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THE

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THE

NATIONAL GEOGRAPHIC MAGAZINE

# THE FIRST LANDFALL OF COLUMBUS

BY

JACQUES W. REDWAY, F. R. G. S.

In examining the evidence concerning the first landfall of Columbus on the shores of the American continent, but little attention has been given heretofore to the evidence that might be found in early maps. Most critics have attempted to solve the problem by plotting the course either forward or backward as might seem most expedient. A few historical writers have been content to brush aside all evidence save that contained in the log book, trusting to logical inference where positive evidence is wanting.

But logical inferences are of value only when there is something like unanimity of agreement, and thus far, with respect to the landfall, they have resulted, not in unanimity of agreement but in diversity. By such inferences Washington Irving fixed upon Cat island; Muñoz believed it to be Watling; Navarrete held it to be Grand Turk; Becher, Parker, Murdoch and Markham clewed sails off various parts of the coast of the present Watling; Captain Fox kept the anchors fast to the catheads until the squadron crept into a lee bight on the south side of Samaná, and Varnhagen let go those same anchors off the reefs of Mariguana.

At the present time, however, but three islands are seriously considered—Mariguana, Watling and Samaná—and the opinions

having the most weight are those of trained seamen. In the following pages I have endeavored to discuss the merits of the two prevailing opinions from a geographic standpoint, making use not so much of a modern chart as of the evidence contained in certain maps of the fifteenth and sixteenth centuries.

There is but one source from which information concerning the first landing-place can be obtained, and that is the log book. Ever since navigation of the sea began it has been the custom to keep this official record of the voyage with the utmost fidelity, for a falsely kept log is an abomination that nowadays will subject the master of the vessel to the severest penalties. In his private log book, the only one whose contents are now known, Columbus admits that he understated the daily run of the carreca *Santa Maria*, but he says that he thus falsified his quasi-official log in order to keep a mutinous crew in subjection. The deception practiced on his crew, however, was a subterfuge that could have misled no one but an ignorant sailor; it could not have deceived the brothers Pinzon, the masters of the two caravels, for they were quite as skillful navigators as Columbus. The private log must have been reasonably correct, therefore, or it would have been exposed by the enemies of the Admiral.

Unfortunately, this document has disappeared and it cannot now be found. All we know of its contents is contained in an abridged and interpolated copy made by that grand old soldier-priest, Las Casas. From the date of October 10, however, the log seems to have been copied in full, and mainly in the *ipsissima verba* of the Admiral.* The interpolations, however, are generally apparent; but, good, bad or indifferent, about the only knowledge we possess is contained in this abridged log, and whatever conclusions one may reach concerning the locus of the landfall and the courses between Guanahani and Cuba, it must stand or fall accordingly as it agrees or disagrees with Las Casas' abridgment. The map of Juan de la Cosa affords no tangible evidence; Columbus' letter to Luis Santangel contains no allusion to the matter.

One might think that with the log and a good chart the estab-

*Apparently Señor Castelar, in his serial article published in the Century Magazine, 1892, has not appreciated the fact that only a part of the log is in the words of Columbus. He quotes freely from Columbus, seemingly oblivious to the fact that much of the material quoted is not the language of Columbus, but that of Las Casas.

lishment of the squadron's course would be an easy matter, but unfortunately this is not the case. At that time there was no instrument sufficiently precise to establish a ship's position to within two or three degrees.* Moreover, in the entire log book there are but one or two references to latitudes, and these are not exact enough to establish anything. Still another difficulty in the way is the variation of the compass. At that time a variation was known to exist, but, a few declinations excepted, no values had been determined. Columbus, indeed, found that his declination was changing, but he did not establish any values.† A change of twenty degrees or more in declination, during the voyage, even if the Admiral had allowed for it, would have made the retracing of the course a difficult matter.

The fact that Columbus did not write well in the Spanish language adds to the difficulty also. He did not punctuate, and many of his sentences are so ambiguous that it is impossible to tell their meaning. For instance, in the journal of Sunday, October 14, he says: "At the break of day I commanded the gig of the ship and the boats of the caravels to be [lowered] and went along the island in a north-northeasterly course to see the other part which was to the other part of the east."‡ This particular passage is so perplexing that at least three different points of Watling island have been selected as the first anchorage.

Within a few years research has narrowed the six islands above named to the three already noted—Watling, Mariguana, and Samaná. Watling island was first proposed by Muñoz, but it is very uncertain that the Watling island of Muñoz is the one at present bearing that name. On the contrary, if the maps of Sayer (1792), Jacobsz (1621) and the so-called map of Vallard (1547) are worth anything as evidence, the Watling island of Muñoz lay to the southeast of the island at present bearing the name Watling. In fact, this island had the relative position that Samaná now occupies.

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* Vasco da Gama used to go ashore and rig a cross-staff on the beach when he wished to find his latitude.

† At the port of Gomera, at the time Columbus sailed, the declination was about 20° E.; at the crossing of the thirty-fifth meridian it was not far from 16° W. At Guanahani it could not have been more than two or three degrees. The agonic, or line of no declination, now passes within a few miles of Samaná.

‡ See note on page 184 for the quotation from the log book.

In his day, Las Casas says that the island which the natives called Guanahani and Columbus renamed San Salvador, was known by the name of Triango. After a diligent search, however, I find no map bearing this name earlier than the third decade of the sixteenth century. This is the famous Weimar map, but unfortunately on this map the names both of Guanahani and Triango appear, the latter an islet a little to the eastward of Guanahani. Both names also appear on several other maps published during the next fifty years, and in the map of Sebastian Cabot (1544) an island, Triangulo, is found bearing the same relative position that Triango holds on the Weimar map. The name also appears on the maps of Gutierrez (1550) and Santa Cruz (1560). The name "Triangulo ou Watling" occurs on an anonymous map in the collection of R. and I. Ottens.* On this map Guanahani also occurs as a separate island.

In 1856 Captain Becher, Royal Navy, discussed the question exhaustively, taking the ground that the present Watling † was the locus of the landfall. His researches forever put an end to any lingering belief that Cat island was the San Salvador of Columbus. His views have been ably supported by the late R. H. Major, Lieutenant Murdoch, United States Navy, and more recently by Captain William H. Parker, formerly of the United States Navy. Captain Parker combines the qualities of a trained seaman with those of a critical scholar. He spent many years in the West Indies and in Spain, and having had access to all papers and documents bearing upon the question, stands in the ranks of the foremost authorities.

Mariguana or, more properly, Mayaguana island has been pointed out by Varnhagen as a probable site of the landfall. It lies in an east-and-west direction, and its shores are broken by spits and coves; but Varnhagen not only ignores the fact that on leaving Guanahani the squadron sailed to the southwest; he omits from his thesis the Admiral's declaration that on the morrow he should sail to the southwest. Varnhagen lays the course due west and anchors the squadron on the windward side of Acklin island (!)

In 1880 Captain Gustavus V. Fox, United States Navy (in 1861 Assistant Secretary of the Navy), published a critical review of

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* Nova Tabula Exhibens Insulas Cuba et Hispaniolam. Amsterdam. (I am unable to give the date. There is a copy in the British Museum.)

† Named from a pirate of the seventeenth century.

the various monographs bearing upon the subject. At the same time he offered a carefully prepared array of evidence in favor of Samaná or Atwood Cay. Owing to the fact that it was published in a government report,* the monograph did not then receive the attention it deserved, and for ten years it was popularly unknown; lately, however, it has commanded much interest. In his Discovery of America, Mr John Fiske adopts Captain Fox's views, and Mr Henry Harrisse, though rather inclining to Acklin island, practically admits that Captain Fox has come nearer to the truth than any other critic.

From the nature of the case it is evident that the question cannot be settled without the aid of the trained seaman. It is equally evident that the problem comes within the domain of the geographer, the cartographer and the historian. No solution will be satisfactory, therefore, that does not meet the conditions imposed by each of these sciences. Several historical papers that have recently appeared have been mercilessly riddled because of their failure to comply with the conditions demanded by the navigator. The sailor, on the other hand, is not always beyond criticism in discussing questions belonging to history or to cartography. Herr Cronau,† a historical writer, for instance, who, in 1890, took the trouble to visit the Bahama islands, declares that he had no difficulty in identifying Riding rocks, on Watling island, as the spot where Columbus landed. Here is a statement that for vernal simplicity has scarcely an equal in historical literature. Had he divided the entire coast of the Bahama islands into five-mile stretches, he could have identified sixty per cent. of them with equal facility. Neither Becher nor Parker succeeded in accomplishing such a wonderful feat, and Herr Cronau has the credit of it all to himself. It may be casually added, however, so very like one another are stretches of coast that, in spite of lighthouses and profiles, scarcely a day passes that masters and pilots of long experience are not deceived. Indeed, there are but few harbors that have not either a "false" entrance or a "false" namesake. Herr Cronau also asserts that Watling island is the only one answering to all the

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* Report of the United States Coast and Geodetic Survey, 1880, Appendix 18.

† In a summary of Herr Cronau's paper, published in the Magazine of American History, March, 1892, President C. K. Adams, of Madison University, endorses this view.

distinctive features enumerated by original authorities, and that "in following the course from Watling there is no difficulty in identifying all the islands at which the fleet stopped." Such a statement is simply ridiculous; if it were true, all dispute about the matter would have ended long ago.

This writer also makes much of the assertion that the island contained a large interior lake. As a matter of fact, however, Columbus makes no such assertion. He says there was a large lagoon in the middle; but a lagoon is one thing and a lake is quite another.* Even Captain Becher falls into this error, a piece of carelessness for which Captain Fox takes him to task. Herr Croman also criticises Kettell's translation of the passage in which Columbus states that, with the boats of the ships, he took a north-northeasterly course to see the other side.† He translates this perplexing passage, "I skirted along the coast towards the north-northeast in order to explore the other part of the island, namely, that which lies to the east." Now this may, or it may not be what Columbus meant; it certainly is not what he wrote, and Herr Croman's guess is no better than that of any other student.

Mr Clements R. Markham in reviewing the question does himself injustice by a few expressions which are certainly ill-chosen. In a very scholarly article he says, concerning the first landfall: "If the materials from the Journal were placed in the hands of any midshipman in Her Majesty's navy, he would put his finger on the true landfall in half an hour." Such a statement as this most certainly will not do. Could the question be so easily settled as all this, it would not have been a bone of contention for more than a century. Furthermore, Mr Markham says: "It is obvious that, if we trace these bearings and distances backwards from Cuba they will bring us to an island that must necessarily be the Guanahani or San Salvador of Columbus. This is the sailor's method." ‡

But what sailor has yet been able to accomplish this problem so suitable for a royal middy's recitation exercise? Where on the coast of Cuba is the place at which the Admiral landed? How much and in what direction was the squadron carried out

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* "Y una laguna in medio muy grande." Log book, October 13.

† En amaneciendo mandé aderezar el batel de la nao y las barcas de las carabelas; y fue al luengo de la isla, en el camino del nornordeste, para ver la otra parte, que era de la otra parte del Leste. Log book, October 14.

‡ Proceedings of the Royal Geographical Society, September, 1892.

of the course by the winds, by the tides, by the swift currents of the West Indian seas? What was lost or gained in latitude and departure in all the many times the vessels were standing off and on? Of all the places in the West Indies at which the squadron anchored, but one, Fort Navidad, is known. Here the carracca *Santa Maria* was wrecked, and forty-two men picked from the crews were left to guard the stockade built from the wrecked vessel. The impression obtains that Puerto Nipe was the first place in Cuba at which the squadron touched. Navarrete takes this view, and so do Captains Becher and Parker. As a matter of fact, there is not a scintilla of evidence to establish such a statement. The Admiral states specifically that there were but twelve fathoms of water in the harbor in which the squadron anchored. But in the roadstead of Puerto Nipe there is a depth of from twenty to thirty-five fathoms, while in the gut through which it opens into the sea there are nearly twice twelve fathoms of water; in the deepest part there are about forty fathoms. Now an estuary into which several mountain torrents are pouring might possibly silt itself up from thirty-odd fathoms to twelve; it could not well scour itself out from twelve fathoms to thirty. Moreover, the course from Islas de Aroas to Puerto Nipe would have been two or three points east of south, but according to the log Columbus lay the course south-southwest, and the westerly current would have carried him still farther westward. Had Messrs Becher, Markham, and Parker considered Puerto Padre as the first anchorage on the coast of Cuba there would have been fewer inconsistencies to explain away.

And this brings me to a statement in Mr Markham's interesting paper that I wish chiefly to consider. He says:

> When we warmly applauded the close reasoning of Major's paper we supposed that the question was at length settled; but as time went on arguments in favor of other islands continued to appear, and an American * in high official position even started a new island, contending that Samaná was the landfall. But Fox's Samaná and Varnhagen's Mayaguana must be "ruled out of court" without further discussion, for they both occur on the maps of Juan de la Cosa and Herrera, on which Gonnahani also appears. It is obvious that they cannot be Guanahani and themselves at the same time; and it is perhaps needless to add that they do not answer to the description of Guanahani by Columbus and meet none of the other requirements.

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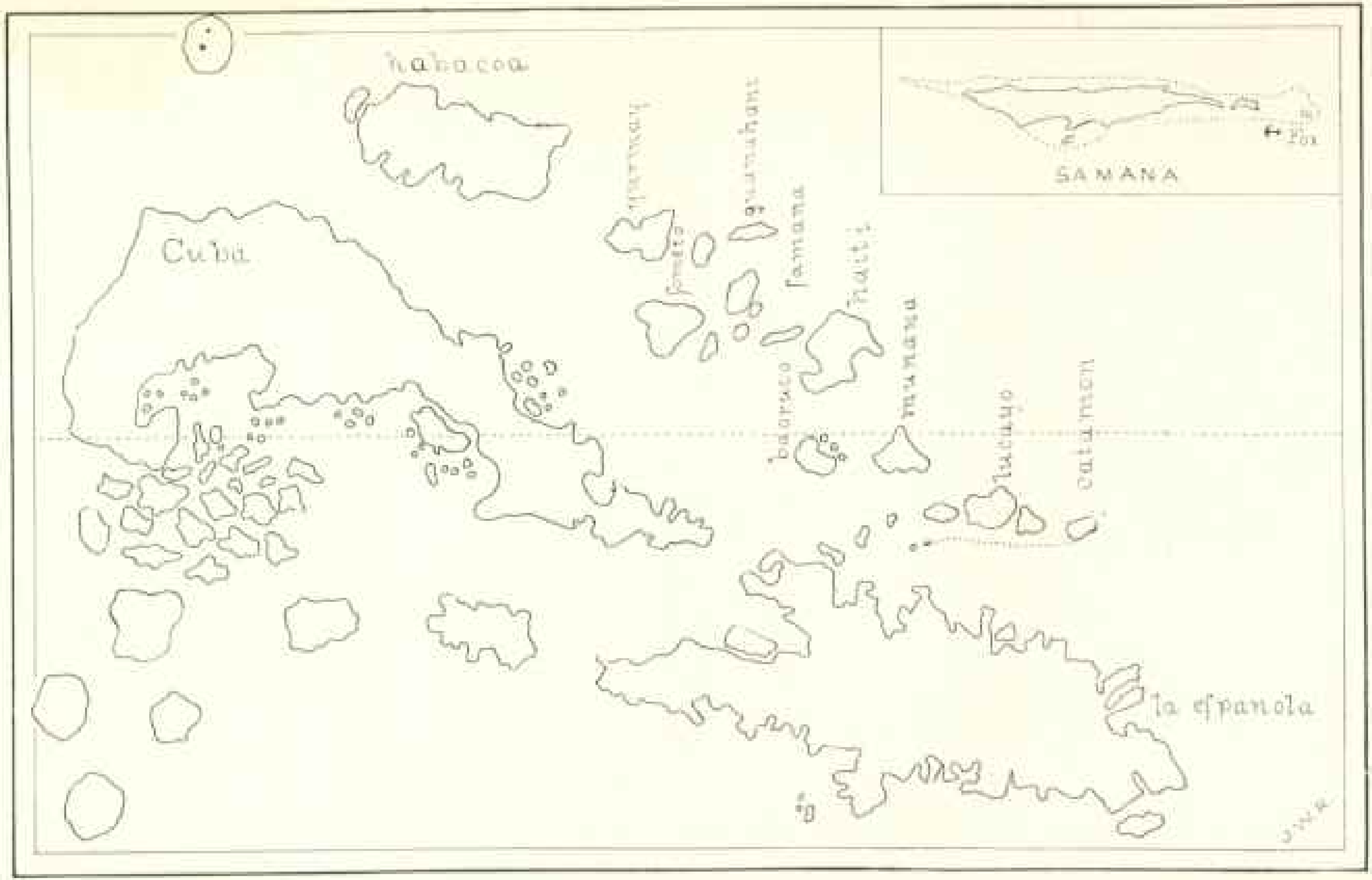
* Captain Gustavus V. Fox.

Now, if Samaná must be dropped without discussion because it appears on a map on which Guanahani also appears, Watling island must also be dropped for the same reason, for it appears with Guanahani on the map of R. and I. Ottens, and on at least half a score of other maps, probably contemporaneous, that the author has examined in the British Museum.

But at the risk of being "ruled out of court" myself, I shall attempt to show that not only can Samaná be Guanahani and itself, but also that for one hundred years or more Samaná was Guanahani and itself at the same time. In the first place, let us look at the map of la Cosa* (see plate 10). On this map it will be observed that the name Samaná may apply to any one of three islands. It is about as near to Guanahani as either of the others, though it is hardly possible to decide upon which it is intended to apply. Incidentally it may be noted that the island which la Cosa marks Haiti is not the one at present bearing the name. That name, in fact, has been transferred to the island Columbus named la Española. Moreover, the transference of names on early maps was by no means an uncommon thing. If Johann Schöner had not carelessly transferred the name "Parias" from the Spanish main to Mexico, instead of putting the rightful "Lariab" there, it is doubtful if the northern part of the western continent would have been called America. An inspection of a very few maps of the sixteenth century will show that the transference and reduplication of names was made in a wholesale manner.

The map of Herrera (see figure 1), upon which Messrs Major and Markham lay so much stress, furnishes but little evidence not found in the map of la Cosa, and although nearly one hundred years later, it is hardly more than a copy of the latter. The most notable difference is in the shape of Guanahani. The east-and-west position by which the Admiral describes it and which it has on la Cosa's chart has been changed to a north-and-south trend. Furthermore, it is no longer northeast of the island of Someto, but almost due north. The island of Samaná on the map of Herrera has the same distance and bearings from Someto that Guanahani has on the map of la Cosa. Just why Messrs Major and Markham place so much confidence in the map of

*The critical part of this map has been traced by the author, copying not only the outlines as found, but inserting their names also, each in the place it occupies on the original.




A PART OF THE MAP OF JUAN DE LA COSA—1500—WITH VIGNETTE OF SAMANA, FROM A MODERN CHART.

Herrera one cannot readily comprehend. Herrera was neither a cartographer nor a sailor. In his time he was the historian of Columbus, but he had none of the material that enabled Navarrete to speak *ex cathedra*, and Navarrete discards Watling island.

Among the maps in the British Museum is one of more than ordinary interest; it is not an original but its fidelity to the original is attested. It bears the inscription, "*Mappa Monde Peinte sur Parchemin par Ordre de Henri II, Roi de France.*" It


FIGURE 1.—*A part of the Map of Herrera—1601—with Vignette of Watling Island from a modern Chart.*

is generally referred to the third decade of the sixteenth century, but from features about it that it is not best to discuss here the author is inclined to place the date about forty years later. At all events it antedates the map of Herrera by thirty years—possibly by seventy years. So far as can be learned, neither its genuineness nor its authenticity has been questioned. The draftsman had a delightfully unique way of conventionalizing the coast outlines. There are several other maps extant coast-charted in the same manner. This feature is therefore not only a quaint and artistic conventionalism; it becomes a valuable ear-mark in identifying the date of certain maps.

On this map (see plate 11) it is interesting to note the appearance of the name "Bahames" and "Guanima," the Cat island of modern maps. I have seen no map of earlier date on which these names occur. But the most important feature is the fact that here, at least, Samaná is itself and Guanahani also. Of the placing of both names to the same island there can be not a shadow of a doubt. Compared with the map of la Cosa, the outlines of Guanahani are geometrically too similar to admit questioning; moreover, its position next to Mayaguana cuts off any further doubts as to its identity. It is the Samaná of today, and the islands to the southwestward are the group comprising Acklin and Crooked islands.

Now the question as to which island the name Samaná belonged has evidently perplexed more than one cartographer. Captain Fox, in his researches, noticed this, and his only error lies in the fact that he did not appreciate the importance of his discovery. The same perplexity led many cartographers to apply the name to the group now comprising Crooked and Acklin islands. Captain Fox gives a list of maps in which the name dodges back and forth from the Crooked group to the present Samaná. Most of these have been examined and verified by the author. Among other maps bearing on the subject are the following, which also include many of those mentioned by Captain Fox.

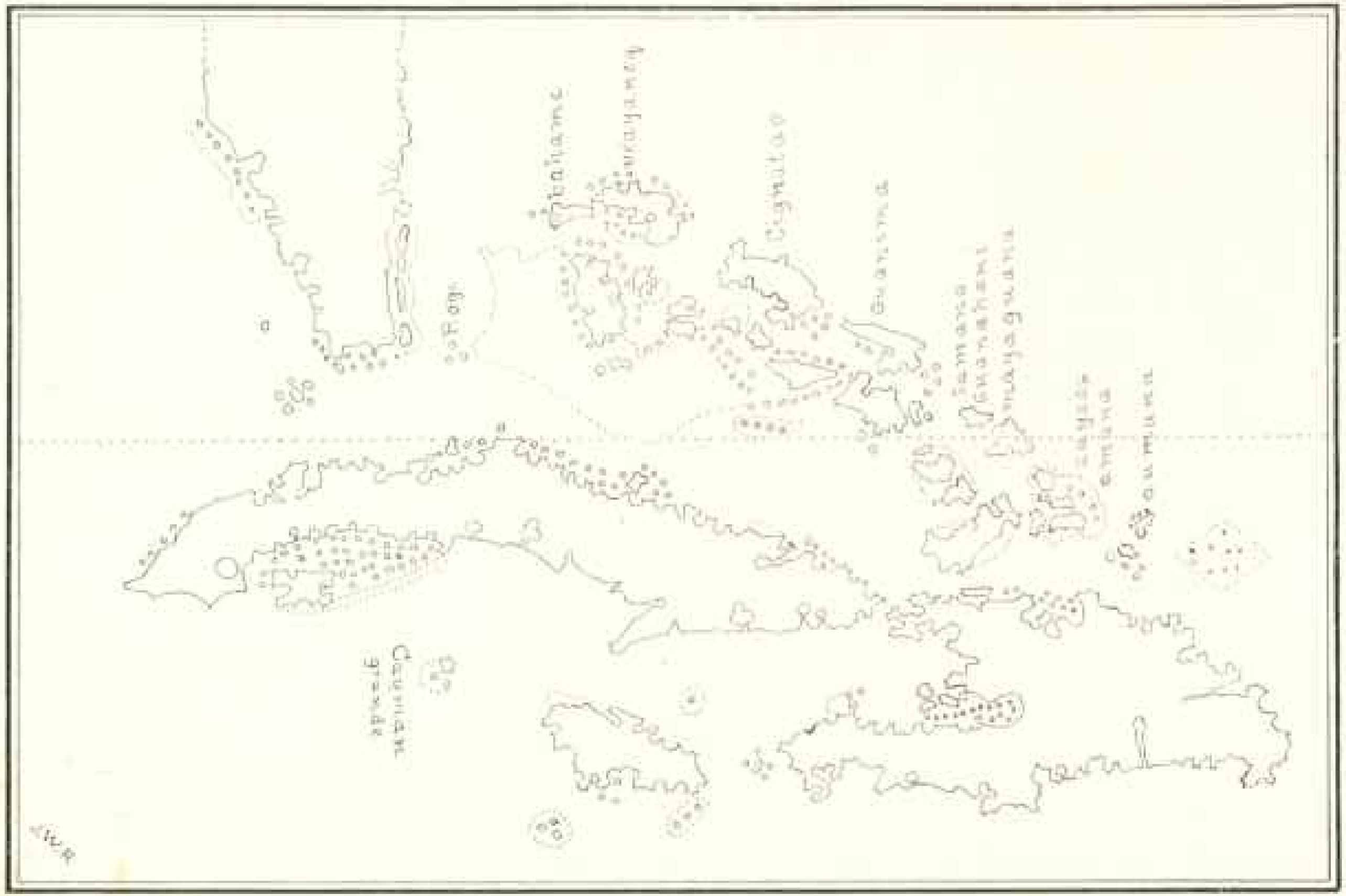
Carte de l'Amerique corrigée et augmentée, etc, P. Bertius, Amsterdam, 1616: The island next Mayaguana is named Triango. Its position, therefore, is that of Samaná. The name is the one Las Casas said that in his time Guanahani bore.

Theatrum Orbis Terrarum, Abraham Ortelius, Antwerp, 1572: Guanahani appears in the position it occupies on the map of Henry II. Samaná is applied to Crooked group. On a map by the same author, 1590, Samaná appears next to Mayaguana.

Map of North America: John Senex, Charles Price, John Maxwell, geographers: The present Crooked group is marked Samani or Krooked. Guanahani is a separate island.

An Accurate Map of North America; also all the West Indies, Eman Bowen, geographer to His Majesty, 1753: Crooked, Fortune, Acklin and Samana form one group. To the northeast, in the position of the present Samaná, is Atwood's Key. This name is also given to Samaná, and it is carried today on the official charts of the United States.

Americæ sive quartæ orbis partis, nova et exactissima descriptio, Diego Gutiero *et al.*, cosmographio, 1562: On this map Samani appears next to Mayaguana.




MAPPA MUNDE PEINTE SUR PARCHEMIN PAR ORDRE DE HENRI II, ROI DE FRANCE—1532.

Atlas Historique, Henri-Abeah, Amsterdam, 1738: Crooked group is here named I. Samana.

Evlanden van West-Indien (date and place not given): Guanahani and Samaná appear on this map attached to islands near Mayaguana.

Cartes Geographiques, d'Anville, 1731–1794: The present group is marked "Samani ou Krooked."

The West India Atlas: Thomas Jeffreys, geographer to the king: The present Samaná is marked "El Terrigo or Atwood's Key, the Samana of the French." Southwest is the Crooked group, one island of which is marked "Samana or Crooked island."

Map of the Bahamas, Delisle and Buache, 1744: On this map Guanahani appears under the name "Isle Nova."

Map of the West Indies, N. Vischer, Amsterdam, 1740: Guanahani appears under the title "Samana or Rum island."

This list might be considerably extended, but the quotations are sufficient to show that the name "Samaná" has been a sort of homeless waif, having several times been transferred. The draughtsman who made the Henry II map evidently believed that Samaná and Guanahani were one and the same island, or he would not have so marked it; but because it was a supernumerary, other cartographers attached it to the Crooked group. So we have Juan de la Cosa's map, on which it is doubtful whether Guanahani is itself or not; the Henry II map, on which Guanahani is certainly itself and Samaná at the same time, and a score or more of later maps on which "Samaná" is applied to the Crooked group. It will be observed, moreover, that Jeffreys retains the name in both places, calling Crooked island "Samaná" and the other "the Samaná of the French"; but when finally the name "Crooked" was exclusively applied to the island at present bearing the name, "Samaná" was put back in its old place. It had previously belonged to an island lying northwest of Mayaguana, and it was put back there. In other words, if the testimony of these maps is worth anything, *Guanahani, El Terrigo, Triangle, Atwood Cay, Isle Nova and Samana are one and the same, and that one is the Guanahani of Columbus.*

Beyond a few observations concerning the second island at which the squadron landed, it is not within the province of this paper to attempt tracing the course to Cuba. It is believed by the writer that the identification of the second island is the chief factor to the locating of the first. Sometime during the 14th of October, Columbus sailed southwestward for the largest island,

which he thought to be about five leagues distant. He reached the island after dark, for in the record of the 15th he says:

I had been standing off, and on this night, fearing to come close to the shore to anchor, for I could not know whether the coast was free from shoals; and intending at dawn to clew up sails; and as the island was over five leagues ahead, rather, seven, and the tide detained me, it was noon when I reached said island; and I found that the side of the island, which is toward the island of San Salvador, runs north and south and is five leagues in length, and the other, which I followed, extends east and west and contains more than ten leagues; and, as from this island I saw another larger one to the west, I clewed up sails, for I had gone all that day until night, because I could not have gone to the western cape, to which I gave the name of the island of Santa Maria de la Concepcion, and about sunset I anchored near said cape.*

This second island Columbus asserts to have a north-and-south side sixteen and an east-and-west side thirty-two miles in length. Now Crooked and Acklin islands—they are practically one †—conform exactly to this description, and there is not another island in the Bahama archipelago that does. The north-and-south side of Crooked island is thirteen; the east-and-west side is twenty-nine miles; the distance from Samaná to the north-eastern point of Crooked island is twenty-three miles—22.3 the log says. An expert sailing master could not come nearer the truth today than did the Admiral. There is but one discrepancy, namely, the Admiral's assertion that the side of the island toward Guanahani is the east (Norte Sur) side. As a matter of fact it is the north (Leste Oueste) side that lies off Guanahani. Whether or not during the night, while standing off and on, the

* Había temporejado esta noche con temor de no llegar á tierra á surgir antes de la mañana *por no saber si* la costa era limpia de bajas, y en amaneciendo cargar velas. Y como la isla fuese mas lejos de cinco leguas, antes será siete, y la marea me detuvo, seria medio dia cuando llegué á la dicha isla y fallé que aquella haz, que es de la parte de la isla de San Salvador, se corre Norte Sur, y hay en ella cinco leguas, y la otra que yo seguí se corria Leste Oueste, y hay en ella mas de diez leguas. Y como desta isla vide otra mayor al Oueste, cargué las velas por andar todo aquel dia fasta noche, porque aun no pudiera haber andado al cabo del Oueste, á la cual puse nombre la isla de la Santa Maria de la Concepcion, y cuasi al ponor del sorgí acerca del dicho cabo. . . .

† The narrow gut that separates them is hardly more than a tidal swale or kill, not more than four or five feet deep at high tide. It is invisible from the deck of a passing vessel.

steersmen had worked the vessels so far to the eastward that they were off the east instead of the north coast, is a matter of conjecture. I am free to admit the objection and do not attempt to explain it away by guesses. The same objection obtrudes itself just as strongly in the consideration of Watling island. In spite of this objection, however, there is not another island that for shape, dimensions, distance and direction so fully meets the requirements of the log as does Crooked island.*

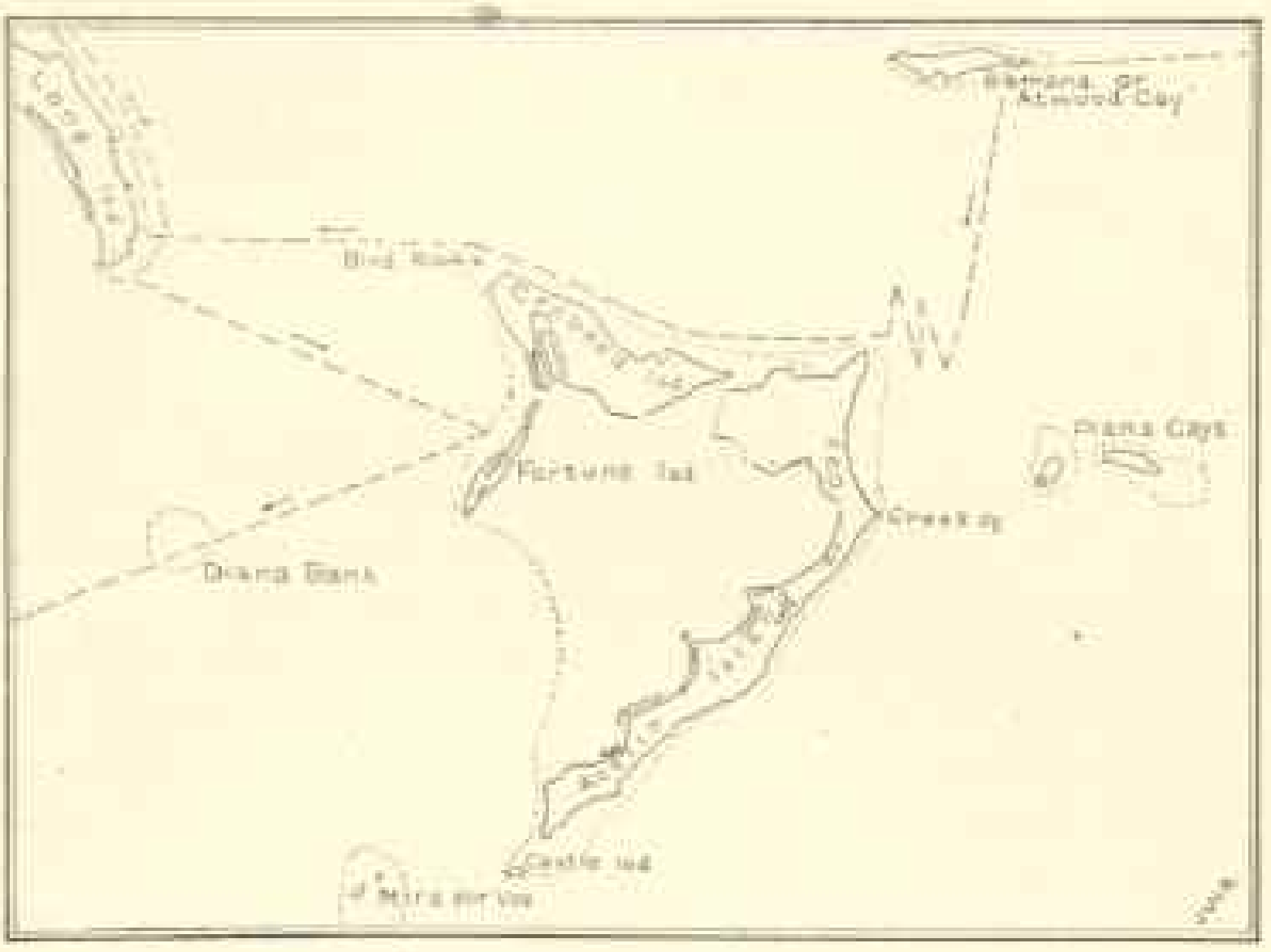



FIGURE 2.—*Modern Map of Samana, Crooked and Acklin Islands.*

Let us now examine the claims of Watling island. The only land visible from Watling that lies southwestward is Rum Cay. Its distance from Watling is twenty-three miles, and the course and distance conform to the requirements of the log, but Rum Cay is only five miles in extent on its eastern and eight miles along its northern shore. Several writers have endeavored to show that the squadron passed to the northward of Rum Cay without anchoring there at all, basing their arguments on the

* The force of this statement is apparent when one compares the size, outlines and relative bearing of the islands, as shown in figure 2, with the log. On this map is also shown the route in accordance with Captain Fox's views.

statement, "I looked for the largest island and determined to make for it." Now there is only one other neighboring island southwest of Watling, and that is Long island. Moreover, no part of Long island is visible from Watling. Not only is it invisible from the masthead, but it is about twice the distance given in the log; still more, neither its shape nor its dimensions conform to the description in the log. Even the careful Captain Becher incorrectly translates the passage "*cargué las velas, por andar toda aquel dia fasta la noche,*" saying, "I made sail, continuing on until night," etc. But *cargar las velas* means to shorten sail—not to crowd on more canvas. Major errs in translating the same passage, saying, "I started for the purpose of sailing," etc. Captain Fox notices these errors and translates the passage correctly. Indeed, there can be no question about it, for it is the recognized nautical expression in the Spanish language for the act which in English is to "clew up."

Just why Watling island should have received the sanction of so many authorities it is difficult to understand, unless it is the fact that this island has two rather large interior lakes; but, under any circumstances, lakes are about the most transitory features of the earth's surface, and the lagoon of low, sandy shores is almost ephemeral; it is found today, and tomorrow it has disappeared. The storm which throws up a spit or walls in a cove today will just as readily undo its work tomorrow. After a lapse of four hundred years the presence or absence of a lagoon counts for nothing.

It is freely admitted that in the foregoing paragraphs the positive identification of Samaná as the first landing-place has not been made. It is believed, however, that material evidence has been added to the question. It is hardly necessary to say that the testimony of any one map counts for but little; but the case is different when we take the consensus of many maps, and in future researches undoubtedly early maps will play a part second only in importance to the log. In closing this paper, therefore, it is suggested that thorough and systematic search for evidence among early maps be made. In the past such search has always been highly fruitful in its results; there is no reason why it should not be equally fruitful in the future.

# JAPAN

BY

D. W. STEVENS

COUNSELOR OF THE IMPERIAL LEGATION OF JAPAN

*(Extract of Address presented before the Society October 19, 1894*)*

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The restoration of 1868 found Japan in a disordered and impoverished condition. The assumption by the Emperor of the imperial power and the relegation of the Shogun to private station were not the results of a sudden emeute or of a hastily planned revolution. The seeds of discontent had been long sown—the fruit was long in maturing. Japan had been closed to the world for centuries; but no people can be shut off completely from knowledge of the rest of mankind, or from contact with the ideas of a progressive age. The government of the Shogun was a feudal despotism, a system as complete as any that ever existed in the middle ages, surviving apparently unimpaired to the last half of the nineteenth century. It was a government which had served a good purpose at one time, for it had quelled and pacified warring factions and had given the nation much needed rest under a wise, if a severe, rule. But its day of usefulness was past; those who controlled it saw the threatening dawn of a new era, and their wisdom became cunning, their severity, tyranny. It may be safely asserted that the Shogunate would have fallen in any event, from internal feuds and dissensions; but strangely enough the death blow to its power was that event of which we Americans are so justly proud—the conclusion of the Perry treaty. It was this dawn of daylight from the outer world which showed intelligent Japanese how thoroughly out of touch their country and, above all, their form of government was with the spirit of the age. It was then that the little band of reformers who were chiefly instrumental in

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*The Editors regret that space will not permit the publishing of this address in full.

bringing about the great change of '68 began their work. They were aided in a measure by the cry of opposition to foreign intrusion which the conclusion of treaties with western powers immediately aroused. There are conservatives in all countries, and the Japanese conservatives of that day formed the Joi or anti-foreign party. Like skillful politicians, those who were seeking the destruction of the illogical and unwieldly dual government availed themselves of this, as well as of all other forms of discontent and opposition, in order to better accomplish their purpose. The facts of history will bear me out in the assertion that, like wise statesmen, they permitted it to have no share in their policy when they themselves came into power.

Glance at the first acts of the Emperor when he assumed the exercise of all those prerogatives of which his ancestors had been deprived for more than three centuries and tell me, if you please, whether the men who guided and directed the counsels of the youthful sovereign were visionary schemers or practical statesmen; whether they were merely lucky speculators trading upon borrowed ideas, or whether they were men who understood their country and their countrymen and cherished a hopeful but not an unreasonable or an illogical ambition for both?

One of the first acts of the Emperor was to issue an edict abolishing the laws against foreign religions and their propagation among the Japanese.

The daimiyos or feudal chiefs surrendered their fiefs to the crown and accepted in lieu the bonds of the government at amounts, it should be added, much less than the value of their original holdings. This, it must not be forgotten, was an entirely voluntary act of self-abnegation.

The samurai or military class, whose privileges, rigorously secured and jealously guarded, made them the real masters of Japan, especially in times of domestic disorder, like their chiefs, the daimiyos, accepted capitalized pensions instead of the regular support to which their fealty and their service had entitled them; and I should add that the dangers to be apprehended from the discontented and turbulent members of this powerful class thus thrown out of employment, and in many cases sadly impoverished, were anticipated and guarded against by the passage and enforcement of a law which has proved itself the highest form of statesmanship. I refer now to the conscription law, by which every Japanese, rich and poor, high and low, is obliged to serve

in the army for a certain period, and thereafter for a certain further time to hold himself in readiness for such service. The wisdom of such a law, in view of a possible uprising of the samurai, was signally proved by the serious outbreak which occurred in Japan in 1877. The result of that rebellion set at rest forever the question of rule by a military class in Japan.

The reorganization of the whole fabric of the public administration was naturally the first care of the imperial government. The departments were all established upon a new and an effective basis. Foreign advisers were employed to assist in the work, and no effort or expense was spared to create a system which would be at once modern, practical and economical.

Time will not permit and it would weary you to recount all that was done. A few instances will serve to illustrate the whole.

The government recognized the importance of education to themselves and to the masses. A complete system of educational institutions was established in every part of the empire, beginning with primary schools in every hamlet, through middle, normal and other more advanced institutions, up to the university in Tokio. Hospitals were endowed, and especial attention was paid to education in medicine and surgery. Nor was any distinction made between the sexes, but schools were established for the education of women as well as of men. This system has been steadily followed throughout, with only those changes which experience has shown to be advisable and beneficial. There are also a number of private educational establishments in Japan, many of which hold a deservedly high rank. Some of these are denominational, established in the first place by foreign missionary bodies, but now exclusively under Japanese control, while others are secular, the result of the labors of men of high scholarly attainments and conspicuous executive ability.

In all public works the government has taken an active and an earnest interest. The establishment of railway and steamship lines, of telegraph and post-roads, and, in short, of all those facilities which increase the comfort and convenience of the nation, have been their constant care. The telegraph and postal systems are equal to those of most countries, while as to railways an increase from 18 miles in 1873 to almost 2,000 miles in 1894 may fairly be regarded as a good result even in this country of phenomenal railway developments.

Nor should it be forgotten that a great deal of the progress which Japan has made in every direction has been due as much to private enterprise as to government direction. The railway and steamship lines, for example, are almost exclusively under the control of private corporations. The government has, of necessity, taken the initiative in many things, but oftentimes it has been merely to set an example which has been readily and aptly followed.

There is another phase of Japanese development which is well worthy of notice. I refer now to the newspaper press. The Japanese, like the ancient Athenians, and, may I add, like modern Americans, are a people who delight in hearing new things. It need hardly be added that the press came to them, as it comes so often to us, to supply "a long-felt want." Its development has been little short of marvelous, and now it flourishes like the green bay tree, from the scholarly periodical, the didactic weekly, the political daily, down to the penny dreadful, for whose columns nothing short of murder and sudden death are fit matter. Many able, intelligent and patriotic men are enlisted in the ranks of the press in Japan, and they already exercise a potent influence upon public opinion and the conduct of public affairs. The government has deemed it necessary to establish regulations for the control of the press—a system more alien to American than to European ideas, but one which experience has shown is necessary to the public welfare, and to that proper distinction between liberty and license to which a youthful but an energetic and a powerful institution like the press of Japan might on occasion be oblivious.

The inhibitions of the press regulations are plain and precise. Their object is clearly stated, the preservation of public peace and morals, and restraint from interference with affairs of state where secrecy is a necessity, such as diplomatic negotiations and the like. The penalties they provide—suspension, fine, and minor imprisonment—are not severe. The heaviest penalty of all, the total suspension and confiscation of the paper, has never been inflicted.

In attempting to describe the changes through which Japan has passed and the effect which they have had upon the development of the country's resources and the increase of national wealth it has not been possible to omit some mention of the political transformation which has been so notable a feature of

her recent history. The one stands to the other in the relation of cause to effect, and what the future may have in store for Japan depends not a little upon the harmonious development of the governmental system which was adopted when the empire emerged from its seclusion.

On March 14, 1868, the Emperor, in the presence of the court nobles and feudal lords, made solemn oath that from that time forth the government and the people should unite in the development of the national power, and that the administrative affairs of the nation should be decided by public deliberation; that encouragement should be given to all the pursuits of life; that all abuses and evil practices should be abolished and the equitable principles of nature should be the guiding star of the nation; that wisdom should be sought in all the countries of the world, and whatever was good and right should be adopted to strengthen the basis of the national and the imperial power.

The solemn obligation thus voluntarily assumed by the ruler of a country whose predecessors had exercised despotic power furnishes the keynote to all that Japan has since accomplished. It clearly foreshadowed not alone the changes which immediately followed, but the consummation of all those changes which took place when in 1889 the Emperor established a constitutional form of government. It will thus be seen that this final result was achieved not on the impulse of the moment or in consequence of any political exigency, but in conformity with a plan adopted from the beginning. That plan was consistently held in view and systematically followed from the outset. The statesmen who under the imperial will guided Japan's destinies then, some of whom are still the trusted advisers of the emperor, wisely decided that the immediate establishment of parliamentary institutions was not practicable; but steps were taken to pave the way for such institutions by extending the rights and privileges of the people, most notably by the creation of the prefectural and other local assemblies, which exercise a certain degree of control over local affairs. These and other similar institutions were designed to educate the people in the practice of self-government, and they were in active operation a number of years before the first imperial diet was opened.

After the resignation of the Shogun in 1868 that office was abolished and a council of state was created, to which the Emperor confided the direction of public affairs. Several changes

in the formation of this council followed, until in 1885 the present executive system was adopted. It consists of a cabinet and a privy council. The former, presided over by the prime minister, is composed of the ministers in charge of the executive departments, who are directly responsible to the Emperor for the management of their offices. The functions of the privy council are purely advisory.

The different prefectures into which the empire is divided are under the charge of governors, appointed by the Emperor upon the recommendation of the minister for home affairs. In each prefecture there is, as I have already stated, a local assembly, which coöperates with the governor in the management of local affairs.

The imperial diet is composed of two houses, a house of peers and a house of representatives. The former body consists of members who hold office as a hereditary right; of a certain number who are elected by the different orders of nobility which are not entitled to seats in the house, and of a certain number appointed by the Emperor.

The members of the house of representatives are elected directly by the people. A property qualification governs the exercise of the electoral franchise.

This, in brief, is the executive and legislative system now in force in Japan. When everything is taken into account, it may be said to have worked smoothly and efficiently. Since the adoption of the constitution and the establishment of the diet there has at times been a great deal of political excitement, but throughout every storm of this kind there has been no attack upon the privileges of the people, no thought of an assault upon the fundamental law. The constitution has been scrupulously observed, and each struggle between the executive and the legislative branches of the government has been carried on within the lines defined by that instrument. Such contests are inevitable where men strive for political supremacy. In Japan they afford a useful vent for political passions, and when, in time, party principles are more clearly enunciated and party lines more sharply drawn, there is no reason to believe that parliamentary government in Japan will not achieve all that was hoped for it. The fact that in Japan, even from ancient times, a system of local self-government in town and village and rural district was conceded by the government and jealously retained

by the people affords perhaps the brightest augury for the success of self-government in Japan.

The systematization and codification of the laws of Japan was one of the first cares of the government after the restoration. It was their wish to adapt them as nearly as possible to western models. All cruel and unusual punishments have been long since abolished, and Japan has today a body of codified law based upon the best models. All of the codes are in successful operation, with the exception of the civil code, which has already been promulgated, but has for some time been undergoing revision at the hands of a commission of experts and will soon be put in operation.

In equal measure the judicial organization of the empire has been made the subject of careful study and thorough reform. In 1872 the Japanese judiciary was made independent of the other branches of the government, and courts were established presided over by judges who performed no other functions.

Ten years ago a system of competitive examination for appointment to judgeships was introduced, and has ever since been in successful operation. The constitution itself provides that jurisdiction shall be exercised by the courts of law according to law; that the organization of the courts shall be determined by law; that the judges shall be appointed from among those who possess the proper qualifications according to law, and that no judge shall be deprived of his office except for misconduct and by due process of law. A statute passed for carrying these constitutional guarantees into effect and providing for a comprehensive and complete reorganization of the courts of justice has been in operation for more than four years.

# GEOGRAPHY OF THE AIR

ANNUAL ADDRESS BY THE VICE-PRESIDENT

GENERAL A. W. GREELY

(*Presented before the Society November 2, 1894*)

The broadening fields of human knowledge have changed their very name in the evolution that has been wrought in manner, means and extent of learning, research and study. We no longer say *science*, but instead *the sciences*. From time to time, as the aggregations of fundamental data and accompanying discussions have become too divergent for easy comparison or too abundant for individual assimilation and reception, they have been divided and subdivided first into branches and eventually into separate sciences.

It is only within the early part of the present century, however, that associations have formed for the study of geographic problems, and yet more recent is the claim and belief that geography is no longer an unappreciated handmaid of history or geology, but rather an able-bodied member of the scientific brotherhood.

At this time, then, it is fitting that the general subject of geography should be very briefly reviewed, especially with reference to its proper place among the sciences, its enlarged scope in the great universities of the world, and the radical transformation in methods of study that makes it a science rather than an accomplishment.

It is twenty years since Germany, first of the great nations, awoke to the value of sound geographic study. Previously taught perfunctorily as an adjunct to history, geography was at that time honored in one of its great universities by a separate chair. Such were the results from this field of research, previously neglected by the other sciences, that other universities speedily followed the example, and at present fourteen of the

twenty-one German universities have professors of geography, with annual salaries running as high as two thousand dollars. Now the tendency to separate history and geography is general, and this latter science is not only compulsory in Germany, but is recognized as of equal value to history, natural science, physics and chemistry.

Geography has assumed similar importance in France, Belgium and Italy. The last-named country, besides imposing proficiency therein as essential to the degree of Ph. D., has established twelve professorships at its great seats of learning. The conservative universities of Great Britain, viewing modern tendencies with distrust, slowly yielded to the inevitable, and while Cambridge decided some ten years since that, among other universities, teachers to be appointed there should be one in geography, yet it is only within a few years that Cambridge and Oxford have formally appointed geographic readers or lecturers.

Formerly the field of geography was unduly restricted by associating it with geology or history—a practice happily waning. Now the pendulum swings to the other extreme, and there is on the part of some enthusiasts a tendency to unduly extend its limit so as to encroach on the domain of other branches of science. The separate sciences necessarily overlap, and no sharp line of division can be drawn that will find universal acceptation.

In my opinion, geographic science should be restricted to the surface of the earth, with its superincumbent or attached objects and attendant atmospheric phenomena, which are to be considered, both in their interrelations with the earth and with each other. The evolution of the earth's surface pertains to geology, but the distribution over the surface of the earth of inorganic matter, whether in the shape of agricultural soils or other forms, with industrial possibilities, pertains to geography. Similarly the distribution of existing faunas and floras is geographic as far as these in any way affect mankind, while their classification and detailed study are botanical, biological or zoölogical. In like manner other physical sciences either touch or overlap that of geography, the same class of data pertaining to different branches, according to its interrelation with man or its bearing on non-geographic sciences.

There is no question that geography, when properly taught, is not only a discipline for the mind, but it also furnishes its students with a body of information both interesting and valuable.

In its comparative branches it trains and stimulates the intellectual faculties; by its contact with nature it develops the powers of observation and reflection, and in its investigations it offers endless opportunities for promoting clearness of expression and logical methods of conclusion. For professional men its stores of knowledge regarding other nations and countries broaden the mind. To merchants the knowledge it affords is indispensable when changed conditions oblige them to seek foreign outlets for their wares. Its utility is even more apparent to statesmen and legislators, whose actions control the destiny of a nation, which, through their geographic ignorance or knowledge may be led into humiliating and unfavorable concessions or may reap material advantages at favorable opportunities. To the tiller of the earth it offers material advantages in its afforded knowledge regarding the influences of elevation, exposure and soil, as shown in the natural vegetation or cultivated crops of various countries. To the investigating scientist it presents a wealth of unsurpassed material, almost untouched, it may be said, relative to the distribution of permanent and transitory fauna and flora, and in regard to its ethnographic data and sociologic conditions, so often affected by man's dependence on the resources of the soil.

It has been objected that the addition of another science to the already overladen course of our great universities is to be deplored, since even now time fails for a complete course. This was a valid objection a quarter of a century since, before the authorities of the great educational institutions of the world came to realize that the field of human knowledge had so broadened that the scientist of the future must be a specialist. Now the initiation of selective courses gives opportunity for additional departments of science, hitherto neglected or ignored. As man is the dominating spirit of the earth, so the study of man is the highest and noblest of all pursuits. Time was when the dead languages and ancient history—the forgotten speech and vain actions of vanished nations—were the heights of secular scholastic ambition, but with advanced civilization there inevitably developed a necessity of formulating and mastering such of the natural sciences as minister to the growing physical needs of mankind. The struggle between the humanities and the natural sciences is practically past, each maintaining its fruitful field of usefulness. We have come now, however, to another age, to a higher stage of civilization, where the brotherhood of man is

practically established, upon a low plane, be it granted, so that the lowest tribes and highest communities are inextricably united. As an illustration consider the barbarous and lately cannibalistic tribes of the Congo basin, sixteen years ago unknown to the world; five years later their future destiny deliberated on and in a measure decided by a congress of fourteen great nations. Yet again, and only a year since, the vast industries of this great nation, with their involved financial interests, almost completely paralyzed in a single week by the telegraphic announcement of an order passed by the board of council of a country held by many to be yet heathenish.

These conditions emphasize the already assumed importance, which, it may be added, will steadily increase, of such branches of science as illustrate the interdependence of the humanities and natural sciences. In other words, of the interaction which takes place between man and his physical environment.

One of the most important phases of geographic knowledge is that pertaining to commercial interests. Indeed, so indefinite, unsatisfactory and inaccessible have been the fundamental data on which rest the success of extensive enterprises that, in default of authoritative geographic departments in the great universities of the world, the business portion of large commercial communities have been obliged to organize bureaus of information or commercial geographic societies for the purpose of collecting the widely separated data pertaining to their special department of commerce. In the United States the lack of such data has very materially retarded the development of its foreign export trade—a condition of affairs so obvious and regrettable that the general government has been constrained to attempt a remedy for the evil by initiating and continuing its valuable and highly appreciated series of consular reports. Unfortunately, however, many of our consuls enter upon their duties in various stages of ignorance as to the underlying principles of commercial geography and commerce as represented by widely separated and dissimilar countries. It requires a mind trained in geographic research to treat the important and various aspects of commercial geography. The successful performance of such duties involves a knowledge of the leading industries of each country; technical familiarity with the raw material used; thorough knowledge of such factors as the method and cost of native labor; local customs; trade restrictions; facilities for transportation; hindrances and advan-

tages of trade routes; navigation conditions, such as port dues, canal charges, lighterage, etc; custom duties, both export and import; local trade methods; the character of currency and the peculiarities of exchange. As an illustration of the value of information on the last-named point may be mentioned Stanley's dismay at finding gold coin the only money recognized at Zanzibar, while his gold sight bills on London or Calcutta were negotiated as a favor at the enormous discount of twenty per cent. It may be said that elsewhere in Africa the friends of the white metal predominate, since in Abyssinia the Maria Theresa dollar (or five-franc piece) of a certain date—1789, I believe—is the only current money, a fact which seriously threatened the success of the Abyssinian campaign until the British government supplied Austrian silver to its supply department.

The extent of geographic science necessitates its division into distinct branches, which, by common consent, include, first, mathematical; second, physical, and, third, political geography. Among other suggested divisions are classical, climatological, historical, etc, which, in my opinion, are inadvisable, except as strictly subordinate divisions for special purposes. Other various and suggested divisions of economic, commercial, industrial, hydrographic and climatological should, in my opinion, be combined to form a fourth branch to be known as economic geography.

Mathematical geography concerns the figure, size and motion of the earth, its delineation on charts, and the determinations of its localities by astronomical methods. Research and instruction in connection with this branch should bear especially on the technology of geography, on the principles and methods of cartography, and on such instruments, methods, etc, as are indispensable to the correct determination of positions.

Political geography considers the earth as divided into separate countries or states, the various methods through which these states subsist and exist as independent or subordinate governments, together with the affiliations and repugnances shown in their intercourse with other states. Under political geography should be studied the existing laws, moral institutions, social organization and modes of government of different countries, together with their domestic and foreign policies, with the ensuing results at home and extraneous influences abroad.

Physical geography sets before us the characteristics of the surface of the earth, and in its entirety presents a concrete idea

of the wonderful fitness of the earth for man's habitation and workshop. It includes the distribution of the animal, vegetal and mineral kingdoms; the atmospheric phenomena; the limits, forms and movements of land and water and their interrelations.

The broad field of physical geography is of extreme practical importance as furnishing a vast array of knowledge not only interesting in itself, but also as furnishing the fundamental bases on which necessarily rest the ultimate conclusions of economic geography in its efforts for the perfect evolution of man's material interests. The course and degree of permanency of the great currents of air and sea, the intensity and variation of the important factors of climate, the distribution of rain and snow, the prevalence of storms, the diversifications of land surfaces and ocean beds, the extent and relation of navigable waters and practicable roads, the habitat of faunas and the distribution of floras useful to mankind, and the ethnographic characteristics of different nations and races are the most important subjects that it furnishes for study and consideration.

Economic geography—which may be said to be the comparative treatment of the political and physical branches—owing to its practical bearings, is the most important part of this science, since it illustrates where, when and how the latent resources of the earth may be most advantageously exploited for the benefit of mankind. It involves a knowledge of the natural resources of different regions, of transportation routes, of natural elements that militate against or are favorable to special pursuits or industries, and of numberless social conditions that may affect the initiation, development or continuance of any material enterprise.

In economic geography efforts should be made to supplement the accumulated data of political and physical geography by special study of soil, climate, trade routes, mineral and vegetal deposits and aggregations, transference and acclimatization of plants and animals, raw industrial materials, industrial appliances, financial methods, trade restrictions, race prejudices or peculiarities, and other elements calculated to assist in the practical solution of the problem of bringing the producer and consumer into such relations as will insure the greatest possible benefit to the world. Problems of this character offer endless and attractive means of cultivating the intellect, since the powers of thought are necessarily exercised and the faculties of observation stimulated.

Ten years ago our Commissioner of Education was asked by the Royal Geographical Society to give information setting forth the condition of geographic science and its appliances in the higher institutions of learning in the United States. The information sought was promised, but not furnished. The answer as regards nearly every college or university might well have been paraphrased from a stock army story of the officer who was directed to report on the morals and manners of an Indian tribe he had visited. He tersely said: "Morals they have none and their manners are disgusting." So scientific geographic instruction until lately has been practically *nil* and its appliances obsolete and deficient, as far as the United States is concerned.

It should not be understood that geographic research, or even genius, has been wanting in the United States. The clear-cut ideas, keen researches, vivid portrayals and lucid reasonings of Guyot have done much to raise the level of physical geography. The most striking contribution by the United States to the geographic benefit of the world was that where, as Humboldt said, a new science was created through the genius of Maury, whose discriminating mind gave the original impulse to that special branch of geographic science now known as oceanography. His invaluable system of charts first delineated together as a unity great ocean currents, constant and variable winds, regions of storm and calm and the known whaling grounds. Few appreciate the enormous practical outcome of Maury's labors, which have saved to mankind tens of millions of dollars through the shortened voyages of its commercial transports, which in tens of thousands, weave and reweave across the seas the web of commercial intercourse essential to human progress and prosperity.

More frequently the reverse side, that of geographic ignorance, has presented itself to the attention of man, with its inevitable train of futile enterprises, wasted efforts and ruined fortunes. Now it is an expensive governmental experiment, foredoomed to non-success with its enforced and hasty generalizations, based on insufficient or incorrect data; again it is a commercial enterprise, a great canal, an industrial scheme, a commercial venture, initiated under geographic conditions that forecast inevitable failure. If it is not an official, squandering tens of thousands of dollars in accumulating for building purposes steam saw-mills and bodies of skilled wood-workers in a treeless region abounding in building stone, it is a host of moneyed individuals buy-

ing worthless land on prophesied possibilities, which a cursory knowledge of economics or even physical geography would authoritatively disprove.

A word relative to what many have thought to be the practical if not the whole of geographic work, explorations and their direct or indirect result. Chancellor's voyage to the White sea reaped millions from the Muscovy trade for England. Hudson, Cook, Bering and others made voyages and discoveries that resulted in equally important additions to the wealth of the civilized world. Explorers by the score have affected the course of trade and influenced the onward march of human progress. I have already alluded to the astounding results flowing from Stanley's African work, which, from the nature of circumstances, can never be paralleled. There will be results of no small value from geographic field explorations in the near future, but it may be admitted, as a whole, that the days of great results from geographic discoveries are practically past.

We must turn, then, to the higher field of geographic research, in which comparison and analysis play the most important part. Recall that from a handful of dried plants the botanist Hooker outlined the extent and general physical conditions of an unknown land; that the geologist Heer in a few score fossil plants read the riddle of wondrous climatic changes that the arctic regions have experienced, and that a geographer forecast the great plateau of interior Africa years before its existence was demonstrated to the satisfaction of the world.

Even higher studies, those of economic geography, await the magic influence of scientific treatment to yield fruition of tremendous import to the future, by forecasting the tendencies of industrial progress as affected by the development and transition of the centers of production of the raw materials, and their interrelations with the great centers of population.

Such fields offer most promising results to investigating scientists, and among those who will reap reputation therefrom let us hope there will be many from the ranks of the members of the National Geographic Society.

# SIR FRANCIS DRAKE'S ANCHORAGE

BY

EDWARD L. BERTHOUD

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The Elizabethan era was the dawn of the birth of the supremacy of the English navy, which was destined in the seventeenth and eighteenth centuries to sweep the seas of Spanish, Dutch and French navies and destroy the commercial monopoly of Spain in the new world.

Foremost among the English to attack the attempted monopoly of Spain in the Americas and the East Indies were Drake and Cavendish, who, with what today seem ridiculously insufficient armaments, shook Spanish pride and conceit, and captured the fabulous wealth they yearly sent in galleons to the mother country.

In 1577, under the auspices of England's queen, a silent partner and sharer in the expected booty, Sir Francis Drake sailed from England to raid the Spanish colonies of North and South America.

Sir Francis Drake was one of the boldest buccaneers and navigators that ever sailed from England; he was every inch a sailor. Of infinite bravery, skill and self-reliance, he sallied out to shear the golden fleece so long the sole monopoly of Spain.

Judged today by the standard of present accepted morality, Drake's naval campaign was but a shade above piracy. It was conquest and plunder, with no pretension to discovery or commerce. What it achieved was merely incidental in his plans of occupation—a mingling of chivalric bravery with a modicum of religious fervor. One Fletcher, a clergyman, was his chaplain and exhorter, but was not a very zealous workman in the vineyard of the Lord. Fletcher and one Pretty have both left an elaborate account of Drake's "res gestæ," which in main facts correspond tolerably well.

Sir Francis Drake (whom Fletcher calls our Admiral), having raided and plundered the west coast of South America and of

Central America and Mexico from Chili to Guatulco, capturing ships, towns and great treasures of gold, silver and plate, spreading a reign of terror in that whole region, reached at last the port of Guatulco, a haven a short distance west of Tehuantepec.

At Guatulco* Drake, knowing that the whole power of Spain was now aroused and on the *qui vive* in the South sea, and that the return route by the straits of Magellan was too dangerous and uncertain, both on account of difficult navigation and certain attack from Spanish fleets, boldly resolved to return to England by the Pacific ocean, the Moluccas and East Indies, and the cape of Good Hope, a longer but a safer route. Leaving Guatulco well loaded with plunder, Drake sailed northwestward instead of westward, his true course, some 500 leagues in longitude, and to June 3 1,400 leagues in all, "until we came into 42° north latitude,"† but Pretty says 43° of the pole arctic.‡

Although Fletcher and Pretty differ somewhat in their account, both agree that the cold for them was intense, after their long cruise in the tropics. Pretty says, "our men being pinched with the same, complained of the extremity thereof," while Fletcher pithily says, "they seemed to be in the frozen zone."

On June 5 our militant chaplain says: "Wee were forced by contrary windes to runne in with the shoare, and so cast anchor in a bad bay." Here the cold continuing and, as Fletcher calls them, "vile, thick and stinking fogges prevailing,"§ they were unable to remain, but were forced to go no farther north.

Curiously enough, at this point of his narrative Fletcher seems to have had his mind or his memory much affected, probably by the aforesaid "fogges," for in the next paragraph he gravely tells that this bad bay was in the height (latitude) of 48° north, not far from the entrance of Puget sound into the Pacific ocean. So if Fletcher is correct in his statement as to the latitudes gained, then from June 3 to June 5, 1579, Drake had sailed in three days 6° of latitude, or over 400 miles; or, taking Pretty's estimate of 5°, some 350 miles; but when they concluded to leave this locality and return southward, they followed the coast, which he says was reasonably plain, yet the hills were covered with snow.

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* World Encompassed, by Fletcher.

† Op. cit.

‡ Pretty's narrative or journal.

§ World Encompassed.

Thus, returning with "propitious windes," our clerical narrator tells us it took them to June 17, 1579, to reach on the coast the parallel of 38° 30′ north latitude, "a convenient and fit harbrough," as Fletcher calls it.

We can say here that Fetcher's bay, with the "vile, stinking fogges," which he says was in 48° north latitude, must be considered as an error made by him in place of 43° latitude.

Greenhow, in his discussion on the Oregon question years ago, comments on the discrepancy of time between Drake's rapid journey northward and the twelve days' time it took the Admiral to sail back to the 38° 30′ point with favoring wind.

Prior, in his Collection of Voyages, a well known English work, plainly says Drake went to 43° north latitude, then sailed back south to 38° latitude.

That this is no surmise on our part as to wind and weather, Fletcher himself says the bay was a most uncomfortable spot for them, and they were driven south to find a better place of anchorage.

After carefully comparing Fletcher's and Protty's narratives, it is evident Drake landed somewhere on the coast of California, but where, is the point of discussion. When, however, we consider the cold and frost experienced by them, the confusion of latitudes given, their northing and abrupt return, we cannot give much weight to their latitudes, taken in the storms and fogs that beset that coast, and that their observations and dead reckoning were not even close approximations, nor can we believe such a magnificent bay and harbor as that of San Francisco could have been so slightingly mentioned by him in the way he narrates, so that the "fit and convenient harbor and fair bay" could not be the bay of San Francisco.

Bryant, in his History of the United States, discusses the probable location of Drake's harbor on the coast of California, and gives from Hondius a map of his anchorage, which has a strong resemblance to Bodega bay and Romanzoff point, now known as Bodega head.

Winsor's Narrative and Critical History of the United States enters largely and interestingly into this subject—a résumé of the arguments advanced on this mooted point—adding to the hitherto scanty cartography of Drake's discovery a copy of Dudley's map, the Arcano del Mare. Dudley's map we think but little elucidates the question. It indicates certain bays and

islands between the 38° and 39° north latitude, one of which is called the bay of Saint Michael, the other Porto di Nueva Albion, which, aside from their approximation to the 38° and 38° 30′ latitude, require constructive imagination to call Bodega bay and the port of San Francisco.

Professor Hale, in Winsor's Narrative and Critical History, hints that it may all be the work of Dudley's imagination.

The map of the coast of California, derived from Father Acosta's work, in Angel's Mémoires Geographiques, curiously resembles Dudley's map in several respects. Bahia de Pinos can be taken to represent Monterey bay, and Cabo de San Francisco as point San Pedro; then follow islands that by a farther stretch of imagination can be supposed to represent the Farallones, while the Bahia de las Islas on the same lines represents the supposed San Francisco bay, if such was supposed to exist in the sixteenth century; but is Cabo de San Francisco a name imposed on that headland after or before Drake's voyage? We hope that Professor Davidson will throw some light on that name in his farther promised collation of Viscaino's survey; but Acosta's map is of date anterior to Viscaino's exploration. We were inclined first to consider the group of islands between Cabo de San Francisco and Punta de Sardine as representing Cabrillo's discoveries, but their distance from Monterey bay and their position toward cape Mendocino seem to preclude this theory.

Now, Fletcher says expressly: "From the height of 48° [43°], in which wee now were, to 38° wee found the land by coasting along to be but low; . . . in 38° 30′ we fell with a convenient and fit harbrough, and June 17 (1579), came to anchor therein, where we continued until July 23d."*

San Francisco bay is in latitude 37° 46′ north. Bodega bay is in 38° 30′ north. It is singular, in view of what Fletcher says, that their anchorage was in 38° 30′; that a bay south of Drake's most southern return journey should be selected as the point where Drake landed and took possession. Drake coasted to 38° latitude, near to point Reyes; he, finding no place of suitable anchorage or to land, returns northward again and anchors in Rodega bay, a most convenient point to refit, where a few days after he indulges (more Anglicano) in the antics of a regal crowning more befitting the Neptunian masquerade of a jolly set of

* Op. cit.,

tars and successful buccaneers laden with plunder, than the honors of a sober discovery, while the inane farce of taking possession for the crown of England disregarded the prior rights of Spanish discovery many years before Drake's landing.

Fletcher, who enters in some detail as to what took place during their residence in the bay, says, on page 64: "This country our general named Albion," etc. Another reason for the "act of possession" was evidently Drake's idea that by it he reaffirmed England's denial of Spain's monopoly, founded on the absurd bull of Pope Alexander sharing the eastern and western hemispheres between Spain and Portugal, a partition scouted by both France and England. The absurdity of the "act of possession" by Sir Francis Drake was in later years repeated in numerous localities on this globe with signal advantage to England.

In this manner the poor ignorant aborigines of Africa, Asia, and America have found themselves invested with the honors of allodial possession, duly transferred to England by the magic of treaties. These, with the claims of first discovery conveniently at hand, backed by presents of cast-off clothing, rum, theatrical crowns and medals of Britannia, formed the foundation for future seizure and annexation.

July 23, 1579, Drake left his anchoring ground, the Indians taking a sorrowful farewell, signaling with fires the departure of the buccaneers.

Fletcher now tells us "that not farre without the harborough did lye certain isles (we called them the isles of Saint James), having on them plentiful and great store of seals and birds, with one of which we fell July 24th, whereon we found such provision as might completely serve our turn for awhile."*

These islands, called by Fletcher the Saint James, are undoubtedly the Farallones, yet it took them one day's sail to reach them from their anchorage. We can hardly think it would take a day to sail from Drakes bay or San Francisco harbor to reach these outlying islets. The preponderance of locality and distance seems to point to Bodega bay as Drake's harbor.

It does not seem possible that in their desultory sailing up and down the coast they would have sailed right into San Francisco bay without hesitation or difficulty in finding it.

Then, again, it seems they discovered the Saint James islands only when they left the coast of California. Could they have

* Loc. cit.

ignored them when in June they sailed along the coast and entered the bay? On the theory that they stopped in Drakes bay near point Reyes, they were in sight of the Farallones. If they had sailed into San Francisco harbor on June 17, 1579, they passed between Drakes bay and the Farallones and could not fail to see or notice them.

A discussion on the values of the latitudes given in the course of the desultory navigation of Drake along the coast of California will not be made here. We leave it to the eminent hydrographer, Professor George Davidson, who has most clearly and sagaciously worked out the devious and puzzling questions involved, from the explorations of Cabrillo and Ferrelo, and he alone is competent to sit in judgment over the positive value of Drake's nautical astronomy.

We have elaborated our theory as founded on conditions and physical facts given by the authorities consulted, while we have accepted the latitudes as closely correct when they are applied to the point discussed, when it can be shown they agree with the landmarks described.

From the survey of Viscaino in 1601–1603 until late in the eighteenth century, the coasts of upper and lower California and Oregon were little known or studied. Serious changes took place after 1620, when map-makers began to consider California an island, an error perpetuated to the middle of the eighteenth century. On Duval's map of 1682, California is represented, and Canada is shown as bordering on California. port San Francisco is in about 40° north latitude, and the Rio del Norte is emptying into the Vermillion—most fanciful and unreal cartography founded on the worst errors of former explorers.

Engel, and others quoted by him, suggested in the last century that the discrepancies between the sixteenth century Spanish explorations and those brought out in the eighteenth century might be ascribed to changes in coast configuration. The shallowing of the sea along the coast, the formation of islands and reefs, were sufficient to account for changes in topographic and hydrographic features.

We are unable to either affirm or deny the possibility of such changes in the 350 years since Cabrillo's exploration, yet we cannot forget that California and the region around San Francisco has been subjected to violent and oft-recurring seismic convulsions, which have elevated the region around San Francisco

many feet above the present Pacific level; and that these convulsions are still far from dormant is yearly witnessed by earthquake shocks, a state of high internal tension which might obliterate that magnificent bay.

Consulting the account of Admiral Viscaino's survey of the coast of California as given in Father Venegas's History of California:*

> The Capitana and tender had no sooner left the harbor of Monterey than they had a favorable wind, which, lasting till the twelfth day, carried them beyond port St Francisco. But the day after, which was the 7th January, the wind shifted to the northwest, but blowing an easy gale, still made some way, and the tender, concluding there was no necessity for standing in for the shore, continued her voyage. The Capitana, thinking they were in company, did not show any light, by which means in the morning they had no sight of each other, and the general (Viscaino) in the Capitana returned to port San Francisco to wait for the tender. . . . Another reason which induced the Capitana to put into Puerto Francisco was to take a survey of it and see if anything was to be found of the San Augustin, which in the year 1595 had, by order of his majesty and the viceroy, been sent from the Philippines by the governor to survey the coast of California under the direction of Sebastian Rodriguez Cermenon, a pilot of known abilities, but was driven ashore in this harbor by the violence of the wind. Among others on board the San Augustin was the pilot Francisco Volanus, who was also chief pilot of this squadron (Viscaino's). . . . And the general was desirous of putting in here to see if there remained any vestiges of the ship and cargo.
>
> The Capitana came to an anchor behind a point of land called la Punta de los Reys.

We consider that this quotation most signally proves that port San Francisco was what is now known as Drakes bay, and that Sebastian Viscaino anchored at the northwestern corner, under Punta de los Reyes; and if we accept Acosta's map as published previous to 1580, then it would appear that port San Francisco is a name given to it by the Spaniards, and in no manner connected with Sir Francis Drake's anchorage or the subsequent dubbing of San Francisco bay as the bay of Sir Francis Drake.

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* Venegas's History of California, pp. 288, 289, ed. 1757.

# NOTE ON THE HEIGHT OF MOUNT SAINT ELIAS

BY

PROFESSOR ISRAEL C. RUSSELL.

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Owing to the wide variations in the reported height of mount Saint Elias, it has been facetiously remarked that the mountain must be undergoing remarkable changes. Now that the accurate measurements of Messrs McGrath and Turner, of the United States Coast and Geodetic Survey, have furnished reliable data for comparison, it is important to note that the height of the peak probably does vary, and that future measurements, although as refined as those just mentioned, may not agree with them.

At first glance it might be thought that the snow falling on a lofty range would be blown off from the ridges and peaks and accumulated to a great thickness only in the depressions. It is now known, however, from abundant observations that this is not the case, but instead drifts form in a peculiar manner on even the most exposed summits, so as to materially increase their height. As I have previously attempted to describe,* the drifts on mountain peaks frequently have the form of a sharp pyramid, set eccentrically on their summits. This is the case on mount Saint Elias. The snow pyramid which gives the mountain its exceedingly sharp tip is certainly not less than 200 feet high, and I should not be surprised if, when the top is reached, the snow would be found to be 300 or 400 feet deep. The height of the pyramid depends on the snowfall, on the direction and force of the wind, on eddies in the air currents caused by the shape of the summit, and on avalanches. Every storm remodels the pyramid in the same manner that snow-drifts at lower elevations change their shapes, and the great avalanches which start from its northern face must affect its height. Still the resulting form, so far as is known, is always an unsymmetrical pyramid, with its steepest slope to the north. Changes in the height of the pyra-

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* Nat. Geog. Mag., vol. iii, 1891, p. 143.

mid are not caused by melting, for the reason that under present climatic conditions the snow near the summit of the mountain does not melt during summer, but at an elevation exceeding about 13,500 feet is always dry and light and resembles the finest meal.

The conditions on which the snow pyramid on mount Saint Elias depend are so variable that it is not reasonable to suppose that its height remains the same at all seasons or from year to year. What the variations may be will perhaps be determined by future measurements of the elevation of the mountain

# GEOGRAPHIC NOTES

BY

CYRUS C. BABB

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## *THE ANTARCTIC CONTINENT**

*Résumé of Exploration Work.*—The first expedition into the Antarctic area was made in 1567 by Alvaro Mendaña, a Peruvian. In 1598 the South Shetland islands, a group south of cape Horn, was discovered by the Dutch, and in 1606 the New Hebrides group was discovered by a second Peruvian expedition.

La Roche, a Frenchman, in 1672 reported the discovery of an island now known as South Georgia island. France in 1772 sent out M de Kerguelen, who sighted land in latitude 49° S. and longitude 69° E. He thought he had discovered the Antarctic continent, but a second expedition the next year showed it to be only a barren island, which now bears his name.

The great English captain, James Cook, was the first, however, to do any serious work in this section. In 1773 he first crossed the southern circle, and the next year he reached latitude 71° 10′ S. in longitude 106° 54′ W. He describes the region as intensely inhospitable, beset with thick fogs and heavy storms, and the ports along the coast, if there were any, as being filled with ice of a great thickness. He also believed that it would be impossible to attain a higher latitude, and it is a fact that his record has been surpassed by only two other men—that is, Captain James Weddell and Sir James Clark Ross.

After Cook came Smith, Palmer and Bransfield in 1819 and 1820, and during this latter year also Bellingshauson, a Russian, attained a latitude of 70° S. in longitude 1° 30′ W., discovering Alexander and Peter islands. Powell discovered the South Orkneys. Cook's record was broken in 1823 when Weddell reached latitude 74° 15′ S. in longitude 34° 17′ W. Here he found an

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*See The Geographical Journal, London, 1894; also the Royal Scottish Geographical Magazine, Edinburgh, 1894; also Antarctica, by General A. W. Greely, Cosmopolitan, July, 1894.

open sea with many whales surrounding his ship and the waters covered with birds.

Biscoe in 1831 landed on Adelaide island, discovering also Graham and Enderby lands. Balleny discovered Balleny islands and Sabrina land. The Frenchman D'Urville sighted Adélie land in 1840, but he was unfortunate in being preceded by only a few days by Wilkes, who, in charge of the expedition from our own country, skirted the shore of this continent through 60° of longitude. He was unable to make a landing, owing to the immense ice cap which, descending from the shore, extended for several miles into the sea. It presented a perpendicular face 100 to 200 feet above the level of the sea, and was unbroken by indentations for the entire length along which he coasted. Later Dallman discovered Kaiser Wilhelm islands and Bismarck strait.

The most successful and the most important expedition to the Antarctic was that of the *Erebus* and *Terror*, under the command of Sir James Clark Ross, between the years 1839 and 1843. He thrice crossed the Antarctic circle. In January, 1841, Victoria land was sighted, consisting of mountain ranges varying from 7,000 to 15,000 feet in height. Along this shore he coasted southward for 500 miles, until his way was intercepted by a perpendicular wall of ice 200 feet in height extending in an east and west direction. Immediately in front of him the volcanic cones of mounts Terror and Erebus arose 10,800 and 12,400 feet in height respectively. The latter at the time of visit was in active eruption, and one can imagine what a magnificent sight it must have been to those men to see an immense mountain peak, located in a vast wilderness of ice and snow, belching forth fire, lava, and smoke. The ice barrier capping this Antarctic continent Ross coasted for 380 miles, until he had to make his way out, owing to the closing in of winter.

The next season this intrepid explorer repeated his last year's trip, but with not so much success. He reached a latitude, however, of 78° 10′ S. In the third season, in 1842–'43, Ross visited the regions south of cape Horn in the vicinity of Erebus and Terror bay. He could not follow Weddell's course, owing to the closing in of heavy pack ice.

The next expedition of importance was that of Her Majesty's ship the *Challenger*, which visited these regions in 1874. Little geographic work as commonly understood—that is, the discovery

of new lands—was done. Her investigations were more confined to a study of the deeper regions of the sea. Very valuable scientific results were obtained, however, and through her soundings and dredgings and in connection with previous discoveries, Dr Murray has been able to outline the Antarctic continent.

In the fall of 1892 an expedition, consisting of four steam whalers, was fitted out from Dundee, Scotland. The Royal Geographical Society well equipped them with scientific instruments, such as chronometers and meteorological instruments, and the surgeons on board of two of the vessels, the *Balaena* and the *Active*, were selected on account of their general scientific training. An account of this expedition may be found in the Scottish Geographical Magazine for February, 1894. The two ships, the *Active* and the *Balaena*, left the Falkland islands December 11, cruising about in search of whales until January 2, when they had reached a latitude of 67° S. On January 6, 1893, a landing was made on a beach of Erebus and Terror bay, where a few specimens of seaweed and moss were found and preserved. No whales of value, as the true whalebone whale, were seen, but of the southern finner and the common hunchback large numbers were encountered. Specimens of the bottlenose and two other species were captured, possibly the *Orca orpensis* and the *Globiocephalus*. Seals were plentiful and a good catch was made in a short time, four species being observed, apparently identical with those described by Ross, but it is doubtful whether the true fur-seal was found.

There was a Norwegian sealer, the *Jason*, in the same vicinity this season. She collected on Seymour island, in Erebus and Terror bay, a number of fossils, which have since been determined as belonging to the lower tertiary.*

In September, 1893, another Norwegian steam whaler, the *Antarctic*, sailed from Tönsberg, Norway, for the southern regions. She was sent out by Commander Svend Föyn. Her sailing master is Captain Leonard Christensen; she is barque-rigged; tonnage, 226, and carries eight whale-boats. Meteorological and other observations are to be made. Last season, in the vicinity of Kerguelen islands, 1,500 seals were caught inside of eight days, no fur-seals, however, being found. At these latter islands the vessel visited Royal sound, where a colony of 59 persons was found, consisting of Europeans, Chinese and Indians. She

*Geographical Journal, January, 1894, p. 11.

then sailed for Australia and arrived at Melbourne on February 27, 1894. This November she will attempt to enter the Antarctic circle in the vicinity of Victoria land.

Finally the last expedition at this date, consisting of the Norwegian whalers *Jason*, *Castor* and *Hertha*, has contributed considerably to our topographic knowledge of Antarctica.*

On December 6, 1893, Captain C. A. Larsen, in the ship *Jason*, attained a latitude of 68° 10′ S. in longitude 60° W., and one of the other vessels reached latitude 69° S. and in a more western longitude. These men have therefore attained a higher southern latitude by four degrees in these longitudes than any previous explorers. New lands were discovered and a number of active as well as extinct volcanoes were sighted.

Large numbers of seals were seen and captured, belonging principally to the *Crested* and *Fisheel* species. Few whales were captured; species seen were as follows: *Blackside*, *Finside*, *Knurhead*, *Minkeside* and the *Rethside*.

On December 1 land was sighted in 65° 43′ S. latitude and 56° 57′ W. longitude and the name of cape Framnes was given to the headland. The land appeared to be high, covered with snow and ice, and stretched in a north and south direction. Many high snow-covered peaks were seen in the interior, and the name of mount Jason was given to one of the more eastern and nearer peaks. The lower slopes of this mountain were free of ice and snow, but it was found impossible to land, owing to the immense ice barrier which extended from the land into the sea for a distance of several miles.

In latitude 66° 42′ S. and longitude 61° 50′ W. high land was sighted, to which was given the name of Foyn land. It consists of four hills, their northern and eastern slopes being free of snow and forming a conspicuous landmark, especially on approaching from the north. Captain Larsen sailed southward for a distance of 300 miles along this ice barrier until on December 6 he attained his highest southern latitude. Further progress in this direction was prevented by the winter ice. On their return several islands were discovered and named Weather, Robertson, Christensen and Seal islands. A landing was made on Christensen island and the greater part of it was found to be free of snow. To the northwest of this island a small volcanic island

* The Voyage of the *Jason* to the Antarctic Regions: The Geographical Journal, London, October, 1894, pp. 333-344; 1 map.

was sighted, to which was given the name of Lindenberg. Captain Larsen says in his journal:

This volcano had the shape of a sugar-loaf and was of considerable height. The ice was melted for a considerable distance around it. It presented a remarkable aspect, as around the top and on the slopes there were funnel-like holes, from which a very black and thick smoke issued from time to time, covering the top itself. In short, it was in full activity.

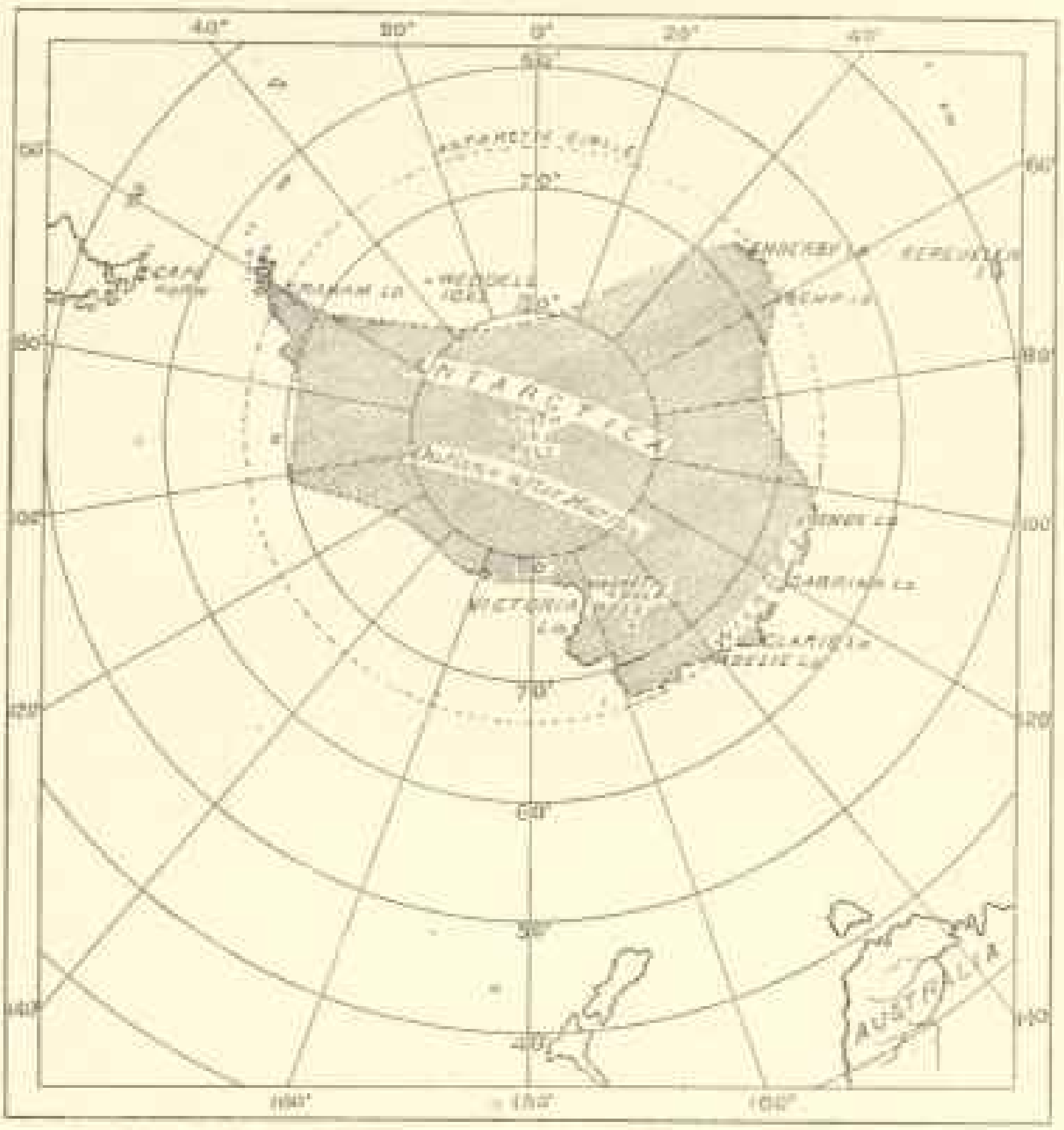


FIGURE 3.—*The Antarctic Continent.*

*The Antarctic Continent.*—Figure 3 is a map of the Antarctic continent according to Murray. He estimates the area as nearly 4,000,000 square miles, or a continent with a greater area than Australia. According to Ross, the rocks of Franklin, Cockburn and Possession islands are of volcanic origin, and in his dredgings to the east of Victoria land volcanic rock was found, but with some fragments of gray granite.

D'Urville, at Adélie land, found a precipitous shore, with elevations from 2,000 to 3,000 feet. The rocks of the neighboring islands were granites and gneisses. Wilkes found on an iceberg in the same vicinity large bowlders of red sandstone and basalt, with smaller gravels, stones, clays and mud. The dredgings of the *Challenger* produced from the great ocean basins volcanic débris, but as the Antarctic continent was approached quartz and granite fragments were found, and in the highest latitudes reached the dredgings consisted mainly of fragments of diorites, granites, mica schists, sand-stones, limestones, and earthy shales.

In the reports of the expeditions previous to those of the Dundee and Norwegian whalers the rocks of the islands to the south of cape Horn are described as of volcanic origin. Dr Bruce, of the *Balæna*, reports the finding of metamorphic and sedimentary rocks in his soundings.

Captain Larsen, of the ship *Jason*, as above stated, collected from Seymour island during his first trip, in 1892, a number of fossils which have been determined as belonging to the lower tertiary. In November of the next year he landed on the same island, but at a different place, and says:

> When we were a quarter of a Norwegian mile from shore and stood about 300 feet above the sea the petrified wood became more and more frequent, and we took several specimens, which looked as if they were of deciduous trees; the bark and branches, as also the year rings, were seen in the logs which lay slanting in the soil. The wood seemed not to have been thrown out of the water; on the contrary, it could never have been in the water, because, in the first case, we found petrified worms, while there were none in the second. At other places we saw balls made of sand and cement resting upon pillars composed of the same constituents. . . . The beach is flat and consists of white sand.

It would seem, therefore, that Antarctica was a true continental area, having the fundamental continental gneiss, with later fossil-bearing sandstones and limestones.

The primary object of Ross's expedition was for the purpose of making magnetic observations, and in this he was very successful, sailing to within 160 miles of the south magnetic pole. He furnished more trustworthy evidence on the meteorological and magnetic conditions of Antarctica than all the preceding and succeeding expeditions put together.

At the time of the reading by Dr Murray of his valuable paper before the Royal Geographical Society, Dr Neumayer, a German scientist, contributed an article showing the desirability, even the

necessity, of observations in this section before the theory of the earth's magnetism could be finally settled.*

The very important problem of the figure of the earth, together with a number of other geodetic questions, cannot be solved without fuller knowledge of this area.

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## *MAGNETIC OBSERVATIONS IN ICELAND, JAN MAYEN AND SPITZBERGEN IN 1892.*†

The May and June number (1893) of the Annuaire of the French Meteorological Society contains an account by M Th. Moreaux of the magnetic observations made in Iceland, Jan Mayen island, and Spitzbergen, in the year 1892, by the officers of the transport *la Manche*.

The secretary of the French navy, at the instance of the minister of public instruction, sent, under command of Captain Bienaimé, the steamer *la Manche* to Jan Mayen and Spitzbergen for scientific purposes, supplementary to a supervision of the Iceland fisheries, which was the ordinary duty for the ship.

The magnetic observations, participated in by several officers, were tabulated and reduced by Lieutenant Exelmans. In Iceland the northern and southeastern shores were ice-bound and the eastern coast nearly unattainable; consequently observations were made upon the northwestern coast at Reykiavick, Dyre, Isa and Patrix fiords.

At Jan Mayen the pier and bench-mark erected by the international Austrian expedition (1882–83) were found intact. Here, as in Iceland, the soil is magnetic, and around the building sheltering the pier was found a fine blackish sand, arising from rock disintegration, which affected very strongly the magnetic needle.

At Spitzbergen several series of determinations were made at Research bay on the spot where Bravais observed in 1839. Bad weather and heavy sea prevented them from landing at cape Thorsden, the Danish magnetic station of 1882, but they succeeded in making observations under favorable conditions, however, in la Manche bay, about 7 miles from the Swedish observatory. In addition, observations were made at sea at 21 separate points in the vicinity of Iceland, in order to verify the opinion,

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*The Renewal of Antarctic Exploration, by John Murray: The Geographical Journal, London, January, 1894, p. 37.

†Translated and condensed by General A. W. Greely.

generally accepted among the Iceland fishermen, that in these waters the actual direction of the compass varies from 20° to 30° from the calculated direction. These observations indicated that the calculated values are never more than three degrees in error.

By comparison with former observations, it was found that the average secular variation of the declination is — 10′ at Jan Mayen (1882–1892) and at Spitzbergen (1838–1892), —7′ at Reykiavick (1836–1892), and —8′ at Bergen (1858–1892).

The secular variation of the inclination and intensity is much less clearly defined. The inclination, for example, appears to have diminished only nine minutes at Reykiavick since 1876, and is now increased at Jan Mayen and Spitzbergen, according to the observations of 1892. The tendency of this variation may seem natural, taking into consideration the distribution of isodynies in the North Polar ocean; but, on the other hand, we know that different inclination compasses do not give identical results; and again, that to make magnetic observations in volcanic lands strictly comparable it is necessary that observers should occupy exactly the same point, and even under these conditions it is uncertain whether the influence of the rocks has not been modified in the meantime.

The following table gives the result of the land observations:

| 1892. | Station. | Latitude. | Longitude. | Declination West. | Inclination. | Horizontal component. |
|---|---|---|---|---|---|---|
| June 13 | Reykiavick | 64°.1 | 21°. W. | 30° 43′.0 | 70° 17′.0 | 0.1310 |
| June 24–25 | Dyrafiord | 65°.5 | 23°.8 W. | 30° 32′.0 | 74° 8′.7 | 0.1157 |
| May 28 | Isafiord | 66°.1 | 23°.6 W. | 40° 22′.0 | | 0.1258 |
| June 4 | Patrix fiord | 65°.6 | 20°.4 W. | 41° 51′.0 | | 0.1179 |
| July 27 | Jan Mayen | 71°.0 | 10°.5 W. | 29° 10′.2 | 79° 14′.2 | 0.0970 |
| August 2 | Spitzbergen (H. B.) | 77°.3 | 12°.2 E. | 17° 3′.8 | 80° 61′.8 * | 0.0939 |
| August 8 | Spitzbergen (C. M. B.) | 76°.5 | 13°.7 E. | 16° 3′.2 | 80° 42′.2 | 0.0888 |

* 79° 45′.0 August 1 and 80° 7′.0 August 2.

## *A NEW LIGHT ON THE DISCOVERY OF AMERICA*

This was the title of a paper by Mr Yule Oldham, read at the meeting of the British Association for the Advancement of Science, last August, at Oxford. He says:*

A glance at the map of the Atlantic ocean will show the three easiest points of access: (1) North America by means of the convenient stepping-

* Scottish Geographical Magazine, September, 1894, page 471.

stones, Iceland and Greenland; (2) Central America, with the help of the steady northeast trade winds; (3) Brazil, in South America, which is not only the nearest point to the Old World, but has the additional advantage of winds and currents tending in its direction. There can be little doubt that America was visited by Norsemen about A. D. 1000, by the first route. Tradition and the records of some early maps, which show some large land masses as far west of the Azores as these are west of Europe, seem to indicate that the second route had been possibly utilized early in the fifteenth century, but the third and easiest was not available till the west African coast as far as cape Verd had been discovered. It was in 1445 that cape Verd was for the first time rounded by one of the exploring expeditions despatched from Portugal by the indefatigable Prince Henry. There is good reason to believe that only two years later Brazil was reached. There is at Milan a remarkable manuscript map, dated A. D. 1448, drawn by Andrea Bianco, of Venice. On this map are shown for the first time the result of the Portuguese discoveries as far as cape Verd, but in addition there is drawn at the edge of the map, southwest from that cape, in the direction of Brazil, a long stretch of coast line labeled "Authentic island," with a further inscription to the effect that it stretches "1,500 miles westward." Antonio Galvano, in "The Discoveries of the World," published in the middle of the sixteenth century, says that in A. D. 1447 a Portuguese ship was carried by a great tempest far westward until an island was discovered, from which gold was brought back to Portugal. As Bianco's map of A. D. 1448 was made in London, it is likely that it represents information about this voyage obtained in Portugal, where Bianco probably called on a voyage from Venice to England. The conclusion to be drawn is that South America was first seen in the very year in which Columbus is believed to have been born, by one of the Portuguese explorers despatched by Prince Henry the Navigator. In the discussion of this paper the author's conclusions were challenged by several gentlemen on the ground that its argument was purely conjectural, and that if such a discovery had been made it would have been known to Columbus and other geographers of the day.

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*MONOGRAPHS OF THE NATIONAL GEOGRAPHIC SOCIETY*

The Board of Managers has the pleasure of announcing that it has made arrangements for the publication of a series of science manuals on the physical features of the United States. The principal object of the publication is to render accessible to every public school in the United States, at a nominal price, accurate and properly correlated information upon the geography of our country, and expressed in simple, untechnical language. Various members of the Society have agitated this question for some time past, and it resulted that in last June,

President Hubbard called a meeting of certain geographers to meet Major J. W. Powell and Professor W. M. Davis of Harvard University and listen to their views upon this subject.

The teacher of geography in this country at the present time has great difficulty in finding information on their subject, especially comprehensive accounts of their home geography, outside of their text-books. A certain amount may be found in reports of geological surveys, state and national, and in scientific journals, but they are generally written in such a technical style that little benefit can be derived from them.

From a suggestion made by Professor Richard Lehmann at the second German Geographical Congress at Halle in 1882 a central commission for the scientific geographic study of Germany was formed. Various publications have appeared under the direction of this commission, including a guide to geographic study and a bibliography of geographic literature. The more important of their results are included, however, in the special volumes on investigation of German geography and ethnology, now reaching seven volumes.*

Our Society will somewhat modify the German plan in that the monographs will be prepared more especially for the teachers of our public schools. It is also the intention of introducing into the series a large number of maps, diagrams and illustrations. Arrangements have been consummated with the American Book Company of New York to publish this series and to bring it to the attention of the school teachers of this country. The plan involves the preparation of material for a physiographic description of the country by districts. The following are some of the subjects and authors proposed:

The elements of physiography, by Major J. W. Powell, director of the Bureau of American Ethnology; The tidal marshes and beaches of the Atlantic coast, by N. S. Shaler, professor of geology, Harvard University; Niagara falls and its history, by G. K. Gilbert, United States Geological Survey; The New England hills, by W. M. Davis, professor of physical geography, Harvard University; The southern Appalachian system, by Bailey Willis, United States Geological Survey; Mount Shasta, by J. S. Diller, United States Geological Survey; The lake region of the northwest, by Professor I. C. Russell, University of Michigan.

Among other proposed subjects are the flood plains of the Mis-

* Forschung en zur deutschen Landes-und Volkskunde.

souri, the Atlantic coastal plain, the Colorado canyon, the Great Plains, the high plateaus of Utah, the valley of California, and the extinct volcanoes of the West.

If this project is successful, the idea is to extend the scope, involving the issue of monographs on the relation of geography to other subjects, types of weather in different parts of the country, rainfall, the storms of the United States; the ocean, including the tides and currents of our shores; the relation of geographic form and historical development; the relations of resources, industries and population, etc.

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*IMPORTANT ANNOUNCEMENT CONCERNING ESSAYS*

The subject of the Essay in competition for the *Gold Medal and Geographic Certificates* of the NATIONAL GEOGRAPHIC SOCIETY, for the year 1895, will be the River Systems of the United States.

The Geographic Gold Medal of the NATIONAL GEOGRAPHIC SOCIETY will be awarded to the best essayist of the entire country, while the second essayist will receive a certificate of honorable mention. The best essayist of each state will receive a certificate of proficiency from the Society.

1. Essays, not exceeding 2,000 words in length, will be received only from such public schools as announce their intention to compete by May 31, 1895.

2. Essays must be entirely composed by the student, who must certify on honor that he has not received aid from any person.

3. The two best essays from each school shall be passed on by a committee of the NATIONAL GEOGRAPHIC SOCIETY in order to select the best essay for each state and for the United States.

4. No certificate shall be awarded unless, in the opinion of the judges, the essay offered possesses sufficient merit to justify such award.

5. ESSAYS MUST BE WRITTEN BY THE END OF THE SCHOOL YEAR IN 1895, AND BE SUBMITTED TO THE NATIONAL GEOGRAPHIC SOCIETY NOT LATER THAN JULY 15, 1895.

One of the most important aims of the NATIONAL GEOGRAPHIC SOCIETY is to stimulate and make more practical the study of geography, particularly with reference to America. The Society therefore seeks the coöperation of all educational workers in making its labors more efficient and general. To this end, gifts

for medals and scholarships are solicited, and identification with the Society by membership and personal effort is suggested.

The Society already comprises among its active workers a considerable number of geographic scientists, who have given liberally of their time and efforts with a view of stimulating public interest in geographic education. The Society is a working one, and in its efforts to exercise an educational influence over the whole of the United States, feels justified in asking liberal support from public-spirited citizens. The Society numbers nearly eleven hundred members, and has active representatives in every state and territory.

All members are earnestly requested to take a special interest in this subject and to bring it to the attention of the school superintendents and teachers in their vicinity. Additional circulars may be obtained of the committee as given below.

General A. W. Gresly, United States Army, Dr T. C. Mendenhall, President Worcester Polytechnic Institute, and Professor W. B. Powell, Superintendent of Public Schools of the District of Columbia, constitute the committee charged with the award of the prizes for 1895.

The Committee on Prizes also desire to announce that in connection with the essays submitted to the Society last year on the river systems of the United States that Miss Cora Combs, of the high school at Chariton, Iowa, received honorable mention on the unanimous recommendation of the judges.

# LAWS OF TEMPERATURE CONTROL OF THE GEOGRAPHIC DISTRIBUTION OF TERRESTRIAL ANIMALS AND PLANTS*

ANNUAL ADDRESS BY VICE-PRESIDENT

DR C. HART MERRIAM

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The tendency of animals and plants to multiply beyond the means of subsistence and to spread over all available areas is well understood. What naturalists wish to know is not how species are dispersed, but how they are checked in their efforts to overrun the earth. Geographic barriers are rare, except in the case of oceans, and since even these were formerly bridged at the north, another cause must be sought. This has been found in the group of phenomena commonly hidden under the word climate, and nearly a century ago it was shown by Humboldt that temperature is the most important of these climatic factors.

In the northern hemisphere animals and plants are distributed in circumpolar belts or zones, the boundaries of which follow lines of equal temperature rather than parallels of latitude. They conform in a general way, therefore, with the elevation of the land, sweeping northward over the lowlands and southward over the mountains. Between the pole and the equator there are three primary belts—Boreal, Austral and Tropical—each of which may be subdivided into minor belts and areas. In the United States the Boreal and Austral regions have each been split into three secondary transcontinental zones. The Boreal are known as the *Arctic*, *Hudsonian* and *Canadian*; the Austral as the *Transition*, *Upper Austral* and *Lower Austral*. The subordinate faunas and floras need not be here considered.

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*The present abstract of the principal results of an investigation carried on under the Department of Agriculture is here published by permission of the Honorable J. Sterling Morton, Secretary of Agriculture. The temperature data have been furnished by the United States Weather Bureau, a branch of the Department of Agriculture. A preliminary announcement of results was made by the author before the Philosophical Society of Washington May 26, 1894.

The area of overlapping of Boreal and Austral types is confined in most parts of the country to the narrow Transition zone, but along the Pacific coast it reaches all the way from southern California to Puget sound. This Pacific coast strip has always proved a stumbling-block to students of geographic distribution of life in America, but has now become the means of verifying the fundamental laws governing this distribution, as shown later.

But while the boundaries of the several zones rarely coincide with absolute mechanical barriers, being fixed in the main by temperature, difference of opinion prevails as to the period during which the temperature exerts its restraining influence, and no formula for the expression of the temperature control has been heretofore discovered. None of the temperature data computed and platted on maps as isotherms are available in locating the exact boundaries of the zones, because these isotherms invariably show the temperature of arbitrary periods, such as months, seasons and years—periods whose beginning and ending have reference to a particular time of year rather than a particular degree or quantity of heat. Thus the temperature for July, which is by far the most important of those commonly shown in isotherms, bears an inconstant relation to the hottest part of the year. In certain localities the four hottest weeks may fall within the month of July, but in other localities they cover the period from the middle of June to the middle of July; in others from the middle of July to the middle of August, and in others still from the early part of August to early September. Similarly, the isotherms showing the mean annual temperature fail to conform to the boundaries of the life zones, although in the far south they may be nearly coincident. The mean summer temperature is obviously inapplicable because of the varying length of the season in different localities.

Several years ago I endeavored to show that the distribution of terrestrial animals and plants is governed by the temperature of the period of growth and reproductive activity, not by the temperature of the whole year; but how to measure the temperatures concerned was not then worked out. The period of growth and reproductive activity is of variable duration, according to latitude, altitude and local conditions of each particular locality. In the tropics and a few other areas it extends over nearly the whole year, while within the Arctic circle and on the summits of high mountains it is of less than two months' dura-

tion.* It is evident, therefore, that while in the tropics there may be a close agreement between the mean annual temperature and the life zones, in the north the widest discrepancy exists between them.

At one time I believed that the mean temperature of the actual period of reproductive activity in each locality was the factor needed,† but such means are almost impossible to obtain, and subsequent study has convinced me that the real temperature control may be better expressed by other data.

For more than a century physiological botanists have maintained that the various events in the life of plants, as leafing, flowering and maturing of fruit, take place when the plant has been exposed to a definite quantity of heat, which quantity is the sum total of the daily temperatures above a minimum assumed to be necessary for functional activity. The minimum used by Boussingault and early botanists generally was the freezing point (0° C. or 32° F.), but Marie-Davy and other recent writers believe that 6° C. or 43° F.‡ more correctly indicates the temperature of the awakening of plant life in spring. In either case the substance of the theory is that *the same stage of vegetation is attained in any year when the sum of the mean daily temperatures reaches the same value*, which value or total is essentially the same for the same plant in all localities. This implies that the period necessary for the accomplishment of a definite physiological act, blossoming for instance, may be short or long, according to local climatic peculiarities, but the total quantity of heat must be the same. The total amount of heat necessary to advance a plant to a given stage came to be known as the *physiological constant* of that stage. Linsser believed this law to be fallacious and maintained that the physiological constant of any particular stage of vegetation was *not the sum total* of heat acquired that time, but the *ratio* or proportion of this sum to the sum total for the entire season. Thus Linsser's physiological constant is the *ratio* of the sum of the mean daily temperatures at the time when any particular stage of vegetation is attained to the sum total for the

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* See N. Am. Fauna, No. 3, September, 1890, pp. 23, 27, 29–32; also Presidential Address, Biological Soc. Wash., vol. viii, April, 1892, pp. 45, 46.

† I began work on this line about fifteen years ago and continued at intervals for ten years before convinced of its impracticability.

‡ The exact equivalent of 6° C. is 42°.8 F.

year. This formula was based on the belief that plants of the same species living in different places arrive at the same phase of development by utilizing the same proportion of the total heat which they receive in the course of a season.

Students of geographic distribution may dismiss this phase of the inquiry as not pertinent to the problem in hand, for we are concerned with the physiological constant *of the species itself*, not of any stage or period in its life history. But what is the physiological constant of a species, and how can it be measured? If it is true that the same stage of vegetation is attained in different years when the sum of the mean daily temperatures reaches the same value, it is obvious that *the physiological constant of a species must be the total quantity of heat or sum of positive temperatures required by that species to complete its cycle of development and reproduction.* The difficulty in computing such sums is in fixing the end of the period during which temperature exerts its influence upon the organism. In the case of plants this can be done by direct observation of a particular individual or crop, in connection with careful thermometric readings covering the whole period of vegetative activity, and data of this sort have been actually recorded by certain European phenologists, but I am not aware that an attempt has been made to correlate the facts thus obtained with the boundaries of the life zones. Since, however, all forms of life are affected by temperature and it is manifestly impracticable to ascertain by direct observation the total quantity of heat necessary to enable the various species of mammals, birds and reptiles to complete the annual cycle of reproduction, and since the areas inhabited by definite assemblages of animals and plants have been found to be essentially coincident, it is evident that a more generalized formula is necessary. If the computation can be transferred from the *species* to the *zone* it inhabits—if a *zone constant* can be substituted for a *species constant*—the problem will be well nigh solved. This I have attempted to do. In conformity with the usage of botanists, a minimum temperature of 6° C. (43° F.) has been assumed as marking the inception of the period of physiological activity in plants and of reproductive activity in animals. The effective temperatures or degrees of normal mean daily heat in excess of this minimum have been added together for each station, beginning when the normal mean daily temperature rises higher than 6° C. in spring and continuing until it falls to

the same point at the end of the season. The sums thus obtained have been platted on a large scale map of the United States,* and isotherms have been run which are found to conform in a most gratifying manner to the northern boundaries of the several life zones, as may be seen on comparing a reduced copy of this map (see plate 12) with a map of the life zones (see plate 14). The latter, it may be observed, is identical, save a few corrections in minor details, with the third edition of my Bio-geographic map of North America (prepared a year ago and published in the Annual Report of the Secretary of Agriculture for 1893).† While the available data are not so numerous as might be desired, the stations in many instances being too far apart, still enough are at hand to justify the belief that *animals and plants are restricted in northward distribution by the total quantity of heat during the season of growth and reproduction.*‡

The isotherm indicating a sum total of 5,500° C. (10,000° F.) coincides with the northern limit of distribution of Transition zone species, agreeing in the main with the dividing line between the two primary life regions of the northern hemisphere—Austral and Boreal. But in areas where extensive overlapping of Austral and Boreal types occurs, as along the Pacific coast from southern California northward to Puget sound, it will be observed that the isotherm in question points, as elsewhere, to the northern limit of Austral types and bears no relation whatever to the southward limit of Boreal types. It is evident, therefore, that the southward range of Boreal species, and perhaps of others also, is regulated by some cause other than the total quantity of heat. This cause was believed to be the mean temperature of the hottest part of the year,§ for it is reasonable to suppose that Boreal species in ranging southward will en-

* Gannett's "Nine-sheet contour map," published by the U. S. Geological Survey.

† The only changes worth mentioning are the introduction of the Tropical along the lower Colorado valley, the extension of the Tropical across the peninsula of Florida, and the extension of the Transition along the Pacific coast strip.

‡ In the case of certain sensitive species another factor enters into the problem, namely, *killing frosts*, for a few species are excluded by the occurrence of frosts from areas having a sufficient total quantity of heat for their needs.

§ This was indicated by mean summer temperatures platted from time to time during the past fifteen years, but the length of the period was never satisfactorily ascertained.

counter, sooner or later, a degree of heat they are unable to endure. The difficulty is in ascertaining the *length of the period* whose mean temperature acts as a barrier. It must be short enough to be included within the hottest part of the summer in high northern latitudes, and would naturally increase in length from the north southward. For experimental purposes, and without attempting unnecessary refinement, the mean normal temperature of the six hottest consecutive weeks of summer was arbitrarily chosen and platted on a large contour map of the United States, as in the case of the total quantity of heat. On comparing a reduced copy of this map (plate 13) with the zone map (plate 14) it appears that the isotherms conform to the southern boundaries of the Boreal, Transition and Upper Austral life zones, and that the isotherm of 18° C. (64°.4 F.) agrees almost precisely with the southern boundary of the Boreal region. The coincidence is indeed so close as to justify the belief that *animals and plants are restricted in southward distribution by the mean temperature of a brief period covering the hottest part of the year.*

If the isotherm of 18° C. (64°.4 F.) for the six hottest consecutive weeks (see plate 13) is compared with that of 5,500° C. (10,000° F.), showing the sum of positive temperatures (see plate 12), it will be observed that the two are coincident in the main except in a few localities. The principal discrepancy is along the Pacific coast from Puget sound to southern California. In this strip maps 12 and 13 not only fail to agree, but are fundamentally different, showing that no constant relation exists between the mean temperature of the six hottest consecutive weeks and the total of heat for the season. The mean temperature of the hottest part of the year from about latitude 35° northward along the coast is truly boreal, being as low as the mean of the corresponding period in northern Maine and other points well within the Boreal zone. The mean of the six consecutive hottest weeks at several points on the coast of California is as follows: At Eureka, on Humboldt bay, 13°.5 C. (56° F.);* at San Francisco, 15°.5 C. (60° F.); at Monterey and Ventura, 17°.5 C. (63°.5 F.).† Strange

* In the following mean temperatures, fractions smaller than one-half a degree are ignored.

† Santa Barbara, between Monterey and Ventura, has a slightly higher mean (67° F.), which is explained by its situation on a low, narrow coastal plain facing the south, with a range of mountains immediately on the north.

as it may seem, San Francisco has a lower normal mean temperature during the hottest part of the year than Eastport, Maine, the mean at Eastport being 16° C. (61° F.). On the other hand, the sum of positive temperatures (the normal mean daily temperatures above 6° C.) at San Francisco is more than 10,000° Fahrenheit higher than at Eastport, being 11,290° C. (20,360° F.) at the former and only 5,470° C. (9,880° F.) at the latter locality. At no point in the Pacific coast strip is the sum of the positive temperatures known to fall below 7,330° C. (13,600° F.), and it reaches 8,200° C. (14,800° F.) at Tatoosh island, off cape Flattery, the extreme northwestern point of the United States. Even at cape Flattery, therefore, the total of heat for the season is 260° C. (500° F.) greater than at Eastport, Maine, though the latter is the more southern locality and has the higher mean summer temperature.

The data at hand for the Pacific coast strip are amply sufficient to demonstrate two important facts: (1) that the temperature of the summer season, the hottest part of the year, is phenomenally low for the latitude and altitude—so low, indeed, as to enable Boreal types to push south to latitude 35°; (2) that the total quantity of heat (the sum of the positive temperatures) for the entire season is phenomenally high for the latitude—so high, indeed, as to enable Austral types to push north to Puget sound. The total of heat is even greater at Puget sound than at Philadelphia, Pittsburg, Cleveland, Indianapolis, Keokuk, or Omaha, though five hundred miles north of the latitude of these places. In other words, the mean temperature of the hottest part of the year is sufficiently low for Boreal species, while the total quantity of heat is sufficiently great for Austral species.

It is evident, therefore, that the principal climatic factors that permit Boreal and Austral types to live together along the Pacific coast are *a low summer temperature combined with a high sum total of heat.* The temperature is remarkably equable throughout the year; it never rises high for any length of time, and killing frosts are rare.

The study of the accompanying maps was the means of leading me, *first*, to the explanation of the anomalous distribution of species on the Pacific coast, where for a distance of more than a thousand miles a curious intermingling of northern and southern forms occurs; and, *second*, to what I now conceive to be the true theory of the temperature control of the geographic distribution of species.

The fundamental laws here developed, phrased for the northern hemisphere, may be briefly formulated as follows:

(1) *The northward distribution of animals and plants is determined by the total quantity of heat—the sum of the effective temperatures.*

(2) *The northward distribution of Boreal, Transition zone, and Upper Austral species is determined by the mean temperature of the hottest part of the year.*

## Zone Temperatures.

*Boreal Zones.*—The distinctive temperatures of the three Boreal zones (Arctic, Hudsonian and Canadian) are not positively known, but the southern limit of the Boreal as a whole is marked by the isotherm of 18° C. (64°.4 F.) for the six hottest consecutive weeks of summer. It seems probable, from the few data available, that the limiting temperatures of the southern boundaries of the Hudsonian and Arctic zones are respectively 14° C. (57°.2 F.) and 10° C. (50° F.) for the same period.

*Transition Zone* species require a total quantity of heat of at least 5,500° C. (10,000° F.), but cannot endure a summer temperature the mean of which for the six hottest consecutive weeks exceeds 22° C. (71°.6 F.). The northern boundary of the Transition zone, therefore, is marked by the isotherm showing a sum of normal positive temperatures of 5,500° C. (10,000° F.), while its southern boundary is coincident with the isotherm of 22° C. (71°.6 F.) for the six hottest consecutive weeks.

*Upper Austral* species require a total quantity of heat of at least 6,400° C. (11,500° F.), but apparently cannot endure a summer temperature the mean of which for the six hottest consecutive weeks exceeds 26° C. (78°.8 F.). The northern boundary of the Upper Austral zone, therefore, is marked by the isotherm showing a sum of normal positive temperatures of 6,400° C. (11,500° F.), while its southern boundary agrees very closely with the isotherm of 26° C. (78°.8 F.) for the six hottest consecutive weeks.

*Lower Austral* species require a total quantity of heat of at least 10,000° C. (18,000° F.). The northern boundary of the Lower Austral zone, therefore, is marked by the isotherm showing a sum of normal positive temperatures of 10,000° C. (18,000° F.). A formula expressing the temperature-control of its southern boundary has not yet been found.

*Tropical* species require a total quantity of heat of at least 14,400° C. (26,000° F.); and, since the Tropical Life region is a broad equatorial belt, it is probable that both its northern and southern boundaries are marked by the isotherm showing a sum of normal positive temperatures of 14,400° C. (26,000° F.).

An interesting fact respecting the relative values of the zones is brought out by the isotherms showing the total quantity of heat necessary for each. It appears that the Transition and Upper Austral zones are not of equal value, but that together they are the exact equivalent of the Lower Austral zone.

| Regions. | Zones. | Governing Temperatures. | | | |
|---|---|---|---|---|---|
| | | *Northern limit.* Sum of normal mean daily temperatures above 6° C. (43° F.). | | *Southern limit.* Normal mean temperature of six hottest consecutive weeks. | |
| | | C. | F. | C. | F. |
| Boreal | Arctic | | | 10°* | 50°* |
| | Hudsonian | | | 14°* | 57°.2* |
| | Canadian | | | 18° | 64°.4 |
| Austral | Transition[1] | 5,500° | 10,000°[4] | 22° | 71°.6 |
| | Upper Austral[2] | 6,400° | 11,500° | 26° | 78°.8 |
| | Lower Austral[3] | 10,000° | 18,000° | | |
| Tropical | | 14,500° | 26,000° | | |

* Estimated from insufficient data.

[1] The Transition zone comprises three principal subdivisions: an eastern or Alleghenian humid area, a western arid area, and a Pacific coast humid area.

[2] The Upper Austral zone comprises two principal subdivisions: an eastern or Carolinian area and a western or Upper Sonoran area.

[3] The Lower Austral zone comprises two principal subdivisions: an eastern or Austroriparian area and a western or Lower Sonoran area.

[4] The Fahrenheit equivalents of Centigrade sum temperatures are stated in round numbers to avoid small figures of equivocal value.

## Secondary Causes Affecting Distribution.

It is not the purpose of the present essay to discuss the secondary causes affecting distribution. At the same time it seems desirable to contrast for a moment the influence of humidity, which is by far the most potent of the secondary causes, with that of temperature, which has been shown to be the primary

controlling cause. Humidity governs details of distribution of numerous species of plants, reptiles and birds, and of a few species of mammals, within the several temperature zones. Thus the palmetto, the green chameleon, the chuck-wills widow and the ricefield mouse inhabit humid parts of the Lower Austral zone (the Austroriparian area), while the mesquite, the leopard lizard, the sickle-billed thrashers and the four-toed kangaroo rats find their homes in arid parts of the same zone (the Lower Sonoran area).

That humidity is less potent than temperature as a controlling factor in distribution may be shown in several ways. The numerical evidence I have given on a previous occasion.* Equally convincing is the circumstance that many genera restricted to particular conditions of temperature range completely across the continent, inhabiting alike the humid and arid subdivisions of their respective zones; but no genus restricted to particular conditions of humidity ranges north and south across the several temperature zones.

Humidity and other secondary causes determine the presence or absence of particular species in particular localities *within* their appropriate zones, but temperature predetermines the possibilities of distribution; it fixes the limits beyond which species cannot pass; it defines broad transcontinental belts within which certain forms may thrive if other conditions permit, but outside of which they cannot exist, be the other conditions never so favorable.

### Explanation of Maps.

The temperature maps show the isotherms that conform to the boundaries of the life zones and the data on which they are based. The spots show the actual positions of the temperature stations.

In map 12, showing the distribution of the sum of effective temperatures, the isotherms conform with the northern boundaries of the life zones (as shown on map 14) as follows: The isotherm of 14,580° C. conforms with the northern boundary of the Tropical; of 10,000° C. with that of the Lower Austral; 6,400° C. with that of the Upper Austral, and 5,500° C. with that of the Transition.

In map 13, showing the normal mean temperature of the six hottest consecutive weeks, the isotherms conform with the southern boundaries of the life zones (as shown on map 14) as follows: The isotherm of 18° C. with the southern boundary of the Boreal; of 22° C. with the southern boundary of the Transition, and 26° C. with the southern boundary of the Upper Austral.

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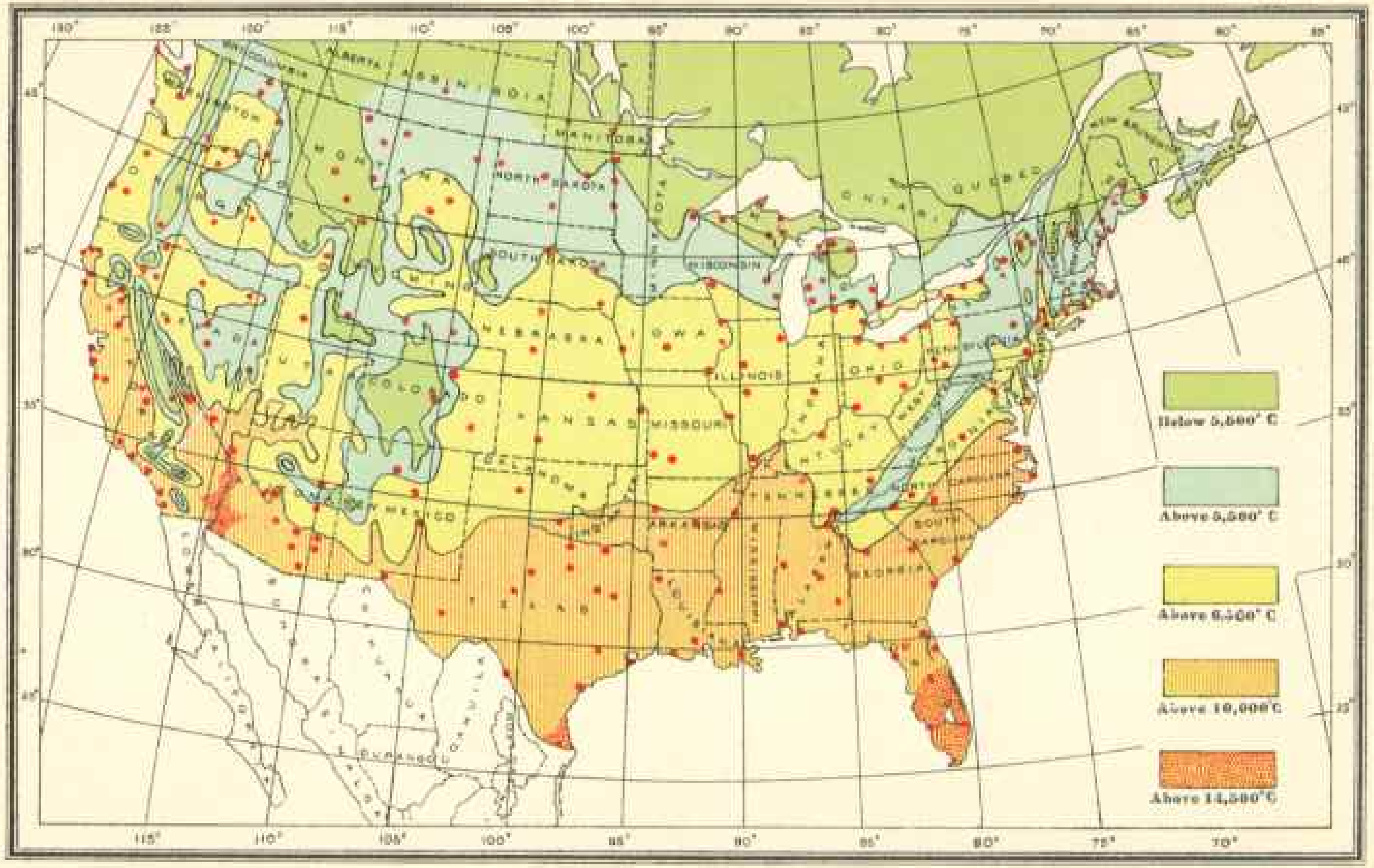
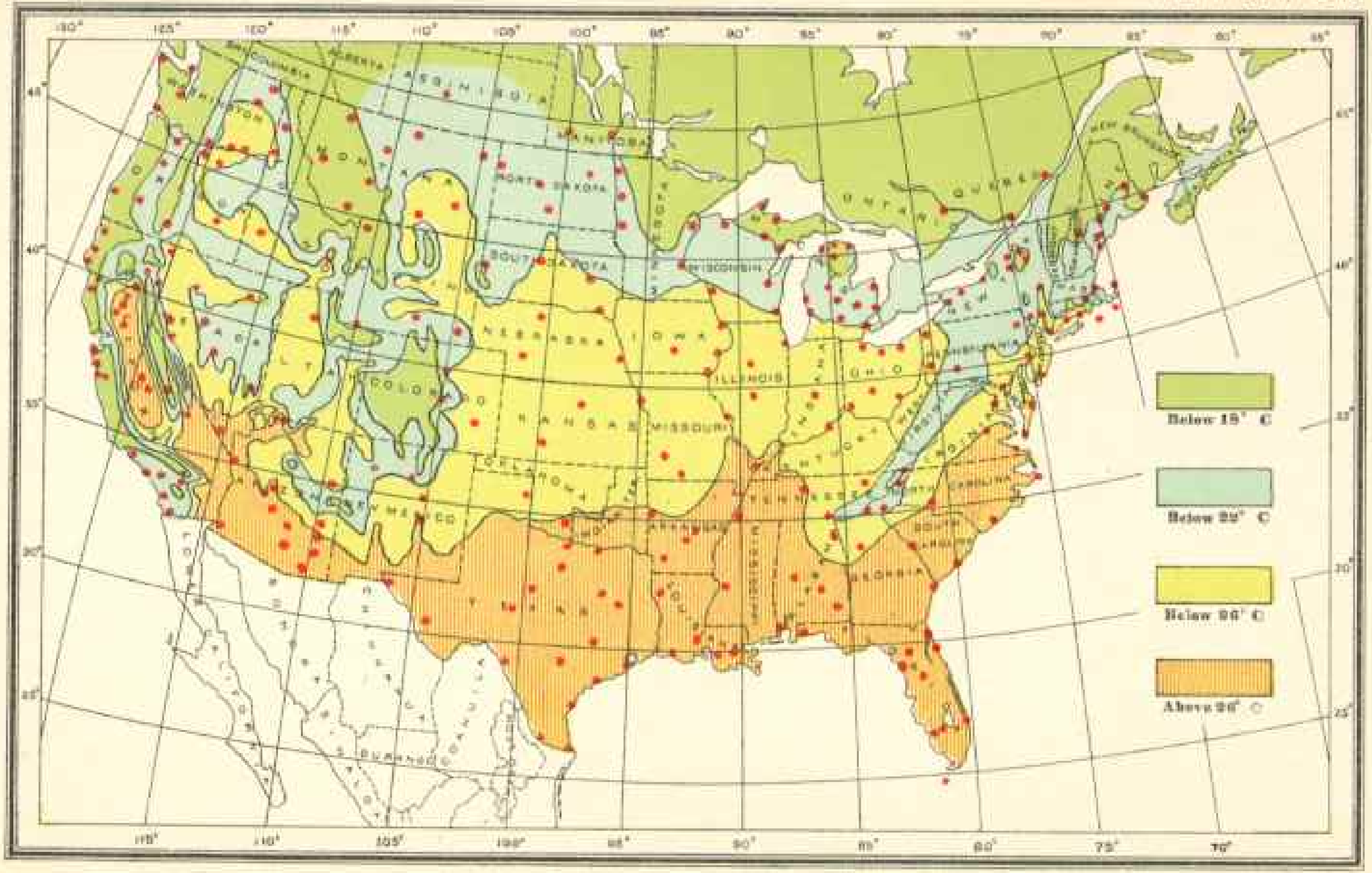
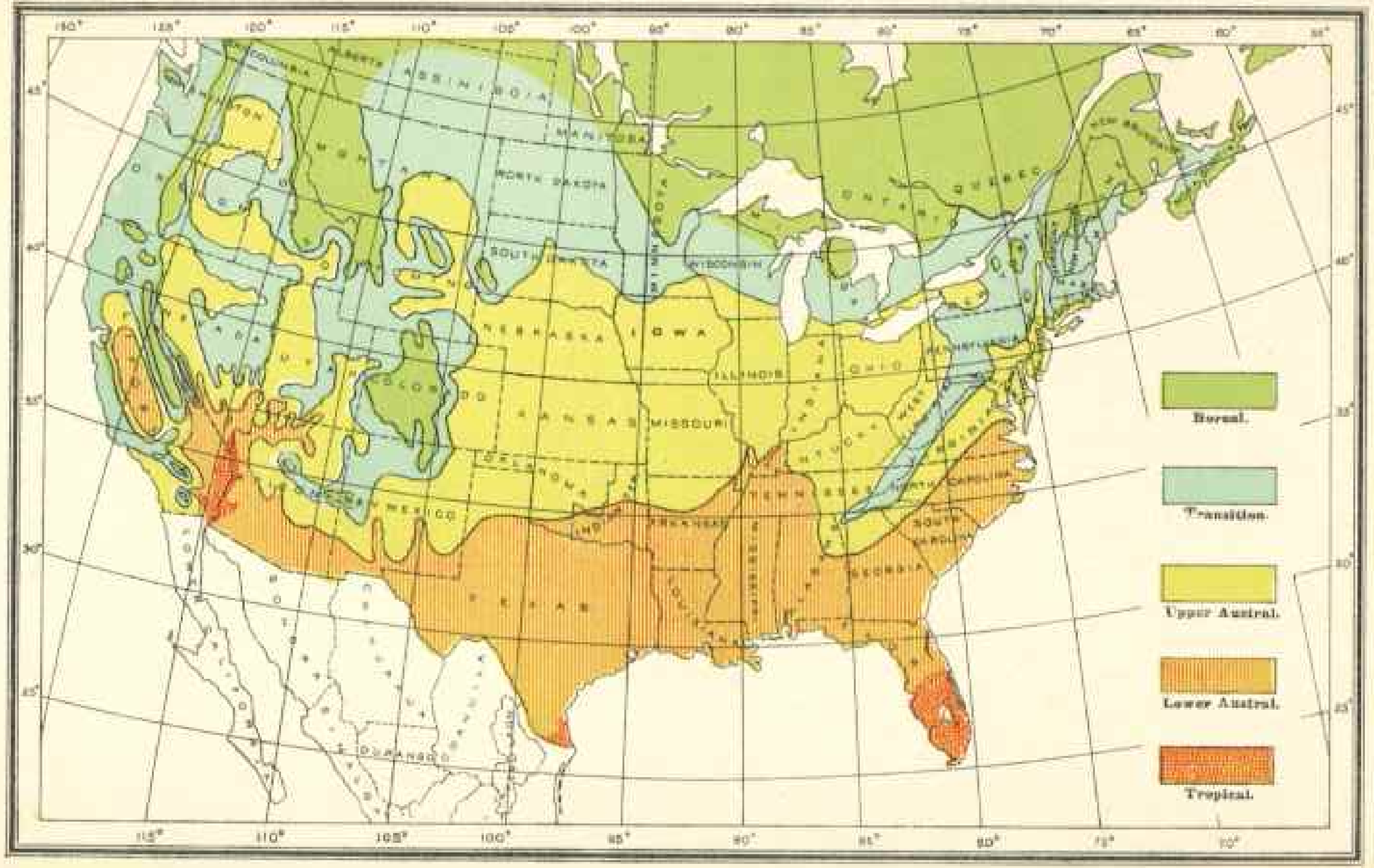
* Presidential Address, Ibid., pp. 47–49.




DISTRIBUTION OF THE TOTAL QUANTITY OF HEAT DURING SEASON OF GROWTH AND REPRODUCTIVE ACTIVITY.
[SUM OF DAILY MEAN TEMPERATURES ABOVE 6° C.]




MEAN TEMPERATURE OF HOTTEST SIX CONSECUTIVE WEEKS OF YEAR.




LIFE ZONES OF THE UNITED STATES.