical purposes, supposing them to be in contact with each other, can touch only with very small surfaces. The electrical fluid is of considerable density, and incapable of being absorbed within a very narrow compass. This is evident, because it passes not through paper and other porous bodies without making a passage for itself, and leaving a visible aperture behind it; and though it assimilates with metals, and passes through them more easily than through other bodies, yet it is plain that it requires a certain quantity of metal to conduct it; for when the conductor falls short of the necessary quantity, it is melted or dissipated by the force of the fluid. This being the case, it follows that the links of a chain *may be* in actual contact (we do not positively affirm that they *are*), and yet the fluid become visible in passing from link to link; for if the point of contact be too small to absorb the *whole* fluid, *part* of it must pass without any metallic conductor through the atmosphere, and thus become apparent to the eye of the spectator.

175 founded on fallacious appearances and contrary to an intuitive and necessary truth.

With respect to light, it is obvious that there cannot possibly be any *demonstration*, in the logical sense of the word, that it is reflected by a power of repulsion acting at some distance from the body; for, in the opinion of all mankind, the primary and solid atoms of matter are too minute to fall under the cognizance of our senses, however assisted by art; and therefore, if light *appears* to be reflected at a distance from the surface of the body, we must conclude, either that between the point of reflection and the apparent surface of the body, there are solid atoms unperceived by us, or that light is reflected by the agency of some other substance than matter. One of these conclusions, we say *must* be drawn, because they are both *possible*, and there is no other alternative but to admit one of them, or to suppose that a thing may act where it is not;

* *Free Discussion between Dr Price and Dr Priestley.*

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not; which is as clearly absurd and *impossible* as that *whatever is, is not.* Again, When part of a beam of light has entered any transparent substance, how does Dr Priestley know that it goes on in a right line, without the least interruption, till it comes to the opposite side? This he can know only by his senses; but the beam may meet with ten thousand interruptions from objects which the senses cannot perceive, and may describe a zig-zag line, of which the deflections are so small as to elude the keenest eye aided by the most powerful glass.

That the component particles of the hardest bodies do not *all* actually touch one another, is indeed evident from the effects of cold and heat upon those bodies: but it does not therefore follow that those bodies have no component particles; but only that they are fewer in number than we are apt to imagine; that all the solid matter in the universe might possibly be compressed within a very narrow sphere; and that it is held together in different bodies and different systems by a power foreign from itself. These are truths which all philosophers have admitted who have thought sufficiently on the subject; but who will admit Dr Priestley's proposition, when it is translated into common English: "That the component *nothings* of the hardest bodies do not actually touch one another, is demonstrable from their being brought nearer together by cold, and by their being removed farther from each other by heat?"

176 Our most adequate notion of matter.

Dr Priestley owns, that if matter be solid it could act upon other matter by impulse. We are certain, that, whatever it be, it can act upon nothing in the manner which he describes; and therefore, to use the words of Dr Price, "matter, if it be any thing at all, must consist of solid particles or atoms occupying a certain portion of space, and therefore *extended*, but at the same time *simple* and *uncompounded*, and incapable of being resolved into any other smaller particles. It must likewise be the different form of these *primary* particles, and their different combinations and arrangement, that constitute the different bodies and kinds of matter in the universe." This is exactly agreeable to the doctrines of Newton; who, after considering the question in every point of view, concludes, that "in the beginning God formed matter in solid, massy, hard, impenetrable, moveable particles, of such sizes and figures, and with such other properties, as most conduced to the end for which he formed them; and that those primary particles being solid, are incomparably harder than any porous bodies compounded of them; even so very hard as never to wear or break in pieces: no ordinary power being able to divide what God himself made one in the creation." To talk, as Dr Priestley does, of matter's being certain *centres of various attractions and repulsions* extending indefinitely in all directions, and to describe these centres as *not* being *physical points* or *solid atoms*, is either to say, that *nothing* attracts and repels; or it is to introduce the divine agency as the immediate cause of all our sensations. The former of these alternatives Dr Priestley disclaims; the latter he seems willing to admit. But if it be his meaning that all our sensations are caused by the immediate agency of God or created spirits, his scheme differs not from that of Berkeley, except in being less elegantly expressed and less ingeniously supported. Berkeley's scheme is evidently *possible.* The commonly received scheme is likewise possible. It remains therefore with the reader, whether he will adopt the system of the Bishop of Cloyne; or admit, with all other philosophers, that matter exists; that it consists of parts actually distinct and separable; and that each of these parts is a *monad* or solid atom, which requires no foreign agency to keep it united.

Of Space and its Modes.

Chap. IV. *Of* Space *and its* Modes.

Having considered bodies in their substance, essences and qualities, and proved that they have a real existence independent of us and our conceptions, we proceed now to inquire into the nature of *space*, *motion*, *number*, and *duration*. These are commonly called the *adjuncts* of body, and are supposed to be absolutely inseparable from its existence. It does not indeed appear that *actual motion* is a necessary adjunct of body, considered as a mere solid, extended, and figured substance; but it is certainly necessary to the existence of organized and animated bodies, and the capability of being moved enters into our conceptions of all bodies whatever. Of these adjuncts, that which first demands our attention is *space:* for without a knowledge of its nature we could not have an adequate idea of motion, and without motion we could have no idea of time. 177 The necessary adjuncts of body, what.

Every body is extended; and between two bodies not in actual contact, we perceive that a third body may be easily introduced. That which admits of the introduction of the third body is what we call *space:* and if it be totally void of matter, it is called *pure space.* Whether there be any space absolutely pure, has been disputed; but that such space is possible, admits of no dispute. Were any one body (a cannon ball for instance) to be annihilated, and the circumambient air, with every other material substance, kept from rushing into the space which the ball had occupied, that portion of space, with respect to matter, would be empty or pure space: whether it would necessarily be filled with mind shall be considered afterwards. Pure space, therefore, is conceivable; and it is conceived as having three dimensions, length, breadth, and depth, which are generally called the three simple modes of space. In this respect it agrees with body: but the agreement proceeds no farther; for space is conceived as destitute of solidity, without which the existence of body is inconceivable. It has been formerly observed, that whatever may be distinctly conceived may possibly exist; but with respect to the existence of pure space, whatever is possible is real: for it shall be shown in the next section, that were there no space absolutely pure or void of matter, there could be no motion. Our business at present is to inquire what the nature of space is, and what notion we ought to have of its existence. 178 Our notion of space, how acquired.

Many modern philosophers consider space as something entirely distinct both from body and mind: some of them ascribe to it no less than four of the attributes of the Deity—*eternity*, *immobility*, *infinity*, and *necessary existence;* and a few of them have gone so far as to call *infinite space* the *sensorium* of the Deity. "The supposal of the existence of *any thing whatever* (says Dr Clarke) 179 Space supposed to be something different from body and mind, and to be eternal and infinite, &c.

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Clarke *) neceſſarily includes a *preſuppoſition* of the exiſtence of *ſpace*. Nothing can poſſibly be conceived to exiſt without thereby preſuppoſing ſpace; which, therefore, I apprehend to be a *property* or *mode* of the ſelf-exiſtent Subſtance; and that, by being evidently neceſſary itſelf, it proves, that the ſubſtance of which it is a property muſt be alſo neceſſary." Elſewhere he ſays, that "ſpace is a property or mode of the ſelf-exiſtent Subſtance, but not of any other ſubſtances. All other ſubſtances are *in* ſpace, and are *penetrated* by it; but the ſelf-exiſtent Subſtance is not in ſpace, nor penetrated by it, but is itſelf (if I may ſo ſpeak) the *ſubſtratum* of ſpace, the *ground* of the exiſtence of *ſpace* itſelf." He acknowledges, however, that ſuch expreſſions as "the ſelf-exiſtent Subſtance is the *ſubſtratum* of ſpace, or ſpace is a property of the ſelf-exiſtent Subſtance, are *not*, perhaps, very proper: but what I mean (ſays he), is this: The idea of *ſpace* (as alſo of *time* or *duration*) is an abſtract or partial idea; an idea of a certain *quality* or *relation*, which we evidently ſee to be neceſſarily exiſting; and yet (which not being itſelf a *ſubſtance*) at the ſame time neceſſarily *preſuppoſes* a ſubſtance, without which it could not exiſt."

* *Demonſtration of the Being and Attributes of God*, and *Correſpondence with a Gentleman in Glouceſterſhire*, paſſim.

Theſe opinions reſpecting ſpace have been adopted by ſucceeding philoſophers of great merit, and particularly by Dr Price; who ſays, that "it is a maxim which cannot be diſputed, that *time* and *place* are neceſſary to the exiſtence of all things. Dr Clarke (continues he) has made uſe of this maxim, to prove that infinite ſpace and duration are the eſſential properties of the Deity; and I think he was right."

Had authority any weight in philoſophy, we know not what modern writers we could oppoſe to the celebrated names of Clarke and Price, unleſs it were Biſhop Berkeley, Dr Law late biſhop of Carliſle, and the author of Ancient Metaphyſics. But the queſtion is not to be decided by authority. Learned and acute as Dr Clarke was, his aſſertions reſpecting ſpace are contradictory and inconſiſtent. If nothing can poſſibly be conceived to exiſt without thereby preſuppoſing the exiſtence of *ſpace*, how can ſpace be a property or mode of the ſelf-exiſtent Subſtance? Are properties prior in the order of nature, or even in our conceptions, to the ſubſtances in which they inhere? Can we frame an abſtract idea of figure, or extenſion, or ſolidity, before we conceive the exiſtence of any one figured, extended, or ſolid ſubſtance? Theſe are queſtions which every man is as capable of anſwering as the Doctors Clarke and Price, provided he can look attentively into his own mind, and trace his ideas to their ſource in ſenſation: and if he be not biaſſed by the weight of great names, we are perſuaded he will find, that if it be indeed true, that the ſuppoſal of the exiſtence of any thing whatever neceſſarily includes a *preſuppoſition* of the exiſtence of ſpace, *ſpace* cannot poſſibly be a *property* or *mode* of the ſelf-exiſtent Subſtance, but muſt of neceſſity be a *ſubſtance* itſelf.

180
This ſuppoſition controverted.

181
Space neceſſary to the exiſtence of every thing.

It is, however, *not* true, that the ſuppoſal of the exiſtence of any thing whatever neceſſarily includes a preſuppoſition of the exiſtence of ſpace. The idea of ſpace is indeed ſo cloſely aſſociated with every viſible and tangible object, that we cannot ſee the one nor feel the other without conceiving them to occupy ſo much of ſpace. But had we never poſſeſſed the ſenſes of ſight and touch, we could not have ſuppoſed the exiſtence of ſpace neceſſary to the exiſtence of any thing whatever. The ſenſes of ſmelling, taſting, and hearing, together with our internal powers of conſciouſneſs and intellect, would certainly have compelled us to believe in our own exiſtence, and to ſuppoſe the exiſtence of other things; but no object either of conſciouſneſs, ſmelling, taſting, or hearing, can be conceived as occupying ſpace. Space and every thing which fills it are conceived as of three dimenſions; but who ever ſuppoſed or can ſuppoſe an *odour*, *taſte*, or *ſound*, to have *length*, *breadth*, and *depth*; or an object of conſciouſneſs to be an ell or an inch long?

Let us ſuppoſe that body and all the viſible world had a beginning, and that once nothing exiſted but that Being which is alone of neceſſary as well as eternal exiſtence; *ſpace*, ſay the followers of Dr Clarke, would then exiſt likewiſe without bounds or limits. But we deſire to know of theſe gentlemen what ſort of a being this ſpace is. It certainly is not *ſubſtance*; neither is it a property; for we have ſeen that the very notions of it, which lead men to ſuppoſe its exiſtence *neceſſary*, render it impoſſible to be a property of the ſelf-exiſtent Being. Is it then nothing? It "is in one ſenſe *: it is nothing *actually* exiſting; but it is ſomething *potentially*; for it has the *capacity* of receiving body whenever it ſhall exiſt. It is not, and cannot, become any thing itſelf, nor hath it any actual exiſtence; but it is that without which nothing corporeal could exiſt." For this reaſon it was that Democritus and Epicurus made ſpace one of the principles of nature; and for the ſame reaſon Ariſtotle has made *privation* one of his three principles of natural things, *matter* and *form* being the other two. But though the privation of *one* form be doubtleſs neceſſary before matter can receive another (for a piece of wax or clay cannot receive the form of a *globe* before it loſe the form of a ſquare), yet Ariſtotle never dreamed that the privation of the ſquare was any property of the globe, or that *privation* itſelf was to be reckoned a real being. On the contrary, he expreſsly calls it *το μη ον*, or *the no being*. In this way, if we pleaſe, we may conſider ſpace, and call it the *privation of fulneſs* or of body. We have indeed a poſitive idea of it, as well as of ſilence, darkneſs, and other privations: but to argue from ſuch an idea of ſpace, that ſpace itſelf is ſomething real, ſeems altogether as good ſenſe as to ſay, that becauſe we have a different idea of *darkneſs* from that of *light*, of *ſilence* from that of *ſound*, of the *abſence* of any thing from that of its *preſence*; therefore *darkneſs*, *ſilence*, *abſence*, muſt be real things, and have as poſitive an exiſtence as *light*, *ſound*, and *body*: and to deny that we have any poſitive idea, or, which is the very ſame thing, any idea at all, of the privations above mentioned, will be to deny what is capable of the moſt complete proof (ſee N° 19.), and to contradict common ſenſe and daily experience. There are therefore ideas, and ſimple ones too, which have nothing *ad extra* correſpondent to them; no proper *idiatum*, archetype, or objective reality: and we do not ſee why the idea of ſpace may not be reckoned of that number. To ſay that *ſpace* muſt have exiſtence becauſe it has ſome properties (for inſtance, *penetrability*, or the *capacity* of receiving body), ſeems † to be the ſame thing as to urge that *darkneſs* muſt be *ſomething* becauſe it has the capacity of *receiving light*; *ſilence* the property of admitting

* *Ancient Metaphyſics.*

† See *Notes on King's Origin of Evil*, and *Law's Enquiry into the Ideas of Space*, &c.

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admitting *ſound*; and *abſence* the property of being ſupplied by *preſence*. To reaſon in this manner is to aſſign abſolute negations; and ſuch as, in the ſame way, may be applied to *nothing*, and then call them *poſitive properties*; and ſo infer that the chimera, thus clothed with them, muſt needs be *ſomething*.

182
Space nothing but the poſſible exiſtence of body.

But it is ſaid, that as we cannot conceive ſpace to be annihilated, it muſt be ſome real thing of eternal and neceſſary exiſtence. If this argument had not been uſed by writers of great merit, and with the beſt intention, we ſhould not have ſcrupled to call it the moſt contemptible ſophiſm that ever diſgraced the page of philoſophy. Whatever now has an *actual* exiſtence, muſt from eternity have had a *poſſible* exiſtence in the ideas of the Divine mind. Body, as an extended ſubſtance, has now an *actual* exiſtence; and therefore it muſt from eternity have had a *poſſible* exiſtence in the ideas of the Divine mind: but the *poſſible exiſtence of body* is all that we can conceive by *ſpace*; and therefore this argument, upon which ſo much ſtreſs has been laid, amounts to nothing more, than that what has from eternity been poſſible, can at no period have been impoſſible. It is evident that the *capacity* or *potentiality* of every thing exiſting muſt have been from eternity; but is capacity or potentiality a real being? All the men and women who ſhall ſucceed the preſent generation to the end of time, have at this moment a poſſibility of exiſtence, nor can that poſſibility be conceived as an impoſſibility; but is it therefore any thing actually exiſting either as a ſubſtance or a quality?

It has been urged, that ſpace muſt be ſomething more than the mere abſence of matter; becauſe if nothing be between bodies, ſuch as the walls of a room, they muſt neceſſarily touch. But ſurely it is not *ſelf-evident* that bodies muſt neceſſarily touch if nothing be between them; nor of the truth of this propoſition can any thing like a proof be brought. It is indeed intuitively certain, that "things, when they are in contact, have nothing between them:" and hence it has raſhly been inferred, that things, when they have nothing between them, are in contact; but this is an illegitimate converſion of the propoſition. Every logician knows, that to convert a propoſition, is to infer from it another whoſe *ſubject* is the *predicate*, and whoſe *predicate* is the *ſubject*, of the propoſition to be converted: but we are taught by Ariſtotle and by common ſenſe, that an *univerſal* affirmative can be converted only into a *particular* affirmative. "Things, when they are in contact, have nothing between them," is an *univerſal* affirmative propoſition; and therefore it can be converted only into the following *particular* affirmative: "Some things, when they have nothing between them, are in contact;" a propoſition which by no means includes in it the contact of the walls of an empty room. The reaſon why the walls of an empty room do not touch, is that they are *diſtant*; but is *diſtance*, in the abſtract, any thing really exiſting? Two individuals differ, or there is a difference between them; but is *difference* itſelf any real external thing? Bodies are long, broad, thick, heavy; but are *length*, *breadth*, *denſity*, *weight*, properly any thing? Have they any real ſeparate archetypes or external idiata? Or can they exiſt but in ſome ſubſtance?

Of Space and its Modes.

The reaſon why ſo many philoſophers have conſidered ſpace as a real external thing, ſeems to be this: Every bodily ſubſtance is extended; but ſpace is conceived to be that which contains body, and therefore to ſpace we likewiſe attribute extenſion. Extenſion is a quality which can have no exiſtence but as united with other qualities in ſome ſubſtance; and it is that of which, abſtracted from all ſubſtances, we can, properly ſpeaking, form no *idea*. We underſtand the meaning of the word, however, and can reaſon about that which it denotes, without regarding the particular ſubſtance in which extenſion may inhere; juſt as we can reaſon about whiteneſs without regarding any one white object, though it is ſelf-evident that whiteneſs, abſtracted from all objects, cannot figure in the mind as an idea. Qualities conſidered in this manner are general and relative notions, the objects of pure intellect, which make no appearance in the imagination, and are far leſs, if poſſible, to be perceived by ſenſe: but it is extremely painful to the mind to dwell upon ſuch notions; and therefore the ever-active fancy is always ready to furniſh them with imaginary *ſubſtrata*, and to make that which was a *general* and *inviſible notion* be conceived as a *particular ideal object*. In the caſe of extenſion this is the more eaſily done, that the notion which we have of a *real ſubſtratum* or ſubſtance, the ſupport of real qualities, is obſcure and relative, being the notion of *ſomething* we know not what. Now, by leaving, if we can, ſolidity and figure out of our conception, and joining the notion of *ſomething* with the notion of *extenſion*, we have at once the *imaginary ſubſtratum* of an *imaginary* quality, or the general notion of extenſion particularized in an imaginary ſubject; and this ſubject we call *ſpace*, vainly fancying that it has a real external and independent exiſtence. Whether this be not all that can be ſaid of ſpace, and whether it be not abſurd to talk of its having any real properties, every man will judge for himſelf, by reflecting upon his own ideas and the manner in which they are acquired. We ourſelves have no doubt about the matter. We conſider pure ſpace as a mere notion relative to the exiſtence of corporeal ſubſtance, as nothing more than the abſence of body, where body is poſſible; and we think the uſual diſtinction between *abſolute* and *relative* ſpace, if taken as real, the groſſeſt abſurdity. We do not, however, pretend to dictate to others; but recommend it to every man to throw away all reſpect for great names, to look attentively into his own thoughts, and on this as on all metaphyſical ſubjects to judge for himſelf.

183
The fallacy which led to the ſuppoſition that ſpace is a real thing.

184
Place, what it is.

Having ſaid ſo much of ſpace in general, we need not waſte much time upon its modes. Indeed the only mode of ſpace, after conſidering it with reſpect to the three dimenſions of body, which now demands our attention, is that which we call *place*. As in the ſimpleſt mode of ſpace we conſider the relation of diſtance between any two bodies or points; ſo, in our idea of *place*, we conſider the relation of diſtance betwixt any thing, and any two or more points, which, being conſidered as at reſt, keep the ſame diſtance one from another. Thus, when we find any thing at the ſame diſtance now at which it was yeſterday from two or more points with which it was then compared, and which have not ſince the compariſon was made changed their

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their diſtance or poſition with reſpect to each other, we ſay that the thing hath kept its *place*, or is in the *ſame place*; but if it hath ſenſibly altered its diſtance from either of theſe points, we then ſay that it hath changed its *place*.

From this view of the nature of place, we need not obſerve that it is a mere relation; but it may be worth while to advert to this circumſtance, that a thing may without falſehood be ſaid to have continued in the ſame place, and at the ſame time to have changed its place, according to the different objects with which it is compared. Thus, if two perſons find a company of cheſs-men ſtanding each upon the ſame ſquare of the cheſs-board where they left them, the one may with truth affirm that they are all in the *ſame place*, or unmoved; and the other may with equal truth affirm that they have all changed *place*. The former conſiders the men only with reſpect to their diſtances from the ſeveral parts of the cheſs-board, which have kept the ſame diſtance and poſition with reſpect to one another. The latter muſt conſider the men with reſpect to their diſtance from ſomething elſe: and finding that the cheſs-board, with every thing upon it, has been removed, we ſhall ſuppoſe, from one room to another, he cannot but ſay that the cheſs-men have changed their place with reſpect to the ſeveral parts of the room in which he formerly ſaw them.

This modification of diſtance, however, which we call *place*, being made by men for their common uſe, that by it they may deſign the particular poſition of objects where they have occaſion for ſuch deſignation, they determine this *place* by reference to ſuch adjacent things as beſt ſerve their preſent purpoſe, without regarding other things which, for a different purpoſe, would better determine the place of the ſame object. Thus in the cheſs-board, the uſe of the *deſignation of the place* of each cheſs-man being determined only within that chequered piece of wood, it would croſs that purpoſe to meaſure it by any thing elſe: but when theſe very cheſs-men are put up in a box, if any one ſhould aſk where the black king is, it would be proper to *determine the place* by reference to ſomething elſe than the cheſs-board; ſuch as the parts of the room or cloſet which contain the box.

185 The univerſe has no place.

That our idea of *place* is nothing but ſuch a relative poſition of things as we have mentioned, will be readily admitted, when it is conſidered that we can have no idea of the place of the *univerſe*. Every *part* of the univerſe has place; becauſe it may be compared with reſpect to its diſtance from other parts ſuppoſed to be fixed. Thus the earth and every planet of our ſyſtem has a place which may be determined by aſcertaining its diſtance from the ſun and from the orbits of the other planets; and the place of the ſyſtem itſelf may be aſcertained by comparing it with two or more fixed ſtars: but all the ſyſtems taken as *one whole* can have no *place*; becauſe there is nothing elſe to which the diſtance and poſition of that whole can be referred. It is indeed true, that the word *place* is ſometimes uſed, we think improperly, to denote that *ſpace* or portion of *ſpace* which any particular body occupies; and in this ſenſe, no doubt, the univerſe has place, as well as the earth or ſolar ſyſtem: but to talk of the place of the univerſe in the other and proper ſenſe of the word, is the groſſeſt nonſenſe.

CHAP. V. *Of* MOTION.

Of Motion.

186 Mobility eſſential to every corporeal ſubſtance, but not natural motion.

MOBILITY, or a capacity of being moved, is eſſential to every corporeal ſubſtance; and by actual motion are all the operations of nature performed. Motion, therefore, if it may be called an *adjunct* of body, is certainly the moſt important of all its adjuncts; and to aſcertain its nature and origin demands the cloſeſt attention of the metaphyſician, as well as of the mechanic and aſtronomer. With the *laws* of motion, as diſcovered by experience, we have at preſent no concern: they are explained and fully eſtabliſhed in other articles of this work (See MECHANICS, MOTION, &c.) The principal queſtions which we have to conſider are: "What is motion? and, By what power is it carried on?"

For an anſwer to the firſt of theſe queſtions, the modern metaphyſician refers every man to his own ſenſes; becauſe, in his apprehenſion, the word motion denotes a ſimple idea which cannot be defined. Among the ancients, the Peripatetics were of a different opinion; and Ariſtotle, whoſe love of dialectic made him define every thing, has attempted to give two definitions of *motion*. As ſome learned men are at preſent labouring to revive this ſyſtem, we ſhall, out of reſpect to them, mention thoſe definitions, and make upon them ſuch remarks as to us appear proper.

187 The Peripatetic definitions of motion

The author of *Ancient Metaphyſics* having obſerved, that both nature and art propoſe ſome end in all their operations; that when the end is obtained, the thing operated upon is in a ſtate of perfection or completion; and that in the operations of both nature and art there is a progreſs, and by conſequence a *change*, from one thing to another; adds, that this change is *motion*. Motion, therefore, according to him, is a change or progreſs to the end propoſed, or to that ſtate of perfection or completion which Ariſtotle calls εντελεχεια. It is not enough, however, that we know *to what* the change or progreſs is made: to have an adequate idea of motion, we muſt likewiſe know *from what* it proceeds. Now it is evident that every thing exiſting, whether by nature or art, was, before it exiſted, poſſible to exiſt; and therefore, adds the ſame author, things do in ſome ſort exiſt even before they exiſt. This former kind of exiſtence is ſaid by Ariſtotle to be εν δυναμει, that is, in *power* or *capacity*. In this way, plants exiſt in their ſeeds; animals in the embryo; works of art in the idea of the artiſts and the materials of which they are made; and, in general, every thing in the cauſes which produce it. From this power or capacity there is a progreſs to *energy* or actual exiſtence; ſo that we are now able to anſwer the queſtion, "*from what*, and *to what*, motion is a change?" for it is univerſally true of all *motion*, that it is a change from *capacity* to *energy*.

"Having thus diſcovered that *motion* lies betwixt *capacity* and *energy*, it is evident (he ſays) that it muſt have a connexion with each of them: and from this double connexion Ariſtotle has given us two definitions of it; one of them taken from the *energy*, or end to which it tends; the other from the *capacity* from which it begins. The firſt is expreſſed in two words, viz. ενεργεια ατελης, or *imperfect energy*; the other is εντελεχεια

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του εν δυναμει ᾗ εν δυναμει; which may be translated thus, *The perfection of what is in capacity, considered merely as in capacity.* The meaning of the last words is, that nothing is considered in the thing that is moved but merely its *capacity;* so that motion is the perfection of that capacity, but not of the thing itself. It is something more (adds the learned author) than mere *capacity;* for it is capacity exerted, which when it has attained its end, so that the thing has arrived at that state to which it is destined by nature or art, ceases, and the thing begins to exist ενεργεια, or *actually.*

188 unintelligible.

By all the admirers of Aristotle, this latter definition has been preferred to the former: for what reason, it is difficult to say. They both involve in the thickest obscurity that which, viewed through the senses, is very easily understood; and on this, as on many other occasions, Aristotle was certainly guilty of darkening counsel by words without knowledge. The author, whose comment on this wonderful definition we have faithfully abridged, admits that it is not intelligible till we know what *change* and *progress* are; but is it possible to conceive any *change* to take place in bodily substances without *motion?* or, if we were called upon to explain what progress is, could we do it better than by saying that it is motion *from* something *to* something? It is likewise very obvious that before we can have an adequate idea of *motion*, we must, according to this definition, know perfectly what the words *capacity*, *energy*, and *perfection* denote; and yet nothing can be more true than that *perfection* denotes a complex conception, which may be easily defined by resolving it into the simple ideas and notions of which it is compounded, whilst *motion* is susceptible of no such resolution. The perfection of a knife is compounded of the temper of the steel and the sharpness of the edge: the perfection of a system of philosophy consists of the importance of the subjects treated, the strength of the author's arguments, and the perspicuity of his style and manner; but of what is the *motion* of a ball, or an *atom*, or any thing else, compounded? We are aware that to this question the modern Peripatetics will reply, That it is not the motion of a *ball*, or an *atom*, or any *one thing*, that their master has so learnedly defined, but motion abstracted from *all individuals*, and made an object of pure intellect; and they will likewise affirm, that by the word *perfection* used in the definition, he does not mean *any one kind* of perfection as adapted to any particular *object* or *end*, but perfection abstracted from *all objects* and *all ends*. The perfection of *nothing* and the motion of *nothing*, for such surely are that motion and that perfection which are abstracted from *all objects* and *ends*, are strange expressions. To us they convey no meaning; and we have reason to think that they are equally unintelligible to men of greater acuteness (o). In a word, *motion* must be seen or felt; for it cannot be defined. To call it the *act of changing place*, or a *passage from one place to another*, gives no information; for *change* and *passage* cannot be conceived without previously conceiving *motion* (p).

189 The Peripatetic division of motion absurd.

The Peripatetics having idly attempted to *define* motion, proceed next to *divide* it into four kinds or classes. This division was by the father of the school pretended to be made from the effects which it produces, and was said by him to belong to three categories, viz. *quality*, *quantity*, and *where*, (see CATEGORY). The first kind is that well-known *motion* from *place* to *place*, which falls under the category last mentioned; the second is *alteration*, by which the quality of any thing is changed, the substance remaining the same. This belongs to the category of *quality*. The third is *increase*, and the fourth *diminution*, both belonging to the category of *quantity*. The ancient atomists, and all the modern metaphysicians of eminence, have with great propriety rejected this division, as being nothing but a collection of absurd distinctions where there is in nature no difference. It has been already shown, that body has no other real qualities than *solidity*, *extension*, and *figure:* but of these the first cannot be altered without destroying the substance; for every thing which is material is equally solid. The extension of a body may indeed be enlarged, and its figure may be altered, while the substance remains the same: but that alteration can be made only by moving from their *places* the solid atoms of which the body is composed. Aristotle's second kind of motion therefore differs not from the first; nor do the third and fourth differ from these two. For a body cannot be *increased* without acquiring new matter, nor diminished without losing some of the matter of which it was originally

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(o) "Nunc dicendum de natura motus. Atque is quidem, cum sensibus clare percipiatur, non tam natura sua, quam doctis philosophorum commentis obscuratus est. Motus nunquam in sensus nostros incurrit sine mole corporea, spatio et tempore. Sunt tamen qui motum, tanquam ideam quandam simplicem et abstractam, atque *ab omnibus aliis rebus sejunctam*, contemplari student. Verum idea illa tenuissima et subtilissima *intellectus aciem eludit:* id quod quilibet secum meditando experiri potest. Hinc nascuntur magnæ difficultates de natura motus, et definitiones, ipsa re quam illustrare debent longe obscuriores. Hujusmodi sunt definitiones illæ Aristotelis et scholasticorum, qui motum dicunt esse *actum mobilis quatenus est mobile*, vel, *actum entis in potentia quatenus in potentia*. Hujusmodi etiam est illud viri inter recentiores celebris, qui asserit *nihil in motu esse reale præter momentaneum illud quod in vi ad mutationem nitente constitui debet.* Porro constat, horum et similium definitionum auctores in animo habuisse abstractam motus naturam, seclusa omni temporis et spatii consideratione, explicare: sed qua ratione abstracta illa motus quintessentia (ut ita dicam) intelligi possit non video."

Berkeley de Motu.

(p) "Multi etiam per *transitum* motum definiunt, obliti scilicet transitum ipsum sine motu intelligi non posse, et per motum definiri oportere: Verissimum adeo est definitiones, sicut nonnullis rebus lucem, ita vicissim aliis tenebras afferre. Et profecto, quascumque res sensu percipimus eas clariores aut notiores definiendo efficere vix quisquam potuerit. Cujus rei vana spe allecti res faciles difficillimas reddiderunt philosophi, mentesque suas difficultatibus, quas ut plurimum ipsi peperissent, implicavere." *Id. ibid.*

originally compoſed: but matter can neither be added nor taken away without motion from place to place; for there is now no creation *de novo*; and we have no reaſon to imagine that, ſince the original creation, a ſingle atom has been ever annihilated. It is therefore paſt diſpute, that local motion is the only motion conceivable; and indeed, as far as we are capable of judging from what we know of body, it is the only motion poſſible.

190 Whether, if but one body exiſted, there could be motion?

This has given riſe to a queſtion which has been debated among modern philoſophers, though, as far as we know, it was never agitated among the ancients, viz. "Whether, if there were but one ſolid body exiſting, that body could poſſibly be moved." Biſhop Berkeley ſeems to be of opinion that it could not; becauſe no motion can be conceived but what has a direction towards ſome *place*, and the relation of place neceſſarily ſuppoſes the exiſtence of two or more bodies. Were all bodies, therefore, annihilated except one globe, it would be impoſſible (he thinks) to conceive that globe in motion (Q). With reſpect to the origin of our *ideas* of motion, his reaſoning appears unanſwerable; but we do not perceive how it concludes againſt the poſſibility of motion itſelf as exiſting in a ſingle body. It has been already ſhown in the chapter of *Simple Apprehenſion and Conception*, that though nothing can be conceived which may not poſſibly exiſt, yet many things may be poſſible which we have not faculties or means to conceive. In the preſent inſtance, were this ſolitary globe animated as our bodies are, were it endowed with all our ſenſes and mental powers, it certainly would not acquire any *idea* of motion though impelled by the greateſt force. The reaſon is obvious; it would have no objects with which to compare its place and ſituation at different periods of time; and the experience of a ſhip at ſea in calm weather, affords ſufficient proof that motion which is equable cannot be perceived by any other means than by ſuch a compariſon. When the waves ſwell and the ſhip pitches, it is indeed impoſſible that thoſe who are on board ſhould not perceive that they are actually in motion; but even this perception ariſes from comparing their poſition with that of the waves riſing and falling around them: whereas in the regions of empty ſpace the animated globe could compare its poſition with nothing; and therefore, whether impelled by equal or unequal forces, it could never acquire the *idea* of motion. It may perhaps be thought, that if this ſolitary globe were a *ſelf*-moving animal, it might acquire the *idea* of motion by inferring its exiſtence from the energy which produced it. But how, we would aſk, could an animal in ſuch circumſtances be *ſelf*-moving? Motion is the effect of ſome cauſe; and it has been already ſhown (ſee N° 117. of this article), that we have no reaſon to ſuppoſe that any being can be the *real* and *primary* cauſe of any effect which that being can neither conceive nor will: but as motion can be perceived only by the ſenſes, a ſolitary animal could have no idea of motion previous to its own exertions; and therefore could neither conceive, nor will, an exertion to produce it. Let us, however, ſuppoſe, that without any end in view it might ſpontaneouſly exert itſelf in ſuch a manner as would produce *ſenſible* motion, were it ſurrounded with other corporeal objects; ſtill we may venture to affirm, that ſo long as it ſhould remain in abſolute ſolitude, the being itſelf would acquire no *idea* of motion. It would indeed be *conſcious* of the *mental* energy, but it could not infer the exiſtence of motion as a conſequence of that energy; for the idea of motion can be acquired only by ſenſe, and by the ſuppoſition there are no objects from which the ſenſes of this ſpherical animal could receive thoſe impreſſions, without which there can be no perception, and of courſe no ideas.

191 Anſwered in the affirmative.

Let us now ſuppoſe, that, while this animated globe is under the influence either of external impulſe or its own ſpontaneous energy, other bodies are ſuddenly brought into exiſtence: would it then acquire the idea of motion? It certainly would, from perceiving its own change of place with reſpect to thoſe bodies; and though at firſt it would not perhaps be able to determine whether itſelf or the bodies around it were moving, yet a little experience would decide this queſtion likewiſe, and convince it that the motion was the effect either of its own *mental energy*, or that external *impulſe* which it had felt before the other bodies were preſented to its view. But it is obvious, that the creation of new bodies at a diſtance, can make no real alteration in the ſtate of a body which had exiſted before them: and therefore, as this animated globe would now *perceive* itſelf to be moving, we may infer with the utmoſt certainty that it *was* moving

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(Q) Having proved that *place*, in the proper ſenſe of the word, is merely relative, and affirmed that all *motion* is relative likewiſe, the biſhop proceeds thus: "Veruntamen ut hoc clarius appareat, animadvertendum eſt, motum nullum intelligi poſſe ſine determinatione aliqua ſeu directione, quæ quidem intelligi nequit, niſi præter corpus motum, noſtrum etiam corpus, aut aliud aliquid, ſimul intelligatur exiſtere. Nam ſurſum, deorſum, ſiniſtrorſum, dextrorſum, omneſque plagæ et regiones in relatione aliqua fundantur, et neceſſario corpus a moto diverſum connotant et ſupponunt. Adeo ut, ſi, reliquis corporibus in nihilum redactis, globus, exempli gratia, unicus exiſtere ſupponatur; in illo nullus motus concipi poſſit: uſque adeo neceſſe eſt, ut detur aliud corpus, cujus ſitu motus determinare intelligatur. Hujus ſententiæ veritas clariſſima elucebit, modo corporum omnium tam noſtri quam aliorum, præter globum iſtum unicum, annihilationem recte ſuppoſuerimus.

"Concipiantur porro duo globi, et præterea nihil corporeum, exiſtere. Concipiantur deinde vires, quomodocunque applicari: quicquid tandem per applicationem virium intelligamus, motus circularis duorum globorum circa commune centrum nequit per imaginationem concipi. Supponamus deinde cœlum fixarum creari: ſubito ex concepto appulſu globorum ad diverſas cœli iſtius partes motus concipietur. Scilicet cum motus natura ſua ſit relativus, concipi non potuit priuſquam darentur corpora correlata. Quemadmodum nec ulla relatio alia ſine correlatis concipi poteſt." *De Motu.*

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moving before; and that the motion of a single body, though not *perceivable* by the senses, might possibly be produced in empty space.

192 Whether motion would be possible in space absolutely full?

Having thus seen that a single body is capable of motion in empty space, the next question that occurs on this subject is, Whether it would be possible to move a body in space that is absolutely full? Such are the terms in which this question is usually put; and by being thus expressed, it has given rise to the dispute among natural philosophers about the existence of a *vacuum*. Perhaps the dispute might have been avoided had the question been more accurately stated. For instance, had it been asked, whether motion would be possible, could matter be supposed absolutely infinite without any the least interstice or vacuity among its solid parts? We apprehend that every reflecting man would have answered in the negative. At any rate, the question ought to be thus stated in metaphysics; because we have seen that space, though a positive term, denotes nothing really existing. Now it being of the very essence of every solid substance to exclude from the place which it occupies every other solid substance, it follows undeniably, that not one particle of an infinite solid could be moved from its place without the previous annihilation of another particle of equal extent; but that annihilation would destroy the infinity. Were matter extended to any degree *less* than infinity, the motion of its parts would undoubtedly be possible, because a sufficient force could separate those parts and introduce among them vacuities of any extent; but without vacuities capable of containing the body to be moved, it is obvious that no force whatever could produce motion. This being the case, it follows, that however far we suppose the material universe extended, there must be vacuities in it sufficient to permit the motion of the planets and all the other heavenly bodies, which we plainly perceive to revolve round a centre; and if so, the next question to be determined is, What can *in vacuo* operate upon such immense bodies, so as to produce a regular and continued motion?

193 Bodies equally indifferent to motion and rest.

That all bodies are equally capable of motion or rest, has by natural philosophers been as completely proved as any thing can be proved by observation and experience. It is indeed a fact obvious to the most superficial observer; for if either of these states were essential to matter, the other would be absolutely impossible. If rest were essential, nothing could be moved; if motion were essential, nothing could be at rest, but every the minutest atom would have a motion of its own, which is contrary to universal experience. With respect to motion and rest, matter is wholly passive. No man ever perceived a body inanimated begin to move, or when in motion stop without resistance. A billiard ball laid at rest on the smoothest surface, would continue at rest to the end of time, unless moved by some force extrinsic to itself. If such a ball were struck by another ball, it would indeed be moved with a velocity proportioned to the impetus with which it was struck; but the impelling ball would lose as much of its own motion as was communicated to that upon which the impulse was made. It is evident, therefore, that in this instance there is no *beginning* of motion, but only the communication of motion from one body to another; and we may still ask, Where had the motion its origin? If the impelling ball was thrown from the hand of a man, or struck with a racket, it is plain that by a volition of the man's mind the motion was first given to his own arm, whence it proceeded through the racket from one ball to another; so that the ball, racket, and arm, were mere instruments, and the mind of the man the only agent or first mover. That motion can be *begun* by any being which is not possessed of life, consciousness, and will, or what is analogous to these, is to us altogether inconceivable. Mere matter or inanimated body can operate upon body only by impulse: but impulse, though from the poverty of language we are sometimes obliged to talk of its agency, is itself merely an effect; for it is nothing more than the contact of two bodies, of which one at least is in motion. An infinite series of effects without a cause is the grossest absurdity; and therefore motion cannot have been communicated from eternity by the impulse of body upon body, but must have been originally produced by a being who acts in a manner analogous to the energies of the human will.

194 Motion produced by impulse can only be in a straight line.

But though motion could not have been begun but by the energy of mind, it is generally believed that it might be continued by the mere passivity of body; and it is a law of the Newtonian philosophy, that a body projected in empty space would continue to move in a straight line for ever. The only reason which can be assigned for this law is, that since body continues to move at all after the impetus of projection has ceased, it could not of itself cease to move without becoming active; because as much force is required to stop a body in motion as to communicate motion to the same body at rest. Many objections have been made to this argument, and to the law of which it is the foundation; but as we do not perceive their strength, we shall not fill our page with a formal examination of them (R). If a single body could exist and have motion communicated to it *in vacuo* by the force

(R) By much the strongest and best urged of these objections which we have seen, is made by Dr Horsley, a man equally learned in mathematics and in ancient and modern philosophy. "I believe with the author of Ancient Metaphysics (says he), that some active principle is necessary for the continuance as well as for the beginning of motion. I know that many Newtonians will not allow this: I believe they are misled, as I myself have formerly been misled, by the expression *a state of motion*. Motion is a change; a continuance of motion is a farther change; a farther change is a repeated effect; a repeated effect requires a repeating cause. State implies the contrary of change; and motion being change, a *state of motion* is a contradiction in terms." See *Ancient Metaphysics*, vol. ii.

If our readers think this reasoning conclusive, they may be in the right; and in that case they will see the necessity of admitting, even for the continuance of rectilineal motion, the *plastic nature*, or something equivalent to

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force of projection, we are persuaded, that from the very passivity of matter, that motion would never have an end; but it is obvious that it could be moved only in a straight line, for an impulse can be given in no other direction.

195 The Newtonian doctrine respecting the causes of the motion of the heavenly bodies.

The heavenly bodies, however, are not moved in straight lines, but in curves round a centre; and therefore their motion cannot have been originally communicated merely by an impressed force of projection. This is admitted by all philosophers; and therefore the Newtonians suppose that the planets are moved in elliptical orbits by the joint agency of two forces acting in different directions. One of these forces makes the planet tend directly to the centre about which it revolves: the other impels it to fly off in a tangent to the curve described. The former they call *gravitation*, which some of them have affirmed to be a property inherent in all matter; and the latter, which is a projectile force, they consider as impressed *ab extra*. By the joint agency of such forces, duly proportioned to each other, Sir Isaac Newton has demonstrated, that the planets must necessarily describe such orbits as by observation and experience they are found actually to describe. But the question with the metaphysician is, Whether such forces be real?

196 Mutual attraction among the heavenly bodies impossible.

With respect to projection, there is no difficulty; but that bodies should mutually act upon each other at a distance, and through an immense vacuum, seems at first sight altogether impossible. If the planets are moved by the forces of gravitation and projection, they must necessarily move *in vacuo;* for the continual resistance of even the rarest medium would in time overcome the force of the greatest impetus: but if they move *in vacuo*, how can they be attracted by the sun or by one another? It is a self-evident truth, that nothing can act but where it is present, either immediately or mediately; because every thing which operates upon another, must perform that operation either by its own immediate agency or by means of some instrument. The sun and planets are not in contact; nor, if the motion of these bodies be *in vacuo*, can any thing material pass as an instrument from the one to the other. We know indeed by experience, that every particle of unorganized matter within our reach has a tendency to move towards the centre of the earth; and we are intuitively certain, that such a tendency must have some cause; but when we infer that cause to be a power of attraction inherent in all matter, which mutually acts upon bodies at a distance, drawing them towards each other, we talk a language which is perfectly unintelligible (s). Nay more, we may venture to affirm that such an inference is contrary to fact. The particles of every elastic fluid fly *from* each other; the flame of a fire darts *upwards* with a velocity for which the weight of the circumambient air cannot account; and the motion of the particles of a plant when growing, is so far from tending toward the *centre* of the earth, that when a flowerpot is inverted, every vegetable in it, as soon as it is arrived at a sufficient length, bends itself over the side of the pot, and grows with its top in the natural position.

197 The heavenly bodies cannot be moved by two forces impressed *ab extra;*

Sensible of the force of these arguments against the possibility to it, without which we have endeavoured to prove, that the heavenly bodies could not revolve round their respective centres in elliptical curves.

(s) A different opinion on this point is held by Professor Stewart in his *Elements of the Philosophy of the Human Mind;* a work of which the merit is such as to make it painful to us to differ in any important opinion from the ingenious author. We shall, however claim the same liberty of dissenting occasionally from him that he has claimed of dissenting from Newton, Locke, Clarke, and Cudworth, from whom he differs widely in thinking it as easy to conceive how bodies can act upon each other at a distance, as how one body can communicate motion to another by impulse. "I allow (says he, p. 79.) that it is impossible to conceive in what manner one body acts upon another at a distance through a vacuum; but I cannot admit that it removes the difficulty, to suppose that the two bodies are in actual contact. That one body may be the efficient cause of the motion of another body placed at a distance from it, I do by no means assert; but only that we have as good reason to believe that this may be possible, as to believe that any one natural event is the efficient cause of another."

If by *efficient* cause be here meant the *first* and *original* cause of motion, we have the honour to agree with the learned professor; for we are persuaded that body inanimated is not, in this sense of the word, the cause of motion either at hand or at a distance: but if he mean (and we think he must, because such was the meaning of Newton, from whom he professes to differ), that we can as easily conceive one body to be the instrumental cause of the motion of another from which it is distant, as we can conceive it to communicate motion by impulse, we cannot help thinking him greatly mistaken. We will not indeed affirm, with the writer whom he quotes, "that although the experiment had never been made, the communication of motion by impulse might have been predicted by reasoning *à priori;*" because we are not certain, that without some such experiment we should ever have acquired adequate notions of the solidity of matter: But if all corporeal substances be allowed to be solid and possessed of that negative power to which philosophers have given the name of *vis inertiæ*, we think it may be easily proved *à priori*, that a sufficient impulse of one hard body upon another *must* communicate *motion* to that other; for when the *vis inertiæ*, by which alone the one body is kept in its place, is less than the *vis impetus* with which the other rushes to take possession of that place, it is evident that the former body *must* give way to the latter, which it can do only by motion, otherwise the two bodies would occupy one and the same place, which is inconsistent with their solidity. But that a substance possessed of a *vis inertiæ* should make another substance possessed of the same negative power quit a place to which itself has no *tendency*, is to us not only *inconceivable*, but apparently impossible, as implying a direct contradiction.

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possibility of an attractive power in matter which operates at a distance, other philosophers have supposed that the heavenly bodies are moved in elliptical orbits by means of two forces originally impressed upon each planet, impelling it in different directions at the same time. But if the tendency of the planets towards the centre of the sun be of the same kind with that of heavy bodies towards the centre of the earth (and if there be such a tendency at all, we have no reason to suppose it different), it cannot possibly be the effect of impulse. A body impelled or projected *in vacuo* would continue to be moved with an equable velocity, neither accelerated nor retarded as it approached the object towards which it was directed; but the velocity of a body tending towards the centre of the earth is continually accelerated: and as we cannot doubt but that the same thing takes place in the motion of a body tending towards the centre of the sun, that motion cannot be the effect of impulse or projection.

198 nor by the agency of any material fluid.

Some of the Newtonians therefore have supposed, "That all kinds of attraction consist in fine imperceptible particles or invisible effluvia, which proceed from every point in the surface of the attracting body, in all right-lined directions every way; which in their progress lighting on other bodies, urge and solicit them towards the superior attracting body; and therefore (say they) the force or intensity of the attracting power in general must always decrease as the squares of the distances increase." The inference is fairly drawn from the fact, provided the fact itself were real or possible: but it is obvious, that if fine imperceptible particles or invisible effluvia were thus issued from every point in the surface of the sun, the earth and other planets could not move *in vacuo;* and therefore the projectile motion would in time be stopped by the resistance of this powerful medium. Besides, is it not altogether inconceivable, nay impossible, that particles issuing *from* the sun should draw the planets *towards* that centre? would they not rather of necessity drive them to a greater distance? To say, that after they have reached the planets, they change their motion and return to the place whence they set out, is to endue them with the powers of intelligence and will, and to transform them from passive matter to active mind.

These difficulties in the theories of attraction and impulse have set philosophers upon fabricating numberless hypotheses: and Sir Isaac Newton himself, who never considered gravitation as any thing more than an effect, conjectured that there might be a very subtile fluid or ether pervading all bodies, and producing not only the motion of the planets, and the fall of heavy bodies to the earth, but even the mechanical part of muscular motion and sensation. Others (T) again have supposed fire, or light, or the electric fluid, to be the universal agent; and some few (U) have acknowledged, that nothing is sufficient to produce the phenomena but the immediate agency of mind.

With respect to the interposition of any material fluid, whether ether, fire, light, or electricity, it is sufficient to say that it does not remove any one difficulty which encumbers the theory of innate attraction. All these fluids are elastic; and of course the particles of which they are composed are distant from each other. Whatever motion, therefore, we may suppose to be given to one particle or set of particles, the question still recurs, How is it communicated from them to others? If one body can act upon another at the distance of the ten-thousandth part of an inch, we can perceive nothing to hinder its action from extending to the distance of ten thousand millions of miles. In the one case as well as the other, the body is acting where it is not present; and if that be admitted to be possible, all our notions of action are subverted, and it is vain to reason about the cause of any phenomenon in nature.

199 The hypothesis of Plato, Aristotle, and Cudworth,

This theory of the intermediate agency of a subtile fluid differs not essentially from the vortices of Des Cartes; which appeared so very absurd to Cudworth, that with a boldness becoming a man of the first genius and learning, he rejected it, and adopted the plastic nature of Plato, Aristotle, and other Greek philosophers. That incomparable scholar observes, that matter, being purely passive, the motion of the heavenly bodies, the growth of vegetables, and even the formation of animal bodies, must be the effect either of the immediate agency of God, or the agency of a *plastic nature* used as an instrument by Divine Wisdom. That they are not the effect of God's immediate agency, he thinks obvious from several circumstances. In the first place, They are performed slowly and by degrees, which is not suitable to our notions of the agency of almighty Power. Secondly, Many blunders are committed in the operations of nature, such as the formation of monsters, &c. which could never be were things formed by the immediate hand of God. He is therefore of opinion, that, after the creation of matter, God employed an inferior agent to give it motion and form, and to carry on all those operations which have been continued in it since the beginning of the world. This agent he calls *plastic nature;* and considers it as a being incorporeal, which penetrates the most solid substance, and, in a manner which he pretends not to explain otherwise than by analogy, actuates the universe. He does not look upon it as a being endued with perception, consciousness, or intelligence; but merely as an instrument which acts under Divine Wisdom according to certain laws. He compares it to art embodied; and quoting from Aristotle, says, Ει ενην εν τω ξυλω ἡ ναυπηγικη ὁμοιως αν τη φυσει εποιει. *If the art of the shipwright were in the timber itself, operatively and effectually, it would there act just as nature doth.* He calls it a certain lower life than the animal, which acts regularly and artificially for ends of which it knows nothing. It may be, he says, either a lower faculty of some conscious soul, or else an inferior kind of life or soul by itself, but depending in either case upon a higher intellect. He is aware with what difficulty such a principle will be admitted by those philosophers who have divided all being into such as is extended and such as is cogitative: but he thinks this division improper. He would divide

(T) The several followers of Mr Hutchinson.
(U) Cudworth, Berkeley, and the author of Ancient Metaphysics.

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divide beings into thoſe which are ſolid and extended, and thoſe which have life or internal energy. Thoſe beings which have life or internal energy he would again divide into ſuch as act with conſciouſneſs, and ſuch as act without it: the latter of which is this plaſtic life of nature. To prove that ſuch an inſtrument is poſſible, or that a being may be capable of operating for ends of which it knows nothing, he inſtances *bees* and other animals, who are impelled by *inſtinct* to do many things neceſſary to their own preſervation, without having the leaſt notion of the purpoſe for which they work. (See INSTINCT). He obſerves, that there is an eſſential difference between reaſon and inſtinct, though they are both the attributes of mind or incorporeal ſubſtance: and that therefore, as we know of two kinds of mind differing ſo widely, there is nothing to hinder us from inferring a third, with powers differing as much from inſtinct as inſtinct differs from reaſon. Mankind are *conſcious* of their own operations, *know* for what *purpoſe* they generally act, and can by the power of *reflection* take a *retroſpective* view of their actions and thoughts, making as it were the mind its own object. Brutes are *conſcious* of their own operations, but they are ignorant of the *purpoſes* for which they operate, and altogether *incapable* of *reflecting* either upon their paſt conduct or paſt thoughts. Between their intellectual powers and thoſe of man, there is a much greater difference than there is between them and a plaſtic nature, which acts as an inſtrument of Divine Wiſdom without any conſciouſneſs of its own operations. Ariſtotle, from whom principally the learned author takes his notion of this plaſtic nature, compares it, with reſpect to the Divine Wiſdom which directs and ſuperintends its operations, to a mere builder or mechanic working under an architect, for the purpoſe of which the mechanic himſelf knows nothing. The words of the Stagyrite are: Τους αρχιτεκτονας περι ἑκαστον τιμιωτερους και μαλλον ειδεναι νομιζομεν των χειροτεχνων, και σοφωτερους ὁτι τας αιτιας των ποιουμενων ισασιν οἱ δ' ὡσπερ και των αψυχων ενια, ποιει μεν, ουκ ειδοτα δε ποιει, ὁιον καιει το πυρ· τα μεν ουν αψυχα φυσει τινι ποιειν τουτων ἑκαστον τους δε χειροτεχνας δι εθος †. "We account the architects in every thing more honourable than the mere workmen, becauſe they underſtand the reaſon of the things done; whereas the other, as ſome inanimate things, only work, not knowing what they do, juſt as the fire burns: the difference between them being only this, that inanimate things act by a certain nature in them, but the workman by habit."

† *Metaphyſ.* lib. i. cap. 1.

200 ſhown to be poſſible.

Still further to prove that a being may be endowed with ſome vital energy of a ſubordinate kind, and yet be deſtitute of conſciouſneſs and perception, the learned author obſerves, that there is no reaſon to think that the ſouls of men in ſound ſleep, lethargies, or apoplexies, are conſcious of any thing; and ſtill leſs, if poſſible, to ſuppoſe that the ſouls of embryos in the womb are from the very firſt moment of their arrival there intelligent and conſcious beings: neither can we ſay, how we come to be ſo differently affected in our ſouls by the different motions made upon our bodies, nor are we conſcious always of thoſe energies by which we impreſs fantaſtic ideas on the imagination. But if it be poſſible for the ſouls of men to be for one inſtant void of conſciouſneſs and intelligence, it follows, that conſciouſneſs is not abſolutely neceſſary to thoſe energies and motions by which life is preſerved. To this it may be added, upon the beſt authority †, "that where animal or vegetable life is concerned, there is in every caſe a different relation between the cauſe and effect, and ſeemingly depending upon the concurrence or influence of ſome farther principle of change in the ſubject, than what ſubſiſts in inanimate matter, or in the cauſes and effects that are the objects of mechanical and chemical philoſophy." Now to this principle of vegetable life, without which, in a ſeed or in a plant, vegetation will neither begin nor continue, though light, heat, air, earth, and water, ſhould concur in the utmoſt perfection, Cudworth expreſly compares his plaſtic nature in the univerſe. It is ſo far (ſays he) from being the firſt or higheſt life, that it is indeed the laſt and loweſt of all lives, being really the ſame thing with the vegetative.

† *Gregory's Philoſophical and Literary Eſſays.*

201 Arguments for its truth: but

Theſe arguments, if the phenomena of elective attractions in chemiſtry be added to them, demonſtrate, we think, the *poſſibility* of ſuch a principle: and to thoſe who are inclined to affirm that no ſuch thing can exiſt, becauſe, according to the deſcription of it given by Cudworth and the ancients, it is neither body nor ſpirit in the proper ſenſe of the words; we be leave to aſk, in the words of Locke, "who told them that there is and can be nothing but ſolid beings which cannot think, and thinking beings that are not extended? which is all that they mean by the terms body and ſpirit." All the Greek philoſophers who were not materialiſts, and even the inſpired writers of the Old and New Teſtaments, conſtantly diſtinguiſh betwen the *ſpirit* and the *ſoul* of a man, calling the former ſometimes νους, and ſometimes πνευμα, and the latter ψυχη; and St Paul, who before he was a Chriſtian, was learned in philoſophy, deſcribes the conſtituent parts of man as three, πνευμα, ψυχη, σωμα, *ſpirit*, *ſoul*, and *body*. This diſtinction, ſetting aſide the *authority* with which it comes to us, ſeems to be well founded; for there are many operations carried on in the human body without any conſcious exertion of ours, and which yet cannot be accounted for by the laws of mechaniſm. Of theſe, Cudworth inſtances the motion of the diaphragm and other muſcles which cauſe reſpiration, and the ſyſtole and diaſtole of the heart; neither of which, he thinks, can be the effect of mere mechaniſm. But, as we are not conſcious of any energy of ſoul from which they proceed, even while we are awake, and ſtill leſs, if poſſible, while we are aſleep; he attributes them, not to the intellect or rational mind, but to this inferior vital principle called ψυχη (V); which, in his opinion, acts the

(V) The exiſtence of this plaſtic nature was warmly debated between Monſieur Le Clerc and Monſieur Bayle. Moſheim, who was inclined himſelf to admit ſuch a principle, gives the following view of Le Clerc's ſentiments from *Bibliotheque Choiſie*, tom. ii. p. 113. "Reſpiratio, inquit, et motus cordis, actiones ſunt, quorum nihil ad animam pertinet. Interim mechanice eas fieri, nullo modo probabile eſt. In voluntariis

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the same part in the system of the human body which the plastic nature acts in the system of the world.—To make the resemblance more striking, he observes, that even the voluntary motion of our limbs, though it proceeds ultimately from an energy of will, seems to be the effect of that energy employing some *instrument* which pervades the sinews, nerves, and muscles of the body; and if the human spirit or πνευμα employ the instrumentality of a plastic nature or ψυχη in moving the small machine of the body, it seems to be far from incredible that the Divine Wisdom should employ the instrumentality of a plastic nature in moving the great machine of the universe.

202 whether it be true or not, the motions of the heavenly bodies are carried on by the constant agency of something incorporeal.

But we need not insist further on the *possibility* of such an instrument. Whatever may be thought of the arguments of Cudworth, of which some are, to say the least of them, plausible, though others appear to us to have very little strength, Dr Clarke has proved, with a force of reasoning not inferior to mathematical demonstration, that the motions of the heavenly bodies are carried on by the agency of something very different from matter, under every possible form. "For, not to say that, seeing matter is utterly incapable of obeying any *laws* in the proper sense of the word, the very original laws of motion themselves cannot continue to take place, but by something superior to matter, *continually* exerting on it a certain force or power according to such certain and determined laws: it is now evident beyond question, that the bodies of all *plants* and *animals* could not possibly have been formed by mere matter according to any general laws of motion. And not only so, but that most universal principle of *gravitation* itself, the spring of almost all the great and regular inanimate motions in the world, answering not at all the *surfaces* of bodies, by which alone they can act upon one another, but entirely to their *solid contents*, cannot possibly be the result of any motion originally impressed upon matter." For though it is true, that the most solid bodies with which we are acquainted are all very porous; and that, therefore a subtile material fluid might penetrate the bodies of the planets, and operate upon them with a force exerted internally; still it is self-evident, that the *greatest* quantities of such a fluid could not enter into those bodies which are *least* porous, and where the greatest force of *gravitation* resides: "and, therefore, this motion must of necessity be caused by something which penetrates the very *solid substance* of all bodies, and continually puts forth in them a force or power entirely different from that by which matter acts upon matter *." Which is, as the same able writer observes, an evident demonstration, not only of the world's being originally made by a supreme intelligent Cause; but moreover, that it depends every moment upon some superior Being, for the preservation of its frame; and that all the great motions in it are caused by some immaterial power *perpetually* and *actually* exerting itself every moment in every part of the corporeal universe. This preserving and governing power, whether it be the immediate power and action of the same Supreme Cause that created the world, or the action of some subordinate instruments appointed by him to direct and preside respectively over certain parts thereof, gives us equally in either way a very noble idea of Providence. We know with certainty, that *real* and *original power* can belong only to a being endowed with intelligence and will; and, therefore, if the existence of Cudworth's (w) plastic nature be admitted, (and we see not why it should be called

* *Evidence of Nat. and Revealed Religion.*

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tariis commotionibus nesciunt animi nostri, quid facto opus sit, ut membra commoveantur: imperant illi tantum. Est vero aliud nescio quid, quod fideliter, si modo organa recte sint affecta, mandata ejus exsequitur. Quidni igitur suspicemur, esse *naturam* in corpore nostro *viventem*, præter animam nostram, cujus sit animæ præceptis et jussis morem gerere? quamquam potentia ejus ita sit definita, ut obedire nequeat animo, nisi recte sese habeant organa. Eadem forte natura, corporis nostri motibus impulsa, animam edocet, quid factum sit, ut ille possit præcipere, quæ ad conservationem corporis necessaria judicat. Anima, pergit, sit hæc vera esse putes, similis erit domino, sibimet ipsi servire nescio, nec ulla facultate alia, quam imperandi et jubendi instructo. Hæc vero natura fictrix non dissimilis erit mancipii cui nihil eorum, quæ dominus meditatur, notum est, quodque nihil aliud facit, quam ut jussis pareat, et dominum de illis rebus admoneat, quæ ad salutem ipsius pertinent." Mosheim proceeds,—Si quis huic loco sic occurrat, Hæc ratione tria fingi in homine principia; respondet vir doctus: "Nullis constares argumentis, binis tantum hominem partibus constare. Eos, qui hominem ex binis tantum partibus component, nulla ratione explicare posse naturam conjunctionis animi et corporis, nisi ipsum Deum statuant cunctis actionibus hominum intervenire: hoc vero Divina Majestate prorsus indignum esse. Definitionem accuratam mediæ hujus naturæ postulantibus sese talem dare non posse definitionem respondet: Hoc unum sese scire: esse eam naturam interiori agendi virtute instructam, quæ ex se et animam et corpus afficere queat; naturam, quæ doceat animam quid rerum geratur in corpore; naturam denique, quæ animi mandatis, quorum tamen caussas nesciat, fideliter obtemperet." Reliqua, quæ illustrandæ hujus rei caussa CLERICUS affert, prætereo. Satis copiosa est in illis, quæ produximus, meditandi materia. *Mosheim. ed. Syst. Intellect.* p. 173.

Such a principle actuating the universe, if it be divested of intelligence, and considered as a second or inferior cause, under the direction of the Supreme, is acknowledged by a very able judge to be a rational hypothesis; and such, if properly pursued, would certainly open a most entertaining scene of natural philosophy.—See *Jones's Answer to an Essay on Spirit.*

(w) Besides Cudworth, we have mentioned Berkeley and the author of *Ancient Metaphysics*, as holding all motion to be an effect of the immediate agency of mind or incorporeal substance. The opinion of the last of these philosophers is not essentially different from Cudworth's; and therefore it is needless to quote from him: Berkeley was better acquainted with the principles of the Newtonian philosophy, as well as an abler mathematician,

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called in (X) queſtion), it can be conſidered only as an inſtrument employed by Divine Wiſdom, as a chiſſel or a ſaw is employed by the wiſdom of the mechanic.

203 This theory not inconſiſtent with the principles of Newton.

Nor let it be imagined, that this ancient theory of motion is in any degree inconſiſtent with the mathematical principles of Sir Iſaac Newton's aſtronomy, or with the calculations raiſed from thoſe principles. Having founded his aſtronomy on analogy between the phenomena of projectile and planetary motions, he aſſigned the ſame or ſimilar *forces* exiſting in nature as the efficient cauſes of both. And indeed, both in the act of deriving his *principles* from the projectile phenomena, and afterwards for the purpoſe of applying them to the planetary, it was neceſſary to analyze the elliptical motion of the heavenly bodies into a compound of two ſimple motions in right lines, produced by the action of theſe different forces; and this might alſo be uſeful for the purpoſes of teaching and demonſtration, juſt as we find it neceſſary, in all parts of ſcience, to ſeparate what in nature is inſeparable, for the convenience and aſſiſtance of the underſtanding. The planetary motions, however, are very probably ſimple and uncompounded, for no experiments can be tried in thoſe diſtant regions; and the aſtronomy of Newton, which is only the application of his mathematical principles to their menſuration from their *analogy* to projectile motions, does not at all require that the forces of gravitation and projection be aſſigned as their real exiſtent cauſes (Y). It is ſufficient for the *analogy*,

matician, than either of theſe pupils of the ancients; and being likewiſe a man who on all ſubjects thought for himſelf, it may be worth while to lay before our readers a ſhort abſtract of his reaſoning reſpecting the origin of motion. His words are: "Totum id quod novimus, cui nomen *corpus* indidimus, nihil in ſe continet quod motus principium ſeu cauſa efficiens eſſe poſſit. *Vis*, *gravitas*, *attractio*, et hujuſmodi voces, utiles ſunt ad ratiocinia et computationes de motu et corporibus motis; ſed non ad intelligendam ſimplicem ipſius motus naturam, vel ad qualitates totidem diſtinctas deſignandas. Attractionem certe quod attinet, patet illam ab Newtono adhiberi, non tanquam qualitatem veram et phyſicam, ſed ſolummodo ut hypotheſin mathematicam. Quin et Leibnitius, niſum elementarem ſeu ſolicitationem ab impetu diſtinguens, fatetur illa entia non re ipſa inveniri in rerum natura, ſed abſtractione facienda eſſe. Similis ratio eſt compoſitionis et reſolutionis virium quarumcunque directarum in quaſcunque obliquas, per diagonalem et latere parallelogrammi. Hæc mechanices et computationi inſerviunt: ſed aliud eſt computationi et demonſtrationibus mathematicis inſervire, aliud rerum naturam exhibere. Revera corpus æque perſeverat in utrovis ſtatu, vel motus vel quietis. Iſta vero perſeverantia non magis dicenda eſt actio corporis, quam exiſtentia ejuſdem actio diceretur. Cæterum reſiſtentiam quam experimur in ſiſtendo corpore moto, ejus actionem eſſe fingimus vana ſpecie deluſi. Revera enim iſta reſiſtentia quam ſentimus, paſſio eſt in nobis, neque arguit corpus agere, ſed nos pati: conſtat utique nos idem paſſuros fuiſſe, ſive corpus illud a ſe moveatur, ſive ab alio principio impellatur. Actio et reactio dicuntur eſſe in corporibus; nec incommode ad demonſtrationes mechanicas. Sed cavendum, ne propterea ſupponamus virtutem aliquam realem, quæ motus cauſa ſive principium ſit, eſſe in iis. Etenim voces illæ eodem modo intelligendæ ſunt ac vox *attractio*; et quemadmodum hac eſt hypotheſis ſolummodo mathematica non autem qualitas phyſica; idem etiam de illis intelligi debet, et ob eandem rationem.

"Auferantur ex idea corporis extenſio, ſoliditas, figura, remanebit nihil. Sed qualitates iſtæ ſunt ad motum indifferentes, nec in ſe quidquam habent, quod motus principium dici poſſit. Hoc ex ipſis ideis noſtris perſpicuum eſt. Si igitur voce *corpus* ſignificatur id quod concipimus, plane conſtat inde non peti poſſe principium motus: pars ſcilicet nulla aut attributum illis cauſa efficiens vera eſt, quæ motum producat. Vocem autem proferre, et nihili concipere, id demum indignum eſſet philoſopho.

"Præter res corporeas, alterum eſt genus rerum cogitantium: in iis autem potentiam ineſſe corpora movendi, propria experientia didicimus, quando quidem anima noſtra pro lubitu poſſit ciere et ſiſtere membrorum motus, quacunque tandem ratione id fiat. Hoc certe conſtat, corpora moveri ad nutum animæ, eamque proinde haud inepte dici poſſe principium motus; particulare quidem et ſubordinatum, quodque ipſum dependeat, a primo et univerſali principio.

"Ex dictis manifeſtum eſt eos qui vim activam, actionem, motus principium, in corporibus revera ineſſe affirmant, ſententiam nulla experientia fundatam amplecti, eamque terminis obſcuris et generalibus adſtruere nec quid ſibi velint ſatis intelligere. E contrario, qui mentem eſſe principium motus volunt, ſententiam propria experientia munitam preferunt, hominumque omni ævo doctiſſimorum ſuffragiis comprobatam.

"Primus Anaxagoras τον νουν introduxit, qui motum inerti materiæ imprimeret: quam quidem ſententiam probat etiam Ariſtoteles, pluribuſque confirmat, aperte pronuncians primum movens eſſe immobile, indiviſibile, et nullum habens magnitudinem. Dicere autem, omne motivum eſſe mobile, recte animadvertit idem eſſe ac ſiquis diceret, omne ædificativum eſſe ædificabile. Plato inſuper in Timæo tradit machinam hanc corpoream, ſeu mundum viſibilem, agitari et animari a mente, quæ ſenſum omnem fugiat. Et Newtonus paſſim nec obſcure innuit, non ſolummodo motum ab initio a Numine profectum eſſe, verum adhuc ſyſtema mundanum ab eodem actu moveri. Hoc ſacris literis conſonum eſt: hoc ſcholaſticorum calcula comprobatur."

De Motu, paſſim.

(X) This we ſay upon the received opinion, that there are things wholly incorporeal. The truth of the opinion itſelf will be conſidered in a ſubſequent chapter.

(Y) Indeed Sir Iſaac himſelf is very far from poſitively aſſigning them as the *real* cauſes of the phenomena. The purpoſe for which they were introduced into his philoſophy he clearly explains in the following words: "Eadem ratione qua projectile vi gravitatis in orbem flecti poſſet et terram totam circumire, poteſt et luna, vel

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analogy, on which the whole philosophy is founded, that the phenomena of motion are known from experiments and observations to be the *same* in *both* instances; that the *principles* or *general laws* mathematically established from the *forces* of the *one* are transferred to the *phenomena* of the *other*; and that the proofs and operations deduced from these principles in the latter case, are confirmed by *facts* and *experience*, the first and final test of truth *.

* *Tatham's Chart and Scale of Truth.*

Chap. VI. *Of* Number.

204 Unity, as an idea, cannot

"Amongst all the ideas that we have, as there is none (says Mr Locke †) suggested to the mind by more ways, so there is none more simple, than that of unity or *one*. It has no shadow of variety or composition in it. Every object our senses are employed about, every idea in our understandings, every thought of our minds, brings this idea along with it: and therefore it is the most intimate to our thoughts, as well as it is, in its agreement to all other things, the most universal idea we have; or number applies itself to men, angels, actions, thoughts, every thing that either doth exist or can be imagined." He seems likewise to be of opinion that we have the idea of *unity* before that of *many*; and that it is by repeating the simple idea of unity in our own minds that we come by the *complex ideas* of *two*, *three*, &c. In this opinion he is joined by Pere Buffier *; who observes that it is impossible to explain the nature of *unity*, because it is the most simple idea, and that which perhaps *first* occurred to the mind.

† *Essay*, book ii. chap. xvi.

* *First Truths.*

That *unity* is a simple idea, must be granted; but it certainly did not first occur to the mind, nor can it be abstracted from all individuals, and apprehended in Locke's sense of the word as a *general idea*. Let any

205 be abstracted from every individual.

man look into his own mind, and then say whether he has a general idea of *one* or *unity* as abstracted from every individual object mental and corporeal. In particular, when he thinks he has completely abstracted it from body and mind, sensations, ideas, actions, and passions, &c. let him be sure, before he pronounce it a general *abstract* idea, that he is not all the while contemplating the idea of its *name*, or of that numerical *figure*, by which it is marked in the operations of arithmetic. Both these ideas are in themselves particular; and become general in their import, only as representing every individual object to which unity is in any sense applicable. But in the chapter *of Abstraction*, we have said enough to convince every person capable of conviction that they are used as signs for whole classes of objects.

Instead of being an abstract general idea, *unity*, as the basis of number, is in fact nothing but a mere *relation*, which cannot be conceived without the related objects; and so far is it from being the *first* idea that occurred to the mind, that it is certainly the result of a comparison, made by the intellect, of two or more objects. The ideas which first occur to the mind are, beyond all doubt, those which are called *ideas of sensation*; and many such ideas every child receives before he is capable of comparing objects and forming to himself notions of number. *Unity*, or the idea of *one*, is indeed the element of the science of *arithmetic*, just as a mathematical *point* is the element of the science of *geometry*; but accurate notions of these elements are, in the progress of knowledge, subsequent to ideas of *many* and of *surfaces*. There is reason to believe that persons totally illiterate have no notion at all of *mathematical points*; and we think it possible to conceive an intelligent and conscious being in such a situation as that he could not acquire a notion of *unity* or *one*. Were a child never to see or feel two objects of the *same kind*, we doubt if he would think of numbering them, or of making such a comparison of the one with the other as would suggest to his mind the relations of *one* and *two*; for these relations imply both a sameness and a difference of the objects beyond the power of a child to ascertain. The difference indeed would be perceptible to the senses, but the senses would perceive no sameness or agreement. A guinea, a shilling, and a ball of lead, impress upon the mind different sensations; and therefore a child undoubtedly distinguishes these objects from one another: but what could make him derive from this his first idea of the relation of number? A guinea, a shilling, and a ball of lead, are not *one*, *two*, *three*, in any sense which a child can comprehend. To be convinced of this, let any man throw a guinea, a shilling, and a ball of lead upon a table, and ask a *clown* what is their number. From being accustomed to retail the *names* of number as signs, without affixing to them any idea of the things signified, he will probably answer with quickness *three*, or perhaps *one*, *two*, *three*: but if he be further asked in what *respect* they are *one*, *two*, *three*, we believe his answer will not be so ready: They are not *one*, *two*, *three guineas*, or *shillings*, or *balls of lead*. A philosopher knows them to be three pieces of the same first matter under different forms, and can therefore apply to them the relation of number with truth and propriety; but of the first matter a *clown* is entirely ignorant, and of course cannot call them *one*, *two*, *three*, in any sense which is at once true and to him intelligible.

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206 Unity, a particular relation.

To make it still more evident, that it is only by comparing together things of the *same kind* that our *first* ideas of unity and number are formed, let us suppose no created being to have hitherto existed except the animated and intelligent globe mentioned in the last chapter, and we think it will be granted that such a being in solitude could never acquire the idea of *unity*. Let

vel vi gravitatis, *si modo gravis sit*, vel alia quacunque vi qua in terram urgeatur, retrahi semper a cursu rectilineo terram versus et in orbem suum flecti: et absque tali vi luna in orbe suo retineri non potest. Hæc vis, si *justo minor* esset, non satis flecteret lunam a cursu rectilineo: si *justo major*, plus satis flecteret, ac de orbe terram versus deduceret. Requiritur quippe ut sit *justæ magnitudinis*: et mathematicorum est invenire vim, qua corpus in dato quovis orbe data cum velocitate accurate retineri possit; et vicissim invenire viam curvilineam, in quam corpus e dato quovis loco data cum velocitate egressum data vi flectatur."——*Principia Mathem.* Def. V.

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Let us next suppose a *cubical* body to be created and exhibited to the senses of this spherical man; the consequence would be a *sensation* or feeling entirely new: but that feeling would not be of *unity*; for, as the author of *Ancient Metaphysics* has somewhere well observed, unity is no object of sensation. The sensation would be of colour, hardness, softness, roughness or smoothness, &c. for beyond these the empire of the senses does not reach. Again, Let another body be created of a colour and figure totally different from the colour and figure of the cube, and the spherical man would then experience new sensations having no agreement with those which he had formerly felt. These different kinds of sensations might be compared together; but the result of the comparison would not be the ideas which are denoted by the words *one* and *two*, but merely that which is expressed by *difference* or *dissimilarity*. Were another cube, however, of exactly the same size and colour with the former to be brought into existence, and both to be at once presented to the view of the spherical man, the rudiments of the idea of number would then be generated in his mind, because he could not but perceive the cubes to be in one respect different and in another the same; different as being distinct from each other, and agreeing in their effects upon the organs of sensation.

207 Men must have made some progress in classing things according to genera and species, before they acquired any notion of number.

It appears, therefore, that mankind must have made some progress in classing things according to their genera and species, before they acquired any correct ideas of the relation of number, or thought of using numerical names or figures as general and discriminating signs: for we say *one, two, three*, &c. only with respect to the species or genus of which each of the things denoted by these numbers is an individual; and if there be any thing which has no genus or species, neither number nor unity can, in the original sense of the words, be predicated of it (z). We say indeed that there is *one* God; but perhaps we do not always attend to the meaning of the expression. Language was formed to answer the common purposes of life; and those purposes are best answered by denoting individuals by the name of the species or genus to which they belong: but *God* belongs to no species or genus, unless he be said improperly (A) to be of the universal genus of *Being*; and therefore, the true meaning of the word *one*, when joined to the verb *is*, and transferred from the creature to the Creator, in such a sentence as—"there *is one* God"—seems to be nothing more than an affirmation that God exists, and that to him the relation of number cannot be applied. In a word, *unity* and *number* are merely relations between the individuals of the same species or genus of being; and men acquire ideas of these relations at the same time and by the same means that they are led to class things into species and genera. As to the processes of addition and subtraction, and the various purposes to which number is applied, these things belong to the science of arithmetic, and fall not under the province of the metaphysician, whose sole object is to ascertain the real nature and causes of things. It may, however, be worth while to observe, that Locke, whose notions of number seem to have been different from ours, owns, that a man can hardly have any ideas of numbers of which his language does not furnish him with names. But if units were either real things, or even positive ideas, we see not how *names* could be necessary to their existence; whereas, if they be nothing more than mere relations, it is obvious that they cannot be conceived but as relative either to beings actually existing, or to names which are the signs of actual beings.

Chap. VII. *Of* Time.

208 Time, a mode of duration in contradistinction to eternity.

When St Augustine was asked what time is? he replied, "*Si non roges, intelligo.*" An answer from which it may be inferred, that he thought the nature of *time* could not be explained by a logical definition. *Time* and *eternity* are commonly considered as the two modes of *duration*; and if duration be taken in what Locke thinks its true and original sense, to denote permanence of existence, with a kind of resistance to any destructive force, the distinction seems to be sufficiently proper. It is indeed the best that we can make or comprehend; for *duration, time*, and *eternity*, are subjects which have perplexed philosophical minds in all ages, and of which, if we have adequate notions, it is very difficult to express these notions in language. Instead of attempting it by previous definitions, the method in which the ancients generally began their inquiries, we shall pursue the better course of induction recommended by Lord Bacon, and endeavour to show by what means we acquire the notion of that mode of duration which is called *time* in contradistinction to

(z) We are happy to find our notions on this subject confirmed by an authority so respectable as that of Professor Stewart. "Without the power of attending separately to things which our senses present to us in a state of union, we never (says this able writer) could have had any idea of *number*: for before we can consider different objects as forming a multitude, it is necessary that we should be able to apply to all of them one common name; or, in other words, that we should reduce them all to the same genus. The various objects, for example, animate and inanimate, which are at this moment before me, I may class and number in a variety of different ways, according to the view of them that I choose to take. I may reckon successively the number of sheep, of cows, of horses, of elms, of oaks, of beeches; or I may first reckon the number of animals, and then the number of trees; or, I may at once reckon the number of all the organized substances which my senses present to me. But whatever be the principle on which my classification proceeds, it is evident that the objects numbered together must be considered in those respects only in which they agree with each other; and that if I had no power of separating the combinations of sense, I never could have conceived them as forming a plurality." *Elements of the Philosophy of the Human Mind*, chap. iv.

(A) We say *improperly*, because beings which were *created* can have nothing in *common* with that Being which is *self-existent*, and upon whose *will* and *power* all other things depend.

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to *eternity*. We begin with time; becaufe we ourfelves exift in it, and it is in fome fenfe familiar to us. If we be able to trace our notions of this mode of duration to their fource, we may then give a definition of it founded on fact and univerfal experience, and afterwards proceed to confider the other mode in conjunction with infinity, to which it is nearly allied.

It has been already obferved (fee N° 92 of this article), that every man, while awake, has a train of fenfations and ideas conftantly paffing through his mind in fuch a manner as that the one fucceeds the other in a regular order. It is not poffible, either, by detaining in the mind one idea to the exclufion of all others, to ftop the courfe of this fucceffion entirely; or, by hurrying fome ideas off the ftage, and calling others in their place, to quicken its progrefs beyond a certain degree. One man indeed has naturally a quicker fucceffion of ideas than another; and all men can, by great exertions, accelerate or retard in a fmall degree the natural flow of their thoughts. A ftudious man lays hold, as it were, of a particular idea, which he wifhes to contemplate, and detains it

209 Whilft the mind is occupied by one idea or notion, there is no perception of time; which

in the imagination, to the exclufion of all others; a man of wit calls remote ideas into view with a rapidity of which a cool and phlegmatic reafoner can form no conception; and a forcible *fenfation* takes full poffeffion of the mind, to the exclufion of all *ideas* whatever. Whilft the attention is wholly occupied by one idea, or by one fenfation, the mind has no notion whatever of time; and were it poffible to detain fuch idea or fenfation alone in the mind till the hand of a clock fhould move from the number of one hour to that of another, the hour, as marked on the dial-plate and meafured by the motion of the hand, would appear but as one inftant abfolutely void of duration. For the truth of this affertion we appeal to the experience of our readers. Such of them as have ever been engaged in deep ftudy muft often have had their attention fo fixed upon one object, that large portions of time, as meafured by the clock, have paffed away wholly unheeded; and every man who has feen a very ftriking and uncommon object, muft remember, that when the fenfation was firft impreffed upon his mind, all other objects, ideas, and notions, and among the reft the notion of time, were for a while excluded.

210 arifes from comparing the fucceffion of our ideas with the permanence of other objects.

No fenfation, however, keeps poffeffion of the whole mind after it has ceafed to be new; nor can the moft vigorous exertions long preferve any one idea from being driven off the ftage by the fucceeding train. Now this fucceffion of ideas appearing and difappearing in their turns, is that which, when compared with the permanency of ourfelves and other things, gives us our firft and jufteft notion of time: for whilft we are thinking, or whilft a feries of ideas is fucceffively paffing through our minds and vanifhing, we know that we ourfelves and the things around us exift; and this exiftence, or continuation of exiftence, commenfurate with the train of our fleeting ideas, is what we call the *duration* of ourfelves and the things around us.

We are aware that our firft notions of time have been often faid to be derived from *motion* as perceived by our fenfes in the objects around us. It is obferved by Euclid, that "if there were no *motion*, there could be no found, nor any fenfe of hearing." "He might have added (fays the author of Ancient Metaphyfics), nor any other perception of fenfe. Further, Without motion there would have been no vifible world, nor generation or production of any kind here below; and, among other things, *time* could have had no exiftence." All this is certainly true; but that corporeal motion, though the original fource of all our ideas, is not that which *immediately* fuggefts to us the notion of time, will be readily granted by him who confiders that motion itfelf is perceived by us only when it excites or accompanies a conftant fucceffion of perceptions and ideas. Motion, when equable and very flow, fuch as that of the hour hand of a common watch, is not perceived by us in its courfe; nor can we difcover that the thing has moved at all, till after we have been fenfible of the lapfe of a confiderable portion of what is commonly called *time*; when we difcover that the hand of the watch has changed its place with refpect to other objects which we know to be fixed. The fame is true of motion remarkably quick: "Let a cannon ball (fays Locke) pafs through a room, and in its way take with it any limb or flefhy parts of a man; it is as clear as any demonftration can be, that it muft ftrike fucceffively the two fides of the room; it is alfo evident that it muft touch one part of the flefh firft, and another after, and fo in fucceffion: and yet I believe nobody who ever felt the pain of fuch a fhot, or heard the blow againft the two diftant walls, could perceive any fucceffion either in the pain or found of fo fwift a ftroke."

Of thefe two phenomena a fatisfactory account may be eafily given; from which we think it will at the fame time be apparent, that the fucceffion of the train of ideas in the mind is the meafure and ftandard of all other fucceffions. We know that the energy of mind which reviews a train of fenfible ideas is of the very fame kind with that which attends to a feries of paffing fenfations (fee N° 68.); and therefore it is natural to fuppofe that we can pay attention to fenfations and ideas paffing with nearly equal velocities. But it has been fhown, that every fenfation remains in the mind or fenforium, for a very fhort fpace after the object which excited it is taken away: whence it follows, that a body communicating to the organs of fenfe a feries of fimilar impreffions fucceeding each other with remarkable rapidity, cannot excite a train of fimilar and diftinct fenfations; becaufe the effects of the firft and fecond impreffions not having vanifhed when thofe of the third and fourth arrive, the whole train of effects muft neceffarily coalefce into one uniform fenfation. This reafoning is confirmed by experience. Similar founds fucceeding each other at confiderable intervals, are all diftinctly perceived; and if the motion be accelerated gradually, it may be carried to a great degree of velocity before the founds be confounded and coalefce into one. "Mr Herfchel having, by means of a clock, produced founds or clicking noifes, which fucceeded each other with fuch rapidity that the intervals between them were, as far as could be judged, the fmalleft poffible, found that he could evidently diftinguifh one hundred and fixty of them in a fecond of time; but beyond that he could by no effort of attention diftinguifh one found from another. The fame philofopher tried another experiment on vifible fenfations. By means of the fame handle and work of the clock, he caufed a wheel in it to turn till

211 The fucceffion of ideas the meafure of all other fucceffions.

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till it acquired the velocity of once in a ſecond. He continued to increaſe the velocity, and obſerved it while revolving at the rate of twenty times round in thirteen ſeconds, and could ſtill diſtinguiſh the teeth and ſpaces from each other; whence it appears (by a computation given at length), that he had two hundred and forty-ſix diſtinct viſible ſenſations generated by equable motion in a ſecond of time. The teeth of the wheel, he owns, were not ſo far viſible as to ſhow their ſhape diſtinctly, much leſs could they have been counted: but he very plainly diſtinguiſhed the circumference to be divided into teeth and ſpaces; and he ſuppoſes that the ſame diviſion might ſtill have been ſeen though the motion had been a little faſter, as far perhaps as two turns in a ſecond, equal to three hundred and twenty ſenſations *." The reaſon that the diviſion could not be ſeen whilſt the wheel moved more rapidly than twice round in a ſecond of time, was doubtleſs the continuance of that agitation in the brain from which each ſenſation proceeded, until a new impreſſion cauſed a new agitation, which coaleſced with the former and removed all diſtinction. Hence it is plain, that no external ſucceſſion can be perceived which moves with a greater velocity than that of which the internal train of ſenſations and ideas is capable. On the other hand, an external ſucceſſion which moves with leſs rapidity than that to which the internal flow of ideas may be reduced, either has not ſufficient force to generate ſenſations at all, or the ſucceſſive impreſſions from which the ſenſations proceed follow one another at ſuch diſtances as to permit the natural train of ideas to intervene between them, and thus deſtroy the perception of the ſucceſſion entirely.

* Watſon's Treatiſe on Time.

To us, therefore, it ſeems evident, that the conſtant and regular ſucceſſion of ideas in the mind of a waking man, is the meaſure and ſtandard of all other ſucceſſions; of which, if any one either exceeds the pace of which our ideas are capable, or falls ſhort of it, the ſenſe of a conſtant and continued ſucceſſion is loſt, and we perceive it not but with certain intervals of reſt between. So that it is not motion, but the conſtant train of ideas in our minds, that ſuggeſts to us our firſt notion of time; of which motion no otherwiſe gives us any conception, than as it cauſes in our minds a conſtant ſucceſſion of ſenſations: and we have as clear a notion of time by attending to the train of ideas ſucceeding each other in our minds, as by a train of ſenſations excited by conſtant and perceptible motion.

That it is merely by comparing the permanent exiſtence of things with the fleeting ſucceſſion of ideas in our own minds that we acquire our notions of time, may perhaps be ſtill more evident from the following narrative quoted by Dr Beattie †, from *L'Hiſtoire de l'Academie Royale des Sciences pour l'année* 1719. "A nobleman of Lauſanne, as he was giving orders to a ſervant, ſuddenly loſt his ſpeech and all his ſenſes. Different remedies were tried without effect. At laſt, after ſome chirurgical operations, at the end of ſix months, during all which time he had appeared to be in a deep ſleep or delirium, his ſpeech and ſenſes were ſuddenly reſtored. When he recovered, the ſervant to whom he had been giving orders when he was firſt ſeized with the diſtemper, happening to be in the room, he aſked whether he had executed his commiſſion, not being ſenſible, it ſeems, that any interval of time, except perhaps a very ſhort one, had elapſed during his illneſs." If this ſtory be true, here was a man, who, by the train of ideas vaniſhing at once from his mind, loſt the perception of what was to others ſix months of time; and had all mankind been in his ſtate, the ſame portion of time would have been irrecoverably loſt even to the annals of chronology.

† Eſſay on Truth.

We are aware of an objection to any inference which may be drawn reſpecting the preſent queſtion from the caſe of this nobleman. It may be ſaid that he had loſt, together with the perception of time, the perception of every thing beſides; and that, therefore, motion may ſtill be the cauſe from which a waking man derives his notions of time. But in reply to this objection, we beg leave to aſk, Whether if a ball had been put in motion on a table, and the nobleman had been told, that a body moved with the velocity of that ball would have been carried over ſo many thouſand miles of diſtance during the time that he lay in a ſtate of inſenſibility, he could from ſuch information alone have formed any tolerable notion of the length of time in which he was inſenſible? He certainly could not, for want of a ſtandard by which to meaſure the rapidity of the motion. He would, indeed, have known inſtantly that he had been inſenſible for a conſiderable length of time, becauſe he had the evidence of former experience that a body carried by perceptible motion over a great extent of diſtance would have generated in his mind a vaſt train of ſucceſſive ſenſations; but till he had attended this ball during part of its courſe, and compared with the permanency of other objects the ſeries of ſenſations which it generated in his mind, he would not have been able to gueſs with any thing near to accuracy the length of time it would take to paſs over a thouſand miles.—The ſame inſenſibility of duration happens to every man in ſound ſleep. From having notions of time, ſuch as they are, formed in our minds, we never indeed ſuppoſe, however ſoundly we have ſlept, that the moment at which we awake in the morning is contiguous to that in which we fell aſleep at night. The reaſon is obvious; every man has been awake whilſt others were ſleeping, and has known by experience, that if they had been awake likewiſe a train of ideas would have paſſed through their minds which muſt have ſuggeſted to them the notions of time. Moſt men, too, have been frequently awake whole nights, and have thus acquired a notion of time as going on inceſſantly, whether perceived by them or not; and this notion being cloſely aſſociated with our ideas of night and morning, we inevitably ſuppoſe a portion of time to have elapſed between them, though unperceived by us in our ſleep. But were a man to ſleep without dreaming from Sunday night till Tueſday morning, and then to awake at his uſual hour as marked on the clock, there are numberleſs inſtances on record to convince us, that he would not of himſelf ſuppoſe, nor perhaps be very eaſily perſuaded, that more than one night had elapſed between his falling aſleep and the moment at which he awoke.

It being thus evident, that our notion of time is ſuggeſted by that compariſon which we inevitably make of the exiſtence of things permanent with the train

Of Time. train of ideas inceffantly paffing through our minds; we may now perhaps be able to anfwer the queftion, "What is time?" It muft of neceffity be one of three things, viz. either the ideal fucceffion itfelf; a certain quality inherent in all objects; or merely the relation of coexiftence between things that are permanent and the trains of fleeting ideas which fucceed each other on the theatre of the imagination. It is not the firft of thefe; for in every train of thought, the appearance of any one idea in the mind occupies no more of the extenfion of time, than a mathematical point occupies of the extenfion of diftance. Ten thoufand mathematical points added together would make no part of a line; and ten thoufand ideas made to coalefce, if that were poffible, would occupy no part of that mode of duration which is called *time*. A point is the boundary of a line, but no part of it: the appearance of an idea in the mind is inftantaneous; and an inftant is the boundary, but no part of time. Hence it follows, that were every thing inftantaneous like ideas in a train, there could be no fuch thing as time, fince nothing could be faid to have in that fenfe of the word any duration. That time is not a quality inherent in all objects, is likewife plain; for we have feen, that were *ideas* as permanent as objects, the notion of time could never have been acquired. Succeffion, though it does not itfelf conftitute time, is effential to its exiftence; and were all motion to ceafe, and the attention of men to be immoveably fixed upon one

212 Time a mere relation of coexiftence. invariable object or clufter of objects, *time* would ceafe likewife. It remains, therefore, that time can be nothing elfe than the relation of coexiftence apprehended between things that are permanent and thefe trains of fleeting ideas which inceffantly fucceed each other on the theatre of the imagination. Thus whilft a man is fteadily looking at one object, which, from its being common, does not occupy his whole mind, he may be confcious of a thoufand ideas ftarting up in his imagination, and each in its turn vanifhing the inftant in which it appeared. Every one of thefe ideas had an exiftence as well as the object at which he is looking; but the exiftence of each of them was inftantaneous and in fucceffion, whilft the exiftence of the external object is permanent. The object, therefore, as contrafted with a train of ideas, is faid to endure or to exift in time, whilft each idea is deftitute of duration, and exifts in no time.

213 Objections anfwered. To this theory fome objections occur, which it will be incumbent upon us to obviate. It may be faid, that though each idea confidered by itfelf is inftantaneous, and occupies no time; yet the whole train when taken together, without being compared with any thing external, is perceived to occupy a confiderable portion of that mode of duration; and that, therefore, time itfelf muft be fomething more than a mere relation between a fleeting fucceffion of ideas and objects of more permanent exiftence. But how, we beg leave to afk, is the whole train perceived to occupy any portion of time? Is it not by being compared with our own exiftence? A man whilft a train of ideas is paffing through his mind may be fuddenly deprived of all his external fenfes, and then indeed it will be impoffible for him to compare the fleeting exiftence of this internal fucceffion with the more permanent exiftence of external things; but, whilft he thinks at all, he muft be confcious of his *own* exiftence, and cannot avoid perceiving, that whilft his ideas pafs in conftant fucceffion, each making an inftantaneous appearance in his mind, he himfelf remains unchanged. Now, what is it that this perception fuggefts to the mind? Evidently nothing more than the relation of coexiftence between a fleeting fucceffion and a permanent object; for were it poffible that the man could be deprived of memory as well as of his fenfes, and ftill have ideas fucceeding each other in his mind, he would then think all objects equally fleeting; he would indeed be himfelf a mere fucceffion of inftantaneous diftinct perfons, and could have no notion whatever of time. His exiftence, though it fhould feem to endure half a century as eftimated by others, muft to himfelf appear to pafs away like a flafh of lightning.

It may be ftill further objected to our theory, that time is meafured by motion; and that it feems very abfurd to talk of meafuring a relation, efpecially a mere *ideal* relation, by a real external thing. In anfwer to this objection, which at firft fight appears formidable, we beg leave to obferve, that all relations are equally ideal; and that yet many of them may be faid to be meafured by real external things, with as much propriety as time can be faid to be meafured by motion. When a man wifhes to afcertain the relation of quantity which one body bears to another, though he knows that fuch a relation has no other than an ideal exiftence, and cannot be conceived but in conjunction with the related bodies, he applies to them fucceffively fome common ftandard; and having difcovered the relation which each bears to that, he compares the one relation with the other, and thus afcertains the relation fought. Juft fo it is with refpect to motion meafuring time. That which to each individual conftitutes real time, is the relation of coexiftence between the fleeting fucceffion of his own ideas and other things of a more permanent nature. But a man has often occafion to afcertain the time of things external which fall not under the infpection of his fenfes; and in fociety all men have tranfactions with one another to be performed in fome determinate portion of time, though there are not, perhaps, two men exifting whofe ordinary trains of thought flow with precifely the fame rapidity. To remedy thefe inconveniences, it was neceffary to invent fome common ftandard, by means of which men might afcertain the duration of actions performed at a diftance, and be able to keep appointments made with each other. The only ftandard proper for thefe purpofes is fuch a conftant and equable motion as has fuggefted a flux of perceptions common to all men in all ages and countries; and hence the motions of the heavenly bodies have been univerfally made ufe of for the common regulators of time. Thefe motions, however, do not conftitute real and natural time, any more than a foot or a yard applied to two diftant bodies conftitutes the relation of quantity which thefe bodies bear to each other. They are merely ftated meafures, to be differently applied according to the different purpofes which we have in view.

Thus, if a man in Europe wifhes to know what would to him have been the *real* and *natural* time of an action performed in the Eaft Indies, he has only to be told that it was co-exiftent, we fhall fuppofe, with

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with a diurnal revolution of the earth; and by comparing this common measure with his usual flow of thought, he can form some notion of the extent of that train of ideas, which, had he been present, would to him have been successively co-existent with the action in question. But when persons have an appointment to keep, this common measure of motion must be differently, or rather partially, applied. In such cases, it is no part of their intention to compare their own existence with that of the whole train of ideas which may pass in the mind of each; for the result of such a comparison, which alone constitutes true and natural time, would not be the same in perhaps any two men: but their purpose is, to compare their own permanent existence only with that train of sensations which shall be excited in the mind by the perceptible motion of the sun, or any other body fixed upon which moves equably; and such a train must consist of an equal number of instants in all men. Neither the sun, nor the hour hand of a common watch, moves with such apparent rapidity as to keep pace with the internal flow of thought of which the most phlegmatic man is conscious. That these bodies move at all, is known only by their visible change of place during the lapse of a considerable portion of real time; and as there is in their course a certain number of places distinctly marked, to which alone it is agreed that the attention is to be turned, it is impossible that of time so computed two men can have different notions. Such time, however, is but partial; and the method of ascertaining it, when compared with that by which we ascertain real time, has a striking resemblance to that by which we ascertain the relation of partial quantity between two distant bodies. When it is our purpose to ascertain the relation of real quantity which one body bears to another, we apply the common standard to each in every dimension of length, breadth, and depth; but when we have no other view than to ascertain the relation of length which the one bears to the other, we apply the common standard to each in that dimension only. Just so it is with regard to real and partial time. When an individual wishes to ascertain what would to him have been the duration of any action which he did not see performed, he applies the common standard to the existence of that action, and to the usual flow of his own thoughts: but when two men talk of the duration of any action, or agree to meet on such a day, they compare the existence of the action, or the distance intervening between the present moment and the day of meeting, only with that partial train of sensations which by the common standard is generated in an equal number, and in the same order, in the minds of both.

214 Time must have had a beginning.

It will be said, that if time be nothing more than a mere relation subsisting between trains of ideas or other fleeting objects, and things of a more permanent existence; and if the universe had a beginning; either time must have had a beginning likewise, or the Deity cannot be immutable. We allow the force of the argument; but instead of an objection, we consider it as a confirmation of the truth of our theory. The Deity, who is immutable, exists not in time, but in eternity; and that these, though from the poverty of language they are both called modes of duration, are yet very different from each other, we shall endeavour to prove in the next chapter.

Of Infinity and eternity.

Chap. VIII. *Of* Infinity *and* Eternity.

215 Why we treat of infinity and eternity among the adjuncts of body.

As corporeal substance is certainly not infinite, and as the present material system has in itself every evidence of its not being eternal, it may seem strange, perhaps to the reader, that we should treat of infinity and eternity among the adjuncts of body. But in modern metaphysics these words are used in a vague sense to denote the extent of space and time; and in this chapter it is our intention to do little more than ascertain their meaning, and to show, in opposition to some celebrated names, of what subjects they may not be predicated. There is a mathematical and a metaphysical infinity, which, though often confounded, ought to be kept distinct. In mathematics, extension is said to be divisible *ad infinitum*, and number is sometimes considered as infinite: but in metaphysics these modes of expression are extremely improper. A positive and metaphysical infinite is that which has no limits, and to which no addition can be made; but it is obvious that there is no number which may not be enlarged, nor any positive idea of extension which has not limits, and which may not be either increased or diminished. The infinity of the mathematician is termed *infinity of power*, and that of the metaphysician *absolute infinity*. The first consists in this, that a being, however great or small it be supposed, may still be conceived to possess more greatness or minuteness than we can form an idea of, even after the utmost stretch of human thought. Thus when it is said, that all extension as such is infinitely divisible, it is not meant that every extended substance contains an infinite number or *real parts*; for then the parts of an inch would be equal to those of a league: but the meaning is, that in ideal extension we can never reach the end of ideal division and subdivision. In like manner, when it is said that number is infinite, the meaning is not that any positive number is without limits, or the possibility of increase, but that we might go on for ever, adding unit to unit, without approaching nearer to the end of the process. If, therefore, the mathematician would speak properly, and without the affectation of paradox, he ought to say that all extension as such is *indefinitely* divisible, and that unit might be added to unit without end; but these phrases suggest notions very different from that of a metaphysical infinite, which is something positive to which nothing can be added (B).

216 Space and time supposed to be, the one infinite, and the other eternal:

That there is something positively infinite, has been very seldom questioned; but it has been warmly disputed among metaphysicians what subjects are infinite. Dr

(B) Ὀυ γαρ ὁυ μηδεν εξω αλλ ὁυ αει τι εξω εστι, τουτο απειρον εστι. *Arist. Phys. Auscult.* lib. ix. cap. 9. page 492. tom. i. *Oper.*

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Dr Clarke and his adherents have contended that ſpace and time are real things; that they are bodies of neceſſary exiſtence; that the former impreſſes us with the idea of its infinity, and that the latter is poſitively eternal. "Time and ſpace (ſays the doctor *) are the *ſine qua non* of all other *things*, and of all other *ideas*. To ſuppoſe either of them *finite*, is an expreſs *contradiction* in the idea itſelf. No man *does* or *can* poſſibly *imagine* either of them to be finite; but only either by *non-attention* or by *choice* he attends perhaps to *part* of his *idea*, and *forbears attending to* the remainder. They who ſuppoſe *ſpace* to be nothing but a *relation between two bodies* are guilty of the abſurdity of ſuppoſing that which is *nothing* to have *real qualities: For the ſpace which is between two bodies* is always unalterably juſt what it was, and has the very ſame dimenſions, quantity, and figure, whether *theſe* or any *other bodies* be there or any where elſe, or not at *all*. Juſt as *time* or *duration* is the ſame, whether you turn your *hour-glaſs* or no, or whether the ſun moves or ſtands ſtill, or whether there *was* or *was not any ſun*, or any *material world* at all. To ſet *bounds* to ſpace is to ſuppoſe it *bounded* by ſomething which itſelf *takes up ſpace*, and that is a *contradiction;* or elſe that it is *bounded by nothing*, which is another contradiction. To ſuppoſe ſpace *removed*, *deſtroyed*, or *taken away*, amounts to the abſurd ſuppoſition of removing a thing away *from itſelf;* that is, if in your *imagination* you *annihilate* the *whole of infinite ſpace*, the whole of *infinite ſpace* will ſtill remain; and if you annihilate any *part* of it, *that part* will ſtill *neceſſarily* remain, as appears by the unmoved ſituation of the *reſt;* and to ſuppoſe it *divided* or *diviſible* amounts to the ſame contradiction."

* *Demonſtration of the Being and Attributes of God, and Correſpondence with a Gentleman of Glouceſterſhire.*

217 But improperly.

The abſurdity of conſidering ſpace as a real external thing has been already evinced in Chap. IV. p. 624. where it was ſhown how we acquire the notion, and what kind of notion it is. Space, as was there obſerved, may be conceived either as the mere abſence and poſſibility of body; or as ideal extenſion, united to, and inhering in, an ideal ſubſtratum. Taken in the former ſenſe, it is an object of pure intellect; in the latter, it is an *idea* or *form* in the imagination. That the abſence of body or matter is the *ſine qua non* of all other things, and all other ideas, Dr Clarke was not diſpoſed to affirm, when he made the divine ſubſtance to pervade every material atom in the univerſe: and to talk of the abſence of body being infinite is a palpable contradiction, unleſs Berkeley's doctrine be true, that the material world has no exiſtence. To ſay that the *poſſibility* of matter is infinite, is to uſe language which has no other meaning than that, however far the material world be on all ſides extended, its extenſion may ſtill be conceived greater and greater *ad infinitum*. This is a poſition which no philoſopher ancient or modern has ever denied; but it is ſo far from implying that we have a poſitive idea of the infinity of the material world, or of any adjunct of the material world, that it is abſolutely inconſiſtent with ſuch infinity. Whatever is capable of perpetual increaſe muſt certainly have limits, and every new addition is the limit of that to which the addition was made.

218 Neither ſpace nor time can be poſitively infinite; and why.

Taken in the ſecond acceptation as an ideal extenſion united with an ideal *ſubſtratum*, ſpace is ſo far from being infinite in any ſenſe of the word, that we will venture to aſſert no man ever contemplated ſuch a *form* in his own imagination, without conceiving it to be bounded. Of this, at leaſt we are certain, that when we have attempted to frame a poſitive idea of pure ſpace, it has not been in our power to diveſt that idea of limits. Thoſe who can frame in their minds real and poſitive ideas wholly abſtracted from every individual object, may indeed perform in this way many feats above our abilities; but as we poſſeſs no ſuch powers of abſtraction, every thing which we can call an idea is limited in the ſame manner that the object itſelf is limited from which the idea was derived.—Thus, the largeſt expanſion that ever we beheld is the concave hemiſphere; and when we try to form the largeſt poſitive idea of pure ſpace, all that we can do is to figure to ourſelves that concave empty of body. We may, indeed, ſuppoſe its diameter to be either a million or ten thouſand millions of miles; and we may go on enlarging it *ad infinitum:* but when we return from this proceſs of intellect to the contemplation of the ideal forms of the imagination, none of theſe forms appear to us larger or more extended than the hemiſphere, which is the object of ſenſe, and they all appear to be bounded, and bounded in the very ſame way.

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With reſpect to the eternity of time, we think Dr Clarke equally miſtaken as with reſpect to the infinity of ſpace. Of time, indeed, we cannot, properly ſpeaking, have any *idea* or mental *form*. Time, as we have ſeen, is a mere relation, and is in itſelf the creature of the mind which has no external *idiatum*. It is ſuggeſted, however, by the fleeting ſucceſſion of our ideas, compared with the more permanent exiſtence of other objects: and therefore ſucceſſion is eſſential to it. But nothing which has parts, whether coexiſtent or in ſucceſſion, can be poſitively infinite. For, "in an infinite ſeries of ſucceſſive generations of men, for inſtance, there will be ſeveral infinites that are parts of one another; and by conſequence one greater than another: which (as has been well argued *) is an expreſs contradiction, ſince the greater muſt neceſſarily bound the leſs, and exceed its limits by ſo much as it is greater than it; that is, muſt make it not infinite. Infinite generations contain an infinitely greater infinity of particular men. An infinite number of men muſt have twice as many hands, and ten times as many fingers, and ſo on. Infinite time has an infinity of ages; theſe a much greater infinity of years, days, hours, &c. Space likewiſe (according to Dr Clarke) has three dimenſions, all infinite. It muſt therefore, contain an infinity of ſurfaces, an infinitely greater infinity of lines, and a ſtill infinitely greater infinity of phyſical points. The caſe is the ſame in number itſelf, which, if we ſuppoſe it to contain an abſolute infinity of thouſands (and we may as well do that as imagine it to comprehend an infinity of units), it will contain ten times as may hundreds, fifty times as many ſcores, and ſo on. All this is only the *indefiniteneſs* of number, which we in vain attempt to turn into a poſitive infinite with which it is totally incompatible. For let us add *one* to any of theſe infinite ſeries of generations, ages, lines, or numbers, which we know to be always in our power, and if it was abſolutely infinite before, here is one more than infinite. If it only becomes infinite now, then one finite added to another finite makes infinity. If it be no larger after

* Dr Law's *Inquiry into the ideas of Space, Time, Immenſity, and Eternity.* See alſo the ſame acute writer's tranſlation of *King's Origin of Evil.*

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ter the addition than it was before, then one part added to another adds nothing; all which are absurdities. The same will appear, if we subtract a part from this supposed absolute infinite, which may be done in any of the forementioned subjects, as well as in every thing which admits of parts, or may be taken in pieces by the mind."

220 The usual reply to the foregoing reasoning shown

To this kind of reasoning Dr Clarke replies as follows: "To endeavour to prove that there cannot possibly be any such thing as *infinite time* or *space*, from the impossibility of an addition of finite parts ever composing or exhausting an infinite; or from the imaginary inequality of the number of years, days, and hours, that would be contained in the one; or of the miles, yards, and feet, that would be contained in the other, is supposing infinites to be made up of numbers of finites; that is, it is supposing finite quantities to be *aliquot* or *constituent parts* of infinite, when indeed they are not so, but do all *equally*, whether *great* or *small*, whether *many* or *few*, bear the very same proportion to an infinite, as mathematical points do to a line, or lines to a superficies, or as moments do to time, that is, none at all. No given number or quantity can be any *aliquot* or *constituent* part of infinite, or be compared at all with it, or bear any kind of proportion to it, or be the foundation of any argument in any question concerning it."

If it be indeed true, and it is that for which we contend, that no given number or quantity can be any aliquot or constituent part of infinite, or be compared at all with it; then it undeniably follows, not that miles, yards, and feet, are no constituent parts of space; or years, days, and hours constituent parts of time; but that space and time cannot possibly be positive infinites. This, we say, follows undeniably: for nothing is more evident, than that all quantities of the same kind, from the largest to the least, bear a certain proportion to each other; and upon the supposition that space is a real extending thing, miles, yards, and feet are included in it, and bear to it the relation of parts to a whole. The same is true of time, days, and hours. To affirm (for no proof is offered), that all finite quantities, whether great or small, whether many or few, do equally bear the very same proportion to an infinite, as mathematical points do to a line, or as moments do to time, is plainly to beg the question—

221 to be a *petitio principii.*

"that *space* considered as a real extended thing is *infinite*;" and to beg it, too, in opposition to the common sense and reason of mankind. Mathematical points we all know to be nothing real, but merely negations of extension; but supposing space to be something real and extended, can any man persuade himself that a mile or a million of miles of this space is likewise a mere negation of extension? With him who can bring himself to this persuasion, we pretend not to argue. He is possessed of faculties, whether true or false, of which we are destitute.

That finite quantities, whether great or small, do all equally bear the same proportion to an *infinite in power*, is indeed true; but it is no great discovery: for such an infinite, as we have seen, is nothing but the continued possibility of repeating the same mental process of addition or multiplication; and he who can go on for ever adding, in his own imagination, foot to foot, or hour to hour, will find it equally easy to add, in the same manner, league to league, or age to age. If he can perform the one operation, he must likewise have power to perform the other; and he cannot but perceive that it is as impossible to come to an end, of adding league to league, or age to age, as of adding foot to foot, or hour to hour; but then he must know that these leagues, feet, ages, and hours, are not real external things, but mere ideas and notions in his mind. If such powers of ideal multiplication and addition be what Dr Clarke means by the ideas of space and time, it is indeed a contradiction to suppose either of them limited; for that is to suppose our powers different from what we know them to be by consciousness and experience. But to confound *powers* with the *objects* of those powers, is certainly very inaccurate; and to suppose, because we can go on for ever adding one portion of ideal space or time to another, that therefore our ideas of space and time are in themselves positively infinite, is a contradiction: for to an idea positively infinite, it is obvious that nothing can be added. Either, therefore, space and time do not impress us with the ideas of their positive infinity; or we cannot have the power of adding league to league, and age to age, without end.

"But (says the doctor) to suppose space removed, destroyed, or taken wholly away, amounts to the absurd supposition of removing a thing from itself; that is, if in your imagination you remove the whole of space, the whole of space will still remain." True, every man has ideas of space treasured up in his imagination, which the sound of the very word space will at all times bring into his immediate view; and whilst he has such ideas, it is impossible that he should not have them; which is all the mystery of the matter, and amounts to nothing more than that a thing cannot be and not be at the same instant. When the doctor affirms, that if "you annihilate any part of space, that part will necessarily remain, as appears by the unmoved situation of the rest," we are not certain that we perfectly understand him. A man may surely think of a cubical inch without thinking of a foot or a yard; and he may suppose the inch taken away from the foot or the yard, and these ideal quantities so much lessened by the subtraction. But if the doctor be here again confounding the powers of the mind with the positive ideas of space, the sentence when explained will be seen to contain nothing to his purpose. Every man has the power of contemplating in idea millions of miles, and millions of ages, and of adding mile to mile, and age to age, without end; and if he try to deprive himself of any part of this power, or to fix a limit to the mental process of addition, he will find that in spite of himself his imagination will ramble beyond the limit assigned, and that he has attempted an impossibility. This, however, is so far from being a proof that his ideas of space and time are positively infinite, that, as we have already observed, it is a proof of the contrary.

222 Space and time are said to be the *sine qua non* of all other things; but

But (says this great man and his followers) "space and time are the *sine qua non* of all other things and all other ideas. The supposal of the existence of *any thing whatever* includes necessarily a *presupposition* of the existence of *space* and *time*;" and, therefore, if there be any thing infinite and eternal, space and time must likewise be so.

To

Of Infinity and Eternity.

To every corporeal fubftance, and every idea of fuch fubftance, fpace and time are indeed neceffary: for every body has extenfion and duration; and every idea of a particular body, being nothing but a fecondary perception in the imagination or memory, muft have the fame relation to imaginary extenfion, that the object from which it was derived has to extenfion which is real. Every idea, too, which remains in the imagination whilft a train of other ideas paffes fucceffively in view, or whilft external things are perceived to change, has real time. But will any man fay that *confcioufnefs*, our notion of *power*, our acts of *willing*, or even *taftes*, *founds*, and *fmells*, are extended, or that the fuppofal of their exiftence neceffarily implies a prefuppofition of the exiftence of fpace? We acquire our ideas of extenfion and fpace by means of our fenfes of touch and fight; and we learn from experience, that things external and extended are the caufes of our fenfations of tafte, found, and fmell. The effects are in our minds clofely affociated with the ideas of their caufes; and it is not perhaps eafy to think of a particular found, tafte, or fmell, without at the fame time thinking of the object by which it was at firft excited in the mind; but had we been originally formed with the powers of confcioufnefs, thinking, and willing, and with no other fenfes than thofe of tafting, fmelling, and hearing, it is obvious that we never could have had the idea of *fpace;* and therefore, that idea cannot poffibly be neceffary to the prefuppofition of every thing elfe. To confcioufnefs, thinking, and willing, fpace is fo far from being neceffary, that we cannot perceive any the moft diftant relation between them. It is not more difficult to conceive a part greater than the whole, than it is to conceive an ell of *confcioufnefs*, of *thought*, or of *will;* nor is it in the power of any man to make *fpace* and *fweetnefs* coalefce in his mind fo as to form of the two fimple ideas one complex conception. The very reverfe is the cafe with refpect to the objects of fight and touch. The idea of every thing which we fee and handle neceffarily coalefces in the mind with the idea of fpace, nor can we poffibly feparate the one from the other; but the things which we fee and handle are neither infinite nor capable of infinity.

223 there are things which have no relation whatever to fpace, or

224 to time.

With refpect to time, the fame obfervations will be found to be juft as with refpect to fpace. Whatever is liable to change, exifts in time and cannot be eternal; but if there be any being immutable, and who views at once all things which to us are paft, prefent, and to come, the exiftence of that being is not commenfurable with time. That fuch a being is poffible no man can doubt, who reflects, that if we had one permanent idea invariably in the mind, we fhould never have acquired the *notion* of fucceffion or of time; and that if there were *actually* no *change* in nature there could not poffibly in nature be any fuch *thing as time.* Every man, therefore, who can conceive exiftence without change, muft be convinced, that "the fuppofal of the exiftence of any thing whatever does *not* neceffarily include the prefuppofition of the exiftence of time; and that there may be an eternity diftinct from time, as well as an infinity diftinct from fpace; nay, that nothing which is properly infinite and eternal can poffibly occupy either fpace or time.

225 Infinity and eternity, what they are.

If it be afked, What kind of infinity and eternity they are which have no relation to fpace and time? Cudworth, treading in the footfteps of the ancients, has long ago anfwered, That they are "abfolute perfection, and neceffary exiftence. For (fays he), *infinite underftanding* and *knowledge* is nothing elfe but *perfect* knowledge, which hath in it no defect or mixture of ignorance, but knows whatfoever is knowable. In like manner, *infinite power* is nothing elfe but *perfect* power, which hath in it no defect or mixture of impotency—a power which can do every thing which is poffible or conceivable. Laftly, *Infinity of duration*, or *eternity*, is really nothing elfe but *perfection*, as including in it *neceffary exiftence* and *immutability;* fo that it is a contradiction to fuppofe fuch a being to have had a beginning, to ceafe to be, or to fuffer or be affected by any change whatever. And becaufe infinity is perfection, therefore nothing which includes in its idea or effence any thing of *imperfection*, as every pofitive idea of number, corporeal magnitude, and fucceffive duration, evidently does, can be truly and properly infinite *."

It muft indeed be confeffed, that the idea of fucceffion fo infinuates itfelf into our ufual ideas of exiftence, and is fo clofely connected with the exiftence of all finite beings, that we find it extremely difficult to imagine the eternal exiftence of God, any otherwife than as an eternally continued feries or fucceffion. Our conftant converfation with material objects, and the affociations thence arifing, make it almoft impoffible for us to confider things abftracted from time and fpace; yet we have the evidence of experience and confcioufnefs, that an idea may be conceived without relation to fpace and time, and that fpace and time cannot be made to coalefce with fome of our notions. The fame muft be true with refpect to infinity and eternity; for we have feen that neither fpace, time, nor any thing elfe which confifts of parts, whether continuous or fucceffive, can be fuppofed to be pofitively infinite, as the fuppofition implies the moft palpable contradiction. But that there may be perfect power, perfect knowledge, and permanent invariable exiftence, is fo far from implying any contradiction, that even we, whofe faculties are fo very narrow, can yet make fome advances towards the conception of fuch perfections. Thus, every man of common underftanding knows that fome things are in themfelves poffible, and others impoffible, to be performed by any power. Of thefe poffibilities and impoffibilities a philofopher knows more than an illiterate man; and one philofopher knows more than another. An intellect more perfect knows more of them than any man; and that intellect which knows them all muft be abfolutely perfect, and incapable of improvement, becaufe it knows every thing which is to be known. The fame is true of perfect power:—but we fhall treat of real infinity and eternity more at large when we come to demonftrate the being and attributes of God. At prefent it is fufficient to have fhown that nothing can be pofitively infinite but a being abfolutely perfect; which never was not, which can produce all things poffible and conceivable, and upon which all other things muft depend.

* *Intellectual Syftem.*

PART

PART III. OF MINDS AND THEIR POWERS.

Chap. I. *Of* Mind *in* General.

THE fcience of metaphyfics comprehends every thing, into the exiftence, nature, or caufes of which any inquiry may be made. But all things of which we have any notion or idea may be divided into mind and body, with their various powers, qualities, and adjuncts. By body is meant that which is folid, extended, inert, and divifible; and its feveral adjuncts are fpace, motion, number, and time. The only mind with which we are *intimately* acquainted is our own; and we know that it is poffeffed of the powers of fenfation, perception, retention, confcioufnefs, reflection, reafon, and will. Thefe are totally different from extenfion, folidity, divifibility, and motion; and therefore it is proper to diftinguifh the being of which they are powers by another name than that of body.

226 Mind diftinguifhed from body.

227 Probably minds of different orders.

Of bodies there are various kinds poffeffing various fenfible qualities; and from analogy it is reafonable to conclude, that there may be various claffes of minds endowed with different kinds or degrees of power. For this indeed we have ftronger evidence than that of analogy. Brute animals evidently poffefs the powers of perception and fpontaneity with fome degree of confcioufnefs; but as they appear not to reflect upon their own conduct, or to have their actions influenced by motives, their minds are inferior to ours, though ftill perfectly diftinct from mere extended, inert, and divifible fubftances. Mind, therefore, confidered with refpect to its powers, is evidently different from body confidered with refpect to its qualities. This is indeed a truth which has feldom if ever been controverted; but it has been long and warmly difputed, Whether mind and body be not both compofed of the fame firft matter?

228 The abfurd hypothefis of Hobbes refpecting mind.

Hobbes fuppofed, that every material atom is endowed with the faculty of fenfation (c); but that for want of memory each fenfation is momentaneous, being inftantly and wholly effaced as foon as its caufe is removed. Though this hypothefis is too abfurd to require a formal and laboured confutation, it may not be improper to obferve, that, if it were true, the hairs of a man's head would feel extreme pain when pinched by the hot iron of the hair-dreffer; and that the nails of his fingers would be feverely tortured when under the operation of the knife or the rafp.

229 Other hypothefes.

Others have fuppofed that each atom of matter has a *tendency towards* fenfation and perception; and that when a fufficient number of thefe atoms are brought together in a certain order, the *united tendencies* produce the *actual* powers which diftinguifh mind from grofs body. This fuppofition is if poffible more abfurd than that of Hobbes. Senfation and perception are of fuch a nature, that a mere *tendency towards* them is inconceivable. A thing muft either be fenfible and percipient, or infenfible and inert: there is evidently no medium. Or if we could fuppofe each individual atom to have a *tendency* towards fenfation, it would by no means follow that a number of fuch atoms brought together in any poffible order would become one fentient, thinking, and active being. A number of bodies laid upon an inclined plane have each a *tendency* to roll downwards; but if the declivity of the plane be not fuch as that their feparate tendencies may overcome the refiftance oppofed to each individual body by friction, the *united tendencies* of all the bodies when brought together will not be able to overpower the refiftance of their united frictions. Juft fo is it with refpect to fenfation and perception: If the tendency of one atom cannot overcome one degree of inertnefs, the tendency of a thoufand atoms will not overcome a thoufand degrees of the fame inertnefs.

230 Only two opinions at prefent on the fubject.

We have juft mentioned thefe abfurd fuppofitions that our article might be complete: but it is proper to inform the reader, that, fo far as we know, neither of them has for thefe many years been maintained by any philofopher of eminence either at home or abroad. The opinions on this fubject, which at prefent divide the republic of letters, are two; and thefe alone are worthy of examination. One party maintains, That perception, memory, reafon, and will, &c. are the powers of a being which muft be immaterial and indivifible: The other alleges, That as we know nothing of thefe powers but from our own confcioufnefs, and as we can trace them in ourfelves to the brain and no farther, we have no reafon to fuppofe that they are the powers of any fubftance diftinct from matter. Both parties, however, diftinguifh that which in man is the fubject of thought from his external organs of fenfe, and agree to call it by the name of *mind;* though the one confiders it as compofed of the fame firft matter with the duft of the ground; whilft the other believes it to have no property whatever in common with that matter.

Were we to adopt fome of the ancient methods of philofophizing, this important queftion might be foon decided. A moft refpectable writer, who has laboured to reftore the metaphyfics of Plato and Ariftotle, hopes to confute the materialifts, by laying down what they muft think arbitrary definitions of mind and matter, and then fhowing that the one is not the other. "In

(c) Scio fuiffe philofophos quofdam, eofdemque *viros doctos*, qui corpora omnia fenfu prædita effe fuftinuerunt: *Nec video*, fi natura fenfionis in reactione fola collocaretur QUOMODO *refutari poffint*. Sed etfi ex reactione etiam corporum aliorum, phantafma aliquod nafceretur; illud tamen, remoto objecto, ftatim cefiaret. Nam nifi ad retinendum motum impreffum, etiam remoto objecto, apta habeant organa, ut habent animalia; ita tantum fentient, ut nunquam fenfiffe fe recordentur. Senfioni ergo, quæ vulgo ita appellatur, neceffario adhæret memoria aliqua.
Hobbes's Phyfic, cap. xxv. fect. 5.

Of Mind in general.

"In all the parts of the material world (says he) there is a perpetual *motion*: For the celestial bodies move constantly in one respect or another; and all here below is in a continual vicissitude of generation and corruption, which cannot be without *motion*. Now, where there is *motion*, there must be something that *moves*: What is *moved* I call *body*; what moves I call *mind*." From this definition he undertakes to prove, that mind must be immaterial. "That there is a relation between *moving* and *being moved* (says he), nobody can deny; and the relation is no other than that of *action* and *passion*. But the nature of relation is such, that it must necessarily be between two things at least; and it is further necessary, that the two things related should exist together. Hence, if there be that which *moves*, there must be a different thing that *is moved*; and wherever the one is, the other must necessarily be; so that nothing can move itself. This being established, I say that what *moves* must be either material or immaterial: for the one of these being the negation of the other, there can be no middle betwixt them; because a thing must necessarily *be*, or not *be*. If then it be immaterial, there is an end of the question: but if it be said to be material, then I say that it must be *moved* itself before it can move any thing else; for it is only in that way that body can move body. If then it must be first moved itself, but cannot itself move itself, what is it that moves itself? If it be answered, That it is another material mover, then I repeat the same question, to which the same answer must be given: and so we have an infinite series of *material movers*, without any beginning or *principle* of *motion*. Now this is absurd, and contradictory to this first principle of natural philosophy, admitted by all philosophers ancient and modern, That *nothing can be produced without a cause**.

* *Ancient Metaphysics.*

For the immateriality of the human mind, and of every being endowed with the powers of perception and thought, the learned writer has better arguments; but it is upon this chiefly that he rests his persuasion, that mind is the only *mover* in the universe. It is needless to observe, that in the very definitions and axioms upon which this reasoning is built, the thing to be proved is taken for granted: for if it be self-evident, that what *moves* is, in the author's sense of the word, *mind*, that what is *moved* is *body*, and that *nothing can move itself*, all reasoning on the subject is superfluous. This, however, is so far from being self-evident, that a materialist may reply, "every animal moves itself, and yet every animal is nothing more than a system of matter." This position, whether true or false, can neither be proved nor confuted by arguments *à priori* founded on general definitions. That animals move themselves, and that to the senses they appear to be nothing else than systems of matter, are facts which cannot be controverted. If we would know whether they have in them a principle of motion which is not material, we must submit to the laws of induction (see LOGIC); and by investigating the essential qualities of matter, endeavour to ascertain whether a material system can be rendered active. That we ourselves have active powers, we know by the most complete of all evidence, viz. consciousness of their energies; and it has been already shown, that such powers as we experience in ourselves cannot exist but in a subject possessed of will and understanding. The question therefore to be first decided between the materialists and immaterialists is, Whether the powers of consciousness, understanding, and will, can result from the particular organization of a system of matter? If they can, we have no reason to attribute them in man to any other source: If these powers appear necessarily to require an immaterial principle for their support, it will probably be granted, that an immaterial principle is the source of every power and every motion in the universe; and the doctrine of *mind*, in the strictest sense of the word, will be sufficiently established.

231 The proper method of investigating the nature of mind.

CHAP. II. *Of the* SUBSTANCE *of the* HUMAN MIND.

232 Arguments for the immateriality of the human mind.

THE most celebrated materialist of this or perhaps of any other age is Dr Priestley; who having in his own imagination divested matter of solidity, and reduced it to mere centres of attraction and repulsion, observes, that "if one *kind of substance* be capable of supporting all the known *properties* of man; that is, if those properties have nothing in them that is absolutely incompatible with one another; we shall be obliged to conclude (unless we openly violate the rules of philosophizing, which will not authorize us to *multiply causes* or kinds of substance *without necessity*), that no other kind of substance enters into his composition; the supposition being manifestly *unnecessary*, in order to account for any appearance whatever.—All the properties that have hitherto been attributed to matter, may be comprised under those of attraction and repulsion. Besides these, man is possessed of the powers of *sensation* or *perception*, and *thought*. But if, without giving the reins to our imaginations, we suffer ourselves to be guided in our inquiries by the simple rules of philosophizing above mentioned, we must necessarily conclude, that these powers also may belong to the same substance that has also the properties of attraction, repulsion, and *extension* (D), which I as well as others call by the name of *matter*. The reason of the conclusion is simply this, that the powers of sensation or perception and thought, as belonging to man, have never been found but in conjunction with a certain *organized system of matter*; and therefore that those powers necessarily exist in and depend upon such a system. This at least must be our conclusion, till it can be shown that these powers are incompatible with the

(D) When Dr Priestley mentions the *extension* of corporeal substance, it must be remembered that he does not mean the extension of any real thing possessed of an independent existence. The extension belongs wholly to the *sphere* or the *combination* of spheres of *attraction* and *repulsion*. The centre itself, which attracts and repels, he repeatedly affirms not to have the dimensions even of a physical point; and he sometimes seems to entertain a doubt whether it be any thing more than a mere relative notion.

Of the Substance of the Human Mind.

the other known properties of the ſame ſubſtance; and for this I ſee no ſort of pretence."

This is what Dr Prieſtley calls the proper and direct proof that the ſentient principle in man is the material ſubſtance of the brain; and he enforces it by the following obſervations: "Had we formed a judgment concerning the neceſſary ſeat of thought by the circumſtances that *univerſally accompany it*, which is our rule in all other caſes, we could not but have concluded that in man it is a property of the *nervous ſyſtem*, or rather of the brain; becauſe, as far as we can judge, the faculty of thinking, and a certain ſtate of the brain, always accompany and correſpond to one another; which is the very reaſon why we believe that any property is inherent in any ſubſtance whatever. There is no inſtance of any man retaining the faculty of thinking when his brain was deſtroyed; and whenever that faculty is impeded or injured, there is ſufficient reaſon to believe that the brain is diſordered in proportion; and therefore we are neceſſarily led to conſider the latter as the ſeat of the former. Moreover, as the faculty of thinking in general ripens and comes to maturity with the body, it is alſo obſerved to decay with it; and if, in ſome caſes, the mental faculties continue vigorous when the body in general is enfeebled, it is evidently becauſe in thoſe particular caſes the *brain* is not much affected by the general cauſe of weakneſs. But, on the other hand, if the brain alone be affected, as by a blow on the head, by actual preſſure within the ſkull, by ſleep, or by inflammation, the mental faculties are univerſally affected in proportion. Likewiſe, As the mind is affected in conſequence of the affections of the body and brain, ſo the body is liable to be reciprocally affected by the affections of the mind, as is evident in the viſible effects of all ſtrong paſſions, hope or fear, love or anger, joy or ſorrow, exultation or deſpair. Theſe are certainly irrefragable arguments, that it is properly no other *than one and the ſame thing* that is ſubject to theſe affections, and that they are neceſſarily dependent upon one another. In fact, there is juſt the ſame reaſon to conclude, that the powers of ſenſation and thought are the neceſſary reſult of a particular organization, as that ſound is the neceſſary reſult of a particular concuſſion of the air. For in both caſes equally the one conſtantly accompanies the other; and there is not in nature a ſtronger argument for a neceſſary connexion of any cauſe and any effect. To adopt an opinion different from this, is to form an hypotheſis without a ſingle fact to ſupport it *."

* *Diſquiſitions on Matter and Spirit.*

Though the ingenious author thinks, that if there be any foundation for the eſtabliſhed rules of philoſophizing, this reaſoning ought to be concluſive, he yet ſubjoins, for the greater ſatisfaction of his readers, ſome additional arguments, or rather, as he ſays, diſtinct illuſtrations of the great argument. They are as follow:

1. "That the faculty of thinking neceſſarily depends, for its *exerciſe* at leaſt, upon a ſtock of ideas, about which it is always converſant, will hardly be queſtioned by any perſon. But there is not a ſingle idea of which the mind is poſſeſſed but what may be proved to have come to it from the bodily ſenſes, or to have been conſequent upon the perceptions of ſenſe. The notion, therefore, of the *poſſibility* of thinking in man, without an organized body, is not only deſtitute of all evidence from actual appearances, but is directly contrary to them; and yet theſe appearances ought alone to guide the judgment of philoſophers.

2. "The only reaſon why it has been ſo earneſtly contended for, that there is ſome principle in man that is not material, is, that it might ſubſiſt, and be capable of ſenſation and action, when the body is dead. But if the mind was naturally ſo independent of the body, as to be capable of ſubſiſting by itſelf, and even of appearing to more advantage, after the death of the body; it might be expected to diſcover ſome ſigns of its independence before death, and eſpecially when the organs of the body were obſtructed, ſo as to leave the ſoul more at liberty to exert itſelf; as in a ſtate of *ſleep* or *ſwooning*, which muſt reſemble the ſtate of death; in which it is pretended that the ſoul is moſt of all alive, moſt active, and vigorous. But judging by appearances, the reverſe of all this is the caſe.

3. "If the mental principle was, in its own nature, immaterial and immortal, all its particular faculties would be ſo too; whereas we ſee that every faculty of the mind without exception is liable to be impaired, and even to become wholly extinct, before death. Since, therefore, all the faculties of the mind, ſeparately taken, appear to be mortal, the ſubſtance or principle in which they exiſt muſt be pronounced to be mortal too.

4. "If the ſentient principle in man be immaterial, it can have no *extenſion*; it can neither have length, breadth, nor thickneſs; and conſequently every thing within it, or properly belonging to it, muſt be *ſimple* and *indiviſible*. Let us now conſider how this notion agrees with the phenomena of ſenſation and ideas. It will not be denied, but that ſenſations or ideas properly exiſt *in the ſoul*, becauſe it could not otherwiſe retain them, ſo as to continue to perceive and think after its ſeparation from the body. Now, whatever ideas are in themſelves, they are evidently produced by external objects, and muſt therefore correſpond to them; and ſince many of the objects or archetypes of ideas are diviſible, it neceſſarily follows, that the ideas themſelves are diviſible alſo. But, how is it poſſible that a thing (be the nature of it what it may) that is *diviſible*, ſhould be contained in a ſubſtance, be the nature of *it* likewiſe what it may, that is *indiviſible*? If the archetypes of ideas have extenſion, the ideas which are expreſſive of them, and are actually produced by them according to certain mechanical laws, muſt have extenſion likewiſe; and therefore the mind in which they exiſt, whether it be material or immaterial, muſt have extenſion alſo. But how any thing can have extenſion and yet be immaterial, without coinciding with our idea of mere empty *ſpace*, I know not."

To the argument, which is here chiefly inſiſted on as being agreeable to the eſtabliſhed rules of philoſophizing, a very able reply has been made, which we ſhall give in the words of its elegant and ſpirited author. But before we attempt to dig up the foundation of the doctor's ſyſtem, it may not be improper to demoliſh, if poſſible, the additional buttreſſes by which it is ſtrengthened. An experienced general, before he ſtorm a citadel which he knows to be ſtrongly ly fortified and skilfully defended, will take care to raze every less important redoubt from which the enemy might annoy him in his rear.

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Answered.

Because the faculty of thinking in general ripens, comes to maturity, and decays with the body, and the body on the other hand is affected by the affections of the mind, the doctor affirms that we have the same reason to conclude, that the powers of sensation and thought are the necessary result of a particular organization, as that sound is the necessary result of a particular concussion of the air. This argument is conclusive only upon the supposition that there is no *positive* evidence whatever for the immateriality of the being which is the subject of thought. If the other reasonings for the materiality and immateriality of the mind be of equal weight, this argument ought doubtless to turn the balance; but if there be the smallest preponderancy in behalf of the immaterialists, it is a mere begging of the question to attempt to counteract it by any inference which can be drawn from the mutual affections of the body and mind. If two such heterogeneous beings as an immaterial mind and an organized body can be supposed united in one person, they must necessarily affect each other; and to affirm, on account of this reciprocal affection, that they are *one and the same*, is equally absurd as to say that an electrician and his apparatus are *one and the same*. Dr Priestley himself did not at first perform his electrical experiments with so much ease as after he had acquired facility by long practice, nor could he even yet perform them so neatly with a bad as with a good apparatus.

That which the doctor calls the first illustration of his argument might be admitted, and the force of the argument itself be consistently denied. Some kind of organized body may be necessary to the mind as an instrument without which it could not exert its faculties; but it would certainly be rash to infer that the mind must *therefore* be a system of matter. An anvil and a hammer are necessary to the exercise of the blacksmith's art; but what would be thought of him who should from this fact conclude, that the blacksmith himself must be a system of iron! This, therefore, instead of illustrating the great argument, seems to be wholly foreign from the question in debate; and it has in fact been admitted by Dr Price *, and thousands of others who reject the doctrine of materialism, as an impious absurdity. The second illustration, however, is more to the purpose; and as it is not new, we shall give it an old answer.

* *Correspondence with Dr Priestley.*

Why do not we perceive external objects in our *sleep* or in a *swoon?* " Because (says Mr Wollaston †), the *passages* are become impracticable, the *windows* shut, and the *nerves* being obstructed, or somehow rendered for the time unless, can transmit no information to it. Why, however, does it not reason and think about *something or other?* Because, all the *marks* by which things are remembered, being for the present choked up or disordered, the remembrance of those *objects* about which it is wont to employ itself, and even of the words (or other signs) in which it uses to reason, and to preserve the deductions and conclusions it makes, is all suspended at least for the time: and so its tables being covered, its books closed, and its tools locked up, the requisites for reasoning are wanting, and no subject offers itself to exercise its thoughts, it having yet had little or no opportunity to take in *higher objects* and more *refined matter* for contemplation. And, to conclude, if it be demanded, Why any one should imagine that the *soul* may think, perceive, act, *after death*, when it doth not do this in sleep, &c.? the answer is, Because those *enclosures* and *impediments* which occasioned the forementioned intermissions, and those great limitations under which it labours at all times, will be removed with its enlargement out of the body. When it shall in its *proper vehicle* be let go, and take its flight into the open fields of heaven, it will then be bare to the immediate impressions of objects: And why should not those impressions which affected the *nerves*, that moved and affected the vehicle and soul in it, *affect the vehicle immediately* when they are immediately made upon it, without the interposition of the nerves? The hand which feels an object at the end of a *staff*, may certainly be allowed to feel the same much better by *immediate contact* without the staff."

† *Religion of Nature Delineated,*

The opinion, that the soul is united to some fine vehicle, which dwells with it in the brain, and goes off with it at death, was not peculiar to Mr Wollaston. It was thought extremely probable by Dr Hartley, and shall be shown afterwards to have been a very ancient opinion; but we do not quote it at present as either well or ill founded, but only as sufficient, in conjunction with the reasoning of its author, to obviate the force of Dr Priestley's second illustration of his argument for the materiality of mind, provided the argument itself be not more powerful than any which the immaterialists can bring against it.

The doctor's third illustration we have already obviated, when we accounted for the mind and the body mutually affecting each other; and we might refer to Dr Price's answer (E) to the fourth, as being, in our opinion, a full confutation of it. But as that author's notions of *mind* and *ideas* differ in some respects from our own, we shall examine this objection to the doctrine of the immaterialists upon principles which we believe Dr Priestley more inclined to admit.

That the sentient principle in man, if it be immaterial,

(E) In *Disquisitions*, p. 37 and 102, it is asserted, that ideas are certainly divisible. " This seems to me very absurd. It would be as proper to assert ideas to be hard or round. The idea of an object is the apprehension, view, or notion of it; and how can this be divisible? Perception is a single and indivisible act. The object perceived may be divisible; but the *perception* of it by the mind cannot be so. It is said in page 95, *that if ideas are not things distinct from the mind, a mind with ideas and a mind without ideas would be the same.*—I maintain, that ideas are not distinct from the mind, but its conceptions; or not *things* themselves, but *notions* of things. How does it follow from hence, that a mind with or without ideas is the same? It would seem that this follows much more from the contrary assertion." *Correspondence between Dr Price and Dr Priestley.*

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terial, can have no extension, is a truth which we think cannot be controverted; and if so, every thing in that principle must be *simple* and *indivisible*. Thus far we agree with Dr Priestley; but with respect to what follows we differ from him entirely. The agitation in the brain, which is the immediate cause of sensation, must indeed correspond to the impression *ab extra* by which it is produced, and therefore must have the property of extension; but that agitation, whatever it be, is not itself sensation any more than a bludgeon is a blow, or a sword is a wound. Dr Priestley, indeed, in answer to Dr Price, affirms, that, according to Hartley's theory, ideas are only *vibrations in the brain*; but whoever shall take the trouble to examine that theory himself, will not find that its author ever advances such an opinion, or considers vibrations as any thing more than the instruments by which sensations and ideas are excited in the sentient principle. A real and proper idea, as we have often repeated, is nothing else than a fainter sensation: but no sensation, from whatever cause it may proceed, is itself extended; nor could we, without memory, the reasoning faculty, and the power of local motion, have acquired from mere sense any notion of extension at all: (see sect. 3. Chap. 1. Part I.). Sensations and ideas are those *appearances* (if we may so say), which vibrations or some other motion in the brain excite in the mind; but a *half* appearance is an absurdity. A man may view *half a tree* with his eyes, and he may contemplate the idea of *half a tree* in his mind; but he cannot have *half a view* or *half an idea* of any thing. Sensations and ideas result from the mutual agency of the brain and sentient principle upon each other; and if the agency of the brain be vibration, more of it may vibrate at one time than at another: but surely the mere relation between its agency at any time and the agency of the mind, can neither have extension nor be divisible; for who ever thought of extending or dividing relations? On this subject it is extremely difficult to write with perspicuity and precision; and what we have said may very possibly be misunderstood. Our notion is to ourselves clear and determinate; but language, which was not invented by metaphysicians, wants words in which it may be properly expressed. Perhaps the reader may understand what we mean, when we say that a sensation or an idea is the instantaneous effect of the mutual agency of the brain and sentient principle. Of this we think every man, by a little attention, may be perfectly convinced, though it may be impossible ever to discover the precise nature of this agency; and if so, it is plain that sensations and ideas cannot be divided, for no instantaneous effect of any kind is divisible. A sensation, and of course a simple and original idea, neither has extension itself, nor suggests the notion of extension *ab extra*. By running the hand or any other member along a solid body, we feel continued resistance: this feeling, or the idea of this feeling, becomes in time so closely associated with all our sensations of touch and sight, that the one cannot be separated from the other; and these associations are what Dr Priestley calls *extended ideas*. Upon the whole then, we think it apparent, that our sensations, and the relicts of our sensations, are unextended and indivisible (F); and that though they suggest

(F) We affirm this only of *human* sensations and ideas, because these are the only sensations and ideas of which we are conscious, and about which we can reason. Other animals are sentient as well as man, and appear to have their sensations excited by impressions *ab extra*; but whether in every species of animals a single impression excites but one sensation common to the whole animal, or different sensations which are felt each by a different faculty or sentient principle, is a question which we are not able to answer. We make this remark, because from the phenomena of sensation in the earthworm and other reptiles, some philosophers of eminence having supposed, that in these creatures the sentient faculty belongs to the material system, and is divisible with it; have thence concluded, we think rashly, that all arguments for the immateriality of the human mind are founded merely on our ignorance. We call this conclusion rash; because, though we know perfectly what a human sensation is, we have so little knowledge of the nature of sensation in worms, that what may be true of the one *principle* of sensation may be false of the other. Indeed, if we are to judge from the phenomena, this is actually the case. It appears from experiments made by Abbe Spallanzani and others, that if a certain number of rings be cut off either from the anterior or posterior part of a worm, or even from both, the remainder will not only continue to live and be sentient, but will also regenerate a new head and a new tail, and become again a complete worm. Nothing like this takes place in man or in the higher orders of animals; and therefore, were it certain that the sentient principle in the worm is diffused through the whole system, and divisible with it, we could not infer that the principle of such sensations as we are conscious of, is likewise extended and divisible. It is, however, so far from being certain that the sentient principle is diffused through the whole worm, that nothing necessarily follows from this fact, but that its seat is at some distance from either extremity. Nay, were it true, as perhaps it is, that a worm may be so divided, as that each of the two sections shall retain life, sensation, and this reproductive power, we would not therefore be authorized to conclude that the sentient principle is *one* coextended and divisible with the material system. The earthworm, like many other reptiles, being an hermaphrodite, which unites in itself both sexes, may possibly consist of two animated systems; which though united by some bond of connexion, by which sensation is communicated from the one to the other, are yet in themselves perfectly distinct. Should this, upon proper investigation, be found to be the case; and should it likewise be found, that when a worm is divided into three or more parts, only one or two of these parts continue to live, there would be no room whatever for supposing that even in these creatures the principle of sensation is extended and divisible. In the mere power of reproducing amputated parts, when that power is considered by itself, there is nothing more wonderful than in the growing of the nails of our fingers, or the hairs

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gest to us the existence of extended things *ab extra*, the sentient being *may* be unextended and indivisible.

Having thus examined Dr Priestley's auxiliary arguments for the materiality of mind, we now proceed to consider his main and direct proof. To this, as we have observed, so able a reply has been made, that it would be injustice to our readers not to lay it before them, in the words of its author. "I readily acknowledge (says this spirited essayist *), that the power of sensation or perception never having been found but in conjunction with a certain organized system of matter, we ought, as philosophers, to conclude that this power necessarily exists in, and results from, that organized system, unless it can be shown to be incompatible with other known properties of the same substance. On the other hand, it must be admitted, that constant conjunction implies *necessary* connexions only when reasons cannot be discovered to prove the conjunction to be accidental and arbitrary. In the present instance, it is alleged, that discerptibility is a property of matter absolutely incompatible with the property of sensation or perception; or in other words, that sensation is a power or property incapable of division. But as the power of the entire system is clearly nothing more than the sum or aggregate of the powers of all the parts, it necessarily follows, that the primary particles of which the system is composed must, upon the material hypothesis, possess distinct powers of sensation; and that those powers combined constitute the indivisible power of sensation belonging to the system; or, in other words, that the *indivisible* power of sensation is a *divisible* power, nay, an infinitely divisible power, if matter be, as philosophers in general allow, an infinitely divisible substance—a conclusion obviously and grossly ridiculous. We are then compelled to acknowledge, that sensation or perception is not the property of a material substance; i. e. if the common mode of expression be retained, it is the property of an immaterial substance; or, to avoid verbal contention, it is a property not resulting from, or necessarily connected with, the organical system, but a property wholly foreign, superinduced, and adventitious (G).

* *Essays, Philosophical, Historical, and Literary*, vol. ii.

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"In

hairs of our heads. The only thing which seems to militate against the simplicity of the principle of sensation in worms, is the continuance of life, &c. with both parts of a worm when cut into two by a knife or pair of scissars; but if a worm be found to have two seats of sensation analogous to the brain in higher animals, and if it be likewise found that life continues only in such sections as retain at least one seat of sensation, the sentient principle in the worm may be as simple and indivisible as in any animal whatever. We neither wish nor expect much stress to be laid upon these hints and conjectures. Should they induce any of our physiological readers, who have leisure, and are at the same time skilled in philosophy, properly so called, to institute a set of experiments upon worms and such reptiles, and to trace apparent effects to their higher causes, they might eventually lead to important discoveries. In the mean time, it is sufficient for our purpose to observe, that whatever be the sentient principle or principles in the earthworm, it is obvious that the whole animal cannot in any case be conscious, as man undoubtedly is, of *one individual sensation*; and that therefore no arguments built upon the phenomena accompanying sensation in worms, can be of any importance in the controversy about the materiality or immateriality of the human mind.

(G) This argument is not new. It was long ago urged by Dr Clarke against Mr Dodwell; and some of our readers may not be ill pleased to see it stated by so masterly a reasoner: "That the soul cannot possibly be *material*, is demonstrable from the single consideration of bare sense or consciousness. For matter being a divisible substance, consisting always of separable, nay of actually separate and distinct parts, it is plain that unless it were essentially conscious, in which case every particle of matter must consist of innumerable separate and distinct consciousnesses, no system of it, in any possible composition or division, can be an individual conscious being. For suppose three or three hundred particles of matter, at a mile or any given distance one from another, is it possible that all these separate parts should in that state be one individual conscious being? Suppose then all these particles brought together into one system, so as to touch one another, will they thereby, or by any motion or composition whatsoever, become one whit less truly distinct beings than they were when at the greatest distance? How then can their being disposed in any possible system make them one individual conscious being? If you will suppose God by his infinite power superadding consciousness to the united particles, yet still these particles being really and necessarily as distinct beings as ever, cannot be *themselves* the *subject* in which that individual consciousness inheres; but the consciousness can only be superadded by the addition of something, which in all the particles must still itself be but one individual being. The soul, therefore, whose power of thinking is undeniably one individual consciousness, cannot possibly be a material substance." *Clarke's Letter to Mr Dodwell*, 2d edition.

That the same mode of reasoning was known to the ancients, Cudworth has shown by numerous quotations; and as an argument certainly loses nothing by antiquity, or by having occurred to thinking men in distant ages, we shall lay before our readers two passages from Plotinus, of which the extract from Clarke's letter (though we are persuaded it was not borrowed by the author) must be considered as little more than a paraphrastical translation.——τι τοινυν φησουσιν, ὁι την ψυχην σωμα ειναι λεγοντες, πρωτον μεν περι ἑκαστου μερους της ψυχης της εν τω αυτω σωματι, ποτερον ἑκαστον ψυχην, ὁια εστι και ἡ ὁλη; και παλιν του μερους το μερος; ουδεν αρα το μηγεθος συνεβαλλετο τη ουσια αυτης· καιτοι εδειγε ποσου τινος οντος· αλλα και ὁλον πολλαχη, οπερ σωμασι παρειναι αδυνατον, εν πλειοσι το αυτο ὁλον εναι, και το μερος ὁ περ το ὁλον, ὑπαρχειν· ει δε ἑκαστον των μερων, ου ψυχην φησουσιν, εξ αψυχων ψυχη αυτοις υπαρξει. *En.* IV. *Lib.* vii. *Cap.* 5.

The same argument is elsewhere stated thus: ει δε ἑκαστον ζωην εχοι, και εν αρκει· ει δε μηδενος αυτων ζωην εχοντος ἡ συνοδος πεποιηκε ζωην, ατοπον· μαλλον δε αδυνατον συμφορησιν σωματων ζωην εργαζεσθαι, και νουν γενναν τα ανοητα. *En.* IV. *Lib.* vii. *Cap.* 2.

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"In opposition to this reasoning, the materialists affirm, that entire systems may possess, and they think themselves warranted to pronounce that organized systems of matter actually do possess, powers essentially different from those which inhere in the several parts. Amongst various familiar though striking illustrations of this truth, it has been said, that a rose possesses the property of sweetness or fragrance, a globe the property of sphericity, a harpsichord the property or power of producing harmony, *aqua regia* the property of dissolving gold, &c. though the component particles of these different organized systems are themselves totally destitute of the powers and properties here enumerated.

"The immaterialists, in reply, assert, that it is not only false in fact, but a direct contradiction, and an absolute impossibility in the nature of things, that a system should possess any property which does not inhere in its component parts. To assert that the power of the whole is the sum or aggregate of the powers of all the parts, is an identical and self-evident proposition, the whole and all the parts being terms precisely synonymous. Whoever, therefore, calls in question the truth of this axiom, must maintain that the power of the whole is something different from the power of all the parts, i. e. that the power of the whole is *not* the power of the whole.

"It will be easy to demonstrate the correspondence of facts with this plain and simple theory. For this purpose, it is necessary to observe, that the properties of matter, or what are generally denominated such, may be divided into real and nominal, which Locke and others have called primary and secondary qualities. Figure, magnitude, and motion, are qualities really inherent in matter; but figure, magnitude, and motion, eternally varied, can produce only different combinations of figure, magnitude, and motion. There are also powers, or qualities, vulgarly considered as inherent properties of matter organically disposed, which are really and truly qualities or affections of the mental or percipient principle, and have no existence when not perceived. Thus the sweetness or fragrance of the rose, considered as mere sweetness and fragrance, can be nothing but an affection of the mind; considered as a quality of the rose, they can mean nothing more than a certain arrangement, configuration, and motion of parts, which in some inexplicable manner produces the sensation of sweetness. In this instance, therefore, the power of the whole is plainly the aggregate of the powers residing in the parts, by the motion and organization of which a certain effect is produced upon a foreign and percipient substance.

"But a globe, we are told, possesses the property of sphericity, though not a single particle amongst that infinite number of which the globe is constituted is itself of a spherical form. The fallacy of this illustration is, however, as easily demonstrable as that of the former. The sphericity of a globe is evidently the sum or aggregate of the curvilinear or convex parts which compose its surface; and the property of the whole is neither more nor less than the combined properties of all its parts. No one doubts, that by new compositions or arrangement of material particles possessing magnitude, figure, and motion, an endless diversity of phenomena may be produced, to which it may be necessary to apply new names. New names, however, do not constitute new properties; and though we give to a globe the appellation of an entire system, and ascribe to it the property of sphericity, we know at the same time that it is really nothing more than a collection of thousands of millions of particles, actually separate and distinct, arranged in that particular form which we denominate spherical. But this can never be regarded as in the remotest manner analogous to the *creation* of the power of perception, in consequence of a certain organical arrangement or disposition of impercipient particles. Though sphericity is, indeed, the property of the entire sphere, yet every part of the sphere, if divided, possesses its share of sphericity. But if the percipient principle be divided, what would become of the power of perception? A sphere equally divided becomes two hemispheres; Does a perception, when divided in like manner, become two demi-perceptions?

"The same reasonings may easily be transferred, and applied to the harpsichord. Can any one be absurd enough to affirm that the power of harmony resides in the harpsichord, as the power of perception does in the mind? After the utmost skill of the artificer has been exerted, we discover nothing more in the harpsichord than new modifications of the old properties of figure, magnitude, and motion, by means of which certain vibrations are communicated to the air, which, conveyed by the medium of the auditory nerves to the sensorium, produce the sensation of harmonic sounds. These new modifications are therefore, attended, indeed, with new and very wonderful effects; but then those effects are produced upon, and are themselves modifications of, the sentient or percipient faculty. And though it is wholly incomprehensible to us in what manner these effects, that is, these *sensations*, are produced, we well know, and perfectly comprehend, that they are not new powers belonging to any organized system of matter; that they have no existence but in a mind perceiving them; and that they are far from militating against that grand and universal axiom, that the power of the whole is nothing more than the united powers of all the parts.

"As to the last instance adduced, of the power of *aqua regia* to dissolve gold, though neither the spirit of salt, nor the spirit of nitre of which it is compounded, separately possesses that power, it is plain, that from the union of these two substances, certain new modes of configuration and motion result; and the solution of gold is the consequence of this new arrangement and motion of the parts. But the particles of which the menstruum is composed were always possessed of the properties of figure and motion; and what is styled a new property, is clearly nothing more than a new effect of the old properties differently modified. In a word, the advocates for materialism may safely be challenged to produce, in the whole compass of nature, a case which bears the least analogy to that which these instances are most unphilosophically adduced to prove and to illustrate. It is an absurdity which transubstantiation itself does not exceed, to maintain that a whole is in reality any thing different from its component parts: and all nature rises up in confutation of an assertion so monstrous and extravagant. To affirm that perception can arise from any combination of impercipient particles, is as truly ridiculous, as to affirm that

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that a combination of the ſeven primary colours with the four cardinal virtues may conſtitute a planet. It is equivalent to an aſſertion, that an epic poem might be compoſed of parallelograms, cones, and triangles. In a word, it is an abſurdity not leſs real, and a little leſs obvious, than that of the blind man who thought that the idea of a ſcarlet colour reſembled the ſound of a trumpet."

If a matter be taken in the common aceptation, to be a ſolid, extended, and inert ſubſtance, this reaſoning for the immateriality of the ſentient principle in man appears to us to have the force of demonſtration,
235 which no difficulties or partial objections, ariſing from our inability to conceive the band of union between two ſuch heterogeneous ſubſtances as mind and body, can ever weaken, and far leſs overturn. But the modern materialiſts deny that matter is either ſolid or inert. "All thoſe facts (ſay they) which led philoſophers to ſuppoſe that matter is impenetrable to other matter, later and more accurate obſervations have ſhown to be owing to *ſomething elſe* than ſolidity and impenetrability, viz. a *power of repulſion*, which for that reaſon they would ſubſtitute in its place. The property of *attraction* or repulſion (ſays Dr Prieſtley) appears to me not to be properly what is *imparted* to matter, but what really *makes it to be what it is*; inſomuch, that without it, it would be nothing at all; and as other philoſophers have ſaid,—'Take away ſolidity, and matter vaniſhes,' ſo I ſay, 'Take away attraction and repulſion, and matter vaniſhes." If this be admitted, the ingenious author hopes that we ſhall not conſider matter with that contempt and diſguſt with which it has generally been treated, there being nothing in its real nature that can juſtify ſuch ſentiments
236 reſpecting it.

Reply by the materialiſts ſhown to be abſurd.

We know not why, upon any hypotheſis, matter ſhould be viewed with contempt and diſguſt.—Whether penetrable or impenetrable, every conſiſtent theiſt conſiders it as one of the creatures of God, perfectly fitted to anſwer all the purpoſes for which it was intended: but were it really deſtitute of ſolidity, and endowed with the powers of attraction and repulſion, we ſhould ſtill be obliged to conſider it as incapable of the powers of ſenſation and thought. If we have any notion at all of what is meant by centres of attraction and repulſion (of which indeed we are far from being confident), it appears to us to be intuitively certain, that nothing can be the reſult of any poſſible combination of ſuch centres, but new and more enlarged ſpheres of attraction and repulſion. But ſurely conſciouſneſs, ſenſation, and will, are as different from attraction and repulſion, as a cube is from the ſound of a trumpet, or as the ſenſations of a felon in the agonies of death are from the attraction of the rope by which he is hanged. If this be admitted, and we are perſuaded it will be denied by no man whoſe underſtanding is not clouded by an undue attachment to paradoxes, the ſentient principle cannot poſſibly be matter; for if, when the powers of attraction and repulſion are taken away, matter vaniſhes; and if conſciouſneſs and ſenſation are not attraction and repulſion; it is not more evident that three and two are not nine, than that the ſubſtance which attracts and repels cannot be that which is conſcious and percipient.

Locke, who was certainly no materialiſt, as he repeatedly affirmed, and indeed demonſtrated, that thought could never be the reſult of any combinations of figure, magnitude, and motion, was yet of opinion, that God by his almighty power might endow ſome ſyſtems of matter with the faculties of thinking and willing. It is always with reluctance that we controvert the opinions of ſo great a man; and it is with ſome degree of horror that we venture in any caſe to call in queſtion the power of Omnipotence.— 237
But Omnipotence itſelf cannot work contradictions; and it appears to us nothing ſhort of a contradiction, to ſuppoſe the individual power of perception inhering in a ſyſtem which is itſelf extended and made up of a number of ſeparate and diſtinct ſubſtances. For let us ſuppoſe ſuch a ſyſtem to be ſix feet long, three feet broad, and two feet deep (and we may as well ſuppoſe a ſyſtem of theſe dimenſions to be percipient, as one that is ſmaller), then it is plain, that every idea muſt be extended, and that part of it muſt be in one place, and part in another. If ſo, the idea of a ſquare inch will be ſix feet long, three feet broad, and two feet deep; and what is ſtill harder to be digeſted, the ſeveral parts of this idea will be at a great diſtance from each other, without any bond of union among them. The being which apprehends one extremity of the idea, is, by the ſuppoſition, ſix feet diſtant from the being which apprehends the other extremity; and though theſe two diſtinct beings belong to one ſyſtem, they are not only ſeparable, but actually ſeparated from each other as all the particles of matter are. What is it then that apprehends as *one* the whole of this extended idea? Part of it may be apprehended by one particle of matter, and part of it by another; but there is nothing which apprehends, or can apprehend, the whole. Perhaps it will be ſaid, the power of apprehenſion is not divided into parts, but is the power of the one ſyſtem, and therefore apprehends at once the whole idea. But a power or faculty cannot be ſeparated from its ſubject, power which inheres in nothing being confeſſedly impoſſible; and a material ſyſtem is not *one ſubject* in which any individual power or faculty can inhere. There muſt, therefore, be united to the ſyſtem ſome *one* being, which is the ſubject of thought, and which is unextended as well as indiviſible. This, we ſay, follows undeniably. For, let us ſuppoſe, that an extended being without ſeparable parts is poſſible, and that ſuch a being is percipient; it is obvious, that the whole of any one of its perceptions could not be in one place. Now, though we ſhould grant to Dr Prieſtley and other materialiſts, that every idea of an extended ſubſtance has itſelf three dimenſions, and is incorporated and commenſurate with the whole percipient ſyſtem; what, upon this ſuppoſition, ſhall we think of conſciouſneſs and of the perception of truth? Is conſciouſneſs or truth extended? If ſo, one ſide or ſuperficies of conſciouſneſs, or of a truth, may be greater or leſs than another, above or below, to the right or to the left; and it will be very proper and philoſophical to ſpeak of the length, breadth, and depth, of conſciouſneſs or of truth. But ſurely to talk of the place or the extenſion of theſe things, is as abſurd as to talk of the colour of ſound, or the ſound of a triangle; and we might as well ſay, that conſciouſneſs is green or red, as that it is an ell or an inch long;

Locke's opinion haſty and ill-founded.

long; and that truth is b ue, as that it has three dimensions.

238 This reasoning is somewhat differently stated by Cudworth; who observes, that if the soul be an extended substance, "it must of necessity be either a physical point (i. e. the least extension possible, if there be any such least extension), or else it must consist of more such physical points joined together. As for the former of these, it is impossible that *one single atom*, or *smallest point* of extension, should be able to perceive distinctly all the *variety* of things, i. e. take notice of all the *distinct* and *different* parts of an *extended object*, and have a *description* or *delineation* of the whole of them upon itself (for that would be to make it the least, and not the least, possible extension at the same time: Besides, to suppose every soul to be but one *physical point*, or the smallest *possible extension*, is to suppose such an essential difference in matter or extension, as that some of the *points* thereof should be *naturally* devoid of all *life*, *sense*, and *understanding*; and others again, naturally *sensitive* and *rational*. And even should this absurdity be admitted, it would yet be utterly inconceivable how there should be *one*, and *but* one, *sensitive* and *rational* atom in every man; how this atom of so *small* dimensions should actuate the whole system; and how it should constantly remain the same from infancy to old age, whilst all the other parts of the system transpire perpetually, and are succeeded by new matter (H).

because the sentient being cannot be extended.

"But if, according to the second hypothesis, souls be extended substances consisting of many points one without another, and all concurring in every sensation; then must every one of these points perceive either a *point* only of the object, or else the *whole*. Now, if every *point* of the *extended soul* perceives only a *point* of the *object*, then is there no *one thing* in us that perceives the whole, or that can compare one part of the object with another. On the other hand, if every *point* of the *extended soul* perceive the *whole object* at once, then would there be *innumerable perceptions* of the same object in every sensation; as many, indeed, as there are points in the extended soul.—And from both these suppositions it would alike follow, that no man is *one single percipient* or person, but that in every man there are innumerable distinct *percipients* or *persons*; a conclusion directly contrary to the infallible evidence of consciousness (I)."

Cogent as these arguments for the immateriality of

(H) Should it be said, that this essential difference between the atoms of matter is not fortuitous; that some of them are created intelligent for the express purpose of animating systems of others which are unintelligent; and that these intelligent atoms do not operate upon the systems with which they are united, by the *vis inertiæ*, *solidity*, or *extension*, of matter, but by the energies of understanding and will: Should this (we say) be alleged, surely it may be asked, for what purpose they are conceived to have the quality of extension? It is evidently of no use; and it has been already shown, and shall be more fully shown afterwards, that by our notions of consciousness and understanding, we are so far from being led to suppose the subject of these powers extended, that we cannot suppose any relation whatever between them and extension. But if these intelligent atoms be divested of their quality of extension, they will be transformed from matter to mind, and become the very things for the existence of which we plead.

(I) As the materialists endeavour to prejudice the public against the notion of an unextended soul, by representing it as a fiction of *Des Cartes*, altogether unknown to the ancients, it may not be improper to give our readers an opportunity of judging for themselves how far this representation is just.—*Plotinus*, reasoning about the nature of the soul from its energies of sensation, expresses himself in these words:—ειτι μελλει αισθανεσθαι τινος, ἑν αυἱο δει ειναι, και τω αυἱω πανἱος αἱιλαμβανεσθαι και ει δια πολλων αισθηἱηριον πλειω τα εισιονἱα, ἡ πολλαι περι ἑν ποιοτητης και δι ἑνος ποικιλον, ὁιον προσωπον· ου γαρ αλλο μεν ρινος αλλο δε οφθαλμων, αλλα ταυἱον ὁμου πανἱωνι. και ει το μεν δι ομματων το δε δι ακοης, εν τι δει ειναι εις ὁ αμφω· ἡ πως αν ειποι ὁἱι ἑἱερα ταυἱα, μη εις το αυἱο ὁμου των αισθησεων ελθον των. "That which perceives in us, must of necessity be one thing, and by one and the same indivisible perceive all; and that whether they be more things entering through several organs of sense, as the many qualities of one substance, or one various and multiform thing, entering through the same organ, as the countenance and picture of a man. For it is not one thing in us that perceives the nose, and another thing the eyes; but it is one and the self-same thing that perceiveth all. And when one thing enters through the eyes, another through the ears, both these also must of necessity come at last to one indivisible; otherwise they could not be compared together, nor one of them be affirmed to be different from the other, the several ideas of them meeting nowhere in one place." Pursuing the same argument, and having observed, that if what perceiveth in us be extended, then one of these three things must of necessity be affirmed, that either every part of this extended soul perceives a part only of the object, or every part of it the whole object; or else, that all comes to some one point, which alone perceives both the several parts of the object and the whole: he observes of the first of these suppositions,—μεγεθει ονἱι τουἱω, ξυμμεριζοιἱο αν· ωσἱε αλλο αλλου μερος και μηδενα ἡμων ὁλου του αισθηἱου αἱιληψιν εχειν· ὡσπερ αν ει εγω μεν αλλου· συ δε αλλου αισθοιο: "If the soul be a magnitude, then must it be divided, together with the sensible object, so that one part of the soul must perceive one part of the object, and another another; and nothing in it, the whole sensible; just as I should have the sense of one thing, and you of another." Of the second supposition he writes in this manner: ει δε ὁτιουν πανἱος αισθησεἱαι· εις απειρα διαιρεισθαι του μεγεθους πεφυκοἱος απειρους και αισθησεις καθ' εκασἱον αισθηἱον συμβησεἱαι γιγνεσθαι ἑκασἱω ὁιον του αυἱου απειρους εν τω ἑγεμονουνἱι ἡμων εικονας: "But if every part of the extended soul perceive the whole sensible object, since magnitude is infinitely divisible, there must be in every man infinite sensations and images of one object."—And as for the third and last part of this disjunction, Plotinus by asserting the infinite divisibility of body, here shows that the supposition of any one physical point is in itself an absurdity. But if it were not, he agrees with Aristotle

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of the ſentient principle appear to be, they have been lately treated with the moſt ſovereign contempt by a writer who profeſſes to be a diſciple of Dr Prieſtley's, but who ſeems not to have learned the modeſty or the candour of his maſter. Dr Prieſtley labours to prove, that to account for the phenomena of perception and volition, &c. it is not neceſſary to ſuppoſe an immaterial principle in man. Mr Cooper with greater boldneſs affirms, and undertakes to demonſtrate with all the parade of mathematical preciſion *, that ſuch a principle is impoſſible. Though the authority of this philoſopher in ſuch inquiries as depend not immediately upon the retort and the furnace, is certainly not great, he yet utters his dogmas with ſuch confidence, that it may not be improper to examine the chief arguments upon which they reſt.

* *Tracts Ethical, Theological, and Political*, vol. i.

239 An attempt to prove the impoſſibility of immaterial ſubſtance

"Suppoſe (ſays he) the ſoul to have no common property with matter; then, no thing can act upon any other but by means of ſome common property. Of this we have not only all the proof that induction of known and acknowledged caſes can furniſh, but that additional proof alſo which ariſes from the impoſſibility of conceiving how the oppoſite propoſition *can* be true. But by the ſuppoſition, the ſoul has no property in common with matter; and therefore the ſoul cannot act upon matter. But by the ſuppoſition of every ſyſtem of immaterialiſm (except thoſe of Malebranche, Berkeley, and Leibnitz), it is deemed an eſſential property of the ſoul, that it acts upon the body, or upon matter; therefore the ſoul can and cannot act upon matter at the ſame time, and in the ſame reſpect. But this is a contradiction in terms; and as two contradictions cannot both be true at the ſame time, the ſuppoſition of the exiſtence of an immaterial ſoul cannot be true; that is, the ſoul does not exiſt."

240 ſhown to be futile.

This reaſoning, the reader will obſerve, is carried on with all the pomp of mode and figure. The propoſitions hang upon each other like the ſeveral ſteps of an algebraic proceſs: but as in ſuch proceſſes one error unwarily admitted produces a falſe reſult, ſo in demonſtrative reaſonings one unſound argument admitted into the premiſes is neceſſarily productive of error in the concluſion. When the author affirms, "that no thing can act upon any other but by means of ſome common property," he affirms without the ſhadow of proof what is certainly not ſelf-evident. He ſays, indeed, that of this we have all the proof that induction of known and acknowledged caſes can furniſh; but unleſs conſciouſneſs be calculated to deceive us, this is unqueſtionably a miſtake. Matter, he repeatedly affirms, has no other properties than thoſe of attraction and repulſion: but a man moves his arm by a mere energy of will; and therefore, according to this demonſtrator, an energy of will muſt be either material attraction or material repulſion. If ſo, it is reaſonable to conclude, that when a man draws his hand towards his head, the centre of his brain exerts its power of *attraction*; and that when he extends his arm at full length before him, the ſame centre exerts its power of *repulſion*. We beg pardon of our readers for detaining them one moment upon ſuch abſurdities as theſe: yet we cannot diſmiſs the argument without taking the liberty to aſk our all-knowing author, How it comes to paſs that the ſame centre ſometimes attracts and ſometimes repels the ſame ſubſtance at the ſame diſtance; nay, that it both attracts and repels ſubſtances of the ſame kind, at equal diſtances, and at the very ſame inſtant of time? This muſt be the caſe, when a man puts one hand to his head, and thruſts another from him; and therefore, it theſe operations be the effect of attraction and repulſion, it muſt be of attraction and repulſion to which induction of known and acknowledged caſes furniſhes nothing ſimilar or analogous, i. e. of ſuch attraction and repulſion as, according to Mr Cooper's mode of reaſoning, does not exiſt. The truth is, that we are not more certain that we ourſelves exiſt, than that an energy of will is neither attraction nor repulſion; and therefore, unleſs all matter be endued with will, it is undeniable, that, whatever be the ſubſtance of the ſoul, one thing acts upon another by a property not common to them both. In what *manner* it thus acts, we pretend not to know: but our ignorance of the *manner* of any operation is no argument againſt the *reality* of the *operation itſelf*, when we have for it the evidence of conſciouſneſs and daily experience; and when the author ſhall have explained to general ſatisfaction how material centres attract and repel each other at a diſtance, we ſhall undertake to explain how one thing acts upon another with which it has no common properties.

241 A ſecond attempt of the ſame kind.

Suſpicious, as it ſhould ſeem, that this reaſoning has not the complete force of mathematical demonſtration, the author ſupports his opinion by other arguments. "Whatever we know (ſays he), we know by means of its properties, nor do we in any caſe whatever certainly know any thing but theſe; and we infer in all caſes the exiſtence of any thing which we ſuppoſe to exiſt from the exiſtence of its properties. In ſhort, our idea of any thing is made up of a combination of our ideas of its properties. Gold is heavy, ductile, tenacious, opaque, yellow, ſoluble in *aqua regia*, &c. Now, let any one ſuppoſe for an inſtant that gold is deprived of all theſe, and becomes neither heavy, ductile, tenacious, opaque, yellow, ſoluble, &c. what remains, will it be gold? Certainly not. If it have other properties, it is another ſubſtance. If it have no properties remaining, it is nothing. For nothing is that which hath no properties. Therefore, if any thing loſe all its properties, it becomes nothing; that is, it loſes its exiſtence. Now, the exiſtence of the ſoul is inferred, like the exiſtence of every thing elſe, from its ſuppoſed properties, which are the phenomena of thinking, ſuch as perception, recollection, judgment, and volition. But in all caſes of *perfect* ſleep, of the operation of a ſtrong narcotic, of apoplexy, of ſwooning, of drowning where the vital powers are not extinguiſhed, of the effects of a violent blow on the back

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Ariſtotle in aſking πως τω αμιξει το μεριστον—thereby plainly indicating, that the ſentient principle is totally ſeparated from extenſion, and can neither be conſidered as extended like a ſuperficies or ſolid, nor unextended as a phyſical point.

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back part of the head, and all other leipothymic affections, there is neither perception, recollection, judgement, nor volition; that is, all the properties of the soul are gone, are extinguished. Therefore, the soul itself loses its existence for the time. If any man shall say, that these properties are only *suspended* for the time, I would desire him to examine what idea he annexes to this suspension; whether it be not neither more nor less than that *they are made not to exist for the time.* Either no more is meant, or it is contradictory to matter of fact; and moreover, if more *be* meant, it may easily be perceived to involve the archetypal existence of abstract ideas, and to contradict the axiom *impossibile est idem esse et non esse.*"

242 Shown to be equally weak.

For the benefit of short-sighted inquirers, it is to be wished that the author had favoured the public with this *proof* which might have been so easily brought; for we can discern no connexion whatever between the suspension of the exercise of the powers of the mind, and the archetypal existence of abstract ideas, or the absurd proposition that it is *possible for the same thing to be and not to be.* We think, however, that we understand enough of this reasoning which he has given us to be able to pronounce with some confidence that it is nothing to the purpose. For, in the *first* place, We beg leave to observe, that between the properties of gold and the powers of thinking, &c. there is no similarity; and that what may be true when affirmed of the one, may be false when affirmed of the other. The powers of the mind are all more or less active; the enumerated properties of gold are all passive. We know by the most complete of all evidence, that the exercise of power *may be* suspended, and the power itself remain unimpaired; but to talk of the suspension of the energies of what was never energetic, if it be not to contradict the axiom *impossibile est idem esse et non esse*, is certainly to employ words which have no meaning. Yet even this argument from the properties of gold might have led the author to suspect that something else may be meant by the suspension of the exercise of powers, than that *those powers are made not to exist for the time.* In a room perfectly dark gold is not yellow; but does it lose any of its essential properties, and become a different substance, merely by being carried from light to darkness? Is a man while in a dark room deprived of the faculty of sight, and one of the powers of his mind made not to exist for the time? The author will not affirm that either of these events takes place. He will tell us that gold exhibits not its yellow appearance, merely because the proper medium of light passes not from it to the eye of the percipient, and that it is only for want of the same medium that nothing is seen by us in perfect darkness. Here, then, by his own confession, is a power of the mind, and a property of an external object, both suspended in their energies, without being annihilated; and no proof has yet been brought that all the powers of the mind may not in the same manner be suspended in their energies without being made not to exist. As light is necessary to vision, but is not itself either the thing which sees or the thing which is seen; so may the brain be necessary to the phenomena of thinking, without being either that which thinks, or that which is thought upon: and as actual vision ceases when light is withdrawn, though the eye and the object both continue to exist; so may the *energy* of thinking cease when the brain is rendered unfit for its usual office, though the being which thinks, and the power of thought, continue to exist, and to exist unimpaired. That this is actually the case every man must be convinced who believes that in thinking he exerts the same powers to-day that he exerted yesterday; and therefore our author's second demonstration of the nonexistence of mind is, like his first, founded upon assertions which cannot be granted.

243 A third attempt of the same kind

Another of these pretended demonstrations is as follows: "If the soul exist at all, it must exist somewhere; for it is impossible to frame to one's self an idea of any thing existing, which exists nowhere. But if the soul exist somewhere, by the terms it occupies space, and therefore is extended; but whatever has extension, has figure in consequence thereof. The soul then, if it exist, hath the properties of extension and figure in common with matter. Moreover, by the supposition of every immaterial hypothesis (except those of Malebranche, Berkeley, and Leibnitz), it acts upon body, i. e. upon matter; that is, it attracts and repels, and is attracted and repelled, for there is no conceivable affection of matter but what is founded on its properties of attraction and repulsion; and if it be attracted and repelled, its reaction must be attraction and repulsion. The soul then has the properties of extension, figure, attraction and repulsion, or solidity. But these comprise every property which matter, as such, has ever been supposed to possess. Therefore the soul is matter, or material. But by the supposition it is immaterial; therefore it does not exist. For nothing can exist whose existence implies a contradiction."

244 shown to confute itself.

Mr Cooper, we see, still proceeds in the direct road of mathematical demonstration; but in the present instance we beg leave to stop him in the very beginning of his course, and to ask *where* the universe exists? When he shall have given such an answer to this question as men of common sense may be able to comprehend, we may perhaps attempt to tell him where an unextended soul exists. If this demonstration be not a collection of words without meaning, the existence of space as a real thing is taken for granted. Space, therefore, has extension, and of course figure; but we believe Mr Cooper will find some difficulty in ascertaining the figure of infinite space. The mind certainly acts upon body. For this we have the evidence of consciousness and experience; but we have no evidence whatever that it must therefore attract and repel, and be attracted and repelled. It has been already observed, that the mind, whatever be its substance, acts upon the body by energies of will. What these are every man knows with the utmost certainty and precision; whilst we may venture to assert, that no man knows precisely what corpuscular attraction and repulsion are, supposing the existence of such powers to be possible. When we speak of attraction and repulsion, we have some obscure notion of bodies acting upon each other at a distance; and this is all that we know of the matter. But when we think of an energy of the human will, the idea of distance neither enters nor can enter into our notion of such an energy. These are facts which we pretend not to prove by a mathematical or a chemical process. Every man must be convinced

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convinced of their truth by evidence more complete than any proof, viz. immediate consciousness of his own thoughts and volitions. This being the case, we may turn Mr Cooper's artillery against himself, and, because mind acts upon body by powers different from attraction and repulsion, argue that body neither attracts nor repels; and were it true, as it is certainly false, that nothing could act upon another but by means of some property common to both, we might infer that every atom of matter is endowed with the powers of volition and intelligence, and by consequence that every man is not one but ten thousand conscious beings, a conclusion which our philosopher seems not inclined to admit.

245 Objections to the doctrine of immaterialism stated and answered.

Having finished his *demonstrations*, the author states other objections to the doctrine of immaterialism, which, as they are not his own nor new, have greater weight. "It appears no more than reasonable (says he), that if the doctrine of materialism be rejected as inadequate to explain the phenomena, these latter should at least be explained in some manner or other better upon the *substituted* than the *rejected* hypothesis; so that it is reasonable to require of an immaterialist that his supposition of a distinct soul should explain the *rationale* of the phenomena of thinking. But, strange to say, so far from attempting to explain these phenomena on the immaterial hypothesis, it is acknowledged on all hands that even on this hypothesis the phenomena are inexplicable." This objection it would certainly be no difficult task to obviate; but from that trouble, small as it is, we are happily exempted by the objector. "I would have it understood (says he), that no materialist ever undertook to say *how* perception results from our organization. What a materialist undertakes to assert is, that perception, *whatever* it be, or *however* it results from, does actually result from our organization." According to Mr Cooper, then, the *rationale* of thinking is equally inexplicable by materialists and immaterialists; and the truth is, that we know the *rationale* of hardly any one operation in nature. We see that the stroke of a racket produces motion in a billiard ball; but how it does so, we believe no man can say. Of the fact, however, we are certain; and know that the motion is produced by some power, about the effects of which we can reason with precision. In like manner we know with the utmost certainty, that we ourselves have the powers of perception and volition; and that these powers cannot be conceived as either an ell or an inch long. How they result from the mutual agency of an immaterial and material substance upon each other, we are indeed profoundly ignorant; but that such is the fact, and that they are not the result of mere organization, we must necessarily believe, so long as it is true that the power of the entire system is nothing more than the sum or aggregate of the powers of all its parts. The immaterial hypothesis contains in it something inexplicable by man: The material hypothesis likewise contains, by the confession of its advocates, something that is equally inexplicable; and is over and above burdened with this contradiction, that the whole is something different from all its parts. It is therefore *no* "singular phenomenon in literary history, that one hypothesis should be rejected as inadequate to account for appearances, and that the hypothesis substituted should, even by the acknowledgment of its abettors, be such as not only not to explain the *rationale* of the appearances, but from the nature of it, to preclude all hopes of such an explanation." This is exactly the case with respect to a *vacuum* in astronomy. That hypothesis does not in the least tend to explain the rationale of the motions of the planets; but yet it must be admitted in preference to a *plenum*, because upon this last hypothesis motion is impossible.

246 Whether as many things may be asserted of the soul as of the body.

"Supposing the existence of the soul, it is an unfortunate circumstance (says Mr Cooper), that we cannot properly assert positively any thing of it at all." Were this the case, it would indeed be a very unfortunate circumstance; but can we not assert positively as many things of the soul as we can of the body? Can we not say with as much propriety and certainty, that the soul has the powers of perception and volition, &c. as that the body is solid and extended, or as that matter has the powers of attraction and repulsion? We know perfectly what perception and volition are, though we cannot have *ideas* or mental images of them; and if our author knows what attraction and repulsion are, we believe he will not pretend to have of them ideas entirely abstracted from their objects. "But granting the soul's existence, it may be asked (says he), Of what use is an hypothesis of which no more can be asserted than its existence?" We have just observed that much more can be asserted of the soul than its existence, viz. that it is something of which perception and will are properties; and he himself asserts nothing of matter but that it is something of which attraction and repulsion are properties.

"This soul, of which these gentlemen (the immaterialists) are conscious, is immaterial essentially. Now I deny (says our author), that we can have any idea at all of a substance purely immaterial." He elsewhere says, that nothing can exist which is not extended, or that extension is inseparable from our notions of existence. Taking the word *idea* in its proper sense, to denote that appearance which external objects make in the imagination, it is certainly true that we can have no *idea* of an immaterial substance; but neither have we, in that sense, any idea of matter abstracted from its qualities. Has Mr Cooper any *idea* of that which attracts and repels, or of attraction and repulsion, abstracted from their objects? He may, perhaps, have, though we have not, very adequate ideas of bodies acting upon each other at a distance; but as he takes the liberty to substitute assertions for arguments, we beg leave in our turn to assert, that those ideas neither are, nor can be, more clear and adequate than our notion of perception, consciousness, and will, united in one being.

247 Extension not inseparable from all notions of existence.

That extension is no otherwise inseparable from our notions of existence than by the power of an early and perpetual association, is evident from this circumstance, that, had we never possessed the senses of sight and touch, we never could have acquired any idea at all of extension. No man, who has thought on the subject, will venture to affirm, that it is absolutely impossible for an intelligent being to exist with no other senses than those of smell, taste, and hearing. Now it is obvious that such a being must acquire some notion of existence

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istence from his own consciousness: but into that notion extension could not possibly enter; for neither sounds, tastes, smells, nor consciousness, are extended; and it is a fundamental article of the materialists creed, that all our ideas are relicts of sensation. Since then existence may be conceived without extension, it may be inferred that they are not inseparable from each other; and since cogitation cannot be conceived with extension, we may reasonably conclude, that the being which thinks is not extended.

Mr Cooper indeed, with his master, talks of extended ideas and extended thoughts: but we must assert, in the words of Cudworth, that "we cannot conceive a *thought* to be of such a certain *length*, *breadth*, and *thickness*, measurable by *inches*, *feet*, and *yards*; that we cannot conceive the *half*, or *third*, or *twentieth* part of a thought; and that we cannot conceive every thought to be of some determinate *figure*, such as *round* or *angular*, *spherical*, *cubical*, *cylindrical*, or the like. Whereas if extension were inseparable from existence, *thoughts* must either be mere *nonentities*, or extended into *length*, *breadth*, and *thickness*; and consequently all truths in us (being nothing but complex thoughts) must be long, broad, and thick, and of some determinate figure. The same must likewise be affirmed of volitions, appetites, and passions, and of all other things belonging to cogitative beings; such as knowledge and ignorance, wisdom and folly, virtue and vice, &c. that these are either all of them absolute *nonentities*, or else extended into three dimensions, and measurable not only by *inches* and *feet*, but also by solid measures, such as *pints* and *quarts*. But if this be absurd, and if these things belonging to soul and mind (though doubtless as great realities at least as the things which belong to body) be *unextended*, then must the substances of souls or minds be themselves unextended, according to that of Plotinus, νους ου διαστας αφ έαυτου, and therefore the human soul cannot be material."

248 That the human mind cannot exert its faculties but in union with some corporeal system, an opinion probable and ancient.

Mr Cooper employs many other arguments to prove the materiality of the sentient principle in man; but the force of them extends no farther than to make it in the highest degree probable, that the mind cannot exert its faculties but in union with some organized corporeal system. This is an opinion which we feel not ourselves inclined to controvert; and therefore we shall not make any particular remarks upon that part of our author's reasonings. That an immaterial and indiscerptible being, such as the soul, is not liable to be *dissolved* with the body, is a fact which cannot be controverted: for what has no parts can perish only by *annihilation*; and of annihilation the annals of the world afford no instance. That an immaterial being, endowed with the powers of perception and volition, &c. *may be capable* of exerting these powers in a state of separation from all body, and that at least one immaterial Being does actually so exert them, or other powers analogous to them, are truths which no man whose arrogance does not surpass his judgment will venture to deny; but the question at present between the most rigid immaterialists and their opponents, is, whether there be ground to think that the human soul is such a being?

Now, when Mr Baxter and his followers confidently affirm, that human perception must *necessarily* subsist after the dissolution of the present mortal and perishable system; and that the soul, when disencumbered of *all body*, will have its faculties greatly *enlarged*; they affirm what to us appears incapable of proof. That a disembodied soul *may* perceive, and think, and act, and that its powers of intellection *may* have a wider range than when they were circumscribed by a corporeal system, which permitted their action upon external objects only through five organs of sense, is certainly *possible*; and the argument by which the materialists pretend to prove it *not* possible, is one of the most contemptible sophisms that ever disgraced the page of philosophy. To affirm, that because our intellectual powers, in their embodied state, seem to decay with the system to which they are united, the mind, when set free, must therefore have no such powers at all, is equally absurd as to say, that because a man shut up in a room which has but one window sees objects less and less distinctly as the glass becomes more and more dimmed, he must in the open air be deprived of the power of vision. But because the human soul *may*, for any thing that we see to the contrary, subsist, and think, and act, in a separate state, it does not therefore necessarily follow that it *will* do so; and every thing that we know of its nature and its energies leads us to think, that without some kind of body by which to act as by an instrument, all its powers would continue dormant. There is not the shadow of a reason to suppose that it existed and was conscious in a prior state; and as its memory at present unquestionably depends upon the state of the brain, there is all the evidence of which the case will admit, that if it should subsist in a future state divested of all body, though it might be endowed with new and enlarged powers of *perception*, it could have no *recollection* of what it did and suffered in *this world*, and therefore would not be a fit object either of reward or of punishment. This consideration has compelled many thinking men, both Pagans and Christians, to suppose that at death the soul carries with it a fine material vehicle, which is its immediate sensorium in this world, and continues to be the seat of its recollection in the next. Such, as we have seen, was the opinion of Mr Wollaston and Dr Hartley; it was likewise the opinion of Cudworth and Locke, who held that the Supreme Being alone is the only mind wholly separated from matter; and it is an opinion which even Dr Clarke, one of the ablest advocates for immaterialism, would not venture positively to deny.

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Nor is this opinion peculiar to a few moderns. Cudworth, after giving a vast number of quotations from Pythagoreans and Platonists, which prove to a demonstration that they held the Deity to be the only mind which perceives and acts without the instrumentality of matter, observes, "from what hath been said, it appeareth, that the most ancient assertors of the incorporeity and immortality of the human soul, yet supposed it to be always conjoined with some body." Thus *Hierocles* plainly: ή λογικη ουσια συμφυες εχουσα σωμα, ούτω παρα του δημιουργου εις το ειναι παρηλθεν, ως μητε το σωμα ειναι αυτην, μητε ανευ σωματος· αλλ αυτην μεν ασωματον, αποπερα τουσθαι δε εις σωμα το όλον αυτης ειδος. *The rational nature having always a kindred body, so proceeded from the demiurgus, as that neither itself is body, nor yet can it be without body; but though itself be incorporeal, yet its whole form is terminated in a body.*

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body. Agreeably to this the definition which he gives of a man is, ψυχη λογικη μεʈα συμφους αθανατου σωμαʈος, *a rational ſoul, together with a kindred immortal body;* and he affirms, that our preſent animated terreſtrial body, or mortal man, is nothing but ἔιδωλον ανθρωπου, *the image of the true man*, or an acceſſion from which it may be ſeparated. Neither does he affirm this only of human ſouls, but alſo of all other rational beings whatſoever below the Supreme Deity, that they always naturally actuate ſome body. Wherefore a demon or angel (which by *Hierocles* are uſed as ſynonymous words), is alſo defined by him after the ſame manner, ψυχη λογικη μεʈα φωʈεινου σωμαʈος, *a rational ſoul, together with a lucid body.* And accordingly *Proclus* upon *Plato's Timæus affirmeth*, παντα δαιμονα των ημεʈερων κρειʈονα ψυχων, και νοεραν εχειν, ψυχην, και οχημα αιθεριον: *That every demon, ſuperior to human ſouls, hath both an intellectual ſoul and an ethereal vehicle, the entireneſs thereof being made up or compounded of theſe two things.* So that there is hardly any other difference between demons or angels, and men, according to theſe philoſophers, but only this, that the former are lapſable into aërial bodies only, and no further; but the latter into terreſtrial alſo. Now, *Hierocles* poſitively affirms this to have been the true cabala, and genuine doctrine of the ancient Pythagoreans, entertained afterwards by Plato: και τουτο των Πυθαγορειων ἠν δογμα, ὁ δε Πλατων υσʈερον εξεφηνεν, απεικασας ξυμφοτω δυναμει υποπʈερου ξευγους τε και ἡνιοχου; πασαν θειαν τε και ανθρωπινην ψυχην. *And this was the doctrine of the Pythagoreans, which Plato afterwards declared; he reſembling every both human and divine ſoul* (i. e. in our modern language, every created rational being) *to a winged chariot, and a driver or charioteer both together:* meaning by the chariot, an animated body; and by the charioteer, the incorporeal ſoul actuating it.

That this Pythagorean opinion of the Deity's being the only mind which thinks and acts without material organs was very generally received by the ancient Chriſtians, might be proved by a thouſand quotations: We ſhall content ourſelves with producing two from the learned *Origen.* "Solius Dei (ſaith this philoſophic father of the church), id eſt, Patris, Filii, et Spiritus Sancti, naturæ id proprium eſt, ut ſine materiali ſubſtantia, et abſque ulla corporeæ adjectionis ſocietate, intelligatur ſubſiſtere *." "Materialem ſubſtantiam opinione quidem et intellectu ſolum ſeparari, a naturis rationalibus, et pro ipſis, vel poſt ipſas affectam videri; ſed nunquam ſine ipſa eas vel vixiſſe, vel vivere: Solius namque Trinitatis incorporea vita exiſtere putabitur †." Should Mr Cooper and his friends aſk, What is the uſe of a ſoul which cannot act without the inſtrumentality of matter? or why we ſhould ſuppoſe the exiſtence of ſuch a ſubſtance? we beg leave, in our turn, to aſk theſe gentlemen, What is the uſe of a brain which cannot ſee without eyes? and why they ſhould ſuppoſe all our ſenſations to terminate in ſuch an internal ſyſtem, ſince the vulgar certainly ſuppoſe their ſenſations to ſubſiſt in their reſpective organs? How this ancient notion, which makes body ſo eſſential a part of man, is conſiſtent with the immortality of the human ſoul, we ſhall inquire in a ſubſequent chapter; in which we ſhall endeavour to aſcertain what kind of immortality we have reaſon to expect, and upon what evidence our expectation muſt reſt. Previous to this inquiry, however, it is neceſſary to enter upon another, which is of the firſt importance, and which every materialiſt has endeavoured to perplex; we mean that which concerns *perſonal identity:* for if, as has been often ſaid, no man is the ſame perſon two days ſucceſſively, it is of no importance to us whether the ſoul be mortal or immortal.

* *Peri Archon*, lib. 1. cap. 6.

† Lib. 2. cap. 2.

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CHAP. III. *Of* PERSONAL IDENTITY.

250 Perſonal identity,

WHETHER we are to live in a future ſtate, as it is the moſt important queſtion which can poſſibly be aſked, ſo it is the moſt intelligible one which can be expreſſed in language. Yet ſtrange perplexities have been raiſed about the meaning of that identity or ſameneſs of perſon, which is implied in the notion of our living now and hereafter, or indeed in any two ſucceſſive moments; and the ſolution of theſe difficulties hath been ſtranger than the difficulties themſelves. To repeat all that has been ſaid on the ſubject would ſwell this chapter to a diſproportionate bulk. We ſhall therefore content ourſelves with laying before our readers the ſentiments of Biſhop Butler, and the fancies and demonſtrations of the philoſopher of Mancheſter. We are induced to adopt this courſe, becauſe we think the illuſtrious biſhop of Durham has exhauſted the ſubject, by ſtating fairly the opinions which he controverts, and by eſtabliſhing his own upon a foundation which cannot be ſhaken, and which are certainly not injured, by the objections of Mr Cooper.

251 though it cannot be defined, eaſily underſtood and aſcertained by conſciouſneſs and memory.

"When it is aſked (ſays this philoſophical prelate*) in what perſonal identity conſiſts? the anſwer ſhould be the ſame as if it were aſked in what conſiſts ſimilitude or equality?—that all attempts to define would but perplex it. Yet there is no difficulty at all in aſcertaining the idea or notion: For as, upon two triangles being compared or viewed together, there ariſes to the mind the notion of ſimilitude; or, upon twice two and four, the notion of equality: ſo likewiſe, upon comparing the conſciouſneſs of one's ſelf or one's own exiſtence in any two moments, there as immediately ariſes to the mind the notion of perſonal identity. And as the two former compariſons not only give us the notions of ſimilitude and equality, but alſo ſhow us that two triangles are ſimilar, and that twice two and four are equal; ſo the latter compariſon not only gives us the notion of perſonal identity, but alſo ſhows us the identity of ourſelves in theſe two moments—the preſent, ſuppoſe, and that immediately paſt, or the preſent and that a month, a year, or twenty years paſt. In other words, by reflecting upon that which is myſelf now, and that which was myſelf twenty years ago, I diſcern they are not two, but one and the ſame ſelf.

* *Diſſertation 1ſt, ſubjoined to the Analogy of Religion*, &c.

252 Theſe, however, do not make perſonal identity.

"But though conſciouſneſs of what is preſent and remembrance of what is paſt do thus aſcertain our perſonal identity to ourſelves; yet, to ſay that remembrance makes perſonal identity, or is neceſſary to our being the ſame perſons, is to ſay that a perſon has not exiſted a ſingle moment, nor done one action, but what he can remember; indeed none but what he reflects upon. And one ſhould really think it ſelf-evident, that conſciouſneſs of perſonal identity preſuppoſes and therefore

fore cannot conſtitute perſonal identity; any more than knowledge, in any other caſe, can conſtitute truth, which it preſuppoſes.

"The inquiry, what makes vegetables the ſame in the common acceptation of the word, does not appear to have any relation to this of perſonal identity; becauſe the word *ſame*, when applied to them and to perſon, is not only applied to different ſubjects, but is alſo uſed in different ſenſes. When a man ſwears to the ſame tree, as having ſtood fifty years in the ſame place, he means only the ſame as to all the purpoſes of property and uſes of common life, and not that the tree has been all that time the ſame in the ſtrict philoſophical ſenſe of the word: For he does not know whether any one particle of the preſent tree be the ſame with any one particle of the tree which ſtood in the ſame place fifty years ago. And if they have not one common particle of matter they cannot be the ſame tree in the proper and philoſophic ſenſe of the word *ſame;* it being evidently a contradiction in terms to ſay they are, when no part of their ſubſtance and no one of their properties is the ſame; no part of their ſubſtance, by the ſuppoſition; no one of their properties, becauſe it is allowed that the ſame property cannot be transferred from one ſubſtance to another: And, therefore, when we ſay that the identity or ſameneſs of a plant conſiſts in a continuation of the ſame life, communicated under the ſame organization to a number of particles of matter, whether the ſame or not; the word *ſame*, when applied to life and to organization, cannot poſſibly be underſtood to ſignify what it ſignifies in this very ſentence, when applied to matter. In a looſe and popular ſenſe, then, the life, and the organization, and the plant, are juſtly ſaid to be the ſame, notwithſtanding the perpetual change of the parts. But, in a ſtrict and philoſophical manner of ſpeech, no man, no being, no mode of being, no any thing, can be the ſame with that with which it has indeed nothing the ſame. Now ſameneſs is uſed in this latter ſenſe when applied to perſons. The identity of theſe, therefore, cannot ſubſiſt with diverſity of ſubſtance.

253 What it is.

"The thing here conſidered, and demonſtratively, as I think, determined, is propoſed by Mr Locke in theſe words: *Whether it* (i. e. the ſame ſelf or perſon) *be the ſame identical ſubſtance?* And he has ſuggeſted what is a much better anſwer to the queſtion than that which he gives it in form: For he defines a perſon *a thinking intelligent being*, &c. and perſonal identity, *the ſameneſs of a rational being;* and then the queſtion is, Whether the ſame rational being is the ſame ſubſtance? which needs no anſwer; becauſe being and ſubſtance are in this place ſynonymous terms. The ground of the doubt, whether the ſame perſon be the ſame ſubſtance, is ſaid to be this, that the conſciouſneſs of our own exiſtence, in youth and in old age, or in any two joint ſucceſſive moments, is not *the ſame individual action*, i. e. not the ſame conſciouſneſs, but different ſucceſſive conſciouſneſſes. Now it is ſtrange that this ſhould have occaſioned ſuch perplexities: for it is ſurely conceivable that a perſon may have a capacity of knowing ſome object or other to be the ſame now which it was when he contemplated it formerly; yet in this caſe, where, by the ſuppoſition, the object is perceived to be the ſame, the perception of it in any two moments cannot be one and the ſame perception. And thus, though the ſucceſſive conſciouſneſſes which we have of our own exiſtence are not the ſame, yet are they conſciouſneſſes of one and the ſame thing or object; of the ſame perſon, ſelf, or living agent. The perſon of whoſe exiſtence the conſciouſneſs is felt now, and was felt an hour or a year ago, is diſcerned to be, not two perſons, but one and the ſame perſon; and therefore is one and the ſame.

254 Falſe notion of perſonal identity

"Mr Locke's obſervations upon this ſubject appear haſty; and he ſeems to profeſs himſelf diſſatisfied with ſuppoſitions which he has made relating to it. But ſome of thoſe haſty obſervations have been carried to a ſtrange length by others; whoſe notion, when traced and examined to the bottom, amounts, I think, to this: 'That perſonality is not a permanent but a tranſient thing: That it lives and dies, begins and ends, continually: That no one can any more remain one and the ſame perſon two moments together, than two ſucceſſive moments can be one and the ſame moment: That our ſubſtance is indeed continually changing: but whether this be ſo or not, is, it ſeems, nothing to the purpoſe; ſince it is not ſubſtance, but conſciouſneſs alone, which conſtitutes perſonality; which conſciouſneſs, being ſucceſſive, cannot be the ſame in any two moments, nor conſequently the perſonality conſtituted by it *.'" Hence it muſt follow, that it is a fallacy upon ourſelves to charge our preſent ſelves with any thing we did, or to imagine our preſent ſelves intereſted in any thing which befel us yeſterday; or that our preſent ſelf will be intereſted in what will befal us to-morrow; ſince our preſent ſelf is not in reality the ſame with the ſelf of yeſterday, but another ſelf or perſon coming in its room, and miſtaken for it; to which another ſelf will ſucceed to-morrow. This, I ſay, muſt follow: for if the ſelf or perſon of to-day and that of to-morrow are not the ſame, but only like perſons; the perſon of to-day is really no more intereſted in what will befal the perſon of to-morrow, than in what will befal any other perſon. It may be thought, perhaps, that this is not a juſt repreſentation of the opinion we are ſpeaking of; becauſe thoſe who maintain it allow that a perſon is the ſame as far back as his remembrance reaches: And indeed they do uſe the words *identity* and *ſame* perſon; nor will language permit theſe words to be laid aſide. But they cannot, conſiſtently with themſelves, mean that the perſon is really the ſame: For it is ſelf-evident, that the perſonality cannot be really the ſame, if, as they expreſsly aſſert, that in which it conſiſts is not the ſame. And as, conſiſtently with themſelves, they cannot, ſo I think it appears they do not, mean that the perſon is *really* the ſame, but only that he is ſo in a fictitious ſenſe, in ſuch a ſenſe only as they aſſert: for this they do aſſert, that any number of perſons whatever may be the ſame perſon. The bare unfolding this notion, and laying it thus naked and open, ſeems the beſt confutation of it. However, ſince great ſtreſs is ſaid to be put upon it, I add the following things:

255 overthrown.

"*Firſt*, This notion is abſolutely contradictory to that certain conviction, which neceſſarily and every moment riſes within us, when we turn our thoughts upon ourſelves, when we reflect upon what is paſt, and look forward to what is to come. All imagination, of a daily change of that living agent which each man calls himſelf

* *Anſwer to Dr Clarke's third Defence of his Lette to Mr Dodwell*, 2d edit p. 44. 56, &c.

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felf for another, or of any fuch change throughout our whole prefent life, is entirely borne down by our natural fenfe of things. Nor is it poffible for a perfon in his wits to alter his conduct with regard to his health or affairs, from a fufpicion that though he fhould live tomorrow he fhould not however be the fame perfon he is to-day.

"*Secondly*, It is not an *idea* or abftract *notion*, or quality, but a being only, which is capable of life and action, of happinefs and mifery. Now all beings confeffedly continue the fame during the whole time of their exiftence. Confider then a living being now exifting, and which has exifted for any time alive: this living being muft have done, and fuffered, and enjoyed, what it has done, and fuffered, and enjoyed, formerly (this living being, I fay, and not another), as really as it does, and fuffers, and enjoys, what it does, and fuffers, and enjoys, this inftant. All thefe fucceffive actions, fufferings, and enjoyments, are actions, enjoyments, and fufferings, of the fame living being; and they are fo prior to all confiderations of its remembering or forgetting, fince remembering or forgetting can make no alteration in the truth of paft matter of fact. And fuppofe this being endued with limited powers of knowledge and memory, there is no more difficulty in conceiving it to have a power of knowing itfelf to be the fame being which it was fome time ago, of remembering fome of its actions, fufferings, and enjoyments, and forgetting others, than in conceiving it to know, or remember, or forget, any thing elfe.

"*Thirdly*, Every perfon is confcious that he is now the fame perfon or felf he was as far back as his remembrance reaches: fince when any one reflects upon a paft action of his own, he is juft as certain of the perfon who did that action, namely himfelf (the perfon who now reflects upon it), as he is certain that the action was at all done. Nay, very often a perfon's affurance of an action having been done, of which he is abfolutely affured, arifes wholly from the confcioufnefs that he himfelf did it: and this he, perfon or felf, muft either be a fubftance or the property of fome fubftance. If *he*, if perfon, be a fubftance; then confcioufnefs that he is the fame perfon, is confcioufnefs that he is the fame fubftance. If the perfon, or *he*, be the property of a fubftance, ftill confcioufnefs that he is the fame property is as certain a proof that his fubftance remains the fame, as confcioufnefs that he remains the fame fubftance would be; fince the fame property cannot be transferred from one fubftance to another.

"But though we are thus certain that we are the fame agents, living beings, or fubftances, now, which we were as far back as our remembrance reaches; yet it is afked, Whether we may not poffibly be deceived in it? And this queftion may be afked at the end of any demonftration whatever; becaufe it is a queftion concerning the truth of perception by memory: and he who can doubt whether perception by memory can in this cafe be depended upon, may doubt alfo whether perception by deduction and reafoning, which alfo include memory, or indeed whether intuitive perception itfelf, can be depended upon. Here then we can go no farther: for it is ridiculous to attempt to prove the truth of our faculties, which can no otherwife be proved than by the ufe or means of thofe fufpected faculties themfelves."

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256 Objection to the foregoing reafoning.

This reafoning, which we believe will to moft men appear unanfwerable, Mr Cooper hopes to overturn by the following obfervations *: "If all imagination of a daily change in us be borne down by our natural fenfe of things, then (fays he) does our natural fenfe of things pofitively contradict known fact; for a daily, a momentaneous, change in us, i. e. in our bodies, does actually take place." True, a daily change in our bodies does take place, and fo likewife does a daily change in our clothes; but furely no man was ever led by his natural fenfe of things to fuppofe, that his limbs or external organs were the feats of fenfation and will, any more than that his coat or his fhoes were any real parts of his trunk or of his feet. But it is only that which thinks and wills than any man confiders in this cafe, as himfelf or his perfon; and if our natural fenfe of things, or confcioufnefs, tell us, that what thinks and wills has continued the fame from a diftance of time as far back as we can remember, it is certain, that whether it be material or immaterial, it has continued from that period, otherwife we can be certain of nothing. "But (fays our philofopher) other known and afcertained facts are frequently borne down by our natural fenfe of things: for how many thoufand years before the days of *Copernicus* was the motion of the earth round the fun entirely borne down by our natural fenfe of things, which made us give full credit to the motion of the fun round the earth? Do not the generality of mankind believe, upon the evidence of their natural fenfe of things, that every part of their body remains exactly the fame today as it was yefterday?"

* *Tracts*, &c.

257 Anfwered.

To the former of thefe queftions we anfwer pofitively, that before the days of *Copernicus* the motion of the earth round the fun was *not* borne down by our *natural fenfe* of things, but by ill-founded hypothefes and inconclufive reafonings. By the natural fenfe of things, nothing can be meant, in this place, but the evidence of confcioufnefs or of external fenfation; but the *actual motion* either of the fun or of the earth is not perceived either by confcioufnefs or by fenfation. Of confcioufnefs nothing is the object but the internal energies and feelings of our own minds; and with regard to the motion of the fun or of the earth, nothing is perceived by the fenfe of fight but that, after confiderable intervals of time, thefe two great bodies have repeatedly changed their places in the heavens with refpect to each other. This is all that on this fubject our *natural fenfe of things* leads us to believe; and is not this infallibly true? Afterwards indeed, by taking for granted the truth of propofitions, for which neither fenfe nor confcioufnefs affords the fhadow of evidence; the vulgar now, and all mankind formerly, reafoned themfelves into the opinion, that the earth ftands ftill, and that the fun moves round it. In vulgar philofophy it is taken for granted, that in the univerfe there is not a *relative* but an *abfolute upwards* and an *abfolute downwards*; that our heads are abfolutely upward, and our feet downward; and that were the earth to revolve round its axis; thefe pofitions would be reverfed, that our heads would be placed beneath our feet, and that we ourfelves would fall from the earth into

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into empty space. Upon these false hypotheses the vulgar reason correctly. They know that bodies cannot change their place without motion; they know that in the time of their remembrance the sun and the earth have been perpetually varying their places with respect to each other; they know that they themselves have never fallen, nor had a tendency to fall, into empty space; and hence they infer that it is the sun and not the earth that moves (K). But will any man say that the absurd suppositions from which this conclusion is logically deduced, have the evidence either of sensation or of consciousness, as the permanency of that living agent which each man calls himself has?

To our authors second question we likewise reply with confidence, that the generality of mankind do *not* believe, upon their natural sense of things, that every part of their body remains exactly the same to-day as it was yesterday. It would be strange indeed if they did, after having repeatedly experienced the waste of increased perspiration or sweating; after having witnessed men emaciated by sickness, and again restored to plumpness in health; and after having perhaps lost whole limbs, which certainly their natural sense of things teaches them to consider as parts of their body. In all these cases, the generality of mankind are as sensible of changes having taken place in their bodies as he who has attended ever so closely to physiological inquiries, though not one of them has the least imagination of a change having taken place in the living agent which each man calls himself.

Bishop Butler observes, that if the living agent be perpetually changing, it is a fallacy upon ourselves to charge our present selves with any thing we did, to imagine our present selves interested in any thing which befel us yesterday, or that our present self will be interested in what will befal us to-morrow. To this judicious observation our daring philosopher replies, "that as the man of to-morrow, though not in all points the same with, yet depends for his existence upon, the man of to-day, there is sufficient reason to care about him." Could he have said that as the man of to-day depends for his existence on the man of to-morrow, there is sufficient reason for the present man to care about the future man; or that as the man of to-morrow depends for his existence on the man of to-day, there is to-day sufficient reason for the future man to care about the present man; we should in either case, if the anachronism had been kept out of sight, have seen the force of his argument. Every man has sufficient reason to care about the ox upon which he is to be fed; but we cannot so clearly perceive what reason the ox has to care about the man.

Not satisfied, it would seem, with this reply, our author proceeds to affirm, "that the man of to-morrow, possessing a reminiscence of the actions of the man of to-day, and knowing that these actions will be referred to him both by himself and others (which is certainly knowing that both himself and others are most iniquitous wretches), they cannot be indifferent to the man of to-day, who looks forward to the properties of the man of to-morrow;" i. e. the reminiscence and knowledge of a future man constitute all the relation that subsists between a present man and his actions; a discovery worthy of an original genius. But as on the subject of personal identity we pretend to no originality, we shall leave this proposition to the meditation of our readers, and take the liberty to ask our author a question or two respecting this same reminiscence, which he is graciously pleased to acknowledge for a property.

He defines identity, "the continued existence of any being unaltered in substance or in properties;" and he repeatedly acknowledges that no identical quality or property can be transferred from one subject to another. Let us now suppose, that a man has a reminiscence of an individual action performed a month ago, and that this reminiscence is accompanied with a consciousness that the action was performed by himself. This supposition, whether true or false, may certainly be made; for it implies nothing more than what every man firmly believes of himself in every act of remembrance. Let us again suppose, that, at the distance of ten or twenty years, the man known by the same name has a reminiscence of the same action, with a consciousness that he himself performed it. Is this reminiscence the same with the former? or is it a different reminiscence? If it be the same, either the person remembering at the distance of ten or twenty years is the same with him who remembered at the distance of a month, or there is an identical quality transferred from one substance to another, which is admitted to be impossible. If reminiscence be itself a real and immediate quality of any substance, and not the mere energy of a power, and if the one reminiscence be different from the other, the subjects in which these two different qualities inhere must likewise be different. Yet the man who has the reminiscence at the distance of a month, has the evidence of consciousness that the action was performed by him; and the man who has the reminiscence at the distance of ten or twenty years, has likewise the evidence of consciousness that the same action was performed by him and not by another. By the confession of Hume and of all philosophers, consciousness never deceives; but here is the evidence of one consciousness in direct opposition to another; and therefore, as two contradictory propositions cannot both be true, either the one reminiscence is the same with the other, or reminiscence is no real quality. That one act of reminiscence should be numerically the same with another, which followed it at the distance of twenty years, is plainly impossible; whence it should seem, that reminiscence itself is no real and immediate quality of any substance. But if this be so, what is reminiscence? We answer, it is plainly neither more nor less than the *energy* of a power, which

(K) This inference too has been so often drawn, that it comes in time to coalesce in the mind with the *sensations*, from which the motion either of the sun or of the earth is deduced with infallible certainty; and hence it is considered as part of that truth which sensation immediately discovers. *See our chapter of* ASSOCIATION.

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which though dormant between its energies, remains unchanged from the one to the other, and which being itself the real and immediate quality of a subject, that subject must likewise remain unchanged. That powers may remain dormant, and yet unchanged, every man must be convinced; who having struck any thing with his hand, knows that he has power to repeat the stroke, and yet does not actually repeat it. Two blows with the hand immediately following each other are numerically different, so that the one cannot with truth be said to be the other; but we have the evidence of external sense, that they are both struck by the same member. In like manner, two energies of reminiscence directed to the same object, and succeeding each other at any interval of time, cannot possibly be one and the same energy; but as the latter energy may include in it the former as well as the object remembered by both, we have the evidence of consciousness that both are energies of the same power; and we have seen, that to suppose them any thing else, may be demonstrated to involve the grossest absurdities and contradictions.

Mr Cooper has other arguments to obviate the force of Bishop Burnet's demonstration of personal identity; such as, that a "high degree of *similarity* between the two succeeding men is sufficient to make the one care about the other;" and, that "a good man, knowing that a future being will be punished or rewarded as the actions of the present man deserve, will have a sufficient motive to do right and to abstain from wrong." But if there be any one of our readers who can suffer himself to be persuaded by such assertions as these, that the living agent which he calls himself is perpetually changing, and at the same time that such change is consistent with the expectation of future rewards and punishments, he would not be reclaimed from his error by any reasoning of ours. We shall therefore trust such trifling with every man's judgment, and proceed to examine our author's *demonstration*, that personal identity has no existence. But here it is no part of our purpose to accompany him through his long chemical ramble, or to controvert his arguments for the nonidentity of vegetable and animal bodies. The only thing to which, after Bishop Butler, we have ascribed identity, is that which in man is sentient and conscious; and the nonidentity of this thing, whatever it be, Mr Cooper undertakes to demonstrate from the known properties of sensations and ideas.

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A pretended demonstration that personal identity is impossible.

This demonstration sets out with a very ominous circumstance. The author, after conducting impressions *ab extra*, from the extremities of the nerves to the brain, affirms, that *sensations* and *ideas* are nothing but "motions in the brain perceived;" i. e. when a man thinks he is looking at a mountain, not only at rest, but to appearance immoveable, he is grossly deceived: for he perceives nothing all the while but *motion in his brain!* Were not the desire of advancing novelties and paradoxes invincible in some minds, we should be astonished at finding such an assertion as this fall from the pen of any man who had paid the slightest attention to the different energies of his own intellect. Motions in the brain, as we have repeatedly observed, are the immediate causes of our sensations; but is it conceivable, is it possible, that any thing should be the cause of itself? The motion of a sword through the heart of a man, is the immediate cause of that man's death; but is the sword or its motion *death* itself, or can they be conceived as being the *sensations* of the *man* in the *agonies of dying?* But sensations and ideas, whatever they be, exist in succession; and therefore, argues our demonstrator, no two sensations or ideas can be one and the same sensation or idea. The conclusion is logically inferred; but what purpose can it possibly serve? What purpose! why it seems "sensations and ideas are the only *existences whose existence* we certainly know (a charming phrase, the *existence* of *existences*, and as original as the theory in which it makes its appearance); and, therefore, from the nature of sensations and ideas there is no such thing as permanent identity." Indeed! what then, we may be permitted to ask, is the import of the word *we* in this sentence? Does it denote a series of sensations and ideas, and does each sensation and each idea certainly know not only itself, but all its ancestors and all its descendants? Unless this be admitted, we are afraid that some other existence besides sensations and ideas must be allowed to be certainly known, and even to have something of a permanent identity. Nay, we think it has been already demonstrated (see Chapter of TIME), that were there not something permanent, there could be no time, and of course no notion of a first and last, or indeed of succession, whether of sensations or ideas. And therefore, if we have such a notion, which the author here takes for granted, and upon which indeed his demonstration rests, it follows undeniably that there is something permanent, and that we *know* there is something permanent, which observes the succession of sensations and ideas.

All this, indeed, Mr Cooper in effect grants; for he is not much startled at the appearance of contradictions in his theory. "I find (says he), by perpetually repeated impressions which I perceive, that my hands, body, limbs, &c. are connected, are parts of one whole. I find, by perpetually repeated perceptions also, that the sensations excited by them are constantly similar, and constantly different from the sensations excited by others." He has then repeated perceptions: but how can this be possible, if *he* be not different from the perceptions, and if *he* do not *remain unchanged* while the perceptions succeed each other at greater or less intervals of time? A striking object passing with rapidity before the eyes of a number of men placed beside each other in a line of battle, would undoubtedly excite a succession of sensations; but surely that succession would not take place in the mind of *any individual* in the line, nor could any *single man* in this case say with truth that he had *repeated* perceptions of the object. In like manner, were that which is sentient perpetually changing, no man could possibly say or suppose that he had repeated perceptions of any thing; for upon this supposition, the man of to-day would have no more connexion with the man who bore his name yesterday, or twenty years ago, than the man in the line had with the first.

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Shown to be absurd and ridiculous.

Upon the whole, we cannot help thinking that Bishop Butler's demonstration of personal identity remains unshaken by the batteries of Mr Cooper.—It rests, indeed, Of Perfonal Identity.

deed, upon the folid bafis of conciou fnefs and memory; and if implicit credit be not given to the evidence of thefe faculties, we cannot proceed a fingle ftep in any inquiry whatever, nor be certain of the truth even of a mathematical demonftration.

260 A difficulty removed.

But as we have ourfelves fuppofed, that to fenfation, reminifcence, and every actual energy of the mind of man, the inftrumentality of fome material fyftem is neceffary, it may perhaps be thought incumbent on us to fhow how the perpetual flux of the particles of matter which compofe the brain, as well as all the other parts of the body, can confift with the identity of the perfon who perceives, remembers, and is confcious. If this cannot be done, our hypothefis, ancient and plaufible as it is, muft be given up; for of perfonal identity it is impoffible to doubt. In this cafe, however, we perceive no difficulty; for if there be united to the brain an immaterial being, which is the fubject of fenfation, confcioufnefs, and will, &c. it is obvious, that all the *intellectual powers* which properly conftitute the perfon, muft be inherent in that being. The material fyftem, therefore, can be neceffary only as an inftrument to excite the energies of thofe powers; and fince the powers themfelves remain unchanged, why fhould we fuppofe that their energies may not be continually exerted by fucceffive inftruments of the fame kind, as well as by one permanent inftrument? the powers of perception and volition are not in the material fyftem, any more than the fenfation of feeing is in the rays of light, or the energy of the blackfmith in the hammer with which he beats the anvil. Let us fuppofe a man to keep his eye for an hour fteadily fixed upon one object. It will not furely be denied, that if this could be done, he would have one uninterrupted and unvaried perception of an hour's duration, as meafured by the clock. Yet it is certain that the rays of light which alone could occafion that perception would be perpetually changing. In like manner, a blackfmith, whilft he continues to beat his anvil, continues to exert the fame power whether he ufes one hammer all the time, or a different hammer at each ftroke. The reafon is obvious; the eye, with all its connexions of brain and mind in the one cafe, and the perfon of the fmith in the other, remain unchanged; and in them alone refide the faculty of fenfation and the power of beating, though neither the faculty nor the power can be exerted without material inftruments. But were it poffible that millions of men could in the fpace of an hour take their turns in rotation with each new ray of light, it is felf-evident, that in this cafe, there would be nothing permanent in fenfation; and therefore, there could not be one uninterrupted and unvaried perception, but millions of perceptions, during the hour, totally diftinct from and unconnected with each other. Let us now fuppofe a man to fix his eye upon an object for the fpace of a minute, and at the diftance of a day or a month to fix it upon the fame object a fecond time. He would not indeed, in this cafe, have one uninterrupted and unvaried perception, but he would be confcious of the energy of the very fame faculty the fecond time as at the firft. Whereas were one man to view an object to-day, and another to view the fame object to-morrow, it is obvious, that he who fhould be laft in the fucceffion could know nothing of the energy of that faculty by which the object was perceived the firft day, becaufe there would be nothing common to the two perceptions.

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Thus then we fee, that *perfonal identity* may with truth be predicated of a compound being, though the material part be in a perpetual flux, provided the immaterial part remain unchanged; and that of fuch a being only is a refurrection from the dead poffible.—For fince the motions of the brain do nothing more than excite to energy the permanent powers of the mind, it is of no fort of confequence to that energy whether thefe motions be continued by the fame numerical atoms, or by a perpetual fucceffion of atoms arranged and combined in the very fame manner. We fhall, therefore, be the fame perfons at the refurrection as at prefent, whether the mind be united to a particular fyftem compofed of any of the numberlefs atoms which have in fucceffion made parts of our prefent bodies, or to a fyftem compofed of totally different atoms, provided that new fyftem be organized in exactly the fame manner with the brain or material vehicle, which is at prefent the immediate inftrument of perception. This (we fay) is felf-evident; but were the immaterial part to change with the changing body, a refurrection of the fame perfons would be plainly impoffible.

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261 The immortality of the foul the general belief in all nations.

Wherever men have been in any degree civilized, and in fome nations where they have been in the moft favage ftate, it has been the general perfuafion, that the mind or foul fubfifts after the diffolution of the body. The origin of this perfuafion, about which difputes have been raifed, no Chriftian hefitates to attribute to revelation. The Egyptians, from whom the Greeks derived many of their theological and philofophical principles, appear to have taught the immortality of the foul, not as a truth difcovered by the exertions of human reafon, but as a dogma derived to them from the earlieft ages by tradition. This indeed may be confidently inferred from the character and conduct of their firft Greek difciples. Thofe early wife men who fetched their philofophy immediately from Egypt, brought it home as they found it, in detached and independent placits. Afterwards, when fchools were formed, and when man began to philofophize by hypothefis and fyftem, it was eagerly inquired upon what foundation in *nature* the belief of the foul's immortality could reft; and this inquiry gave rife to the various difquifitions concerning the *fubftance* of the foul, which have continued to exercife the ingenuity of the learned to the prefent day. It was clearly perceived, that if confcioufnefs, thought, and volition, be the refult of any particular modification of matter and motion, the living and thinking agent muft perifh with the diffolution of the fyftem; and it was no lefs evident, that if the being which perceives, thinks, and wills, be not material, the mind of man *may* fubfift after the refolution of the body into its component particles. The difcovery of the immateriality of the mind was therefore one *ftep towards* the proof of its immortality; and in the opinion of many philofophers, whofe hopes ought to reft on a furer bafis, it was alone a complete proof.—"They who hold fenfative perception in brutes (fays a pious writer)

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writer *) to be an argument for the immateriality of their souls, find themselves under the necessity of allowing those souls to be immortal."

* See the Procedure, Extent, and Limits of the Understanding.

262 The philosophers of ancient Greece believed likewise in its pre-existence

The philosophers of ancient Greece, however, felt not themselves under any such necessity. Whatever were their opinions respecting the souls of brutes, they clearly perceived that nothing which had a beginning of existence could be naturally immortal, whether its substance were material or immaterial.—"There never was any of the ancients before Christianity (says the accurate Cudworth), that held the soul's future permanency after death, who did not likewise assert its pre-existence; they clearly perceiving, that if it were once granted that the soul was generated, it could never be proved but that it might be also corrupted. And, therefore, the assertors of the soul's immortality commonly began here, first to prove its pre-existence, proceeding thence to establish its permanency after death. This is the method of proof used in Plato: Ην που ἡμων ἡ ψυχη πριν εν τωδε τω ανθρωπινω ειδει γενεσθαι, ὡστε και ταυτη αθανατον τι εοικεν ἡ ψυχη ειναι. *Our soul was somewhere before it came to exist in this human form, and thence it appears to be immortal, and as such will subsist after death.*

263 and absolute eternity.

To give this argument for immortality any strength, it must be taken for granted, not only that the soul existed in a *prior* state, but that it existed from all *eternity*; for it is obvious, that if it had a beginning in any state, it may have an end either in that state or in another. Accordingly, Plato asserts in plain terms its eternity and self-existence, which, as we learn from Cicero, he infers from its being the principle of motion in man. "Quin etiam cæteris, quæ moventur, hic fons, hoc principium est movendi. *Principii autem nulla est origo.* Nam ex principio oriuntur omnia: ipsum autem nulla ex re alia nasci potest: nec enim esset id principium, quod gigneretur aliunde †." This, it must be acknowledged, is very contemptible reasoning; but the opinion which it was intended to prove was held by all the philosophers. They were unanimous in maintaining the *substance* of the soul, though not its *personality*, to be eternal *à parte ante* as well as *ad partem post*; and Cicero, where he tells us that this opinion passed from *Pherecydes Syrus* to Pythagoras, and from Pythagoras to *Plato*, expresses their notion of the soul's duration by the word *sempiternus* ‡, which, in its original and proper sense, is applicable only to that which has neither beginning nor end.

† *Tuscul.* lib. i. cap. 23.

‡ *Tuscul.* lib. i.

Indeed none of the philosophers of ancient Greece appear to have believed a creation (see CREATION) possible: for it was a maxim universally received among them, *De nihilo nihil fit, in nihilum nil posse reverti*; that *nothing can come from nonentity, or go to nonentity.* This maxim, as held by the theistical philosophers, the learned Cudworth labours to interpret in a sense agreeable to our notions of the origin of the world; but the quotations urged by himself must convince every competent reader that on this occasion he labours in vain. For instance, when Aristotle writes of Parmenides and Melissus, that ουδεν ουδε γινεσθαι φασιν ουδε φθειρεσθαι των οντων, *they say that no real entity is either made or destroyed*; what can be his meaning, but that those philosophers taught that nothing could be either created or annihilated? He testifies the same thing of *Xenophanes* and *Zeno*, when he says that it was a fundamental principle of their philosophy—μη ενδεχεσθαι γινεσθαι μηδεν εκ μηδενος—*that it is impossible that any thing should be made out of nothing.* And of Empedocles, when he relates απαντα ταυτα κακεινος ὁμολογει ὁτι εκ τε μη οντος αμηχανον εστι γινεσθαι το τε ον εξολλυσθαι ανηνυστον και αρρηκτον —*That he acknowledges the very same thing with other philosophers*, viz. *that it is impossible that any thing should be made out of nothing, or perish into nothing.* But it is needless to multiply quotations respecting the opinions of single philosophers. Of all the physiologers before himself and Plato, Aristotle says, without exception, περι ταυτης ὁμογνωμονουσι της δοξης ὁι περι φυσεως, ὁτι το γιγνομενον εκ μη οντων γιγνεσθαι αδυνατον †—*That they agree in this opinion, that it is impossible that any thing should be made out of nothing*: and he calls this the common principle of naturalists; plainly intimating, that they considered it as the greatest absurdity to suppose that any real entity in nature could either be brought from nothing or reduced to nothing.

† Physic. lib. i. cap. 5.

The author of the *Intellectual System*, in order, perhaps, to hide the impiety of this principle, endeavours to persuade his readers, that it was urged only against the hypothesis of forms and qualities of bodies considered as real entities, distinct from matter. But how it could be supposed to militate against that particular opinion, and not against the possibility of all creation, is to us perfectly inconceivable. The father of the school which analyzed body into matter and form, together with by far the greater part of his followers, taught the eternity of both these principles (L); and therefore maintained, as strenuously as any atomist, the universal maxim, *De nihilo nihil fit.* Even Plato himself, whose doctrine of *ideas* is supposed to wear a more favourable aspect than Aristotle's *forms* to the truths of revealed religion, taught the *eternity* of *matter*; but whether as a self-existing substance, or only as an emanation from the Deity, is a question which has

(L) *Aristotelem*, et plerosque Peripateticorum, in vulgus notum est, in hac fuisse sententia—nec *natum* esse, nec *interiturum* unquam hunc mundum. Vid. *PETRUS GASSENDUS Physic.* sect. i. lib. i. cap. 6. *JAC. THOMASIUS de Stoica mundi exustione*, Diss. 4. et alii. Plures ita haud dubie senserunt philosophorum veterum. Hinc video *MANILIUM* in *Astronomico*, lib. i. inter philosophorum de mundo sententias hanc, ac si præcipua esset, primo commemorare loco:

Quem sive ex nullis repetentem semina rebus,
NATALI QUOQUE EGERE placet, semperque FUISSE,
ET FORE, PRINCIPIO pariter FATOQUE carentem.

Mosheim's edition of Cudworth's Intellectual System, lib. i. cap. 3. sect. 33. note 60. On this subject see also *Ancient Metaphysics.*

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has been disputed. That he admitted no proper creation, may be confidently inferred from Plutarch; who, writing upon the generation of animals, according to the doctrine laid down in the *Timæus*, has the following passage: Βελτιον ουν, Πλατωνι πειθομενους τον μεν κοσμον ὑπο θεου γεγονεναι λεγειν και αδειν· ὁ μεν γαρ καλλιςος των γεγονοτων ὁιδε αριςος των αιτιων την δε ΟΥΣΙΑΝ και ΥΛΗΝ εξ ης γεγονεν ου γενομενην, αλλα ὑποκειμενην αει τω δημιουργω εις διαθεσιν και ταξιν αυτης, και προς εξομοιωσιν, ὡς δυνατον ην παρασχειν· ου γαρ εκ του μη οντος ἡ γενεσις, αλλ᾽ εκ του μη καλως, μηδ᾽ ικανως εχοντος, ὡς οικιας και ἱματιον, και ανδριαντος *. *It is therefore better for us to follow Plato, and to say and sing that the world was made by God. For as the world is the best of all works, so is God the best of all causes. Nevertheless, the SUBSTANCE or MATTER out of which the world was made, was NOT itself made, but was always ready at hand, and subject to the artificer, to be ordered and disposed by him. For the making of the world was not the production of it out of nothing, but out of an antecedent bad and disorderly state, like the making of a house, garment, or statue.*

* Plut. Op. tom. ii. p. 1014.

If, then, this be a fair representation of the sentiments of Plato, and surely the author understood those sentiments better than the most accomplished modern scholar can pretend to do, nothing is more evident, than that the founder of the academy admitted of no proper creation, but only taught that the matter which had existed from eternity in a chaotic state, was in *time* reduced to order by the *Demiurgus* or Supreme Being. And if such were the sentiments of the divine Plato, we cannot hesitate to adopt the opinion of the excellent Mosheim, which the reader will probably be pleased to have in his own words: "Si à Judæis discedas, nescio an ullus antiquorum philosophorum mundum negaverit æternum esse. Omnes mihi æternum professi videntur esse mundum: hoc uno vero disjunguntur, quod nonnulli ut *Aristoteles*, *formam* et *materiam* simul hujus orbis, alii vero, quorum princeps facile Plato, *materiam* tantum *æternam*, formam vero, à Deo comparatam, dixerunt †."

† Notes on *Cudworth's Intellectual System*.

Now, it is a fact so generally known, as not to stand in need of being proved by quotations, that there was not among them a single man who believed in the existence of mind as a being more excellent than matter, and essentially different from it, who did not hold the superior of at least equal antiquity with the inferior substance. So true is this, that Synesius, though a Christian, yet having been educated in one of the schools of philosophy, could not, by the hopes of a bishopric, be induced to dissemble this sentiment: αμελει την ψυχην ουκ αξιωσω ποτε σωματος ὑστερογενη νομιζειν‡. —*I shall never be persuaded to think my soul younger than my body.* This man probably believed, upon the authority of the scriptures, that the matter of the visible world was created in time; but he certainly held with his philosophic masters, that his own soul was as old as any atom of it, and that it had consequently existed in a prior state before it animated his present body.

‡ *Epist.* 105.

264 They supposed all souls to be emanations from the first mind;

Those who maintained that the world was uncreated, maintained upon the same principle that their souls were uncreated likewise; and as they conceived all bodies to be formed of one first matter, so they conceived all souls to be either emanations from the one first Mind, or discerpted parts of it. Aristotle, who distinguishes between the intellectual and sensitive souls, says expressly of the former, that it "enters from without, and is DIVINE;" adding this reason for his opinion, that "its energy is not blended with that of the body—λειπεται δε τον νουν μονον θυραθεν επεισιεναι, και θειον ειναι μονον· ουδε γαρ αυτου τη ενεργεια κοινωνει σωματικη ενεργεια*. As to the Stoics, *Cleanthes* held (as Stobæus informs us†), that "every thing was made out of one, and would be again resolved into one." But let Seneca speak for them all: "Quid est autem, cur non existimes in eo *divini* aliquid existere, qui DEI PARS est? Totum hoc, quo continemur, et unum est, et Deus: et socii ejus sumus, et membra ‡—*Why should you not believe something to be divine in him, who is indeed PART OF GOD? That WHOLE in which we are contained is ONE, and that one is GOD; we being his companions and MEMBERS.* Epictetus says, *The souls of men have the nearest relation to God, as being PARTS or FRAGMENTS of him, DISCERPTED and TORN from his SUBSTANCE;* συναφεις τω θεω, ἁτε αυτου μορια ουσαι και αποσπασματα. Plato writes to the very same purpose, when, without any softening, he frequently calls the soul *God*, and *part of God*. And Plutarch says, that "Pythagoras and Plato held the soul to be immortal; for that, launching out into the soul of the universe, it returns to its parent and original—Πυθαγορας, Πλατων, ἀφθαρτον ειναι την ψυχην· εξιουσαν γαρ εις την του παντος ψυχην, αναχωρειν προς το ομογενες ||." Plutarch declares his own opinion to be, that "the soul is not so much the work and production of God, as a PART of him; nor is it made BY him, but FROM him, and OUT of him: ἡ δε ψυχη ουκ εργον εςι μονον, αλλα και μερος· ουδ᾽ ΥΠ᾽ αυτου, αλλ᾽ ΑΠ᾽ αυτου, και ΕΞ αυτου γεγονεν §." But it is needless to multiply quotations. Cicero delivers the common sentiments of his Greek masters on this head, when he says ¶, "A natura deorum, ut doctissimis sapientissimisque placuit, HAUSTOS animos et LIBATOS habemus." And again: "Humanus autem animus DECERPTUS EX MENTE DIVINA: cum alio nullo, nisi cum ipso Deo (si hoc fas est dictu), comparari potest."

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* *De Generatione Animalium*, lib. ii. cap. 3.

† *Eclog. Physs.* c. 20.

‡ *Epist.* 92.

|| *De Placitis Philosophorum*, lib. iv. cap. 7.

§ *Platon Quæst.*

¶ *De Divinatione*, lib. i. cap. 49.

265 But differed in opinion as to the mode of their separation.

Whilst the philosophers were thus unanimous in maintaining the soul to be a part of the self-existent Substance, they differed in opinion, or at least expressed themselves differently, as to the mode of its separation from its divine parent. Cicero and the Stoics talk as if the Supreme Mind were extended, and as if the human soul were a part literally torn from that mind, as a limb can be torn from the body. The Pythagoreans and Platonists seem to have considered all souls as emanations from the divine Substance rather than as parts torn from it, much in the same way as rays of light are emanations from the sun. Plato, in particular, believed in two self-existent principles, God and matter. The former he considered as the supreme Intelligence, incorporeal, without beginning, end, or change; and distinguished it by the appellation of το αγαθον, *the Good.* Matter, as subsisting from eternity, he considered as without any one *form* or *quality* whatever, and as having a natural tendency to disorder. Of this chaotic mass God formed a perfect world, after the eternal pattern in his own mind, and endowed it with a soul or emanation from himself. In the language of Plato, therefore, the universe being animated by a soul which proceeds from God, is called the *son of God;* and

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and ſeveral parts of nature, particularly the heavenly bodies, are *gods*. The human ſoul, according to him, is derived by emanation from God, through the intervention of this ſoul of the world; and receding farther from the firſt intelligence, it is inferior in perfection to the ſoul of the world, though even that ſoul is debaſed by ſome material admixture. To account more fully for the origin and preſent ſtate of human ſouls, Plato ſuppoſes *, that "when God formed the univerſe, he ſeparated from the ſoul of the world inferior ſouls, equal in number to the ſtars, and aſſigned to each its proper celeſtial abode; but that thoſe ſouls, (by what means, or for what reaſon, does not appear), were ſent down to the earth into human bodies, as into ſepulchres or priſons." He aſcribes to this cauſe the depravity and miſery to which human nature is liable; and maintains, that it "is only by diſengaging itſelf from all animal paſſions, and riſing above ſenſible objects, to the contemplation of the world of intelligence, that the ſoul of man can be prepared to return to its original ſtate." Not inconſiſtently with this doctrine, our philoſopher frequently ſpeaks of the ſoul of man as conſiſting of three parts: or rather he ſeems to have thought that man has three ſouls; the firſt the principle of intelligence, the ſecond of paſſion, and the third of appetite (M); and to each he aſſigns its proper place in the human body. But it was only the intellectual ſoul that he conſidered as immortal.

* *Enfield's Abridgement of Brucker's Hiſtory of Philoſophy.*

Ariſtotle taught, in terms equally expreſs, that the human ſoul is a part of God, and of courſe that its ſubſtance is of eternal and neceſſary exiſtence. Some of his followers, indeed, although they acknowledged *two firſt principles*, the active and the paſſive, yet held, with the Stoics, but *one ſubſtance* in the univerſe; and to reconcile theſe two contradictory propoſitions, they were obliged to ſuppoſe matter to be both active and paſſive. Their doctrine on this ſubject is thus delivered by Cicero: "De natura ita dicebant, ut eam dividerent in res duas, ut altera eſſet efficiens, altera autem quaſi huic ſe præbens, ea quæ efficeretur aliquid. In eo, quod efficeret, vim eſſe cenſebant; in eo autem quod efficeretur, materiam quandam; in UTROQUE TAMEN UTRUMQUE. Neque enim materiam ipſam cohærere potuiſſe, ſi nulla vi contineretur, neque VIM SINE ALIQUA MATERIA; nihil eſt enim, quod non alicubi eſſe cogatur †." *They divided nature into two things, as the firſt principles; one whereof is the efficient or artificer, the other that which offers itſelf to him for things to be made out of it. In the efficient principle, they acknowledged active force; in the paſſive, a certain matter; but ſo, that in EACH BOTH OF THESE WERE TOGETHER: foraſmuch as neither the matter could cohere together unleſs it were contained by ſome active force, nor THE ACTIVE FORCE SUBSIST OF ITSELF WITHOUT MATTER; becauſe that is nothing which may not be compelled to be ſomewhere.* Agreeably to this ſtrange doctrine, Arrian, the interpreter of Epictetus, ſays of himſelf, *ειμι ανθρωπος, μερος των παντων, ὡς ὡρα ἡμερας*, "I am a man (a part of the *το παν* or *univerſe*), as an hour is part of the day."

† *Academicum.* lib. i. cap. 6.

Ariſtotle himſelf is generally ſuppoſed to have believed in the external exiſtence of two ſubſtances, *mind* and *matter*; but treating of the generation of animals, he ſays, *ενδε το παντι θερμοτης ψυχικη, ως τροπον τινα παντα ψυχης ειναι πληρη διο συνισταται ταχεως ὁποταν εμπεριληφθη* ‡. *In the univerſe there is a certain animal heat, ſo as that after a manner all things are full of mind; wherefore they are quickly completed (or made complete animals) when they have received a portion of that heat.* This *heat*, from which, according to Cicero ||, the Stagyrite derived all ſouls, has, it muſt be confeſſed, a very material appearance; inſomuch that the learned Moſheim ſeems to have been doubtful whether he admitted of any immaterial principle in man; but for this doubt there appears to us to be no ſolid foundation. Ariſtotle expreſsly declares, that *this heat is not fire* nor any *ſuch power, but a ſpirit which is in the ſeeds* or *elementary principles of bodies; τουτο δε ου πυρ, ουδε τοιαυτη δυναμις εστιν, αλλα το εμπεριλαμβανομενον εν τω σπερματι και εν τω αφρωδει πνευμα* §. And as the excellent perſon himſelf acknowledges (N), that Ariſtotle taught the exiſtence of two principles, God and matter, not indeed ſubſiſting

‡ *De Generatione Animalium*, lib. iii. cap. 11.

|| *Tuſcul.* lib. i. c. 3.

§ *De Generatione Animalium*, lib. ii. c. 3.

(M) "Plato triplicem finxit animam; cujus principatum, id eſt, rationem, in capite, ſicut in arce, poſuit: et duas partes ſeparare voluit, iram et cupiditatem, quas locis diſcluſit; iram in pectore, cupiditatem ſubter præcordia locavit." *Ciceronis Tuſc. Quæſt.* lib. i. cap. 10.

This hypotheſis has been adopted by the learned author of Ancient Metaphyſics: but it cannot be proved by argument, and is in direct oppoſition to conſciouſneſs. Were there three diſtinct minds in each man—the principles of intelligence, of paſſion, and of appetite, it is obvious that *each man* would be *three perſons*, and that *none* of theſe perſons could know any thing of the powers and properties of the *other two*. The intelligent perſon could not reaſon about *paſſion* or *appetite*; nor could the perſons who know nothing but paſſion and appetite reaſon about *intelligence*, or indeed about any thing elſe. The very queſtion at iſſue, therefore, furniſhes the moſt complete proof poſſible, that the ſame individual which each man calls himſelf, is the principle of intelligence, of paſſion, and of appetite; for if the Platonic hypotheſis were true, that queſtion could never have been ſtarted, as no one individual of the human race could have underſtood all its terms. It may be juſt worth while to mention, that the author of Ancient Metaphyſics, attributing all motion, and even the coherence of the minute particles of body, to the immediate agency of mind, of courſe furniſhes every human body with at leaſt *four minds*. This fourth mind differs not from the *plaſtic nature* of Cudworth, and is likewiſe a Platonic notion apparently better founded. That there are in our bodies motions perpetually carried on by the agency of ſomething which is not the principle of either our intelligence, our paſſions, or our appetites, is a fact which cannot be denied; but if thoſe motions proceed immediately from mind, it muſt either be from the *ſupreme* mind, or from ſome *ſubordinate* mind, acting under the ſupreme, but wholly *diſtinct from and independent* of that which each man calls himſelf.

(N) "Non cum illis componi prorſus poteſt ARISTOTELES, qui bina rerum ſeparataque ſtatuunt principia, Deum

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ing separately, but eternally linked together by the closest union; we think it follows undeniably, that this heat, from which he derived all souls, must be that mind which he called *God*, and which he considered as the actuating soul of the universe.

Upon these principles neither Aristotle nor the Stoics could believe with Plato, that in the order of nature there was first an emanation from the Supreme Mind to animate the universe, and then through this universal soul other emanations to animate mankind. The Stagyrite believed, that the Supreme Mind himself is the soul of the world, and that human souls are immediately derived from him. The genuine Stoics, acknowledging but one substance, of necessity considered both the souls and bodies of men as portions of that substance, which they called το εν; though still they affected to make some unintelligible distinction between body and mind. But however the various schools differed as to those points, they were unanimous as to the soul's being a part of the self-existing Substance; and Cicero gives their whole system from Pacuvianus in words which cannot be misunderstood:

> Quicquid est hoc, omnia animat, format, alit, auget, creat,
> Sepelit, recipitque in sese omnia, omniumque idem est Pater:
> Indidemque eadem, quæ oriuntur de integro, atque eodem occidunt.

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Upon these principles they maintained the necessary existence of the soul;

To these verses he immediately subjoins the following query: "Quid est igitur, cur, cum domus sit omnium una, eaque communis, cumque *animi hominum SEMPER FUERINT, FUTURIQUE SINT*, cur ii, quid ex quoque eveniat, et quid quamque rem significet, perspicere non possint *?" And upon the same principle he elsewhere argues, not merely for the immortality, but for the *eternity* and *necessary existence* of the soul: "Animorum nulla in terris origo inveniri potest: His enim in naturis nihil inest, quod vim memoriæ mentis, cogitationis habeat; quod et præterita teneat, et futura provideat, et complecti possit præsentia; quæ sola divina sunt. Nec invenietur unquam, unde ad hominem venire possint, nisi à Deo. Ita quicquid est illud, quod sentit, quod sapit, quod vult, quod viget, cæleste et divinum est; OB EAMQUE REM ÆTERNUM SIT NECESSE EST †." This was indeed securing the future permanency of the soul in the most effectual manner; for it is obvious, that what had not a beginning can never have an end, but must be of eternal and necessary existence.

* *De Divinatione*, lib. i. p. 57.

† *Frag. de Consolatione.*

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but not in its distinct and personal capacity.

But when the ancients attributed a proper eternity to the soul, we must not suppose that they understood it to be eternal in its *distinct* and *personal existence*. They believed that it proceeded or was *discerpted* in *time* from the substance of God, and would *in time* be again *resolved* into that substance. This they explained by a close vessel filled with sea water, which swimming a while upon the ocean, does, on the vessel's breaking, flow in again, and mingle with the common mass. They only differed about the time of this reunion; the greater part holding it to be at death; but the Pythagoreans not till after many transmigrations. The Platonists went between these two opinions; and rejoined pure and unpolluted souls immediately to the Universal Spirit; but those which had contracted much defilement, were sent into a succession of other bodies, to be purged and purified, before they returned to their parent substance *."

* *Warburton's Divine Legation.*

268
A similar doctrine held by the Bramins.

A doctrine similar to this of Plato has been held from time immemorial by the Bramins in India, whose sacred books teach, "That intellect is a PORTION of the GREAT SOUL of the universe, breathed into all creatures, to animate them for a certain time; that after death it animates other bodies, or returns like a *drop* into that *unbounded ocean* from which it first arose; that the souls of men are distinguished from those of other animals, by being endowed with reason and with a consciousness of right and wrong; and that the soul of him who adheres to right as far as his powers extend, is at death ABSORBED INTO THAT DIVINE ESSENCE, never more to re-animate flesh. On the other hand, the souls of those who do evil, are not at death disengaged from all the elements; but are immediately clothed with a body of fire, air, and *akash* (a kind of celestial element, through which the planets move, and which makes no resistance) in which they are for a time punished in hell. After the season of their grief is over, they reanimate other bodies: and when they arrive through these transmigrations at a state of purity, they are absorbed into God, where all PASSIONS are UTTERLY UNKNOWN, and where CONSCIOUSNESS IS LOST IN BLISS †."

† See *Preliminary Dissertation to Dow's History of Indostan.*

269
This doctrine incompatible with a future state of rewards and punishments, and

Whether the Greeks derived their notions of the divinity and transmigration of souls from the east, or whether both they and the Bramins brought the same doctrines at different periods from Egypt, it is foreign from the purpose of this article to inquire. Certain it is, that the philosophers of Greece and India argued in the very same manner, and upon the very same principles, for the *natural* immortality of the soul; and that the immortality which they taught was wholly incompatible with God's moral government of the world, and with a future state of rewards and punishments. That this is true of the doctrine of the Bramins, is evident from the last-quoted sentence: for if the soul, when absorbed into the Divine essence, loses all consciousness of what it did and suffered in the body, it cannot possibly be rewarded for its virtues practised upon earth. That the philosophers of Greece taught the same cessation of consciousness, might be inferred with the utmost certainty, even though we had not Aristotle's express declaration to that purpose: For as they all believed their souls to have existed before they were infused into their bodies, and as each must have been conscious that he remembered nothing of his former state (o), it was impossible to avoid concluding,

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Deum et materiam. Arctissime enim utrumque hoc initium conjunxit Stagyrita, atque ipsa naturæ necessitate Deum cohærere cum mole hac corporea putavit." *Cudworth's Intellectual System*, Book i. Chap. iv. Sect. 6. note 3.

(o) This is expresly acknowledged by Cicero, though he held with his Greek masters the eternity of the soul. In cluding, that in the future ſtate of his ſoul as little would be remembered of the preſent. Accordingly Ariſtotle teaches, that "the agent intellect only is immortal and eternal, but the paſſive corruptible,"—τουτο μονον αθανατον και αιδιον ὁ δε παθητικος νους φθαρτος *. Cudworth thinks this a very doubtful and obſcure paſſage; but Warburton, whoſe natural acuteneſs often diſcovered the ſenſe of ancient authors when it had eſcaped the ſagacity of abler ſcholars, has completely proved, that by the *agent intellect* is meant the *ſubſtance* of the ſoul, and by the *paſſive* its *particular perceptions*. It appears therefore that the Stagyrite, from the common principle of the ſoul's being a part of the Divine ſubſtance, draws a concluſion againſt a future ſtate of rewards and puniſhments; which though all the philoſophers (except Socrates) embraced, yet all were not ſo forward to avow.

* *De Anima*, lib. iii. cap. 6.

270 Groſsly abſurd in itſelf;

That the hypotheſis of the ſoul's being a part of the Divine ſubſtance is a groſs abſurdity, we ſurely need not ſpend time in proving. The argument long ago urged againſt it by St Auſtin muſt ere now have occurred to every reader. In the days of that learned father of the church, it was not wholly given up by the philoſophers; and in his excellent work of the *City of God*, he thus expoſes its *extravagance* and impiety: "Quid infelicius credi poteſt, quam Dei partem vapulare, cum puer vapulat? Jam vero *partes Dei* fieri *laſcivas*, *iniquas*, *impias*, atque omnino *damnabiles*, quis ferre poteſt niſi qui prorſus inſanit?

271 yet the only principle from which the ſoul can be inferred to be eſſentially immortal.

But though this hypotheſis be in the higheſt degree abſurd and wholly untenible, we apprehend it to be the only principle from which the *natural* or *eſſential* immortality of the ſoul can poſſibly be inferred. If the ſoul had a *beginning* it *may* have an *end*; for nothing can be more evident than that the being which had not exiſtence of itſelf, cannot of itſelf have perpetuity of exiſtence. Human works, indeed, continue in being after the power of the workman is withdrawn from them; but between human works and the Divine there is this immenſe difference, that the former receive from the artiſt nothing but their form; whereas the latter receive from the Creator both their form and their ſubſtance. Forms are nothing but modifications of ſubſtance; and as ſubſtances depend upon God and not upon man, human works are continued in being by that fiat of the Creator, which made the ſubſtances of which they are compoſed ſuſceptible of different forms, and of ſuch a nature as to retain for a time whatever form may be impreſſed upon them. Human works therefore are continued in being by a power different from that by which they are finiſhed; but the works of God depend wholly upon that power by which they were originally brought into exiſtence; and were the Creator to withdraw his ſupporting energy, the whole creation would ſink into nothing.

272 Baxter's argument for the natural or eſſential immortality of the ſoul.

Self-evident as this truth certainly is, ſome eminent philoſophers *ſeem* to have queſtioned it. "No ſubſtance or being (ſays Mr Baxter *) can have a natural tendency to annihilation, or to become nothing. That a being which once exiſts ſhould ceaſe to exiſt is a real effect, and muſt be produced by a real cauſe: But this cauſe could not be planted in the nature of any ſubſtance or *being* to become a tendency of its nature; *for it could not be a free cauſe*, otherwiſe it muſt be a *being* itſelf, the ſubject of the *attribute freedom*, and therefore not the property of another *being*; *nor a neceſſary cauſe*, for ſuch a cauſe is only the effect of ſomething impoſing that neceſſity, and ſo no cauſe at all."

* *Inquiry into the Nature of the Human Soul*, vol. i. ſect. 3.

273 Inconcluſive,

That the author's meaning in this argument is good, cannot, we think, be controverted; but he has not expreſſed himſelf with his uſual accuracy. He ſeems to confound *cauſes* with the *abſence* of cauſes, and the *effects* of the *former* with the *conſequences* of the *latter*. The viſible world was brought into exiſtence by the actual energy of the power of God; and as the viſible world had nothing of itſelf, it can *remain* in exiſtence only by a *continuance* of the *ſame energy*. This energy therefore is at the preſent moment as *real a cauſe* as it was ſix thouſand years ago, or at any period when it may have been firſt exerted; and the viſible world is its *real and permanent effect*. But would the ceaſing of this energy be likewiſe a *cauſe?* It would certainly be followed with the annihilation of the viſible world, juſt as the withdrawing of the ſun-beams would be followed with darkneſs on the earth. Yet as no one has ever ſuppoſed that darkneſs, a nonentity, is a *poſitive effect* of the ſun or of his beams, but only a mere negative conſequence of their abſence; ſo, we think, no one who believes in creation can conſider that deſtruction which would inevitably follow the withdrawing of the energy by which all things are ſupplied, as the *poſitive effect* of a contrary energy, or as any thing more than a *negative conſequence* of the ceaſing of that volition or energy of power by which God at firſt brought things into exiſtence. For "where the *foundation* of exiſtence lies *wholly* in the power of an infinite Being *producing*, the *ground* of the *continuance* of that exiſtence muſt be wholly in the ſame power *conſerving*; which has, therefore, with as much truth as frequency, been ſtyled a continued creation (P)."

274 and in effect given up by himſelf.

The force of this reaſoning Mr Baxter certainly ſaw, when he ſaid, that "a tendency to perſevere in the ſame ſtate of nature, and a tendency to change it, are contradictories, and impoſſible to be planted in the ſame ſubject at once: or, not to urge the contradiction, if the laſt prevailed, the remaining in the ſame ſtate for any given time would be impoſſible. We forget the true cauſe of all theſe tendencies, *the will of God*, which it is abſurd to ſuppoſe contrary to itſelf. The tendency in matter to perſevere in the ſame ſtate of reſt or motion, is nothing but *the will of the Creator*, who preſerves all things in their exiſtence and manner of exiſtence: nor can we have recourſe to any other cauſe

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In anſwer to ſome very fooliſh aſſertions concerning the evil of death, he ſays, "Ita, qui nondum nati ſunt, miſeri jam ſunt, quia non ſunt: et nos ipſi, ſi poſt mortem miſerì futuri ſumus, miſeri ſuimus antequam nati. Ego autem *non commemini, antequam ſum natus, me miſerum*. *Tuſcul.* lib. i. cap. 6.

(P) See Stillingfleet's *Origines Sacræ*, where this queſtion is treated in a very maſterly manner by one of the ableſt metaphyſicians of the 17th century. See alſo our article PROVIDENCE.

cauſe for the preſervation of immaterial ſubſtance in its exiſtence. Therefore theſe tendencies are to be aſcribed to the will of God, and it is abſurd to ſuppoſe them contrary."

275 Analogical evidence of the immortality of the ſoul, and a moral proof of a future ſtate of rewards and puniſhments.

All this is unqueſtionably true. The exiſtenee or nonexiſtence of matter and of created ſpirits depends wholly upon the will of God; and we cannot ſuppoſe him to be willing to-day the reverſe of what he willed yeſterday, becauſe we know that all his volitions are directed by unerring wiſdom. We have likewiſe the evidence of experience, that nothing is ever ſuffered to periſh but particular ſyſtems, which periſh only *as ſyſtems* by a decompoſition of their parts. A being, which like the ſoul has no parts, can ſuffer no decompoſition; and therefore, if it periſh, it muſt periſh by annihilation. But of annihilation there has not hitherto been a ſingle inſtance; nor can we look for a ſingle inſtance without ſuppoſing the volitions of God to partake of that unſteadineſs which is characteriſtic of man. Corporeal ſyſtems, when they have ſerved their purpoſe, are indeed reſolved into their component parts; but the matter of which they were compoſed, ſo far from being *loſt*, becomes the matter of *other ſyſtems* in endleſs ſucceſſion. Analogy, therefore, leads us to conclude, that when the human body is diſſolved, the immaterial principle by which it was animated continues to think and act, either in a ſtate of ſeparation from all body, or in ſome material vehicle to which it is intimately united, and which goes off with it at death; or elſe that it is preſerved by the Father of ſpirits, for the purpoſe of animating a body in ſome future ſtate. When we conſider the different ſtates through which that living and thinking *individual*, which each man calls himſelf, goes, from the moment that it firſt animates an embryo in the womb, to the diſſolution of the man of fourſcore; and when we reflect likewiſe on the wiſdom and *immutability* of God, together with the various diſſolutions of corporeal ſyſtems, in which we know that a ſingle atom of matter has never been loſt; the preſumption is certainly ſtrong, that the ſoul ſhall ſubſiſt after the diſſolution of the body. But when we take into the conſideration the *moral* attributes of God—his juſtice and goodneſs, together with the unequal diſtribution of happineſs and miſery in the preſent world; this preſumption from analogy amounts to a *complete moral proof* that there ſhall be a future ſtate of rewards and puniſhments (Q) (ſee Moral *Philoſophy* and Religion): and if we eſtimate the duration of the rewards by the benevolence of Him by whom they are to be conferred, we cannot imagine them ſhorter than eternity.

Chap. V. *Of* Necessity *and* Liberty.

276 Freedom of agency implied in accountableneſs.

In the preceding chapter we have adverted to that great *moral proof* for a future ſtate, and the immortality of the ſoul, ariſing from the relation in which man, as a being accountable for his conduct, ſtands to a God of almighty power, infinite wiſdom, and perfect juſtice. But the circumſtance of accountableneſs implies freedom of agency; for it is contrary to all our notions of right and wrong (ſee Moral *Philoſophy*), that a man ſhould be either rewarded or puniſhed for actions which he was neceſſitated or compelled to perform.

277 Every man has power to do what he wills:

Human actions are of three kinds: one, where we act by inſtinct, without any view to conſequenees; one, where we act by will, in order to obtain ſome end; and one, where we act againſt will. It is the ſecond kind of actions only which confers upon the agent merit or demerit. With reſpect to the firſt, he acts blindly (ſee Instinct), without deliberation or choice; and the external act follows from the inſtinctive impulſe, no leſs neceſſarily than a ſtone by its gravity falls to the ground. With reſpect to the laſt, he is rather an inſtrument than an agent; and it is univerſally allowed, that were a ſtrong man to put a ſword into the hand of one who is weaker, and then to force it through the body of a third perſon, he who held the ſword would be as guiltleſs of the murder as the ſword itſelf. To be entitled to rewards, or liable to puniſhment, a man muſt act voluntarily; or in other words, his actions muſt proceed from that energy of mind which is termed *volition;* and, we believe, it has never been denied, that all men have power to do whatſoever they *will*, both with reſpect to the operations of their minds and the motions of their bodies, uncontrouled by any foreign principle or cauſe. "Every man (ſays Prieſtley) is at liberty to turn his thoughts to whatever ſubject he pleaſes, to conſider the reaſons for or againſt any ſcheme or propoſition, and to reflect upon them as long as he ſhall think proper; as well as to walk wherever he pleaſes, and to do whatever his hands and other limbs are capable of doing." Without ſuch liberty as this, morality is inconceivable.

278 But different opinions entertained of the freedom of volition.

But though philoſophers have in general agreed with reſpect to the power which a man has to perform ſuch actions as he wills, they have differed widely in opinion reſpecting the nature of his volitions. That theſe are the reſult of motives, has ſeldom if ever been queſtioned; but whether that reſult be neceſſary ſo as that the agent has no ſelf-determining power to decide detween different motives, has been warmly diſputed by men equally candid, impartial, and intelligent. The principal writers on the ſide of neceſſity are, Hobbes, Collins, Hume, Leibnitz, Lord Kames, Hartley, Edwards, Prieſtley, and perhaps Locke. On the other ſide are Clarke, King, Law, Reid, Butler, Price, Bryant, Wollaſton, Horſley, Beattie, and Gregory,

(Q) It was by ſuch arguments that Socrates reaſoned himſelf into the belief of a future ſtate of rewards and puniſhments. He was ſingular, as we have already obſervéd, in this belief; and he was as ſingular in confining himſelf to the ſtudy of morality. "What could be the cauſe of this belief, but this reſtraint, of which his belief was a natural conſequence? For having confined himſelf to morals, he had nothing to miſlead him; whereas the reſt of the philoſophers, applying themſelves with a kind of fanaticiſm to *phyſics* and *metaphyſics*, had drawn a number of abſurd, though ſubtle, concluſions, which directly oppoſed the conſequences of thoſe moral arguments."
Warburton's Div. Leg. vol. ii.

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gory, &c. To give a ſhort view of this celebrated queſtion, is all that our limits will permit; and as we do not think ourſelves competent to ſettle the diſpute, it were perhaps a thing deſirable to give the oppoſite reaſonings in the words of thoſe eminent authors themſelves. It muſt, however, be obvious to the reader, that the ſtyle and manner of ſo many different writers are extremely various, and that to introduce them all into our abſtract, would make the whole a maſs of confuſion. We ſhall, therefore, ſelect one writer to plead the cauſe of neceſſity, ſupplying his defects from thoſe who, though inferior to him on the whole, may yet have argued more ably on ſome particular points which the queſtion involves; and to this combined reaſoning we ſhall ſubjoin ſuch anſwers as to us appear moſt concluſive. Hartley, Hume, and Prieſtley, are perhaps the moſt profound reaſoners on the ſide of neceſſity; but there is ſo much more perſpicuity in the arguments of Lord Kames, that we cannot help preferring them, as being on the whole better calculated to give the ordinary reader a fair view of the ſubject.

279 Scheme of neceſſity, according to Lord Kames.

"Into actions done with a view to an end (ſays his lordſhip *), deſire and will enter: deſire to accompliſh the end goes firſt; the will to act, in order to accompliſh the end, is next; and the external act follows of courſe. It is the will then, that governs every external act done as a mean to accompliſh an end; and it is deſire to accompliſh the end that puts the will in motion; deſire, in this view, being commonly termed the *motive* to act. But what is it that raiſes deſire? The anſwer is ready: It is the proſpect of attaining ſome agreeable end, or of evading one that is diſagreeable. And if it be inquired, what makes an object agreeable or diagreeable? the anſwer is equally ready: It is our nature that makes it ſo. Certain viſible objects are agreeable, certain ſounds, and certain ſmells: other objects of theſe ſenſes are diſagreeable. But there we muſt ſtop; for we are far from being ſo intimately acquainted with our own nature as to aſſign the cauſes.

* *Sketches of the Hiſtory of Man*, Book iii. Sketch 2. part 1. ſect. 8.

"With reſpect to inſtinctive actions, no perſon, I preſume, thinks that there is any freedom. With reſpect to voluntary actions, done in order to produce ſome effect, the neceſſity is the ſame, though leſs apparent at firſt view. The external action is determined by the will: the will is determined by deſire; and deſire by what is agreeable or diſagreeable. Here is a chain of cauſes and effects, not one link of which is arbitrary, or under command of the agent: he cannot will but according to his deſire; he cannot deſire, but according to what is agreeable or diſagreeable in the objects perceived: nor do theſe qualities depend on his inclination or fancy; he has no power to make a beautiful woman ugly, nor to make a rotten carcaſs ſmell ſweetly.

"Many good men, apprehending danger to morality from holding our actions to be neceſſary, endeavour to break the chain of cauſes and effects above mentioned; maintaining, that whatever influence deſire or motives may have, it is the agent himſelf who is the cauſe of every action; that deſire may adviſe, but cannot command; and, therefore, that a man is ſtill free to act in contradiction to deſire and to the ſtrongeſt motives.

"That a being may exiſt which in every caſe acts blindly and arbitrarily, without having any end in view, I can make a ſhift to conceive: but it is difficult for me even to imagine a thinking and rational being, that has affections and paſſions, that has a deſirable end in view, that can eaſily accompliſh this end; and yet after all can fly off or remain at reſt, without any cauſe, reaſon, or motive, to ſway it. If ſuch a whimſical being can poſſibly exiſt, I am certain that man is not that being. There is not, perhaps, a perſon above the condition of a changeling, but can ſay *why* he did ſo and ſo, what moved him, what he intended. Nor is a ſingle fact ſtated to make us believe that ever a man acted againſt his own will or deſire, who was not compelled by external force.—On the contrary, conſtant and univerſal experience proves, that human actions are governed by certain inflexible laws; and that a man cannot exert his ſelf-motive power but in purſuance of ſome deſire or motive.

"Had a motive always the ſame influence, actions proceeding from it would appear no leſs neceſſary than the actions of matter. The various degrees of influence that motives have on different men at the ſame time, and on the ſame man at different times, occaſion a doubt, by ſuggeſting a notion of chance. Some motives, however, have ſuch influence as to leave no doubt: a timid female has a phyſical power to throw herſelf into the mouth of a lion roaring for food; but ſhe is withheld by terror no leſs effectually than by cords: if ſhe ſhould ruſh upon a lion, would not every one conclude that ſhe was frantic? A man, though in a deep ſleep, retains a phyſical power to act, but he cannot exert it. A man, though deſperately in love, retains a phyſical power to refuſe the hand of his miſtreſs; but he cannot exert that power in contradiction to his own ardent deſire, more than if he were faſt aſleep. Now, if a ſtrong motive have a neceſſary influence, there is no reaſon for doubting, but that a weak motive muſt alſo have its influence, the ſame in kind, though not in degree. Some actions indeed are ſtrangely irregular; but let the wildeſt actions be ſcrutinized, there will always be diſcovered ſome motive or deſire, which, however whimſical or capricious, was what influenced the perſon to act. Of two contending motives, is it not natural to expect that the ſtronger will prevail, however little its exceſs may be? If there be any doubt, it muſt ariſe from a ſuppoſition, that a weak motive may be reſiſted arbitrarily. Where then are we to fix the boundary between a weak and a ſtrong motive? If a weak motive can be reſiſted, why not one a little ſtronger, and why not the ſtrongeſt? Between two motives oppoſing each other, however nearly balanced, a man has not an arbitrary choice but muſt yield to the ſtronger. The mind, indeed, fluctuates for ſome time, and finds itſelf in a meaſure looſe: at laſt, however, it is determined by the more powerful motive, as a balance is by the greater weight after many vibrations.

"Such, then, are the laws that govern our voluntary actions. A man is abſolutely free to act according to his own will; greater freedom than which is not conceivable. At the ſame time, as man is made accountable for his conduct to his Maker, to his fellow

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low creatures, and to himself, he is not left to act arbitrarily; for at that rate he would be altogether unaccountable: his will is regulated by desire; and desire by what pleases or displeases him.—Thus, with regard to human conduct, there is a chain of laws established by nature; no one link of which is left arbitrary. By that wise system, man is made accountable; by it he is made a fit subject for divine and human government: by it persons of sagacity foresee the conduct of others; and by it the prescience of the Deity with respect to human actions is clearly established."

Of the doctrine of necessity, a more perspicuous or plausible view than this is not to be found in any work with which we are acquainted. It is indeed defective, perhaps, as his lordship only *hints* at the *nature* of that relation which subsists between motive and action; but from his comparing the fluctuations of the mind between two contending motives, to the vibrations of a balance with different weights in the opposite scales, there is no room to doubt but that he agreed exactly in opinion with Mr Hume and Dr Priestley. Now, both these writers hold, that the relation of motives to volition and action, is the very same with that which subsists between cause and effect in physics, as far as they are both known to us.

280 Mr Hume, and

"It is universally allowed (says Mr Hume *), that matter, in all its operations, is actuated by a necessary force; and that every natural effect is so precisely determined by the energy of its cause, that no other effect, in such particular circumstances, could possibly have resulted from it. The degree and direction of every motion is, by the laws of nature, prescribed with such exactness, that a living creature may as soon arise from the shock of two bodies, as motion in any other degree or direction than what is actually produced by it. Would we, therefore, form a just and precise idea of *necessity*, we must consider whence that idea arises, when we apply it to the operation of bodies. But our idea of this kind of necessity and causation arises entirely from the uniformity observable in the operations of nature, where similar objects are constantly conjoined together, and the mind is determined by custom to infer the one from the appearance of the other. These two circumstances form the whole of that necessity which we ascribe to matter. Beyond the *constant conjunction* of similar objects, and the consequent *inference* from one to the other, we have no notion of any necessity or connexion." He then gives a pretty long detail to prove a great uniformity among the actions of men in all nations and ages; and concludes that part of his argument with affirming, "not only that the conjunction between motives and voluntary actions is as regular and uniform as that between the cause and effect in any part of nature; but also, that this regular conjunction has been universally acknowledged among mankind, and has never been the subject of dispute either in philosophy or common life." He afterwards observes, "That men begin at the wrong end of this question concerning liberty and necessity, when they enter upon it by examining the faculties of the soul, the influence of the understanding, and the operations of the will. Let them first discuss a more simple question, namely, the operations of body, and of brute unintelligent matter, and try whether they can there form any idea of causation and necessity, except that of a constant conjunction of objects, and subsequent inference of the mind from one to another. If these circumstances form in reality the whole of that necessity which we conceive in matter, and if these circumstances be also universally acknowledged to take place in the operations of the mind, the dispute is at an end; at least must be owned to be thenceforth merely verbal. When we consider how aptly *natural* and *moral* evidence link together, and form only one chain of argument, we shall make no scruple to allow that they are of the same nature, and derived from the same principles.—Between a connected chain of natural causes and voluntary actions, the mind feels no difference in passing from one link to another; nor is less certain of a future event which depends upon motives and volitions, than if it were connected with the objects present to the memory and senses by a train of causes, cemented together by what we are pleased to call a *physical* necessity. The same experienced union has the same effect on the mind, whether the united objects be motives, volition and action, or figure and motion. We may change the names of things, but their nature and their operation on the understanding never change."

* *Inquiry concerning Human Understanding*, sect. 8.

281 Dr Priestley.

Dr Priestley, in words a little different, teaches the very same doctrine which was taught by Mr Hume.—"In every determination of the mind (says he *), or in cases where volition and choice are concerned, all the previous circumstances to be considered are the *state of mind* (including *every thing belonging to the will itself*), and the *views of things* presented to it; the latter of which is generally called the *motive*, though under this term some writers comprehend them both. To distinguish the *manner* in which events depending upon *will* and *choice* are produced, from those in which no volition is concerned, the former are said to be produced *voluntarily*, and the latter *mechanically*. But the same general maxims apply to them both. We may not be able to determine *à priori* how a man will act in any particular case; but it is because we are not particularly acquainted with his *disposition of mind*, *precise situation*, and *views of things*. But neither can we tell in which way the wind will blow to-morrow, though the *air* is certainly subject to no other than necessary laws of motion.

* *The Doctrine of Philosophical Necessity illustrated.*

"It is universally acknowledged, that there can be no effect without an adequate cause. This is even the foundation on which the only proper argument for the being of a God rests. And the necessarian asserts, that if, in any given state of mind, with respect both to *disposition* and *motives*, two different determinations or volitions be possible, it can be so on no other principle, than that one of them shall come under the description of an *effect without a cause*; just as the beam of a balance might incline either way, though loaded with equal weights. It is acknowledged, that the mechanism of the balance is of one kind, and that of the mind of another; and, therefore, it may be convenient to denominate them by different words; as, for instance, that of the balance may be termed a *physical*, and that of the mind a *moral* mechanism. But still, if there be a *real mechanism* in both cases, so that there can be only one result

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result from the same previous circumstances, there will be a *real necessity*, enforcing an absolute certainty in the event. For it must be understood, that all that is ever meant by *necessity in a cause*, is that which produces *certainty in the effect*."

Such is the nature of human volitions, according to every necessarian of eminence who has written on the subject since the days of Hobbes: and if this theory be just, if there be a constant and inseparable conjunction of motives and actions similar to that of cause and effect in physics, it is obvious, that in volition the mind is as inert as body is in motion.

282 View of human liberty.

This consequence is indeed avowed and insisted upon by Hume, Priestley, and their adherents; whilst the advocates for human liberty, on the other hand, contend for an absolute exemption of the will from all internal *necessity*, arising from its own frame and constitution, the impulse of superior beings, or the operations of objects, reasons, or motives, &c. By this they do not mean, that between motives and volitions there is no relations whatever, or that a man can ever choose evil as evil, or refuse good as good. Such an assertion would be contrary to consciousness and universal experience. But what they endeavour to prove is, that the conjunction of motive and volition is not inseparable, like that of cause and effect in physics; that a man may in most cases choose according to any one of two or more motives presented to his view; that by choosing any thing, he may make it in some measure agreeable by his own act, or, to speak more properly, may bend his desire to it; that in volition, the mind is not inert; and that, therefore, we are under no *necessity* to act in a particular manner in any given case whatever.

That the conjunction of motive and action is not constant like that of cause and effect in physics, and that by consequence the mind in forming volitions is not inert, has been evinced by Dr Gregory with the force and precision of mathematical demonstration.—Former writers on the side of liberty had often observed, that upon the supposition of the *inertia* of mind, a man, with equal and opposite motives presented at once to his view, would, during their continuance, remain perfectly at rest, like a balance equally loaded in both scales. The observation is admitted to be just by all the advocates for necessity; but they contrive to evade its consequences, by denying that in any given case a man can be at once assailed by two equal and opposite motives. Thus, when it is said that a porter, standing with his face due north, must remain in that position at perfect rest, as long as equal motives shall at once be offered to him for travelling eastward and westward, the necessarians admit the force of the argument; but when it is added that a guinea, offered for every mile that he should travel in each of these opposite directions, ought therefore to fix him at rest till one of the offers be withdrawn, they deny that the desire of gaining the guineas is the *whole* of the motives which operate upon his mind. He may have, say they, some secret reason which we cannot discern for preferring the one direction to the other; and that reason, added to the guinea, will make him go eastward or westward, just as an ounce thrown into either scale of a balance poised by equal weights will make that scale preponderate. Though we think that this solution of the difficulty can satisfy no man who is not already biassed to the necessarian system; and though, even were it to be admitted, it seems to militate against the constant conjunction of motives and actions, unless it can be proved that the porter must travel the road which he has been necessitated to choose with reluctance and a heavy heart; yet as it may admit of endless quibbling upon ambiguous words, the philosophical world is much indebted to Dr Gregory † for an argument which, in our opinion, can neither be overturned nor evaded, and which demonstrates that the conjunction of motive and action cannot be constant and inseparable, like that of cause and effect in physics.

† *Essay on the Relation between Motive and Action.*

283 Demonstration that the conjunction of motive and action is constant.

His reasoning is to this purpose: Suppose a porter to be offered a guinea for every mile that he shall travel directly eastward. If there be no physical cause or moral motive to keep him at rest, or to induce him to move in another direction, there cannot be a doubt, upon either hypothesis, but he will glady embrace the proposal, and travel in the direction pointed out to him, till he shall have gained as much money as to satisfy his most avaricious desires. The same thing would have happened, if a guinea had been offered for every mile that he should travel due south. In these two cases taken separately, the relation between the man's motions and his actions would be strikinglly analogous to that between a single impulse and motion in physics. Let us now suppose the two offers to be made at the same instant, and the man to be assured that if he travel eastward he can have no part of the reward promised for his travelling to the south, and that if he travel southward he can have no part of the reward promised for his travelling to the east. What is he to do in this case? If his mind be inert in volition, and if the two motives operate upon him with the same necessity that causes operate in physics, it is obvious that the man could travel neither towards the east nor towards the south, but in a diagonal direction from north-west to south-east; and this he must do *willingly*, although perfectly satisfied that he could gain nothing by his journey. As this inference is contrary to fact and universal experience, the doctor very justly concludes that the premises, from which it is deduced by mathematical reasoning, must be false and absurd; or, in other words, that the relation between motive and action cannot be that of constant conjunction, like the relation between cause and effect in physics.

He uses many arguments of the same kind, and equally convincing, to prove the absurdity of supposing the inertness of mind, and only an occasional conjunction of motives and actions; but we forbear to quote them, both because we wish his book to be read, and because we think the single argument which we have borrowed from him sufficient to demolish the theory of Priestley and Hume, which rests wholly upon the hypothesis of the *constant* conjunction of motive and action.

But is it then not really true, that the external action is determined by the will, the will by desire, and desire by what is agreeable or disagreeable? That the external action is universally determined by the will, is certainly true; but that the will is necessitated and universally determined by the desire is as certainly false. If Potiphar's

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Potiphar's wife was handsome, and made her proposals to Joseph with any degree of female address; and if his constitution was like that of other young men; there cannot be a doubt but that he felt a *desire* to do what she requested of him: yet we know that he *willed* to do otherwise, and in direct opposition to his *desire* fled from the room. Perhaps it may be said, that his volition to flee was the effect of a contrary and stronger *desire* not to sin against God; but this is confounding the reader, by calling two energies of mind, between which there is little or no similarity, by the same name. He perceived, or knew, that to comply with his mistress's request would be to sin against God; he knew that he ought not to sin against God, and therefore he chose or determined himself not to do it. We can easily conceive how the presence, attitudes, and address, of the lady might be agreeable to him, and excite desire. There may very possibly be more than one of our readers, who, during the course of their lives, have experienced something of the same kind: but could abstract truth be in the same way agreeable, so as to excite in his mind a *desire* of virtue sufficient to annihilate or banish the *desire* of the woman? As well may it be said that one sensation can annihilate another, that the beautiful colours of the rainbow can remove the sensation of stench from the mind of him who is plunged into the midst of a dunghill, or that the smell of a rose can make a man insensible to the pain of a stroke inflicted by a bludgeon. Sensitive desire, and the perception of duty, are things so totally different, that to consider them as operating against each other, like different weights in the opposite scales of a balance, is as absurd as to suppose that sound can operate against colour, or colour against smell. A man may prefer sound to colour, or colour to smell, and act accordingly; but the determination must be wholly his own, unless these two sensations be themselves either agents or physical causes of the *same kind*, like the weights in the opposite scales of the balance.

284 Men do not always determine themselves by the strongest motive.

The advocates for liberty do not pretend, that in matters of importance a man ever acts without some motive or reason for his conduct. All that they insist upon is, that between two or more motives of different kinds he has a liberty of choice, and that he does not always determine himself by that which he knows to be the greatest. Without such freedom, they think men might be often brought into situations where they could not act at all, and where inaction would at the same time be in the highest degree absurd. Thus, were two bags of gold containing each a thousand or ten thousand guineas, to be placed on the same table, before a man whose family is perishing for want, and were the man to be told that he might take either of them, but not both, is it conceiveable that he would be held in perpetual suspense between the two? No; he would instantly and with alacrity take up one of them, without feeling the least regret for the want of the other. This action would, indeed, be the consequence of a very powerful motive, the desire to obtain honestly that wealth of which he and his family stood so much in need. That motive, however, being general, would draw him equally to both bags; and it remains with the necessarians to say by what else than a self determining power he could take either the one or the other. When it is affirmed, that such self-determination would be an effect without a cause, the advocates for liberty cannot help thinking that their antagonists are guilty of advancing as an argument a *petitio principii*; for the affirmation is true, only if the mind in volition be inert, and the *inertia* of the mind is the sole question at issue. If the mind be not inert, it is plain, that in consequence of a man's self-determination, no effect would be produced without a sufficient cause. At any rate, motives cannot be causes. In the proper sense of the word, a cause is that which produces an effect; but the production of an effect requires active power; and power being a quality, must be the quality of some being by whom it may be exerted. Power may be dormant, and therefore power without will produces no effect. Are motives, then, real beings endowed with power and will? No; they are only views of things or mental conceptions, which in the strictest sense of the word are passive; and between two motives the mind determines itself, without receiving an impulse from either.

Nor is it only between motives of equal force that men have the power of determining themselves. Whoever believes in a future state of rewards and punishments, and yet acts in a manner which he knows to be offensive to Him who is to be the future and final judge, unquestionably prefers to the strongest of all motives, another which even to himself appears to have comparatively but very little strength. Whether there be men who occasionally act in this manner, is a question which can be decided only by an appeal to every one's consciousness. That there are, we can have no doubt; for we never met with a single individual, not biassed by system, who was not ready to acknowledge, that during the course of his life he had done many things, which at the time of action he clearly perceived to be contrary to his true interest. Without a self-determining power in the mind, this could never be the case. Did motives operate with the necessity of physical causes, it is obvious that in every possible situation the strongest must constantly prevail; and that he who in certain circumstances had in time past done any particular thing, would on a return of the same circumstances do the very same thing in every time future. Dr Priestley, indeed, wishes to persuade his readers that this is actually the case. "In every determination of the mind (says he), or in cases where volition and choice are concerned, all the previous circumstances to be considered are the *state of mind* (including) *every thing belonging to the will itself*), and the various views of things presented to it;" and he affirms, that "whenever the same precise circumstances occur twice, the very same determination or choice will certainly be made the second time that was made the first." This is an assertion of which no man can controvert the truth; for it is an identical proposition. If in the circumstances previous to the determination of the mind, *every thing* belonging to the *will itself* must be included, it is self-evident that he who in any given circumstances has acted a particular part, will on a return of these circumstances act the same part a second time; for this is only saying, that he who on two different occasions shall exert volitions of the same tendency, will not on these occasions exert volitions of which the tendencies are different. But the question to

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to be decided is, Whether a man, in the same general state of mind, possessed of the same degree of health, and conscious of the same appetites, must, in external circumstances perfectly alike, necessarily exert at all times the same volitions. That the human mind is under no such necessity, we think every man's consciousness and experience may abundantly satisfy him; for there are, perhaps, but very few who have not at one time resisted temptations, to which at another they have chosen to yield.

285 If they did, folly as well as merit and demerit would be banished from the world.

That there is a relation between motives and actions, must be confessed; but that relation is neither *necessity*, nor constant conjunction. If it were, all actions would be perfectly rational; and folly, as well as merit and demerit, would be banished from the conduct of men. What is the particular nature of that relation which subsists between the voluntary actions of men, and the motives from which they proceed, can be known to every individual only by an attentive and unbiassed reflection on the operations of his own mind. Without this reflection, no man can be made to understand it by the reasonings of philosophers, and with it no man can need the aid of those reasonings. That a self-determining power, such as that for which we plead, contributes to the sum of human happiness, has been shown by Archbishop King and his ingenious translator; who have proved, with the force of demonstration, that the mind can take pleasure in the object of its choice, though that object be in itself neither agreeable nor disagreeable to our natural appetites; and that if it could not, it would be in vain in such a world as ours to hope for any portion of felicity. Into that detail our limits will not permit us to enter: but to the reader who wishes for further information, we beg leave to recommend the last edition of King's Origin of Evil, by Dr Law late bishop of Carlisle; without, however, vouching for the truth of all the opinions advanced by either of those learned writers.

Before we conclude this chapter, it may be proper to observe, that it is only in volition that we are conscious of any original active power in ourselves, and that without such consciousness we could never have acquired the *notion* of active power. In our desires and appetites, we neither are active nor suppose ourselves active. Lord Kames, and most necessarians, confound desire with volition; but that they are perfectly distinct is plain from this circumstance, that we daily *desire* many things which we know to be wholly *out* of our own power*, whereas no man ever *willed* what he did not believe to be *in* his own power. We all *desire* or wish that our children may be virtuous, wise, and happy; and though we are conscious that it is not in our power to make them so, we cannot banish the desire from our breasts. But madmen only have ever *willed* virtue, wisdom, and happiness, to any person; and if there was ever a man so extravagantly mad as to exert such a volition as this, he has at the time fancied himself a divinity, and therefore believed that the object of his volition depended upon himself. When the astronomer, whose character is so admirably drawn by our great master of moral wisdom †, fancied himself the regulator of the weather and the distributor of the seasons, he might *will* either *rain* or *sunshine* as he thought proper, because he considered the object of his volition as depending upon a power imparted to him from heaven; but though he might *desire* he could not *will*, the rising or the falling of *winds*, for these he confessed were not subjected to his authority. In a word, without freedom in volition, power is inconceivable; and therefore it is as certain that we are free agents, as that we have any notion of active powers.

* *Reid's Essays on the Active Powers of Man*

† *Rasselas Prince of Abyssinia.*

Of the Being and Attributes of God.

Chap. VI. *Of the* Being *and* Attributes *of* God.

It has been already observed, that as of bodies there are various kinds, endowed with various properties; so the probability is, that of minds endowed with different powers, or different degrees of power, the variety may be as great, or perhaps greater. The existence and powers of our own minds are made known to us by consciousness and reflection; and from our dependent state, and the mutability of the objects around us, we are necessarily led to infer the existence of another mind, which is independent, unchangeable, eternal, and the cause of all things which have a beginning of existence. Between that mind and our own, we can hardly avoid believing that there are many orders of "thrones, dominations, princedoms, virtues, powers;" but as we have no intuitive knowledge of such intermediate beings, and cannot from any thing which we perceive discern the *necessity* of their existence, they are not properly the object of science. The existence however, and many of the attributes, of One First Cause, are capable of the strictest demonstration; "for the invisible things of Him from the creation of the world are clearly seen, being understood by the things which are made." 286 The existence of God capable of demonstration.

Of this great truth, the most important by far which can occupy the mind of man, many demonstrations have been given both by divines and by philosophers. We shall lay before our readers such a one as to us appears perfectly conclusive, being founded on the intuitive knowledge which we have of our own existence, and therefore independent of all theories about the nature and reality of the material world.

Every man, whether he adopt the common theory or that of Berkeley respecting matter, is conscious that he *himself* exists, and must therefore grant that *something now* exists. But, if any thing exists *now* *, then must something have *always* existed; otherwise that thing which *now* exists, must either have been created by *nothing*, i. e. have been *caused by no cause*, or else it must have *created itself*, acting before it existed. Both these suppositions are so palpably absurd, that no atheist has avowed them, either among the ancients or the moderns. We must therefore admit, either that there is some one *independent* being, which now exists, and always has existed; or that the things which we know to exist at present (every man's *self* for instance), were produced by *something* which had its *existence* from *something else*, which also depended upon *some other cause*, and so on in an *infinite series of caused* or *successive beings*. But this last supposition, though it has been often made, is as grossly absurd as either of the two former. For of this infinite series, either *some one* part has *not* been successive to any other or 287 Some one independent Being has existed from eternity,

* See *Notes to King's Origin of Evil*.

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or elſe *all* the ſeveral parts of it have been ſucceſſive. If ſome one part of it was *not ſucceſſive*, then it had a *firſt part;* which deſtroys the ſuppoſition of its infinity (R). If *all* the ſeveral parts of it have been ſucceſſive, then have they all once been *future;* but if they have *all* been future, a time may be conceived when none of them had exiſtence: and if ſo, then it follows, either that all the *parts*, and conſequently the *whole* of this infinite ſeries, muſt have ariſen from *nothing*, which is abſurd; or elſe that there muſt be ſomething in the *whole* beſides what is contained in *all the parts*, which is alſo abſurd.

As the poſſibility or impoſſibility of an infinite ſeries of dependent beings is the main queſtion at iſſue between the atheiſts and us, we ſhall ſtate the preceding reaſoning in a manner ſomewhat different. For this purpoſe, let us ſuppoſe ſome one to affirm, that the courſe of generation has had no beginning, and conſequently that the number of ſucceſſive births has been infinite. We would aſk ſuch a perſon, Whether before the birth of Abraham, for example *, there had paſt an infinite ſeries of generations or not? If not, the courſe of generation muſt have had a beginning, which is the concluſion for which we contend. But if the ſeries paſt was infinite, then at the birth of Joſeph the great-grandſon of Abraham, it is evident, that more generations were paſt, and that the number then was greater than that which was ſuppoſed to be infinite; ſo that upon this ſuppoſition we have a number that is both infinite and not infinite, which is a manifeſt contradiction. Should it be ſaid that the number of generations was infinite, as well at the birth of Abraham as at the birth of Joſeph; it will then follow, that one infinite may be greater than another of the very ſame kind; and conſequently that an infinite may be bounded, i. e. be finite. But ſhould it be alleged, that the number of births at Abraham's was finite, and became infinite when it reached to Joſeph's, it will then follow, that one finite number added to another may make an infinite number, which is directly contrary to every poſſible notion of infinity. We might argue in the ſame manner againſt an infinite ſeries of every kind, the very ſuppoſition of which involves the moſt palpable contradictions. See Chap. *Of* INFINITY *and* ETERNITY.

* See an *Eſſay towards an Eviction of the Being and Attributes of God, by Seth Ward* —Printed at Oxford, 1655.

288 whoſe duration is not commenſurate with ſucceſſion, and

From the impoſſibility of an infinite ſeries it neceſſarily follows, that there exiſts, and muſt have exiſted from eternity, ſome one independent being, whoſe duration cannot be commenſurate with ſucceſſion, and to whom the relation of time is not applicable. Here will ſome atheiſts preſently imagine, that by the ſame mode of reaſoning they may diſprove the exiſtence of God: for do not they who thus deſtroy the eternity of the world, deſtroy at the ſame time the eternity of the Creator? If time itſelf be not eternal, how can the Deity or any thing elſe be ſo?

In urging theſe queſtions, it muſt be taken for granted that time is eſſential to all exiſtence, and that God cannot be eternal otherwiſe than by a ſucceſſive flux of infinite time. But it has been already ſhown (N° 224.), that ſucceſſive duration is not eſſential to exiſtence; that we can even *conceive* exiſtence without ſucceſſion; and it may here be added, that if we ſuppoſe a perfect being alone in nature, we ſhall find it impoſſible to imagine any *ſucceſſion of ideas*, any *flux of moments*, or any *alteration* or *increaſe* whatever in his knowledge and eſſence. Such duration as we are acquainted with can have no relation to an immutable Being, while ſuppoſed to exiſt alone; but as ſoon as he determined to exerciſe his ſeveral attributes in the production of ſomething diſtinct from himſelf, then, and not till then, have we reaſon to think that *time*, *ſucceſſion*, and *increaſe*, began. Theſe atheiſtical queſtions, therefore, inſtead of containing an objection to the exiſtence of a Deity, afford a plain demonſtration of it: for ſince it is not more evident that ſomething now exiſts than that ſomething muſt have exiſted from eternity; and ſince it has been ſhown, that neither the world in its preſent ſtate, nor time, nor any thing capable of change or ſucceſſion, can poſſibly be eternal; it follows, that there muſt neceſſarily be ſome Being who, in the order of nature, is before time, and who, in the ſtability and immutable perfection of his own intelligence, comprehends at once his *yeſterday*, *to-day*, and *for ever*. "The atheiſts (ſays the excellent Cudworth *) can here only ſmile, or make wry faces, and ſhow their little wit in quibbling upon *nunc ſtans*, or a *ſtanding now of eternity;* as if that *ſtanding eternity* of the *Deity* (which with ſo much reaſon hath been contended for by the ancient *genuine theiſts*) were nothing but a *pitiful ſmall moment of time ſtanding ſtill*, and as if the duration of all beings whatſoever muſt needs be like our own: whereas the duration of every thing muſt of neceſſity be agreeable to its nature; and therefore, as that whoſe *imperfect nature* is ever *flowing* like a river, and conſiſts in *continual motion* and *change* one after another, muſt needs have accordingly a *ſucceſſive* and *flowing duration* ſliding perpetually from *preſent* into *paſt*, and always haſting on towards the *future*, expecting ſomething of itſelf which is not yet in being; ſo muſt that whoſe perfect nature is *eſſentially immutable* have *permanent and unchanging duration*, never loſing any thing of itſelf once preſent, nor yet running forward to meet ſomething of itſelf which is not yet in being."

* *Intellectual Syſtem*, book i. chap. 5.

289 who is ſelf-exiſtent, and

From the eternity of the Supreme Being we neceſſarily infer his independence or ſelf-exiſtence; for that which never had a *beginning* of exiſtence cannot poſſibly have any cauſe of that exiſtence, or in any manner depend upon any other being, but muſt exiſt of itſelf, or be *ſelf exiſtent*.

290 cannot ceaſe to be.

Eternity *ad partem poſt*, or *neceſſary exiſtence*, or the impoſſibility of ever ceaſing to be, follows from independence: For to the nature of that which exiſts without any cauſe, exiſtence muſt be eſſential. But a being whoſe exiſtence is of itſelf and eſſential to its nature, cannot be *indifferent* to exiſtence or nonexiſtence, but muſt exiſt *neceſſarily*. And here it may be proper to obſerve, that the word *neceſſity*, when applied to exiſtence, may be taken in two acceptations very different from each other †; either as it ariſes from the relation which the exiſtence of that being, of which it is affirmed, has to the exiſtence of *other things;* or from the relation which the *actual* exiſtence of that thing has to the *manner* of its *own* exiſtence.

† *Notes to King on Evil*, and *Law's Inquiry into the Ideas of Space*, &c.

In

(R) Των απειρων ουκ εϛιν ουδεν πρωτον, *Ariſt. Phyſ.* lib. viii. cap. 5. ſect. 4.

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In the former sense, when necessity of existence has relation to the existence of other things, it denotes that the supposition of the *non*-existence of that thing of which necessity is affirmed, implies the non-existence of things which we *know to exist*. Thus, some independent being does *necessarily exist*; because, to suppose *no independent* being, implies that there are *no dependent beings*; the contrary of which we know to be true.

291 What is meant by necessary existence.

In the second sense, when the necessity of existence arises from the relation which the actual existence of any thing has to the *manner* of its own existence, necessity means, that the thing, of which it is affirmed, exists after such a manner as that it never could in *time past* have *been nonexistent*, or can in *time future cease to be*. Thus, *every independent being*, as it exists without a cause, *is necessarily* existing; because existence is *essential* to such a being; so that it never could *begin* to exist, and never can *cease to be*: For to suppose a being to begin to exist, or to lose its existence, is to suppose a *change* from nonentity to entity, or *vice versa*; and to suppose such a change is to suppose a cause upon which that being depends. Every being, therefore, which is independent, i. e. which had no cause of its existence, must exist *necessarily*, and cannot possibly have begun to exist in time past, or cease to be in time future.

292 Only one necessarily existent being in the former sense; and

These two kinds of necessity as applied to existence, though they have been often confounded, are in themselves perfectly distinct: For though a being cannot be necessarily existent in the *former* sense without being so in the latter also; yet may it be necessarily existent in the latter sense without being so in the former. For any thing that we know to the contrary, there may be two or more beings existing *necessarily* in the latter sense of the word *necessity*, i. e. with regard to *independence* and the *manner* of their own existence: but in the former sense of the word, i. e. in relation to *this system*, there can be but *one necessarily* existent being; for it is obvious that no more are necessary to account for the production of the *dependent* beings which we know to exist. To suppose the non-existence of *all independent* beings, implies the non-existence of all dependent beings, ourselves, and every thing else; but to suppose the non-existence of all independent beings except *one*, involves in the supposition no such absurdity.

293 though there might be more than one in the latter, they would be no gods to us.

Thus the phenomena of nature lead us, by the strictest reasoning, to one first cause, which is sufficient for their production; and therefore none but *one* first cause can in this sense of the word be *necessary*: And though several more *independent* beings might possibly exist, yet they would be no gods to us: they would have no relation to us demonstrable by reason, nor we any thing to do with them. For if the supposition of their existence were not requisite to the production of this system, which it obviously would not be, we could *perceive* no necessity for it at all; we could never discover it by our own faculties, and therefore it could be nothing to us. And though two or three such beings should exist, and act in the formation and government of their *respective* systems, or *agree in one*; yet till their existence and operations were made known to us, and a natural relation discovered, nothing would be due from us to them. They would have no *religious* or *moral* relations to us; and we should have no reason to call more than one of them *our* creator, preserver, and governor, which is the proper sense of the word *God*.

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294 Impossible to demonstrate that there can be but one self-existent Being.

To show in this manner that there is only *one* eternal self-existent Being which bears the relation of *God to us*, seems to be going as far as is necessary, or as natural light will lead us. Those who endeavour to *demonstrate* that there *cannot possibly* be *more than one* self-existent Being, either reason in a circle, or proceed upon principles which their antagonists cannot be compelled to grant. When they deduce the Divine unity from independence or omnipotence, they evidently presuppose it in their definition of these attributes: and when they infer it from the nature of space and duration, which they consider as modes of the self-existent Being, they take it for granted, that space and duration have a real existence, independent of us and our thoughts; and that the one is infinite and the other eternal, contrary to what has been already proved, we think, with the force of demonstration. The celebrated Dr Clarke made much use of space and duration in his attempt to demonstrate that there can be but one self-existent Being; but he argues for the same thing from the nature of necessity as applied to existence.

293 Dr Clarke's first demonstration of the unity

"Necessity (says he *), absolute in itself, is *simple* and *uniform* and *universal*, without any possible *difference*, *difformity*, or *variety*, whatsoever: and all *variety* or *difference* of *existence* must needs arise from some *external* cause, and be *dependent upon it*, and *proportionable* to the efficiency of that *cause*, whatsoever it be. *Absolute necessity*, in which there can be *no variation* in *any kind* or *degree*, cannot be the *ground* of existence of a *number* of beings, however *similar* and *agreeing*: because, without any *other difference*, even *number* is itself a manifest *difformity* or *inequality* (if I may so speak) of *efficiency* or *causality*."

* *Demonstration of the Being and Attributes of God*, Prop. 7.

296 examined, and shown to be inconclusive.

Such is this great man's first argument from necessity, to prove that there cannot be more than one self-existent Being. But what is this *necessity* which proves so much? It is the ground of existence (he says) of that which exists of itself; and if so, it must, in the order of nature, and in our conceptions, be antecedent to that being of whose existence it is the ground. Concerning such *a* principle, there are but three suppositions which can possibly be made; and all of them may be shown to be absurd and contradictory. We may suppose either the *substance* itself, some *property* of that substance, or something *extrinsic* to both, to be this *antecedent ground* of existence prior in the order of nature to *the first cause*.

One would think, from the turn of the argument which here represents this antecedent necessity as *efficient* and *causal*, that it were considered as something *extrinsic* to the first cause †. Indeed if the words have any meaning in them at all, or any *force* of argument, they must be so understood, just as we understand them of any external cause producing its effect. But as an *extrinsic* principle is absurd in itself, and is besides rejected by Dr Clarke, who says expressly, that " of the thing which derives not its being from any other thing, this *necessity* or ground of existence must be *in* the thing itself," we need not say a word more of the last of these suppositions.

† *Dissertation on the Argument à priori*, added to *Law's Inquiry into the Ideas of Space, Time, Immensity*, &c.

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Let us then consider the first; let us take the *substance* itself, and try whether *it* can be conceived as *prior* or *antecedent* to itself in our conceptions or in the order of nature. Surely we need not observe that nothing can be more absurd or contradictory than such a supposition. Dr Clarke himself repeatedly affirms, and it would be strange indeed if he did not affirm, that no *being*, no *thing* whatever, can be conceived as in any respect prior to the first cause.

The only remaining supposition is, that some *attribute* or *property* of the self-existent Being may be conceived as in the order of nature *antecedent* to that being. But this, if possible, is more absurd than either of the two preceding suppositions. An *attribute* is *attributed* to its *subject* as its ground or support, and *not* the *subject* to its *attribute*. A *property*, in the very notion of it, is *proper* to the substance to which it belongs, and *subsequent* to it both in our conceptions and in the order of nature. An *antecedent* attribute, or *antecedent* property, is a solecism as great, and a contradiction as flat, as an *antecedent subsequent* or *subsequent antecedent*, understood in the same sense and in the same syllogism. Every property or attribute, as such, presupposes its subject; and cannot otherwise be understood. This is a truth so obvious and so forcible, that it sometimes extorts the assent even of those who upon other occasions labour to obscure it. It is confessed by Dr Clarke *, that "the scholastic way of proving the *existence* of the self-existent Being from the absolute perfection of his nature, is ὑστερον προτερον. For all or any perfections (says he) presuppose existence; which is a *petitio principii*." If therefore properties, modes, or attributes in God, be considered as perfections (and it is impossible to consider them as any thing else), then, by this confession of the great author himself, they must all or any of them *presuppose* existence. It is indeed immediately added in the same place, "that bare necessity of existence does not presuppose, but infer existence;" which is true only if such necessity be supposed to be a principle *extrinsic*, the absurdity of which has been already shown, and is indeed universally confessed. If it be a *mode* or *property*, it must *presuppose* the existence of its subject, as certainly and as evidently as it is a *mode* or a *property*. It might perhaps *à posteriori* infer the existence of its subject, as effects may infer a cause; but that it should infer in the other way *à priori* is altogether as impossible as that a *triangle* should be a *square*, or a *globe* a *parallelogram*.

* *Answer to the Sixth Letter.*

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A second demonstration of the same author

Doubtful, as it would seem, of the force of his first argument, which even those who pretend to be convinced by it acknowledge to be obscure, the doctor gives a second, which we must confess appears to us to be still more obscure, and if possible less conclusive. "To suppose two or more *distinct beings* existing *of themselves* necessarily and *independent* of each other, implies (he says) this *contradiction*, that *each* of them being independent from the other, they may either of them be supposed to exist *alone*; so that it will be no contradiction to suppose the other not to exist; and consequently *neither of them* will be necessarily existing. Whatsoever therefore exists necessarily is the one simple essence of the self-existent Being; and whatsoever differs from that is not necessarily existing, because in absolute necessity there can be no *difference* or *diversity* of existence.

"Necessity is used here in two different senses *, both as *absolute* and *relative*. In the former, neither of the two beings can exist without the other, i. e. without our supposing the other to exist also, since that is equally necessary. In the latter, either of them may exist alone, i. e. as without the help of the other, or without the supposition of the other as requisite to its own existence. The consequence, therefore, that either of them may exist alone, and so neither of them is necessary, is a mere *equivocation* on *necessity*, using it both in an absolute and relative sense at the same time." But as this is a question of the highest importance, and as the author was a man of great worth, we shall consider his argument upon the supposition that the word *necessity* has from the beginning to the end of it the same invariable meaning.

* *Law's Inquiry into the Ideas of Space*, &c. chap. 6.

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examined, and shown to be equally inconclusive.

It has been already observed, that there are only two senses in which that word can be applied to the existence of any being; and whether it be here used in the one or the other of these senses, the reasoning, if resolved into a syllogism, will appear to be inconclusive. If the word be taken in that sense of necessity which arises from the relation that dependent beings which we know to exist bear to some one independent Being, the argument will stand thus:

> From a known effect no more causes can be *necessarily* inferred than what are sufficient to account for that effect; but
> *One* self-existent and independent Being is sufficient to account for all the phenomena of nature; therefore, from the phenomena, &c.
> *No more* than *one* such Being can be *necessarily* inferred to exist.

But though no more than *one* independent being can in this sense of the word *necessarily* exist, it by no means follows from this syllogism, that two or more such beings may not *possibly* exist. It is, indeed, a plain contradiction to say, that two or more self existent beings are in this sense *necessary*; but surely there is no contradiction in saying, that two or twenty such beings are *possible*. We could not, therefore, by this argument convict a person of absurdity, who should affirm that two or more independent beings *actually* exist. We might, indeed, deny the existence of them all but *one*, because one is sufficient to account for those phenomena, from which alone we know that *any* independent being exists: but because one of them might be supposed to exist *alone*, so that it would be no contradiction to suppose the other not to exist; we know not how the doctor came to affirm, in direct opposition to his own demonstration, that *not one* of them would be necessarily existing.

Necessity, as applied to existence, in the other sense of the word, arises, as we have seen, from the relation which the *actual* existence of the being, of which it may be affirmed, has to the *manner* of that being's existence. It is the same necessity, we are told *, with that which is the cause of the unalterable proportion between two and four; and it is considered as the *formal* cause or *ground* of the existence of an independent being. Were it not for the strange expressions *formal cause* and *ground* of *existence*, we should have no objection to this account of that *necessity* by which a being independent undoubtedly exists: but this kind of

* *Answer to the Sixth Letter* from a Gentleman in Gloucestershire.

of neceſſity is a principle which will not ſupport the ſuperſtructure which the learned author labours to raiſe upon it. The ſame *neceſſity* which is the cauſe of the unalterable proportion between *two* and *four*, is likewiſe the cauſe of the unalterable proportion between *three* and *ſix*, between *four* and *eight*, and between *five* and *ten*, &c. But if it can be the cauſe of ſo many different proportions of the ſame kind, why may it not be the *formal cauſe* or *ground* of exiſtence to as *many independent beings* of the ſame kind as well as to *one?* The following ſyllogiſm, we apprehend, to be legitimate both in mode and figure, and its concluſion is directly contrary to the propoſition which the doctor deduces from the ſame notion of neceſſity.

> If neceſſity, conſidered as a *formal cauſe* or *ground of exiſtence*, be in *one inſtance* of its cauſality the formal cauſe or ground of exiſtence to *many things* of the ſame kind, it *may* likewiſe in *every other inſtance* of its cauſality, be the formal cauſe or ground of exiſtence to many things of the ſame kind.
>
> But ſuch neceſſity, in that inſtance of its cauſality where it is the formal cauſe or ground of exiſtence to the unalterable proportion between two and four, *is* the formal cauſe or ground of exiſtence to *many proportions* of the ſame kind.
>
> Therefore, the ſame neceſſity in that other inſtance of its cauſality, where it is ſaid to be the formal cauſe or ground of exiſtence to *one* independent being, undoubtedly *may be* the formal cauſe or ground of exiſtence to *many independent beings* of the ſame kind.

299 Neceſſity, a dangerous principle.

Thus it appears, that *neceſſity*, in any ſenſe in which it can be properly affirmed of exiſtence, cannot be the foundation of any argument to prove the impoſſibility of more than one ſelf-exiſtent being. It is indeed a principle from which we apprehend that no poſitive concluſion whatever can be deduced by reaſoning *à priori*. That neceſſity of exiſtence may be predicated of a being which is independent and uncreated, is ſelf-evident; becauſe to the *nature* of ſuch a being, exiſtence is eſſential. But whilſt *that nature* itſelf remains wholly *incomprehenſible* by us, it is impoſſible that we ſhould diſcover, by our own unaſſiſted reaſon, whether it can be the nature of *only one*, or of *more than one*, independent being. To argue from neceſſity, as if it were the cauſe or ground of exiſtence to ſuch a being, is certainly abſurd, if it be not impious; for if that to which exiſtence is eſſential, does not exiſt without any cauſe efficient or formal, we ſhall be obliged to inquire after a cauſe or ground of this cauſe, and thus be involved in all the abſurdities and contradictions of an infinite ſeries. We have inſiſted the longer on this point, becauſe *neceſſity*, as the foundation of the argument *à priori*, has ſometimes been employed to very bad purpoſes. Attempts have been made from the notion of *neceſſary* exiſtence, to prove that the Supreme Being cannot be a free agent, and to ſet the firſt principles of the religion of nature at variance with thoſe which are revealed in the Scriptures.

300 The unity of God highly probable.

But though we are firmly perſuaded that the divine unity cannot be *demonſtrated à priori*, we are far from thinking it incapable of any *proof*. On the contrary, the common arguments *à poſteriori* drawn from the *order* and *harmony* of the world, have always ſatisfied us, and in our opinion muſt ſatisfy every perſon capable of proportioning his aſſent to evidence, that the Creator and Preſerver of ſuch a ſyſtem has but *one will* and *one intelligence*, and therefore is himſelf but *one being*. But *proof* is one thing, and *demonſtration* is, in the proper ſenſe of the word, another (G). And if we cannot arrive at *abſolute* certainty concerning this important truth by the light of nature, we ought to be the more thankful for that revelation, which has put the unity of God paſt diſpute to all who believe the holy Scriptures.

301 God omnipotent.

The being which is ſelf-exiſtent and independent muſt be alſo *omnipotent*. That ſuch a being has *active power in ſome degree*, is ſhown at the ſame time and by the ſame medium that we prove his exiſtence; and ſince he depends upon no cauſe for his exiſtence or his power, he cannot depend upon any for the exertion of that power, and conſequently no *limits* can be applied to it. Limitation is an *effect* of ſome *ſuperior cauſe*, which in the preſent inſtance there cannot be: conſequently to ſuppoſe *limits* where there can be no *limiter*, is to ſuppoſe an *effect* without a *cauſe*. For a being to be *limited* or *deficient* in any reſpect *, is to be *dependent* in that reſpect on ſome *other* being which gave it juſt ſo much and no more; conſequently that being which in *no reſpect* depends upon any other is in *no reſpect* limited or deficient. In all beings capable of increaſe or diminution, and conſequently incapable of *perfection* or *abſolute infinity*, *limitation* or *defect* is indeed a neceſſary conſequence of exiſtence, and

* *Notes to King on Evil.*

(G) John Gerhard and John Voſſius both cite *Gabriel Biel* as acknowledging the unity of God to be incapable of rigid demonſtration; and with the ſentiments of that ſchoolman, thoſe two learned divines profeſs their own to agree.

Sed Biel (1 Sant. Diſt. 2. Q. 10. Art. 3.), ſtatuit "quod tantum *unum* eſſe Deum, ſit *creditum* et *non-demonſtratum* ratione naturali nobis in via poſſibili." Id nos ita interpretamur; etiamſi ex *naturæ libro* rationes *non contemnendæ* pro *unitate* divinæ eſſentiæ aſſerenda erui poſſint, eas tamen ad fidei πληροφοριαν cordibus noſtris ingenerandum, non ſatis efficaces eſſe. Ergo mens prius confirmanda eſt ex *verbo Dei*, et illuſtribus teſtimoniis in quibus ſe Deus generi humano patefecit: Poſtea utiliter poteſt addi conſideratio philoſophicarum demonſtrationum. *Gerhard. Loc. Comm.* tom. i. p. 106.

Diſſentit *Gabriel Biel*, qui ante annos hoſce 140 *Tubingenſi* Gymnaſio præfuit. Is cenſet *probabiles* magis rationes eſſe quam *evidentes* et *certas*.—Verum eſto ſane, ut ſolæ non ſint αποδεικτικαι: At magnum iis pondus addit *traditio* vetus; tum autem quod argumenta iſthæc, ſi non prorſus αποδεικτικα, ſaltem uſque adeo *probabilia* ſint, ut της πολυθειας patroni nihil ullius momenti adferre valeant; cur pluſquam unum ſtatuere deum potius conveniat. *Voſſ. de Idolatria*, lib. i. c. 2.

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and is only a *negation* of that perfection which is wholly incompatible with their nature; and therefore in theſe beings it requires no further cauſe. But in a being *naturally capable* of *perfection* or abſolute *infinity*, all *imperfection* or *finiteneſs*, as it cannot flow from the *nature* of that being, ſeems to require ſome *ground* or *reaſon*; which reaſon, as it is foreign from the being itſelf, muſt be the effect of ſome other external cauſe, and conſequently cannot have place in the *firſt cauſe*. That the ſelf-exiſtent being is *capable* of perfection or abſolute infinity muſt be granted, becauſe he is manifeſtly the ſubject of one infinite or perfect attribute, viz. *eternity*, or abſolute invariable exiſtence. In this reſpect his exiſtence has been ſhown to be perfect, and therefore it *may* be perfect in every other reſpect alſo. Now that which is the ſubject of one infinite attribute or perfection, muſt have all its attributes infinitely or in perfection; ſince to have any perfections in a finite limited manner, when the ſubject and theſe perfections are both *capable* of ſtrict *infinity*, would be the forementioned abſurdity of poſitive limitation without a cauſe. To ſuppoſe this eternal and independent being limited *in* or *by* its own *nature*, is to ſuppoſe ſome *antecedent nature* or *limiting quality* ſuperior to that being, to the exiſtence of which no *thing*, no *quality*, is in any reſpect *antecedent* or *ſuperior*. And to ſuppoſe that there is no ſuch thing as *active power* in a being which is evidently the fountain of all power, is the groſſeſt of all abſurdities. The ſame method of reaſoning will prove knowledge and every other perfection to be *infinite* in the Deity, when once we have proved that perfection to belong to him at all; at leaſt it will ſhow, that to ſuppoſe it limited is unreaſonable, ſince we can find no manner of *ground* for limitation in any reſpect; and this is as far as we need go, or perhaps as natural light will lead us.

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Omnipotence can do every thing which does not imply a contradiction.

Of the omnipotence of the ſupreme Being ſome philoſophers, as well theiſts as atheiſts, have talked very abſurdly. *Hobbes* *, with a view to make this attribute appear impoſſible and ridiculous, affirms "that God by his omnipotence or infinite power could turn a tree into a ſyllogiſm." And *Des Cartes* †, though certainly no atheiſt, childiſhly aſſerts, that all things whatever, even abſtract truth and falſehood, do ſo depend upon the arbitrary will and power of God, as that if he had pleaſed, "twice two ſhould not have been four, nor the three angles of a plain triangle equal to two right ones." But the true notion of Omnipotence, ſo far from implying a power to turn a tree into a ſyllogiſm, or to make twice two not equal to four, implies only that the being poſſeſſed of it can actually perform whatever can be conceived by the moſt perfect underſtanding; conception in this caſe being the meaſure of poſſibility. Now every thing may be conceived by a mind ſufficiently enlarged which does not involve in it a direct contradiction; but what we clearly diſcern to imply a contradiction, ſuch as that a thing may be and not be at the ſame inſtant, cannot be conceived by any intellect, or made to exiſt by any power.

* *Leviath.* chap. 3.

† *Reſponſ. ad Objectiones Sextas*, § 6.

And thus has this attribute of the Divinity been always ſtated, not only by the wiſer Chriſtians, but alſo by moſt of the ancient philoſophers themſelves, who expreſsly admit that "nothing is exempted from the divine power, but only to make that which hath been done to be undone (H)."

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Creation poſſible to Omnipotence.

And here it may be aſked, Whether creation, in the proper ſenſe of the word (ſee CREATION), be within the compaſs of infinite power. All the ancient philoſophers, who were unenlightened by the rays of divine revelation, held that it is not *; grounding their opinion upon this maxim, *Ex nihilo nihil fit*. But the maxim will ſupport no ſuch concluſion.—The ancients, or at leaſt the Peripatetic ſchool, with the metaphyſics of which we are beſt acquainted, conſidered four kinds of cauſes, the *efficient*, the *material*, the *formal*, and the *final*; and though they extended the maxim to the firſt *two*, if not to all theſe cauſes, it is a ſelf-evident truth only when applied to the *efficient cauſe*. Without the actual exertion of *power*, it is indeed moſt certain that nothing could be brought into exiſtence; but it is ſo far from being clear that pre-exiſtent matter, or, as Ariſtotle choſe to expreſs himſelf, a *material cauſe*, muſt be ſuppoſed for infinite power to operate upon, that, we think, every man may find complete evidence of the contrary in himſelf. That ſenſation, intelligence, conſciouſneſs, and volition, are not the reſult of any modifications of figure and motion, is a truth as evident as that conſciouſneſs is not ſwift, nor volition ſquare. If then theſe be the powers or properties of a being diſtinct from matter, which we think capable of the completeſt proof, every man who does not believe that his mind has exiſted and been conſcious from eternity, muſt be convinced that the power of creation has been exerted in himſelf. If it be denied that there is any immaterial *ſubſtance* in man, ſtill it muſt be confeſſed, that, as matter is not eſſentially conſcious, and cannot be made ſo by any particular organization, there is ſome real *thing* or *entity*, call it what you pleaſe, which has either exiſted and been conſcious from eternity, or been in time brought from non-entity into exiſtence by an exertion of infinite power.

* See *Moſheim's Diſſertation on this Subject, in his Edition on Cudworth's Intellectual System.*

To this perhaps ſome one may object, that upon our own ſuppoſition of the inability of the human mind to exert its faculties but in union with ſome material and organized ſyſtem, the mind of every man may have exiſted from eternity without being conſcious of its own exiſtence; and that, therefore, we have in ourſelves no evidence of *creation*, but only of the union of two ſelf-exiſtent ſubſtances, which, in their prior ſtate, had been diſtinct and ſeparate from each other. But ſuch an objection as this, we beg leave to reply, can ariſe from nothing but miſapprehenſion of our hypotheſis, and of the reaſons by which we think it ſupported. We ſuppoſe, that to the exertion of the human faculties, a body of ſome kind or other may be neceſſary as an inſtrument, not merely from what we obſerve of the dependence of perception

(H) Το δε γεγονος ουκ ενδεχεται μη γενεσθαι· διο αγαθως Αγαθων.
Μονου γαρ αυτου και θεος στερισκεται,
Αγενητα ποιειν, άσσ᾽ αν ᾖ πεπραγμενα. *Ariſt. ad Licomach.* lib. vi. cap. 2.

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tion and memory on the state of the brain, but because we cannot conceive a Creator of infinite wisdom and goodness to immerse in systems of matter, minds to which he knows that such systems must be always useless and often hurtful. We believe, therefore, that our souls and bodies were created and formed for each other; but as our present adversaries admit not of a Creator, we must ask them, How their self-existent souls have been disposed of from eternity, and by what power they have all in due succession been united each to its proper body? As before the union they were not conscious, they could not unite themselves; and to suppose them united by some superior intelligence, is to suppose them in some respects dependent on that intelligence, which seems not to accord with their self-existence. Whatever is self-existent and eternal must be independent; and if possessed of any power, cannot be conceived to have that power limited.—We repeat, therefore, that every man has in himself sufficient evidence that creation is possible; for if infinite power can create an immaterial and percipient being, it may surely be supposed capable of creating dead and unintelligent matter.

But the creation of the material system may be shown to be in the highest degree probable by other arguments. The same reasoning which proves the impossibility of an infinite series and of eternal time, proves that the universe cannot have existed from eternity in its present state. But if it has not existed from eternity in its present state, it belongs to the opponents of creation to say what was its former. We talk indeed of *chaos;* but such language, when a Creator is not admitted, is most unphilosophical trifling. It appears from the most accurate inquiries that have been made into the substance and essence of body *, that the atoms of which each mass is composed are held together by a foreign force. If by chaos be meant matter, when this force is supposed to be removed, we must beg leave to say, that of such a substance we have neither idea nor notion, and cannot distinguish it from nonentity. The original atoms of matter, we believe indeed to require no other agency to keep each entire than that *fiat* by which it was created; but still, as those atoms are conceived to be solid and extended, they must be capable of division by infinite power; and if that *fiat* or influence which makes them solid and extended were removed, they would lose solidity and extension, and of course become nothing. So far is it, therefore, from being true, that the creation of matter appears to be impossible, that we are compelled by every thing that we know of it to believe that matter cannot possibly be self existent.

* *Baxter's Inquiry into the Nature of the Human Soul.*

"Because it is undeniably certain, concerning ourselves (says Cudworth †), and all imperfect beings, that none of these can create any *new substance*, men are apt to measure all things by their own scantling, and to suppose it universally impossible for any power whatever thus to create. But since it is certain, that imperfect beings can themselves produce *some things* out of nothing pre-existing, as *new cogitations, new local motion*, and *new modifications* of things corporeal, it is surely reasonable to think that an absolutely perfect Being can do *something more*, i. e. create *new substances*, or give them their whole being. And it may well be thought as easy for God or an Omnipotent Being, to make a whole world, matter and all, ἐξ οὐκ ὄντων, as it is for us to create *a thought* or to move a finger, or for the sun to send out rays, or a candle light; or lastly, for an opaque body to produce an image of itself in a glass or water, or to project a shadow: all these imperfect things being but the *energies, rays, images*, or *shadows*, of the Deity. For a substance to be made out of nothing by *God*, or a *Being infinitely perfect*, is not for it to be made out of nothing in the impossible sense, because it comes from him who is *all*. Nor can it be said to be impossible for any thing whatever to be made by that which hath not only *infinitely greater perfection*, but also *infinite active power*. It is indeed true, that infinite power itself cannot do things in their own nature impossible; and, therefore, those who deny creation, ought to prove, that it is absolutely impossible for a *substance*, though not for an *accident* or *modification*, to be brought from non-existence into *being*. But nothing is in itself impossible, which does not imply a contradiction: and though it be a contradiction for a thing to be and not to be at the same time, there is surely no contradiction in conceiving an imperfect being, which before was not, afterwards to be." To call in question the possibility of creation, because we have no *adequate conception* how a thing can be brought into existence, would be in the highest degree absurd; for it may be doubted, whether we have *adequate* conceptions of any thing except our own ideas and their various relations (1).

† *Intellectual System*, book i. chap. 5.

304 God a free agent; but

The Being which is self-existent, omnipotent, and omniscient, is not a *necessary*, but a *free* agent; for *active*

(1) "Ridicula foret et inepta ejus temeritas, qui corporum ideo creationem sibi duceret negandum esse, quod ejus creationis *clarum et perspicuam notionem* effingere cogitatione nobis haud licet. Infinita enim est rerum copia, quarum perspicuis et apertis caremus notionibus. Et si omnia neganda continuo nobis essent, quorum confusam tantum et imperfectam consequi possumus notionem, omnia fere nobis essent neganda, exceptis *relationibus*, quas inter notiones quasdam abstractas esse intelligimus. Quis interiorem sibi naturam rerum, tam corporum, quam spirituum, cognitam esse dixerit? Et esse tamen has naturas, omni plane dubitatione vacat. Quis quemadmodum altera harum naturarum agat in alteram, sese scire, affirmet? Quis causas sibi patere, propter quas hi vel illi effectus, quos videmus quotidie contingere, a certis veniant corporibus, jure glorietur? Nec tamen quisquam est, qui vel illam animæ in corpus operationem, vel hos effectus in dubium revocare ausit. Teneamus igitur ea, quæ certo novimus, nec idcirco nos ab illis dimoveri patiamur, quod multa rursus sunt, quorum naturam ignoramus; contra multa nos fugere et cognitionem nostram superare, æquo et tranquillo feramus animo." *Joannis Clerici contra eos qui negant, ex nihilo ulla ratione fieri posse aliquid, observationes; in Moshemii edit. Intellec. Syst.*

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tive power implies *freedom*, and *infinite* power *infinite* freedom. What, therefore, hath no bounds set to its power, what can have no opposition made to its will, nor restraint laid on its actions, must both will and act freely. "If the Supreme Cause were not a being endowed with liberty and choice, but a mere necessary agent, then would it follow, as Dr Clarke well observes *, that nothing which is not, could *possibly* have been; and that nothing which is, could *possibly* not have been; and that no mode or circumstance of the existence of any thing could *possibly* have been in any respect otherwise than it now actually is. All which being evidently most false and absurd; it follows, on the contrary, that the Supreme Cause is not a mere necessary agent, but a Being endued with liberty and choice."

* *Demonstration of the Being and Attributes of God.*

To this reasoning it has been lately replied †, that "Clarke must have known, that all those who contend against the free agency of the Deity, do of course acknowledge, that nothing could have happened, or does happen, or will happen, but what actually has happened, or doth happen, or will happen; and that it is most false and absurd to deny it." It is, therefore, according to the necessarians, absolutely impossible, that at present there could exist upon this earth more or fewer persons than are now actually alive; that the earth could move in any other direction than from west to east; or that there could be more or fewer planets in the solar system. Yet is it most certain, that there *have been fewer persons* on the earth than there are now; that there is not a cultivated country in Europe which could not contain *more* people than now inhabit it; that the comets move in very different directions from that of west to east; and that as, till very lately, we *conceived* only six primary planets in the system, it is evidently *possible* that the system *might contain* no more. Upon the supposition, therefore, that the Supreme Being acts under a physical necessity, the same things are possible and not possible at the same time, which is the grossest of all absurdities. It might have been objected with much more plausibility, that the First Cause cannot possibly be free, because he must needs do always what is best in the whole; but it will be seen by and by, that among different created systems, there is no reason for supposing any one absolutely *best*.

† *Cooper's Tracts.*

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himself unchangeable.

But though this Being be *free*, and as such the author of *change* in other beings, yet he must himself be *unchangeable*; for all changes have a beginning, and consequently are effects of some *prior causes*. But there can be nothing prior to the existence of this Being, as he is *eternal*; neither any *cause* of it, as he is *independent*; nor consequently any *change* in it, except we could suppose him to *change himself*, which is the same absurdity as to *produce* himself, i. e. to be at *the same time both effect* and *cause*.

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Omniscience, &c. proved in a different manner.

Omniscience, as well as some of the foregoing attributes of the Supreme Being, may perhaps be more easily deduced thus ‡. We find in ourselves such qualities as *thought* and *intelligence*, *power* and *freedom*, &c. for which we have the evidence of consciousness as much as for our own existence. Indeed it is only by our consciousness of these that our existence is known to ourselves. We know likewise that these are *perfections*, and that to have them is better than to be without them. We find also that they have not been in us from eternity. They must, therefore, have had a *beginning*, and consequently some *cause*, for the very same reason that a *being* beginning to exist in time requires a cause. Now this cause, as it must be *superior* to its *effect*, must have those perfections in a *superior* degree; and if it be the *first cause*, it must have them in an *infinite* or *unlimited* degree, since *bounds*, or *limitation* without a limiter, would, as we have already shown, be an *effect* without a *cause*.

‡ *Notes to King on Evil.*

It is indeed obvious, that the *omniscience* of the Supreme Being is implied in his very existence. "For all things being not only present to him, but also entirely *depending* upon him, and having *received* both their *being* itself and all their powers and faculties *from him*, it is manifest that as he knows all things that are, and penetrates every part of their substance with his all-seeing eye, so must he likewise know *all possibilities* of things, that is, all effects that *can be*. For, being alone self-existent, and having alone given to all things all the powers and faculties with which they are endued, it is evident that he must of necessity know perfectly what all and each of these powers and faculties, *which are derived wholly from himself*, can possibly produce. And seeing at one boundless view, or more properly in his own ideas, all the possible compositions and divisions, variations and changes, circumstances and dependencies of things, all their possible relations one to another, and their dispositions or fitnesses to certain and respective ends, he must without possibility of error know exactly what is best and properest in every one of the numberless possible cases, or methods of disposing things; and understand perfectly how to order and direct the respective means to bring about what he so knows to be in its kind, or on the whole, the best and fittest in the end. This is what is meant by infinite wisdom, or omniscience *;" and it has been readily admitted by every man who has believed in the existence of a God, as the creator and preserver of all things.

* *Clarke's Demonstration*, &c.

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God foreknows the actions of free agents.

Doubts, however, have been entertained by theists, and pious theists, whether omniscience itself can certainly foreknow what are called contingent events, such as the actions of free agents; and some few there are professing to be even Christians, who have boldly pronounced such knowledge to be impossible. That we have no adequate notion *how* events, which are called contingent, can be certainly foreknown, must indeed be granted; but we are not, therefore, authorized to say that such knowledge is impossible, unless it can be clearly shown to imply a contradiction. They who suppose that it implies a contradiction, must likewise suppose, that, where there is not a chain of necessary causes, there can be no certainty of any future event; but this is evidently a mistake. "For let us suppose that there is in man a power of beginning motion, and of acting with what has been of late called *philosophical* freedom; and let us suppose farther that the actions of such a man cannot possibly be foreknown; will there not yet be in the nature of things, notwithstanding this supposition, the same *certainty of event* in every one of the man's actions, as if they were ever so fatal and necessary? For instance, suppose the man, by an internal principle of motion, and an absolute freedom of mind, to do some particular action *to-day*, and suppose it was

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was not possible that this action should have been foreseen *yesterday*, was there not nevertheless the same *certainty of event* as if it had been foreseen, and absolutely necessary? That is, would it not have been as *certain a truth* yesterday, and from eternity, that this action was in event *to be performed to-day*, notwithstanding the supposed freedom, as it is now a *certain and infallible truth* that it is performed? Mere *certainty of event*, therefore, does not in any measure imply *necessity* *." And surely it implies no contradiction to suppose, that every future event which in the nature of things is *now certain*, may *now be certainly known* by that intelligence which is omniscient. The *manner* how God can foreknow future events, without a *chain of necessary causes*, it is indeed impossible for us to explain: yet some sort of *general notion* of it we may conceive. "For, as a man who has no influence over another person's actions, can yet often perceive beforehand what that other will do; and a wiser and more experienced man, with still *greater probability* will foresee what another, with whose disposition he is perfectly acquainted, will in certain circumstances do; and an angel, with still *less degrees of error*, may have a further prospect into men's future actions: so it is very reasonable to conceive, that God, without influencing men's wills by his power, or subjecting them to a chain of necessary causes, cannot but have a knowledge of future free events, as much *more certain* than men or angels can possibly have, as the *perfection* of *his* nature is greater that that of *theirs*. *The distinct manner how* he foresees these things we cannot, indeed, explain; but neither can we explain the *manner* of numberless other things, of the reality of which, however, no man entertains a doubt †." We must therefore admit, so long as we perceive no contradiction in it, that God always knows all the free actions of men, and all other beings endued with liberty; otherwise he would know many things now of which he was once ignorant, and consequently his *omniscience* would receive addition from events, which has been already shown to be contrary to the true notion of infinity.—In a being incapable of change, knowledge has nothing to do with *before* or *after*. To every purpose of knowledge and power, all things are to him equally present. He knows perfectly every thing that is, and what to us is future he knows in the very same manner as he knows what to us is present.

* Clarke's *Demonstration*.

† Clarke's *Demonstration*, &c.

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God infinitely perfect, all-sufficient, and omnipresent.

Thus have we demonstrated the necessary existence of a being who is *eternal*, *independent*, *unchangeable*, *omnipotent*, *free in his actions*, and *omniscient*; and this is the being whom we worship as God. *Eternity*, *independence*, *immutability*, *omnipotence*, *liberty*, and *omniscience*, which seem to be all the *natural* attributes which we can discover in the divine nature, as they are conceived to be differently combined, make us speak of him in different terms. His enjoying in an absolute manner every conceivable power or perfection, makes us call him a Being *infinitely perfect*. His being capable of no want, defect, or unhappiness of any kind, denotes him to be *all sufficient in himself*; and the unlimited exercise of his knowledge and power, demonstrates him to be *omnipresent*. That such a Being must be incomprehensible by us, and by every creature, is a truth self-evident; and yet in all ages men of the best intentions have been vainly attempting this impossibility. The manner of his omniscience, for instance, has been the subject of much disputation among those who ought to have reflected that they know not how their own minds were present to their own bodies.—The celebrated Dr Clarke and his adherents, who considered space as the *sine qua non* of all other things, insisted, that God must be infinitely extended; and that, as wherever his substance is, there his attributes must be, it is thus that his knowledge and power are present with every creature. But this notion labours under insuperable difficulties.

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The manner of the divine omnipresence incomprehensible.

For "if the Divine substance be infinitely extended, then will there be part of it in this place and part in that. It must be commensurate with all particular beings, so that some will occupy more and some less of its dimensions. By this account it will be very proper and philosophical to say, that God is not in *heaven*, but only a *part* of him; and that an *elephant* or a *mountain*, a *whale* or a wicked *giant*, have more of the essence or presence of God with them, than the *holiest* or *best* man in the world, unless he be of equal size: all which, as has been well observed *, are at least harsh and grating expressions. As the attributes of the Divine Being must be considered in the same manner with his substance, we shall likewise, upon this notion of omnipresence, have a part of his knowledge and power in this place, and a part of them in that; and of these parts the one must be greater or less than the other, according to the dimensions of the place with which it is commensurate; which is a supposition that appears to us harsher, if possible, than even the former.

* Watt's *Essays*, and Law's *Inquiry into the Ideas Space, Time, Immensity*, &c.

"Should it be said that the divine attributes are not to be considered as having parts (though we see not how they can be considered otherwise than as their subject), they must then exist *completely* in every point of this immense expansion. Be it so; and what follows? Why, every point of this infinitely expanded being will be omniscient and omnipotent by itself; an inch of it will have as much wisdom and power as a yard, a mile, or the whole; and, instead of one infinite wisdom and power, we shall have millions: For as these parts of the substance are conceived *distinctly*, and one individual part is not another, so must the attributes be likewise conceived, and the individual power and knowledge of one part be distinct from that of another." And if so, it follows, that one point of this expanded being has equal power and intelligence with the whole; so that the notion of extension being *necessary* to God's presence with every creature, involves in it the most palpable contradiction. That God is at all times and in all places so present with every creature as to have an absolute knowledge of and power over it, is indeed capable of the strictest demonstration; but we think it great presumption to assign the particular *mode* of his presence, especially such a one as is neither agreeable to the nature of an absolutely perfect Being, nor in the least necessary to the exercise of any one perfection which he can be proved to possess. Philosophers and divines have offered several names for the manner in which God is present with his works; but we choose rather to confess, that the *manner* of his presence is to us, and probably to every creature, wholly incomprehensible. Nor need we be be surprised or staggered at this, when we reflect that the manner in which our own minds are present

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preſent with our bodies is to us as incomprehenſible as the manner in which the ſupreme Mind is preſent with every thing in the univerſe. That our minds have a power over our limbs, we know by experience: but that they are not extended or ſubſtantially diffuſed through them, is certain; becauſe men daily loſe arms and legs, without loſing any part of their underſtanding, or feeling their energies of volition in the ſmalleſt degree weakened. But we need purſue this ſubject no farther. It has been confeſſed by one of the moſt ſtrenuous advocates * for the extenſion of the Deity and all minds, that "there is an incomprehenſibleneſs in the *manner* of every thing, about which no controverſy can or ought to be concerned."

* *Mr Jackſon's Exiſtence and Unity*, &c. page 110.

310 God's moral attributes reſult from his natural perfections.

The moral attributes of God may be deduced from his natural ones, and are immediate conſequences of them when exerciſed on other beings. They may be termed his *ſecondary relative* attributes, as they ſeem to be the perfection of his *external acts* rather than any *new internal* perfections. And though the exiſtence of any moral quality or action is not capable of ſtrict *demonſtration*, becauſe every moral action or quality, as ſuch, depends upon the *will* of the agent, which muſt be abſolutely free; yet we have as great aſſurance that there are moral qualities in God, and that he will always act according to theſe qualities, as the nature of the thing admits; and may be as well ſatisfied of it, as if it were capable of the moſt rigid demonſtration. This important point, however, cannot be ſo clearly or ſo firmly eſtabliſhed by abſtract reaſoning as by taking a ſcientific view of the works of creation, which evince the goodneſs, holineſs, and juſtice of their Author, as well as his perfect wiſdom and infinite power. The conſideration, therefore, of the moral attributes of God, together with his providence, and the duties thence incumbent on man, is the proper buſineſs of other articles (ſee RELIGION, THEOLOGY, and MORAL *Philoſophy*.

311 How they ought to be conceived.

At preſent we ſhall only obſerve, that by reaſoning *à priori* from his exiſtence and his natural perfections, we muſt neceſſarily infer that his actions are the reſult of unmixed benevolence. Every wiſe agent has ſome end in view in all his actions; it being the very eſſence of folly to act for no end: but there cannot be an end of action which is not either ſelfiſh or benevolent. Selfiſhneſs is the offspring of want and imperfection, and is therefore the ſource of moſt *human* actions; becauſe men are weak and imperfect beings, capable of daily additions to their happineſs. When the thief plunders a houſe at midnight, when the highwayman robs a traveller on the road, and even when the aſſaſſin murders the man who never injured him; it will be found that their actions ſpring not from an innate deſire to inflict miſery upon others, but from a proſpect of reaping advantage to themſelves. The object of the thief and the robber is obvious: it is to gain money, which is the mean of procuring the comforts of life. Even the aſſaſſin has always the ſame ſelfiſh end in view: either he is *bribed* to commit the murder, or he fancies that his horrid deed will remove an *obſtacle* from the way to his own happineſs. But they are not vicious men *only* who act from ſelfiſh conſiderations: much of human *virtue*, when traced to its ſource, will be found to have its origin in the deſire of happineſs. When a man gives his money to feed the hungry and to clothe the naked, he believes that he is acting agreeably to the will of Him to whom he and the poor ſtand in the ſame relation; and he looks for a future and eternal reward. By continuing the practice, he ſoon acquires the habit of benevolence; after which, indeed, he looks for no further reward, when performing particular actions, than the immediate pleaſure of doing good. This ſelfiſhneſs of man is the neceſſary conſequence of his progreſſive ſtate. But the Being who is independent, omnipotent, omniſcient, and, in a word, poſſeſſed of every poſſible perfection, is incapable of progreſſion, or of having any acceſſion whatever made to his happineſs. He is immutable; and muſt of neceſſity have been as happy from eternity, when exiſting alone, as after the creation of ten thouſand worlds. When, therefore, he willed the exiſtence of other beings, he could have nothing in view but to communicate ſome reſemblance of his own perfections and happineſs. That he had *ſome* end in view, follows undeniably from his infinite wiſdom. That he could not have a *ſelfiſh* end, follows with equal certainty from his own infinite perfections; and as there is no medium, in the actions of a wiſe Being, between ſelfiſhneſs and benevolence, we muſt neceſſarily conclude, that the creation was the reſult of unmixed benevolence or perfect goodneſs. The other moral attributes of the Deity, his juſtice, mercy and truth, ought therefore to be conſidered only as ſo many different views of the ſame *goodneſs* in the *Creator*, and various ſources of *happineſs* to the *creature*. Theſe are always *ſubordinate* to and *regulated* by this one principal perfection and brighteſt ray of the Divinity.

"Thus we conceive his *juſtice* to be exerted on any being no farther than his goodneſs neceſſarily requires, in order to make that being, or others, *ſenſible* of the *heinous nature* and *pernicious effects of ſin* *, and thereby to bring them to as great a degree of happineſs as their ſeveral natures are capable of. His *holineſs* hates and abhors all wickedneſs, only as its neceſſary conſequences are abſolute and unavoidable miſery; and his veracity or faithfulneſs ſeems to be concerned for truth, only becauſe it is connected with and productive of the happineſs of all rational beings; to provide the propereſt means for attaining which great end, is the exerciſe of his *wiſdom*." Such is the view of God's moral attributes, which the abſtract contemplation of his natural perfections neceſſarily gives; and whether this way of conceiving them be not attended with leſs difficulty than the common manner of treating them under the notion of two infinites *diametrically oppoſite*, muſt be left to the judgment of the reader.

* *Notes to King on Evil.*

312 The origin of evil.

But if the Creator and ſupreme Governor of all things be a Being of infinite power, perfect wiſdom and pure benevolence, how came evil into the works of creation? This is a queſtion which has employed the ſpeculative mind from the firſt dawning of philoſophy, and will continue to employ it till our faculties be enlarged in a future ſtate, when philoſophy ſhall give place to more perfect knowledge. To theſe meditations, as has been well obſerved ‡, humanity is not equal. Volumes have been written on the ſubject; but we believe that the following extract from Dr

‡ *Johnſon's Review of a free Inquiry into the Origin of Evil.*

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Dr Clarke contains all that can be advanced with certainty, and all that is necessary to vindicate the ways of God to man.

"All that we call evil (says that able reasoner †), is either an *evil of imperfection*, as the want of certain faculties and excellencies which other creatures have; or *natural evil*, as pain, death, and the like; or *moral evil*, as all kinds of vice. The *first* of these is not properly an evil: for every power, faculty, or perfection, which any creature enjoys, being the free gift of God, which he was no more obliged to bestow than he was to confer being or existence itself, it is plain, that the want of any certain faculty or perfection in any kind of creatures, which never belonged to their nature, is no more an evil to them, than their never having been created or brought into being at all could properly be called an evil." To this we may add, that as no created being can be self-existent and independent, imperfection is unavoidable in the creation, so that the evil of defect (as it is most absurdly called) must have been admitted, or nothing could ever have existed but God. "The *second* kind of evil which we call *natural* evil, is either a necessary consequence of the former, as *death* to a creature on whose nature immortality was never conferred; and then it is no more properly an evil than the former: Or else it is counterpoised in the whole with as great or greater good, as the *afflictions and sufferings of good men*: and then also it is properly no evil. Or else it is a *punishment*; and then it is a necessary consequence of the *third* and last sort of evil, viz. *moral evil*. And *this* arises wholly from the abuse of *liberty*, which God gave to his creatures for other purposes, and which it was reasonable and fit to give them for the perfection and order of the whole creation: only they, contrary to God's intention and command, have abused what was necessary for the perfection of the whole, to the corruption and depravation of themselves. And thus have all sorts of evils entered into the world, without any diminution to the infinite goodness of its Creator and Governor."

† *Demonstration of the Being and Attributes of God.*

313 Whether the present be the best system possible.

But though evil could not be totally excluded from the universe, are we not authorized to infer, from the infinite power, wisdom, and goodness of the Creator, that the present system is upon the whole the very best system possible? Undoubtedly we are, if of possible systems there *can be a best*: but this is so far from being evident, that we think it implies a contradiction. A best of beings there is, viz. God, who is possessed of infinite perfections; but there cannot be a best of creatures or of created systems. To prove this, we need only reflect, that wherever creation stops, it must stop infinitely short of infinity; and that how perfect soever we conceive any creature or system of creatures to be, yet the distance between that and God is not lessened, but continues infinite. Hence it follows, that the nature of God and his omnipotence is such, that whatever number of creatures he has made, he may still add to that number; and that however good or perfect the system may be on the whole, he might still make others equally good and perfect.

314 Origin of that question.

The dispute, whether a being of infinite power, wisdom, and benevolence, must be supposed to have created the *best possible system*, and the embarrassment of men's understandings about it, seem to have arisen from their taking the words *good*, *better*, and *best*, for absolute qualities inherent in the nature of things, whereas in truth they are only relations arising from certain appetites. They have indeed a foundation, as all relations have, in something absolute, and denote the thing in which they are founded; but yet they themselves imply nothing more than a relation of congruity between some appetite and its objects. This is evident; because the same object, when applied to an appetite to which it has a congruity, is good; and bad, when applied to an appetite to which it has no congruity. Thus, the earth and air to terrestrial animals are good elements, and necessary to their preservation: to those animals the water is bad, which yet affords the best receptacle to fishes. *Good*, therefore, being relative to appetite, that must be reckoned the best creature by us which has the strongest appetites, and the surest means of satisfying them all, and securing its own permanent happiness. And though the *substance* of creatures is chiefly to be regarded as contributing to their perfection, yet we have no way of measuring the perfection of different substances but by their qualities, *i. e.* by their appetites by which they are sensible of good and evil, and by their powers to procure those objects from which they receive that sense of things which makes them happy.

315 No system absolutely best.

It is plain, therefore, that whatever system we suppose in nature, God might have made another equal to it; his infinite wisdom and power being able to make other creatures equal in every respect to any that we know or can conceive, and to give them equal or stronger appetites, and as certain or more certain ways of satisfying them. We see in many cases, that very different means will answer the same end. A certain number of regular pyramids will fill a space; and yet irregular ones will do it as well, if what we take from the one be added to another; and the same thing may be done by bodies of the most irregular and different figures in the same manner: and therefore we may very well conceive, that the answering of appetites, which is all the *natural good* that is in the world, may as well be obtained in another system as in this; provided we suppose, that where the appetites of the sentient beings are changed, the objects are also suited to them, and an equal congruity among the parts of the whole introduced. This is so easily conceived, that in an indefinite number of possible worlds, we do not see why it may not be done in numberless ways by infinite power and wisdom.

316 God not necessitated by his goodness to create the present in preference to all other worlds.

If then it be plain, that there might have been many other worlds, or even but one, equal to this in all respects as to goodness, there could be no necessity, either physical or moral, that God should create the one rather than the other; because nothing could make the one better, or to him more agreeable, than the other but his own free choice. Either, therefore, God must be possessed of absolute freedom, or, among a number of possibilities equally perfect, he could not have made a choice, and so nothing would ever have been created. It is not, then, as Leibnitz and others argue, the natural and necessary goodness of some particular things, *represented by the divine ideas*, which determines God to prefer them to all others, if understood of his *first* act of producing them; but it is

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is his own free choice which, among many equal *potential* goods, makes some things *actually* good, and determines them into existence. When those are once supposed to exist, every thing or action becomes good which tends to their happiness and preservation; and to suppose their all-perfect Author to have any other end in view than their preservation and happiness, is the same absurdity as to suppose that knowledge may produce ignorance; power, weakness; or wisdom folly.

We have now finished what we proposed under the article Metaphysics. It has swelled in our hands to a large extent; and yet it can be considered as little more than an introduction to that science, which comprehends within its wide grasp every thing existing. The reader who wishes to pursue these interesting speculations, should study diligently the authors whom we have consulted, and to whom we have been careful to refer in the margin. Were we to make a selection, we should without hesitation recommend Aristotle and Plato among the ancients; and Cudworth, Locke, Hartley, and Reid, among the moderns. These philosophers, indeed, on many points, differ exceedingly from one another; but he who wishes not to adopt opinions at random, should know what can be said on both sides of every question.

Metaplasmus || Metastasio.

METAPLASMUS, in *Grammar*, a transmutation or change made in a word, by adding, retrenching, or altering a syllable or letter thereof.

METAPONTUM, or METAPONTIUM, in *Ancient Geography*, a town of Lucania, on the Sinus Tarentinus, to the west of Tarentum; built by the Pylians who returned from Troy; and where Pythagoras is said to have taught in the time of Servius Tullius. *Metapontini*, the people; who pretended to show in a temple of Minerva, the tools with which Epeus built the wooden horse, (Justin). Now a tower, called *Torre di Mare*, in the Basilicata of Naples.

METASTASIO, L'ABBE PIERRE BONAVENTURE, a celebrated Italian poet, whose real name was *Trapassi*, was born at Assise, on January 3d, 1698. His talent for poetry was first unfolded by the reading of Tasso; and he began to compose verses at ten years of age. " A prodigy of this nature (says Metastasio) made such an impression on my master, the celebrated Gravina, that he thenceforth considered me as a plant worthy of being cultivated by his own hands." Metastasio was only fourteen years of age when he composed his tragedy entitled *Il Giustino;* in which he appears too close and scrupulous an imitator of the Grecian drama. Our young poet unfortunately lost his patron in 1717; who left him his heir, " as being a young man of the most promising abilities." Metastasio, at the age of nineteen, being, in consequence of this inheritance, superior to those wants which repress the exertions of genius, and to which men of abilities are too often subject, gave full scope to his inclination for poetry. He began his dramatic career with the *Didonne Abandonnata*, which was acted at Naples in 1724; the music was composed by Sarro. He soon acquired such celebrity, that in 1729 he was invited to Vienna by the emperor Charles VI.; who appointed him imperial poet, and granted him a pension of 4000 florins. From that time some of his works were presented at every court festival; and notwithstanding the extreme magnificence of these entertainments, they would now be forgotten were it not for the verses which he composed upon the occasion. The courts of Vienna and Madrid vied with each other in the presents which they conferred upon him. From Maria Theresa he received a snuff-box and a port-folio set with diamonds, and a golden candlestick with a screen. Ferdinand VI. king of Spain, informed of the great merit of Metastasio by Farinelli, of whom he was a passionate admirer, sent him a present of a casket mounted with gold, and furnished with the different implements of writing. This favourite of kings and of the muses was of a cheerful temper, and was exceedingly temperate: to this he was probably indebted for the uninterrupted health which he enjoyed, and for the entire possession of his senses and faculties to the most advanced period of old age. He took his meals, arose, and went to bed, always at stated hours. This exactness and order were scrupulously observed even in the most trifling actions of his life. He used to say in jest, that he dreaded hell for no other reason but because it was a place *ubi nullus ordo, sed sempiternus horror inhabitat.* He had even his stated hours for making verses; to which he scrupulously adhered, without waiting for the moment of poetical enthusiasm. He was equally regular in the duties of the Christian as in the labours of the scholar. His behaviour was that of a true philosopher: his ambition extended no farther than the attainment of literary fame; and he despised every civil mark of distinction. When Charles VI. offered him the title of *Count* or of *Baron*, which add no real worth or dignity to the possessor, but frequently make him appear in a more ridiculous light, he instantly begged the favour that he would allow him still to continue *Metastasio.* The empress Maria Theresa afterwards wished to bestow upon him the small cross of St Stephen; but he excused himself on account of his age, which would prevent him from assisting at the festivals of the order. He was attacked by a fever on the 2d of April 1782; and he died on the 12th of the same month, at the age of 84. Before his death he received the sacrament according to the form of the Romish church; and Pius VI. who was then at Vienna, sent him his apostolical benediction *in articulo mortis.* He left about 150,000 florins. He composed a great number of tragic operas, and several small dramatic pieces which have been set to music. We have different editions of them in 4to, 8vo, and 12mo; and M. Richelet has published a translation of them into French, in 12 vols. small 12mo.

The greatest part of Metastasio's writings will confer immortality on their author. His dialogue is natural,

tural, ſimple, and eaſy; his ſtyle is always pure and elegant, and ſometimes ſublime and pathetic. His ſubjects are noble, intereſting, and excellently adapted for repreſentation. He was perfectly acquainted with the reſources of his art, and has ſubjected the opera to rules. He ſtripped it of its machinery, and of the marvellous, which was fitted to excite the gaze of aſtoniſhment, but which gave no inſtruction to the underſtanding, and made no impreſſion on the heart. His deſcriptions are copied from nature; the ſituations of his characters never fail to raiſe an intereſt in the reader, and often excite the tear of pity. His fables are celebrated; his characters are noble and well ſupported; his plots are excellently conducted, and happily unravelled. "There are ſcenes (ſays Voltaire) worthy of Corneille when he does not declaim, and of Racine when he is not feeble." His operas, in point of the pathetic, may be compared with our fineſt tragedies; and may be read with great pleaſure, independent of the charms of the muſic. We muſt not, however, expect to find in Metaſtaſio that exact regularity, and that fertile ſimplicity, which conſtitutes the excellence of ſome of our tragic poets: But though he ſometimes tranſgreſſes the unities of time and place, he always preſerves the unity of intereſt. Notwithſtanding all theſe advantages, ſome critics will not allow him the merit of invention, which is the firſt qualification of a poet. They conſider him only as a ſucceſsful imitator of the French tragic writers, from whom a great part of his beauties are borrowed, and place him at the head of the fineſt wits in Italy, but deny that he poſſeſſed genius. He was a fond admirer of the ancients; and this admiration, increaſing with the ſolidity of his underſtanding, continued to the laſt period of his life. He recommended reading them, as he himſelf had done, in a chronological order. His memory was excellent, and continued unimpaired even in old age. Horace was his favourite author, and he could repeat almoſt the whole of his verſes. Metaſtaſio, who, as we have obſerved, was the pupil of the celebrated Gravina, added a gentleneſs of character peculiar to himſelf to the accuracy of thinking and great erudition of his maſter. His abilities and fame were reſpected by the critics in general; and whereas the life of moſt men of letters is one continued warfare, his days happily glided away in tranquillity and peace. The circumſtance which occaſioned the change of his name is thus related in a late anecdote: "Gravina's barber, who, like moſt of his profeſſion, was a great talker, one day informed him, that in the *Place de la Valicella*, where he had his ſhop, a young boy came every evening, and ſung extempore verſes of his own compoſition, ſo harmonious and elegant that all the paſſengers ſtopped to liſten to them. Gravina, upon this information, added one to the number of the young poet's audience, and found the verſes ſo ſuperior to the idea which he had formed of them from the account of the barber, and ſo much above the capacity of a child of ten or eleven years of age, that he inſtantly determined to undertake the cultivation of ſo promiſing a plant. His firſt care was to put the young *Trapaſſi* (which was the boy's name) to ſchool; but apprehending that the ordinary methods of education might check the progreſs of ſo uncommon talents, he took him home to his own houſe, and changed his name into *Metaſtaſio*, which ſignifies the ſame thing in Greek. In ſhort, by a plan of education and by inſtructions ſuited to his genius, Gravina laid the foundation of that reputation which he predicted, and which Metaſtaſio now enjoys." *Vies des Hommes Illuſtres d'Italie*, tom. i. p. 187.

METASTASIS, in *Medicine*, a tranſpoſition or ſettlement of ſome humour or diſeaſe in ſome other part; and ſometimes it ſignifies ſuch an alteration of a diſeaſe as is ſucceeded by a ſolution.

METATARSUS (μετα, *beyond*, and ταρσος, *the tarſus*), in anatomy, that part of the human ſkeleton containing the middle of the foot. See ANATOMY *Index*.

METATHESIS, in *Grammar*, a ſpecies of the metaplaſmus; being a figure whereby the letters or ſyllables of a word are tranſpoſed, or ſhifted out of their uſual ſituations, as *piſtris* for *priſtis*, *Lybia* for *Libya*, &c.

This word is, by phyſicians, uſed with reſpect to morbific cauſes, which when they cannot be evacuated, are removed to places where they are leſs injurious.

METELIN, the modern name of the iſland of Leſbos. See LESBOS and MITYLENE.

In the Iriſh Philoſophical Tranſactions for 1789, we have a deſcription of this iſland by the earl of Charlemont, in which he ſpeaks with raptures of its beauties. "The mountains, whoſe rugged tops exhibit a pleaſing interſperſion of rocks and fine groves, have their green ſides, for many miles along the coaſt, covered with olives, whoſe leſs agreeable verdure is corrected, embelliſhed, and brightened by a lively mixture of bays and laurels aſpiring to the height of foreſt trees, of myrtles and pomegranates, of arbutes rich at once in bloſſom and in berry, of mulberries growing wild and laden with fruit, &c. Winter is here unknown, the verdure is perpetual, and the frequency of evergreens gives to December the colour of June. The parching heat of ſummer is never felt; the thick ſhade of trees, and thouſands of cryſtal ſprings which everywhere ariſe and form themſelves into unnumbered rivulets, joined to the refreſhing ſea breeze, the conſtant corrective and companion of noontide heat, qualify the burning air and render the year a never-ending May. The houſes are conſtructed in ſuch a manner as to have the beſt view of theſe natural beauties. Each is a ſquare tower neatly built of hewn ſtone, ſo high as to overtop the trees, and to command a view of the ſea and neighbouring iſlands. The lower ſtories are granaries and ſtorehouſes; and the habitable apartments are all at the top, to which you aſcend by a ſtone ſtair, built for the moſt part on the outſide, and ſurrounding the tower; ſo that from the apartment the trees are overlooked, and the whole country is ſeen; while the habitations themſelves, which are very numerous, peering above the groves, add life and variety to the enchanting proſpect, and give an air of human population to theſe woodlands, which might otherwiſe be ſuppoſed the region of Dryads, of Naiads, and of Satyrs."

The moſt remarkable thing, however, in this iſland is a cuſtom by which the women have here openly uſurped thoſe rights of ſovereignty which in other countries

Metelin.

countries are ſuppoſed to belong eſſentially to the men. "Contrary (ſays his lordſhip) to the uſage of all other countries, the eldeſt daughter here inherits; and the ſons, like daughters everywhere elſe, are portioned off with ſmall dowers, or, which is ſtill worſe, turned out pennyleſs to ſeek their fortune. If a man have two daughters, the eldeſt, at her marriage, is entitled to all her mother's poſſeſſions, which are by far the greater part of the family eſtate, as the mother, keeping up her prerogative, never parts with the power over any portion of what ſhe has brought into the family, until ſhe is forced into it by the marriage of her daughter; and the father alſo is compelled to ruin himſelf by adding whatever he may have ſcraped together by his induſtry. The ſecond daughter inherits nothing, and is condemned to perpetual celibacy. She is ſtyled a *calogria*, which ſignifies properly a religious woman or nun, and is in effect a menial ſervant to her ſiſter, being employed by her in any office ſhe may think fit to impoſe, frequently ſerving her as waitingmaid, as cook, and often in employments ſtill more degrading. She wears a habit peculiar to her ſituation, which ſhe can never change; a ſort of monaſtic dreſs, coarſe, and of a dark brown. One advantage, however, ſhe enjoys over her ſiſter, that whereas the elder, before marriage, is never allowed to go abroad, or to ſee any man, her neareſt relations only excepted, the calogria, except when employed in domeſtic toil, is in this reſpect at perfect liberty. But when the ſiſter is married, the ſituation of the poor calogria becomes deſperate indeed, and is rendered ſtill more humiliating by the compariſon between her condition and that of her happy miſtreſs. The married ſiſter enjoys every ſort of liberty; the whole family fortune is hers, and ſhe ſpends it as ſhe pleaſes; her huſband is her obſequious ſervant, her father and mother are dependent upon her, ſhe dreſſes in a moſt magnificent manner, covered all over, according to the faſhion of the iſland, with pearls and with pieces of gold, which are commonly ſequins; thus continually carrying about her the enviable marks of affluence and ſuperiority, while the wretched calogria follows her as a ſervant, arrayed in ſimple homeſpun brown, and without the moſt diſtant hope of ever changing her condition. Such a diſparity may ſeem intolerable, but what will not cuſtom reconcile? Neither are the misfortunes of the family yet at an end. The father and mother, with what little is left them, contrive by their induſtry to accumulate a ſecond little fortune; and this, if they ſhould have a third daughter, they are obliged to give to her upon her marriage; and the fourth, if there ſhould be one, becomes her calogria, and ſo on through all the daughters alternately. Whenever the daughter is marriageable, ſhe can by cuſtom compel the father to procure her a huſband; and the mother, ſuch is the power of habit, is fooliſh enough to join her in teaſing him into an immediate compliance, though its conſequences muſt be equally fatal and ruinous to both of them. From hence it happens, that nothing is more common than to ſee the old father and mother reduced to the utmoſt indigence, and even begging about the ſtreets, while their unnatural daughters are in affluence; and we ourſelves have frequently been ſhown the eldeſt daughter parading it through the town in the greateſt ſplendour, while her mother and ſiſter followed her as ſervants, and made a melancholy part of her attendant train.

"The ſons, as ſoon as they are of an age to gain a livelihood, are turned out of the family, ſometimes with a ſmall preſent or portion, but more frequently without any thing to ſupport them; and thus reduced, they either endeavour to live by their labour, or, which is more uſual, go on board ſome trading veſſel as ſailors or as ſervants, remaining abroad till they have got together ſome competency, and then return home to marry and to be henpecked. Some few there are who, taking advantage of the Turkiſh law, break through this whimſical cuſtom, who marry their calogrias, and retain to themſelves a competent proviſion: but theſe are accounted men of a ſingular and even criminal diſpoſition, and are hated and deſpiſed as conformiſts to Turkiſh manners, and deſerters of their native cuſtoms; ſo that we may ſuppoſe they are few indeed who have the boldneſs to depart from the manners of their country to adopt the cuſtoms of their deteſted maſters, and to brave the contempt, the deriſion, and the hatred, of their neighbours and fellow-citizens.

"Of all theſe extraordinary particulars I was informed by the French conſul, a man of ſenſe and of indiſputable veracity, who had reſided in this iſland for ſeveral years, and who ſolemnly aſſured me that every circumſtance was true: but indeed our own obſervation left us without the leaſt room for doubt, and the ſingular appearance and deportment of the ladies fully evinced the truth of our friend's relation. In walking through the town, it is eaſy to perceive, from the whimſical manners of the female paſſengers, that the women, according to the vulgar phraſe, *wear the breeches*. They frequently ſtopped us in the ſtreets, examined our dreſs, interrogated us with a bold and manly air, laughed at our foreign garb and appearance; and ſhowed ſo little attention to that decent modeſty which is or ought to be the true characteriſtic of the ſex, that there is every reaſon to ſuppoſe they would, in ſpite of their haughtineſs, be the kindeſt ladies upon earth, if they were not ſtrictly watched by the Turks, who are here very numerous, and would be ready to puniſh any tranſgreſſion of their ungallant laws with arbitrary fines. But nature and native manners will often baffle the efforts even of tyranny. In all their cuſtoms theſe manly ladies ſeem to have changed ſexes with the men. The woman rides aſtride, the man ſits ſideways upon the horſe; nay, I have been aſſured that the huſband's diſtinguiſhing appellation is his wife's family name. The women have town and country houſes, in the management of which the huſband never dares interfere. Their gardens, their ſervants, are all their own; and the huſband, from every circumſtance of his behaviour, appears to be no other than his wife's firſt domeſtic, perpetually bound to her ſervice, and ſlave to her caprice. Hence it is that a tradition obtains in the country, that this iſland was formerly inhabited by Amazons; a tradition, however, founded upon no ancient hiſtory that I know of. Sappho indeed, the moſt renowned female that this iſland has ever produced, is ſaid to have had manly inclinations; in which, as Lucian informs us, ſhe did but conform with the ſingular manners of her countrywomen: but I do not find that the mode in which ſhe

ſhe choſe to ſhow theſe inclinations is imitated by the preſent female inhabitants, who ſeem perfectly content with the dear prerogative of abſolute ſway, without endeavouring in any other particular to change the courſe of nature; yet will this circumſtance ſerve to ſhow, that the women of Leſbos had always ſomething peculiar, and even peculiarly maſculine, in their manners and propenſities. But be this as it may, it is certain that no country whatſoever can afford a more perfect idea of an Amazonian commonwealth, or better ſerve to render probable thoſe ancient relations which our manners would induce us to eſteem incredible, than this iſland of Metelin. Theſe lordly ladies are for the moſt part very handſome in ſpite of their dreſs, which is ſingular and diſadvantageous. Down to the girdle, which as in the old Grecian garb is raiſed far above what we uſually call the waiſt, they wear nothing but a ſhift of thin and tranſparent gauze, red, green, or brown, through which every thing is viſible, their breaſts only excepted, which they cover with a ſort of handkerchief; and this, as we are informed, the Turks have obliged them to wear, while they look upon it as an encumbrance, and as no inconſiderable portion of Turkiſh tyranny. Long ſleeves of the ſame thin material perfectly ſhow their arms even to the ſhoulder. Their principal ornaments are chains of pearl, to which they hang ſmall pieces of gold coin. Their eyes are large and fine; and the noſe, which we term Grecian, uſually prevails among them, as it does indeed among the women of all theſe iſlands. Their complexions are naturally fine; but they ſpoil them by paint, of which they make abundant uſe; and they disfigure their pretty faces by ſhaving the hinder part of the eyebrow, and replacing it with a ſtraight line of hair neatly applied with ſome ſort of gum, the brow being thus continued in a ſtraight and narrow line till it joins the hair on each ſide of their face. They are well made, of the middle ſize, and for the moſt part plump; but they are diſtinguiſhed by nothing ſo much and ſo univerſally as by a haughty, diſdainful, and ſupercilious air, with which they ſeem to look down upon all mankind as creatures of an inferior nature, born for their ſervice, and doomed to be their ſlaves; neither does this peculiarity of countenance in any degree diminiſh their natural beauty, but rather adds to it that ſort of bewitching attraction which the French call *piquant*."

His lordſhip has been at great pains to inveſtigate the origin of ſuch a ſingular cuſtom; but is unable to find any other example in hiſtory than that of the Lycians, who called themſelves by the names of their mothers, and not of their fathers. When aſked by their neighbours who they were? they deſcribed themſelves by their maternal genealogy. If a gentlewoman ſhould marry a ſlave, the children by that marriage were accounted noble; but ſhould the firſt man among them marry a foreign woman, the children would be accounted ignoble. This cuſtom is mentioned by ſeveral ancient authors. A difficulty of no little magnitude occurs, however, in accounting for the derivation of the inhabitants of Leſbos from the Lycians. This is ſolved in the following manner: In times of the moſt remote antiquity, the iſland of Leſbos was peopled by the Pelaſgi, who, under their leader Xanthus, the ſon of Trioppas king of Argos, firſt inhabited Leſbos: previous to that time they had dwelt in a certain part of Lycia which they had conquered; and in this country we may ſuppoſe they had learned the cuſtom in queſtion.

METELLUS, the ſurname of the family of the Cæcilii at Rome, the moſt known of whom were ——A general who defeated the Achæans, took Thebes and invaded Macedonia, &c.—Q. Cæcilius, who rendered himſelf illuſtrious by his ſucceſſes againſt Jugurtha the Numidian king, from which he was ſurnamed Numidicus. Another who ſaved from the flames the palladium, when Veſta's temple was on fire. He was then high prieſt. He loſt his ſight and one of his arms in the action; and the ſenate, to reward his zeal and piety, permitted him always to be drawn to the ſenate houſe in a chariot, an honour which no one had ever before enjoyed. He alſo gained a great victory over the Carthaginians, &c.—Q. Cæcilius Celer, another who diſtinguiſhed himſelf by his ſpirited exertions againſt Catiline. He married the ſiſter of Clodius, who diſgraced him by her incontinence and laſciviouſneſs. He died 57 years before Chriſt. He was greatly lamented by Cicero, who ſhed tears at the loſs of one of his moſt faithful and valuable friends. L. Cæcilius, a tribune in the civil wars of J. Cæſar and Pompey. He favoured the cauſe of Pompey, and oppoſed Cæſar when he entered Rome with a victorious army. He refuſed to open the gates of Saturn's temple, in which were depoſited great treaſures; upon which they were broke open by Cæſar, and Metellus retired when threatened with death. Q. Cæcilius, a warlike general who conquered Crete and Macedonia, and was ſurnamed *Macedonicus*. He had four ſons, of whom three were conſuls, and the other obtained a triumph, all during their father's lifetime. A general of the Roman armies againſt the Sicilians and Carthaginians. Before he marched, he offered ſacrifices to all the gods except Veſta; for which neglect the goddeſs was ſo incenſed, that ſhe demanded the blood of his daughter Metella. When Metella was going to be immolated, the goddeſs placed a heifer in her place, and carried her to a temple at Lanuvium, of which ſhe became the prieſteſs. Another ſurnamed *Dalmaticus* from his conqueſt over Dalmatia, A. U. C. 634.—Cimber, one of the conſpirators againſt J. Cæſar. It was he who gave the ſignal to attack and murder the dictator in the ſenate houſe. —Pius, a general in Spain againſt Sertorius, on whoſe head he ſet a price of 100 talents and 20,000 acres of land.

METEMPSYCHOSIS, (formed of μετα, "beyond," and εμψυχω, "I animate or enliven"), in the ancient philoſophy, the paſſage or tranſmigration of the ſoul of a man, after death, into the body of ſome other animal.

Pythagoras and his followers held, that after death men's ſouls paſſed into other bodies, of this or that kind, according to the manner of life they had led. If they had been vicious, they were impriſoned in the bodies of miſerable beaſts, there to do penance for ſeveral ages: at the expiration whereof, they returned afreſh to animate men. But, if they lived virtuouſly, ſome happier brute, or even a human creature, was to be their lot.

What led Pythagoras into this opinion was, the

perſuaſion

persuasion he had that the soul was not of a perishable nature: whence he concluded that it must remove into some other body upon its abandoning this. Lucan treats this doctrine as a kind of officious lie, contrived to mitigate the apprehension of death, by persuading men that they only changed their lodging, and only ceased to live to begin a new life.

Reuchlin denies this doctrine; and maintains that the metempsychosis of Pythagoras implied nothing more than a similitude of manners, desires, and studies, formerly existing in some person deceased, and now revived in another alive. Thus when it was said that Euphorbus was revived in Pythagoras, no more was meant than that the martial virtue which had shone in Euphorbus at the time of the Trojan war, was now, in some measure, revived in Pythagoras, by reason of the great respect he bore the *athletæ*. For those people wondering how a philosopher should be so much taken with men of the sword, he palliated the matter, by saying, that the soul of Euphorbus, i. e. his genius, disposition, and inclinations, were revived in him. And this gave occasion to the report, that Euphorbus's soul, who perished in the Trojan war, had transmigrated into Pythagoras.

Ficinus asserts, that what Plato speaks of the migration of a human soul into a brute, is intended allegorically, and is to be understood only of the manners, affections, and habits, degenerated into a beastly nature by vice. Serranus, though he allows some force to this interpretation, yet inclines rather to understand the metempsychosis of a resurrection.

Pythagoras is said to have borrowed the notion of a metempsychosis from the Egyptians; others say, from the ancient Brachmans. It is still retained among the Banians and other idolaters of India and China; and makes the principal foundation of their religion. So extremely are they bigotted to it, that they not only forbear eating any thing that has life, but many of them even refuse to defend themselves from wild beasts. They burn no wood, lest some little animalcule should be in it; and are so very charitable, that they will redeem from the hands of strangers any animals that they find ready to be killed. See PYTHAGOREANS.

METEMPTOSIS (from μετα, *post*, and πιπτω, *cado*, "I fall,") a term in chronology, expressing the solar equation, necessary to prevent the new moon from happening a day too late. By which it stands contradistinguished from *proemptosis*, which signifies the lunar equation, necessary to prevent the new moon from happening a day too soon.

The new moons running a little backwards, that is, coming a day too soon at the end of 312 years and a half; by the proemptosis, a day is added every 300 years, and another every 2400 years: on the other hand, by the metemptosis, a bissextile is suppressed each 134 years; that is, three times in 400 years. These alterations are never made but at the end of each century; that period being very remarkable, and rendering the practice of the calendar easy.

There are three rules for making this addition or suppression of the bissextile day, and, by consequence, for changing the index of the epacts. 1. When there is a metemptosis without a proemptosis, the next following, or lower index, must be taken. 2. When there is a proemptosis without a metemptosis, the next preceding or superior index is to be taken. 3. When there are both a metemptosis and a proemptosis, or when there is neither the one nor the other, the same index is preserved. Thus, in 1600, we had D: in 1700, by reason of the metemptosis, C was taken: in 1800, there was both a proemptosis and a metemptosis; so the same index was retained. In 1900, there will be a metemptosis again, when B will be taken: which will be preserved in 2000, because there will then be neither the one nor the other. This is as far as we need compute for it: But Clavius has calculated a cycle of 301,800 years; at the end of which period, the same indices return in the same order. See EPACT.

METEOR, (by the Greeks called μετεωρα, q. d. *sublima* or "high raised;" by the Latins *impressiones* as making signs or impressions in the air), commonly denotes any bodies in the air that are of a transitory nature. Hence it is extended to the phenomena of hail, rain, snow, thunder, &c.; but is most commonly confined to those unusual and fiery appearances named *falling stars*, *ignes fatui*, *auroræ boreales*, &c. See METEOROLOGY.

METEOROLITE. This term is derived from the Greek μετεωρα, a *meteor*, and λιθος, a *stone*; and denotes a stony substance, exhibiting peculiar characters, and whose descent to the earth is usually accompanied by the appearance and explosion of a fire-ball.

Luminous meteors have, in all ages, been observed in the atmosphere. It is also well known that their disappearance has frequently been attended with a loud noise; but that they should moreover terminate in the fall of one or more solid bodies to the earth's surface, is a position so repugnant to our ordinary conceptions of the tenor of physical events, that we cannot admit it as a fact on slight or scanty evidence. With due deference, however, to some philosphers of name, we are not prepared to assert, that it implies impossibility. For who has explored the higher regions of the atmosphere? or who knows what may take place beyond its precincts? If a solid result from the combination of two aeriform substances, as muriatic acid and ammoniacal gases; if oxygen, the properties of which are most familiar to us in the state of gas, can undergo fixation, and if fluids can pass into crystalline forms, is it too bold to presume, that the same, or similar processes, effected in the grand laboratory of the atmosphere, may be within the range of possible occurrences? At all events, the same Being who called into existence those sublime and countless masses of matter which revolve in space, may, to serve purposes unknown to us, create bodies of dimensions infinitely smaller, and destined to impinge on some planetary orb. The reasoning of an angel may not convince us, that a part is greater than the whole, or that the value of two and two is equivalent to six; but a very ordinary logician may prove to our satisfaction, that the contact of particles of matter in portions of space which lie beyond our globe, is no chimerical supposition. Every thing around us proclaims, that matter is subject to incessant change. New forms and new modifications are ever springing into being: and can we doubt, that the same particles, as they may happen to be affected or influenced by various circumstances, may exist in the state of gas, of aqueous vapour, or of a concrete mass?

Again, it ſurely will not be ſeriouſly maintained, that, from the rarity of a phenomenon, we are warranted to infer its non-exiſtence. The appearance of a comet is a rare, but not a fictitious, occurrence. Nay, we may ſafely advance a ſtep farther, and aſſert, without fear of confutation, that the exiſtence of a phenomenon, if otherwiſe well atteſted, cannot be diſproved by our inability to explain it. How multiplied, in fact, are the ſubjects, even of our daily and hourly obſervation, which we cannot satisfactorily expound? We cannot ſay why a ſmall ſeed ſhould gradually unfold into a large tree, why flame ſhould produce heat, why the hand ſhould act in immediate ſubſerviency to the will, or why a contuſion of the brain ſhould induce ſtupor, alienation of mind, or death. It is one thing to prove a fact, and it is another to account for it.

From theſe premiſes it follows in courſe, that we are not entitled to reject the exiſtence of meteoric ſtones, provided it be eſtabliſhed by valid teſtimony. Should the hiſtorical evidence, on a fair and diſpaſſionate review, be deemed concluſive, we may afterwards examine the theories which have been propoſed for the ſolution of the appearance.

From the Scriptures of the Old Teſtament we are not aware that any paſſage can be cited in direct corroboration of the deſcent of ſtones from the atmoſphere. The ingenious and fanciful Mr Edward King, indeed, in his "Remarks concerning ſtones ſaid to have fallen from the clouds, both in theſe days, and in ancient times," adverts to the 13th verſe of the 18th Pſalm.—"The Lord alſo thundered out of heaven, and the Higheſt gave his thunder: hail-ſtones and *coals of fire*." This laſt expreſſion has, no doubt, been conjectured to denote real hard bodies, in a ſtate of ignition; and the term ανθρακες, employed by the cautious Seventy, rather favours ſuch an interpretation. The ſame expreſſion, however, occurs in the preceding verſe, without admitting this interpretation; and the phraſe ſeems to be only a figurative mode of deſcribing lightning. In the ſober latitudes of the north, and even in colloquial language, we talk of *balls of fire* and *thunderbolts*, without any reference to ſolid matter. Mr King likewiſe quotes the 11th verſe of the 10th chapter of Joſhua.—"And it came to paſs, as they fled from before Iſrael, and were in the going down to Beth-horon, that the Lord caſt down *great ſtones* from heaven upon them unto Azekah, and they died: there were more which died with hail-ſtones, than they whom the children of Iſrael ſlew with the ſword." Here, the expreſſion, *great ſtones* is leſs equivocal than *coals of fire;* yet the context hardly allows us to doubt, that the great ſtones were really hail-ſtones, or rather, perhaps, lumps of ice, conſolidated in the atmoſphere, ſuch as occaſionally fall in hot countries, and ſuch as alarmed the whole of Paris and its neighbourhood in 1788. At any rate, the ſlaughter of the Canaanites is repreſented as reſulting from the ſpecial interpoſition of divine power; and the conſideration of miracles is irrelevant to our preſent purpoſe.

If from ſacred, we turn to the early period of profane hiſtory, we ſhall find the annals of public events very copiouſly interſperſed with notices of ſtrange appearances, many of which may be ſafely aſcribed to the aſcendency which ſuperſtition long obtained over the human mind. The ſcepticiſm of the learned is, however, ſometimes not leſs injudicious and indiſcriminate than the credulity of the ſavage; and he who ſhould reſolve every extraordinary event, which is recorded by the writers of Greece and Rome, into a "cunningly deviſed fable," would not be leſs reprehenſible for want of candour, than the untutored ruſtic, who yields his aſſent to every alleged miracle, is to be taxed with want of diſcernment.

Although theſe general poſitions can ſcarcely admit of diſpute, it becomes extremely difficult, after a lapſe of many ages, and in the collation of marvellous records, to ſeparate truth from falſehood. In our attempts to proſecute this analytical proceſs, we may ſometimes advance a certain length with perfect ſecurity, without being able to trace uniformly the preciſe lines of demarcation. Thus, in regard to the topic of our preſent diſcuſſion, we know, that in various periods of the world the vulgar have aſcribed a celeſtial origin to ſtones of a peculiar configuration, as to certain modifications of pyrites, to belemnites, orthoceratites, &c. which the ſubſequent obſervations of naturaliſts have proved to be of mineral formation, and to the heads of arrows and ſharpened flints, which have been faſhioned by the hand of man, and which, accordingly we are authorized to exclude from the ex-terreſtrial catalogue. But when ſubſtances diſſimilar from theſe, and coinciding in any one character or circumſtance with modern ſpecimens of atmoſpheric ſtone, are reported by the ancients to have fallen from the clouds, the diſtance of ages and the lameneſs of the documents may powerfully affect our appreciation of the reputed evidence.

When, therefore, we ſhortly touch on a few of the many inſtances which might be quoted from the annals of antiquity, we mean not to vouch for the truth even of theſe particular inſtances; but merely to admit their probability, and the weight which the mention of them may be conſidered to add to that of ſubſequent and recent narrations.

Through the midſt of fable which envelopes the hiſtory of the *bætuli*, we diſcern ſome characters which correſpond with thoſe of meteorolites. Thus, in the Λιθικα, a poem falſely aſcribed to Orpheus, the σιδηριτης, which M. Falconet properly claſſes with the bætuli, is ſaid to be *rough*, *heavy*, and *black*. Damaſcius, in an extract of his life of Iſidorus, preſerved by Photius, relates that the bætuli fell on Mount Libanus, in *a globe of fire*. A fragment of Sanchoniathon, preſerved in Euſebius, (Præpar. Evangel. i. 10.), moreover informs us, that theſe ſtones were fabricated by the god *Uranus* (or *Heaven*), one of whoſe four ſons was named *Bætul.* May not this mythological genealogy be regarded as merely emblematical of their deſcent from the upper regions of the atmoſphere? In the ſame chapter we are told that Aſtarte found a *ſtar* which had *fallen from heaven*, and honoured it with conſecration in the city of Tyre. The ſtone denominated "the mother of the gods," if we can believe Appian, Herodian, and Marcellinus, *fell from heaven*. Ariſtodemus, cited by the Greek ſcholiaſt on Pindar, aſſerts that it *fell encircled by fire*, on a hill, at the feet of the Theban bard. It is ſaid to have been of a *black* colour, and of an *irregular* ſhape. Herodian (lib. v.) expreſsly declares, that the Phœnicians had no ſtatue of the ſun, poliſhed by the hand; but only a certain ſtone, circular below, and terminated

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terminated acutely above, in the form of a cone, of a *black* colour, and that, according to report, it *fell from heaven*, and was regarded as the image of the sun.

Among various instances which might be selected from Livy, is that of a shower of stones on Mount Alba, in the reign of Tullus Hostilius, or about six hundred and fifty-two years before the birth of Christ. When the senate were told, that it had *rained stones*, they doubted the fact, and deputed commissioners to inquire into the particulars. They were then assured, that stones had really fallen, *haud aliter quam quum grandinem venti glomeratam in terras agunt.* On this occasion, the historian mentions, that similar events were celebrated by a festival of nine days. *Mansit solemne, ut quandocumque idem prodigium nuntiaretur, feriæ per novem dies agerentur.*

But one of the most remarkable cases which occurs in the records of antiquity, is that which is mentioned in the 58th chapter of the second book of Pliny's Natural History, of a large stone which fell near Egospotamos, in Thrace, in the second year of the seventy-eighth Olympiad, or, according to our chronology, about four hundred and sixty-seven years before the Christian era. Pliny assures us, that this extraordinary mass was still shewn in his day; and that it was as large as a cart, and of a *burnt colour*. The Greeks pretended that it had *fallen from the sun*, and that Anaxagoras had predicted the day of its arrival on the earth's surface. According to Plutarch, in the life of Lysander, the inhabitants of the Chersonesus held the Thracian stone in great veneration, and exhibited it as a public show. His account of its first appearance is chiefly extracted from the relation of Daimachus of Platææ, and may be thus translated. "During seventy-five successive days before the stone fell, a large fiery body, like a cloud of flame, was observed in the heavens, not fixed to one point, but wandering about with a broken, irregular motion. By its violent agitation, several fiery fragments were forced from it, impelled in various directions, and darted with the velocity and brightness of so many shooting stars. After this body had fallen on the Chersonesus, and the people had assembled to examine it, they could find no inflammable matter, nor the slightest trace of combustion, but a real stone, which, though large, by no means corresponded to the dimension of the flaming globe which they had seen in the sky, but seemed to be only a piece detached from it." Daimachus, it is true, may, on this occasion, have given way to his reputed love of the marvellous; and we can easily believe that the *seventy-five continuous days* are either an error of the copyist, or an original exaggeration; yet, from the marked coincidence of some of the circumstances with those more fully detailed in the sequel, there arises the presumption that a meteorolite really fell at the place and period above assigned.

From this period, till near the close of the fifteenth century, any historical notices which we have been enabled to collect, are so vague and scanty, that, in this abridged view of the subject, we may pass them over in silence.

Professor Bantenschoen, of the central school of Colmar, first directed the attention of naturalists to some of the old chronicles, which commemorate with much *naivete*, and in the true spirit of the times, the fall of the celebrated stone of Ensisheim. The following account accompanied this very singular mass, when it was suspended in the church.

"In the year of the Lord 1492, on Wednesday, which was Martinmas eve, the 7th of November, there happened a singular miracle: for, between eleven o'clock and noon, there was a loud peal of thunder, and a prolonged confused noise, which was heard to a great distance, and a stone fell from the air, in the jurisdiction of Ensisheim, which weighed 260 pounds, and the confused noise was, moreover, much louder than here. There a child saw it strike on a field, situated in the upper jurisdiction, towards the Rhine and Inn, near the district of Gilgard, which was sown with wheat, and did it no harm, except that it made a hole there: and then they conveyed it from that spot; and many pieces were broken from it, which the landvogt forbade. They, therefore, caused it to be placed in the church, with the intention of suspending it as a miracle; and many people came hither to see this stone. So there were remarkable conversations about this stone: but the learned said, that they knew not what it was; for it was beyond the ordinary course of nature, that such a large mass should smite the earth from the height of the air; but that it was really a miracle of God; for, before that time, never any thing was heard like it, nor seen, nor described. When the people found that stone, it had entered into the earth, to the depth of a man's stature, which every body explained to be the will of God, that it should be found, and the noise of it was heard at Lucerne, at Villing, and in many other places, so loud, that it was believed that houses had been overturned: And as the king (Maximilian) was here, the Monday after St Catherine's day, of the same year, his royal excellence ordered the stone which had fallen to be brought to the castle, and after having conversed a long time about it with the noblemen, he said the people of Ensisheim should take it, and order it to be hung up in the church, and not allow any body to take any thing from it. However, his excellency took two pieces of it, of which he kept one, and sent the other to the duke Sigismund of Austria: and they spoke a great deal about this stone, which they suspended in the choir, where it still is; and a great many people came to see it."

Trithemius, in his Hirsaugiensian Annals, employs language to this effect.—"In the same year, on the 7th day of November, in the village of Suntgaw, near the townlet of Ensisheim, not far from Basil, a city of Germany, a stone, called a thunder-stone, of a prodigious size, for we know from eye-witnesses that it weighed 255 pounds, fell from the heavens. Its fall was so violent, that it broke into two pieces. The most considerable is still exhibited at the door of the church of Ensisheim, suspended by an iron chain, as a proof of the fact which we have mentioned, and to preserve it in the public recollection."—We learn also from Paul Lang that there arose a furious storm on the 7th of November 1492, and that while the thunder roared, and the heavens appeared all on fire, a stone of enormous size fell near Ensisheim. "Its form was that of the the Greek delta, with a triangular point. They still show it at Ensisheim as an astonishing phenomenon."

It is worthy of observation, that these chroniclers lived at the period which they assign to the descent of the

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the stone; and that, though their names are hastening to oblivion, Trithemius yielded to few of his contemporaries in labour and learning; while Lang, a German Benedictine as he was, travelled in search of historical monuments, arraigned the license of the catholic clergy, and applauded the independence of Luther and Melancthon.

Of the Ensisheim stone, which has been transported to the national library at Colmar, and which, notwithstanding various *dilapidations*, still weighs 150 pounds, some interesting specimens may now be seen in the cabinets of the curious. Robert Ferguson, Esq. younger of Raith, has, in the most polite and obliging manner, gratified us with the sight of a small fragment, which belongs to his valuable collection of minerals at Raith house in Fifeshire, Scotland.

We are fully aware, that M. Barthold has laboured to convince his readers (Journal de Physique, Ventose, year 8.) that the far-famed mass of Ensisheim is merely argillo-ferrugineous, of secondary formation, detached from an adjacent mountain, and conveyed to the spot on which it was found by some torrent or land-flood. In this opinion, we might partially acquiesce, did not the artlessness of contemporary and concurring records militate against it, and had not the more accurate analysis of Vauquelin detected the same constituent parts as in the other stony and metalline substances denominated meteoric. "It is certainly composed of silica," observes this celebrated chemist, "of magnesia, of iron, of nickel, of sulphur, and of a small quantity of lime.—Particular trials have convinced me of the presence of sulphur and nickel in the grains of malleable iron, and in the pyrites, though in different proportions. This stone, then, in every respect, resembles others which have fallen from the atmosphere."

In the Commentary of Surius, a Carthusian monk of Cologne, mention is made of a shower of large stones in Lombardy, in 1510. These stones were harder than flint, and smelled of sulphur. The heaviest weighed 120 pounds.—The same event is more particularly related by Cardan, in his work intitled *de Rerum Varietate* (lib. xiv. c. 72.). According to this author, near the river Adda, not far from Milan, and at five o'clock in the evening, about 1120 stones fell from the air, one of them weighing 120 pounds and another 60 pounds. Many were presented to the French governor, and his deputy. At three o'clock P. M. the sky appeared as if in a general blaze; and the passage, though somewhat ambiguous, would lead us to infer, that the meteor was visible for two hours. Like many of the learned and unlearned of his day, Cardan instantly connects the extraordinary appearance with the political transactions of his district.

We next pass to an interesting extract from the memoirs of the emperor Jehangire, written in Persian, by himself, and translated by Colonel Kirkpatrick.

"*A. H. 1030, or 16th year of the reign.*—The following is among the extraordinary occurrences of this period.

"Early on the 30th of Furverdeen of the present year (1620), and in the eastern quarter of the heavens, there arose in one of the villages of the purgunnah of Jalindher, such a great and tremendous noise, as had nearly, by its dreadful nature, deprived the inhabitants of the place of their senses. During this noise, a luminous body was observed to fall from above, on the earth, suggesting to the beholders the idea that the firmament was raining fire. In a short time, the noise having subsided, and the inhabitants having recovered from their alarm, a courier was dispatched to *Mahommed Syeed*, the aumul of the aforesaid purgunnah, to advertise him of this event. The aumil, instantly mounting his horse, proceeded to the spot. Here he perceived the earth, to the extent of a dozen of yards in length and breadth, to be burned to such a degree, that not the least trace of verdure, or a blade of grass remained; nor had the heat yet subsided entirely.

"*Mahommed Syeed* hereupon directed the aforesaid space of ground to be dug up; when the deeper it was dug, the greater was the heat of it found to be. At length a lump of iron made its appearance, the heat of which was so violent, that one might have supposed it to have been taken from a furnace. After some time it became cold: when the aumil conveyed it to his own habitation, from whence he afterwards dispatched it in a sealed bag to court.

"Here I had this substance weighed in my presence. Its weight was 160 tolahs (A). I committed it to a skilful artisan, with orders to make of it a sabre, a knife, and a dagger. The workman reported, that the substance was not malleable, but shivered into pieces under the hammer.

"Upon this I ordered it to be mixed with other iron. Conformably to my orders, three parts of the *iron of lightning* (B) were mixed with one part of common iron; and from the mixture were made two sabres, one knife, and one dagger."

Our limits will not permit us to give the whole of the extract, nor the remarks of the Right Hon. Charles Greville and Colonel Kirkpatrick, which were read before the Royal Society of London, on the 27th January, 1803. We feel, however, no hesitation in attaching to this document something very nearly approaching to direct evidence of the fact in question.

The celebrated Gassendi relates, that, on the 27th of November, 1627, about 10 o'clock A. M. during a very clear sky, he saw a flaming stone, of the apparent diameter of four feet, fall on Mount *Vaision*, an eminence situated between the small towns of Perne and Guillaumes, in Provence. This stone was surrounded by a luminous circle of different colours, nearly resembling the rainbow, and its fall was accompanied with a noise like the discharge of artillery. It weighed 59 pounds; and its specific gravity was to that of common marble as 14 to 11. It was of a dark metallic colour, and extremely hard. Though it was not subjected to chemical analysis, and is not now to be found, the circumstances which have been stated by the philosopher are sufficiently

(A) A tolah is about 180 grains, Troy weight.
(B) This expression is equivalent to our term *thunder-bolt*.

sufficiently minute to operate on the conviction of those who are willing to be convinced.

From a curious book printed at Paris in 1672, and now become very scarce, entitled *Conversations tirées de l'Académie de M. l'Abbé Bourdelot, contenant diverses recherches et observations physiques, par le Sieur Legallois*, we make the ensuing extract.

"A member presents a fragment of two stones which fell near Verona, one of which weighed 300, and the other 200 pounds. These stones," says he, "fell during the night, when the weather was perfectly mild and serene. They seemed to be all on fire, and came from above, but in a slanting direction, and with a tremendous noise. This prodigy terribly alarmed 300 or 400 eye-witnesses, who were at a loss what to think of it. These stones fell with such rapidity, that they formed a ditch, in which after the noise had ceased, the spectators ventured to approach them, and examine them more closely. They then sent them to Verona, where they were deposited in the Academy, and that learned body sent fragments of them to different places." That which accompanied the above intimation was of a yellowish hue, very easily pulverized, and smelled of sulphur.—In the course of examining one of these stones, M. Laugier, professor of pharmacy at Paris, has recently detected the presence of chrome, by means of the caustic alkali.—The date of the Verona phenomena, if we have been correctly informed, is 1663.

In the Bornian collection there is a substance which is designated *Ferrum retractorium, granulis nitentibus, matrice virescenti immixtis (Ferrum virens Lin.), cujus fragmenta ab unius ad viginti usque librarum pondus, cortice nigro scoriaceo circumdata, ad Plann, prope Tabor, circuli Bechinensis Bohemiæ, passim reperiuntur.* The following note is subjoined. (*Quæ fragmenta 3 Julii anni* 1753, *inter tonitrua, è cœlo pluisse creduliores quidam asserunt*). The expression *creduliores quidam*, it may be alleged, at once destroys the evidence of this memorandum. It deserves, however, to be noted, that, in regard to our present subject, what was formerly accounted the credulity of the vulgar, may now, on several occasions, be construed into probability, if not into matter of fact; and that Mr Greville has found the identical fragment to have the same composition with other meteoric stones. Hence, we are compelled either to admit its ex-terrestrial origin, or the existence of a substance, originally belonging to the earth, and yet agreeing in character with those deemed atmospheric. The former part of the alternative is perfectly consonant with well-authenticated facts; whereas of the latter, we are not warranted to pronounce, that a single case has hitherto been established to the satisfaction of any chemist or mineralogist.

But we have now to turn our attention to a report of M. de la Lande, inserted in the Historical Almanack of Bresse, for 1756.

In the month of September 1753, about one o'clock P. M. when the weather was very hot, and very serene, without the least appearance of a cloud, a very loud noise, like the discharge of two or three cannons, was heard within the circumference of six leagues, but was of very short duration. This noise was loudest in the neighbourhood of Pont-de-Vesle; and at Liponas, a village three leagues from the last-mentioned place, it was even accompanied with a hissing, like that of a cracker. On the same evening there were found at Liponas and at Pin, two blackish masses, of a form nearly circular, but very uneven, which had fallen on ploughed ground, and sunk, by their own weight, to half a foot below the surface. One of them weighed about twenty pounds; and a fragment of one of them weighing $11\frac{1}{2}$lb. was preserved in the cabinet of M. Varenne de Beost, at Dijon. The basis of these masses resembled a grayish whinstone, and was very refractory; and some ferrugineous particles were disseminated in grains, filaments, or minute masses, through the substance of the stone, especially in its fissures. This iron, when subjected to a red heat, became obedient to the magnet. The black coating on the surface, M. de la Lande ascribes to fusion, induced by violent heat. This gentleman's acknowledged respectability and accuracy of observation, combined with the circumstances which he has adduced, circumstances, too, which, if mistated, lay so open to public investigation, powerfully plead in favour of his testimony.

On the 15th of September, 1760, according to the abbé Bachelay, about half past four o'clock P. M. there appeared near the chateau de Chevabrie, in the neighbourhood of Lucé, a small town of the province of Maine, a stormy cloud, from which proceeded a loud peal of thunder, like the discharge of cannon, and followed by a noise which was mistaken by several people for the lowing of oxen. This sound was heard over a space of about two leagues and a half, but unaccompanied by any perceptible flame. The reapers in the parish of Perigué, about three leagues from Lucé, on hearing the same noise, looked up, and saw an opake body, which described a curve, and fell on soft turf, on the high road from Mons, near which they were at work. They all quickly ran up to it, and found a sort of stone, nearly half of which was buried in the earth, and the whole so hot that it could not be touched. At first they ran away in a panic; but on returning to the spot some time after, they found the stone precisely in the same situation, and sufficiently cooled to admit of being handled, and narrowly examined. It weighed seven ounces and a half, and was of a triangular form, presenting, as it were, three rounded horns, one of which, at the moment of the fall, had entered into the ground, and was of a gray or ash colour, while the rest, which was exposed to the air, was very black. When the abbé presented this stone to the academy, that body appointed three of its number, namely, Messieurs Lavoisier, Fougeroux, and Cadet, to examine and analyse it. This task they performed with more care and accuracy than M. de la Lande had done on the preceding occasion; but their trial was confined to an integral part of the whole, considered as a homogeneous substance, in place of being repeated on each of the constituent parts. The substance was of a pale cinereous hue, speckled with an infinite number of small and shining metallic points, visible through a magnifying glass. That part of the outer surface which remained above ground was incrusted with a thin black coating, which seemed to have undergone fusion, and which gave a few sparks when struck with steel. The specific gravity of the mass was 3535.—Two other stones, nearly of the same characters, the one reported to have fallen at Aire, in Artois, and the

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the other in the Cotentin, in Normandy, were presented to the academy in the course of the same year by M. Garson de Boyaval, honorary lieutenant-general of the bailliage of Aire, and the younger M. Morand. According to the academical report, these three stones, when compared, presented no difference to the eye, were of the same colour, and nearly of the same grain, exhibiting metallic and pyritous particles, and covered with a black and ferrugineous incrustation. Although the coincidence of facts and circumstances, in three places so remote from one another, did not convince the academy that these stones had been conveyed to the earth by lightning, yet it induced them to invite naturalists to prosecute the examination of the subject.

On the 20th of November 1768, a stone fell at Mauerkircken near the Inn, in Bavaria, that weighed 38lb. was of a triangular form, and only eight inches in thickness. Its fall was accompanied by a hissing noise, and great darkness in the atmosphere. This meteorolite penetrated two feet and a half into the soil. Part of it is in the cabinet of the right honourable Charles Greville, which is now in the British Museum; and a fragment may be seen in Mr Ferguson's collection quoted above.

The next remarkable case on record occurred on the 20th of August 1789, at Barbotan, near Roquefort, in the *Landes* of Bourdeaux, and is thus related by Citizen Lomet, who was known to several members of the institute, and happened to be at Agen when the meteor appeared.

"It was a very bright fire-ball, luminous as the sun, of the size of an ordinary balloon, and, after inspiring the inhabitants with consternation, burst and disappeared. A few days after, some peasants brought stones, which they said fell from the meteor; but the philosophers to whom they offered them laughed at their assertions as fabulous. The peasants would have now more reason to laugh at the philosophers"—One of these stones broke through the roof of a cottage, and killed a herdsman and some cattle. Vauquelin, who received a *proces-verbal* of the circumstances, also examined one of the specimens. The fragment procured by Mr Ferguson has visibly all the characters of a genuine meteorolite.

A much more remarkable phenomenon, however, of the same description, occurred near Agen, on the 24th of July 1790. An inhabitant of St Severe communicates the following particulars to M. Darcet the chemist, who was then resident at Paris.

"Our towns-people were yesterday very much alarmed. About a quarter past nine o'clock, in the evening, there suddenly appeared in the air a fire-ball, dragging a long train, which diffused a very vivid light over the horizon. This meteor soon disappeared, and seemed to fall at one hundred paces from us. It was quickly followed by an explosion louder than that of cannon or of thunder. Every body dreaded being buried under the ruins of his house, which seemed to give way from the concussion. The same phenomenon was seen, and the report heard, in the neighbouring towns, as Mont de Marsan, Tartas, and Dax. The weather in other respects was very calm, without a breath of wind or a cloud, and the moon shone in all her brightness."

M. Darcet's brother, a clergyman in that part of the country, sent him a small stone, which was picked up on the morning after the explosion, and the history of which he was scrupulously anxious to investigate. Being satisfied with respect to all the particulars, he at length dispatched it to Paris, accompanied with some curious remarks. "When these stones fell," says he, "they had not their present degree of hardness. Some of them fell on straw, bits of which stuck to the stones, and incorporated with them. I have seen one in this predicament. It is at present at La Bastide; but I cannot persuade the owner to part with it***. Those which fell on the houses produced a noise, not like that of stones, but rather of a substance which had not yet acquired compactness."

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We subjoin the *proces-verbal*—a simple but authentic document.

"In the year one thousand seven hundred and ninety, and the 30th day of the month of August, we, the Sieur Jean Duby, mayor, and Louis Maullon, procurator of the commune of the municipality of La Grange de Juillac, and Jean Darmite, resident in the parish of La Grange de Juillac, certify in truth and verity, that, on Saturday the 24th of July last, between nine and ten o'clock in the evening, there passed a great fire, and after it we heard in the air a very loud and extraordinary noise; and, about two minutes after, there fell stones from heaven, but fortunately there fell only a very few, and they fell about ten paces from one another in some places, and in others nearer, and finally, in some other places, farther, and falling, most of them, of the weight of about half a quarter of a pound each; some of about half a pound, like that found in our parish of La Grange; and on the borders of the parish of Creon, they were found of a pound weight; and in falling they seemed not to be inflamed, but very hard and black without, and within of the colour of steel; and, thank God, they occasioned no harm to the people, nor the trees, but only to some trees which were broken on the houses; and most of them fell gently, and others fell quickly, with a hissing noise; and some were found which had entered into the earth, but very few. In witness whereof we have written and signed these presents. (Signed) DUBY, Mayor—DARMITE."

Monsieur Baudin mentions, that, as M. Carris of Barbotan and he were walking in the court of the castle of Mormes about half past nine o'clock, in the evening of the 24th of July 1790, when the air was perfectly calm, and the sky cloudless, they found themselves suddenly surrounded by a pale clear light, which obscured that of the moon, though the latter was nearly full. On looking up, they observed, almost in their zenith, a fire-ball of a larger apparent diameter than that of the moon, dragging a tail, which seemed to be five or six times longer than the diameter of its body, and which gradually tapered to a point, the latter approaching to blood red, though the rest of the meteor was of a pale white. This luminous body proceeded with great velocity from south to north, and in two seconds split into portions of considerable size, like the fragments of a bursting bomb. These fragments became extinguished in the air, and some of them, as they fell, assumed that deep red colour, which had been observed at the point of the tail. Two or three minutes after M. Baudin and his friend heard a dreadful explosion, like the simultaneous firing of several pieces of ordance; but they were not sensible of any tremulous motion under their feet, though the concussion

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sion of the atmosphere shook the windows in their frames, and threw down kitchen utensils from their shelves. When these gentlemen removed to the garden, the noise still continued, and seemed to be directly over their heads. Some time after it had ceased, they heard a hollow sound rolling, in echoes, for fifty miles, along the chain of the Pyrenees, and at the end of about four minutes gradually dying away in distance. At the same time, a strong sulphureous odour was diffused in the atmosphere. The interval which occurred between the disruption of the meteor, and the loud report, induced M. Baudin to conjecture, that this fireball must have been at least eight miles from the earth's surface, and that it fell about four miles from Mormes. "The latter part of my conjecture, says he, was soon confirmed by an account which we received of a great many stones having fallen from the atmosphere at Juillac and in the neighbourhood of Barbotan." It appears, indeed, from the concurring testimony of intelligent persons worthy of credit, that the meteor really exploded at a little distance from Juillac, and that its fragments were found lying in an almost circular space, of nearly two miles in diameter. Some of them weighed eighteen or twenty, and a few, it is alleged, even fifty pounds. M. de Carris procured one of 18 lbs. which he transmitted to the Parisian Academy of Sciences. That examined by M. Baudin was small, but heavy in proportion to its size, black on the outside, grayish within, and interspersed with many minute, shining, metallic particles. These last circumstances perfectly accord with the fragment of a Barbotan stone preserved in Mr Ferguson's collection.

In one of his letters to Professor St Amand, M. Goyon d'Arzas remarks, that these stones, though generally smooth on the outside, presented some longitudinal cracks, or fissures, while their interior parts exhibited symptoms of metallic veins, especially of a ferrugineous complexion. When yet red hot, and scattered in various directions, they formed that magnificent fire-work, that shower of flame, which enlightened the horizon over a large tract of country; for this extraordinary meteor was seen at Bayonne, Auch, Pau, Tarbes, and even at Bourdeaux and Toulouse. At the last-mentioned place it excited little attention, on account of its great distance, and its appearing only a little brighter than a shooting star. It, moreover, deserves to be noted, that the meteorolites in question were found on a bare moor, of an extremely thin soil, on which no such stones, or indeed stones of any description, had been observed in the memory of man. They who are solicitous of additional information on this part of our subject, may consult N^{os}. 23 and 24 of the *Journal des Sciences Utiles* of Montpelier, for 1790, and the *Decade Philosophique* for February 1796.

When all the circumstances of the case are duly considered, we need not be surprised, that they should produce conviction on the minds of many men of science, who, till then, possessed "an evil heart of unbelief." M. de St Amand ingenuously confessed to M. Pictet of Geneva, that he had treated this novel topic with unmerited contempt, and that the evidence deduced from the similar characters of the stones should not be rashly rejected. The learned and the unlearned of the district in which the phenomenon is stated to have occurred, attest its existence; the professor of natural history in the central school of Agen renounces his former scepticism; Vauquelin analyses a specimen, and finds it to contain the same chemical substances as other meteorolites, and in nearly the same proportions; and shall we be so unreasonable as to withhold our assent, merely because we have not *ocular demonstration* of the alleged particulars?

Our chronological series of cases has now brought us to the fall of several meteorolites near Sienna, the particulars of which, as reported by the late earl of Bristol and Sir William Hamilton, are recorded in the first part of the Philosophical Transactions for 1795 (page 103). Mr King, likewise in the tract which we have already quoted, communicates some interesting circumstances relative to this phenomenon, chiefly extracted from an account of it published by Professor Soldani. While we refer our readers to these details, we cannot omit mentioning that, in regard to aspect and composition, the Sienna stones are perfectly analogous to others already noticed, and very different from any that occur in Tuscany. As the meteor from which they were discharged appeared on the morning after a violent eruption of Vesuvius, they were at first supposed to be volcanic, till cool reflection and examination betrayed the extravagance of such a hypothesis. The precise number of stones which were collected on this occasion is not specified, but many of them were small, weighing from a quarter of an ounce to two ounces. A pretty entire specimen occurs in Mr Ferguson's collection.—The date of the Sienna meteor is the 16th of June, 1794.

On the 13th of December of the following year, about three o'clock in the afternoon, another of these singular stones, weighing 56 pounds, fell near the country house of Captain Topham, in Yorkshire. The captain's report, which is inserted in the Gentleman's Magazine for 1796, is distinct and satisfactory; while the chemical examination of the mass, detailed in Mr Howard's paper, in the Philosophical Transactions for 1802, affords a still more decisive proof of its atmospheric origin. M. de Drée, also, found it to correspond exactly in aspect and character, with fragments of meteor stones from Benares and Ville franche. The original mass is in the possession of Mr Sowerby author of English Botany, &c. It is larger than a man's head.

Mr Southey, in his letters from Spain and Portugal, transcribes the authenticated relation of another instance of the descent of a stone from the clouds on the 19th of February 1796. But we pass to some of the most important details relative to the stone which is affirmed to have fallen near Ville-franche, in the department of the Rhone, on the 12th of March, 1798. When it was transmitted to Professor Sage, member of the National Institute, he considered it at first, as only a pyritous and magnetical ore of iron, although it bore no resemblance to any known species of ore of that metal, since it contained nickel, silica, magnesia, and native iron, which shone like steel when polished. "It is of an ash gray colour, says M. Sage, granulated and speckled with gray, shining, and pyritous metallic points. One of its surfaces is covered with a dingy black enamel, about the third of a line in thickness. This stone acts very powerfully on the magnetic needle. When the senator Chasset transmitted it to me, it was

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was accompanied with an hiſtorical notice of ſimilar import with that which M. Delievre, of Ville-franche, who ſaw and deſcribed the phenomenon on the ſpot."

At ſix o'clock in the evening, a round body, which diffuſed the moſt vivid light, was obſerved in the vicinity of Ville-franche, moving weſtward, and producing a hiſſing, like that of a bomb which traverſes the air. This luminous body, which was ſeen at the ſame time at Lyons and on Mont-Cenis, marked its path by a red track of fire, and exploded, about 200 toiſes from the earth with a tremendous report and concuſſion. One of the flaming fragments fell on the vineyard of Peter Crepier, an inhabitant of Sales. On the ſpot where this portion of the meteor was ſeen to fall, and in a freſh opening of about 20 inches in depth, and 18 in width, was found a black maſs, 15 inches in diameter, and rounded on one ſide.

An account of the ſame meteor was publiſhed in the Journal de Phyſique, for Floreal, year 11, by M. de Drée. From his minute and deliberate inveſtigation, it appears that the fire-ball had ſcarcely fixed the attention of the inhabitants of the Sales and of the adjacent villages, when its rapid approach, accompanied by a terrible whizzing noiſe, like that of an irregular hollow body, traverſing the air with unuſual velocity, inſpired the whole commune with alarm, eſpecially when they obſerved it paſſing over their heads, at an inconſiderable elevation. It left behind a long train of light, and emitted, with an almoſt unceaſing crackling, ſmall vivid flames, like little ſtars. Its fall was remarked, at the diſtance of only 50 paces, by three labourers, one of whom, named Montillard, let fall his coat and bundle of ſticks that he might run the faſter, while the other two, Chardon and Lapoces, fled with equal precipitation to Sales, where the alarm had become general.—Theſe three witneſſes atteſt the aſtoniſhing rapidity of the meteor's motion, and the hiſſing which proceeded from the ſpot where it fell. So terrified was Crepier at the exploſion, that he locked himſelf up with his family, firſt in his cellar, and then in his private apartment, nor ventured abroad till next morning, when, in the company of M. Blandel, Chardon, Lapoces, and many others, he repaired to the opening which had been made by the fire ball. At the bottom of this opening, which was 18 inches deep, including the entire thickneſs of the mould, they found a large black maſs, of an irregularly ovoid form, having a fanciful reſemblance to a calf's head. Though no longer hot, it ſmelled of gun-powder and was cracked in ſeveral places. When the obſervers broke it, and diſcovered nothing but ſtone, indifference ſucceeded to curioſity, and they coolly aſcribed its appearance to cauſes more or leſs whimſical and ſupernatural.

The original weight of this ſtone was about twenty pounds. Its black vitrified ſurface gave fire with ſteel. Its interior was hard, earthy, aſh-coloured, of a granular texture, preſenting different ſubſtances ſcattered through it, namely, iron in grains, from the ſmalleſt ſize to a line or even more in diameter, ſomewhat malleable, but harder and whiter than forged iron; white pyrites, both lamellated and granular, and in colour approaching to nickel; ſome gray globules, which ſeemed to preſent the characters of trapp, and a very few and ſmall particles of ſteatites, inclining to an olive hue. On account of its heterogeneous compoſition, its ſpecific gravity could not be eaſily aſcertained. One hundred parts of the maſs gave, according to Vauquelin, 46 of ſilica, 38 oxide of iron, 15 magneſia, 2 nickel, and 2 lime. The exceſs of this reſult was aſcribed to the abſorption of oxygen by the native iron during the proceſs. A ſmall ſpecimen of this maſs belongs to Mr Ferguſon's collection.

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On the 19th of December 1798, about eight o'clock in the evening, the inhabitants of Benares and its neighbourhood obſerved in the heavens a very luminous meteor, in the form of a large ball of fire, which exploded with a loud noiſe, and from which a number of ſtones were precipitated near Krakhut, a village about fourteen miles from the city of Benares. Mr Davis, the judge and magiſtrate of the diſtrict affirmed that its brilliancy equalled the brighteſt moonlight. Both he and Mr Erſkine, the aſſiſtant collector, were induced to ſend perſons in whom they could confide to the ſpot where this ſhower of ſtones was aſſerted to have taken place, and thus obtained additional evidence of the phenomenon, and ſeveral of the ſtones, which had penetrated about ſix inches into fields recently watered. Mr Maclane, a gentleman who reſided near Krakhut, preſented Mr Howard with part of a ſtone, which had been brought to him the morning after its deſcent, by the watchman who was on duty at his houſe, and through the roof of whoſe hut it had paſſed, and buried itſelf ſeveral inches in the floor, which was of conſolidated earth. Before it was broken, it muſt have weighed upwards of two pounds.

At the time that this meteor appeared, the ſky was perfectly ſerene; not the ſmalleſt veſtige of a cloud had been ſeen ſince the 11th of the month, nor was any obſerved for many days after.

"Of theſe ſtones (ſays Mr Howard), I have ſeen eight nearly perfect, beſides parts of ſeveral others, which had been broken by the poſſeſſors, to diſtribute among their friends. The form of the more perfect ones appeared to be that of an irregular cube, rounded off at the edges; but the angles were to be obſerved on moſt of them. They were of various ſizes, from about three to upwards of four inches in their largeſt diameter; one of them, meaſuring four inches and a quarter, weighed two pounds twelve ounces. In appearance they were exactly ſimilar; externally they were covered with a hard black coat, or incruſtation, which in ſome parts had the appearance of varniſh or bitumen; and on moſt of them were fractures, which, from their being covered with a matter ſimilar to that of the coat, ſeemed to have been made in the fall, by the ſtones ſtriking againſt each other, and to have paſſed through ſome medium, probably an intenſe heat, previous to their reaching the earth. Internally they conſiſted of a number of ſmall ſpherical bodies, of a ſlate colour, imbedded in a whitiſh gritty ſubſtance, interſperſed with bright ſhining ſpiculæ, of a metallic or pyritical nature. The ſpherical bodies were much harder than the reſt of the ſtone: the white gritty part readily crumbled, on being rubbed with a hard body; and on being broken, a quantity attached itſelf to the magnet, but more particularly the outſide coat or cruſt, which appeared almoſt wholly attractable by it."

Here we are furniſhed with another circumſtantial and authenticated narrative, by individuals above the rank

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rank of suspicion, and who were prompted solely by motives of curiosity, to examine with due deliberation the particulars which they have reported.

The history of the extraordinary shower of stones which fell near l'Aigle, in Normandy, on the 26th of April 1803, first appeared in the ensuing artless letter, addressed by M. Marais, an inhabitant of the place, to his friend in Paris.

"*At l'Aigle, the 13th Floréal, year* 11.

"An astonishing miracle has just occurred in our district. Here it is, without alteration, addition, or diminution. It is certain, that it is the truth itself.

"On Friday last, 6th Floréal (26th April), between one and two o'clock in the afternoon, we were roused by a murmuring noise like thunder. On going out we were surprised to see the sky pretty clear, with the exception of some small clouds. We took it for the noise of a carriage, or of fire in the neighbourhood. We were then in the meadow, to examine whence the noise proceeded, when we observed all the inhabitants of the Pont de Pierre at their windows, and in gardens, inquiring concerning a cloud, which passed in the direction of from south to north, and from which the noise issued, although that cloud presented nothing extraordinary in its appearance. But great was our astonishment when we learned, that many and large stones had fallen from it, some of them weighing ten, eleven, and even seventeen pounds, in the space between the house of the Buat family (half a league to the north-north-east of l'Aigle) and Glos, passing by St Nicolas, St Pierre, &c. which struck us at first as a fable, but which was afterwards found to be true.

"The following is the explanation given of this extraordinary event by all who witnessed it.

"They heard a noise like that of a cannon, then a double report still louder than the preceding, followed by a rumbling noise, which lasted about ten minutes, the same which we also heard, accompanied with hissings, caused by these stones, which were counteracted in their fall by the different currents of air, which is very natural in the case of such a sudden expansion. Nothing more was heard; but it is remarkable, that previously to the explosion, the domestic fowls were alarmed, and the cows bellowed in an unusual manner. All the country-folks were much dismayed, especially the women, who believed that the end of the world was at hand. A labourer at la Sapée fell prostrate on the ground, exclaiming, 'Good God! is it possible that thou canst make me perish thus? Pardon, I beseech thee, all the faults I have committed,' &c. The most trifling objects, in fact, might create alarm, for it is not improbable, that history offers no example of such a shower of stones as this. The piece which I send was detached from a large one, weighing eleven pounds, which was found between the house of the Buats and le Fertey. It is said, that a collector of curiosities purchased one of seventeen pounds weight, that he might send it to Paris. Every body in this part of the country is desirous of possessing a whole stone, or a fragment of one, as an object of curiosity. The largest were darted with such violence that they entered at least a foot into the earth. They are black on the outside, and grayish, as you see, within, seeming to contain some species of metal and nitre. If you know before us of what ingredients they are composed, you will inform us. One fell near M. Bois de la Ville, who lives near Glos. He was much afraid, and took shelter under a tree. He has found a great number of them of different sizes, in his court-yard, his wheat fields, &c. without reckoning all those which the peasants have found elsewhere. Numberless stories, more or less absurd, have been circulated among the people. You know that our country is fertile in such tales. Cousin Moutardier sends one of these stones to Mademoiselle Hébert; and he is not less eager than we are, to know how these substances can be compressed and petrified in the air. Do try to explain the process.

"The person who gave me the largest stone which I send to you, went to take it at the moment that it fell, but it was so hot that it burned him. Several of his neighbours shared the same fate in attempting to lift it.

"The elder Buat has just arrived, and desires us to add, that a fire-ball was observed to hover over the meadow. Perhaps it was wild-fire."

At the sitting of the institute, on the 9th of May, Fourcroy read a letter, addressed from l'Aigle to Vauquelin, and which sufficiently corroborates the preceding statements. But we pass to the substance of M. Biot's letter, addressed to the minister of the interior, and published in the *Journal des Débats*, (14th Thermidor, year 11.). The writer, who is advantageously known for his scientific attainments, was deputed by government to repair to the spot, and collect all the authentic facts. The contents of his letter have been since expanded into the form of a memoir, which manifests the caution and good sense which guided his inquiries, and which, we are surprised to learn, has not appeared in an English translation.

M. Biot left Paris on the 25th of June, and in place of proceeding directly to l'Aigle, went first to Alençon, which lies fifteen leagues to the west-south-west of it. He was informed on his way, that a globe of fire had been observed moving towards the north, and that its appearance was followed by a violent explosion. From Alençon he journeyed through various villages to l'Aigle, being directed in his progress by the accounts of the inhabitants, who had all heard the explosion on the day and at the hour specified. Almost all the inhabitants of twenty hamlets, scattered over an extent of upwards of two leagues square affirmed that they were eye-witnesses of a dreadful shower of stones which was darted from the meteor. The following is his summary of the whole evidence.

"On Tuesday, 6th Floréal, year 11, about one o'clock, P. M. the weather being serene, there was observed from Caen, Pont d'Audemer, and the environs of Alençon, Falaise, and Verneuil, a fiery globe, of a very brilliant splendor, and which moved in the atmosphere with great rapidity. Some moments after, there was heard at l'Aigle, and in the environs of that town, in the extent of more than thirty leagues in every direction, a violent explosion, which lasted five or six minutes. At first there were three or four reports, like those of cannon, followed by a kind of discharge which resembled the firing of musketry; after which there was heard a dreadful rumbling like the

the beating of a drum. The air was calm, and the ſky ſerene, except a few clouds, ſuch as are frequently obſerved.

"This noiſe proceeded from a ſmall cloud which had a rectangular form, the largeſt ſide being in a direction from eaſt to weſt. It appeared motionleſs all the time that the phenomenon laſted; but the vapours of which it was compoſed, were projected momentarily from different ſides, by the effect of the ſucceſſive exploſions. This cloud was about half a league to the north-north-weſt of the town of l'Aigle. It was at a great elevation in the atmoſphere, for the inhabitants of two hamlets, a league diſtant from each other, ſaw it at the ſame time above their heads. In the whole canton over which this cloud was ſuſpended, there was heard a hiſſing noiſe like that of a ſtone diſcharged from a ſling, and a great many mineral maſſes exactly ſimilar to thoſe diſtinguiſhed by the name of *meteor-ſtones* were ſeen to fall.

"The diſtrict in which theſe maſſes were projected, forms an elliptical extent of about two leagues and a half in length, and nearly one in breadth, the greateſt dimenſion being in a direction from ſouth-eaſt to north-weſt, forming a declination of about 22 degrees. This direction, which the meteor muſt have followed, is exactly that of the magnetic meridian, which is a remarkable reſult. The greateſt of theſe ſtones fell at the ſouth-eaſtern extremity of the large axis of the ellipſe, the middle-ſized in the centre, and the ſmaller at the other extremity. Hence it appears that the largeſt fell firſt, as might naturally be ſuppoſed. The largeſt of all thoſe that fell weighs ſeventeen pounds and a half. The ſmalleſt which I have ſeen weighs about two *gros* (a thouſandth part of the laſt). The number of all thoſe which fell is certainly above two or three thouſand."

As we cannot make room for an analyſis of M. Biot's more extended communication, we ſhall be contented to ſelect only two facts.

The *curé* of St Michael declared, that he obſerved one of the ſtones fall, with a hiſſing noiſe, at the feet of his niece, in the court-yard of his parſonage, and that it rebounded upwards of a foot from the pavement. He inſtantly requeſted his niece to fetch it to him; but as ſhe was too much alarmed, a woman who happened alſo to be on the ſpot, took it up; and it was found in every reſpect to reſemble the others.

As one *Piche*, a wire-manufacturer belonging to the village of *Armées*, was working with his men in the open air, a ſtone grazed his arm, and fell at his feet; but it was ſo hot, that, on attempting to take it up, he inſtantly let it fall again.

He who compares the various accounts of the l'Aigle meteor, with a critical eye, may detect ſome apparent contradictions, which, however, on reflection, are found to be ſtrictly conformable to truth. Thus, according to ſome, the meteor had a rapid motion, others believed it ſtationary; ſome ſaw a very luminous ball of fire, others only an ordinary cloud. Spectators, in fact, viewed it in different poſitions with reſpect to its direction. They who happened to be in its line of march, would ſee it ſtationary, for the ſame reaſon, that we fancy a ſhip under full ſail to be motionleſs, when we are placed in its wake, or when we view it from the harbour to which it is approaching in a ſtraight line. They, on the other hand, who had a ſide view of the meteor, would reckon its progreſs the more rapid, in proportion as their poſition approached to a right angle with its line of paſſage. They, again, who ſaw it from behind, as the inhabitants of l'Aigle, would perceive only the cloud of vapour, which it left in its train, and which, in the dark, would figure like a blazing tail, in the ſame manner as the ſmoke of a volcano appears black during the day and red at night. Laſtly, they who were placed in front of the meteor, would reckon it ſtationary, but brilliant and cloudleſs.

It deſerves to be remarked, that the l'Aigle ſtones were very friable for ſome days after their deſcent, that they gradually acquired hardneſs, and that after they had loſt the ſulphureous odour on their ſurface, they ſtill retained it in their ſubſtances, as was found by breaking them. Profeſſor Sage ſubmitted them to ſeveral comparative trials with thoſe of Ville-franche; and, though the l'Aigle ſpecimens preſent ſome globules of the ſize of a ſmall coriander ſeed, of a darker gray than the maſs, and not attractable by the magnet, yet, in reſpect of granular texture and general aſpect, the coincidence was ſo ſtriking as to lead one to ſuppoſe that they were all parts of the ſame maſs.

The l'Aigle ſtones, according to Fourcroy, are generally irregular, polygonal, often cuboid, ſometimes ſubcuneiform, and exceedingly various in their diameter and weight. All are covered with a black gravelly cruſt, conſiſting of a fuſed matter, and filled with ſmall agglutinated grains of iron. The greater part of them are broken at the corners, either by their ſhock againſt each other, or by falling on hard bodies. The internal parts reſemble thoſe of all the ſtones analyzed by Meſſrs Howard and Vauquelin, being gray, a little varied in their ſhades, granulated, and as it were ſcaly, ſplit in many parts, and filled with brilliant metallic points, exactly of the ſame aſpect as thoſe of other ſtones of a like deſcription. The proportions of their conſtituent materials are ſtated as nearly, 54 ſilex, 36 oxidated iron, 9 magneſia, 3 nickel, 2 ſulphur, and 1 lime, the five per cent. of increaſe ariſing from the oxidation of the metals produced by the analyſis.

Of the two ſpecimens which M. Biot preſented to the celebrated Patrin, one was leſs compact, and of a lighter gray than the other, and likewiſe preſented ſmall patches of a ruſt colour. When immerſed in water, it gave a hiſſing ſound, like the humming of a fly, which is held by one wing. As it began to dry, it was obſerved to be marked by curvilinear and parallel layers. The more compact ſpecimens, when moiſtened, preſented no ſuch appearances, but aſſumed the aſpect of a gray porphyry, with a baſe of trap, mottled with ſmall white ſpots, and ſpeckled with metallic points.

Two fine ſpecimens of the l'Aigle ſtone, one of them nearly entire, may be ſeen in Mr Ferguſon's collection, which we have already repeatedly quoted.

Previouſly to the exploſion of the 26th of April 1803, no meteorolites had been found by the inhabitants of the l'Aigle diſtrict, nor in the mineralogical collections of the department; nor the ſlighteſt mention of them made in the geological documents of this portion of Normandy: the mines, founderies, and forges, had produced nothing ſimilar, in the form of droſs or ore, nor had the country exhibited any trace of volcanoes.

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canoes. The meteor at once appears, and a multitude of ſtones of the peculiar character noted above are ſeen ſcattered on a determined ſpace of ground, in a manner, and accompanied with circumſtances, which could not formerly have eſcaped obſervation. Let us likewiſe reflect, that the young and the old, ſimple peaſants dwelling at a diſtance from one another, ſagacious and rational workmen, reſpectable eccleſiaſtics, young ſoldiers devoid of timidity, individuals, in ſhort, of various manners, profeſſions, and opinions, united by no common ties, all agree in atteſting a fact, which contributed neither directly nor indirectly to promote their own intereſt, and they all aſſign the manifeſtation of this fact to the ſame day and hour. They, moreover, point to exiſting veſtiges of the deſcent of ſolid ſubſtances, and they declare, in terms unſuſceptible of miſconſtruction or ambiguity, that they ſaw the maſſes in queſtion roll down on roofs, break branches of trees, rebound from the pavement, and produce ſmoke where they fell. Theſe recitals, and theſe veſtiges, are limited to a tract of territory which has been accurately defined; while beyond the precincts of this tract, not a ſingle particle of a meteorolite has been found, nor a ſingle individual who pretends that he ſaw a ſtone fall.

Having now, we preſume, advanced ample and ſatisfactory evidence of the exiſtence of meteorolites, we ſhall forbear to enlarge this article by dwelling on inſtances of inferior notoriety to thoſe which we have recounted, and ſhall merely note the dates of ſubſequent examples.

On the 4th of July 1803, a fire-ball ſtruck the White Bull Inn at Eaſt-Norton, and left behind it ſeveral meteoric fragments.—On the 13th of December of the ſame year, a ſimilar phenomenon occurred at the village of St Nicholas, in Bavaria.—At Poſſil, near Glaſgow in Scotland, a meteor-ſtone fell, with a loud and hiſſing noiſe, on the 5th April 1804.—The next inſtance which we have to mention occurred near Apt, in the department of Vaucluſe, on the 6th of October of the ſame year; and the laſt which has come to our knowledge happened at half paſt five o'clock, in the evening of the 15th March 1806, near Alais in Languedoc.

It ſeems reaſonable, however, to ſuppoſe, that the fall of meteoric ſubſtances takes place more frequently than is commonly ſuppoſed, ſince ſeveral foreign collections of foſſils contain ſpecimens of reputed celeſtial origin, and exhibiting the genuine atmoſpheric phyſiognomy. It is likewiſe worthy of remark, that many relations of the phenomenon may have ſunk into oblivion, from the contempt with which they were heard by the learned, and that on a fair computation of chances, meteors may have ſometimes exploded on deſert tracts of land, and ſtill more frequently over the pathleſs expanſe of the waters.

That ſome of the relations to which we have alluded are vague and unſatisfactory, cannot be denied, but the circumſtantial teſtimony conveyed by others is more pointed and poſitive; and the whole maſs of hiſtorical proof, eſpecially when combined with the argument deduced from the identity of the phyſical and chemical conſtitution of the ſtones, appears to us to be altogether irreſiſtible.

In the courſe of our inquiry into this novel and intereſting ſubject, we have aſcertained a variety of circumſtances which render it highly probable, if not indubitable, that thoſe detached maſſes of native iron, whoſe hiſtory has ſo often ſtaggered and perplexed the geologiſt, are only modifications of meteoric depoſitions. The Tartars, for example, aſcribe the deſcent of the Siberian maſs deſcribed by Chladni, Pallas, Patrin, &c. to a period that is loſt in the remoteneſs of antiquity; and while tradition thus favours our hypotheſis, the analogy which is obviouſly obſervable in point of texture and chemical characters with thoſe of other ſolid bodies, whoſe fall is no longer queſtioned, ſtrengthens tradition. According to the diſcoveries of Prouſt and Klaproth, native iron, reputed meteoric, differs from that which occurs in a foſſil ſtate by the preſence of nickel. The former of theſe celebrated analyſts obtained 50 grains of ſulphate of nickel from 100 of the South American maſs, and his reſults are corroborated by Mr Howard and the Count de Bournon.

Of the two pieces of Siberian iron poſſeſſed by Mr Greville, one, which was tranſmitted by Dr Pallas, weighs ſeveral pounds; and another preſents a cellular and ramified texture, analogous to that of ſome very light and porous volcanic ſcoriæ. When attentively examined, there may be perceived in it not only empty cells, but alſo impreſſions or cavities of greater or leſs depth, and in ſome of which there remains a tranſparent ſubſtance, of a yellowiſh green colour. The iron itſelf is very malleable; and may be eaſily cut with a knife, or flattened under the hammer. The ſpecific gravity is 6487, which is obviouſly inferior to that of unforged iron that has undergone fuſion, and may be partly owing to the oxidizement of the ſurface of the iron, and partly to the many minute cavities in its ſubſtance, which are often rendered viſible by fracture, and which have their ſurface alſo oxidized. The fracture is ſhining and ſilvery, like that of white caſt iron; but its grain is much ſmoother and finer; and it is much more malleable when cold. The heavier ſpecimen is more ſolid and compact, exhibiting no cavities or pores, though its ſurface is ramified and cellular. So blended and incorporated is its compact part with the yellowiſh-green ſubſtance mentioned above, that if the whole of the latter could be ſubtracted, the remainder would conſiſt of iron in the metallic ſtate, and would diſplay the ſame cellular appearance as the preceding ſpecimen, or as the ſuperficial portion of that now deſcribed. This ſtony part of the compoſition uſually aſſumes the appearance of ſmall nodules, generally of an irregular ſhape, but ſometimes nearly globular, with a ſmooth, ſhining, and glaſſy ſurface. This ſubſtance, which is always more or leſs tranſparent, is hard enough to cut glaſs, but makes no impreſſion on quartz. It becomes electric by friction, is very refractory, and varies in ſpecific gravity from 3263 to 3300. Of all ſubſtances hitherto known, it approaches moſt to the peridot, or Wernerian chryſolite, which yielded to Klaproth nearly the ſame reſults which this ſubſtance did to Howard. In the maſs of iron, it is liable to decompoſition, changing to an opake white, and crumbling into a gritty dry powder, when lightly preſſed or ſqueezed between the fingers.—"I cannot help obſerving (ſays the count de Bournon), that there appears to exiſt a very intereſting analogy between theſe tranſparent nodules and the globules I deſcribed as making part of the ſtones ſaid to to have fallen on the earth. This analogy, though not a very strong one, may lead us to suppose, that the two substances are similar in their nature, but that the globules are less pure, and contain a greater quantity of iron."

The native iron from Bohemia is compact, like the large specimen from Siberia, in Mr Greville's collection, and like it contains nodules, but not so numerous. They are besides quite opake, and very much resemble the globules in atmospheric stones. This iron contains nearly five per cent. of nickel. Between five and six per cent. of the same metal seems to exist in a piece of native iron brought from Senegal.

Though our limits will not permit us to dwell with minuteness on the physical and chemical characters of meteorolites, we shall shortly state those which the count de Bournon found to appertain to the specimens from Benares, and which may serve as no unfair standard of the aspect and composition of the others.

Like all of the same origin which were subjected to the count's examination, the Benares stones are covered over the whole extent of their surface, with a thin crust, of a deep black colour, sprinkled over with small asperities, which make it feel somewhat like shagreen or fish skin. Their fracture exhibits a grayish colour, and a granulated texture, like that of coarse grit-stone. By help of a lens, they are perceived to be composed of four different substances. One of these occurs in great abundance, in the form of small bodies, some of which are perfectly globular, others rather elongated or elliptical, and all of various sizes, from that of a small pin's head to that of a pea, or nearly so. These small globules are usually gray, sometimes inclining much to brown, and always opake; they are easily broken in any direction, have a conchoidal fracture, and a fine, smooth, compact grain, with a slight degree of lustre, approaching to enamel; lastly, they can destroy the polish of glass without being able to cut it, and sparkle faintly when struck with steel. Another of these substances is martial pyrites, of an indeterminate form, and reddish yellow colour, slightly verging to the nickel tint, or to that of artificial pyrites; of a somewhat loosely granulated texture, and irregularly distinguished in the mass, being black when reduced to powder, and not attractible by the magnet. The third of these substances consists of small particles of iron, in a perfectly metallic state, so that they may be easily flattened or extended under the hammer. Though in a much smaller proportion than the pyrites just mentioned, they impart the magnetic attraction to the stone. When a piece of the latter was pulverized, and the particles of iron separated from it as accurately as possible, by means of a magnet, they appeared to compose about 200 parts of the weight of the stone. These three substances are united by means of a fourth, which is nearly of an earthy consistency, and of a whitish gray colour.—The black crust, or outward coating, though of very inconsiderable thickness, emits bright sparks when struck with steel, may be broken by the hammer, and seems to possess the same properties with the black oxide of iron, though, like the substance of the stone, it is occasionally intermixed with small particles of iron in the metallic state. These are easily distinguished, by passing a file over the crust, which reveals their lustre. The specific gravity of the Benares stones is 3352. None of them, when breathed on, emit the argillaceous odour.

In consequence of various experiments, M. Sage infers that meteorolites are composed of native iron, sulphuret of nickel, quartz or silica, alumina, and magnesia; that the proportions of iron and nickel vary; that the quartz seems to form at least the half of the stone, the alumina and magnesia the sixth, and the sulphur the 30th part. These general results pretty nearly accord with the more special reports of Howard and Vauquelin, except that the latter makes no mention of alumina, the existence of which in atmospheric stones is by no means distinctly ascertained.

We shall only beg leave to add, on this part of our subject, that Laugier, an ingenious chemist, by employing the caustic alkali, has detected a small portion of chrome. The results of his experiments, which are stated in the 58th volume of the *Annales de Chimie*, are 1st, That the five stones from Verona, Barbotan, Ensisheim, l'Aigle, and the neighbourhood of Apt, besides the principles already recognized, contain about one per cent. of chrome. 2dly, That it is very probable, that all meteorolites contain this principle, since they all resemble one another in their physical and chemical properties, and have all, apparently, the same origin; and, 3dly, That in many cases, the perfection of chemical analysis requires, that the same substance should be treated both by acids and alkalies, since experience has shown, that a principle which eluded the former method, has been revealed by the latter.

Having now, as we apprehend, sufficiently established the existence and nature of meteorolites, we hope our readers will excuse us from enlarging on the various causes which have been assigned for their origin, as these seem to lie beyond the reach of our present state of knowledge. After a candid and patient review of the principal theories, we conceive that they are at best gratuitous, and that most of them are open to many and formidable objections.

The *terrestrial* hypotheses, we believe, begin already to be generally abandoned, as untenable. Until the phenomenon of exploding meteors had been distinctly observed and recorded, Lemery and others could maintain, with some degree of plausibility, that lightning might tear up the ground, and convert soil into a compact mass. But the appearances of a thunder storm and of a fire-ball are now ascertained to differ in various important respects. Spectators worthy of credit have seen the latter terminate in the fall of solid bodies; and the composition of these solid bodies has been found to differ from that of all the known fossil substances on the surface of the globe. It is in vain, then, to allege, that they are formed on the ground by common lightning, which has often produced very extraordinary effects, but which never generated thousands of stones in fine calm weather. The supposition, that such stones have been projected from some of our volcanoes, is hardly less conceivable. The ashes which accompany a violent eruption of Ætna or Vesuvius have, from their levity, been carried to a very considerable distance; but we are totally unacquainted with any projectile force which could dart solid masses many hundred miles, through such a dense medium as the atmosphere. The compact lavas of burning mountains are never found

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found remote from the ſcene of their formation, and none of them preſent the characters and aſpect of the ſtones which we have deſcribed. M. Bory de St Vincent, indeed, in his *Voyage dans les quatre Principales Iſles des Mers d'Afrique*, very pompouſly expounds a doctrine, which, in our opinion, carries its confutation along with it. According to this writer, meteorolites were projected from immenſe depths, in an early ſtage of the earth's exiſtence, when ignivomous mountains were endued with propelling forces ſufficient to drive maſſes of matter into the regions of ſpace, where they were conſtrained to obey, for ages, the combined laws of impulſe and gravitation, until, in the progreſs of time, their ſpiral revolutions at length terminated on the ſurface of their native earth. Before we can adopt ſuch an extravagant hypotheſis, we muſt be convinced, that at one period of the hiſtory of our globe, the agency of ſubterraneous fire was adequate to communicate planetary motion to ſplinters of rock, without heaving up the rocks themſelves, and that the rotatory movement, though once eſtabliſhed, muſt gradually diminiſh and ceaſe. The demonſtration of theſe poſitions is ſurely not leſs arduous than the explanation of the phenomenon which they are intended to ſolve.

Of thoſe who contend for the *atmoſpherical* formation of meteorolites, ſcarcely any two agree in regard to the manner by which ſuch formation is effected. Patrin, who is ſolicitous to extend and illuſtrate his darling theory of volcanoes, labours at great length to maintain the exiſtence of a regular circulation of gaſeous fluids between the primitive ſchiſtoſe ſtrata of the globe, and its ſurrounding atmoſphere, and, from this fancied circulation, which he flatters himſelf he has *demonſtrated*, he deduces, quite at his eaſe, the occaſional ignition and concretion of portions of theſe fluids in the higher regions of the air. This ingenious mineralogiſt and geologiſt is ſo extremely tenacious of theſe ideas that we ſhall not attempt to diſturb his ſelf-complacency; but he will excuſe us if we refuſe our aſſent to reſults which reſt on imaginary foundations. The celebrated Muſchenbroeck, in one part of his writings, aſcribes the deſcent of ſtones from the air to earthquakes and volcanic eruptions, an opinion which later obſervations have diſproved. In other paſſages, however, he ſeems to incline to a modification of the atmoſpherical hypotheſis, and endeavours to trace the origin of ſhooting ſtars to an accumulation of the volatile matters which are ſuſpended in the air. It is extremely probable, that ſhooting ſtars and fiery meteors have an intimate relation to one another, if they are not identical appearances; but it is certain that the former move at a much greater diſtance from our earth than fire-balls, and only occaſion a tranſient luminous appearance in their paſſage through the upper regions of the atmoſphere. Perhaps they are analogous to thoſe teleſcopic ſparks of light which were obſerved by M. Schröter. Muſchenbroeck, however, adopts the vulgar notion of their falling to the earth, and ſeems to confound their reſidue with *tremella noſtoc*. M. Salverte has given extenſion to the theory of formation from vapours, by having recourſe to the agency of hydrogen gas. According to him, in conſequence of the decompoſition of water, which is conſtantly going on at the ſurface of the earth, immenſe quantities of hydrogen gas are continually riſing into the atmoſphere, and aſcending to its higher regions. As this gas is capable of diſſolving metals, it carries along with it a portion of iron and nickel. During thunder-ſtorms this gas is kindled by electricity; the metals are depoſited, reduced, melted, and vitrified; in other words, meteors are produced and ſtones formed. This hypotheſis is ſcarcely more ſatisfactory than the others. It does not account for the preſence of magneſia and ſilica, nor does it explain why the ſtones are always compoſed of the ſame materials. Beſides, the exiſtence of hydrogen gas in the atmoſphere has not been proved, far leſs that it forms a ſeparate atmoſphere, which is contrary to all experience; and it is well known, that a little hydrogen, mixed with a large portion of atmoſpheric air, cannot be fired by electricity. In general, we may obſerve, that, if the origin of meteorolites be really atmoſpherical, the matters of which they are compoſed muſt have exiſted in one of two ſtates, namely, in very attenuated particles or concretions of the matters themſelves volatilized and held in ſolution in the air, or only in the *elements* of theſe matters. In the firſt caſe, when abandoned by their menſtruum to their reciprocal tendencies, they would unite by aggregation only; in the ſecond, by chemical combination. Now, we can hardly ſuppoſe that diſengagement of light and violent detonation ſhould reſult from the mere affinity of aggregation, whereas they are ſtrictly ſymptomatic of the affinity of compoſition. This, and various other conſiderations which might be ſtated, if we could make room for them, induce us to regard the doctrine of combination as the moſt plauſible. M. Izarn, who has publiſhed a treatiſe on *Atmoſpheric Lithology*, has entered into a tedious and ſomewhat obſcure expoſition of his own theory, founded on this principle. We ſhall give the ſummary, as nearly as we can, in his own words.

"Gaſeous ſubſtances, arranged in ſpherical maſſes in the upper regions of the air, being admitted, the various agitations of the atmoſphere ſhould naturally waft ſome of theſe maſſes from their inſulating medium into one capable of combining with them. If the combination begins, the diſengagement of light is explained. In proportion as the combination advances, the ſpecific gravities are changed; and, conſequently, a change of place will commence, and that in the quarter which preſents leaſt reſiſtance, or where the medium is moſt rarefied, in courſe rather towards the ſouth than the north. Hence, moſt fire-balls are obſerved to move from north to ſouth, or from north-eaſt to ſouth-weſt. Motion being once impreſſed, the maſs traverſes other media, capable of ſupplying new principles, which ſtill increaſing the weight, determine the curve; and when at length the principles which are at work, and which iſſue in all directions, have attained the requiſite proportion for extinguiſhing the elements in the birth of the compound, the grand operation is announced by the exploſion, and the product takes its place among the ſolids."—That the ſtones in queſtion are produced by chemical combination in the higher regions of the atmoſphere, and that they are thus formed from their own elements, are ſuppoſitions fully as probable as any that have been advanced on the ſubject; but whether the union of their parts be effected in the manner detailed by M. Izarn, we are unable to determine, both becauſe we are uncertain if we perfectly comprehend his

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his meaning, and because our range of data is as yet too circumscribed, to warrant any specific or decisive conclusions.

A much bolder theory has been suggested, and its *possibility* demonstrated by the celebrated French astronomer, La Place, who shews, that meteorolites *may be* the products of lunar volcanoes. As this romantic view of the subject has obtained the suffrages of some men of science, and has excited the ridicule of others, we shall present the reasoning on which it is founded, in the popular and perspicuous language of Dr Hutton of Woolwich.

" As the attraction of gravitation extends through the whole planetary system, a body placed at the surface of the moon is affected chiefly by two forces, one drawing it toward the centre of the earth, and another drawing it toward that of the moon. The latter of these forces, however, near the moon's surface, is incomparably the greater. But, as we recede from the moon, and approach toward the earth, this force decreases, while the other augments; till at last a point of station is found between the two planets, where these forces are exactly equal, so that a body placed there must remain at rest; but if it be removed still nearer to the earth, then this planet would have the superior attraction, and the body must fall towards it. If a body then be projected from the moon towards the earth, with a force sufficient to carry it beyond the point of equal attraction, it must necessarily fall on the earth. Such then is the idea of the manner in which the bodies must be made to pass from the moon to the earth, if that can be done, the *possibility* of which is now necessary to be considered.

" Now, supposing a mass to be projected from the moon, in a direct line towards the earth, by a volcano, or by the production of steam by subterranean heat; and supposing for the present these two planets to remain at rest; then it has been demonstrated, on the Newtonian estimation of the moon's mass, that a force projecting the body with a velocity of 12,000 feet in a second, would be sufficient to carry it beyond the point of equal attraction. But this estimate of the moon's mass is now allowed to be much above the truth; and on M. la Place's calculation, it appears that a force of little more than half the above power would be sufficient to produce the effect, that is, a force capable of projecting a body with a velocity of less than a mile and a half per second. But we have known cannon balls projected by the force of gunpowder, with a velocity of 2500 feet per second or upwards, that is, about half a mile. It follows, therefore, that a projectile force, communicating a velocity about three times that of a cannon ball, would be sufficient to throw the body from the moon beyond the point of equal attraction, and cause it to reach the earth. Now there can be little doubt that a force equal to that is exerted by volcanoes on the earth, as well as by the production of steam by subterranean heat, when we consider the huge masses of rock, so many times larger than cannon balls, thrown on such occasions to heights also so much greater. We may easily imagine, too, such cause of motion to exist in the moon as well as in the earth, and that in a superior degree, if we may judge from the supposed symptoms of volcanoes recently observed in the moon by the powerful tubes of Dr Herschel; and still more, if we consider that all projections from the earth suffer an enormous resistance and diminution, by the dense atmosphere of this planet; while it has been rendered probable, from optical considerations, that the moon has little or no atmosphere at all, to give any such resistance to projectiles.

" Thus then we are fully authorized in concluding, that the case of *possibility* is completely made out; that a known power exists in nature, capable of producing the foregoing effect, of detaching a mass of matter from the moon, and transferring it to the earth in the form of a flaming meteor, or burning stone; at the same time we are utterly ignorant of any other process in nature by which the same phenomenon can be produced. Having thus discovered a way in which it is possible to produce those appearances, we shall now endeavour to show, from all the concomitant circumstances, that these accord exceedingly well with the natural effects of the supposed cause, and thence give it a very high degree of *probability*.

" This important desideratum will perhaps be best attained, by examining the consequences of a substance supposed to be projected by a volcano from the moon into the sphere of the earth's superior attraction; and then comparing those with the known and visible phenomena of the blazing meteors or burning stones that fall through the air on the earth. And if in this comparison a striking coincidence or resemblance shall always or mostly be found, it will be difficult for the human mind to resist the persuasion that the assumed cause involves a degree of probability but little short of certainty itself. Now the chief phenomena attending these blazing meteors or burning stones, are these: 1. That they appear or blaze out suddenly. 2. That they move with a surprising rapid motion, nearly horizontal, but a little inclined downwards. 3. That they move in several different directions with respect to the points of the compass. 4. That in their flight they yield a loud whizzing sound. 5. That they commonly burst with a violent explosion and report. 6. That they fall on the earth with great force in a sloping direction. 7. That they are very hot at first, remain hot a considerable time, and exhibit visible tokens of fusion on their surface. 8. That the fallen stony masses have all the same external appearance and contexture, as well as internally the same nature and composition. 9. That they are totally different from all our terrestrial bodies, both natural and artificial.

" Now these phenomena will naturally compare with the circumstances of a substance projected by a lunar volcano, and in the order in which they are here enumerated. And first, with respect to the leading circumstance, that of a sudden blazing meteoric appearance, which is not that of a small bright spark, first seen at an immense distance, and then gradually increasing with the diminution of its distance. And this circumstance appears very naturally to result from the assumed cause. For, the body being projected from a lunar volcano, may well be supposed in an ignited state, like inflamed matter thrown up by our terrestrial volcanoes, which passing through the comparatively vacuum, in the space between the moon and the earth's sensible atmosphere, it will probably enter the superior parts of this atmosphere with but little diminution of its original

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nal heat; from which circumftance, united with that of its violent motion, this being 10 or 12 times that of a cannon ball, and through a part of the atmofphere probably confifting chiefly of the inflammable gas rifing from the earth to the top of the atmofphere, the body may well be fuppofed to be fuddenly inflamed, as the natural effect of thefe circumftances; indeed it would be furprifing if it did not. From whence it appears, that the fudden inflammation of the body, on entering the earth's atmofphere, is exactly what might be expected to happen.

"2. To trace the body through the earth's atmofphere; we are to obferve that it enters the top of it with the great velocity acquired by defcending from the point of equal attraction, which is fuch as would carry the body to the earth's furface in a very few additional feconds of time if it met with no obftruction. But as it enters deeper in the atmofphere, it meets with ftill more and more refiftance from the increafing denfity of the air, by which the great velocity of fix miles per fecond muft foon be greatly reduced to one that will be uniform, and only a fmall part of its former great velocity. This remaining part of its motion will be various in different bodies, being more or lefs as the body is larger or fmaller, and as it is more or lefs fpecifically heavy; but, for a particular inftance, if the body were a globe of 12 inches diameter, and of the fame gravity as the atmofpheric ftones, the motion would decreafe fo as to be little more than a quarter of a mile per fecond of perpendicular defcent. Now while the body is thus defcending, the earth itfelf is affected by a twofold motion, both the diurnal and the annual one, with both of which the defcent of the body is to be compounded. The earth's motion of rotation at the equator is about 17 miles in a minute, or two-fevenths of a mile in a fecond; but in the middle latitudes of Europe little more than the half of that, or little above half a quarter of a mile in a fecond; and if we compound this motion with that of the defcending body, as in mechanics, this may caufe the body to appear to defcend obliquely, though but a little, the motion being nearer the perpendicular than the horizontal direction. But the other motion of the earth, or that in its annual courfe, is about 20 miles in a fecond, which is 80 times greater than the perpendicular defcent in the inftance above mentioned; fo that, if this motion be compounded with the defcending one of the body, it muft neceffarily give it the appearance of a very rapid motion, in a direction nearly parallel to the horizon, but a little declining downwards. A circumftance which exactly agrees with the appearances of thefe meteoric bodies, as ftated in the fecond article of the enumerated phenomena.

"3. Again, with regard to the apparent direction of the body; this will evidently be various, being that compounded of the body's defcent and the direction of the earth's annual motion at the time of the fall, which is itfelf various in the different feafons of the year, according to the direction of the feveral points of the ecliptic to the earth's meridian or axis. Ufually, however, from the great excefs of the earth's motion above that of the falling body, the direction of this muft appear to be nearly oppofite to that of the former. And in fact this exactly agrees with a remark made by Dr Halley, in his account of the meteors in his paper above given, where he fays that the direction of the meteor's motion was exactly oppofite to that of the earth in her orbit. And if this fhall generally be found to be the cafe, it will prove a powerful confirmation of this theory of the lunar fubftances. Unfortunately, however, the obfervations on this point are very few, and moftly inaccurate; the angle or direction of the fallen ftones has not been recorded; and that of the flying meteor commonly miftaken, all the various obfervers giving it a different courfe, fome even directly the reverfe of others. In future, it will be very advifable that the obfervers of fallen ftones, obferve and record the direction or bearing of the perforation made by the body in the earth, which will give us perhaps the courfe of the path nearer than any other obfervation.

"4. In the flight of thefe meteoric ftones, it is commonly obferved, that they yield a loud whizzing found. Indeed it would be furprifing if they did not. For if the like found be given by the fmooth and regularly formed cannon ball, and heard at a confiderable diftance, how exceedingly great muft be that of a body fo much larger, which is of an irregular form and furface too, and ftriking the air with 50 or 100 times the velocity.

"5. That they commonly burft and fly in pieces in their rapid flight, is a circumftance exceedingly likely to happen, both from the violent ftate of fufion on their furface, and from the extreme rapidity of their motion through the air. If a grinding ftone, from its quick rotation, be fometimes burft and fly in pieces, and if the fame thing happen to cannon balls when made of ftone and difcharged with confiderable velocity, merely by the friction and refiftance of the air; how much more is the fame to be expected to happen to the atmofpheric ftones, moving with more than 50 times the velocity, and when their furface may well be fuppofed to be partly loofened or diffolved by the extremity of the heat there.

"6. That the ftones ftrike the ground with a great force, and penetrate to a confiderable depth, as is ufually obferved, is a circumftance only to be expected from the extreme rapidity of their motion, and their great weight, when we confider that a cannon ball, or a mortar fhell, will often bury itfelf many inches, or even fome feet in the earth.

"7. That thefe ftones, when foon fought after and found, are hot, and exhibit the marks of recent fufion, are alfo the natural confequences of the extreme degree of inflammation in which their furface had been put during their flight through the air.

"8. That thefe ftony maffes have all the fame external appearance and contexture, as well as internally the fame nature and compofition, are circumftances that ftrongly point out an identity of origin, whatever may be the caufe to which they owe fo generally uniform a conformation. And when it is confidered,

"9. That in thofe refpects they differ totally from all terreftrial compofitions hitherto known or difcovered, they lead the mind ftrongly to afcribe them to fome other origin than the earth we inhabit; and none fo likely as coming from our neighbouring planet.

"Upon the whole then (continues Dr Hutton), it appears

appears highly probable, that the flaming meteors, and the burning ſtones, that fall on the earth, are one and the ſame thing. It alſo appears impoſſible, or in the extremeſt degree improbable, to aſcribe theſe either to a formation in the ſuperior parts of the atmoſphere, or to the eruptions of terreſtrial volcanoes, or to the generation by lightning ſtriking the earth. But, on the other hand, that it is poſſible for ſuch maſſes to be projected from the moon ſo as to reach the earth; and that all the phenomena of theſe meteors or falling ſtones, having a ſurpriſing conformity with the circumſtances of maſſes that may be expelled from the moon by natural cauſes, unite in forming a body of ſtrong evidence, that this is in all probability and actually the caſe.

M. Poiſſon, an ingenious French mathematician, has ſhown by an algebraical calculation, the poſſibility of a projectile reaching our planet from the moon. His calculation, however, which may be found in the work of Izarn, quoted above, (p. 238. et ſeq.) proceeds on the ſuppoſition that our ſatellite has no atmoſphere, or next to none. There are, no doubt, appearances which ſeem to favour this ſuppoſition, but they do not amount to poſitive proof of the fact. Even could the latter be eſtabliſhed, the combuſtion of a volcano, without the preſence of atmoſpheric air, would remain to be explained. But, granting this difficulty too to be ſurmounted, there are other circumſtances which we cannot eaſily reconcile to the lunar hypotheſis. The occaſional arrival of fragments of lava on the earth's ſurface, would argue, on a fair computation of chances, ſuch a copious diſcharge of volcanic matters, that the moon, by this time, would conſiſt of hardly any thing elſe. Again, if we may be allowed to reaſon from analogy, the volcanic productions of the moon ſhould exhibit varieties of aſpect and compoſition like thoſe with which we are acquainted, and not a definite and preciſe number of the ſame ingredients. We may alſo remark, that the ſoft and incoherent ſtate of ſeveral of the recent ſpecimens of meteorolites can ill accord with their ſuppoſed paſſage through any conſiderable portion of ſpace; and that the l'Aigle phenomenon, which is ſo diſtinctly recorded, evidently ſuggeſts the notion of inſtantaneous formation in the atmoſphere. And, though this view of the ſubject may be regarded by ſome as inexplicable, we cannot conceive that it is more ſo than the doctrine of cryſtallization, or than many of the reſults of chemical combination, whoſe exiſtence it is impoſſible to deny. Theſe and other arguments may, we apprehend, be fairly urged againſt any theory which attempts to explain the hiſtory of meteors by the agency of lunar volcanoes.

The hypotheſis of Dr Chladni, which likewiſe boaſts of its advocates, though ſtill more extravagant than the preceding, deſerves to be ſtated. As earthy, metallic, and other particles form the principal component parts of our planet, among which iron is the prevailing part, other planetary bodies, he affirms, may conſiſt of ſimilar, or, perhaps, the ſame component parts, though combined and modified in a very different manner. There may alſo be denſe matters accumulated in ſmaller maſſes, without being in immediate connexion with the larger planetary bodies, diſperſed throughout infinite ſpace, and which, being impelled either by ſome projecting power or attraction, continue to move until they approach the earth, or ſome other body; when, being overcome by attractive force, they immediately fall down. By their exceeding great velocity, ſtill increaſed by the attraction of the earth and the violent friction in the atmoſphere, a ſtrong electricity and heat muſt neceſſarily be excited, by which means they are reduced to a flaming and melted condition, and great quantities of vapour and different kinds of gaſes are thus diſengaged, which diſtend the liquid maſs to a monſtrous ſize, till, by a ſtill farther expanſion of theſe elaſtic fluids, they muſt at length diſplode. That portions of coſmical matter are allowed to revolve in ſpace, and to terminate their career on the ſurface of a planet, is a poſition too gratuitous and vague, to be readily admitted, but the belief of which involves no principle of atheiſm or impiety, as ſome of Dr Chladni's antagoniſts have very unhandſomely inſinuated. If worlds diſappear and others ſpring into exiſtence, a ſportive imagination may be permitted to indulge in the innocent ſuppoſition, that fragments of their materials are detached from their fractured maſſes, and obey thoſe laws of attraction which ſeem to extend their influence to the remoteſt corners of the univerſe.

Such of our readers as are ſolicitous of obtaining more ample information on the ſubject of this article, may conſult *Izarn's Lithologie Atmoſpherique; Biot's Relation d'un Voyage fait dans le departement de l'Orne, pour conſtater la réalité d'un Météore obſervé à l'Aigle; Böttiger's Obſervations on the Accounts given by ancient authors of Stones ſaid to have fallen from the Clouds; Fulda's Memoir on Fire-balls; Cavallo's Elements of Natural Philoſophy; Klaproth on Meteoric Stones; Soldani's Account of the Tuſcan Meteor; Chladni's Treatiſe on the Siberian Maſs of Iron; Mr Edward King's Remarks concerning Stones ſaid to have fallen from the Clouds;* and ſeveral of the more recent tranſactions of learned ſocieties and periodical ſcientific communications, as thoſe of the Royal Society of London, of the Inſtitute at Paris, the Journal de Phyſique, Annales de Chimie, Bibliotheque Britannique, Decade Philoſophique, Journal des Mines, Philoſophical Magazine, Nicholſon's Journal, &c. &c.

METEOROLOGICAL, ſomething belonging to meteors.

METEOROLOGICAL Journal, is a table recording the daily ſtate of the air, exhibited by the barometer, thermometer, hygrometer, anemometer, and other meteorological inſtruments. We have many journals of this kind, kept at the houſe of the Royal Society, and by different obſervers in other places, in the Philoſophical Tranſactions, the Memoirs of the Academy of Sciences, and ſimilar publications.

METEOROLOGY.

METEOROLOGY.

INTRODUCTION.

1 Object of meteorology.

METEOROLOGY is that part of natural ſcience which treats of the changes that take place in our atmoſphere, as they are perceptible to our ſenſes, or as they are indicated by certain inſtruments which the ingenuity of man or accident has diſcovered to anſwer that purpoſe. In as far as it deſcribes the phenomena produced by ſuch changes, meteorology is a department of natural hiſtory; but in its attempts to account for the appearances, it is almoſt entirely dependent on NATURAL PHILOSOPHY and CHEMISTRY.

2 Its connection with chemiſtry.

The connection of METEOROLOGY with CHEMISTRY is ſufficiently evident to thoſe who take only a ſuperficial view of the ſubject, though it has only of late attracted the notice of philoſophers. That the air is ſometimes hotter and ſometimes colder than uſual; that it is at one time much rarefied, and at another greatly condenſed; now uncommonly dry, and now ſurcharged with moiſture—are circumſtances that daily meet the ſenſes of the moſt caſual obſerver, as they are circumſtances that powerfully, and often unpleaſantly, arreſt his attention. That theſe changes are the reſult of decompoſitions and combinations that are continually going on in the atmoſphere, and of new modifications of its component principles, is manifeſt to him who is acquainted merely with the firſt elements of modern chemiſtry.

3 Indeed to modern chemiſtry this ſcience is indebted for the progreſs it has made within the laſt 50 years; a period which may be conſidered as the ſecond epoch of meteorology. In fact, this ſcience is ſtill in its infancy; but from the ardour with which it is now cultivated, from the abilities of the philoſophers who are engaged in the ſtudy, and from the progreſs that is daily making in the kindred ſciences, we may reaſonably look forward to a period, at no great diſtance, when it ſhall pleaſe the great Author of nature to unveil many of thoſe wonders which are now involved in darkneſs and obſcurity, and permit us to controul the jarring elements, as he has allowed us to exerciſe dominion over the beaſts of the earth, the fowls of the air, and the fiſhes of the ſea.

4 Means of improving meteorology.

A late ingenious writer on the climate of Britain has ſuggeſted ſome uſeful hints for the improvement of meteorology, which we ſhall here extract. "With this view, our firſt ſtep muſt be *that* recommended by Mr Kirwan and others, to eſtabliſh correſponding ſocieties in different parts of the world; theſe ſocieties muſt be furniſhed with ſimilar apparatus, equally adjuſted, and graduated in their conſtruction, for making obſervations on the weather. In our own iſland it will be neceſſary to procure regiſters, carefully kept, from the different parts of the ſea coaſt, and from thoſe parts of the country ſituated in the interior. The various ſtates of the barometer, thermometer, hygrometer, and electroſcope, ſhould be carefully noted; with the variations and the degrees of wind, as well as the diurnal and nocturnal aſpect of the heavens diſcriminately marked; the appearance of the ſky; and in familiar language, ſuch as might be underſtood by the reſpective and diſtant obſervers; for inſtance, whether the ſun is totally or partially obſcured by vapour;—whether the clouds are mottled, or fleaky;—whether they aſſume the appearance of horizontal ſtreaks, or appear in radii apparently from a centre—or in maſſes of denſe vapour—or looſe and fleecy—or thoſe familiarly known by the name of *mare-tail* clouds—with any other new or accuſtomed phenomena. The common terms *fair*, *cloudy*, or *wet*, are inſufficient for forming a judgment of the weather; as the term fair is generally at preſent expreſſed only in oppoſition to *rain*, without diſtinguiſhing whether the atmoſphere is obſcure, dull, or bright. The appearance of the ſtratum of air on the earth's ſurface, *that is*, *the ſpace between the clouds and the earth*, ſhould be always accurately deſcribed. Is there a blue haze, white miſt, and denſe fog? or is the air tranſparent? which is the caſe when diſtant objects appear more than commonly diſtinct and near to the eye of the obſerver: the temperature of the ocean at *full tide* ſhould be frequently aſcertained, as it will be found to have conſiderable influence in theſe reſpects on an inſular country. By the remarks of obſervers, ſtationed in various parts of our coaſts, we ſhould ſoon be enabled to diſcover when vapour is wafted in from the ſea, or generated by the aqueous and vegetable ſurface of our iſland. During a north-weſt wind, which is frequently attended with ſtorms of hail and rain, and uſually experienced in the ſpring, an obſerver ſtationed on the coaſt of Sligo in Ireland, or Denbighſhire in Wales, might aſcertain whether the diſpoſition of the atmoſphere to ſtorm and cloud came in with the air from the Atlantic ocean, or was generated by the vapours of our own iſland. It would be deſirable alſo again, that the temperature and blue hazy appearance of the atmoſphere during the north-eaſt winds, ſo common in May and June, ſhould be noticed by obſervers on the north-eaſt coaſt, in the counties of York, Lincoln, Eſſex, and Kent; and by others, on the oppoſite weſtern coaſts of Pembroke, Devon, and Cornwall, ſo as to determine what changes in temperature this wind undergoes in its paſſage over the iſland; and whether or not the degree of haze increaſes or diminiſhes by its progreſs from either quarter; and whether the vapour is more or leſs diſpoſed to produce ſtorms?

By ſuch comparative obſervations on the coaſt, conjoined with thoſe made by others in the central parts of the kingdom, we might rapidly proceed in meteorological ſcience, or, as it is commonly called, a knowledge of the weather. The obſervations made in the interior of the country would enable us at all times to trace the origin and progreſs of ſtorms: in ſituations where tillage or paſturage is moſt attended to, the effects of ſpring froſts and blights ſhould be particularly noticed, as well as the firſt appearance of the aphis and coccus, the caterpillar and larvæ of other inſects, on fruit trees, and particularly thoſe peculiar to the *hop plantations*. The firſt opening of the vernal foliage on trees

Introduction.

trees and hedges in the ſpring, ſhould likewiſe be remarked, and compared with the ſtarting up graſs on the highly manured paſtures in the neighbourhood of towns, and on thoſe alſo aſſiſted with manure, as well as the natural herbage on the commons and waſtes. Some attention ſhould be paid to the effects of thunder ſtorms, in deſtroying the aphis and other deſtructive inſects, the peſt of fruit and hop plantations; and the firſt appearance of the mildew or ruſt on wheat ſhould be particularly obſerved, and remarks made to aſcertain, whether or not the moiſture, which occaſions the diſeaſe in its commencement was attended with wind and rain, or a cloſe damp ſtate of the air. The different kinds of ſoil, where the crops, from the diſeaſe, ſuffered moſt, ſhould be noticed, and the ſituation of the land for ventilation, with the height of the fences, ſize of incloſures, and vicinity to coppices, trees, or hedge-rows *."

* *Williams on the Climate of Britain.*

5 Importance of the ſcience.

The importance of the ſtudy of meteorology requires little elucidation. In climates where the ſucceſſion of ſeaſons is nearly ſtated and regular, where the periods of parching drought or deluging torrents, of the tempeſtuous hurricane or the refreſhing breeze, are fixed and aſcertained, mankind has little to do, but expect the dreaded changes, and provide againſt their devaſtations; but in countries like our own, where all the viciſſitudes of ſeaſons may take place in the courſe of a few hours, it is of the higheſt conſequence to inveſtigate the nature of the change, and the circumſtances that precede or accompany it. To the farmer, the mariner, the traveller, the phyſician, meteorology is in ſome meaſure a ſtudy of neceſſity; to the philoſopher it is a ſtudy of intereſt and delight; and to the obſerver of nature it affords objects of grandeur and ſublimity not to be found in any other department of his favourite ſcience. Surely nothing can contribute more to elevate the mind of man, to raiſe it "from nature up to nature's God," than the contemplation of the ſweeping whirlwind, the dazzling lightning, or the awful thunder.

Our limits will not admit of our entering into a hiſtorical detail of the progreſs of meteorology; but it may be proper in this place to enumerate the principal writers on this ſcience both in our own country and on the continent.

6 Writers on meteorology.

In this country, we may reckon Dr Kirwan, (in his "Eſtimate of the Temperature of different Climates"), his "Eſſay on the Variations of the Atmoſphere," and in the "Iriſh Tranſactions", Mr John Dalton (chiefly in the "Mancheſter Memoirs"), Col. Capper (in his "Obſervations on the Winds and Monſoons"), Mr Williams (in his "Climate of Great Britain"), and Mr Luke Howard (in the Philoſophical Magazine), as the principal cultivators of meteorological knowledge; and on the continent, the names of Cotte ("*Traite de Meteorologie*," and *Journal de Phyſique*), Sauſſure ("*Eſſai ſur l'Hygrometrie*," and *Voyage aux Alpes*"), De Luc (A) ("*Recherches ſur les Modifications de l'Atmoſphere*," "*Idees ſur la Meteorologie*," and other works), and Lamarck (ſee *Journ. de Phyſ.* paſſim) ſtand moſt conſpicuous in this branch of natural ſcience.

In conſidering the ſubject of meteorology, we may properly divide it into ſeven general heads: 1. Of the changes which take place in the gravity of the air; 2. Of the changes of the temperature of the air; 3. Of the changes produced by evaporation and rain; 4. Of the changes produced by winds; 5. Of atmoſpherical electricity; 6. Of meteors, or thoſe viſible phenomena accompanied with light, which take place in the atmoſphere or near the ſurface of the earth; and, 7. The application of the principles of meteorology to the uſeful purpoſes of life. Of theſe heads, the fifth has been already fully conſidered under ELECTRICITY, and much of the ſixth has been exhauſted under METEOROLITE. The remaining circumſtances will form the ſubjects of the following chapters. 7

CHAP. I. *Of the Changes which take place in the Gravity of the Air.*

MANY of the facts relating to this part of our ſubject have been already anticipated under the article BAROMETER, and ſeveral circumſtances fall to be conſidered more properly under PNEUMATICS than in this place. We ſhall here confine ourſelves to a general view of the changes in the gravity of the atmoſphere, as indicated by the barometer, in various ſituations on or near the ſurface of the earth, and briefly examine the concluſions that may be drawn from them.

Mercury ſtands higheſt at the level of the ſea.

The moſt general fact indicated by the barometer is, that this inſtrument ſhews us the weight of a column of air

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(A) In again mentioning the name of a philoſopher ſo reſpectable as M. de Luc, we embrace the firſt opportunity of doing him juſtice, and of vindicating his character againſt an unfortunate miſconception of the late Profeſſor Robiſon, a miſtake which we have inadvertently contributed to diſſeminate, by quoting Dr Robiſon's ſtatement in our account of Dr Black, where M. de Luc is accuſed of having arrogated to himſelf Dr Black's diſcovery of *latent heat*.

M. de Luc's vindication of himſelf (as printed in the 12th number of the Edinburgh Review) is before the public. We owe it to candour and juſtice to acknowledge our conviction that Dr Robiſon was too haſty in his aſſertion, and that M. de Luc, ſo far from arrogating to himſelf the doctrine of *latent heat*, has, in various parts of his numerous writings, expreſsly mentioned Dr Black as the author of that doctrine. This will appear from the following citations. In his "Introduction à la Phyſique terreſtre," p. 102, M. de Luc thus expreſſes himſelf. "Ne connoiſſant point le *feu latent*, dans la vapeur à toute temperature, *dont la premiere decouverte eſt due au* Dr Black, &c. Again, p. 232. of the ſame work. "Ce qui developpoit l'idée de *chaleur latente par laquelle le Dr Black avoit deſigné ce phénomêne*,"—and at p. 385, "Le Dr Black ayant découvert qu'une certaine quantité de chaleur diſparoit quand la vapeur de l'eau bouillante ſe forme, *nomma ce phénoméne chaleur latente* dans la vapeur."

We truſt that theſe quotations, with M. de Luc's own juſtification of himſelf above referred to, will be ſufficient to exculpate him from the charge of *literary felony* ſo warmly brought againſt him by Profeſſor Robiſon; and we have no doubt the Profeſſor himſelf, were he ſtill alive, would under ſuch evidence retract his accuſation.

Gravity of the Air.

air whoſe baſe is equal to the diameter of the mercury in the tube, and whoſe height is equal to the extent of the atmoſphere above the place of obſervation. As the height of this column muſt vary in different ſituations, and muſt, *cæteris paribus*, be greateſt at the level of the ſea, the mercury in the tube will, under the ſame circumſtances, ſtand higheſt in ſuch a ſituation.

9 Medium height 30 inches.

The medium height of the barometer at the level of the ſea is 30 inches, as has been found by obſervations in the Britiſh channel, and in the Mediterranean ſea, at the temperatures of 55° and 60°; on the coaſt of Peru at the temperature of 84°, and in latitude 80°. As we aſcend above the ſurface of the earth, the medium height of the mercury diminiſhes; and ſome late obſervations made in balloons at a conſiderable diſtance above the tops of the higheſt mountains, have ſhewn that in the higher regions of the air, the column of mercury is very conſiderably ſhortened. This fact, as we have ſeen (ſee BAROMETER), has been uſefully applied to the meaſuring of heights and depths that cannot be aſcertained by the uſual geometrical methods. As the abſolute gravity of the atmoſphere is conſtantly varying even in the ſame place, the column of air preſſing on the ſurface of the mercury without the tube, muſt preſs with more or leſs force, in proportion as theſe changes are greater; and hence the barometer points out theſe variations, falling when the atmoſphere is lighter, and riſing when it is heavier than uſual. For an account of the obſervations that were made on the riſe and fall of the barometer by the earlier philoſophers, and the attempts which were made by them to explain theſe phenomena, ſee BAROMETER.

It will be of advantage here to conſider the variations of the barometer, as they take place in different ſituations, in order, if poſſible, to point out the cauſe by which theſe variations are produced, as this cauſe muſt have conſiderable influence on the changes of the weather.

10 Variation of the barometer between the tropics very ſmall.

It is found, that between the tropics the variations of the barometer are exceedingly ſmall, and it is remarkable, that in that part of the world it does not deſcend above half as much for every 200 feet of elevation as it does beyond the tropics *. In the torrid zone, too, the barometer is elevated about $\frac{2}{3}$ of a line twice every day; and this elevation happens at the ſame time with the tides of the ſea †.

* *Jour. de Phyſ.* 1790. p. 268.
† *Ibid.*

As the latitude advances towards the poles, the range of the barometer gradually increaſes, till at laſt it amounts to two or three inches. This gradual increaſe will appear from the following table.

* *Kirw. Iriſh Tranſ.* vol. iii. 47.
† *Aſiatic Reſearches*, vol. ii. Appendix.
‡ *Mancheſt. Mem.* vol. iv.
§ *Edin Tranſ* vol. ii.
‖ *Tranſ Philadelph.* vol. ii.
** *Edin. Tranſ.* vol. ii. p. 229.

Table of the Range of the Barometer.

Latitude.	Places.	Range of the Barometer. Greateſt.	Annual.
0°	Peru	0.20 *	
22 23′	Calcutta	0.77 †	
40 55	Naples	1.00 ‡	
51 8	Dover	2.47 §	1.80
53 13	Middlewick	3.00 §	1.94
53 23	Liverpool	2.89 ‖	1.96
59 56	Peterſburgh	3.45 **	2.77

There is, however, ſome exception to this general rule, as in North America the range of the barometer is much leſs than in the correſponding European latitudes.

The range of the barometer is greater at the level of the ſea than on mountains, and in the ſame degree of latitude the extent of the range is in the inverſe ratio of the height of the place above the level of the ſea.

It appears probable that the barometer has a tendency to riſe during the day from morning to evening, and that this tendency is greateſt between 2 and 9 P. M. the greateſt elevation being at this laſt period. The elevation at 2 differs from that at 9 by $\frac{4}{11}$, while that at 2 differs from the morning elevation only by $\frac{1}{11}$; and that in certain climates the greateſt elevation takes place at 2 o'clock *.

* *Jour. de Phyſ.* 1790. p. 11.

The range of the barometer is greater in winter than in ſummer, as appears from ſome obſervations made at Kendal during five years; the mean range from October to March being 7.982, and that from April to September being only 5.447 †.

† *Mancheſt. Mem.* vol. iv. p. 547.

When the atmoſphere is ſerene and ſettled the mercury is generally high; and in calm weather, when it is inclined to rain, the mercury is low. On the approach of high winds it ſinks, as it does with a ſoutherly wind, but riſes very high on the approach of eaſterly and northerly winds. It is found, however, that at Calcutta the mercury is higheſt with north-weſterly and northerly, and loweſt with ſouth-eaſterly winds.

The mercury ſuddenly falls on the approach of tempeſts, and during their continuance undergoes great oſcillations.

To theſe general facts that have been obſerved on the riſe and fall of the barometer, we ſhall annex the following axioms by M. Cotte.

11 Cotte's axioms on the barometer.

1. The greateſt changes of the barometer commonly take place during clear weather, with a north wind; and the ſmall riſings during cloudy, rainy, or windy weather, with a ſouth, or nearly ſouth wind.

2. The ſtate of the mercury changes more in the winter than in the ſummer months; ſo that its greateſt riſing and falling takes place in winter; but its mean elevation is greater in ſummer than in winter.

3. The changes of the ſtate of the barometer are nearly null at the equator, and become greater the more one removes from it towards the poles.

4. They are more conſiderable in valleys than on mountains.

5. The more variable the wind, the more changeable the ſtate of the barometer.

6. It is lower at midnight and noon than at other periods of the day; its greateſt daily height is towards evening.

7. Between 10 at night and 2 in the morning, and alſo in the day, the riſing and falling of the mercury are leſs; the contrary is the caſe between 6 and 10 in the morning and evening.

8. Between 2 and 6 in the morning and evening it riſes as often as it falls; but in ſuch a manner that it oftener riſes about that time in the winter months, and falls oftener in the ſummer months.

9. The oſcillations are leſs in ſummer, greater in winter, and very great at the equinoxes.

10. They

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10. They are greater alſo in the daytime than during the night.

11. The higher the ſun riſes above the horizon, the leſs are the oſcillations; they increaſe as he approaches the weſtern ſide of the horizon, and are exceedingly great when he comes oppoſite to the eaſtern part of the horizon.

12. They are, to a certain degree, independent of the changes of temperature.

13. The mercury generally riſes between the new and the full moon, and falls between the latter and the new moon.

14. It riſes more in the apogee than the perigee; it uſually riſes between the northern luniſtice and the ſouthern, and falls between the ſouthern luniſtice and the northern.

15. In general, a compariſon of the variations of the mercury with the poſitions of the moon gives nothing certain; the reſults of N° 13. and 14. are the moſt conſtant.

16. In the neighbourhood of Paris the barometer never continues 24 hours without changing.

17. The barometers in the weſtern diſtricts riſe and fall ſooner than thoſe in the more eaſtern.

18. When the ſun paſſes the meridian, the mercury, if falling, continues to fall, and its fall is often haſtened.

19. When the mercury at the ſame period is riſing, it falls, remains ſtationary, or riſes more ſlowly.

20. When the mercury, under the ſame circumſtances, is ſtationary, it falls, unleſs before or after it becomes ſtationary, it has been in the act of riſing.

21. The above changes commonly take place between 11 in the morning and 1 in the afternoon, but oftener before than after noon.

22. Before high tides there is almoſt always a great fall of the mercury; this takes place oftener at the full than the new moon.

Such is a general view of the variations in the gravity of the air, as far as they have been obſerved by the barometer; and we ſhall now endeavour to give ſome plauſible theory of them.

13 Atmoſphere forms two inclined planes meeting at the equator.

It is evident that the denſity of the atmoſphere is leaſt at the equator, and greateſt at the poles; for at the equator the centrifugal force, the diſtance from the centre of the earth, and the heat (all of which tend to diminiſh the denſity of the air), are at their maximum, while at the poles they are at their minimum. The mean height of the barometer at the level of the ſea, all over the globe, is 30 inches; the weight of the atmoſphere, therefore, is the ſame all over the globe. This weight depends on the denſity and height of the air; where the denſity is greateſt, its height muſt be leaſt; and on the contrary, where its denſity is leaſt, its height muſt be greateſt. The height of the atmoſphere, therefore, muſt be greateſt at the equator, and leaſt at the poles; and it muſt decreaſe gradually between the equator and the poles, ſo that its upper ſurface will reſemble two inclined planes, meeting above the equator their higheſt part*.

* *Iriſh Tranſ.* vol. ii. p. 43, &c.

During ſummer, when the ſun is in our hemiſphere, the mean heat between the equator and the pole does not differ ſo much as in winter. Hence the rarity of the atmoſphere at the pole, and conſequently its height, will be increaſed. The upper ſurface of the atmoſphere, therefore, in the northern hemiſphere, will be leſs inclined; while that of the ſouthern hemiſphere, from contrary cauſes, will be much more inclined. The reverſe will take place during our winter.

The denſity of the atmoſphere depends in a great meaſure on the preſſure of the ſuperincumbent column, and therefore decreaſes according to the height, as the preſſure of the ſuperincumbent column conſtantly decreaſes. But the denſity of the atmoſphere in the torrid zone will not decreaſe ſo faſt as in the temperate and frigid zones, becauſe its column is larger, and becauſe there is a greater proportion of air in the higher part of this column. This accounts for the obſervation of Mr Caſſon, that the barometer ſinks only half as much for every 200 feet of elevation in the torrid as in the temperate zones. The denſity of the atmoſphere at the equator, therefore, though at the ſurface of the earth it is leſs, muſt at a certain height equal, and at a ſtill greater muſt exceed, the denſity of the atmoſphere in the temperate zones and at the poles.

14 Why the mercury is higheſt in winter in northern latitudes.

We ſhall preſently endeavour to prove, that a quantity of air is conſtantly aſcending at the equator, and that part of it at leaſt reaches and continues in the higher parts of the atmoſphere. From the fluidity of air, it is evident that it cannot accumulate above the equator, but muſt roll down the inclined plane which the upper ſurface of the atmoſphere aſſumes towards the poles. As the ſurface of the atmoſphere of the northern hemiſphere is more inclined during our winter than that of the ſouthern hemiſphere, a greater quantity of the equatorial current of air muſt flow over upon the northern than upon the ſouthern hemiſphere; ſo that the quantity of our atmoſphere will be greater during winter than that of the ſouthern hemiſphere; but during ſummer the reverſe will take place. Hence the greateſt mercurial heights take place during winter, and the range of the barometer is leſs in ſummer than in winter.

The denſity of the atmoſphere is in a great meaſure regulated by the heat of the place; wherever the cold is greateſt, there the denſity of the atmoſphere will be greateſt, and its column ſhorteſt. High countries, and ranges of lofty mountains, the tops of which are covered with ſnow the greateſt part of the year, muſt be much colder than other places ſituated in the ſame degree of latitude, and conſequently the column of air over them much ſhorter. The current of ſuperior air will linger and accumulate over theſe places in its paſſage towards the poles, and thus occaſion an irregularity in its motion, which will produce a ſimilar irregularity in the barometer. Such accumulations will be formed over the north-weſtern parts of Aſia, and over North America; hence the barometer uſually ſtands higher, and varies leſs there, than in Europe. Accumulations alſo are formed upon the Pyrenees, the Alps, the mountains of Africa, Turkey in Europe, Tartary, and Tibet. When theſe accumulations have gone on for ſome time, the denſity of the air becomes too great to be balanced by the ſurrounding atmoſphere; it ruſhes down on the neighbouring countries, and produces cold winds which raiſe the barometer. Hence the riſe of the barometer which generally attends north-eaſt winds in Europe, as they proceed from accumulations in the north-weſt of Aſia, or about the pole; hence, too, the north-weſt wind from the mountains of Tibet raiſes the barometer at Calcutta.

We

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We shall presently endeavour to shew, that considerable quantities of air are occasionally destroyed in the north polar regions. When this happens, the atmosphere to the south rushes in to supply the deficiency. Hence south-west winds take place, and the barometer falls.

As the mean heat of our hemisphere differs in different years, the density of the atmosphere, and consequently the quantity of equatorial air which flows towards the poles, must also be variable. Does this range correspond to the mean annual heat; that is to say, Is the range greatest when the heat is least, and least when the heat is greatest? In some years greater accumulations than usual take place in the mountainous parts in the south of Europe and Asia, owing, perhaps, to earlier falls of snow or to the rays of the sun having been excluded by long-continued fogs. When this takes place, the atmosphere in the polar regions will be proportionably lighter. Hence the prevalence of southerly winds during some winters more than others.

As the heat in the torrid zone never differs much, the density, and consequently the height, of the atmosphere, will not vary much. Hence the range of the barometer within the tropics is comparatively small; and it increases gradually as we approach the poles, because the difference of the temperature, and consequently of the density, of the atmosphere, increases with the latitude.

The diurnal elevation of the barometer in the torrid zone corresponding to the tides, observed by Mr Casson and others, must be owing to the influence of the moon on the atmosphere. This influence, notwithstanding the ingenious attempts of D'Alembert and several other philosophers, seems altogether inadequate to account for the various phenomena of the winds. It is not so easy to account for the tendency which the barometer has to rise as the day advances. Perhaps it may be accounted for by the additional quantity of vapour added to the atmosphere, which by increasing the quantity of the atmosphere, may possibly be adequate to produce the effect.

The falls of the barometer which precede, and the oscillations which accompany, violent storms and hurricanes, shew us that these phenomena are produced by very great rarefactions, or perhaps destructions of air, in particular parts of the atmosphere. The falls of the barometer, too, that accompany winds, proceed from the same cause. The observation made by Mr Copland, that a high barometer is accompanied by a temperature above the mean, will be easily accounted for by every one acquainted with Dr Black's theory of latent heat. The higher the mercury stands, the denser the atmosphere must be; and the denser it becomes, the more latent heat it must give out. It is well known that air evolves heat when condensed artificially. The falling of the barometer, which generally precedes rain, remains still to be accounted for; but we know too little about the causes by which rain is produced, to be able to account for it in a satisfactory manner.

It has been for some time suspected that the variation of the barometer is affected by the changes of the moon. The theory of lunar influence has been discussed on the continent chiefly by Lamarck and Cotte, (see Journal de Physique, *passim*); and in this country by Mr Luke Howard. Mr Howard's suspicions of this influence on the barometer were first conceived, in consequence of the printed charts, of which he made use in keeping a register of the barometer, having the phases of the moon marked on them, and of his observing a remarkable coincidence between these and certain states of the mercury. This coincidence consists in the depression of the barometrical line on the approach of the new and full moon, and its elevation on that of the quarters. In above 30 out of the 50 lunar weeks in the year 1798, the barometer was found to have changed its general direction once in each week, in such a manner as to be either rising or at its *maximum*, for the week preceding and following, about the time of each quarter; and to be either falling or at its *minimum*, for the two weeks, about the new and full. It is remarkable, that the point of greatest depression during the year, viz. to 28.67, was found about 12 hours after the new moon on the 8th of November; and, that at its greatest and extraordinary elevation to 30.89, on the 7th of February, at the time of the last quarter. Moreover, this coincidence appeared to take place most regularly in fair and moderate weather; and, in general, when the barometer fell, during the interval between the new or full moon and the quarters, an evident perturbation in the atmosphere accompanied; of which may be instanced February 15. to 23. when the barometer, after an uncommon rise, continued to fall rapidly after the new moon, with severe cold, which ended suddenly in stormy and wet weather: again, June 13. to 20. when two weeks of fair weather ended in a thunder storm. In the greater part of December the usual coincidence disappeared, and the converse took place; the barometer being low at the quarter and high at the full, amidst continual alternations of rain, frost, and snow, and, for part of the time, high winds. On the two days preceding the last quarter, the barometer rose rapidly, and rain followed.

On the whole, Mr Howard thought there appeared sufficient ground, on the evidence of the year 1798, to suppose that the gravity of our atmosphere, as indicated by the barometer, may be subject to certain periodical changes, effected by a cause more steady and regular than either change of temperature, currents, or solution and precipitation of water, to which he believes the whole variation has been heretofore attributed.

The mean of the register at large appeared to be 29.89, whence it appears that the depression at the new and full moon either amounted to more, on the whole, than the elevations at the quarters, or that they fell out nearer to the time. He was quite satisfied, in passing through this register, that if he had allowed himself to choose the higher rotations about the quarters, and the lower about the new and full, with a latitude of 24 or 36 hours, it would have made the results as much more favourable to his conclusions as in her former case.

Now, to omit the consideration of other proofs for the present, it appeared to him evident, that the atmosphere is subject to a periodical change of gravity, whereby the barometer, on a mean of ten years, is depressed at least one-tenth of an inch while the moon is passing from the quarters to the full and new; and elevated, in the same proportion, during the return to the quarter. To what causes shall we attribute this periodical change, other than the attraction of the sun and moon for the matter composing the atmosphere?

The atmosphere is a gravitating fluid, differing, in a physical

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physical ſenſe, from the water, chiefly in poſſeſſing leſs gravity; and it is demonſtrated *à priori* on the principles of the Newtonian philoſophy, that it ought to have its tides as well as the ocean, although in a degree as much leſs perceptible as is its gravity.

He ſuppoſes, therefore, that the joint attractions of the ſun and moon at the new moon, and the attraction of the moon predominating over the ſun's weaker attraction at the full, tend to depreſs the barometer, by taking off from the gravity of the atmoſphere, as they produce a high tide in the waters, by taking off from their gravity; and, again, that the attraction of the moon being diminiſhed by that of the ſun at her quarters, this diminution tends to make a high barometer, together with a low tide, by permitting each fluid to preſs with additional gravity upon the earth *.

* *Phil. Mag.* vol. vii. p 355.

Chap. II. *Of the Changes which take place in the Temperature of the Air.*

It is obvious to the moſt careleſs obſerver, that the temperature of the air varies conſiderably even in the ſame place, and at the ſame ſeaſon. This conſtant variation muſt be attributed to the reflected rays of the ſun, which communicate heat from the ſurface of the earth to the ſurrounding atmoſphere. As from this cauſe the heat of thoſe places which are ſo ſituated as to be moſt warmed by the ſun's rays is always greateſt, and as this temperature varies in every place with the ſeaſon of the year, and diminiſhes according to the height of the air above the ſurface; and as the earth at the equator is expoſed to the moſt perpendicular rays of the ſun, the earth is there hotteſt, and its heat diminiſhes gradually from the equator to the poles. Of courſe, the temperature of the air muſt vary in the ſame manner, being hotteſt over the equator, and diminiſhing in temperature towards the poles, where it is coldeſt. Though it is hotteſt at the equator, its heat, as in all other ſituations, gradually diminiſhes there, as we aſcend above the ſurface of the earth.

Though there is a conſiderable difference in every part of the world between the temperature of the atmoſphere in ſummer and in winter; though in the ſame ſeaſon the temperature of almoſt every day, and even every hour, differs from that which precedes and follows it; though the heat varies continually in the moſt irregular and ſeemingly capricious manner—ſtill there is a certain mean temperature in every climate, which the atmoſphere has always a tendency to obſerve, and which it neither exceeds nor comes ſhort of beyond a certain number of degrees. What this temperature is, may be known by taking the mean of tables of obſervations kept for a number of years; and our knowledge of it muſt be the more accurate the greater the number of obſervations is.

15 Mean annual temperature greateſt at the equator.

The mean annual temperature is greateſt at the equator (or at leaſt a degree or two on the north ſide of it), and it diminiſhes gradually towards the poles, where it is leaſt. This diminution takes place in arithmetical progreſſion, or, to ſpeak more properly, the annual temperatures of all the latitudes are arithmetical means between the mean annual temperature of the equator and that of the pole. This was firſt aſcertained by Mr Meyer; and Dr Kirwan improving on Meyer's hint, has calculated in the following table the mean annual temperature of every latitude between the equator and the pole. It muſt be remarked, however, that this table is calculated only for a particular part of the earth's ſurface, viz. that part of the Atlantic ocean which lies between the 80° of northern, and the 45° of ſouthern latitude, extending weſtward as far as the Gulf ſtream, and to within a few leagues of the coaſt of America, and for all that part of the Pacific ocean that reaches from 45° of north latitude to 40° of ſouth latitude, and extending between the 20th and 275th degree of longitude eaſt from London. This part of the ocean is called by Dr Kirwan the ſtandard, and was beſt ſuited to his purpoſe, as the reſt of the ocean is ſubject to irregularities, which will be noticed preſently (D).

Lat.	Temper.	Lat.	Temper.	Lat.	Temper.	Lat.	Temper.	Lat.	Temper.	Lat.	Temper.	Lat.	Temper.
90	31.	77	33.7	64	41.2	51	52.4	38	63.9	25	74.5	12	81.7
89	31.04	76	34.1	63	41.9	50	52.9	37	64.8	24	75.4	11	82.0
88	31.10	75	34.5	62	42.7	49	53.8	36	65.7	23	75.9	10	82.3
87	31.14	74	35.0	61	43.5	48	54.7	35	66.6	22	76.5	9	82.7
86	31.2	73	35.5	60	44.3	47	55.6	34	67.4	21	77.2	8	82.9
85	31.4	72	36.0	59	45.09	46	56.4	33	68.3	20	77.8	7	83.2
84	31.5	71	36.6	58	45.8	45	57.5	32	69.1	19	78.3	6	83.4
83	31.7	70	37.2	57	46.7	44	58.4	31	69.9	18	78.9	5	83.6
82	32.0	69	37.8	56	47.5	43	59.4	30	70.7	17	79.4	0	84.0
81	32.2	68	38.4	55	48.4	42	60.3	29	71.5	16	79.9		
80	32.6	67	39.1	54	49.2	41	61.2	28	72.3	15	80.4		
79	32.9	66	39.7	53	50.2	40	62.0	27	72.8	14	80.8		
78	33.2	65	40.4	52	51.1	39	63.0	26	73.8	13	81.3		

Dr

(D) In calculating this table, Dr Kirwan proceeded on the following principle. Let the mean annual heat at the equator be m and at the pole $m-n$; put φ for any other latitude; the mean annual temperature of that latitude will be $m-n \times \text{ſin.}\ \varphi^2$. If, therefore, the temperature of any two latitudes be known, the value of m and n may be found. Now, the temperature of north latitude 40° has been found by the beſt obſervations to be 62.1°, and

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Dr Kirwan has alſo calculated in the following table the mean monthly temperature of the ſame ſtandard (E).

Latit.	80°	79°	78°	77°	76°	75°	74°	73°	72°	71°	70°	69°	68°	67°	66°	65°	64°	63°	62°
Jan.	22.	22.5	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	27.5	28.	28.	28.	29.	30.	31.
Feb.	23.	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	28.	28.	28.5	29.	30.	31.	32.	33.
March	27.	27.5	28.	28.5	29.	29.5	30.	30.5	31.	31.5	32.	32.5	33.	33.5	34.	35.	36.	37.	38.
April	32.6	32.9	33.2	33.7	34.1	34.5	35.	35.5	36.	36.6	37.2	37.8	38.4	39.1	39.7	40.4	41.2	41.9	42.7
May	36.5	36.5	37.	37.5	38.	38.5	39.	39.5	40.	40.5	41.	41.5	42.	42.5	43.	44.	45.	46.	47.
June	51.	51.	51.5	52.	52.	52.	52.5	53.	53.5	54.	54.	54.5	54.5	54.5	55.	55.	55.5	55.5	56.
July	50.	50.	50.5	51.	51.	51.	51.5	52.	52.5	53.	53.5	53.5	53.5	54.	54.5	54.5	55.	55.	55.5
Aug.	39.5	40.	41.	41.5	42.	42.5	43.	43.5	44.	44.5	45.	45.5	46.	47.	48.	48.5	49.	50.	51.
Sept.	33.5	34.	34.5	35.	35.5	36.	36.5	37.	38.	38.5	39.	39.5	40.	41.	42.	43.	44.	45.	46.
Oct.	28.5	29.	29.5	30.	30.5	31.	31.5	32.	32.5	33.	33.5	34.	34.	35.	36.	37.	37.5	38.	39.
Nov.	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	28.	28.5	29.	30.	31.	32.	32.5	33.	34.
Dec.	22.5	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	28.	28.	29.	30.	30.5	31.	31.	32.

Latit.	61°	60°	59°	58°	57°	56°	55°	54°	53°	52°	51°	50°	49°	48°	47°	46°	45°	44°	43°
Jan.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	42.5	43.5	43.	42.5	44.	44.5	45.	45.5
Feb.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	44.5	44.5	45.	45.5	46.	46.5	47.	48.
March	39.	40.	41.	42.	43.	44.6	45.	46.	48.	49.	50.	50.5	51.	52.5	53.	53.5	54.5	55.5	56.5
April	43.5	44.3	45.09	45.8	46.7	47.5	48.4	49.2	50.2	51.1	52.4	52.9	53.8	54.7	55.6	56.4	57.5	58.4	59.4
May	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.	58.5	59.	60.	61.	62.	63.	64.	65.
June	56.	56.	56.5	57.	57.	57.5	58.	58.5	59.	59.	60.	61.	62.	63.	64.	65.	66.	67.	68.
July	55.5	56.	56.5	57.	57.5	58.	59.	60.	61.	62.	63.	63.5	64.	65.	66.	67.	68.	69.	69.5
Aug.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.	63.5	64.	65.	66.	67.	68.	69.	69.5
Sept.	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.5	59.	60.	61.	62.	63.	64.	66.
Oct.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	50.5	51.	52.	53.	54.	55.	56.	57.
Nov.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.5	46.	46.5	47.	48.	49.	50.	51.	52.	53.
Dec.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	44.	44.5	45.	46.	47.	48.	49.	50.	51.

Latit.	42°	41°	40°	39°	38°	37°	36°	35°	34°	33°	32°	31°	30°	29°	28°	27°	26°	25°	24°
Jan.	46.	46.5	49.5	51.	52.	53.5	55.	56.5	59.5	63.	63.	63.	63.5	63.5	63.5	64.	64.5	65.5	67.
Feb.	49.	50.	53.	56.5	58.	60.	61.	62.	63.	64.5	66.	67.	68.5	68.5	69.5	69.5	70.5	71.	72.
March	58.5	59.5	60.	60.5	61.	62.	63.	64.	65.	66.5	67.5	68.5	69.5	71.	72.	72.5	73.	73.5	74.5
April	60.3	61.2	62.1	63.	63.9	64.8	65.7	66.6	67.4	68.3	69.1	69.9	70.7	71.5	72.3	72.8	73.8	74.5	75.4
May	66.	67.	68.	69.	70.	70.5	71.	71.5	72.	72.5	73.	73.	73.5	74.5	75.5	76.	76.5	77.5	78.
June	69	70.	70.5	71.	71.	71.	71.5	71.5	72.	72.5	73.	73.	73.5	74.5	75.5	76.	76.5	78.	78.5
July	70.	70.	71.	71.	72.	72.	72.5	72.5	72.5	72.5	73.	73.	73.5	74.5	75.5	76.	76.5	78.	78.5
Aug.	70.	70.	71.	71.	72.	72.	72.5	72.5	72.5	72.5	73.	73.	73.5	74.5	75.5	76.	76.5	78.	78.5
Sept.	68.	69.5	70.5	71.	71.5	72.	72.5	72.5	72.5	72.5	73.	73.	73.5	74.	75.5	76.	76.5	77.5	78.
Oct.	58.	59.	60.	61.	62.	63.	64.	65.	66.	67.5	68.5	69.5	70.5	71.	72.5	72.5	73.	73.5	74.5
Nov.	54.	55.	56.	57.	58.	59.	60.	61.	62.	63.	64.5	65.5	66.5	68.	69.	69.5	71.5	72.	73.5
Dec.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.5	63.5	64.5	66.	67.	67.5	68.5	69.5	70.

Latit.

and that of latitude 50°, 52.9°. The ſquare of the ſine of 40° is nearly 0.419, and the ſquare of the ſine of 50° is nearly 0.586. Therefore,

$$m-0.41\,n=62.1, \text{ and}$$
$$m-0.58\,n=52.9\text{; therefore,}$$
$$62.1+0.41\,n=52.9+058\,n,$$

as each of them, from the two firſt equations, is equal to m. From this laſt equation the value of n is found to be nearly 53; and m is nearly equal to 84. The mean temperature of the equator, therefore, is 84°, and that of the pole 31°. To find the mean temperature for every other latitude we have only to find 88 arithmetical means between 84 and 31.

(E) In calculating the table of mean monthly temperature, Dr Kirwan proceeded on the following principles. The mean temperature of April ſeems to approach very nearly to the mean temperature of the whole year, and as far as heat depends on the action of the ſolar rays, the mean heat of each month may be conſidered as propor-

tional

Temperature of the Air.

Latit.	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°
Jan.	68.	69.	71.	72.	72.5	73.	73.5	74.	74.5	75.	76.	76.5	77.	77.5
Feb.	72.	72.5	74.	75.	76.	76.5	77.	77.5	78.	78.5	79.	79.5	79.8	80.
March	75.	75.5	76.	77.	77.5	78.	78.5	79.	79.5	80.	80.8	81.	81.5	81.8
April	75.9	76.5	77.2	77.8	78.3	78.9	79.4	79.9	80.4	80.8	81.3	81.7	82.	82.3
May	78.5	79.5	80.	80.5	81.	81.5	82.	82.5	83.	83.	83.5	84.	84.	84.3
June	79.	79.5	80.	80.5	81.5	82.	82.5	83.	83.5	83.8	84.	84.3	84.6	84.8
July	79.	79.5	80.	80.5	81.5	82.	82.5	83.	83.5	83.8	84.	84.3	84.6	84.8
Aug.	79.	79.5	80.	80.5	81.5	82.	82.5	83.	83.5	83.8	84.	84.3	84.6	84.8
Sept.	78.5	79.	79.5	80.	81.	81.5	82.	82.5	83.	83.	83.5	84.	84.3	84.6
Oct.	75.	75.5	77.	78.	79.	80.	81.	81.5	82.	82.5	83.	83.5	83.8	84.
Nov.	74.	74.5	75.	75.5	76.	77.	78.	78.5	79.	79.5	80.	80.5	80.8	81.
Dec.	71.	71.5	72.	72.5	73.	74.	75.	75.5	76.	76.5	77.	77.5	78.	78.5

16 It appears from the above table that January is the coldeſt month in every latitude; that July is the warmeſt month in all latitudes above 48°; that in lower latitudes Auguſt is generally the warmeſt month; that the difference between the hotteſt and coldeſt months increaſes according to the diſtance of the place from the equator. All habitable latitudes are found to enjoy a medium heat of 60° for at leaſt 2 months, which is a very favourable circumſtance, as probably no corn could be produced under a lower medium temperature. The temperatures within 10° of the poles differ very little, nor do they differ much within 10° of the equator. Hence it was unneceſſary to note theſe latitudes in the table. The temperatures of different years vary but little near the equator, but this difference increaſes more and more as the latitudes approach the poles.

17 Temperature decreaſes as we aſcend in the air.

It is well known that the temperature of the atmoſphere gradually diminiſhes according to the height of the place above the level of the ſea. It was found by Dr Hutton of Edinburgh, that a thermometer kept on the top of Arthur's ſeat, a height of about 800 feet, uſually ſtood 3° lower than one kept at the foot of this hill; and Bouguer obſerved that on the top of Pinchincha, a height of about 15564 feet, a thermometer ſtood 54° lower than it did at the level of the ſea in the ſame latitude.

We are indebted to Dr Kirwan for a very ingenious method of determining the rate of the diminution in the temperature in particular caſes, having the temperature of the ſurface of the earth given. The temperature of the atmoſphere conſtantly diminiſhing as we riſe above the level of the ſea, we muſt at a certain height arrive at a point where a perpetual congelation takes place. This point muſt vary in height according to the latitude, being higheſt at the equator, and coming gradually nearer the earth as we approach the poles; it muſt vary alſo with the ſeaſon, being higheſt in ſummer, and loweſt in winter. The cold on the top of Pinchincha was found by M. Bouguer to extend from 7° to 9° below the freezing point every morning juſt before ſunriſe; hence he concluded that between the tropics the medium height of the term of congelation (where it freezes at ſome part of the day all the year round) ſhould be fixed at 15577 feet above the level of the ſea; but in latitude 28°, and during the ſummer, at 13440 feet. If we take the difference between the temperature at the equator, and the freezing point, this difference will bear the ſame proportion to the term of congelation at the equator, that the difference between the medium temperature at any other latitude and the freezing point bears to the term of congelation at that latitude. Suppoſe the medium heat at the equator to be 84°, the difference between which and 32° is 52°; and ſuppoſe the medium heat of latitude 28° to be $72\frac{3}{10}$°, the difference between which and 32° is $40\frac{3}{10}$°. Then by the following proportion, 52° : 15577 = $40\frac{3}{10}$: 12,720 gives us the term of congelation at 28°. In this way Dr Kirwan proceeded in calculating the following table.

18 Term of perpetual congelation.

Lat.

tional to the mean altitude of the ſun, or rather to the ſine of that altitude. If, therefore, we have the mean heat of April, and the ſine of the ſun's altitude given, the mean heat of May may be found by the following proportion:

As the ſine of the ſun's mean altitude in April : the mean heat of April = the ſine of the ſun's mean altitude in May : mean heat of May.

In the ſame manner the mean heat of June, July, and Auguſt may be found; but for the temperature of the ſucceeding months we muſt take into conſideration another circumſtance, ſince the above rule would make the temperature of theſe months too low, as it does not take in the heat derived from the earth, which is nearly equal to the mean annual temperature. The real mean heats of theſe months muſt be conſidered as an arithmetical mean between the aſtronomical and terreſtrial heats. Thus, for latitude 51°, the aſtronomical heat of September being 44.6°, and the mean annual heat 52.4°, the real heat of September ought to be $\frac{44.6+52.4}{2} = 48.5$. Dr Kirwan, however, after going through a tedious calculation, found the reſults to correſpond ſo little with actual obſervation, that he drew up the table partly from calculating from principles, and partly from an examination of ſeveral ſea journals.

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Lat.	Mean height of the term of congelation, in feet.	Lat.	Mean height of the term of congelation, in feet.
0°	15577	45°	7658
5	15457	50	6260
10	15067	55	4912
15	14498	60	3684
20	13719	65	2516
25	13030	70	1557
30	11592	75	748
35	10664	80	120
40	9016		

This laſt height of 120 feet M. Bouguer called the lower term of congelation. He alſo diſtinguiſhed another term of congelation above which no viſible vapour riſes, and this he called the upper term of congelation. This line is conſidered by Kirwan as much leſs variable during the ſummer months than the lower line, and it has therefore been adopted by him to determine the rate of diminution in the temperature as we aſcend into the atmoſphere. He has calculated its height for every degree of north latitude in the following table.

N. Lat.	Feet.	N. Lat.	Feet.	N. Lat.	Feet.	N. Lat.	Feet.
0	28000	26	22906	48	12245	70	4413
5	27784	27	22389	49	11750	71	4354
6	27644	28	21872	50	11253	72	4295
7	27504	29	21355	51	10124	73	4236
8	27364	30	20838	52	8965	74	4177
9	27224	31	20492	53	7806	75	4119
10	27084	32	20146	54	6647	76	4067
11	26880	33	19800	55	5617	77	4015
12	26676	34	19454	56	5533	78	3963
13	26472	35	19169	57	5439	79	3911
14	26268	36	18577	58	5345	80	3861
15	26061	37	17985	59	5251	81	3815
16	25781	38	17393	60	5148	82	3769
17	25501	39	16801	61	5068	83	3723
18	25221	40	16207	62	4989	84	3677
19	24941	41	15712	63	4910	85	3631
20	24661	42	15217	64	4831	86	3592
21	24404	43	14722	65	4752	87	3553
22	24147	44	14227	66	4684	88	3514
23	23890	45	13730	67	4616	89	3475
24	23633	46	13235	68	4548	90	3432
25	23423	47	12740	69	4480		(F)

From the modes of eſtimating the diminution of temperature now given, which agree extremely well with obſervation, we find that the temperature diminiſhes in arithmetical progreſſion, and hence we infer that the temperature of the air at a diſtance from the earth is owing to the conducting power of the air, and not to the aſcent of hot air from the ſurface of the earth.

Temperature of the Air.

19 Temperature of the air above the earth owing to the conducting power of the air.

It is however found that in winter the upper ſtrata of the air are often warmer than the lower; and this ſuperior heat, almoſt conſtantly obſerved in winter, is attributed by Dr Kirwan to a current of warm air from the equator, rolling towards the north pole during our winter *.

* *Iriſh Tranſ.* vol. viii. p. 375.

We have now given the general method of finding the medium annual temperature all over the globe; but there are ſeveral exceptions to our general inferences which muſt be particularly mentioned.

20 Temperature of the North Pacific ocean.

That part of the Pacific ocean which lies between north latitude 52° and 66° is no broader at its northern extremity than 42 miles, and at its ſouthern extremity its breadth ſcarcely exceeds 1300 miles: it is reaſonable to ſuppoſe, therefore, that its temperature will be conſiderably influenced by the ſurrounding land, which conſiſts of ranges of mountains, covered a great part of the year with ſnow; and there are beſides a great many high, and conſequently cold, iſlands ſcattered through it. For theſe reaſons Dr Kirwan concludes, that its temperature is at leaſt 4° or 5° below the ſtandard. But we are not yet furniſhed with a ſufficient number of obſervations to determine this with accuracy.

21 Of the ſouthern hemiſphere.

It is the general opinion, that the ſouthern hemiſphere beyond the 40° of latitude is conſiderably colder than the correſponding parts of the northern hemiſphere. See America.

22 Of ſmall ſeas.

Small ſeas ſurrounded with land, at leaſt in temperate and cold climates, are generally warmer in ſummer and colder in winter than the ſtandard ocean, becauſe they are much influenced by the temperature of the land. The gulf of Bothnia, for inſtance, is for the moſt part frozen in winter; but in ſummer it is ſometimes heated to 70°, a degree of heat never to be found in the oppoſite part of the Atlantic. The German ſea is above 3° colder in winter, and 5° warmer in ſummer, than the Atlantic. The Mediterranean ſea is, for the greater part of its extent, warmer both in ſummer and winter than the Atlantic, which therefore flows into it. The Black ſea is colder than the Mediterranean, and flows into it.

The eaſtern parts of North America are much colder than the oppoſite coaſt of Europe, and fall ſhort of the ſtandard

(F) Dr Kirwan has given us the following rule for aſcertaining the temperature at any required height, ſuppoſing we know the temperature of the ſurface of the earth.

For the temperature obſerved at the ſurface of the earth, put m; for the given height h, and t for the height of the upper term of congelation at the given latitude; then $\dfrac{m-32}{\frac{t}{100}-1}$ = the diminution of temperature for every 100 feet of elevation; or it is the common difference of the terms of the progreſſion required. Let this common difference thus found be denoted by c; then $c \times \frac{h}{100}$ gives us the whole diminution of temperature from the ſurface of the earth to the given height. Let this diminution be denoted by d, then $m-d$ is obviouſly the

Temperature of the Air.

ſtandard by about 10° or 12°, as appears from American meteorological tables. The cauſes of this remarkable difference are many. The higheſt part of North America lies between 40° and 50° of north latitude, and 100° and 110° of longitude weſt from London, for there the greateſt rivers originate. The very height, therefore, makes this ſpot colder than it would otherwiſe be. It is covered with immenſe foreſts, and abounds with large ſwamps and moraſſes, which render it incapable of receiving any great degree of heat; ſo that the rigour of winter is much leſs tempered by the heat of the earth than in the old continent. To the eaſt lie a number of very large lakes, and farther north, Hudſon's bay; about 50 miles on the ſouth of which there is a range of mountains which prevent its receiving any heat from that quarter. This bay is bounded on the eaſt by the mountainous country of Labrador and by a number of iſlands. Hence the coldneſs of the north-weſt winds and the lowneſs of the temperature. But as the cultivated parts of North America are now much warmer than formerly, there is reaſon to expect that the climate will become ſtill milder when the country is better cleared of woods, though perhaps it will never equal the temperature of the old continent.

23 Of iſlands.

Iſlands are warmer than continents in the ſame degree of latitude; and countries lying to the windward of extenſive mountains or foreſts are warmer than thoſe lying to the leeward. Stones or ſand have a leſs capacity for heat than earth has, which is always ſomewhat moiſt; they heat or cool, therefore, more rapidly and to a greater degree. Hence the violent heat of Arabia and Africa, and the intenſe cold of Terra del Fuego. Living vegetables alter their temperature very ſlowly, but their evaporation is great; and if they be tall and cloſe, as in foreſts, they exclude the ſun's rays from the earth, and ſhelter the winter ſnow from the wind and the ſun. Woody countries, therefore, are much colder than thoſe which are cultivated.

We ſhall conclude this chapter with a ſeries of meteorological axioms reſpecting the temperature of the air, by M. Cotte.

24 Cotte's axioms reſpecting temperature.

1. The extreme degrees of heat are almoſt everywhere the ſame; this, however, is not the caſe in regard to the extreme degrees of cold.

2. The thermometer riſes to its extreme height oftener in the temperate zones than in the torrid zone.

3. It changes very little between the tropics; its variations, like thoſe of the barometer, are greater the more one proceeds from the equator towards the poles.

4. It riſes higher in the plains than on mountains.

5. It does not fall ſo much in the neighbourhood of the ſea as in inland parts.

6. The wind has no influence on its motions.

7. Moiſture has a peculiar influence on it, if followed by a wind which diſperſes it.

8. The greateſt heat, and the greateſt cold, take place about ſix weeks after the northern or ſouthern ſolſtice.

9. The thermometer changes more in ſummer than in winter.

10. The coldeſt period of the day is before ſunriſe.

11. The greateſt heat in the ſun and the ſhade ſeldom takes place on the ſame day.

12. The heat decreaſes with far more rapidity from September and October, than it increaſed from July to September.

13. It is not true, that a very cold winter is the prognoſtic of a very hot ſummer.

Chap. III. *Of the Changes which take place in the Air with reſpect to Evaporation and Rain.*

Evaporation and Rain.

There ſeems no reaſon to doubt that water exiſts in the atmoſphere in an intermediate ſtate between that of a fluid and that of abſolute ſteam. This is the ſtate of vapour, of the qualities of which it is proper that we ſhould here take a general view. 25 Qualities of vapour.

We are indebted to the experiments of Sauſſure and de Luc for much of our knowledge of the qualities of vapour. It is an elaſtic inviſible fluid like common air, but lighter; being to common air, according to Sauſſure, as 10 to 14, or, according to Kirwan, as 10 to 12; it cannot paſs beyond a certain maximum of denſity, otherwiſe the particles of water which compoſe it unite together, and form ſmall, hollow, viſible veſicles, called *veſicular vapour*; which is of the ſame ſpecific gravity with atmoſpherical air. It is of this vapour that clouds and fogs are compoſed. This maximum increaſes with the temperature; and at the heat of boiling water is ſo great, that ſteam can reſiſt the whole preſſure of the air, and exiſt in the atmoſphere in any quantity.

After what has been ſtated under Chemistry with reſpect to the nature and properties of vapour, we have nothing here to add on that ſubject, except to give the reſult of obſervations that have been made on the ſtate of vapour in the atmoſphere.

It is found that the evaporation of water into the air is confined entirely to the ſurface, and hence it is always proportional to the ſurface expoſed to the action of the air. Accordingly, obſervation ſhows that in maritime countries, and in marſhy ſituations in the neighbourhood of lakes, rivers, &c. the evaporation is much greater than in inland countries, and dry ſituations. 26 Evaporation confined to the ſurface.

It is found that evaporation is greateſt in hot weather; whence it muſt depend, in ſome degree, on the temperature 27 Proportional to the temperature of the air.

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the temperature required. An example will make this rule ſufficiently obvious. In latitude 56° the heat below being 54°; required the temperature of the air at the height of 803 feet?

Here $m=54$, $t=5533$, $\frac{m-32}{\frac{t}{100}-1}=\frac{22}{54\cdot33}=0404=c$, and $c\times\frac{h}{100}=0.404\times8.03=3\cdot24=d$, and $m-d=$ $54-3\cdot24=50\cdot75$. Hence we ſee that the temperature of the air at the height of 803 feet above the ſurface is $50^{\circ}\cdot75$.

ture of the air. This was aſcertained by Mr Dalton from actual experiments, the reſult of which was, that the quantity evaporated per minute from a given ſurface of water at a given temperature, is to the quantity evaporated from the ſurface at 212°, as the force of vapour at the given temperature is to the force of vapour at 212°. By means of the table expreſſing the force of vapour at various temperatures given under CHEMISTRY, p. 468, we may diſcover by the above rule the quantity of water at a given temperature loſt by evaporation.

There are ſeveral circumſtances that affect the quantity of vapour riſing from water, even at the ſame temperature. Thus, we find that evaporation is leaſt in calm weather, increaſes when there is wind, and is greater in proportion as the wind is ſtronger. This evidently ariſes from the agitation of the water, by which a new ſurface is perpetually expoſed to the action of the air.

We ſhall here inſert a table by Mr Dalton, expreſſing the quantity of vapour raiſed in various atmoſpheric temperatures, from a circular ſurface ſix inches in diameter.

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Temperature.	Force of vapour in inches.	Evaporating force in grains.			Temperature.	Force of vapour in inches.	Evaporating force in grain.		
212°	30	120	154	189	212°	30	120	154	189
20°	.129	.52	.67	.82	53°	.415	1.66	2.13	2.61
21	.134	.54	.69	.85	54	.429	1.71	2.20	2.69
22	.139	.56	.71	.88	55	.443	1.77	2.28	2.78
23	.144	.58	.73	.91	56	.458	1.83	2.35	2.88
24	.150	.60	.77	.94	57	.474	1.90	2.43	2.98
25	.156	.62	.79	.97	58	.490	1.96	2.52	3.08
26	.162	.65	.82	1.02	59	.507	2.03	2.61	3.19
27	.168	.67	.86	1.05	60	.524	2.10	2.70	3.30
28	.174	.70	.90	1.10	61	.542	2.17	2.79	3.41
29	.180	.72	.93	1.13	62	.560	2.24	2.88	3.52
30	.186	.74	.95	1.17	63	.578	2.31	2.97	3.63
31	.193	.77	.99	1.21	64	.597	2.39	3.07	3.76
32	.200	.80	1.03	1.26	65	.616	2.46	3.16	3.87
33	.207	.83	1.07	1.30	66	.635	2.54	3.27	3.99
34	.214	.86	1.11	1.35	67	.655	2.62	3.37	4.12
35	.221	.89	1.14	1.39	68	.676	2.70	3.47	4.24
36	.229	.92	1.18	1.45	69	.698	2.79	3.59	4.38
37	.237	.95	1.22	1.49	70	.721	2.88	3.70	4.53
38	.245	.98	1.26	1.54	71	.745	2.98	3.83	4.68
39	.254	1.02	1.31	1.60	72	.770	3.08	3.96	4.84
40	.263	1.05	1.35	1.65	73	.796	3.18	4.09	5.00
41	.273	1.09	1.40	1.71	74	.823	3.29	4.23	5.17
42	.283	1.13	1.45	1.78	75	.851	3.40	4.37	5.34
43	.294	1.18	1.51	1.85	76	.880	3.52	4.52	5.53
44	.305	1.22	1.57	1.92	77	.910	3.65	4.68	5.72
45	.316	1.26	1.62	1.99	78	.940	3.76	4.83	5.91
46	.327	1.31	1.68	2.06	79	.971	3.88	4.99	6.10
47	.339	1.36	1.75	2.13	80	1.00	4.00	5.14	6.29
48	.351	1.40	1.80	2.20	81	1.04	4.16	5.35	6.54
49	.363	1.45	1.86	2.28	82	1.07	4.28	5.50	6.73
50	.375	1.50	1.92	2.36	83	1.10	4.40	5.66	6.91
51	.388	1.55	1.99	2.44	84	1.14	4.56	5.86	7.17
52	.401	1.60	2.06	2.51	85	1.17	4.68	6.07	7.46

The firſt column of the above table expreſſes the temperature; the ſecond, the correſponding force of vapour; the other three columns give the number of grains of water that would be evaporated from a ſurface of ſix inches in diameter in the reſpective temperatures, on the ſuppoſition of there being previouſly no aqueous vapour in the atmoſphere. Theſe columns preſent the extremes and the mean of evaporation likely to be noticed, or nearly ſuch; for the firſt is calculated upon the ſuppoſition of 35 grains loſs per minute from the veſſel of three inches and a quarter in diameter; the ſecond 45, and the third 55 grains per minute.

As yet we have ſtated only the degree of evaporation that would take place under various circumſtances, provided that the atmoſphere were, at the time, entirely free from moiſture; but as this can ſcarcely happen, it becomes neceſſary to aſcertain the rate of evaporation when qualified by the vapour already exiſting in the atmoſphere. This is readily done by firſt finding the force of the vapour already in the atmoſphere, as above directed, and ſubtracting it from the force of vapour at the given temperature. The remainder is the actual force of evaporation, from which, by the laſt table, we find the required rate of evapora-

 tion.

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tion. Suppoſe, for inſtance, it be required to know the rate of evaporation at the temperature of 59°. From the laſt table we ſee that the force of vapour at 59° is about 0.5 or $\frac{1}{60}$ its force at 212°. Now, ſuppoſe that by trials we find the force of the vapour whieh already exiſts in the atmoſphere to be 0.25 or $\frac{1}{120}=\frac{1}{2}$ of $\frac{1}{60}$. Subtracting the latter from the former, we have for a remainder 0.25=the force of evaporation required, whieh is therefore juſt the half of what it would be if the atmoſphere were entirely free from vapour.

The force of vapour exiſting in the atmoſphere is ſcarcely ever equal to the force of vapour of the temperature of the atmoſphere. Hence evaporation may, with a few exceptions, be conſidered as going on without intermiſſion. Attempts have been made to aſcertain the quantity of evaporation that takes place in the courſe of a year; but the inveſtigation of this problem is ſo difficult, that theſe attempts have ſucceeded only in obtaining approximations towards the truth. Mr Dobſon of Liverpool, from a courſe of experiments made in 1772, 1773, 1774, and 1775, eoncludes that the mean annual evaporation from the ſurface of water, amounted to 36.78 inches. The proportions for each month are as follows.

	Inches.		Inches.
January	1.50	July	5.11
February	1.77	Auguſt	5.01
March	2.64	September	3.18
April	3.30	October	2.51
May	4.34	November	1.51
June	4.41	December	1.49

The experiments of Mr Dalton ſhew that the evaporation from the ſurfaee of water in a very dry and hot ſummer day, was rather more than two tenths of an ineh.

Several experiments have been made on the quantity of evaporation from land, eſpecially by Mr Williams in America, and Dr Watſon, Mr Dalton and Mr Hoyle in Britain.

Mr Williams's experiments appear to ſhew that the evaporation from the ſurface of ſuch land as is covered with trees and other vegetables is about one third greater than the evaporation from the ſurface of water, though much reliance is not laid on theſe experiments.

28 Evaporation from land.

From an experiment made by Dr Watſon during ſummer, when the earth had been parched by a month's drought, it appeared that 1600 gallons of water were evaporated from a ſingle acre in 12 hours *. Dr Watſon's experiment, however, was of a nature that did not admit of great preeiſion.

29 Experiments by Dalton and Hoyle.

The experiments made by Mr Dalton and Mr Hoyle in the years 1796, 1797, and 1798, are the moſt exact that have been made on this ſubject, and we ſhall therefore conſider them more at large. They were made with the following apparatus. Having proeured a cylindrical veſſel made of tin plate, three feet deep and ten inches in diameter, they inſerted into it two pipes directed downwards, ſo that water might paſs through them into two bottles. One pipe was fixed near the bottom of the veſſel, and the other about an ineh from the top. The veſſel was filled up for a few inches with gravel and ſand, and all the reſt with good freſh ſoil. It was then put into a hole in the ground, and the ſpace around filled up with earth exeept on one ſide, for the eonvenience of putting bottles to the two pipes; then ſome water was poured on the earth to ſadden it, and all that would drain off was ſuffered to eſeape. Hence the earth may be eonſidered as ſaturated with moiſture. The ſoil was kept for ſome weeks above the level of the upper pipe, but after that it was conſtantly allowed to be a little below it, thus preventing any water from running off through that pipe. The top of the ſoil for the firſt year was bare; but for the two laſt years it was covered with graſs like other turf. The apparatus being thus prepared, a correct regiſter was kept of the quantity of rain water which ran off from the ſurface of the earth by the upper pipe, as long as that was below the earth, and alſo of the quantity of water which paſſed through the three feet of earth, and ran off by the lower pipe; and a rain gauge of an equal diameter with the cylinder was kept near it, for the purpoſe of meaſuring the quantity of rain which fell in any eorreſponding time. Then, by ſubtracting the quantity of water which paſſed through the pipes from that in the rain gauge, the remainder was eonſidered as equal to the quantity evaporated from the ſurface of the earth in the cylinder. The mean annual reſult of theſe experiments is ſhewn in the following table.

* Watſon's Chemical Eſſays, vol. iii. 54.

30 Reſult.

	Water through the two pipes.			Mean.	Mean Rain.	Mean Evap.
	1796. Ineh.	1797. Ineh.	1798. Inch.	Ineh.	Ineh.	Inch.
January	1.897—	.680—	1.774+	1.450+	2.458	1.008
February	1.778—	.918—	1.122	1.273	1.801	.528
March	.431—	.070—	.335	.279	.902	.623
April	.220—	.295—	.180	.232	1.717	1.485
May	2.027—	2.443+	.010	1.493+	4.177	2.684
June	.171—	.726	—	.299	2.483	2.184
July	.153—	.025	—	.059	4.154	4.095
Auguſt	—	—	.504	.168	3.554	3.386
September	—	.976	—	.325	3.279	2.954
October	—	.680	—	.227	2.899	2.672
November	—	1.044	1.594	.879	2.934	2.055
December	.200	3.077	1.878+	1.718+	3.202	1.484
	6.877—	10.934—	7.379	8.402	33.560	25.158
Rain	30.629—	38.791—	31.259			
Evap.	23.725—	27.857—	23.862			

It

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It appears from these experiments, that at Manchester the mean annual evaporation of water is above 25 inches; and if we add to this with Mr Dalton 5 inches for the dew which falls, the whole quantity evaporated in a year will be 30 inches. On the whole, we may perhaps estimate the mean annual evaporation from the whole surface of the globe at 35 inches from every square inch of surface, making the whole water annually evaporated over the whole globe equal to 94.450 cubic miles.

31 Mean annual evaporation over the globe.

Were this prodigious mass of water all to subsist in the atmosphere at once, it would increase its mass by about $\frac{1}{12}$, and raise the barometer nearly 3 inches. But this never happens; no day passes without rain in some part of the earth; so that part of the evaporated water is continually precipitated again. Indeed it would be impossible for the whole of the evaporated water to subsist in the atmosphere at once, at least in the state of vapour.

The higher regions of the atmosphere contain less vapour than the strata near the surface of the earth. This was observed both by M. de Saussure and M. de Luc.

32 At some height above the tops of mountains the atmosphere is probably still drier, for it was observed by Saussure, that on the tops of mountains the moisture of the air was rather less during the night than the day. And there can be little doubt that every stratum of air descends a little lower during the night than it was during the day, owing to the cooling and condensing of the stratum nearest the earth. Vapours, however, must ascend very high, for we see clouds forming far above the tops of the highest mountains.

Rain never begins to fall while the air is transparent; the invisible vapours first pass their maximum, and are changed into vesicular vapours; clouds are formed, and these clouds gradually dissolve in rain. Clouds, however, are not formed in all parts of the horizon at once; the formation begins in one particular spot, while the rest of the air remains clear as before; this cloud rapidly increases till it overspreads the whole horizon, and then the rain begins.

33 Clouds always form at some height.

It is remarkable, that though the greatest quantity of vapour exists in the lower strata of the atmosphere, clouds never begin to form there, but always at some considerable height. It is remarkable too, that the part of the atmosphere at which they form has not arrived at the point of extreme moisture, nor near that point, even a moment before their formation. They are not formed then because a greater quantity of vapour had got into the atmosphere than could remain there without passing its maximum. It is still more remarkable, that when clouds are formed, the temperature of the spot in which they are formed is not always lowered, though this may sometimes be the case. On the contrary, the heat of the clouds themselves is sometimes greater than that of the surrounding air *. Nor is the formation of clouds owing to the capacity of air for combining with moisture being lessened by cold; so far from that, we often see clouds which had remained in the atmosphere during the heat of the day, disappear in the night, after the heat of the air was diminished.

* *De Luc la Meteorol.* vol. ii. 100.

34 The formation of clouds and rain as yet unexplained.

The formation of clouds and rain cannot be accounted for by a single principle with which we are acquainted. It is neither owing to the saturation of the atmosphere, nor the diminution of the heat; nor the mixture of airs of different temperatures, as Dr Hutton supposes: for clouds are often formed without any wind at all either above or below them; and even if this mixture constantly took place, the precipitation, instead of accounting for rain, would be almost imperceptible.

It is a very remarkable fact, that evaporation often goes on for a month together in hot weather without any rain. This sometimes happens in this country; it happens every year in the torrid zone. Thus at Calcutta, during January 1785, it never rained at all; the mean of the thermometer for the whole month was $66\frac{1}{2}°$; there was no high wind, and indeed during great part of the month little wind at all.

The quantity of water evaporated during such a drought must be very great; yet the moisture of the air, instead of being increased, is constantly diminishing, and at last disappears almost entirely. For the dew, which is at first copious, diminishes every night; and if Dr Watson's experiment formerly mentioned be attended to, it will not be objected that the quantity of evaporation is also very much diminished. Of the very dry state to which the atmosphere is reduced during long droughts, the violent thunder-storms with which they often conclude is a very decisive proof. Now what becomes of all this moisture? It is not accumulated in the atmosphere above the country from which it was evaporated, otherwise the whole atmosphere would in a much less period than a month be perfectly saturated with moisture. If it be carried up daily through the different strata of the atmosphere, and wafted to other regions by superior currents of air, how is it possible to account for the different electrical state of the clouds situated between different strata, which often produces the most violent thunder-storms? They could not have remained in the lower strata of the atmosphere, and been daily carried off by winds to other countries; for there are often no winds at all during several days to perform this office; nor in that case would the dews diminish, nor could their presence fail to be indicated by the hygrometer.

It is impossible for us to account for this remarkable fact upon any principle with which we are acquainted. The water can neither remain in the atmosphere, nor pass through it in the state of vapour. It must therefore assume some other form; but what that form is, or how it assumes it, we know not. There are, therefore, two steps of the process which takes place between evaporation and rain, with which we are entirely unacquainted; first, the state of the vapour after it enters into the atmosphere, and second, the cause by which it is made to lay aside the new form which it assumed, return to its state of vapour, and descend in form of rain. Several theories have been contrived to account for this phenomenon, but they are all untenable on the present known laws of chemical action.

The mean annual quantity of rain is greatest at the equator, and decreases gradually as we approach the poles. Thus at Granada, Antilles, 12° N. Lat. it is 126 inches.

Cape François, St Domingo	19°	46′	120
Calcutta - -	22	23	81
Rome - - -	41	54	39
England - -	33	0	32
Petersburgh . - -	59	16	16

On

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On the contrary, the number of rainy days is smallest at the equator, and increases in proportion to the distance from it. From N. Lat. 12° to 43° the mean number of rainy days is 78; from 43° to 46° the mean number is 103; from 46° to 50° it is 134; from 51° to 60°, 161 days.

35 Rainy days often more numerous in winter.

The number of rainy days is often greater in winter than in summer; but the quantity of rain is greater in summer than in winter. At Petersburgh, the number of rainy or snowy days during winter is 84, and the quantity which falls is only about 5 inches; during summer the number of rainy days is nearly the same, but the quantity which falls is about 11 inches.

More rain falls in mountainous countries than in plains. Among the Andes it is said to rain almost perpetually, while in Egypt it scarcely ever rains at all. If a rain-gauge be placed on the ground, and another at some height perpendicularly above it, more rain will be collected into the lower than into the higher; a proof that the quantity of rain increases as it descends, owing perhaps to the drops attracting vapour during their passage through the lower strata of the atmosphere where the greatest quantity resides. This, however, is not always the case, as Mr Copland of Dumfries discovered in the course of his experiments. He observed also, that when the quantity of rain collected in the lower gauge was greatest, the rain commonly continued for some time; and that the greatest quantity was collected in the higher gauge only either at the end of great rains, or during rains which did not last long. These observations are important, and may, if followed out, give us new knowledge of the causes of rain. They seem to show, that during rain the atmosphere is somehow or other brought into a state which induces it to part with its moisture; and that the rain continues as long as this state continues. Were a sufficient number of observations made on this subject in different places, and were the atmosphere carefully analysed during dry weather, during rain, and immediately after rain, we might soon perhaps discover the true theory of rain.

36 More rain falls in the day than in the night.

Rain falls in all seasons of the year, at all times of the day, and during the night as well as the day; though, according to M. Toaldo, a greater quantity falls during the day than the night. The cause of rain, then, whatever it may be, must be something which operates at all times and seasons. Rain falls also during the continuance of every wind, but oftenest when the wind blows from the south. Falls of rain often happen likewise during perfect calms.

37 Mean annual quantity of rain in Great Britain

It appears from a paper published by M. Cotte in the *Journal de Physique* for October 1791, containing the mean quantity of rain falling at 147 places, situated between N. Lat. 11° and 60°, deduced from tables kept at these places, that the mean annual quantity of rain falling in all these places is 34.7 inches. Let us suppose then (which cannot be very far from the truth), that the mean annual quantity of rain for the whole is 34 inches. The superficies of the globe consists of 170,981,012 square miles, or 686,401,498,471,475,200 square inches. The quantity of rain, therefore, falling annually will amount to 23,337,650,812,030,156,800 cubic inches, or somewhat more than 91,751 cubic miles of water. This is 6.191 cubic miles of water less than the quantity of water evaporated. It seems probable therefore, if the imperfection of our data warrant any conclusion, that some of the vapour is actually decomposed in the atmosphere, and converted into oxygen and hydrogen gas.

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The dry land amounts to 52,745,253 square miles; the quantity of rain falling on it annually therefore will amount to 30,960 cubic miles. The quantity of water running annually into the sea is 13,140 cubic miles; a quantity of water equal to which must be supplied by evaporation from the sea, otherwise the land would soon be completely drained of its mosture.

The quantity of rain falling annually in Great Britain may be seen from the following table:

Years of observation.	Places.	Rain in Inches.
3	Dover - -	37.52
5	Ware, Hertfordshire -	23.6
8	London - -	17.5
8	Kimbolton - -	23.9
45	Lyndon - -	22.21
5	Chatsworth, Derbyshire -	27.865
8	Manchester - -	43.1
18	Liverpool - -	34.41
7	Lancaster - -	40.3
5	Kendal - -	61.223
14	Dumfries - -	36.127
10	Branxholm, 44 miles S. W. of Berwick - -	31.26
5	Langholm - -	36.73
5	Dalkeith - -	25.124
20	Glasgow - -	31.
8	Hawkhill - -	28.966
	Mean	32.532

Mr Dalton has estimated the quantity of rain that falls in England at 21 inches; but as no account is taken of what falls in Wales and Scotland, this estimate probably falls much short of the real annual quantity. In this country it generally rains less in March than in November, in the proportion at a medium of 7 to 12. It generally rains less in April than October, in the proportion of 1 to 2 nearly at a medium. It generally rains less in May than September; the chances that it does so are at least as 4 to 3: but when it rains plentifully in May, it generally rains but little in September; and when it rains one inch or less in May, it rains plentifully in September.

The degree of moisture that is present in the atmosphere at any given time, is measured by the hygrometer. Under the article HYGROMETER we have amply described several of the most important instruments of that kind; but there is one hygrometer, viz. that of Mr Leslie, which remains to be described in this place. Figures of the instrument are given in Plate CCLXXVI. fig. 13, 14.

The principal part of the instrument is composed of two glass tubes terminated by hollow balls, one transparent and the other opaque. The tubes are selected, as regular as possible, from 4 to 8 inches long, and about $\frac{3}{20}$ of an inch thick, or as slender as those employed for 38 Leslie's hygrometer.

for thermometers, but with a much wider bore. This, in one tube, muſt be from $\frac{1}{40}$ to the $\frac{1}{60}$ of an inch in diameter, and an exact calibre, at leaſt not differing by $\frac{1}{50}$ between both its extremities. To the end of it a ſmall piece of black enamel is attached, and blown into an opaque ball, from 4 to $\frac{1}{10}$ of an inch diameter. The correſponding tube may have its bore of the ſame, or rather a greater width, but its uniformity is not at all eſſential. Near the extremity it is ſwelled out into a thin cylinder, almoſt $\frac{1}{10}$ of an inch wide, and from $\frac{3}{10}$ to $\frac{6}{10}$ long; the inner cavity only being enlarged, without altering the exterior regularity of the tube. The ſhort bit of glaſs where this cylinder terminates, is now blown into a thin pellucid ball, as nearly of the ſize of the former as the eye can judge. The exact equality of the balls would be unattainable, and fortunately the theory of the inſtrument does not require it. When a dark and a bright object are viewed together, the latter, from an optical deception, appears always larger than the reality; and for this reaſon, ſays Mr Leſlie, I prefer making the clear ball a ſlight degree ſmaller than the black one. In the mean time a coloured liquor is prepared by diſſolving carmine in concentrated ſulphuric acid, in a phial with a ground ſtopper, taking care to avoid heat, as by this the colouring-matter would be charred, and the beauty of the liquor deſtroyed.

The tubes are now cut to nearly equal lengths, and the end of each ſwelled out a little, to facilitate their junction. Cloſe to the black ball, the tube is bent by the flame of a candle into a ſhoulder, ſuch, that the root of the ball ſhall come into a line with the inner edge of the tube. This ball, being then warmed, the end of the tube is dipt into the acid liquor, and as much of it allowed to riſe and flow into the cavity, as may be gueſſed ſufficient to fill both tubes, excepting the cylinder. The two tubes are then, by the help of a blow-pipe, ſolidly joined together in one ſtraight piece, without having any knot or protuberance. About half an inch from the joining, and nearer the cylinder, it is gently bent round by the flame of a candle, till the clear ball is brought to touch the tube $\frac{3}{4}$ inch directly below the black one. The inſtrument is now to be graduated; and the ſcale choſen by Mr Leſlie is that which correſponds to the centigrade thermometer. Mr Leſlie thus deſcribes the mode of graduating the inſtrument.—The inſtrument is held in an oblique poſition, that the coloured liquor may collect at the bottom of the black ball, into which a few minute portions of air muſt, from time to time, be forced over, by heating the oppoſite ball with the hand. In this way, the interpoſed liquid will gradually be made to deſcend into the tube, and aſſume its proper place; and it ſhould remain for a week or two in an inclined poſition, to let every particle drain out of the black ball. If any trace of fluid collects in rings within the bore, they are eaſily diſpelled with a little dexterity and manipulation, which, though it would be difficult to deſcribe, is moſt readily learnt and practiſed. The ſmall cavity at the joining facilitates the rectification, by affording the means of ſending a globule of air in either direction. In fixing the zero of the ſcale, Mr Leſlie ſet the inſtrument in a remote corner of the room, or partly cloſed the window-ſhutters. When completely adjuſted, the top of the coloured liquor, if held upright, ſhould ſtand nearly oppoſite to the middle of the cylindrical reſervoir.

In this ſtate of preparation, the inſtrument is ready for being graduated. The clear ball and the contiguous part of the parallel tube are therefore covered with two or three folds of thin bibulous paper, moiſtened with pure water, to make it act as a hygrometer; and there is attached to the ſame tube a temporary ſcale, by means of a ſoft cement compoſed of bees-wax and roſin. A flat round piece of wood being provided with four or five pillars that ſcrew into it, the inſtrument is fixed to one of them in an erect poſition, and on each ſide is diſpoſed a fine correſponding thermometer, inverted, and at the ſame height, the one having its bulb covered with wet bibulous paper. Then half a yard of flannel is dried as much as poſſible without ſingeing, before a good fire, and rolling it up like a ſleeve, it is lapped looſely round the lower part of the pillars, and the whole is incloſed under a large bell-glaſs. The flannel powerfully abſorbs moiſture from the confined air, and creates an artificial dryneſs of 80 or 100 degrees. In the ſpace of a quarter or half an hour, the full effect is produced, and the quantities being noted at two or three ſeparate times, the mean reſults are adopted. The deſcent, meaſured by the temporary ſcale, being then augmented in the proportion of ten to the difference of the two thermometers, will give the length that correſponds to 100°. After the ſtandard inſtrument is conſtructed, others are thence graduated with the utmoſt eaſe; the firſt being planted in the centre, and the reſt, with their temporary ſcales, ſtuck to the encircling pillars. For greater accuracy, the obſervation ſhould be made in a room without a fire, or a ſcreen ought to be interpoſed between the fire and the apparatus.

The ſlips of ivory intended for the ſcales are divided into equal parts, and ſhould contain from 100° to 150°. The edges are filed down and chamfered, to fit eaſily between the parallel tubes; and they are ſecured in their place by a ſtrong ſolution of iſinglaſs. The lower ball and its annexed cylinder, are covered with thin ſilk of the ſame colour as the upper ball, and a few threads are likewiſe lapped about that part of the tube which it touches. The inſtrument is laſtly cemented into a piece of wood, either end of which admits a cylindrical caſe that ſerves equally to protect or to hold it. On other occaſions, the hygrometer is inſerted into the ſocket of a round bottom-piece where it ſtands vertical.

The above deſcription refers particularly to fig. 14. Fig. 13. differs from this, only in having the balls of an equal height, and bended in oppoſite directions, which Mr Leſlie conſiders as more convenient for ſome purpoſes to which the inſtrument is applied, to be mentioned hereafter, but which renders the inſtrument leſs portable.

39 Theory of the inſtrument.

The action of this hygrometer depends on the following principle; *That the cold produced by evaporation will accurately denote the degree of dryneſs of the air, or its diſtance from the point of ſaturation.* To diſcover the dryneſs or humidity of the air, therefore, we have only to find the change of temperature induced in a body of water inſulated, or expoſed on all ſides to evaporation. The ſteps which led Mr Leſlie from theſe ſimple

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simple principles to the construction of the present ingenious instrument, are detailed by him in a paper published in Nicholson's Journal for January 1800, to which we must refer our readers for the particulars, contenting ourselves with the following summary view.

If two thermometers be filled with any expansible fluid, and having the bulb of the one wet and the other dry, they will, by their difference, denote the state of the air in respect to humidity. Mr Leslie's object was to combine two such instruments, so that they should indicate merely their difference of temperature; and this object he has completely attained by the present instrument. In ordinary cases, the intermediate liquor would continue stationary; for the air in both balls having the same temperature, and consequently the same elasticity, the opposite pressures would precisely counteract each other; but if, from the action of the external air on the moistened surface, one ball became colder, it is manifest the liquor would be pushed towards it by the superior elasticity of the air included in the other ball, so as to mark, by the space of its approach, the depression of temperature induced by evaporation.

This instrument does not merely point out the dryness of the air; it enables us to determine the *absolute quantity* of moisture which it is capable of imbibing; for the conversion of water into steam is found to consume 524° of the centigrade division; and evaporation, analogous in its effects, may be presumed to occasion the same waste of heat. If, therefore, air had the same capacity as water, for each degree of the hygrometer it would deposit as much heat as it would abstract by dissolving the $\frac{1}{3240}$ part of its weight of humidity. But the capacity of air is to that of water as 11 to six, and consequently it would require in that proportion a greater evaporation to produce the same effect. We may hence conclude, that, for each hygrometric degree, the air would require $\frac{11}{6} \times \frac{1}{3240}$ or $\frac{1}{2838}$ part by weight of water to effect saturation.

Strictly speaking, the degrees marked by this hygrometer do not measure the dryness of the air at its actual temperature, but only its state of dryness when cooled down to the standard of the wet ball. The law, however, being known of the dissolving power of air as affected by heat, it is easy, from the disposition of the air with respect to humidity at one temperature to derive that at any other. It will suffice to mention the result of a number of careful experiments:—Supposing air at the freezing point to be capable of holding 50 parts of moisture; at 10° centigrade, it will hold 100; at 20°, 200; at 30°, 400; thus doubling at each increase of 10°. Hence a table may be constructed by which these conversions will be easily made.

To omit nothing that tends to elucidate the theory of the instrument, we must observe that the air in its contact with the humid surface is not absolutely cooled to the same temperature; the air and water really meet each other at an intermediate point determined by their compounded density and capacity. Consequently the indications of the hygrometer ought to be augmented by the $\frac{1}{464}$ part, or $\frac{11}{6} + \frac{1}{850}$. But this quantity is too small in any case to be regarded.

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CHAP. IV. *Of the Changes produced in the Air by Winds.*

40 IN considering the subject of winds, we shall first briefly detail their natural history, so far as it has not been already anticipated, and shall then endeavour to trace the laws by which they are regulated, or explain the manner in which their varieties are produced. As the direction of the winds is of the greatest consequence, especially in a commercial view, we shall first point out the direction of the most prevalent winds in various quarters of the world.

Between the tropics the winds are the most regular. 41 Trade-winds.
In those parts of the Pacific and Atlantic oceans which lie nearest the equator, there is a regular wind during the whole year called the *trade-wind*. On the north side of the equator it blows from the north-east, varying frequently a point or two towards the north or east; and on the south side of it, from the south-east, changing sometimes in the same manner towards the south or east. The space included between the second and fifth degrees of north latitude is the internal limit of these two winds. There the winds can neither be said to blow from the north nor the south; calms and violent storms are frequent. This space varies a little in latitude as the sun approaches either of the tropics. In the Atlantic ocean the trade-winds extend farther north on the American than on the African coast; and as we advance westward, they become gradually more easterly, and decrease in strength. Their force diminishes likewise as we approach their utmost boundaries. It has been remarked also, that as the sun approaches the tropic of cancer, the south-east winds become gradually more southerly, and the north-east winds more easterly: exactly the contrary takes place when the sun is approaching the tropic of capricorn.

The trade-wind blows constantly in the Indian ocean 42 Monsoons.
from 10° south latitude to near 30°; but to the northward of this the winds change every six months, and blow directly opposite to their former course. These regular winds are called *monsoons*, from the Malay word *moossin*, which signifies a season. When they shift their direction, variable winds and violent storms succeed, which last for a month, and frequently longer; and during that time it is dangerous for vessels to continue at sea.

The monsoons in the Indian ocean may be reduced to two; one on the north and another on the south side of the equator; which extend from Africa to the longitude of New Holland and the east coast of China, and which suffer partial changes in particular places from the situation and inflection of the neighbouring countries.

Between 3° and 10° of south latitude the south-east trade-wind continues from April to October; but during the rest of the year the wind blows from the north-west. Between Sumatra and New Holland this monsoon blows from the south during our summer months, approaching gradually to the south-east as we advance towards the coast of New Holland; it changes about the end of September, and continues in the opposite direction till April. Between Africa and Madagascar its direction is influenced by the coast; for it blows

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blows from the north-east from October to April, and during the rest of the year from the south-west.

43 Direction of the trade-winds throughout the year.

Over all the Indian ocean to the northward of the third degree of south latitude, the north-east trade-wind blows from October to April, and a south-west wind from April to October. From Borneo, along the coast of Malacca and as far as China, this monsoon in summer blows nearly from the south, and in winter from the north by east. Near the coast of Africa, between Mozambique and Cape Guardafeu, the winds are irregular during the whole year, owing to the different monsoons which surround that particular place.—Monsoons are likewise regular in the Red sea; between April and October they blow from the north-west, and during the other months from the south-east, keeping constantly parallel to the coast of Arabia.

44 Of monsoons.

Monsoons are not altogether confined to the Indian ocean; on the coast of Brazil, between Cape St Augustine and the island of St Catharine, the wind blows between September and April from the east or north-east, and between April and September from the south-west. The bay of Panama is the only place on the west side of a great continent where the wind shifts regularly at different seasons: there it is easterly between September and March; but between March and September it blows chiefly from the south and south-west.

Such in general is the direction of the winds in the torrid zone all over the Atlantic, Pacific, and Indian oceans; but they are subject to particular exceptions, which we shall now endeavour to enumerate. On the coast of Africa, from Cape Bayador to Cape Verde, the winds are generally north-west; from thence to the island of St Thomas near the equator they blow almost perpendicular to the shore, bending gradually as we advance southwards, first to the west and then to the south-west. On the coast of New Spain likewise, from California to the bay of Panama, the winds blow almost constantly from the west or south-west, except during May, June, and July, when land-winds prevail, called by the Spaniards *Popogayos*. On the coast of Chili and Peru, from 20° to 30° south latitude, to the equator, and on the parallel coast of Africa, the wind blows during the whole year from the south, varying according to the direction of the land towards which it inclines, and extending much farther out to sea on the American than the African coast. The trade-winds are also interrupted sometimes by westerly winds in the bay of Campeachy and the bay of Honduras.

As to the countries between the tropics, we are too little acquainted with them to be able to give a satisfactory history of their winds.

45 Of sea and land breezes.

In all maritime countries between the tropics, of any extent, the wind blows during a certain number of hours every day from the sea, and during a certain number towards the sea from the land; these winds are called the *sea and land breezes*. The sea breeze generally sets in about 10 in the forenoon, and blows till six in the evening; at seven the land breeze begins and continues till eight in the morning, when it dies away. During summer the sea breeze is very perceptible on all the coasts of the Mediterranean sea, and even sometimes as far north as Norway.

In the island of St Lewis on the coast of Africa, in 16° north latitude, and 16° west longitude, the wind during the rainy season, which lasts from the middle of July to the middle of October, is generally between the south and the east: during the rest of the year it is for the most part east or north-east in the morning; but as the sun rises, the wind approaches gradually towards the north, till about noon it gets to the west of north, and is called a *sea breeze*. Sometimes it shifts to the east as the sun descends, and continues there during the whole night. In February, March, April, May and June, it blows almost constantly between the north and west. In the island of Bulama, which likewise lies on the west coast of Africa, in 11° north latitude, the wind during nine months of the year blows from the south-west; but in November and December, a very cold wind blows from the north-east.

In the kingdom of Bornou, which lies between 16° and 20° north latitude, the warm season is introduced about the middle of April by sultry winds from the south-east, which bring along with them a deluge of rain. In Fezzan, in 25° north latitude, and 35° east longitude, the wind from May to August blows from the east south-east, or south-west, and is intensely hot.

46 Winds in Abyssinia.

In Abyssinia the winds generally blow from the west, north-west, north, and north-east. During the months of June, July, August, September and October, the north and north-east winds blow almost constantly, especially in the morning and evening; and during the rest of the year they are much more frequent than any other winds.

47 At Calcutta.

At Calcutta, in the province of Bengal, the wind blows during January and February from the south-west and south; in March, April, and May from the south; in June, July, August, and September, from the south and south-east; in October, November, and December, from the north-west. At Madras the most frequent winds are the north and north-east.—At Tivoli in St Domingo, and the isles des Vaches, the wind blows oftenest from the south and south-east. From these facts it appears, that in most tropical countries with which we are acquainted, the wind generally blows from the nearest ocean, except during the coldest months, when it blows towards it.

48 In the temperate zones.

In the temperate zones the direction of the wind is by no means so regular as between the tropics. Even in the same degree of latitude, we find them often blowing in different directions at the same time, while their changes are often so sudden and capricious, that to account for them has been hitherto found impossible. When winds are violent and continue long, they generally extend over a large tract of country; and this is more certainly the case when they blow from the north-east, than from any other points. By the multiplication and comparison of meteorological tables, some regular connection between the changes of the atmosphere in different places may in time be observed, which will at last lead to a satisfactory theory of the winds. It is from such tables chiefly that the following facts have been collected.

49 In Virginia.

In Virginia, the prevailing winds are between the *south-west*, *west*, *north*, and *north-west*; the most frequent is the *south-west*; which blows more constantly in June, July, and August, than at any other season. The north-west winds blow most constantly in Novem-

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ber, December, January, and February. At Ipswich in New England, the prevailing winds are also between the south-west, west, north, and north-east; the most frequent is the north-west. But at Cambridge, in the same province, the most frequent wind is the south-east. The predominant winds at New York are the north and west. In Nova Scotia north-west winds blow for three-fourths of the year. The same wind blows most frequently at Montreal in Canada, but at Quebec the wind generally follows the direction of the river St Lawrence, blowing either from the north-east or south-west. At Hudson's bay westerly winds blow for three-fourths of the year; the north-west wind occasions the greatest cold; but the north and north-east are the vehicles of snow.

It appears from these facts, that westerly winds are most frequent over the whole eastern coast of North America; that in the southern provinces south-west winds predominate, and that the north-west become gradually more frequent as we approach the frigid zone.

50 In Egypt.

In Egypt, during part of May, and during June, July, August, and September, the wind blows almost constantly from the *north*, varying sometimes in June to the west, and in July to the west and the east; during part of September, and in October and November, the winds are variable, but blow more regularly from the east than any other quarter; in December, January, and February, they blow from the north, north-west, and west; towards the end of February they change to the south, in which quarter they continue till near the end of March; during the last days of March and in April they blow from the south-east, south, and south-west, and at last from the east; and in this direction they continue during a part of May.

51 In the Mediterranean.

In the Mediterranean the wind blows nearly three-fourths of the year from the north; about the equinoxes there is always an easterly wind in that sea, which is generally more constant in spring than in autumn. These observations do not apply to the gut of Gibraltar, where there are seldom any winds except the east and the west. At Bastia, in the island of Corsica, the prevailing wind is the south-west.

52 In Syria.

In Syria the north wind blows from the autumnal equinox to November; during December, January, and February, the winds blow from the west and south-west; in March they blow from the south, in May from the east, and in June from the north. From this month to the autumnal equinox the wind changes gradually as the sun approaches the equator; first to the east, then to the south, and lastly to the west. At Bagdad the most frequent winds are the south-west and north-west; at Pekin, the north and the south; at Kamtschatka, on the north-east coast of Asia, the prevailing winds blow from the west.

53 In Italy.

In Italy the prevailing winds differ considerably according to the situation of the places where the observations have been made. At Rome and Padua they are northerly, at Milan easterly. All that we have been able to learn respecting Spain and Portugal is, that on the west coast of these countries the west is by far the most common wind, partieularly in summer; and that at Madrid the wind is north-east for the greatest part of the summer, blowing almost constantly from the Pyrenean mountains. At Berne in Switzerland, the prevailing winds are the north and west; at St Gothard, the north-east; at Lausanne the north-west and south-west.

54 Result of M. Cotte's observations on the direction of the winds in France.

M. Cotte has given us the result of observations made at 86 different places of France, from which it appears, that along the whole south coast of that empire the wind blows most frequently from the north, north-west, and north-east: on the west coast, from the west, south-west, and north-west; and on the north coast from the south-west. That in the interior parts of France the south-west wind blows most frequently in 18 places; the west wind in 14; the north in 13; the south in 6; the north-east in 4; the south-east in 2; the east and north-west each of them in one. On the west coast of the Netherlands, as far north as Rotterdam, the prevailing winds are probably the south-west; at least this is the case at Dunkirk and Rotterdam. It is probable also, that along the rest of this coast, from the Hague to Hamburgh, the prevailing winds are the north-west, at least these winds are most frequent at the Hague and at Franeker. The prevailing wind at Delft is the south-east, and at Breda the north and the east.

55 Direction of the winds in Germany.

In Germany the east wind is most frequent at Gottingen, Munich, Weissemburg, Dusseldorff, Saganum, Erford, and at Buda in Hungary; the south-east at Prague and Wirtsburg; the north-east at Ratisbon, and the west at Manheim and Berlin.

56 At London.

From an average of 10 years of the register kept by order of the Royal Society, it appears, that at London the winds blow in the following order:

Winds.	*Days.*	*Winds.*	*Days.*
South-west	112	South-east	32
North-east	58	East	26
North-west	50	South	18
West	53	North	16

It appears from the same register, that the south-west wind blows at an average more frequently than any other wind during every month of the year, and that it blows longest in July and August; that the north-east blows most constantly during January, March, April, May, and June, and most seldom during February, July, September, and December; and that the north-west wind blows oftener from November to March, and more seldom during September and October, than any other months. The south-west winds are also most frequent at Bristol, and next to them are the north-east.

57 Table of winds at Lancaster.

The following table of the winds at Lancaster has been drawn up from a register kept for seven years at that place.

Winds.	*Days.*	*Winds.*	*Days.*
South-west	92	South-east	35
North-east	67	North	30
South	51	North-west	26
West	41	East	17

58 At Dumfries.

The following table is an abstract of nine years observations made at Dumfries by Mr Copland.

Winds.	*Days.*	*Winds,*	*Days.*
South	$82\frac{1}{2}$	North	$36\frac{1}{2}$
West	69	North-west	$25\frac{1}{2}$
East	68	South-east	$18\frac{1}{2}$
South-west	$50\frac{1}{2}$	North-east	$14\frac{1}{2}$

The

Winds.

59 At Cambuſlang.

The following table is an abſtract of ſeven years obſervations, made by Dr Meek at Cambuſlang, near Glaſgow.

Winds.	*Days.*	*Winds.*	*Days.*
South-weſt	174	North-eaſt	104
North-weſt	40	South-eaſt	47

It appears from the regiſter from which this table was extracted, that the north-eaſt wind blows much more frequently in April, May, and June, and the ſouth-weſt in July, Auguſt, and September, than at any other period. We learn from the Statiſtical Account of Scotland, that the ſouth-weſt is by far the moſt frequent wind all over that kingdom, eſpecially on the weſt coaſt. At Saltcoats in Ayrſhire, for inſtance, it blows three-fourths of the year; and along the whole coaſt of Murray on the north-eaſt ſide of Scotland, it blows for two-thirds of the year. Eaſt winds are common over all Great Britain during April and May; but their influence is felt moſt ſeverely on the eaſtern coaſt.

The following table exhibits a view of the number of days during which the weſterly and eaſterly winds blow in a year, at different parts of the iſland. Under the term weſterly are included the north-weſt, weſt, ſouth-weſt, and ſouth; the term eaſterly is taken in the ſame latitude.

Years of obſervation.	Places.	Wind. Weſterly	Wind. Eaſterly.
10	London	233	132
7	Lancaſter	216	149
51	Liverpool	190	175
9	Dumfries	227.5	137.5
10	Branxholm	232	133
7	Cambuſlang	214	151
8	Hawkhill near Edin.	229.5	135.5
	Medium	220.3	144.7

60 Direction of the winds in Ireland.

In Ireland, the ſouth-weſt and weſt are the grand trade-winds, blowing moſt in ſummer, autumn, and winter, and leaſt in ſpring. The north-eaſt blows moſt in ſpring, and nearly double to what it does in autumn and winter. The ſouth-weſt and north-weſt are nearly equal, and are moſt frequent after the ſouth-weſt and weſt.

61 At Copenhagen, and in Ruſſia.

At Copenhagen the prevailing winds are the eaſt and ſouth-eaſt; at Stockholm, the weſt and north. In Ruſſia, from an average of a regiſter of 16 years, the winds blow from November to April in the following order.

	W.	N.W.	E.	S.W.	S.	N.E	N.	S.E.
Days	45	26	23	22	20	19	14	12

And during the other ſix months,

	W.	N.W.	E.	S.W.	S.	N.E.	N.	S.E.
Days	27	27	19	24	22	15	32	18

The weſt wind blows during the whole year 72 days; the north-weſt 53, the ſouth-weſt and north 46 days each. During ſummer it is calm for 41 days, and during winter for 21. In Norway the moſt frequent winds are the ſouth, the ſouth-weſt and ſouth-eaſt. The wind at Bergen is ſeldom directly weſt, but generally ſouth-weſt or ſouth-eaſt; a north-weſt, and eſpecially a north-eaſt wind, are but little known there.

From the whole of theſe facts, it appears that the moſt frequent winds on the ſouth coaſts of Europe are the north, the north-eaſt and north-weſt, and on the weſtern coaſt the ſouth-weſt; that in the interior parts which lie moſt contiguous to the Atlantic ocean, ſouth-weſt winds are alſo moſt frequent; but that eaſterly winds prevail in Germany. Weſterly winds are alſo moſt frequent on the north-eaſt coaſt of Aſia.

It is probable that the winds are more conſtant in the ſouth temperate zone, which is in a great meaſure covered with water, than in the north temperate zones, where their direction muſt be frequently interrupted and altered by mountains and other cauſes.

62 Main winds at the Cape of Good Hope.

M. de la Bailie, who was ſent thither by the French king to make aſtronomical obſervations, informs us, that at the Cape of Good Hope the main winds are the ſouth-eaſt and north-weſt; that other winds ſeldom laſt longer than a few hours; and that the eaſt and north-eaſt winds blow very ſeldom. The ſouth-eaſt wind blows in moſt months of the year, but chiefly from October to April; the north-weſt prevails during the other ſix months, bringing along with it rain, and tempeſts, and hurricanes. Between the Cape of Good Hope and New Holland the winds are commonly weſterly, and blow in the following order: north-weſt, ſouth-weſt, weſt, north.

63 In the Pacific ocean.

In the great South ſea, from latitude 30° to 40° ſouth, the ſouth-eaſt trade-wind blows moſt frequently, eſpecially when the ſun approaches the tropic of Capricorn; the wind next to it in frequency is the north-weſt, and next to that is the ſouth-weſt.

Thus it appears that the trade-winds ſometimes extend farther into the ſouth temperate zone than their uſual limits, particularly during ſummer; that beyond their influence the winds are commonly weſterly, and that they blow in the following order: north-weſt, ſouth-weſt, weſt.

64 Theory of the winds.

We have now conſidered pretty much at large the direction of the winds in different parts of the earth's ſurface. Another very curious part of the hiſtory of the winds relates to their violence, and the effects with which they are attended, or to the hiſtory of hurricanes, whirlwinds, tornadoes, &c. Of ſome of theſe we have already treated under the articles HURRICANE and HARMATTAN; and the confined limits of this article oblige us to refer our readers for more particulars to Capper's Obſervations on the Winds and Monſoons.

65 Velocity of the winds almoſt infinitely various.

As to the velocity of the wind, its variations are almoſt infinite, from the gentleſt breeze, to the hurricane which tears up trees and blows down houſes. Our moſt violent winds take place when neither the heat nor the cold is greateſt; violent winds generally extend over a large tract of country, and they are accompanied with ſudden and great falls in the mercury of the barometer. The wind is ſometimes very violent at a diſtance from the earth, while it is quite calm at its ſurface. On one occaſion Lunardi went at the rate of 70 miles an hour in his balloon, though it was quite calm at Edinburgh when he aſcended, and continued ſo during his whole voyage.

66 Velocity of the winds.

A pretty good idea of the velocity of the wind, under different circumſtances, may be formed from the following table, which was drawn up by Mr Smeaton.

Miles per Hour	Feet per Second.	Perpendicular force on one ſquare foot, in Avoirdupois pounds and parts.	
1	1.47	.005	Hardly perceptible.
2	2.93	.020	Juſt perceptible.
3	4.4	.044	
4	5.87	.079	Gently pleaſant.
5	7.33	.123	
10	14.67	.492	Pleaſant, briſk.
15	22.	1.107	
20	29.34	1.968	Very briſk.
25	36.67	3.075	
30	44.01	4.429	High wind.
35	51.34	6.027	
40	58.68	7.873	Very high wind.
45	66.01	9.963	
50	73.35	12.300	Storm or tempeſt.
60	88.02	17.715	Great ſtorm.
80	117.36	31.490	Hurricane.
100	146.7	49.200	Hurricane that tears up trees and carries buildings before it.

For the means of aſcertaining the velocity of the winds, ſee ANEMOMETER and ANEMOSCOPE.

We ſhall now endeavour to explain the phenomena that we have been deſcribing, or to form a plauſible theory of the winds.

The atmoſphere is a fluid ſurrounding the earth, and extending to an unknown height. Now all fluids tend invariably to a level: if a quantity of water be taken out of any part of a veſſel, the ſurrounding water will immediately flow in to ſupply its place, and the ſurface will become level as before; or if an additional quantity of water be poured into any part of the veſſel, it will not remain there, but diffuſe itſelf equally over the whole. Such exactly would be the caſe with the atmoſphere. Whatever therefore deſtroys the equilibrium of this fluid, either by increaſing or diminiſhing its bulk in any particular place, muſt at the ſame time occaſion a wind.

67 Air, beſides its qualities in common with other fluids, is alſo capable of being dilated and compreſſed. Suppoſe a veſſel filled with air: if half the quantity which it contains be drawn out by means of an air-pump, the remainder will ſtill fill the veſſel completely; or if twice or three times the original quantity be forced in by a condenſer, the veſſel will ſtill be capable of holding it.

Rarefied air is lighter, and condenſed air heavier than common air. When fluids of unequal ſpecific gravities are mixed together, the heavier always deſcend and the lighter aſcend. Were quickſilver, water, and oil, thrown into the ſame veſſel together, the quickſilver would uniformly occupy the bottom; the water the middle, and the oil the top. Were water to be thrown into a veſſel of oil, it would immediately deſcend, becauſe it is heavier than oil. Exactly the ſame thing takes place in the atmoſphere. Were a quantity of air, for inſtance, to be ſuddenly condenſed at a diſtance from the ſurface of the earth, being now heavier than before, it would deſcend till it came to air of its own denſity; or, were a portion of the atmoſphere at the ſurface of the earth to be ſuddenly rarefied, being now lighter than the ſurrounding air, it would immediately aſcend.

68 Cauſe of the trade-winds.

If a bladder half filled with air be expoſed to the heat of a fire, the air within will ſoon expand, and diſtend the bladder; if it be now removed to a cold place, it will ſoon become flaccid as before. This ſhews that heat rarefies, and that cold condenſes air. The ſurface of the torrid zone is much more heated by the rays of the ſun than the frozen or temperate zones, becauſe the rays fall upon it much more perpendicularly. This heat is communicated to the air near the ſurface of the torrid zone, which being thereby rarefied, aſcends, and its place is ſupplied by colder air, which ruſhes in from the north and ſouth.

The diurnal motion of the earth is greateſt at the equator, and diminiſhes gradually as we approach the poles, where it ceaſes altogether. Every ſpot of the earth's ſurface at the equator moves at the rate of 15 geographical miles in a minute; at 40° of latitude it moves at about 11 miles and a half in a minute, and at the 30° at nearly 13 miles. The atmoſphere, by moving continually round along with the earth, has acquired the ſame degree of motion, ſo that thoſe parts of it which are above the equator move faſter than thoſe which are at a diſtance. Were a portion of the atmoſphere to be tranſported in an inſtant from latitude 30° to the equator, it would not immediately acquire the velocity of the equator; the eminences of the earth, therefore, would ſtrike againſt it, and it would aſſume the appearance of an eaſt wind. This is the caſe in a ſmaller degree with the air that flows towards the equator, to ſupply the place of the rarefied air which is continually aſcending; and this, when combined with its real motion from north to ſouth, muſt cauſe it to aſſume the appearance of a north-eaſterly wind on this ſide the equator, and of a ſouth-eaſterly beyond it.

The motion weſtward occaſioned by this difference in celerity alone, would be very ſmall; but it is increaſed by another circumſtance. Since the rarefaction of the air in the torrid zone is owing to the heat derived from the contiguous earth, and ſince this heat is owing to the perpendicular rays of the ſun, thoſe parts muſt be hotteſt where the ſun is actually vertical; and conſequently the air above them muſt be moſt rarefied; the contiguous parts of the atmoſphere will therefore be drawn moſt forcibly to that particular ſpot. Now, ſince the diurnal motion of the earth is from eaſt to weſt, this hotteſt ſpot will be continually ſhifting weſtwards, and this will occaſion a current of the atmoſphere in that direction. That this cauſe really operates, appears from a circumſtance already mentioned: When the ſun approaches either of the tropics, the trade-wind on the ſame ſide of the equator aſſumes a more eaſterly direction, evidently from the cauſe here mentioned, while the oppoſite trade-wind being deprived of this additional impulſe, blows in a direction more perpendicular to the equator.

69 What increaſes the weſterly direction of the trade-wind.

The weſterly direction of the trade-wind is ſtill farther increaſed by another cauſe. Since the attraction of the ſun and moon produces ſo remarkable an effect

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effect upon the ocean, we cannot but suppose that an effect equally great, at least, is produced upon the atmosphere. Indeed as the atmosphere is nearer the moon than the sea is, the effects produced by attraction upon it ought to be greater. When we add to this the elasticity of the air, or that disposition which it has to dilate itself when freed from any of its pressure, we cannot but conclude, that the tides in the atmosphere are considerable. Now since the apparent diurnal motion of the moon is from east to west, the tides must follow it in the same manner, and consequently produce a constant motion in the atmosphere from east to west. This reasoning is confirmed by the observations of several philosophers, particularly of M. Casson, that in the torrid zone the barometer is always two-thirds of a line higher twice every 24 hours than during the rest of the day; and that the time of this rise always corresponds with the tides of the sea; a proof that it proceeds from the same cause.

All these different causes probably combine in the production of the trade-winds; and from their being sometimes united, and sometimes distinct or opposite, arise all those little irregularities which take place in the direction and force of the trade-winds.

Since the great cause of these winds is the rarefaction of the atmosphere by the heat of the sun, its ascension and the consequent rushing in of colder air from the north and south, the internal boundary of the trade-winds must be that parallel of the torrid zone which is hottest, because there the ascension of the rarefied air must take place. Now since the sun does not remain stationary, but is constantly shifting from one tropic to the other, we ought naturally to expect that this boundary would vary together with its exciting cause; that therefore, when the sun is perpendicular to the tropic of Cancer, the north-east trade-wind would extend no farther south than north latitude 23° 30′; that the south-east wind would extend as far north; and that, when the sun was in the tropic of Capricorn, the very contrary would take place. We have seen, however, that though this boundary be subject to considerable changes from this very cause, it may in general be considered as fixed between the second and fifth degrees of north latitude.

Though the sun be perpendicular to each of the tropics during part of the year, he is for one half of it at a considerable distance, so that the heat which they acquire, while he is present, is more than lost during his absence. But the sun is perpendicular to the equator twice in a year, and never farther distant from it than $23\frac{1}{2}°$; being therefore twice every year as much heated, and never so much cooled as the tropics, its mean heat must be greater, and the atmosphere in consequence generally most rarefied at that place. Why then, it will be asked, is not the equator the boundary of the two trade-winds? To speak more accurately than we have hitherto done, the internal limit of these winds must be that parallel where the mean heat of the earth is greatest. This would be the equator, were it not for a reason that shall now be explained.

It has been shewn by astronomers, that the orbit of the earth is an ellipsis, and that the sun is placed in one of the foci. Were this orbit to be divided into two parts by a straight line perpendicular to the transverse axis, and passing through the centre of the sun, one of these parts would be less than the other; and the earth during its passage through the small part of its orbit, would constantly be nearer the sun than while it moved through the other portion. The celerity of the earth's motion in any part of its orbit is always proportioned to its distance from the sun; the nearer it is to the sun it moves the faster; the farther distant, the slower. The earth passes over the smaller portion of its orbit during our winter, which must therefore be shorter than our summer, both on account of this part of the orbit being smaller than the other, and on account of the increased celerity of the earth's motion. The difference, according to Cassini, is 7 days, 23 hours, 53 minutes. While it is winter in the northern, it is summer in the southern hemisphere; wherefore the summer in the southern hemisphere must be just as much shorter than the winter, as our winter is shorter than our summer. The difference, therefore, between the length of the summer in the two hemispheres is almost 16 days. The summer in the northern hemisphere consists of $190\frac{1}{2}$ days, while in the southern it consists only of $174\frac{1}{2}$. They are to one another nearly in the proportion of 14 to 12.8; and the heat of the two hemispheres may probably have nearly the same proportion to one another. The internal limit of the trade-winds ought to be that parallel where the mean heat of the globe is greatest; this would be the equator, if both hemispheres were equally hot; but since the northern hemisphere is the hottest, that parallel ought to be situated somewhere in it; and since the difference between the heat of the two hemispheres is not great, the parallel ought not to be so far distant from the equator.

The trade-wind would blow regularly round the whole globe if the torrid zone were all covered with water. If the Indian ocean were not bounded by land on the north, it would blow there in the same manner as it does in the Atlantic and Pacific oceans. The rays of light pass through a transparent body without communicating any, or at least but a small degree of heat. If a piece of wood be inclosed in a glass vessel, and the focus of a burning-glass directed upon it, the wood will burn to ashes, while the glass through which all the rays passed is not even heated. When an opaque body is exposed to the sun's rays, it is heated in proportion to its opacity. If the bulb of a thermometer be exposed to the sun, the mercury will not rise so high as it would do if this bulb were painted black. Land is much more opaque than water; it becomes therefore much warmer when both are equally exposed to the influence of the sun. For this reason, when the sun approaches the tropic of Cancer, India, China, and the adjacent countries, become much hotter than the ocean which washes their southern coasts. The air over them becomes rarefied, and ascends, while colder air rushes in from the Indian ocean to supply its place. As this current of air moves from the equator northward, it must, for a reason already explained, assume the appearance of a south-west wind; and this tendency eastward is increased by the situation of the countries to which it flows. This is the cause of the south-west monsoon, which blows during summer in the northern parts of the Indian ocean. Between Borneo and the coast of China, its direction is almost due north, be-

cause

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cause the country to which the current is directed lies rather to the west of north; a circumstance which counteracts its greater velocity.

In winter, when the sun is on the south side of the equator, these countries become cool, and the north-east trade-wind resumes its course, which, had it not been for the interference of these countries, would have continued the whole year.

As the sun approaches the tropic of Capricorn, it becomes almost perpendicular to New Holland; that continent is heated in its turn, the air over it is rarefied, and colder air rushes in from the north and west to supply its place. This is the cause of the north-west monsoon, which blows from October to April, from 3° to 10° south latitude. Near Sumatra its direction is regulated by the coast: this is the case also between Africa and Madagascar.

The same cause which occasions the monsoons, gives rise to the winds which blow on the west coasts of Africa and America. The air above the land is hotter and rarer, and consequently lighter than the air above the sea; the sea air, therefore, flows in, and forces the lighter land atmosphere to ascend.

The same thing will account for the phenomena of the sea and land breezes. During the day, the cool air of the sea, loaded with vapours, flows in upon the land, and takes the place of the rarefied land air. As the sun declines, the rarefaction of the land air is diminished; thus an equilibrium is restored. As the sea is not so much heated during the day as the land, neither is it so much cooled during the night, because it is constantly exposing a new surface to the atmosphere. As the night approaches, therefore, the cooler and denser air of the hills (for where there are no hills there are no sea and land breezes) falls down upon the plains, and pressing upon the now comparatively lighter air of the sea, causes the land breeze.

The rarefied air which ascends between 2° and 5° north latitude, has been shewn to be the principal cause of the trade-winds. As this air ascends, it must become gradually colder, and consequently heavier; it would therefore descend again if it were not buoyed up by the constant ascent of new rarefied air. It must therefore spread itself to the north and south, and gradually mix in its passage with the lower air; and the greater part of it probably does not reach far beyond 30°, which is the external limit of the trade-wind. Thus there is a constant circulation of the atmosphere in the torrid zone; it ascends near the equator, diffuses itself towards the north and south, descends gradually as it approaches 30°, and, returning again towards the equator, performs the same circuit. It has been the opinion of the greater part of those who have considered this subject, that the whole of the rarefied air which ascends near the equator, advances towards the poles and descends there. But if this were the case, a constant wind would blow from both poles towards the equator, and the trade winds would extend over the whole earth; for otherwise the ascent of air in the torrid zone would very soon cease. A little reflection must convince us that it cannot be true. Rarefied air differs in nothing from the common air, except in containing a greater quantity of heat. As it ascends, it gradually loses this superfluous heat. What then should hinder it from descending, and mixing with the atmosphere below? That there is a constant current of superior air, however, towards the poles, cannot be doubted; but it consists principally of hydrogen gas. We shall immediately attempt to assign the reason why its accumulation at the pole is not always attended with a north wind.

If the attraction of the moon and the diurnal motion of the sun have any effect upon the atmosphere, and that they have some effect can hardly be disputed, there must be a real motion of the air westwards within the limits of the trade-winds. When this body of air reaches America, its further passage westwards is stopt by the mountains which extend from one extremity of that continent to the other. From the momentum of this air, when it strikes against the sides of these mountains, and from its elasticity, it must acquire from them a considerable velocity, in a direction contrary to the first, and would therefore return eastwards again if this were not prevented by the trade-winds. It must therefore rush forwards in that direction where it meets with the least resistance; that is, towards the north and south. As air is nearly a perfectly elastic body, when it strikes against the sides of the American mountains, its velocity will not be perceptibly diminished, though its direction be changed. Continuing to move, therefore, with the velocity of the equator, when it arrives at the temperate zones it will assume the appearance of a north-east or south-east wind. To this is to be ascribed the frequency of south-west winds over the Atlantic ocean and western parts of Europe. Whether these winds are equally frequent in the northern Pacific ocean, we have not been able to ascertain; but it is probable that the mountains in Asia produce the same effect as those in America.

It is not impossible that another circumstance may also contribute to the production of these winds. The oxygen, which is rather heavier than common air, may mix with the atmosphere; but the hydrogen (a cubic foot of which weighs only 41.41 grains, while a cubic foot of oxygen weighs 593.32 grains) may ascend to the higher regions of the atmosphere.

By what means the decomposition is accomplished (if it takes place at all) we cannot tell. There are probably a thousand causes in nature of which we are entirely ignorant. Whether heat and light, when long applied to vapours, may not be able to decompound them, by uniting with the hydrogen, which seems to have a greater attraction for heat than oxygen has, or whether the electrical fluid may not be capable of producing this effect, are questions which future observations and experiments must determine. Dr Franklin filled a glass tube with water, and passed an electrical shock through it; the tube was broken in pieces, and the whole water disappeared. He repeated the experiment with ink instead of water, and placed the tube upon white paper: the same effects followed, and the ink, though it disappeared completely, left no stain on the paper. Whether the water in these cases was decomposed or not, it is impossible to say; but the supposition that it was, is not improbable. An experiment might easily be contrived to determine the point.

This decomposition would account for the frequency of south-west winds, particularly in summer; for this new air is furnished to supply the place of that which is forced northwards by the causes already explained.

Perhaps

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Perhaps it may be a confirmation of this conjecture, that the fouth weft winds generally extend over a greater tract of country than moft other winds which blow in the temperate zones. What has been faid of fouth-weft winds holds equally with regard to north-weft winds in the fouth temperate zone.

After fouth-weft winds have blown for fome time, a great quantity of air will be accumulated at the pole, at leaft if they extend over all the northern hemifphere; and it appears, from comparing the tables kept by fome of our late navigators in the northern Pacific ocean with fimilar tables kept in this ifland, that this is fometimes the cafe fo far as relates to the Atlantic and Pacific oceans. When this accumulation becomes great, it muft, from the nature of fluids, and from the elafticity of the air, prefs with a confiderable and increafing force on the advancing air; fo that in time it becomes ftronger than the fouth-weft wind. This will occafion at firft a calm, and afterwards a north wind, which will become gradually eafterly as it advances fouthwards, from its not affuming immediately the velocity of the earth. The mafs of the atmofphere will be increafed in all thofe places over which this north-eaft wind blows; this is confirmed by the almoft conftant rife of the barometer during a north-eaft wind.

Whatever tends to increafe the bulk of the atmofphere near the pole, muft tend alfo to increafe the frequency of north-eaft winds; and if there be any feafon when this increafe takes place more particularly, that feafon will be moft liable to thefe winds. During winter the northern parts of Europe are covered with fnow, which is melted in the beginning of fummer, when the heat of the fun becomes more powerful. Great quantities of vapour are during that time raifed, which will augment both the bulk and weight of the atmofphere, efpecially if the conjecture about the converfion of vapour into air has any foundation. Hence north-eaft winds are moft prevalent during May and June.

But it will be faid, if this hypothefis were true, the fouth-weft and north-eaft winds ought to blow alternately, and continue each of them for a ftated time; whereas the fouth-weft wind blows fometimes longer and fometimes fhorter, neither is it always followed by a north-eaft wind.

If the conjecture about the decompofition of vapour in the torrid zone be true, the hydrogen which formed a part of it will afcend from its lightnefs, and form a ftratum above the atmofpherical air, and gradually extend itfelf, as additional hydrogen rifes, towards the north and fouth, till at laft it reaches the poles. The lightnefs of hydrogen is owing to the great quantity of heat which it contains; as it approaches the poles it muft lofe a great part of this heat, and may in confequence become heavy enough to mix with the atmofphere below. Oxygen makes a part of the atmofphere; and its proportion near the poles may fometimes be greater than ordinary, on account of the additional quantity brought thither from the torrid zone. Mr Cavendifh mixed oxygen and hydrogen together in a glafs jar; and upon making an electrical fpark pafs through them, they immediately combined and formed water.

That there is electric matter at the poles, cannot be doubted. The abbé Chappe informs us, that he faw thunder and lightning much more frequently at Tobolfki and other parts of Siberia, than in any other part of the world. In the north of Europe, the air, during very cold weather, is exceedingly electric; fparks can be drawn from a perfon's hands and face, by combing his hair, or even powdering him with a puff. Æpinus was an eye-witnefs to this fact, and to ftill more aftonifhing proofs of the electricity of the atmofphere during great colds.

2

May not the appearance of the aurora borealis be owing to the union of oxygen and hydrogen by the intervention of the electric fluid? That it is an electrical phenomenon, at leaft, can hardly be doubted. Artificial electricity is much ftrengthened during an aurora, as M. Volta and Mr Canton have obferved; and the magnetic needle moves with the fame irregularity during an aurora that has been obferved in other electrical phenomena. This fact we learn from Bergman and De la Lande. Many philofophers have attempted to demonftrate that auroræ boreales are beyond the earth's atmofphere; but the very different refults of their calculations evidently prove that they were not poffeffed of fufficient data.

If this conjecture be true, part of the atmofphere near the poles muft at times be converted into water. This would account for the long continuance of fouth-weft winds at particular times; when they do fo, a decompofition of the atmofphere is going on at the pole. It would render this conjecture more probable, if the barometer fell always when a fouth-weft wind continues long.

70 South-weft winds very common after auroræ boreales.

If this hypothefis be true, a fouth-weft wind ought always to blow after auroræ boreales; and we are informed by Mr Winn, that this is actually the cafe. This he found never to fail in 23 inftances. He obferved alfo, that when the aurora was bright, the gale came on within 24 hours, but did not laft long: but if it was faint and dull, the gale was longer in beginning, and lefs violent, but it continued longer. This looks like a confirmation of our conjecture. Bright auroræ are probably nearer than thofe which are dull. Now, if the aurora borealis be attended with a decompofition of a quantity of air, that part of the atmofphere which is neareft muft firft rufh in to fupply the diftant parts. Juft as if a hole were bored in the end of a long veffel filled with water, the water neareft the hole would flow out immediately, and it would be fome time before the water at the other end of the veffel began to move. The nearer we are to the place of precipitation, the fooner will we feel the fouth-weft wind. It ought therefore to begin fooner after a bright aurora, becaufe it is nearer than a dull and faint one. Precipitations of the atmofphere at a diftance from the pole cannot be fo great as thofe which take place near it; becaufe the cold will not be fufficient to condenfe fo great a quantity of hydrogen; fouth-weft winds, therefore, ought not to laft fo long after bright as after dull auroræ. Winds are more violent after bright auroræ, becaufe they are nearer the place of precipitation; juft as the water near the hole of the veffel runs fwifter than that which is at a confiderable diftance.

71 Probable caufes of fouth-weft winds.

If thefe conjectures have any foundation in nature, there are two fources of fouth-weft winds; the firft has its origin in the trade-winds, the fecond in precipitations of the atmofphere near the pole. When they originate from the firft caufe, they will blow in countries farther

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farther south for some time before they are felt in those which are farther north; but the contrary will take place when they are owing to the second cause. In this last case, too, the barometer will sink considerably; and it actually does so constantly after auroræ, as we are informed by Mr Madison, who paid particular attention to this subject. By keeping accurate meteorological tables in different latitudes, it might easily be discovered whether these consequences be true, and of course whether the above conjectures be well or ill grounded.

72 Winds commonly begin at the place towards which they blow.

It appears that winds generally commence at that point towards which they blow; and hence they must arise from a rarefaction and consequent displacing of the air in some particular place, by the action of heat, or some other cause. Perhaps, according to the idea of Mr Williams, this cause may be an increased precipitation of the superior strata of air, rendered unusually dense from its being surcharged with moisture in the place where the wind begins to blow, or from an increased evaporation from a humid surface in the opposite direction.

Hurricanes are constantly preceded by a great depression of the thermometer; and in these cases the wind often seems to blow from every direction towards the quarter where this fall of the barometer is observed.

Violent winds from the north-east have repeatedly been observed to begin at the quarter towards which they blow. In 1740 Dr Franklin was prevented from observing an eclipse of the moon at Philadelphia by a north-east storm, which came on about seven o'clock in the evening. He was surprised to find afterwards that it had not come on at Boston till near 11 o'clock; and, upon comparing all the accounts which he received from the several colonies of the beginning of this and other storms of the same kind, he found it to be always an hour later the farther north-east, for every 100 miles. "From hence (says he) I formed an idea of the course of the storm, which I will explain by a familiar instance. I suppose a long canal of water stopped at the end by a gate. The water is at rest till the gate is opened; then it begins to move out through the gate, and the water next the gate is first in motion, and moves on towards the gate, and so on successively, till the water at the head of the canal is in motion, which it is last of all. In this case the water moves indeed towards the gate; but the successive times of beginning the motion are in the contrary way, viz. from the gate back to the head of the canal. Thus to produce a north-east storm, I suppose some great rarefaction of the air in or near the gulf of Mexico; the air rising thence has its place supplied by the next more northern, cooler, and therefore denser and heavier air; a successive current is formed, to which our coast and inland mountains give a north-east direction."

Several instances of a similar kind have occurred. In 1802, Dr Mitchell observed a storm which began at Charlestown on the 21st of February, at two o'clock P. M. but was not observed at Washington, several hundred miles to the north-east, till five o'clock; at New York till 10, nor at Albany till daybreak of the following morning. Hence it appears that it must have moved at the rate of 1100 miles in 11 hours, or 100 miles an hour.

A remarkable storm of this kind, in which the wind was easterly, and attended with a heavy fall of snow, was observed in Scotland on the 8th of February 1799; but the motion of the wind was much slower. It began to snow at Falkirk on the 7th of February at six in the evening, but at Edinburgh not till one o'clock A. M. on the 8th; and the snow was not observed at Dunbar till seven hours after. The storm continued 11 hours, during which time it did not travel more than 100 miles.

Currents of air from the poles naturally assume a north-east direction as they advance southwards, because their diurnal motion becomes less than that of the earth. Various circumstances, however, may change this direction, and cause them to become north, or even north-west winds. The south-west winds themselves may often prove sufficient for this; and violent rains, or great heat, by lessening or rarefying the atmosphere in any country, will produce the same effect in countries to the westwards, when north winds happen to be blowing.

In North America, the north-west winds become gradually more frequent as we advance northwards. The east coast of this continent, where the observations were made from which this conclusion was drawn, is alone cultivated; the rest of the country is covered with wood. Now cultivated countries are generally considered as warmer than those which are uncultivated, though Mr Williams is of a different opinion; and on this circumstance founds his hypothesis of the climate of Britain being much deteriorated during the last 50 years. The air, therefore, in the interior parts of the country should be constantly colder than the east coast. This difference will scarcely be perceptible in the southern parts, because there the influence of the sun is very powerful; but it will become gradually greater as we advance northwards, because the influence of the sun diminishes, and the continent becomes broader. Hence north-west winds ought to become more frequent upon the east coast as we advance northwards; and they will probably cease to blow so often as soon as the whole continent of North America becomes cultivated.

73 Different currents often appear in the atmosphere at the same time.

There is one curious circumstance which deserves attention. One current of air is often observed to blow at the surface of the earth, while a current in the contrary direction is flowing in a superior part of the atmosphere. Dr Thomson on one occasion observed three currents of this kind blowing all at the same time in contrary directions. It has been affirmed that changes of weather commonly commence in the upper strata, and that they are gradually extended by the current of air that commences above, proceeding towards the lower parts of the atmosphere.

74 Partial winds.

Besides these more general winds, there are others which extend only over a very small part of the earth. These originate from many different causes. The atmosphere is principally composed of three different kinds of air, oxygen, azote, and carbonic acid, to which may be added water. Great quantities of each of these ingredients are constantly changing their aërial form, and combining with various substances; or they are separating from other bodies, assuming the form of air, and mixing with the atmosphere. Partial deficiences, therefore, and partial accumulations, must be continually

Meteors ally taking place in different parts of the atmoſphere, which will occaſion winds varying in direction, violence, and continuance, according to the ſuddenneſs and the quantity of air deſtroyed or produced. Beſides theſe, there are many other ingredients conſtantly mixing with the atmoſphere, and many partial cauſes of condenſation and rarefaction in particular places. To theſe, and probably to other cauſes hitherto unknown, are to be aſcribed all thoſe winds which blow in any place beſides the general ones already explained; and which, as they depend on cauſes hitherto at leaſt reckoned contingent, will probably for ever prevent uniformity and regularity in the winds. All theſe cauſes, however, may, and probably will, be diſcovered: the circumſtances in which they will take place, and the effects they will produce, may be known; and whenever this is the caſe, the winds of any place may in ſome meaſure be reduced to calculation.

Chap. V. *Of Meteors.*

75 Meteors. THE principal luminous phenomena denominated meteors, have been fully conſidered under ATMOSPHERIC ELECTRICITY. Thoſe meteors that burſt in the air, and are followed by the falling of ſtones or other mineral ſubſtances, have been fully deſcribed and accounted for under METEOROLITE. We have here only to notice briefly the meteors called *falling ſtars*, and *ignes fatui*.

76 Falling ſtar. The falling or ſhooting ſtar is a very common phenomenon, and takes place more eſpecially at thoſe ſeaſons and in thoſe ſituations where the aurora borealis is moſt frequently obſerved. Indeed they are conſidered by moſt philoſophers as modifications of the ſame phenomenon, and depending on the ſame cauſe. We have ſeen good reaſon to conclude that the aurora borealis is an electrical meteor; and if the falling ſtar is ſo nearly allied to the aurora as is ſuppoſed, it muſt alſo be produced by electricity. Mr G. Morgan ſeems to have no doubt of the electrical nature of this meteor, and remarks that if what appears as an undulating flaſh in the aurora, could be concentrated or confined within ſmaller dimenſions, it would probably aſſume the appearance of a falling ſtar. He founds this opinion chiefly on the following experiment.

Into a tube 48 inches long, and $\frac{1}{4}$ inch diameter, Mr Morgan conveyed as much air, as, under the common preſſure of the atmoſphere, would fill two inches in length of the ſame tube. (The tube we preſume was previouſly exhauſted of air.) One extremity of the tube he connected with the ground by means of good conductors, and faſtened to the other a metallic ball. Through the tube thus filled with rarefied air, he ſent electric ſparks of different magnitudes, by bringing the ball within the ſtriking diſtance of different fixed conductors. When the ſparks were ſmall, a flaſh like that of the aurora borealis, ſeemed to fill the whole tube; but when the ſpark was what might be made to ſtrike through 10 inches in the open air, it appeared to ſtrike through the whole length of the tube, with all the brilliancy and ſtraightneſs of a falling ſtar. If, however, he extracted part of the air out of the tube, by the air-pump, he could never make the electric fluid aſſume any form excepting that of a flaſh; but by exchanging the tube for another with a thermometrical ball, and treating it in the ſame manner as the preceding, the flaſh never appeared, but the fluid in its paſſage aſſumed all the brilliancy of a falling ſtar. Meteors.

It is eaſy to trace the ſimilarity of circumſtances that take place in this experiment, and in the natural phenomenon of the falling ſtar. Both take place in rarefied air; both are remarkable for the brightneſs of their light, and for the ſtraightneſs of their direction. That falling ſtars are frequently, if not always, the concentration of an aurora borealis, may be inferred from their being the conſtant attendants of a very electrical ſtate of the atmoſphere; and from their frequent appearance near that portion of the heavens which is illumined by the northern lights at the time of their appearance.

Mr Morgan was riding towards Norwich late at night, when to the north-eaſt of the town he beheld a fine conical ſtream of the aurora borealis. The whole body every now and then flaſhed, as if an additional quantity of electric fluid were thrown into it, and nearly at the ſame inſtant he perceived what is vulgarly called a falling ſtar, darting from its ſummit. This appearance he obſerved twice ſucceſſively.

The *ignis fatuus*, or *will-with-the-wiſp*, that appears 77 Ignis fatuus. ſo often in boggy, marſhy and damp ſituations, decoying the unwary traveller, and terrifying the ſuperſtitious vulgar, ſeems to be rather of a phoſphoric than an electric nature, ſimilar to the light which is emitted by ſtale fiſh, rotten wood, and other putreſcent ſubſtances. Sir Iſaac Newton defined it to be a vapour ſhining without heat.

A remarkable *ignis fatuus* was obſerved by Mr Derham, in ſome boggy ground, between two rocky hills. He was ſo fortunate as to be able to approach it within two or three yards. It moved with a briſk and deſultory motion about a dead thiſtle, till a ſlight agitation of the air, occaſioned, as he ſuppoſed, by his near approach to it, occaſioned it to jump to another place; and as he approached, it kept flying before him. He was near enough to ſatisfy himſelf, that it could not be the ſhining of glow-worms or other inſects—it was one uniform body of light.

M. Beccaria mentions two of theſe luminous appearances, which were frequently obſerved in the neighbourhood of Bologna, and which emitted a light equal to that of an ordinary faggot. Their motions were unequal, ſometimes riſing, and ſometimes ſinking towards the earth; ſometimes totally diſappearing, though in general they continued hovering about ſix feet from the ground. They differed in ſize and figure; and indeed, the form of each was fluctuating, ſometimes floating like waves, and dropping ſparks of fire. He was aſſured there was not a dark night in the whole year in which they did not appear; nor was their appearance at all affected by the weather, whether cold or hot, ſnow or rain. They have been known to change their colour from red to yellow; and generally grew fainter as any perſon approached, vaniſhing entirely when the obſerver came very near to them, and appearing again at ſome diſtance.

Dr Shaw alſo deſcribes a ſingular *ignis fatuus*, which he ſaw in the Holy Land. It was ſometimes globular, or in the form of the flame of a candle; and immediately afterwards ſpread itſelf ſo much, as to involve the whole company in a pale inoffenſive light, and

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and then was observed to contract itself again, and suddenly disappear. In less than a minute, however, it would become visible as before, and run along from one place to another; or would expand itself over more than three acres of the adjacent mountains. The atmosphere at this time was thick and hazy.

All these luminous appearances are probably owing to the extrication of hydrogen gas so slightly impregnated with phosphorus as to continue emitting a faint light, without producing that brilliant flash which follows the sudden extrication into the air, of the common phosphorated hydrogen gas obtained in the usual chemical experiment of throwing phosphuret of lime into water.

Chap. VI. *Of the Application of Meteorology to Prognosticating the Weather.*

It has ever been a principal object among mankind, to foretel the changes of weather that are likely to follow particular appearances in the sky, among the heavenly bodies, &c.; and it has been often alleged, that in this respect the philosopher is far behind the husbandman and the shepherd. Were the former, however, to add to his scientific researches the observations to which the latter are indebted for their judgment of the weather, he would soon be far superior to them in this respect.

79 Kirwan's conclusions on the weather.

Dr Kirwan has lately endeavoured to discover probable rules for prognosticating the weather in different seasons, as far as regards this climate, from tables of observation alone; and from comparing a number of these observations made in England, from 1677 to 1789, he found,

1. That when there has been no storm before or after the vernal equinox, the ensuing summer is generally *dry*, at least five times in six.

2. That when a storm happens from an easterly point, either on the 19th, 20th, or 21st of May, the succeeding summer is generally *dry* four times in five.

3. That when a storm arises on the 26th, 27th, or 29th of May (and not before), in any point, the succeeding summer is generally *dry* four times in five.

4. If there be a storm at south-west or west-south-west on the 19th, 20th, 21st, or 22d of March, the succeeding summer is generally *wet* five times in six.

In this country winters and springs, if dry, are most commonly cold; if moist, warm: on the contrary, dry summers and autumns are usually *hot*, and moist summers cold. So that if we know the moistness or dryness of a season, we can judge pretty accurately of its temperature.

From a table of the weather kept by Dr Rutty, in Dublin, for 41 years, Dr Kirwan endeavoured to calculate the probabilities of particular seasons being followed by others. Though his rules relate chiefly to the climate of Ireland, yet as probably there is not much difference between that island and Britain, in the general appearance of the seasons, we shall mention his conclusions here.

In 41 years there were six wet springs, 22 dry, and 13 variable; 20 wet summers, 16 dry, and five variable; 11 wet autumns, 11 dry, and 19 variable. A season according to Dr Kirwan, is counted *wet*, when it contains two wet months. In general, the quantity of rain which falls in dry seasons is less than five inches; in wet seasons more. Variable seasons are those in which there falls between 30 and 36 pounds, a pound being equal to .157637 of an inch.

80 Probable succession of seasons.

The order in which the different seasons succeeded each other, was as in the following table.

			Times	Probability.
A dry spring	Has been followed by a	dry Summer	11	$\frac{11}{22}$
		wet Summer	8	$\frac{8}{22}$
		variable Summer	3	$\frac{3}{22}$
A wet spring		dry Summer	0	0
		wet Summer	5	$\frac{5}{6}$
		variable Summer	1	$\frac{1}{6}$
A variable spring		dry Summer	5	$\frac{5}{13}$
		wet Summer	7	$\frac{7}{13}$
		variable Summer	1	$\frac{1}{13}$
A dry summer		dry Autumn	5	$\frac{5}{10}$
		wet Autumn	5	$\frac{5}{16}$
		variable Autumn	6	$\frac{6}{16}$
A wet summer		dry Autumn	5	$\frac{5}{20}$
		wet Autumn	3	$\frac{3}{20}$
		variable Autumn	12	$\frac{12}{20}$
A variable summer		dry Autumn	1	$\frac{1}{5}$
		wet Autumn	3	$\frac{3}{5}$
		variable Autumn	1	$\frac{1}{5}$
A dry spring and dry summer		dry Autumn	3	$\frac{3}{11}$
		wet Autumn	4	$\frac{4}{11}$
		variable Autumn	4	$\frac{4}{11}$
A dry spring and wet summer		dry Autumn	2	$\frac{2}{8}$
		wet Autumn	0	0
		variable Autumn	6	$\frac{6}{8}$
A wet spring and dry summer		dry Autumn	0	0
		wet Autumn	0	0
		variable Autumn	0	0
A wet spring and wet summer		dry Autumn	2	$\frac{2}{5}$
		wet Autumn	1	$\frac{1}{5}$
		variable Autumn	2	$\frac{2}{5}$
A wet spring and variable summer		dry Autumn	1	$\frac{1}{41}$
		wet Autumn	0	0
		variable Autumn	0	0
A dry spring and variable summer		dry Autumn	0	0
		wet Autumn	2	$\frac{2}{3}$
		variable Autumn	1	$\frac{1}{3}$
A variable spring and dry summer		dry Autumn	2	$\frac{2}{4}$
		wet Autumn	0	0
		variable Autumn	2	$\frac{2}{4}$
A variable spring and wet summer		dry Autumn	1	$\frac{1}{7}$
		wet Autumn	1	$\frac{1}{7}$
		variable Autumn	5	$\frac{5}{7}$
A variable spring and variable summer		dry Autumn	0	0
		wet Autumn	1	$\frac{1}{41}$
		variable Autumn	0	0

81 Rules for prognosticating the weather.

Hence Dr Kirwan deduced the probability of the kind of seasons which would follow others. This probability is expressed in the last column of the table, and is to be understood in this manner. The probability that

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This method of Dr Kirwan, if there is ſuch a connexion between the different ſeaſons that a particular kind of weather in one has a tendency to produce a particular kind of weather in the next, as it is reaſonable to expect from theory, may in time, by multiplying obſervations, come to a great degree of accuracy, and may at laſt, perhaps, lead to that great deſideratum, a rational theory of the weather. As we wiſh to throw as much light as poſſible on this important ſubject, we ſhall add to theſe a few maxims, the truth of which has either been confirmed by long obſervation, or which the knowledge we have already acquired of the cauſes of the weather has eſtabliſhed on tolerably good grounds.

1. A moiſt autumn with a mild winter is generally followed by a cold and dry ſpring, which greatly retards vegetation. Such was the year 1741.

2. If the ſummer be remarkably rainy, it is probable that the enſuing winter will be ſevere; for the unuſual evaporation will have carried off the heat of the earth. Wet ſummers are generally attended with an unuſual quantity of ſeed on the white thorn and dog-roſe buſhes. Hence the unuſual fruitfulneſs of theſe ſhrubs is a ſign of a ſevere winter.

3. The appearance of cranes and birds of paſſage early in autumn announces a very ſevere winter; for it is a ſign it has already begun in the northern countries.

4. When it rains plentifully in May, it will rain but little in September, and *vice verſa*.

5. When the wind is ſouth-weſt during ſummer or autumn, and the temperature of the air unuſually cold for the ſeaſon, both to the feeling and the thermometer, with a low barometer, much rain is to be expected.

6. Violent temperatures, as ſtorms or great rains, produce a ſort of criſis in the atmoſphere, which produces a conſtant temperature, good or bad, for ſome months.

7. A rainy winter predicts a ſteril year: a ſevere autumn announces a windy winter.

82 Signs of rain from birds.

To the above we ſhall add the following maxims, drawn from obſervation, and with theſe ſhall conclude this article.—Sea and freſh water-fowls, ſuch as cormorants, ſea-gulls, muir-hens, &c. flying from ſea, or the freſh waters, to land, ſhew bad weather at hand: land fowls flying to waters, and theſe ſhaking, waſhing, and noiſy, eſpecially in the evening, denote the ſame; geeſe, ducks, cats, &c. picking, ſhaking, waſhing, and noiſy; rooks and crows in flocks, and ſuddenly diſappearing; pyes and jays in flocks, and very noiſy; the raven or hooded-crow crying in the morning, with an interruption in their notes, or crows being very clamorous at even; the heron, bittern, and ſwallow flying low; birds forſaking their meat and flying to their neſts; poultry going to rooſt, or pigeons to their dove-houſe; tame fowls grubbing in the duſt, and clapping their wings; ſmall birds ſeeming to duck and waſh in the ſand; the late and early crowing of the cock, and clapping his wings; the early ſinging of wood-larks; the early chirping of ſparrows; the early note of the chaffinch near houſes; the dull appearance of robin-redbreaſt near houſes; peacocks and owls unuſually clamorous.

83 Wind from birds.

Sea and freſh-water fowls gathering in flocks to the banks, and there ſporting, eſpecially in the morning; wild-geeſe flying high, and in flocks, and directing their courſe eaſtward; coots reſtleſs and clamorous; the hoopoe loud in his note; the king's-fiſher taking to land; rooks darting or ſhooting in the air, or ſporting on the banks of freſh waters; and laſtly, the appearance of the maleſigie at ſea, is a certain forerunner of violent winds, and (early in the morning) denotes horrible tempeſts at hand.

84 Fair weather from birds.

Halcyons, ſea-ducks, &c. leaving the land and flocking to the ſea; kites, herons, bitterns, and ſwallows flying high and loud in their notes; lapwings reſtleſs and clamorous; ſparrows after ſunriſe reſtleſs and noiſy; ravens, hawks, and keſtrils (in the morning), loud in their notes; robin redbreaſt mounted high, and loud in his ſong; larks ſoaring high, and loud in their ſongs; owls hooting with an eaſy and clear note; bats appearing early in the evening.

85 Rain from beaſts.

Aſſes braying more frequently than uſual; hogs playing, ſcattering their food, or carrying ſtraw in their mouths; oxen ſnuffing the air, looking to the ſouth, while lying on their ſides, or licking their hoofs; cattle gaſping for air at noon; calves running violently and gamboling; deer, ſheep, or goats, leaping, fighting, or puſhing; cats waſhing their face and ears; dogs eagerly ſcraping up earth; foxes barking, or wolves howling; moles throwing up earth more than uſual; rats and mice more reſtleſs than uſual; a grumbling noiſe in the belly of hounds.

86 Rain from inſects.

Worms crawling out of the earth in great abundance; ſpiders falling from their webs; flies dull and reſtleſs; ants haſtening to their neſts; bees haſtening home, and keeping cloſe in their hives; frogs and toads drawing nigh to houſes; frogs croaking from ditches; toads crying on eminences; gnats ſinging more than uſual; but, if gnats play in the open air, or if hornets, waſps, and glow-worms appear plentifully in the evening, or if ſpiders webs are ſeen in the air, or on the graſs, or trees, theſe do all denote fair and warm weather at hand.

87 Rain from the ſun.

Sun riſing dim or wateriſh; riſing red with blackiſh beams mixed along with his rays; riſing in a muſty or muddy colour; riſing red and turning blackiſh; ſetting under a thick cloud; ſetting with a red ſky in the eaſt.

N. B. Sudden rains never laſt long; but when the air grows thick by degrees, and the ſun, moon, and ſtars ſhine dimmer and dimmer, then it is like to rain ſix hours uſually.

88 Wind from the ſun.

Sun riſing pale and ſetting red, with an iris; riſing large in ſurface; riſing with a red ſky in the north; ſetting of a bloody colour; ſetting pale, with one or more dark circles, or accompanied with red ſtreaks; ſeeming concave or hollow; ſeeming divided, great ſtorms; parhelia, or mock ſuns, never appear, but are followed by tempeſts.

89 Fair weather from the ſun.

Sun riſing clear, having ſet clear the night before; riſing while the clouds about him are driving to the weſt; riſing with an iris around him; and that iris wearing away equally on all ſides, then expect fair and ſettled weather; riſing clear and not hot; ſetting in red clouds, according to the old obſervation:

The

Weather.

The evening red and morning gray,
Is the ſure ſign of a fair day.

90 Rain from the moon. Moon pale in colour, rain; horns blunt at firſt riſing, rain; horns blunt, at or within two or three days after the change, denotes rain from that quarter; an iris with a ſouth wind, rain next day; wind ſouth third night after change, rain next day; the wind ſouth, and the moon not ſeen before the fourth night, rain moſt of that month; full moon in April, new and full moon in Auguſt, for moſt part bring rain; mock moons are the forerunners of great rains, land floods, and inundations.

91 Wind from the moon. Moon ſeeming greatly enlarged; appearing of a red colour; horns ſharp and blackiſh; if included with a clear and ruddy iris; if the iris be double or ſeem to be broken in parts, tempeſts.

N. B. On the new moon, the wind for the moſt part changes.

When the moon, at four days old, has her horns ſharp, ſhe foretels a tempeſt at ſea, unleſs ſhe has a circle about her, and that too entire, becauſe, by that ſhe ſhews that it is not like to be bad weather, till it is full moon.

92 Fair weather from the moon. Moon ſeeming to exhibit bright ſpots; a clear iris with full moon; horns ſharp fourth day, fair till full; horns blunt at firſt riſing, or within two or three days after change, denotes rain for that quarter; but fair weather the other three quarters; moon clear three days after change and before full, always denotes fair weather. After every change and full, rains for the moſt part, ſucceeded by fair ſettled weather; moon clear and bright, always fair weather.

93 Weather from the ſtars. Stars ſeeming large, dull, and pale of colour, rain; or when their twinkling is not perceptible, or if encompaſſed with an iris. In ſummer, when the wind is at eaſt, and ſtars ſeem greater than uſual, then expect ſudden rain; ſtars appearing great in number, yet clear and bright, ſeeming to ſhoot or dart, denote fair weather in ſummer, and in winter froſt.

94 Rain from the clouds. In cloudy weather, when the wind falls, rain follows; clouds growing bigger, or ſeeming like rocks or towers ſettling on tops of mountains; coming from the ſouth, or often changing their courſe; many in number at north-weſt in the even; being black in colour from the eaſt, rain at night; but out of the weſt, rain next day; being like fleece of wool, from the eaſt, rain for two or three days; lying like ridges about mid day in

95 Wind from the clouds. the ſouth-weſt, ſhews great ſtorms both of wind and rain to be nigh. Clouds flying to and fro; appearing ſuddenly from the ſouth or weſt; appearing red, or accompanied with redneſs in the air, eſpecially in the morning; being of a leadiſh colour in the north-weſt; ſingle clouds denote wind from whence they come; but if at ſunſet, clouds appear with golden edges, or diminiſh in bulk, or ſmall clouds ſink low, or draw againſt the wind, or appear ſmall, white, and ſcattered in the north-weſt (ſuch as are vulgarly called mackerel) when the ſun is high, theſe are ſigns of fair weather.

N. B. It is often obſerved, that though the mackerel ſky denotes fair weather for that day, yet for the moſt part, rain follows in a day or two after.

96 Rain from a rainbow. After a long drought, the rainbow denotes ſudden and heavy rains; if green be the predominant colour, it denotes rain, but if red, wind with rain; if the clouds grow darker, rain; if the bow ſeems broken, violent ſtorms; if appearing at noon, much rain; if in the weſt great rain, with thunder.

N. B. It is obſerved, that if the laſt week in February, and the firſt fortnight of March, be moſtly rainy, and attended with frequent appearances of the bow, a wet ſpring and ſummer may be expected.

The rainbow appearing after rains, denotes fair weather at hand, if the colours grow lighter, fair; if the bow ſuddenly diſappears, fair; if the bow appear in the morning, it is the ſign of ſmall rains, followed by fair weather; and if appearing at night, fair weather; if appearing in the eaſt in the evening, fair; if the bow appear double, it denotes fair weather at preſent but rain in a few days; if in autumn, it continues fair for two days after the appearance of the aurora borealis, expect fair weather for at leaſt eight days more. 97 Fair weather from the rainbow.

If miſts be attracted to the tops of hills then expect rain in a day or two; if, in dry weather, they be obſerved to aſcend more than uſual, then expect ſudden rain; miſts in the new moon foreſhew rain in the old; miſts alſo in the old moon denote rain to happen in the new; a miſty white ſcare, in a clear ſky in the ſouth-eaſt, is always a forerunner of rain. 98 Rain from miſts.

If miſts diſſipate quickly, or deſcend after rain, it is a ſure ſign of fair weather; a general miſt before ſunriſing near the full moon, denotes fair weather for about a fortnight running. If after ſunſet or before ſunriſe, a white miſt ariſe from the waters and meads, it denotes warm and fair weather next day. A miſty dew on the inſide of glaſs windows ſhews fair weather for that day. 99 Fair weather from miſts.

Wood ſwelling, or ſtones ſeeming to ſweat; lute or viol ſtrings breaking; printed canvas or paſted maps relaxing; ſalt becoming moiſt; rivers ſinking, or floods ſuddenly abating; remarkable halo about the candle; great dryneſs of the earth; pools ſeeming troubled or muddy; yellow ſcum on the ſurface of ſtagnant waters; dandelion or pimpernel ſhutting up; trefoil ſwelling in ſtalk, while the leaves bow down. 100 Rain from inanimate bodies.

N. B. A dry ſpring is always attended with a rainy winter.

Wind ſhifting to the oppoſite point; ſea calm, with a murmuring noiſe; a murmuring noiſe from the woods and rocks when the air is calm; leaves and feathers ſeeming much agitated; tides high when the thermometer is high; trembling or flexuous burning of flames; coal burning white with a murmuring noiſe; thunder in the morning with a clear ſky; thunder from the north. 101 Wind from inanimate bodies.

N. B. Whenſoever the wind begins to ſhift, it will not reſt till it come to the oppoſite point; and if the wind be in the north, it will be cold; if in the north-eaſt colder; if in the ſouth; it brings rain; but if in the ſouth-weſt more rain.

The ſudden cloſing of gaps in the earth; the remarkable riſing of ſprings or rivers; if the rain begins an hour or two before ſunriſe it is like to be fair ere noon; but if an hour or two after ſunriſe, it for the moſt part happens to continue all day and then to ceaſe; when it begins to rain from the ſouth with a high wind for two or three hours, and that the wind falls, and it ſtill continues raining, it is then like to continue for 12 hours or more, and then to ceaſe. 102 Signs of rain, ceaſing.

N. B.

Weather.

103 Of wind ceasing. *N. B.* These long rains seldom hold above 24 hours, or happen above once a-year.

A hasty shower after raging winds is a sure sign of the storm being near an end. If the water ruckles and frequent bubbles arise, or if the halcyon or king's-fisher attempts the sea while the storm lasts, or moles come out of their holes, or sparrows chirp merrily, these are all certain signs of the storm ceasing.

Both sea and fresh-water fishes by their frequent rising and fluttering on the surface of the water, foretel the storm nigh over, but especially dolphins spouting up water in a storm foretel a calm.

N. B. Let the wind be in what quarter it will, upon the new moon, it presently changes.

104 Signs of hail. Clouds white, inclining to yellow, and moving heavily though the wind be high, is a sure sign of hail; if the eastern sky before sunrise be pale, and refracted rays appear in thick clouds, then expect great storms of hail: white clouds in summer are a sign of hail, but in winter they denote snow, especially when we perceive the air to be a little warm; in spring or winter, when clouds appear of blueish white, and expand much, expect small hail or drizzling, which properly is no other than frozen mists.

105 Signs of thunder. Meteors shooting in the summer's evening, or chops and clefts in the earth, when the weather is sultry, always foretel thunder is nigh; in summer or harvest, when the wind has been south two or three days, and the thermometer high, and clouds rise with great white tops like towers, as if one were upon the top of another, and joined with black on the nether side, expect rain and thunder suddenly; if two such clouds arise, one on either hand, it is then time to look for shelter, as the thunder is very nigh.

N. B. It is observed that it thunders most with a south wind and least with an east.

106 Signs of cold and frosty weather. Sea-pyes, starlings, fieldfares, with other migratory birds, appearing early, denote a cold season to ensue; the early appearance of small birds in flocks, and of robin-redbreasts near houses; sun in harvest setting in a mist or broader than usual; moon bright, with sharp horns, after change; wind shifting to the east or north after change; sky full of twinkling stars; small clouds hovering low in the north; snow falling small, while clouds appear on heaps like rocks.

N. B. Frosts in autumn are always succeeded with rain.

107 Signs of thaw. Snow falling in large flakes while the wind is at south; cracks appearing in the ice; sun looking waterish; the moon's horns blunted; stars looking dull; wind turning to the south; wind extremely shifting. It is also observed, that, if October and November be frost and snow, January and February are like to be open and mild.

108 Signs of drought. Fair weather for a week together, while the wind is all that time in the south, is, for the most part, followed by a great drought; if February be for most rainy, spring and summer quarters are like to be so too; but if it happen to be altogether fair, then expect a drought to follow; if lightning follow after 24 hours of dry and fair weather, drought will follow, but if within 24 hours, expect great rains.

109 Signs of a hard winter. A moist and cold summer, and mild autumn, are sure signs of a hard and severe winter: store of hips and haws denote the same; the hazel-tree flowering is ever observed to foretel the same; acorns found without any insect is a sure prognostic of a hard winter.

110 Signs of pestilential seasons. A dry and cold winter with a southerly wind; a very rainy spring, sickness in summer; if summer be dry with the wind northerly, great sickness is like to follow; great heats in spring time without winds; roots having a luscious taste, while the wind has been long southerly without rain; and, lastly, great quantities of stinking atoms, insects or animals, as flies, frogs, snakes, locusts, &c.

111 Experiments with the leech. Inclose the leech worm in an eight ounce phial glass, three-fourths filled with water, covered with a bit of linen; let the water be changed once a week in summer, and once a fortnight in winter.

If the leech lies motionless at the bottom in a spiral form, fair weather; if crept to the top, rain; if restless, wind; if very restless, and without the water, thunder; if in winter at bottom, frost; but if in the winter it pitches its dwelling on the mouth of the phial, snow. See HELMINTHOLOGY (F).

112 Signs of the weather from the barometer. In calm weather, when the air is inclined to rain, the mercury is low; but when tending to fair, it will rise; in very hot weather when falling, it foreshews thunder; if rising in winter, frost; but if falling in frost, thaw; if rising in a continued frost, snow; if foul weather quickly on its falling, soon over; if fair weather quickly on its rising, soon over; also if rising high in foul weather, and so continuing for two or three days, before the foul weather is over, then expect a continuance of fair weather; but, if in fair weather the mercury fall low, and so continue for two or three days, then expect much rain, and probably high winds.

N. B. In an east wind, the mercury always rises and falls lowest before great winds*.

* *Nicholson's Journal*, Feb. 1804, p. 149.

It was intended to insert in this article a summary view of the opinions of Toaldo, Cotte, and Lamarck, respecting the influence of the moon in producing changes in our atmosphere; but peculiar circumstances render it necessary to postpone this view till we come to the article MOON.

(F) In compliance with the writer of this paper, we have retained this passage on the leech; though, as we stated, when treating of the *Hirudo medicinalis*, in HELMINTHOLOGY, we are very sceptical respecting the *weather-judging* faculties of that worm.

INDEX.

Thaw,

Meteoromancy || Methodists.

METEOROMANCY, a species of divination by meteors, principally by lightning and thunder. This method of divination passed from the Tuscans to the Romans, with whom, as Seneca informs us, it was held in high esteem.

METESSIB, an officer of the eastern nations, who has the care and oversight of all the public weights and measures, and sees that things are made justly according to them.

METHEGLIN, a species of mead; one of the most pleasant and general drinks which the northern parts of Europe afford, and much used among the ancient inhabitants: (See MEAD). The word is Welsh, *meddyglin*, where it signifies the same.—There are divers ways of making it; one of the best whereof follows: Put as much new honey, naturally running from the comb, into spring water, as that when the honey is thoroughly dissolved an egg will not sink to the bottom, but be just suspended in it; boil this liquor for an hour or more, till such time as the egg swim above the liquor about the breadth of a groat; when very cool, next morning it may be barrelled up; adding to each 15 gallons an ounce of ginger, as much of mace and cloves, and half as much cinnamon, all grossly pounded; a spoonful of yeast may be also added at the bung hole to promote the fermentation. When it has done working, it may be closely stopped up; and after it has stood a month, it should be drawn off into bottles.

METHOD, the arrangement of our ideas in such a regular order, that their mutual connexion and dependence may be readily comprehended. See LOGIC, part iv.

METHODISTS, in ecclesiastical history, is a denomination applied to different sects, both Papists and Protestants.

I. The *Popish Methodists* were those polemical doctors, of whom the most eminent arose in France towards the middle of the 17th century, in opposition to the Huguenots or Protestants. Those Methodists, from their different manner of treating the controversy with their opponents, may be divided into two classes. The one may comprehend those doctors, whose method of disputing with the Protestants was disingenuous and unreasonable, and who followed the examples of those military chiefs, who shut up their troops in intrenchments and strong holds, in order to cover them from the attacks of the enemy. Of this number were the Jesuit Veron, who required the Protestants to prove the tenets of their church by plain passages of scripture, without being allowed the liberty of illustrating those passages, reasoning upon them, or drawing any conclusions from them; Nihusius, an apostate from the Protestant religion; the two Walenburgs, and others, who confined themselves to the business of answering objections and repelling attacks; and Cardinal Richelieu, who confined the whole controversy to the single article of the divine institution and authority of the church. The Methodists of the second class were of opinion, that the most expedient manner of reducing the Protestants to silence, was not to attack them by piecemeal, but to overwhelm them at once, by the weight of some general principle or presumption, some universal argument, which comprehended or might be applied to all the points contested between the two churches: thus imitating the conduct of those military leaders who, instead of spending their time and strength in sieges and skirmishes, endeavoured to put an end to the war by a general and decisive action. These polemics rested the defence of Popery upon prescription; the wicked lives of Protestant princes who had left the church of Rome; the crime of religious schism; the variety of opinions among Protestants with regard to doctrine and discipline;

Methodifts.

pline; and the uniformity of the tenets and worship of the church of Rome. To this clafs belong Nicolle the Janfenift doctor, the famous Boffuet, &c.

II. The *Proteftant Methodifts* form a very confiderable body in this country. The fect was founded in the year 1729 by one Mr Morgan and Mr John Wefley. In the month of November that year, the latter being then fellow of Lincoln college, began to fpend fome evenings in reading the Greek New Teftament, along with Charles Wefley ftudent, Mr Morgan commoner of Chrift church, and Mr Kirkham of Merton college. Next year two or three of the pupils of Mr John Wefley, and one pupil of Mr Charles Wefley obtained leave to attend thefe meetings. Two years after they were joined by Mr Ingham of Queen's college, Mr Broughton of Exeter, and Mr James Hervey; and in 1735 they were joined by the celebrated Mr Whitefield, then in his 18th year.

At this time it is faid that the whole kingdom of England was tending faft to infidelity. "It is come (fays Bifhop Butler), I know not how, to be taken for granted by many perfons, that Chriftianity is not fo much as a fubject of inquiry, but that it is now at length difcovered to be fictitious; and accordingly they treat it as if in the prefent age this were an agreement among all people of difcernment, and nothing remained but to fet it up as a principal fubject of mirth and ridicule, as it were by way of reprifals, for its having fo long interrupted the pleafures of the world." The Methodifts are faid, with great probability, to have been very inftrumental in ftemming this torrent. They obtained their name from the exact regularity of their lives; which gave occafion to a young gentleman of Chrift church to fay, "Here is a new fet of *Methodifts* fprung up;" alluding to a fect of ancient phyficians which went by that name. This extreme regularity, however, foon brought a charge againft them, perhaps not altogether without foundation, of being too fcrupulous, and carrying their fanctity to too great a height. In particular it was urged, that they laid too much ftrefs upon the rubrics and canons of the church, infifted too much on obferving the rules of the univerfity, and took the fcriptures in too literal a fenfe; and to the name of *Methodifts* two others were quickly added, viz. thofe of *Sacramentarians* and the *Godly Club*.

The principal perfon in this club while in its infancy appears to have been Mr Morgan, and next to him Mr John Wefley. They vifited the fick, and inftituted a fund for the relief of the poor; and the better to accomplifh their benevolent defigns, Mr Wefley abridged himfelf of all his fuperfluities, and even of fome of the neceffaries of life; and by propofing the fcheme to fome gentlemen, they quickly increafed their funds to 80l. *per annum*. This, which one fhould have thought would have been attended with praife inftead of cenfure, quickly drew upon them a kind of perfecution; fome of the feniors of the univerfity began to interfere, and it was reported "that the college cenfors were going to blow up the Godly Club*." They found themfelves, however, patronifed and encouraged by fome men eminent for their learning and virtue; fo that the fociety ftill continued, though they had fuffered a fevere lofs in 1730 in the death of Mr Morgan, who had indeed been the founder of it. In the month of October 1735, John and Charles Wefley, Mr Ingham, and Mr Delamotte fon to a merchant in London, embarked for Georgia along with Mr Oglethorpe, afterwards General Oglethorpe. The defign of this voyage was to preach the gofpel to the Indians. By this time, however, it appears that Mr Wefley had embraced fuch notions as may without the leaft breach of charity be accounted fanatical. Thus in a letter to his brother Samuel, he conjures him to banifh from his fchool "the claffics with their poifon," and to introduce inftead of them fuch Chriftian authors as would work together with him in "building up his flock in the knowledge and love of God."

* See *Wefley's Life*, p. 105.

During the voyage fuch a profufion of worfhip was obferved, as we cannot help thinking favoured more of a Pharifaical than Chriftian behaviour; an account of which, as a fimilar ftrictnefs would certainly be inculcated upon the difciples, and confequently muft give a juft idea of the principles of the early Methodifts, we fhall here tranfcribe from Mr Wefley's life. "From four in the morning till five, each of us ufed private prayer; from five to feven we read the Bible together, carefully comparing it (that we might not lean to our own underftandings) with the writings of the earlieft ages; at feven we breakfafted; at eight were the public prayers; from nine to twelve learned the languages and inftructed the children; at twelve we met to give an account to one another what we had done fince our laft meeting, and what we defigned to do before our next; at one we dined; the time from dinner to four we fpent in reading to thofe of whom each of us had taken charge, or in fpeaking to them feparately as need required; at four were the evening prayers, when either the fecond leffon was explained (as it always was in the morning), or the children were catechifed and inftructed before the congregation; from five to fix we again ufed private prayer; from fix to feven I read in our cabin to two or three of the paffengers, of whom there were about 80 Englifh on board, and each of my brethren to a few more in theirs; at feven I joined with the Germans in their public fervice, while Mr Ingham was reading between decks to as many as defired to hear; at eight we met again, to inftruct and exhort one another; between nine and ten we went to bed, when neither the roaring of the fea nor the motion of the fhip could take away the refrefhing fleep which God gave us."

As they proceeded in their paffage, this aufterity inftead of being diminifhed was increafed. Mr Wefley difcontinued the ufe of wine and flefh; confining himfelf to vegetables, chiefly rice and bifcuit. He ate no fupper; and his bed having been made wet by the fea, he lay upon the floor, and flept foundly till morning. In his Journal he fays, "I believe I fhall not find it needful to go to bed, *as it is called*, any more;" but whether this was really done or not, we cannot fay.

The miffionaries, after their arrival, were at firft very favourably received, but in a fhort time loft the affections of the people entirely. This was owing to the behaviour of Mr Wefley himfelf, who appeared not only capricious but frequently defpotic. He particularly gave offence by infifting upon the baptifm of children by immerfion; and his exceffive aufterity, with regard to himfelf

Methodists. himself did not tend to give his hearers any favourable opinion either of the superior sanctity or wisdom of their teacher. At last, on account of a difference with Mr Causton the storekeeper and chief magistrate of Savannah which ended in a law-suit, he was obliged to return to England.

Thus the cause of Methodism seemed to be entirely lost in Georgia. But Mr Wesley was soon succeeded by a more popular and successful champion, viz. Mr George Whitefield; who having spent his time during the voyage in converting the soldiers with whom he sailed, arrived at Savannah in Georgia on the 7th of May 1738. Here he was received by Mr Delamotte, was joined by several of Mr Wesley's hearers, and became intimate with some other ministers. Mr Ingham had made some progress in converting a few runaway Creek Indians, who had a settlement about four miles from Savannah; but being obliged to return to England in a few months, this design was frustrated, and the Indians in a few years separated. During the short time that Mr Whitefield resided at Savannah, he became extremely popular; and indeed the instances of his success in the way of making converts are very surprising. However, he was obliged to return to England in the autumn of that year, that he might receive priests orders. On his return to America in October 1739, he landed at Philadelphia, and instantly began his spiritual labours as in other places; being attended with astonishing success not only there but wherever he went. Passing through the colonies of Virginia, Maryland, North and South Carolina, the number of converts continually increased; but on his arrival at Savannah, he found the colony almost deserted. He now resumed the scheme he had formerly projected of building an Orphan-house; and for this he made the first collection at Charlestown in South Carolina, amounting to about 70l. sterling. His zeal in the cause of religion, or of the colony, were not, however, sufficient to procure him the favour of those in power. On his return to Philadelphia, after a short stay at Savannah, the churches were denied him; but he was made ample amends by the success which attended his field preachings and private efforts. Religious societies were everywhere set up, and many were converted with symptoms of enthusiasm, different according to their various tempers and constitutions. During this excursion, he was so successful in his collection for the Orphan-house, that on his return to Savannah he brought along with him money and provisions to the value of 500l. sterling.

The success in Georgia was now greater than ever; but the many charities which it was necessary to supply, rendered it necessary in a short time for him to undertake another journey to Charlestown. Here his principles met with the greatest opposition. He had lost the favour of the commissary by his field-preaching, and was denied the sacrament. The opposition, however, was altogether fruitless; the number of converts increased wherever he went, and he now undertook a voyage to New England. In this place also the established clergy were his enemies; but the usual success attended his other endeavours, and procured 500l. more for the use of the Orphans in Georgia.

From the year 1741 to 1743 America was deprived of Mr Whitefield's preaching, he having spent that interval in England; but in 1744 he again set out for the western continent. The remarkable success which had hitherto attended his labours now stirred up many opponents; and these had met with the greater success, as none of the Methodist preachers whom he had left were possessed of such abilities either to gain the favour of those who heard them, or to defend their doctrines against objections. Mr Whitefield's success, however, was the same as before: he even found means to inspire the military class with such sentiments of devotion, that Colonel Peppereil could not undertake his expedition against Louisbourg without first consulting Mr Whitefield; and great numbers of New-Englanders went volunteers, confident of victory, in consequence of the discourses of their teacher.

From the continent of America Mr Whitefield took a voyage to the Bermudas islands; and here, as everywhere else, he met with the most surprising success. Here also collections were made for the Orphan-house in Savannah, which were transmitted to that place.

Supposing it to be better for his cause to visit different countries, than to take up a permanent residence in one, Mr Whitefield left Bermudas in a few months, and did not return to America till 1751, when the Orphan-house was found to be in a very flourishing situation. After a short stay, he set sail again for Britain. Here he remained two years, and then set out on another visit to America, landing at Charlestown on the 27th of May 1754. His presence constantly revived the spirits and cause of his party, and added to their numbers wherever he went. Next year he returned to England; but after labouring in the usual manner, and meeting with the usual success there till the year 1763, he set sail again for America, and arrived at Virginia in the latter end of August. He now visited all the colonies, and found that great progress had been made in converting the Indians. On his arrival at Georgia, matters were found in a very flourishing situation, and he received the thanks of the governor and principal people for the great benefit he had been to the colony; which shows, that the stories which had been so industriously propagated, concerning the avarice of him and other Methodist preachers, were, partly at least, unfounded. In 1765 he returned to England; and in 1769 made his seventh and last voyage to America, landing at Charlestown on the 30th of November the same year. He was still attended with the same success; and indeed it is impossible to read, without admiration, an account of the efforts made by himself and Mr Wesley, to propagate their tenets in the different parts of the world.

For a very considerable time Mr Whitefield was the only Methodist who paid any attention to America; and in that country he was more popular than even in Europe. Towards the end of his life, several Methodists having emigrated from Britain, formed distinct societies in New York and Philadelphia. These quickly increased in number; and, about the time that the war with Britain began, their numbers amounted to about 3000 in Virginia, Maryland, New York, and Pennsylvania. They would probably have increased much more, had it not been for the imprudence of some of their preachers, who introduced

troduced politics into their difcourfes, and thus rendered themfelves obnoxious to the people among whom they lived. Among thofe who hurt the caufe in this manner was Mr Wefley himfelf, who, by writing a piece entitled *A Calm Addrefs to the American Colonies*, would in all probability have ruined it, had not a gentleman, with whom he was connected, deftroyed or fent back to England the whole impreffion as foon as it arrived in America, fo that its exiftence was fcarce known in that continent. At the conclufion of the war, Dr Coke, who in 1776 had left a curacy in England in order to join Mr Wefley, paid a vifit to his friends in America; though it had been imagined that a total feparation had taken place between the American and European Methodifts. This breach was, however, made up by a manoeuvre of Mr Wefley; for no fooner had the Americans obtained their independence, than he, who had hitherto branded them with the name of *rebels*, fent a congratulatory letter on their freedom from the "State and the Hierarchy," and exhorting them to "ftand faft in that liberty with which God had fo ftrangely made them free." To fhow his zeal in their fervice ftill farther, he gave ordination, by laying on of hands, to feveral preachers who were to embark for America, and confecrated Dr Coke one of the bifhops of the Methodift Epifcopal church in that country. He extracted alfo from the liturgy of the Englifh church one for the American Methodifts, taking particular care to expunge every expreffion that had a particular refpect to the regal authority.

Such proceedings in one who had formerly profeffed fuch extraordinary attachment to the Englifh church, could not but require an apology; and this was accordingly made in a paftoral letter tranfmitted to the American focieties, and addreffed "to Dr Coke, Mr Aftbury, and our brethren in North America." In this letter he makes the following defence of his conduct. "Lord King's account of the primitive church convinced me, many years ago, that bifhops and prefbyters are the fame order, and confequently have the fame right to ordain. For many years I have been importuned, from time to time, to exercife this right, by ordaining part of our travelling preachers. But I have ftill refufed, not only for the fake of peace, but becaufe I was determined, as little as poffible, to violate the eftablifhed order of the national church to which I belonged. But the cafe is widely different between England and North America. Here there are bifhops who have a legal jurifdiction: in America there are none, neither any parifh minifters: fo that for fome hundred miles together, there is none either to baptize, or to adminifter the Lord's fupper. Here, therefore, my fcruples are at an end; and I conceive myfelf at full liberty, as I violate no order, and invade no man's right, by appointing and fending labourers into the harveft. It has indeed been propofed to defire the Englifh bifhops to ordain part of our preachers for America; but to this I object. 1. I defired the bifhop of London to ordain only one, but could not prevail. 2. If they confented, we know the flownefs of their proceedings; but the matter admits of no delay. 3. If they would ordain them now, they would likewife expect to govern them; and how grievoufly would that entangle us. 4. As our American brethren are now totally difentangled, both from the ftate and the Englifh hierarchy, we dare not entangle them again either with the one or the other. They are now at full liberty fimply to follow the fcripture and the primitive church; and we judge it beft, that they fhould ftand faft in that liberty wherewith God has fo ftrangely made them free."

Dr Coke, on the confecration of Mr Aftbury to the office of a bifhop, made another apology. "The church of England (fays he), of which the fociety of Methodifts in general have till lately profeffed themfelves a part, did for many years groan in America under grievances of the heavieft kind. Subjected to a hierarchy which weighs every thing in the fcale of politics, its moft important interefts were repeatedly facrificed to the fuppofed advantages of England. The churches were in general filled with the parafites and bottle-companions of the rich and great. The humble and moft importunate entreaties of the oppreffed flocks, yea the reprefentations of a general affembly itfelf, were contemned and defpifed. Every thing facred muft bow down at the feet of a party; the holinefs and happinefs of mankind be facrificed to their views; and the drunkard, the fornicator, and the extortioner, triumphed over bleeding Zion, becaufe they were faithful abettors of the ruling powers. The memorable revolution has ftruck off thefe intolerable fetters, and broken the antichriftian union which before fubfifted between church and ftate. And had there been no other advantage arifing from that glorious epoch, this itfelf, I believe, would have made ample compenfation for all the calamities of the war; one happy confequence of which was the expulfion of moft of thofe hirelings, who "ate the fat, and clothed themfelves with the wool, but ftrengthened not the difeafed," &c. The parochial churches in general being hereby vacant, our people were deprived of the facraments through the greateft part of thefe ftates, and continue fo ftill. What method can we take in fo critical a juncture? God has given us fufficient refources in ourfelves; and, after mature deliberation, we believe that we are called to draw them forth.

"But what right have you to ordain?" The fame right as moft of the churches in Chriftendom; our ordination, in its loweft view, being equal to any of the prefbyterian, as originating with three prefbyters of the church of England. "But what right have you to exercife the epifcopal office?" To me the moft manifeft and clear. God has been pleafed to raife up, by Mr Wefley, in America and Europe, a numerous fociety well known by the name of *Methodifts*. The whole body have invariably efteemed this man as their chief paftor under Chrift. He has conftantly appointed all their religious officers from the higheft to the loweft, by himfelf or his delegate. And we are fully perfuaded there is no church office which he judges expedient for the welfare of the people intrufted to his charge, but, as effential to his ftation, he has power to ordain. "But, do not you break the fucceffion?" The uninterrupted fucceffion of bifhops is a point that has long been given up by the moft able Proteftant defenders of epifcopacy. Bifhop Hoadley himfelf, in his celebrated controverfy with Dr Calamy, allows it to be unneceffary. His words are, 'To the 13th queftion I anfwer, that I think not an uninterrupted line of fucceffion cession of regularly ordained bishops necessary.' He also grants the authenticity of the anecdote given us by St Jerome, which informs us, that the church of Alexandria had no regular succession from the time of St Mark the evangelist, the first bishop of that church, to the time of Dionysius, a space of 200 years; but the college of presbyters, on the death of a bishop, elected another in his stead. We are also informed, from the epistle of St Clement to the Corinthians, written soon after the death of St Paul, a writer whose works are next in precedence to the canon of scripture, and probably written by immediate inspiration, that the church of Corinth was then governed only by a college of presbyters. And from the epistle of Polycarp to the church of Philippi, written in 116, we also find that the Christian Philippians were then governed only by a college of presbyters. So that the primitive Christians were so far from esteeming the regular succession as essential to the constitution of a Christian church, that, in some instances, episcopacy itself was wholly omitted.

Such was the defence urged by Mr Wesley for this extraordinary assumption of episcopal powers: a conduct, however, of which he afterwards repented, as tending to make a final separation betwixt his followers and the church of England. Yet it does not appear that this had any bad effect on the minds of his American brethren; for Dr Coke, on his arrival on the western continent, found the societies numerous and flourishing. His first efforts were directed against the slave trade; and not only the abolition of that traffic, but the release of all those who were actually slaves at the time, seem to have been his favourite objects. By interfering in this matter, however, perhaps with too much zeal, he involved himself in danger. Some riots took place, and a lady offered the mob 50 guineas if they would give the Doctor 100 lashes. This piece of discipline would have been inflicted, had it not been for the interposition of a sturdy colonel; and the Doctor had not only the satisfaction of escaping the intended punishment, but of seeing his doctrine so far attended to, that some slaves were emancipated.

Mr Hampson, in his Memoirs of Mr Wesley, observes, that "the colonists, in the infancy of Methodism, conducted themselves with more propriety than the English. There was little or no persecution, nor any thing like a riot, except in one or two instances which have been mentioned as the consequence of the animadversions on slavery; and even these were productive of no mischief. Not a creature was materially injured; no bones were broken, nor any lives lost; which was not the case in this country. Here many thousands of innocent people were subjected to the grossest indignities, and several were eventually sacrificed to the fury of their persecutors.

"While we commend the Americans for their behaviour in opposition to the brutality of English mobs, it may be proper to inquire into the sources of this distinction. Something of this may have arisen from similarity of sentiment. The Americans, from the first beginnings of colonization, had been accustomed to the doctrines of the old puritans and nonconformists, which in many respects have a near affinity to the Methodistic tenets. The origin of Methodism in America was seldom, if ever, attended, either under the discourses of Mr Whitefield's or Mr Wesley's preachers, with those ridiculous effects with which it was accompanied in these kingdoms. Most of the preachers, who went over to the continent, having laboured for some years in Europe previous to their having crossed the water, had exhausted their wildfire; so that their discourses were more scriptural and rational than those of the primitive Methodists. Another reason may be found in the education of the Americans. As a people, they are better cultivated than the body of the English; they are chiefly composed of merchants and a respectable yeomanry: and there is but a small proportion of that class, so superabundant here, which we distinguish by the name of *mob*.

"The only exception we have heard, to their exemption from the extravagancies which in this country marked the infancy of Methodism, is a custom they have introduced in Maryland and Virginia. Frequently, at the conclusion of a sermon, the whole congregation began to pray and to praise God aloud. The uproar which this must create may easily be conceived. Some we are told, are great admirers of this species of enthusiasm, in which every man is his own minister, and one sings and another prays, with the most discordant devotion. But we will not dignify such indecency with such a name. Its proper appellation is *fanaticism*. We hope, that, for the future, religion will never appear in this country under so odious a form; and greatly is it to be lamented, that, among the friends of Christianity, any such absurdities should arise, to furnish infidels with occasions of triumph."

Our author informs us, that the occupation of the Methodist preachers in America was very laborious. In the course of the day they frequently rode 20 or 30 miles, preaching twice or thrice, and sometimes to considerable congregations. Notwithstanding this labour, however, few or none of them ever thought of returning to Britain. Several reasons may be assigned for the pleasure they took in this laborious exercise. "Their excursions (says Mr Hampson) through immense forests abounding in trees of all sorts and sizes, were often highly romantic. Innumerable rivers and falls of water; vistas opening to the view, in contrast with the uncultivated wild; deer now shooting across the road, and now scouring through the woods, while the eye was frequently relieved by the appearance of orchards and plantations, and the houses of gentlemen and farmers peeping through the trees; formed a scenery so various and picturesque, as to produce a variety of reflection, and present, we will not say to a philosophic eye, but to the mind of every reasonable creature, the most sublime and agreeable images.

"Their worship partook of the general simplicity. It was frequently conducted in the open air. The woods resounded to the voice of the preacher, or to the singing of his numerous congregations; while their horses, fastened to the trees, formed a singular addition to the solemnity. It was indeed a striking picture; and might naturally impress the mind with a retrospect of the antediluvian days, when the hills and valleys re-echoed the patriarchal devotions, and a Seth or an Enoch, in the shadow of a projecting rock, or beneath the foliage of

Methodists. of some venerable oak, delivered his primeval lectures, and was a "preacher of righteousness to the people."

The American hospitality is supposed by Mr Hampson to have been another reason for the assiduity of the Methodist teachers, as well as the consciousness of being well employed, and the satisfaction resulting from considerations of public utility. As many of the preachers were men of fervent piety, this reflection would have its full weight; and the instruction of the ignorant and the reformation of the profligate would be considered as the best recompense of their labours. Spreading themselves through the continent, they took in Nova Scotia, Georgia, with the principal places in both Carolinas, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, and New York; numbering upwards of 43,000 members of their society, exclusive of about 80 itinerants, and a considerable number of local preachers, who took no circuits, but assisted occasionally in the neighbourhood of their respective residence.

The large and expensive buildings which the colonists have erected for public worship, almost exceed credibility; and several colleges are founded for the instruction of youth. How far the proposed plan of uniting genuine religion and extensive learning will be carried into execution, time only can discover. It must materially depend on the character of the presidents and tutors, and the provision that shall be made for their support. Men of real erudition will never be procured at low salaries; and it is in vain to attempt establishments of this sort without a liberal provision for the professors in every branch of science. Two of these places are called *Cokesbury* and *Wesley Colleges*. How they are endowed, or whether they propose to obtain authority to confer degrees, we are not informed. But perhaps they are rather schools than colleges; which indeed is a circumstance to be wished, as good grammar schools are of the utmost service to the progress of literature.

The great success which attended the Methodist preachers in America naturally determined Mr Wesley to try the West India islands. The Moravians had already attempted to establish their principles in some of these islands; and in 1786 some preachers were sent from the Methodists in England to the West Indies. In many of these they met with success. Societies were formed in Barbadoes, St Vincent's, Dominica, St Christopher's, Nevis, Antigua, St Eustatius, Tortola, and St Croix, amounting in all to near 5000 persons. At this time the whole number of Methodists in America and the West Indies amounted to about 48,302. These societies consisted both of whites and blacks: on the continent they were mostly whites, but in the islands negroes. "But it is to be observed (says Mr Hampson) that the subjection of the negroes, and the obedience in which they are trained, must inculcate a docility peculiarly favourable to the purposes of a mission." Some of the missionaries went also to St Vincent's, where they met with some success, and have established some schools, in which their children are carefully instructed in the principles of religion.

"In January 1789 (says our author), Dr Coke paid a visit to Jamaica, and gave them several sermons. As he made but a short stay, it could hardly be considered as a fair trial. Should a mission be established here, as well as in the other islands, which will probably be the case, it is hoped it will be the means of correcting one vice at least, and that is duelling; a savage relict of Gothic barbarity, by which all the islands have for many years been distinguished. Perhaps too it will give some check to the spirit of luxury and dissipation; and teach the planters, if it be found impracticable to emancipate their slaves, at least to treat them with humanity." Methodists.

It has been debated among the leading men of the Methodistical profession, whether the cause might not be served by sending missionaries to the East Indies and to Africa; but these projects were dropped, as there was no invitation, nor any prospect of success if it had been adopted. A mission has been formed to the new settlement called *Kentucky*, on the confines of the Indian territories, near the Mississippi. The danger of the missionaries at the time they undertook this service was certainly very great; yet such was their zeal for the cause, that they voluntarily offered themselves: but we are not yet informed what success they have met with.

While Methodism was thus making rapid progress in America, its teachers were equally indefatigable in Britain. A most remarkable particular, however, occurs with regard to Mr Wesley himself; for though he had gone to Georgia, as has been already related, to convert the Indians to Christianity, yet on his return to England in 1738, he took it into his head that he, their teacher, was not yet converted: the reason was, that he had not the faith of assurance. This, however, was not long wanting. He arrived in England on the first day of February, and was blest with the assurance on the sixth of March following. This was immediately announced to the public; and the consequence, if we may believe him, was, that God then began to work by his ministry, which he had not done before. Being joined by one Kinchin, a fellow of Corpus, they travelled to Manchester, Holms Chapel, Newcastle in Staffordshire, and other places, where they preached, exhorted, and conversed on religious subjects, in public houses, stables, &c. sometimes meeting with success and sometimes not. During this peregrination Mr Wesley certainly displayed a great deal of superstition, which we must undoubtedly suppose to have been communicated to his hearers, and to have caused them act on many occasions in a very ridiculous manner. An instance follows:—"The next day (says he), March 11th, we dined at Birmingham, and, soon after we left it, were reproved for our negligence there (in letting those who attended us go without either exhortation or instruction) by a severe shower of hail!" About the latter end of March or beginning of April he and his companion began to pray *extempore*, leaving off entirely the forms of the church of England, to which he had formerly been so devoted. The doctrine of instantaneous conversion, which his imagination had suggested to him as a work performed on himself, was greedily received by some of his hearers; and all the converts to the new doctrine confirmed themselves, and contributed greatly to persuade others, by declarations of their *experiences*, as they called them: however, Methodists.

ever, though a knowledge of the saving assurance had been given on March 6th, he does not date his conversion sooner than May 24th of the same year.

This new doctrine of an instantaneous, and in fact miraculous impulse, though greatly relished by the enthusiastical part of the society, was very much disliked by others, particularly Mr Charles Wesley his brother, who warned him of the mischief he was doing; though he himself was soon converted, and, what is very astonishing, two days before John Wesley himself. The particulars related of these miraculous conversions are truly disgraceful, and could not but bring into contempt the society which consisted of such enthusiasts. "Many (says Mr Hampson) are represented as falling suddenly to the ground, in horror and agony not to be conceived, and rising again with equal expressions of peace and consolation."—Their conversions were usually attended with these violent symptoms; and, for several years, few meetings occurred where Mr Wesley presided, without one or more instances of the same kind. It was not possible that such transactions should pass without notice. The confusion that too often prevailed, the emotions of the persons affected, and the exultations of the rest, which were severally animadverted upon, gave great and general offence. Many insisted, that it must either be occasioned by the heat of the rooms, and the agitation of the animal spirits under discourses of the most alarming nature; or that it was mere artifice and hypocrisy.

In the mean time, two of the sons of a Mrs Hutton in London, happening to become converts to the new doctrine, this lady was so much offended, that she wrote to Mr Samuel Wesley, informing him, that she was of opinion his brother John had lost his senses; and requesting, that the next time he came to his house, he, Mr Samuel, would either confine or convert him. All that could be done, however, to prevent the progress of the new doctrine was insufficient; and the first Methodist society was formed in London on the first of May 1738, when about 50 agreed to meet together once a-week, for free conversation, begun and ended with singing and prayer.

All this time, however, it seems that the conversion of Mr Wesley was far from being so complete as that of many of his hearers. He had preached and converted others, while he himself was absolutely unconverted. The knowledge of the true saving faith was only revealed to him on the 6th of March, and he did not experience its power till the 24th of May; and even after this, his doubts and fears were still so great, that on the 13th of June he undertook a voyage to Germany, where, in the company of Count Zinzendorff, his faith seems to have been thoroughly confirmed.

On Mr Wesley's return, September 16th, 1738, he applied himself with the greatest assiduity and success to the propagation of his doctrine. Multitudes of converts were made in various parts of the kingdom; and the reproaches poured upon him by his opponents, seemed to have rendered his zeal more fervent if possible than before. It is remarkable, however, that some of his old friends were now so much offended with his conduct or his principles, that they absolutely refused to keep company with him. His original plan seems to have been, to make an union of clergymen, and disseminate his principles by their means. But in this he succeeded so ill, that in a letter written in 1742, he wished for a clerical assistant, were he only in deacons orders: but adds, "I know of none such, who is willing to cast in his lot with us; and I scarce expect I shall, because I know how fast they are rivetted in the service of the devil and the world before they leave the university."—Finding at last that nothing could be done with them, he was obliged to have recourse to lay preachers; and easily selected those who appeared to have the greatest talents for prayer and exhortation in the private meetings appointed for that purpose. This he at once raised himself to be the head of a sect; as the lay preachers willingly yielded obedience to him who had the advantages of superior learning and abilities, and was besides in orders as a clergyman; and this obedience he did not fail on every occasion to exact.

If his doctrine had formerly given offence to the established clergy, the appointment of lay preachers was reckoned much worse; and their being appointed without any form of ordination whatever, which almost all of them were, subjected them to contempt and reproach, which their want of learning, and very often of natural abilities, did not contribute to remove. Thus finding the churches shut against him and his followers, he was obliged to preach in the fields, and made his first essay in this way on the second of April 1739, in the neighbourhood of Bristol; Mr Whitefield having set him an example the day before.

The success of those ignorant and itinerant preachers, with their absurd and uncharitable discourses and behaviour, so provoked their adversaries, that a persecution was soon commenced against them. Mr Wesley himself was calumniated in the harshest manner, being sometimes said to be a Jesuit, sometimes an illiterate enthusiast, as the people took it into their heads. Many pretended to answer him in writing, without being able to do so: the consequence was, that their deficiency of argument was supplied by invective, and the most scandalous performances made their appearance. Some of the English clergy so far forgot themselves as to instigate the mob against them, and the most cruel outrages were committed upon them in various places. For some time the persecuted party adhered to the doctrines of passive obedience and non-resistance, which their inhuman adversaries did not fail to take the advantage of.—The less they were opposed, the more insolent they became. The Methodists were frequently in danger of their lives. Men, women with child, and even children, were knocked down and abused with the same undistinguishing fury. Houses were stripped of their furniture, vast quantities of furniture carried off, featherbeds cut in pieces and strewed over the streets, several reputable people were forced into the army, &c. To the disgrace of magistracy also it was found, that when application was made to the justices of the peace, redress was commonly denied; nor was a stop put to these shameful proceedings without a royal mandate for the purpose.

From the year 1738 to 1747 Mr Wesley and his itinerants were employed in various parts of England. In

Methodists. In 1747 he went over to Dublin, where a society had been formed by one Mr Williams a clergyman.—Here they proved so successful, notwithstanding the number of Papists, and the violence of their other opponents, that in 1750 they had erected meeting-houses in every part of the kingdom, and had formed 29 circuits, which employed 67 itinerants, besides a considerable number of local preachers. An invitation was given to Mr Wesley, in 1751, to visit Scotland, by an officer in quarters at Musselburgh. He accordingly took a journey thither the same year; but left the place, after preaching in it once or twice. In 1753 he returned to Scotland, and visited Glasgow. Societies were at length formed in that city, as well as at Edinburgh, Dundee, Aberdeen, Inverness, and a few other places: but his success was by no means equal to what it had been in other parts; for in 1790 the number of circuits in Scotland was no more than eight, which were supplied by 20 itinerants.

Mr Whitefield, the other great labourer in the vineyard, was equally indefatigable, and probably more successful than Mr Wesley. Before entering into orders, he had formed a society of religious persons at Gloucester: here he preached his first sermon on the Necessity and Benefit of Religious Society; here he became extremely popular, as well as at Bristol and London, while preparing to set sail for Georgia for the first time; and in all places to which he came, large collections were made for the poor. He maintained the same doctrine with Mr Wesley as to the new birth; which likewise gave offence to the clergy when delivered by him, as it had done with Mr Wesley. In the various intervals of his voyages to America, he employed himself with the very same assiduity in Britain and in Ireland, which we have already taken notice of in the western continent. His success was everywhere prodigious. In 1741 he was invited to Scotland, and preached his first sermon there at Dunfermline. From thence he went to Edinburgh, and preached in several of the established churches, but differed with Messrs Ralph and Ebenezer Erskine; so that he, as well as Mr Wesley, proved unsuccessful in forming a coalition with any other religious party. In the private way, however, his success was very considerable, at Edinburgh, Glasgow, Aberdeen, Dundee, and other places. In 1742 he paid a second visit to Scotland, and a third one in 1748. In 1751 he visited Ireland for the first time; and preached to great multitudes, without being molested, even in places where others had been mobbed. From thence he returned to Scotland the same year, and speaks in very favourable terms of the attention the people there paid to their Bibles. In 1752 and 1753 he again visited the same kingdom, and the last time distinguished himself by preaching against the playhouse in Glasgow. In 1756 he returned; and by his animated discourses at Edinburgh against Popery and arbitrary power, was owned to have contributed very much to the increase of courage and loyalty in this country. Next year he again visited the Scottish capital during the time that the General Assembly sat, and his sermons were attended by several of the members. At Glasgow he made a large collection for the poor of that city, and from thence took a voyage to Ireland. He was received with the usual affection by the lower classes of Protestants; but the Popish rabble, exasperated at his success, almost murdered him with stones. After passing through a great part of Ireland, visiting England and Wales, he paid another visit to Scotland, where four clergymen now lent him their pulpits. His last visit was in the summer of 1758, when his congregations were as large as ever; and it is to his endeavours principally that we are to ascribe the great number of Methodist societies now existing in Scotland.

With regard to the religious principles of the Methodists, we cannot enter into any particular detail; neither indeed are there any doctrines peculiar to all included under that name, except the single one of universal redemption. In March 1741, Mr Whitefield being returned to England, entirely separated from Mr Wesley and his friends, "because he did not hold the decrees."—Here was the first breach, which warm men persuaded Mr Whitefield to make, merely for a difference of opinion. Those indeed who believed universal redemption, had no desire at all to separate: but those who held particular redemption, would not hear of any accommodation, being determined to have no fellowship with men that "were in such dangerous errors." So there were now two sorts of Methodists so called; those for particular, and those for general, redemption.

History of Methodism, &c.

Not many years passed, before William Cudworth and James Relly separated from Mr Whitefield.—These were properly Antinomians, absolute avowed enemies to the law of God, which they never preached or professed to preach, but termed all *legalists* who did. With them, preaching the law was an abomination. They had nothing to do with the law. They would preach Christ, as they called it; but without one word either of holiness or good works. Yet these were still denominated *Methodists*, although differing from Mr Whitefield both in judgment and practice, abundantly more than Mr Whitefield did from Mr Wesley.

In the mean time, Mr Venn and Mr Romaine began to be spoken of: and not long after Mr Madan and Mr Berridge, with a few other clergymen, who, although they had no connexion with each other, yet preaching salvation by faith, and endeavouring to live accordingly, to be Bible Christians, were soon included in the general name of *Methodists*. And so indeed were all others who preached salvation by faith, and appeared more serious than their neighbours. Some of these were quite regular in their manner of preaching: some were quite irregular, (though not by choice; but necessity was laid upon them, they must preach irregularly, or not at all): and others were between both; regular in most, though not in all particulars.

In 1762, George Bell and a few other persons began to speak great words. In the latter end of the year they foretold that the world would be at an end on the 28th of February. Mr Wesley, with whom they were then connected, withstood them both in public and private. This they would not endure: so, in January and February 1763, they separated from him, under the care of Mr Maxfield, one of Mr Wesley's preachers. But still Mr Maxfield and his adherents,

rents, even the wildest enthusiasts among them, go under the general name of *Methodists*, and so bring a scandal upon those with whom they have no connexion.

At present, those who remain with Mr Wesley are mostly Church of England men. They love her articles, her homilies, her liturgy, her discipline, and unwillingly vary from it in any instance. Mean time, all who preach among them declare, *we are all by nature children of wrath*, but *by grace we are saved through faith*: saved from both the guilt and from the power of sin. They endeavour to live according to what they preach, to be plain Bible Christians; and they meet together at convenient times, to encourage one another therein. They tenderly love many that are Calvinists, though they do not love their opinions. Yea, they love the Antinomians themselves; but it is with a love of compassion only, for they hate their doctrines with a perfect hatred; they abhor them as they do hell fire: being convinced nothing can so effectually destroy all faith, all holiness, and all good works.

We shall conclude this article with the words of Mr Hampson, which must certainly be accounted just, whatever objections may be made to some parts of the principles or behaviour of the Methodists. "If they possess not much knowledge, which, however, we do not know to be the case, it is at least certain, they are not deficient in zeal: and without any passionate desire to imitate their example, we may at least commend their endeavours for the general good. Every good man will contemplate with pleasure the operation of the spirit of reformation, whether foreign or domestic; and will rejoice in every attempt to propagate Christianity in the barbarous parts of the world. An attempt which, if in any tolerable degree successful, will do infinitely more for their civilization and happiness, than all the united energies of those boasted benefactors of mankind, the philosophic infidels."

The minutes of the conference of the Methodists held at Leeds in August, 1806, represent the numbers of that society to be as follows:

In Great Britain,	-	-	110,803
In Ireland,	-	-	23,773
Gibraltar,	-	-	40
Nova Scotia, New Brunswick, and Newfoundland,	-	-	1418
West Indies, whites 1775, coloured people 13,165,	-	-	14,940
United States, whites 95,628, coloured people 24,316,	-	-	119,945
		Total,	270,919

METHODISTS (*Methodici*), in the history of medicine, a sect of ancient physicians, who reduced the whole art of healing to a few common principles or appearances. The Methodists were the followers of Thessalus; whence they were also called *Thessalici*. They were strenuously opposed by Galen in several of his writings; who scrupled not to assert, that the methodical heresy ruined every thing that was good in the art. According to Quincy, the *Methodists* (*Methodici*) are those physicians who adhere to the doctrine of Galen, and the schools; and who cure with bleeding, purges, &c. duly applied according to the symptoms, circumstances, &c. in opposition to empirics and chemists, who use violent medicines, and pretended secrets or nostrums.

METHUSELAH, the son of Enoch and father of Lamech, was born in the year of the world 687, begat Lamech in 874, and died in 1656, being the very year of the deluge, at the age of 969, which is the greatest age that has been attained to by any mortal man upon earth (Gen. v. 21, 22, &c.). According to the text of the septuagint, Methuselah must have lived 14 years after the deluge; and according to other copies, he died six years before it: but it is generally agreed on, that these copies, as well as the septuagint, are corrupted in this place.

METHYMNA, in *Ancient Geography*, a town of the island of Lesbos. It was the second city of the island in greatness, population, and opulence. Its territory was fruitful, and the wines it produced excellent. It was the native place of Theophrastus, and of Arion the musician. When the whole island of Lesbos revolted from the power of the Athenians, Methymna alone remained firm to its ancient allies.

METOECI, a name given by the Athenians to such as had their fixed habitations in Attica, though foreigners by birth. The *metœci* were admitted by the council of Areopagus, and entered in the public register. They differed both from the πολῖται and ξενοι; because the *politæ* or "citizens" were freemen of Athens, and the *xeni* or "strangers" had lodgings only for a short time; whereas the *metœci* though not freemen of Athens, constantly resided upon the spot whither they had removed.

METONYMY, in *Rhetoric*, is a trope in which one name is put for another, on account of the near relation there is between them. See ORATORY, N° 51.

METOPE, in *Architecture*, is the interval or square space between the triglyphs of the Doric frieze, which among the ancients used to be painted or adorned with carved work, representing the heads of oxen or utensils used in sacrifices.

METOPOSCOPY, the pretended art of knowing a person's dispositions and manners by viewing the traces and lines in the face. Ciro Spontoni, who has written expressly on metoposcopy, says, that seven lines are examined in the forehead, and that each line is considered as having its particular planet: the first is the line of Saturn, the second of Jupiter, the third of Mars, &c. Metoposcopy is only a branch of physiognomy, which founds its conjectures on all the parts of the body.

METRE, μετρια, in *Poetry*, a system of feet of a just length.

The different metres in poetry, are the different manners of ordering and combining the quantities, or the long and short syllables; thus hexameter, pentameter, iambic, sapphic verses, &c. consist of different metres or measures. See HEXAMETER.

In English verses, the metres are extremely various and arbitrary, every poet being at liberty to introduce any new form that he pleases. The most usual are the heroic, generally consisting of five long and five short syllables, and verses of four feet, and of three feet, and a cæsura or single syllable.

The ancients, by variously combining and transposing their quantities, made a vast variety of different measures,

measures, by forming spondees, &c. of different feet. See POETRY.

METRETES, a Grecian measure, containing something more than nine English gallons. See MEASURE.

METRICAL VERSES, are those consisting of a determinate number of long and short syllables; as those of the Greek and Latin poets.—Capellus observes, that the genius of the Hebrew language is incompatible with metrical poetry.

METROCOMIA (from μητηρ, *mother*, and κωμη, *town* or *village*), a term in the ancient church-history, signifying "a borough or village that had other villages under its jurisdiction."—What a metropolis was among cities, a *metracomia* was among country towns. The ancient *metrocomiæ* had each its choriepiscopus or rural dean, and here was his see or residence. See METROPOLIS and CHORIEPISCOPUS.

METRONOMI, the name given by the Athenians to five officers in the city and ten in the *Piræus*, whose duty it was to inspect all sorts of measures except those of corn. The *Piræus* was the greatest mart in Attica.

METROPOLIS (from μητηρ, *mother*, and πολις, *city*), the capital of a country or province; or the principal city, and as it were mother of all the rest.

The term METROPOLIS is also applied to archiepiscopal churches, and sometimes to the principal or mother-church of a city. The Roman empire having been divided into 13 dioceses and 120 provinces, each diocese and each province had its metropolis or capital city, where the proconsul had his residence. To this civil division the ecclesiastical was afterwards adapted, and the bishop of the capital city had the direction of affairs, and the pre-eminence over all the bishops of the province. His residence in the metropolis gave him the title of *metropolitan*. This erection of metropolitans is referred to the end of the third century, and was confirmed by the council of Nice. A metropolitan has the privilege of ordaining his suffragans; and appeals from sentences passed by the suffragans are preferred to the metropolitan.

METROPOLIS, in *Ancient Geography*, a town of Acarnania, a little to the south of Stratos.—Another, of Lydia; situated between Colophon and Priene, near the Caÿster.—A third, of Phrygia; sacred to the mother of the gods, who was here worshipped.—A fourth Metropolis of Estiotis, a district in Thessaly, to the east of Gomphi, and the last town of that district. *Metropolitæ*, the people.

METULUM, in *Ancient Geography*, a considerable city of Liburnia, at the siege of which Octavius Cæsar was wounded. Said to be the metropolis, and situated on two eminences, intersected by a valley (Appian). Now generally thought to be *Metling* in Carniola. E. Long. 16. N. Lat. 46. 5.

METZ, an ancient, large, and strong town of France, and capital of the territory of Messin, with a citadel and a bishop's see, whose bishop used to hold the title of a prince of the empire. The cathedral church is one of the finest in Europe, and the square called *Coslin* and the house of the governor are worth seeing. The Jews live in a part of the town by themselves, where they have a synagogue. The sweetmeats they make here are in high esteem. It is seated at the confluence of the rivers Moselle and Seille. E. Long. 6. 16. N. Lat. 49. 7.

MEVANIA, in *Ancient Geography*, a town of the Cisapennine Umbria; seated at the confluence of the Tina and Clitumnus, on the Via Flaminia, famous for its herds of white cattle brought up there for sacrifice; the white colour said to be owing to the waters of the Clitumnus (Virgil). Mevania was the country of Propertius. *Mevenates* the people. Now said to be *Bevagna*, in the territory of the Pope.

MEURSIUS, JOHN, a learned and laborious writer, was born at Losdun, near the Hague, in 1579. He early discovered a fondness for polite literature and the sciences; and went to study law at Orleans with the son of Barneveldt, whom he accompanied in his travels. In 1610 he was made professor of history at Leyden, and afterwards Greek professor. In the following year, the magistrates of the United Provinces proved how high their opinion was of his abilities, by fixing on him to write the history of his country. Meursius married in the year 1612. His wife, Anna Catherina Bilberbeccia, descended from a very ancient and noble family in Angermond a city of Pomerania, possessed many amiable qualities, and rendered his domestic life remarkably happy, while he discharged the duties of his professorship with an assiduity equal to his abilities. At the same time the republic of letters did not lose the advantages to be derived from his labours; for during the fourteen years of his residence at Leyden, the works which he published were more numerous than those which had been presented to the world by the whole body of professors from the original foundation of the university in 1575.

Meursius's writings had now spread his reputation in every part of Europe; nor was the fame of his diligence and talents as a professor less known. In so high a rank, indeed, did he stand among his literary contemporaries, that Christian IV. king of Denmark conferred on him the place of historiographer royal, and invited him to undertake the professorship of history and politics in the academy of Sora, which was founded by King Frederick II. although the revival of its honours and dignities may be dated from this period, when it seemed to be again founded under the auspices of Christian IV. Meursius and his family left Leyden in the year 1635. On his arrival at Sora, he was received with the most friendly tokens of regard by his majesty and the Danish nobility, and more particularly by Chancellor Rosenkrantz, on whom he has bestowed very ample praises in one of his letters. Here he resided, equally beloved and admired, for above twelve years. His pupils were not very numerous, but his exertions never relaxed. Those hours likewise which were not devoted to the duties of his professorship, he employed in revising the works of the ancients and in philological disquisitions.

His health did not suffer by the intenseness of application, till in the year 1638 he had a violent attack of the stone, from which disorder he had suffered severely. In a letter to Vossius he thus describes his melancholy condition: "The state of my health during the whole of the last winter has been truly deplorable. My sufferings from the stone have been really

Meursius. really dreadful. I have voided so many, that the repeated discharges brought on a wound which emitted blood for above four months. I was next attacked by a tertian fever, which increased constantly, and produced an universal lassitude of body, a dejection of spirits, and a total loss of appetite. But, thank heaven, I have now in some measure recovered my strength, and gotten the better of these complaints." He recovered from this attack; but in the following year the disorder returned with redoubled violence, and brought on a consumption, which terminated his existence on the 20th day of September 1639. He left behind him a son who was named after him, and one daughter.

So mild were the dispositions of Meursius, that in all his writings he constantly avoided literary disputes. He was sometimes unavoidably drawn into them; but constantly endeavoured to promote a reconciliation rather than widen any breach, by his replies to the attacks of his adversaries. In his friendships he was firm and affectionate. Of his domestic life, whatever is known has been gathered from his letters. The same easy tranquillity seems to have attended him in every situation. In his family he was particularly fortunate. In his son, to whom he gave his own name, he seemed to behold his own youth renewed. The same application, the same eagerness in the pursuit of knowledge, marked the conduct of this promising young man; who did not long survive his father, but died soon after he had recommended himself to the notice of the learned world by his publications. They were only three in number; but displayed so much solid learning that they have been assigned to the father, John Meursius, by l'Abbé Beughem and others. This mistake was occasioned as much by the similitude of their names, as by the nature of their works, and their manner of treating philological subjects.

His works may be divided into four classes, of which each might form a separate volume if they were ever to be republished. Meursius himself indeed, in one of his letters to Vossius, proposes such a division. From that epistle, and from another which the younger Meursius sent to G. I. Vossius, who strongly advised him to republish the whole of his father's writings, and from the collections of his posthumous works which have appeared from Struvius, Groschupsius, Moller, and some others, a catalogue of his works might be formed. Some assistance will also be derived from the indexes published in their respective works, by Hankins, Desselius, Wettenius, and Bartholinus. The plan which Meursius recommends for publishing his works, is to insert in the first volume all that he has written relative to Athens; in the second, his historical pieces; in the third, his miscellaneous dissertations; and in the fourth, the various authors which he published, with his notes and corrections.

A scandalous and indecent work, which is entitled *Meursii elegantiæ Latini sermonis*, and has *Aloisiæ Sigeæ Satyræ Sotadicæ* annexed to it, is very falsely attributed to Meursius; nor indeed are the *Satires* with more reason assigned to Aloisia Sigea, who was a Spanish lady eminent for her piety and virtue. The real author of these infamous productions was Westrenius, an advocate at Copenhagen, who probably assumed the name of Meursius, in order to shield himself from the disgrace which would naturally have attended the writer of such a performance.

Meursius || Mexico.

MEW, SEA-MEW, or *Sea-mall*. } See LARUS, ORNI-
Winter MEW, or *Coddy-moddy*. } THOLOGY *Index*.

MEWING, the falling off or change of hair, feathers, skin, horns, or other parts of animals, which happens in some annually, in others only at certain stages of their lives; but the generality of beasts mew in the spring. An old hart casts his horns sooner than a young one, which is commonly in the months of February and March, after which they begin to button in March or April: and as the sun grows strong, and the season of the year puts forth the fruits of the earth, so their heads grow, and are summed full by the middle of June. It is to be observed, that if a hart be gelt before he has a head, he will never have any; and if he be gelt after he has a head, he will never cast his horns; again, if he be gelt when he has a velvet head, it will always be so, without fraying or burnishing.

MEXICO, a province of the Spanish empire in America, once a celebrated kingdom, the most powerful and civilized in the new world; lying between the 14th and 21st degrees of north latitude, and between 91 and 103 degrees west longitude; being near 2000 miles in length, and in some places 600 miles in breadth.

1 Toltecans the first inhabitants.

The Toltecans are the most ancient Mexican nation of which we know any thing. They were expelled, as we are told, from their own country (supposed by Clavigero to have been *Tollan*, to the northward of Mexico) in the year 472; and for some time led a wandering life. In whatever place they determined to reside for any considerable time, they erected houses and cultivated the ground. Thus their migrations were extremely slow, and it was not till 104 years after they set out that they reached a place about 50 miles to the eastward of the city of Mexico, where they settled for 20 years, giving to their new place of residence the name of *Tollantzinco*. From thence they proceeded about 40 miles farther to the west, where they built a city called, from the name of their country, *Tollan*, or *Tula*.

2 Their history.

After the final settlement of the Toltecans, the government was changed into a monarchy. Their first king began his reign in 667, and their monarchy lasted 384 years, during which time they reckon just eight princes. We are not, however, to imagine that each of their kings lived long enough to make up this space. It was a custom among them that the name of the king should be continued for 52 years, and no longer, from the time he ascended the throne. If he died within that period, the government was carried on in his name by a regency; if he survived, he was obliged to resign his authority. During the four centuries that the Toltecan monarchy continued, they had increased very considerably in number, and had built many cities; but when in the height of prosperity, almost the whole nation was destroyed by a famine occasioned by drought; and a pestilence, probably the consequence of the former. "According to Torquemada (says our author), at a certain festival-ball made by the *Toltecans*, the *sad-looking* devil appeared to them of a gigantic size, with immense arms, and in the midst of the entertainment he embraced and suffocated them; that then he appeared in the form of a child with a putrid head, and

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and brought the plague; and, finally, at the persuasion of the same devil, they abandoned the country of Tula."

3 Succeeded by the Chichemecas.

They were succeeded by the Chichemecas, a much more barbarous people, who came from an unknown country called *Amaquemecan*, where they had for a long time resided; but of which no traces of remembrance can be found among any of the American nations known to Europeans; so that Clavigero supposes it must have been very far to the northward.

The motive which the Chichemecas had for leaving their own country is not known. They were eighteen months on their journey, and took possession of the desolate country of the Toltecas about an hundred years after the former had left it. They were much more uncivilized than the Toltecans; but, however, had a regular form of monarchical government, and in other respects were less disgusting in their manners than some of the neighbouring nations. The last king who reigned in Amaquemecan before the departure of the Chichemecas, had left his dominions between his two sons Auchcauhtli and Xolotl, and the latter conducted the new colony. Having proceeded from the ruins of Tula towards Chempoalla and Tepepolio, Xolotl sent his son to survey the country. The prince crossed the borders of the lakes and the mountains which surround the vale of Mexico; then ascending to the top of a very high one, he viewed the whole country, and took possession of it in the name of his father, by shooting four arrows to the four winds.

4 Xolotl their first king.

Xolotl being informed by his son of the nature of the country, chose for the capital of his kingdom Tenayuca, about six miles to the northward of the city of Mexico, and distributed his people in the neighbouring territory; but as most of them went to the northward, that part obtained the name of the country of the Chichemecas, in distinction from the rest. Here a review of the people was taken, and their number, according to Torquemada, was more than a million.

Xolotl finding himself peacefully settled in his new dominion, sent one of his officers to explore the sources of some of the rivers of the country. While performing this task he came to the habitations of some Toltecans, who it seems had still kept together, and were likely once more to become a nation. As these people were not inclined to war, and greatly esteemed for their knowledge and skill in the arts, the Chichemecas entered into a strict alliance with them, and Prince Nopaltzin, who had first surveyed the country, married a Toltecan princess. The consequence of this alliance was the introduction of the arts and knowledge of the Toltecans among the Chichemecas. Till now the latter had subsisted entirely by hunting, and such fruits and roots as the earth spontaneously produced. They were clad in the skins of wild beasts, and, like these beasts, they are said to have sucked the blood of the animals they caught; but after their connection with the Toltecans they began to sow corn, to learn the art of digging and working metals, to cut stones, manufacture cotton, and, in every respect, to make great improvements.

5 His people civilized by the Toltecans.

6 New inhabitants arrive and obtain settlements.

When Xolotl had reigned about eight years in his new territories, an embassy of six persons arrived from a distant country not far from *Amaquemecan*, expressing a desire of coming with their people to reside in the country of the Chichemecas. The king gave them a gracious reception, and assigned them a district; and, in a few years after, three other princes, with a great army of Acolhuans, who were likewise neighbours of Amaquemecan, made their appearance. The king was at that time at Tezcuco, to which place he had removed his court: and here he was accosted by the princes, who, in a submissive and flattering manner, requested him to allow them a place in his happy country, where the people enjoyed such an excellent government. Xolotl not only gave them a favourable reception, but offered them his two daughters in marriage, expressing his concern that he had no more, that none might have been excluded from the royal alliance. On the third prince, however, he bestowed a noble virgin of Chalco, in whom the Toltecan and Chichemecan blood were united. The nuptials were celebrated with extraordinary pomp; and the two nations, after the example of the sovereigns, continued to intermarry. As the Acolhuans were the more civilized nation of the two, the name of Chichemecas began to be appropriated to the more rude and barbarous part, who preferred hunting to agriculture, or chose a life of savage liberty in the mountains to the restraints of social laws. These barbarians associated with the Otomies, another savage nation who lived to the northward, occupying a tract of more than three hundred miles in extent; and by their descendants the Spaniards were harassed for many years after the conquest of Mexico.

7 Division of the dominions of Xolotl.

As soon as the nuptial rejoicings were over, Xolotl divided his territories into three parts, assigning one to each of the princes. Acolhuatzin, who had married his eldest daughter, had Azcopazalco, 18 miles to the westward of Tezcuco; Chiconquauhtli, who married the other, had a territory named Xaltocan; and Tzontecomatl, who married the lady of inferior rank, had one named Coatlichan. The country continued for some time to flourish, population increased greatly, and with it the civilization of the people; but as these advanced, the vices of luxury and ambition increased in proportion. Xolotl found himself obliged to treat his subjects with more severity than formerly, and even to put some of them to death.—This produced a conspiracy against him, which, however, he had the good fortune to escape; but while he meditated a severe revenge on the conspirators, he was seized with the distemper of which he died, in the fortieth year of his reign, and in a very advanced age.

8 Nopaltzin the second king.

Xolotl was succeeded by his son Nopaltzin, who at the time of his accession is supposed to have been about sixty years of age. In his time, the tranquillity of the kingdom, which had begun to suffer disturbance under his father, underwent much more violent shocks, and civil wars took place. Acolhuatzin, the only one of the three princes who remained alive, thinking the territory he possessed too narrow, made war upon the lord of a neighbouring province named Tapotzotlan, and deprived him of his territory. Huetzin, son to the late Prince Tzontecomatl, lord of Coatlichan, fell in love with the grand-daughter of the queen, a celebrated beauty, but was rivalled by a neighbouring lord, who determined to support his pretensions

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pretensions by force of arms. Huetzin, however, got the better, defeated and killed his adversary, and then possessed himself of the lady and his estate. This was followed by a rebellion of the whole province of Tollantzinco, so that the king himself was obliged to take the field. As the rebels were very numerous, the royal army was at first defeated; but having at last received a strong reinforcement, the rebels were overcome, and their ringleaders severely punished. The king did not long survive the restoration of tranquillity to his dominions. He died in the thirty-second year of his reign, and ninety-second of his age, leaving the throne to his eldest son Tlotzin, who was an excellent prince, and reigned thirty-six years.

9 Quinatzin a luxurious prince.

Quinatzin, the son and successor of Tlotzin, proved a vain and luxurious prince. His accession to the throne was celebrated with much greater pomp than any of his predecessors. Xolotl had removed his court from Tenayuca to Tezcuco; but being disgusted with this last place, on account of the conspiracy formed against him there, he had returned to Tenayuca.—There the court continued till the reign of Quinatzin, who removed it back to Tezcuco.

10 Disturbances in various parts.

The reign of Quinatzin, though tranquil at first, was soon disturbed by dangerous revolts and rebellions. These first broke out in two states, named Maztitlan and Totopec, situated among the northern mountains. The king, having collected a great army, marched without delay against the rebels, and challenged their leaders to come down and fight him in the plain.—This challenge being accepted, a furious engagement ensued, in which, though great numbers fell on both sides, no decisive advantage was gained by either party. Frequent engagements took place for the space of forty days, until at last the rebels, perceiving that their own numbers were daily diminishing, without any possibility of being recruited like the royal army, made a final surrender to the king, who punished the ringleaders with great severity. Tranquillity, however, was not yet restored: the rebellion spread to such a degree, that the king was obliged not only to take the field in person, but to employ six other armies, under the command of faithful and experienced generals, to reduce the rebels. Those proved so successful in their enterprises, that in a short time the rebellious cities were reduced to obedience, and the kingdom enjoyed the blessings of peace during the long reign of Quinatzin, who is said to have sat on the throne for no less than sixty years. He was succeeded by his son Techotlatla; but as the affairs of the Acolhuans now began to be connected with those of the Mexicans, it will be proper to give some account of that people.

11 Migrations of the Mexicans.

The Mexicans, called also the Aztecas, dwelt till the year 1160 in a country called *Aztlan*, situated to the north of the gulf of California, as appears by the route they pursued in their journey; but how far to the northward we are not certainly informed. Betancourt makes it no less than 2700 miles, and Boturini says it was a province of Asia. The cause of their migration is said to have been as follows:

Among the Aztecas was a person of great authority, named *Huiztilin*, to whose opinion every one paid the utmost deference. He had conceived a design to persuade his countrymen to change their residence; and to effect this he fell upon the following stratagem. Having heard, while meditating on his scheme, a little bird singing on the branches of a tree, the notes of which resembled the word *Tihui*, which in the Azteca language signified "let us go," he took that opportunity to work upon the superstition of the people. With this view, he took along with him a respectable person, and made him attend to the note of the bird. "What can it mean (says he), but that we must leave this country, and find ourselves another? Without doubt it is the warning of some secret divinity who watches over our welfare: let us obey, therefore, his voice, and not draw his anger upon us by a refusal." Tecpaltzin, for that was the name of his friend, readily agreed to the interpretation; and both of them being persons of great influence, their united persuasions soon gained over to their project the bulk of the nation, and they accordingly set out.

12 Separation of the tribes.

The Aztecas, when they left their original habitations, were divided into six tribes; but at Culiacan the Mexicans were left with their god * by five of them, viz. the Xochimilcas, Tepanecas, Chalcese, Tlahuicas, and Tlascalans. The cause of this separation is not known, but it was probably occasioned by some disagreement among themselves; for the remaining tribe was divided into two violent factions, which persecuted one another: neither did they afterwards construct any more edifices. However, they always travelled together, in order to enjoy the company of their imaginary god. At every place where they stopped an altar was erected to him; and at their departure they left behind them all their sick, and probably also some others to take care of them, or such as were not willing to endure the fatigue of farther journeys. They stopped in Tula nine years, and eleven more in the neighbouring parts. At last, in 1216, they arrived at Zumpanco, a considerable city in the vale of Mexico, where they were received in a very hospitable manner by the lord of that district. He not only assigned them proper habitations, but became very much attached to them; and even demanded from among them a wife for his son Ilhuicatl. This request was complied with; and from this marriage all the Mexican kings descended.

* *A wooden image.*

13 The Mexicans persecuted,

The Mexicans continued to migrate from one place to another along the lake of Tezcuco. Xolotl, who was then on the throne of the Acolhuans or Chichemecas, allowed them to settle in whatever places of his dominions they thought proper; but some of them finding themselves harassed by a neighbouring lord, were obliged, in 1245, to retire to Chapoltepec, a mountain on the western borders of the lake, scarcely two miles distant from the site of Mexico. This took place in the reign of Nopaltzin, when disturbances began to take place in the Acolhuan dominions. The Mexicans, however, did not find themselves any more secure in their new place of residence than formerly: they were persecuted by the neighbouring lords, and obliged to take refuge in a number of small islands, named *Acocolco*, at the southern extremity of the lake of Mexico. Here for 52 years they lived in the most miserable manner, subsisting on fish, insects, roots, &c. and clothing themselves with the leaves of the amoxtli, which abounds in that lake.

14 and enslaved.

In this miserable plight the Mexicans continued till the year 1314, when they were reduced to a state of the

the most absolute slavery. This was done by the king of a petty state named Colhuacan, who, it is said, being unwilling to allow the Mexicans to maintain themselves in his territories without paying tribute, made war upon them, subdued and enslaved them. Others affirm that, pretending compassion for their miserable situation, he offered them a more commodious place of residence. The Mexicans readily accepted the offer; but had scarcely set out to take possession of their new place of residence when they were attacked by the Colhuans, made prisoners, and carried off for slaves.

15 Regain their liberty by cruelty.

After some years a war broke out betwixt the Colhuans and Xochimilcas, in which the latter gained such advantages, that they were obliged to employ their slaves to assist them. They accordingly ordered them to prepare for war, but without furnishing them with arms necessary for a military enterprise; so that the Mexicans were obliged to content themselves with long staves, having their points hardened in the fire; they also made knives of the stone itztli, and shields of reeds woven together. They agreed not to waste their time in making prisoners, but to content themselves with cutting off one ear of their enemies, and then leaving them without farther injury. They adhered punctually to this resolution; and rushing furiously upon the Xochimilcas, cut off an ear from as many as they could, killing those who struggled to such a degree that they could not effect their purpose. In short, so well did the Mexicans acquit themselves in this engagement, that the Xochimilcas fled, and took refuge among the mountains. After the battle, the Colhuan soldiers presented themselves before their general with the prisoners they had taken, by the number of which alone they judged of their valour. The Mexicans had taken only four, and these they kept concealed for the abominable purpose of sacrificing them. The Colhuans, therefore, seeing no trophies of their valour, began to reproach them with cowardice; but the Mexicans, producing their baskets of ears, desired them to judge from these how many prisoners they might have taken, had they not been unwilling to retard their victory by taking up time in binding them.

Notwithstanding the valour displayed by the Mexicans in this engagement, it doth not appear that their haughty masters were in the least inclined to afford them easier terms than before. Having erected an altar to their god, they demanded of their lord something precious to offer in sacrifice to him; but he in disdain sent them a dirty cloth, enclosing the filthy carcass of a vile bird. This was carried by Colhuan priests; and without any ceremony laid upon the altar. The Mexicans, with apparent unconcern, removed this filthy offering, and put in its place a knife made of itztli, and an odoriferous herb. On the day of consecration, the Colhuan prince attended with his nobility; not with a view to do honour to the festival, but to make a mockery of the Mexicans. Their derision, however, was soon changed into horror, when the Mexicans, after a solemn dance, brought forth the four Xochimilcan prisoners they had taken; and, after having made them dance a little, cut open their breasts with the knife which lay on the altar, and plucking out their hearts, offered them, while yet palpitating with life, to their diabolical idol. This had such an effect upon the spectators, that both king and subjects desired the Mexicans

16 The first human sacrifice in Mexico.

3

immediately to quit their territories and go where they pleased. This order was instantly obeyed: the whole nation took their route towards the north, until they came to a place named *Acatzitzintlan*, situated betwixt two lakes, and afterwards named *Mexicaltzinco*; but for some reason or other, being discontented with this situation, as indeed they seem very often to have been, they proceeded to *Iztacalco*, still nearer to the site of Mexico. Here they formed the image of a little mountain of paper, and danced round it a whole night, singing their victory over the Xochimilcas, and reuniting thanks to their god for having freed them from the yoke of the Colhuans. Clavigero is of opinion, that by this mountain they represented Colhuacan, as in their pictures it was always represented by a hunch-backed mountain; and this is the literal signification of the name.

17 The city of Mexico founded.

The city of Mexico was founded in the year 1325, in the most incommodious situation we can imagine, viz. on a small island named Tenochtitlan, in the middle of a great lake, without ground to cultivate for their subsistence, or even room sufficient to build their habitations. Their life was therefore as miserable here for some time as it had been when they were on the islands at the end of the lake, and they were reduced to the same shifts to maintain themselves. To enlarge the boundaries of their island, they drove palisades into those parts of the water which were most shallow, terracing them with stones and turf, and uniting to their principal island several other smaller ones which lay in the neighbourhood. To procure to themselves afterwards stones, wood, &c. for constructing their habitations, as well as clothing and other necessaries, they instituted a commerce with the people who dwelt on the borders of the lake, supplying them with fish, waterfowl, and other more minute inhabitants of the lake and marshes, which they contrived to render eatable; and in return for all this they received the necessaries above mentioned. The greatest effort of their industry, however, was the construction of floating gardens, by means of bushes and the mud of the lake; and these they brought to such perfection that they produced maize, pepper, chia, French beans, and gourds.

18 The two factions separate.

For thirteen years that the Mexicans had to struggle with extreme difficulty, they remained at peace; but no sooner did they begin to prosper and live comfortably, than the inveterate enmity betwixt the two factions broke out in all its fury. This produced a separation; and one of the parties took up their residence on a small island at a little distance to the northward, which, from a heap of sand found there, they at first named *Xaltilolco*, but afterwards *Tlatelolco*, from a terrace constructed by themselves. This island was afterwards united to that of Tenochtitlan.

About this time the Mexicans divided their city into four parts, a division which still subsists; each quarter having now its tutelar saint, as it had formerly its tutelar god. In the midst of their city was the sanctuary of their great god *Mexitli*, whom they constantly preferred to all the rest. To him they daily performed acts of adoration: but instead of making any progress in humanity, they seem to have daily improved in the most horrible barbarities, at least in their religion. The dreadful sacrifices made of their prisoners, could only be exceeded by that which we are now about to relate.

19 Monstrous barbarity of their religion.

relate.

relate. Being now on a more reſpectable footing than formerly, they ſent an embaſſy to the petty king of Colhuacan, requeſting him to ſend them one of his daughters, that ſhe might be conſecrated the mother of their protecting god. The unſuſpecting prince readily complied with their deſire.—The unfortunate princeſs was conducted in great triumph to Mexico; but no ſooner was ſhe arrived, than ſhe was ſacrificed in a ſhocking manner; and, to add to the horror of the deed, the body was flayed, and one of the braveſt young men of the nation dreſſed in her ſkin. Her father, ignorant of this dreadful tranſaction, was invited by the Mexicans to be preſent at the apotheoſis of his daughter, and went to ſee the ſolemnity, and to worſhip the new divinity. He was led into the ſanctuary, where the young man ſtood clothed in the bloody ſkin of his daughter; but the darkneſs of the place prevented him from ſeeing what was before him. They gave him a cenſer in his hand, and ſome copal to begin his worſhip; but having diſcovered by the flame of the copal the horrible ſpectacle, he ran out in a diſtracted manner, calling upon his people to revenge the injury; but this they were not able to do at that time nor ever after.

In the year 1352 the Mexican government was changed from an ariſtocracy to a monarchy. At firſt they were governed by 20 lords, of whom one had an authority ſuperior to the reſt. This naturally ſuggeſted the idea of monarchy; and to this change they were alſo induced by the contemptible ſtate in which their nation ſtill continued, thinking that the royal dignity would confer upon it a degree of ſplendour which otherwiſe it could not enjoy; and that by having one leader, they would be better able to oppoſe their enemies. Proceeding, therefore, to elect a king, the choice fell upon Acamapitzin, a man of great eſtimation among them, and deſcended from Opochtli, a noble Aztecan, and a princeſs of the royal family of Colhuacan. As he was yet a bachelor, they attempted to negociate a marriage, firſt with the daughter of the lord of Tacuba, and then of the king of Azcapozalco: but theſe propoſals being rejected with diſdain, they applied to Acolmiztli lord of Coatlichan, and a deſcendant of one of the three Acolhuan princes; who complied with their requeſt, and the nuptials were celebrated with great rejoicings.

20 Acamapitzin the firſt king of Mexico.

21 The Tlatelolcos alſo chooſe a king.

In the mean time, the Tlatelolcos, the natural rivals of the Mexicans, reſolved not to be behind them in any thing which had the leaſt appearance of augmenting the glory of their ſtate. They likewiſe, therefore, choſe a king; but not thinking proper to chooſe him from among themſelves, they applied to the king of the Tepanecas, who readily ſent them his ſon; and he was crowned firſt king of Tlatelolco in 1353. In this the Tlatelolcos ſeem to have had a deſign of humbling their rivals, as well as rendering themſelves more reſpectable; and therefore it is probable, that they had repreſented the Mexicans as wanting in that reſpect due to the Trepanecan monarch, as having elected a king without his leave, though at the ſame time they were tributaries to him. The conſequence of this was, that he took a reſolution to double their tribute. Hitherto they had paid only a certain number of fiſh and waterfowl; but now they were ordered to bring alſo ſeveral thouſands of fir and willow plants to be ſet in the roads and gardens of Azcapozalco, and to tranſport to the court a great floating garden, which produced vegetables of every kind known in Anahuac. This being accompliſhed with great difficulty, the king commanded them next year to bring him another garden, with a duck and ſwan in it both ſitting upon eggs; but ſo, that on their arrival at Azcapozalco the brood might be ready to hatch. This was alſo done; and the prince had the ſatisfaction of ſeeing the young birds come out of the eggs. The third year they were ordered to bring a live ſtag along with a garden. This was more difficult than any of the former taſks; becauſe they were obliged, in order to hunt the ſtag, to go to the mountains of the continent, where they were in danger of falling into the hands of their enemies; however, this alſo was accompliſhed, and the deſire of the king gratified.

22 Mexicans oppreſſed.

In this manner the Mexicans were oppreſſed for no leſs than 50 years. They freed themſelves, however, from all their difficulties by vigorous exertions, abſurdly aſcribing to the protection of that malevolent being whom they worſhipped the glory of every deliverance. Acamapitzin governed this city, which at that time comprehended the whole of his dominions, for 37 years in peace. His queen being barren, he married another wife, but without abandoning the firſt; and theſe two, inſtead of being rivals to one another, lived together in the utmoſt harmony; the firſt wife taking upon herſelf the charge of educating *Huitzilihuitl*, the ſon of the ſecond. He had, beſides, ſeveral children by other women, and one named *Itzcoatl*, who afterwards proved one of the beſt and moſt renowned kings who ſat on the throne of Mexico. He is ſaid alſo to have conquered four conſiderable cities; but Clavigero thinks he muſt in this only have been an auxiliary, it being very improbable, that while he could ſcarce maintain his own territories, he ſhould think of foreign conqueſts.

Acamapitzin died in 1389, greatly lamented by the Mexicans, and his death was followed by an interregnum of four months. As the deceaſed monarch had formerly reſigned his authority into the hands of his nobles, it was neceſſary that a new election ſhould take place; and when this was done, the choice fell upon Huitzilihuitl, the ſon of Acamapitzin. As he was ſtill unmarried, it was reſolved, if poſſible, to procure him an honourable and advantageous match. With this view, a deputation of nobility was ſent to the king of Azcapozalco, requeſting, in very humble terms, an alliance with one of his daughters. The expreſſions made uſe of by theſe ambaſſadors are ſaid by our author to have been particularly elegant in the Mexican language: but it is difficult to underſtand how a ſpeech made among a people ignorant of the art of writing could be particularly recorded at the interval of ſome hundreds of years after. They are as follow: "We beſeech you, with the moſt profound reſpect, to take compaſſion on our maſter and your ſervant Huitzilihuitl, confined among the thick ruſhes of the lake.—He is without a wife, and we without a queen.—Vouchſafe, Sir, to part with one of your jewels or moſt precious feathers. Give us one of your daughters, who may come to reign over us in a country which belongs to you."

23 Huitzilihuitl the ſecond king.

This

Mexico.

24 Marries a daughter of the king of the Tepanecans.

This piece of oratory had ſuch an effect upon the king, that he granted their requeſt, and a Tepanecan princeſs was conducted in great triumph to Mexico, where the marriage was ſolemnized with the utmoſt joy. Though this princeſs brought him a ſon the firſt year of their marriage, the king, in order to ſtrengthen himſelf by freſh alliances, married alſo the daughter of another prince, by whom he had Montezuma *Ilhuicamina*, the moſt celebrated of all the Mexican kings.

As the Mexicans advanced in wealth and power, ſo did their rivals the inhabitants of Tlatelolco.—Their firſt king died in 1399, leaving his ſubjects greatly improved in civilization, and the city much enlarged and beautified. The rivalſhip which ſubſiſted between the two cities had indeed greatly contributed to the aggrandizement of both. The Mexicans had formed ſo many alliances by marriage with the neighbouring nations, had ſo much improved their agriculture and floating gardens on the lake, and had built ſo many more veſſels to ſupply their extended commeree and fiſhing, that they were enabled to celebrate their ſecular year, anſwering to A. D. 1402, with greater magnificence than they had ever done ſince they left their original country of Atztlan.

25 Unfortunate reign of Techotlala's ſon.

All this time Techotlala, the ſon of Quinatzin, continued to reign in Acolhuacan, and for 30 years enjoyed uninterrupted tranquillity; but being now very far advanced in years, and finding his end approach, he called to him his ſon Ixtlilxochitl, and recommended to him to beware of the ambitious diſpoſition of the king of Azcapozalco, as he was apprehenſive that he might attempt ſomething againſt the peace of the empire. His ſuſpicions were verified; for on the death of Techotlala, which happened in 1406, the king of Azcapozalco, without making the uſual ſubmiſſions to the new king, to whom he was a feudatory, ſet out for his own territories, with a view to ſtir up the other feudatory princes to rebellion. Having called to him the kings of Mexico and Tlatelolco, he told them, that Techotlala, who had long tyrannized over that country, being dead, he deſigned to procure freedom to the princes, ſo that each might rule his own territory entirely independent of the king of Acolhuaean; but for this purpoſe he needed their aſſiſtance, and truſted to their well known ſpirit to take part with him in the enterpriſe. He informed them likewiſe, that in order to enſure ſucceſs, he would find means to unite other princes in the eonfederacy.

The new king of Acolhuacan, in the mean time, was employed in ſettling the affairs of his kingdom, and endeavouring to gain the good will of his ſubjects. The combination againſt him was ſoon diſcovered: but though Ixtlilxochitl was deſirous of heading his army in perſon, he was diſſuaded from ſo doing by his courtiers; ſo that the eonduct of the war was committed to his generals. To weaken the enemy, they ravaged the territories of ſix revolted ſtates: but, notwithſtanding this, and the ſuperior diſcipline of the royal army, the war was carried on by the rebels with great obſtinacy, their armies being conſtantly recruited by freſh troops in proportion to their loſſes. At laſt, after three years of a ruinous war, the king of Azcapozalco, finding that his reſources would at laſt fail him, ſued for peace; but with a deſign of accompliſhing by treachery what he had not yet been able to do by force. His adverſary, equally reduced with himſelf, conſented to a peace, though he knew very well that the Tepanecan prince intended to obſerve it no longer than ſuited his purpoſe.

26 Chimalpopoca third king of Mexico.

In the year 1409 died Huitzilihuitl king of Mexico, who likewiſe left the right of electing a ſucceſſor to the nobility. They made choice of his brother Chimalpopoca; and from thence it became an eſtabliſhed law to chooſe one of the brothers of the deceaſed king, or, if he had no brothers, to elect one of his grandſons. While the new prince was endeavouring to ſecure himſelf on the throne, the treacherous Tezozomoc uſed all means in his power to ſtrengthen the party he had formed againſt the king of Acolhuacan. In this he was attended with ſuch ſucceſs, that the unfortunate prince found himſelf reduced to the neceſſity of wandering among the neighbouring mountains, at the head of a ſmall army, accompanied by the lords of Huexotla and Coatlichan, who remained always faithful to him. The Tepanecans diſtreſſed him to ſuch a degree, by intercepting his proviſions, that he was forced to beg them of his enemies. One of his grandſons was ſent to Otompan, a rebel ſtate, to requeſt them to ſupply their king with the proviſions he ſtood in need of, and to exhort them to abandon the cauſe of the rebels, which they had eſpouſed. No taſk could be more dangerous; yet ſuch was the magnanimity of the young prince's diſpoſition, that he readily ſet out on the journey; nor was he deterred by the information he got that there were in the place certain Tepanecans who had come on purpoſe to publiſh a proclamation from Tezozomoc. He went boldly to the moſt public place of the town, and in preſence of thoſe who publiſhed the proclamation made known his requeſt. This heroiſm, however, did not meet with the ſucceſs it deſerved. His propoſitions were derided from the moment they were made; but the people did not offer any farther inſult, until one of the meaner ſort threw a ſtone at him, exciting others of the ſame ſtamp to put him to death. The Tepanecans, who had hitherto continued ſilent, perceiving their opportunity, joined in the general cry to kill the prince, and began alſo to throw ſtones. The prince attempted firſt to defend himſelf, and afterwards to eſcape by flight; but, both being equally impoſſible, he fell under a ſhower of ſtones. The Tepanecans exulted in this act of treachery, and ſoon after cut off Ixtlixochitl himſelf, after having treacherouſly perſuaded him to a conference with two of their captains. This perfidious act was committed in ſight of the royal army, who were too weak to revenge it; the royal corpſe was ſaved with difficulty; and *Nezahualcojotl*, heir apparent to the crown, was obliged to ſhelter himſelf among the buſhes from the fury of his enemies.

27 Diſtreſs and death of the king of Acolhuacan.

28 Acolhuacan conquered by Tezozomoc.

Tezozomoc having now in a great meaſure gained his point, proceeded to pour down his troops upon thoſe cities and diſtricts which had remained faithful to the late unfortunate monarch. The people made a moſt deſperate defence, and killed vaſt numbers of their enemies; but at laſt being themſelves reduced by the calamities of war, and in danger of total extermination, they were obliged to quit their habitations and fly to other countries. The tyrant, then, finding himſelf

Mexico. felf fuperior to all his adverfaries, gave Tezcuco in fief to Chimalpopoca king of Mexico, Huexotla to Tlacacotl king of Tlatelolco; placing faithful governors in other places, and appointing Azcapozalco, the capital of his own territory, the royal refidence and capital of Acolhuacan.

Prince Nezahualcojotl was prefent in difguife at this difpofal of his dominions, along with feveral other perfons of diftinction who were enemies of the tyrant; and fo much was he tranfported with paffion, that it was with difficulty he could be reftrained from killing Tezozomoc on the fpot, though this would certainly have been done at the expence of his own life. All the reft of the Acolhuacan empire fubmitted; and Nezahualcojotl faw himfelf for the prefent deprived of all hopes of obtaining the crown.

29 His tyranny and death.

Tezozomoc had now attained the fummit of his ambition: but inftead of conciliating the minds of his new fubjects, oppreffed them with new taxes; and being confcious of the precarious fituation in which he ftood, and tormented with remorfe on account of his crimes, fell into melancholy, and was conftantly haunted with frightful dreams. He was now become fo old, that his body no longer retained its natural heat. He was therefore obliged to be covered up with cotton in a great cradle, not being able to fit erect in a chair. In this miferable condition, however, he never forgot his tyranny or cruelty. From his cradle he iffued oppreffive laws relating to the Acolhuacans; and almoft with his laft breath renewed his commands with regard to Nezahualcojotl. At laft he expired in the year 1422, leaving the crown to his fon Tajatzin.

30 The throne ufurped by Maxtlaton.

Tezozomoc was no fooner dead than Maxtlaton, without paying the leaft regard to his father's will, began to exercife the functions of a fovereign. Though it was the right of Tajatzin to invite to his father's funeral whom he pleafed, Maxtlaton took that upon himfelf. Nezahualcojotl, though not invited, came among the reft; but though Teuctzintli, brother to Maxtlaton, infifted upon his being put to death, the latter oppofed it, as it could not then be done privately, and he hoped to find another opportunity. No fooner were the funeral ceremonies over, however, than Maxtlaton behaved in fuch a manner to his brother Tajatzin, that the prince thought proper to retire to Chimilpopoca king of Mexico, to whom he had been particularly recommended by his father, in order to have his advice. This monarch, agreeable to the character of that age and people, advifed him to invite his brother to an entertainment, and then murder him. Unluckily for them both, this difcourfe was overheard by a fervant, who in expectation of a reward informed the tyrant of what he had heard: but inftead of this, Maxtlaton, pretending to difbelieve his ftory, drove the informer from his prefence with ignominy. Notwithftanding this pretence, the tyrant had not the leaft doubt of the truth of what was told him; and therefore determined to rid himfelf of his brother without delay. This he foon accomplifhed in the very fame way that had been projected againft himfelf. Tajatzin, along with the kings of Mexico, Tlatelolco, and fome other feudatory princes, were invited by Maxtlaton to an entertainment. The king of Mexico prudently excufed himfelf, but the unfufpecting Tajatzin fell into the fnare. He came to the place of entertainment, and was inftantly put to death. The company were greatly alarmed; but Maxtlaton, having explained to them his reafons for fo doing, they not only excufed him, but proclaimed him king; to which it is not to be doubted that their fears greatly contributed. Mexico. 31 Tajatzin murdered.

32 Miferable fate of the king of Mexico.

Though the king of Mexico efcaped a fudden death by his abfence at this time, it was only to perifh in a more flow and ignominious manner. The vengeance of Maxtlaton firft appeared by fending him a woman's drefs in return to the prefent he fent him as a feudatory; which being a reflection upon his courage, was the higheft affront that could be offered him. This infult, however, was quickly followed by one of a much higher nature. Having heard that one of the Mexican prince's wives was an extraordinary beauty, he enjoined fome Tepanecan ladies, who were accuftomed to vifit that princefs, to invite her to fpend fome days with them at Azcapozalco. This being complied with, the tyrant eafily got an opportunity of ravifhing her, and then fent her back to her hufband. Chimilpopoca was fo much affected by this misfortune, that he refolved to offer himfelf up a facrifice to his god. Maxtlaton, however, was refolved that he fhould not have even this fatisfaction. At the very time of the ceremony, therefore, he fent a body of troops; who entering Mexico without refiftance, carried off the king alive, to the aftonifhment of the multitude; and who probably were fo much confounded by this unexpected adventure, that they did not think of making any refiftance.

Chimilpopoca being carried prifoner to Azcapozalco, was confined in a ftrong wooden cage, the common prifon for criminals. Maxtlaton ftill was not fatisfied: he wifhed to get into his hands Nezahualcojotl; and with this view fent a meffage to him, pretending that he was willing to come to an agreement with him refpecting the kingdom of Acolhuacan. Though the prince was well affured of the tyrant's treacherous intentions, he went boldly to his palace, prefented himfelf before him, and told him that he had heard of the imprifonment of the king of Mexico; he had heard alfo that he wifhed to take away his own life; he defired him to do fo, and to gratify his malice. Maxtlaton was fo ftruck with this fpeech, that he affured the prince he had not formed any defign againft his life, and that he neither had put to death the king of Mexico, nor would do fo. He then gave orders for his being properly entertained, and even allowed him to pay a vifit to the king of Mexico in prifon. The unfortunate Chimilpopoca, after reciting his misfortunes, requefted the prince not to return to court, where they would certainly fall upon fome project for taking away his life; and having pathetically recommended to him the care of his fubjects, made him a prefent of a gold pendant and fome other jewels he wore; after which they took a laft farewell. 33 He is vifited in prifon by Nezahualcojotl.

34 Itzcoatl raifed to the throne of Mexico, who affifts Nezahualcojotl.

In the mean time, the Mexicans raifed to the throne Itzcoatl, the fon of Acamapitzin by a flave, and who was accounted the moft prudent, juft, and brave, of all the Mexican nation. His election was no lefs pleafing to Nezahualcojotl and his party, than it was offenfive to Maxtlaton. An alliance was quickly concluded between

Mexico

between the exiled prince and the king of Mexico; and this was soon followed by the commencement of hostilities on the part of the former. His first enterprise was against the city of Tezcuco, which he determined to take by assault, but was prevented by the submission of the inhabitants. He put to death, however, all the officers established by the tyrant; and all the Tepanecans he found there. The very same day another large city named Acolman was furiously attacked by a detachment of his army; great numbers put to the sword, and among the rest the governor, who was brother to Maxtlaton; and the same day also Coatlichan was taken by the Chalcese.

The Mexican monarch, hearing of the successes of his ally, sent an embassy to congratulate him upon them. His ambassador was a son of king Huitzilihuitl, named *Montezuma*, who for his invincible courage and great qualities was surnamed the *man of great heart and the archer of heaven*. The journey was extremely dangerous; but Montezuma undertook it without any fear, accompanied by another nobleman. They got in safety to the place where the prince was; but had the misfortune to be taken prisoners, and were carried to Chalco; the lord of which city, named Toteotzin, was an inveterate enemy to the Mexicans. By him he was immediately put in close confinement, under the care of one Quateozin, who was inviolably attached to the Mexican interest. Orders were given to the latter to provide no sustenance for the prisoners but what was prescribed by his lord, until the mode of death which they were to suffer should be determined. Toteotzin then sent his prisoners to them, that they might be sacrificed there if they thought proper. These people, however, rejected the proposal with disdain; on which Toteotzin, thinking to regain the favour of Maxtlaton, informed him of the prisoners he had in his possession. But Maxtlaton called him a double minded traitor, and commanded him instantly to set the prisoners at liberty. Before this answer arrived, however, Quateozin had instructed the prisoners how to make their escape, and directed them also not to return by land lest they should again be intercepted, but to embark at a certain place, and proceed by water to Mexico. They followed his advice exactly; and having got to the place to which they were directed, arrived safely at their city, to the great surprise and joy of the inhabitants.

35
Dangerous embassy undertaken by Montezuma.

Toteotzin, enraged at the loss of his prisoners, put Quateozin to a cruel death, destroying also all his family excepting one son and a daughter; of whom the latter fled to Mexico, where she was highly honoured on her father's account. Maxtlaton, too, notwithstanding his generosity to the prisoners (which Clavigero derives from mere opposition to Toteotzin), prepared to wage a formidable war with the Mexicans, who had agreed to unite their troops with those of the prince. The Mexican populace, terrified at engaging so powerful an enemy, demanded that their king should submit and beg for peace. So great was the tumult, that the king himself was obliged to consent; and it required the utmost exertions of Montezuma's eloquence to persuade the people to agree to a commencement of hostilities. This being done at last, the king next called together the chief nobility, and asked which of them would have the courage to carry an embassy to the king of the Tepanecans? This adventure appeared so hazardous, that all of them kept a deep silence, until Montezuma declared himself willing to undertake the arduous enterprise. He was ordered to propose peace to Maxtlaton, but to accept of no dishonourable conditions; to which he punctually adhered. Maxtlaton refused to give any immediate answer, but promised to give one next day, after he had consulted his nobility. Montezuma, dreading some treachery if he staid all night, promised to return next day; which he did, and was told that Maxtlaton had determined upon war. Montezuma then performed the ceremony of challenging him, by presenting him with certain defensive weapons, anointing his head, and fixing feathers upon it, as was customary to do with dead persons. Lastly, He protested, in the name of his master, that as Maxtlaton would not accept of the offered peace, he and all the Tepanecans would infallibly be ruined. Maxtlaton showed not the least sign of displeasure, but gave Montezuma arms in like manner to present to the king of Mexico; and directed him, for his personal security, to return in disguise through a small outlet from the palace. Montezuma followed his advice; but as soon as he found himself out of danger, began to insult the Tepanecan guards; and though they rushed violently upon him, he not only escaped from their attacks, but killed one or two of them.

36
Maxtlaton declares war against Mexico.

On his return to Mexico, the populace were again thrown into the utmost consternation by the news that war was inevitable, as the chiefs of the two nations had challenged one another. They now requested the king to allow them to retire from their city, of which they supposed the ruin to be certain. The king encouraged them with the hopes of victory. "But if we are conquered (replied they), what will become of us?" "If that happens (answered the king), we are that moment bound to deliver ourselves into your hands, to be made sacrifices at your pleasure." "Be it so (replied they), if we are conquered; but if we obtain the victory, we and our descendants are bound to be tributary to you; to cultivate your lands and those of your nobles; to build your houses; and to carry for you, when you go to war, your arms and baggage."

Matters being thus settled, intelligence was sent to Prince Nezahualcojotl to repair with his army to Mexico, which he did without delay; and the day after his arrival a furious engagement took place. The Tepanecan army was commanded by a general named *Mazatl*; Maxtlaton himself not judging it proper to quit his capital. The soldiers on both sides fought with the utmost bravery; but towards night the Mexicans, disheartened by seeing the army of their enemies continually increasing in number, began once more to lose their courage and talk of surrendering. The king, greatly concerned, asked Montezuma what should be done to dissipate the fears of the people? That brave prince replied, that they must fight till death; that if they died with their arms in their hands, it would be honourable; but to survive their defeat, would be eternal ignominy. Nothing could be more salutary than this advice at so critical a juncture: for the Mexicans were already begun to implore the mercy of their enemies, and to promise to sacrifice their chiefs, whose ambition had brought the whole nation into

37
He is defeated and killed.

Mexico. into ſuch a dilemma. On hearing this, the whole body of nobility, with the king and Montezuma at their head, aſſaulted the enemy ſo furiouſly, that they repulſed them from a ditch of which they had taken poſſeſſion; after which, Montezuma, happening to encounter Mazatl the Tepanecan general, ſtruck him ſuch a blow on the head that he fell down lifeleſs. Thus the Mexicans were inſpired with freſh courage, and their enemies proportionally diſpirited: however, they retired for that night to the city, in ſome hopes of being able to retrieve their fortune next day. Maxtlaton encouraged them by every method in his power; but fortune proved ſtill more unfavourable than the day before. The Tepanecans were now entirely defeated, and the city of Azcapozalco taken. Maxtlaton, who ſeems not to have had the courage to fight, had not now the preſence of mind to fly. He attempted indeed to hide himſelf; but being quickly diſcovered, he was beaten to death with ſticks and ſtones. The city was plundered, the inhabitants butchered, and the houſes deſtroyed by the victors.

38 The Tepanecans entirely reduced. This victory proved deciſive in favour of the confederates. Every other place of ſtrength in the country was quickly reduced, until the Tepanecans, finding themſelves on the verge of deſtruction, ſent an humble embaſſy to the king of Mexico, requeſting to be taken under his protection, and to become tributaries to him. Itzcoatl received them graciouſly; but threatened them with total extirpation if they violated the fidelity they had ſworn to him.

Itzcoatl, after this extraordinary ſucceſs, took care to have the above-mentioned contract ratified between the nobility and common people, by which the latter were bound to perpetual ſervices. Thoſe who had diſcouraged the ſoldiers in time of battle were baniſhed for ever from the ſtate of Mexico; while Montezuma and others who had diſtinguiſhed themſelves by their bravery, were rewarded with lands, as was uſual with other conquerors.

39 Nezahualcojotl made king of Acolhuacan. Itzcoatl, now finding himſelf firmly ſeated on the throne of Mexico, ſet about performing his engagements to the Acolhuacan prince, by ſeating him on the throne of his anceſtors. Having again joined their armies, they marched againſt Huaxotla, a city which refuſed to ſubmit, even though terms of pardon were offered them. Inſtead of this, they raſhly ventured a battle, in which they were entirely defeated; and were then fain to ſend a deputation of their old men, pregnant women, &c. as was cuſtomary in caſes of diſtreſs, to move the enemy to compaſſion. At laſt all obſtacles being removed, Nezahualcojotl was ſeated on the throne of Acolhuacan, the auxiliary troops were diſmiſſed, and Itzcoatl left at liberty to purſue his conqueſts, in which he was ſtill aſſiſted by the king of Acolhuacan. The firſt expedition was againſt Cojohuacan, and other two Tepanecan cities, who had not only refuſed ſubmiſſion themſelves, but excited others to ſhake off the yoke alſo.

40 Conqueſts of the Mexicans. The war againſt them proved bloody. Three battles were fought, in which Itzoatl gained no other advantage than making the enemy retreat a little; but in the fourth, while the two armies were hotly engaged, Montezuma, with a body of choſen troops, which he had placed in ambuſcade, attacked the rear-guard of the rebels with ſuch vigour, that they were ſoon diſordered, and obliged to fly to the city. The conquerors purſued them thither; and Montezuma perceiving that they intended to fortify themſelves in the greater temple, fruſtrated their deſign by getting poſſeſſion of it and burning the turret. By this diſaſter they were ſo much terrified, that they fled to the mountains ſouth of Cojohuacan; but even there the royal army overtook and purſued them more than 30 miles, till they came to another mountain, where, quite exhauſted with fatigue, and ſeeing no means of eſcape, they were obliged to ſurrender at diſcretion.

Having thus happily accompliſhed the conqueſt of Cojohuacan and the other rebellious cities, the two kings returned to Mexico. Itzcoatl gave great part of the Tepanecan country, with the title of king of *Tacuba*, to *Totoquihuatzin*, a grandſon of Tezozomoc, but who does not appear to have been any way concerned in his projects againſt the Mexicans.

41 Alliance between the kings of Mexico, Acolhuacan, and Tepaneca. An alliance was then formed among the three kings on the following terms: The king of Tacuba held his crown on condition of ſerving the king of Mexico with all his troops, at any time when required; for which he was to have a fifth part of the ſpoils taken from the enemy. The king of Acolhuacan was likewiſe to aſſiſt the king of Mexico in war; and for this he was to have a third part of the plunder, after deducting the ſhare of the king of Tacuba; and the remainder was to belong to the king of Mexico. The kings of Tacuba and Acolhuacan were both declared honorary electors of the kings of Mexico; the real electors being four nobles: and the king of Mexico was likewiſe bound to aſſiſt in the wars of his allies whenever it was demanded.

After having thus ſettled matters among themſelves, and rewarded their ſoldiers, Itzcoatl ſet out with Nezahualcojotl for Tezcuco, where the Acolhuacan king was crowned with all poſſible ceremony. Here the new king took every method which prudence could ſuggeſt to eſtabliſh his authority on a permanent baſis; but while he was thus employed, the Xochimilcas, fearing leſt the Mexicans might conquer their country as they had done that of the Tepanecans, held a council on what was to be done to prevent ſuch a diſgrace. In this council it was determined to commence hoſtilities againſt that riſing ſtate, before it ſhould become more formidable by new conqueſts.

42 Other conqueſts. Itzcoatl was no ſooner informed of this determination, than he ſent Montezuma with a great army againſt them. The Xochimilcas met him with one ſtill more numerous; but being worſe diſciplined, they were quickly defeated, and their city taken in a very ſhort time after. This conqueſt was followed by the reduction of Cuitlahuac, ſituated on a ſmall iſland in the lake of Chalco. Their inſular ſituation gave them confidence to attack the formidable power of the Mexicans. The king was ſo ſenſible of the difficulty of this enterpriſe, that he propoſed to attack them with the whole force of the alliance: Montezuma, however, with only a ſmall number of men of his own training, whom he furniſhed with proper veſſels, reduced them in ſeven days.

43 Montezuma I. king of Mexico. Itzcoatl died in the year 1436, at a very advanced age, in the height of proſperity, and was ſucceeded by Montezuma I. the greateſt monarch that ever ſat on the Mexican throne. Before his coronation, in order to comply with the barbarous rites of his religion,

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gion, he made war upon the Chalcese, in order to procure the prisoners who were to be sacrificed at his coronation; and scarce was this ceremony over, when a new war commenced, which terminated in the destruction of that city. This quarrel happened between the Chalcese and the Tezcucans. Two of the royal princes of Tezcuco having gone a-hunting on the mountains which overlook the plains of Chalco, while employed in the chase, and separated from their retinue, with only three Mexican lords, fell in with a troop of Chalcese soldiers; who, to gratify the cruelty of their master, carried them all prisoners to Chalco. The cruel and inconsiderate tyrant who commanded there instantly put them all to death: after which he caused their bodies to be salted, dried, and placed in an hall of his palace, where they served as supporters to the pine torches burned there for lights every evening. The king of Tezcuco, overwhelmed with grief, and to the last degree exasperated at such an inhuman act, called for the assistance of the allied kings. The city was attacked at once by land and water. The inhabitants, knowing that they had no mercy to expect, fought like men in despair. Even the old tyrant who commanded them, though unable to walk, caused himself to be carried in a litter among the combatants; notwithstanding which they were totally defeated, and the most severe vengeance executed upon them.

44 Chalco taken.

Montezuma, on his return, found himself obliged to encounter an enemy more formidable on account of his vicinity, than more powerful ones at a distance. This was the king of Tlatelolco, who had formerly conspired against the life of Itzcoatl; and finding himself disappointed in this, had tried to reduce his power by entering into a confederacy with some of the neighbouring lords. At that time his designs proved abortive, but he resumed them in the time of Montezuma; the consequence of which was, that he was defeated and killed. One *Moquihuix* was chosen in his room; in whose election it is probable that Montezuma had a considerable share. This was followed by conquests of a much more important nature. The province of *Cuihixcas*, lying to the southward, was added to his dominions, comprehending a tract of country more than 150 miles in breadth; then, turning to the westward, he conquered another named *Tzompahuacan*. This success, however, was for a short time interrupted by a war with Atonaltzin, lord of a territory in the country of the Mixtecas. This prince, puffed up on account of the great wealth he possessed, took it into his head that he would allow no Mexican to travel through his country. Montezuma sent ambassadors to know the reason of such strange conduct; but Atonaltzin gave them no other answer than showing them some part of his wealth, making a present to the king, and desiring them from thence to observe how much the subjects of Atonaltzin loved him; and that he willingly accepted of war, which was to determine whether he should pay tribute to the Mexicans or the Mexicans to him. Montezuma having informed his allies of this insolent answer, sent a considerable army against Atonaltzin, but had the mortification to be informed of its defeat; in consequence of which the pride of Atonaltzin was increased to a great degree. Montezuma, greatly chagrined at this first check, determined to head his next army in person; but before he could call together another, Atonaltzin had drawn into a confederacy with him the Huexotzincas and Tlascalans, who were glad of the opportunity, as they supposed, of reducing the power of the Mexicans. Their numbers, however, availed but little; Montezuma in the very first engagement totally defeated the confederate army. The allies of Atonaltzin were particularly unfortunate; for such of them as were not killed in the field of battle, were destroyed by their own party out of revenge for the unfortunate event of the battle.

45 Tlatelolco reduced, and Moquihuix made king.

46 Atonaltzin defeated, and the Mexican dominions enlarged.

By this victory the Mexican monarch became master not only of his dominions of Atonaltzin, but of many other neighbouring princes, against whom he made war on account of their having put to death some Mexican merchants or couriers without any just cause. The conquest of *Cuetlachtlan* or *Cotasta*, however, which he attempted in 1457, proved a much more difficult task. This province lies on the coast of the Mexican gulf, and had been formerly inhabited by the Olmecans, whom the Tlascalans had driven out. The inhabitants were very numerous; but dreading the power of Montezuma, called in those of Tlascala, together with the Huexotzincas, to their assistance. Along with these the allies drew the Cholulans also into the confederacy; so that this seems to have been the most formidable combination that had yet been formed against the Mexican power. Montezuma collected an excellently equipped army; which, however, he did not on this occasion command in person. It contained a great number of persons of very high rank, among whom were three princes of royal blood, and *Moquihuix* king of Tlatelolco already mentioned. The combination of the three republics against Mexico was not known at court when the army set out; but Montezuma, being informed of it soon after, sent an order to his generals to return. This accorded so ill with the romantic notions of valour entertained by the Mexicans, that a consultation of the generals was held whether they should obey it or not. At last it was determined that the king's order should be obeyed; but no sooner was this agreed to than Moquihuix accused them all of cowardice, and threatened, with his own troops, unassisted, to go and conquer the enemy. His speech had such an effect upon them all, that they went to meet the confederates. The Cotastese fought with great valour, but were unable to resist the royal forces; and their allies were almost totally destroyed. Six thousand two hundred of them were taken prisoners, and soon after sacrificed to the Mexican god of war in the barbarous manner already described. The victory was said to have been owing principally to the valour and good conduct of Moquihuix, insomuch that to this day a song made in his praise on that occasion is known in Mexico. Montezuma was so well pleased with the victory, that he not only forgave the disobedience of his orders, but bestowed upon Moquihuix a princess, one of his own cousins, to wife.

47 Inundation and famine at Mexico.

During the reign of this great monarch a violent inundation happened in Mexico. The lake, swelled by the excessive rains which fell in the year 1446, poured its waters into the city with so much violence that many

many houſes were deſtroyed, and the ſtreets inundated to ſuch a degree that boats were everywhere made uſe of. The inundation was ſoon followed by a famine. This was occaſioned by the ſtinting of the crop of maize in 1448; the ears while young and tender being deſtroyed by froſt. In 1450 the crop was totally loſt for want of water; and in 1451, beſides the unfavourable ſeaſons, there was a ſcarcity of ſeed. Hence, in 1452, the neceſſities of the people became ſo great, that they were obliged to ſell themſelves for ſlaves in order to procure ſubſiſtence. Montezuma permitted them to go to other countries for ſupport; but being informed that many ſold themſelves for a few days proviſion, he ordered, by proclamation, that no woman ſhould ſell herſelf for leſs than 400 ears of wheat, nor any man for leſs than 500. He opened alſo the public granaries for the relief of the lower claſſes; but nothing was able to ſtop the progreſs of the famine.

48
Axayacatl ſucceeds Montezuma.

Montezuma was ſucceeded by Axayacatl, who like his predeceſſor inſtantly commenced a war, for no other reaſon than that he might have priſoners to ſacrifice at his coronation. He purſued Montezuma's plan of conqueſt; in which, however, he was leſs ſucceſsful, many of the provinces reduced by that monarch having revolted after his death, ſo that it was neceſſary to reconquer them. On his returning ſucceſsful from one of theſe expeditions, he built a new temple, to which he gave the name of *Coatlon;* but the Tlatelolcos, whoſe ancient rivalſhip ſeems to have revived on the death of Montezuma, built another in oppoſition, which they called *Coaxolotl.* Thus the former hatred between the two nations was renewed, and a diſcord took place which ended in the ruin of the Tlatelolcos.

49
Death of the kings of Acolhuacan and Tacuba.

The Mexicans ſuſtained an irreparable loſs in 1469 and 1470 by the death of their allies the kings of Tacuba and Acolhuacan.

The king of Tacuba was ſucceeded by his ſon Chimalpopoca, and the Acolhuacan monarch by his ſon Nezahualpilli. A ſhort time after the acceſſion of the latter, the war broke out between the Tlatelolcos and Mexicans, which ended in the deſtruction of the former. King Moquihuix had been married by Montezuma to a ſiſter of Axayacatl, now on the throne of Mexico; but it appears that this princeſs never was greatly the object of his affection. On the contrary, he took all methods of expreſſing his diſlike, either out of enmity to herſelf, or envy of the ſuperior greatneſs of her brother. Not content with this, he entered into an alliance with a great number of the neighbouring ſtates, in order to reduce the Mexican greatneſs. His wife, however, being informed of this ſcheme, communicated the particulars to her brother; and ſoon after, being impatient of the ill uſage ſhe received, came to Mexico with her four ſons to claim the protection of her brother. This uncommon accident exaſperated the Mexicans and Tlatelolcos againſt each other to ſuch a degree, that wherever they met, they fought, abuſed, and murdered each other. The king of Tlatelolco prepared for war with many horrid ceremonies, of which the drinking of human blood was one. A day was appointed for attacking Mexico. Xiloman, lord of Colhuacan, was to begin the attack, afterwards to pretend flight, in order to induce the Mexicans to follow him; after which the Tlatelolcos were to fall upon their rear.

50
Tlatelolco reduced, and the king killed.

For ſome reaſon, however, with which we are not acquainted, the Tlatelolcos began the attack without waiting for Xiloman; the conſequence of which was, that he retired in diſguſt, leaving them to finiſh their battle the beſt way they could. The engagement laſted till night, when the Tlatelolcos were obliged to retire. Axayacatl, during the night, diſpoſed of his troops in all the roads which led to Tlatelolco, appointing them to meet in the market-place. The Tlatelolcos, finding themſelves attacked on all ſides, retired gradually before the Mexicans, until at laſt they were forced into the market-place, where they found themſelves worſe than ever on account of its narrowneſs, which did not allow them room to act. The king ſtood on the top of the great temple, encouraging his men to exert themſelves againſt the enemy. His words, however, had now loſt their uſual influence. He not only was not obeyed, but was reproached with cowardice becauſe he did not come down and fight among the reſt. At laſt the Mexicans arrived at the temple, and aſcended to the balcony where the king was. He made a deſperate defence for a little; but by a violent puſh in the breaſt was thrown backwards upon the ſteps of the temple, and ſtunned or perhaps killed by the fall.

The Tlatelolcos being thus reduced, Axayacatl next ſet out on an expedition againſt the Matlazincas, a tribe in the vale of Toluca, who ſtill refuſed to ſubmit to the Mexican yoke. Having proved ſucceſsful in this expedition, he undertook to ſubdue alſo the northern part of the valley, now called *Valle d' Ixtlahuacan,* particularly *Xiquipilco,* a conſiderable city and ſtate of the Otomics, whoſe chief was much renowned for ſtrength and bravery. Axayacatl, who likewiſe valued himſelf on theſe qualities, encountered him in ſingle combat. In this, however, he was overmatched, and received a violent wound in the thigh; after which he would have been taken priſoner, had not ſome young Mexicans made a deſperate effort for his reſcue. Notwithſtanding this diſaſter, Axayacatl's army gained a complete victory, carrying off 11,060 priſoners, among whom was the chief of the Otomies himſelf, and two of his officers who had attacked the king. Theſe chiefs were put to death at an entertainment of the allied kings, the ſight of their agonies not interrupting in the leaſt the mirth of the feaſt; ſo much were they familiarized to the ſhedding of human blood.

51
Axayacatl wounded and in great danger.

He was ſucceeded by his elder brother Tizoc. He intended to have built a larger temple than any that had yet been ſeen in Mexico, though that originally built had been greatly enlarged by ſome of his predeceſſors. For this purpoſe he collected a great quantity of materials; but before he could bring his projects to bear, he was taken off by a conſpiracy of his ſubjects. During the reign of Tizoc, the Acolhuacans made war upon the Huexotzincas, ruined their city, and conquered their territory. Nezahualpilli alſo, the Acolhuacan monarch, though he had already ſeveral wives, had not made any of them queen, having wiſhed to confer that honour upon one of the royal family of Mexico. Tizoc readily gave him one of his grand-daughters, who had a ſiſter of ſingular beauty named *Xocotzin.* The friendſhip betwixt theſe two ladies was ſuch, that the one could

52
Is ſucceeded by Tizoc.

not

Mexico. not think of being ſeparated from the other; for which reaſon the new queen ſought and obtained permiſſion to take her ſiſter along with her to Tezcuco. Xocotzin had not been long there before the king fell in love with her, and married her with the title of queen likewiſe. Soon after this ſecond marriage, the firſt queen brought forth a ſon named *Cacamatzin*, who ſucceeded him in the throne, and was afterwards taken priſoner by the Spaniards.

53 Ahuitzotl dedicates a temple with a multitude of human victims.

Ahuitzotl, the brother of Tizoc, ſucceeded him in the kingdom of Mexico. His firſt object was to finiſh the great temple begun by his predeceſſor; and ſuch was the number of workmen, that it was completed in four years. During the time that it was building, the king employed himſelf in making war with different nations, reſerving all the priſoners he took for victims at the dedication of the temple. The number of priſoners ſacrificed at this dedication is ſaid by Torquemada to have been 72,324; by other hiſtorians 64,060. The miſerable victims were ranged in two files, each a mile and a half in length, terminating at the temple. The ſame year another temple was built by a feudatory lord, in imitation of the great one built by the king; at the dedication of which a vaſt number of priſoners were alſo ſacrificed. Theſe temples were dedicated in 1486. In 1487 happened a violent earthquake; and Chimalpopoca king of Acolhuacan died, who was ſucceeded by Totoquihuatzin II.

Ahuitzotl died in 1502, of a diſorder produced by a contuſion in his head. At the time of his death, the Mexican empire was brought to its utmoſt extent. His ſucceſſor, Montezuma *Xocojotzin* or Montezuma *Junior*, was a perſon of great bravery, beſides which he was likewiſe a prieſt, and held in great eſtimation on account of his gravity and the dignity of his deportment. His election was unanimous; and the nobles congratulated themſelves on the happineſs the country was to enjoy under him, little thinking how ſhort the duration of their happineſs or of their empire was to be.

54 Montezuma.

The firſt care of the new monarch, as uſual, was to procure victims for the barbarous ſacrifices to be made at his coronation. The people of Atlixco, who had again ſhaken off the Mexican yoke, were the ſufferers on this occaſion, being once more reduced, though not without great loſs on the part of the Mexicans, ſome of whoſe braveſt officers periſhed in the war. The ceremony of coronation was performed with ſuch pomp as had never been ſeen before in Mexico; but no ſooner was this ceremony over than Montezuma began to diſcover a pride which nobody had ſuſpected before. All his predeceſſors had been accuſtomed to confer offices upon perſons of merit, and thoſe who appeared the moſt able to diſcharge them, without any partiality as to birth or wealth. Montezuma, however, diſapproved of the conduct of his predeceſſors, under pretence that the plebeians ſhould be employed according to their rank; for that in all their actions the baſeneſs of their birth and the meanneſs of their education appeared: and in conſequence of this maxim he deprived all the commoners of the offices they held about the court, declaring them incapable of holding any for the future. All the royal ſervants now were people of rank. Beſides thoſe who lived in the palace, 600 feudatory lords and nobles came to pay court to him. They paſſed the whole day in the antichamber, where none of their ſervants were permitted to enter; converſing in a low voice, and waiting the orders of their ſovereign.—The ſervants of theſe lords were ſo numerous that they occupied three ſmall courts of the palace, and many waited in the ſtreets.

In every reſpect Montezuma kept up, as far as was poſſible, an extravagant appearance of dignity. His kitchen utenſils were of the fineſt earthen ware, and his tablecloths and napkins of the fineſt cotton; but none of theſe ever ſerved the emperor more than once, being immediately made a preſent of to ſome nobleman. The veſſels in which his chocolate and other drinks from cocoa were prepared, were all of gold, or ſome beautiful ſea-ſhell, or naturally-formed veſſels, curiouſly varniſhed. He had alſo gold plate, but it was uſed only on particular occaſions in the temple. The number and variety of his diſhes aſtoniſhed the Spaniards. He took great delight in the cleanlineſs of his own perſon, and of every thing about him. He bathed regularly every day, and had baths in all his palaces. Every day he wore four dreſſes, never uſing again thoſe which he had put off, but reſerving them as largeſſes for the nobility, or thoſe who had diſtinguiſhed themſelves in war. The expence of all this rendered him very diſagreeable to a great number of his ſubjects; though others were pleaſed with the readineſs he ſhowed to relieve the neceſſities of individuals, and his generoſity in rewarding his generals and miniſters who deſerved it. Among other actions worthy of imitation, he appointed the city of Colhuacan as an hoſpital for all invalids, who after having faithfully ſerved the crown either in the civil or military line, required a proviſion on account of their age and infirmities. In this place they were maintained and attended at the expence of the king. 55 Magnificence diſplayed in his palace.

The reign of Montezuma, even before the arrival of the Spaniards, was far from being ſo glorious with regard to his ſucceſſes in war as thoſe of his predeceſſors had been. He reduced indeed one rebellious province, and conquered another which had never before been ſubjugated; but in his war with Tlaſcala he was by no means ſucceſsful. This was but a ſmall republic at no great diſtance from the capital, but the inhabitants were remarkable for their bravery and independent ſpirit. The neighbouring ſtates, however, who had been reduced by the Mexicans, envious of their liberty and proſperity, exaſperated the Mexicans againſt them, by repreſenting that the Tlaſcalans were deſirous of making themſelves maſters of the maritime provinces on the Mexican gulf, and that by their commerce with theſe provinces they were increaſing their wealth and power, and gaining the hearts of the people with whom they were to traffic. In conſequence of this repreſentation, ſtrong garriſons were placed on the frontiers of Tlaſcala, to obſtruct the commerce of the inhabitants, and thus to deprive them of the means of obtaining ſome of the neceſſaries of life. The Tlaſcalans complained; but received no other anſwer than that the king of Mexico was lord of all the world, and that the Tlaſcalans muſt ſubmit and pay tribute to him. The Tlaſcalans returned a ſpirited anſwer to this inſolent ſpeech, and began to fortify their frontier. They had already encloſed all the lands of the republic 56 His unſucceſsful war with Tlaſcala.

Mexico.

blic with intrenchments; and to thefe they now added a wall of fix miles in length on the weft fide, where an invafion was moft to be apprehended; and fo well did they defend themfelves, that though they were frequently attacked by the neighbouring ftates in alliance with Mexico, or fubject to it, not one of them was able to wreft a foot of ground from them. Thus a continual feries of wars and engagements took place between the ftates of Mexico and this republic, which continued till the arrival of the Spaniards.

57 Apprehenfions entertained by the Mexicans of the arrival of a new people.

During the remainder of Montezuma's reign the empire was difturbed by various rebellions, of which the accounts are not fufficiently interefting to merit a particular detail; but in the year 1508, Montezuma began to entertain apprehenfions of that fatal event which at length overtook him. An expedition having been undertaken againft a very diftant region named Amatla, the army in marching over a lofty mountain were attacked by a furious north wind, accompanied with fnow; which made great havock in the army, many of them perifhing with cold, and others being killed by the trees rooted up by the wind. The remains of the army continued their march to Amatla, where they were almoft all killed in battle. By this and other calamities, together with the appearance of a comet, the Mexicans were thrown into the utmoft confternation. Montezuma was fo terrified by thefe omens, that having in vain confulted his aftrologers, he applied to the king of Acolhuacan, who was reported to be very fkilful in divination. Nezahualpilli having conferred with him upon the fubject, told Montezuma that the comet prefaged fome calamity which was about to befal their kingdoms by the arrival of a new people: but this being unfatisfactory to the emperor, the king of Acolhuacan challenged him to a game at foot-ball, ftaking the truth of his prediction on the iffue of the game. Montezuma loft the game, but did not yet acquiefce in the truth of his prediction. He therefore applied to a celebrated aftrologer, whom it feems he had not yet confulted; but he confirmed the interpretation of Nezahualpilli: for which the emperor caufed his houfe to be pulled down, and himfelf buried in the ruins.

58 Conqueft of Mexico undertaken by Cortes.

Mexico itfelf was firft difcovered, though imperfectly, by a Spaniard named *Nunez de Balboa*; but in 1518 the conqueft of it was undertaken by a celebrated adventurer named *Ferdinando Cortes*. On the 10th of February 1519, he fet fail from the Havannah in Cuba; and foon landed on the ifland of Cozumel, on the coaft of Yucatan, difcovered the preceding year. Here he joined one of his officers named *Pedro d'Alvaredo*, who had arrived fome days before, and collected fome booty and taken a few prifoners. But the general feverely cenfured his conduct; and the prifoners were difmiffed, after they had been informed by an Indian interpreter named *Melchior*, that fuch injuries were entirely difagreeable to the intentions and wifhes of Cortes. Here he muftered his army, and found that it amounted to 508 foldiers, 16 horfemen, and 109 mechanics, pilots, and mariners. Having encouraged his men by a proper fpeech, and releafed, by means of fome Indian ambaffadors, a Spaniard named *Jerom de Aguilar*, who had been detained a prifoner for eight years, he proceeded to the river Tabafco, where he hoped to be received in a friendly manner, as one Grijalva had been a fhort time before; but, from fome unknown caufe, he was violently attacked by them: however, the fuperiority of the Spanifh arms foon decided the victory, and the inhabitants were obliged to own the king of Caftile as their fovereign.

The Spaniards then continued their courfe weftward, to the harbour of St Juan de Ullua; where they were met by two Mexican canoes, which carried two ambaffadors from the emperor of that country, and fhowed the greateft figns of peace and amity. Their language was unknown to Aguilar; but one of the female prifoners above mentioned underftood it, and tranflated it into the Yucatan tongue; after which Aguilar interpreted the meaning in Spanifh. This flave was afterwards named *Donna Marina*, and proved very ufeful in their conferences with the natives.

59 State of the empire at that time.

At this time the Mexican empire, according to Dr Robertfon, was arrived at a pitch of grandeur to which no fociety had ever attained in fo fhort a period. Though it had fubfifted only for 130 years, its dominion extended from the north to the fouth fea, over territories ftretching about 500 leagues from eaft to weft, and more than 200 from north to fouth; comprehending provinces not inferior in fertility, population, and opulence, to any in the torrid zone.— Though by nature Montezuma poffeffed a good deal of courage and refolution; yet from the firft moment that the Spaniards appeared on his coaft, he difcovered fymptoms of timidity and embarraffment, and all his fubjects were embarraffed as well as himfelf. The general difmay which took place on this occafion was partly owing to the ftrange figure the Spaniards made, and the prodigious power of their arms; but partly alfo to the following circumftance. An opinion prevailed almoft univerfally among the Americans, that fome dreadful calamity impended over their heads, from a race of formidable invaders who fhould come from regions towards the rifing fun, to overrun and defolate their country.

By means of his two interpreters, Donna Marina and Aguilar, Cortes learned that the chiefs of the Mexican embaffy were deputies from Pilpatoe and Teutile; the one governor of a province under the emperor, and the other the commander of all his forces in that province: the purport of their embaffy was to inquire what his intentions were in vifiting their coafts, and to offer him what affiftance he might need in order to continue his voyage. Cortes, in his turn, alfo profeffed the greateft friendfhip; and informed the ambaffadors, that he came to propofe matters of the utmoft confequence to the welfare of the prince and his kingdom; which he would more fully unfold in perfon to the governor and the general. Next morning, without waiting for any anfwer, he landed his troops, his horfes, and his artillery; began to erect huts for his men, and to fortify his camp.

60 Cortes lands and fortifies his camp.

The next day the ambaffadors had a formal audience; at which Cortes acquainted them, that he came from Don Carlos of Auftria, king of Caftile, the greateft monarch of the eaft, and was intrufted with propofitions of fuch moment, that he would impart them to none but the emperor himfelf, and therefore required to be conducted immediately to the capital. This demand produced the greateft uneafinefs; and

Mexico.

61 The Indians endeavour to dissuade him from going to the capital, but in vain.

and the ambassadors did all in their power to dissuade Cortes from his design, endeavouring to conciliate his good will by the presents sent him by Montezuma. These they introduced with great parade, and consisted of fine cotton cloth, of plumes of various colours, and of ornaments of gold and silver to a considerable value, the workmanship of which appeared to be as curious as the materials were rich. But these presents served only to excite the avidity of the Spaniards, and to increase their desire for becoming masters of a country which abounded with so many precious commodities. Cortes indeed could scarcely restrain himself so far as to hear the arguments made use of by the ambassadors to dissuade him from going to the capital; and, in a haughty, determined tone, insisted on his former demand of being admitted to a personal interview with their sovereign.

During this conversation, some painters in the retinue of the Mexican chiefs had been diligently employed in delineating, upon white cotton cloths, figures of the ships, horses, artillery, soldiers, and whatever else attracted their eyes as singular.

62 Montezuma made acquainted with his design.

While exerting their utmost efforts in representing all these wonderful things, messengers were immediately despatched to Montezuma with the pictures, and a full account of every thing that had passed since the arrival of the Spaniards, together with some European curiosities to Montezuma; which Cortes believed would be acceptable on account of their novelty. The Mexican monarchs had couriers posted at proper stations along the principal roads; and as these were trained to agility by a regular education, they conveyed intelligence with surprising rapidity. Though the city in which Montezuma resided was above 180 miles from St Juan de Ullua, Cortes's presents were carried thither, and an answer returned to his demands, in a few days. As the answer was unfavourable, Montezuma had endeavoured to mollify the Spanish general by the richness of his presents. These consisted of the manufactures of the country; cotton stuffs so fine, and of such delicate texture, as to resemble silk; pictures of animals, trees, and other natural objects, formed with feathers of different colours, disposed and mingled with such skill and elegance as to rival the works of the pencil in truth and beauty of imitation. But what chiefly attracted their attention, were two large plates of a circular form; one of massive gold representing the sun, the other of silver representing the moon. These were accompanied with bracelets, collars, rings, and other trinkets of gold; and that nothing might be wanting which could give the Spaniards a complete idea of what the country afforded, some boxes filled with pearls, precious stones, and grains of gold unwrought, as they had been found in the mines or rivers, were sent along with the rest. Cortes received all with an appearance of the most profound respect for Montezuma; but when the Mexicans, presuming upon this, informed him, that their master, though he desired him to accept of what he had sent as a token of his regard for the prince whom he represented, would not give his consent that foreign troops should approach nearer to his capital, or even allow them to continue longer in his dominions, Cortes declared in a manner more resolute and peremptory

63 Sends an unfavourable answer, but accompanied with rich presents.

64 Cortes still insists on his demands.

than formerly, that he must insist on his first demand; as he could not, without dishonour, return to his own sovereign until he was admitted into the presence of the prince whom he was appointed to visit in his name.

The pusillanimity of the Indian monarch afforded time to the Spaniards to take measures which would have been out of their power had they been vigorously attacked on their first refusal to obey his orders. Cortes used every method of securing the affections of the soldiers; which indeed was very necessary, as many of them began to exclaim against the rashness of his attempt in leading them against the whole force of the Mexican empire. In a short time Teutile arrived with another present from Montezuma, and together with it delivered the ultimate orders of that monarch to depart instantly out of his dominions; and when Cortes, instead of complying with his demands, renewed his request of audience, the Mexican immediately left the camp with strong marks of surprise and resentment. Next morning, none of the natives appeared; all friendly correspondence seemed to be at an end, and hostilities were expected to commence every moment. A sudden consternation ensued among the Spaniards, and a party was formed against him by the adherents of Velasques; who took advantage of the occasion, and deputed one of their number, a principal officer, to remonstrate, as if in name of the whole army, against his rashness, and to urge the necessity of his returning to Cuba. Cortes received the message without any appearance of emotion; and as he well knew the temper and wishes of his soldiery, with much complacency he pretended to comply with the request now made him, and issued orders that the army should be in readiness next day to embark for Cuba. Upon hearing this, the troops, as Cortes had expected, were quite outrageous: they positively refused to comply with these orders, and threatened immediately to choose another general if Cortes continued to insist on their departure.

65 Montezuma peremptorily commands him to leave his dominions.

Our adventurer was highly pleased with the disposition which now appeared among his troops: nevertheless, dissembling his sentiments, he declared, that his orders for embarking had proceeded from a persuasion that it was agreeable to his fellow-soldiers, to whose opinion he had sacrificed his own; but now he acknowledged his error, and was ready to resume his original plan of operation. This speech was highly applauded; and Cortes, without allowing his men time to cool, set about carrying his designs into execution. In order to give a beginning to a colony, he assembled the principal persons in his army, and by their suffrages elected a council and magistrates, in whom the government was to be vested. The persons chosen were most firmly attached to Cortes; and the new settlement had the name of *Villa Rica de la Vera Cruz;* that is, the rich town of the true cross.

66 Villa Rica founded.

Before this court of his own making, Cortes did not hesitate at resigning all his authority, and was immediately re-elected chief-justice of the colony, and captain-general of his army, with an ample commission, in the king's name, to continue in force till the royal pleasure should be farther known. The soldiers eagerly ratified their choice by loud acclamations; and Cortes, now considering himself as no longer accountable to any subject, began to assume a much

67 The government of the new colony vested in Cortes.

Mexico. much greater degree of dignity, and to exercise more extensive powers than he had done before.

Cortes having thus strengthened himself as well as he could, resolved to advance into the country; and to this he was encouraged by the behaviour of the cacique or petty prince of Zempoalla, a considerable town at no great distance. Here he was received in the most friendly manner imaginable, and had a re-
68 spect paid towards him almost equivalent to adoration. The cacique informed him of many particulars relating to the character of Montezuma.—He told him that he was a tyrant, haughty, cruel, and suspicious; who treated his own subjects with arrogance, ruined the conquered provinces by his extortions, and often tore their sons and daughters from them by violence; the former to be offered as victims to his gods, the latter to be reserved as concubines for himself and favourites. Cortes, in reply, artfully insinuated, that one great object of the Spaniards in visiting a country so remote from their own was, to redress grievances, and to relieve the oppressed; and having encouraged him to hope for this interposition in due time, continued his march to Quiabislan, the territory of another cacique, and where, by the friendly aid of the Indians, a Spanish colony was soon formed.

Character of Montezuma given by the cacique.

During the residence of Cortes in these parts, he so far wrought on the minds of the caciques of Zempoalla and Quiabislan, that they ventured to insult the Mexican power, at the very name of which they had been formerly accustomed to tremble. Some of Montezuma's officers having appeared to levy the usual tribute, and to demand a certain number of human victims, as an expiation of their guilt in presuming to hold intercourse with those strangers whom the emperor had commanded to leave his dominions; instead of obeying his orders, they made them prisoners, treated them with great indignity, and, as their superstition was no less barbarous than Montezuma's, they threatened to sacrifice them to their gods.

Though Cortes had now taken such measures as in a manner ensured his success; yet as he had thrown off all dependence on the governor of Cuba, who was his lawful superior, and apprehended his interest at court, he thought proper, before he set out on his intended expedition, to take the most effectual measures against the impending danger. With this view, he persuaded the magistrates of his colony to address a letter to the king, containing a pompous account of their own services, of the country they had discovered, &c. and of the motives which had induced them to throw off their allegiance to the governor of Cuba, and to settle a colony dependent on the crown alone, in which the supreme power, civil as well as military, had been vested in Cortes; humbly requesting their sovereign to ratify what had been done by his royal authority.

Some soldiers and sailors, secretly disaffected to Cortes, formed a design of seizing one of the brigantines, and making their escape to Cuba, in order to give such intelligence to the governor as might enable him to intercept the vessel which was to carry the treasure and despatches to Spain. This conspiracy was conducted with profound secrecy; but at the moment when every thing was ready for execution, the secret was discovered by one of the associates. The latent spirit of disaffection which Cortes was now too well convinced had not been extinguished amongst his troops, gave him very great uneasiness. The only method which he could think of to prevent such conspiracies for the future was to destroy his fleet, and thus deprive his soldiers of every resource except that of conquest: and with this proposal he persuaded his men to comply. With universal consent therefore the ships were drawn ashore, and, after being stripped of their sails, rigging, iron work, and whatever else might be of use, they were broke in pieces.

Mexico. 69 Cortes burns his fleet.

Cortes having thus rendered it necessary for his troops to follow wherever he chose to lead, began his march to Zempoalla with 500 infantry, 15 horse, and six field pieces. The rest of his troops being less fit for active service, he left them as a garrison in Villa Rica, under the command of Escalante, an officer of merit, and warmly attached to his interest. The cacique of Zempoalla supplied him with provisions; and with 200 of those Indians called *Tamanes*, whose office, in a country where tame animals were unknown, was to carry burdens, and perform all manner of servile labour. He offered likewise a considerable body of troops; but Cortes was satisfied with 400; taking care, however, to choose persons of such note, that they might serve as hostages for the fidelity of their master.

Nothing memorable happened till the Spaniards arrived on the confines of the republic of Tlascala. The inhabitants of that province were warlike, fierce, and revengeful, and had made considerable progress in agriculture and some other arts. They were implacable enemies to Montezuma; and therefore Cortes hoped that it would be an easy matter for him to pro- 70
cure their friendship. With this view, four Zempoallans of high rank were sent ambassadors to Tlascala, dressed with all the badges of that office usual among the Indians. The senate were divided in their opinions with regard to the proposals of Cortes: but at last Magiscatzin, one of the oldest senators, and a person of great authority, mentioned the tradition of their ancestors, and the revelations of their priests; that a race of invincible men, of divine origin, who had power over the elements, should come from the east to subdue their country. He compared the resemblance which the strangers bore to the persons figured in the traditions of Mexico, their dominion over the elements of fire, air, and water; he reminded the senate of their prodigies, omens, and signals, which had lately terrified the Mexicans, and indicated some very important event; and then declared his opinion, that it would be rashness to oppose a force apparently assisted by heaven, and men who had already proved, to the sad experience of those who opposed them, that they were invincible. This orator was opposed by Xicotencal, who endeavoured to prove that the Spaniards were at best but powerful magicians: that they had rendered themselves obnoxious to the gods by pulling down their images and altars (which indeed Cortes had very imprudently done at Zempoalla); and of consequence, that they might easily be overcome, as the gods would not fail to resent such an outrage. He therefore voted for war, and advised the crushing of these invaders at one blow.

Sends ambassadors to the republic of Tlascala.

The advice of Xicotencal prevailed; and in consequence of it, the ambassadors were detained; which giving

giving Cortes the alarm, he drew nearer the city of Tlaſcala. They ſuffered him with his army drawn up

71 The Tlaſcalans reſolve on war.

in good order, to paſs a ſtrong wall between two mountains, which might have been very advantageouſly defended againſt him. He had not advanced far beyond this paſs, however, before a party of Tlaſcalans with plumes were diſcovered, which denoted that an army was in the field. Theſe he drove before him by a detachment of ſix horſe, obliged them to join another party, and then reinforcing the advanced detachment, charged the enemy with ſuch vigour that they began to retire. Five thouſand Tlaſcalans then ruſhed out of their hiding places, juſt as the infantry came up to aſſiſt their ſlender body of cavalry. The enemy attacked with the utmoſt fury: but were ſo much diſconcerted by the firſt diſcharge of the fire-arms, that they retreated in confuſion, furniſhing the Spaniards with an opportunity of purſuing them with great ſlaughter. Cortes, however, ſuppoſing that this could not be their whole force, advanced with the utmoſt caution, in order of battle, to an eminence, from whence he had a view of the main body of the Tlaſcalan army commanded by Xicotencal, conſiſting of no fewer than 40,000 men. By theſe the ſmall army of Cortes was entirely ſurrounded; which Xicotencal no ſooner perceived, than he contracted the circle with incredible diligence, while the Spaniards were almoſt overwhelmed with ſhowers of arrows, darts, and ſtones. It is impoſſible but in this caſe many of the Spaniards muſt have periſhed, had it not been for the inſufficiency of the Indian weapons. This circumſtance gave the Spaniards a prodigious advantage over them; and therefore the Tlaſcalans, notwithſtanding their valour and ſuperiority in number, could accompliſh no more in the preſent inſtance, than to kill one horſe and ſlightly wound nine ſoldiers.

The Tlaſcalans being taught by this, and ſome ſubſequent encounters, how much they were inferior to the Spaniards, began to conceive them to be really what Magiſcatzin had ſaid; a ſuperior order of beings, againſt whom human power could not prevail. In this extremity they had recourſe to their prieſts, requiring them to reveal the cauſes of ſuch extraordinary events, and to declare what means they ſhould take to repel ſuch formidable invaders. The prieſts, after many ſacrifices and incantations, delivered their reſponſe, That theſe ſtrangers were the offspring of the ſun, procreated by his animating energy in the regions of the eaſt: that, by day, while cheriſhed with the influence of his parental beams, they were invincible; but by night, when his reviving heat was withdrawn, their vigour declined and faded like herbs in the field, and they dwindled down into mortal men. In conſequence of this, the Tlaſcalans acted in contradiction to one of their moſt eſtabliſhed maxims in war, and ventured to attack the enemy in the night time, hoping to deſtroy them when enfeebled and ſurpriſed. But the Spaniſh centinels having obſerved ſome extraordinary move-

72 But are defeated and ſue for peace.

ments among the Tlaſcalans, gave the alarm. Immediately the troops were under arms, and ſallying out, defeated their antagoniſts with great ſlaughter, without allowing them to approach the camp. By this diſaſter the Tlaſcalans were heartily diſpoſed to peace; but they were at a loſs to form an adequate idea of the enemies they had to deal with. They could not aſcertain the nature of theſe ſurpriſing beings, or whether they were really of a benevolent or malignant diſpoſition. There were circumſtances in their behaviour which ſeemed to favour each opinion. On the one hand, as the Spaniards conſtantly diſmiſſed the priſoners whom they took, not only without injury, but often with preſents of European toys, and renewed their offers of peace after every victory; this lenity amazed people accuſtomed to the exterminating ſyſtem of war known in America, and who ſacrificed and devoured without mercy all the captives taken in battle; and diſpoſed them to entertain ſentiments favourable to their humanity. But, on the other hand, as Cortes had ſeized 50 of their countrymen who brought proviſions to their camp, and cut off their heads; this bloody ſpectacle, added to the terror occaſioned by the fire-arms and horſes, filled them with dreadful ideas of their ferocity. Accordingly they addreſſed them in the following manner: "If (ſaid they) you are divinities of a cruel and ſavage nature, we preſent to you five ſlaves, that you may drink their blood and eat their fleſh. If you are mild deities, accept an offering of incenſe and variegated plumes. If you are men, here is meat, bread, and fruit, to nouriſh you."

After this addreſs, the peace was ſoon concluded, to the great ſatisfaction of both parties. The Tlaſcalans yielded themſelves as vaſſals to the crown of Caſtile, and engaged to aſſiſt Cortes in all his operations; while he took the republic under his protection, and promiſed to defend their perſons and poſſeſſions from injury and violence. 73 Which is granted.

Cortes left no method untried to gain the favour and confidence of the Tlaſcalans; which, however, he had almoſt entirely loſt, by his untimely zeal in deſtroying their idols as he had done thoſe of Zempoalla. But he was deterred from this raſh action by his chaplain Father Bartholomew de Olmedo; and left the Tlaſcalans in the undiſturbed exerciſe of their ſuperſtition, requiring only that they ſhould deſiſt from their horrid practice of offering human victims. As ſoon as his troops were fit for ſervice, he reſolved to continue his march towards Mexico, notwithſtanding the remonſtrances of the Tlaſcalans, who looked upon his deſtruction as unavoidable if he put himſelf into the power of ſuch a faithleſs prince as Montezuma. But the emperor, probably intidimated with the fame of his exploits, had reſolved to admit his viſit; and informed Cortes that he had given orders for his friendly reception at Cholula, the next place of any conſequence on the road to Mexico. 74 Cortes continues his march for Mexico.

Cortes was received with much ſeeming cordiality; but 6000 Tlaſcalan troops who accompanied him were obliged to remain without the town, as the Cholulans refuſed to admit their ancient enemies within their precincts. Yet two of theſe, by diſguiſing themſelves, got into the city, and acquainted Cortes that they obſerved the women and children belonging to the principal citizens retiring every night in a great hurry, and that ſix children had been ſacrificed in the great temple; a ſign that ſome warlike enterpriſe was at hand. At the ſame time Donna Marina, the interpreter, received information from an Indian woman of diſtinction, whoſe confidence ſhe had gained, that the deſtruction of the Spaniards was concerted; that a body of Mexican troops lay concealed near the town; that ſome of the ſtreets were barricaded, in others deep pits or trenches were dug, 75 Treachery of Montezuma and the Cholulans.

Mexico. dug, and ſlightly covered over, as traps into which the horſe might fall; that ſtones and miſſile weapons were collected on the tops of the temples, with which to overwhelm the infantry; that the fatal hour was already at hand, and their ruin unavoidable. Cortes, alarmed at this news, ſecretly arreſted three of the chief prieſts, from whom he extorted a confeſſion that confirmed the intelligence he had already received. As not a moment was to be loſt, he inſtantly reſolved to prevent his enemies, and to inflict on them ſuch dreadful vengeance as might ſtrike Montezuma and his ſubjects with terror. On a ſignal given, the troops ruſhed out, and fell upon the multitude, deſtitute of leaders, and ſo much aſtoniſhed, that the weapons dropped from their hands, and they ſtood motionleſs, and incapable of defence. While the Spaniards attacked them in front, the Tlaſcalans did the ſame in the rear; the ſtreets were filled with ſlaughter; the temples, which afforded a retreat to the prieſts and ſome leading men, were ſet on fire, and they periſhed in the flames. At length the carnage ceaſed, after the ſlaughter of 6000 Cholulans, without the loſs of a ſingle Spaniard. Cortes then releaſed the magiſtrates; and reproaching them bitterly for their intended treachery, declared, that as juſtice was now appeaſed, he forgave the offence; but required them to recal the inhabitants who had fled, and re-eſtabliſh order in the town.

76 Severe puniſhment of the Cholulans.

77 Diſaffection of Montezuma's ſubjects.

From Cholula, Cortes advanced directly towards Mexico; and throughout the whole of his journey was entertained with accounts of the oppreſſions and cruelty of Montezuma. This gave him the greateſt hope of accompliſhing his deſign; as he now perceived that the empire was entirely divided, and no ſort of unanimity prevailed among them. No enemy appeared to check his progreſs. Montezuma was quite irreſolute; and Cortes was almoſt at the gates of the capital before the emperor had determined whether to receive him as a friend or oppoſe him as an enemy. But as no ſign of open hoſtility appeared, the Spaniards, without regarding the fluctuations of Montezuma's ſentiments, continued their march to Mexico, with great circumſpection and the ſtricteſt diſcipline, though without ſeeming to ſuſpect the prince whom they were about to viſit.

78 Meeting of Cortes and Montezuma.

When they drew near the city, about 1000 perſons who appeared to be of diſtinction, came forth to meet them, adorned with plumes, and clad in mantles of fine cotton. Each of theſe, in his order, paſſed by Cortes, and ſaluted him according to the mode deemed moſt reſpectful and ſubmiſſive in their country. They announced the approach of Montezuma himſelf, and ſoon after his harbingers came in ſight. There appeared firſt 200 perſons in an uniform dreſs, with large plumes of feathers, alike in faſhion, marching two and two, in deep ſilence, barefooted, with their eyes fixed on the ground. Theſe were followed by a company of higher rank, in their moſt ſhowy apparel: in the midſt of whom was Montezuma, in a chair or litter richly ornamented with gold and feathers of various colours. Four of his principal favourites carried him on their ſhoulders, others ſupported a canopy of curious workmanſhip over his head. Before him marched three officers with rods of gold in their hands, which they lifted up on high at certain intervals; and at that ſignal all the people bowed their heads, and hid their faces, as unworthy to look on ſo great a monarch. When he drew near, Cortes diſmounting, advanced towards him with officious haſte, and in a reſpectful poſture. At the ſame time Montezuma alighted from his chair, and leaning on the arms of two of his near relations, approached with a ſlow and ſtately pace, his attendants covering the ſtreet with cotton cloths, that he might not touch the ground. Cortes accoſted him with profound reverence, after the European faſhion. He returned the ſalutation, according to the mode of his country, by touching the earth with his hand, and then kiſſing it. This ceremony appeared ſuch amazing condeſcenſion in a proud monarch, who ſcarcely deigned to conſider the reſt of mankind as of the ſame ſpecies with himſelf, that all his ſubjects firmly believed thoſe perſons, before whom he humbled himſelf in this manner, to be ſomething more than human. Accordingly, as they marched through the crowd, the Spaniards frequently, and with much ſatisfaction, heard themſelves denominated *teules*, or *divinities*. Nothing material paſſed in this firſt interview. Montezuma conducted Cortes to the quarters which he had prepared for his reception; and immediately took leave of him with a politeneſs not unworthy of a court more refined: "You are now (ſays he), with your brothers, in your own houſe; refreſh yourſelves after your fatigue, and be happy until I return." The place allotted to the Spaniards for their lodging was a houſe built by the father of Montezuma. It was ſurrounded by a ſtone wall, with towers at proper diſtances, which ſerved for defence as well as for ornament; and its apartments and courts were ſo large as to accommodate both the Spaniards and their Indian allies. The firſt care of Cortes was to take precautions for his ſecurity, by planting the artillery ſo as to command the different avenues which led to it, by appointing a large diviſion of his troops to be always on guard, and by poſting centinels at proper ſtations, with injunctions to obſerve the ſame vigilant diſcipline as if they were within ſight of an enemy's camp.

In the evening Montezuma returned to viſit his gueſts with the ſame pomp as in their firſt interview; and brought preſents of ſuch value, not only to Cortes and to his officers, but even to the private men, as proved the liberality of the monarch to be ſuitable to the opulence of his kingdom. A long conference enſued, in which Cortes learned what was the opinion of Montezuma with reſpect to the Spaniards. It was an eſtabliſhed tradition, he told him, among the Mexicans, that their anceſtors came originally from a remote region, and conquered the provinces now ſubject to his dominion; that after they were ſettled there, the great captain who conducted this colony returned to his own country, promiſing, that at ſome future period his deſcendents ſhould viſit them, aſſume the government, and reform their conſtitutions and laws; that, from what he had heard and ſeen of Cortes and his followers, he was convinced that they were the very perſons whoſe appearance their prophecies taught them to expect; that accordingly he had received them, not as ſtrangers, but as relations of the ſame blood and parentage, and deſired that they might conſider themſelves as maſters in his dominions; for both himſelf and his ſubjects ſhould be ready to comply with their will, and even to prevent their wiſhes. Cortes made a rely in his uſual ſtyle with reſpect to the dignity and power of his ſovereign, and his intention in ſending him into that country; artfully endeavouring ſo to frame his diſcourſe, that it might coincide as much as poſſible with the idea which Montezuma had formed concerning the origin of the Spaniards. Next morning, Cortes and ſome of his principal attendants were admitted to a public audience of the emperor. The three ſubſequent days were employed in viewing the city; the appearance of which, ſo far ſuperior in the order of its buildings and the number of its inhabitants to any place the Spaniards had beheld in America, and yet ſo little reſembling the ſtructure of an European city, filled them with ſurpriſe and admiration.

79 Deſcription of the city of Mexico.

Mexico is ſituated in a large plain, environed by mountains of ſuch height, that though within the torrid zone, the temperature of its climate is mild and healthful. All the moiſture which deſcends from the high grounds is collected in ſeveral lakes, the two largeſt of which, of about 90 miles in circuit, communicate with each other. The waters of the one are freſh, thoſe of the other brackiſh. On the banks of the latter, and on ſome ſmall iſlands adjoining to them, the capital of Montezuma's empire was built. The acceſs to the city was by artificial cauſeways or ſtreets, formed of ſtones and earth, about 30 feet in breadth. As the waters of the lake, during the rainy ſeaſon, overflowed the flat country, theſe cauſeways were of conſiderable length. That of Tacuba on the weſt a mile and a half; that of Tezcuco on the north-weſt three miles; that of Cuoyacan towards the ſouth ſix miles. On the eaſt there was no cauſeway, and the city could be approached only by canoes. In each of theſe cauſeways were openings at proper intervals, through which the waters flowed; and over theſe beams of timber were laid, which being covered with earth, the cauſeway or ſtreet had everywhere an uniform appearance. As the approaches to the city were ſingular, its conſtruction was remarkable. Not only the temples of their gods, but the houſes belonging to the monarch, and to perſons of diſtinction, were of ſuch dimenſions, that in compariſon with any other buildings which had been diſcovered in America, they might be termed *magnificent*. The habitations of the common people were mean, reſembling the huts of other Indians. But they were all placed in a regular manner, on the banks of the canals which paſſed through the city, in ſome of its diſtricts, or on the ſides of the ſtreets which interſected it in other quarters. In ſeveral places were large openings or ſquares, one of which, allotted for the great market, is ſaid to have been ſo ſpacious that 40,000 or 50,000 perſons carried on traffic there. In this city, the pride of the New World, and the nobleſt monument of the induſtry and art of man, while unacquainted with the uſe of iron, the Spaniards, who are moſt moderate in their computations, reckon that there were at leaſt 60,000 inhabitants.

80 Uneaſineſs of the Spaniards.

But how much ſoever the novelty of thoſe objects might amuſe or aſtoniſh the Spaniards, they felt the utmoſt ſolicitude with reſpect to their own ſituation. From a concurrence of circumſtances, no leſs unexpected than favourable to their progreſs, they had been allowed to penetrate into the heart of a powerful kingdom, and were now lodged in its capital, without having once met with open oppoſition from its monarch. The Tlaſcalans, however, had earneſtly diſſuaded them from placing ſuch confidence in Montezuma as to enter a city of ſuch a peculiar ſituation as Mexico, where that prince would have them at mercy, ſhut up as it were in a ſnare, from which it was impoſſible to eſcape. They aſſured them that the Mexican prieſts had, in the name of the gods, counſelled their ſovereign to admit the ſtrangers into the capital, that he might cut them off there at one blow with perfect ſecurity. The Spaniards now perceived, too plainly, that the apprehenſions of their allies were not deſtitute of foundation; that, by breaking the bridges placed at certain intervals on the cauſeways, or by deſtroying part of the cauſeways themſelves, their retreat would be rendered impracticable, and they muſt remain cooped up in the centre of a hoſtile city, ſurrounded by multitudes ſufficient to overwhelm them, and without a poſſibility of receiving aid from their allies. 81

Some hoſtilities between the Spaniards and Mexicans.

Before he ſet out from Cholula, Cortes had received advice from Villa Rica, that Qualpopoca, one of the Mexican generals on the frontiers, having aſſembled an army in order to attack ſome of the people whom the Spaniards had encouraged to throw off the Mexican yoke, Eſcalante had marched out with part of the garriſon to ſupport his allies; that an engagement had enſued, in which, though the Spaniards were victorious, Eſcalante, with ſeven of his men, had been mortally wounded, his horſe killed, and one Spaniard had been ſurrounded by the enemy and taken alive; that the head of this unfortunate captive, after being carried in triumph to different cities, in order to convince the people that their invaders were not immortal, had been ſent to Mexico. Cortes, though alarmed with this intelligence, as an indication of Montezuma's hoſtile intentions, had continued his march. But as ſoon as he entered Mexico he became ſenſible, that, from an exceſs of confidence in the ſuperior valour and diſcipline of his troops, as well as from the diſadvantage of having nothing to guide him in an unknown country but the defective intelligence which he received from people with whom his mode of communication was very imperfect, he had puſhed forward into a ſituation, where it was difficult to continue, and from which it was dangerous to retire. Diſgrace, and perhaps ruin, was the certain conſequence of attempting the latter. The ſucceſs of his enterpriſe depended upon ſupporting the high opinion which the people of New Spain had formed with reſpect to the irreſiſtible power of his arms. Upon the firſt ſymptom of timidity on his part, their veneration would ceaſe, and Montezuma, whom fear alone reſtrained at preſent, would let looſe upon him the whole force of his empire. At the ſame time, he knew that the countenance of his own ſovereign was to be obtained only by a ſeries of victories; and that nothing but the merit of extraordinary ſucceſs could ſcreen his conduct from the cenſure of irregularity. From all theſe conſiderations, it was neceſſary to maintain his ſtation, and to extricate himſelf out of the difficulties in which one bold ſtep had involved him, by venturing upon another ſtill bolder. The ſituation was trying, but his mind was equal to it; and after revolving the matter with deep attention, he fixed upon a plan no leſs extraordinary than daring. He determined to ſeize Montezuma in his palace, and carry him a priſoner to the 82

Cortes reſolves to ſeize Montezuma in his palace.

Mexico. the Spanish quarters. From the superstitious veneration of the Mexicans for the person of their monarch, as well as their implicit submission to his will, he hoped, by having Montezuma in his power, to acquire the supreme direction of their affairs; or at least, with such a sacred pledge in his hands, he made no doubt of being secure from any effort of their violence.

This he immediately proposed to his officers. The timid startled at a measure so audacious, and raised objections. The more intelligent and resolute, conscious that it was the only resource in which there appeared any prospect of safety, warmly approved of it, and brought over their companions so cordially to the same opinion, that it was agreed instantly to make the attempt. At his usual hour of visiting Montezuma, Cortes went to the palace, accompanied by Alvarado, Sandoval, Lugo, Velasquez de Leon, and Davila, five of his principal officers, and as many trusty soldiers. Thirty chosen men followed, not in regular order, but sauntering at some distance, as if they had no object but curiosity; small parties were posted at proper intervals, in all the streets leading from the Spanish quarters to the court; and the remainder of his troops, with the Tlascalan allies, were under arms, ready to sally out on the first alarm. Cortes and his attendants were admitted without suspicion; the Mexicans retiring, as usual, out of respect. He addressed the monarch in a tone very different from that which he had employed in former conferences; reproaching him bitterly as the author of the violent assault made upon the Spaniards by one of his officers, and demanding public reparation for the loss which he had sustained by the death of some of his companions, as well as for the insult offered to the great prince whose servants they were. Montezuma, confounded at this unexpected accusation, and changing colour either from the consciousness of guilt, or from feeling the indignity with which he was treated, asserted his own innocence with great earnestness; and, as proof of it, gave orders instantly to bring Qualpopoca and his accomplices prisoners to Mexico. Cortes replied, with seeming complaisance, that a declaration so respectable left no doubt remaining in his own mind; but that something more was requisite to satisfy his followers, who would never be convinced that Montezuma did not harbour hostile intentions against them, unless, as an evidence of his confidence and attachment, he removed from his own palace and took up his residence in the Spanish quarters, where he should be served and honoured as became a great monarch. The first mention of so strange a proposal bereaved Montezuma of speech, and almost of motion. At length he haughtily answered, "That persons of his rank were not accustomed voluntarily to give up themselves as prisoners; and were he mean enough to do so, his subjects would not permit such an affront to be offered to their sovereign." Cortes, unwilling to employ force, endeavoured alternately to soothe and intimidate him. The altercation became warm: and having continued above three hours, Velasquez de Leon, an impetuous and gallant young man, exclaimed with impatience, "Why waste more time in vain? Let us either seize him instantly, or stab him to the heart." The threatening voice and fierce gestures with which these words were uttered, struck Montezuma. The Spaniards, he was sensible, had now proceeded so far, as left him no hope that they would recede. His own danger was imminent, the necessity unavoidable. He saw both; and abandoning himself to his fate, complied with their request. Mexico.

83 The emperor carried to the Spanish quarters.

His officers were called. He communicated to them his resolution. Though astonished and afflicted, they presumed not to question the will of their master, but carried him in silent pomp, all bathed in tears, to the Spanish quarters.

They at first pretended to treat Montezuma with great respect; but soon took care to let him know that he was entirely in their power. Cortes wished that the shedding the blood of a Spaniard should appear the most heinous crime that could be committed; and therefore not only took a most exemplary vengeance on those who had been concerned in the affair of Villa Rica, but even but the emperor himself in chains till the execution of the Mexican general was over. By these, and other insults, he at last gained entirely the ascendant over this unhappy monarch; and he took care to improve his opportunity to the utmost. He sent his emissaries into different parts of the kingdom, accompanied with Mexicans of distinction, who might serve both to guide and to protect them. They visited most of the provinces, viewed their soil and productions, surveyed with particular care the districts which yielded gold or silver, pitched upon several places as proper for future colonies, and endeavoured to prepare the minds of the people for submitting to the Spanish yoke: and while they were thus employed, Cortes, in the name and by the authority of Montezuma, degraded some of the principal officers in the empire, whose abilities or independent spirit excited his jealousy; and substituted in their place persons who he imagined would be more obsequious. One thing, however, was still wanting to complete his security. He wished to have such a command of the lake as might ensure a retreat, if, either from levity or disgust, the Mexicans should take arms against him, and break down the bridges or causeways, in order to enclose him in the city. In order to obtain this without giving disgust to the emperor or his court, Cortes artfully inflamed the curiosity of the Indians with accounts of the Spanish shipping, and those floating palaces that moved with such velocity on the water, without the assistance of oars; and when he found that the monarch himself was extremely desirous of seeing such a novelty, he gave him to understand, that nothing was wanting to his gratification besides a few necessaries from Vera Cruz, for that he had workmen in his army capable of building such vessels. The bait took with Montezuma; and he gave immediate orders that all his people should assist Cortes in whatever he should direct concerning the shipping. By this means, in a few days, two brigantines were got ready, full rigged and equipped; and Montezuma was invited on board, to make the first trial of their sailing, of which he could form no idea. Accordingly he embarked for this purpose, and gave orders for a great hunting upon the water, in order that all his people might be diverted with the novelty presented by the Spaniards. On the day appointed, the royal equipage was ready early in the morning; and the lake was covered with a multitude of boats and canoes loaded with people. The Mexicans had augmented the

84 Cortes rules the empire.

85 By a pretence, he obtains leave to build two brigantines on the lake.

Mexico. the number of their rowers on board the royal barges, with an intention to disgrace the Spanish vessels, which they regarded as clumsy, unwieldy, and heavy. But they were soon undeceived; a fresh gale started up, the brigantines hoisted sail, to the utter astonishment of all the spectators, and soon left all the canoes behind; while the monarch exulted in the victory of the Spaniards, without once considering that now he had effectually rivetted his own chains.

86 Montezuma owns himself a vassal to the king of Spain.

Cortes having obtained this important point, resolved to put the condescension of the emperor to a trial still more severe. He urged Montezuma to acknowledge himself a vassal to the crown of Castile; to hold his crown of him as superior, and to subject his dominions to the payment of an annual tribute. With this requisition, humiliating as it was, Montezuma complied. He called together the chief men of his empire, and, in a solemn harangue, reminded them of the traditions and prophecies which led them to expect the arrival of a people sprung from the same stock with themselves, in order to take possession of the supreme power; he declared his belief that the Spaniards were this promised race; and that therefore he recognised the right of their monarch to govern the Mexican empire, would lay his crown at his feet, and obey him as a tributary. While uttering these words, Montezuma discovered how deeply he was affected in making such a sacrifice. Tears and groans frequently interrupted his discourse. The first mention of such a resolution struck the assembly dumb with astonishment. This was followed by a sullen murmur of sorrow mingled with indignation; which indicated some violent eruption of rage to be near at hand. This Cortes foresaw, and seasonably interposed to prevent it, by declaring that his master had no intention to deprive Montezuma of the royal dignity, or to make any innovation upon the constitution and laws of the Mexican empire. This assurance, added to their dread of the Spanish arms, and the authority of their monarch's example, extorted the consent of the assembly; and the act of submission and homage was executed with all the formalities which the Spaniards pleased to prescribe.

87 The Spaniards divide their treasure.

Montezuma, at the request of Cortes, accompanied this profession of fealty and homage with a magnificent present to his new sovereign; and, after his example, his subjects brought in very liberal contributions. The Spaniards then collected all the treasure which had been either voluntarily bestowed upon them at different times by Montezuma, or had been extorted from his people under various pretences; and having melted the gold and silver, the value of these amounted to 600,000 pesos. The soldiers were impatient to have it divided; and Cortes complied with their desire. A fifth of the whole was set apart as the tax due to the king. Another fifth was allowed to Cortes as commander. The sums advanced by the governor of Cuba, who had originally fitted out the expedition, were then deducted. The remainder was then divided among the army, including the garrison of Vera Cruz, in proportion to their different ranks; and after so many deductions, the share of a private man did not exceed 100 pesos. This sum fell so far below their sanguine expectations, that it required all the address, and no small exertions of the liberality of Cortes, to prevent an open mutiny. However, he at last restored tranquillity; but had no sooner escaped this danger, than he involved himself, by his imprudent zeal for religion, in one much worse. Montezuma, though often importuned, had obstinately refused to change his religion, or abolish the superstitious rites which had been for such a long time practised throughout his dominions. This at last transported the Spaniards with such rage, that, in a sally of zeal, he led out his soldiers in order to throw down the idols in the great temple by force. But the priests taking arms in defence of their altars, and the people crowding with great ardour to support them, Cortes's prudence overruled his zeal, and induced him to desist from his rash attempt, after dislodging the idols from one of the shrines, and placing in their stead an image of the Virgin Mary.

88 Cortes attempts to destroy the Mexican idols.

89 Which produces a general dissafection.

From this moment the Mexicans began to meditate the expulsion or the destruction of the Spaniards. The priests and leading men held frequent meetings with Montezuma for this purpose. But as any violent attempt might have proved fatal to the captive monarch, it was thought proper first to try more gentle means. Having called Cortes into his presence, he observed, that now, as all the purposes of his embassy were fully accomplished, the gods had declared their will, and the people signified their desire, that he and his followers should instantly depart out of the empire. With this he required them to comply, or unavoidable destruction would fall suddenly on their heads. This unexpected requisition, as well as the manner in which it was delivered, alarmed Cortes. However, he supposed that more might be gained by a feigned compliance than by open resistance; and therefore replied with great composure, that he had already begun to prepare for his return; but as he had destroyed the vessels in which he arrived, some time was requisite for building other ships. This appeared reasonable; and a number of Mexicans were sent to Vera Cruz to cut down timber, and some Spanish carpenters were appointed to superintend the work.

90 The Spaniards are commanded to depart.

91 An armament sent from Cuba against Cortes.

Cortes flattered himself, that, during this interval, he might either find means to avert the threatened danger, or receive such reinforcements as would enable him to defend himself. Nine months had now elapsed since Portocarrero and Montejo had sailed with his despatches to Spain; and he daily expected a return, with a confirmation of his authority from the king, without which all that he had done served only to mark him out as an object of punishment. While he remained in great anxiety on this account, news were brought that some ships had appeared on the coast. These were imagined by Cortes to be a reinforcement sent him from Spain: but his joy was of short continuance, for a courier very soon arrived from Vera Cruz, with certain information that the armament was fitted out by Velasquez, the governor of Cuba; and instead of bringing succours, threatened them with immediate destruction.

Velasquez had been excited to this hostile measure chiefly through the indiscretion, or rather treachery, of the messengers of Cortes; who, contrary to his express injunctions, had landed on the island of Cuba, and given intelligence of all that had passed: and Velasquez, transported with rage at hearing of the proceedings of Cortes, had now sent against him this armament; consisting of 18 ships, which carried 80 horsemen, Mexico. men, 800 infantry, of which 80 were musketeers, and 120 cross bowmen, commanded by a brave officer named *Pamphilo de Narvaez*; whose instructions were, to seize Cortes and his principal officers, to send them prisoners to him, and then to complete the discovery and conquest of the country in his name. This proved a most afflicting piece of new to Cortes.

92 Which is defeated by that general. Having now no resource but in war, he left 150 men under the command of Pedro de Alvarado, an officer of great bravery, and much respected by the Mexicans, to guard the capital and the captive emperor; while he himself marched with the remainder, to meet his formidable opponent, who had taken possession of Zempoalla. Even after being reinforced by Sandoval his governor of Vera Cruz, the force of Cortes did not exceed 250 men. He hoped for success chiefly from the rapidity of his motions and the possibility of surprising his enemies; and as he chiefly dreaded their cavalry, he armed his soldiers with long spears, accustoming them to that deep and compact arrangement which the use of this formidable weapon enabled them to assume. As he advanced, however, he repeated his proposals of accommodation; but these being constantly rejected, and a price set upon his head, he at last attacked Narvaez in the night-time, entirely defeated and took him prisoner, obliging all his troops to own allegiance to himself.

Nothing could be more seasonable than this victory, by which Cortes found his army very considerably increased; for most of the soldiers of Narvaez chose rather to follow Cortes than to return to Cuba, whither the conqueror had offered to send them if they

93 Dangerous situation of the Spaniards left at Mexico. chose. His affairs at Mexico, in the mean time, were in the utmost danger of being totally ruined; and had this decisive victory been delayed but a few days longer, he must have come too late to save his companions. A short time after the defeat of Narvaez, a courier arrived from Mexico with the disagreeable intelligence that the Mexicans had taken arms; and having seized and destroyed the two brigantines which he had built in order to secure the command of the lake, had attacked the Spaniards in their quarters, killed some, and wounded many more, burnt their magazine of provisions, and, in short, carried on hostilities with such fury, that though Alvarado and his men defended themselves with undaunted resolution, they must either be cut off by famine, or sink under the multitude of their enemies. This revolt was excited by motives which rendered it still more alarming. On the departure of Cortes for Zempoalla, the Mexicans flattered themselves, that the long-expected opportunity of restoring their sovereign to liberty, and driving out the Spaniards, was arrived; and consultations were accordingly held for bringing about both these events. The Spaniards in Mexico, conscious of their own weakness, suspected and dreaded these machinations; but Alvarado, who had neither the prudence nor the address of Cortes, took the worst method imaginable to overcome them. Instead of attempting to soothe or cajole the Mexicans, he waited the return of one of their solemn festivals, when the principal persons in the empire were dancing, according to custom, in the court of the great temple; he seized all the avenues which led to it; and, allured partly by the rich ornaments which they wore in honour of their gods, and partly by the facility of cutting off at once the authors of that conspiracy which he dreaded, he fell upon them, unarmed and unsuspicious of danger, and massacred a great number; none escaping but such as made their way over the battlements of the temple. An action so cruel and treacherous filled not only the city, but the whole empire, with indignation and rage; and the Mexicans immediately proceeded in the manner above mentioned.

Cortes advanced with the utmost celerity to the relief of his distressed companions: but as he passed along, had the mortification to find that the Spaniards were generally held in abhorrence. The principal inhabitants had deserted the towns through which he passed; no person of note appeared to meet him with the usual respect; nor were provisions brought to his camp as usual. Notwithstanding these signs of aversion and horror, however, the Mexicans were so ignorant of the military art, that they again permitted him to enter the capital without opposition; though it was in their power to have easily prevented him, by breaking down the bridges and causeways which led to it. 94 Cortes allowed to return to Mexico;

Cortes was received by his companions with the utmost joy; and this extraordinary success so far intoxicated the general himself, that he not only neglected to visit Montezuma, but expressed himself very contemptuously concerning him. These expressions being reported among the Mexicans, they all at once flew to arms, and made such a violent and sudden attack, that all the valour and skill of Cortes were scarce sufficient to repel them. 95 but is furiously attacked by the natives. This produced great uneasiness among the soldiers of Narvaez, who had imagined there was nothing to do but to gather the spoils of a conquered country. Discontent and murmurings, however, were now of no avail; they were enclosed in a hostile city, and, without some extraordinary exertions, were inevitably undone. Cortes, therefore, made a desperate sally; but, after exerting his utmost efforts for a whole day, was obliged to retire with the loss of 12 killed, and upwards of 60 wounded. Another sally was attempted with the like bad success, and in it Cortes himself was wounded in the hand.

The Spanish general was now thoroughly convinced of his error; and therefore betook himself to the only resource which was left; namely, to try what effect the interposition of Montezuma would have to soothe or overawe his subjects. When the Mexicans approached the next morning to renew the assault, that unfortunate prince, at the mercy of the Spaniards, and reduced to the sad necessity of becoming the instrument of his own disgrace, and of the slavery of his people, advanced to the battlements in his royal robes, and with all the pomp in which he used to appear on solemn occasions. At the sight of their sovereign, whom they had been long accustomed to reverence almost as a god, the Mexicans instantly forebore their hostilities, and many prostrated themselves on the ground: but when he addressed them in favour of the Spaniards, and made use of all the arguments he could think of to mitigate their rage, they testified their resentment with loud murmurings; and at length broke forth 96 Montezuma killed.

Mexico.

forth with ſuch fury, that before the ſoldiers, appointed to guard Montezuma, had time to cover him with their ſhields, he was wounded with two arrows, and a blow on his temple with a ſtone ſtruck him to the ground. On ſeeing him fall, the Mexicans inſtantly fled with the utmoſt precipitation: but the unhappy monarch, now convinced that he was become an object of contempt even to his own ſubjects, obſtinately refuſed all nouriſhment; and thus in a ſhort time ended his days.

97
A terrible engagement between the Spaniards and Mexicans.

On the death of Montezuma, Cortes having loſt all hope of bringing the Mexicans to any terms of peace, prepared for retreat. But his antagoniſts, having taken poſſeſſion of a high tower in the great temple, which overlooked the Spaniſh quarters, and placing there a garriſon of their principal warriors, the Spaniards were ſo much expoſed to their miſſile weapons, that none could ſtir without danger of being killed or wounded. From this poſt, therefore, it was neceſſary to diſlodge them at any rate; and Juan de Eſcobar, with a large detachment of choſen ſoldiers, was ordered to make the attack. But Eſcobar, though a valiant officer, and though he exerted his utmoſt efforts, was thrice repulſed. Cortes, however, ſenſible that not only his reputation, but the ſafety of his army, depended on the ſucceſs of this aſſault, cauſed a buckler to be tied to his arm, as he could not manage it with his wounded hand, and ruſhed with his drawn ſword among the thickeſt of the combatants. Encouraged by the preſence of their general, the Spaniards returned to the charge with ſuch vigour, that they gradually forced their way up the ſteps, and drove the Mexicans to the platform at the top of the tower. There a dreadful carnage began; when two young Mexicans of high rank, obſerving Cortes, as he animated his ſoldiers, reſolved to ſacrifice their own lives in order to cut off the author of ſo many calamities which deſolated their country. They approached him in a ſuppliant poſture, as if they intended to lay down their arms; and ſeizing him in a moment, hurried him towards the battlements, over which they threw themſelves headlong, in hopes of dragging him along with them. But Cortes, by his ſtrength and agility, diſengaged himſelf from their graſp; ſo that the two Mexicans periſhed alone.

As ſoon as the Spaniards became maſters of the tower, they ſet fire to it, and without further moleſtation continued the preparations for their retreat. This became the more neceſſary, as their enemies, aſtoniſhed at this laſt effort of their valour, had now entirely changed their ſyſtem of hoſtility; and, inſtead of inceſſant attacks, endeavoured, by barricading the ſtreets, and breaking down the cauſeways, to cut off the communication of the Spaniards with the continent, and thus to ſtarve an enemy whom they could not ſubdue. The firſt point to be determined, was whether they ſhould march out openly in the face of day, when they could diſcern every danger, or whether they ſhould endeavour to retire ſecretly in the night. The latter was preferred, partly from hopes that the ſuperſtition of the Mexicans would prevent them from attacking them in the night, and partly from their own ſuperſtition in giving credit to the predictions of a private ſoldier, who pretended to aſtrology, and aſſured them of ſucceſs if they retreated in this manner. Towards midnight, therefore, they began their march, in three diviſions. Sandoval led the van; Pedro Alvarado and Velaſquez de Leon had the conduct of the rear; and Cortes commanded in the centre, where he placed the priſoners, among whom were a ſon and two daughters of Montezuma, together with ſeveral Mexicans of diſtinction, the artillery, baggage, and a portable bridge of timber intended to be laid over the breaches in the cauſeway. They marched in profound ſilence along the cauſeway which led to Tacuba, becauſe it was ſhorter than any of the reſt, and, lying moſt remote from the road towards Tlaſcala and the ſea coaſt, had been left moſt entire by the Mexicans.

They reached the firſt breach in the cauſeway without moleſtation, hoping that their retreat was undiſcovered. But the Mexicans had not only watched all their motions, but made preparations for a moſt formidable attack. While the Spaniards were intent upon placing their bridges in the breach, and occupied in conducting their horſes and artillery along it, they were ſuddenly alarmed with the ſound of warlike inſtruments, and found themſelves aſſaulted on all ſides by an innumerable multitude of enemies. Unfortunately the wooden bridge was wedged ſo faſt in the mud by the weight of the artillery, that it was impoſſible to remove it. Diſmayed at this accident, the Spaniards advanced with precipitation to the ſecond breach. The Mexicans hemmed them in on every ſide; and though they defended themſelves with their uſual courage, yet, crowded as they were in a narrow cauſeway, their diſcipline and military ſkill were of little avail; nor did the obſcurity of the night allow them to derive much advantage from their fire-arms or the ſuperiority of their other weapons. At laſt the Spaniards, overborne with the numbers of their enemies, began to give way, and in a moment the confuſion was univerſal. Cortes, with about 100 foot ſoldiers, and a few horſe, forced his way over the two remaining breaches in the cauſeway, the bodies of the dead ſerving to fill up the chaſms, and reached the main land. Having formed them as ſoon as they arrived, he returned with ſuch as were yet capable of ſervice, to aſſiſt his friends in their retreat. He met with part of his ſoldiers who had forced their way through the enemy, but found many more overwhelmed by the multitude of their aggreſſors, or periſhing in the lake; and heard the grievous lamentations of others whom the Mexicans were carrying off in triumph to be ſacrificed to the god of war.

98
Cortes retreats with great loſs.

In this fatal retreat more than one half of Cortes's army periſhed, together with many officers of diſtinction. All the artillery, ammunition, and baggage, were loſt; the greater part of the horſes and above 2000 Tlaſcalans were killed, and only a very ſmall part of their treaſure ſaved. The firſt care of the Spaniſh general was to find ſome ſhelter for his wearied troops; for, as the Mexicans infeſted them on every ſide, and the people of Tacuba began to take arms, he could not continue in his preſent ſtation. At laſt he diſcovered a temple ſeated on an eminence, in which he found not only the ſhelter he wanted, but ſome proviſions; and though the enemy did not intermit their attacks throughout the day, they were without much difficulty prevented from making any impreſſion. For

ſix

Mexico. six days after, they continued their march through a barren, ill cultivated, and thinly peopled country, where they were often obliged to feed on berries, roots, and the stalks of green maize; at the same time they were harassed without intermission by large parties of Mexicans, who atacked them on all sides. On the sixth day they reach Otumba, not far from the road between Mexico and Tlascala. Early next morning they began to advance towards it, flying parties of the enemy still hanging on their rear; and amidst the insults with which they accompanied their hostilities, Donna Marina remarked, that they often exclaimed with exultation, "Go on, robbers; go to the place where you shall quickly meet the vengeance due to your crimes." The meaning of this threat the Spaniards did not comprehend, until they reached the summit of an eminence before them. There a spacious valley opened to their view, covered with a vast army as far as the eye could reach. The Mexicans, while with one body of their troops they harassed the Spaniards in their retreat, had assembled their principal force on the other side of the lake; and marching along the road which led directly to Tlascala, posted it in the plain of Otumba, through which they knew Cortes must pass. At the sight of this incredible multitude, which they could survey at once from the rising ground, the Spaniards were astonished, and even the boldest began to despair. But Cortes, without allowing their fears time to operate, after warning them briefly that no alternative remained but to conquer or die, led them instantly to the charge. The Mexicans waited their approach with unusual fortitude: yet such was the superiority of the Spanish discipline and arms, that the impression of this small body was irresistible; and whichever way its force was directed, it penetrated and dispersed the most numerous battalions. But while these gave way in one quarter, new combatants advanced from another; and the Spaniards, though successful in every attack, were ready to sink under these repeated efforts, without seeing any end to their toil, or any hope of victory. At that time Cortes observed the great standard of the empire, which was carried before the Mexican general, advancing; and fortunately recollecting to have heard, that on the fate of it depended the event of every battle, he assembled a few of his bravest officers, whose horses were still capable of service, and placing himself at their head, pushed towards the standard with such impetuosity that he bore down every thing before him. A chosen body of nobles, who guarded the standard, made some resistance, but were soon broken. Cortes, with a stroke of his lance, wounded the Mexican general, and threw him to the ground. One of his followers alighting, put an end to his life, and laid hold of the imperial standard. The moment that their leader fell, and the standard, towards which all directed their eyes, disappeared, an universal panic struck the Mexicans; and, as if the bond which held them together had been dissolved, every ensign was lowered, each soldier threw away his weapons, and fled with precipitation to the mountains. The Spaniards, unable to pursue them far, returned to collect the spoils of the field; and these were so valuable as to be some compensation for the wealth which they had lost in Mexico; for in the enemy's army were most of their principal warriors dressed out in their richest ornaments, as if they had been marching to assured victory.

99 The battle of Otumba.

100 Mexicans defeated.

The day after this important action (being July 8. 1520), the Spaniards entered the Tlascalan territories, where they were received with the most cordial friendship. Cortes endeavoured to avail himself of this disposition as much as possible; for which purpose he distributed among them the rich spoils taken at Otumba with such a liberal hand, that he made himself sure of obtaining from the republic whatever he should desire. He drew a small supply of ammunition, and two or three field-pieces, from his stores at Vera Cruz. He despatched an officer of confidence with four ships of Narvaez's fleet to Hispaniola and Jamaica, to engage adventurers, and to purchase horses, gunpowder, and other military stores. And as he knew that it would be in vain to attempt the reduction of Mexico, unless he could secure the command of the lake, he gave orders to prepare, in the mountains of Tlascala, materials for building 12 brigantines, so that they might be carried thither in pieces, ready to be put together, and launched when he stood in need of their service. But, in the mean time, his soldiers, alarmed at the thoughts of being exposed to such calamities a second time, presented a remonstrance to their general, in which they represented the imprudence of attacking a powerful empire with his shattered forces, and formally required him to return back to Cuba. All the eloquence of Cortes could now only prevail with them to delay their departure for some time, when he promised to dismiss such as should desire it. However, this was only a pretence; for Cortes, in fact, had the conquest of Mexico as much at heart as ever. Without giving his soldiers an opportunity of caballing, therefore, he daily employed them against the people of the neighbouring provinces, who had cut off some detachments of Spaniards during his misfortunes at Mexico; and by which, as he was constantly attended with success, his men soon resumed their wonted sense of superiority.

101 Cortes receives an unexpected reinforcement.

But all the efforts of Cortes could have been of little avail, had he not unexpectedly obtained a reinforcement of Spanish soldiers. These belonged to an armament fitted out by Francisco de Garay, governor of Jamaica, who had long aimed at dividing with Cortes the glory and gain of annexing the empire of Mexico to the crown of Castile. They had, however, unadvisedly made their attempt on the northern provinces, where the country was poor and the inhabitants fierce and warlike; so that, after a succession of disasters, they were now obliged to venture into Vera Cruz, and cast themselves upon the mercy of their countrymen; and here they also were soon persuaded to throw off their allegiance to their master, and to enlist with Cortes. About the same time a ship arrived in Spain, freighted by some private adventurers, with military stores; and the cargo was eagerly purchased by Cortes, while the crew, following the example of the rest, joined him at Tlascala.

From these various quarters, the army of Cortes was augmented with 180 men and 20 horses; by which means he was enabled to dismiss such of the soldiers of Narvaez as were most troublesome and discontented; after the departure of whom he still mustered 550 infantry, of whom 80 were armed with muskets or cross-

croſs-bows, 40 horſemen, and nine pieces of artillery. At the head of theſe, with 10,000 Tlaſcalans and other

102 He ſets out again for Mexico.

friendly Indians, he began his march towards Mexico, on the 28th of December, ſix months after his fatal retreat from that city.

As ſoon as Cortes entered the enemy's territories, he diſcovered various preparations to obſtruct his progreſs. But his troops forced their way with little difficulty; and took poſſeſſion of Tezeuco, the ſecond city of the empire, ſituated on the banks of the lake, about 20 miles from Mexico. Here he determined to eſtabliſh his head quarters, as the moſt proper ſtation for launching his brigantines, as well as for making his approaches to the capital. In order to render his reſidence there more ſecure, he depoſed the cacique or chief, who was at the head of that community, under pretence of ſome defect in his title, and ſubſtituted in his place a perſon whom a faction of the nobles pointed out as the right heir of that dignity. Attached to him by this benefit, the new cacique and his adherents ſerved the Spaniards with inviolable fidelity.

As the conſtruction of the brigantines advanced ſlowly under the unſkilful hands of ſoldiers and Indians, whom Cortes was obliged to employ in aſſiſting three or four carpenters who happened fortunately to be in his ſervice, and as he had not yet received the reinforcement which he expected from Hiſpaniola, he was not in a condition to turn his arms directly againſt the capital. To have attacked a city ſo populous, ſo well prepared for defence, and in a ſituation of ſuch peculiar ſtrength, muſt have expoſed his troops to inevitable deſtruction. Three months elapſed before the materials for conſtructing the brigantines were finiſhed, and before he heard any thing with reſpect to the ſucceſs of his negociation in Hiſpaniola. This, however,

103. Cortes makes great progreſs.

was not a ſeaſon of inaction to Cortes. He attacked ſucceſſively ſeveral of the towns ſituated around the lake; and though all the Mexican power was exerted to obſtruct his operations, he either compelled them to ſubmit to the Spaniſh crown, or reduced them to ruins. Other towns he endeavoured to conciliate by more gentle means; and though he could not hold any intercourſe with the inhabitants but by the intervention of interpreters, yet, under all the diſadvantages of that tedious and imperfect mode of communication, he had acquired ſuch thorough knowledge of the ſtate of the country, as well as of the diſpoſitions of the people, that he conducted his negociations and intrigues with aſtoniſhing dexterity and ſucceſs. Moſt of the cities adjacent to Mexico were originally the capitals of ſmall independent ſtates; and ſome of them having been but lately annexed to the Mexican empire, ſtill retained the remembrance of their ancient liberty, and bore with impatience the rigorous yoke of their new maſters. Cortes having early obſerved ſymptoms of their diſaffection, availed himſelf of this knowledge to gain their confidence and friendſhip. By offering with confidence to deliver them from the odious dominion of the Mexicans, and by liberal promiſes of more indulgent treatment if they would unite with him againſt their oppreſſors, he prevailed on the people of ſeveral conſiderable diſtricts, not only to acknowledge the king of Caſtile as their ſovereign, but to ſupply the Spaniſh camp with proviſions, and to ſtrengthen his army with auxiliary troops. Guatimozin, on the firſt appearance of defection among his ſubjects, exerted himſelf with vigour to prevent or to puniſh their revolt; but, in ſpite of his efforts, the ſpirit continued to ſpread. The Spaniards gradually acquired new allies; and with deep concern he beheld Cortes arming againſt his empire thoſe very hands which ought to have been active in his defence, and ready to advance againſt the capital at the head of a numerous body of his own ſubjects.

While, by theſe various methods, Cortes was gradually circumſcribing the Mexican power within ſuch narrow limits that his proſpect of overturning it ſeemed neither to be uncertain nor remote, all his ſchemes were well nigh defeated by a conſpiracy againſt his own perſon, and which was diſcovered only a ſhort time before it was to have been executed. Though many were concerned, Cortes did not think proper to puniſh any more than the principal ringleader, whom he cauſed immediately to be hanged; and then, without allowing them leiſure to ruminate on what had happened, and as the moſt effectual means of preventing the return of a mutinous ſpirit, he determined to call forth his troops immediately to action. Fortunately a proper occaſion for this occurred, without his ſeeming to court it. He received intelligence, that the materials for building the brigantines were at length completely finiſhed, and waited only for a body of Spaniards to conduct them to Tezcuco. The command of this convoy, conſiſting of 200 foot ſoldiers, 15 horſemen, and two field-pieces, he gave to Sandoval, who by the vigilance, activity, and courage, which he manifeſted on every occaſion, was growing daily in his confidence, and in the eſtimation of his fellow-ſoldiers. The Tlaſcalans furniſhed 8000 *Tamenes*, an inferior order of men deſtined for ſervile taſks, to carry the materials on their ſhoulders, and appointed 15,000 warriors to accompany and defend them. Sandoval made the diſpoſition for their progreſs with great propriety, placing the Tamenes in the centre, one body of warriors in the front, another in the rear, with conſiderable parties to cover the flanks. To each of theſe he joined ſome Spaniards, not only to aſſiſt them in danger, but to accuſtom them to regularity and ſubordination. Parties of Mexicans frequently appeared hovering around them on the high grounds: but perceiving no proſpect of ſucceſs in attacking an enemy continually on his guard, and prepared to receive them, they did not venture to moleſt him; and Sandoval had the glory of conducting ſafely to Tezcuco a convoy on which all the future operations of his countrymen depended.

Cortes determined to attack the city from three different quarters; from Tezcuco on the eaſt ſide of the 104 Mexico beſieged.
lake, from Tacuba on the weſt, and from Cuayocan towards the ſouth. Thoſe towns were ſituated on the principal cauſeways which led to the capital, and intended for their defence. He appointed Sandoval to command in the firſt, Pedro de Alvarado in the ſecond, and Chriſtoval de Olid in the third; allotting to each a numerous body of Indian auxiliaries, together with an equal diviſion of Spaniards, who, by the junction of the troops from Hiſpaniola, amounted now to 86 horſemen, and 818 foot ſoldiers; of whom 118 were armed with muſkets or croſs-bows. Their train of artillery conſiſted of three battering cannon, and 15 field-pieces.

Mexico.

pieces. He reſerved for himſelf, as the ſtation of greateſt importance and danger, the conduct of the brigantines, each armed with one of his ſmall cannon, and manned with 25 Spaniards.

As Alvarado and Olid proceeded towards the poſts aſſigned them, they broke down the aqueducts which the ingenuity of the Mexicans had erected for conveying water into the capital, and, by the diſtreſs to which this reduced the inhabitants, gave a beginning to the calamities which they were deſtined to ſuffer. Alvarado and Olid found the towns, of which they were ordered to take poſſeſſion, deſerted by their inhabitants, who had fled for ſafety to the capital, where Guatimozin had collected the chief force of his empire, as there alone he could hope to make a ſucceſsful ſtand againſt the formidable enemies who were approaching to aſſault him.

105 The Spaniards defeat the Mexicans, and become maſters of the lake.

The firſt effort of the Mexicans was to deſtroy the fleet of brigantines, the fatal effects of whoſe operations they foreſaw and dreaded. Though the brigantines, after all the labour and merit of Cortes in forming them, were of inconſiderable bulk, rudely conſtructed, and manned chiefly with landmen, hardly poſſeſſed of ſkill enough to conduct them, they muſt have been objects of terror to a people unacquainted with any navigation but that of their lake, and poſſeſſed of no veſſel larger than a canoe. Neceſſity, however, urged Guatimozin to hazard the attack; and hoping to ſupply by numbers what he wanted in force, he aſſembled ſuch a multitude of canoes as covered the face of the lake. They rowed on boldly to the charge, while the brigantines, retarded by a dead calm, could ſcarcely advance to meet them. But as the enemy drew near, a breeze ſuddenly ſprung up; in a moment the ſails were ſpread, and the brigantines with irreſiſtible impetuoſity broke their feeble opponents, overſet many canoes, and diſſipated the whole armament with ſuch ſlaughter, as convinced the Mexicans, that the progreſs of the Europeans in knowledge and arts rendered their ſuperiority greater on this new element than they had hitherto found it by land.

From that time Cortes remained maſter of the lake; and the brigantines not only preſerved a communication between the Spaniards in their different ſtations, though at a conſiderable diſtance from each other; but were employed to cover the cauſeways on each ſide, and keep off the canoes, when they attempted to annoy the troops as they advanced towards the city. He formed the brigantines in three diviſions, allotting one to each ſtation, with orders to ſecond the operations of the officer who commanded there. From all the three ſtations he puſhed on the attack againſt the city with equal vigour; but in a manner ſo very different from that by which ſieges are conducted in regular war, as might appear no leſs improper than ſingular to perſons unacquainted with his ſituation. Each morning his troops aſſaulted the barricades which the enemy had erected on the cauſeways, forced their way over the trenches which they had dug, and through the canals where the bridges were broken down, and endeavoured to penetrate into the heart of the city, in hopes of obtaining ſome deciſive advantage, which might force the enemy to ſurrender, and terminate the war at once; but when the obſtinate valour of the Mexicans rendered the efforts of the day ineffectual, the Spaniards retired in the evening to their former quarters. Thus their toil and danger were, in ſome meaſure, continually renewed, the Mexicans repairing in the night what the Spaniards had deſtroyed through the day, and recovering the poſts from which they had driven them. But neceſſity preſcribed this ſlow and untoward mode of operation. The number of his troops was ſo ſmall, that Cortes durſt not, with a handful of men, attempt to make a lodgement in a city where he might be ſurrounded and annoyed by ſuch a multitude of enemies. The remembrance of what he had already ſuffered by the ill-judged confidence with which he had ventured into ſuch a dangerous ſituation, was ſtill freſh in his mind. The Spaniards, exhauſted with fatigue, were unable to guard the various poſts which they daily gained; and though their camp was filled with Indian auxiliaries, they durſt not devolve this charge upon them, becauſe they were ſo little accuſtomed to diſcipline, that no confidence could be placed in their vigilance. Beſides this, Cortes was extremely ſolicitous to preſerve the city as much as poſſible from being deſtroyed, both as he deſtined it to be the capital of his conqueſts, and wiſhed that it might remain as a monument of his glory. From all theſe conſiderations, he adhered obſtinately, for a month after the ſiege was opened, to the ſyſtem which he had adopted. The Mexicans, in their own defence, diſplayed valour which was hardly inferior to that with which the Spaniards attacked them. On land, on water, by night and by day, one furious conflict ſucceeded to another. Several Spaniards were killed, more wounded, and all were ready to ſink under the toils of unintermitting ſervice, which were rendered more intolerable by the injuries of the ſeaſon, the periodical rains being now ſet in with their uſual violence.

Aſtoniſhed and diſconcerted with the length and difficulties of the ſiege, Cortes determined to make one great effort to get poſſeſſion of the city before he relinquiſhed the plan which he had hitherto followed, and had recourſe to any other mode of attack. With this view he ſent inſtructions to Alvarado and Sandoval to advance with their diviſions to a general aſſault, and took the command in perſon of that poſted on the cauſeway of Cuyocan. Animated by his preſence, and the expectation of ſome deciſive event, the Spaniards puſhed forward with irreſiſtible impetuoſity. They broke through one barricade after another, forced their way over the ditches and canals, and having entered the city, gained ground inceſſantly, in ſpite of the multitude and ferocity of their opponents. Cortes, though delighted with the rapidity of his progreſs, did not forget that he might ſtill find it neceſſary to retreat; and in order to ſecure it, appointed Julian de Alderete, a captain of chief note in the troops which he had received from Hiſpaniola, to fill up the canals and gaps in the cauſeway as the main body advanced. That officer deeming it inglorious to be thus employed, while his companions were in the heat of action and the career of victory, neglected the important charge committed to him, and hurried on inconſiderately to mingle with the combatants. The Mexicans, whoſe military attention and ſkill were daily improving, no ſooner obſerved this, than they carried an account of it to their monarch.

Guatimozin inſtantly diſcerned the conſequences of the

Mexico. the error which the Spaniards had committed, and, with admirable presence of mind, prepared to take advantage of it. He commanded the troops posted in the front to slacken their efforts, in order to allure the Spaniards to push forward, while he despatched a large body of chosen warriors through different streets, some by land, and others by water, towards the great breach in the causeway, which had been left open. On a signal which he gave, the priests in the great temple struck the great drum consecrated to the god of war. No sooner did the Mexicans hear its doleful solemn sound, calculated to inspire them with contempt of death and with enthusiastic ardour, than they rushed upon the enemy with frantic rage. The Spaniards, unable to resist men urged on no less by religious fury than hope of success, began to retire, at first leisurely, and with a good countenance; but as the enemy pressed on, and their own impatience to escape increased, the terror and confusion became so general, that when they arrived at the gap in the causeway, Spaniards and Tlascalans, horsemen and infantry, plunged in promiscuously, while the Mexicans rushed upon them fiercely from every side, their light canoes carrying

106 Cortes repulsed in an attack.

them through shoals which the brigantines could not approach. In vain did Cortes attempt to stop and rally his flying troops; fear rendered them regardless of his entreaties or commands. Finding all his endeavours to renew the combat fruitless, his next care was to save some of those who had thrown themselves into the water; but while thus employed, with more attention to their situation than to his own, six Mexican captains suddenly laid hold of him, and were hurrying him off in triumph; and though two of his officers rescued him at the expence of their own lives, he received several dangerous wounds before he could break loose. Above 60 Spaniards perished in the rout; and what rendered the disaster more afflicting, 40 of these fell alive into the hands of an enemy never known to show mercy to a captive.

The approach of night, though it delivered the dejected Spaniards from the attacks of the enemy, ushered in, what was hardly less grievous, the noise of their barbarous triumph, and of the horrid festival with which they celebrated their victory. Every quarter of the city was illuminated; the great temple shone with such peculiar splendour, that the Spaniards could plainly see the people in motion, and the priests busy in hastening the preparations for the death of the prisoners. Through the gloom they fancied that they discerned their companions by the whiteness of their skins, as they were stripped naked and compelled to dance before the image of the god to whom they were to be offered. They heard the shrieks of those who were sacrificed, and thought they could distinguish each unhappy victim by the well-known sound of his voice. Imagination added to what they really saw or heard, and augmented its horror. The most unfeeling melted into tears of compassion, and the stoutest heart trembled at the dreadful spectacle which they beheld.

Cortes, who, besides all that he felt in common with his soldiers, was oppressed with the additional load of anxious reflections natural to a general on such an unexpected calamity, could not like them relieve his mind by giving vent to its anguish. He was obliged to assume an air of tranquillity in order to revive the spirits and hopes of his followers. The juncture, indeed, required an extraordinary exertion of fortitude. The Mexicans, elated with their victory, sallied out next morning to attack him in his quarters. But they did not rely on the efforts of their own arms alone: they sent the heads of the Spaniards whom they had sacrificed to the leading men in the adjacent provinces, and assured them that the god of war, appeased by the blood of their invaders, which had been shed so plentifully on his altars, had declared with an audible voice, that in eight days time those hated enemies should be finally destroyed, and peace and prosperity re-established in the empire. Mexico.

107 The Mexicans renew the attack with great fury.

A prediction, uttered with such confidence, and in terms so void of ambiguity, gained universal credit among a people prone to superstition. The zeal of the provinces which had already declared against the Spaniards augmented, and several which had hitherto remained inactive took arms with enthusiastic ardour to execute the decrees of the gods. The Indian auxiliaries who had joined Cortes, accustomed to venerate the same deities with the Mexicans, and to receive the responses of their priests with the same implicit faith, abandoned the Spaniards as a race of men devoted to certain destruction. Even the fidelity of the Tlascalans was shaken, and the Spanish troops were left almost alone in their stations. Cortes, finding that he attempted in vain to dispel the superstitious fears of his confederates by argument, took advantage, from the imprudence of those who had framed the prophecy in fixing its accomplishment so near at hand, to give them a striking demonstration of its falsity. He suspended all military operations during the period marked out by the oracle. Under cover of the brigantines, which kept the enemy at a distance, his troops lay in safety, and the fatal term expired without any disaster.

His allies, ashamed of their own credulity, returned to their station. Other tribes, judging that the gods, who had now deceived the Mexicans, had decreed finally to withdraw their protection from them, joined his standard; and such was the levity of a simple people, moved by every slight impression, that, in a short time after such a general defection of his confederates, Cortes saw himself, if we may believe his own account, at the head of 150,000 Indians. Even with such a numerous army, he found it necessary to adopt a new and more wary system of operation. Instead of renewing his attempts to become master of the city at once, by such bold but dangerous efforts of valour as he had already tried, he made his advances gradually, and with every possible precaution against exposing his men to any calamity similar to that which they still bewailed. As the Spaniards pushed forward, the Indians regularly repaired the causeways behind them. As soon as they got possession of any part of the town, the houses were instantly levelled with the ground. Day by day, the Mexicans, forced to retire as their enemies gained ground, were hemmed in within more narrow limits. Guatimozin, though unable to stop the career of the enemy, continued to defend his capital with obstinate resolution, and disputed every inch of ground. But the Spaniards, having not only varied their mode of attack, but, by order of Cortes, having changed the weapons with

108 Cortes adopts a more cautious method of proceeding.

Mexico. with which they fought, were again armed with the long Chinantlan ſpears, which they had employed with ſuch ſucceſs againſt Narvaez; and, by the firm array in which this enabled them to range themſelves, they repelled, with little danger, the looſe aſſault of the Mexicans; incredible numbers of whom fell in the conflicts, which they renewed every day. While war waſted without, famine began to conſume them within the city. The Spaniſh brigantines, having the entire command of the lake, rendered it impoſſible to receive any ſupply of proviſions by water. The vaſt number of his Indian auxiliaries enabled Cortes to ſhut up the avenues to the city by land. The ſtores which Guatimozin had laid up were exhauſted by the multitudes which crowded into the capital to defend their ſovereign and the temples of their gods. Not only the people, but perſons of the higheſt rank, felt the utmoſt diſtreſſes of want. What they ſuffered brought on infectious and mortal diſtempers, the laſt calamity that viſits beſieged cities, and which filled up the meaſure of their woes.

109 Guatimozin refuſes to ſubmit on any terms.

But, under the preſſure of ſo many and ſuch various evils, the ſpirit of Guatimozin remained firm and unſubdued. He rejected with ſcorn every overture of peace from Cortes; and, diſdaining the idea of ſubmitting to the oppreſſors of his country, determined not to ſurvive its ruin. The Spaniards continued their progreſs. At length all the three diviſions penetrated into the great ſquare in the centre of the city, and made a ſecure lodgment there. Three-fourths of the city were now reduced, and laid in ruins. The remaining quarter was ſo cloſely preſſed, that it could not long withſtand aſſailants who attacked it from their new ſtation with ſuperior advantage, and more aſſured expectation of ſucceſs. The Mexican nobles, ſolicitous to ſave the life of a monarch whom they revered, prevailed on Guatimozin to retire from a place where reſiſtance was now vain, that he might rouſe the more diſtant provinces of the empire to arms, and maintain there a more ſucceſsful ſtruggle with the public enemy. In order to facilitate the execution of this meaſure, they endeavoured to amuſe Cortes with overtures of ſubmiſſion, that, while his attention was employed in adjuſting the articles of pacification, Guatimozin might eſcape unperceived. But they made this attempt upon a leader of greater ſagacity and diſcernment than to be deceived by their arts. Cortes ſuſpecting their intention, and aware of what moment it was to defeat it, appointed Sandoval, the officer on whoſe vigilance he could moſt perfectly rely, to take the command of the brigantines, with ſtrict injunctions to watch every motion of the enemy. Sandoval, attentive to the charge, obſerving ſome large canoes crowded with people rowing along the lake with extraordinary rapidity, inſtantly gave the ſignal to chaſe. Gracia Holguin, who commanded the fleeteſt brigantine, ſoon overtook them, and was preparing to fire on the foremoſt canoe, which ſeemed to carry ſome perſon whom all the reſt followed and obeyed. At once the rowers dropt their oars, and all on board, throwing down their arms, conjured him with cries and tears to forbear, as the emperor was there. Holguin eagerly ſeized his prize; and Guatimozin, with a dignified compoſure, gave himſelf up into his hands, requeſting only that no inſult might be offered to the empreſs or his children. When conducted to Cortes, he appeared neither with the ſullen fierceneſs of a barbarian, nor with the dejection of a ſupplicant. "I have done," ſaid he, addreſſing himſelf to the Spaniſh general, "what became a monarch. I have defended my people to the laſt extremity. Nothing now remains but to die. Take this dagger," laying his hand on one which Cortes wore, "plant it in my breaſt, and put an end to a life which can no longer be of uſe."

Mexico. 110 He is taken priſoner.

111 Mexico ſubmits.

As ſoon as the fate of their ſovereign was known, the reſiſtance of the Mexicans ceaſed; and Cortes took poſſeſſion of that ſmall part of the capital which yet remained undeſtroyed. Thus terminated the ſiege of Mexico, the moſt memorable event in the conqueſt of America. It continued 75 days, hardly one of which paſſed without ſome extraordinary effort of one party in the attack, or of the other in the defence of a city, on the fate of which both knew that the fortune of the empire depended. As the ſtruggle here was more obſtinate, it was likewiſe more equal, than any between the inhabitants of the Old and New Worlds. The great abilities of Guatimozin, the number of his troops, the peculiar ſituation of his capital, ſo far counterbalanced the ſuperiority of the Spaniards in arms and diſcipline, that they muſt have relinquiſhed the enterpriſe, if they had truſted for ſucceſs to themſelves alone. But Mexico was overturned by the jealouſy of neighbours who dreaded its power, and by the revolt of ſubjects impatient to ſhake off its yoke. By their effectual aid, Cortes was enabled to accompliſh what, without ſuch ſupport, he would hardly have ventured to attempt. How much ſoever this account of the reduction of Mexico may detract, on the one hand, from the marvellous relations of ſome Spaniſh writers, by aſcribing that to ſimple and obvious cauſes which they attribute to the romantic valour of their countrymen, it adds, on the other, to the merit and abilities of Cortes, who, under every diſadvantage, acquired ſuch an aſcendant over unknown nations, as to render them inſtruments towards carrying his ſcheme into execution.

The exultation of the Spaniards, on accompliſhing this arduous enterpriſe, was at firſt exceſſive. But this was quickly damped by the cruel diſappointment of thoſe ſanguine hopes which had animated them amidſt ſo many hardſhips and dangers. Inſtead of the inexhauſtible wealth which they expected from becoming maſters of Montezuma's treaſures, and the ornaments of ſo many temples, their rapaciouſneſs could collect only an inconſiderable booty amidſt ruins and deſolation (A). Guatimozin, aware of his impending fate, had ordered what remained of the riches amaſſed by his anceſtors to be thrown into the lake. The Indian auxiliaries, while the Spaniards were engaged in conflict

(A) The gold and ſilver, according to Cortes, amounted only to 120,000 peſos, (Relat. 280, A.) a ſum far inferior to that which the Spaniards had formerly divided in Mexico.

flict with the enemy, had carried off the moſt valuable part of the ſpoil. The ſum to be divided among the conquerors was ſo ſmall, that many of them diſdained to accept of the pittance which fell to their ſhare, and all murmured and exclaimed; ſome againſt Cortes and his confidants, whom they ſuſpected of having ſecretly appropriated to their own uſe a large portion of the riches which ſhould have been brought into the common ſtock; others againſt Guatimozin, whom they accuſed of obſtinacy, in refuſing to diſcover the place where he had hidden his treaſure.

Arguments, entreaties, and promiſes, were employed in order to ſoothe them; but with ſo little effect, that Cortes, from ſolicitude to check this growing

112 Guatimozin tortured.

ſpirit of diſcontent, gave way to a deed which ſtained the glory of all his great actions. Without regarding the former dignity of Guatimozin, or feeling any reverence for thoſe virtues which he had diſplayed, he ſubjected the unhappy monarch, together with his chief favourite, to torture, in order to force from them a diſcovery of the royal treaſures, which it was ſuppoſed they had concealed. Guatimozin bore whatever the refined cruelty of his tormentors could inflict, with the invincible fortitude of an American warrior. His fellow-ſufferer, overcome by the violence of the anguiſh, turned a dejected eye towards his maſter, which ſeemed to implore his permiſſion to reveal all that he knew. But the high-ſpirited prince, darting on him a look of authority mingled with ſcorn, checked his weakneſs, by aſking, "Am I now repoſing on a bed of flowers?" Overawed by the reproach, he perſevered in his dutiful ſilence, and expired. Cortes, aſhamed of a ſcene ſo horrid, reſcued the royal victim from the hands of his torturers, and prolonged a life reſerved for new indignities and ſufferings.

113 The Spaniards become maſters of the whole Mexican empire.

The fate of the capital, as both parties had foreſeen, decided that of the empire. The provinces ſubmitted one after another to the conquerors. Small detachments of Spaniards marching through them without interruption, penetrated, in different quarters, to the great Southern ocean, which, according to the ideas of Columbus, they imagined would open a ſhort as well as eaſy paſſage to the Eaſt Indies, and ſecure to the crown of Caſtile all the envied wealth of thoſe fertile regions; and the active mind of Cortes began already to form ſchemes for attempting this important diſcovery. In his after-ſchemes, however, he was diſappointed; but Mexico hath ever ſince remained in the hands of the Spaniards.

114 Ancient diviſions of Mexico.

The *ancient* kingdom of Mexico, properly ſo called, was divided into ſeveral provinces, of which the vale of Mexico itſelf was the fineſt in every reſpect. It is ſurrounded by verdant mountains, meaſuring upwards of 120 miles in circumference at their baſe. A great part of this vale is occupied by two lakes, the upper one of freſh water, but the lower one brackiſh, communicating with the former by means of a canal. All the water running from the mountains is collected in this lower lake, on account of its being in the bottom of the valley; hence it was ready, when ſwelled by extraordinary rains, to overflow the city of Mexico, as has been already obſerved. This delightful region contained the three imperial cities of Mexico, Acolhuacan, and Tlacopan; beſides 40 others, with innumerable villages and hamlets; but the moſt conſiderable of theſe, according to Clavigero, now ſcarcely retain one-twentieth part of their former magnificence. The principal inland provinces to the northward were the Otomies; to the ſouth-weſt the Malatzincas and Cuitlatecas; to the ſouth the Tlahuicas and Cohuixcas; to the ſouth-eaſt, after the ſtates of Itzocan, Jauhtepac, Quauhquecollon, Atlixco, Tehuacan, and others, were the great provinces of the Mixtecas, the Zapotecas, and the Chiapanecas; towards the eaſt were the provinces of Tepayacac, the Popolocas, and Totonacas. The maritime provinces on the Mexican gulf were Coatzacualco and Cuetlachtlan, called by the Spaniards *Cotaſta*. On the Pacific ocean were thoſe of Coliman, Zacatollan, Tototepec, Tecuantepec, and Zoconochco.

The province of the Otomies began in the northern part of the vale of Mexico, extending through the mountains to the north to the diſtance of 90 miles from the city of Mexico; the principal cities being Tollan or Tula, and Xilotepec: the latter made the capital of the country by the Spaniards. Beyond the ſettlements of the Otomies, the country for more than a thouſand miles in extent was inhabited only by barbarous and wandering ſavages.

The Malatzinca province contained the valley of Tolocan, and all the country from *Taximaroa* to the frontier of the kingdom of Michuacan. The valley of Tolocan is upwards of 40 miles long from ſouth-eaſt to north-weſt, and 30 in breadth where broadeſt. Its principal city, named alſo *Tolocan*, is ſituated at the foot of a high mountain covered with ſnow, 30 miles diſtant from Mexico.

The country of the Cuitlatecas extended from north-eaſt to ſouth-weſt, upwards of 200 miles, extending as far as the Pacific ocean. Their capital was named Mexcaltepec, once a great and populous city, ſituated upon the ſea-coaſt; but of which the ruins are now ſcarcely viſible. That of the Tlahuicas was named Quauhnahuac, and ſituated about 40 miles to the ſouthward of Mexico. The province extended almoſt 60 miles ſouthward, commencing from the ſouthern mountains of the vale of Mexico.

The country of the Cohuixcas extended on the ſouthward as far as the Pacific ocean, through that part where at preſent the port and city of Acapulco lie. It was divided into the ſtates of Tzompanco, Chilapan, Tlapan, and Tiſtla; the latter a very hot and unwholeſome country. To this province belonged a place named *Tlachco*, celebrated for its ſilver mines.

The province of the Mixtecas extended from *Acatlan*, a place diſtant about 120 miles from Mexico, as far as the Pacific ocean towards the ſouth-eaſt. The inhabitants carried on a conſiderable commerce, and had ſeveral well-inhabited cities and villages. To the eaſt of the Mixtecas were the Zapotecas, ſo called from their capital Teotzapotlan. In their diſtrict was the valley of Huaxyacac, now Oaxaca or Guaxaca.

The province of Mazatlan lay to the northward of the Mixtecas; and to the northward and eaſtward of the Zapotecas was *Ghimantla*, having their capitals of the ſame name with their provinces. The Chiapanecas, Zoqui, and Queleni, were the laſt of the Mexican provinces towards the ſouth-eaſt. On the ſide of the mountain Popocatepec and around it lay ſeveral ſtates, of of which the moſt conſiderable were Cholallan and Huexotzinco. Theſe two having, with the aſſiſtance of the Tlaſcalans, ſhaken off the Mexican yoke, re-eſtabliſhed their former ariſtocratical government. The Cholulans poſſeſſed a ſmall hamlet called Cuitlaxcoapan, in the place where the Spaniards afterwards founded the city of Angelopoli, which is the ſecond of New Spain.

To the eaſtward of Cholula lay a conſiderable ſtate named Tepeyacac; and beyond that the Popolocas, whoſe principal cities were Tecamachalco and Quecholac. To the ſouthward of the Popolocas was the ſtate of Tahuacan, bordering upon the country of the Mixtecas; to the eaſt, the maritime province of Cuetlachtlan; and to the north the Totonacas. The extent of this province was 150 miles, beginning from the frontier of Zacatlan, a ſtate diſtant about 80 miles from the court, and terminating in the gulf of Mexico. Beſides the capital, named *Mizquihuacan*, this country had the beautiful city of Chempoallan, ſituated on the coaſt of the gulf; remarkable for being that by which the Spaniards entered the Mexican empire.

Coliman was the moſt northerly of the provinces on the Pacific ocean; the capital, named alſo Coliman, being in lat. 19. long. 92. W. Towards the ſouth-eaſt was the province of Zacotlan, with its capital of the ſame name; then came the coaſt of the Cuitlatecas; after it that of the Cohuixcans, in which was the celebrated port of Acapulco. The *Jopi* bordered on the Cohuixca coaſt; and adjoining to that the Mixteca country, now called *Xicayan;* next to that was the large province of Tecuantepec; and, laſtly, that of Xoconochco.

This province, the moſt ſoutherly of the Mexican empire, was bounded on the eaſt and ſouth-eaſt by the country of Xochitepec, which did not belong to Mexico; on the weſt by Tecuantepec; and on the ſouth by the ocean. The capital, called alſo *Xoconochco*, was ſituated between two rivers, in 14 degrees of latitude and 103 W. longitude. On the Mexican gulf there were, beſides the country of the Totonecas, the provinces of Cuetlachtlan and Coatzacualco; the latter bounded on the eaſt by the ſtates of Tabaſco and the peninſula of Yucatan. The province of Cuetlachtlan comprehended all the coaſt between the rivers Alvarado and Antigua, where the province of the Totonecas began.

115 Climate.

The climate of this vaſt country varies very much according to the ſituation of its different parts. The maritime places are hot, unhealthy, and moiſt. The lands which lie in the neighbourhood of high mountains, the tops of which are always covered with ſnow, muſt of neceſſity be cold; and Clavigero informs us, that he has been on a mountain not more than 25 miles diſtant from the city of Mexico, where there was white froſt and ice even in the dog-days. "All the other inland countries (ſays our author), where the greateſt population prevailed, enjoy a climate ſo mild and benign, that they neither feel the rigour of winter nor the heats of ſummer. It is true, in many of theſe countries, there is frequently white froſt in the three months of December, January, and February, and ſometimes even it ſnows; but the ſmall inconvenience which ſuch cold occaſions continues only till the riſing ſun: no other fire than his rays is neceſſary to give warmth in winter; no other relief is wanted in the ſeaſon of heat but the ſhade: the ſame clothing which covers men in the dog-days defends them in January, and the animals ſleep all the year under the open ſky.

116 Cauſes of mildneſs of the climate.

"This mildneſs and agreeableneſs of climate under the torrid zone is the effect of ſeveral natural cauſes entirely unknown to the ancients, who did not believe it to be inhabited; and not well underſtood by ſome moderns, by whom it is believed unfavourable to thoſe who live in it. The purity of the atmoſphere, the ſmaller obliquity of the ſolar rays, and the longer ſtay of this luminary above the horizon in winter, in compariſon of other regions farther removed from the equator, concur to leſſen the cold, and to prevent all that horror which disfigures the face of nature in other climes. During that ſeaſon a ſerene ſky and the natural delights of the country are enjoyed; whereas, under the frigid, and even for the moſt part under the temperate zones, the clouds rob man of the proſpect of heaven, and the ſnow buries the beautiful productions of the earth. No leſs cauſes combine to temper the heat of ſummer. The plentiful ſhowers which frequently water the earth after mid-day from April or May to September or October; the high mountains, continually loaded with ſnow, ſcattered here and there through the country of Anahuac; the cool winds which breathe from them in that ſeaſon; and the ſhorter ſtay of the ſun above the horizon, compared with the circumſtances of the temperate zone, transform the climes of thoſe happy countries into a cool and cheerful ſpring. But the agreeableneſs of the climate is counterbalanced by thunder ſtorms, which are frequent in ſummer, particularly in the neighbourhood of the mountain of Tlaſcala; and by earthquakes, which are at all times felt, though with leſs danger than terror. Storms of hail are neither more frequent nor more ſevere than in Europe."

117 Mexican volcanoes.

One undoubted inconvenience which Mexico has is that of volcanoes. One named by the Spaniards *Volcan d'Orizaba* is higher than the peak of Teneriffe, according to the Jeſuit Tallandier, who meaſured them both. It began to ſend forth ſmoke in the year 1545, and continued burning for 20 years, but has not diſcovered any ſymptoms of eruption ſince that time. It is of a conical figure; and may be ſeen at 50 leagues diſtance. The top is always covered with ſnow, but the lower part with woods of pine and other valuable timber. It is about 90 miles to the eaſtward of the capital.

Two other mountains, named *Popocatepec* and *Iztaccihuatl*, which lie near each other, at the diſtance of 33 miles to the ſouth-eaſt of Mexico, are likewiſe ſurpriſingly high. Clavigero ſuppoſes the former to be higher than the higheſt of the Alps, conſidering the elevated ground on which the baſe of it ſtands. It has a crater more than half a mile wide; from which, in the time of the Mexican kings, great quantities of ſmoke and flame iſſued. In the 17th century it frequently threw out great ſhowers of aſhes upon the adjacent places; but in the 18th century hardly any ſmoke has been obſerved. This mountain is named by the Spaniards *Volcan*, and the other *Sierra Nevada*. The latter has alſo ſometimes emitted flames.

Mexico. Both of them have their tops always covered with ſnow in ſuch quantities, that the maſſes which fall down upon the neighbouring rocks ſupply the cities of Mexico, Gelopoli, Cholula, and all the adjacent country to the diſtance of 40 miles, with that commodity; of which the conſumpt is ſo great, that in 1746 the impoſt upon what was conſumed in the city of Mexico amounted to 15,222 Mexican crowns; ſome years after it amounted to 20,000; and is now in all probability a great deal more.

Beſides theſe volcanoes, there are others in Mexico of a very remarkable height. The great chain of mountains called the *Andes* is continued through the iſthmus of Panama and through all Mexico, until they are loſt in the unknown mountains of the north. The moſt conſiderable of that chain is known in Mexico by the name of *Sierra Madre*, particularly in Cinaloa and Tarahumara, provinces no leſs than 1200 miles diſtant from the capital.

118 Rivers and lakes. Mexico is well watered by very conſiderable rivers, though none of them are comparable to thoſe of South America. Some of theſe run into the gulf of Mexico, and others into the Pacific ocean. The Alvarado has its principal ſource among the mountains of the Zapotecas, and diſcharges itſelf by three navigable mouths into the Mexican gulf, at the diſtance of 30 miles from Vera Cruz. The moſt celebrated of the rivers which run into the Pacific ocean is that called by the Spaniards *Guadalaxara* or *Great River*. It riſes in the mountains of Toloccan; and after running a courſe of more than 600 miles, diſcharges itſelf into the ocean in 22° latitude.

There are likewiſe in this country ſeveral lakes of very conſiderable magnitude; but thoſe of Nicaragua, Chapallan, and Pazquaro, which are of the greateſt extent, did not belong to the ancient Mexican empire. The moſt remarkable were thoſe in the vale of Mexico, upon which the capital of the empire was founded. Of theſe, the freſh water one, called the *lake of Chalco*, extended in length from eaſt to weſt 12 miles, as far as the city of Xochimilco; from thence, taking a northerly direction, it incorporated itſelf by means of a canal with the lake of Tezcuco; but its breadth did not exceed ſix miles. The other, named the *lake of Tezcuco*, extended 15, or rather 17 miles from eaſt to weſt, and ſomething more from ſouth to north; but its extent is now much leſs, by reaſon of the Spaniards having diverted the courſe of many of the ſtreams which run into it. This lake is ſalt, which Clavigero ſuppoſes to ariſe from the nature of the ſoil which forms its bed.

Beſides theſe, there are a number of ſmaller lakes, ſome of which are very delightful. There is a vaſt variety of mineral waters, of the nitrous, ſulphureous, and aluminous kinds, ſome of them ſo hot that meat may be boiled in them. At Tetuhuacan is a kind of petrifying water, as well as in ſeveral other parts of the empire. One of them forms a kind of ſmooth white ſtones, not diſpleaſing to the taſte; the ſcrapings of which taken in broth are celebrated as a diaphoretic, probably without any good reaſon. The doſe for a perſon not difficult to be ſweated is one dram of the ſcrapings. Many of the rivers of Mexico afford ſurpriſing and beautiful caſcades; particularly the great river Guadalaxara, at a place called *Tempizque*, 15 miles to the ſouthward of that city. Along a deep river called *Atoyaque* is a natural bridge, conſiſting of a vaſt mound of earth, along which carriages paſs conveniently. Clavigero ſuppoſes it to have been the fragment of a mountain thrown down by an earthquake, and then penetrated by the river.

119 Natural productions. The mineral productions of Mexico are extremely valuable, ſuch as gold and ſilver in abundance, two ſpecies of copper, tin, lead, mercury, ſulphur, alum, vitriol, amber, and aſphaltum. It alſo produces diamonds, amethyſts, cats-eyes, cornelians, and ſome green ſtones reſembling emeralds, as alſo quarries of jaſper and marble of various colours. There are ſaid to be whole mountains of loadſtone, and a fine white talc which may be burnt into an excellent plaſter.

The ſoil is capable of producing all the neceſſaries, and even the luxuries of human life. Hiſtorians mention no fewer than 1200 plants which are all indigenous, or natives of the country; but as theſe are ſaid to be chiefly medicinal, we muſt conclude that provident nature has furniſhed them with many more which are intended for nouriſhment.

This country abounds with a great variety of flowers, numbers of which are peculiar to itſelf, while many exotics even rival them in luxuriance, ſuch in particular as are imported from Europe. Water-melons, apples, pears, peaches, apricots, figs, &c. are among the exotics, which thrive in a manner equal to any of the indigenous productions. All the maritime countries abound with cocoa-nut trees, of which Hernandez mentions four kinds, the ſmalleſt of which is moſtly uſed for chocolate and other drinks.

Prior to the introduction of corn from Europe, maize was the principal grain of Mexico, and of which there were ſeveral ſpecies. It was brought from America to Spain, and from thence to the other countries of Europe. The principal kind of pulſe uſed by the people was the French bean, the different ſpecies of which exceeded in number thoſe of the maize; and one of them in particular not only ſupported the poorer claſs, but even the Spaniſh nobility deemed it a luxury. Hiſtorians enumerate five ſpecies of eſculent roots, excluſive of many culinary vegetables imported from the Canaries, Spain, and other European countries. This country produces a variety of palm trees, from the fibres of the leaves of one ſpecies of which the Mexicans manufacture thread. The timber trees are numerous, and, in reſpect of quality, ſaid to be inferior to none in the world. There are whole woods of cedars and ebonies, and ſome trees mentioned by Clavigero are of a moſt ſtupendous magnitude. This author mentions one that meaſured 107 Paris feet in height; and Acoſta ſpeaks of one that was 16 fathoms in circumference. A remarkable fir tree hollowed by lightning, contained within it 100 young men, according to the teſtimony of the archbiſhop of Toledo, who went to view it in the year 1770.

120 Medicinal and aromatic gums. This country abounds alſo with aromatic and medicinal trees, producing gums, reſins, &c. From one of theſe a balſam is produced not in the leaſt inferior to the celebrated balſam of Mecca. It is of a reddiſh black or yellowiſh white, of a ſharp bitter taſte, and of a ſtrong but moſt grateful odour. It is common in the provinces of Panuco and Chiapan, and other warm countries.

The

The tree producing liquid amber, the liquid ſtorax of the Mexicans, is of a large ſize, the leaves ſimilar to thoſe of the maple, indented, white in one part and dark in the other, diſpoſed of in threes; the fruit is thorny and round, but polygonous, with the ſurface and the angles yellow; the bark of the tree partly green and partly tawney. By inciſions in the trunk they extract that valuable ſubſtance named *liquid amber*, and the oil of the ſame name, which is ſtill more valuable. Liquid amber is likewiſe obtained from a decoction of the branches, but it is inferior to that obtained from the trunk.

The name *copalli* in Mexico is generic, and common to all the reſins; but eſpecially ſignifies thoſe made uſe of for incenſe. There are ten ſpecies of theſe trees yielding reſins of this kind; the principal of which is that from which the COPAL is got, ſo well known in medicine and varniſhes. A great quantity of this was made uſe of by the ancient Mexicans, and is ſtill uſed for ſimilar purpoſes by the Spaniards. The *tecopalli* or *tepecopalli* is a reſin ſimilar to the incenſe of Arabia; which diſtils from a tree of moderate ſize that grows in the mountains, having a fruit like an acorn, and containing the nut enveloped in a mucilage, within which there is a ſmall kernel uſeful in medicine.

The *mizquitl*, or mezquite, is a ſpecies of true acacia, and the gum diſtilled from it is ſaid to be the true gum arabic. It is a thorny ſhrub, with branches irregularly diſpoſed, the leaves ſmall, thin, and pinnated; the flowers being like thoſe of the birch-tree. Of the elaſtic gum, which is found in plenty in Mexico, the natives were in uſe to make foot-balls, which, though heavy, have a better ſpring than thoſe filled with air. With this they varniſh their hats, cloaks, boots, and great coats, in a manner ſimilar to what is done in Europe with wax; and by which means they are rendered all water proof.

121 Mexican animals.

The quadrupeds found in Mexico at the arrival of the Spaniards, were lions, tygers, wild cats, bears, wolves, foxes, the common ſtags, white ſtags, bucks, wild goats, badgers, polecats, weaſels, martins, ſquirrels, polatucas, rabbits, hares, otters, and rats. All theſe animals are ſuppoſed to be common to both continents. The white ſtag, whether it be the ſame ſpecies of the other or not, is undoubtedly common to both, and was known to the Greeks and Romans. The Mexicans call it the *king of the ſtags*. M. Buffon imagines the white colour of this creature to be the effect of capitivity; but Clavigero ſays, that it is found wild, and of the ſame white colour, on the mountains of New Spain. In many other points, he alſo controverts the opinions of this celebrated naturaliſt, who will not allow the lion, tyger, or rabbit, to be natives of America.

Clavigero enumerates the quadrupeds common to New Spain with the reſt of the continent of America. Among theſe he will not allow a place to the Peruvian ſheep, the *huanaco*, and ſloth; all of which are peculiar to South America. Hernandez indeed makes mention of the Peruvian ſheep, and gives a drawing of it; but this was only on account of a few individuals brought thence from Peru, which the Mexicans called by that name, in the ſame manner as he deſcribes ſeveral animals of the Philippine iſles; not that they had ever been bred in Mexico, or found in any country of North America, unleſs it was ſome individual carried there, as they are carried as a curioſity from Europe. The animals which he allows to be common to both countries are, the Mexican hog, the moufete, the opoſſum, the armadillo, the *techichi*, a ſmall animal reſembling a dog; which being perfectly dumb, gave occaſion to a report that the Mexican dogs could not bark. The fleſh of this animal was eaten by them, and was eſteemed agreeable and nouriſhing food. After the conqueſt of Mexico, the Spaniards having neither large cattle nor ſheep, provided their markets with this quadruped; by which means, the ſpecies ſoon came to be extinct, though it had been very numerous. The land-ſquirrel is very numerous in the kingdom of Michuacan, has great elegance of form, and is extremely graceful in its movements; but it cannot be tamed, and bites moſt furiouſly every perſon who approaches it.

Beſides theſe, there are ſea lions, ratoons, and that voracious animal named the *tapir*. Oviedo informs us, that he has ſeen it at one bite tear off two or three hand-breadths of ſkin from a hound, and at another a whole leg and thigh. The fleſh is eatable, and its ſkin is valued on account of its being ſufficiently ſtrong to reſiſt muſket-balls. There are likewiſe great numbers of monkeys of many different kinds; ſome of which have heads reſembling thoſe of dogs. Some of them are ſtrong and fierce, equalling a man in ſtature when they ſtand upright.

Among the animals peculiar to Mexico, is one named *coyoto*, which appears to have been inaccurately deſcribed by natural hiſtorians; ſome making it one ſpecies and ſome another. It is about the ſize of a maſtiff, but more ſlender. The eyes are yellow and ſparkling, ears ſmall pointed, and erect; the ſnout blackiſh, ſtrong limbs, and the feet armed with large crooked nails. The tail is thick and hairy, the ſkin a mixture of black, brown, and white; and the voice is compounded of the howl of the wolf and the bark of the dog. It purſues the deer, and will ſometimes even attack men. Its uſual pace is a trot, but ſo quick that a horſe at the gallop can ſcarcely overtake it. The *tlalcojotl* or *tlalcoyoto* is about the ſize of a middling dog, and the largeſt animal that lives under the earth. Its head has ſome reſemblance to that of a cat; but in colour and length of hair it reſembles the lion.—It has a long thick tail, and feeds upon poultry and ſmall animals, which it catches in the night-time. The *tepeizuintli*, or mountain-dog, though it is but of the ſize of a ſmall dog, is ſo bold that it attacks deer, and ſometimes kills them. Its hair and tail are long, the body black, but the head, neck, and breaſt, white. M. Buffon reckons this animal the ſame with the glutton, but Clavigero denies it. Another animal, larger than the two foregoing, is called the *xoloitzcuintli*. Some of theſe are no leſs than four feet in length. It has a face like the dog, but tuſks like the wolf, with erect ears, the neck groſs, and the tail long.—It is entirely deſtitute of hair, excepting only the ſnout, where there are ſome thick crooked briſtles. The whole body is covered with a ſmooth, ſoft aſh-coloured ſkin, ſpotted partly with black and tawney. This ſpecies of animals, as well as the two former, are almoſt totally extinct. A Lyncean academician named

Mexico. named *Giovanni Fabri*, has endeavoured to prove that the xoloitzcuintli is the ſame with the wolf of Mexico; but this is denied by Clavigero.

A curious animal of the mole kind is called *tozan* or *tuza*. It is about the ſize of a European mole, but very different otherwiſe. The body is about ſeven or eight inches long, and well made; the ſnout like that of a mouſe, the ears ſmall and round, with the tail ſhort. The mouth is armed with very ſtrong teeth, and its paws are furniſhed with ſtrong crooked nails, with which it digs its habitation in the earth. It is extremely deſtructive to the corn fields by the quantity of grain it ſteals, and to the highways by the number of holes it makes in them; for when, on account of the dimneſs of its ſight, it cannot find its firſt hole, it makes another, and ſo on. It digs the earth with its claws and two canine teeth, which it has in the upper jaw.

122 Mexican birds. The birds are ſo numerous, and of ſuch various appearances and qualities, that Mexico has been called the country of birds, as Africa is of quadrupeds. Hernandez deſcribes above 200 peculiar to the country. He allows to the eagles and hawks of Mexico a ſuperiority over thoſe of Europe; and the falcons of this country were formerly eſteemed ſo excellent, that, by the deſire of Philip II. a hundred of them were ſent every year over to Spain. The largeſt, the moſt beautiful, and the moſt valuable kind of eagles, is called by the Mexicans *itzquauhtli*, and will purſue not only the larger kinds of birds, but quadrupeds, and even men.

The ravens of Mexico, do not, like thoſe of other countries, feed upon carrion, but ſubſiſt entirely by ſtealing corn. The carrion is devoured by the birds called in South America *gallinazzi*, in Mexico *zopilots* and *aure*. By Hernandez they are ſaid to be a ſpecies of ravens; but, according to Clavigero, they are very different, not only in their ſize, but in the ſhape of their head, their flight, and their voice.

The aquatic birds are very numerous, and of great variety.—There are at leaſt 20 ſpecies of ducks, a vaſt number of geeſe, with ſeveral kinds of herons, great numbers of ſwans, quails, water rails, divers, king's fiſhers, pelicans, &c. The multitude of ducks is ſometimes ſo great, that they cover the fields, and appear at a diſtance like flocks of ſheep. Some of the herons and egrets are perfectly white, ſome aſh-coloured; others have the plumage of the body white, while the neck, with the tops and upper part of the wings, and part of the tail, are enlivened with a bright ſcarlet, or beautiful blue.

Numbers of the other claſſes of birds are valuable for their fleſh, plumage, or ſong, while ſome are remarkable for their extraordinary inſtinct or other properties. Clavigero enumerates more than 70 ſpecies of thoſe which afford an agreeable and wholeſome food. Beſides the common fowls which were brought from the Canaries to the Antilles, and from theſe to Mexico, there were, and ſtill are, fowls peculiar to the country itſelf. Theſe partly reſemble the common fowl and partly the peacock, whence they had the name of *gallipavos* from the Spaniards. From Mexico they were imported into Europe, where they have multiplied very faſt, eſpecially in Italy, though the common fowls have multiplied much more in Mexico.

There are great numbers of birds valuable on account of their plumage, which was made uſe of by the Mexicans in their excellent moſaic works; an art which ſeems now to be totally loſt. Peacocks have been carried from the old continent to Mexico; but, not being attended to, have propagated very ſlowly. The birds remarkable for their ſong are likewiſe very numerous; among which that called the *centxonitl*, by Europeans the *mocking-bird*, is the moſt remarkable, on account of its counterfeiting naturally the notes of all others it hears. There are great numbers of beautiful parrots; and there is a bird which counterfeits the human voice, but in a kind of burleſque tone, and will follow travellers a great way. The *tzacua* is remarkable for its inſtinct. Birds of this kind live in ſociety, every tree being a village or city to them, having great numbers of neſts in the neighbourhood of each other, all hanging from the boughs. One of them, whoſe office it is to be the head or guard of the village, reſides in the middle of the tree; from which it flies about from one neſt to another, viſiting them all, and after ſinging a little, returns to its place, while the reſt continue perfectly ſilent. If any bird of a different ſpecies approaches the tree, he flies to it, and with his bill and wings endeavours to drive it off; but if a man or any large animal comes near, he flies ſcreaming to another tree; and if at that time any of his fellows happen to be returning to their neſts, he meets them, and, changing his note, obliges them to retire again: as ſoon as he perceives the danger over, he returns to his wonted round of viſiting the neſts.

Mexico, like all other American countries, abounds with reptiles, many of them of an enormous ſize. 123 Reptiles. The crocodiles are not leſs to be dreaded than thoſe of Africa or Aſia, and there are likewiſe ſome of thoſe monſtrous ſerpents met with in the Eaſt Indies and in South America: though happily the ſpecies of thoſe terrible creatures ſeems to be nearly extinct, as they are ſeldom to be found but in ſome ſolitary wood, or other remote place. There are great numbers of lizards, ſome of which the people ſuppoſe to be poiſonous; but Clavigero thinks this opinion ill-founded. There are ſeveral kinds of poiſonous ſerpents, of which the rattleſnake is one.

The aquatic animals are innumerable. Clavigero mentions a ſpecies of frogs ſo large that a ſingle one 124 Aquatic animals. will weigh a pound, and which are excellent food.—Of fiſh proper for food, he ſays that he has counted upwards of 100 ſpecies, without taking in the turtle, crab, lobſter, or any other cruſtaceous animal. The ſharks are well known for their voracity. A whole ſheep's ſkin, and even a large butcher's knife, has been found in the belly of one of them. They are accuſtomed to follow veſſels, to devour any filth that is thrown overboard: and, according to Oviedo, they have been known to keep up with ſhips ſailing before a fair wind for no leſs than 500 miles. The bottetto is a fiſh about eight inches in length, but exceſſively thick. While this fiſh lies alive upon the beach, it ſwells whenever it is touched to an enormous ſize, and boys often take pleaſure in making it burſt with a kick. The liver is ſo poiſonous as to kill with ſtrong convulſions in half an hour after it is eaten.

Of flying and other minute inſects, the number is 125 Inſects. prodigiouſly great. There are a variety of beetles: ſome

Mexico. ſome of a green colour make a great noiſe in flying; on which account children are fond of them. There are great numbers of ſhining beetles, which make a delightful appearance at night, as well as the luminous flies which abound in the country. There are ſix kinds of bees and four kinds of waſps; of which laſt, one collects wax and honey of a very ſweet taſte; another is called the *wandering waſp* from its frequent change of abode; and in conſequence of theſe changes, it is conſtantly employed in collecting materials for its habitations. The lake of Mexico abounds with a kind of fly, the eggs of which are depoſited upon the flags and ruſhes in ſuch quantities as to form large maſſes. Theſe are collected by the fiſhermen, and carried to market for ſale. They are eaten by both Mexicans and Spaniards, and have much the ſame taſte as the caviare of fiſh. There are abundance of gnats in the moiſt places and lakes; but the capital, though ſituated upon a lake, is entirely free from them. The butterflies are in vaſt numbers, and their wings glow with colours far ſuperior to thoſe of Europe; the figures of ſome of them are given by Hernandez. But notwithſtanding its beauties and advantages, Mexico is ſubject to the dreadful devaſtations of locuſts, which ſometimes occaſion the moſt deſtructive famines.

There are ſome of the worms of Mexico made uſe of by the inhabitants as food; others are poiſonous. There are great numbers of ſcolopendræ and ſcorpions, ſome of the former growing to an immenſe ſize. Hernandez ſays, that he has ſeen ſome of them two feet long and two inches thick. The ſcorpions are very numerous; and in the hot parts of the country their poiſon is ſo ſtrong as to kill children, and give terrible pain to adults. Their ſting is moſt dangerous during thoſe hours of the day in which the ſun is hotteſt. There is a miſchievous kind of tick, which in the hot countries abounds among the graſs. From thence it eaſily gets upon the clothes, and from them upon the ſkin. There it fixes with ſuch force, from the particular figure of its feet, that it can ſcarcely be got off. At firſt it ſeems nothing but a ſmall black ſpeck, but in a ſhort time enlarges to ſuch a degree, from the blood which it ſucks, that it equals the ſize of a bean, and then aſſumes a leaden colour. If it is not ſpeedily removed, a wound is made ſimilar to that which the nigera or chegoe makes.

126 Silk and cochineal. Mexico produces ſilk-worms: and the manufacture of ſilk might be carried on to great advantage, were it not prohibited for ſome political reaſons. Beſides the common ſilk, there is another found in the woods, very white, ſoft, and ſtrong. It grows on the trees in ſeveral maritime places, particularly in dry ſeaſons. Unleſs by poor people, however, this ſilk is not turned to any uſe, partly from inattention to their intereſts, but "chiefly (ſays our author) from the obſtructions which would be thrown in the way of any one who ſhould attempt a trade of that kind. We know from Cortes's letters to Charles V. that ſilk uſed to be ſold in the Mexican markets; and ſome pictures are ſtill preſerved, done by the ancient Mexicans upon a paper made of ſilk."

Cochineal is one of the moſt valuable products of Mexico, and great care is taken to rear the inſect in different parts; but the beſt is that which comes from the province of Mizteca. Some have reckoned that more than 2500 bags of cochineal are ſent every year from Mizteca to Spain; and the trade in that article carried on by the city of Oazaca is computed at 200,000 crowns value.

127 General deſcription of the inhabitants. Though Mexico was originally inhabited by a number of different nations, yet all of them reſembled each other pretty much, not only in character, but in external appearance. "They generally rather exceed (ſays Clavigero) than fall under the middle ſize, and are well proportioned in all their limbs. They have good complexions, narrow foreheads, black eyes, clean, firm, white, and regular teeth; thick, black, coarſe, gloſſy hair; thin beards, and generally no hair upon their legs, thighs, and arms, their ſkin being of an olive colour. There is ſcarcely a nation on earth in which there are fewer perſons deformed; and it would be more difficult to find a ſingle hump-backed, lame, or ſquint-eyed man among a thouſand Mexicans, than among a hundred of any other nation. The unpleaſantneſs of their colour, the ſmallneſs of their foreheads, the thinneſs of their beards, and the coarſeneſs of their hair, are ſo far compenſated by the regularity and fine proportion of their limbs, that they can neither be called very beautiful nor the contrary, but ſeem to hold a middle place between the extremes. Their appearance neither engages nor diſguſts; but among the young women of Mexico, there are many very beautiful and fair, whoſe beauty is at the ſame time rendered more winning by the natural ſweetneſs of their manner of ſpeaking, and by the pleaſantneſs and natural modeſty of their whole behaviour. They become grayheaded and bald earlier than the Spaniards; and although moſt of them die of acute diſeaſes, it is not very uncommon among them to attain the age of a hundred. They are now, and ever have been, moderate in eating, but their paſſion for ſtrong liquors is carried to the greateſt exceſs. Formerly they were kept within bounds by the ſeverity of the laws; but now that theſe liquors are become ſo common, and drunkenneſs is unpuniſhed, one half of the people ſeem to have loſt their ſenſes; and this, together with the poor manner in which they live, expoſed to all the baneful impreſſions of diſeaſe, and deſtitute of the means of correcting them, is undoubtedly the principal cauſe of the havock which is made among them by epidemical diſorders.

"Many perſons allow the Mexicans to poſſeſs a great talent of imitation, but deny them that of invention; a vulgar error, which is contradicted by the ancient hiſtory of that people. Their minds are affected by the ſame variety of paſſions with thoſe of other nations, but not to an equal degree. The Mexicans ſeldom exhibit thoſe tranſports of anger, or frenzies of love, which are ſo common in other countries. They are ſlow in their motions; and ſhow a wonderful tenacity and ſteadineſs in thoſe works which require time and long-continued attention. They are moſt patient of injury and hardſhip; and where they ſuſpect no evil intention, are moſt grateful for any kindneſs ſhown: but ſome Spaniards, who cannot diſtinguiſh patience from inſenſibility, nor diſtruſt from ingratitude, ſay provebially, that the Indians are alike inſenſible

insensible to injuries or benefits. That habitual distrust which they entertain of all who are not of their nation, prompts them often to lie and betray; so that good faith certainly has not been respected among them so much as it deserves. They are by nature taciturn, serious, and austere; and show more anxiety to punish crimes than to reward virtues.

"Generosity and perfect disinterestedness are the principal features of their character. Gold with the Mexicans has not that value which it enjoys elsewhere. They seem to give without reluctance what has cost them the utmost labour to acquire. The neglect of selfish interests, with the dislike which they bear to their rulers, and consequently their aversion to perform the tasks imposed by them, seem to have been the only grounds of that much exaggerated indolence with which the Americans have been charged; and, after all, there is no set of people in that country who labour more, or whose labour is more necessary. The respect paid by the young people to the old, and by children to their parents, seem to be feelings that are born with them. Parents are very fond of their children; but the affection which husbands bear to their wives is certainly less than that which wives bear to their husbands; and it is very common for the men to love their neighbours wives better than their own.

"Courage and cowardice seem alternately so to affect their minds, that it is often difficult to determine whethe the one or the other predominates. They meet dangers with intrepidity, when they proceed from natural causes, but are easily terrified by the stern look of a Spaniard. That stupid indifference about death and eternity, which many authors have thought inherent in the character of every American, is peculiar only to those who are yet so rude and uninformed as to have no idea of a future state."

128 Of the Toltecas and Chichemecas.

The Toltecas, who first inhabited Mexico, were accounted much more polished than those who came after them, insomuch that in after ages it was customary to distinguish people of ingenuity and learning by the name of Toltecas. They always lived in society, collected into cities, under the government of kings, and had regular laws. They were more addicted to the arts of peace than of war; and it was to them that the succeeding nations owed themselves indebted for their knowledge of the culture of grain, cotton, pepper, &c. They understood the art of casting gold and silver, and melting them in whatever forms they pleased, acquiring also great reputation from their skill in cutting gems of all kinds; and they were besides well versed in the sciences of astronomy and chronology.

According to the ancient histories of these people, they observed, about a hundred years before the Christian era, how far the solar year exceeded the civil one; supplying the defect, as we do, by the addition of a day once in four years. In the year 660, while their monarchy continued in Tula, a celebrated astronomer named Huematzin, assembled with the king's consent all the wise men of the nation; and with their assistance painted a famous book named *Teoamoxtli*, or "divine book," in which were represented, in very plain figures, the origin of the Indians, their dispersion after the confusion of tongues at Babel, their journey in Asia, their first settlements in America, the founding of the kingdom of Tula, and their progress till that time: but these, and other accounts of their great knowledge and accuracy, favour too much of exaggeration, or perhaps invention, from both which it is impossible to clear the Spaniards when speaking of American affairs.

129 Their progress in agriculture.

The Chichemecas derived their knowledge of agriculture from the Toltecas, and of consequence the Mexicans also. Being destitute of ploughs or animals of sufficient strength to assist them in their labour, they made use of an instrument of hard copper, which they called *coatl* or *coa*, but differing in shape either from a spade or mattock. They used copper axes to cut trees, the figure of which was the same with ours; only that they put the axe into the eye of the handle, instead of putting the handle into the eye of the axe as we do. They had several other instruments of agriculture, but the forms of them are not mentioned by historians. They watered their fields by means of the rivers and small torrents which came from the mountains; raising dams to collect them, and forming canals to conduct them properly to the places which required moisture. They used enclosures of stone, as well as hedges for the fields, using for their hedges the aloe plant, which is well calculated for the purpose; and what reparations were necessary they gave in December. They dibbled their maize: a method of sowing more slow indeed than the ordinary one, but which certainly repays the trouble by a vastly larger crop, as well as by saving a very considerable quantity of seed. Close to the newly sown fields they commonly erected a small tower of wood, where a man kept watch, in order to drive away the birds that came to feed upon the grain; a custom still preserved among the Spaniards.

130 Magnificent gardens.

In the cultivation of their gardens, the Mexicans were extremely skilful and magnificent; planting in them not only kitchen herbs, but fruit trees, medicinal herbs, and flowers, with great taste and regularity. Some of the royal gardens excited the admiration of the Spaniards so much, that Cortes, in a letter to Charles V. informed him that the garden at Huaxtepec was the most extensive, the most beautiful, and most delightful, that had ever been beheld. It was six miles in circumference, and watered by a beautiful river which crossed it; and there were pleasure houses erected at proper distances from one another. It was for many years preserved by the Spaniards.——The plants most cultivated, next to maize, were cotton, cocoa, and aloe; which last served a great many useful purposes. See Aloe.

131 Tame animals.

Though they had not the advantage of the larger quadrupeds, as horses, oxen, or sheep, they bred up an immense number of quadrupeds unknown in Europe. Private persons brought up the small quadrupeds already mentioned, resembling little dogs; as well as turkeys, quails, geese, ducks, and other kinds of fowl. In the houses of the great men were bred fish, deer, rabbits, and a variety of birds; and in the royal palaces, almost all the species of quadrupeds and winged animals to be found in these kingdoms were kept, as well as a great number of aquatic animals and reptiles. According to Clavigero, Montezuma II. surpassed all the kings in the world in this kind of magnificence;

and there never was a nation equal to the Mexicans in the care they took in taming animals.

132 Paintings. Painting was an art in great requeſt among the Mexicans, and one of very great uſe; as it was only by means of paintings that they recorded their hiſtories. This art they derived, like others, from the Toltecas. Some of theſe paintings were mere images of their gods, kings, heroes, or of terreſtrial objects. Others were hiſtorical, containing an account of particular events; others mythological, of which a volume is preſerved in the great library of the order of Bologna: others were codes of law, civil and religious; while ſome were chronological, aſtronomical, or aſtrological; in which were repreſented their calendar, the poſition of the ſtars, changes of the moon, eclipſes, and prognoſtications and variations of the weather. Great numbers of theſe were burned by the ſuperſtitious Spaniards, who imagined that they contained ſome emblems of heathen worſhip. They had likewiſe geographical paintings, which ſerved not only to ſhow the extent and boundaries of their poſſeſſions, but likewiſe the ſituation of places, the direction of the coaſts, and the courſe of the rivers. In his firſt letter to Charles V. Cortes ſays, that having made inquiries if there was any ſecure harbour for veſſels on the Mexican coaſt, Montezuma preſented him with a painting of the whole coaſt, from the port of Vera Cruz, at that time called *Chalchiuhuecan*, to the river Coatzacualco. Another author informs us alſo, that Cortes, in a long and difficult voyage which he made to the bay of Honduras, made uſe of a chart preſented to him by the lords of Coatzacualco, in which all the places and rivers were marked from the coaſt of Coatzacualco to Huejacallan.

The cloth on which paintings were done was made of the thread of the aloe or a kind of palm; or they painted on ſheep's ſkins or upon paper. This laſt was made of the leaves of a certain kind of aloe, ſteeped like hemp, and afterwards waſhed, ſtretched, and ſmoothed. They uſed alſo the bark of other trees, prepared with gum: but we are ignorant of the method they uſed in the manufacture. This paper is ſimilar in thickneſs to the European paſteboard, but ſofter, ſmoother, and more eaſy for writing. In general it was made up in very long ſheets which they preſerved in rolls, or folded like bed ſkreens. The volume of Mexican paintings, preſerved in the library of Bologna, is a thick ſkin, ill dreſſed, compoſed of different pieces painted all over, and folded up in that manner. The beautiful colours which they employed both in their paintings and in their dyes, were obtained from wood, leaves, and the flowers of different plants, as well as from various animal ſubſtances. Their white was made from a kind of ſtone which burns into a fine plaſter; or from a mineral, which after being made into a paſte worked like clay, and formed into ſmall balls, turns white in the fire like Spaniſh white. Their *black* was got from another mineral, which has a diſagreeable ſmell, or from the ſoot of a kind of pine collected in ſmall earthen veſſels. They obtain *blue* and *azure* colours from indigo; but their mode of obtaining theſe was very different from that uſed by the moderns. They put the branches of the plant into hot, or rather lukewarm, water; and after having ſtirred them about for a ſufficient time with a ſtick or ladle, they paſſed the water, when impregnated with the dye, into certain pots or cups, in which they let it remain until the ſolid part of the dye was depoſited; after which they poured off the water. This ſediment was firſt dried in the ſun, and afterwards put between two plates before a fire until it grew hard. They had another plant which likewiſe afforded a blue colour, but inferior to the indigo. *Red* was obtained from the ſeeds of the achiot or rocou, and *purple* from cochineal. Their *yellows* were ochre, and a colour extracted from the beautiful flower of a plant reſembling artemiſia. With nitre theſe flowers afforded a fine orange colour; and by means of alum they extracted other colours.

The Mexican painters were by no means arrived at much perfection in the knowledge of light and ſhade, or of deſign; nevertheleſs, in ſome of the ancient paintings, particularly in the portraits of their kings, the proportions were exactly obſerved. Beſides paintings, however, the Mexicans are ſaid to have employed hieroglyphics and characters; but this is abſolutely denied by Clavigero; who tells us, that "they repreſented material things by their proper figures; but, in order to ſave labour, paper, and colours, they contented themſelves with repreſenting part of an object, which was ſufficient to make it underſtood. But as we cannot underſtand the writings of others till we have learned to read them; in like manner thoſe American authors, who ſay that the Mexicans made uſe of characters, required to have been firſt inſtructed in the Mexican manner of repreſenting objects, in order to have been able to underſtand the paintings which ſerved them in place of writing. When they would repreſent any perſon, they painted a man or a human head, and over it a figure expreſſing the meaning of his name, as appears in the figures of the Mexican kings. To expreſs a city or village, they painted in like manner a figure which ſignified the ſame thing, with its name. To form their hiſtories or annals, they painted on the margin of the cloth or paper the figures of the years in ſo many ſquares, and at the ſide of each ſquare the event or events which happened that year: and if, on account of the number of years, the hiſtory of which they meant to relate, they could not all be contained in one canvas, they were continued on another. With reſpect to the order of repreſenting the years and events, it was at the liberty of the hiſtorian to begin at whichever angle of the piece he pleaſed; but at the ſame time conſtantly obſerving, that if the painting began at the upper angle of the right-hand, he proceeded towards the left; but if it began, as it moſt commonly did, at the upper angle of the left hand, he proceeded ſtraight downwards. If he painted the firſt year at the lower angle of the left, he continued towards the right; but if he began at the lower angle of the right, he painted ſtraight upwards: ſo that on the upper part of his canvas he never painted from left to right, nor ever on the lower part from right to left; never advanced upwards from the left, nor downwards from the right. When this method of the Mexicans is underſtood, it is eaſy to diſcover at firſt ſight which is the beginning and which the ending of any hiſtorical painting. Their paintings, however, ought not to be conſidered as a regular full hiſtory, but only as monuments and aids of tradition. We cannot expreſs too

133 They did not uſe hieroglyphics or characters.

Mexico.

ſtrongly the care which parents and maſters took to inſtruct their children and pupils in the hiſtory of the nation. They made them learn ſpeeches and diſcourſes which they could not expreſs by the pencil; they put the events of their anceſtors into verſe, and taught them to ſing them. This tradition diſpelled the doubts and undid the ambiguity which paintings alone might have occaſioned; and, by the aſſiſtance of thoſe monuments, perpetuated the memory of their heroes and of virtuous examples, their mythology, rites, laws, and cuſtoms.

134 Careful to preſerve their traditions.

135 Preserved the memory of events by knotted threads.

"Nor did that people only make uſe of tradition, paintings, and ſongs, to preſerve the memory of events, but alſo of threads of different colours and differently knotted. This curious method of the repreſentation of things, however much uſed in Peru, does not appear to have been employed in the province of Anahuac, if not in the moſt early ages; for no traces of ſuch monuments are now to be found. Boturini ſays, that after the moſt diligent ſearch, he with difficulty found one in a place in Tlaſcala, the threads of which were already waſted and conſumed by time. If thoſe who peopled South America ever paſſed the country of Anahuac, they poſſibly might have left there this art, which was afterwards abandoned for that of painting, introduced by the Toltecans or ſome other nation ſtill more ancient."

136 Their knowledge in ſculpture.

The Mexicans arrived at greater perfection in ſculpture, caſting of metals, and moſaic works, than in painting. Sculpture was likewiſe one of the arts exerciſed by the ancient Toltecans; but the Mexicans had ſculptors among them when they left their native country of Atztlan. Several of the Toltecan ſtatues, however, were preſerved till the time of the conqueſt, particularly that of the idol Tlaloc, placed upon the mountain of the ſame name, and ſome gigantic ſtatues in one of their temples. Stone and wood were the uſual materials of their ſtatues: the former was worked with a chiſſel made of flint; and, in ſpite of the unfitneſs of the inſtrument, ſuch was the phlegmatic nature of the people, that they ſurmounted every difficulty ariſing from the tediousneſs of the work. In their ſtatues they learned to expreſs all the attitudes and poſtures of which the human body is capable. They obſerved the proportions exactly, and could when neceſſary execute the moſt delicate ſtrokes with the chiſſel. They not only made entire ſtatues, but cut out in wood and in ſtone figures in baſſo relievo; of which kind are thoſe of Montezuma II. and one of his ſons, recorded with praiſes by Acoſta. They alſo made ſtatues of clay and wood, employing for theſe a chiſſel of copper. The number of their ſtatues was in proportion to that of their idols; but ſo active were the Spaniſh prieſts in deſtroying theſe, that there is now ſcarce any veſtige of them remaining. The foundation of the firſt church in Mexico was laid with idols; on which occaſion many thouſand ſtatues of their gods were neceſſarily broke in pieces. In caſting of metals, however, the Mexicans greatly excelled their works either of painting or ſculpture. "The miracles they produced of this kind (ſays Clavigero), would not be credible, if, beſides the teſtimony of thoſe who ſaw them, a great number of curioſities of this kind had not been ſent from Mexico to Europe. The works of gold and ſilver ſent in preſents from the conqueror Cortes to Charles V. filled the goldſmiths of Europe

137 Excelled in the art of caſting metals.

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Mexico.

with aſtoniſhment; who, as ſeveral authors of that period atteſt, declared that they were altogether inimitable. The Mexican founders made both of gold and ſilver the moſt perfect images of natural bodies. They made a fiſh in this manner, which had its ſcales alternately one of ſilver and the other of gold; a parrot with a moveable head, tongue, and wings; and an ape with a moveable head and feet, having a ſpindle in its hand in the attitude of ſpinning. They ſet gems in gold and ſilver, and made moſt curious jewellery of great value. In ſhort, theſe ſort of works were ſo admirably finiſhed, that even the Spaniſh ſoldiers, all ſtung with the ſame wretched thirſt for gold, valued the workmanſhip above the materials. This wonderful art, formerly practiſed by the Toltecas, the invention of which they aſcribed to one of their gods, has been entirely loſt by the debaſement of the Indians, and the indolent neglect of the Spaniards. We are doubtful if there are any remains of thoſe curious works; at leaſt we apprehend that it would be more eaſy to find them in ſome of the cabinets of Europe than in all New Spain. Covetouſneſs to profit by the materials muſt unqueſtionably have conquered all deſire to preſerve them as curioſities." The works of the Mexicans in gold and ſilver, executed with the hammer, were much inferior to thoſe of the Europeans.

But of all the works executed by the ancient Mexicans, thoſe of moſaic were the moſt curious, as well as moſt highly valued by themſelves. Theſe were made of the feathers of birds; and for procuring them they reared a great number of thoſe birds of fine plumage, with which the country abounded, not only in the royal palaces, but alſo in private houſes; and at certain ſeaſons they carried off the feathers for theſe purpoſes, or to ſell them at market. They valued particularly the feathers of the humming birds, on account of their ſmallneſs, fineneſs, and various colours; and in theſe, as well as other birds of fine plumage, nature ſupplied them not only with all the colours producible by art, but likewiſe with many which art cannot imitate. Their moſaic works, as well as indeed all others of the Mexicans, required infinite patience. At the undertaking of every work of this kind ſeveral artiſts aſſembled; and having agreed upon a deſign, and fixed their meaſure and proportions, each artiſt charged himſelf with the execution of a certain part of the image, and exerted himſelf ſo diligently in it, that he frequently ſpent a whole day in adjuſting a feather; firſt trying one and then another, viewing it ſometimes one way, then another, until he found one which gave his part that ideal perfection propoſed to be attained. When the part which each artiſt undertook was done, they aſſembled again to form the entire image from them. If any part happened to be in the leaſt deranged, it was wrought again until it was perfectly finiſhed. They laid hold of the feathers with ſmall pincers, that they might not do them the leaſt injury, and paſted them on the cloth with ſome glutinous matter; then they united all the parts upon a little table or a plate of copper, and flattened them ſoftly until they left the ſurface of the image ſo equal and ſmooth, that it appeared to be the work of a pencil. Theſe works were prodigiouſly admired by the Spaniards.

138 Beautiful moſaic.

The Mexicans were ſkilled in architecture even before

139 Their architecture.

Mexico. fore they left their native country; and many edifices still remain which were constructed by them during their frequent journeys from one place to another. At their first arrival on the lake, they had no other materials to build their houses with but reeds and mud, until the success of their commerce allowed them to purchase better materials. When the city came to its perfection, the houses of the principal people were constructed of stone and lime: they consisted of two floors, having halls, large court-yards, and chambers fitly disposed: the roofs were flat and terraced; the walls so well whitened, polished, and shining, that they appeared to the Spaniards when at a distance to have been constructed of silver. The floor was paved with plaster, perfectly level, plain, and smooth. Many of their houses were crowned with battlements and turrets; and their gardens had fish ponds, and the walks of them symmetrically laid out. The large houses had in general two entrances, the principal one to the street, the other to the canal: they had no wooden doors to their houses, but covered the entrance with small reeds, from whence they suspended a string of cocoa shells, or some other materials which would make a noise, so as to awake the attention of the family when any person lifted up the reeds to enter the house. —The houses of the poorer sort were constructed of reeds, unburnt bricks, stone, or mud; and the roofs made of a kind of a long hay which grows plentifully in the fields, particularly in the warm parts of the country. For this purpose they used also the leaves of the aloe placed in the manner of tiles, to which they bear some resemblance both in thickness and shape. One of the columns or supports of these houses was generally a tree in the vigour of its growth; by which means, besides the pleasure derived from its foliage and shade, they saved themselves some labour and expence. These houses had one or more apartments according to the circumstances of the family.

The ancient Mexicans understood the method of constructing arches or vaults, as appears from some remains of their buildings as well as from their paintings. They had likewise cornices and other ornaments of architecture. They had also square or cylindrical columns; but it is not known whether they had any capitals or not. They frequently adorned them with figures in *basso relievo;* but their great ambition was to have them all made out of one stone. The foundations of the large houses in the capital were laid upon beams of cedar driven into the ground, on account of its want of solidity; and the same method is still practised by the Spaniards. The roofs of these were made of cedar, fir, cypress, pine, &c. In the royal palaces the columns were of marble or even of alabaster, which the Spaniards mistook for jasper. In the reign of Ahuizotl a new kind of stone, named *tetzontli*, was discovered in the Mexican lake, which was ever afterwards made use of for building. It is hard, light, and porous like a sponge; by which means the lime adheres very firmly to it It is valued likewise on account of its colour, which is a blood red. Some of the pavements were chequered with marble and other valuable stones.

140 Remarkable aqueducts.

The most remarkable piece of Mexican architecture were their aqueducts. There were two which conveyed the water to the capital from the distance of two miles. These were constructed of stone and cement five feet high, and two paces broad, upon a road for that purpose upon the lake; by which the water was brought to the entrance of the city, from whence it was sent forth in smaller channels to supply the different fountains. The famous aqueduct of Chempoallan, which was done in the 16th century, is worthy of being ranked among the greatest in Europe. The conductor of this work was a Franciscan missionary named *Tembleque;* and it was executed with great skill by the Chempoallese. The water was brought from a great distance, and the country through which it must pass was mountainous and rocky; but every difficulty was overcome by the industry of the Mexicans. The aqueduct, including all the turnings and windings, exceeded 30 miles in length. The principal difficulty consisted in crossing three great precipices, over which they were obliged to construct three bridges, the first of 47, the second of 13, and the third of 67 arches. The largest arch was 100 feet high, and 61 broad; so that a large vessel could have passed under it. It must, however, be observed, that, in executing this undertaking, the Mexicans were undoubtedly assisted by European tools, and the directions of European workmen; so that we cannot with strict propriety call it one of their works.

141 Excellent jewellers.

They were expert jewellers, and understood the art of cutting and polishing the stones, as well as of setting them. The gems most common in their country were the emeralds, amethysts, carnelians, turquoises, and some others. Emeralds were so common, that no lord or noble wanted them; and none of them died without having one fixed to his lip, that it might serve him, as they imagined, in the other world, instead of a heart. When Cortes returned the first time to Spain, he brought with him five emeralds, valued, by the jewellers there, at 100,000 ducats. The first was in the form of a rose; the second of a horn; the third of a little fish with eyes of gold; the fourth in the form of a bell, with a fine pearl for a clapper. The fifth was a small cup with a foot of gold, and four little golden chains which united in a pearl in the form of a button. For this alone the Genoese merchants offered 40,000 ducats, in order to sell it again to the grand signior. Besides these, he had two emerald vases valued at 300,000 ducats; but these last were lost by shipwreck in the unfortunate expedition of Charles V. against Algiers. There are no such gems wrought at present, nor is it even known where the emerald mines are situated; though it is said there are still some large pieces of this precious stone in some of the churches; but the priests take care to secure them with iron chains, lest they should be carried off.

142 Manufactures of different kinds.

In other more common manufactures the Mexicans were by no means deficient. The earthen ware of Cholula was much praised by the Spaniards; and they had the art of ornamenting this kind of ware with various colours, though they did not understand the making of glass. Their carpenters wrought with instruments of copper; and there are still remains of their labours which display a tolerable skill. Almost every one was acquainted with the method of making cloth. Being destitute of wool, common silk, lint, or hemp, they were obliged to supply the deficiency by other materials. For wool they substituted cotton,

for

for ſilk they uſed feathers, the wool of the hare or rabbit; and inſtead of lint and hemp, they uſed the fibrous part of the leaves of the aloe. From theſe laſt they obtained a thread as fine as from lint; and from ſome ſpecies they had a coarſer ſort reſembling hemp. To obtain this thread they ſoaked the leaves in water, cleaned them, expoſed them to the ſun, and then beat them till they were fit to be ſpun. Sometimes they interwove with their cotton the fineſt down on the belly of the rabbits or hares, after having ſpun it into thread; and of theſe they made moſt beautiful cloths, which were particularly uſed for winter waiſtcoats for the lords. Their cotton manufactures were equal to any produced in Europe; they wove them with different figures and colours, repreſenting different animals and flowers. Of feathers interwoven with cotton they made mantles and bed-curtains, carpets, gowns, &c. Theſe were exceedingly beautiful; but this kind of manufacture is now loſt, though there are ſtill ſome of theſe garments in the poſſeſſion of the principal lords, who wear them upon ſolemn occaſions.

143 Their horrible religion.

All theſe advances towards civilization, however, in the ancient Mexicans, were much more than counterbalanced by the horrible barbarities they committed in their religious ceremonies, and in which they exceeded every nation on earth. Human ſacrifices were indeed in uſe among all the ancient heathens; but ſuch prodigious maſſacres at the dedication of their temples are unheard of in hiſtory. Whether they uſed theſe barbarous ſacrifices in their own country, or whether the practice began with that of the four Xochimilca priſoners, is not known; but as they only uſed their priſoners or ſlaves whom they bought in this way, it is impoſſible that, during the infancy of their ſtate, the number of human victims could have been very great. Moſt of thoſe unhappy creatures periſhed by having their breaſts opened, and their hearts pulled out; ſome were drowned, others ſtarved to death with hunger; and ſometimes they were burnt. Priſoners of high rank were allowed to die by what Clavigero calls the *gladiatorian* ſacrifice, which was performed in the following manner: Near to the greater temple of large cities, in an open ſpace of ground ſufficient to contain an immenſe number of people, was a round terrace eight feet high, upon which was placed a large round ſtone reſembling a millſtone in ſhape, but much larger, almoſt three feet high, well poliſhed, and having figures cut upon it. On this ſtone, which was called *temalcatl*, the priſoner was placed, armed with a ſhield and ſhort ſword, and tied by one foot. Here he was encountered by a Mexican officer or ſoldier better armed than himſelf. If the priſoner was vanquiſhed, he was carried, dead or alive, to the temple, where his heart was taken out and offered in the uſual manner; but if he conquered ſix combatants, he gained his life and liberty. An inſtance, however, is given in which this cuſtom was infringed; for the Huetzotzincas having taken the principal lord of Cholula, a man of ſingular bravery, he overcame ſeven combatants; notwithſtanding which he was put to death; but on this account the Huetzotzincas were rendered for ever infamous among theſe nations.

144 Gladiatorian ſacrifice.

145 Number of human victims annually ſacrificed.

Hiſtorians differ concerning the number of victims who periſhed annually in theſe ſacrifices: Clavigero inclines to think it was 20,000, but others make it much more. Zumarraga, the firſt biſhop of Mexico, ſays in a letter of the 12th of June 1531, addreſſed to the general chapter of his order, that in that capital alone there were above 20,000 victims annually ſacrificed. Some authors, quoted by Gomara, ſay that 50,000 were annually ſacrificed in the various parts of the empire. Acoſta ſays, that there was a certain day of the year on which they ſacrificed 5000 victims, and another on which 20,000 were ſacrificed. According to others they ſacrificed, on the mountain Tepeyacac only, 20,000 annually to one of their female deities. On the other hand, Bartholomew de las Caſas reduces the number of human victims to 50 or at moſt to 100. "We are ſtrongly of opinion (ſays Clavigero), that all theſe authors have erred in the number; Las Caſas by diminution, and the reſt by exaggerating the truth."

146 Their monſtrous auſterities.

Beſides the cruelties which they practiſed upon others, the Mexicans were accuſtomed to treat themſelves with the moſt inhuman auſterities, thinking that the diabolical rage of their deities would be appeaſed by human blood. "It makes one ſhudder (ſays Clavigero), to read the auſterities which they practiſed upon themſelves, either in atonement for their tranſgreſſions, or in preparation for their feſtivals. They mangled their fleſh as if it had been inſenſible, and let their blood run in ſuch profuſion as if it had been a ſuperfluous fluid in the body. The effuſion of blood was frequent and daily with ſome of their prieſts. They pierced themſelves with the ſharpeſt ſpines of the aloe, and bored ſeveral parts of their bodies, particularly their ears, lips, tongue, and the fat of their arms and legs. Through the holes which they made with theſe ſpines they introduced pieces of cane, the firſt of which were ſmall; but every time this penitential ſuffering was renewed, a thicker piece was made uſe of. The blood which flowed from them was carefully collected in the leaves of the plant *aczojatl*. They fixed the bloody ſpines in little balls of hay, which they expoſed upon the battlements of the walls of the temple, to teſtify the penance which they did for the people. Thoſe who exerciſed ſuch ſeverities upon themſelves within the encloſure of the greater temple of Mexico, bathed in a pond that was formed there, and which, from being always tinged with blood, was called *ezapan*."

147 Their dreſs.

The dreſs of the Mexicans was very ſimple; that of the men conſiſted only of a large belt or girdle, the two ends of which hung down before and behind; the women wore a ſquare mantle, about four feet long; the two ends were tied upon the breaſt or upon one ſhoulder. The Mexican gown was alſo a piece of ſquare cloth, in which the women wrapped themſelves from the waiſt down to the middle of the leg. They wore alſo a ſmall under veſt or waiſtcoat without ſleeves, named *huepilli*.

The dreſs of the poorer ſort was made of the thread of the mountain palm, or of coarſe cotton; but thoſe of better ſtation wore the fineſt cotton embelliſhed with various colours, and figures of animals or flowers; or woven with feathers, or the fine hair of the rabbit, &c. The men wore two or three mantles, and the women three or four veſts, and as many gowns, putting the longeſt undermoſt, ſo that a part of each of them might be ſeen. Their ſhoes were only ſoles of leather, or coarſe cloth of the mountain palm tied with

Mexico. with ſtrings; but thoſe of the great people were adorned with ribbands of gold and jewels. They all wore long hair, and thought themſelves diſhonoured by being ſhaved, or having their hair clipped, except the conſecrated virgins in the temple. The women wore it looſe; but the men tied it up in different forms, and adorned their heads with fine feathers, both when they danced and went to war. With this ſimplicity, however, they mixed no ſmall quantity of extravagance. Beſides feathers and jewels, with which they uſed to adorn their heads, they wore ear-rings, pendants at their upper lip, as well as many at their noſes, necklaces, bracelets for the hands and arms, as well as certain rings like collars which they wore about their legs. The ear-rings of the poor were ſhells, pieces of cryſtal, amber, &c.; but the rich wore pearls, emeralds, amethyſts, or other gems ſet in gold.

Inſtead of ſoap the Mexicans uſed a kind of fruit called *copalxocotl;* the pulp of which is white, viſcous, and very bitter, makes water white, raiſes a froth, and will clean linen like ſoap. They uſed alſo a kind of root named *amolli*, which is not unlike the *ſaponaria* of the old continent. It is now more uſed for waſhing the body, eſpecially the head than for clothes. Clavigero ſays, that there is a kind of this root which dyes the hair of a golden colour, and that he has been witneſs to this effect on the hair of an old man.

148 Modern inhabitants, &c.

The principal inhabitants of Mexico, in modern times, are Spaniards ſent thither by the court, to fill the poſts of government. They are obliged like thoſe in the mother country who aſpire to any eccleſiaſtical, civil, or military employments, to prove that there have been neither heretics, Jews, Mohammedans, nor any perſon in their family who has been called before the inquiſition for four generations. Merchants who are deſirous of going to Mexico, as well as to other parts of America, without becoming coloniſts, are compelled to obſerve the ſame forms. They are alſo obliged to ſwear that they have 300 palms of merchandiſe, their own property, in the fleet in which they embark, and that they will not carry their wives with them. On theſe abſurd conditions they become the principal agents of the European commerce with the Indies. Though their charter is only to continue three years, and a little longer for countries more remote, it is of great importance. To them alone belongs the right of ſelling, as commiſſioners, the major part of the cargo. If theſe laws were obſerved, the merchants ſtationed in the new world would be confined to diſpoſe of what they have received on their own account.

The predilection which adminiſtration has for Spaniards born in Europe, has reduced the Spaniſh Creoles to acquieſce in ſubordinate ſtations. The deſcendants of the companions of Cortes, and of thoſe who came after them, being conſtantly excluded from all places of honour or of truſt that were any way conſiderable, have ſeen the gradual decay of the power that ſupported their fathers. The habit of being obliged to bear that unjuſt contempt with which they have been treated, has at laſt made them become really contemptible. They have totally loſt, in the vices which originate from indolence, from the heat of the climate, and from a ſuperfluous enjoyment of all things, that firmneſs and that ſort of pride which have ever characterized their nation. A barbarous luxury, ſhameful pleaſures, and romantic intrigues, have enervated all the vigour of their minds; and ſuperſtition hath completed the ruin of their virtues. Blindly devoted to prieſts too ignorant to enlighten them by their inſtructions, too depraved to edify them by their example, and too mercenary to attend to both theſe duties of their function, they have no attachment to any part of their religion but that which enfeebles the mind; and have neglected what might have contributed to rectify their morals.

The Meſtees, who conſtitute the third order of citizens, are held in ſtill greater contempt. It is well known that the court of Madrid, in order to repleniſh a part of that dreadful vacancy which the avarice and cruelty of the conquerors had occaſioned, and to regain the confidence of thoſe who had eſcaped their fury, encouraged as much as poſſible the marriage of Spaniards with Indian women. Theſe alliances, which became pretty common throughout all America, were particularly frequent in Mexico, where the women had more underſtanding and were more agreeable than in other places. The Creoles transferred to this mixed progeny the contemptuous ſlight they received from the Europeans. Their condition, equivocal at firſt, in proceſs of time was fixed between the whites and the blacks.

Theſe blacks are not very numerous in Mexico. As the natives are more intelligent, more robuſt, and more induſtrious, than thoſe of the other colonies, they have hardly introduced any Africans except ſuch as were required either to indulge the caprice, or perform the domeſtic ſervice, of rich people. Theſe ſlaves, who are much beloved by their maſters, on whom they abſolutely depend, who purchaſed them at an extravagant price, and who make them the miniſters of their pleaſures, take advantage of the high favour they enjoy, to oppreſs the Mexicans. They aſſume over theſe men, who are called *free*, an aſcendant which keeps up an implacable hatred between the two nations. The law has ſtudied to encourage this averſion, by taking effectual meaſures to prevent all connexion between them. Negroes are prohibited from having any amorous correſpondence with the Indians; the men, on pain of being mutilated; the women, of being ſeverely puniſhed. On all theſe accounts, the Africans, who in other ſettlements are enemies to the Europeans, are in the Spaniſh Indies their warm friends.

Authority has no need of this ſupport, at leaſt in Mexico, where population is no longer what it was formerly. The firſt hiſtorians, and thoſe who copied them, have recorded, that the Spaniards found there 10,000,000 of ſouls. This is ſuppoſed to have been the exaggerated account of conquerors, to exalt the magnificence of their triumph; and it was adopted, without examination, with ſo much the more readineſs, as it rendered them the more odious. We need only trace with attention the progreſs of thoſe ruffians who at firſt deſolated theſe fine countries, in order to be convinced that they had not ſucceeded in multiplying men at Mexico and the adjacent parts, but by depopulating the centre of the empire; and that the provinces which are remote from the capital, differed in nothing from the other deſerts of South and North America.

Mexico.

America. It is making a great conceſſion, to allow that the population of Mexico has only been exaggerated one half: for it does not now much exceed 2,000,000.

149 Mexicans cruelly treated by the Spaniards.

It is generally believed, that the firſt conquerors maſſacred the Indians out of wantonneſs, and that even the prieſts incited them to theſe acts of ferocity. Undoubtedly theſe inhuman ſoldiers frequently ſhed blood without even an apparent motive; and certainly their fanatic miſſionaries did not oppoſe theſe barbarities as they ought to have done. This was not, however, the real cauſe, the principal ſource of the depopulation of Mexico; it was the work of a ſlow tyranny, and of that avarice which exacted from its wretched inhabitants more rigorous toil than was compatible with their conſtitution and the climate.

This oppreſſion was coeval with the conqueſt of the the country. All the lands were divided between the crown, the companions of Cortes, and the grandees or miniſters who were moſt in favour at the court of Spain. The Mexicans, appointed to the royal domains, were deſtined to public labours, which originally were conſiderable. The lot of thoſe who were employed on the eſtates of individuals was ſtill more wretched. All groaned under a dreadful yoke; they were ill fed; they had no wages given them; and ſervices were required of them, under which the moſt robuſt men would have ſunk. Their misfortunes excited the compaſſion of Bartholomew de las Caſas.

150 Bartholomew de las Caſas takes their part.

This man, ſo famous in the annals of the new world, had accompanied his father in the firſt voyage made by Columbus. The mildneſs and ſimplicity of the Indians affected him ſo ſtrongly, that he made himſelf an eccleſiaſtic, in order to devote his labours to their converſion. But this ſoon became the leaſt of his attention. As he was more a *man* than a *prieſt*, he felt more for the cruelties exerciſed againſt them than for their ſuperſtitions. He was continually hurrying from one hemiſphere to the other, in order to comfort the people for whom he had conceived an attachment, or to ſoften their tyrants. This conduct, which made him be idolized by the one and dreaded by the other, had not the ſucceſs he expected. The hope of ſtriking awe, by a character revered among the Spaniards, determined him to accept the biſhoprick of Chiapa in Mexico. When he was convinced that this dignity was an inſufficient barrier againſt that avarice and cruelty which he endeavoured to check, he abdicated it. It was then that this courageous, firm, diſintereſted man, accuſed his country before the tribunal of the whole univerſe. In his account of the tyranny of the Spaniards in America, he accuſes them of having deſtroyed 15,000,000 of Indians. They ventured to find fault with the acrimony of his ſtyle; but no one convicted him of exaggeration. His writings, which indicate the amiable turn of his diſpoſition, and the ſublimity of his ſentiments, have ſtamped a diſgrace upon his barbarous countrymen, which time hath not, and never will, efface.

151 Their condition rendered ſomewhat eaſier.

The court of Madrid, awakened by the repreſentations of the virtuous Las Caſas, and by the indignation of the whole world, became ſenſible at laſt, that the tyranny it permitted was repugnant to religion, to humanity, and to policy; and reſolved to break the chains of the Mexicans. Their liberty was now only conſtrained by the ſole condition, that they ſhould not quit the territory where they were ſettled. This precaution owed its origin to the fear that was entertained of their going to join the wandering ſavages to the north and ſouth of the empire.

With their liberty their lands ought alſo to have been reſtored to them; but this was not done. This injuſtice compelled them to work ſolely for their oppreſſors. It was only decreed, that the Spaniards, in whoſe ſervice they laboured, ſhould ſtipulate to keep them well, and pay them to the amount of 5l. 5s. a-year.

From theſe profits the tribute impoſed by government was ſubtracted, together with 4s. 4½d. for an inſtitution which it is aſtoniſhing the conquerors ſhould have thought of eſtabliſhing. This was a fund ſet apart in each community, and appropriated to the relief of ſuch Indians as were decayed or indiſpoſed, and to their ſupport under private or public calamities.

The diſtribution of this fund was committed to their caciques. Theſe were not the deſcendants of thoſe whom they found in the country at the time of the conqueſt. The Spaniards choſe them from among thoſe Indians who appeared the moſt attached to their intereſts; and were under no apprehenſions at making theſe dignities hereditary. Their authority was limited to the ſupporting the police in their diſtrict, which in general extended eight or ten leagues; to the collecting the tribute of thoſe Indians who laboured on their own account, that of the others being ſtopt by the maſters whom they ſerved; and to the preventing their flight by keeping them always under their inſpection, and the not ſuffering them to contract any engagement without their conſent. As a reward of their ſervices, theſe magiſtrates obtained from government a property. They were permitted to take out of the common ſtock 2½d. annually for every Indian under their juriſdiction. At laſt they were empowered to get their fields cultivated by ſuch young men as were not yet ſubject to the poll tax; and to employ girls, till the time of their marriage, in ſuch occupations as were adapted to their ſex, without allowing them any ſalary except their maintenance.

Theſe inſtitutions, which totally changed the condition of the Indians of Mexico, irritated the Spaniards to a degree not to be conceived. Their pride would not ſuffer them to conſider the Americans as free men; nor would their avarice permit them to pay for labour which hitherto had coſt them nothing. They employed themſelves ſucceſſively, or in combination, craft, remonſtrances, and violence, to effect the ſubverſion of an arrangement which ſo ſtrongly contradicted their warmeſt paſſions; but their efforts were ineffectual. Las Caſas had raiſed up for his beloved Indians protectors who ſeconded his deſign with zeal and warmth. The Mexicans themſelves, finding a ſupport, impeached their oppreſſors before the tribunals; and even the tribunals that were either weak or in the intereſt of the court. They carried their reſolution ſo far, as even unanimouſly to refuſe to work for thoſe who had treated any of their countrymen with injuſtice. This mutual agreement, more than any other circumſtance, gave ſolidity to the regulations

Mexico. gulations which had been decreed. The other, prefcribed by the laws, was gradually eftablifhed. There was no longer any regular fyftem of oppreffion; but merely feveral of thofe particular vexations which a vanquifhed people, who have loft their government, can hardly avoid from thofe who have fubdued it.

Thefe clandeftine acts of injuftice did not prevent the Mexicans from recovering from time to time, certain detached portions of that immenfe territory of which their fathers had been defpoiled. They purchafed them of the royal domain, or of the great proprietors. It was not their labour which enabled them to make thefe acquifitions: for this they were indebted to the happinefs of having difcovered, fome of them mines, others treafures which had been concealed at the time of the conqueft. The greateft number derived their refources from the priefts and monks, to whom they owed their exiftence.

Even thofe who experienced a fortune lefs propitious, procured for themfelves, by the fole profits of their pay, more conveniences than they had enjoyed before they underwent a foreign yoke. We fhould be very much deceived, were we to judge of the ancient profperity of the inhabitants of Mexico by what has been faid of its emperor, its court, its capital, and the governors of its provinces. Defpotifm had there produced thofe fatal effects which it produces everywhere. The whole ftate was facrificed to the caprices, pleafures, and magnificence, of a fmall number of perfons.

The government drew confiderable advantages from the mines which it caufed to be worked, and ftill greater from thofe which were in the hands of individuals. The falt works greatly added to its revenue. Thofe who followed agriculture, at the time of harveft paid in a kind of a third of all the produce of the lands, whether they belonged to them as their own property, or whether they were only the farmers of them. Men who lived by the chafe, fifhermen, potters, and all mechanics, paid the fame proportion of their induftry every month. Even the poor were taxed at certain fixed contributions, which their labour or their alms might put them in a condition to pay.

The Mexicans are now lefs unhappy. Our fruits, our corn, and our cattle, have rendered their food more wholefome, agreeable, and abundant. Their houfes are better built, better difpofed, and better furnifhed. Shoes, drawers, fhirts, a garment of wool or cotton, a ruff, and a hat, conftitute their drefs. The dignity which it has been agreed to annex to thefe enjoyments has made them better economifts, and more laborious. This cafe, however, is far from being univerfal; it is even very uncommon in the vicinity of the mines, towns, and great roads, where tyranny feldom fleeps; but we often find it with fatisfaction in remote parts, where the Spaniards are not numerous, and where they have in fome meafure become Mexicans.

The employments of this people are very various. The moft intelligent, and thofe who are in eafy circumftances, devote themfelves to the moft neceffary and moft ufeful manufactures, which are difperfed through the whole empire. The moft beautiful manufactures are eftablifhed among the people of Tlafcala. Their old capital, and the new one, which is called *Angelos*, are the centre of this induftry. Here they manufacture cloth that is pretty fine, callicoes that have an agreeable appearance, certain flight filks, good hats, gold lace, embroidery, lace, glaffes, and a great deal of hardware.

152 Manufactures and produce of the country.

The care of flocks affords a maintenance to fome Mexicans, whom fortune or nature have not called to more diftinguifhed employments. America, at the time it was difcovered, had neither hogs, fheep, oxen, horfes, nor even any domeftic animal. Columbus carried fome of thefe ufeful animals to St Domingo, from whence they were generally difperfed; and in Mexico, more than in any other place, thefe have multiplied prodigioufly. They count their horned cattle by thoufands, whofe fkins are become an object of confiderable exportation. The horfes are degenerated, but the quality is compenfated by the number. Hogs lard is here fubftituted for butter. Sheep's wool is dry, coarfe, and bad, as it is everywhere between the tropics.

The vine and olive tree have experienced the fame degeneracy. The cultivation of them was at firft prohibited, with a view of leaving a free market for the commodities of the mother country. In 1706, permiffion was given to the Jefuits, and a little afterwards to the marquis Del Valle, a defcendant from Cortes, to cultivate them. The attempts have not proved fuccefsful. The trials, indeed, that have been made, have not been abandoned; but no perfon has folicited the liberty of following an example which did not promife any great emoluments. Other cultures have been more fuccefsful. Cotton, fugar, filk, cocoa, tobacco, and European corn, have all thriven in fome degree. The Spaniards are encouraged to profecute the labours which thefe cultures require, from the happy circumftance of their having difcovered iron mines, which were entirely unknown to the Mexicans, as well as fome mines of a kind of copper that is hard enough to ferve for implements of hufbandry. All thefe articles, however, for want of men and induftry, are merely confumed within the country.—There is only the vanilla, indigo, and cochineal, which make part of the trade of Mexico with other nations.

New MEXICO, fo called becaufe of its being difcovered later than Old Mexico, a country of America, is bounded on the north by high mountains, beyond which is a country altogether unknown; by Louifiana on the eaft; by New Spain on the fouth; and on the weft by the gulf of California, and the Rio Colorado; extending, it is faid, above 1000 miles from eaft to weft, and about 900 from fouth to north; but the twentieth part of the country within thefe limits is neither cultivated nor inhabited either by Spaniards or Indians. As it lies in the midft of the temperate zone, the climate, in general, is very pleafant; the fummers, though very warm, are neither fultry nor unwholefome; and the winters, though pretty fharp, are far from being infupportable, and, for the moft part, clear and healthy.

The greateft encomiums are lavifhed on the fertility of the foil, the richnefs of the mines, and the variety of valuable commodities produced in this country. It is faid to be beautifully diverfified with fields, meadows, rifing rising grounds, and rivers; abounding with fruit and timber trees, turquoises, emeralds, and other precious stones, mines of gold and silver, a great variety of wild and tame cattle, fish and fowls. Upon the whole, we may safely affirm, that New Mexico is among the pleasantest, richest, and most plentiful countries in America, or any other part of the world. There are few great or navigable rivers in it: the most considerable are, the Rio Solado and Rio del Norte, which, with several smaller streams, fall into the gulf of Mexico. On the coast of the gulf are divers bays, ports, and creeks, which might be easily converted into excellent harbours, if the Spaniards were possessed of any portion of that commercial spirit which animates the other maritime nations of Europe.

The Spanish writers tell us, that New Mexico is inhabited by a great variety of Indian nations or tribes, totally unconnected with each other; but the principal are the Apaches, a brave, warlike, resolute people; fond of liberty, and the inveterate enemies of tyranny and oppression. About the close of the 17th century, thinking themselves aggrieved by the Spanish government, they made a general insurrection, and did a great deal of mischief; but were at last obliged to submit, and have since been curbed by stronger garrisons. Most of the natives are now Christians. When the Spaniards first entered this country, they found the natives well clothed, their lands cultivated, their villages neat, and their houses built with stone. Their flocks also were numerous, and they lived more comfortably than most of the other savages of America. As to religion, they were idolaters, and worshipped the sun and moon; but whether they offered human sacrifices, we are not sufficiently informed.

The number of provinces in this country is not well ascertained: some writers making them only five, others 10, 15, 20, and 25; but adding no description, either of them or the towns contained in them, excepting the capital, Santa Fé, which we are told stands near the source of the Rio del Norte, in 36° of north latitude, and about 130 leagues from the gulf: that it is a well built, handsome, rich town; and the seat of the bishop, suffragan of Mexico, as well as the governor of the province, who is subordinate to the viceroy of Mexico or New Spain.

MEZERAY, Francis Eudes de, an eminent French historian, the son of Isaac Eudes a surgeon, was born at Rye, in Lower Normandy, in 1610; and took the surname of *Mezeray*, from a hamlet near Rye. Having performed his studies at Caen, he discovered a strong inclination to poetry; but going to Paris, he, by the advice of one of his friends, applied himself to the study of politics and history, and procured the place of commissary at war, which he held for two campaigns. He then shut himself up in the college of St Barbe, in the midst of books and manuscripts; and, in 1643, published the first volume of the History of France, in folio; and some years after, the other two volumes. Mezeray in that work surpassed all who had written the history of France before him, and was rewarded by the king with a pension of 4000 livres. In 1668, he published an Abridgement of his History of France, in three volumes 4to, which was well received by the public; but as he inserted in that work the origin of most of the taxes, with very free reflections, M. Colbert complained of it, when Mezeray promised to correct what he had done in a second edition; but those corrections being only palliations, the minister caused half of his pension to be suppressed. Mezeray complained of this in very severe terms; when he obtained no other answer than the suppression of the other half. Vexed at this treatment, he resolved to write on subjects that could not expose him to such disappointments; and composed his treatise on the origin of the French, which did him much honour. He was elected perpetual secretary to the French academy; and died in 1683. He is said to have been a man extremely negligent in his person, and so careless in his dress, that he might have passed for a beggar rather than for what he was. He was actually seized one morning by the *archers des pauvres*, or parish officers; which mistake was so far from provoking him, that he was highly diverted with it, and told them, that "he was not able to walk on foot, but that as soon as a new wheel was put to his chariot, he would attend them wherever they thought proper." He used to study and write by candle light, even at noon-day in summer; and, as if there had been no sun in the world, always waited upon his company to the door with a candle in his hand. With regard to religion, he affected Pyrrhonism; which however was not, it seems, so much in his heart as in his mouth. This appeared from his last sickness; for having sent for those friends who had been the most usual witnesses of his licentious talk about religion, he made a sort of recantation, which he concluded with desiring them "to forget what he might formerly have said upon the subject of religion, and to remember, that Mezeray dying was a better believer than Mezeray in health." Besides his history, he also wrote, 1. A continuation of the history of the Turks. 2. A French translation of John de Salisbury's Latin treatise on the vanities of the court. 3. There are attributed to him several satires against the government; and in particular, those that bear the name of *Sandricourt*.

MEZIERS, a strong town of France in the department of Ardennes, with a citadel. It was besieged with a powerful army by Charles V. who was obliged to raise the siege in 1521. It is seated on the river Maese, partly upon a hill, and partly in a valley, in E. Long. 4. 48. N. Lat. 49. 46.

MEZIRIAC, Claude Gaspar Backet Sieur de, one of the most ingenious men of the 17th century, was born at Bresse, of an ancient and noble family. He was a good poet in French, Italian, and Latin; an excellent grammarian, a great Greek scholar, and an admirable critic. He was well versed in the controversies, both in philosophy and religion; and was deeply skilled in algebra and geometry, of the former of which he gave proof by publishing the six books of Diophantus, enriched with a very able commentary and notes. In his youth he spent a considerable time at Paris and at Rome; at which last place he wrote a small collection of Italian poems, in competition with Vaugelas, who was there at the same time; among which there are imitations of the most beautiful similes contained in the first eight books of the Æneid. He also translated Ovid's Epistles; a great part of which he illustrated with very curious commentaries of his own. Whilst he he was at Paris, they talked of making him preceptor of Louis XIII. upon which he left the court in great haste, and afterwards declared that he had never felt so much pain upon any occasion of his life; for he seemed to have already upon his shoulders the important weight of the whole kingdom. He undertook the translation of all Plutarch's works, with notes; which he had brought nearly to a conclusion, when he died at Bourg, in Bresse, anno 1638, at 45 years of age. He left behind him several finished works, that were not printed.

MEZUZOTH, in the Jewish customs, certain pieces of parchment, which the Jews fix to the door-posts of their houses, taking that literally which Moses commands them, saying, "Thou shalt never forget the laws of thy God, but thou shalt write them upon the posts of thy house, and on thy gates." This expression means nothing else, but that thou shalt always remember them, whether thou comest into thy house or goest out. But the Hebrew doctors imagined, that the lawgiver meant something more than this. They pretended that, to avoid making themselves ridiculous, by writing the commandments of God without their doors, or rather to avoid exposing themselves to the profanation of the wicked, they ought at least to write them on a parchment, and to enclose it in something. Therefore they wrote these words upon a square piece of parchment prepared on purpose, with a particular ink, and a square kind of character. Deut. vi. 4, 5, 6, 7, 8, 9. "Hear, O Israel, the Lord our God is one Lord," &c.—Then they left a little space, and afterwards went on, Deut. xi. 13. "And it shall come to pass if thou shalt hearken diligently to my commandments," &c. as far as, "Thou shalt write them upon the door-posts of thy house," &c. After this they rolled up the parchment, and put it into a case of reeds or other matter; they wrote on the end of the case the word *Shaddai*, which is one of the names of God; and they put it at the doors of their houses, chambers, and all places most frequented; they fixed it to the knockers of the door, on the right side; and as often as they entered in or went out they touched it in this place, with the end of their finger, which they afterwards kissed out of devotion. The Hebrew word *mezuza* properly signifies the door-posts of a house; but it is also given to this roll of parchment now mentioned.

MEZZOTINTO, a particular manner of representing figures on copper, so as to form prints in imitation of painting in Indian ink. See ENGRAVING.

The invention of this art has been usually attributed to Prince Rupert. But Baron Heinikin, a very judicious and accurate writer upon the subject of engraving, asserts, with great appearance of truth, that it was a lieutenant-colonel de Siegan, an officer in the service of the landgrave of Hesse, who first engraved in this manner; and that the print which he produced was a portrait of the princess Amelia Elizabeth of Hesse, engraved in the year 1643. Prince Rupert learned the secret from this gentleman, and brought it into England when he came over the second time with Charles II. Prince Rupert's print of An Executioner holding a Sword in one Hand and a Head in the other, a half length, from Spagnoletto, is dated 1658. This art has never been cultivated with success in any country but England.

The prince laid his grounds on the plate with a channelled roller: but one Sherwin, about the same time, laid his grounds with a half-round file, which was pressed down with a heavy piece of lead. Both these grounding tools have been laid aside for many years; and a hand tool, resembling a shoe-maker's cutting board knife, with a fine crenelling on the edge, was introduced by one Edial, a smith by trade, who afterwards became a mezzotinto painter.

It is very different from the common way of engraving. To perform it, they rake, hatch, or punch, the surface of the plate all over with a knife, or instrument made for the purpose, first one way, then the other, across, &c. till the surface of the plate be thus entirely furrowed with lines or furrows, close and as it were contiguous to each other; so that, if an impression was then taken from it, it would be one uniform blot or smut. This done, the design is drawn or marked on the same face; after which, they proceed with burnishers, scrapers, &c. to expunge and take out the dents or furrows, in all the parts where the lights of the piece are to be; and that more or less as the lights are to be stronger or fainter; leaving those parts black which are to represent the shadows or deepenings of the draught.

As it is much easier to scrape or burnish away parts of a dark ground corresponding with the outline of any design sketched upon it, than to form shades upon a light ground by an infinite number of hatches, strokes, and points, which must all terminate with exactness on the outline, as well as differ in their force and manner; the method of scraping, as it is called, in mezzotinto, consequently becomes much more easy and expeditious than any other method of engraving. The instruments used in this kind of engraving are cradles, scrapers, and burnishers.

In this engraving, the plate must be prepared and polished in the same manner as for other engraving; and afterwards divided equally by lines parallel to each other, and traced out with very soft chalk.—The distance of these lines should be about one-third of the length of the face of the cradle which is to be used, and these lines should be marked with capital letters, or strokes of the chalk. The cradle is then to be placed exactly betwixt the two first lines, and passed forwards in the same direction; being kept as steady as possible, and pressed upon with a moderate force. The same operation must be repeated with respect to all the other lines; till the instrument has thus passed over the whole surface of the plate.—Other lines must be then drawn from the extremities of the other two sides, in the same manner; which, intersecting the first at right angles, will with them form squares; and the same operation must be repeated with the cradle as in the case of the first. New lines must then be drawn diagonally, and the cradle passed betwixt them as before; and when the first diagonal operation is performed, the lines must be crossed at right angles as the former, and the cradles passed betwixt them in the same manner.—The plate having undergone the action of the cradle, according to the disposition of the first order of lines, a second set must be formed, having the same di-

stances

Mezzotinto.

ftances from each other as the firft. But they muft be fo placed as to divide thofe already made into fpaces one-third lefs than their whole extent; i. e. every one after the firft on each fide will take in one-third of that before it, e. g. beginning at A, of which the firft third muft be left out; a third of B will confequently be taken in, and fo of the reft. Thefe lines of the fecond order muft be marked with fmall letters, or leffer ftrokes, to diftinguifh them from the firft: and the fame treatment of the plate muft be purfued with refpect to them as was practifed for the others. When this fecond operation is finifhed, a third order of lines muft be made; the firft of which, e. g. in A, muft omit two-thirds of it, and confequently take in two-thirds of B, &c. By thefe means, the original fpaces will be exactly divided into equal thirds; and the cradle muft be again employed betwixt thefe lines as before.—When the whole of this operation is finifhed, it is called *one turn;* but in order to produce a very dark and uniform ground, the plate muft undergo the repetition of all thefe feveral operations for above twenty times; beginning to pafs the cradle again betwixt the firft lines, and proceeding in the fame manner through all the reft. When the plate is prepared with a proper ground, the fketch muft be chalked on it, by rubbing the paper on the backfide with chalk. It is alfo proper to overtrace it afterwards with black lead or Indian ink. The fcraping is then performed, by paring or cutting away the grain of the ground in various degrees; fo that none of it is left in the original ftate except in the touches of the ftrongeft fhade. The general manner of proceeding is the fame as drawing with white upon black paper. The maffes of light are firft begun with; and thofe parts which go off into light in their upper part, but are brown below: the reflections are then entered upon; after which the plate is blackened with a printer's blacking ball made of felt, in order to difcover the effect: and then the work is proceeded with; obferving always to begin every part in the places where the ftrongeft lights are to be.

The art of fcraping mezzotintos has been applied to the printing with a variety of colours, in order to produce the refemblance of paintings. The inventor of the method of doing this was J. C. Le Blon, a native of Frankfort, and pupil of Carlo Marata, between the years 1720 and 1730. It was eftablifhed by the inventor on this principle, that there are three primitive colours, of which all the reft may be compofed by mixing them in various proportions; that any two of thefe colours being mixed together, preferve their original power, and only produce a third colour fuch as their compound muft neceffarily give; but if tranfparent colours be mixed, and three primitive kinds compounded together, they deftroy each other, and produce black, or a tendency to it, in proportion to the equality or inequality of the mixture; and that if, therefore, thefe three colours be laid, either feparately or upon each other, by three plates, engraved correfpondently on thefe principles to the colouring of the defign, the whole variety of teints neceffary may be produced. The requifites, therefore, to the execution of any defign in this method of printing are as follows: 1. To fettle a plan of the colouring to be imitated; fhowing where the prefence of each of the three fimple colours is neceffary, either in its pure ftate or combined with fome other, to produce the effect required; and to reduce this plan to a painted fketch of each, in which not only the proper outlines, but the degree of ftrength fhould be expreffed. 2. To engrave three plates according to this plan, which may print each of the colours exactly in the places where, and proportion in which, they are wanted. 3. To find three tranfparent fubftances proper for printing with thefe three primitive colours. The manner in which M. le Blon prepared the plates was as follows: The three plates of copper were firft well fitted with refpect to fize and figure to each other, and grounded in the fame manner as thofe defigned for mezzotinto prints: and the exact place and boundary of each of the three primitive colours, conformably to the defign, were fketched out on three papers, anfwering in dimenfions to the plate. Thefe fketches were then chalked on the plates; and all the parts of each plate that were not to convey the colour to which it was appropriated to the print, were entirely fcraped away, as in forming the light of mezzotinto prints. The parts that were to convey the colours were then worked upon; and where the moft light or diluted teints of the colour were to be, the grain in the ground was proportionably taken off; but where the full colour was required, it was left entire. In this regard was had, not only to the effects of the colour in its fimple ftate, but to its combined operation, either in producing orange-colour, green, or purple, by its admixture with one alone; and likewife to its forming brown, gray, and fhades of different degrees, by its co-operation with both the others. But though the greateft part of the engraving was performed in the mezzotinto manner, yet the graver was employed occafionally for ftrengthening the fhades, and for correcting the outline where it required great accuracy and fteadinefs. It was found neceffary fometimes to have two feparate plates for printing the fame colour, in order to produce a ftronger effect: but the fecond plate, which was ufed to print upon the firft, was intended only to glaze and foften the colours in particular parts that might require it. With refpect to the black and brown teints, which could not be fo conveniently produced in a due degree by the mixture of the colours, umber and black were likewife ufed.

With refpect to the order in which the plates are to be applied, it may be proper to obferve, that the colour which is leaft apparent in the picture fhould be laid on firft; that which is betwixt the moft and leaft apparent next; and that which predominates laft; except where there may be occafion for two plates for the fame colour, as was before mentioned; or where there is any required for adding browns and fhades.

M. le Blon applied this art to portraits, and fhowed, by the fpecimens he produced, the poffibility of its being brought, by farther improvements, to afford imitations of painting which might have fome value. It is neverthelefs much better adapted to the fimpler fubjects, where there are fewer intermixtures of colours; and where the accuracy of the reflections, and demi-teints, are not fo effentially neceffary to the truth of the defign, from the greater latitude of form, and difpofition of the colour, as in plants, anatomical figures, and fome fubjects of architecture. But perhaps plates engraved

graved or rather finished with the tool, particularly with respect to the outline, would be better accommodated in some of these cases than those prepared only by scraping.

M. Cochin remarks, at the end of an account he has given of M. le Blon's manner, that though this ingenious artist confined his method principally to the use of three colours; yet, should this invention be again taken up and cultivated, there would be more probability of success in using a greater variety; and that several different kinds might be printed by one plate, provided they were laid on in their respectively proper places by printing-balls, which should be used for that colour only. His hint might however be very greatly improved, by the further assistance of pencils, accommodated to the plates, for laying on the colours in the proper parts.—For the method of taking off mezzotinto prints on glass, see *BACK-painting*.

MIASMA, among physicians, a particular kind of effluvia, by which certain fevers, particularly intermittents, are produced.

MICA, *Muscovy glass*, or *Glimmer*, a species of mineral substance. See MINERALOGY *Index*.

MICAH, or *The Book of MICAH*, a canonical book of the Old Testament, written by the prophet Micah, who is the sixth of the twelve lesser prophets. He is cited by Jeremiah, and prophesied in the days of Jotham, Ahaz, and Hezekiah. He censures the reigning vices of Jerusalem and Samaria, and denounces the judgments of God against both kingdoms. He likewise foretels the confusion of the enemies of the Jews, the coming of the Messiah, and the glorious success of his church.

MICHAEL, or MICHEL, (i. e. *who is like to God?*) The scripture account of Michael is, that he was an archangel, who presided over the Jewish nation, as other angels did over the Gentile world, as is evident of the kingdoms of Persia and Greece, (Dan. x. 13.); that he had an army of angels under his command (Rev. xii. 7.); that he fought with the Dragon, or Satan and his angels; and that, contending with the Devil, he disputed about the body of Moses, (Jude 9.). As to the combat between Michael and the Dragon, some authors understand it literally, and think it means the expulsion of certain rebellious angels, with their head or leader, from the presence of God. Others take it in a figurative sense; and refer it, either to the contest that happened at Rome between St Peter and Simon Magus, in which the apostle prevailed over the magician, or to those violent persecutions under which the church laboured for three hundred years, and which happily ceased when the powers of the world became Christian. Among the commentators who maintain the former opinion is Grotius; and among those who take it in a figurative sense are Hammond and Mede.

The contest about the body of Moses is likewise taken both literally and figuratively. Those who understand it literally are of opinion, that Michael by the order of God hid the body of Moses after his death; and that the Devil endeavoured to discover it, as a fit means to entice the people to idolatry, by a superstitious worship of his relics. But this dispute is figuratively understood to be a controversy about rebuilding the temple, and restoring the service of God among the Jews at Jerusalem; the Jewish church being fitly enough styled the body of Moses. It is thought by some, that this story of the contest between Michael and the Devil was taken by St Jude out of an apocryphal book called *The Assumption of Moses*.

The Romish church celebrates three appearances of Michael, of which no mention is made in scripture, and which have happened, they say, a long time after the age of the apostles. The first appearance of this archangel was at Colossæ in Phrygia, but at what time is uncertain. The second is that of Mount Garganus, in the kingdom of Naples, about the end of the fifth century. The third is his appearance to Aubert bishop of Avranches, upon a rock called the *Tomb*, where at this day is the abbey of St Michael. This was about the year 706. The first of these festivals is observed on the 6th of September, the second on the 8th of May, and the last on the 16th of October. It has been supposed, that it was Michael the archangel who conducted the Israelites in their journey through the wilderness, (see Exod. xxxii. 20, 23, and xxxiii. 2.); that it was he who appeared to Moses in the burning bush; who appeared to Joshua in the fields of Jericho, and to Gideon and Manoah the father of Samson; and, in a word, to him have been imputed the greatest part of the most remarkable appearances either in the Old or New Testament.

MICHAEL ANGELO. See ANGELO.

Mount MICHAEL, formerly one of the most celebrated state prisons of France, lies about 20 miles from Granville. It is a rock situated in the middle of the bay of Avranches; and is only accessible at low water. Nature has completely fortified one side, by its craggy and almost perpendicular descent, which renders it impracticable to mount it by any address or courage, however consummate. The other parts are surrounded by walls fenced with semilunar towers after the Gothic manner; but sufficiently strong, together with the advantage of its situation, to render it impregnable to any attack. At the foot of the mountain begins a street or town, which winds round its base to a considerable height. Above are chambers where state prisoners are kept, and where there are other buildings intended for residence. On the summit is erected the abbey itself, occupying a prodigious space of ground, and of a strength and solidity equal to its enormous size; since it has for many centuries withstood all the injuries of the weather, to which it is so much exposed. In an apartment, called the *Sale de Chavalerie*, the knights of St Michael used to meet in solemn convocation on important occasions. They were the defenders and guardians of this mountain and abbey, as those of the Temple, and of St John of Jerusalem, were of the holy sepulchre. The hall in which they met is very spacious, but rude and barbarous. At one end is a painting of the archangel, the patron of their order; and in this hall Louis XI. first instituted and invested with the insignia of knighthood the chevaliers of the cross of St Michael. There is a miserable dark apartment, or rather dungeon, in which many eminent persons were formerly confined. In the middle of it is a cage, composed of prodigious bars of wood; and the wicket which gives entrance into it is 10 or 12 inches in thickness. The inside of it comprises about 12 or 14 feet square, and it is nearly 20 in height. Towards

Michael.

wards the latter end of the 17th century, a newswriter in Holland, who had presumed to print some very severe and sarcastic reflections on Madame de Maintenon, was confined in this place. Some months after his publication, he was induced, by a person sent expressly for that purpose, to make a tour into French Flanders. The moment he had quitted the Dutch territories, he was put under arrest; and immediately, by his majesty's express command, conducted to Mount Michael, where he was shut up in this cage. Here he lived upwards of 23 years; and here he at length expired. During the long nights of winter, no candle or fire was allowed him. He was not permitted to have any book. He saw no human face, except the gaoler, who came once every day to present him, through a hole in the wicket, with his little portion of bread and wine. No instrument was given him with which he could destroy himself: but he found means at length to draw out a nail from the wood, with which he engraved, or cut on the bars of his cage, certain fleurs de lis and armorial bearings, which formed his only employment and recreation. They are very curiously performed considering the rudeness of his instrument.

The subterraneous chambers in this mountain are said to be so numerous, that the gaolers themselves do not know them. There are certain dungeons called *oubliettes*, into which they were accustomed anciently to let down malefactors guilty of very heinous crimes: they provided them with a loaf of bread and a bottle of wine, and then they were totally forgotten, and left to perish by hunger in the dark vaults of the rock. This punishment, however, has not been inflicted by any king in the last or present century.

Here also is a remarkable chamber, in one corner of which is a kind of window: between this and the wall of the building is a very deep space, of near 100 feet perpendicular, at the bottom of which is another window opening to the sea. It is called the *Hole of Montgomeri;* and the history of it is as follows: In the year 1559, Henry II. king of France was unfortunately killed at a tournament by the count de Montgomeri *. He was a Huguenot; and having escaped the massacre of Paris, made head against the royal forces in Normandy, supported by Queen Elizabeth with arms and money. Being driven from his fortresses in these parts, he retired to a rock called the *Tombelaine*. This is another similar to Mount Michael; only three quarters of a league from it, and of nearly equal dimensions. At that time there was a castle upon it, which has since been demolished, and of which scarce any vestiges now remain. From this fortress, accessible only at low-water, he continually made excursions, and annoyed the enemy, who never dared to attack him. He coined money, laid all the adjacent country under contribution, and rendered himself universally dreaded. Desirous, however, to surprise Mount Michael, he found means to engage one of the monks resident in the abbey; who promised to give him the signal for his enterprise by displaying a handkerchief. The monk having made the signal, betrayed him, and armed all his associates, who waited Montgomeri's arrival. The chieftan came, attended by 50 chosen soldiers, all desperate, and capable of any attempt. They crossed the sand; and having placed their scaling-ladders, mounted one by one. As they came to the top, they were despatched, each in turn, without noise. Montgomeri, who followed last, discovered the perfidy, and escaped with only two of his men, with whom he regained the Tombelaine. They preserve with great care the ladders and grappling irons used on this occasion. The count was at last besieged and taken prisoner, by the mareschal de Matignon, in 1574, at Domfront, in Normandy; and Catharine de Medicis, who hated him for having been, though innocently, the cause of her husband's death, caused him to be immediately executed.

* See *France*, N° 140.

The church of Mount Michael is a great curiosity. It stands on nine pillars of most enormous dimensions, built on the solid rock. Each of them appears to be about 25 feet in circumference: besides these, there are two others much inferior in size, on which the centre of the church rests, and over which is the tower. The following is the legendary account of the origin of this church: In the reign of Childibert II. there was a bishop of Avranches named *St Aubert*. To this holy man the archangel Michael was pleased to appear one night, and ordered him to go to this rock to build a church. St Aubert treated this as a dream; upon which the angel appeared a second time; and being still disobeyed, he returned a third time, when, by way of imprinting his command upon the saint's memory, he made a hole in his skull, by touching it with his thumb. The skull is still preserved in the treasury of the church. It is enclosed in a little shrine of gold, and a crystal, which opens over the orifice, admits the gratification of curiosity by the minutest examination of it. The hole is of a size and shape proportionable to the thumb said to have produced it; but it is impossible to determine whether it has been really made by a knife or any other way. It is not to be supposed that the saint would forget such a sensible mark of the angel's displeasure; he therefore immediately repaired to the rock, and constructed a small church, as he had been commanded. Here, however, true history supplies the place of fable; and informs us, that it was in 966 when Richard the second duke of Normandy began to build the abbey. It was completed about the year 1070, under William the Conqueror, though many other additions were made by succeeding abbots.

In the treasury of the church are innumerable other relics: among which some few have a real and intrinsic value. There is a fine head of Charles VI. of France, cut in a crystal, and the representation of a cockle-shell in gold, weighing many pounds, given by Richard II. duke of Normandy, when he founded the abbey. There is an arm said to belong to *St Richard* king of England; but who this saint was it must be very difficult to determine. Such is the history of the prison, abbey, and church of Mount Michael previous to the revolution; they have probably undergone some changes since that period.

Michael, St Michael's.

St MICHAEL'S, a borough town of Cornwall, between St Columb and Truro, 247 miles from London. Though one of the oldest boroughs in the county by prescription, and of great note in the Saxon times, it is a mean hamlet in the parishes of Newland and St Enidore; yet it is governed by a portreeve, chosen yearly by a jury of the chief inhabitants, out of the six chief tenants, called deputy lords of the manor, because they hold lands in the borough. Here is

St Michael's, Michaelis. is no market, but two fairs. A court-leet is held here twice a-year. This place was formerly called Modiſhole, and afterwards Michael. Its liſt of members begins in the 6th of Edward VI.

St MICHAEL'S Mount, in the county of Cornwall, in the corner of Mount's Bay, is a very high rock, only divided by the tide from the main land, ſo that it is land and iſland twice a-day. The town here was burnt by the French in the reign of King Henry VIII. At the bottom of this mount, in digging for tin, there have been found ſpear heads, battle axes, and ſwords, of braſs, all wrapt up in linen. The county is contracted here into a ſort of iſthmus, ſo that it is ſcarcely four miles between the Channel and the Severn ſea.—Large trees have been driven in by the ſea between this mount and Penzance.

MICHAELIS, JOHN DAVID, a celebrated biblical critic, and author of many eſteemed works, was the eldeſt ſon of Dr Chriſtian Benedict Michaelis, profeſſor in the univerſity of Halle in Lower Saxony, and was born at that place, Feb. 27. 1717. His father devoted him at an early age to an academical life; and with that view he received the firſt part of his education in a celebrated Pruſſian ſeminary, called the *Orphan houſe*, at Glanche, in the neighbourhood of his native place. He commenced his academical career at Halle in 1733, and took his maſter's degree in the faculty of philoſophy in 1739. In 1741 he made an excurſion to this country, where his ſuperior knowledge of the oriental languages, which was conſiderably increaſed by his indefatigable reſearches in the Bodleian library at Oxford, introduced him to the acquaintance, and gained him the eſteem, of our firſt literary characters; with ſeveral of whom, and particularly Biſhop Lowth, he was in correſpondence for many years. On his return to Halle, after an abſence of fifteen months, he began to read lectures on the hiſtorical books of the Old Teſtament, which he continued after his removal to Gottingen in 1745. In 1746 he was appointed profeſſor extraordinary, and ſoon after profeſſor of philoſophy, in that univerſity. The next year he obtained a place of ſecretary to the Royal Society there, of which he was director in 1761, and was ſoon afterwards made aulic counſellor by the court of Hanover. In 1764 his diſtinguiſhed talents, but chiefly a publication relative to a journey to Arabia, which was undertaken by ſeveral literary men, at the expence of the king of Denmark, in conſequence of his application by means of Count Bernſdorff, procured him the honour of being choſen a correſpondent, and afterwards foreign member of the Academy of Inſcriptions at Paris, of whom the inſtitution admitted only eight; and in the ſame year he became a member of the ſociety of Haerlem. In 1775, Count Hopkin, who eighteen years before had prohibited the uſe of his writings at Upſal, when he was chancellor of that univerſity, prevailed upon the king of Sweden to confer on him the order of the Polar Star, as a national compenſation. In 1786 he was raiſed to the diſtinguiſhed rank of privy counſellor of juſtice by the court of Hanover; and in 1788 received his laſt literary honour, by being unanimouſly elected a fellow of the Royal Society of London.—His great critical knowledge of the Hebrew language, which he diſplayed in a new tranſlation of the Bible, and in other works, raiſed him to a degree of eminence almoſt unknown before in Germany; and his indefatigable labours were only equalled by his deſire of communicating the knowledge he acquired to the numerous ſtudents of all countries who frequented his admirable lectures, which he continued to deliver on various parts of the ſacred writings in half-yearly courſes, and on the Hebrew, Arabic, and Syriac languages, to the laſt year of his life. He was profeſſor in the univerſity of Gottingen 45 years, and, during that long period, he filled the chair with dignity, credit, and uſefulneſs. He died October 22. 1791, aged 74. He is ſaid to have left behind him ſeveral valuable MSS. Of the works that were publiſhed during his life-time, and which are very numerous, a catalogue, in the order of their publication, is given in the *Gentleman's Magazine* for March 1792.

Michaelis ‖ Mickle.

MICHAELMAS, or *Feaſt of St MICHAEL and all Angels*, a feſtival of the Chriſtian church, obſerved on the 29th of September. See MICHAEL.

MICKLE, WILLIAM JULIUS, the celebrated tranſlator of the Luſiad, was the ſon of the reverend Alexander Mickle a Scotiſh clergyman, who had formerly been a diſſenting miniſter in London, an aſſiſtant to the reverend Dr Watts, and one of the tranſlators of Bayle's Dictionary. This gentleman having reſided a few years in London, was preſented to the church of Langholm in Scotland, where he married; and our author was one of the younger ſons. He was born about the year 1735, and was educated by his father. In his early years his paſſion for poetry frequently diſcovered itſelf; though till the age of 13 he did not ſhow any particular attachment to books. At that time having accidentally met with Spencer's Faery Queen, he became enamoured of his manner of writing, and inſtantly began to imitate him. After the death of his father, he came to Edinburgh to reſide with an uncle who was a brewer there, and who admitted him into a ſhare of his buſineſs; not being qualified to ſucceed in this line, he went to London about the time of the concluſion of the war which began in 1755, with a view to procure a commiſſion in the marine ſervice. Here he was diſappointed; but introduced himſelf to the firſt Lord Lyttelton, to whom he ſent one of his poems. From his Lordſhip, however, he received no other favour than being admitted to ſeveral interviews, and encouraged to perſevere in his poetical plans.

So cloſely did our author cultivate the ſtudy of the muſes, that before he was 18 years of age he had written two tragedies and half an epic poem; but all theſe were committed to the flames. The firſt of his poems which appeared in print was publiſhed in one of the Edinburgh magazines, and entitled, "On paſſing through the Parliament Cloſe of Edinburgh at Midnight." This was afterwards inſerted in A Collection of Original Poems by a Scotch gentleman, vol. ii. p. 137.

From the time of Mr Mickle's arrival in London till the year 1765, it is not known how he employed his time, though it is probable that he was employed in ſome branch of the printing buſineſs; and in 1765 he engaged himſelf as corrector to the Clarendon preſs. This year he publiſhed the Poem which firſt brought him into notice, entitled, "Pollio, an Elegiac Ode, written in the Wood near R—— (Roſlin) Caſtle," 4to.

Mickle.

4to. This was an elegy written on the death of his brother, which, previous to its publication, had been ſhown to Lord Lyttelton, and received ſome corrections from him. The latter, in an epiſtle to the author, ſpoke of it as equal to any thing of the kind in our language. In 1767 he publiſhed a poem called "The Concubine, in two cantos, after the manner of Spencer," 4to; and in 1769 he publiſhed, "A Letter to Mr Harwood, wherein ſome of his evaſive gloſſes, falſe tranſlations, and blundering criticiſms, in ſupport of the Arian Hereſy, contained in his literal tranſlation of the New Teſtament, are pointed out and confuted," 8vo: and next year he publiſhed "Mary Queen of Scots, an Elegy;" "Hengiſt and Mary, a ballad;" and "Knowledge, an Ode;" in Pearch's Collection of Poems. In 1770 he publiſhed "Voltaire in the Shades, or Dialogues on the Deiſtical Controverſy," 8vo. The Elegy on Mary had been ſubmitted to the judgment of Lord Lyttelton, who declined to criticiſe it, not for its deficiency in poetical merit, but from thinking differently from the author concerning that unfortunate princeſs.

About this time Mr Mickle was a frequent writer in the Whitehall Evening Poſt; but a more important work now engaged his attention. When no more than 17 years of age he had read Caſtara's tranſlation of the Luſiad of Camoens into French, and then projected the deſign of giving an Engliſh tranſlation of it. From this, however, he was prevented by various avocations till the year 1771, when he publiſhed the firſt book as a ſpecimen: and having prepared himſelf by acquiring ſome knowledge of the Portugueſe language, he determined to apply himſelf entirely to this work. With this view he quitted his reſidence at Oxford, and went to a farm houſe at Foreſt-hill, where he purſued his deſign with unremitting aſſiduity till the year 1775, when the work was entirely finiſhed.

During the time that Mr Mickle was engaged in this work, he ſubſiſted entirely by his employment as corrector of the preſs; and on his quitting that employment he had only the ſubſcriptions he received for his tranſlation to ſupport him. Notwithſtanding theſe difficulties, he adhered ſteadily to the plan he had laid down, and completed it in about five years.

When his work was finiſhed, Mr Mickle applied to a perſon of great rank, with whom his family had been connected, for permiſſion to dedicate it to him. Permiſſion was granted, and his patron honoured him with a very polite letter; but after receiving a copy, for which an extraordinary price was paid for the binding, he did not think proper to take any notice of the author. At laſt a gentleman of high rank in the political world, a firm friend to the author, and who afterwards took him under his protection, waited on the patron, and heard him declare that he had not read the work, but that it had been repreſented not to have the merit it was at firſt ſaid to poſſeſs. The applauſe with which the work was received, however, ſoon baniſhed from the author's mind thoſe diſagreeable ſenſations which had been occaſioned by the contemptuous neglect of his patron, as well as ſome ſevere criticiſms which had been circulated concerning it. A ſecond edition was prepared in 1778, with a plate prefixed to it, executed by the celebrated artiſt Mortimer; on whom Mr Mickle wrote an epitaph in 1779. This year alſo he publiſhed a pamphlet, entitled, "A Candid Examination of the Reaſons for depriving the Eaſt India Company of its Charter, contained in The Hiſtory and Management of the Eaſt India Company from its Commencement to the Preſent Time; together with ſome Strictures on the Self-Contradictions and Hiſtorical Errors of Dr Adam Smith, in his Reaſons for the Abolition of the ſaid Company," 4to. About this time ſome of his friends thought of recommending him to the king as deſerving of a penſion; but this ſcheme was never put in execution. Dr Lowth, biſhop of London, would have put him into orders, and provided for him in the church; but this was not agreeable to our author's diſpoſition. While he was meditating a publication of all his poems, in which he would moſt probably have found his account, he was appointed ſecretary to Commodore Johnſtone, who had lately obtained the command of the Romney man of war. In November 1779 he arrived at Liſbon, and was named by his patron joint agent for the prizes which were taken. In this capital and its neighbourhood he reſided more than ſix months, being every where received with every mark of politeneſs and attention; and during this period he compoſed his poem called "Almada Hill," which in 1781 was publiſhed in quarto. He collected alſo many particulars concerning the manners of the Portugueſe, which he intended alſo to have publiſhed. During his ſtay at Liſbon the Royal Academy was opened; and Mr Mickle, who was preſent at the ceremony of its commencement, had the honour to be admitted a member under the preſidency of Don John of Braganza, duke of Lafoens. His preſence being thought neceſſary in England to attend to the proceedings of the courts of law reſpecting the condemnation of ſome of the prizes, he did not accompany the Commodore in his laſt expedition, nor did he go any more to ſea. In 1782 he publiſhed "The Prophecy of Queen Emma, an ancient Ballad lately diſcovered, written by Johannes Turgottus, prior of Durham, in the reign of William Rufus; to which is added by the Editor, an Account of the Diſcovery, and Hints towards a Vindication of the Authenticity, of the Poems of Oſſian and Rowley," 8vo.

In June this year Mr Mickle married Miſs Tomkins, daughter of the perſon with whom he reſided at Foreſt-hill, while engaged in tranſlating the Luſiad. Having received ſome fortune with this lady, as well as made ſome money himſelf when in the ſervice of Commodore Johnſtone, he now enjoyed a comfortable independence. He afterwards fixed his reſidence at Wheatley in Oxfordſhire, and devoted his time to the reviſion of his poetical works, which he propoſed to publiſh by ſubſcription. During the laſt ſeven years of his life he was employed in writing for the European Magazine. The Fragments of Leo, and ſome of the moſt approved reviews of books, in that periodical work, were of his production. He died after a ſhort illneſs, on the 25th of October 1788, at Wheatley, leaving one ſon behind him. His poetry poſſeſſes much beauty, variety, harmony of numbers, and vigour of imagination: his

Mickle || Micrometer.

his life was without reproach; his foibles were few and inoffenſive; his virtues many; and his genius very conſiderable.

MICROCOSM, a Geek term ſignifying the *little world;* uſed by ſome for *man*, as being ſuppoſed an epitome of the univerſe or great world.

MICROGRAPHY, the deſcription of objects viewed with the aſſiſtance of a microſcope. See *MICROSCOPIC objects*.

MICROMETER, an aſtronomical inſtrument, by which ſmall angles, or the apparent magnitudes of objects viewed through teleſcopes or microſcopes are meaſured with great exactneſs.

Micrometer firſt invented by Gaſcoigne.

1. The firſt TELESCOPIC micrometers were only mechanical contrivances for meaſuring the image of an object in the focus of the object-glaſs. Before theſe contrivances were thought of, aſtronomers were accuſtomed to meaſure the field of view in each of their teleſcopes, by obſerving how much of the moon they could ſee through it, the ſemidiameter being reckoned at 15 or 16 minutes; and other diſtances were eſtimated by the eye, comparing them with the field of view. Mr Gaſcoigne, an Engliſh gentleman, however, fell upon a much more accurate method before the year 1641, and had a Treatiſe on Optics prepared for the preſs; but he was killed during the civil wars in the ſervice of Charles I. and his manuſcript was never found. His inſtrument, however, fell into the hands of Mr R. Townly *, who ſays, that by the help of it he could mark above 40,000 diviſions in a foot.

* *Phil. Tranſ.* N° 25.

2. Mr Gaſcoigne's inſtrument being ſhown to Dr Hooke, he gave a drawing and deſcription of it, and propoſed ſeveral improvements †. Mr Gaſcoigne divided the image of an object in the focus of the object-glaſs, by the approach of two pieces of metal ground to a very fine edge, in the place of which Dr Hooke would ſubſtitute two fine hairs ſtretched parallel to one another.

† See *Phil. Tranſ. Abr.* vol. i. p. 217. *Hooke's Poſthumous Works*, p. 497, 498; and *Phil. Tranſ.* vol. xlviii. p. 190.

Huygens's micrometer.

3. Mr Huygens meaſured the apparent diameters of the planets, by firſt determining the quantity of the field of view in his teleſcope; which, he ſays, is beſt done by obſerving the time that a ſtar takes up in paſſing over it, and then preparing two or three long and ſlender braſs plates, of various breadths, the ſides of which are very ſtraight, and converging to a ſmall angle. In uſing theſe pieces of braſs, he made them ſlide in two ſlits, made in the ſides of the tube, oppoſite to the place of the image, and obſerved in what place it juſt covered the diameter of any planet, or any ſmall diſtance that he wanted to meaſure ‡. It was obſerved, however, by Sir Iſaac Newton, that the diameters of planets, meaſured in this manner, will be larger than they ſhould be, as all lucid objects appear to be when they are viewed upon dark ones.

‡ *Syſtema Saturnium*, p. 82.

Marquis of Malvaſia's micrometer.

4. In the Ephemerides of the Marquis of Malvaſia, publiſhed in 1662, it appears that he had a method of meaſuring ſmall diſtances between fixed ſtars and the diameters of the planets, and alſo of taking accurate draughts of the ſpots of the moon by a net of ſilver wire, fixed in the focus of the eye-glaſs. He likewiſe contrived to make one of two ſtars paſs along the threads of this net, by turning it, or the teleſcope, as much as was neceſſary for that purpoſe; and he counted, by a pendulum-clock, beating ſeconds, the time that elapſed in its paſſage from one wire to another, which gave him the number of minutes and ſeconds of a degree contained between the intervals of the wires of his net, with reſpect to the focal length of his teleſcope.

Micrometer.

Auzout's micrometer.

5. In 1666, Meſſrs Auzout and Picard publiſhed a deſcription of a micrometer, which was nearly the ſame with that of the Marquis of Malvaſia, excepting the method of dividing it, which they performed with more exactneſs by a ſcrew. In ſome caſes they uſed threads of ſilk, as being finer than ſilver wires. Dechales alſo recommends a micrometer conſiſting of fine wires, or ſilken threads, the diſtances of which were exactly known, diſpoſed in the form of a net, as peculiarly convenient for taking a map of the moon.

De la Hire's micrometer.

6. M. de la Hire ſays, that there is no method more ſimple or commodious for obſerving the digits of an eclipſe than a net in the focus of the teleſcope. Theſe, he ſays, were generally made of ſilken threads; and that for this particular purpoſe ſix concentric circles had alſo been made uſe of, drawn upon oiled paper; but he adviſes to draw the circles on very thin pieces of glaſs with the point of a diamond. He alſo gives ſeveral particular directions to aſſiſt perſons in the uſe of them.

Common micrometer. Plate CCCXXXV. Fig. 1.

7. *Conſtruction of Different Micrometers*. The firſt we ſhall deſcribe is the common micrometer. Let ABCD be a ſection of the teleſcope at the principal focus of the object-glaſs, or where the wires are ſituated, which are placed in a ſhort tube containing the eye-glaſs, and may be turned into any poſition by turning that tube; mn is a fine wire extended over its centre; vw, xy, are two parallel wires well defined, and perpendicular to mn; vw is fixed, and xy moves parallel to it by means of a ſcrew, which carries two indexes over a graduated plate, to ſhow the number of revolutions and parts of a revolution which it makes. Now to meaſure any angle, we muſt firſt aſcertain the number of revolutions and parts of a revolution correſponding to ſome known angle, which may be thus done: 1ſt, Bring the inner edges of the wires exactly to coincide, and ſet each index to 0; turn the ſcrew, and ſeparate the wires to any diſtance; and obſerve the time a ſtar m is in paſſing along the wire mn from one vertical wire to the other: for that time, turned into minutes and ſeconds of a degree, will be the angle anſwering to the number of revolutions, or the angle correſponding to the diſtance. Thus, if d=coſ. of the ſtar's declination, we have $15'\,dm$, the angle correſponding to this diſtance; and hence, by proportion, we find the angle anſwering to any other. 2*dly*, Set up an object of a known diameter, or two objects at a given diſtance, and turn the ſcrew till the vertical wires become tangents to the object, or till their opening juſt takes in the diſtance of the two objects upon the wire mn; then from the diameter, or diſtance of the two objects from each other, and their diſtance from the glaſs, calculate the angle, and obſerve the number of revolutions and parts correſponding. 3*dly*, Take the diameter of the ſun on any day, by making the wires tangents to the oppoſite limbs, and find, from the nautical almanac, his diameter on that day. Here it will be beſt to take the upper and lower limbs of the ſun when on the meridian, as he has then no motion perpendicular to the horizon. If the edges do not coincide when the indexes ſtand at 0, we muſt allow for the error. Inſtead of making a proportion, it is better to have a table calculated to ſhow the angle correſponding

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Micrometer.

ing to every revolution and parts of a revolution. But the obſerver muſt remember, that when the micrometer is fixed to teleſcopes of different focal lengths, a new table muſt be made. The whole ſyſtem of wires is turned about in its own plane, by turning the eye-tube round with the hand, and by that means the wire *m n* can be thrown into any poſition, and conſequently angles in any poſition may be meaſured. Dr Bradley added a ſmall motion by a rack and pinion to ſet the wires more accurately in any poſition.

8. But the micrometer, as now contrived, is of uſe, not only to find the angular diſtance of bodies in the field of view at the ſame time, but alſo of thoſe which, when the teleſcope is fixed, paſs through the field of view ſucceſſively; by which means we can find the difference of their right aſcenſions and declinations. Let A *a*, B *b*, C *c*, be three parallel and equidiſtant wires, the middle one biſecting the field of view; HOR a fixed wire perpendicular to them paſſing through the centre of the field; and F *f*, G *g*, two wires parallel to it, each moveable by a micrometer ſcrew, as before, ſo that they can be brought up to HOR, or a little beyond. Then to find the angular diſtance of two objects, bring them very near to B *b*, and in a line parallel to it, by turning about the wires, and bring one upon HOR, and by the micrometer ſcrew make F *f* or G *g* paſs through the other; then turn the ſcrew till that wire coincides with HOR, and the arc which the index has paſſed over ſhows their angular diſtance. If the objects be further remote than you can carry the diſtance of one of the wires F *f*, G *g* from HOR, then bring one object to F *f* and the other to G *g*; and turn each micrometer ſcrew till they meet, and the ſum of the arcs paſſed over by each index gives their angular diſtance. If the objects be two ſtars, and one of them be made to run along HOR, or either of the moveable wires as occaſion may require, the motion of the other will be parallel to theſe wires, and their difference of declinations may be obſerved with great exactneſs; but in taking any other diſtances, the motion of the ſtars being oblique to them, it is not quite ſo eaſy to get them parallel to B *b*; becauſe if one ſtar be brought near, and the eye be applied to the other to adjuſt the wires to it, the former ſtar will have gotten a little away from the wire. Dr Bradley, in his account of the uſe of this micrometer, publiſhed by Dr Maſkelyne in the Philoſophical Tranſactions for 1772, thinks the beſt way is to move the eye backwards and forwards as quick as poſſible; but it ſeems to be beſt to fix the eye at ſome point between, by which means it takes in both at once ſufficiently well defined to compare them with B *b*. In finding the difference of declinations, if both bodies do not come into the field of view at the ſame time, make one run along the wire HOR, as before, and fix the teleſcope and wait till the other comes in, and then adjuſt one of the moveable wires to it, and bring it up to HOR, and the index gives the difference of their declinations. The difference of time between the paſſage of the ſtar at either of the croſs moveable wires, and the tranſit of the other ſtar over the croſs fixed wire (which repreſents a meridian), turned into degrees and minutes, will give the difference of right aſcenſion. The ſtar has been here ſuppoſed to be biſected by the wire; but if the wire be a tangent to it, allowance muſt be made for the breadth of the wire, provided the adjuſtment be made for the coincidence of the wires. In obſerving the diameters of the ſun, moon, or planets, it may perhaps be moſt convenient to make uſe of the outer edges of the wires, becauſe they appear moſt diſtinct when quite within the limb: but if there ſhould be any ſenſible inflection of the rays of light in paſſing by the wires, it will be beſt avoided by uſing the inner edge of one wire and the outward edge of the other; for by that means the inflection at both limbs will be the ſame way, and therefore there will be no alteration of the relative poſition of the rays paſſing by each wire. And it will be convenient in the micrometer to note at what diviſion the index ſtands when the moveable wire coincides with HOR; for then you need not bring the wire when a ſtar is upon it up to HOR, only reckon from the diviſion at which the index then ſtands to the above diviſion.

Fig. 2.

The divided object-glaſs micrometer hinted at by Mr Savery.

9. With a micrometer thus adapted to a teleſcope, Mr S. Savery of Exeter propoſed a new way of meaſuring the difference between the greateſt and leaſt apparent diameters of the ſun, although the whole of the ſun was not viſible in the field of view at once. The method we ſhall briefly deſcribe. Place two object-glaſſes inſtead of one, ſo as to form two images whoſe limbs ſhall be at a ſmall diſtance from each other; or inſtead of two perfect lenſes, he propoſed to cut a ſingle lens into four parts of equal breadths by parallel lines, and to place the two ſegments with their ſtraight ſides againſt each other, or the two middle fruſtums with their oppoſite edges together; in either caſe, the two parts which before had a common centre and axis, have now their centres and axes ſeparated, and conſequently two images will be formed as before by two perfect lenſes. Another method in reflectors was to cut the large concave reflector through the centre, and by a contrivance to turn up the outer edges whilſt the ſtraight ones remained fixed; by which means the axis of the two parts became inclined, and formed two images. Two images being formed in this manner, he propoſed to meaſure the diſtance between the limbs when the diameters of the ſun were the greateſt and leaſt, the difference of which would be the difference of the diameters required. Thus far we are indebted to Mr Savery for the idea of forming two images; and the admirable uſes to which it was afterwards applied, we ſhall next proceed to deſcribe.

Improved by Mr John Dollond.

10. The divided object-glaſs micrometer, as now made, was contrived by the late Mr John Dollond, and by him adapted to the object-end of a reflecting teleſcope, and has been ſince by the preſent Mr P. Dollond his ſon applied with equal advantage to the end of an achromatic teleſcope. The principle is this: The object-glaſs is divided into two ſegments in a line drawn through the centre; each ſegment is fixed in a ſeparate frame of braſs, which is moveable, ſo that the centres of the two ſegments may be brought together by a handle for that purpoſe, and thereby form one image of an object; but when ſeparated they will form two images, lying in a line paſſing through the centre of each ſegment; and conſequently the motion of each image will be parallel to that line, which can be thrown into any poſition by the contrivance of another handle to turn

Micrometer.

Fig. 3.

turn the glaſs about in its own plane. The braſs-work carries a vernier to meaſure the diſtance of the centres of the two ſegments. Now let E and H be the centres of the two ſegments, F their principal focus, and PQ two diſtant objects in FE, FH, produced, or the oppoſite limbs of the ſame object PBQD; then the images of P and Q, formed by each ſegment, or the images of the oppoſite limbs of the object PBQD, coincide at F: hence two images $m z$ F, $n x$ F of that object are formed, whoſe limbs are in contact; therefore the angular diſtance of the points P and Q is the ſame as the angle which the diſtance EH ſubtends at F, which, as the angles ſuppoſed to be meaſured are very ſmall, will vary as EH extremely nearly; and conſequently if the angle correſponding to one interval of the centres of the ſegments be known, the angle correſponding to any other will be found by proportion. Now to find the interval for ſome one angle, take the horizontal diameter of the ſun on any day, by ſeparating the images till the contrary limbs coincide, and read off by the vernier the interval of their centres, and look into the nautical almanac for the diameter of the ſun on that day, and you have the correſponding angle. Or if greater exactneſs be required than from taking the angle in proportion to the diſtances of their centres, we may proceed thus:—Draw FG perpendicular to EH, which therefore biſects it; then one half EH, or EG, is the tangent of half the angle EFH; hence, half the diſtance of their centres is to the tangent of half the angle correſponding to that diſtance as half any other diſtance of the centres is to the tangent of half the correſponding angle (A).

11. From this the method of meaſuring ſmall angles is manifeſt; for we conſider P, Q either as two objects whoſe images are brought together by ſeparating the two ſegments, or as the oppoſite limbs of one object PBQA, whoſe images, formed by the two ſegments E, H, touch at F; in the former caſe, EH gives the angular diſtance of the two objects; and in the latter, it gives the angle under which the diameter of the object appears. In order to find the angular diſtance of two objects, therefore, ſeparate the ſegments till the two images which approach each other coincide; and to find the diameter of an object, ſeparate the ſegments till the contrary limbs of the images touch each other, and read off the diſtance of the centres of the ſegment from the vernier (B), and find the angle as directed in the laſt article. Hence appears one great ſuperiority in this above the wire micrometer; as, with the one any diameter of an object may be meaſured with the ſame eaſe and accuracy; whereas with the other we cannot with accuracy meaſure any diameter, except that which is at right angles to the direction of motion.

12. But, beſides theſe two uſes to which the inſtrument ſeems ſo well adapted, Dr Maſkelyne * has ſhown, how it may be applied to find the difference of right aſcenſions and declinations. For this purpoſe, two wires at right angles to each other, biſecting the field of view, muſt be placed in the principal focus of the eye-glaſs, and moveable about in their own plane.—Let HCR c be the field of view, HR and C c the two wires; turn the wires till the weſternmoſt ſtar (which is the beſt, having further to move) run along ROH; Fig. 4. then ſeparate the two ſegments, and turn about the micrometer till the two images of the ſame ſtar lie in the wire C c; and then, partly by ſeparating the ſegments, and partly by raiſing or depreſſing the teleſcope, bring the two innermoſt images of the two ſtars to appear and run along ROH, as a, b, and the vernier will give the difference of their declinations; becauſe, as the two images of one of the ſtars coincided with C c, the image of each ſtar was brought perpendicularly upon HR, or to HR in their proper meridian. And, for the ſame reaſon, the difference of their times of paſſing the wire CO c will give their difference of right aſcenſions. Theſe operations will be facilitated, if the teleſcope be mounted on a polar axis. If two other wires KL, MN, parallel to C c, be placed near H and R, the obſervation may be made on two ſtars whoſe difference of meridians is nearly equal to HR the diameter of the field of view, by bringing the two images of one of the ſtars to coincide with one of theſe wires. If two ſtars be obſerved whoſe difference of declinations is well ſettled, the ſcale of the micrometer will be known.

* Phil. Tranſ. 1771.

13. It has hitherto been ſuppoſed, that the images of the two ſtars can be both brought into the field of view at once upon the wire HOR: but if they cannot, ſet the micrometer to the difference of their declinations as nearly as you can, and make the image which comes firſt run along the wire HOR, by elevating or depreſſing the teleſcope; and when the other ſtar comes in, if it do not alſo run along HOR, alter the

(A) If the object is not diſtant let f be the principal focus; then Ff : FG :: FG : FK (FG being produced to meet a line joining the apparent places of the two objects P, Q,), ∴ dividendo, fG : FG :: GK : FK, and alternando, fG : GK :: FG : FK :: (by ſimilar triangles) EH : PQ, hence $\frac{EH}{fG} = \frac{PQ}{GK}$, therefore the angle ſubtended by EH at f = the angle ſubtended by PQ at G; and conſequently, as fG is conſtant, the angle meaſured at G is, in this caſe, alſo proportional to EH. The inſtrument is not adapted to meaſure the angular diſtance of bodies, one of which is near and the other at a diſtance, becauſe their images would not be formed together.

(B) To determine if there be any error in the adjuſtment of the micrometer ſcale, meaſure the diameter of any ſmall well-defined object, as Jupiter's equatoreal diameter, or the longeſt axis of Saturn's ring, both ways, that is, with 0 on the vernier to the right and left of 0 on the ſcale, and half the difference is the error required. This error muſt be added to or ſubtracted from all obſervations, according as the diameter meaſured with 0 on the vernier, when advanced on the ſcale, is leſs or greater than the diameter meaſured the other way. And it is alſo evident, that half the ſum of the diameters thus meaſured gives the true diameter of the object.

Micrometer. the micrometer till it does, and half the sum of the numbers shown by the micrometer at the two separate observations of the two stars on the wire HOR will be the difference of their declinations. That this should be true, it is manifestly necessary that the two segments should recede equally in opposite directions; and this is effected by Mr Dollond in his new improvement of the object-glass micrometer.

14. The difference of right ascensions and declinations of Venus or Mercury in the sun's disk and the sun's limb may be thus found. Turn the wires so that the north limb n of the sun's image AB, or the north limb of the image V of the planet, may run along the wire RH, which therefore will then be parallel to the equator, and consequently C c a secondary to it; then separate the segments, and turn about the micrometer till the two images V v of the planet pass C c at the same time, and then by separating the segments, bring the north limb of the northernmost image V of the planet to touch HR, at the time the northernmost limb n of the southernmost image AB of the sun touches it, and the micrometer shows the difference of declinations of the northernmost limbs of the planet and sun, for the reason formerly given (Art. 11.) we having brought the northernmost limbs of the two innermost images V and AB to HR, these two being manifestly interior to v and the northernmost limb N of the image PQ. In the same manner we take the difference of declinations of their southernmost limbs; and half the difference of the two measures (taking immediately one after another) is equal to the difference of the declinations of their centres, without any regard to the sun's or planet's diameters, or error of adjustment of the micrometer; for as it affects both equally, the difference is the same as if there were no error: and the difference of the times of the transits of the eastern or western limbs of the sun and planet over C c gives the difference of their right ascensions. Fig. 5.

15. Instead of the difference of right ascensions, the distance of the planet from the sun's limb, in lines parallel to the equator, may be more accurately observed thus: Separate the segments, and turn about the wires and micrometer, so as to make both images V, v, run along HR, or so that the two intersections I, T of the sun's image may pass C c at the same time. Then bring the planet's and sun's limbs into contact, as at V, and do the same for the other limb of the sun, and half the difference gives the distance of the centre of the planet from the middle of the chord on the sun's disk parallel to the equator, or the difference of the right ascensions of their centres, allowing for the motion of the planet in the interval of the observations, without any regard to the error of adjustment, for the same reason as before. For if you take any point in the chord of a circle, half the difference of the two segments is manifestly the distance of the point from the middle of the chord; and as the planet runs along HR, the chord is parallel to the equator. Fig. 6.

In like manner, the distances of their limbs may be measured in lines perpendicular to the equator, by bringing the micrometer into the position already described, (Art. 13.), and instead of bringing V to HR, separate the segments till the northernmost limbs coincide as at V; and in the same manner make their southernmost images to coincide, and half the difference of the two measures, allowing for the planet's motion, gives the difference of the declinations of their centres. Fig. 7.

Hence the true place of a planet in the sun's disc may at any time of its transit be found; and consequently the nearest approach to the centre and the time of ecliptic conjunction may be deduced, although the middle should not be observed.

Disadvantage of the object-glass micrometer.

16. But however valuable the object-glass micrometer undoubtedly is, difficulties sometimes have been found in its use, owing to the alteration of the focus of the eye, which will cause it to give different measures of the same angle at different times. For instance, in measuring the sun's diameter, the axis of the pencil coming through the two segments from the contrary limbs of the sun, as PF, QF, fig. 3. crossing one another in the focus F under an angle equal to the sun's semidiameter, the union of the limbs cannot appear perfect, unless the eye be disposed to see objects distinctly at the place where the images are formed; for if the eye be disposed to see objects nearer to or further off than that place, in the latter case the limbs will appear separated, and in the former they will appear to lap over (c). This imperfection led Dr Maskelyne to inquire, whether some method might not be found of producing two distinct images of the sun, or any other object, by bringing the axis of each pencil to coincide, or very nearly so, before the formation of the images, by which means the limbs when brought together would not be liable to appear separated from any alteration of the eye; and this he found would be effected by the refraction of two prisms, placed either without or within the telescope; and on this principle, placing the prisms within, he constructed a new micrometer, and had one executed by Mr Dollond, which upon trial answered as he expected. The construction is as follows.

Dr Maskelyne's prismatic micrometer. Fig. 8, 9.

17. Let AB be the object-glass; $a\,b$ the image, suppose of the sun, which would have been formed in the principal focus Q; but let the prisms PR, SR be placed to intercept the rays, and let EF, WG, be two rays proceeding from the eastern and western limbs of the sun, converging, after refraction at the lens, to a and b; and suppose the refraction of the prisms to be such, that in fig. 8. the ray EFR, after refraction at R

(c) For if the eye can see distinctly an image at F, the pencils of rays, of which PF, QF are the two axes, diverging from F, are each brought to a focus on the retina at the same point; and therefore the two limbs appear to coincide: but if we increase the refractive power of the eye, then each pencil is brought to a focus, and they cross each other before the rays come to the retina, consequently the two limbs on the retina will lap over; and if we diminish the refractive power of the eye, then each pencil being brought to a focus beyond the retina, and not crossing till after they have passed it, the two limbs on the retina must be separated.

Micrometer.

R by the prism PR, may proceed in the direction RQ; and as all the rays which were proceeding to *a* suffer the same refraction at the prism, they will all be refracted to Q; and therefore, instead of an image *a b*, which would have been formed by the lens alone, an image Q *c* is formed by those rays which fall on the prism PR; and for the same reason, the rays falling on the prism SR will form an image Q *d*: and in fig. 9. the image of the point *b* is brought to Q, by the prism PR, and consequently an image Q *d* is formed by those rays which fall on PR: and for the same reason, an image Q *c* is formed by the rays falling on SR. Now in both cases, as the rays EFR, WGR, coming from the two opposite limbs of the sun, and forming the point of contact of the two limbs, proceed in the same direction RQ, they must thus accompany each other through the eye-glass and also through the eye, whatever refractive power it has, and therefore to every eye the images must appear to touch. Now the angle *a* R *b* is twice the refraction of the prism, and the angle *a* C *b* is the diameter of the sun; and as these angles are very small, and have the same subtense *a b*, we have the angle *a* R *b* : angle *a* C *b* :: CQ : RQ.—Now as CQ is constant, and also the angle *a* R *b* being twice the refraction of the prism, the angle *a* C *a* varies as RQ. Hence the extent of the scale for measuring angles becomes the focal length of the object-glass, and the angle measured is in proportion to the distance of the prisms from the principal focus of the object-glass; and the micrometer can measure all angles (very small ones excepted, for the reason given in Art. 19.) which do not exceed the sum of the refractions of the prisms; for the angle *a* C *b*, the diameter of the object to be measured, is always *less* than the angle *a* R *b*, the sum of the refractions of the prisms, except when the prisms touch the object-glass, and then they become *equal*. The scale can never be out of adjustment, as the point o, where the measurement begins, answers to the focus of the object-glass, which is a fixed point for all distant objects, and we have only to find the value of the scale answering to some known angle: for instance, bring the two limbs of the sun's images into contact, and measure the distance of the prisms from the focus, and look in the nautical almanac for the sun's diameter, and you get the value of the scale.

Fig. 8. 18. In fig. 8. the limb Q of the image Q *c*, is illuminated by the rays falling on the object-glass between A and F, and of the image Q *d* by those falling between B and G; but in fig. 9. the same limbs are illuminated by the rays falling between B and F, A and G respectively, and therefore will be more illuminated than in the other case; but the difference is not considerable in achromatic telescopes, on account of the great aperture of the object-glass compared with the distance FG.

It might be convenient to have two sets of prisms, one for measuring angles not exceeding 36′, and therefore fit for measuring the diameters of the sun and moon, and the lucid parts and distances of the cusps in their eclipses; and another for measuring angles not much greater than 1′, for the conveniency of measuring the diameters of the planets. For as Q *c* : QR :: sum of the refractions of the prisms : angle *a* C *b*, the apparent diameter of the object, it is evident that if you diminish the third term, you must increase the second in the same ratio, in order to measure the same angle; and thus by diminishing the refractive angle of the prisms, you throw them further from Q, and consequently avoid the inconvenience of bringing them near to Q, for the reason in the next paragraph; and at the same time you will increase the illumination in a small degree. The prisms must be achromatic, each composed of two prisms of flint and crown glass, placed with their refracting angles in contrary directions, otherwise the images will be coloured.

19. In the construction here described, the angle measured becomes evanescent when the prisms come to the principal focus of the object-glass, and therefore o on the scale then begins: but if the prisms be placed in the principal focus they can have no effect, because the pencil of rays at the junction of the prisms would then vanish, and therefore it is not practicable to bring the two images together to get o on the scale. Dr Maskelyne, therefore, thought of placing another pair of prisms within, to refract the rays *before* they came to the other prisms, by which means the two images would be formed into one before they came to the principal focus, and therefore o on the scale could be determined. But to avoid the error arising from the multiplication of mediums, he, instead of adding another pair of prisms, divided the object-glass through its centre, and sliding the segments a little it separated the images, and then by the prisms he could form one image very distinctly, and consequently could determine o on the scale; for by separating the two segments you form two images, and you will separate the two pencils so that you may move up the two prisms, and the two pencils will fall on each respectively, and the two images may be formed into one. In the instrument which Dr Maskelyne had made, o on the scale was chosen to be about $\frac{2}{7}$ of the focal length of the object-glass, and each prism refracted 27′. By this means all angles are measured down to o.

20. In the Philosophical Transactions for 1779, Mr Ramsden has described two new micrometers, which he contrived with a view of remedying the defects of the object-glass micrometer.

21. 1. One of these is a *catoptric* micrometer, which, besides the advantage it derives from the principle of reflection, of not being disturbed by the heterogeneity of light, avoids every defect of other micrometers, and can have no aberration, nor any defect arising from the imperfection of materials or of execution; as the extreme simplicity of its construction requires no additional mirrors or glasses to those required for the telescope; and the separation of the images being effected by the inclination of the two specula, and not depending on the focus of any lens or mirror, any alteration in the eye of an observer cannot affect the angle measured. It has peculiar to itself the advantages of an adjustment, to make the images coincide in a direction perpendicular to that of their motion; and also of measuring the diameter of a planet on both sides of the zero, which will appear no inconsiderable advantage to observers who know how much easier it is to ascertain the contact of the external edges of two images than their perfect coincidence. Ramsden's reflecting micrometer.

22. A represents the small speculum divided into two equal parts; one of which is fixed on the end of the arm B; the other end of the arm is fixed on a steel axis Fig. 10.

Micrometer.

axis X, which crosses the end of the telescope C. The other half of the mirror A is fixed on the arm D, which arm at the other end terminates in a socket y, that turns on the axis X; both arms are prevented from bending by the braces a a. G represents a double screw, having one part e cut into double the number of threads in an inch to that of the part g: the part e having 100 threads in one inch, and the part g 50 only. The screw e works in a nut F in the side of the telescope, while the part g turns in a nut H, which is attached to the arm B; the ends of the arms B and D, to which the mirrors are fixed, are separated from each other by the point of the double screw pressing against the stud h, fixed to the arm D, and turning in the nut H on the arm B. The two arms B and D are pressed against the direction of the double screw e g by a spiral spring within the part n, by which means all shake or play in the nut H, on which the measure depends, is entirely prevented.

From the difference of the threads on the screw at e and g, it is evident, that the progressive motion of the screw through the nut will be half the distance of the separation of the two halves of the mirror; and consequently the half mirrors will be moved equally in contrary directions from the axis of the telescope C.

23. The wheel V fixed on the end of the double screw had its circumference divided into 100 equal parts, and numbered at every fifth division with 5, 10, &c. to 100, and the index I shows the motion of the screw with the wheel round its axis, while the number of revolutions of the screw is shown by the divisions on the same index. The steel screw at R may be turned by the key S, and serves to incline the small mirror at right angles to the direction of its motion. By turning the finger head T, the eye-tube P is brought nearer or farther from the small mirror, to adjust the telescope to distinct vision; and the telescope itself hath a motion round its axis for the conveniency of measuring the diameter of a planet in any direction. The inclination of the diameter measured with the horizon is shown in degrees and minutes by a level and vernier on a graduated circle, at the breech of the telescope.

Fig. 11.

A correction to be applied to the angle.

24. Besides the table for reducing the revolutions and parts of the screw to minutes, seconds, &c. it will require a table for correcting a small error which arises from the eccentric motion of the half-mirrors. By this motion their centres of curvature will approach a little towards the large mirror: the equation for this purpose in small angles is insensible; but when angles to be measured exceed ten minutes, it should not be neglected. Or, the angle measured may be corrected by diminishing it in the proportion the versed sine of the angle measured, supposing the eccentricity radius, bears to the focal length of the small mirror.

25. Mr Ramsden preferred Cassegrain's construction of the reflecting telescope to either the Gregorian or Newtonian; because in the former, the errors of one speculum are corrected by those of the other. From a property of the reflecting telescope, not generally known, that the apertures of the two specula are to each other very nearly in the proportion of their focal lengths, it follows, that their aberrations will be in the same proportion; and these aberrations will be in the same direction, if the two specula are concave; or in contrary directions, if one speculum is concave and the other convex. In the Gregorian telescope, both specula being concave, the aberration at the second image will be the sum of the aberrations of the two mirrors; but in the Cassegrainian telescope one mirror being concave and the other convex, the aberration at the second image will be the difference between the two aberrations. By assuming such proportions for the *foci* of the specula as are generally used in the reflecting telescope, which is about as 1 to 4, the aberration in the Cassegrainian construction will be to that in the Gregorian as 3 to 5.

Mr Ramsden's eye-glass micrometer.

26. The other is a *dioptric* micrometer, or one suited to the principle of refraction. This micrometer is applied to the erect eye-tube of a refracting telescope, and is placed in the conjugate focus of the first eye-glass: in which position, the image being considerably magnified before it comes to the micrometer, any imperfection in its glass will be magnified only by the remaining eye-glasses, which in any telescope seldom exceeds five or six times. By this position also the size of the micrometer glass will not be the $\frac{1}{100}$ part of the area which would be required if it was placed in the object-glass; and, notwithstanding this great disproportion of size, which is of great moment to the practical optician, the same extent of scale is preserved, and the images are uniformly bright in every part of the field of the telescope.

Plate cccxxxvi.

27. Fig. 12. represents the glasses of a refracting telescope; x y, the principal pencil of rays from the object-glass O; t t and u u, the axis of two oblique pencils; a, the first eye-glass; m, its conjugate focus, or the place of the micrometer; b the second eye-glass; c the third; and d the fourth, or that which is nearest the eye. Let p be the diameter of the object-glass, e the diameter of a pencil at m, and f the diameter of the pencil at the eye; it is evident, that the axes of the pencils from every part of the image will cross each other at the point m; and e, the width of the micrometer-glass, is to p the diameter of the object-glass, as m a is to g o, which is the proportion of the magnifying power at the point m; and the error caused by an imperfection in the micrometer-glass placed at m will be to the error, had the micrometer been at O, as m is to p.

Fig. 13.

28. Fig. 13. represents the micrometer; A, a convex or concave lens bisected by a plane across its centre; one of these semi lenses is fixed in a frame B, and the other in the frame E; which two frames slide on a plate H, and are pressed against it by thin plates a a: the frames B and E are moved in contrary directions by turning the button D: L is a scale of equal parts on the frame B; it is numbered from each end towards the middle with 10, 20, &c. There are two verniers on the frame E, one at M and the other at N, for the convenience of measuring the diameter of a planet, &c. on both sides the zero. The first division on both these verniers coincides at the same time with the two zeros on the scale, L; and, if the frame is moved towards the right, the relative motion of the two frames is shown on the scale L by the vernier M; but if the frame B be moved towards the left, the relative motion is shown by the vernier N.—This micrometer has a motion round the axis of vision, for the convenience of measuring the diameter of a planet, &c. in any direction, by turning

Micrometer. ing an endless screw F; and the inclination of the diameter measured with the horizon is shown on the circle g by a vernier on the plate V. The telescope may be adjusted to distinct vision by a screw, which moves the whole eye-tube with the micrometer nearer to or farther from the object-glass, as telescopes are generally made; or the same effect may be produced without moving the micrometer, by sliding the part of the eye tube m on the part n, by help of a screw or pinion.

Disadvantages of the common micrometer.

29. Notwithstanding these improvements on micrometers, they are still liable to many sources of error. The imperfections of the wire micrometer, (which was still the most correct instrument for measuring small angles) when employed to determine the distance of close double stars, have been ably pointed out by Dr Herschel.

30. When two stars are taken between the parallel wires the diameters must be included. Dr Herschel * has in vain attempted to find lines sufficiently thin to extend them across the centres of the stars so that their thickness might be neglected. The threads of the silk-worm, with such lenses as he uses, are so much magnified that their diameter is more than that of many of the stars. Besides, if they were much smaller, the deflection of light would make the attempt to measure the distance of the centres this way fruitless; for he has always found the light of the stars to play upon those lines and separate their apparent diameters into two parts. Now since the spurious diameters of the stars thus included, are continually changing with the state of the air, and the length of time we look at them, we are, in some respect, left at an uncertainty; and our measures taken at different times, and with different degrees of attention, will vary on that account. Nor can we come at the true distance of the centres of any two stars, unless we know the semidiameters of the stars themselves; for different stars have different apparent diameters, which, with a power of 227, may differ from each other as far as two seconds (D).

* *Phil. Trans.* 1782.

31. The next imperfection arises from a deflection of light upon the wires when they approach very near to each other; for if this be owing to a power of repulsion lodged at the surface, it is easy to see that such powers must interfere with each other, and give the measures larger in proportion than they would have been if the repulsive power of one wire had not been opposed by a contrary power of the other wire.

32. Another disadvantage of these micrometers is an uncertainty of the real zero. The least alteration in the situation and quantity of light will affect the zero; and a change in the position of the wires will sometimes produce a difference. To remove this difficulty Dr Herschel always found his zero while the apparatus preserved the situation which it had when his observations were made; but this introduces an additional observation.

33. The next imperfection, is that every micrometer hitherto used requires either a screw, or a divided bar and pinion, to measure the distance of the wires or the two images. Those acquainted with works of this kind are sensible how difficult it is to have screws perfectly equal in every thread or revolution of each thread; or pinions and bars that shall be so evenly divided as to be depended upon in every leaf and tooth to the two or three thousandth part of an inch: and yet, on account of the small scale of those micrometers, these quantities are of the greatest consequence; an error of a single thousandth part inducing in most instruments a mistake of several seconds.

34. The greatest imperfection of all is, that the wires require to be illuminated; and when Dr Herschel had double stars to measure, one of which was very obscure, he was obliged to be content with less light than is necessary to make the wires distinct; and several stars on this account could not be measured at all, though not too close for the micrometer.

Dr Herschel, therefore, was led to direct his attention to the improvement of these instruments; and the result of his endeavours has been a very ingenious *lamp-micrometer*, which is not only free from the imperfections above specified, but also possesses the advantages of a large scale.

Dr Herschel's lamp micrometer. Fig. 14.

35. It is represented in fig. 14. where ABGCFE is a stand nine feet high, upon which a semicircular board $q\,h\,o\,g\,p$ is moveable upwards or downwards, and is held in its situation by a peg p put into any one of the holes of the upright piece AB. This board is a segment of a circle of fourteen inches radius, and is about three inches broader than a semicircle, to give room for the handles r D, e P, to work. The use of this board is to carry an arm L, thirty inches long, which is made to move upon a pivot at the centre of the circle, by means of a string, which passes in a groove upon the edge of the semicircle $p\,g\,o\,h\,q$; the string is fastened to a hook at o (not expressed in the figure, being at the back of the arm L), and passing along the groove from $o\,h$ to q is turned over a pulley at q, and goes down to a small barrel e, within the plane of the circular board, where a double-jointed handle e P commands its motion. By this contrivance, we see, the arm L may be lifted up to any altitude from the horizontal position to the perpendicular, or be suffered to descend by its own weight below the horizontal to the reverse perpendicular situation. The weight of the handle P is sufficient to keep the arm in any given position; but if the motion should be too easy, a friction spring applied to the barrel will moderate it at pleasure.

36. In front of the arm L a small slider, about three inches long, is moveable in a rabbet from the end L towards the centre backwards and forwards. A string is fastened to the left side of the little slider, and goes towards L, where it passes round a pulley at m, and returns under the arm from m, n, towards the centre, where it is led in a groove on the edge of the arm, which is of a circular form, upwards to a barrel (raised above the plane of the circular board) at r, to which the handle r D is fastened. A second string is fastened to the slider, at the right side, and goes towards the centre, where it passes over a pulley n; and the weight w, which is suspended by the end of this string, returns the slider towards the centre, when a contrary turn of the handle permits it to act.

37. By a and b are represented two small lamps, two inches high, $1\frac{1}{2}$ in breadth by $1\frac{1}{4}$ in depth. The sides, back, and top, are made so as to permit no light to be seen, and the front consists of a thin brass sliding door. The flame in the lamp a is placed three-tenths of an inch from

(D) These imperfections are remedied in the instrment described in p. 801.

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from the left side, three-tenths from the front, and half an inch from the bottom. In the lamp b it is placed at the same height and distance, measuring from the right side. The wick of the flame consists only of a single very thin lamp cotton-thread; for the smallest flame being sufficient, it is easier to keep it burning in so confined a place. In the top of each lamp must be a little slit lengthways, and a small opening in one side near the upper part, to permit the air to circulate to feed the flame. To prevent every reflection of light, the side opening of the lamp a should be to the right, and that of the lamp b to the left. In the sliding door of each lamp is made a small hole with the point of a very fine needle just opposite the place where the wicks are burning, so that when the sliders are shut down, and every thing dark, nothing shall be seen but two fine lucid points of the size of two stars of the third or fourth magnitude. The lamp a is placed so that its lucid point may be in the centre of the circular board where it is fixed. The lamp b is hung to the little slider which moves in the rabbet of the arm, so that its lucid point, in an horizontal position of the arm, may be on a level with the lucid point in the centre. The moveable lamp is suspended upon a piece of brass fastened to the slider by a pin exactly behind the flame, upon which it moves as a pivot. The lamp is balanced at the bottom by a leaden weight, so as to remain upright, when the arm is either lifted above or depressed below the horizontal position. The double-jointed handles r D, e P, consist of deal rods, 10 feet long, and the lowest of them may have divisions, marked upon it near the end P, expressing exactly the distance from the central lucid point in feet, inches, and tenths.

38. Hence we see, that a person at a distance of 10 feet may govern the two lucid points, so as to bring them into any required position south or north preceding or following from 0 to 90° by using the handle P, and also to any distance from six-tenths of an inch to five or six and twenty inches by means of the handle D. If any reflection or appearance of light should be left from the top or sides of the lamps, a temporary screen, consisting of a long piece of pasteboard, or a wire frame covered with black cloth, of the length of the whole arm, and of any required breadth, with a slit of half an inch broad in the middle, may be affixed to the arm by four bent wires projecting an inch or two before the lamps, situated so that the moveable lucid point may pass along the opening left for that purpose.

Fig. 15. Fig. 15. represents part of the arm L, half the real size; S the slider; m the pulley, over which the cord $x t y z$ is returned towards the centre; v the other cord going to the pulley n of fig. 14. R the brass piece moveable upon the pin c, to keep the lamp upright. At R is a wire rivetted to the brass piece, upon which Fig. 16. 17. is held the lamp by a nut and screw. Fig. 16. 17. represent the lamps a, l, with the sliding doors open, to show the situation of the wicks. W is the leaden weight with a hole d in it, through which the wire R of fig. 15. is to be passed when the lamp is to be fast- Fig. 18. ened to the slider S. Fig. 18 represents the lamp a with the sliding door shut; l the lucid point; and ik the openings at the top, and s at the sides, for the admission of air.

39. The motions of this micrometer are capable of great improvement by the application of wheels and pinions, and other mechanical resources; but as the principal object is only to be able to adjust the two lucid points to the required position and distance, and to keep them there for a few minutes, while the observer measures their distance, it will be unnecessary to say more upon the subject.

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Method of applying the lamp micrometer.

40. It is well known that we can with one eye look into a telescope, and see an object much magnified, while the other eye may see a scale upon which the magnified picture is thrown. In this manner Dr Herschel generally determined the power of his telescopes; and any one who has been accustomed to make such observations will seldom mistake so much as one in fifty in determining the power of an instrument, and that degree of exactness is fully sufficient for the purpose.

41. When Dr Herschel uses this instrument he puts it at ten feet distance from the left eye, in a line perpendicular to the tube of his Newtonian telescope, and raises the moveable board to such a height that the lucid point of the central lamp may be upon a level with the eye. The handles, lifted up, are passed through two loops fastened to the tube, just by the observer, so as to be ready for his use. The end of the tube is cut away, so as to leave the left eye entirely free to see the whole micrometer.

42. The telescope being directed to a double star, it is viewed with the right eye, and at the same time with the left it is seen projected upon the micrometer: then, by the handle P, the arm is raised or depressed so as to bring the two lucid points to a similar situation with the two stars; and, by the handle D, the moveable lucid point is brought to the same distance of the two stars, so that the two lucid points may be exactly covered by the stars.

43. With a rule, divided into inches and fortieth parts, the distance of the lucid points is thus determined with the greatest accuracy; and the measure thus obtained is the tangent of the magnified angle under which the stars are seen to a radius of ten feet; therefore, the angle being found and divided by the power of the telescope, the real angular distance of the centres of a double star is ascertained. On September 25. 1781, Dr Herschel measured α Herculis with this instrument. Having caused the two lucid points to coincide with the stars, he found the radius or distance of the central lamp from the eye 10 feet 4.15 inches; the tangent or distance of the two lucid points 50.6 fortieth parts of an inch; this gives the magnified angle 35′, and dividing by the power 460, we obtain 4″ 34‴ for the distance of the centres of the two stars. The scale of the micrometer at this convenient distance, with the power of 460, is above a quarter of an inch to a second; and by putting on a power of 932, we obtain a scale of more than half an inch to a second, without increasing the distance of the micrometer; whereas the most perfect micrometers, with the same instrument, had a scale of less than the two thousandth part of an inch to a second.

Mr Brewster's micrometer.

44. Mr Brewster has lately directed his attention to the improvement of micrometers, and has invented one in particular which appears to be highly deserving of notice in this place. In this instrument a pair of *fixed* wires is made to subtend different angles by varying the magnifying power of the telescope, by sliding one tube within another; whereas in all other micrometers with wires

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wires this effect is produced by mechanical contrivances. Mr Brewster's method of shutting and opening the wires optically is therefore free from all those sources of error to which other micrometers are subject, and renders it particularly useful to the practical astronomer; while the mode of changing the manifying power by the motion of a second object-glass affords a length of scale equal to the local distance of the principal object-glass. The same principle is peculiarly applicable to the Gregorian telescope; for the magnifying power of this instrument can be changed by merely increasing or diminishing the distance of the eye-piece from the large speculum.

45. In the common micrometer, which can manifestly, as well as Mr Cavallo's and Mr Brewster's, be used in the mensuration of distances, the focal length of the telescope to which it is attached remains always the same; so that a correction computed from an optical theorem must be applied to every angle that is measured: but in Mr Brewster's telescope and micrometer, the focal length varies in the same proportion as the distance of the object; and consequently no correction of the angles can be necessary. To obviate the necessity of having a stand for the instrument, which would prevent its usefulness at sea, Mr Brewster divides the second or moveable object-glass into two, as in the divided object-glass micrometer. By this contrivance two images are formed, and these images are separated or made to form different angles at the eye, by bringing the moveable object-glass nearer to the fixed one. In determining the angle, therefore, we have only to bring the two images of the object into contact; and such contact the eye is capable of ascertaining even during the agitation of a carriage, as the two images retain the same relative position whatever be their absolute motion.

This ingenious instrument, being formed with sliding tubes, is very portable and convenient; and will be found extremely useful to military gentlemen, and others who may wish to ascertain distances without a more cumbersome apparatus. *Haüy's Nat. Phil. by Gregory*, v. ii. p. 427.

46. Mr Brewster, we understand, still continues to direct his attention to the subject of micrometers, keeping in view the improvement of these instruments, not only in greater accuracy of construction, but also in their more extensive application to various practical purposes. An account of those uses and improvements is to form the subject of an appropriate publication; and, if we are rightly informed, the author deems them of sufficient importance to secure to himself, by patent, the exclusive right to the advantages which he thinks will arise from using them.

Cavallo's mother-of-pearl micrometer.

47. A very simple micrometer for measuring small angles with the telescope has been invented by Mr Cavallo*. It consists of a thin and narrow slip of mother-of-pearl finely divided, and situated in the focus of the eye-glass of a telescope, just where the image of the object is formed. It is immaterial whether the telescope be a refractor or a reflector, provided the eye-glass be a convex lens.

*Ph. Transf. 1771. p. 283.

The simplest way of fixing it is to stick it upon the diaphragm, which generally stands within the tube, in the focus of the eye-glass. When thus fixed, the divisions of the micrometrical scale will appear very distinct, unless the diaphragm is not exactly in the focus; in which case, the scale must be placed accurately in the focus of the eye-glass, either by moving the diaphragm, or by interposing any thin substance, such as paper or card between it and the scale. This construction is fully sufficient, when the telescope is always to be used by the same person; but when different persons are to use it, then the diaphragm which supports the micrometer must be constructed so as to be easily moved backwards or forwards, though that motion need not be greater than about $\frac{1}{8}$ or $\frac{1}{10}$ of an inch.

The scale of the micrometer is represented in fig. 19. which is about four times greater than one which Mr Cavallo has adapted to a three-feet achromatic telescope that magnifies about 84 times. It is something less than the 24th part of an inch broad; its thickness is equal to that of common writing paper; and the length of it is determined by the breadth of the field of view. The divisions are 200ths of an inch, and the lines which form them reach from one edge of the scale to about the middle of it, excepting every fifth and tenth division, which are longer. Two divisions of the scale in the telescope already mentioned are very nearly equal to one minute; and as a quarter of one of those divisions may be easily distinguished by the eye, an angle of one-eighth part of a minute, or of $7''\frac{1}{2}$, may be measured with it. Fig. 19.

In looking through a telescope furnished with such a micrometer, the field of view appears divided by the micrometer scale, the breadth of which occupies about $\frac{1}{7}$th of the aperture; and as the scale is semitransparent, that part of the object which is behind it may be discerned sufficiently well to ascertain the division, with which its borders coincide. Fig. 20. shows the appearance of the field of the telescope with the micrometer, when directed to the title page of the Philosophical Transactions, in which it appears that the thickness of the letter C is equal to three-fourths of a division, the diameter of the O is equal to three divisions, and so on. Fig. 20.

48. After having adapted this micrometer to the telescope, we must then ascertain the value of the divisions. It is hardly necessary to mention in this place, that though those divisions measure the chords of the angles, and not the angles or arches themselves, and the chords are not as the arches, yet in small angles the chords, arches, sines, and tangents, follow the same proportion so very nearly, that the difference may be safely neglected: so that if one division of this micrometer is equal to one minute, we may conclude, that two divisions are equal to two minutes, three divisions to three minutes, and so on. In order to ascertain the value of the divisions of this micrometer, the following simple and accurate method may be adopted.

Mark upon a wall the length of six inches, by making two dots or lines six inches asunder, or by fixing a six-inch ruler upon a stand; then place the telescope before it so that the ruler or six-inch length may be at right angles with the direction of the telescope, and just 57 feet $3\frac{1}{2}$ inches distant from the object-glass of the telescope: this done, look through the telescope at the ruler or other extension of six inches, and observe how many divisions of the micrometer are equal to it, and that same number of divisions is equal to half a degree, or 30′, as may be shewn by plane trigonometry.

49. When this value has been once ascertained, any other angle measured by any other number of divisions is determined by simple proportion. Thus, if the diameter of the sun seen through the same telescope, be equal to

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12 divisions, say as $11\frac{1}{2}$ divisions are to 30 minutes, so are 12 divisions to $\left(\frac{12' \times 30'}{11.5}\right)$ $31'.3$, which is the required diameter of the sun.

Notwithstanding the facility of this calculation, a scale may be made answering to the divisions of a micrometer, which will show the angle corresponding to any number of divisions by mere inspection. Thus, for the above-mentioned small telescope, the scale is represented in fig. 21. AB is a line drawn at pleasure; it is then divided into 23 equal parts, and those divisions which represent the divisions of the micrometer that are equal to one degree, are marked on one side of it. The line then is divided again into 60 equal parts, which are marked on the other side of it; and these divisions represent the minutes which correspond to the divisions of the micrometer: thus the figure shows, that six divisions of the micrometer are equal to $15\frac{1}{2}$ minutes, $11\frac{1}{4}$ divisions are nearly equal to 29 minutes, &c. What has been said of minutes may be said of seconds also, when the scale is to be applied to a large telescope.

Fig. 21.

50. We shall therefore add some practical rules to render this micrometer useful to persons unacquainted with trigonometry and the use of logarithms.

Problem I. The angle, not exceeding one degree, which is subtended by an extension of one foot perpendicular to the axis of the telescope being given, to find its distance from the object-glass of the telescope.

Rule 1. If the angle be expressed in minutes, say, as the given angle is to 60, so is 687.55 to a fourth proportional, which gives the answer in inches.—2. If the angle be expressed in seconds, say, as the given angle is to 3600, so is 687.55 to a fourth proportional, which expresses the answer in inches.

Example. At what distance is a globe of one foot diameter when it subtends an angle of two seconds?

$$2'' : 3600'' :: 687.55 : \frac{3600 \times 687.55}{2} = 1237590$$

inches, or $103132\frac{1}{2}$ feet, which is the answer required.

Problem II. The angle, not exceeding one degree, which is subtended by any known extension, being given, to find its distance from the object-glass of the telescope.

Rule. Proceed as if the extension were of one foot by Problem I. and call the answer B; then, if the extension in question be expressed in inches, say, as 12 inches are to that extension, so is B to a fourth proportional, which is the answer in inches; but if the extension in question be expressed in feet, then you need only multiply it by B, and the product is the answer in inches.

Example. At what distance is a man six feet high, when he appears to subtend an angle of $30''$.

By Problem I. if the man were one foot high, the distance would be 82506 inches; but as he is six feet high, therefore multiply 82506 by 6, and the product gives the required distance, which is 495036 inches, or 41253 feet.

For greater conveniency, especially in travelling, or in such circumstances in which one has not the opportunity of making even the easy calculations required in those problems, the following two tables have been computed; the first of which shows the distance answering to any angle from one minute to one degree, which is subtended by a man, the height of which has been called an extension of six feet; because, at a mean, such is the height of a man when dressed with hat and shoes on.

Thus, if it is required to measure the extension of a street, let a foot ruler be placed at the end of the street; measure the angle it subtends, which suppose to be $36'$, and in the table you will have the required distance opposite $36'$, which is $95\frac{1}{2}$ feet. Thus also a man who appears to be $49'$ high, is at the distance of 421 feet.

Angles subtended by an extension of one Foot at different Distances.

Angles.	Distances in Feet.	Angles.	Distances in Feet.
Min. 1	3437.7	Min. 31	110.9
2	1718.9	32	107.4
3	1145.9	33	104.2
4	859.4	34	101.1
5	687.5	35	98.2
6	572.9	36	95.5
7	491.1	37	92.9
8	429.7	38	90.4
9	382.0	39	88.1
10	343.7	40	85.9
11	312.5	41	83.8
12	286.5	42	81.8
13	264.4	43	79.9
14	245.5	44	78.1
15	229.2	45	76.4
16	214.8	46	74.7
17	202.2	47	73.1
18	191.0	48	71.6
19	180.9	49	70.1
20	171.8	50	68.7
21	162.7	51	67.4
22	156.2	52	66.1
23	149.4	53	64.8
24	143.2	54	63.6
25	137.5	55	62.5
26	132.2	56	61.4
27	127.3	57	60.3
28	122.7	58	59.2
29	118.5	59	58.2
30	114.6	60	58.3

Angles subtended by an Extension of six Feet at different Distances.

Angles.	Distances in Feet.	Angles.	Distances in Feet.
Min. 1	20626.8	Min. 14	1473.3
2	10313.	15	1375.
3	6875.4	16	1298.1
4	5156.5	17	1213.3
5	4125.2	18	1145.9
6	3437.7	19	1085.6
7	2946.6	20	1031.4
8	2578.2	21	982.2
9	2291.8	22	937.6
10	2062.6	23	896.8
11	1875.2	24	859.4
12	1718.8	25	825.
13	1586.7	26	793.3

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Angles.	Diftances in Feet.	Angles.	Diftances in Feet.
Min. 27	763.9	Min. 44	4688
28	736.6	45	4584
29	711.3	46	448.4
30	687.5	47	438.9
31	665.4	48	429.7
32	644.5	49	421.
33	625.	50	412.5
34	606.6	51	404.4
35	589.3	52	396.7
36	572.9	53	389.2
37	557.5	54	381.9
38	542.8	55	375.
39	528.9	56	368.3
40	515.6	57	361.9
41	503.1	58	355.6
42	491.1	59	349.6
43	479.7	60	343.7

Mr Brewfter's circular mother-of-pearl micrometer.

51. The following is the account of a micrometer invented by Mr Brewfter, of the circumftances which led to the invention, and of its advantages. We fhall give it in his own words *.

* Phil. Mag. vol. xxix. p. 48.

" In the winter of 1805 (he obferves), when I was employed in delineating the furface of the moon, I wifhed to meafure the diameter of the lunar fpots by applying Mr Cavallo's micrometer to a thirty-inch achromatic telefcope made by Berge. But as the eye-piece was moved by a rack and pinion, and confequently could not turn round its axis, the micrometer muft have remained ftationary, and could only meafure angles in one direction. This difficulty, indeed, might have been furmounted by a mechanical contrivance for turning the diaphragm about its centre, or more fimply by giving a motion of rotation to the tube which contains the third and fourth eye-glaffes. Such a change in the eye-piece, however, was both inconvenient and difficult to be made. Mr Cavallo's micrometer, therefore, has this great difadvantage, that it cannot be ufed in reflecting telefcopes, or in any achromatic telefcope where the adjuftment of the eye-piece is effected by rackwork, unlefs the ftructure of thefe inftruments is altered for the purpofe. Another difadvantage of this micrometer arifes from the flip of mother-of-pearl paffing through the centre of the field. The picture in the focus of the eye-glafs is broken into two parts, and the view is rendered ftill more unpleafant by the inequality of the fegments into which the field is divided. In addition to thefe difadvantages, the different divifions of the micrometer are at unequal diftances from the eye-glafs which views them, and therefore can neither appear equally diftinct nor fubtend equal angles at the eye.

" Finding that Mr Cavallo's inftrument laboured under thefe imperfections, I thought of a circular mother-of-pearl micrometer which is free from them all, and has likewife the advantage of a kind of diagonal fcale, increafing in accuracy with the angle to be meafured. This micrometer, which I got executed by Miller and Adie, optical inftrument-makers in Edinburgh, and which I have often ufed, both in determining fmall angles in the heavens and fuch as are fubtended by terreftrial objects, is reprefented in fig. 27. which exhibits its appearances in the focus of the fourth eye-glafs. The black ring, which forms part of the figure, is the diaphragm, and the remaining part is a ring of mother-of-pearl, having its interior circumference divided into 360 equal parts. The mother-of-pearl ring, which appears connected with the diaphragm, is completely feparate from it, and is fixed at the end of a brafs tube which is made to move between the third eye-glafs and the diaphragm, fo that the divided circumference may be placed exactly in the focus of the glafs next the eye. When the micrometer is thus fitted into the telefcope, the angle fubtended by the whole field of view, or by the diameter of the innermoft circle of the micrometer, muft be determined either by meafuring a bafe or by the paffage of an equatoreal ftar, and the angles fubtended by any number of divifions or degrees will be found by a table conftructed in the following manner.

Plate cccxxxvi. Fig. 27.

52. " Let A mpn B, fig. 28. be the interior circumference of the micrometer fcale, and let mn be the object to be meafured. Bifect the arch mn in p, and draw C m, C p, C n. The line C p will be at right angles to mn, and therefore mn will be twice the fine of half the arch mn. Confequently, AB : $mn =$ rad. fine of $\frac{1}{2}\, mpn$; therefore $mn \times \mathrm{R} = \text{fin.}\ \frac{1}{2}\, mpn \times \mathrm{AB}$, and $mpn = \frac{\text{fin.}\ \frac{1}{2}\, mpn \times \mathrm{AB}}{\mathrm{R}} = \frac{\text{fin.}\ \frac{1}{2}\, mpn}{\mathrm{R}} \times \mathrm{AB}$; a formula by which the angle fubtended by the chord of any number of degrees may be eafily found. The firft part of the formula, viz. $\frac{\text{fin.}\ \frac{1}{2}\, mpn}{\mathrm{R}}$ is conftant, while AB varies with the fize of the micrometer and with the magnifying power which is applied. We have therefore computed the following table, containing the value of the conftant part of the formula for every degree or divifion of the fcale.

Fig. 28.

Deg.	Conftant Part of the formula.	Deg	Conftant Part.	Deg.	Conftant Part.	Deg	Conftant Part.
1	.0087	21	.1822	41	.3502	61	.5075
2	.0174	22	.1908	42	.3584	62	.5150
3	.0262	23	.1994	43	.3665	63	.5225
4	.0349	24	.2079	44	.3746	64	.5299
5	.0436	25	.2164	45	.3827	65	.5373
6	.0523	26	.2250	46	.3907	66	.5446
7	.0610	27	.2334	47	.3987	67	.5519
8	.0698	28	.2419	48	.4067	68	.5592
9	.0785	29	.2504	49	.4147	69	.5664
10	.0872	30	.2588	50	.4226	70	.5735
11	.0958	31	.2672	51	.4305	71	.5807
12	.1045	32	.2756	52	.4384	72	.5878
13	.1132	33	.2840	53	.4462	73	.5948
14	.1219	34	.2923	54	.4540	74	.6018
15	.1305	35	.3007	55	.4617	75	.6088
16	.1392	36	.3090	56	.4695	76	.6157
17	.1478	37	.3173	57	.4771	77	.6225
18	.1564	38	.3256	58	.4848	78	.6293
19	.1650	39	.3338	59	.4924	79	.6361
20	.1736	40	.3420	60	.5000	80	.6428

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Mr Brewster's circular micrometer.

Deg.	Constant Part of the Formula.	Deg	Constant Part.	Deg.	Constant Part.	Deg.	Constant Part.
81	.6494	106	.7986	131	.9100	156	.9781
82	.6561	107	.8039	132	.9135	157	.9799
83	.6626	108	.8090	133	.9171	158	.9816
84	.6691	109	.8141	134	.9205	159	.9833
85	.6756	110	.8192	135	.9239	160	.9848
86	.6820	111	.8241	136	.9272	161	.9863
87	.6884	112	.8290	137	.9304	162	.9877
88	.6947	113	.8339	138	.9336	163	.9890
89	.7009	114	.8387	139	.9367	164	.9903
90	.7071	115	.8434	140	.9397	165	.9914
91	.7133	116	.8480	141	.9426	166	.9925
92	.7193	117	.8526	142	.9455	167	.9936
93	.7254	118	.8572	143	.9483	168	.9945
94	.7314	119	.8616	144	.9511	169	.9954
95	.7373	120	.8660	145	.9537	170	.9962
96	.7431	121	.8704	146	.9563	171	.9969
97	.7490	122	.8746	147	.9588	172	.9976
98	.7547	123	.8788	148	.9613	173	.9981
99	.7604	124	.8829	149	.9636	174	.9986
100	.7660	125	.8870	150	.9659	175	.9990
101	.7716	126	.8910	151	.9681	176	.9994
102	.7771	127	.8949	152	.9703	177	.9996
103	.7826	128	.8988	153	.9724	178	.9998
104	.7880	129	.9026	154	.9744	179	1.0000
105	.7934	130	.9063	155	.9763	180	1.0000

53. "In order to find the angle ſubtended by any number of degrees, we have only to multiply the conſtant part of the formula correſponding to that number in the table by AB, or the angle ſubtended by the whole field. Thus if AB is 30 minutes, as it happens to be in the micrometer which I have conſtructed, the angle ſubtended by 1 degree of the ſcale will be $30' \times .009 = 16\frac{2}{5}$ ſeconds, and the angle ſubtended by 40 degrees will be $30' \times .342 = 10'\ 15.6''$; and by making the calculation it will be found that as the angle to be meaſured increaſes, the accuracy of the ſcale alſo increaſes; for when the arch is only 1 or 2 degrees, a variation of 1 degree produces a variation of about 16 ſeconds in the angle; whereas when the arch is between 170 and 180, the variation of a degree does not produce a change much more than one ſecond in the angle. This is a moſt important advantage in the circular ſcale, as in Cavallo's micrometer a limit is neceſſarily put to the ſize of the diviſions.

"It is obvious, from an inſpection of fig. 27. that there is no occaſion for turning the circular micrometer round its axis, becauſe the divided circumference lies in every poſſible direction. In fig. 2. for example, if the object has the direction *a b* it will be meaſured by the arch *a o b*, and if it lies in the line *c d* it will be meaſured by the arch *c r d*.

"In the circular micrometer which I have been in the habit of uſing, AB, or the diameter of the field of view, is exactly half an inch, the diameter of the braſs tube in which it is fixed is one inch, the length of the tube half an inch, and the degrees of the divided circumference $\frac{1}{250}$th of an inch."

54. II. The micrometer has not only been applied to teleſcopes, and employed for aſtronomical purpoſes; but there have alſo been various contrivances for adapting it to MICROSCOPICAL obſervations. Mr Leeuwenhoeck's method of eſtimating the ſize of ſmall objects was by comparing them with grains of ſand, of which 100 in a line took up an inch. Theſe grains he laid upon the ſame plate with his objects, and viewed them at the ſame time. Dr Jurin's method was ſimilar to this; for he found the diameter of a piece of fine ſilver wire, by wrapping it as cloſe as he could about a pin, and obſerving how many rings made an inch; and he uſed this wire in the ſame manner as Leeuwenhoeck employed his ſand. Dr Hooke looked upon the magnified object with one eye, while at the ſame time he viewed other objects placed at the ſame diſtance with the other eye. In this manner he was able, by the help of a ruler, divided into inches and ſmall parts, and laid on the pedeſtal of the microſcope, to caſt as it were the magnified appearance of the object upon the ruler, and thus exactly to meaſure the diameter which it appeared to have through the glaſs; which being compared with the diameter as it appeared to the naked eye, ſhowed the degree in which it was magnified.

Micrometer.

Application of the micrometer to microſcopes.

55. Mr Martin * recommended ſuch a micrometer for a microſcope as had been applied to teleſcopes: for he adviſes to draw a number of parallel lines on a piece of glaſs, with the fine point of a diamond, at the diſtance of one-fortieth of an inch from one another, and to place it in the focus of the eye-glaſs. By this method, Dr Smith contrived to take the exact draught of objects viewed by a double microſcope; for he adviſes to get a lattice, made with ſmall ſilver wires or ſquares, drawn upon a plain glaſs by the ſtrokes of a diamond, and to put it into the place of the image, formed by the object-glaſs: then by transferring the parts of the object, ſeen in the ſquares of the glaſs or lattice upon ſimilar correſponding ſquares drawn on paper, the picture may be exactly taken. Mr Martin alſo introduced into compound microſcopes another micrometer, conſiſting of a ſcrew.

* *Martin's Optics*, p. 277.

65. The mode of actual admeaſurement (Mr Adams obſerves †) is without doubt the moſt ſimple that can be uſed; as by it we comprehend, in a manner, at one glance, the different effects of combined glaſſes; and as it ſaves the trouble, and avoids the obſcurity, of the uſual modes of calculation: but many perſons find it exceedingly difficult to adopt this method, becauſe they have not been accuſtomed to obſerve with both eyes at once. To obviate this inconvenience, the late Mr Adams contrived an inſtrument called the *Needle-Micrometer*, which was firſt deſcribed in his *Micrographia Illuſtrata;* and of which, as now conſtructed, we have the following deſcription by his ſon Mr George Adams in the ingenious Eſſays above quoted.

† *Microſcopical Eſſays*, p. 59.

This micrometer conſiſts of a ſcrew, which has 50 threads to an inch; this ſcrew carries an index, which points to the diviſions on a circular plate, which is fixed at right angles to the axis of the ſcrew. The revolutions of the ſcrew are counted on a ſcale, which is an inch divided into 50 parts; the index to theſe diviſions is a flower-de-luce marked upon the ſlider, which carries the needle point acroſs the field of the microſcope. Every revolution of the micrometer ſcrew meaſures $\frac{1}{50}$th part of an inch, which is again ſubdivided by means of the diviſions on the circular plate, as

Micrometer. as this is divided into 20 equal parts, over which the index paffes at every revolution of the fcrew; by which means we obtain with eafe the meafure of 1000th part of an inch: for 50, the number of threads on the fcrew in one inch, being multiplied by 20, the divifions on the circular plate are equal to 1000; fo that each divifion on the circular plate fhows that the needle has either advanced or receded 1000th part of an inch.

57. To place this micrometer on the body of the microfcope, open the circular part FKH, fig. 25. by taking out the fcrew G, throw back the femicircle FK, which moves upon a joint at K; then turn the fliding tube of the body of the microfcope, fo that the fmall holes which are in both tubes may exactly coincide, and let the needle *g* of the micrometer have a free paffage through them; after this, fcrew it faft upon the body by the fcrew G. The needle will now traverfe the field of the microfcope, and meafure the length and breadth of the image of any object that is applied to it. But further affiftance muft be had, in order to meafure the object itfelf, which is a fubject of real importance; for though we have afcertained the power of the microfcope, and know that it is fo many thoufand times, yet this will be of little affiftance towards afcertaining an accurate idea of its real fize; for our ideas of bulk being formed by the comparifon of one object with another, we can only judge of that of any particular body, by comparing it with another whofe fize is known: the fame thing is neceffary, in order to form an eftimate by the microfcope; therefore, to afcertain the real meafure of the object, we muft make the point of the needle pafs over the image of a known part of an inch placed on the ftage, and write down the revolutions made by the fcrew, while the needle paffed over the image of this known meafure; by which means we afcertain the number of revolutions on the fcrew, which are adequate to a real and known meafure on the ftage. As it requires an attentive eye to watch the motion of the needle point as it paffes over the image of a known part of an inch on the ftage, we ought not to truft to one fingle meafurement of the image, but ought to repeat it at leaft fix times; then add the fix meafures thus obtained together, and divide their fum by fix, or the number of trials; the quotient will be the mean of all the trials. This refult is to be placed in a column of a table next to that which contains the number of the magnifiers.

58. By the affiftance of the fectoral fcale, we obtain with eafe a fmall part of an inch. This fcale is fhown at fig. 22, 23, 24, in which the two lines *c a*, *c b*, with the fide *a b*, form an ifofceles triangle; each of the fides is two inches long, and the bafe ftill only of one-tenth of an inch. The longer fides may be of any given length, and the bafe ftill only one-tenth of an inch. The longer lines may be confidered as the line of lines upon a fector opened to one-tenth of an inch. Hence whatever number of equal parts *c a*, *c b* are divided into, their tranfverfe meafure will be fuch a part of one-tenth as is expreffed by their divifions. Thus if it be divided into ten equal parts, this will divide the inch into 100 equal parts; the firft divifion next *c* will be equal to 100th part of an inch, becaufe it is the tenth part of one-tenth of an inch. If thefe lines are divided into twenty equal parts, the inch will be by that means divided into 200 equal parts. Laftly, if *a b*, *c a*, are made three inches long, and divided into 100 equal parts, we obtain with eafe the 1000th part. The fcale is reprefented as folid at fig. 23. but as perforated at fig. 22. and 24. fo that the light paffes through the aperture, when the fectoral part is placed on the ftage.

Fig. 25.

Fig. 22, 23, 24.

59. To ufe this fcale, firft fix the micrometer, fig. 25. to the body of the microfcope; then fit the fectoral fcale, fig. 24. in the ftage, and adjuft the microfcope to its proper focus or diftance from the fcale, which is to be moved till the bafe appears in the middle of the field of view; then bring the needle point *g*, fig. 25. (by turning the fcrew L) to touch one of the lines *c a*, exactly at the point anfwering to 20 on the fectoral fcale. The index *a* of the micrometer is to be fet to the firft divifion, and that on the dial plate to 20, which is both the beginning and end of its divifions; we are then prepared to find the magnifying power of every magnifier in the compound microfcope which we are ufing.

60. *Example.* Every thing being prepared agreeable to the foregoing directions, fuppofe you are defirous of afcertaining the magnifying power of the lens marked N° 4. turn the micrometer fcrew until the point of the needle has paffed over the magnified image of the tenth part of one inch; then the divifion, where the two indices remain, will fhow how many revolutions, and parts of a revolution, the fcrew has made, while the needle point traverfed the magnified image of the one-tenth of an inch; fuppofe the refult to be 26 revolutions of the fcrew, and 14 parts of another revolution, this is equal to 26 multiplied by 20, added to 14; that is, 534,000 parts of an inch.—The 26 divifions found on the ftraight fcale of the micrometer, while the point of the needle paffed over the magnified image of one-tenth part of an inch, were multiplied by 20, becaufe the circular plate CD, fig. 25. is divided into 20 equal parts; this produced 520; then adding the 14 parts of the next revolution, we obtain the 534,000 parts of an inch, or five-tenths and 3400 parts of another tenth, which is the meafure of the magnified image of one-tenth of an inch, at the aperture of the eye-glaffes or at their foci. Now if we fuppofe the focus of the two eye-glaffes to be one inch, the double thereof is two inches; or if we reckon in the 1000th part of an inch, we have 2000 parts for the diftance of the eye from the needle point of the micrometer. Again, if we take the diftance of the image from the object at the ftage at 6 inches, or 6000, and add thereto 2000, double the diftance of the focus of the eye-glafs, we fhall have 8000 parts of an inch for the diftance of the eye from the object; and as the glaffes double the image, we muft double the number 534 found upon the micrometer, which then makes 1068: then, by the following analogy, we fhall obtain the number of times the microfcope magnifies the diameter of the object; fay, as 240, the diftance of the eye from the image of the object, is to 800, the diftance of the eye from the object; fo is 1068, double the meafure found on the micrometer, to 3563, or the number of times the microfcope magnifies the diameter of the object. By working in this manner, the magnifying power of each lens ufed with the compound microfcope may be eafily found, though the refult will be

Fig. 25.

Micrometer.

be different in different compound microſcopes, varying according to the combination of the lenſes, their diſtance from the object and one another, &c.

61. Having diſcovered the magnifying power of the microſcope, with the different object-lenſes that are uſed therewith, our next ſubject is to find out the real ſize of the objects themſelves, and their different parts: this is eaſily effected, by finding how many revolutions of the micrometer ſcrew anſwer to a known meaſure on the ſectoral ſcale or other object placed on the ſtage; from the number thus found, a table ſhould be conſtructed, expreſſing the value of the different revolutions of the micrometer with that object lens, by which the primary number was obtained. Similar tables muſt be conſtructed for each object lens. By a ſet of tables of this kind, the obſerver may readily find the meaſure of any object he is examining; for he has only to make the needle point traverſe over this object, and obſerve the number of revolutions the ſcrew has made in its paſſage, and then look into his table for the real meaſure which correſponds to this number of revolutions, which is the meaſure required.

Deſcription of Mr Coventry's micrometers for microſcopes.

62. Mr Coventry of Southwark has favoured us with the deſcription of a micrometer of his own invention; the ſcale of which, for minuteneſs, ſurpaſſes every inſtrument of the kind of which we have any knowledge, and of which, indeed, we could ſcarcely have formed a conception, had he not indulged us with ſeveral of theſe inſtruments, graduated as underneath.

The micrometer is compoſed of glaſs, ivory, ſilver, &c. on which are drawn parallel lines from the 10th to the 10,000th part of an inch. But an inſtrument thus divided, he obſerves, is more for curioſity than uſe: but one of thoſe which Mr Coventry has ſent us is divided into ſquares, ſo ſmall that ſixteen millions of them are contained on the ſurface of one ſquare inch, each ſquare appearing under the microſcope true and diſtinct; and though ſo ſmall, it is a fact, that animalcula are found which may be contained in one of theſe ſquares.

The uſe of micrometers, when applied to microſcopes, is to meaſure the natural ſize of the object, and how much that object is magnified. To aſcertain the real ſize of an object in the ſingle microſcope, nothing more is required than to lay it on the micrometer, and adjuſt it to the focus of the magnifier, noticing how many diviſions of the micrometer it covers. Suppoſe the parallel lines of the micrometer to be the 1000th of an inch, and the object covers two diviſions; its real ſize is 500ths of an inch; if five, 200ths, and ſo on.

But to find how much the object is magnified, is not mathematically determined ſo eaſily by the ſingle as by the compound microſcope: but the following ſimple method (ſays Mr Coventry) I have generally adopted, and think it tolerably accurate. Adjuſt a micrometer under the microſcope *o*, ſay the 100th of an inch of diviſions, with a ſmall object on it; if ſquare, the better: notice how many diviſions one ſide of the object covers, ſuppoſe 10: then cut a piece of white paper ſomething larger than the magnified appearance of the object: then fix one eye on the object through the microſcope, and the other at the ſame time on the paper, lowering it down till the object and the paper appear level and diſtinct: then cut the paper till it appear exactly the ſize of the magnified object; the paper being then meaſured, ſuppoſe an inch ſquare: Now, as the object under the magnifier, which appeared to be one inch ſquare, was in reality only ten hundredths, or the tenth of an inch, the experiment proves that it is magnified ten times in length, one hundred times in ſuperfices, and one thouſand times in cube, which is the magnifying power of the glaſs; and, in the ſame manner, a table may be made of the power of all the other glaſſes.

In uſing the compound microſcope, the real ſize of the object is found by the ſame method as in the ſingle: but to demonſtrate the magnifying power of each glaſs to greater certainty, adopt the following method.—Lay a two-feet rule on the ſtage, and a micrometer level with its ſurface (an inch ſuppoſe, divided into 100 parts): with one eye ſee how many of thoſe parts are contained in the field of the microſcope, (ſuppoſe 50); and with the other, at the ſame time, look for the circle of light in the field of the microſcope, which with a little practice will ſoon appear diſtinct; mark how much of the rule is interſected by the circle of light, which will be half the diameter of the field. Suppoſe eight inches; conſequently the whole diameter will be ſixteen. Now, as the real ſize of the field, by the micrometers, appeared to be only 50 hundredths, or half an inch, and as half an inch is only one 32d part of 16 inches, it ſhows the magnifying power of the glaſs to be 32 times in length, 1024 ſuperfices, and 32,768 cube (E).

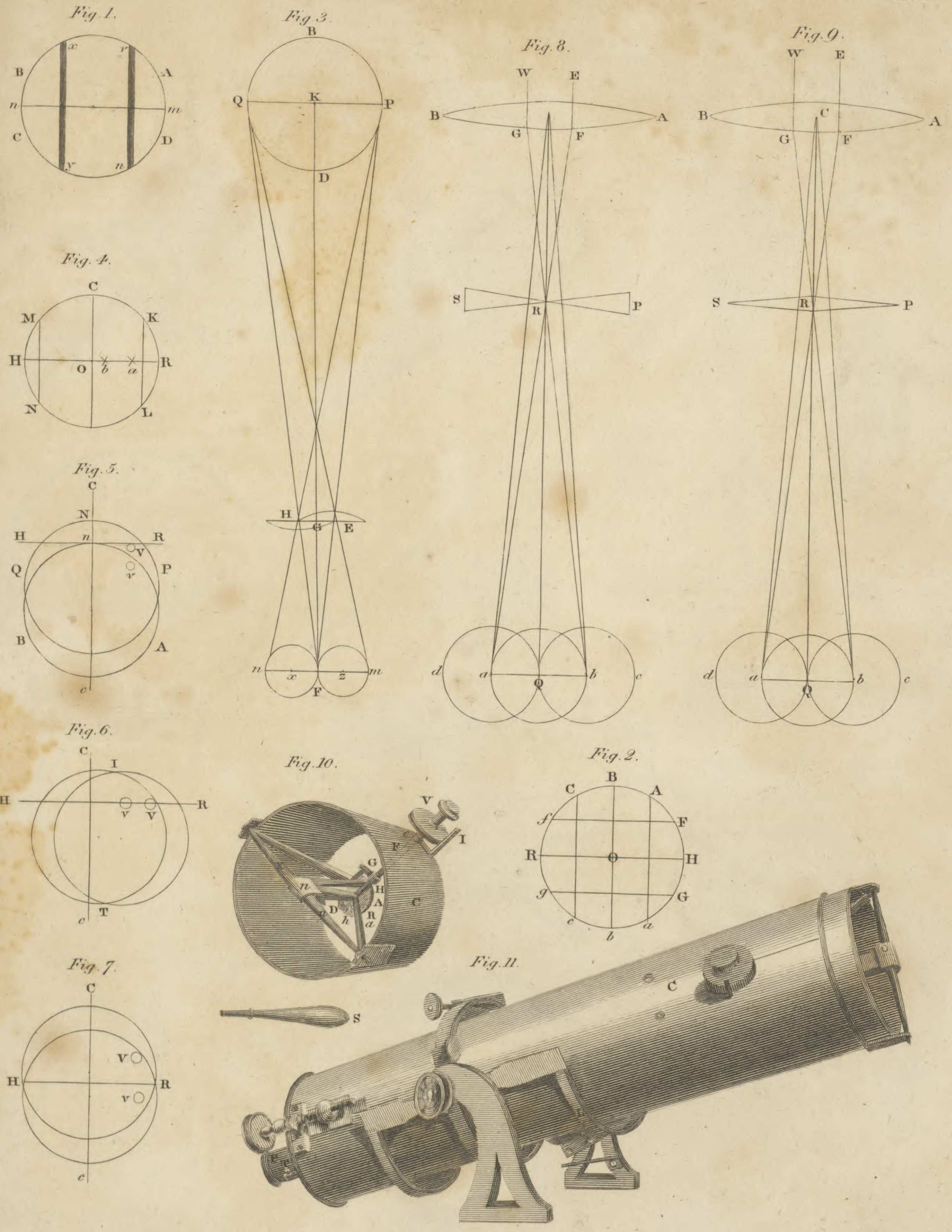
63. Another way of finding the magnifying power of compound microſcopes, is by uſing two micrometers of the ſame diviſions; one adjuſted under the magnifier, the other fixed in the body of the microſcope in the focus of the eye-glaſs. Notice how many diviſions of the micrometer in the body are ſeen in one diviſion of the micrometer under the magnifier, which again muſt be multiplied by the power of the eye-glaſs. Example: Ten diviſions of the micrometer in the body are contained in one diviſion under the magnifier; ſo far the power is increaſed ten times: now, if the eye-glaſs be one inch focus, ſuch glaſs will of itſelf magnify about ſeven times in length, which, with the ten times magnified before, will be ſeven times ten, or 70 times in length, 4900 ſuperfices, and 343,000 cube.

"If (ſays Mr Coventry) theſe micrometers are employed in the ſolar microſcope, they divide the object into ſquares on the ſcreen in ſuch a manner as to render it extremely eaſy to make a drawing of it. And (ſays he) I apprehend they may be employed to great advantage with ſuch a microſcope as Mr Adams's lucernal; becauſe this inſtrument may be uſed either by day or night, or in any place, and gives the actual magnifying power without calculation."

The

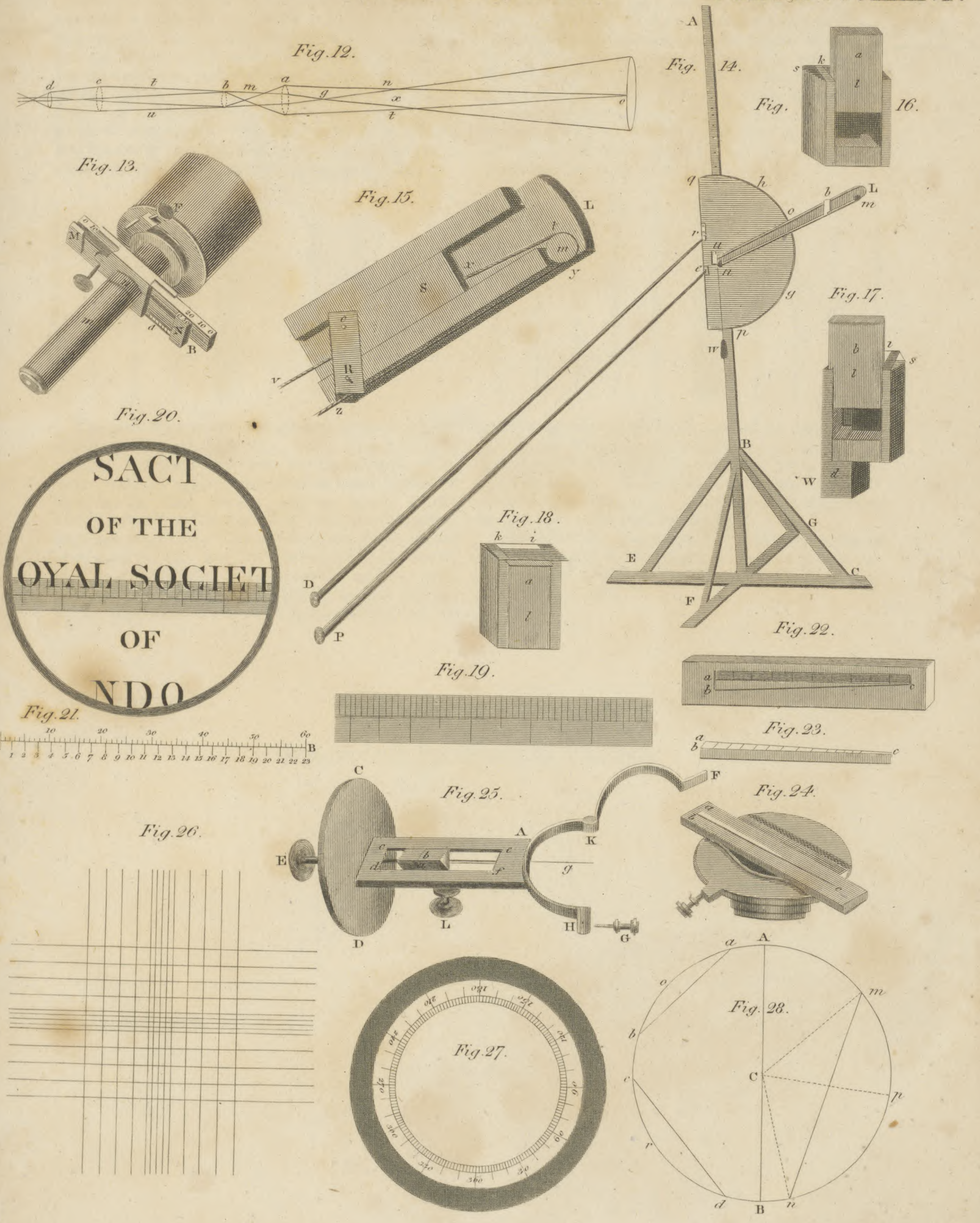
(E) It will be neceſſary, for great accuracy, as well as for comparative obſervations, that the two-feet rule ſhould always be placed at a certain diſtance from the eye: eight inches would, in general, be a proper diſtance.

MICROMETER. PLATE CCCXXXV.



E. Mitchell sculpt.

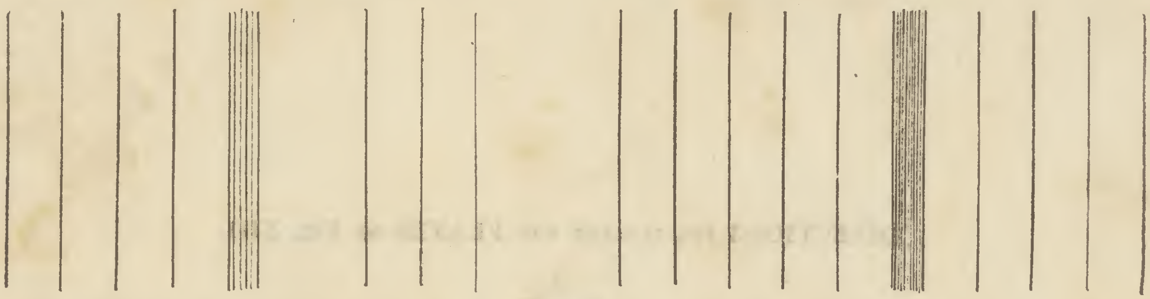
MICROMETER. PLATE CCCXXXVI.



F. Mitchell sculp.t

The case with which we have been favoured by Mr Coventry contains six micrometers, two on ivory and four on glass. One of those on ivory is an inch divided into one hundred parts, every fifth line longer than the intermediate ones, and every tenth longer still, for the greater ease in counting the divisions under the microscope, and is generally used in measuring the magnifying power of microscopes. The other ivory one is divided into squares of the 50th and 100th of an inch, and is commonly employed in measuring opaque objects.

Those made of glass are for transparent objects, which, when laid on them, show their natural size.—That marked on the brass 100, are squares divided to the 100th of an inch: that marked 5000 are parallel lines forming nine divisions, each division the 1000th of an inch; the middle division is again divided into 5, making divisions to the 5000th of an inch. That marked 10,000 is divided in the same manner, with the middle division divided into 10, making the 10,000th of an inch. Example:



The glass micrometer without any mark is also divided, the outside lines into 100th, the next into 1000th, and the inside lines into the 4000th of an inch: these are again crossed with an equal number of lines in the same manner, making squares of the 100th, 1000th, and 4000th of an inch, thus demonstrating each other's size. The middle square of the 1000th of an inch (see fig. 26.) is divided into sixteen squares; now as 1000 squares in the length of an inch, multiplied by 1000, gives one million in an inch surface; by the same rule, one of those squares divided into 16 must be the sixteen millionth part of an inch surface. See fig. 26. which is a diminished view of the apparent surface exhibited under the magnifier N° 1. of Wilson's microscope. In viewing the smallest lines, Mr Coventry uses N° 2. or 3.; and they are all better seen, he says, by candle than by day-light.

MICROPUS, Bastard Cudweed; a genus of plants belonging to the syngenesia class, and in the natural method ranking under the 49th order, *Compositæ*. See Botany *Index*.

END OF THE THIRTEENTH VOLUME.

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[illegible] to face page [illegible]
[illegible]

PART II.

[illegible]
[illegible]