TREATISE ON INVERTEBRATE PALEONTOLOGY

Part L

MOLLUSCA 4

Revised

Volume 4: Cretaceous Ammonoidea

C. W. WRIGHT with J. H. CALLOMAN and M. K. HOWARTH

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Part W, Revised. MISCELLANEA, Supplement 2 (Conodonta), xxviii + 202 p., frontis., 858 fig., 1981.

THIS VOLUME

Part L, Revised. MOLLUSCA 4, Volume 4 (Cretaceous Ammonoidea), xx + 362 p., 2,070 illus. on 216 fig., 1996.

VOLUMES IN PREPARATION

Part B. PROTISTA 1 (Chrysomonadida, Coccolithophorida, Charophyta, Diatomacea, etc.).
Part E, Revised. PORIFERA. Volume 2.
Part G, Revised. BRYOZOA (additional volumes).
Part H, Revised. BRACHIOPODA.
Part I. Introduction to MOLLUSCA (part).
Part J. MOLLUSCA 2 (Caenogastropoda, Streptoneura exclusive of Archaeogastropoda, Euthyneura).
Part L, Revised. MOLLUSCA 4 (Ammonoidea) (additional volumes).
Part M. MOLLUSCA 5 (Coleoidea).
Part O, Revised. ARTHROPODA 1 (Trilobita).
Part Q, Revised. ARTHROPODA 3 (Ostracoda).

EDITORIAL PREFACE

From the outset the aim of the *Treatise on Invertebrate Paleontology* has been to present a comprehensive and authoritative yet compact statement of knowledge concerning groups of invertebrate fossils. Typically, preparation of early *Treatise* volumes was undertaken by a single specialist with a synoptic view of the group being monographed. More rarely, two or perhaps three specialists worked together. Recently, however, both new *Treatise* volumes and revisions of existing ones have been undertaken increasingly by teams of specialists led by a coordinating author. Part L, Mollusca 4(4), Revised has been prepared by a single author, Dr. C. W. Wright, and even this volume is part of a much larger project on all the ammonoids that involves a number of specialists. Nevertheless, few paleontologists have such an all-encompassing command of a major group of fossils as Dr. Wright has of the Cretaceous ammonoids. We are indeed privileged that he has found both the time and the energy over the years to compile this information and share it with the paleontological and geological communities.

This volume on the Cretaceous Ammonoidea is the final section of the revision of Part L. Other volumes planned for the series are an introductory volume, volume 2 on Paleozoic ammonoids, and volume 3 on Triassic and Jurassic ammonoids. In a way, it is unfortunate that the fourth volume in the series is being published first, but even more unfortunate would be to delay publication of Dr. Wright's manuscript, which brings information on the ammonoids up to date, a group of fossils that is vitally important for stratigraphy.

ZOOLOGICAL NAMES

Questions about the proper use of zoological names arise continually, especially questions regarding both the acceptability of names and alterations of names that are allowed or even required. Regulations prepared by the International Commission on Zoological Nomenclature (ICZN) and published in 1985 in the *International Code of Zoological Nomenclature,* hereinafter referred to as the *Code,* provide procedures for answering such questions. The prime objective of the *Code* is to promote stability and universality in the use of the scientific names of animals, ensuring also that each generic name is distinct and unique, while avoiding

unwarranted restrictions on freedom of thought and action of systematists. Priority of names is a basic principle of the *Code,* but under specified conditions and by following prescribed procedures, priority may be set aside by the Commission. These procedures apply especially where slavish adherence to the principle of priority would hamper or even disrupt zoological nomenclature and the information it conveys.

The Commission, ever aware of the changing needs of systematists, is undertaking a revision of the *Code* that will further enhance nomenclatorial stability. Nevertheless, the nomenclatorial tasks that confront zoological taxonomists are formidable and have often justified the complaint that the study of zoology and paleontology is too often merely the study of names rather than the study of animals. It is incumbent upon all systematists, therefore, at the outset of their work to pay careful attention to the *Code* to enhance stability by minimizing the number of subsequent changes of names, too many of which are necessitated by insufficient attention to detail. To that end, several pages here are devoted to aspects of zoological nomenclature that are judged to have chief importance in relation to procedures adopted in the *Treatise,* especially in this volume. Terminology is explained, and examples are given of the style employed in the nomenclatorial parts of the systematic descriptions.

GROUPS OF TAXONOMIC CATEGORIES

Each taxon belongs to a category in the Linnaean hierarchical classification. The *Code* recognizes three groups of categories, a species-group, a genus-group, and a family-group. Taxa of lower rank than subspecies are excluded from the rules of zoological nomenclature, and those of higher rank than superfamily are not regulated by the *Code.* It is both natural and convenient to discuss nomenclatorial matters in general terms first and then to consider each of these three, recognized groups separately. Especially important is the provision that within each group the categories are coordinate, that is, equal in rank, whereas categories of different groups are not coordinate.

FORMS OF NAMES

All zoological names can be considered on the basis of their spelling. The first form of a name to be published is defined as the original spelling (*Code,* Article 32), and any form of the same name that is published later and is different from the original spelling is designated a subsequent spelling (*Code,* Article 33). Not all original spellings are correct, nor are all subsequent spellings.

Original Spellings

If the first form of a name to be published is consistent and unambiguous, the original is defined as correct unless it contravenes some stipulation of the *Code* (Articles 11, 27 to 31, and 34) or unless the original publication contains clear evidence of an inadvertent error in the sense of the *Code,* or, among names belonging to the family-group, unless correction of the termination or the stem of the type genus is required. An original spelling that fails to meet these requirements is defined as incorrect.

If a name is spelled in more than one way in the original publication, the form adopted by the first reviser is accepted as the correct original spelling, provided that it complies with mandatory stipulations of the *Code* (Articles 11 and 24 to 34).

Incorrect original spellings are any that fail to satisfy requirements of the *Code,* represent an inadvertent error, or are one of multiple original spellings not adopted by a first reviser. These have no separate status in zoological nomenclature and, therefore, cannot enter into homonymy or be used as replacement names; and they call for correction. For example, a name originally published with a diacritical mark, apostrophe, diaeresis, or hyphen requires correction by deleting such features and uniting parts of the name originally separated by them, except that deletion of an umlaut from a vowel in a name derived

from a German word or personal name unfortunately requires the insertion of *e* after the vowel. Where original spelling is judged to be incorrect solely because of inadequacies of the Greek or Latin scholarship of the author, nomenclatorial changes conflict with the primary purpose of zoological nomenclature as an information retrieval system. One looks forward with hope to a revised *Code* wherein the rules enhance stability rather than classical scholarship, thereby facilitating access to information.

Subsequent Spellings

If a subsequent spelling differs from an original spelling in any way, even by the omission, addition, or alteration of a single letter, the subsequent spelling must be defined as a different name. Exceptions include such changes as an altered termination of adjectival specific names to agree in gender with associated generic names; changes of family-group names to denote assigned taxonomic rank; and corrections that eliminate originally used diacritical marks, hyphens, and the like. Such changes are not regarded as spelling changes conceived to produce a different name. In some instances, however, species-group names having variable spellings are regarded as homonyms as specified in the *Code* (Article 58).

Altered subsequent spellings other than the exceptions noted may be either intentional or unintentional. If "demonstrably intentional" (*Code,* Article 33, p. 73), the change is designated as an emendation. Emendations may be either justifiable or unjustifiable. Justifiable emendations are corrections of incorrect original spellings, and these take the authorship and date of the original spellings. Unjustifiable emendations are available names with their own author and date of publication. They are junior objective synonyms of the name in its original form.

Unintentional, subsequent, incorrect spellings are not available. They do not enter into homonymy and cannot be used as replacement names.

AVAILABLE AND UNAVAILABLE NAMES

Editorial prefaces of some previous volumes of the *Treatise* have discussed in appreciable detail the availability of the many kinds of zoological names that have been proposed under a variety of circumstances. Much of that information, while important, does not pertain to the present volume, in which the author has used fewer terms for such names. The reader is referred to *Part G, Bryozoa (Revised)* of the *Treatise* and to the *Code* (Articles 10 to 20) for further details on availability of names. Here, suffice it to say that an available zoological name is any that conforms to all mandatory provisions of the *Code.* All zoological names that fail to comply with mandatory provisions of the *Code* are unavailable and have no status in zoological nomenclature. Both available and unavailable names are classifiable into groups that have been recognized in previous volumes of the *Treatise,* although not explicitly differentiated in the *Code.* Among names that are available, these groups include inviolate names, perfect names, imperfect names, vain names, transferred names, improved or corrected names, substitute names, and conserved names. Kinds of unavailable names include naked names (see *nomina nuda* below), denied names, impermissible names, null names, and forgotten names.

Nomina nuda include all names that fail to satisfy provisions stipulated in Article 11 of the *Code,* which states general requirements of availability. In addition, they include names published before 1931 that were unaccompanied by a description, definition, or indication (*Code,* Articles 12 and 16) and names published after 1930 that (1) lacked an accompanying statement of characters that differentiate the taxon, (2) were without a definite bibliographic reference to such a statement, (3) were not proposed expressly as a replacement (*nomen novum*) of a preexisting available name (*Code,* Article 13a), or (4) for genus-group names, were unaccompanied by definite fixation of a type species by original designation or indication (*Code,*

Article 13b). *Nomina nuda* have no status in nomenclature, and they are not correctable to establish original authorship and date.

VALID AND INVALID NAMES

Important considerations distinguish valid from available names on the one hand and invalid from unavailable names on the other. Whereas determination of availability is based entirely on objective considerations guided by articles of the *Code*, conclusions as to validity of zoological names may be partly subjective. A valid name is the correct one for a given taxon, which may have two or more available names but only a single correct, hence valid, name, which is also generally the oldest name that it has been given. Obviously, no valid name can also be an unavailable name, but invalid names may be either available or unavailable. It follows that any name for a given taxon other than the valid name, whether available or unavailable, is an invalid name.

One encounters a sort of nomenclatorial no-man's land in considering the status of such zoological names as *nomina dubia* (doubtful names), which may include both available and unavailable names. The unavailable ones can well be ignored, but names considered to be available contribute to uncertainty and instability in the systematic literature. These can ordinarily be removed only by appeal to the ICZN for special action. Because few systematists care to seek such remedy, such invalid but available names persist in the literature. A few such names are found in this volume.

NAME CHANGES IN RELATION TO GROUPS OF TAXONOMIC CATEGORIES

Species-Group Names

Detailed consideration of valid emendation of specific and subspecific names is unnecessary here, both because the topic is well understood and relatively inconsequential and because the *Treatise* deals with genus-group names and higher categories. When the form of adjectival specific names is changed to agree with the gender of a generic name in transferring a species from one genus to another, one need never label the changed name as *nomen correctum.* Similarly, transliteration of a letter accompanied by a diacritical mark in the manner now called for by the *Code*, as in changing originally *bröggeri* to *broeggeri,* or eliminating a hyphen, as in changing originally published *cornu-oryx* to *cornuoryx,* does not require the designation *nomen correctum.* Of course, in this age of computers and electronic data bases, such changes of name, which are perfectly valid for the purposes of scholarship, run counter to the requirements of nomenclatorial stability upon which the preparation of massive, electronic data bases is predicated.

Genus-Group Names

Conditions warranting change of the originally published, valid form of generic and subgeneric names are sufficiently rare that lengthy discussion is unnecessary. Only elimination of diacritical marks and hyphens in some names in this category and replacement of homonyms seem to furnish basis for valid emendation. Many names that formerly were regarded as homonyms are no longer so regarded, because two names that differ only by a single letter or in original publication by the presence of a diacritical mark in one are now construed to be entirely distinct.

As has been pointed out above, difficulty typically arises when one tries to decide whether a change of spelling of a name by a subsequent author was intentional or unintentional, and the decision has often to be made arbitrarily.

Family-group Names: Authorship and Date

All family-group taxa having names based on the same type genus are attributed to the author who first published the name of any of these groups, whether tribe, subfamily, or

family (superfamily being almost inevitably a later-conceived taxon). Accordingly, if a family is divided into subfamilies or a subfamily into tribes, the name of no such subfamily or tribe can antedate the family name. Moreover, every family containing differentiated subfamilies must have a nominotypical subfamily (*sensu stricto*), which is based on the same type genus as the family. Finally, the author and date set down for the nominotypical subfamily invariably are identical with those of the family, irrespective of whether the author of the family or some subsequent author introduced subdivisions.

Corrections in the form of family-group names do not affect authorship and date of the taxon concerned, but in the *Treatise* recording the authorship and date of the correction is desirable because it provides a pathway to follow the thinking of the systematists involved.

Family-Group Names: Use of *nomen translatum*

The *Code* specifies the endings only for subfamily (-inae) and family (-idae) names, but all family-group taxa are defined as coordinate (*Code,* Article 36, p. 77): "A name established for a taxon at any rank in the family group is deemed to be simultaneously established with the same author and date for taxa based upon the same name-bearing type (type genus) at other ranks in the family group, with appropriate mandatory change of suffix [Art. 34a]." Such changes of rank and concomitant changes of endings as elevation of a tribe to subfamily rank or of a subfamily to family rank, if introduced subsequent to designation of a subfamily or family based on the same nominotypical genus, are *nomina translata.* In the *Treatise* it is desirable to distinguish the valid alteration in the changed ending of each transferred family-group name by the term *nomen translatum,* abbreviated to *nom. transl.* Similarly for clarity, authors should record the author, date, and page of the alteration. This is especially important for superfamilies, for the information of interest is the author who initially introduced a taxon rather than the author of the superfamily as defined by the *Code.* The latter is merely the individual who first defined some lower-ranked, family-group taxon that contains the nominotypical genus of the superfamily. On the other hand, the publication that introduces the superfamily by *nomen translatum* is likely to furnish the information on taxonomic considerations that support definition of the taxon.

An example of the use of *nomen translatum* is the following.

Family HEXAGENITIDAE Lameere, 1917

[*nom. transl.* DEMOULIN, 1954, p. 566, *ex* Hexagenitinae LAMEERE, 1917, p. 74]

Family-Group Names: Use of *nomen correctum*

Valid name changes classed as *nomina correcta* do not depend on transfer from one category of the family group to another but most commonly involve correction of the stem of the nominotypical genus. In addition, they include somewhat arbitrarily chosen modifications of endings for names of tribes or superfamilies. Examples of the use of *nomen correctum* are the following.

Family STREPTELASMATIDAE Nicholson, 1889

[*nom. correct.* WEDEKIND, 1927, p. 7, *pro* Streptelasmidae NICHOLSON in NICHOLSON & LYDEKKER, 1889, p. 297]

Family PALAEOSCORPIDAE Lehmann, 1944

[*nom. correct.* PETRUNKEVITCH, 1955, p. 73, *pro* Palaeoscorpionidae LEHMANN, 1944, p. 177]

Family-group Names: Replacements

Family-group names are formed by adding combinations of letters, which are prescribed for family and subfamily, to the stem of the name belonging to the genus first chosen as type of the assemblage. The type genus need not be the first genus in the family to have been named and defined, but

among all those included it must be the first that gives its name in a publication to a family-group taxon. Once fixed, the family-group name remains tied to this nominotypical genus even if the generic name is changed by reason of status as a junior homonym or junior synonym, either objective or subjective. Seemingly, the *Code* requires replacement of a family-group name only if the nominotypical genus is found to have been a junior homonym when it was proposed (*Code,* Article 39, p. 79), in which case "... it must be replaced either by the next oldest available name from among its synonyms, including those of its subordinate taxa, or, if there is no such name, by a new replacement name based on the valid name of the former type genus." Authorship and date of the new, replacement family-group name are determined by its first publication, but, for subsequent application of the rule of priority, the name takes the date of the old, replaced name (see Recommendation 40A). Many family-group names that have been in use for a long time are *nomina nuda,* since they fail to satisfy criteria of availability (*Code,* Article 11f). These demand replacement by valid names.

The aim of family-group nomenclature is to yield the greatest possible stability and uniformity, just as in other zoological names. Both taxonomic experience and the *Code* (Article 40) indicate the wisdom of sustaining family-group names based on junior subjective synonyms if they have priority of publication, for opinions of the same worker may change over time. The retention of first-published family-group names that are found to be based on junior objective synonyms, however, is less clearly desirable, especially if a replacement name derived from the senior objective synonym has been recognized very long and widely. Moreover, to displace a widely used, family-group name based on the senior objective synonym by disinterring a forgotten and virtually unused family-group name based on a junior objective synonym because the latter happens to have priority of publication is unsettling.

A family-group name may need to be replaced if the nominotypical genus is transferred to another family-group. If so, the first-published of the generic names remaining in the family-group taxon is to be recognized in forming a replacement name.

Suprafamilial Taxa: Taxa above Family-Group

International rules of zoological nomenclature as given in the *Code* affect only lower-rank categories: subspecies to superfamily. Suprafamilial categories (suborder to phylum) are either not mentioned or explicitly placed outside of the application of zoological rules. The *Copenhagen Decisions on Zoological Nomenclature* (1953, Articles 59 to 69) proposed adopting rules for naming suborders and higher taxa up to and including phylum, with provision for designating a type genus for each, in such manner as not to interfere with the taxonomic freedom of workers. Procedures were outlined for applying the rule of priority and the rule of homonymy to suprafamilial taxa and for dealing with the names of such taxa and their authorship, with assigned dates, if they should be transferred on taxonomic grounds from one rank to another. The adoption of terminations of names, different for each category but uniform within each, was recommended.

The Colloquium on Zoological Nomenclature, which met in London during the week just before the 15th International Congress of Zoology convened in 1958, thoroughly discussed the proposals for regulating suprafamilial nomenclature, as well as many others advocated for inclusion in the new *Code* or recommended for exclusion from it. A decision that was supported by a wide majority of the participants in the colloquium was against the establishment of rules for naming taxa above family-group rank, mainly because it was judged that such regulation would unwisely tie the hands of taxonomists. For example, a class or order defined by an author at a given date, using chosen morphologic characters (e.g., gills of

bivalves), should not be allowed to freeze nomenclature, taking precedence over another class or order that is proposed later and distinguished by different characters (e.g., hinge teeth of bivalves). Even the fixing of type genera for suprafamilial taxa would have little, if any, value, hindering taxonomic work rather than aiding it. No basis for establishing such types and for naming these taxa has yet been provided.

The considerations just stated do not prevent the editors of the *Treatise* from making rules for dealing with suprafamilial groups of animals described and illustrated in this publication. Some uniformity is needed, especially for the guidance of *Treatise* authors. This policy should accord with recognized general practice among zoologists; but where general practice is indeterminate or nonexistent, our own procedure in suprafamilial nomenclature needs to be specified as clearly as possible. This pertains especially to decisions about names themselves, about citation of authors and dates, and about treatment of suprafamilial taxa that, on taxonomic grounds, are changed from their originally assigned rank. Accordingly, a few rules expressing *Treatise* policy are given here, some with examples of their application.

1. The name of any suprafamilial taxon must be a Latin or Latinized, uninominal noun of plural form, or treated as such, with a capital initial letter and without diacritical mark, apostrophe, diaeresis, or hyphen. If a component consists of a numeral, numerical adjective, or adverb, this must be written in full.

2. Names of suprafamilial taxa may be constructed in almost any manner. A name may indicate morphological attributes (e.g., Lamellibranchiata, Cyclostomata, Toxoglossa) or be based on the stem of an included genus (e.g., Bellerophontina, Nautilida, Fungiina) or on arbitrary combinations of letters (e.g., Yuania); none of these, however, can end in -idae or -inae, which terminations are reserved for family-group taxa. No suprafamilial name identical in form to that of a genus or to another published suprafamilial name should be employed (e.g., order Decapoda LATREILLE, 1803, crustaceans, and order Decapoda LEACH, 1818, cephalopods; suborder Chonetoidea MUIR-WOOD, 1955, and genus *Chonetoidea* JONES, 1928). Worthy of notice is the classificatory and nomenclatorial distinction between suprafamilial and family-group taxa that, respectively, are named from the same type genus, since one is not considered to be transferable to the other (e.g., suborder Bellerophontina ULRICH & SCOFIELD, 1897; superfamily Bellerophontacea MCCOY, 1851; family Bellerophontidae MCCOY, 1851). Family-group names are not coordinate with suprafamilial names.

3. The rules of priority and homonymy lack any force of international agreement as applied to suprafamilial names, yet in the interest of nomenclatorial stability and to avoid confusion these rules are widely applied by zoologists to taxa above the family-group level wherever they do not infringe on taxonomic freedom and long-established usage.

4. Authors who accept priority as a determinant in nomenclature of a suprafamilial taxon may change its assigned rank at will, with or without modifying the terminal letters of the name, but such changes cannot rationally be judged to alter the authorship and date of the taxon as published originally. A name revised from its previously published rank is a transferred name (*nomen translatum*), as illustrated in the following.

Order CORYNEXOCHIDA Kobayashi, 1935

[*nom. transl.* MOORE, 1959, p. 217, *ex* suborder Corynexochida KOBAYASHI, 1935, p. 81]

A name revised from its previously published form merely by adoption of a different termination without changing taxonomic rank is an altered name (*nomen correctum*).

Order DISPARIDA Moore & Laudon, 1943

[*nom. correct.* MOORE in MOORE, LALICKER, & FISCHER, 1952, p. 613, *pro* order Disparata MOORE & LAUDON, 1943, p. 24]

A suprafamilial name revised from its previously published rank with accompanying change of termination, which signal the change of rank, is recorded as a *nomen translatum et correctum.*

Order HYBOCRINIDA Jaekel, 1918

[*nom. transl. et correct.* MOORE in MOORE, LALICKER, & FISCHER, 1952, p. 613, *ex* suborder Hybocrinites JAEKEL, 1918, p. 90]

5. The authorship and date of nominotypical subordinate and supraordinate taxa among suprafamilial taxa are considered in the *Treatise* to be identical since each actually or potentially has the same type. Examples are given below.

Subclass ENDOCERATOIDEA Teichert, 1933

[*nom. transl.* TEICHERT in TEICHERT *et al.*, 1964, p. 128, *ex* order Endoceroidea TEICHERT, 1933, p. 214]

Order ENDOCERIDA Teichert, 1933

[*nom. correct.* TEICHERT in TEICHERT *et al.*, 1964, p. 165, *pro* order Endoceroidea TEICHERT, 1933, p. 214]

Suborder ENDOCERINA Teichert, 1933

[*nom. correct.* TEICHERT in TEICHERT *et al.*, 1964, p. 165, *ex* Endoceratina SWEET, 1958, p. 33, suborder]

TAXONOMIC EMENDATION

Emendation has two distinct meanings as regards zoological nomenclature. These are (1) alteration of a name itself in various ways for various reasons, as has been reviewed, and (2) alteration of the taxonomic scope or concept for which a name is used. The *Code* (Article 33a and Glossary, p. 148) concerns itself only with the first type of emendation, applying the term to intentional changes, either justified or unjustified, of the original spelling of a name. The second type of emendation primarily concerns classification and inherently is not associated with change of name. Little attention generally has been paid to this distinction in spite of its significance.

Most who have emended zoological names refer to what they consider a material change in application of the name such as may be expressed by an importantly altered diagnosis of the assemblage covered by the name. The abbreviation *emend.* then accompanies the name with statement of the author and date of the emendation. On the other hand, many systematists think that publication of *emend.* with a zoological name is valueless because taxonomic concepts are altered whenever a subspecies, species, genus, or other taxon is incorporated into or removed from a higher zoological taxon. Inevitably associated with such classificatory expansions and restrictions is some degree of emendation affecting diagnosis. Granting this, still it is true that now and then somewhat more extensive revisions are put forward, generally with published statement of the reasons for changing the application of a name. To erect a signpost at such points of most significant change is worthwhile, both as aid to subsequent workers in taking account of the altered nomenclatorial usage and to indicate where in the literature cogent discussion may be found. Authors of contributions to the *Treatise* are encouraged to include records of all especially noteworthy emendations of this nature, using the abbreviation *emend.* with the name to which it refers and citing the author, date, and page of the emendation.

Examples from *Treatise* volumes follow.

Order ORTHIDA Schuchert & Cooper, 1932

[*nom. transl. et correct.* MOORE in MOORE, LALICKER, & FISCHER, 1952, p. 220, *ex* suborder Orthoidea SCHUCHERT & COOPER, 1932, p. 43; *emend.*, WILLIAMS & WRIGHT, 1965, p. 299]

Subfamily ROVEACRININAE Peck, 1943

[Roveacrininae PECK, 1943, p. 465; *emend.*, PECK in MOORE & TEICHERT, 1978, p. 921]

STYLE IN GENERIC DESCRIPTIONS

Citation of Type Species

In the *Treatise* the name of the type species of each genus and subgenus is given immediately following the generic name with its accompanying author, date, and page reference or after entries needed for definition of the name if it is involved in homonymy. The

originally published combination of generic and trivial names of this species is cited, accompanied by an asterisk (*), with notation of the author and date of original publication. An exception in this procedure is made, however, if the species was first published in the same paper and by the same author as that containing definition of the genus of which it is the type. In this instance, the initial letter of the generic name followed by the trivial name is given without repeating the name of the author and date. Examples of these two sorts of citations follow.

Orionastraea SMITH, 1917, p. 294 [**Sarcinula phillipsi* MCCOY, 1849, p. 125; OD]

Schoenophyllum SIMPSON, 1900, p. 214 [**S. aggregatum*; OD]

If the cited type species is a junior synonym of some other species, the name of this latter also is given, as follows.

Eopachydiscus WRIGHT, 1955, p. 570 [**Pachydiscus laevicaniculatus* LASSWITZ, 1904, p. 236; OD; =*Ammonites marcianus* SHUMARD, 1854, p. 209

In some instances the type species is a junior homonym. If so, it is cited as shown in the following example.

Prionocyclus MEEK, 1871b, p. 298 [**Ammonites serratocarinatus* MEEK, 1871a, p. 429, *non* STOLICZKA, 1964, p. 57; =*Prionocyclus wyomingensis* MEEK, 1876, p. 452]

In the *Treatise* the name of the type species is always given in the exact form it had in the original publication except that diacritical marks are removed. Where other mandatory changes are required, these are introduced later in the text, typically in a figure caption.

Original Fixation of Type Species

It is desirable to record the manner of establishing the type species, whether by original designation (OD) or by subsequent designation (SD). The type species of a genus or subgenus, according to provisions of the *Code,* may be fixed in various ways in the original publication; or it may be fixed subsequently in ways specified by the *Code* (Article 68) and described in the next section. Type species fixed in the original publication include (1) *original designation* (in the *Treatise* indicated by "OD") when the type species is explicitly stated or (before 1931) indicated by "n. gen., n. sp." (or its equivalent) applied to a single species included in a new genus, (2) defined by use of *typus* or *typicus* for one of the species included in a new genus (adequately indicated in the *Treatise* by the specific name), (3) established by *monotypy* if a new genus or subgenus has only one originally included species (in the *Treatise* indicated as "M"), and (4) fixed by *tautonymy* if the genus-group name is identical to an included species name not indicated as the type.

Subsequent Fixation of Type Species

The type species of many genera are not determinable from the publication in which the generic name was introduced. Therefore, such genera can acquire a type species only by some manner of subsequent designation. Most commonly this is established by publishing a statement naming as type species one of the species originally included in the genus. In the *Treatise* such fixation of the type species by subsequent designation in this manner is indicated by the letters "SD" accompanied by the name of the subsequent author (who may be the same person as the original author) and the date of publishing the subsequent designation. Some genera, as first described and named, included no mentioned species (for such genera established after 1930, see below); these necessarily lack a type species until a date subsequent to that of the original publication when one or more species is assigned to such a genus. If only a single species is thus assigned, it automatically becomes the type species. Of course, the first publication containing assignment of species to the genus that originally lacked any included species is the one concerned in fixation of the type species, and if this publication names two or more species as belonging to the genus but did not designate a type species, then a later "SD" designation is necessary. Examples of the use of "SD" as employed in the *Treatise* follow.

Hexagonaria GÜRICH, 1896, p. 171 [**Cyathophyllum hexagonum* GOLDFUSS, 1826, p. 61; SD LANG, SMITH, & THOMAS, 1940, p. 69]

Mesephemera HANDLIRSCH, 1906, p. 600 [**Tineites lithophilus* GERMAR, 1842, p. 88; SD CARPENTER, herein]

Another mode of fixing the type species of a genus is action of the International Commission of Zoological Nomenclature using its plenary powers. Definition in this way may set aside application of the *Code* so as to arrive at a decision considered to be in the best interest of continuity and stability of zoological nomenclature. When made, it is binding and commonly is cited in the *Treatise* by the letters "ICZN," accompanied by the date of announced decision and reference to the appropriate numbered opinion.

Subsequent designation of a type species is admissible only for genera established prior to 1931. A new genus-group name established after 1930 and not accompanied by fixation of a type species through original designation or original indication is not available (*Code,* Article 13b). Effort of a subsequent author to validate such a name by subsequent designation of a type species constitutes an original publication making the name available under authorship and date of the subsequent author.

Homonyms

Most generic names are distinct from all others and are indicated without ambiguity by citing their originally published spelling accompanied by name of the author and date of first publication. If the same generic name has been applied to two or more distinct taxonomic units, however, it is necessary to differentiate such homonyms. This calls for distinction between junior homonyms and senior homonyms. Because a junior homonym is invalid, it must be replaced by some other name. For example, *Callophora* HALL, 1852, introduced for Paleozoic trepostomate bryozoans, is invalid because GRAY in 1848 published the same name for Cretaceous-to-Holocene cheilostomate bryozoans. BASSLER in 1911 introduced the new name *Hallophora* to replace HALL's homonym. The *Treatise* style of entry is given below. Note that in previous volumes of the *Treatise* such replacement names would have included the designation "*nom. subst. pro.*"

Hallophora BASSLER, 1911, p. 325, *nom. nov. pro Callophora* HALL, 1852, p. 144, *non* GRAY, 1848

In like manner, a replacement generic name that is needed may be introduced in the *Treatise* (even though first publication of generic names otherwise in this work is generally avoided). An exact bibliographic reference must be given for the replaced name as in the following example.

Mysterium DE LAUBENFELS, herein, *nom. nov. pro Mystrium* SCHRAMMEN, 1936, p. 183, *non* ROGER, 1862 [**Mystrium porosum* SCHRAMMEN, 1936, p. 183; OD]

Otherwise, no mention of the existence of a junior homonym generally is made.

Synonymous Homonyms

An author sometimes publishes a generic name in two or more papers of different date, each of which indicates that the name is new. This is a bothersome source of errors for later workers who are unaware that a supposed first publication that they have in hand is not actually the original one. Although the names were separately published, they are identical and therefore definable as homonyms; at the same time they are absolute synonyms. For the guidance of all concerned, it seems desirable to record such names as synonymous homonyms. In the *Treatise* the junior of one of these is indicated by the abbreviation "jr. syn. hom."

Not infrequently, identical family-group names are published as new names by different authors, the author of the later-introduced name being ignorant of previous publication(s) by one or more other workers. In spite of differences in taxonomic concepts as indicated by diagnoses and grouping of genera and possibly in assigned rank, these family-group taxa, being based on the same type genus, are nomenclatorial homonyms. They are also synonyms. Wherever encoun-

tered, such synonymous homonyms are distinguished in the *Treatise* in the same manner as generic names.

A rare but special case of homonymy exists when identical family names are formed from generic names having the same stem but differing in their endings. An example is the family name Scutellidae R. & E. RICHTER, 1925, based on *Scutellum* PUSCH, 1833, a trilobite. This name is a junior homonym of Scutellidae GRAY, 1825, based on the echinoid genus *Scutella* LAMARCK, 1816. The name of the trilobite family was later changed to Scutelluidae (ICZN, Opinion 1004, 1974).

Synonyms

In the *Treatise,* citation of synonyms is given immediately after the record of the type species. If two or more synonyms of differing date are recognized, these are arranged in chronological order. Objective synonyms are indicated by the accompanying designation "obj.," others being understood to constitute subjective synonyms, of which the types are also indicated. Examples showing *Treatise* style in listing synonyms follow.

Mackenziephyllum PEDDER, 1971, p. 48 [**M. insolitum;* OD] [=*Zonastraea* TSYGANKO in SPASSKIY, KRAVTSOV, & TSYGANKO, 1971, p. 85, *nom. nud.; Zonastraea* TSYGANKO, 1972, p. 21 (type, *Z. graciosa;* OD)]

Kodonophyllum WEDEKIND, 1927, p. 34 [**Streptelasma Milne-Edwardsi* DYBOWSKI, 1873, p. 409; OD; =*Madrepora truncata* LINNÉ, 1758, p. 795, see SMITH & TREMBERTH, 1929, p. 368] [=*Patrophontes* LANG & SMITH, 1927, p. 456 (type, *Madrepora truncata* LINNÉ, 1758, p. 795; OD); *Codonophyllum* LANG, SMITH, & THOMAS, 1940, p. 39, obj.]

Some junior synonyms of either the objective or the subjective sort may be preferred over senior synonyms whenever uniformity and continuity of nomenclature are served by retaining a widely used but technically rejectable name for a genus. This requires action of ICZN, which may use its plenary powers to set aside the unwanted name, validate the wanted one, and place the concerned names on appropriate official lists.

MATTERS SPECIFIC TO THIS VOLUME

Biogeography

Purists, *Treatise* editors among them, would like nothing better than a stable world with a stable geography that makes possible a stable biogeographical classification. Global events of the past few years have shown how rapidly geography can change, and in all likelihood we have not seen the last of such change as new, so-called republics continue to spring up all over the globe. One expects confusion among readers in the future as they try to decipher such geographical terms as U.S.S.R., Yugoslavia, or Ceylon. Such confusion is unavoidable, as books must be completed and published at some real time. Libraries would be limited indeed if publication were always to be delayed until the world had settled down.

Insofar as possible, ammonoid genera from the former Soviet Union are referred to the republics in which they are found. In some instances, however, other kinds of information are given. For example, the distribution of *Arcthoplites* is noted as central Russia and Transcaspia, whereas *Lewesiceras* is said to have come from central Asia and *Anahoplitoides* from Transcaspia and eastern Siberia. In addition, such terms as central Europe and western Europe are likely to mean different things to different people. A certain amount of imprecision is introduced by the use of all such terms, of course, but it is probably no greater than the imprecision that stems from the fact that the work of paleontology is not yet finished, and the geographical ranges of many genera are imperfectly known.

Range Charts and Stratigraphical Ranges

Readers may notice that stratigraphical range charts in this volume are somewhat different from those in volumes published before 1992. Charts herein were prepared using RangeChart, an unpublished, computer-software program developed by Kenneth C. Hood and David W. Foster, both

now with Exxon, when they were graduate students at The University of Kansas. RangeChart sorts the taxa by their ranges and the degree of certainty of those ranges and uses different weights of lines for different categories. A revised version of the program, RangeChart 2.0, is in preparation.

Few higher taxa are more biostratigraphically restricted than the higher taxa of ammonoids. Nevertheless, although ammonoids are especially good guide fossils for zoning the Mesozoic, dividing their discussion on a temporal rather than a biosystematic basis presents problems. Cretaceous ammonoids have Jurassic ancestors, some genera of which are more appropriately dealt with in the volume on Triassic and Jurassic ammonoids, which will be published later. In the discussion of the order Ammonoidea on page one of this volume, the rationale for treating genera is presented, that is, for either discussing genera fully or only listing them.

Stratigraphic subdivisions of the Cretaceous follow BIRKELUND and others (1984), including their recommendation (p. 3) "... to use the prefixes Lower and Upper or Lower, Middle and Upper for these substages so as to avoid introduction of new substage names." Moreover, because of disagreement as to how many Cretaceous stages to include in the Neocomian and Senonian Subseries, BIRKELUND and others recommend against formally recognizing these two subseries. The Ryazanian and Berriasian are very approximately equivalent, but because of provincialism at the Jurassic-Cretaceous boundary doubt remains as to the exact correlation between the top and bottom boundaries of these stages. For this reason, the two cannot be equated (C. W. WRIGHT, 1995, personal communication). In the stratigraphical range chart, those taxa the ranges of which are given in the text as Ryazanian are shown as Berriasian and marked with an asterisk. Finally, those who would use this volume as a source of data for other purposes have their work cut out for them. Ranges in the text are given to formally defined substages, but limitations of space necessitated giving ranges only to stage on the stratigraphical range charts. In references to stratigraphical and biogeographical ranges of subgenera that coincide with those of the genus of which they are a part, occurrence and distribution mean different things: "occurrence as for genus" refers to stratigraphy; "distribution as for genus" refers to biogeography.

Terminology for Sutures

The terminology that is used herein to describe ammonoid sutures is that of WEDEKIND (1916) as reviewed by KULLMANN and WIEDMANN (1970). E refers to external lobe; L refers to lateral lobe; U refers to umbilical lobe; and I refers to internal lobe.

Bibliographic Citations

One aspect of citations of the literature requires explanation. Some of the older literature is more readily available as reprints than in its originally published form. It was once the practice of printers to repaginate reprints. Thus, two page numbers are given in some references. For example, in the following citation, UHLIG, 1883, p. 227(100), page 227 is the page in the original publication, and page 100 is the page in the reprint.

Names of Authors: Translation and Transliteration

Chinese scientists have become increasingly active in systematic paleontology in the past two decades. Chinese names cause headaches for English-language bibliographers for two reasons. First, no scheme exists for one-to-one transliteration of Chinese characters into roman letters. Thus, a Chinese author may change the roman-letter spelling of his name from one publication to another. For example, the name Chang, the most common family name in the world reportedly held by some one billion people, might also be spelled Zhang. The principal purpose of a bibliography is to provide the reader with entry into the literature. Quite arbitrarily, therefore, in the interest of information retrieval, the *Treatise* editorial staff has decided

to retain the roman spelling that a Chinese author has used in each of his publications rather than attempting to adopt a common spelling of an author's name to be used in all citations of his work. It is entirely possible, therefore, that the publications of a Chinese author may be listed in more than one place in the bibliography.

Second, most but by no means all Chinese list their family name first followed by given names. People with Chinese names who study in the West often reverse the order, putting the family name last as is the Western custom. Thus, for example, Dr. Yi-Maw Chang, now on the staff of the Paleontological Institute, was Chang Yi-Maw when he lived in Taiwan. When he came to America, he became Yi-Maw Chang, and his subsequent bibliographic citations are listed as "Chang, Yi-Maw." The *Treatise* staff has adopted the convention of listing family names first, inserting a comma, and following this with given names or initials. We do this even for Chinese authors who have not reversed their names in the Western fashion.

Several systems exist for transliterating the Cyrillic alphabet into the roman alphabet. We have adopted System II from J. Thomas Shaw's *Transliteration of Modern Russian for English-Language Publications,* which is the same as the Library of Congress system for transliteration of modern Russian with diacritical marks omitted.

Acknowledgments

All the *Treatise* volumes revising the Ammonoidea have involved a great deal of cooperation among the authors and editorial staff over a period of many years. The staff of the Paleontological Institute has remained remarkably stable as these volumes have progressed, but nevertheless quite a number of people have been involved with the volumes. They deserve special mention here, for without their efforts the *Treatise* project as a whole and this volume on Cretaceous ammonoids specifically would not be what they are today. Not the least of these are two of the previous Editors and Directors of the Paleontological Institute: Curt Teichert and Richard A. Robison. The previous Assistant Editor for Text, Virginia Ashlock, and the previous Assistant Editor for Illustrations, the late Roger B. Williams, worked closely with Dr. Wright on the volume. The present Assistant Editor for Text, Elizabeth Brosius, and the Assistant Editor for Illustrations, Jane Kerns, have faced admirably the formidable task of moving the volume through the final stages of editing and into and beyond the production phase. In this they have been ably assisted by Jill Hardesty and Karen Renteria with word processing; Jill Krebs with editing the references and editorial backup; and Jack Keim with photography and preparation of range charts. Yi-Maw Chang, the remaining member of the Paleontological Institute staff, is involved with preparation of PaleoBank, the paleontological data base for future *Treatise* volumes, and has not been closely involved with the ammonoid *Treatise.*

This Editorial Preface is an extensive revision of the prefaces prepared for previous *Treatise* volumes by former editors, including the late Raymond C. Moore, Curt Teichert, and Richard A. Robison. I am indebted to them for preparing earlier prefaces and for the leadership they have provided in bringing the *Treatise* project to its present status.

Finally, I am pleased to extend on behalf of the members of the staff of the Paleontological Institute, both past and present, our thanks to Dr. C. W. Wright for the unwavering scholarship, dedication to the task, and scrupulous attention to detail that have marked his involvement with the project from the outset and, indeed, his entire career as a specialist on the order Ammonoidea.

Roger L. Kaesler
Lawrence, Kansas
July 26, 1995

AUTHOR'S PREFACE

Since the first edition of volume L appeared in 1957, quite apart from the great mass of publications of Cretaceous ammonites that has led to an approximate doubling of available generic taxa, there have been six special developments that have affected the contents of this volume of the second edition. (1) The general recognition of dimorphism, presumably sexual, now identified in almost all Cretaceous families, has considerably modified knowledge of genera as well as species and has led to many instances of synonymy. (2) In contrast, large numbers of progenetic dwarf genera, themselves dimorphic, have been described, and facile attribution of these forms as microconchs of much larger taxa has been avoided. (3) Advances in the understanding of sutural ontogeny, particularly of the four- and five-lobed primary sutures, has led to great improvements in classification. (4) Realization of the extent to which many famous faunas comprise only or mainly the small nuclei of originally much larger ammonites has affected the diagnosis of many taxa. (5) Intensive research into and recollecting of classic faunas has much increased understanding of phylogeny and stratigraphical realationships. (6) Identification of aptychi as parts of ammonite jaws, commonly identifiable only as to family, has increased the undesirability of treating their names as those of specific taxa, on a level with ammonite species.

Papers have begun to appear applying cladistic methods to the classification of various groups of Cretaceous ammonites. As might be expected, these result in the proposal of a plethora of new higher taxa. Since adoption of these taxa in a small proportion of the total would lead to serious discordance with the classification of the remaining majority, they are ignored here. No doubt a cladistic approach will one day be applied to the whole of the ammonites, despite their multiple convergences, the great variation of morphology within apparent biospecies, and our ignorance of the full sets of characters of many species. Nevertheless, this volume has been compiled over three and a half decades within an earlier convention, and its author believes that the time for a full cladistic revision has not yet come.

Working as an amateur dependent on private resources, except for six years as a research fellow at Wolfson College, Oxford, the author could not have completed his task without immense assistance from colleagues and correspondents all over the world in the form of separates of published papers, gifts and loans of specimens, and discussion and criticism. He owes particular debts of gratitude to the late W. J. Arkell, with whom he worked on the first edition; to W. J. Kennedy; to J. H. Callomon, who also coauthored the Craspeditidae; and to M. K. Howarth, who also provided the text on Tetragonitaceae and the lists of Cretaceous taxa in Phylloceratina and Lytoceratina for the present volume. The meticulous editorship and other assistance from the staff of the *Treatise* office have been beyond compare.

C. W. Wright
Seaborough
Dorset
United Kingdom
September 1995

PART L, Revised

MOLLUSCA 4

AMMONOIDEA

VOLUME 4

C. W. WRIGHT with J. H. CALLOMON and M. K. HOWARTH

CONTENTS

SYSTEMATIC DESCRIPTIONS OF THE ORDER AMMONOIDEA 1
Suborder Phylloceratina 1
Superfamily Phylloceratoceae 1
Family Phylloceratidae 1
Suborder Lytoceratina 2
Superfamily Lytoceratoceae 2
Family Lytoceratidae 2
Superfamily Tetragonitaceae 2
Family Gaudryceratidae 2
Family Tetragonitidae 6
Suborder Ammonitina 9
Superfamily Haploceratoceae 9
Family Haploceratidae 9
Family Oppeliidae 10
Family Binneyitidae 15
Superfamily Perisphinctaceae 17
Family Polyptychitidae 17
Family Oosterellidae 42
Family Olcostephanidae 42
Family Holcodiscidae 48
Family Neocomitidae 49
Superfamily Desmoceratoceae 67
Family Desmoceratidae 69
Family Silesitidae 86
Family Kossmaticeratidae 87
Family Cleoniceratidae 93
Family Pachydiscidae 101
Family Muniericeratidae 107
Superfamily Pulchelliaceae 111
Family Pulchelliidae 111
Superfamily Hoplitaceae 114
Family Hoplitidae 114
Family Schloenbachiidae 126
Family Placenticeratidae 126
Family Engonoceratidae 130
Superfamily Acanthoceratoceae 133
Family Leymeriellidae 133

Family Brancoceratidae 134
Family Lyelliceratidae 147
Family Flickiidae 151
Family Forbesiceratidae 152
Family Acanthoceratidae 154
Family Vascoceratidae 175
Family Pseudotissotiidae 177
Family Collignoniceratidae 183
Family Tissotiidae 198
Family Coilopoceratidae 201
Family Sphenodiscidae 203
Suborder Ancyloceratina 206
Superfamily Ancyloceratacea 206
Family Bochianitidae 208
Family Ancyloceratidae 210
Family Heteroceratidae 226
Family Hemihoplitidae 228
Family Hamulinidae 230
Family Ptychoceratidae 231
Family Labeceratidae 233
Family Macroscaphitidae 233
Superfamily Turrilitacea 234
Family Anisoceratidae 234
Family Hamitidae 239
Family Turrilitidae 241
Family Nostoceratidae 245
Family Diplomoceratidae 248
Family Baculitidae 255
Superfamily Scaphitacea 258
Family Scaphitidae 258
Superfamily Douvilleiceratacea 266
Family Douvilleiceratidae 266
Family Trochleiceratidae 269
Family Astiericeratidae 270
Superfamily Deshayesitacea 271
Family Deshayesitidae 271
Family Parahoplitidae 274
Correlation Chart for the Cretaceous 279
Ranges of Taxa 282
Glossary 304
References 309
Index 353

SYSTEMATIC DESCRIPTIONS

Order AMMONOIDEA Zittel, 1884

Cretaceous ammonites belong to the four suborders Phylloceratina, Lytoceratina, Ammonitina, and Ancyloceratina. The long-ranging Phylloceratina extend from low in the Triassic to the top of the Cretaceous, and those that occur in the Cretaceous belong to genera that originated in the Jurassic or are closely related to them. None of them form a suprageneric group that is characteristic of the Cretaceous. Consequently, Phylloceratina that occur in the Cretaceous are included in this volume as a genus list only. Abbreviated details of their type species, synonyms, and biostratigraphical ranges within the Cretaceous are given here, but a full description of each genus will be found in the Jurassic volume of the ammonoid *Treatise.*

Lytoceratina range from the base of the Jurassic to the top of the Cretaceous, and two superfamilies are recognized, Lytocerataceae and Tetragonitaceae. Cretaceous Lytocerataceae range to the Cenomanian and belong to genera that originated in the Jurassic or are closely related to them, so they are also included here as a generic list only. These genera will be described fully in the Jurassic *Treatise* volume. Tetragonitaceae, on the other hand, are confined to the Cretaceous, where they form a characteristic superfamily ranging from the Barremian to the Maastrichtian. They are described in full in this volume.

Ammonitina likewise range from the base of the Jurassic to the top of the Cretaceous. A few survivors of the largely Jurassic Haploceratacеae, Haploceratidae and Oppeliidae (Streblitinae), range into the Cretaceous and are described in this volume with the wholly Cretaceous Oppeliidae (Aconeceratinae) and Binneyitidae. The Perisphinctaceae are predominately Jurassic, but three important families—Polyptychitidae, Olcostephanidae, and Neocomitidae—are mainly Lower Cretaceous and, with minor derivative families, are fully described here. Desmocerataceae, Pulchelliaceae, Hoplitaceae, and Acanthocerataceae are wholly Cretaceous and are dealt with in this volume.

Ancyloceratina had a few late Jurassic members but flourished in the Cretaceous and are all described in this volume.

Suborder PHYLLOCERATINA Arkell, 1950

Superfamily PHYLLOCERATACEAE Zittel, 1884

Family PHYLLOCERATIDAE Zittel, 1884

Subfamily PHYLLOCERATINAE Zittel, 1884

Phylloceras (Phylloceras) SUESS, 1865 [**Ammonites heterophyllus* J. SOWERBY, 1820] [=*Rhacoceras* HYATT, 1867; *Xeinophylloceras* BUCKMAN, 1921 in 1909–1930; *Heterophylloceras* KOVACS, 1939; *Pseudophylloceras* BEZNOSOV, 1957]. *Lower Cretaceous (Berriasian–Barremian).*

P. (Partschiceras) FUCINI, 1923 in 1923–1935 [**Ammonites partschi* HAUER, 1854, *non* KLIPSTEIN, 1843] [=*Procliviceras* FUCINI, 1923 in 1923–1935; *Macrophylloceras* SPATH, 1927a; *Proclivioceras* ROMAN, 1938; *Partschiphylloceras* ROMAN, 1938; *Adobofoloceras* JOLY, 1977]. *Lower Cretaceous (Berriasian)–Upper Cretaceous (Maastrichtian).*

P. (Zetoceras) KOVACS, 1939 [**Ammonites zetes* ORBIGNY, 1850a] [=*Lavizzaroceras* KOVACS, 1939]. *Lower Cretaceous (Berriasian–Valanginian).*

Phyllopachyceras SPATH, 1925e [**Ammonites infundibulum* ORBIGNY, 1841]. *Lower Cretaceous (Barremian)–Upper Cretaceous (Maastrichtian).*

Hypophylloceras (Hypophylloceras) SALFELD, 1924 [**Phylloceras onoense* STANTON, 1895] [=*Goretophylloceras* COLLIGNON, 1948; *Euphylloceras* DRUSHCHITS, 1953b; *Aphrodituceras* MAHMOUD, 1955]. *Lower Cretaceous (Valanginian)–Upper Cretaceous (Cenomanian).*

H. (Neophylloceras) SHIMIZU, 1934 [**Ammonites (Scaphites?) ramosus* MEEK, 1857] [=*Paraphylloceras* SHIMIZU, 1935a, *non* SALFELD, 1919; *Hyporbulites* BREISTROFFER, 1947a; *Epiphylloceras* COLLIGNON, 1956]. *Lower Cretaceous (Aptian)–Upper Cretaceous (Maastrichtian).*

Carinophylloceras KLINGER, WIEDMANN, & KENNEDY, 1975 [**C. collignoni* KLINGER, WIEDMANN, & KENNEDY]. *Lower Cretaceous (Lower Albian).*

Subfamily CALLIPHYLLOCERATINAE Spath, 1927

Calliphylloceras SPATH, 1927a [**Phylloceras disputabile* ZITTEL, 1869] [=*Neocalliphylloceras* BESAIRIE, 1936; *Capitanioceras* KOVACS, 1939]. *Lower Cretaceous (Berriasian–Albian).*

Holcophylloceras SPATH, 1927a [**Phylloceras mediterraneum* NEUMAYR, 1871] [=*Salfeldiella* SPATH, 1927a; *Telegdiceras* KOVACS, 1942]. *Lower Cretaceous (Berriasian–Aptian).*

Ptychophylloceras SPATH, 1927a [**Phylloceras feddeni* WAAGEN, 1875 in 1873–1875] [=*Tatroceras* KOVACS, 1939; *Neumayriceras* SORRENTINO, 1942, *non* ROLLIER, 1909; *Tatrophylloceras* BEZNOSOV, 1957]. *Lower Cretaceous (Berriasian–Aptian).*

Sowerbyceras PARONA & BONARELLI, 1895 [**Ammonites tortisulcatus* ORBIGNY, 1841] [=*Martelliceras* SORRENTINO, 1942, *non* SCHINDEWOLF, 1925; *Gyrophyllites* WIEDMANN, 1963]. *Lower Cretaceous (Berriasian–Albian).*

Suborder LYTOCERATINA Hyatt, 1889

Superfamily LYTOCERATACEAE Neumayr, 1875b

Family LYTOCERATIDAE Neumayr, 1875b

Subfamily LYTOCERATINAE Neumayr, 1875b

Lytoceras SUESS, 1865 [**Ammonites fimbriatus* J. SOWERBY, 1817a] [=*Ophiceras* SUESS, 1865; *Thysanoceras* HYATT, 1867; *Thysanolytoceras* BUCKMAN, 1905; *Trachylytoceras* BUCKMAN, 1913 in 1909–1930; *Fimbrilytoceras* BUCKMAN, 1918 in 1909–1930; *Kallilytoceras* BUCKMAN, 1921 in 1909–1930; *Lobolytoceras* BUCKMAN, 1923 in 1909–1930; *Cosmolytoceras* SPATH, 1924; *Crenilytoceras* BUCKMAN, 1926 in 1909–1930; *Orcholytoceras* BUCKMAN, 1926 in 1909–1930; *Saturnoceras* ANDERSON, 1938; *Biasaloceras* DRUSHCHITS, 1953a; *Dinolytoceras* BEZNOSOV, 1956; *Valentolytoceras* BEZNOSOV, 1956]. *Lower Cretaceous (Berriasian)–Upper Cretaceous (Cenomanian).*

Pterolytoceras SPATH, 1927a [**Ammonites exoticus* OPPEL, 1863 in 1862–1863]. *Lower Cretaceous (Berriasian–Valanginian).*

Eulytoceras SPATH, 1927a [**Ammonites inaequalicostatus* ORBIGNY, 1840]. *Lower Cretaceous (Hauterivian–Lower Aptian).*

Hemilytoceras SPATH, 1927a [**Ammonites immanis* OPPEL, 1865]. *?Lower Cretaceous.*

Metalytoceras SPATH, 1927a [**Lytoceras triboleti* UHLIG, 1902]. *Lower Cretaceous (Valanginian).*

Ammonoceratites BOWDITCH, 1822 [**Ammonites lamarcki* BOWDITCH, 1822] [=*Ammonoceras* LAMARCK, 1822]. *Lower Cretaceous (Albian).*

Argonauticeras ANDERSON, 1938 [**Lytoceras argonautarum* ANDERSON, 1902] [=*Pseudotetragonites* DRUSHCHITS, 1956]. *Lower Cretaceous (Upper Aptian–Middle Albian).*

Pictetia UHLIG, 1883 [**Crioceras astierianum* ORBIGNY, 1842]. *Lower Cretaceous (Upper Aptian–Middle Albian).*

Protetragonites HYATT, 1900 [**Ammonites quadrisculcatus* ORBIGNY, 1841] [=*Hemitetragonites* SPATH, 1927a; *Leptotetragonites* SPATH, 1927a]. *Lower Cretaceous (Berriasian–Upper Albian).*

Carinolytoceras WIEDMANN, 1962c [**C. carinatum* WIEDMANN, 1962c]. *Lower Cretaceous (Upper Aptian).*

Superfamily TETRAGONITACEAE Hyatt, 1900

[*nom. transl.* WIEDMANN, 1962a, p. 147, *ex* Tetragonitidae HYATT, 1900, p. 568]

More involute than Lytoceratacеae, with whorl section less circular and becoming angled in some forms; several auxiliary saddles developing in suture line; shell lirate, striate, smooth, or occasionally strongly ribbed, and constrictions usually present. *Lower Cretaceous (Barremian)–Upper Cretaceous (Maastrichtian).*

Derived from *Protetragonites* (Lytoceratidae) in the Barremian. The two families, Gaudryceratidae and Tetragonitidae, are closely related in the Lower Cretaceous but more distinct in the Upper Cretaceous. Gaudryceratidae retain the quinquelobate primary suture of the Lytoceratacеae, but some Tetragonitidae develop a sexlobate primary suture. HENDERSON, 1970; KENNEDY & HENDERSON, 1992a; KULLMANN & WIEDMANN, 1970; MURPHY, 1967c; WIEDMANN, 1962a, 1962b; WRIGHT & KENNEDY, 1984; WRIGHT & MATSUMOTO, 1954.

Family GAUDRYCERATIDAE Spath, 1927

[Gaudryceratidae SPATH, 1927a, p. 66] [=Gaudryceratinae WRIGHT, 1957b, p. 200; Hypogaudryceratinae SHIMIZU, 1934, p. 67; Kossmatellinae BREISTROFFER, 1953b, p. 71; Vertebritinae WIEDMANN, 1962a, p. 150]

Whorl section typically rounded or elliptical, sometimes depressed; shell ornamented with lirae or fine riblets, occasionally smooth, and with constrictions; suture with symmetrically bifid saddles and a single main saddle in internal suture, but with additional

small saddles in some forms. KENNEDY & KLINGER, 1979b; KENNEDY & SUMMESBERGER, 1986. *Lower Cretaceous (Barremian)–Upper Cretaceous (Maastrichtian).*

Eogaudryceras SPATH, 1927a, p. 66 [**Ammonites numidus* COQUAND, 1880, p. 22; OD]. Moderately evolute; whorl section rounded to rectangular; smooth or ornamented with fine radial lirae; constrictions present in some and may become strong. KENNEDY & KLINGER, 1979b. *Lower Cretaceous (Barremian–Upper Albian):* France, Spain, England, Bulgaria, Caucasus, Italy, Switzerland, Algeria, South Africa (Zululand), Madagascar, Egypt (Sinai), California, Antarctica (Alexander Island).

E. (Eogaudryceras). Whorl section initially trapezoidal, becoming rounded and sometimes compressed in adults; fine, sinuous lirae projected strongly forwards over venter, but mold is smooth; constrictions weak or absent, typically on inner whorls only; suture with symmetrically bifid saddles and large suspensive lobe. MURPHY, 1967c. Occurrence and distribution as for genus.——FIG. 1,*3a–d.* **E. (E.) numidum* (COQUAND), Barremian; *a,b,* lectotype (designated HOWARTH, herein), Algeria (Djebel-Ouach, Constantine), ×1 (Sayn, 1890, pl. 1, fig. 3a,b); *c,d,* France (Hyèges, Alpes-de-Haute Provence), ×1 (Murphy, 1967c, pl. 5, fig. 1–2).

E. (Eotetragonites) BREISTROFFER, 1947b, p. 72 [**E. raspaili;* OD]. Whorl section initially rather depressed and more angular or rectangular than in *E. (Eogaudryceras)* at all growth stages; outer surface of shell smooth or finely striate; constrictions moderate to strong at all growth stages and projected gently forwards over venter; suture line with asymmetrically bifid saddles and incipient second lateral saddle in internal suture. Derived from *E. (Eogaudryceras)* in the Upper Aptian. *Lower Cretaceous (Upper Aptian–Middle Albian):* France, Spain, Switzerland, Bulgaria, Caucasus, South Africa (Zululand), Madagascar, Egypt (Sinai), California, Antarctica (Alexander Island).——FIG. 1,*1a,b.* **E. (Eotetragonites) raspaili* BREISTROFFER, Upper Aptian, France (Hyèges, Alpes-de-Haute Provence); ×1 (Kilian, 1913, pl. 11, fig. 3).——FIG. 1,*1c,d.* *E. (E.) wintunium* (ANDERSON), Upper Aptian, northern California; ×1 (Murphy, 1967c, pl. 3, fig. 5–6).

Anagaudryceras SHIMIZU, 1934, p. 67 [**Ammonites sacya* FORBES, 1846, p. 113; OD] [=*Paragaudryceras* SHIMIZU, 1934, p. 67 (type, *Gaudryceras limatum* YABE, 1903, p. 34; OD); *Murphyella* MATSUMOTO in MATSUMOTO, MURAMOTO, & TAKAHASHI, 1972, p. 208 (type, *Kossmatella (Murphyella) enigma;* OD)]. Whorl section always rounded; early whorls circular or depressed; later whorls compressed and higher; mold smooth, but shell with very fine, prorsiradiate or sinuous lirae; periodic, collared constrictions on inner whorls becoming more numerous on outer whorls, where they form broad, flattened, foldlike ribs. Derived from *E. (Eogaudryceras)* in the early Albian. KENNEDY & KLINGER, 1979b; WRIGHT & KENNEDY, 1984; HENDERSON & MCNAMARA, 1985. *Lower Cretaceous (Middle Albian)–Upper Cretaceous (Maastrichtian):* England, France, Germany, Austria, Romania, Algeria, Angola, South Africa (Zululand), Madagascar, southeastern India, Japan, Sakhalin, Kamchatka, Alaska, British Columbia, California, New Zealand, Antarctica (Seymour Island).——FIG. 1,*4a–d.* **A. sacya* (FORBES), Upper Albian or Cenomanian, southeastern India (Verdachellum); *a,b,* holotype, BMNH C.51067, ×1 (new); *c,d,* holotype of *Ammonites buddha* FORBES, BMNH C.22673, ×0.7 (new).

Gaudryceras GROSSOUVRE, 1894, p. 225 [**Ammonites mitis* HAUER, 1866, p. 305; SD BOULE, LEMOINE, & THEVENIN, 1906, p. 11(31)] [=*Epigaudryceras* SHIMIZU, 1934, p. 67 (type, *Lytoceras striatum* JIMBO, 1894, p. 35(181); OD); *Hemigaudryceras* SHIMIZU, 1934, p. 67 (type, *Lytoceras (Gaudryceras) denmanense* WHITEAVES, 1901, p. 31; OD); *Neogaudryceras* SHIMIZU, 1934, p. 67 (type, *Gaudryceras tenuiliratum* YABE, 1903, p. 19; OD); *Pseudogaudryceras* SHIMIZU, 1934, p. 67 (type, *Gaudryceras tenuiliratum* var. *infrequens* YABE, 1903, p. 28; OD)]. Inner whorls evolute, serpenticone, rounded or depressed; later whorls expanding more rapidly and becoming compressed; ornamented with lirae or wirelike, flexuous ribs, single or branched, which may coarsen and bunch on the outer whorls; variable, foldlike ribs may also develop on the outer whorls; periodic constrictions on inner mold marked by depressions and collars on the shell surface. Suture with wide, bifid saddles and lobes and a retracted suspensive lobe. Lirae and ribs coarser than in *Anagaudryceras.* KENNEDY & KLINGER, 1979b. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Maastrichtian):* worldwide.

G. (Gaudryceras). Large, with constrictions; developing foldlike ribs on body chamber. KENNEDY & SUMMESBERGER, 1979. Occurrence and distribution as for genus.——FIG. 2,*4a,b.* **G. (G.) mite* (HAUER), Coniacian, Gosau Beds, Austria (Strobl, Wolfgangsee); holotype, ×0.7 (Kennedy & Summesberger, 1979, pl. 1).

G. (Mesogaudryceras) SPATH, 1927a, p. 66 [**Ammonites leptonema* SHARPE, 1855, p. 32; OD]. Smaller, more involute and expanding more quickly than *G. (Gaudryceras);* whorls more compressed from an early stage, sometimes developing trigonal whorl section, widest near umbilicus, and with narrowly arched venter; lirae distant at first, then fine, dense, and strongly projected on the venter; no constrictions. WRIGHT & KENNEDY, 1984. *Upper Cretaceous (Lower Cenomanian–Middle Cenomanian):* England, France, Germany, Romania, Ukraine (Crimea), Turkmenistan (Kopet-Dag), Greenland.——FIG. 2,*3a,b.* **G. (M.) leptonema* (SHARPE), Lower or Middle Cenomanian, Lower Chalk, England (Ventnor, Isle of Wight); holotype, GSM 7762, ×1.

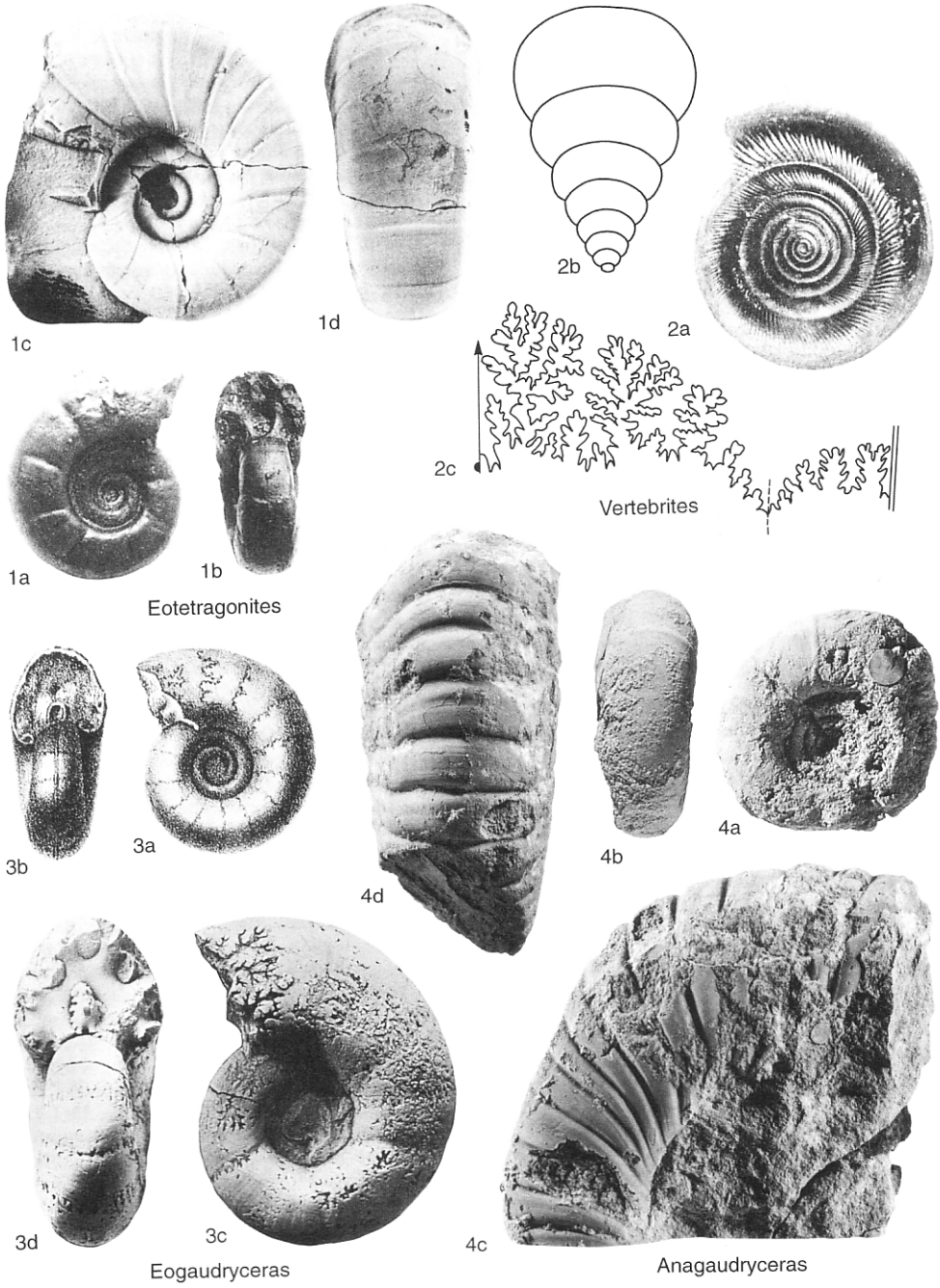


FIG. 1. Gaudryceratidae (p. 3–5)

Vertebrites MARSHALL, 1926, p. 138 [**V. murdochi*; M]. Very evolute, slowly expanding serpenticones retaining depressed, subrectangular whorl section throughout growth; fine, prorsiradiate lirae dividing into many finer lirae over venter; internal suture containing several saddles. HENDERSON, 1970; KENNEDY & KLINGER, 1979b. *Upper Cretaceous (Santonian–Maastrichtian):* Belgium, Algeria, South Africa (Zululand, Pondoland), Madagascar, southeastern India, Japan, New Caledonia, New Zealand, California, Texas, Mexico, Chile.——FIG. 1,*2a–c.* **V. murdochi* MARSHALL, Upper Campanian, New

Zealand (west shore of Waitapu Bay, Whangaroa Harbour); *a,* lectotype, ×1; *b,* lectotype, ×1.7; *c,* lectotype, ×4 (all Marshall, 1926, pl. 20, fig. 9, pl. 30, fig. 1–2).

Zelandites Marshall, 1926, p. 147 [**Z. kaiparaensis;* M] [=*Varunaites* Shimizu, 1926, p. 548 (type, *Ammonites varuna* Forbes, 1846, p. 107; OD); *Hypogaudryceras* Shimizu, 1934, p. 67 (type, *Desmoceras kawanoi* Jimbo, 1894, p. 28(174); M); *Anazelandites* Matsumoto, 1938c, p. 146 (type, *Lytoceras (Gaudryceras) flicki* Pervinquière, 1907, p. 65; OD)]. Earliest whorls round but quickly becoming more compressed, high-whorled, and more involute, typically with long, sloping umbilical walls and whorl sides convergent towards a rounded venter; smooth or with very fine lirae and frequent, moderate to strong, radial or prorsiradiate and gently sinuous constrictions on internal mold; suture with asymmetrical first lateral lobe and many recurved auxiliary saddles. *Lower Cretaceous (Lower Albian)–Upper Cretaceous (Upper Maastrichtian):* England, France, Sardinia, Spain, Tunisia, South Africa (Zululand), Madagascar, southeastern India, Japan, Sakhalin, New Zealand, Alaska, British Co-

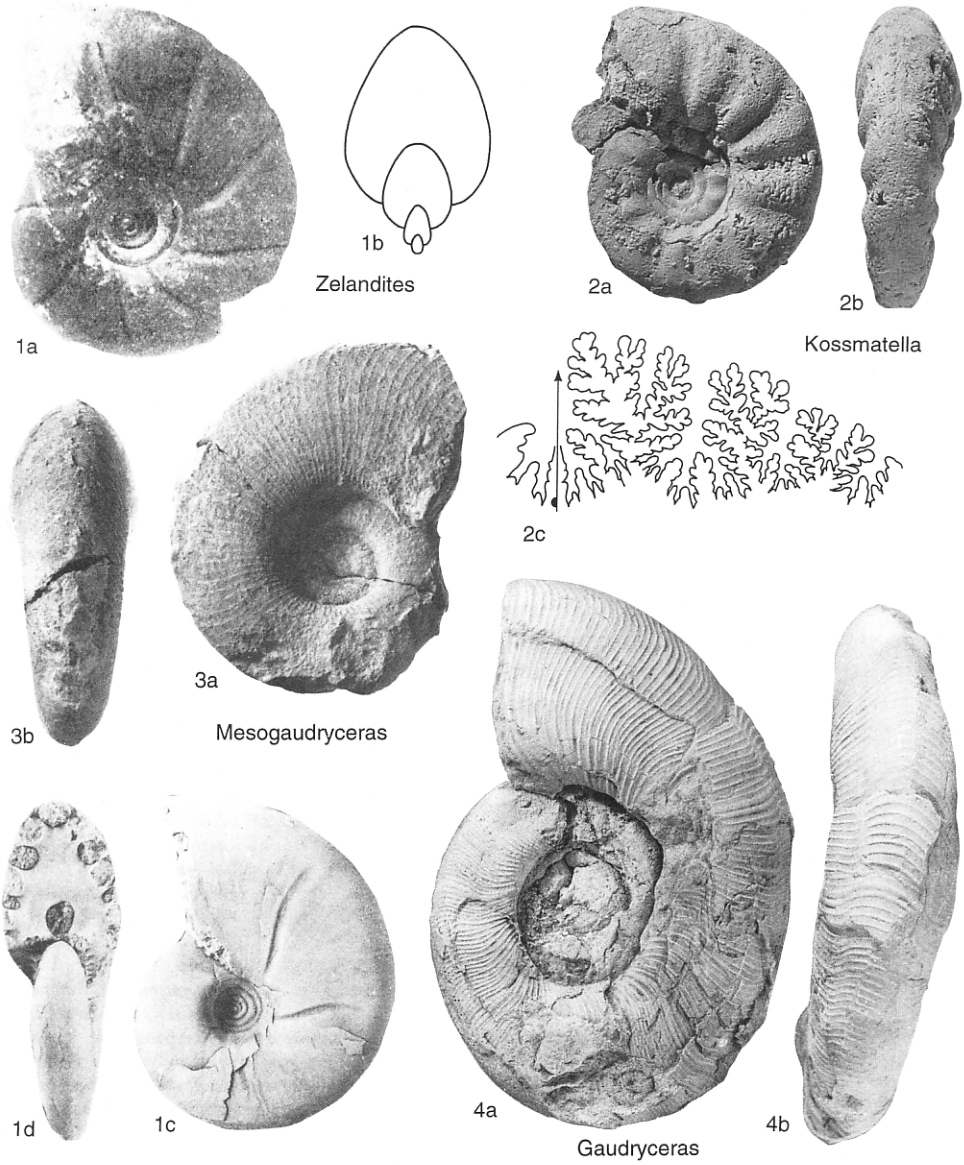


Fig. 2. Gaudryceratidae (p. 3–6)

lumbia, California, Chile, Antarctica (Seymour Island).——FIG. 2,*1a,b.* **Z. kaiparaensis* MARSHALL, Upper Campanian, New Zealand (Bull's Point, Kaipara Harbour); paralectotype, ×1.5 (Marshall, 1926, pl. 31, fig. 1–2).——FIG. 2,*1c,d. Z. varuna* (FORBES), Maastrichtian, Seymour Island; ×1.4 (Macellari, 1986, fig. 11.11–12).

Kossmatella JACOB, 1907, p. 285 [**Ammonites agassizianus* PICTET, 1847, p. 303; SD ROMAN, 1938, p. 43] [=*Guderianites* WIEDMANN, 1962b, p. 63 (type, *Kossmatella costata* H. DOUVILLÉ, 1916, p. 96; OD)]. Whorl section rounded and depressed in early whorls and becoming higher, compressed, and more involute in later whorls; deep constrictions occurring on inner mold, with large lateral bulge between constrictions; bulges in some forming swollen lateral tubercles, in others forming a row of nodes near umbilical edge which bifurcate or trifurcate into smaller bulges that are continuous over venter; shell surface with fine, single or bifurcating lirae; suture containing several recurved auxiliary saddles. WIEDMANN, 1962b; WIEDMANN & DIENI, 1968; KENNEDY & KLINGER, 1979b. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Middle Cenomanian):* France, Spain, Sardinia, Italy, Poland, South Africa (Zululand), Madagascar, Egypt (Sinai), southeastern India, Alaska, California, Mexico.——FIG. 2,*2a–c.* **K. agassizianus* (PICTET), Upper Albian, Switzerland (Saxonet, Savoyen); *a,b,* lectotype, Muséum d'Histoire Naturelle de Genève, Pi"GV"/4,3a,b,d, ×1 (new); *c,* ×5 (Wiedmann, 1962a, p. 166, fig. 25).

Family TETRAGONITIDAE Hyatt, 1900

[Tetragonitidae HYATT, 1900, p. 568]

Whorl section rectangular or trapezoidal in early whorls, sometimes depressed; usually smooth, but some genera lirate or striate; constrictions on internal mold strongly prorsiradiate but usually recurved across venter, corresponding with collars on outer shell surface; major saddles of suture are irregularly trifid, several auxiliary saddles present, and there are two or more saddles in internal suture; dorsal lobe may form a septal lobe on preceding septum. Derived from *Eogaudryceras.* MURPHY, 1967c; KENNEDY & KLINGER, 1977a. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Maastrichtian).*

Subfamily TETRAGONITINAE Hyatt, 1900

[*nom. transl.* WRIGHT, 1957b, p. 203, *ex* Tetragonitidae HYATT, 1900, p. 568]

Whorl section angled in early whorls, but may become rounded and inflated in later whorls. MURPHY, 1967a. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Maastrichtian).*

Tetragonites KOSSMAT, 1895, p. 131 [**Ammonites timotheanus* PICTET, 1847, p. 295; OD] [=*Epigoniceras* SPATH, 1925f, p. 29 (type, *Lytoceras (Tetragonites) epigonus* KOSSMAT, 1895, p. 135(39); OD); *Eoepigoniceras* SHIMIZU, 1935a, p. 165, *nom. nud.* (type, *Tetragonites kingianus* KOSSMAT, 1895, p. 137; OD); *Neoepigoniceras* SHIMIZU, 1935a, p. 165, *nom nud.* (type, *N. schmidti;* OD); *Tingriceras* CHAO, 1976, p. 538 (type, *T. chanaense;* OD]. Moderately evolute; whorl section subrectangular, trapezoidal, or rounded; shell smooth or with growth lines only; usually with oblique, prorsiradiate constrictions on internal mold only, with corresponding collars on outside of shell; suture with deep external lobe, several auxiliary saddles, either straight or recurved, and two or more unequal internal saddles. KENNEDY & KLINGER, 1977a; WRIGHT & KENNEDY, 1984. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Maastrichtian):* England, France, Spain, Switzerland, Ukraine (Crimea), Caucasus, Algeria, Tunisia, Angola, South Africa (Zululand), Mozambique, Madagascar, Egypt (Sinai), southeastern India, Tibet, Japan, Sakhalin, New Zealand, Alaska, British Columbia, California, Oregon, Texas, Mexico, Peru, Antarctic Peninsula.

T. (Tetragonites). No siphonal ridge on venter; constrictions prorsiradiate on side of whorl, then bending backwards at ventrolateral shoulder to form a sinus on venter. Occurrence and distribution as for genus.——FIG. 3,*3a–c.* **T. (T.) timotheanus* (PICTET), Upper Albian, Switzerland (Saxonet, Savoyen); *a,b,* lectotype, Muséum d'Histoire Naturelle de Genève, Pi"GV"/3,1, ×1 (new); *c,* ×3 (Wiedmann, 1962a, p. 172, fig. 31).——FIG. 3,*3d,e. T. (T.) epigonus* (KOSSMAT), Campanian, southeastern India (Varagur); lectotype, ×1 (Kossmat, 1895, pl. 17, fig. 4a,b).

T. (Carinites) WIEDMANN, 1973b, p. 609 [**T. spathi* FABRE, 1940, p. 214; OD]. Developing a feeble ventral ridge; constrictions projected forwards to form angle on venter. WRIGHT & KENNEDY, 1984. *Upper Cretaceous (Middle Cenomanian):* England, France, Ukraine (Crimea), Caucasus, Russia (Dagestan).——FIG. 3,*4a,b.* **T. (C.) spathi* FABRE, France (Cassis, Bouches-du-Rhône); holotype, ×1 (Wiedmann, 1973b, pl. 8, fig. 10b,c).

Saghalinites WRIGHT & MATSUMOTO, 1954, p. 110 (*ex* SHIMIZU, 1935a, p. 181, *nom. nud.*) [**Ammonites cala* FORBES, 1846, p. 104; OD]. Similar to *Tetragonites* but more evolute, serpenticone, and with whorls enlarging very slowly; whorl section rounded, slightly depressed, becoming trapezoidal or octagonal; smooth or with growth striae only; constrictions weak to strong, usually highly oblique and curved. KENNEDY & KLINGER, 1977a; KENNEDY, 1986a; KENNEDY & HENDERSON, 1992a. *Upper Cre-*

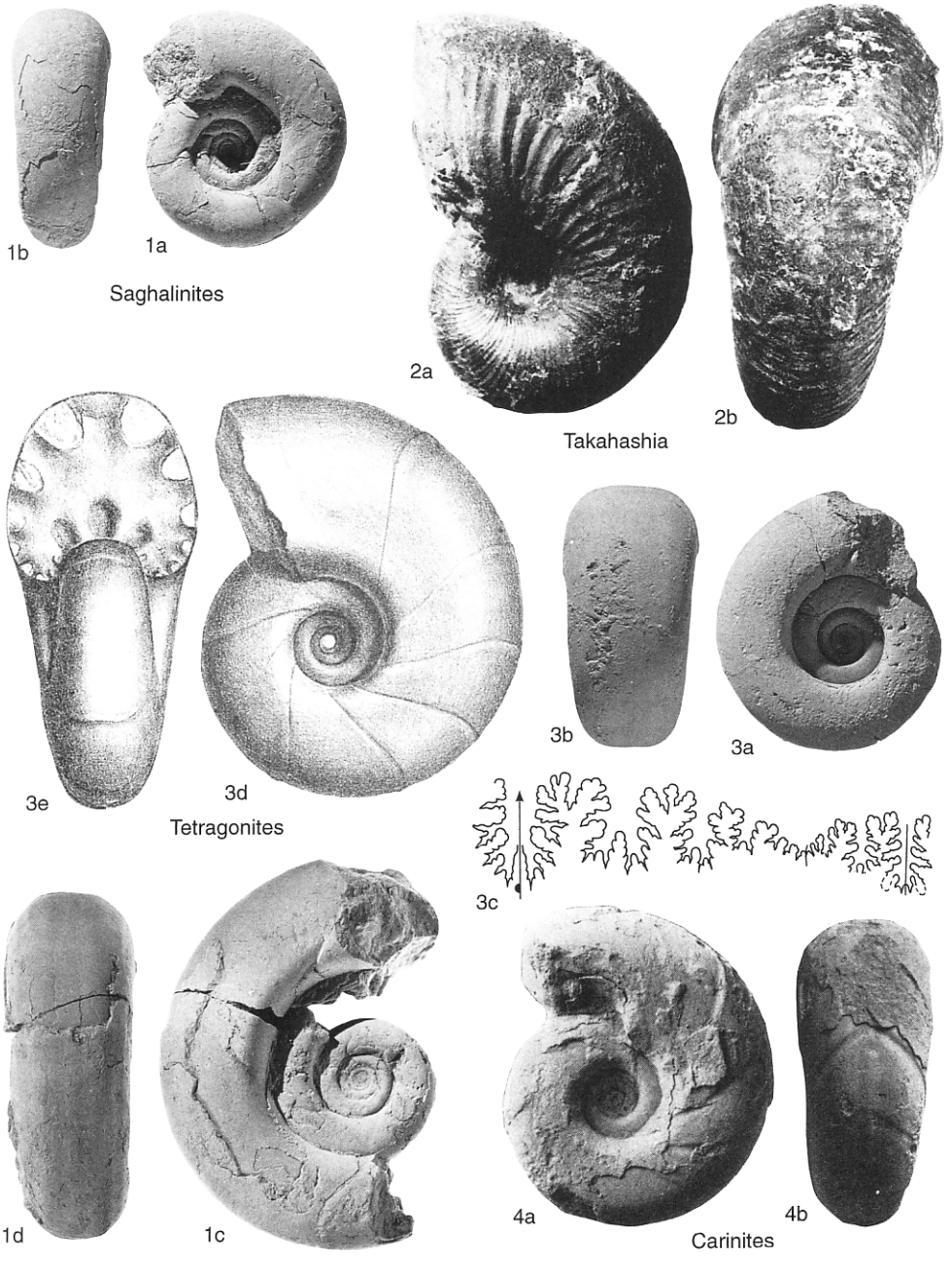


FIG. 3. Tetragonitidae (p. 6–9)

taceous (Upper Santonian–Maastrichtian): France, Switzerland, The Netherlands, Denmark, Italy, Germany, Austria, Spain, Ukraine, Tunisia, South Africa (Zululand, Pondoland), Madagascar, Japan, southeastern India, Sakhalin, Greenland, Argentina (Patagonia), Antarctic Peninsula.——FIG. 3,*1a–d.*

**S. cala* (FORBES), Maastrichtian, southeastern India (Pondicherry); *a,b,* lectotype, BMNH C.51057, ×1 (new); *c,d,* paralectotype, BMNH C.51058, ×0.7 (new).

Pseudophyllites KOSSMAT, 1895, p. 137(41) [**Ammonites indra* FORBES, 1846, p. 105; M]. Largest

tetragonitid genus, with adults up to 300 mm in diameter; inner whorls as in *Tetragonites* but quickly becoming much more involute and inflated, with higher whorls, a rounded whorl section, and no constrictions; fine radial growth lines and spiral striae forming reticulate pattern on shell; suture highly incised, with several auxiliary saddles. KENNEDY, 1986d; KENNEDY & KLINGER, 1977a; KENNEDY & HENDERSON, 1992a. *Upper Cretaceous (Upper Santonian–Upper Maastrichtian):* Northern Ireland, France, Spain, Poland, Austria, South Africa (Zululand), Madagascar, southeastern India, Japan, Sakhalin, Western Australia, New Zealand, Greenland, Alaska, British Columbia, California, New Jersey, Mississippi, Chile, Argentina, ?Brazil, Antarctic Peninsula.——FIG. 4,*1a–c.* **P. indra* (FORBES), Maastrichtian, southeastern India (Pondicherry); *a,b,* lectotype, BMNH C.51068, ×0.5 (new); *c,* ×0.8 (Kossmat, 1895, pl. 17, fig. 6).

Parajaubertella MATSUMOTO, 1942c, p. 666 [**P. kawakitana;* OD]. Outer whorls like *Takahashia* or large *Anagaudryceras,* enlarging rapidly, with backwardly curving, foldlike ribs; inner whorls of 10 to 40 mm diameter more depressed, with vertical umbilical walls and rounded umbilical edge; also resembling a large *Gabbioceras,* but inner whorls having neither the sloping umbilical walls (resulting in a funnel-shaped umbilicus) nor the angled umbilical edge of that genus; suture much incised, with several recurved auxiliary saddles. MATSUMOTO, 1959; MURPHY, 1967c. *Lower Cretaceous (?Upper Albian)–Upper Cretaceous (Lower Cenomanian):* Japan, Sakhalin, Alaska.——FIG. 4,*2a–c.* **P. kawakitana,* Lower Cenomanian, South Sakhalin (Yuno-sawa, Naibuchi valley); *a,* holotype, University of Tokyo, Geology Department I-371.b, ×0.5 (new); *b,c,* paratypes, *b,* ×2.5, *c,* ×2 (Matsumoto, 1942c, p. 668, fig. 2c,d).

Takahashia MATSUMOTO, 1984b, p. 33 [**T. eureka;* OD]. Very similar to *Pseudophyllites* in size, shell form, ornament, and suture, but of much older geological age and developing moderately strong radial ribs, which curve backwards on side of whorl and form a shallow sinus on the venter. *Upper Cre-*

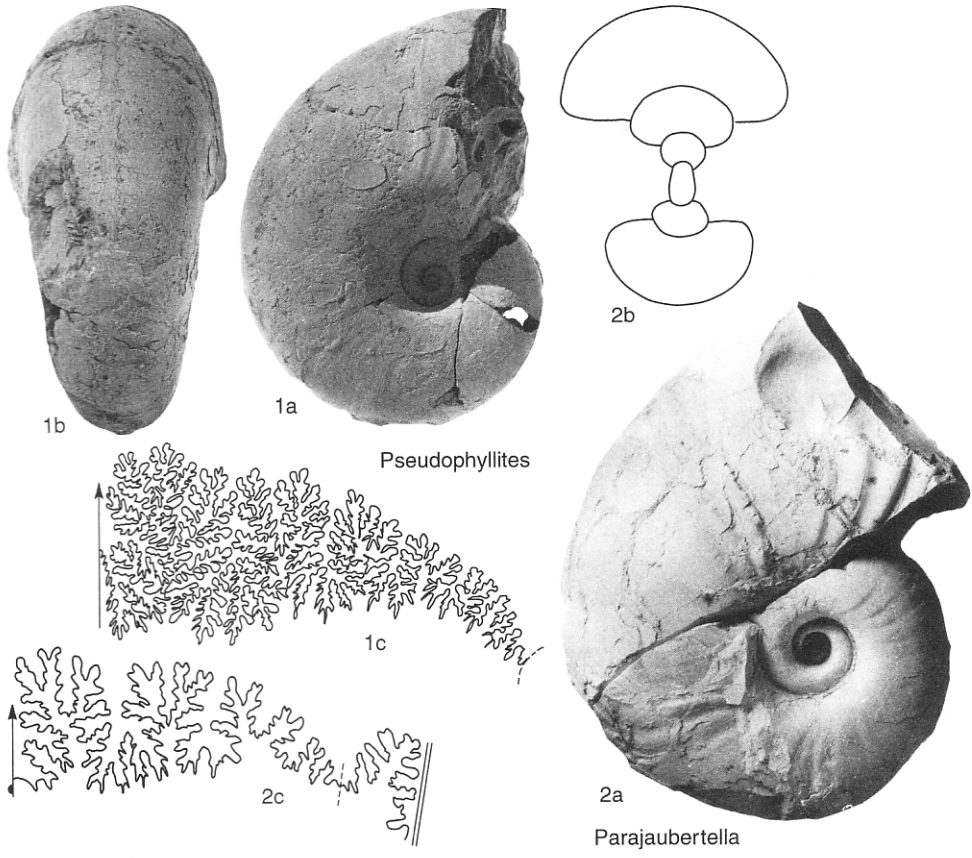


FIG. 4. Tetragonitidae (p. 7–8)

taceous (Lower Cenomanian): Japan.——FIG. 3,*2a,b.* **T. eureka* MATSUMOTO, Hokkaido (Katsurazawa quarry, Ikushumbets River); holotype, ×0.4 (Matsumoto, 1984b, fig. 1).

Subfamily GABBIOCERATINAE Breistroffer, 1953

[Gabbioceratinae BREISTROFFER, 1953b, p. 71]

Highly depressed, cadicone forms, with a sharp ventrolateral angle, but may become compressed and round-whorled on two outermost whorls; shell lirate, with constrictions and collars; suture with one or two auxiliary saddles and two unequal internal saddles. Derived from *Eogaudryceras (E.) numidum* (COQUAND) in the mid-Aptian. WIEDMANN, 1962c; MURPHY, 1967b; KENNEDY & KLINGER, 1977a. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Lower Cenomanian).*

Gabbioceras HYATT, 1900, p. 570 [**Ammonites batesi* GABB, 1869, p. 132, *non* TRASK, 1855; OD; =*Gabbioceras angulatum* ANDERSON, 1902, p. 87]. Inner whorls evolute, highly depressed, cadicone, with flat, sloping umbilical walls, sharp ventrolateral angle, and highly arched venter; later whorls losing cadicone shape to become rounded, compressed, with no ventrolateral angle; shell with prorsiradiate lirae; constrictions on inner mold, with corresponding collars on shell surface, occurring occasionally on cadicone whorls and more frequently on outer whorls. MURPHY, 1967b. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Lower Cenomanian):* France, Spain, Caucasus, northern Africa, Madagascar, California.——FIG. 5,*1a–c.* **G. angulatum* ANDERSON, Upper Aptian, northern California; *a,b,* lectotype of *Ammonites batesi* GABB, ×0.7 (GABB, 1869, pl. 21, fig. 10); *c,* California (Ono), ×1 (Murphy, 1967b, pl. 64, fig. 1).

Jauberticeras JACOB, 1907, p. 285 [**Ammonites jaubertianus* ORBIGNY, 1850b, p. 200; OD] [=*Jaubertella* JACOB, 1908, p. 12, 17 (type, *Ammonites jaubertianus* ORBIGNY, 1850b, p. 200; SD SPATH, 1927a, p. 66)]. Known only up to posterior part of body chamber at a small size; whorls always cadicone; differing from *Gabbioceras* in having almost flat or only slightly arched venter; shell lirate, especially on umbilical wall, and occasional constrictions on internal mold corresponding with collars on the shell. KENNEDY & KLINGER, 1977b. *Lower Cretaceous (Upper Aptian–Upper Albian):* France, Spain, Caucasus, northern Africa, Madagascar, South Africa (Zululand).——FIG. 5,*2a–f.* **J. jaubertianus* (ORBIGNY), Upper Aptian, France (Hyèges, Alpes-de-Haute Provence); *a–c,* lectotype, MNHN 5591, ×1 (new); *d–f,* ×1 (Murphy, 1967b, pl. 64, fig. 20–22).

Suborder AMMONITINA Hyatt, 1889

Superfamily HAPLOCERATACEAE Zittel, 1884

[*nom. transl.* ARKELL, 1957, p. 271, *ex* Haploceratidae ZITTEL, 1884, p. 411]

Typically compressed to discoidal; whorl sections ranging from oval with narrowly rounded venter to uni- or tricarinate oxycones with sharp keel; ribbing falcoid or falcate to obsolescent. Dimorphism moderate to extreme; microconchs often with aberrantly coiled and ornamented adult body chambers, their peristomes with prominent lappets. Double-valved aptychi known in many groups, sometimes as the only evidence of the former presence of ammonites (Aptychus Limestone facies of the Alps). Distribution pandemic but concentrated in the lower paleolatitudes of the Tethyan Realm. *Middle Jurassic (Aalenian)–Upper Cretaceous (Lower Santonian).*

The origin of the superfamily remains uncertain. Three of the main stems appeared more or less simultaneously in the Upper Aalenian, but the roots must lie lower, in the Toarcian. The lappeted microconchs point to the Hildoceratinae, as do iterative homeomorphies in such characters as tricarinate venters and midlateral spiral grooves. Rates of evolution in some lineages were imperceptibly low (Lissoceratidae, Haploceratidae). Distribution patterns coupled with the almost total absence of ribbing at all stages in both dimorphs suggest a pelagic habitat for these, akin to that of most Lytoceratina and Phylloceratina.

Family HAPLOCERATIDAE Zittel, 1884

[Haploceratidae ZITTEL, 1884, p. 411]

Small to medium-sized, fairly involute, smooth, featureless shells. Strongly but inconspicuously dimorphic; macroconchs with sinuous adult peristomes, moderately complex septal sutures characterized by well-

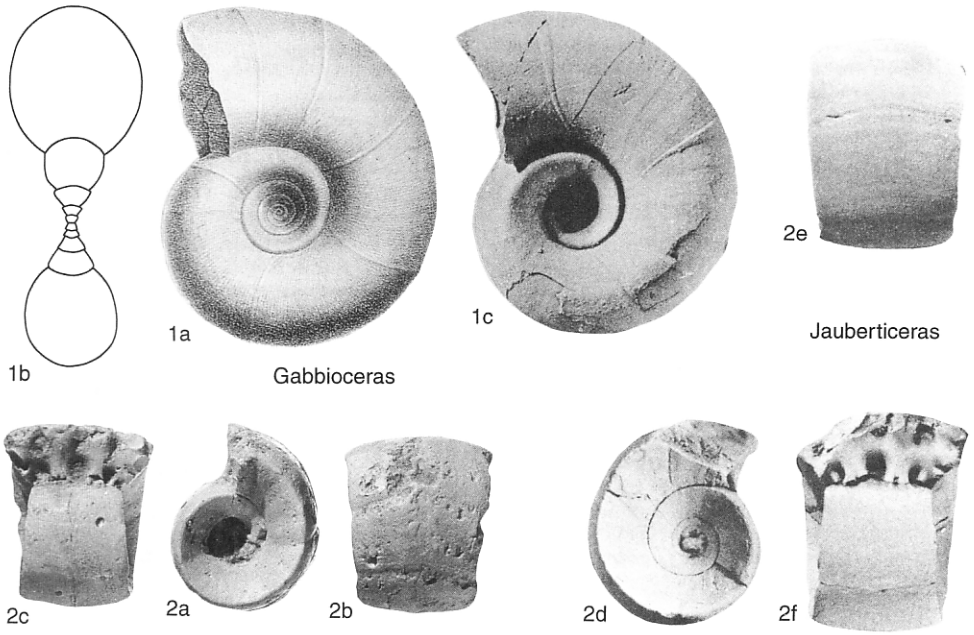


FIG. 5. Tetragonitidae (p. 9)

incised, somewhat asymmetric lobes; microconchs with short lappets. *Upper Jurassic (Kimmeridgian)–Lower Cretaceous (Upper Hauterivian, ?Lower Barremian).*

This family is probably derived from Taramelliceratinae of the Oppeliidae via *Metahaploceras* and *Glochiceras* (partim) in the Kimmeridgian, persisting almost unchanged through the Tithonian to the Barremian. Haploceratidae are homeomorphs of Lissoceratidae, an equally featureless and unchanging lineage that ranged from early Middle Jurassic into the Upper Oxfordian, but probably not directly related, for Lissoceratidae and Oppeliinae, ancestors of the Taramelliceratinae, were already fully differentiated at their first joint appearance in the Lower Bajocian. The septal sutures of Lissoceratidae are also characteristically distinct.

Haploceras ZITTEL, 1870, p. 166 [**Ammonites elimatus* OPPEL, 1865, p. 549; SD SPATH, 1923d, p. 14] [=*Hypolissoceras* BREISTROFFER, 1947a, 2nd unnumbered page (type, *Ammonites carachtheis* ZEUSCHNER, 1846, pl. 4, fig. 1; OD); *Neoglochiceras* PATRULIUS & AVRAM, 1976, p. 168 (*non* COLLIGNON, 1960, explanation of pl. 145, *nom. nud.*), obj.]. Whorl section high-ovate. Microconchs with ventral crenulation on adult body chamber. *Upper Jurassic (Kimmeridgian,* beckeri *Zone)–Lower Cretaceous (Valanginian):* Tethys.——FIG. 6,*1a,b.* **H. elimatum* (OPPEL); macroconch, Upper Tithonian, Czech Republic, ×0.7 (Zittel, 1868).——FIG. 6,*1c–e. H. carachtheis* (ZEUSCHNER), Upper Tithonian, Czech Republic; microconch, ×1 (Zittel, 1868).

Neolissoceras SPATH, 1923d, p. 33 [**Ammonites grasianus* ORBIGNY, 1841, p. 141; M]. Compressed, involute, smooth; differing from *Haploceras* in flat-sided whorl section, flatly rounded venter, and distinct umbilical margin; one species with blunt keel. Sutures as in *Haploceras*. Contains *Aptychus beyrichi* var. *fractocostata* TRAUTH. *Upper Jurassic (?Upper Tithonian), Lower Cretaceous (Berriasian–Upper Hauterivian, ?Lower Barremian):* southern Europe, Madagascar, Punjab.——FIG. 6,*2a–c.* **N. grasianum* (ORBIGNY); *a,b,* Upper Tithonian, France; ×0.5 (Orbigny, 1840–1842); *c,* Valanginian, France, ×10 (Wiedmann, 1966a).

Family OPPELIIDAE H. Douvillé, 1890

[*nom. correct.* ARKELL, 1951, p. 6 *pro* Oppelidae BONARELLI, 1894, p. 81, *nom. correct. pro* Oppeliidés H. DOUVILLÉ, 1890, p. 287]

Typically compressed to oxycone; involute; strongly dimorphic. Macroconchs with distant, falcoid to falcate primary ribbing becoming smooth, simple aperture, and dense, complex sutures with deeply incised lobes arranged regularly on a straight baseline in decreasing length from external to umbilical edges. Microconchs tending to

genicular coiling on adult body chamber, with highly developed, often spatulate, lappets. Sutures generally regular but complex. *Middle Jurassic (Lower Bajocian)–Lower Cretaceous (Upper Albian).*

This is a diverse clade with a common root in the Oppeliinae of the early Middle Jurassic (Bajocian), the precise origin of which is still uncertain. The earliest forms appear to be *Praeoppelia* from the uppermost Aalenian, which share some morphological features of coiling, ribbing, and dimorphism with contemporary *Bradfordia* and *Lissoceras* but differ strongly in other features, including the falcoid ribbing and complex sutures. A line of descent can then be followed via oxycone *Oxycerites* of the late Middle Jurassic into Ochetoceratinae of the Oxfordian and thence, as assumed here, into the Streblitinae from the Kimmeridgian into the Hauterivian. Subsequent branches became more evolute and strongly ribbed (Hecticoceratinae), acquired runcinate biclavellate venters (Distichoceratinae), or developed various styles of blunt tuberculation (Taramelliceratinae).

Subfamily STREBLITINAE Spath, 1925

[*nom. transl.* Spath, 1928b, p. 147, *ex* Streblitidae Spath, 1925b, p. 115]

Discoidal oxycones with very narrow umbilici; macroconchs high-keeled or narrowly tabulate with sharp, crenulate keels, becoming inflated on the adult body chamber; venter on adult body chamber broadening and developing shallow sulcus; ribbing variable but frequently recapitulating distant, falcate primaries with midlateral spiral groove so characteristic of ancestral *Oxycerites,* with fine but dense secondaries or even tertiaries

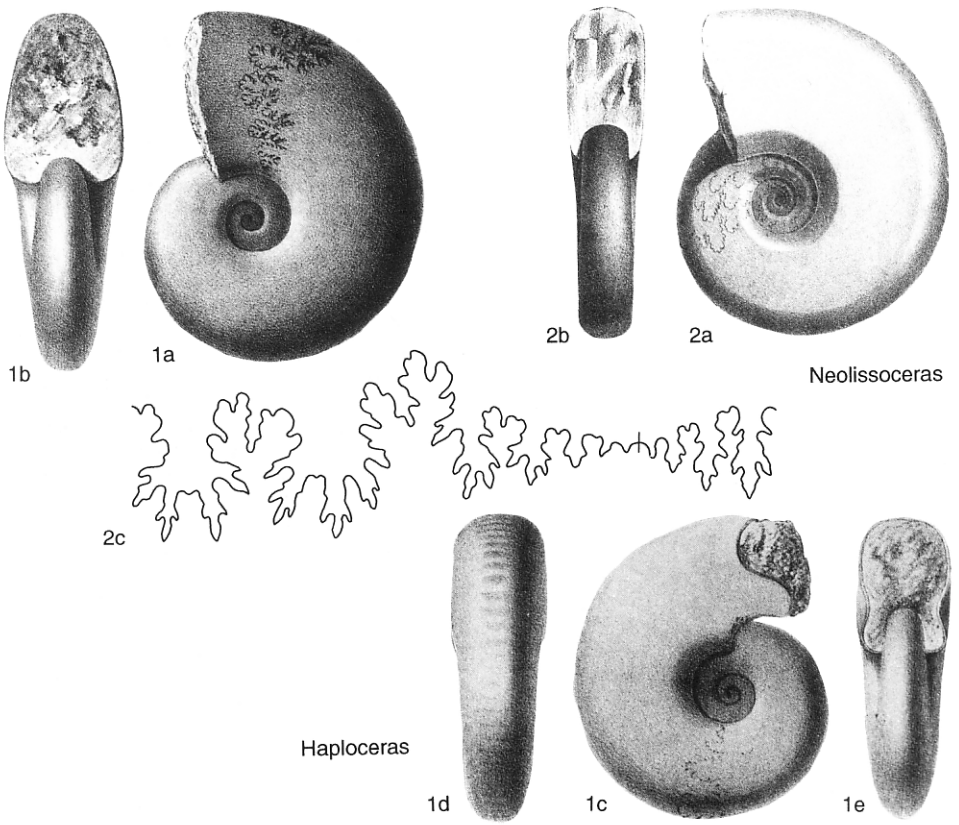


Fig. 6. Haploceratidae (p. 10)

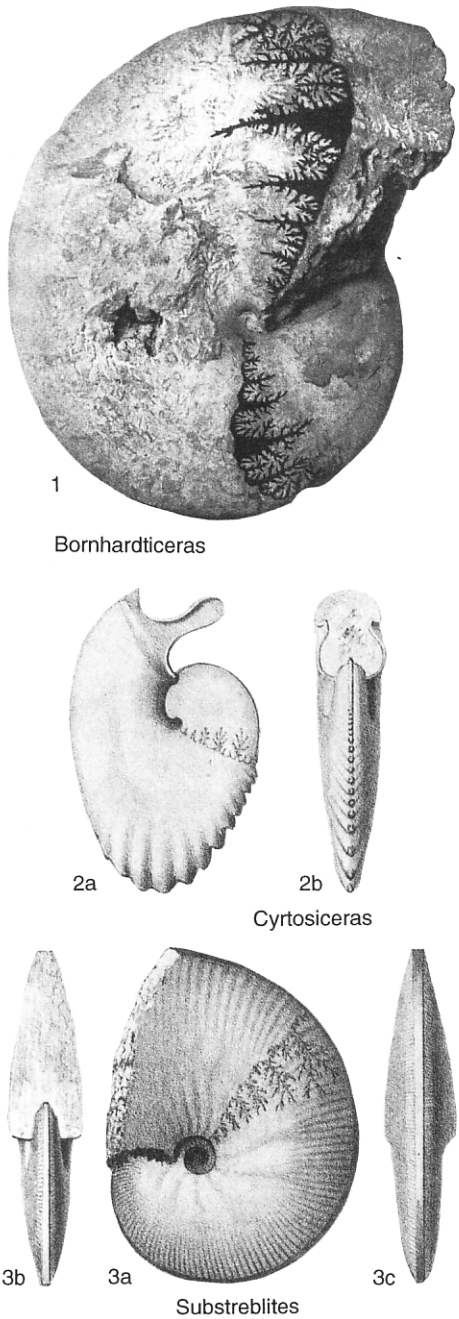


FIG. 7. Oppeliidae (p. 12)

strengthening outwards towards the external margin. Microconchs very variable, smooth to densely ribbed with finely crenulate keels; adult body chambers more or less strongly modified, excentrically coiled, sometimes bizarrely (*Cyrtosiceras*), with prominent lappets. *Upper Jurassic (Kimmeridgian)–Lower Cretaceous (Hauterivian).*

Taken here to have evolved from Ochetoceratinae via forms such as *Strebliticeras* HÖLDER, 1955.

Uhligites KILIAN, 1913, p. 338 [**Streblites kraffti* UHLIG, 1903, p. 44; SD ROMAN, 1938, p. 164]. Venter rounded; ribbing feeble. Suture with exceptionally large lobe L. *Lower Cretaceous (Upper Valanginian):* Madagascar.

Substreblites SPATH, 1925b, p. 115 [**Ammonites zonarius* OPPEL, 1865, p. 548; OD]. Like *Streblites* (Upper Jurassic), but venter with narrow, raised, flat band; sutures similar to *Streblites* with dense, strongly incised, long lobes on straight baseline but even more and narrower. *Upper Jurassic (Tithonian)–Lower Cretaceous (Upper Valanginian):* France, central Europe, Ukraine (Crimea), Pakistan (Salt Range), Antarctica.——FIG. 7,*3a–c.* **S. zonarius* (OPPEL), Upper Tithonian, Czech Republic; ×1 (Zittel, 1868).

Cyrtosiceras HYATT, 1900, p. 569 [**Ammonites macrotelus* OPPEL, 1865, p. 548; OD] [=*Meunieria* GREGORIO, 1922, p. 16 (*non* KIEFFER, 1904, p. 408(42)), obj.]. Compressed; umbilicus occluded; phragmocone with minutely crenulate venter; adult body chamber modifying strongly, with coiling becoming excentrically geniculate, ventral crenulae swelling briefly before fading altogether, final aperture contracting by umbilical uncoiling, and peristome marked by terminal constriction and subspatulate lappet. Sutures similar to those of *Substreblites.* These forms are almost certainly the microconchs of *Substreblites,* but sutures are somewhat less strongly incised. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Berriasian):* Czech Republic (Moravia), Romania, Ukraine (Crimea).——FIG. 7,*2a,b.* **C. macrotelus* (OPPEL), Upper Tithonian, Carpathians; ×1 (Zittel, 1868).

Bornhardticeras BÖHM & RIEDEL, 1933, p. 122 [**Placenticeras discoidale* MÜLLER, 1900, p. 558; M]. Whorl section squarish in early stages, heightening later; adult platycone with rounded keelless venter as in *Uhligites;* ribs falcoid, sporadically with 2 rows of lateral tubercles, fading in adult. Sutures with long, tapering lobes with short lateral branches; saddle E/L divided by large adventive lobe. *Lower Cretaceous (Hauterivian):* Tanzania.——FIG. 7,*1.* **B. discoidale* (MÜLLER); ×0.3 (Böhm & Riedel, 1933).

Subfamily ACONECERATINAE Spath, 1923

[*nom. transl.* WRIGHT, 1957b, p. 285 *ex* Aconeceratidae SPATH, 1923d, p. 35]

Small to medium-sized; involute; compressed; sides flat or slightly convex; keel sharp to slightly rounded, entire or crenu-

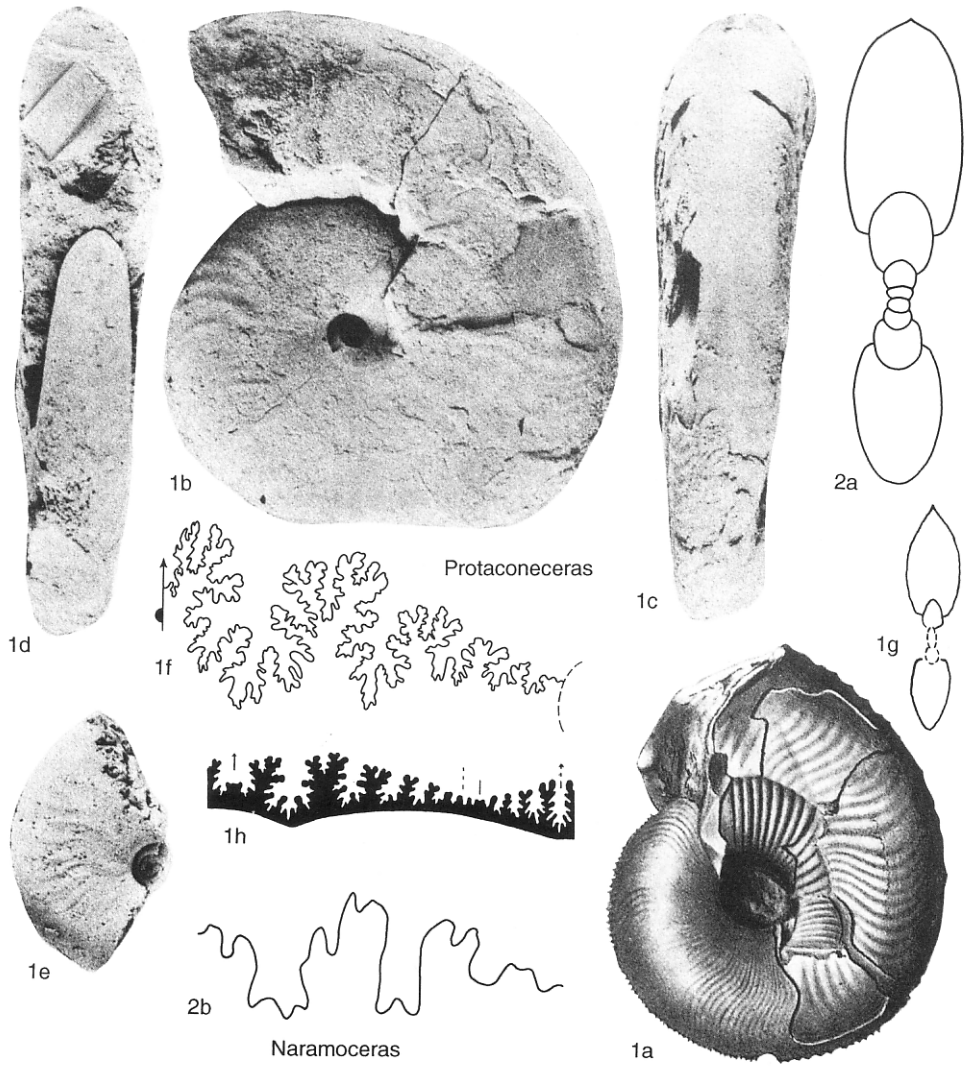


FIG. 8. Oppeliidae (p. 13–14)

late. Aperture of microconchs with long rostrum and lappets. Shell smooth or with flexuous to falcate lirae or ribs. Suture with second lateral saddle projecting well in front of the first. CASEY, 1961d; KENNEDY & KLINGER, 1979a.

WIEDMANN (1966a, p. 70) derives the subfamily (as a family) from the bluntly keeled *Neolissoceras aberrans* (Upper Valanginian, France), but since the subfamily evolves into haploceratoid forms (CASEY, 1961d, p. 119), it is more likely that it was derived from Streblitinae, which survived at least to the Hauterivian. *Lower Cretaceous (Upper Hauterivian–Upper Albian).*

Protaconeceras CASEY, 1954b, p. 269 [**Oppelia patagoniensis* FAVRE, 1908, p. 634; OD]. Keel low, coarsely crenulate in early stages; sides rather convex; flexuous striae or feeble, typically flat, ribs on outer flank of body chamber continuous to keel. Suture with wider and shallower elements than in *Aconeceras. Lower Cretaceous (Upper Hauterivian):* England, France, Argentina (Patagonia).——FIG. 8, *1a–f.* **P. patagoniense* (FAVRE), Upper Hauterivian, Patagonia; *a,* ×2 (Favre, 1908); *b–d,* macro-

conch, ×1 (Riccardi, Aguirre Urreta, & Medina, 1987); *e,* microconch, ×1; *f,* suture, ×2 (Riccardi, Aguirre Urreta, & Medina, 1987).——FIG. 8,*1g,h. P.* sp., Upper Hauterivian, England; *g,* ×2; *h,* ×3 (Casey, 1954b).

Aconeceras HYATT, 1903, p. 100 [**Ammonites nisus* ORBIGNY, 1841, p. 184; M] [=*Adolphia* STOLLEY, 1907, p. 269, obj. (type, *Ammonites nisus;* SD CASEY, 1961d, p. 123); *Adolphites* HENNIG, 1932, p. 348 (? error for *Adolphia*)]. Involute oxycones with finely to coarsely serrate, solid or hollow keel, flat or gently convex sides, and angular umbilical rim; smooth at first but sooner or later with prorsiradiate, falcate striae or feeble to strong, flat ribs. Suture variable with long and narrow to short and wide elements; saddles may be phylloid. [Attempts to divide the more or less oxycone aconeceratines on the basis of ribs or height and fineness of denticulation of keel seem unsuccessful; in Barremian to Albian populations there is no stratigraphical separation of the various features. *Aconeceras* is therefore here interpreted widely with the conventional genera retained provisionally as subgenera.] *Lower Cretaceous (Upper Barremian–Lower Albian):* Europe, Greenland, Algeria, South Africa, Madagascar, Australia (Queensland), Western Australia, Argentina, Nepal.

A. (Aconeceras). Compressed; sides more or less flat; keel low, finely denticulate; ribs feeble, appearing late in ontogeny. Occurrence and distribution as for genus.——FIG. 9,*7a–c. *A. (A.) nisus* (ORBIGNY), Upper Aptian, France; *a,* ×1.5; *b,* ×1; *c,* ×4 (all Sarasin, 1893).

A. (Sanmartinoceras) BONARELLI in BONARELLI & NÁGERA, 1921, p. 27 [**S. patagonicum;* M] [=*Eofalciferella* BRUNNSCHWEILER, 1959, p. 13 (type, *E. condoni;* OD)]. Whorl section stouter and sides more convex than in *A. (Aconeceras);* keel high and serrated to low; juvenile stage smooth, then falciform striae strengthening into rather strong ribs on outer part of side or throughout. Microconchs with long rostrum and lappets and spiral depression at midflank; presumed macroconchs with no depression. *Lower Cretaceous (Upper Aptian–Lower Albian):* Europe, South Africa (Zululand), Madagascar, Nepal, Western Australia, Argentina, Antarctica, Greenland.——FIG. 9,*2. A. (S.) groenlandicum* ROSENKRANTZ in BOGVAD & ROSENKRANTZ, Upper Aptian, Greenland; microconch, ×1 (Casey, 1961d).

A. (Sinzovia) SAZONOVA, 1958, p. 126 [**Ammonites trautscholdi* SINZOW, 1870, p. 118; OD; =*S. (S.) sazonovae* WRIGHT, herein, *nom. nov. pro Ammonites trautscholdi* SINZOW, *non* OPPEL, 1862 in 1862–1863, p. 143]. Keel very low; juvenile smooth stage shorter than in *A. (Sanmartinoceras);* inner part of side tending to be smooth. *Lower Cretaceous (Lower Aptian–Lower Albian):* Europe, Russia, Madagascar, Nepal, southern Australia, Argentina.——FIG. 9,*3a–c. *A. (S.) sazonovae* (WRIGHT), Lower Aptian, Russia; *a,b,* ×1; *c,* approximately ×2 (all Casey, 1961d).

A. (Theganoceras) WHITEHOUSE, 1926, p. 202 [**Oppelia scalata* KOENEN, 1902, p. 54; OD]. Keel low; juvenile smooth stage short; ribs acutely falcate, fine, and more or less continuous from umbilical rim; ribs may form small umbilical bullae and incipient ventrolateral clavi. Suture with short, wide saddles. *Lower Cretaceous (Lower Aptian–Upper Aptian):* England, Germany, South Africa (Zululand), Antarctica (Alexander Island).——FIG. 9,*6. *A. (T.) scalatum* (KOENEN), Upper Aptian, Germany; ×1 (Koenen, 1902).

A. (Gyaloceras) WHITEHOUSE, 1927, p. 114 [**G. smithi;* OD]. Inflated; body chamber with rounded venter. Possibly macroconch of some *Aconeceras. Lower Cretaceous (Upper Aptian):* Queensland. *Lower Cretaceous (?Upper Albian):* Nigeria.——FIG. 9,*1. *A. (G.) smithi,* Upper Aptian, Queensland; ×0.75 (adapted from Whitehouse, 1927).

Doridiscus CASEY, 1961d, p. 137 [**D. rotulus;* OD]. Evolute and inflated with subrectangular section, flat sides, and rounded shoulders; keel very low, minutely beaded; weak, falcoid lirae on sides. Suture simpler than *Aconeceras* and with fewer auxiliaries. *Lower Cretaceous (Lower Aptian):* England.——FIG. 9,*5a–c. *D. rotulus,* Isle of Wight; ×1 (all Casey, 1961d).

Nothodiscus CASEY in COLLIGNON, 1962b, p. 32 [**N. planus;* OD]. Very evolute with flat sides and narrow, flat venter; ventrolateral shoulders sharply rounded but not angular; feeble keel persisting to diameter of 35 mm; test with falcoid growth lines. Suture with same number of elements as *Aconeceras* but simpler. *Lower Cretaceous (Upper Aptian):* Madagascar.

Falciferella CASEY, 1954b, p. 273 [**F. milbournei;* OD]. Flat-sided with venter rounded, then feebly keeled, and then flat; with irregular, fine, dense, falcate striae or riblets. Suture simplifying but still with moderately incised elements; lobe L trifid; U2 bifid. *Falciferella* is transitional to and resembles the Binneyitidae in shape, but it retains the aconeceratine keel at some stage, and lobe L at least is more or less trifid. *Lower Cretaceous (Middle Albian–Upper Albian):* England, France.——FIG. 9,*4a–c. *F. milbournei,* Middle Albian, England: *a,b,* ×2; *c,* ×4 (all Casey, 1954b).

Naramoceras MCNAMARA, 1985, p. 263 [**Falciferella breadeni* BRUNNSCHWEILER, 1959, p. 15; OD]. Venter rounded on phragmocone, feebly keeled on body chamber; with falcate ribs. More evolute and suture simpler than in *Falciferella.* Probably a progenetic dwarf offshoot of *Falciferella. Lower Cretaceous (Middle Albian–Upper Albian):* South Australia.——FIG. 8,*2a,b. *N. breadeni* (BRUNNSCHWEILER); *a,* ×3; *b,* ×7 (both McNamara, 1985).

Koloceras RICCARDI, AGUIRRE URRETA, & MEDINA, 1987, p. 167 [**K. talenkanum;* OD]. Venter rounded to tabulate with intermittent, feeble keel; with falcate striae to weak ribs. Suture with lobes L and U2 trifid to subbifid. *Lower Cretaceous (Upper Albian):* Argentina (Patagonia), Angola.

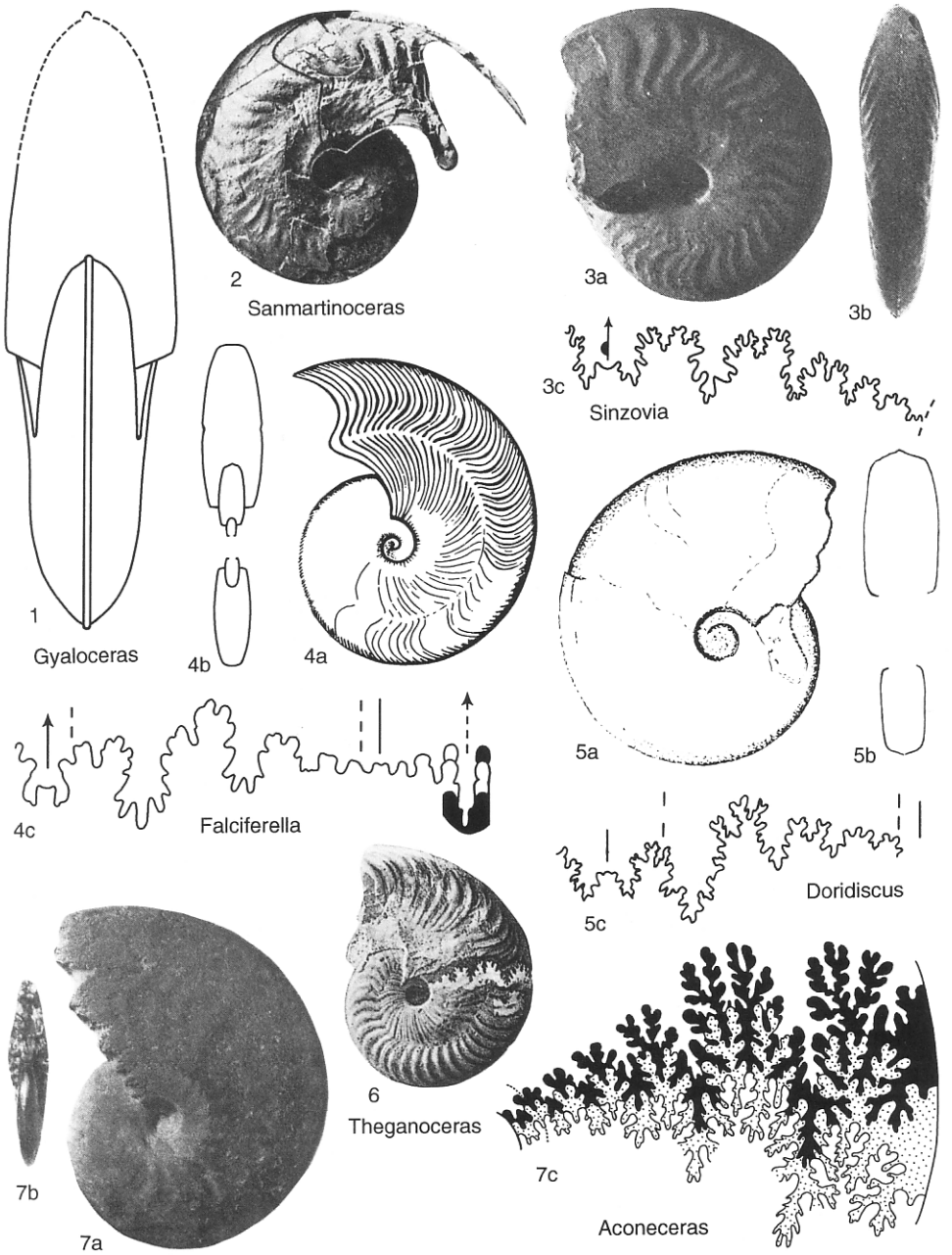


FIG. 9. Oppeliidae (p. 14)

Family BINNEYITIDAE Reeside, 1927

[Binneyitidae REESIDE, 1927a, p. 4]

Small, compressed, flat-sided, with flat or sulcate venter and weak ornament of sinuous to falcate striae or riblets; ornament may be strengthened or visible only on shoulders. Sutures simplifying with one or more lobes bifid, tending to have long, narrow, simple or entire elements with parallel sides; second lateral saddle projecting beyond first. Nacreous shell with metallic luster as in

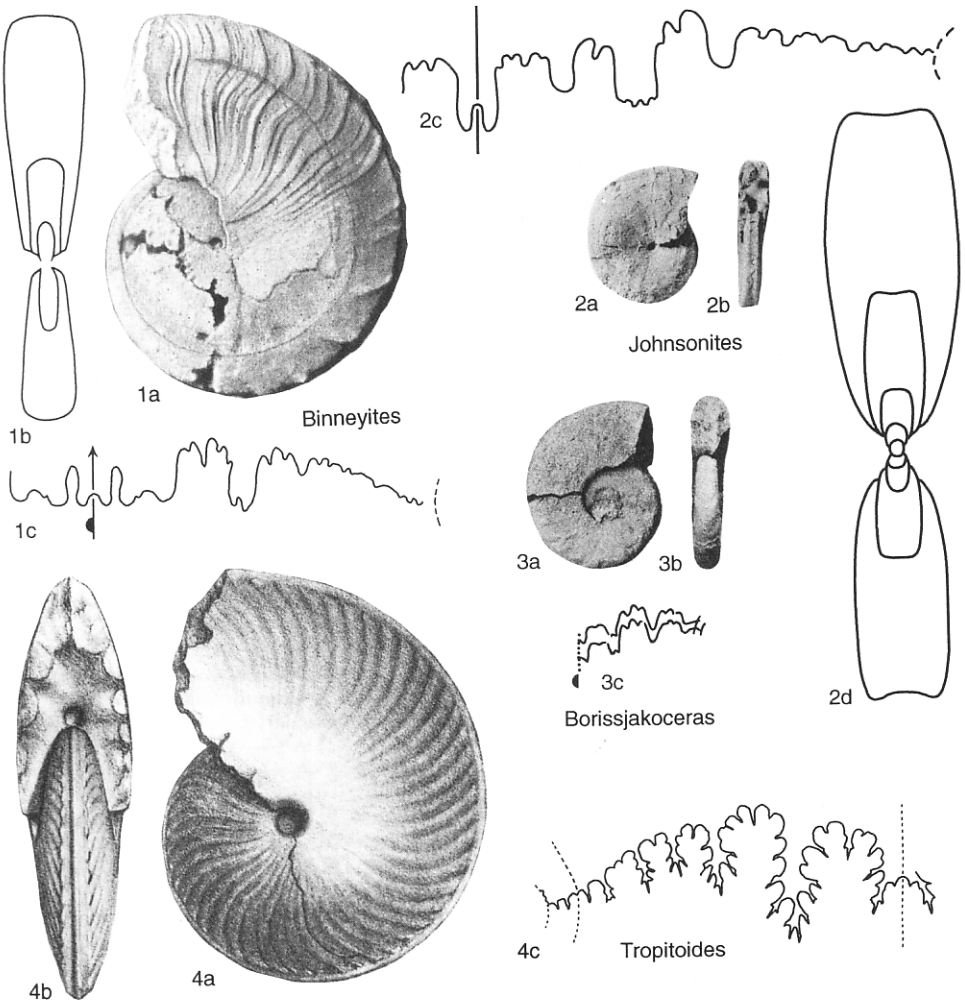


FIG. 10. Oppeliidae & Family Uncertain (p. 16–17)

Aconeceratinae. Binneyitidae are derived from the Aconeceratinae by way of *Falciferella. Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Santonian).*

Borissjakoceras ARKHANGELSKY, 1916, p. 55 [**B. mirabilis;* OD]. Moderately evolute to rather involute; flat-sided; venter bluntly trapezoidal to rounded; surface smooth except for traces of prorsiradiate ribs on shoulders. Suture simple with deep, narrow, parallel-sided L and broad saddles; saddle E/L bifid or entire, L/U trifid. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Turonian):* France, Angola, South Africa (Zululand), northern Siberia, Turkestan, Bathurst Island, New Zealand, Alaska, British Columbia, USA (Western Interior), Colombia, Argentina, Greenland.——FIG. 10,*3a–c.* **B. mirabilis,* Lower Turonian, Turkestan; *a,b,* ×1; *c,* ×3 (all Arkhangelsky, 1916).

Johnsonites COBBAN, 1961, p. 743 [**J. sulcatus;* OD]. Flat-sided, with flat to feebly sulcate venter; smooth or with weak, falcoid ribs. Suture with deep, narrow external lobe divided by long, narrow foliole. *Upper Cretaceous (Upper Cenomanian):* Wyoming, Colorado.——FIG. 10,*2a–d.* **J. sulcatus,* Wyoming; *a,b,* ×1; *c,d,* ×4 (all Cobban, 1961).

Binneyites REESIDE, 1927a, p. 4 [**B. parkensis;* M]. Very involute; venter flat; shoulders sharper and ventrolateral ornament stronger than in *Borissjakoceras.* Suture with long, narrow, parallel-sided, bifid or entire first lateral saddle, simple and broadening L, and very simple other elements; auxiliaries tending to increase in number with time. *Upper Cretaceous (Lower Turonian–Lower Santonian):* USA (Western Interior).——FIG. 10,*1a–c.*

**B. parkensis,* Coniacian, Wyoming; *a,b,* ×2; *c,* ×4 (Reeside, 1927a).

Family Uncertain

Tropitoides SPATH, 1925e, p. 102 [**Ammonites obesus* STOLICZKA, 1865, p. 55; OD]. Involute, high-whorled, with slightly convex sides sloping towards rather narrow venter bearing prominent, slightly rounded keel; close, rather flat, falcoid ribs ending in feeble ventrolateral clavi. [Suture with second lateral saddle projecting beyond other elements and the minute umbilicus recall Aoneceratinae but other features and stratigraphical horizon render connection unlikely.] *Upper Cretaceous (?Middle Turonian, Upper Turonian):* France, Israel, southern India.——FIG. 10,*4a–c.* **T. obesus* (STOLICZKA), ?Middle Turonian, southern India; *a,b,* ×0.75; *c,* ×1 (all Kossmat, 1895–1898).

Superfamily PERISPHINCTACEAE Steinmann, 1890

Family POLYPTYCHITIDAE Wedekind, 1918

[*nom. correct.* SPATH, 1924a, p. 87, *pro* Polyptichitidae WEDEKIND, 1918, p. 103]

With the widespread retreat of the seas from many marginal areas of the northern hemisphere at the end of the Jurassic, the descendents of the boreal Dorsoplanitinae diversified in separate faunal provinces or subprovinces covering a rapidly changing pattern of partially isolated, shallow epicontinental seas. Their remains are now found in scattered outcrops of highly incomplete, often condensed successions with phosphatic concretions. Difficulty in correlation is such that each faunal province retains its own scheme of zonation. Six such provinces may be distinguished: (1) Spilsby (eastern England–eastern Greenland); (2) Lower Saxony; (3) Russian Platform; (4) Siberian Arctic (including the Barents shelf and Spitsbergen); (5) Canadian Arctic (Sverdrup basin, Yukon); (6) northern Pacific cordillera (northern California, Oregon, Washington, British Columbia). It is often difficult to decide to what extent faunal differences reflect differences in age or provincialism, and condensation can make it hard to establish the variability of contemporaneous assemblages or biospecies. Classification has therefore led to phylogenetic schemes of improbable complexity.

Morphologically, the range of forms found in the family is unusually wide and untypical of perisphinctids in general. It includes involute, compressed homeomorphs of some Macrocephalitinae or Aulacostephanidae (*Tollia*); sphaerocones or cadicones that may be hard to distinguish from Cadoceratinae or Pachyceratidae (*Polyptychites*); serpenticones, homeomorphs of Stephanoceratinae (*Simbirskites*); and even oxycones, homeomorphic with Oxynoticeratinae (*Platylenticeras*). Sometimes the whole range from platy- to sphaerocones is found within the variability of what is almost certainly but a single biospecies (e.g., *Thorsteinssonoceras ellesmerense* JELETZKY, 1965). Interruption of ribbing on the venter to give a smooth band evolved several times in the family and has therefore as little systematic value here as elsewhere in the Perisphinctaceae. Constrictions similarly came and went.

The transition from the typical perisphinctid, ancestral Jurassic Dorsoplanitinae to the Craspeditinae was accompanied by an extensive modification of the external septal suture to a characteristic and persistent craspeditid plan. The external and lateral lobes shortened, thickened at their bases, and became less incised. The retracted umbilical or suspensive lobe was replaced as a major element by a series of 4 to 7 auxiliary lobes arranged in order of steadily decreasing size away from the first lateral lobe towards the umbilical seam, sometimes so simplified as to be almost vestigial. The baseline is straight or only gently curved, and its sweep towards the umbilicus can be slightly adapical (retracted) or even adoral, sometimes called reversed. In the Polyptychitinae there was a partial return to the more usual perisphinctid plan. The family carries on consistently the style of dimorphism established earlier. The microconchs are isocostate with no adult peristomal modifications of any kind, as in *Dorsoplanites,* making them often inconspicuous. The macroconchs are usually

variocostate, many becoming smooth, but there are isocostate exceptions (early *Polyptychites*). The dimorphic size ratio lies between 2:1 and 4:1. Relative abundances can be highly polarized, some known assemblages consisting almost completely of either macro- or microconchs. Ribbing is variable, but broad, short, subdued primary ribs or bullae are prominent up to the Valanginian. Most notable, however, is the frequent occurrence of polyschizotomous secondary ribbing in all combinations from dichotomous and bidichotomous to truly virgatotome, repeating the whole range found in what are thus seen to have been the ultimate ancestors, the Ataxioceratidae of the middle Upper Jurassic. This and the form of dimorphism distinguish Polyptychitidae from Olcostephanidae, with which they have at times been confused. *Upper Jurassic (Upper Volgian)–Lower Cretaceous (Upper Hauterivian).*

Subfamily CRASPEDITINAE Spath, 1924

[*nom. transl.* SPATH, 1931b, p. 547, *ex* Craspeditidae SPATH, 1924c, p. 17] [=Garniericeratinae SPATH, 1952, p. 9]

Inner whorls compressed and involute; ribbing light and dense, soon fading; macroconchs tending to become inflated with residual, widely spaced, bullate primary ribs. Adults small to medium sized. Sutures highly simplified. Includes two separate series of faunas, one in the Spilsby Province, the other in the Russian Platform, Siberian Arctic, and Canadian Arctic provinces. GERASIMOV, 1969; JELETZKY, 1966; CASEY, 1973; SHUL'GINA, 1969a. *Upper Jurassic (Upper Volgian)–Lower Cretaceous (Lower Ryazanian).*

Subcraspedites SPATH, 1923c, p. 308 [**Ammonites plicomphalus* J. de C. SOWERBY, 1823, p. 145, *non* J. SOWERBY, 1822, p. 82; SD SPATH, 1924c, p. 17; =*S. sowerbyi* SPATH, 1952, p. 18]. Inner whorls finely ribbed, with secondary ribs in dense sheaves projected on venter; outer whorls developing coarse, blunt, short primary ribs. Sharpness of secondary ribbing external, not impressed on internal molds. Intermediate between *Laugeites* and *Craspedites*. CASEY, 1973. *Upper Jurassic (Upper Volgian)–Lower Cretaceous (Lower Ryazanian):* England.

S. **(Swinnertonia)** SHUL'GINA, 1972b, p. 138 [**Subcraspedites cristatus* SWINNERTON, 1935, p. 33; OD]. The earliest forms of *Subcraspedites;* evolute, densely ribbed like ancestral *Laugeites* (Upper Jurassic); ribbing suddenly and strongly modified in small adult macroconchs, giving widely spaced, sharp, primary ribs and dense sheaves of secondary ribs persisting to the end. CASEY, 1973; SWINNERTON, 1935. *Upper Jurassic (Upper Volgian,* primitivus *Zone):* England.——FIG. 11,*3a. S. (Swinnertonia) subundulatus;* topotype, macroconch, ×1 (Casey, 1973; reprinted by permission of John Wiley & Sons, Ltd., © 1973).——FIG. 11,*3b,c. *S. (Swinnertonia) cristatus;* holotype, ×1 (Swinnerton, 1935).

S. **(Subcraspedites)** [=*Volgidiscus* CASEY, 1973, p. 239 (type, *Subcraspedites lamplughi* SPATH, 1936, p. 81; OD)]. Outer whorls moderately involute, primary ribs subdued, secondary ribs fine and dense, persisting to the end; adult body chamber beginning to resemble *Craspedites. Upper Jurassic (Upper Volgian,* preplicomphalus–lamplughi *Zones):* England.——FIG. 11,*1a–d. *S. (S.) sowerbyi* SPATH; *a,b,* holotype, macroconch, ×1; *c,* ×1, *d,* ×1.5, topotypes (Casey, 1973; reprinted by permission of John Wiley & Sons, Ltd., © 1973).

S. **(Runctonia)** CASEY, 1973, p. 240 [**R. runctoni;* OD]. Involute, compressed microconchs with semifastigiate venter; secondary ribs chevronlike, fading on venter; suture simplified on ascending baseline. Macroconchs apparently smooth except for ornament on umbilical and ventrolateral shoulders. Morphologically transitional to *Hectoroceras. Lower Cretaceous (Lower Ryazanian,* runctoni *Zone):* England.——FIG. 11,*2a–d. *S. (R.) runctoni* CASEY, holotype; *a,b,* shell, ×1; *c,d,* section, ×1; *e,* suture, ×1.5 (Casey, 1973; reprinted by permission of John Wiley & Sons, Ltd., © 1973).

Craspedites PAVLOW, 1892, p. 474 [*non* "*Craspedites* (*pro -donites* HAECKEL, 1865) ALLMAN, 1872, p. 174," cited by NEAVE, 1939, p. 860, but no trace of *Craspedites* in ALLMAN (hydroids), hence presumably an incorrect subsequent spelling of *Craspedonites* without status] [**Ammonites okensis* ORBIGNY, 1845b, p. 436; SD R. DOUVILLÉ, 1911, fiche no. 213]. Inner whorls compressed, involute, finely and densely ribbed; macroconchs becoming inflated, umbilicus narrow and craterlike, ribbing becoming rounded and subdued or fading altogether. Some species with constrictions. *Upper Jurassic (Upper Volgian):* England, Russian Platform, Arctic.

C. **(Craspedites)** [=*Mosquites* SAZONOVA, 1971, p. 30 (type, *Craspedites mosquensis* GERASIMOV, 1960, p. 171; OD); *Trautscholdiceras* SAZONOVA, 1977, p. 90 (type, *Ammonites kaschpurensis* TRAUTSCHOLD, 1866, p. 16; OD); *Vitaliites* SHUL'GINA, 1985, p. 116 (type, *Ammonites subditus* TRAUTSCHOLD, 1877, p. 392; OD)]. Highly variable, usually involute and inflated, with smooth outer whorls; simple sutures typical of subfamily. [*Mosquites* (for small cadicones retaining subdued secondary ribbing to the end but losing primary ribs) and *Trautscholdiceras* (for small cadicones with constrictions and with

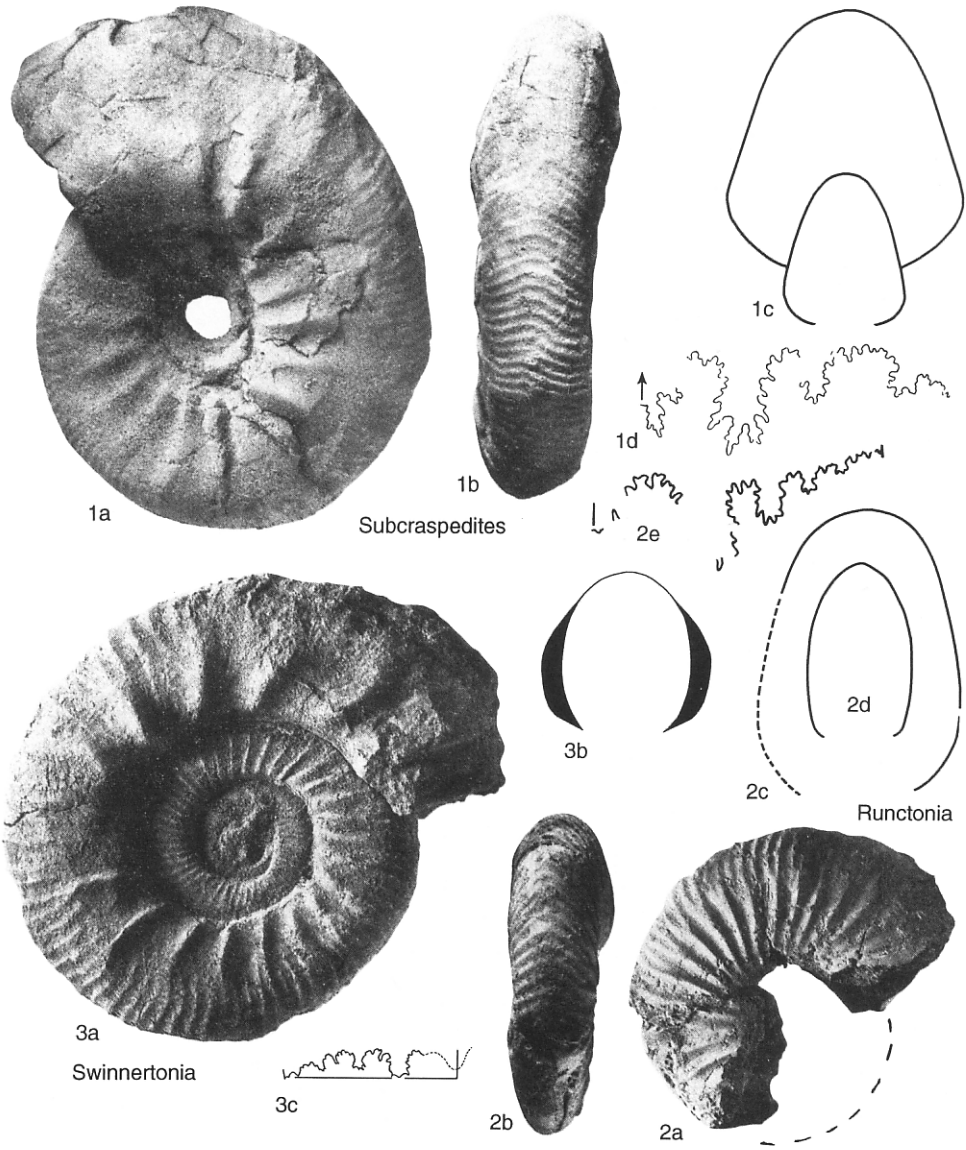


FIG. 11. Polyptychitidae (p. 18)

smooth body chambers except for well-spaced circumumbilical bullae) seem unnecessary.] GERASIMOV, 1969; SHUL'GINA, 1969a. *Upper Jurassic (Upper Volgian):* England, Russian Platform (Moscow and Volga basins, Pechora), northern Urals, northern Siberia, Novaya Zemlya, Spitsbergen.——FIG. 12,*2a–c.* **C. (C.) okensis* (ORBIGNY), Russia; lectotype, macroconch, ×1 (R. Douvillé, 1911).

C. **(Taimyroceras)** BODYLEVSKII, 1956, p. 82 [**T. taimyrense;* OD]. Has most of the characters of *C. (Craspedites),* but venter flatter with smooth band. [A large collection from a single concretion gives a good idea of intraspecific variability (JELETZKY, 1966).] ERSHOVA, 1969. *Upper Jurassic (Upper Volgian,* taimyrensis *Zone):* northern Siberia, Spitsbergen, Arctic Canada (Ellesmere Island).——FIG. 12,*1a–c.* **C. (T.) taimyrensis* BODYLEVSKII, Kheta basin, northern Siberia; topotype?, macroconch, ×1 (Shul'gina, 1969a).

C. **(Kachpurites)** SPATH, 1923c, p. 307 [**Ammonites fulgens* TRAUTSCHOLD, 1861, p. 270; SD SPATH, 1924c, p. 17]. Small, smooth; probably microconchs of *C. (Craspedites)* whose inner whorls they resemble; adult body chambers compressed and evolute; ribbing variable, some forms wholly smooth, some regaining short, distant primary ribs, others retaining secondary ribs only.

GERASIMOV, 1969; SHUL'GINA, 1969. Occurrence and distribution much as for genus.——FIG. 12,*3a–c.* **C. (K.) fulgens* (TRAUTSCHOLD), Moscow basin; *a,b,* lectotype designated herein, *non* NIKITIN, 1881, pl. 4, fig. 48, designated by SPATH (1947, p. 12), but not a syntype, ×1 (Trautschold, 1861); *c,* ribbed variant, ×1 (Gerasimov, 1969).——FIG. 12,*3d–f. C. (K.) nekrassovi* (PRIGORIEVSKY), Moscow basin; showing peristome, ×1 (Gerasimov, 1969).

Garniericeras SPATH, 1923c, p. 307, *nom. nov. pro Garnieria* BOURGUIGNAT, 1877, p. 2, *non* SAYN, 1901, p. 14 (which is an objective synonym of *Platylenticeras* HYATT, 1900, p. 590) [**Ammonites catenulatus* FISCHER VON WALDHEIM, 1837 in 1830–1837, p. 169; SD SPATH, 1924c, p. 17 (incorrectly

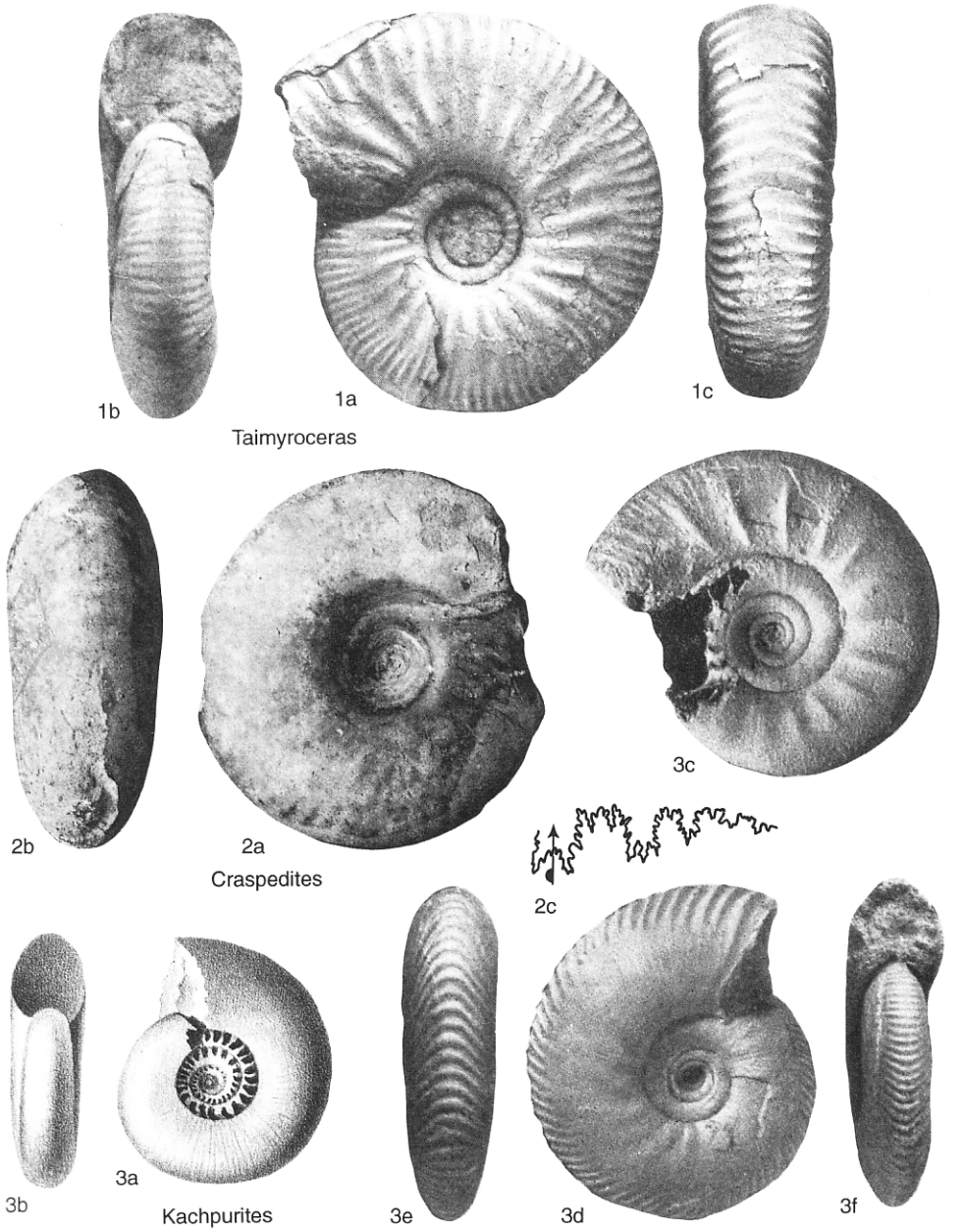


FIG. 12. Polyptychitidae (p. 18–20)

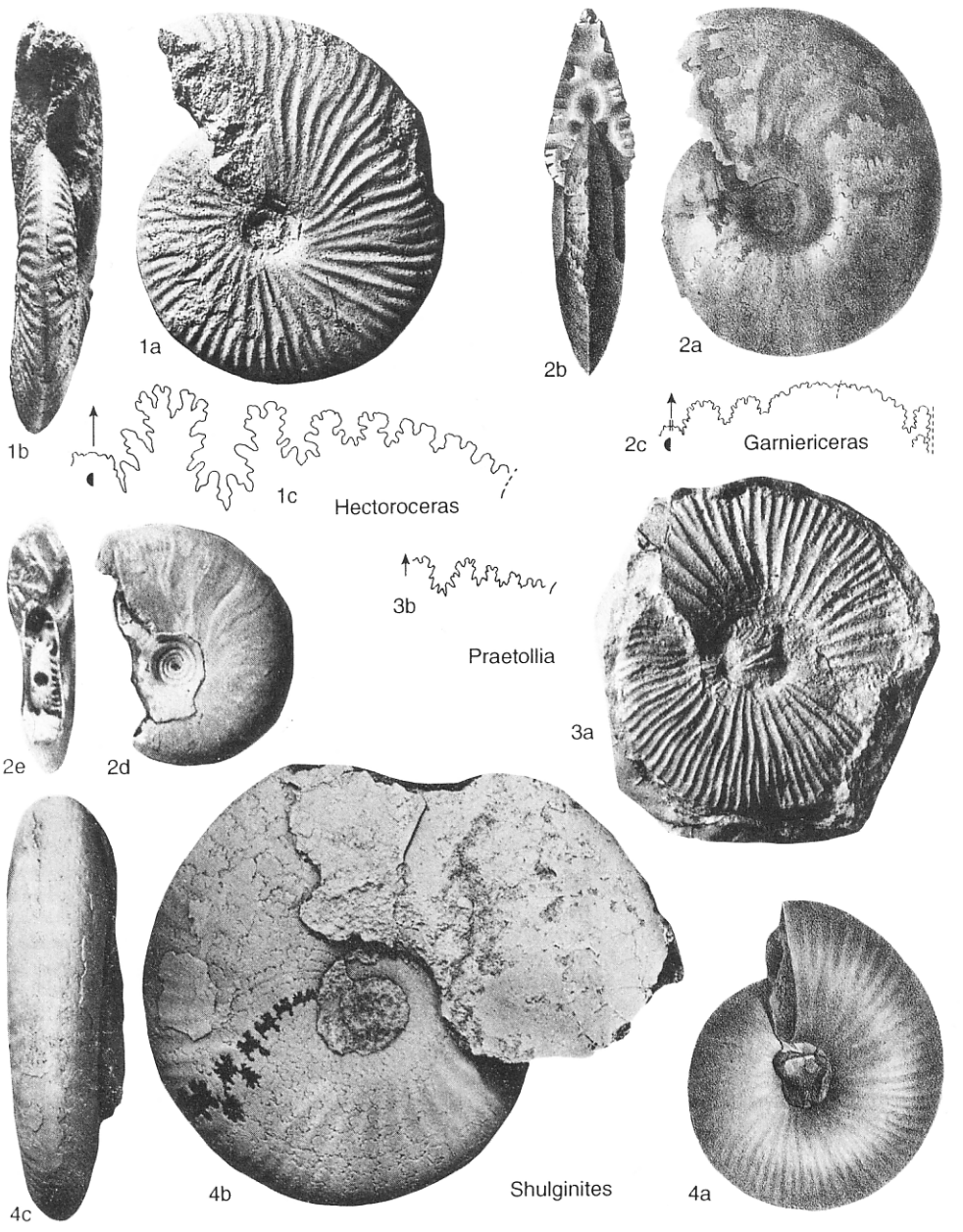


FIG. 13. Polyptychitidae (p. 20–22)

given as *"Oxynoticeras" catenulatum* TRAUTSCHOLD, but later (SPATH, 1947, p. 12) rectified)]. Involute oxycones with sharp to keeled venters; radial primary ribs faint or obsolete; sutures of craspeditid plan but even more simplified. Dimorphic; sizes similar to those of *Craspedites* and *Kachpurites;* tests of microconchs becoming markedly striated near the adult aperture as in some *Kachpurites.* SPATH, 1947; GERASIMOV, 1969; SHUL'GINA, 1969a. *Upper Jurassic (Upper Volgian)–Lower Cretaceous (Lower Ryazanian,* fulgens–rjazanensis *Zones):* Russian Platform, northern Urals, northern Siberia.——FIG. 13,*2a–c.* **G. catenulatum* (FISCHER VON WALDHEIM); *a,b,* macroconch, ×0.7 (Nikitin, 1884); *c,* ×1.5 (Spath, 1947).——FIG. 13,*2d,e. G. interjectum* (NIKITIN), Moscow basin; microconch, ×0.7 (Gerasimov, 1969).

Praetollia SPATH, 1952, p. 12 [**P. maynci;* OD]. Involute, compressed; ribbing fine, slightly flexed, dividing low on side as in *Hectoroceras,* but sharper and

stronger, mostly bifurcate in young, later trifurcate or with intercalatories, uninterrupted on venter, resembling *Pectinatites* (Upper Jurassic). Suture craspeditid. [Slightly older than *Hectoroceras* but overlapping in range; phyletic relations somewhat uncertain.] CASEY, 1973. *Lower Cretaceous (Lower Ryazanian,* kochi *Zone):* eastern Greenland (main occurrence), North Sea, northern Siberia, Moscow basin (rare).——FIG. 13,*3a,b,* **P. maynci,* eastern Greenland; *a,* holotype, ×0.7; *b,* ×1 (Spath, 1952).

Hectoroceras SPATH, 1947, p. 20 [**H. kochi;* OD]. Compressed, flat-sided, with small to minute umbilicus. Ribbing flexuous and subdued, branching low on sides. Sutures with many auxiliaries. [A widespread, specialized offshoot from main craspeditid lineage.] *Upper Jurassic (?Upper Volgian)–Lower Cretaceous (Lower Ryazanian):* England, Russian Platform, northern Siberia, eastern Greenland.

H. (Hectoroceras). Venter narrowly arched and sharpened; ribbing dense; regular, rounded, straight, and prorsiradiate primary ribs branching at midside or higher into 2 or 3 falcoid secondary ribs; secondary ribs disappearing on venter; towards end of adult body chamber, ribs becoming single, equal, and continuous across venter and fading. SHUL'GINA, 1972a; KLIMOVA, 1972; CASEY, 1973; SURLYK & others, 1973; CASEY, MESEZHNIKO, & SHUL'GINA, 1977. *Lower Cretaceous (Lower Ryazanian,* kochi *Zone):* eastern Greenland, eastern England, Denmark, Moscow basin (rare), northern Urals, northern Siberia.——FIG. 13,*1a–c.* **H. kochi,* eastern Greenland, topotype; *a,b,* ×0.7 (Surlyk & others, 1973); *c,* ×1.4 (Spath, 1947).

H. (Shulginites) CASEY, 1973, p. 239 [**Oxynoticeras tolijense* NIKITIN, 1884, p. 65; OD] [= *Toljaiceras* SHUL'GINA in SAKS & SHUL'GINA, 1974, p. 545, obj.]. Venter subacute on early whorls, becoming rounded; ribbing as in *H. (Hectoroceras)* but fading, leaving adult body chamber smooth. Suture ascending. *Upper Jurassic (?Upper Volgian)–Lower Cretaceous (?Lower Ryazanian):* northern Urals, northern Siberia.——FIG. 13,*4a–c.* **H. (S.) tolijense* (NIKITIN), probably Lower Ryazanian, western Siberia; *a,* lectotype, ×1 (Nikitin, 1884); *b,c,* topotype, ×1 (Casey, 1973; reprinted by permission of John Wiley & Sons, Ltd., © 1973).

Subfamily TOLLIINAE Spath, 1952

[*nom. correct.* ARKELL, 1957, p. 344, *ex* Tollinae SPATH, 1952, p. 9] [=Suritidae SAZONOVA, 1971, p. 24; Menjaitinae SAZONOVA, 1971, p. 73; Peregrinoceratinae SAZONOVA & SAZONOVA, 1984, p. 97 (where cited as "Peregrinoceratinae SAZONOVA, 1979," reference not traced)]

Predominantly compressed and rather involute; strong primary ribs typically dividing at midside, either indistinctly (early forms) or clearly di- to polyschizotomously (later forms), into numerous secondary ribs; secondary ribs projecting on venter; macroconchs tending to become smooth. Sutures still craspeditid in plan. Descendants of Craspeditinae (*Subcraspedites*), the dividing line being arbitrary. Most genera widespread throughout the Boreal Realm, but some local faunas developed (e.g., *Menjaites*). *Lower Cretaceous (Lower Ryazanian–Valanginian).*

Borealites KLIMOVA, 1969, p. 129 [**B. fedorovi;* OD]. Inner whorls with oval section and strong ribbing bifurcating at or above midside, as in later *Surites;* middle whorls in macroconchs more inflated, with thickened primary ribs trifurcating; later still intercalatories appearing and ribs disappearing below branching point, as in ancestral *Subcraspedites.* [The subgenera are doubtfully distinct.] CASEY, 1973; KLIMOVA, 1972. *Lower Cretaceous (Lower Ryazanian–Upper Ryazanian):* England, Russia, Spitsbergen, northern Canada, northern and eastern Greenland.

B. (Borealites) [=?*Pronjaites* SAZONOVA, 1971, p. 54 (type, *Olcostephanus bidevexus* BOGOSLOVSKII, 1897, p. 55; OD)]. Similar to genus, but ribbing persisting on venter. Holotype of type species is macroconch. [Type material of *Pronjaites* is too fragmentary for distinct generic diagnosis and probably comprises only a compressed species of *B. (Borealites).*] *Lower Cretaceous (Lower Ryazanian):* distribution as for genus.——FIG. 14,*1a–c.* **B. (B.) fedorovi, kochi* Zone, Siberia (northern Urals); holotype, macroconch, ×1 (Klimova, 1969).——FIG. 14,*1d,e.* **?B. (B.) bidevexus,* (BOGOSLOVSKII), *sibiricus* Zone, Siberia; ×1 (Bogoslovskii, 1897).

B. (Pseudocraspedites) CASEY, MESEZHNIKOV, & SHUL'GINA, 1977, p. 30 [**Subcraspedites anglicus* SHUL'GINA, 1972b, p. 139; OD]. Large, more finely ribbed than *B. (Borealites);* outer whorls becoming evolute and almost smooth, retaining distant primary bullae; homeomorphs of some *Subcraspedites* and even *Dorsoplanites* (Upper Jurassic), although suture remaining craspeditid. *Lower Cretaceous (Lower Ryazanian,* kochi *Zone):* northern Siberia, northern Canada.——FIG. 14,*2a,b.* **B. (P.) anglicus,* northern Siberia; holotype, ×0.75 (Shul'gina, 1972b).

B. (Ronkinites) SHUL'GINA, 1972b, p. 147 (*non* BASOV & others, 1970, p. 21, *nom. nud.*) [**Subcraspedites (Ronkinites) rossicus;* OD]. Whorl section round to squarish; constrictions weak. ?Microconch of *B. (Pseudocraspedites). Lower Cretaceous (Upper Ryazanian):* Siberia, northern Canada.——FIG. 14,*3a,b.* **B. (R.) rossicus* (SHUL'GINA), Siberia; ×0.75 (Shul'gina, 1972b).

Surites SAZONOV, 1951, p. 59 [**S. pechorensis;* OD]. Compressed to inflated, evolute to involute, but all forms slowly uncoiling, with many whorls exposed in the umbilicus; inner and middle whorls with strong, sharp ribbing; primary ribs bifurcating at or above midside into sharp, strong secondary ribs; secondary ribs moderately to strongly projected on venter. Macroconchs variocostate, some retaining

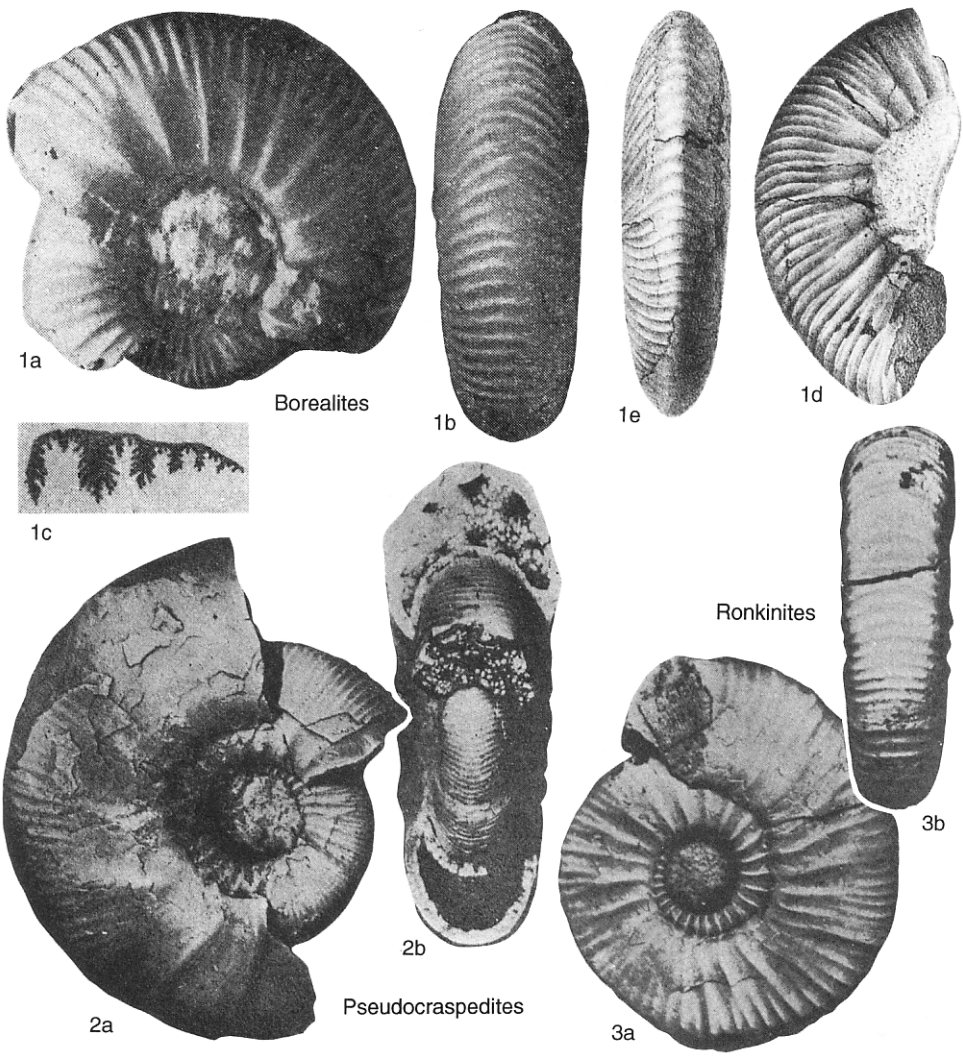


FIG. 14. Polyptychitidae (p. 22)

only traces of circumumbilical, bullate primary ribs or faint secondary ribs on flattened venter. Many genera doubtfully distinct, even at specific level. SAZONOVA, 1971, 1972, 1977; CASEY, 1973. *Lower Cretaceous (Lower Ryazanian–Upper Ryazanian)* Russian Platform, northern Urals, northern Siberia, eastern Greenland, England, northern Canada.

S. (Praesurites) MESEZHNIKOV & ALEKSEEV in MESEZHNIKOV & others, 1983, p. 122 [**S. (P.) elegans;* OD]. Involute, compressed; transitional between *Craspedites* and *S. (Surites),* retaining coiling of *Craspedites* but having coarse, projected, biplicate secondary ribbing of *Surites* on inner whorls. *Lower Cretaceous (Lower Ryazanian):* subpolar Urals.——FIG. 15,*1a,b.* **S. (P.) elegans;* holotype, ×1 (Mesezhnikov & others, 1983).

S. (Surites) [=?*Chandomirovia* SAZONOV, 1951, p. 61 (type, *C. ilekensis;* OD); *Bogoslovskia* SAZONOVA, 1965, p. 103 (1961, p. 12, *nom. nud.*) (type, *Olcostephanus stenomphalus* PAVLOW, 1890, p. 117, *partim,* pl. 3, fig. 10 only; OD; =*B. pseudostenomphala* SAZONOVA, 1971, p. 53); *Stchirowskiceras* SAZONOVA, 1971, p. 57 (type, *S. principale;* OD); *Subpolyptychites* SAZONOVA, 1971, p. 88 (type, *S. distinctus;* OD); *Suridiscus* SAZONOVA, 1977, p. 63 (type, *Stchirowskiceras (Suridiscus) subprincipale;* OD)]. Macroconchs large, coarsely ribbed, moderately involute, and inflated. Occurrence and distribution as for genus. ——FIG. 15,*2a–c.* **S. (S.) pechorensis* SAZONOV, Upper Ryazanian, Russia (River Sura); holotype, macroconch, ×1 (Sazonova, 1965). ——FIG. 15,*2d,e. S. (S.) simplex* (BOGOSLOVSKII),

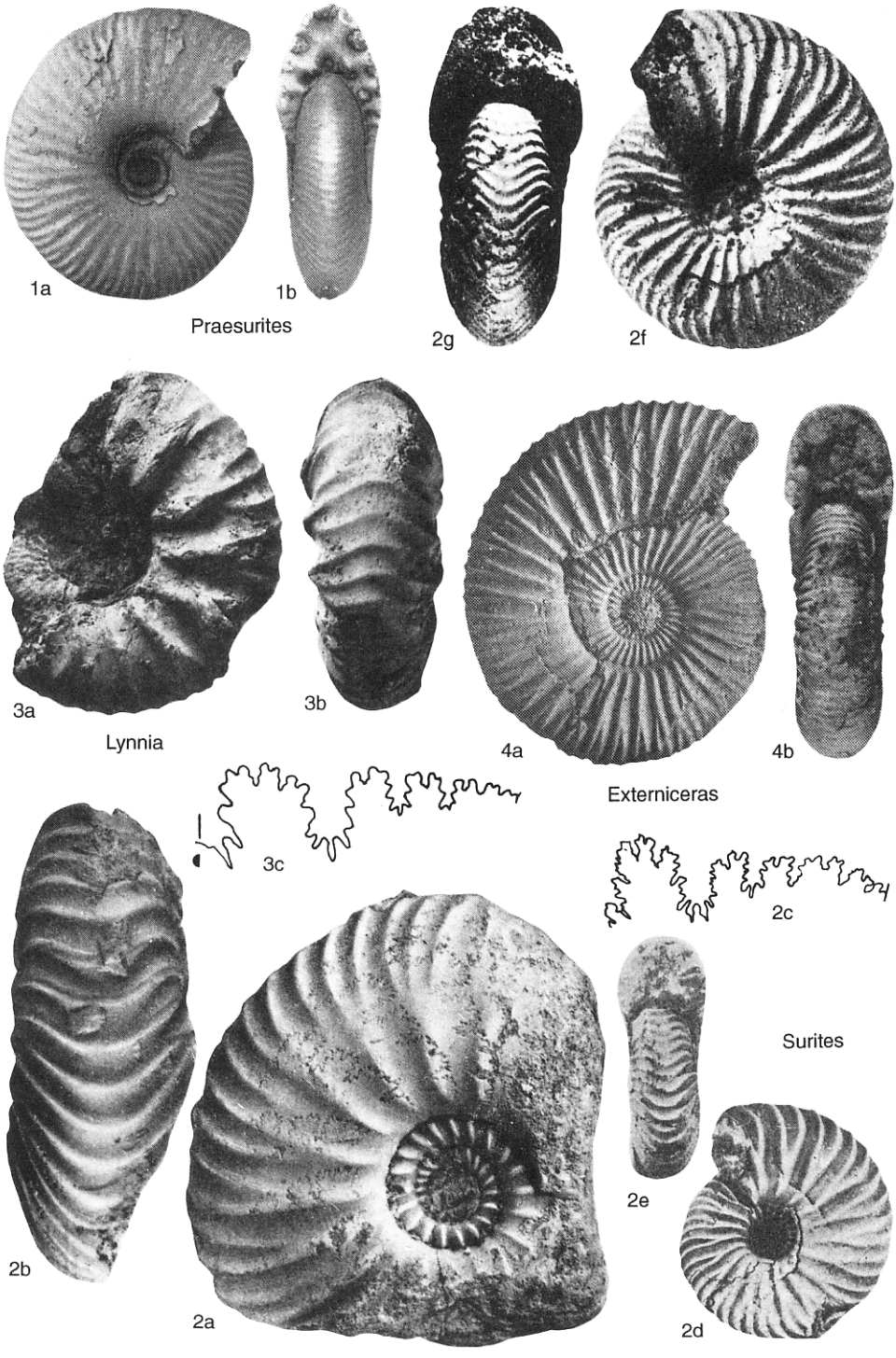


FIG. 15. Polyptychitidae (p. 23–25)

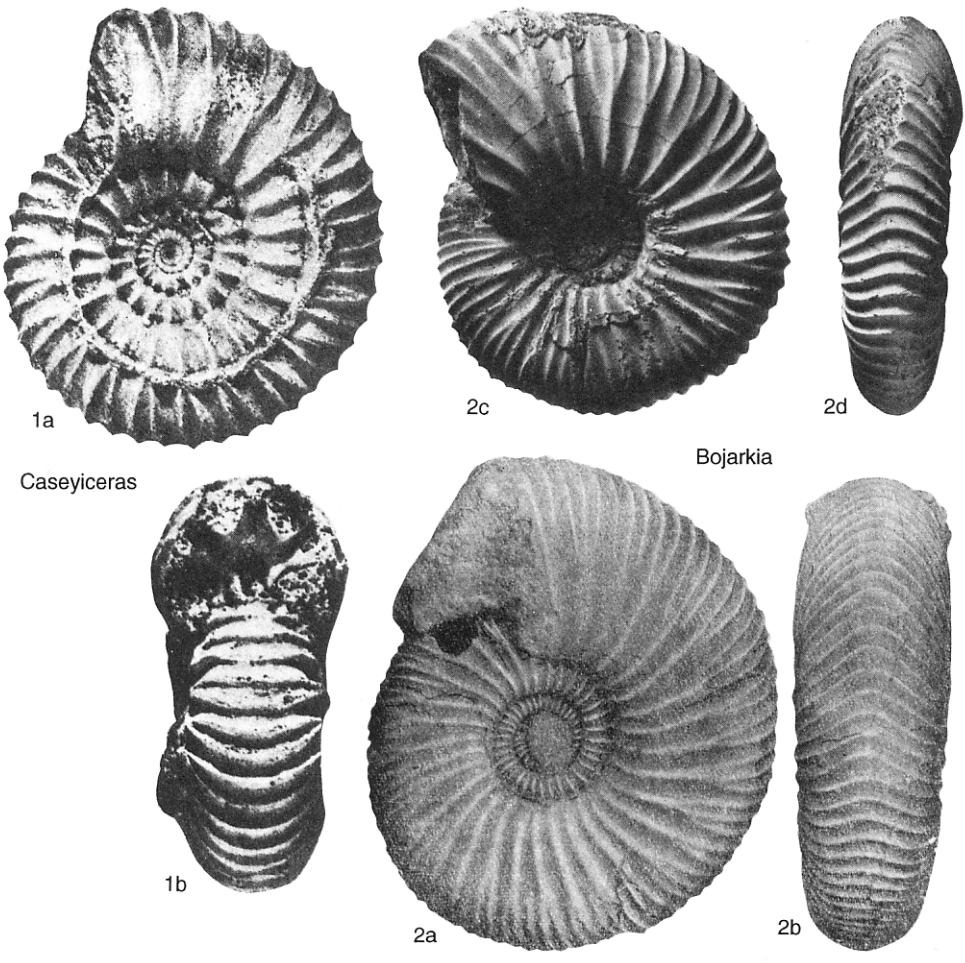


FIG. 16. Polyptychitidae (p. 25–26)

Russia (River Sura); lectotype, microconch, ×1 (Sazonova, 1971).——FIG. 15,*2f,g. S. (S.) pseudostenomphalus* (SAZONOVA), Upper Ryazanian, Moscow basin; neotype, ×1 (Sazonova, 1972).

S. **(Caseyiceras)** SAZONOVA, 1971, p. 44 [**C. caseyi;* OD]. Evolute with depressed whorls; ribs coarse, dominantly biplicate, and only moderately projected on venter. *Lower Cretaceous (Ryazanian):* Russia.——FIG. 16,*1a,b. *S. (C.) caseyi* (SAZONOVA); holotype, probably microconch, ×1 (Sazonova, 1972).

S. **(Externiceras)** SAZONOVA, 1971, p. 49 [**Perisphinctes solowaticus* BOGOSLOVSKII, 1897, p. 78; OD]. Evolute; densely and finely ribbed; *Perisphinctes*-like, long, thin primary ribs branching two-thirds up side. *Lower Cretaceous (Upper Ryazanian):* Russia.——FIG. 15,*4a,b. *S. (E.) solowaticus* (BOGOSLOVSKII); microconch, ×1 (Sazonova, 1971).

S. **(Lynnia)** CASEY, 1973, p. 254 [**S. (L.) icenii;* OD]. Whorl section subquadrate; microconchs with ribs fine at first, later coarse and trifurcating high on side. *Lower Cretaceous (Upper Ryazanian,* icenii *Zone):* England.——FIG. 15,*3a–c. *S. (L.) icenii,* holotype; *a,b,* ×1; *c,* ×3 (Casey, 1973; reprinted by permission of John Wiley & Sons, Ltd., © 1973).

S. **(Bojarkia)** SHUL'GINA, 1969b, p. 46 [**B. mesezhnikowi;* OD]. Whorl sides flat, subparallel; venter broadly rounded; ribs rather fine and close; biplicate secondary ribbing disappearing early. Not well distinguished from *S. (Surites);* late forms transitional to *Tollia,* particularly the inner whorls. *Lower Cretaceous (Upper Ryazanian):* England, Russia, Siberia.——FIG. 16,*2a,b. *S. (B.) mesezhnikowi* (SHUL'GINA), *mesezhnikowi* Zone, northern Siberia; holotype, macroconch, ×0.7 (Shul'gina, 1969b).——FIG. 16,*2c,d. S. (B.) stenomphalus* (PAVLOW),

stenomphalus Zone, England; lectotype, microconch, ×1 (Casey, 1973; reprinted by permission of John Wiley & Sons, Ltd., © 1973).

Peregrinoceras SAZONOVA, 1971, p. 63 [**Olcostephanus pressulus* BOGOSLOVSKII, 1897, p. 68; OD]. Inner whorls polygyrate as in *Surites* but with well-differentiated ribbing as in *Tollia;* primary ribs well spaced, short, dividing indistinctly at midside into sheaves of dense, fine secondary ribs projected on venter; outer whorls of macroconchs involute and tending to smoothness. SAZONOVA, 1971, 1972; CASEY, 1973. *Lower Cretaceous (Upper Ryazanian,* tzikwinianus and albidum *Zones):* England, northern Greenland, Russian Platform, Transcaspia.——FIG. 17,*3a.* **P. pressulum* (BOGOSLOVSKII), Moscow basin; topotype, macroconch, ×1 (Sazonova, 1972).——FIG. 17,*3b,c. P.* cf. *albidum* CASEY, England; microconch, ×0.7 (Casey, 1973; reprinted by permission of John Wiley & Sons, Ltd., © 1973).

Tollia PAVLOW, 1914, p. 39 [**T. tolli;* SD ARKELL, 1957, p. 344]. More or less involute and high-whorled; compressed; primary ribs distinct, rising with sharp curve on umbilical shoulder and running straight and prorsiradiate on inner part of side; secondary ribs projected strongly ventrolaterally. On early whorls each primary rib with 2 or 3 fine secondary ribs; on middle whorls primary ribs normally trifurcate with 1 or 2 intercalatories but occasionally bidichotomous. Macroconchs with ribs tending to weaken at midside and outer whorls smooth or having secondary ribs only on ventrolateral shoulders; constrictions present. Suture craspeditid, with graded auxiliaries. [Forms found in the Upper Valanginian resemble *Tollia* in coiling but have bi- and polyschizotomous secondary ribbing in the style of *Dichotomites* (subfamily Polyptychitinae). They have therefore usually been regarded as homeomorphs and assigned to the separate genus *Homolsomites.*] SHUL'GINA, 1972; KLIMOVA, 1972a. *Lower Cretaceous (Lower Valanginian–Upper Valanginian):* England, northern Germany, Russia (Pechora region, northern Urals, northern Siberia, Novaya Zemlya), northern and eastern Greenland, northern Canada, British Columbia, Oregon, northern California.

T. (**Tollia**) [=*Neotollia* SHUL'GINA, 1969b, p. 48 (type, *Tollia klimovskiensis* KRIMGOL'TS in KRIMGOL'TS, PETROVA, & PCHELINTSEV, 1953, p. 76; OD); *Bodylevskites* KLIMOVA, 1978b, p. 50 (type, *B. harabylensis;* OD)]. Compressed at all stages, with not much variability; ribs bi- or trifurcating on inner whorls. [*Neotollia,* with ribbing regularly bifurcating on the inner whorls and primary ribs less differentiated, and *Bodylevskites,* based on poor type material of late forms from the *syzranicus* Zone of northern Siberia with secondary ribs already in part polyptychitid, seem unnecessary.] Occurrence as for genus: distribution more restricted than *Surites* or *Polyptychites,* largely displaced on the central Russian Platform and in lower Saxony by other groups.——FIG. 17,*1a,b.* **T. (T.) tolli* PAVLOW, northern Siberia; *a,b,* paralectotype, macroconch, ×0.5 (Pavlow, 1914).——FIG. 17,*1c,d. T.* sp. aff. *tolli,* England; microconch, ×1 (Casey, 1973; reprinted by permission of John Wiley & Sons, Ltd., © 1973).

T. (**Neocraspedites**) SPATH, 1924c, p. 17 [**Craspedites semilaevis* KOENEN, 1902, p. 80; OD]. Rather involute and compressed with weak umbilical bullae, smooth sides, and fine, even secondary ribs on venter. [KEMPER's claim (1978, p. 194) that the craspeditid (i.e., tolliine) Lower Valanginian type species is unrelated to Upper Valanginian species of the group of *T. undulatus* and *complanatus* (KOENEN), said to be derived from *Dichotomites,* is questionable.] *Lower Cretaceous (Lower Valanginian–Upper Valanginian):* England, northern Germany, Greenland.——FIG. 17,*4a,b.* **T. (N.) semilaevis* (KOENEN), Lower Valanginian, Germany; ×1 (Koenen, 1902).

Virgatoptychites VORONETS, 1958, p. 68 [**V. changalassensis;* OD]. Similar to *Tollia* in coiling and style of ribbing but with macroconchs smaller, strongly ribbed to the end; middle and outer whorls slightly variocostate, with strong polyschizotomous secondary ribbing of varying degree up to and including true virgatotome. A widespread group coeval with and derived from *Tollia.* At some levels, possibly only one extreme of range of the variability of *Tollia;* at others, distinct with no intergrading. Microconchs probably inseparable from those of *Tollia.* VORONETS, 1962. *Lower Cretaceous (Lower Valanginian):* England, northern Germany, northern Siberia, northern Canada.

V. (**Virgatoptychites**). More inflated than *Tollia,* with whorl section broadly oval; outer whorls with regularly virgatotome ribs. Occurrence as for genus: northern Siberia, northern Canada.——FIG. 18,*3a,b.* **V. (V.) pachsaensis* VORONETS, northern Siberia; ×0.7 (Voronets, 1962).

V. (**Propolyptychites**) KEMPER, 1964, p. 23 [**Polyptychites quadrifidus* KOENEN, 1902, p. 109; OD] [=*Paratollia* CASEY, 1973, p. 257 (type, *P. kemperi;* OD)]. Ribbing relatively delicate, with or without weak umbilical nodes; compressed, *Tollia*-like stage of early whorls prolonged; secondary ribs irregularly polyschizotomous as in *Polyptychites,* but not virgatotome. [*Paratollia* merely covers the more densely and finely ribbed forms.] Occurrence as for genus: England, northern Germany.——FIG. 18,*2a,b.* **V. (P.) quadrifidus* (KOENEN), northern Germany; ×1 (Kemper, 1964).——FIG. 18,*2c,d. V. (P.) pumilio* (VOGEL), northern Germany; paratype, microconch, ×1 (Vogel, 1959).

Nikitinoceras D. N. SOKOLOV, 1913, p. 80 [**Olcostephanus hoplitoides* NIKITIN, 1888, p. 96; SD SAZONOVA, 1961, p. 12, 1977, p. 76, *non* JELETZKY, 1979, p. 11] [=*Temnoptychites* PAVLOW, 1914, p. 44, obj. (for dates of publication of SOKOLOV and PAVLOW, see BODYLEVSKII, 1967, p. 103; SAZONOVA & SAZONOV, 1991, p. 61; and synonymy already indicated by SPATH, 1924c, p. 17)]. Highly variable, re-

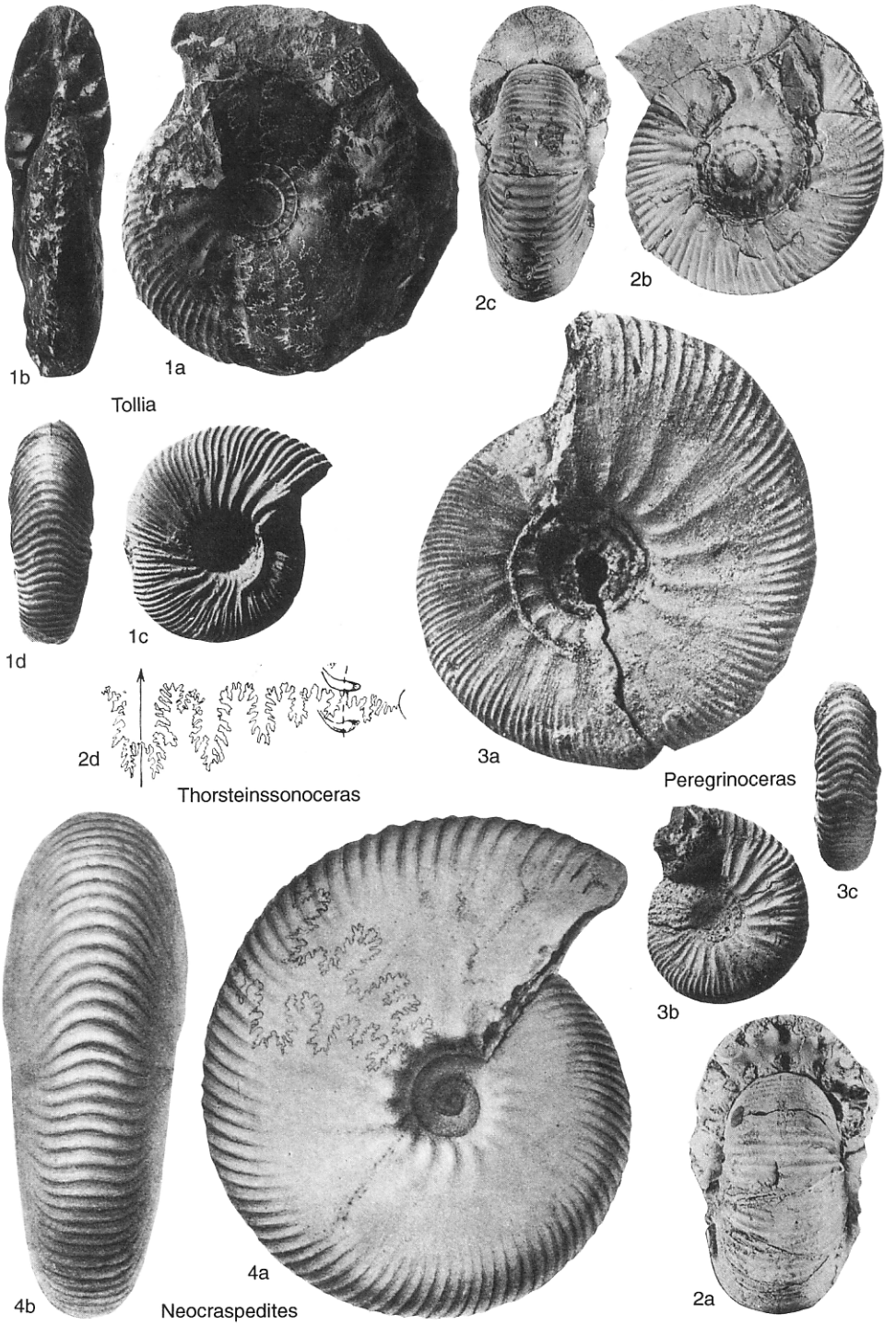


FIG. 17. Polyptychitidae (p. 26–29)

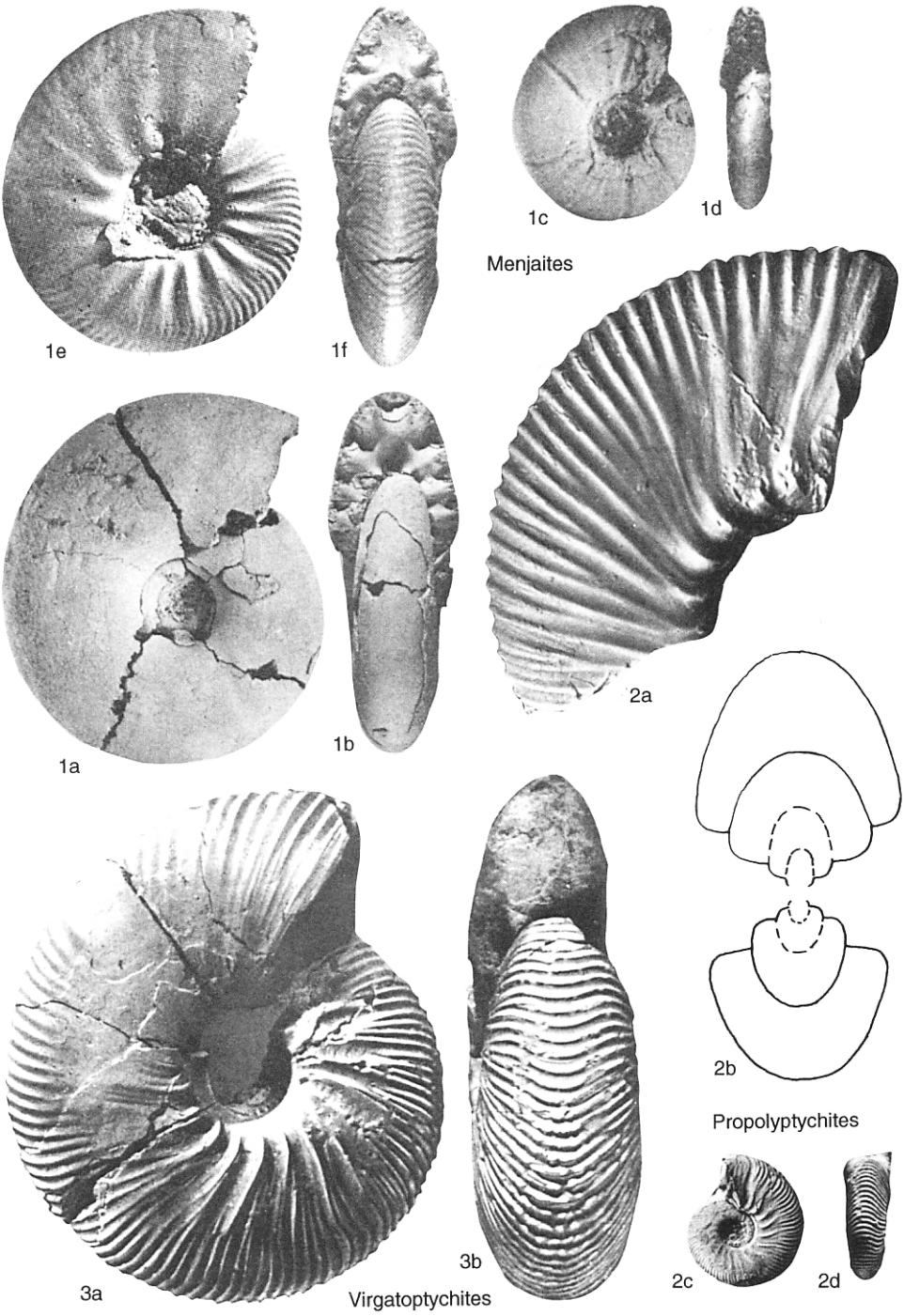


FIG. 18. Polyptychitidae (p. 26–29)

peating the whole range of forms found in the earlier *Surites* and later *Polyptychites*, from compressed to cadicone, involute to evolute, finely to extremely coarsely ribbed; microconchs small, with strong biplicate ribs to the end; macroconchs variocostate, ribbing modifying to indistinct polyptychitid before

fading altogether; all forms united by a common but variably persistent feature, the fading or complete interruption of the secondary ribbing on the venter. Sutures typically craspeditid. [The subgenera may reflect largely the extremes of coiling but in part also small differences in ages.] BODYLEVSKII, 1967; JELETZKY, 1979. *Lower Cretaceous (Lower Valanginian):* Russian Platform (*hoplitoides* Zone), western and northern Siberia (*syrzanicum* Zone), Novaya Zemlya, Greenland, northern Canada (*troelseni* and *kemperi* Zones).

N. (**Bodylevskiceras**) SAZONOVA, 1977, p. 75 (*non* 1971, p. 74, *nom. nud.*) [**Temnoptychites elegans* BODYLEVSKII in LUPPOV, BODYLEVSKII, & GLAZUNOVA, 1949, p. 200; OD]. Compressed, *Tollia*-like forms, some species having quite narrow ranges of variability. *Lower Cretaceous (Lower Valanginian):* northern Siberia, Novaya Zemlya, northern Canada.——FIG. 19,*3a–d.* **N. (B.) elegans* (BODYLEVSKII), Novaya Zemlya; *a–c,* holotype, ×0.7; *d,* topotype, ×1 (Bodylevskii, 1967).

N. (**Nikitinoceras**). Macroconchs of intermediate inflation and coarseness of ribbing; polyschizotomy setting in fairly early. Occurrence and distribution as for genus.——FIG. 19,*1a,b.* **N. (N.) hoplitoides* (NIKITIN), Moscow basin, lectotype; ×1 (Nikitin, 1888).

N. (**Russanovia**) BODYLEVSKII, 1967, p. 109 [**Ammonites diptychus* KEYSERLING, 1846, p. 32; OD] [=*Subtemnoptychites* KLIMOVA, 1978a, p. 101 (type, *Temnoptychites (S.) prodigialis;* OD); *Keyserlingyceras* SAZONOVA, 1961, p. 12, *nom. nud.*]. Cadicones with depressed whorl section; microconchs and early whorls of macroconchs with coarse, strong, distant bifurcating ribs weakening sometimes only barely perceptibly on the venter; outer whorls of macroconchs like typical *Polyptychites.* Occurrence and distribution as for genus.——FIG. 19,*2a,b.* **N. (R.) diptychum* (KEYSERLING), Pechora; lectotype, ×1 (Bodylevskii, 1967).——FIG. 19,*2c,d. N. (R.) rudis* BODYLEVSKII, 1967, Novaya Zemlya; holotype, microconch, ×1 (Bodylevskii, 1967).

Thorsteinssonoceras JELETZKY, 1965, p. 1 (1964, p. 40, *nom. nud.*) [**T. ellesmerense;* OD]. Involute; whorl section somewhat wider than high to depressed-coronate; ribbing very variable; middle whorls with umbilical bullae and virgatotome, simple or bidichotomous bundles of 3 to 5 secondary ribs; last 2 whorls smooth except for umbilical bullae. Constrictions normally present. Early whorls indistinguishable from *Polyptychites,* but suture with 4 or 5 ascending auxiliaries. *Lower Cretaceous (Lower Valanginian):* Siberia, Spitsbergen, Ellesmere Island.——FIG. 17,*2a–d.* **T. ellesmerense,* Ellesmere Island; *a–c,* ×0.5; *d,* ×1 (Jeletzky, 1965; courtesy of the Geological Survey of Canada).

Menjaites SAZONOVA, 1971, p. 74 [**M. imperceptus;* OD] [=*Costamenjaites* SAZONOVA, 1971, p. 83 (type, *C. jucundus;* OD); *Luppoviceras* SAZONOVA, 1977, p. 52 (type, *L. validum;* OD); *Sabydites* BOGOMOLOV & BURDYKINA, 1989, p. 18 (type, *S. menjaiteformis;* OD)]. Moderately involute; whorl section high-oval; umbilical wall shallow and rounded. Ribbing on inner whorls variable but always subdued and soon fading; in some species weak primary ribs branching into bundles of threadlike secondary ribs but fading early, with or without strong constrictions; in others more pronounced, bullate primary ribs dividing into sheaves as in *Tollia,* persisting to the middle whorls, and sometimes interrupted on the venter (*Costamenjaites*); macroconchs becoming large, with middle and outer whorls wholly smooth. Craspeditid suture much simplified on a rectiradiate baseline. [A well-defined local group confined largely to the central Russian Platform where it takes the place of the closely related *Tollia.*] *Lower Cretaceous (Lower Valanginian,* undulatoplicatilis *Zone):* Russia, ?England. ——FIG. 18,*1a–d.* **M. imperceptus,* central Russia (River Menya); *a,b,* ×0.75; *c,d,* ×1 (Sazonova, 1971).——FIG. 18,*1e,f. M. certus* (SAZONOVA), central Russia; ×1 (Sazonova, 1971).

Subfamily POLYPTYCHITINAE Wedekind, 1918

[Polyptychitinae WEDEKIND, 1918, p. 103]

Very variable. In earlier groups rather evolute forms dominant, ranging from moderately inflated to very depressed, cadicone, or sphaerocone; macroconchs medium-sized, mildly to strongly variocostate. Later forms involute to evolute but on the whole only moderately inflated and large to very large, so that microconchs may be homeomorphic with earlier macroconchs. Ribbing variable; inner whorls may be smooth and constricted up to 15 mm diameter; middle and outer whorls generally with elevated or bullate primary ribs branching in simple bundles, irregularly polyschizotomously or virgatotomously (*Polyptychites*) or bidichotomously (*Dichotomites*). *Lower Cretaceous (Lower Valanginian–Lower Hauterivian).*

Most of these characters appear already in various Tolliinae, from which the Polyptychitinae as a whole were undoubtedly derived; but the precise phyletic pathway remains unclear. Alternatives include *Nikitinoceras* or *Virgatoptychites (Propolyptychites).* There is no clear morphological demarcation except possibly in the sutures, which continue broadly craspeditid in plan but with longer, more slender lateral lobes and a reduced number of auxiliaries in the earlier forms. Most genera are widespread in the Boreal Realm, but some are local (e.g., *Wellsia*). IMLAY, 1960; KEMPER, 1978.

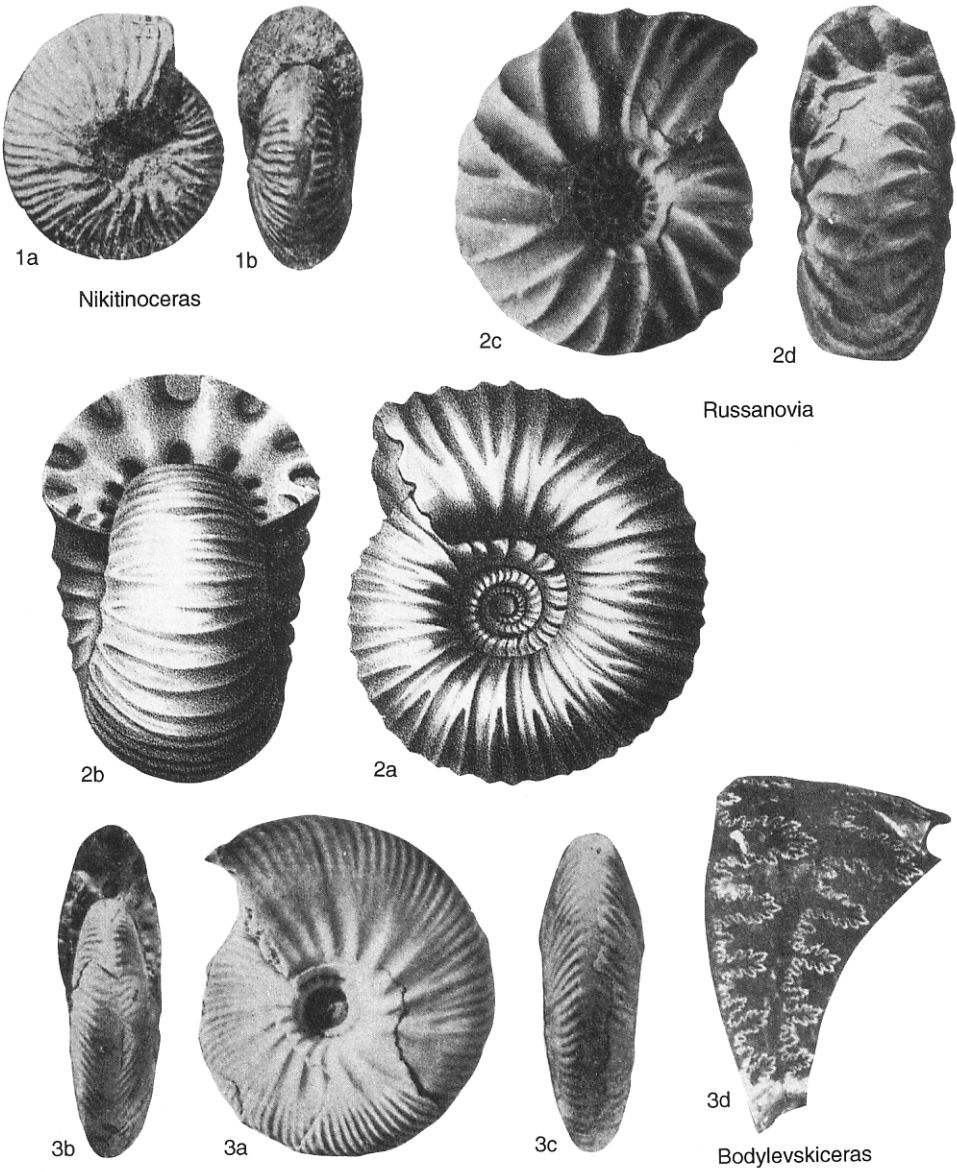


FIG. 19. Polyptychitidae (p. 29)

Polyptychites PAVLOW, 1892, p. 476 [**Ammonites polyptychus* KEYSERLING, 1846, p. 327; SD ROMAN, 1938, p. 391]. Moderately involute to very evolute; whorl section rather compressed to depressed, coronate or sphaerocone; more or less prominent, normally oblique umbilical bullae or round tubercles giving rise to 2 or more ribs; some ribs branching once or twice again; ribbing may be virgatotome; inner whorls of some species may have sharp, high, biplicate or triplicate ribs. Suture with 2 or 3 auxiliary lobes. *Lower Cretaceous (Lower Valanginian–Upper Valanginian):* northern Eurasia, France, ?Mexico, ?California, northern Canada, Greenland.

P. (Siberiptychites) KEMPER & JELETZKY in KEMPER, 1977, p. 3 [**Ammonites stubendorffi* SCHMIDT, 1872, p. 133; OD]. Cadicones with steep umbilical walls, dense and fine ribbing; homeomorphs of *Macrocephalites* but with constrictions, sometimes to a late stage; suture with 3 auxiliary lobes. *Lower Cretaceous (Lower Valanginian,* stubendorffi *Zone):* northern Siberia,

Greenland, northern Canada.——FIG. 20,*1a–c.* **P. (S.) stubendorffi* (SCHMIDT), northern Siberia; lectotype, herein designated, ×0.7 (Pavlow, 1914, pl. 6, fig. 1a–c).

P. (Astieriptychites) BODYLEVSKII, 1960, p. 172 (*non* 1950 MS, *nec* in VORONETS, 1958a, p. 24, *nom. nud.*) [**Astieriptychites astieriptychus* BODYLEVSKII, 1960, p. 172 (*Polyptychites astieriptychus* BODYLEVSKII, 1957, p. 98, *nom. nud.*); OD] [=*Neopolyptychites* SHUL'GINA, 1983, p. 85 (type, *N. arcticus;* OD)]. Cadicones with well-spaced, strong primary nodes on umbilical edge dividing immediately into sheaves of dense, fine secondary ribs as in *Olcostephanus. Lower Cretaceous (Lower Valanginian, below* P. (Polyptychites)*):* northern Siberia, northern Canada.——FIG. 21,*1a,b.* **P. (A.) astieriptychus* (BODYLEVSKII); holotype, ×0.7 (Bodylevskii, 1960).

P. (Euryptychites) PAVLOW, 1914, p. 18 [**Olcostephanus latissimus* NEUMAYR & UHLIG, 1881, p. 159(30); SD WRIGHT, 1957b, p. 348] [=*Pseudoeuryptychites* JELETZKY, 1986, p. 352 (type, *Euryptychites pavlovi* VORONETS, 1962, p. 78; OD); *Hollwediceras* JELETZKY & KEMPER, 1988, p. 86 (type, *Polyptychites sphaericus* KOENEN, 1902, p. 122; OD); *Palaeodichotomites* BOGOMOLOV, 1989, p. 59 (type, *Olcostephanus (Polyptychites) triplodiptychus* PAVLOW, 1892, p. 480; OD)]. Cadicones with closer umbilical nodes and fewer ribs than in *P. (Astieriptychites). Lower Cretaceous (Lower Valanginian):* distribution as for genus.——FIG. 20,*3a,c.* **P. (E.) latissimus* (NEUMAYR & UHLIG), Germany; *a,b,* ×0.5; *c,* ×1 (Neumayr & Uhlig, 1881).

P. (Primitiviptychites) KLIMOVA, 1983, p. 117 [**Olcostephanus rectangulatum* BOGOSLOVSKII, 1902, p. 136; OD]. Small, cadicone, strongly and sharply ribbed microconchs, probably of several subgenera of *Polyptychites. Lower Cretaceous (Lower Valanginian):* northern Russia, Siberia.——FIG. 20,*2a,b. P. (P.) rectangulatum* (BOGOSLOVSKII); lectotype, ×1 (Bogoslovskii, 1902).

P. (Siberites) KLIMOVA in GOL'BERT & KLIMOVA, 1983, p. 149 [**S. savitzkii;* OD]. Compressed, involute, with dense, virgatotome ribbing as in other groups of *Polyptychites,* of which it may be merely a compressed end-member in range of variability. *Lower Cretaceous (Lower Valanginian,* syrzanicus *Zone):* northern Siberia.——FIG. 21,*2.* **P. (S.) savitzkii;* holotype, ×1 (Gol'bert & Klimova, 1983).

P. (Polyptychites) [=*Amundiptychites* KEMPER & JELETZKY, 1979, p. 3 (type, *A. sverdrupi;* OD)]. Typically fairly evolute; whorl section moderately compressed to moderately depressed; ribs dense and rather high to sparse, low, and rounded. Early forms medium-sized; later ones becoming large. Occurrence and distribution as for genus.——FIG. 21,*3a–c. P. (P.) keyserlingi* (NEUMAYR & UHLIG), Lower Valanginian (*keyserlingi* Zone), northern Germany; *a,b,* lectotype, ×0.7; *c,* ×0.5 (Koenen, 1902).——FIG. 21,*3d. P. euomphalus* KOENEN, Lower Valanginian (*keyserlingi* Zone), northern Germany; microconch, ×0.7 (Koenen, 1902).

Dichotomites KOENEN, 1909, p. 9 [**Ammonites bidichotomus* ORBIGNY, 1841, p. 190; M] [=*Bidichotomites* SAZONOV, 1951, p. 57, obj., *?lapsus, nom. nud.*]. Inner and middle whorls moderately involute, flat-sided, and compressed, with high-arched and narrow venter; outer whorls may become more evolute and round-whorled, but no cadicones or sphaerocones; ribbing dense, with primary ribs short, accentuated on steep umbilical margins; ribbing on inner whorls and microconchs frequently to regularly bidichotomous with 2 distinct levels of bifurcation low and high on whorl side, becoming irregularly polyschizotomous on outer whorls as in ancestral *Polyptychites.* Macroconchs large to very large (up to 450 mm), only mildly variocostate, retaining at least vestigial dense ribbing to end. Sutures generally with 3 auxiliary lobes, on a rectiradiate (craspeditid) baseline in microconchs, but becoming florid and retracted into an umbilical lobe on outer whorls of macroconchs as these reapproach the more usual perisphinctid mode of coiling. [Boreal, but with considerable southerly spread into sub-Mediterranean province; some local faunas.] NEUMAYR & UHLIG, 1881; THIEULOY, 1977a; KEMPER, 1978. *Lower Cretaceous (Upper Valanginian):* southern and eastern Paris basin, southern Jura mountains, northern Germany, Pechora region, northern Siberia, northern Canada, British Columbia.

D. (Prodichotomites) KEMPER, 1971, p. 52 [**Polyptychites polytomus* KOENEN, 1902, p. 88; OD] [=*Ringnesiceras* KEMPER & JELETZKY, 1979, p. 5 (type, *R. amundense;* OD); *Elleficeras* KEMPER & JELETZKY, 1979, p. 11 (type, *Ringnesiceras (E.) ellefense;* OD)]. Rather inflated, with convex sides; microconchs becoming evolute; ribbing strong, dense, sharp, with irregular branching. Early forms transitional from *Polyptychites,* from compressed forms of which they may be barely distinguishable. KEMPER, 1978. *Lower Cretaceous (Upper Valanginian,* hollwedensis–triptychoides *Zones):* northern Germany, France, northern Canada.——FIG. 22,*2a,b.* **D. (P.) polytomus* (KOENEN), *polytomus* Zone, northern Germany; holotype, ×0.5 (Koenen, 1902).

D. (Dichotomites). Sides more or less flat, subparallel or convergent; ribbing coarse to fine. Occurrence and distribution as for genus.——FIG. 22,*1a–c.* **D. (D.) bidichotomus* (ORBIGNY); *a,* nucleus of macroconch, *callidiscus* Zone, France, ×0.5 (Thieuloy, 1977a); *b,c,* complete microconch, *bidichotomoides* Zone, northern Germany, ×0.7 (Kemper, 1978).——FIG. 22,*1d–f. D. (D.) grotriani* NEUMAYR & UHLIG, northern Germany; macroconch (closely resembling syntype of *D. bidichotomus* in ORBIGNY, 1841), *d,e,* ×0.25; *f,* ×0.5 (Neumayr & Uhlig, 1881).

Homolsomites CRICKMAY, 1930, p. 63 [**H. poecilotomus;* OD; =*Holcodiscus? stantoni* MCLELLAN, 1927,

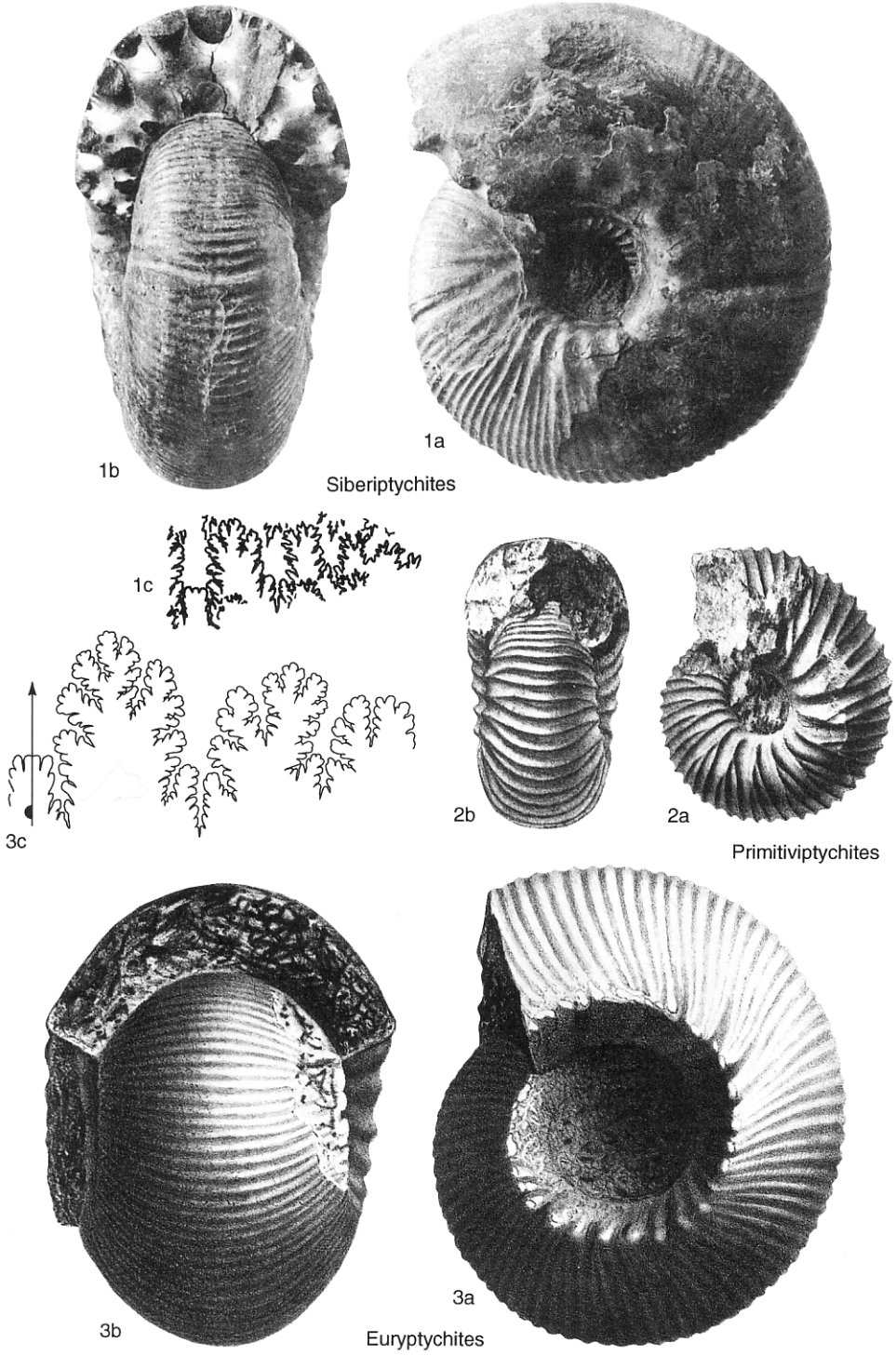


FIG. 20. Polyptychitidae (p. 30–31)

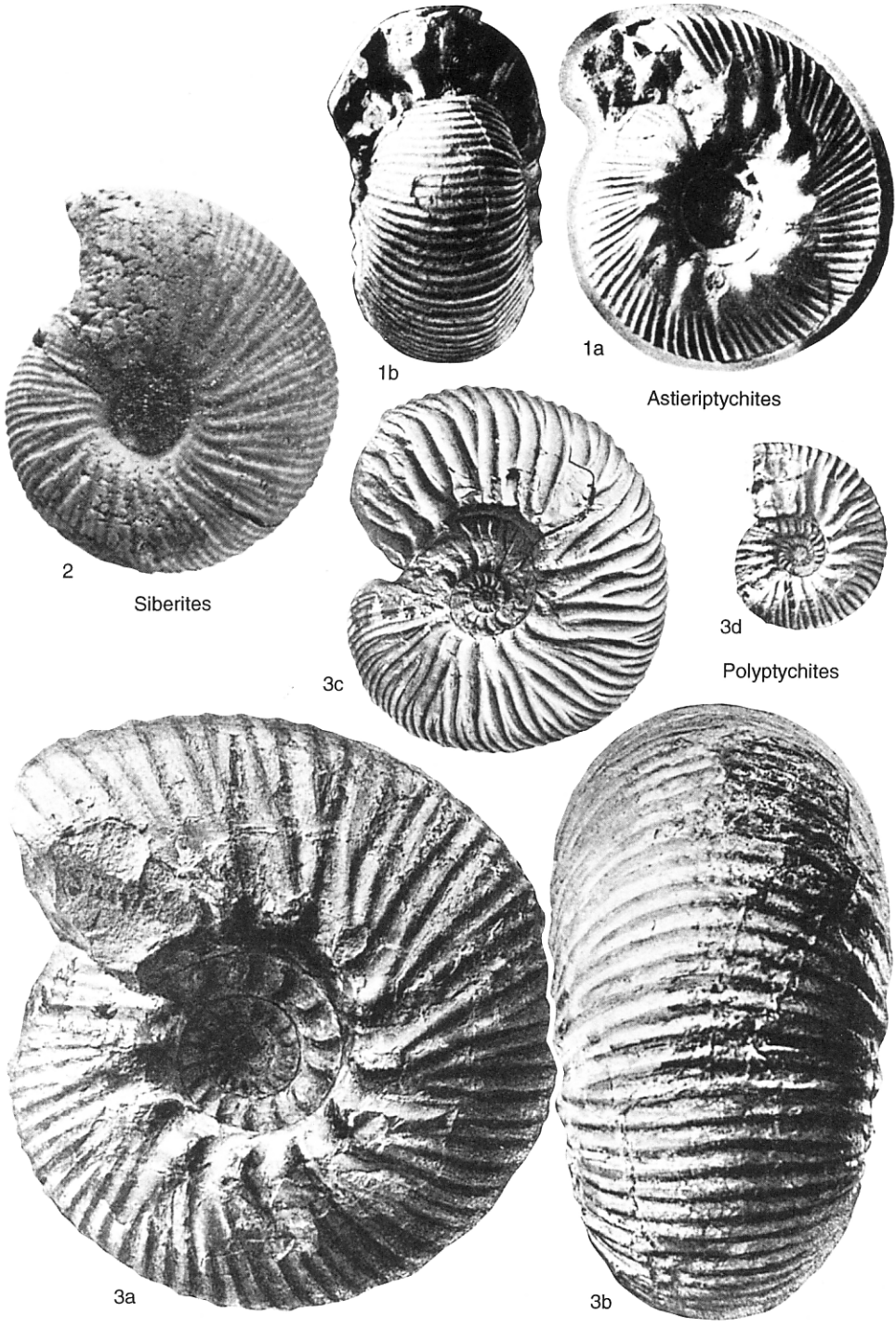


FIG. 21. Polyptychitidae (p. 31)

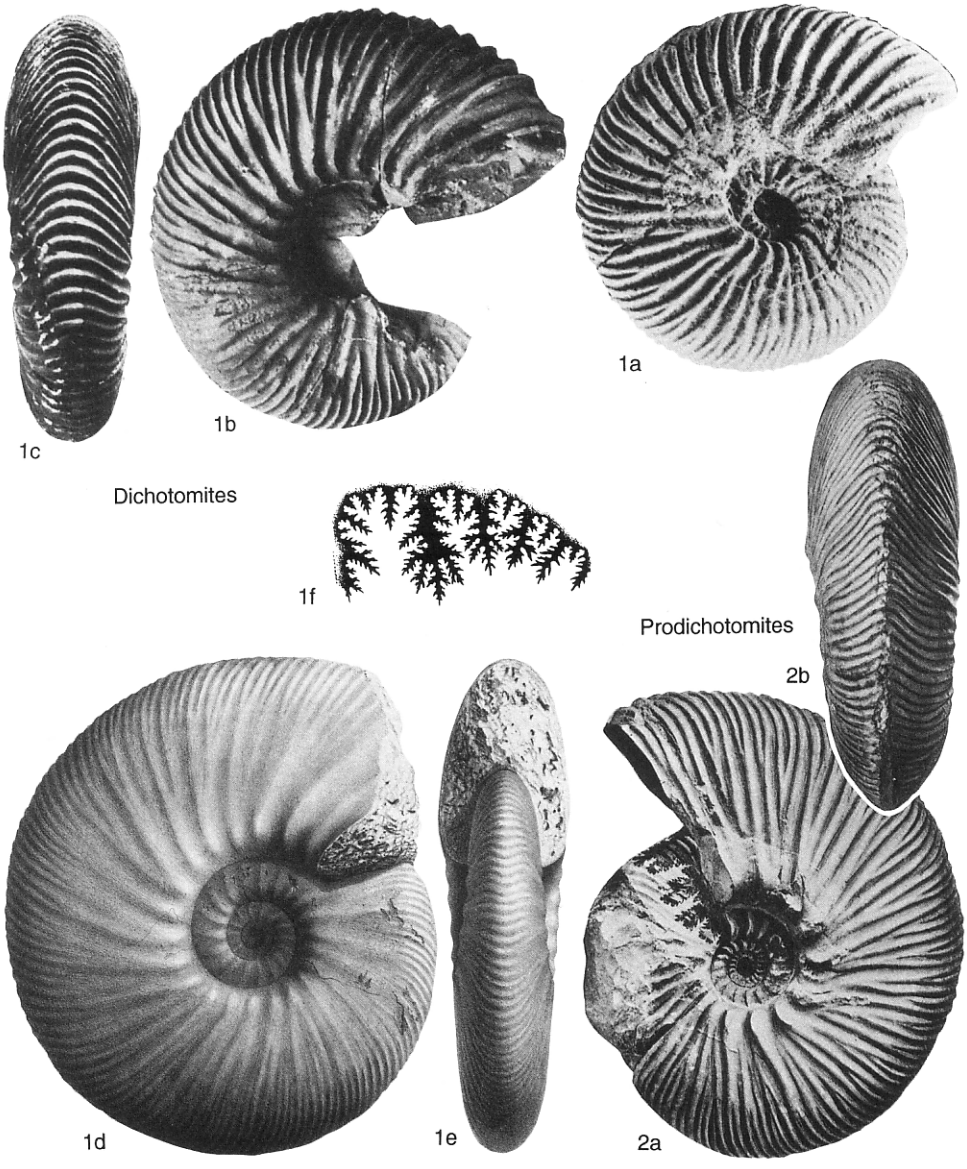


FIG. 22. Polyptychitidae (p. 31)

p. 115] [=*Wellsia* IMLAY, 1957, p. 275 (type, *Dichotomites oregonensis* ANDERSON, 1938, p. 1; OD)]. Similar to *Tollia* in its coiling, whorl section, size, and dimorphism, but ribbing and suture like those of *Dichotomites;* primary ribs dense, rectiradiate, dividing bidichotomously; secondary ribs projected on venter. Suture with long, narrow, and florid lobes. [Either late descendants of *Tollia* that have independently evolved the bidichotomous ribbing of *Dichotomites* or, more probably, yet another independent development of a *Tollia*-like morphology as found previously in such genera as *Craspedites (Taimyroceras)* and subsequently in *Simbirskites (Craspedodiscus).* Distribution limited, predominantly in the North Pacific Cordilleran Province.] *Lower Cretaceous (Upper Valanginian–Lower Hauterivian):* northern Siberia, British Columbia, northern Canada, California, Oregon, Washington.——FIG. 23*a–e.* **H. stantoni* (MCLELLAN), Upper Valanginian, Washington; *a–c,* holotype, microconch, ×1; *d,e,* inner whorls and suture of a macroconch, ×1 (Imlay, 1960).——FIG. 23*f,g. H. oregonensis* (ANDERSON), Lower Hauterivian, Oregon; macroconch, ×0.7 (Imlay, 1960).

Subfamily PLATYLENTICERATINAE Casey, 1973

[Platylenticeratinae CASEY, 1973, p. 258]

Compressed, involute; venter narrowly tabulate to oxyconic; ribbing subdued or absent; craspeditid sutures highly simplified on straight or only gently curved baseline, with principal lobes little differentiated, squat, and often asymmetrical and broad saddles bearing many auxiliaries. *Lower Cretaceous (Lower Valanginian–Upper Valanginian).*

Platylenticeras of the Lower Valanginian is widely distributed but mostly boreal, dominant in northern Germany. Its origins lie in Polyptychitinae (KEMPER, 1961) rather than in Berriasellinae (CASEY, 1973) or in Olcostephanidae (KEMPER, RAWSON, & THIEULOY, 1981). Some small forms of uncertain affinities (*Paquiericeras*) are found in the Valanginian of the northern margins of the Tethys.

Platylenticeras HYATT, 1900, p. 590 [**Amaltheus (Oxynoticeras) heteropleurus* NEUMAYR & UHLIG, 1881, p. 135; OD] [=*Garnieria* SAYN, 1901, p. 14, *non* BOURGUIGNAT, 1877, p. 2 (type, *A. (O.) heteropleurus* NEUMAYR & UHLIG, 1881, p. 135; SD CALLOMON & WRIGHT, herein)]. Rather evolute to very involute, more or less compressed oxycones; early whorls ribbed; later ones smooth; one stock with, the other without umbilical tubercles. Suture asymmetrical, with short element bluntly subdivided. KEMPER, 1961; THIEULOY, 1977a. *Lower Cretaceous (Lower Valanginian):* England, France, Germany, Switzerland, Czechoslovakia, Poland, ?Spitsbergen, ?Russia (northern Urals).

P. (**Platylenticeras**). Without umbilical tubercles. Occurrence and distribution as for genus.—— FIG. 24,*2a–c.* **P. (P.) heteropleurum* (NEUMAYR & UHLIG), Germany; *a,b,* ×0.7 (Neumayr & Uhlig, 1881); *c,* ×1.5 (Kemper, 1961).

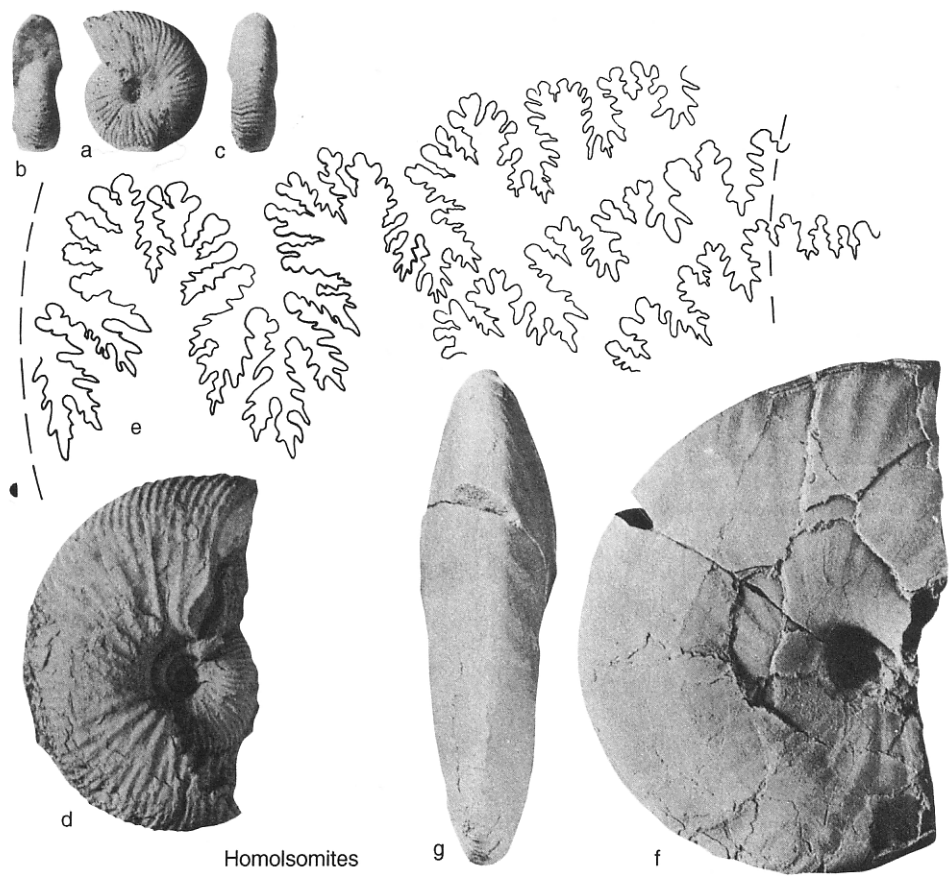


FIG. 23. Polyptychitidae (p. 31–34)

P. (**Tolypeceras**) HYATT, 1903, p. 103 [**Ammonites marcousianus* PICTET & CAMPICHE, 1859, p. 168 (ORBIGNY, 1850a, p. 65, *nom nud.*); OD]. Umbilical tubercles present, generally large and rounded. *Lower Cretaceous (Lower Valanginian):* France, Germany, Switzerland.——FIG. 24,*1a,b.* **P. (T.) marcousianum* (PICTET & CAMPICHE), France; ×0.5 (Pictet & Campiche, 1858–1864).

Delphinites SAYN, 1901, p. 23 [**D. ritteri;* M] [=*Pseudogarnieria* SPATH, 1923c, p. 307 (type, *Oxynoticeras undulatoplicatile* STCHIROWSKY, 1894, p. 372; OD); *Proleopoldia* SPATH, 1923c, p. 307 (type, *Hoplites kurmyschensis* STCHIROWSKY, 1894, p. 378; OD)]. Early whorls to varying stage with more or less convex sides and tabulate to slightly concave venter bordered by small, opposite clavi; later whorls with lanceolate section and slightly flexed, well-spaced ribs, with or without strong umbilical bullae. THIEULOY, 1977a. *Lower Cretaceous (Lower Valanginian):* England, France, Russia.——FIG. 24,*5a,b.* **D. ritteri,* France; ×1 (Sayn, 1901).——FIG. 24,*5c,d. D.* cf. *kurmyschensis* (STCHIROWSKY), England; ×1 (Casey, 1973; reprinted by permission of John Wiley & Sons, Ltd., © 1973).——FIG. 24,*5e–g. D. kurmyschensis* (STCHIROWSKY), Russia; ×0.5 (Stchirowsky, 1894).——FIG. 24,*5h–j. D. undulatoplicatile* (STCHIROWSKY), Russia; ×0.5 (Stchirowsky, 1894).

Paquiericeras SAYN, 1901, p. 26 [**P. paradoxum;* M]. Small, evolute, with narrowly rounded, fastigiate or sharp venter; smooth or with weak or strong ribs, with or without minute umbilical tubercles. Suture with narrow-necked, ovoid lobes, simple or complex. THIEULOY, 1977a. *Lower Cretaceous (upper Lower Valanginian–lower Upper Valanginian):* France.

P. (**Paquiericeras**). Flat-sided with narrowly rounded to fastigiate venter; smooth or with very weak lirae and flexuous riblets. Lobes of suture simple. Occurrence and distribution as for genus.——FIG. 24,*4a,b.* **P. (P.) paradoxum;* ×1.——Fig. 24,*4c,d, P. (P.) paradoxum tuberculatum* VERMEULEN, Upper Valanginian, France; ×1 (Vermeulen, 1972).

P. (**Julianites**) THIEULOY, 1977a, p. 407 [**P. (J.) undulatum;* OD]. Oxycones with keel undulating, at least in mature stages; ribs strong and straight, close or distant. Suture more incised than in *P. (Paquiericeras)* with wider E. *Lower Cretaceous (upper Lower Valanginian):* France.——FIG. 24,*3a,b.* **P. (J.) undulatum* (THIEULOY); *a,* ×1; *b,* ×3 (Thieuloy, 1977a).

Subfamily SIMBIRSKITINAE Spath, 1924

[*nom. transl.* SPATH, 1931b, p. 546, *ex* Simbirskitidae SPATH, 1924a, p. 87]

Repeats most characters of various Polyptychitinae but with difference of aspect. Macroconchs large, involute to evolute, compressed to coronate but not cadicone; primary ribs generally with spinate or bullate tubercles on umbilical shoulder or at midside (as in some *Stephanoceras* or *Reineckeia* of the Jurassic) giving rise to 2 to 6 secondary ribs, more or less projected on the venter; ribs may weaken or disappear on outer whorls of compressed forms. Microconchs isocostate, ranging from perisphinctoid homeomorphs of *Pavlovia* (of the Jurassic) to discoidal imitations of *Subcraspedites* or *Tollia.* Sutures normally with 3 auxiliary lobes; baseline in macroconchs ascending to second lateral, then retracted to incipient umbilical lobe in evolute forms. Derived from Polyptychitinae, from which separation is arbitrary and depends largely on stratigraphical breaks. Boreal with considerable extensions into sub-Mediterranean provinces. CHERNOVA, 1951, 1952; RAWSON, 1971; IMLAY, 1960. *Lower Cretaceous (Lower Hauterivian–Upper Hauterivian).*

Simbirskites PAVLOW, 1892, p. 499 [**Ammonites decheni* F. A. ROEMER, 1841, p. 85; SD ROMAN, 1938, p. 393]. Degree of involution variable between species and with growth; compressed; whorl section rounded or coronate; umbilical bullae more or less prominent, tending in later species to move up sides, and each giving rise to 2 to 4 secondary ribs; secondary ribs fine on inner whorls but coarse, low, and rounded on outer; ribbing variable, in simple bundles or polyptychitine. Suture with broad or narrow saddles. [Subgenera largely intergrade.] *Lower Cretaceous (Lower Hauterivian–Upper Hauterivian):* northern Eurasia, France, Japan, California, Oregon, northwestern Canada.

S. (**Hollisites**) IMLAY, 1957, p. 276 [**H. lucasi;* OD] [=*Hertleinites* IMLAY, 1958, p. 1032, *nom. nov. pro Hertleinia* IMLAY, 1957, p. 275, *non* MARKS, 1949, p. 457 (type, *Neocraspedites aguila* ANDERSON, 1938, p. 156; OD)]. Macroconchs large; inner whorls moderately involute and whorl section subquadrate, compressed; becoming more evolute, perisphinctoid, on outer whorls; ribbing dense; primaries gently curved, untuberculate, branching into polyptychitoid sheaves of secondaries. Microconchs with predominately dichotomous ribs. Suture florid. Early forms probably transitional from *Dichotomites.* IMLAY, 1960. *Lower Cretaceous (Lower Hauterivian):* California, Oregon.——FIG. 25*a–c.* **S. (H.) lucasi* (IMLAY), Oregon; holotype, ×0.5 (Imlay, 1960).——FIG. 25*d,e. S. (H.) dichotomus* (IMLAY), Oregon; holotype, microconch, ×1 (Imlay, 1960).——FIG. 26*a–c. S. (H.) aguila* (ANDERSON), California; *a,b,* ×0.6, *c,* ×1 (Imlay, 1960).

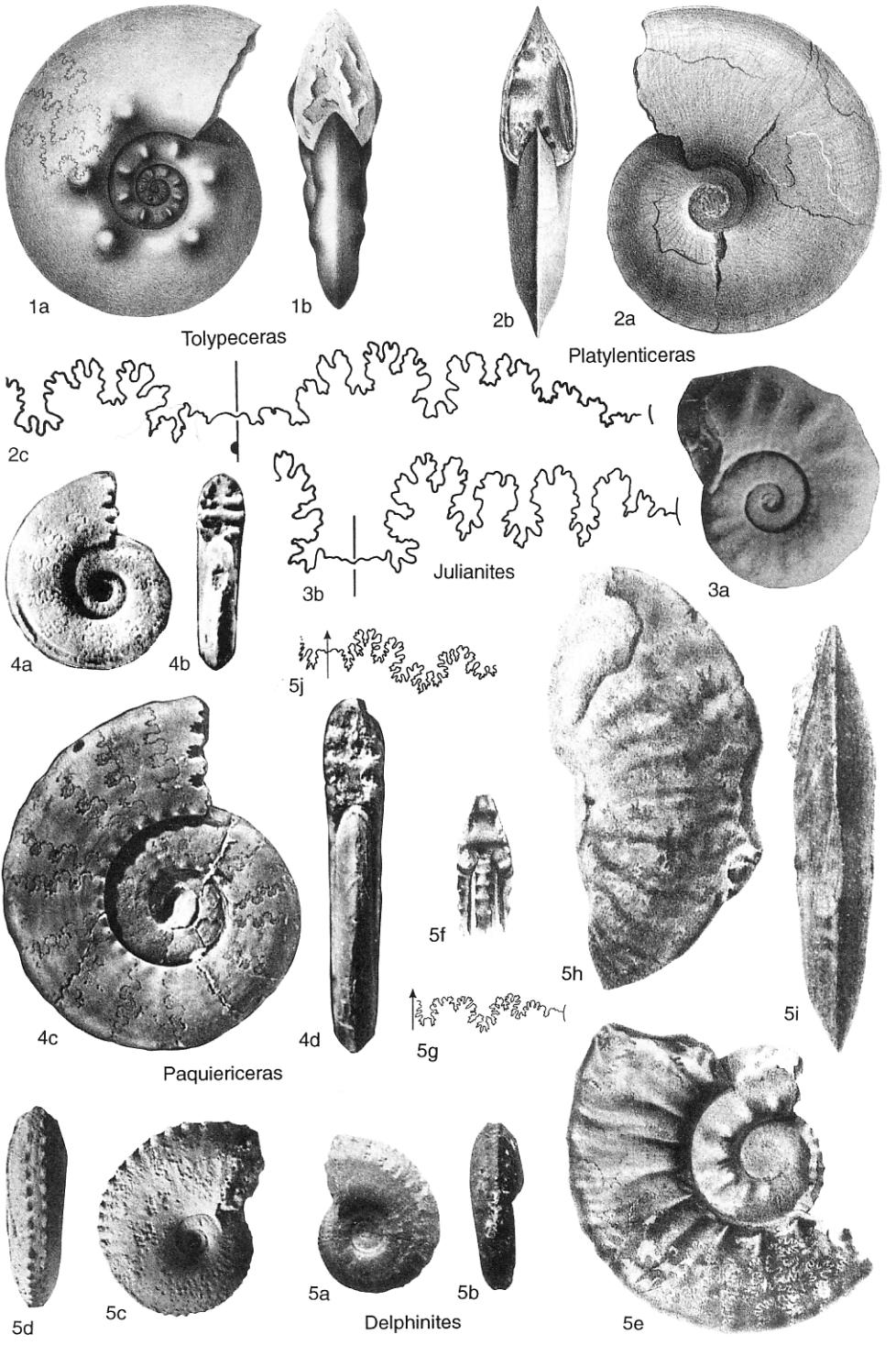


Fig. 24. Polyptychitidae (p. 35–36)



Fig. 25. Polyptychitidae (p. 36)

S. **(Speetoniceras)** SPATH, 1924a, p. 76, 87 [**S. subbipliciforme;* OD] [=*Subspeetoniceras* IVANOV & ARISTOV, 1969, p. 90 (ARISTOV, 1968, p. 174, *nom. nud.*) (type, *Speetoniceras inversioides* ARISTOV, 1967, p. 21; OD)]. Up to 60 cm in diameter; moderately to very evolute, with sharp, bullate primary ribs giving rise to 2 or 3 sharp, high, well-spaced secondary ribs; secondary ribs crossing venter with marked forward bend; innermost whorls may be more finely ribbed, foreshadowing *S. (Milanowskia),* but thereafter whorl section and ribbing remains uniform. Suture with relatively broad saddles. *Lower Cretaceous (Lower Hauterivian):* England, Heligoland, Spitsbergen, Russia, Oregon.——FIG. 27,*2a,b.* **S. (S.) subbipliciformis* (SPATH), England; holotype, ×1 (Rawson, 1971).——FIG. 27,*2c,d. S. (S.) inverselobatus* (NEUMAYR & UHLIG), Germany; macroconch, ×0.25 (Neumayr & Uhlig, 1881).——FIG. 27,*2e,f. S (S.) inversum* (PAVLOW), Russia; microconch, ×0.7 (Rawson, 1971).

S. **(Simbirskites)** [=*Thysanotoceras* WHITEHOUSE, 1927, p. 109 (type, *Ammonites picteti* WEERTH, 1884, p. 12; OD); ?*Californiceras* SHIMIZU, 1931, p. 15 (type, *Ammonites traski* GABB, 1864,

p. 63; OD; type material destroyed, see IMLAY, 1960a, p. 210); *Gorodzovia* IVANOV & ARISTOV, 1969, p. 91 (type, *G. mosquitini;* OD)]. Inflated; whorl section rounded to coronate, at least on middle whorls; short primary ribs branching at prominent spinate or bullate tubercles into 2 to 4 secondary ribs as in *Reineckeia.* Microconchs reverting to simple or biplicate ribbing on adult body chamber. Occurrence and distribution as for genus.——FIG. 28*a–c.* **S. (S.) decheni* (ROEMER), Upper Hauterivian, Siberia; ×1 (Pavlow, 1901).——FIG. 28*d,e. S. (S.) nodocinctus* (WEERTH), Upper Hauterivian, Germany; microconch, ×1 (Weerth, 1884).——FIG. 28*f,g. S. (S.) arminius* (WEERTH), Upper Hauterivian, Germany; microconch, ×1 (Pavlow, 1901).——FIG. 28*h. S. (S.) picteti* (WEERTH), Upper Hauterivian, Germany; macroconch, ×1 (Weerth, 1884).

S. (Milanowskia) CHERNOVA, 1952, p. 50 [**Ammonites spetonensis* G. M. YOUNG & BIRD, 1828, p. 265; OD (original spelling)] [=*Pavlovites* IVANOV & ARISTOV, 1969, p. 88 (type, *Speetoniceras polyptychoides* ARISTOV, 1967, p. 18; OD)]. More or less compressed; short primary ribs branching at subdued tubercles into 2 to 5 generally close and low secondary or intercalated ribs. Occurrence and distribution as for genus.——FIG. 27,*1a,b.* **S. (M.) spetonensis* (YOUNG & BIRD), Upper Hauterivian, England; ×1 (Howarth, 1962).

S. (Craspedodiscus) SPATH, 1924a, p. 77 [**Ammonites clypeiformis* JUDD, 1867, p. 246, *non* ORBIGNY, 1841, p. 137; OD; a deliberate misapplication under Article 70(c), and type thereby becomes **Craspedodiscus clypeiformis* SPATH, 1924a, p. 77 [Article 70(c)(i)], of which *S. (C.) juddi* RAWSON, 1971, p. 62 is a junior synonym; *S. (C.) juddi* RAWSON is available to replace it. However, *S. (C.) clypeiforme* SPATH is probably a subjective synonym of *Ammonites discofalcatus* LAHUSEN, 1874, p. 67] [=*Hannoverites* KEMPER, 1968, p. 148, *nom. nud.*]. Inner whorls involute, compressed, flat-sided, with narrowly arched, densely ribbed venter; primary ribs dividing indistinctly into sheaves of many fine secondary ribs; lateral tubercles very fine or absent. Outer whorls of macroconchs becoming evolute in early forms but remaining involute and becoming acute in later forms; in some later forms venter almost carinate, the whole shell discoidal; ribbing becoming subdued or disappearing. RAWSON, 1971. *Lower Cretaceous (Upper Hauterivian):* England, northern Germany, Russia.——FIG. 27,*3a,b.* **S. (C.) clypeiformis* SPATH, England; holotype, ×0.5 (Rawson, 1971).——FIG. 27,*3c–e. S. (C.) discofalcatus* (LAHUSEN), Russia; ×0.5 (Pavlow, 1901).

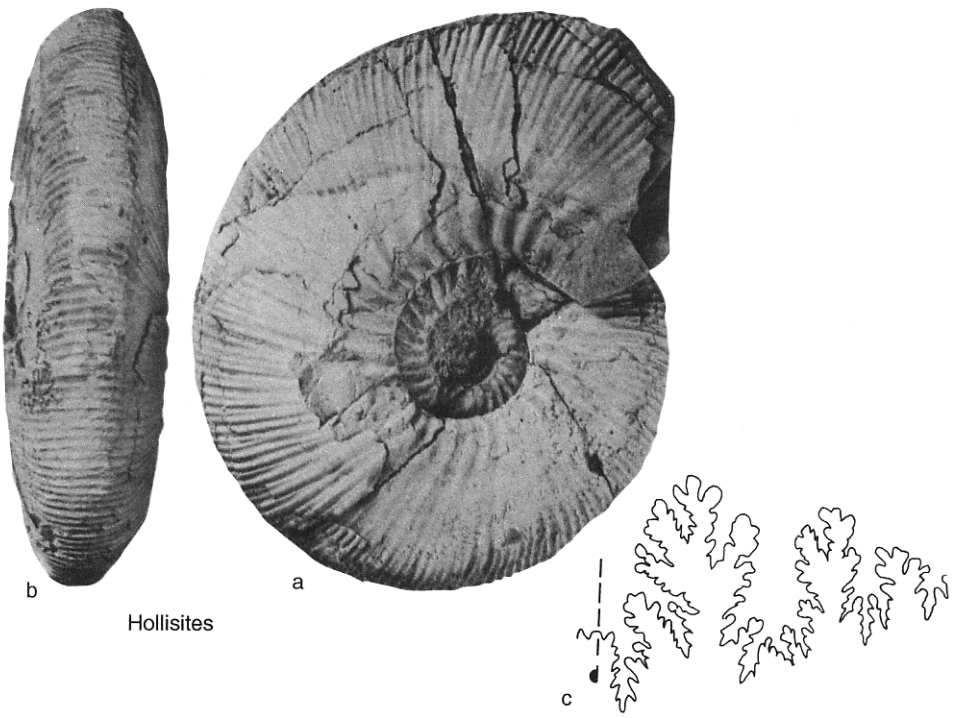


Fig. 26. Polyptychitidae (p. 36)

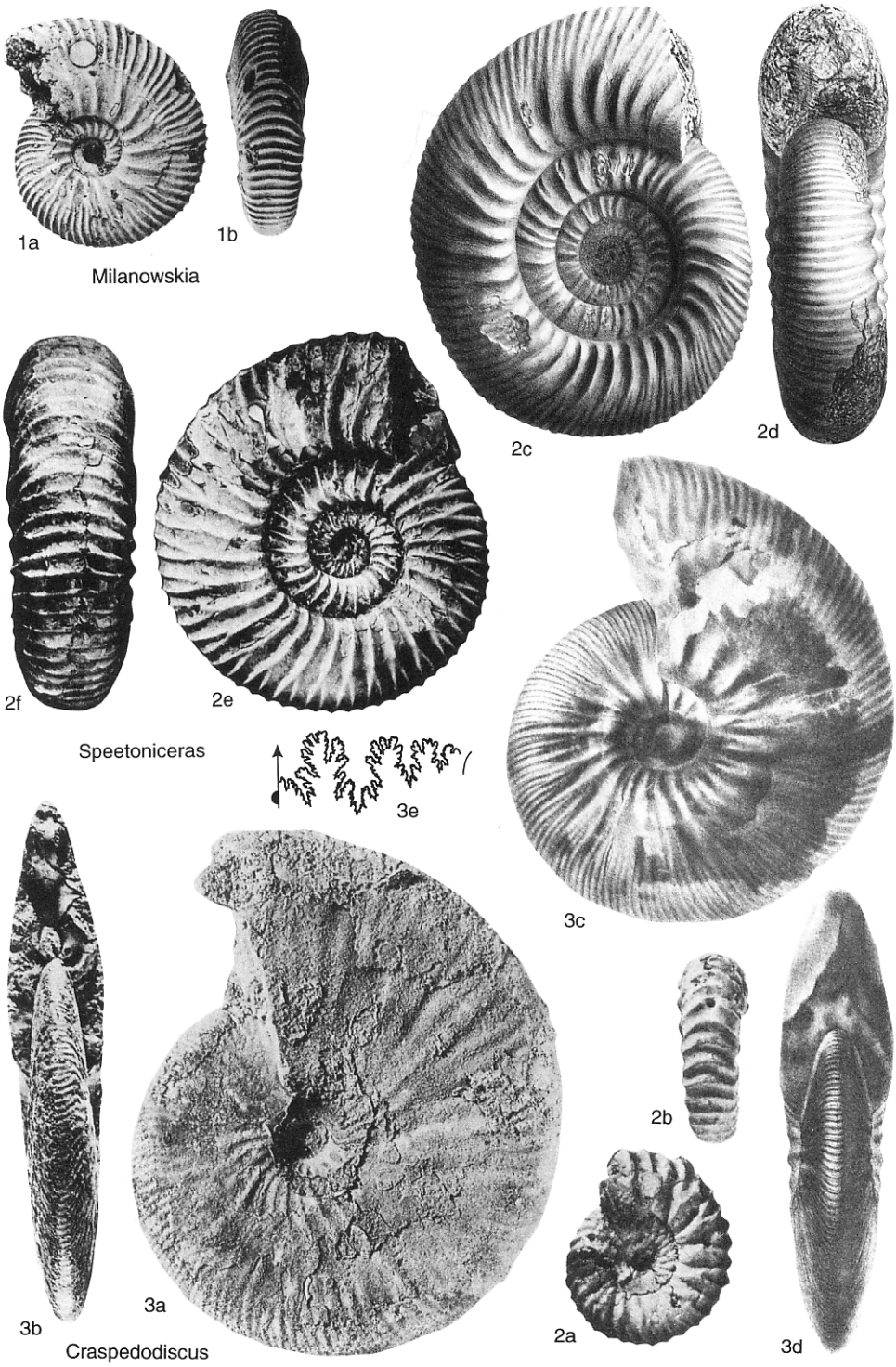


Fig. 27. Polyptychitidae (p. 38–39)

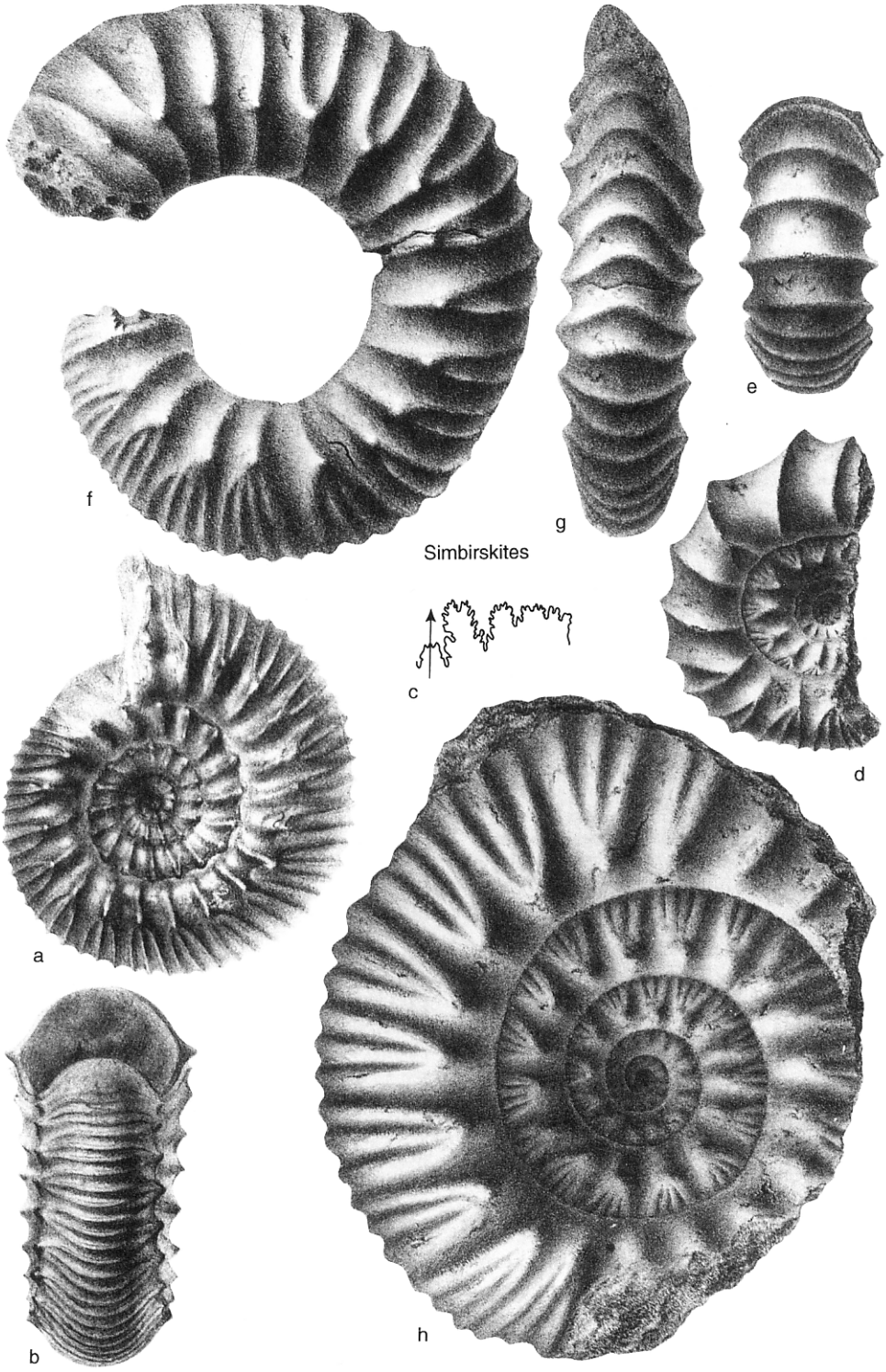


Fig. 28. Polyptychitidae (p. 38–39)

Family OOSTERELLIDAE Breistroffer, 1940

[*nom. transl.* WRIGHT, 1957b, p. 362, *ex* Oosterellinae BREISTROFFER, 1940, p. 143(73)]

Keeled, strongly ribbed, more or less compressed derivatives of Platylenticeratinae. VERMEULEN, 1972; COMPANY, 1987. *Lower Cretaceous (Upper Valanginian–Lower Hauterivian).*

Oosterella KILIAN, 1911, p. 117, *nom. nov. pro Nicklesia* KILIAN, 1910c, p. 226, *non* HYATT, 1903, p. 138 [**Ammonites cultratus* ORBIGNY, 1841, p. 145; SD ROMAN, 1938, p. 345]. Involute, compressed, with high keel that may undulate; ribs strong, blunt, irregularly simple and branching; point of furcation may rise with growth and may form prominent midlateral tubercles. *Lower Cretaceous (Upper Valanginian–Lower Hauterivian):* France, Spain, Germany, Switzerland, Austria, Morocco, Algeria, Mexico, Columbia.——FIG. 29,*1a,b.* **O. cultrata* (ORBIGNY), Lower Hauterivian, France; ×0.5 (Orbigny, 1840–1842).

Pseudosterella SPATH, 1924a, p. 88 [**Mortoniceras fischeri* NICKLÈS, 1892, p. 191; SD ROMAN, 1938, p. 346]. Compressed, evolute, with stout, serrated keel; ribs strong, simple, rectiradiate, and sharply projected on shoulders. Homeomorph of *Amoebites* (Lower Kimmeridgian). *Lower Cretaceous (Upper Valanginian):* Spain, France, Columbia.——FIG. 29,*2a,b.* **P. fischeri* (NICKLÈS); ×3 (Nicklès, 1892).

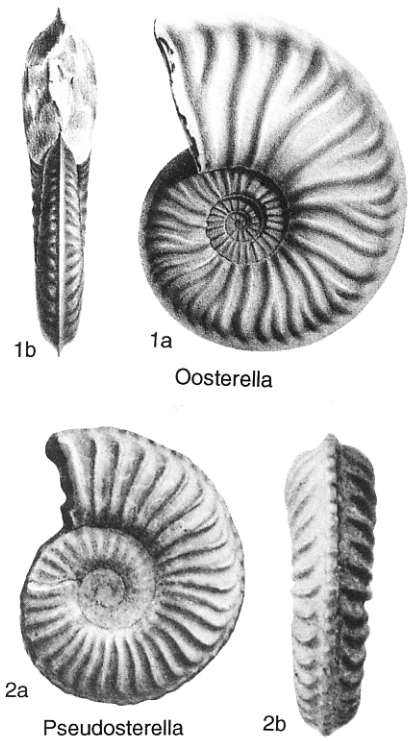


Fig. 29. Oosterellidae (p. 42)

Family OLCOSTEPHANIDAE Haug, 1910

[Holcostephanidae HAUG, 1910, p. 1167 (incorrect original spelling); ICZN Opinion 575, 1959, Family-Group Name No. 281]

Round-whorled to moderately compressed, normally with strong constrictions. Ribs typically bundled at umbilical tubercles, but some genera with single ribs. Inner whorls and dwarf genera may have lateral or ventrolateral tubercles. Strongly dimorphic; microconchs with long, spatulate lappets. Primitive subfamily Spiticeratinae includes members that overlap Olcostephaninae morphologically, and the latter are presumably derived from the former. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Lower Hauterivian).*

PAVLOW (1892, p. 470) used the term Olcostephanini to cover a wide range of species referred by some authors to several genera. He in fact referred them all to *Olcostephanus,* distributing them in several subgenera. Olcostephanini must be treated as a plural noun referring to members of a genus under Article 11(f)(i)(2) of the *International Code of Zoological Nomenclature* (3rd Edition). Since it was not accepted generally as a family name, as required by Article 11(f)(iii), it does not take priority over Olcostephanidae HAUG, 1910.

Subfamily SPITICERATINAE Spath, 1924

[*nom. transl.* ARKELL & WRIGHT, 1957 in ARKELL, KUMMEL, & WRIGHT, p. 345, *ex* Spiticeratidae SPATH, 1924a, p. 89]

Whorls rounded or higher than wide, moderately evolute, with strong, normally curved constrictions; early whorls commonly with primary ribs bearing lateral tubercles (at which ribs branch) and with ventral groove bordered, in some, by ventrolateral tubercles; later whorls having umbilical bullae with 2 to 4 bundled, prorsiradiate ribs branching again irregularly and crossing venter in obtuse chevrons or transversely; in some ornament weakening or disappearing at varying stages. Suture in some with strongly retracted sus-

pensive lobe. UHLIG, 1903, 1910c; DJANÉLIDZÉ, 1922b. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Upper Berriasian).*

Proniceras BURCKHARDT, 1919, p. 40 [**Ammonites pronus* OPPEL, 1865, p. 554; SD ROMAN, 1938, p. 381]. Rather small; inner whorls with ribs simple or bifurcating high up side, strongly curved, and without tubercles; later whorls with curved umbilical bullae and simple, biplicate or triplicate ribs; ornament may weaken on body chamber. *Upper Jurassic (Upper Tithonian):* southern and central Europe, northern Africa, Madagascar, Iraq, Iran, Pakistan, California, Mexico.——FIG. 30,*2a,b.* **P. pronus* OPPEL, Poland; lectotype designated herein, ×1 (Zittel, 1868, pl. 15, fig. 8a,b).

?Simospiticeras OLORIZ & TAVERA, 1979, p. 183 [**S. lojense;* OD]. Evolute; whorl section subquadrate to trigonal, almost keeled at middle growth stages; ornament poorly known because of bad preservation, but blunt umbilical nodes and ventral ribs in forwardly pointing chevrons are visible; lateral ornament not preserved; 3 or 4 curved constrictions to a whorl. [Genus is one of the earliest Spiticeratinae and may be a link with Simoceratidae.] *Upper Jurassic (basal Upper Tithonian):* Spain.——FIG. 30,*1a,b.* **S. lojense;* holotype, ×0.75 (Oloriz & Tavera, 1979).

Umiaites SPATH, 1931b, p. 546 [**U. rajnathi;* OD]. Poorly known from specimens still septate at 100 mm diameter. Close to *Proniceras* but largest known specimen septate, with whorl compressed and nearly smooth. *Upper Jurassic (Upper Tithonian):* India (Kachchh).——FIG. 30,*3a,b.* **U. rajnathi* SPATH; holotype, ×0.7 (Spath, 1931b).

Spiticeras UHLIG, 1903, p. 83 [**Ammonites spitiensis* BLANFORD, 1863, p. 131; SD ROMAN, 1938, p. 380] [=*Somaliceras* SPATH, 1925b, p. 145 (type, *S. isariforme;* OD)]. Inner whorls inflated, with ribs branching from midlateral tubercles; later whorls inflated to compressed or subquadrate, with fine ribs branching from umbilical tubercles, but some species tending to become smooth; curved constrictions generally present. Suture with more or less strongly developed suspensive lobe. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Berriasian):* southern and central Europe, northern Africa, Somalia, Madagascar, Iraq, Yemen, Pakistan, India, California, Mexico, Cuba, Argentina, Chile.

S. (Spiticeras) [=*Bihenduloceras* SPATH, 1925b, p. 152 (type, *B. gregoryi;* M)]. Inner whorls coronate with lateral tubercles, followed from diameter of 10 to 30 mm by bituberculate stage with umbilical and lateral tubercles, then lateral tubercles fading; ribs bifurcate from the lateral tubercles, then later issuing in bundles from the umbilical tubercles; some species tending to become smooth. Outer whorls with high, narrowly rounded venter or subquadrate. Occurrence and distribution as for genus.——FIG. 31,*1a–d.* **S. (S.) spitiense* (BLANFORD), Berriasian, India (Spiti Valley); *a,b,* holotype, ×0.5; *c,d,* paratype, ×0.5 (Uhlig, 1903).——FIG. 31,*1e,f.* *S. (S.) gregoryi* (SPATH), Berriasian, Somalia; ×0.5 (Spath, 1925b).

S. (Kilianiceras) DJANÉLIDZÉ, 1922b, p. 49 [**Stephanoceras damesi* STEUER, 1897, p. 193(67); SD ROMAN, 1938, p. 382]. Evolute up to large size; whorl section rounded; ornament coarse; bituberculate stage much more persistent than in *S. (Spiticeras).* Occurrence as for genus: France, Madagascar, Argentina, ?California.——FIG. 31,*2a,b.* **S. (K.) damesi* (STEUER), Berriasian, Argentina; holotype, ×0.5 (Steuer, 1897).

Negreliceras DJANÉLIDZÉ, 1922b, p. 49 [**Ammonites negreli* MATHERON, 1880 in 1878–1880, pl. B-27; SD ROMAN, 1938, p. 382] [=*Praenegreliceras* COLLIGNON, 1960, explanation of pl. 164, fig. 663, *nom. nud.* because no differentia was given and no type species designated]. Compressed from early stage and without lateral tubercles; fine ribs branching from umbilical bullae, but later whorls tending to become smooth. Suture with strongly retracted suspensive lobe. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Lower Berriasian):* southern and central Europe, Tunisia, Pakistan, Madagascar, California, Mexico, Argentina.——FIG. 31,*3a,b.* **N. negreli* (MATHERON), Lower Berriasian, France; ×0.75 (Djanélidzé, 1922b).

Groebericeras A. F. LEANZA, 1945, p. 82 [**G. bifrons;* OD; =*Ammonites rocardi* POMEL, 1889, p. 65]. Moderately involute, becoming more evolute with age; whorl section compressed to rounded, widest at umbilical margin, tapering to narrowly rounded venter; ribs curved, prorsiradiate, and single with intercalated secondaries, ribs tending to weaken and in some to disappear on outer whorls; constrictions following course of ribs; umbilical, lateral, and ventrolateral tubercles may be present up to small diameters. Suspensive lobe of suture not markedly retracted. *Lower Cretaceous (?Lower Berriasian, Upper Berriasian):* Spain, Algeria, Iraq, Nepal, Argentina.——FIG. 31,*4a,b.* **G. rocardi* (POMEL), ?Lower Berriasian, Argentina; lectotype of *G. bifrons* LEANZA, ×0.75 (A. F. Leanza, 1945).

?Aspidostephanus SPATH, 1925b, p. 144 [**Holcostephanus depressus* STEUER, 1897, p. 192(66); OD]. Inflated and depressed to coronate, with broad, smooth venter; early whorls with strong, distant ribs bearing umbilical and lateral tubercles, but later whorls smooth except for umbilical tubercles and whorl height increasing. *Upper Jurassic (?Tithonian)–Lower Cretaceous (Berriasian):* France, Balearic Islands, northern Africa, Argentina.——FIG. 30,*4a–c.* **A. depressus* (STEUER), Berriasian, Argentina; ×0.7 (Steuer, 1897).

Subfamily OLCOSTEPHANINAE Haug, 1910

[Olcostephaninae HAUG, 1910, p. 1167] [=Taraisitinae A. CANTU-CHAPA, 1966, p. 16; ?Provalanginitinae FATMI, 1972, p. 351]

Moderately involute to moderately evolute, compressed to globular or cadicone; generally primary ribs splitting on umbilical

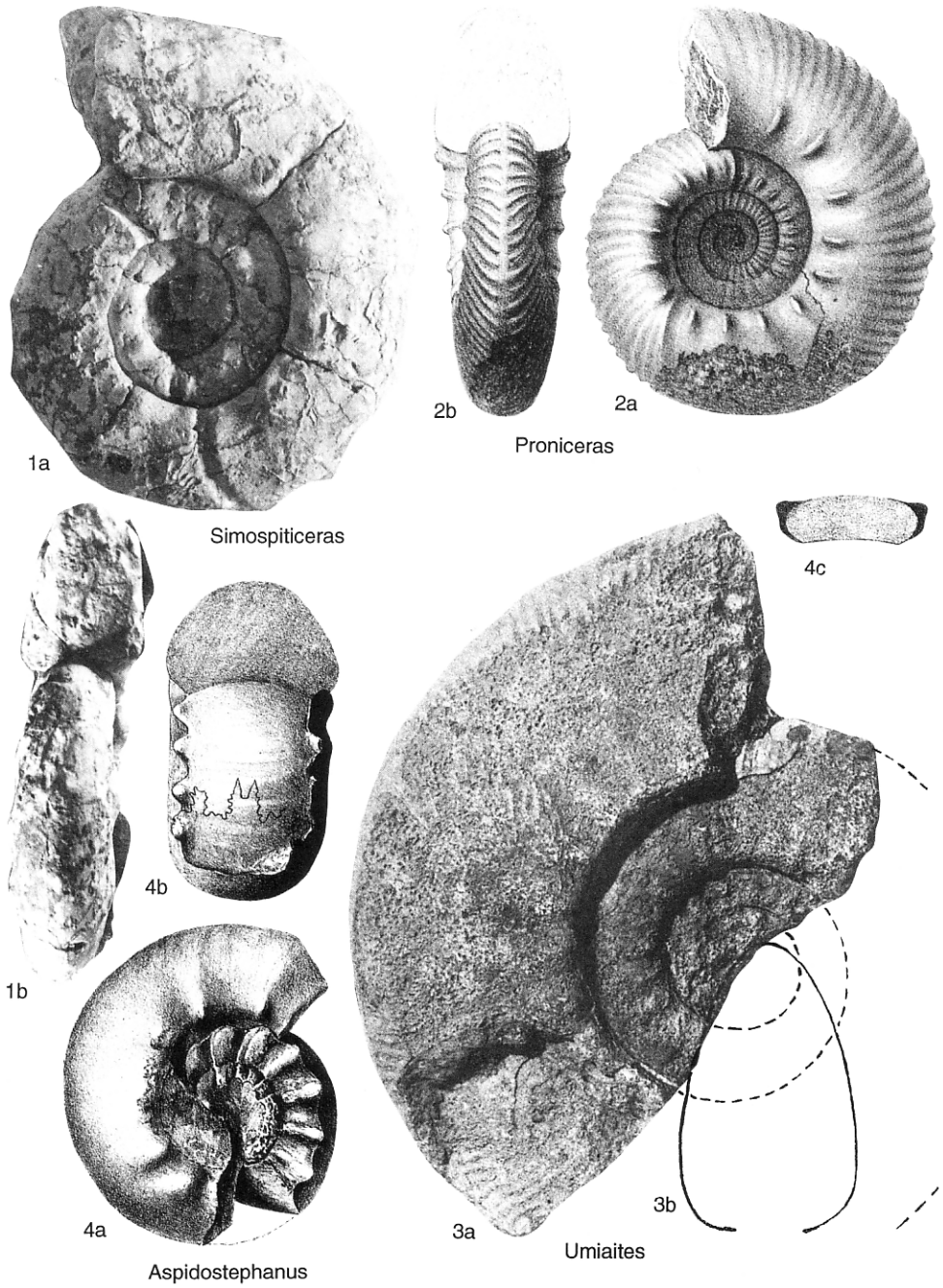


FIG. 30. Olcostephanidae (p. 43)

shoulder at spine or bulla into sheaf of secondary ribs that cross venter without interruption; strong constrictions normally present at some stage of growth. Typical forms include large macroconchs with simple apertures and smaller, lappeted microconchs. Subfamily also includes succession of dwarf genera with specialized ribbing and tuberculation on outer whorls, derived from different species of *Olcostephanus* or other genera. *Upper Jurassic*

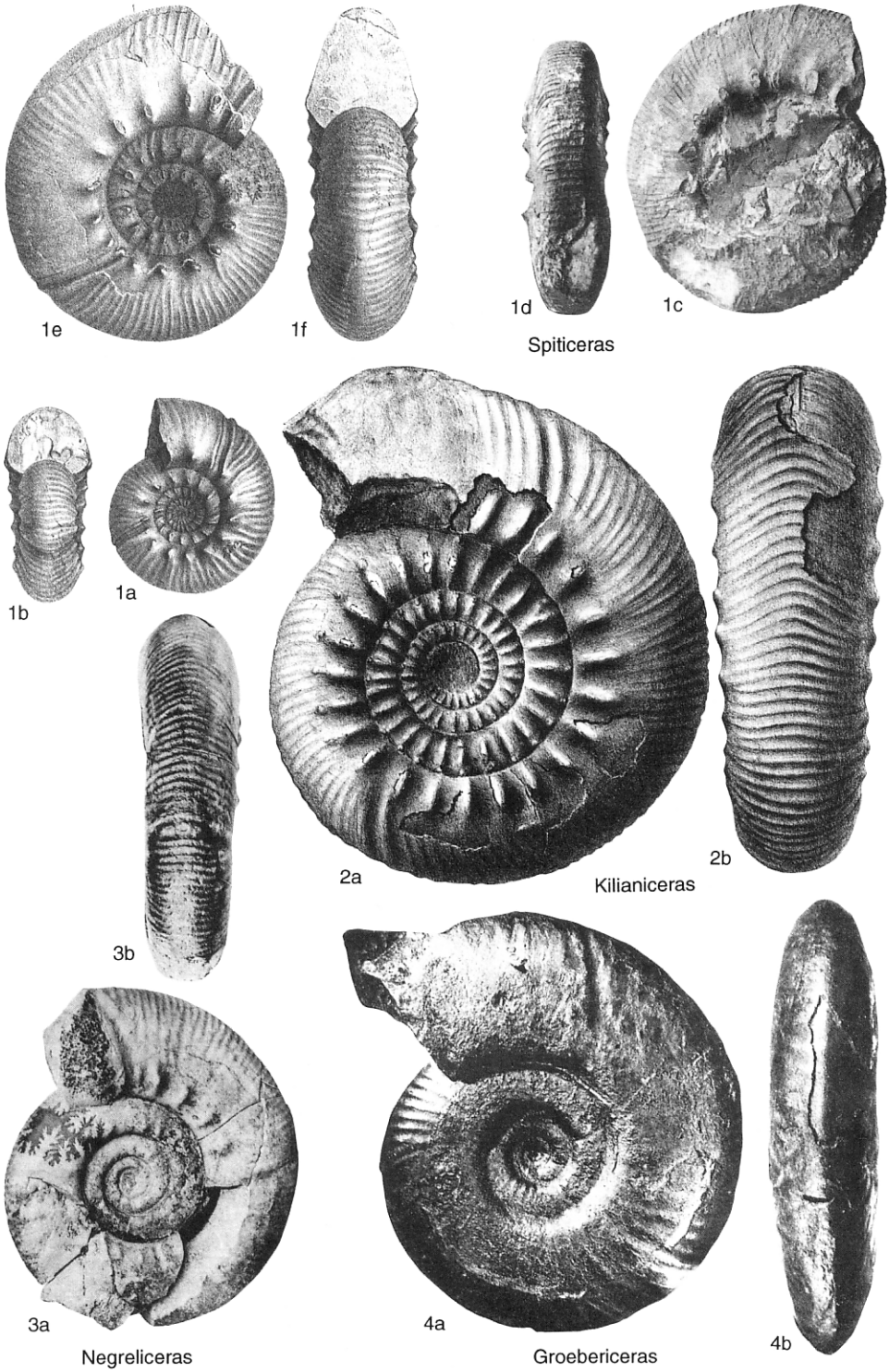


FIG. 31. Olcostephanidae (p. 43)

(?Tithonian)–Lower Cretaceous (Lower Valanginian–Lower Hauterivian).

Olcostephanus NEUMAYR, 1875b, p. 922, ICZN Opinion 575 [**Ammonites astierianus* ORBIGNY, 1840, p. 115; OD] [=*Holcostephanus* SAYN, 1889, p. 679, illegit. emend., ICZN Rejected Name no. 1301; *Astieria* PAVLOW, 1892, p. 471, obj. (type, *Ammonites astierianus* ORBIGNY, 1840, p. 115; SD WRIGHT, herein)]. Rather evolute to rather involute, compressed to globose or cadicone, with well-rounded venter; short primary ribs on umbilical wall, with or without umbilical bullae or spines, giving rise to 2 or more straight or slightly curved, radial, rursi- or prorsiradiate secondary ribs; additional secondary ribs may be intercalated; secondary ribs may, rarely, branch but are never virgatotome; marked constrictions with collared ribs, oblique to other ribs, present in early stages of macroconchs or throughout. Macroconchs with simple, collared apertures; microconchs with short to long, spatulate lappets. *Lower Cretaceous (Lower Valanginian–Lower Hauterivian):* Europe, southern Africa, eastern Africa, Madagascar, Pakistan, Mexico, Colombia, Peru.

O. (Olcostephanus) [=*Subastieria* SPATH, 1923d, p. 32 (type, *Olcostephanus (Astieria) sulcosus* PAVLOW, 1892, p. 499; OD); *Rogersites* SPATH, 1924a, p. 75; (type, *Holcostephanus modderensis* KITCHIN, 1908, p. 202; OD; =*H. rogersi* KITCHIN, 1908, p. 201); *Taraisites* A. CANTU-CHAPA, 1966, p. 16 (type, *T. boesi;* OD); *Satoites* A. CANTU-CHAPA, 1966, p. 16, *nom. nud.* (type, *S. oshimense, nom. nud.;* OD); *Lemurostephanus* THIEULOY, 1977a, p. 432 (type, *O. madagascariensis* LEMOINE, 1906, p. 182; OD); *Jeanthieuloyites* COOPER, 1981, p. 260 (type, *Rogersites quinquestriatus* BESAIRIE, 1936, p. 142; OD)]. Ribbing sharp and dense to coarse and distant; umbilical tubercles present. Occurrence and distribution as for genus.——FIG. 32*a,b.* **O. (O.) astierianus* (ORBIGNY), Upper Valanginian, France; lectotype, macroconch, ×0.75 (Cooper, 1981).——FIG. 32*c,d. O. (O.) atherstoni* (SHARPE), Upper Valanginian, Germany; microconch, ×0.75 (Neumayr & Uhlig, 1881).——FIG. 32*e,f. O. (O.) sulcosus* PAVLOW, Lower Hauterivian, England; holotype, ×1 (Pavlow, 1892).——FIG. 32*g,h. O. (O.) rogersi* (KITCHIN), Upper Valanginian, southern Africa; holotype, macroconch, ×0.5 (Kitchin, 1908). ——FIG. 32*i. O. (O.) madagascariensis* LEMOINE, Upper Valanginian, Madagascar; holotype, ×0.75 (Collignon, 1962a).

O. (Mexicanoceras) IMLAY, 1938, p. 562 [**M. kanei;* OD] [=*Maderia* IMLAY, 1938, p. 557 (type, *M. coronata;* OD)]. Tending to have smooth siphonal band, typically forming distinct groove, but significance uncertain as probably all figured specimens are nuclei. [*Maderia* comprises coronate forms with less distinct smooth band.] *Lower Cretaceous (Lower Hauterivian):* Mexico.——FIG. 33,*1a–c.* **O. (M.) kanei;* ×1 (Imlay, 1938).

O. (Jeannoticeras) THIEULOY, 1965, p. 212 [**Ammonites jeannotii* ORBIGNY, 1841, p. 188; OD]. Compressed; pairs of secondary ribs branching from barely bullate primary ribs and separated by single intercalatory. *Lower Cretaceous (Upper Valanginian–Lower Hauterivian):* Europe, Tanzania, Oregon, Mexico.——FIG. 33,*2a–d.* **O. (J.) jeannotii* (ORBIGNY), Lower Hauterivian, France; *a,b,* ×1 (Orbigny, 1840); *c,* macroconch and *d,* microconch, ×1 (courtesy of L. Bulot).

Baronnites BULOT, COMPANY, & THIEULOY, 1990, p. 403 [**Saynoceras hirsutum* FALLOT & TERMIER, 1923, p. 41; OD]. Dwarf; inner whorls as in *Olcostephanus;* ribs gradually fading on venter and strong umbilical and ventral tubercles appearing. *Lower Cretaceous (Lower Valanginian):* Spain, France.

Saynoceras MUNIER-CHALMAS in MUNIER-CHALMAS & DE LAPPARENT, 1894, p. 464 [**Ammonites verrucosus* ORBIGNY, 1841, p. 191; OD]. Dwarf, involute; inner whorls inflated, smooth or with weak ribs; outer whorls trapezoidal in section, with variable, sharp lateral and ventrolateral tubercles, opposite or alternate on venter, appearing suddenly by thickening of ribs. Aperture of microconchs with long lappets. Suture with wide, short elements. THIEULOY, 1965. *Lower Cretaceous (Lower Valanginian–Upper Valanginian):* France, Spain, Balearic Islands, Germany, Mexico.——FIG. 34,*4a,b.* **S. verrucosum* (ORBIGNY), France; ×1 (Fallot & Termier, 1923).

Parastieria SPATH, 1923b, p. 144 [**Acantoceras? peltoceroides* PAVLOW, 1892, p. 510; OD]. Dwarf; inner whorls as in *O. (Olcostephanus),* with 2 or 3 secondary ribs arising from slight umbilical bullae; outer whorl high and compressed, with straight or slightly sinuous, distant, high, flat-topped ribs and no tubercles. Aperture of microconchs with long, spatulate lappets. *Lower Cretaceous (Lower Hauterivian):* England.——FIG. 34,*3a,b.* **P. peltoceroides* (PAVLOW); ×1 (Pavlow, 1892).

Capeloites LISSON, 1937, p. 3 [**C. larozai;* OD; =*Ammonites perelegans* MATHERON, 1878, pl. C-21, fig. 3]. Dwarf; outer whorl compressed with narrow, rounded venter, in early whorls umbilical bullae pinched, with coarse and fine ribs branching irregularly; in later whorls umbilical bullae weakening and all ribs fine; aperture of microconch collared with broad, spatulate lappets. *Lower Cretaceous (?Lower Hauterivian):* France, Peru.——FIG. 34,*2a,b.* **C. perelegans* (MATHERON), Peru; ×1 (Thieuloy, 1969).

Ceratotuberculus IMLAY, 1938, p. 568 [**C. casitensis;* OD]. Dwarf; inner whorls as in *Olcostephanus;* outer whorls high, compressed, with prominent umbilical and ventrolateral bullae joined by bundled, looped, or zigzagged ribs; venter more or less grooved. *Lower Cretaceous (Lower Hauterivian):* Mexico.——FIG. 34,*5a,b.* **C. casitensis;* ×1 (Imlay, 1938).——FIG. 34,*5c,d. C. linguituberculatus* IMLAY; ×1 (Imlay, 1938).

Valanginites KILIAN, 1910c, p. 196 [**Ammonites nucleus* F. A. ROEMER, 1841, p. 87 (*non* PHILLIPS, 1829, p. 174; see ICZN Opinion 1610, 1990); SD ROMAN, 1938, p. 386] [=*Rotundites* STOLLEY, 1937,

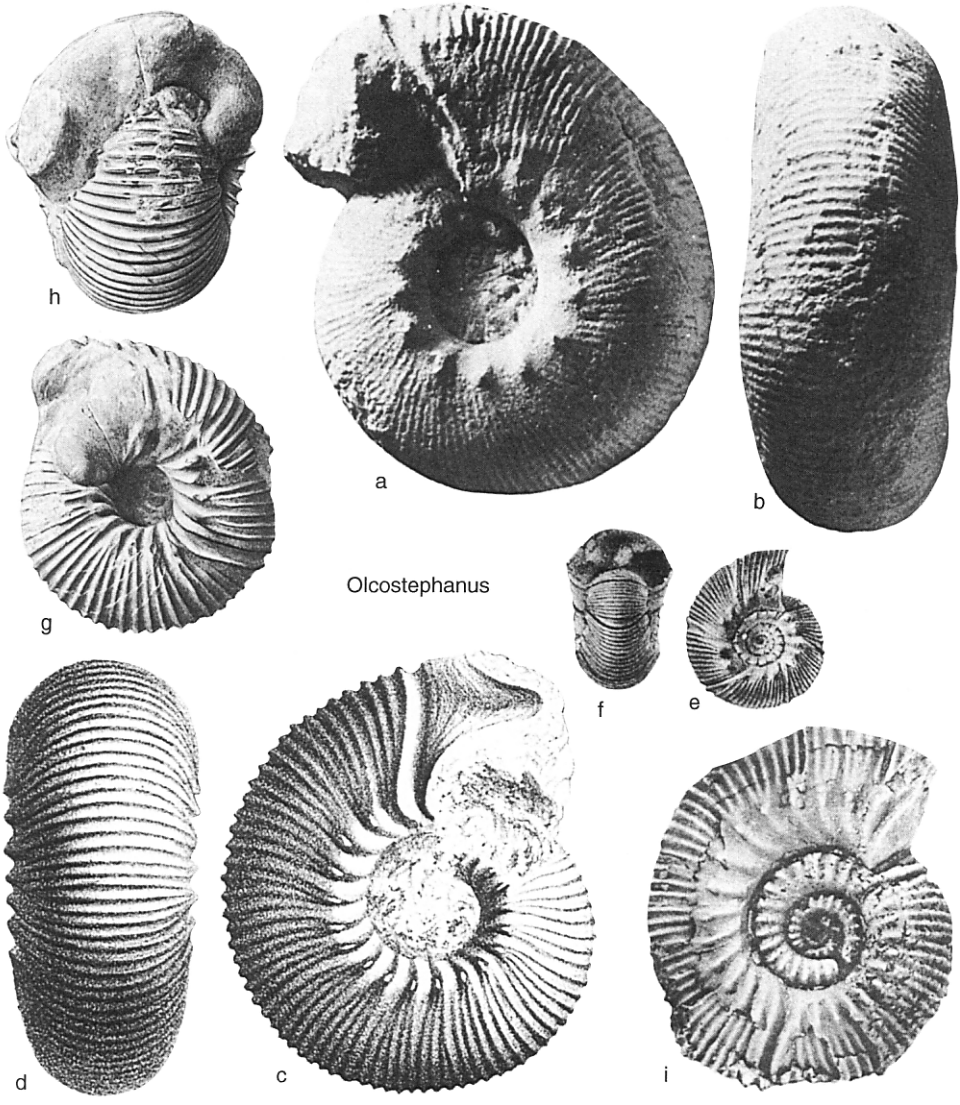
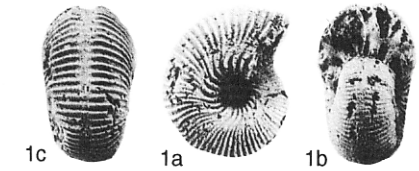


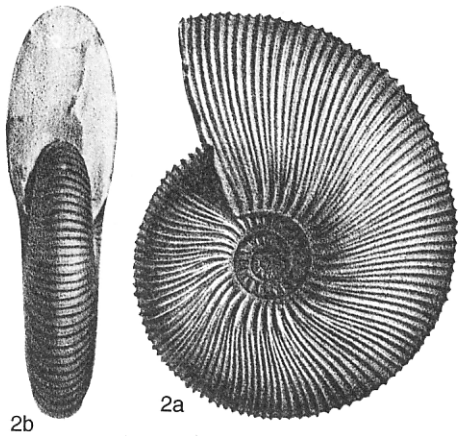
FIG. 32. Olcostephanidae (p. 46)

p. 450, *nom. nud.; Dobrodgeiceras* NIKOLOV, 1963, p. 94, *nom. nov. pro Dobrodgeites* NIKOLOV, 1962, p. 69, *non* KITTL, 1908, p. 522 (type, *Dobrodgeites ventrotuberculatus* NIKOLOV, 1962, p. 70; OD; =*Holcostephanus wilfridi* KARAKASCH, 1902, p. 14)]. Small, very involute sphaerocones with elliptical umbilicus and oblique, constricted, and collared aperture; ornament ranging from very weak, straight, bundled or bidichotomous ribs with or without slight umbilical bullae to coarse, blunt, concave primary ribs branching at midside, with or without a large tubercle, into 3 to 6 strong secondary ribs; variably with (*Dobrodgeiceras*) or without large siphonal tubercles on some ribs on later part of body chamber. THIEULOY & GAZAY, 1967; RICCARDI & WESTERMANN, 1970. *Lower Cretaceous (Lower Valanginian–Upper Valanginian):* France, Germany, Switzerland, Bulgaria, Ukraine (Crimea), Peru, Argentina.——FIG. 34,*1a,b.* **V. nucleus* (ROEMER), Upper Valanginian, Germany; ×1 (Koenen, 1902).——FIG. 34,*1c,d. V. wilfridi* (KARAKASCH), Upper Valanginian, Bulgaria; ×1 (Nikolov, 1962).

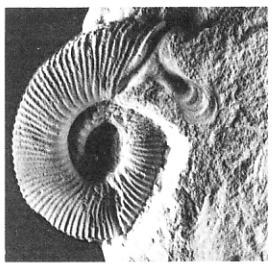
?Provalanginites FATMI, 1972, p. 351 [**P. rhodesi;* OD]. Excentrumbilicate sphaerocones agreeing in all respects with *Valanginites* KILIAN. [But recorded from more than one locality in the lowest of three members of the Chichale Formation of Pakistan. *Provalanginites* is found at least 15 meters below the top, in beds said to be Kimmeridgian to Upper Tithonian, and apparently associated with *Proniceras* and lying below *Himalayites,* and is succeeded, however, by the middle member, most of which is



Mexicanoceras



Jeannoticeras



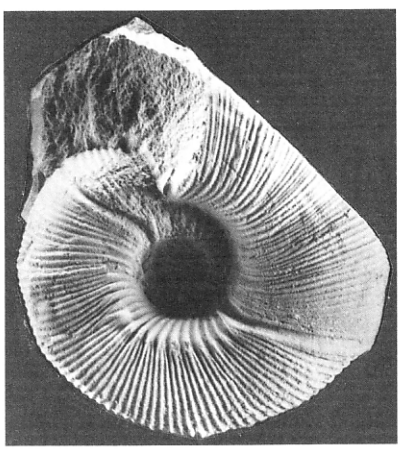


FIG. 33. Olcostephanidae (p. 46)

Upper Valanginian with abundant *Olcostephanus* but not, apparently, *Valanginites*. The genus has not been recorded from the Tithonian anywhere else, and there are no known plausible Tithonian relatives. The stratigraphic position needs reconfirmation]. *Upper Jurassic (?Tithonian):* Pakistan.

Family HOLCODISCIDAE Spath, 1923

[Holcodiscidae SPATH, 1923d, p. 35] [=Astieridiscidae TZANKOV & BRESKOVSKI, 1982, p. 492; Metahoplitidae TZANKOV & BRESKOVSKI, 1982, p. 492]

Moderately involute with rounded, rectangular, or depressed whorl section; straight or sinuous, fine, dense ribs typically continuing over venter and may be periodically truncated by oblique, enlarged ribs, with or without umbilical, lateral, and ventrolateral tubercles. Suture rather simple. *Lower Cretaceous (?Middle Hauterivian, Barremian).*

Probably derived from Olcostephaninae from which distinction is doubtful; separation into subfamilies, on the lines of the families of TZANKOV & BRESKOVSKI (1982), may be found to be useful.

?Holcoptychites GERTH, 1921, p. 143 [**Polyptychites neuquensis* R. DOUVILLÉ, 1910, p. 10; SD WRIGHT, 1957b, p. 371]. Whorl section with convergent, convex sides; constrictions rather numerous and straight, bordered by prominent, rounded ribs; primary ribs single or branching from umbilical bullae; most ribs branching again at midflank; ribs may disappear on outer whorls. H. A. LEANZA & WIEDMANN, 1980. *Lower Cretaceous (Middle Hauterivian):* Argentina.——FIG. 35,*2a,b.* **H. neuquensis* (DOUVILLÉ), ×0.7 (R. Douvillé, 1910).

Astieridiscus KILIAN, 1910c, p. 265 [**Holcodiscus morleti* KILIAN, 1889a, p. 676; SD ROMAN, 1938, p. 389]. Sides slightly flattened; venter rounded; with dense, sharp, slightly flexuous, simple or branching ribs but no umbilical or other tubercles except on innermost whorls. Superficially resembles *Olcostephanus. Lower Cretaceous (Barremian):* France, Spain, Balearic Islands.——FIG. 35,*3a,b.* **A. morleti* (KILIAN), France; ×1 (Kilian, 1889a).

Holcodiscus UHLIG, 1882a, p. 86, 93 [**Ammonites caillaudianus* ORBIGNY, 1850a, p. 99; OD]. Circular to rectangular whorl section; fine, low, straight or flexuous, simple or branched ribs, periodically truncated by thin, high, enlarged ribs bearing lateral and ventrolateral tubercles; inner whorls tending to have depressed whorl section and to resemble *Olcostephanus. Lower Cretaceous (Barremian):* central and southern Europe, California, Mexico.——FIG. 35,*4a,b.* **H. caillaudianus* (ORBIGNY), France; ×1 (Kilian, 1889a).

Almohadites WIEDMANN, 1966b, p. 66 [**A. subcamelinus;* OD]. Similar to *Holcodiscus* but with simplifying suture and ventral furrow between rib

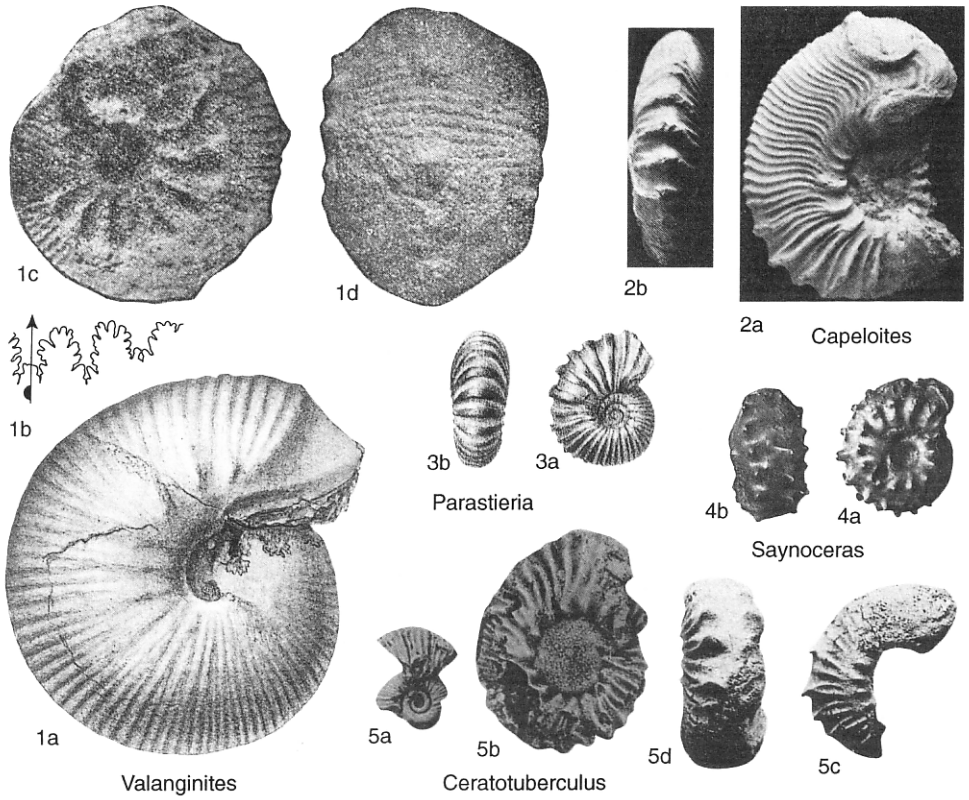


FIG. 34. Olcostephanidae (p. 46–47)

endings. *Lower Cretaceous (Lower Barremian):* central and southern Europe.——FIG. 35,*5a–c. *A. subcamelinus,* Spain; *a,b,* ×2; *c,* enlarged (Wiedmann, 1966b).

Parasaynoceras BREISTROFFER, 1947b, p. 92(76) [**Ammonites horridus* ORBIGNY, 1850a, p. 100; OD] [=?*Neoastieria* OBATA & MATSUKAWA, 1984, p. 172 (type, *Astieria cadoceroides* KARAKASCH, 1907, p. 127; OD)]. Depressed offshoot of *Holcodiscus* with very large lateral and ventrolateral spines, each covering several fine, sharp ribs. [*Neoastieria* is probably transitional from *Holcodiscus.*] *Lower Cretaceous (Barremian):* France, ?Japan, Mexico, Colombia. ——FIG. 35,*6a,b. *P. horridum* (ORBIGNY); *a,* France; ×1 (Cottreau, 1937); *b,* Colombia, ×1 (Etayo-Serna, 1968).

Metahoplites SPATH, 1924a, p. 84 [**Ammonites henoni* COQUAND, 1880, p. 369; M]. Involute (evolute forms are probably distinct generically), compressed, rather high-whorled, with venter flattened sooner or later; dense, fine ribs branching near umbilicus. *Lower Cretaceous (Barremian):* France, Balearic Islands, northern Africa.

M. (**Metahoplites**). Venter flat from early stage; at first with ribs uniting in twos and threes at small ventrolateral clavi; later whorls with no clavi and ribs crossing venter transversely; no constrictions on later whorls. Occurrence and distribution as for genus.——FIG. 35,*7a–d. *M. (M.) henoni* (COQUAND), Tunisia; ×1 (Sayn, 1891).

M. (**Medjeziceras**) BUSNARDO & DAVID, 1957, p. 110 [**Spitidiscus (Medjeziceras) collignoni;* OD]. Retaining rounded venter later than *M. (Metahoplites);* later whorls with concave venter having smooth, sharp edges; constrictions throughout. *Lower Cretaceous (Lower Barremian):* Algeria.——FIG. 35,*1a–c. *M. (M.) collignoni* (BUSNARDO & DAVID); ×2 (Busnardo & David, 1957).

?Gymnoplites SPATH, 1933a, p. 828 [**G. simplex;* OD]. Poorly known. Outer whorl smooth. Possibly related to *Astieridiscus. Lower Cretaceous (?Barremian):* western India.

Family NEOCOMITIDAE Salfeld, 1921

[*nom. transl.* SPATH, 1923d, p. 31, *ex* Neocomitinae SALFELD, 1921, p. 347] [=Palaeohoplitidae ROMAN, 1938, p. 319, *nom. nud.* because not named after an included genus]

A very varied family characterized by tendency to become compressed and flat-sided with tabulate or grooved venter. Primitive forms differing little from many earlier

Perisphinctaceae, but different genera developing umbilical, lateral, or ventrolateral tubercles in various combinations. Initially ribs simple at umbilical margin and bifurcating on outer part of sides (Berriasellinae), but in Neocomitinae ribs branching both at umbilical margin and again on outer part of sides. Slight changes in the suture at the umbilical seam mark a third subfamily (Endemoceratinae), which may well not be monophyletic. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Upper Hauterivian, ?Lower Barremian).*

Subfamily BERRIASELLINAE Spath, 1922

[*nom. transl.* Roman, 1938, p. 324, *ex* Berriasellidae Spath, 1922a, p. 111]

The primitive subfamily, more or less compressed, with ribs single at umbilical margin, branching halfway or more up sides; venter tabulate or grooved at least at some stage of growth; with no tubercles or with some combination of umbilical, midlateral, and ventrolateral tubercles. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Upper Berriasian, ?Lower Valanginian).*

Berriasella Uhlig, 1905, p. 601 [**Ammonites privasensis* Pictet, 1867, p. 84; SD Roman, 1938, p. 324] [=*Stenoceras* Uhlig, 1911, p. 354, *non* Orbigny, 1849, p. 287 (type, *Hoplites storrsi* Stanton, 1895, p. 79; M); *Parodontoceras* Spath, 1923c, p. 305 (type, *Hoplites callistoides* Behrendsen, 1891, p. 402; OD); *Picteticeras* Le Hégarat, 1973, p. 67, *nom. nud.* because no type species designated; *Hegaratella* Nikolov & Sapunov, 1977, p. 102 (type, *Berriasella paramacilenta* Mazenot, 1939, p. 127; OD)]. More or less compressed but generally with convex sides; ribbing distinct and sharp, biplicate or simple, not modifying until close to aperture; venter with narrow, smooth band or groove at least on early whorls. Grigorieva, 1938; Le Hégarat, 1973; Mazenot, 1939; Nikolov, 1966a; Uhlig, 1903–1910. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Berriasian):* southern and central Europe, northern Africa, Madagascar, Turkey, Ukraine (Crimea), Iran, Himalayas, New Caledonia, New Zealand, California, Mexico, Cuba, Argentina.

B. (Berriasella). No tubercles. Occurrence and distribution as for genus.——Fig. 36,*1a,b.* **B. (B.) privasensis* (Pictet), Upper Tithonian, France; lectotype, ×0.75 (Mazenot, 1939).——Fig. 36,*1c,d.* *B. (B.) callistoides* (Behrendsen), Upper Tithonian, Argentina; holotype, ×0.7 (Mazenot, 1939).

B. (Elenaella) Nikolov, 1966, p. 640 [**B. cularensis* Mazenot, 1939, p. 75; OD] [=?*Delphinella* Le Hégarat, 1971, p. 852 (type, *Hoplites delphinensis* Kilian, 1889c, p. 662; OD)]. Inner whorls as in *B. (Berriasella)* but slightly more evolute; outer whorls, at least of macroconchs, with umbilical tubercles developing and ribs disappearing. Occurrence as for genus: France.——Fig. 36,*2a,b.* **B. (E.) cularensis,* Upper Tithonian, France; holotype, ×1 (Mazenot, 1939).

Substeueroceras Spath, 1923c, p. 305 [**Odontoceras koeneni* Steuer, 1897, p. 171(45); OD]. Ribbing fine and dense, with secondaries branching at midside, transverse and not interrupted on tabulate venter. *Upper Jurassic (Upper Tithonian):* ?Somalia, Iraq, Iran, California, Mexico, Peru, Argentina.——Fig. 36,*4a–c.* **S. koeneni* (Steuer), Argentina; ×0.4 (Steuer, 1897).

Andiceras Krantz, 1928, p. 37 [**A. trigonostomum;* SD Arkell in Arkell, Kummel, & Wright, 1957, p. 352]. Very evolute, with wiry, simple, and widely biplicate ribs, not projected; venter narrow, deeply grooved. *Upper Jurassic (Upper Tithonian):* Paraguay.——Fig. 36,*5a,b.* **A. trigonostomum;* ×0.7 (Krantz, 1928).

Parandiceras Spath, 1939a, p. 76 [**P. rota;* OD]. Very evolute, compressed; ribs fine, simple or bifurcating at midside, ending in small ventrolateral tubercles bordering narrow venter with narrow groove; with shallow constrictions. *Lower Cretaceous (Berriasian or Lower Valanginian):* Pakistan, Argentina.——Fig. 36,*3a,b.* **P. rota,* Pakistan; ×0.5 (Spath, 1939a).

Riasanites Spath, 1923c, p. 306 [**Ammonites rjasanensis* Lahusen, 1883, p. 69; OD] [=*Tauricoceras* Kvantaliani & Lysenko, 1979, p. 629 (type, *T. crassicostatum;* OD]. Compressed; ribs strong, coarsely biplicate; venter with smooth band or grooved. *Lower Cretaceous (Lower Ryazanian, Berriasian):* Russia, Ukraine (Crimea), ?Turkey, ?Mexico, ?Argentina.——Fig. 37,*3a,b.* **R. rjasanensis* (Lahusen), Lower Ryazanian, Russia; ×0.7 (Nikitin, 1888).

Blanfordiceras Cossmann, 1907, p. 64, *nom. nov. pro Blanfordia* Uhlig, 1905, p. 602, *non* Adams, 1863, p. 424 [**Ammonites wallichi* Gray, 1832, pl. 100, fig. 3] [=*Blanfordiceras* Spath, 1923e, p. 16, obj. syn. and hom.; *Pseudoblanfordia* Spath, 1925b, p. 145 (type, *Hoplites australis* Burckhardt, 1903, p. 64; OD)]. Like *Berriasella* but inflation greater, ribs more projected on shoulders and minutely tuberculate on either side of stronger and more persistent ventral groove; ribs becoming stronger and more widely spaced on body chamber. *Upper Jurassic (Upper Tithonian):* Pakistan, Himalayas, Indonesia, New Guinea, California, Argentina.——Fig. 38,*1a,b.* **B. wallichi* (Gray), India (Spiti Valley); holotype, BMNH C.5041, ×0.7 (new).

Malbosiceras Grigorieva, 1938, p. 102 [**Ammonites malbosi* Pictet, 1867, p. 77; OD] [=*Pomeliceras* Grigorieva, 1938, p. 103, *non* Hoedemaker, 1981, p. 246 (type, *Ammonites breveti* Pomel, 1889, p. 74; OD); *Mazenoticeras* Nikolov, 1966a, p. 641 (type,

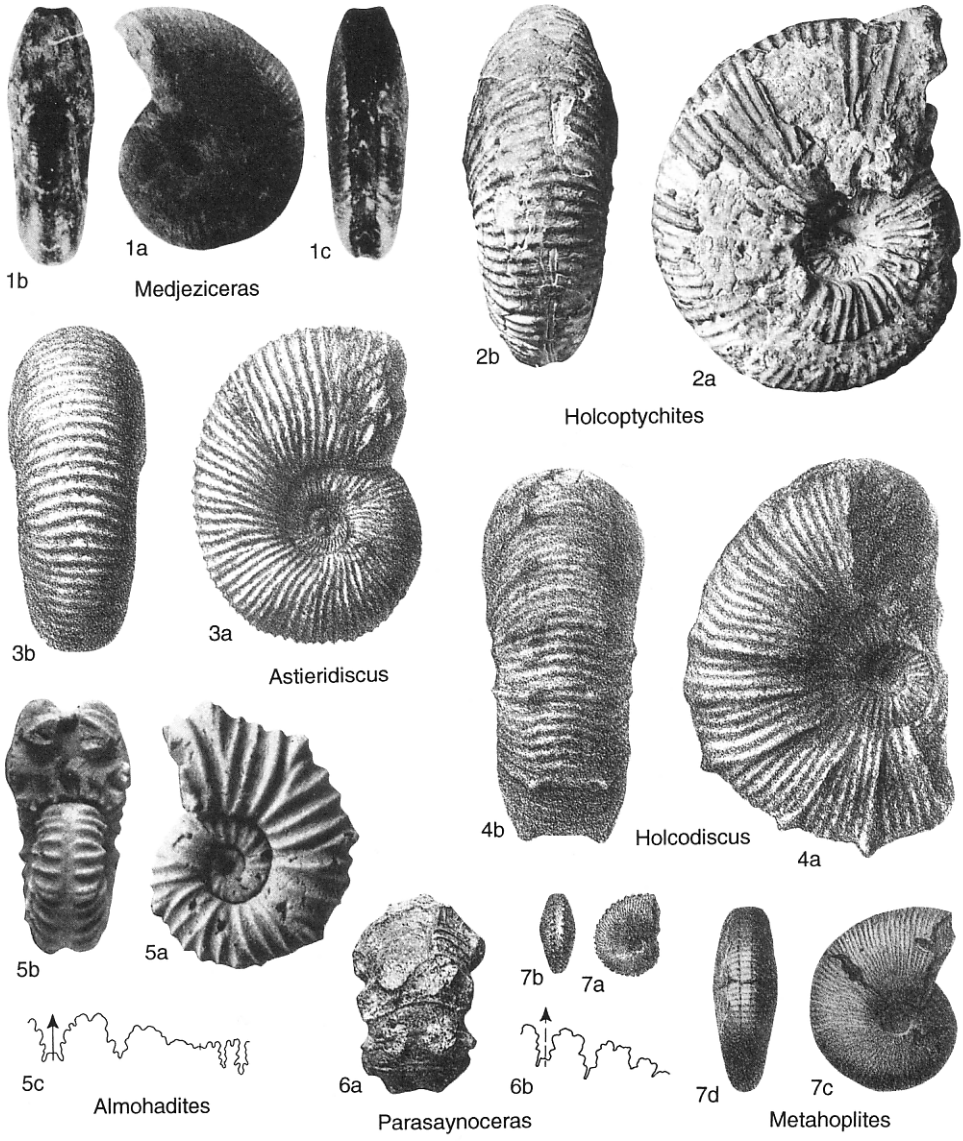


FIG. 35. Holcodiscidae (p. 48–49)

Berriasella broussi MAZENOT, 1939, p. 91; OD); ?*Retowskiceras* NIKOLOV, 1966a, p. 641 (type, *Perisphinctes andrussovi* RETOWSKI, 1893, p. 257(52); OD); *Chapericeras* HOEDEMAKER, 1981, p. 245 (type, *Ammonites chaperi* PICTET, 1868, p. 242; OD)]. Inner whorls much as in *Berriasella* with venter variably rounded, truncated, or feebly grooved; at varying stage in midgrowth midlateral tubercles appear on periodic ribs, with umbilical tubercles appearing later; intercalated ribs without tubercles are confined or not to outer third of side. [Some synonyms may be useful as subgenera, but variation between type species seems to be continuous.] *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Upper Berriasian):* southern Europe, northern Africa, Madagascar.——FIG. 37,*2a–c.* **M. malbosi* (PICTET), Berriasian, France; holotype, ×0.5 (Mazenot, 1939).

Protacanthodiscus SPATH, 1923c, p. 305 [**Hoplites andreae* KILIAN, 1889c, p. 670; OD]. Inner whorls as in *Berriasella,* but lateral tubercles may appear on some ribs; middle and outer whorls with some distant, bituberculate primary ribs irregularly branching at later tubercles, with many intercalatories and

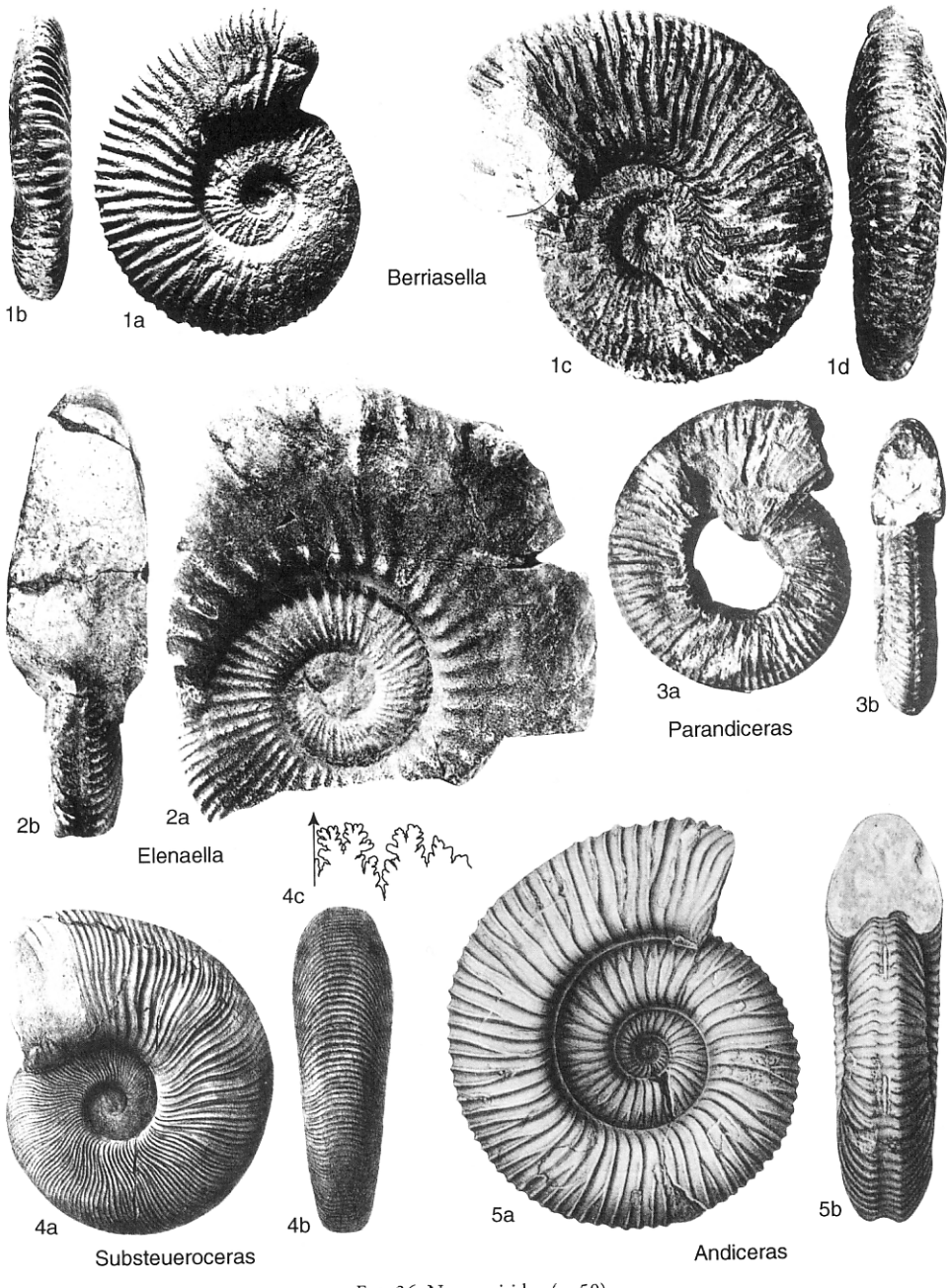


FIG. 36. Neocomitidae (p. 50)

untuberculate primaries; venter with smooth band, in some bordered by incipient small bullae, in others by parabolic nodes. *Upper Jurassic (Upper Tithonian):* southern Europe, northern Africa, Ukraine (Crimea), Pakistan, California, Mexico, Peru, Argentina.——FIG. 37,*1a,b.* **P. andreae* (KILIAN), Spain; holotype, ×0.7 (Mazenot, 1939).

Chigaroceras HOWARTH, 1992, p. 641 [**C. banikense;* OD]. Involute, compressed, with rounded venter; umbilical wall undercut, umbilical edge well defined; primary ribs arising mostly from small umbilical tubercles, rectiradiate or slightly prorsiradiate, branching into 2 or 3 secondaries at midflank, mostly at distinct midlateral tubercles.

Upper Jurassic (Upper Tithonian): Iraq.——FIG. 37,*4a,b.* **C. banikense;* holotype, ×0.75 (Howarth, 1992).

Neocosmoceras BLANCHET, 1922, p. 158 [**Hoplites sayni* SIMIONESCU, 1899, p. 6; SD ROMAN, 1938, p. 332] [=*Octagoniceras* SPATH, 1924a, p. 88 (type, *Ammonites octagonus* BLANFORD in SALTER & BLANFORD, 1865, p. 83; M); *Euthymiceras* GRIGORIEVA, 1938, p. 102 (type, *Ammonites euthymi* PICTET, 1867, p. 76; OD); *Transcaspiites* LUPPOV in

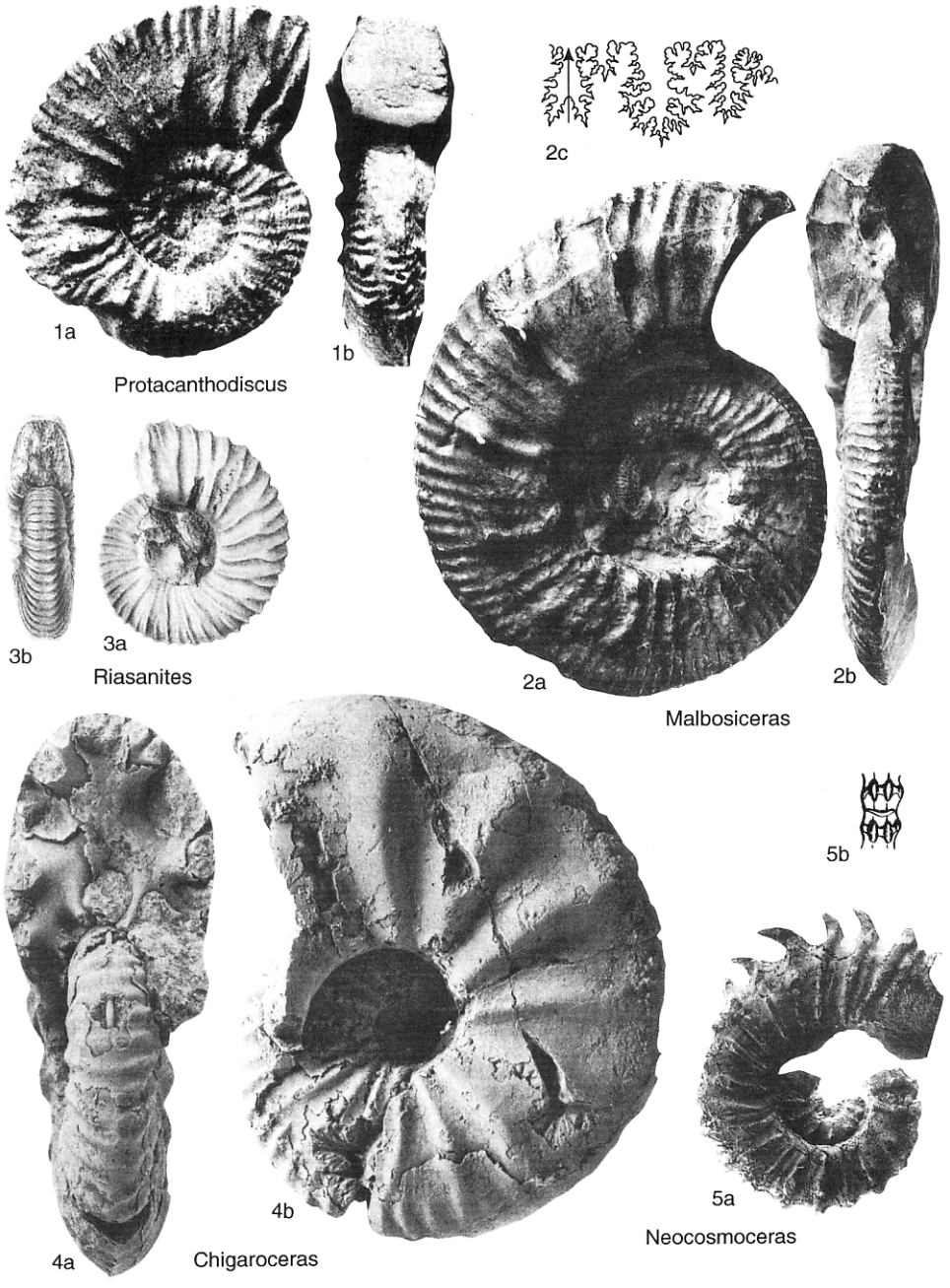


FIG. 37. Neocomitidae (p. 50–54)

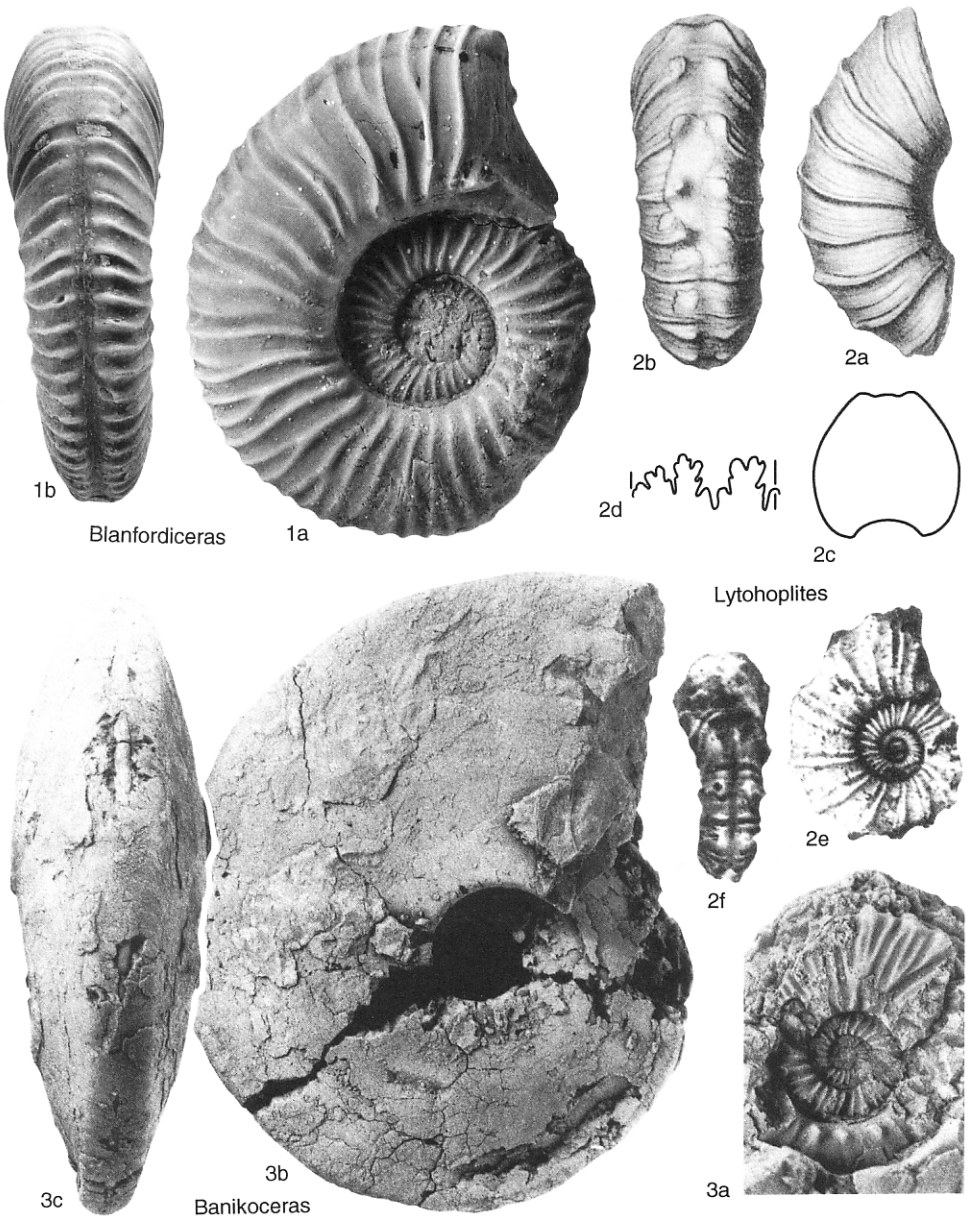


FIG. 38. Neocomitidae (p. 50–55)

BOGDANOVA, LUPPOV, & MIKHAILOVA, 1985, p. 146 (type, *Protacanthodiscus transcaspius* LUPPOV, BODYLEVSKII, & GLAZUNOVA, 1949, p. 222; OD)]. Whorl section polygonal; from early stage very coarse, distant, trituberculate ribs branching obscurely at lateral tubercle; umbilical tubercles bullate, tending to weaken with growth; large ventrolateral tubercles bordering smooth, concave venter, in some produced into large, recurved spines on body chamber. [*Euthymiceras,* distinguished only by bullate rather than clavate ventrolateral tubercles, should be included. Distinction from *Protacanthodiscus* is uncertain.] *Lower Cretaceous (Berriasian):* southern Europe, northern Africa, Madagascar, Ukraine (Crimea), Pakistan, Himalayas, California, Peru, Argentina.——FIG. 37,*5a,b.* **N. sayni* (SIMIONESCU), France; lectotype, ×0.5 (Mazenot, 1939).

Banikoceras HOWARTH, 1992, p. 648 [**B. involutum;*

OD]. Inner whorls much as in *Neocosmoceras;* outer whorls smooth, very involute, high-whorled with converging sides, and with deeply undercut umbilical wall. *Lower Cretaceous (Upper Berriasian):* Iraq.——FIG. 38,*3a–c.* **B. involutum,* holotype; *a,* ×2; *b,c,* ×0.7 (Howarth, 1992).

Lytohoplites SPATH, 1925b, p. 144 [**Hoplites burckhardti* MAYER-EYMAR in BURCKHARDT, 1900, p. 17; OD]. Very evolute; whorl section subquadrate to polygonal; main ribs distant, high, thin, twinned, and simple or obscurely biplicate; intermediate ribs feeble to strong, some looped; main ribs ending in transverse or oblique ventrolateral bullae bordering ventral furrow. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Berriasian):* Algeria, Madagascar, Cuba, Argentina.——FIG. 38,*2a–d.* **L. burckhardti* (MAYER-EYMAR), ?Upper Tithonian, Argentina; ×1 (Burckhardt, 1903).——FIG. 38,*2e,f. L. besairei* COLLIGNON, Upper Tithonian, Madagascar; ×1 (Collignon, 1960).

Subfamily NEOCOMITINAE Salfeld, 1921

[Neocomitinae SALFELD, 1921, p. 347]

Derivatives of, perhaps various, Berriaselinae, normally with flat or grooved venter and angular shoulders, typically with some or all ribs branching at umbilical shoulder. The compressed high-whorled forms with tabular venter are presumably the central stock that gave rise to a succession of branches that were either more evolute with subquadrate or polygonal whorl section and distant, tuberculate ribs or were involute, high-whorled, and smooth. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Lower Hauterivian).*

Pseudargentiniceras SPATH, 1925b, p. 145 [**Ammonites abscissus* OPPEL in ZITTEL, 1868, p. 97; OD]. Evolute, compressed; venter with persistent, smooth band or groove; ribbing fine, dense at first, bifurcating on outer part of side, gradually becoming more distant with varying proportion of ribs branching in pairs at umbilical margin and umbilical tubercles developing. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Berriasian):* southern and central Europe, northern Africa, ?Himalayas.——FIG. 39,*1a,b.* **P. abscissum* (OPPEL), Upper Tithonian, Austria; lectotype, ×1 (Zittel, 1868).

Protothurmannia CRICKMAY, 1932, p. 1 [**P. rezanoffiana;* OD]. Differing from *Pseudoargentiniceras* only in loss of ventral smooth band in maturity and perhaps in having more complex suture. *Upper Jurassic (Upper Tithonian):* California.

Dalmasiceras DJANÉLIDZÉ, 1922a, p. 256 [**Ammonites dalmasi* PICTET, 1867, p. 73; SD ROMAN, 1938, p. 337]. Compressed; early whorls with ribs branching from small but distinct umbilical tubercles, interrupted on venter and tending to form ventrolateral tubercles; later whorls with persistent umbilical tubercles but ribs tending to disappear and venter becoming rounded without groove. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Upper Berriasian):* southern Europe, Tunisia.——FIG. 39,*4a–c.* **D. dalmasi* (PICTET), Upper Tithonian, France; neotype, ×1 (Mazenot, 1939).

Subalpinites MAZENOT, 1939, p. 224 [**S. fauriensis;* OD] [=*Jabronella* NIKOLOV, 1966a, p. 640 (type, *Berriasella jabronensis* MAZENOT, 1939, p. 120; OD); *Erdenella* NIKOLOV, 1979, p. 337 (type, *Hoplites paquieri* SIMIONESCU, 1899, p. 7; OD); *Pomeliceras* HOEDEMAKER, 1981, p. 246, *non* GRIGORIEVA, 1938, p. 103, obj.]. Compressed, with convex flanks and slightly flattened, indistinctly grooved venter; early whorls with ribs mainly branching in twos and threes from umbilical margin and again at midflank; later whorls with strong umbilical and weaker lateral tubercles on main ribs, branching at midflank, with variable intercalatories. *Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Lower Valanginian):* France, Spain, Bulgaria, Madagascar.——FIG. 39,*2a,b.* **S. fauriensis* MAZENOT, Upper Berriasian, France; ×0.8 (Le Hegarat, 1973).

Argentiniceras SPATH, 1924a, p. 89 [**Odontoceras malarguense* STEUER, 1897, p. 181(55); OD] [=*Andesites* GERTH, 1925, p. 74 (type, *Perisphinctes loncochensis* STEUER, 1897, p. 187(61); OD); ?*Boncheviceras* NIKOLOV, 1966a, p. 641 (type, *Berriasella ardescensis* MAZENOT, 1939, p. 136; OD)]. Whorl section subquadrate; coarse ribs not interrupted on venter, branching irregularly, their umbilical ends tending to form incipient tubercles. *Lower Cretaceous (Berriasian):* ?France, Argentina.——FIG. 39,*3a–c.* **A. malarguense* (STEUER), Argentina; ×0.5 (Steuer, 1897).

Frenguelliceras A. F. LEANZA, 1945, p. 4 [**F. magister;* OD]. Very evolute; with coarse, simple or widely splayed ribs branching at umbilical margin; venter with gradually weakening groove bordered by incipiently tuberculate rib endings. *Lower Cretaceous (Lower Berriasian):* Argentina.——FIG. 39,*5a,b.* **F. magister;* ×0.5 (A. F. Leanza, 1945).

Subthurmannia SPATH, 1939a, p. 48 [**S. fermori;* OD] [=*Subthurmanniceras* NIKOLOV, 1960, p. 171, obj. (illegitimate emendation); *Tirnovella* NIKOLOV, 1966a, p. 639 (type, *Berriasella alpillensis* MAZENOT, 1939, p. 73; OD); *Fauriella* NIKOLOV, 1966a, p. 640 (type, *Berriasella gallica* MAZENOT, 1939, p. 140; OD); *Strambergella* NIKOLOV, 1966a, p. 640 (type, *Ammonites carpathicus* ZITTEL, 1868, p. 107; OD); *Pseudoneocomites* HOEDEMAKER, 1982, p. 68 (type, *Hoplites retowskyi* SARASIN & SCHÖNDELMAYER, 1901, p. 72; OD)]. Rather evolute, compressed, with gently convex sides; early whorls with flat venter and with ribs single or in pairs at umbilical margin, the branching point raised in a slight bulla, and with most ribs branching again at outer third of

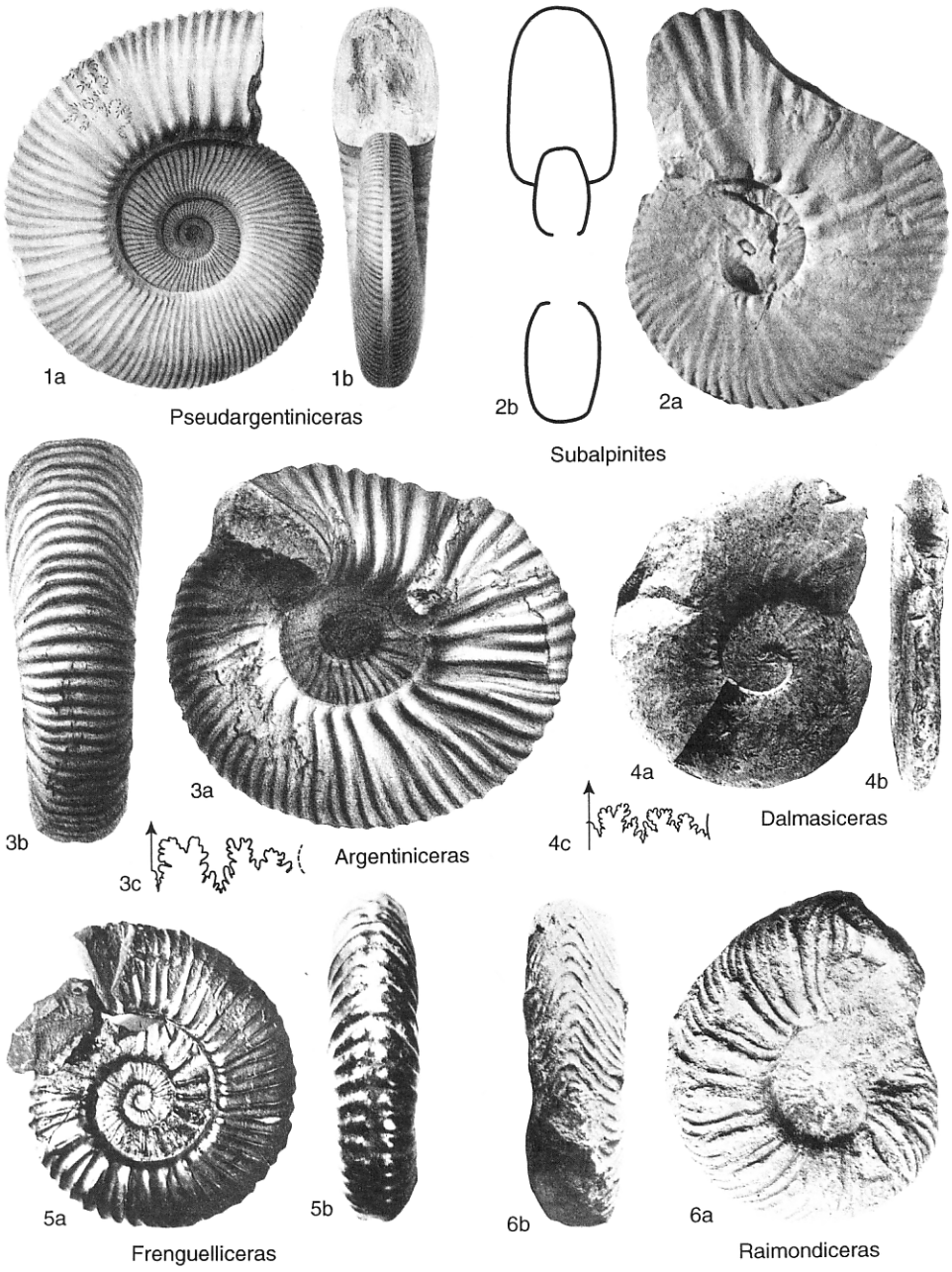


FIG. 39. Neocomitidae (p. 55–58)

side; later whorls with rounded venter, with or without smooth band or shallow groove, in some with primary ribs becoming coarse and distant. [Separation as *Tirnovella* of slightly more involute, higher-whorled species with tendency of ornament to weaken on body chamber seems unnecessary.]

Upper Jurassic (Upper Tithonian)–Lower Cretaceous (Lower Valanginian): southern Europe, Pakistan, Peru.——FIG. 40,*3a,b.* **S. fermori,* ?Berriasian, Pakistan; ×0.3 (Spath, 1939a).——FIG. 40,*3c,d. S. gallica* (MAZENOT), Lower Berriasian, France; ×1 (Mazenot, 1939).

Raimondiceras SPATH, 1924a, p. 87 [**Hoplites raimondii* LISSON, 1907, p. 41; OD] [=*Pfluckeria* LISSON in LISSON & BOIT, 1924, p. 57, obj.]. With every third or fourth rib flared and bituberculate, branching at lateral tubercles; secondaries acutely projected on narrowly rounded venter. Venter is not grooved as stated in SPATH's diagnosis (see *Acantholissonia*). ["*Hoplites* juv. *raimondii* (GABB)" in LISSON, 1907 bears no resemblance to "*Ammonites Remondii*" GABB, 1864, p. 66, and little to "*Ammonites Raimondianus*" GABB, 1877, p. 268, and is here treated as a new species *Hoplites*

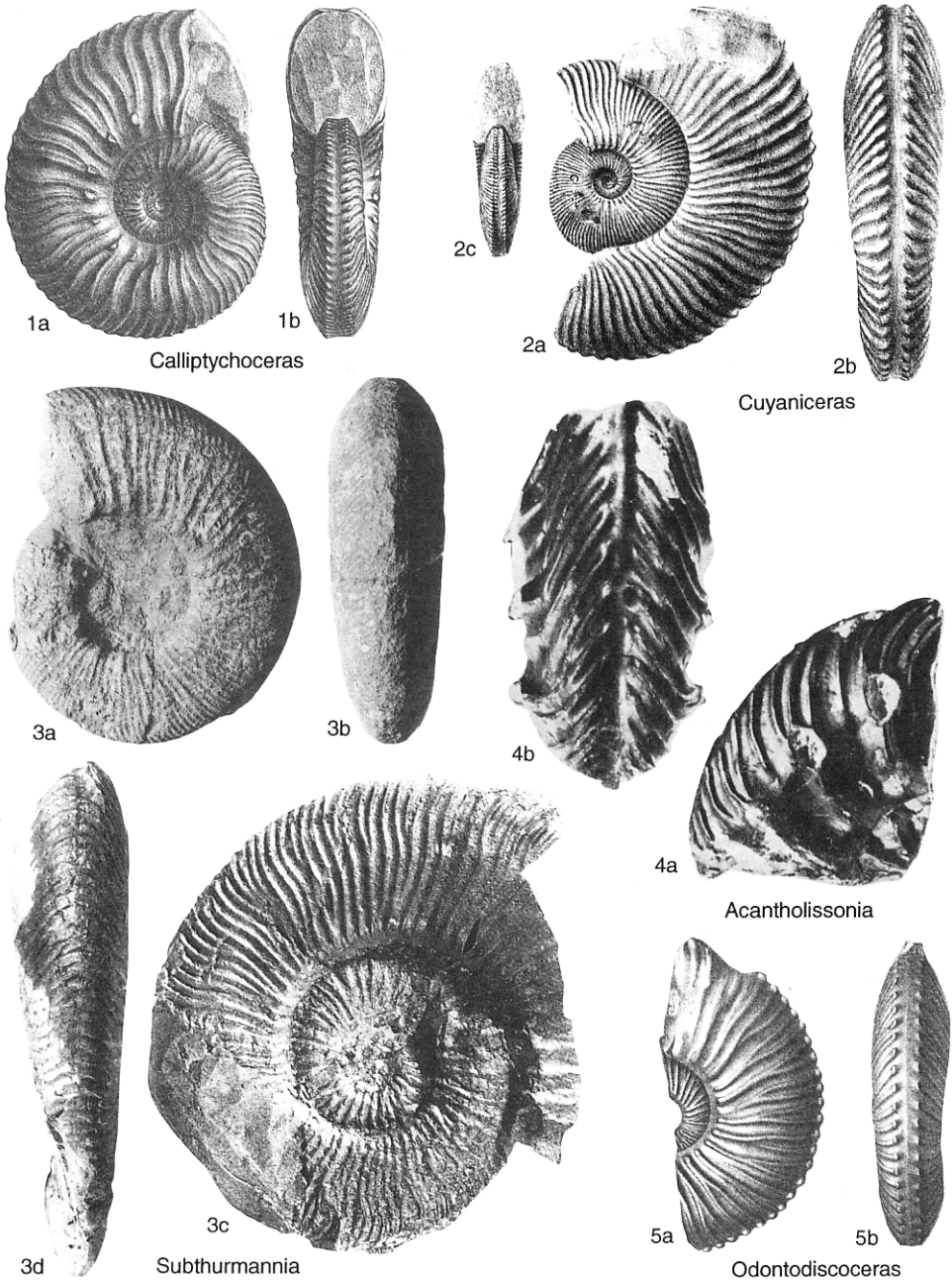


FIG. 40. Neocomitidae (p. 55–58)

raimondii LISSON.] *Upper Jurassic (Upper Tithonian):* ?Pakistan, Peru.——FIG. 39,*6a,b.* **R. raimondii* (LISSON); ×0.5 (Lisson, 1907).

Acantholissonia H. A. LEANZA, 1972, p. 67 [**Spiticeras gerthi* WEAVER, 1931, p. 428; OD]. Like *Raimondiceras* but with stronger tuberculation and persistent, deep ventral groove. *Lower Cretaceous (Lower Valanginian):* Colombia, Argentina.——FIG. 40,*4a,b.* **A. gerthi* (WEAVER), Argentina; ×1 (H. A. Leanza, 1972).

Cuyaniceras A. F. LEANZA, 1945, p. 52 [**Odontoceras transgrediens* STEUER, 1897, p. 186(40); SD ARKELL, 1952, p. 860]. Moderately compressed; inner whorls involute, with fine ribs branching near umbilical margin and most again on outer part of side; outer whorl more evolute with most ribs single and ending in a small, rounded or clavate tubercle; venter distinctly but shallowly grooved. *Lower Cretaceous (Berriasian):* Mexico, Argentina.——FIG. 40,*2a–c.* **C. transgrediens* (STEUER), Argentina; ×0.5 (Steuer, 1897).

Calliptychoceras SPATH, 1924a, p. 88 [**Neocomites calliptychus* UHLIG, 1910a, p. 251; M]. More evolute and inflated than *N. (Neocomites),* with sinuous ribs, fine at first, coarse later, branching from distinct umbilical tubercles, most branching again at midflank, with slight, sharp, oblique ventrolateral bullae bordering smooth venter. *Lower Cretaceous (Berriasian–Valanginian):* Madagascar, India.——FIG. 40,*1a,b.* **C. calliptychum* (UHLIG), Valanginian, India (Spiti Valley); ×0.7 (Uhlig, 1910a).

Odontodiscoceras SPATH, 1924a, p. 88 [**Neocomites odontodiscus* UHLIG, 1910a, p. 250; M]. Rather compressed, with convex sides; ribs mainly single from umbilicus, branching more or less regularly at midflank, ending in small ventrolateral clavi beside smooth venter. *Lower Cretaceous (Berriasian–Valanginian):* Madagascar, India.——FIG. 40,*5a,b.* **O. odontodiscum* (UHLIG), Valanginian, India (Spiti Valley); ×0.5 (Uhlig, 1910a).

Thurmanniceras COSSMANN, 1901, p. 58, *nom. nov. pro Thurmannia* HYATT, 1900, p. 585, *non* HEER, 1852, p. 11 [**Ammonites thurmanni* PICTET & CAMPICHE, 1860, p. 250; OD] [=*Thurmannites* KILIAN & REBOUL, 1914, p. 2, obj.]. Compressed, rather evolute; venter flat on early and rounded on later whorls; ribs arising singly or in twos from slight umbilical bullae; ribs feeble to strong, gently flexuous to falcoid, irregularly branched near midside or simple with intercalatories, with small, transverse ventrolateral bullae, interrupted or not on venter; commonly with strong constrictions; ornament tending to weaken at midflank near aperture. Most described forms are microconchs with long lappets. *Lower Cretaceous (Upper Berriasian–Upper Valanginian):* southern and central Europe, Morocco, Madagascar, Pakistan, Himalayas, Sumatra, California, Mexico, Peru, Argentina.

T. (Thurmanniceras). Body chamber more or less unmodified. Occurrence as for genus.——FIG. 41,*1a–c.* **T. (T.) thurmanni* (PICTET & CAMPICHE), Lower Valanginian, France; ×1 (Sayn, 1907a).

T. (Clavithurmannia) THIEULOY in BUSNARDO, THIEULOY, & MOULLADE, 1979, p. 43 [**T. (C.) foraticostatum;* OD]. Large; middle whorls as in *T. (Thurmanniceras);* last half of outer whorl as in *Neocosmoceras,* with trituberculate major ribs, ventrolateral clavi, and generally one intermediate rib. Questionably a macroconch of some *Thurmanniceras. Lower Cretaceous (Lower Valanginian):* France.——FIG. 41,*2.* **T. (C.) foraticostatum;* ×0.3 (Busnardo, Thieuloy, & Moullade, 1979).

Limaites LISSON in LISSON & BOIT, 1924, p. 57 [**Hoplites leopoldinus* var. *peruanum* LISSON, 1907, p. 45; M]. Involute, very compressed, flat-sided, with narrow, tabulate venter; ribs fine, fasciculate, gradually fading on outer whorl except near venter; some weak midlateral tubercles. *Lower Cretaceous (Berriasian* or *Lower Valanginian):* Peru.——FIG. 41,*4a–e.* **L. peruanus* (LISSON); ×1 (Lisson, 1907).

Kilianella UHLIG, 1905, p. 614 [**Hoplites pexiptychus* UHLIG, 1882b, p. 389; SD ROMAN, 1938, p. 332] [=*Parakilianella* SATO, 1961, p. 537, *nom. nud.* (type, *P. umazawensis;* OD); *Luppovella* NIKOLOV, 1966a, p. 642 (type, *Thurmannia (Killianella) superba* SAYN, 1907a, p. 51; OD)]. Evolute; moderately compressed to moderately inflated; ribs strong, flexuous, simple or branching at midflank or in some at umbilical edge; ribs may be tuberculate at umbilical edge or midflank or ventrolaterally; constrictions generally present to a late stage. There seems to be a complete transition from untuberculate to trituberculate species. [*Parakilianella* is based on a probable microconch.] *Lower Cretaceous (Upper Berriasian–Upper Valanginian, ?Lower Hauterivian):* southern and central Europe, Madagascar, Pakistan, Himalayas, Sumatra, California, Mexico.——FIG. 41,*3a.* **K. pexiptycha* (UHLIG), Lower Valanginian, Austria; ×1 (Uhlig, 1882b).——FIG. 41,*3b,c. K. roubaudiana* (ORBIGNY), Valanginian, France; ×1 (Kilian, 1889a).——FIG. 41,*3d,e. K. superba* SAYN, Upper Valanginian, France; ×0.5 (Sayn, 1907a).

Sarasinella UHLIG, 1905, p. 618 [**Hoplites ambiguus* UHLIG, 1902, p. 45; SD LEMOINE, 1906, p. 180]. Moderately compressed to moderately inflated; inner whorls with some or all ribs bearing strong umbilical and midlateral tubercles at which ribs bifurcate and slight, sharp radial or oblique ventrolateral bullae; on outer whorls umbilical tubercles becoming dominant, with most ribs branching from them; midlateral tubercles dying out, although some second branching of ribs occurs; venter deeply grooved to flat. *Lower Cretaceous (Valanginian):* France, Austria, Ukraine (Crimea), Morocco, Madagascar, India (Spiti Valley), Pakistan (Salt Range), Alexander Land.——FIG. 42,*2a,b.* **S. ambigua* (UHLIG), Austria; ×0.75 (Uhlig, 1902).——FIG. 42,*2c,d. S. varians* UHLIG, Spiti; ×0.5 (Uhlig, 1910a).

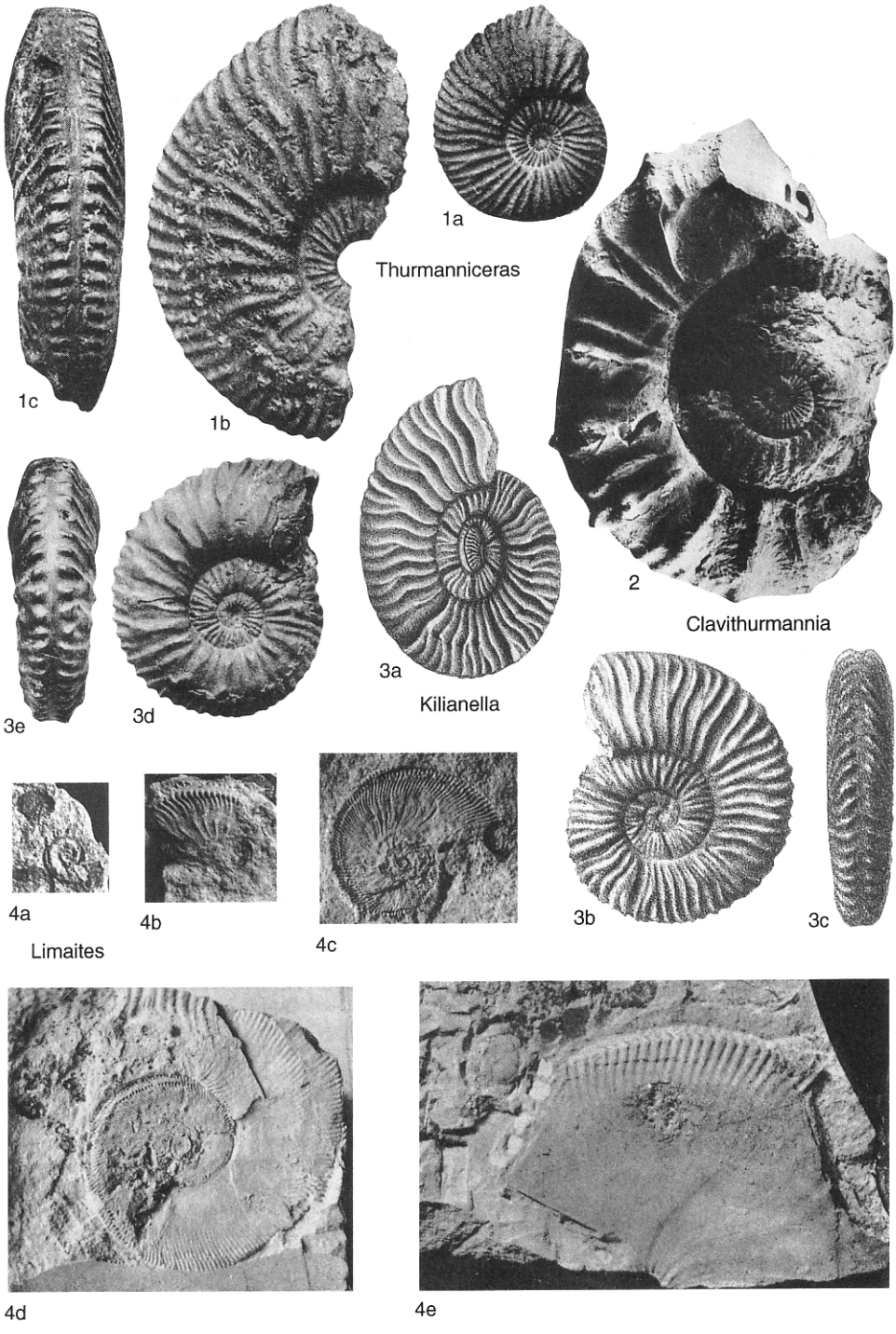


FIG. 41. Neocomitidae (p. 58)

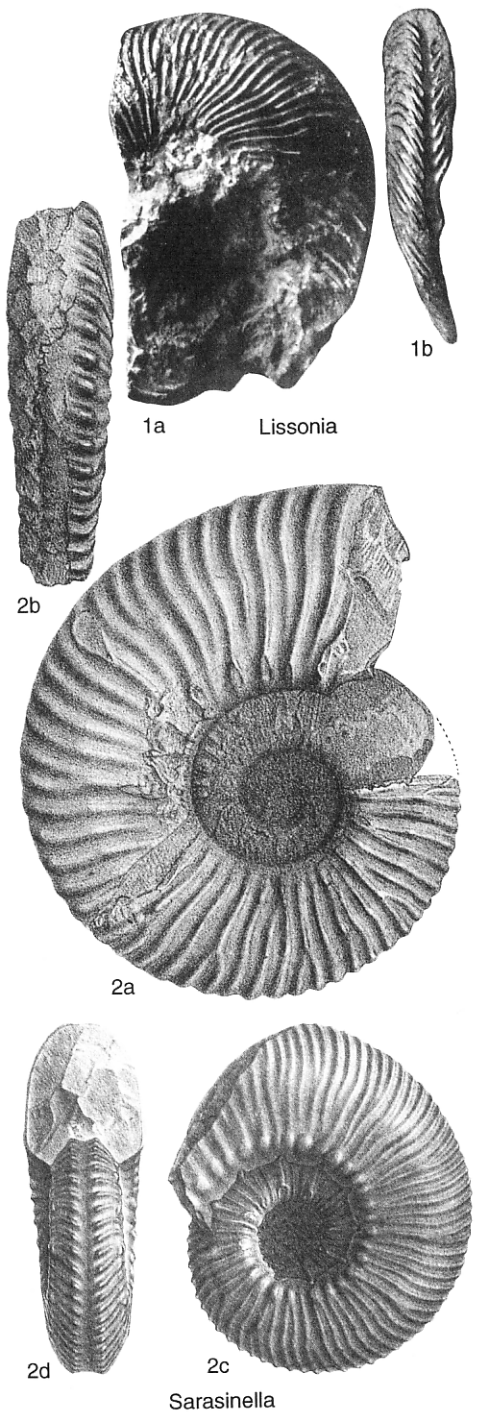


FIG. 42. Neocomitidae (p. 58–61)

Neocomites UHLIG, 1905, p. 620 [**Ammonites neocomiensis* ORBIGNY, 1841, p. 202; SD SAYN, 1906, p. 122]. Rather involute, with flat sides; ribs flexuous, prorsiradiate, branching in small sheaves from slight umbilical tubercles and generally branching irregularly higher up the side or intercalated; all ribs ending in small, slightly oblique bullae on either side of smooth, flat venter; on later whorls ribs may cross venter more or less transversely. Sutures with large, subsymmetrical, trifid L with parallel sides. *Lower Cretaceous (Lower Valanginian–Lower Hauterivian):* southern and central Europe, northern Africa, Israel, Madagascar, Pakistan (Salt Range), Himalayas, Borneo, Sumatra, Texas, Mexico, Peru, Argentina.

N. **(Neocomites)** [=*Busnardoites* NIKOLOV, 1966a, p. 642 (type, *Ammonites desori* PICTET & CAMPICHE, 1860, p. 246; OD)]. Ribbing on body chamber unchanged; venter becoming only slightly rounded. Occurrence and distribution as for genus.——FIG. 43,*1a–c.* **N. (N.) neocomiensis* (ORBIGNY), Lower Valanginian, France; *a,b,* ×1 (Orbigny, 1840–1842); *c,* ×10 (Wiedmann, 1966a).

N. **(Varlheidites)** RAWSON & KEMPER, 1978, p. 166 [**V. peregrinus;* OD]. Microconch and inner whorls of macroconch as in *N. (Neocomites);* outer whorl of macroconch with periodic, enlarged trituberculate ribs. *Lower Cretaceous (lower Upper Valanginian):* Germany.——FIG. 43,*2a–d.* **N. (V.) peregrinus* (RAWSON & KEMPER); *a,b,* holotype, inner whorls of macroconch, ×0.5; *c,d,* outer whorl of macroconch, ×0.5 (Rawson & Kemper, 1978).

N. **(Teschenites)** THIEULOY, 1971, p. 2298 [**Hoplites neocomiensis* var. (*Ammonites neocomiensiformis* HOHENEGGER *in. litt.*) UHLIG, 1902, p. 56; OD]. Body chamber with rounded venter; umbilical tubercles and primary ribs tending to strengthen and ribs to weaken on midflank, ventrolateral tubercles tending to be absent and ribs to cross venter in rounded arc. *Lower Cretaceous (Upper Valanginian–Lower Hauterivian):* France, Germany, Switzerland, Ukraine (Crimea), Israel.——FIG. 43,*3.* **N. (T.) neocomiensiformis* (UHLIG), Upper Valanginian, France; ×0.75 (Thieuloy, 1977b).

N. **(Eristavites)** NIKOLOV, 1966a, p. 641 [**Neocomites platycostatus* SAYN, 1907a, p. 33; OD]. Venter becoming rather broad; ribs irregular, sparse, some thicker and tending to be trituberculate. Occurrence and distribution as for genus.——FIG. 43,*5a,b.* **N. (E.) platycostatus* SAYN, Upper Valanginian, France; ×1 (Sayn, 1907a).

Criosarasinella THIEULOY, 1977b, p. 109 [**C. furcillata;* OD]. Early whorls crioconic, with simple, trituberculate, enlarged ribs and two to five simple minor ones; later whorls in contact and ornamented as in *Neocomites,* with secondary branching of ribs near ventrolateral shoulders. *Lower Cretaceous (Upper Valanginian):* France, Bulgaria.

——FIG. 43,*4*. **C. furcillata*, France; ×0.7 (Thieuloy, 1977b).

Lissonia GERTH, 1925, p. 111 [**Hoplites riveroi* LISSON, 1907, p. 51; OD]. Compressed, involute, with deeply grooved venter; ribs fine, sharp, simple, bifurcating at midflank, strongly projected on rounded ventrolateral shoulder; no tubercles. *Lower Cretaceous (Upper Valanginian):* Peru.——FIG. 42,*1a,b*. **L. riveroi* (LISSON); ×1 (Lisson, 1907).

Subfamily ENDEMOCERATINAE Schindewolf, 1966

[*nom. transl.* WRIGHT, 1981, p. 173, *ex* Endemoceratidae SCHINDEWOLF, 1966, p. 375(551)] [=Leopoldiinae THIEULOY, 1971, p. 2298]

Differing from Neocomitinae only in having suture with lobe U1 not divided into ventral and dorsal elements and in tendency to greater asymmetry of L. Very doubtfully a single phylogenetic entity. *Lower Cretaceous (Upper Valanginian–Upper Hauterivian, ?Lower Barremian).*

Karakaschiceras THIEULOY, 1971, p. 2299 [**Hoplites biassalensis* KARAKASCH, 1889, p. 435; OD]. Moderately to very involute; sides slightly convex, converging to more or less narrow venter, flat except on body chamber; ribs strong at least in young, springing in twos or threes from umbilical bullae and ending in distinct, small ventrolateral bullae, opposite or alternate, with smooth siphonal band. *Lower Cretaceous (?Lower Valanginian, Upper Valanginian):* England, France, Germany, Austria, Poland, Ukraine (Crimea), Argentina.——FIG. 44,*1a,b*. **K. biassalense* (KARAKASCH); *a*, Crimea, ×0.75 (Karakasch, 1907); *b*, England, ×0.75 (Kemper, Rawson, & Thieuloy, 1981).

Neohoploceras SPATH, 1939a, p. 105 [**Ammonites submartini* MALLADA, 1887, p. 17; OD] [=*Arnoldia* STOLLEY, 1937, p. 453, *non* MAYER-EYMAR, 1887, p. 27 (type, *Ammonites arnoldi* PICTET & CAMPICHE, 1860, p. 252; M)]. Inner whorls inflated, with ribs branching irregularly from umbilical and midlateral tubercles, some simple; deep constrictions with collars behind, commonly flared ventrolaterally; venter grooved, concave, or rounded; outer whorls becoming compressed, without constrictions. *Lower Cretaceous (Upper Valanginian):* England, France, Germany, Spain, Madagascar, Pakistan (Salt Range).——FIG. 44,*5a,b*. **N. submartini* (MALLADA), Salt Range; ×0.75 (Spath, 1939a).

Stoicoceras WHITEHOUSE, 1927, p. 109 [**Ammonites (Hoplites) teutobergensis* WEERTH, 1884, p. 20; OD] [=*Dicostella* BUSNARDO, 1966b, p. 236 (type, *D. pitrei;* OD; =*Hoplites (Neocomites) houdardi* var. *tuberculata* ROMAN, 1933, p. 19)]. Large; moderately inflated and evolute to rather compressed and more involute; primary ribs strong, short, straight or flexed, with or without umbilical bullae at which they may branch, and branching at midflank into two strongly curved secondaries, generally with slightly oblique ventrolateral bullae; venter flat, midline smooth. Approximate homeomorph of some *Acanthodiscus. Lower Cretaceous (Upper Valanginian):* France, Germany, Switzerland.——FIG. 45,*5a,b*. **S. teutobergense* (WEERTH), Germany; ×0.25 (Kemper, Rawson, & Thieuloy, 1981).——FIG. 45,*3c*. *S. tuberculatum* (ROMAN), France; ×0.5 (Busnardo, 1966b).

Chamalocia THIEULOY, 1971, p. 2299 [**Leopoldia subaenigmatica* SAYN, 1907a, p. 55; OD]. Involute; whorls high, subrectangular; venter narrow and flat, separated from the sides by oblique bevels; ribs on sides and venter, with pointed ventrolateral tubercles, disappearing early. Suture rather simple, with short and very wide saddles. *Lower Cretaceous (Upper Valanginian):* France.——FIG. 45,*1a–c*. **C. subaenigmatica* (SAYN), *a,b*, ×1; *c*, ×3 (Sayn, 1907).

Lyticoceras HYATT, 1900, p. 586 [**Ammonites cryptoceras* ORBIGNY, 1840, p. 24; OD] [=*Besairieceras* COLLIGNON, 1962a, p. 58 (type, *B. colcanapi;* OD); *Endemoceras* THIERMANN, 1964, p. 369 (type, *Hoplites amblygonius* NEUMAYR & UHLIG, 1881, p. 168; OD); *Eleniceras* BRESKOVSKI, 1967, p. 47 (type, *E. stevrecensis;* OD)]. Rather evolute to rather involute; moderately to very compressed; venter gently rounded to tabulate; ribs more or less dense, sharp, slightly sinuous to falcoid, some branching near umbilical shoulder but most near middle or outer third of whorl side; primary ribs may be raised and sharpened at umbilical edge to form a slightly twisted bulla; all ribs generally bearing slight but distinct ventrolateral, spinate to clavate tubercles and crossing venter in gentle curve or distinct chevron but may be weak or absent on midline on internal molds; outer whorls may develop more or less regular, single or paired and looped, enlarged, trituberculate ribs, with or without associated constrictions. Suture with deeply incised saddles and very asymmetric L. Some forms are adult at diameters of 70 to 80 mm, others at over 300 mm; but boundaries between macroconchs and microconchs are not yet worked out. [Given the wide morphological variation within the northern group separated as *Endemoceras,* it seems unnecessary to separate the type species, *cryptoceras,* on the basis of its early and middle whorls not having ventral chevrons and ventrolateral tubercles being spinate rather than clavate, or *Besairieceras* on the basis of body chambers with large umbilical tubercles projecting into the umbilicus, or *Eleniceras* on the basis of enlarged trituberculate ribs appearing at an earlier stage.] *Lower Cretaceous (Upper Valanginian–Lower Hauterivian):* England, France, Germany, Poland, Czech Republic, Bulgaria, Madagascar.——FIG. 46*a–d*. **L. cryptoceras* (ORBIGNY), Lower Hauterivian, France; *a,b*, lectotype, ×0.5 (Wright, 1975); *c,d*, ×1 (Kemper, Rawson, & Thieuloy, 1981).——FIG. 46*e*. *L. stevrecensis* (BRESKOVSKI), Lower Hauterivian, Bulgaria; ×0.75 (Breskovski, 1967).——FIG. 46*f,g*. *L. colcanapi* (COLLIGNON), Upper Valanginian, Madagascar; *f*, ×0.5; *g*, ×1 (Collignon,

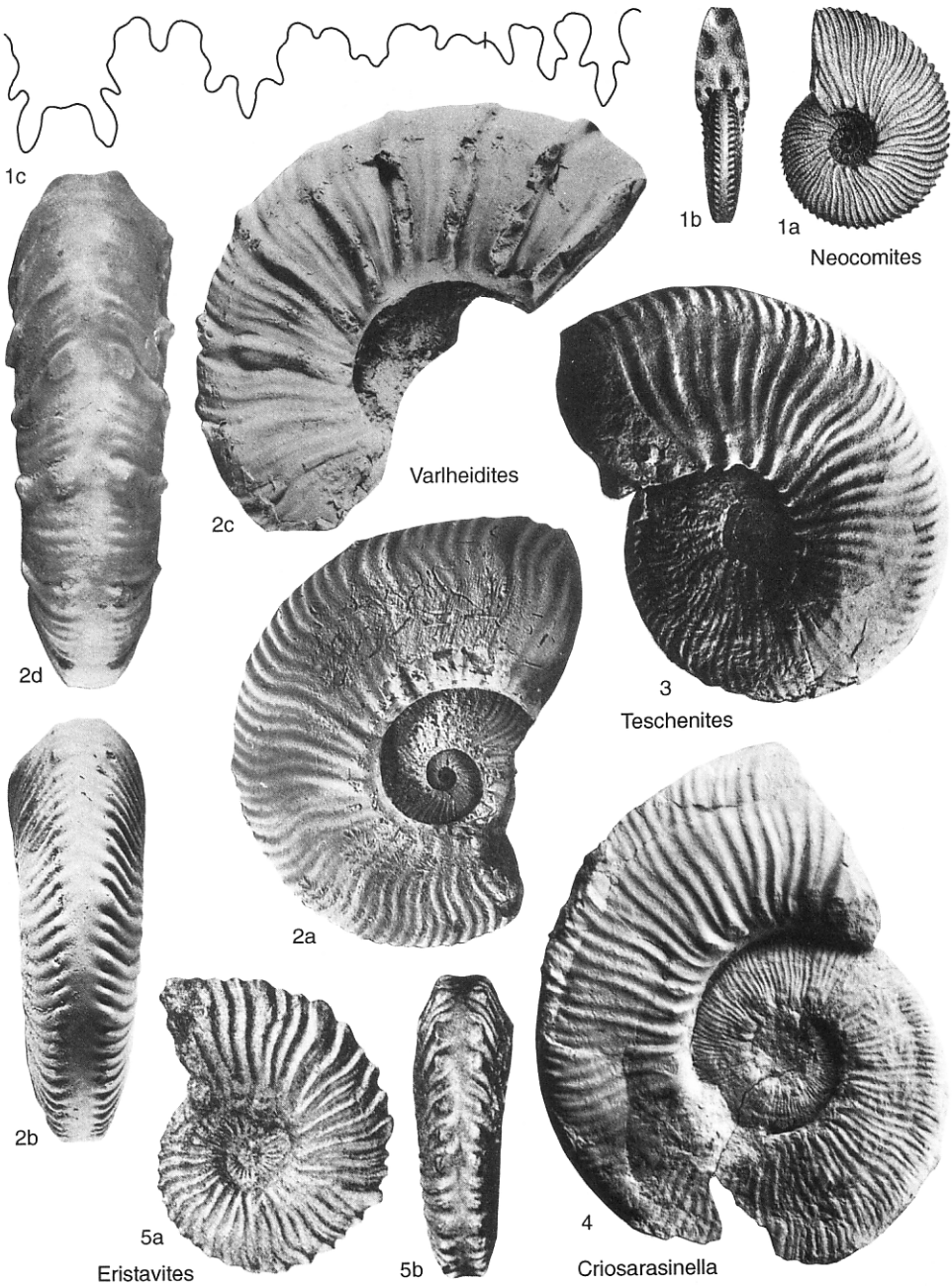


FIG. 43. Neocomitidae (p. 60–61)

1962a).——FIG. 47*a,b. L. amblygonium* (NEUMAYR & UHLIG), Lower Hauterivian, Germany; *a,* lectotype, ×0.5; *b,* ×0.5 (Thiermann, 1963).——FIG. 47*c,d. L. regale* (PAVLOW), Lower Hauterivian, England; lectotype, BMNH C.34948, ×0.75 (new).

Favrella R. DOUVILLÉ, 1909a, p. 164 [**Neocomites americanus* FAVRE, 1908, p. 613; OD] [=*Patagoniceras* WETZEL, 1960, p. 249 (type, *Neocomites steinmanni* FAVRE, 1908, p. 620; OD)]. Very evolute, with dorsum barely impressed; ribs distant, narrow, and high, mostly simple but rarely branching at umbilical tubercles on early whorls, rectiradiate until outer third where they curve sharply forward to form acute ventral chevrons, interrupted

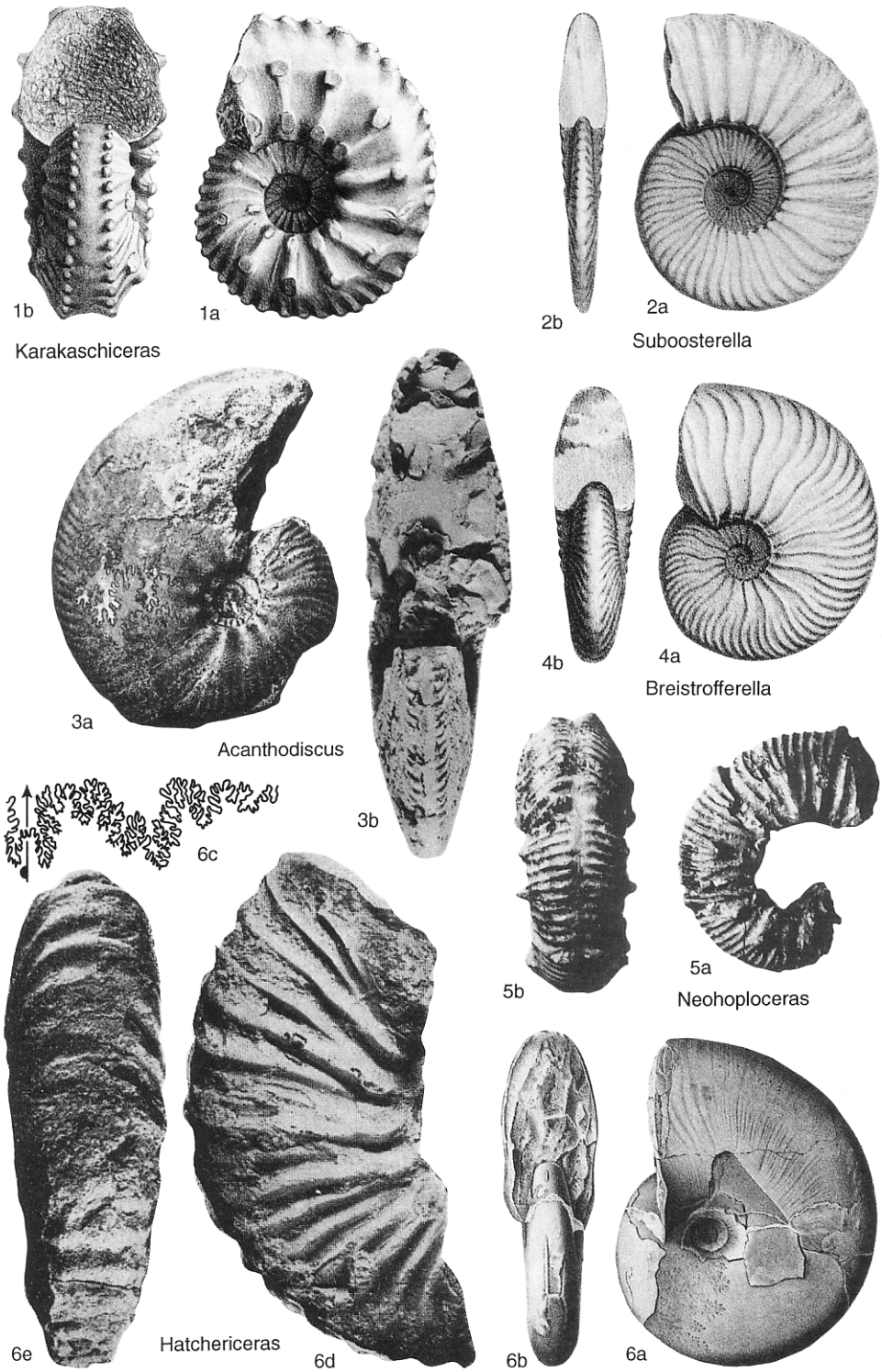


FIG. 44. Neocomitidae (p. 61–64)

siphonally on inner whorls, interrupted or not on outer. *Lower Cretaceous (?Lower Hauterivian):* Argentina.——FIG. 45,*6a,b.* **F. americana* (FAVRE); lectotype, ×0.3 (Favre, 1908).

Pseudofavrella A. F. LEANZA & H. A. LEANZA, 1973, p. 130 [**Hoplites angulatiformis* BEHRENDSEN, 1892, p. 16; OD]. Moderately evolute, with more or less trapezoidal whorl section. Sharp, high primary ribs springing from distant umbilical bullae and running radially for two-thirds of side, then bending forward at a subdued lateral tubercle and raised into fairly prominent ventrolateral tubercle, crossing the venter in a strong forward arc. Short secondary ribs with ventrolateral tubercles are irregularly intercalated. Suture with deep, rather wide lateral lobe and second and third lateral saddles projecting beyond the first. Distinguished from *Lyticoceras* by its rectiradiate primary and shorter secondary ribs. *Lower Cretaceous (Lower Hauterivian):* Colombia, Argentina.——FIG. 48,*2a–c.* **P. angulatiformis* (BEHRENDSON), Argentina; ×1 (A. F. Leanza & H. A. Leanza, 1973).

?Hatchericeras STANTON, 1901, p. 35 [**H. patagonense;* OD] [=*Pseudohatchericeras* A. F. LEANZA, 1970, p. 244 (type, *Hatchericeras argentinense* STANTON, 1901, p. 39; OD)]. Large, involute, compressed; early whorls with strong ribs, ranging from blunt and coarse to fine, branching from umbilical margin, with or without umbilical tubercles, slightly sinuous, prorsiradiate, widening on outer third of side or not, crossing venter transversely or interrupted; later whorls smooth with rounded venter. Suture with wide L divided by large folioles. *Lower Cretaceous (Upper Hauterivian* or *Lower Barremian):* South Africa (Zululand), Queensland, Argentina.——FIG. 44,*6a–e.* **H. patagonense,* Patagonia; *a–c,* ×0.2 (Stanton, 1901); *d,e,* ×1 (A. F. Leanza, 1970).

?Cruasiceras BUSNARDO, 1970b, p. 137 [**Ammonites cruasensis* TORCAPEL, 1884, p. 137(7); M]. High-whorled, with rounded venter and regularly branching ribs. Perhaps descended from *Lyticoceras. Lower Cretaceous (lower Upper Hauterivian):* France.

Distoloceras HYATT, 1900, p. 588 [**Ammonites hystrix* PHILLIPS, 1829, p. 123; OD] [=*Rodighieroites* COMPANY, 1987, p. 158 (type, *R. cardulus;* OD)]. Very evolute to criocone; whorl section polygonal; ribs coarse and tuberculate from early stage, strongly projected ventrolaterally, differentiated on outer whorls; on inner whorls ribs with large ventrolateral, normally midlateral, and sometimes umbilical spines, with or without such spines on outer whorls. Suture as in *Lyticoceras. Lower Cretaceous (Upper Valanginian–Lower Hauterivian):* England, ?France, Spain, Germany.——FIG. 48,*1a,b.* **D. hystrix* (PHILLIPS), Lower Hauterivian, England; ×1 (Howarth, 1962).——FIG. 48,*1c,d. D. pavlowi* SPATH, Lower Hauterivian, England; holotype, BMNH C.34976, ×1 (new).

Acanthodiscus UHLIG, 1905, p. 607 [**Ammonites radiatus* BRUGUIÈRE, 1789, p. 21; SD ROMAN, 1938, p. 338]. Whorls stout to compressed, with smooth, flat to concave venter; strong, straight primary ribs rising from moderate umbilical tubercles, simple, bi-, or trifurcating at large midlateral tubercles and ending at smaller ventrolateral nodes; later whorls tending to be smooth. [SAYN's (1907b, p. 193) statement that it is convenient to restrict *Acanthodiscus* to the group of *A. radiatus* (BRUGUIÈRE) is not a valid lectotype designation of that species, nor is SPATH's similar statement (1924a, p. 87).] *Lower Cretaceous (Lower Hauterivian):* Europe, Morocco, Madagascar, California, Mexico.——FIG. 44,*3a,b.* **A. radiatus* (BRUGUIÈRE), Germany; ×0.4 (Neumayr & Uhlig, 1881).

Leopoldia MAYER-EYMAR, 1887, p. 77 [**Ammonites leopoldinus* ORBIGNY, 1840, p. 104; SD ROMAN, 1938, p. 341] [=*Hoplitides* KOENEN, 1902, p. 170, obj.; *Solgeria* UHLIG, 1905, p. 624, obj.; *Renevierites* BUSNARDO & THIEULOY, 1989, p. 132 (type, *Leopoldia renevieri* BAUMBERGER, 1906, p. 38; OD]. Early whorls compressed, with parallel sides; primary ribs rather strong and flexuous; secondary ribs soon becoming confined to outer part of sides; all ribs ending in small ventrolateral clavi; middle and late whorls smooth, with high, oval section, generally with sides converging to narrowly rounded, rarely acute, venter. Probably derived from compressed *Acanthodiscus. Lower Cretaceous (Lower Hauterivian):* Europe, Morocco, Madagascar, Peru, Argentina.——FIG. 45,*4a,b.* **L. leopoldina* (ORBIGNY), France; ×0.5 (Orbigny, 1840–1842).

Suboosterella SPATH, 1924a, p. 88 [**Ammonites heliacus* ORBIGNY, 1840, p. 108; SD ROMAN, 1938, p. 346]. Compressed, discoidal, evolute, with smooth, narrowly rounded venter; ribs on early and middle whorls branching widely near midflank, on outer whorls simple with blunt ends. *Lower Cretaceous (Lower Hauterivian):* France, Austria.——FIG. 44,*2a,b.* **S. heliaca* (ORBIGNY), France; ×0.75 (Orbigny, 1840–1842).

Breistrofferella THIEULOY, 1971, p. 2299 [**Ammonites castellanensis* ORBIGNY, 1840, p. 109; OD]. Rather involute, inflated microconchs with oval whorl section, smooth, rounded venter, and falcoid, alternately long and short ribs dying away on shoulders and with hardly any umbilical tuberculation. *Lower Cretaceous (Lower Hauterivian):* France, Switzerland.——FIG. 44,*4a,b.* **B. castellanensis* (ORBIGNY), France; ×1 (Orbigny, 1840).

Hannaites IMLAY, 1957, p. 275 [**Neocomites riddlensis* ANDERSON, 1938, p. 167; OD]. Like *Leopoldia* but with flat venter crossed by strong, transverse ribs, constrictions on outer whorls, and uncoiling body chamber. *Lower Cretaceous (Lower Hauterivian):* Oregon.——FIG. 45,*3a,b.* **H. riddlensis* (ANDERSON); ×1 (Anderson, 1938).

Saynella KILIAN, 1910b, p. 150 [**Ammonites clypeiformis* ORBIGNY, 1841, p. 137; SD SPATH, 1924a, p. 88]. Smooth or feebly ribbed oxycones, after early ribbed stage. Probably derived from *Leopoldia. Lower Cretaceous (Hauterivian):* England, France, Switzerland.——FIG. 45,*2a,b.* **S. clypeiformis* (ORBIGNY), France; ×0.125 (Orbigny, 1840–1842).

Malgesaynella BUSNARDO, 1970a, p. 94 [**Saynella besairiei* COLLIGNON, 1949a, p. 73; OD]. Compressed, high-whorled; venter narrowly rounded;

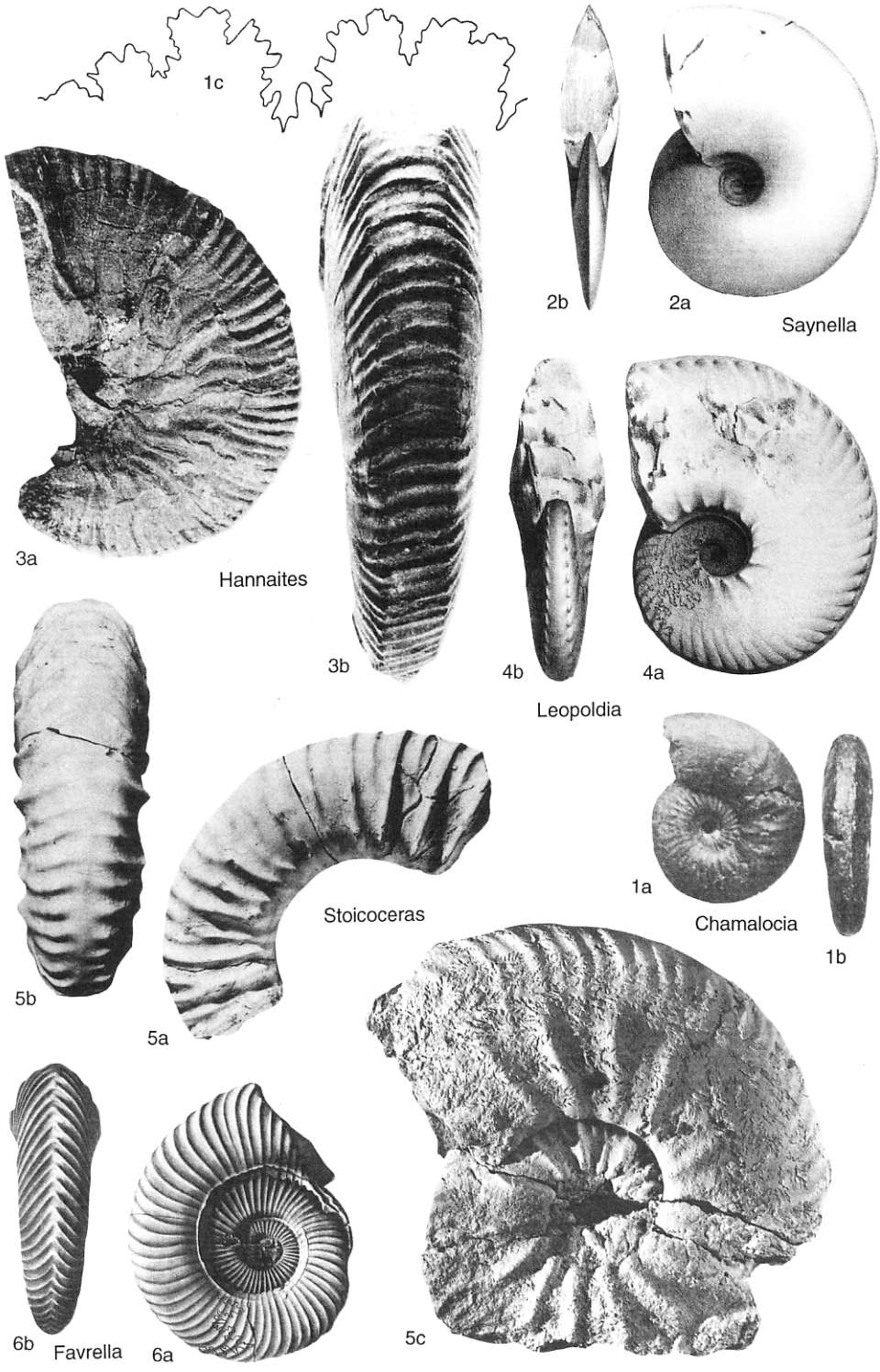


FIG. 45. Neocomitidae (p. 61–64)

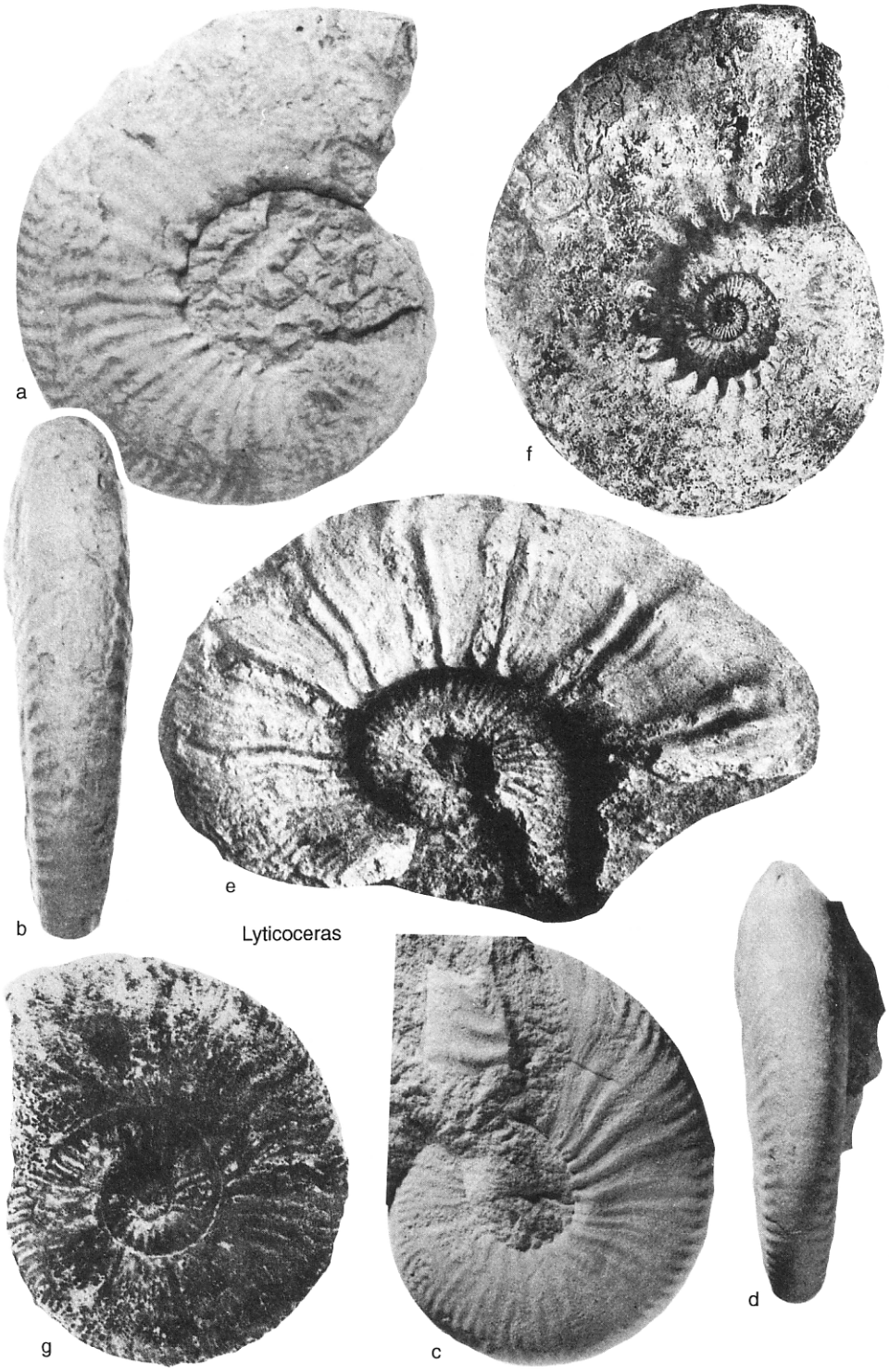


FIG. 46. Neocomitidae (p. 61–62)

inner whorls with fairly strong primary ribs around the umbilicus and fine secondaries on shoulders and periphery; outer whorls smooth. Suture with wide, rather short elements. *Lower Cretaceous (?Hauterivian):* Madagascar.——FIG. 48,*3a,b.* **M. besairiei* (COLLIGNON); *a,* ×1; *b,* ×2 (Busnardo, 1970a).

Superfamily DESMOCERATACEAE Zittel, 1895

[*nom. transl.* WRIGHT & WRIGHT, 1951, p. 18, *ex* Desmoceratidae ZITTEL, 1895, p. 426]

Generally round- or oval-whorled, but some lanceolate or keeled; commonly smooth or with weak ribs, but some genera and families strongly ribbed and tuberculate; constrictions commonly present. Suture simple or complex, with or without retracted suspensive lobe; L symmetrically or asymmetrically trifid in nearly all. Probably strongly dimorphic throughout; macroconchs with simple apertures; microconchs with lappets and rostrum in most families, but lappets appear to be lacking in Pachydiscidae. *Lower Cretaceous (Upper Valanginian)–Upper Cretaceous (Upper Maastrichtian).*

In recent years it has variously been suggested that the superfamily Desmoceratacеae had a monophyletic origin in Phylloceratidae, diphyletic in Phylloceratidae and Lytoceratidae, or monophyletic in Haploceratacеae. Some of the latter have sutures generally similar to those of early Desmoceratacеae, but constrictions are not found in Haploceratacеae. Adult sutures of many Desmoceratacеae repeatedly develop resemblances to those of some Lytoceratacеae but only in particular features, and the basic pattern is quite different. It is probably equally significant that almost all characters of the ornament of Desmoceratacеae and their derivatives Hoplitaceae and Acanthoceratacеae repeat those of various Perisphinctaceae. The previously presumed most primitive desmoceratacean, *Eodesmoceras,* thought to be Valanginian, turns out to be based on probably Albian fragments of *Puzosia* and *Desmoceras.* Lower to Upper Hauterivian *Spitidiscus* include species with inner whorls closely resembling *Barremites* and *Valdedorella;* earliest species of *Spitidiscus* (Upper Valanginian) closely resemble *Olcostephanus,* and there is no significant sutural difference. Though a secure conclusion on the origin of the group cannot yet be reached, origin in Perisphinctaceae seems very natural.

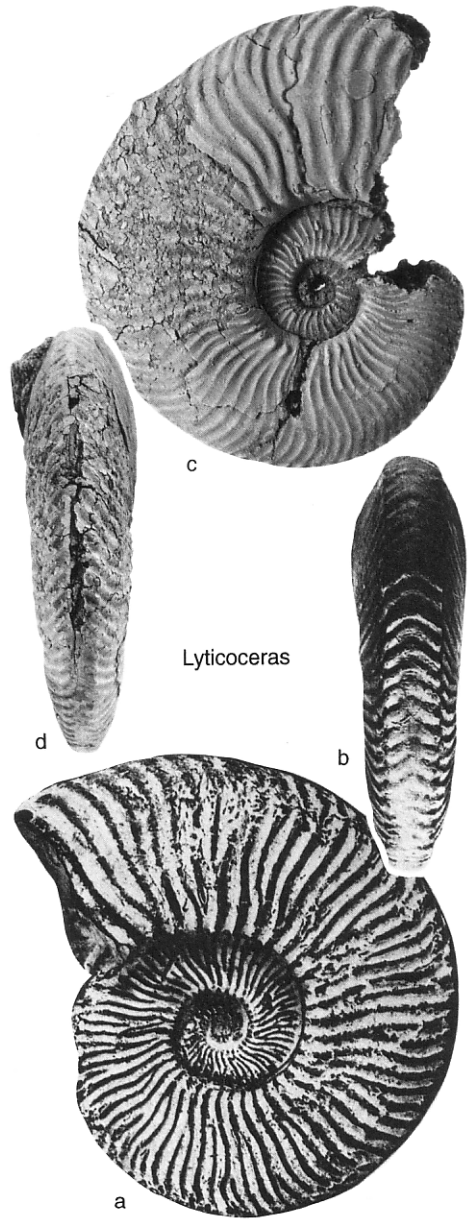


FIG. 47. Neocomitidae (p. 61–62)

The superfamily is here retained as distinct from its derivative Hoplitaceae,

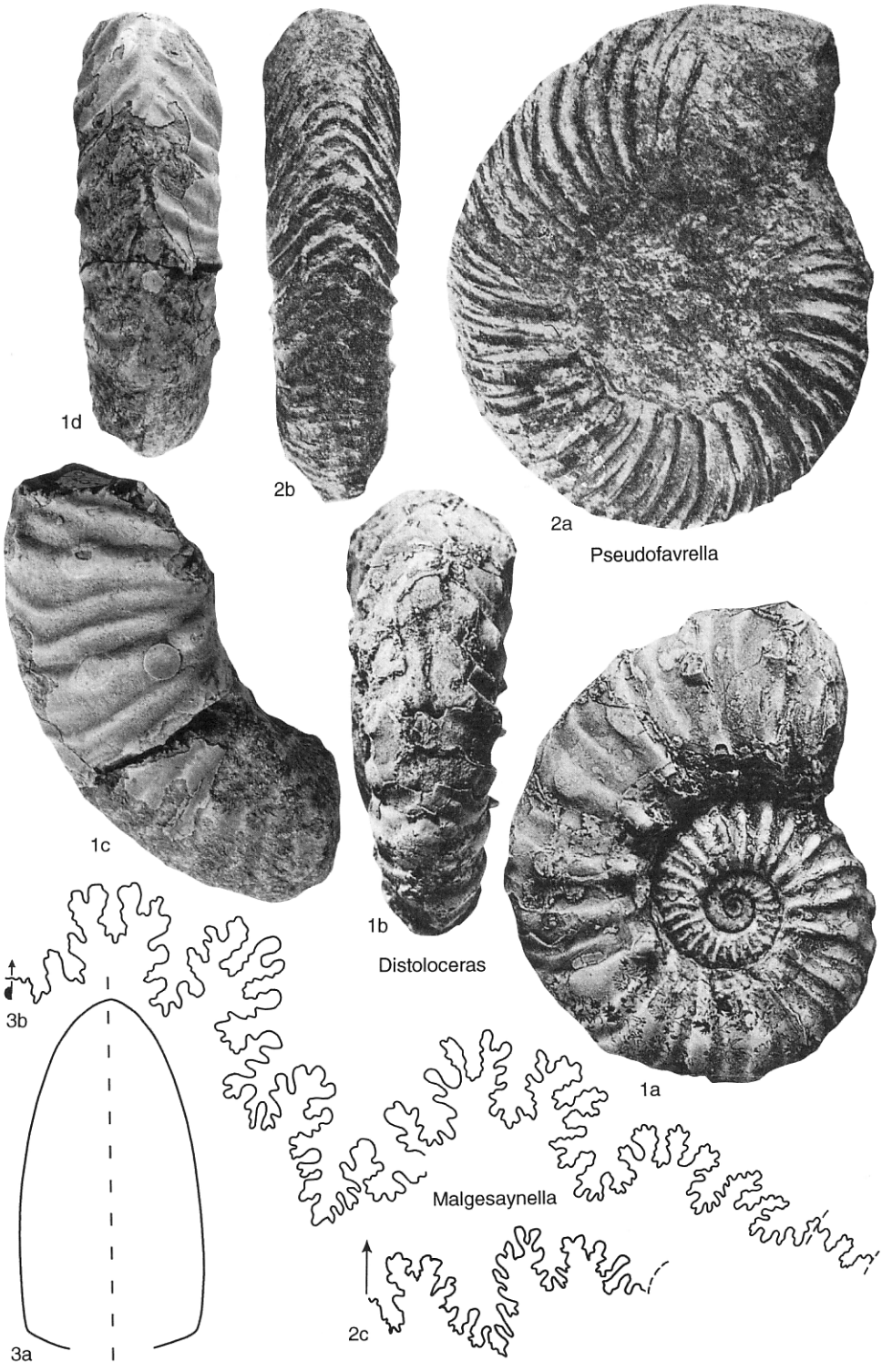


FIG. 48. Neocomitidae (p. 64–67)

although sutural ontogeny is closely similar, because the latter developed distinctive characters of ornament.

Family DESMOCERATIDAE Zittel, 1895

[Desmoceratidae ZITTEL, 1895, p. 426]

Characters of superfamily, excluding most of the more strongly ornamented forms. *Lower Cretaceous (Upper Valanginian)–Upper Cretaceous (Upper Maastrichtian).*

There is little agreement on boundaries of subfamilies, and the present scheme can only be regarded as provisional. Recent splintering, however, seems unnecessary and unhelpful, since the group is very uniform in morphology and changes in characters are mostly gradual.

Subfamily BARREMITINAE Breskovski, 1977

[Barremitinae BRESKOVSKI, 1977, p. 893] [=Torcapellinae BRESKOVSKI, 1977, p. 891, *nom. correct.* WRIGHT, herein, *pro* Torcapelinae BRESKOVSKI; tribe Cassidoiceratini BRESKOVSKI, 1977, p. 893]

Whorl section ranging from more or less circular through rectangular to oxyconic; ribbing, if present, generally weak. Suture relatively simple, without markedly retracted suspensive lobe. The more or less oxyconic, Hauterivian genera separated as Torcapellinae are probably not closely related to each other. *Lower Cretaceous (Upper Valanginian–Upper Barremian).*

The subfamily includes most of the genera previously placed in Eodesmoceratinae (WRIGHT, 1955, p. 567), but *Eodesmoceras celestini* (PICTET & CAMPICHE, 1860, p. 276), type species of *Eodesmoceras* (SPATH, 1923d, p. 33), was based on what now seem to be fragments of Albian *Puzosia* and *Desmoceras* (BUSNARDO & THIEULOY, 1989, p. 121); the holotype of Valanginian *E. haughtoni* (SPATH, 1930d) is too small to be identifiable.

Spitidiscus KILIAN, 1910c, p. 264 [**Ammonites rotula* J. de C. SOWERBY, 1827b, p. 136; SD ROMAN, 1938, p. 389]. Rather involute to rather evolute; whorl section more or less circular to flat-sided; frequent constrictions straight or slightly sinuous, moderately deep but wide, truncating low, single or rarely branching ribs. Earliest species have slight umbilical tubercles. *Lower Cretaceous (Upper Valanginian–Upper Hauterivian, ?Lower Barremian):* England, France, Spain, Austria.——FIG. 49, *1a–c.* **S. rotula* (J. de C. SOWERBY), Hauterivian, England; *a,b,* ×1; *c,* enlarged (Pavlow, 1892).

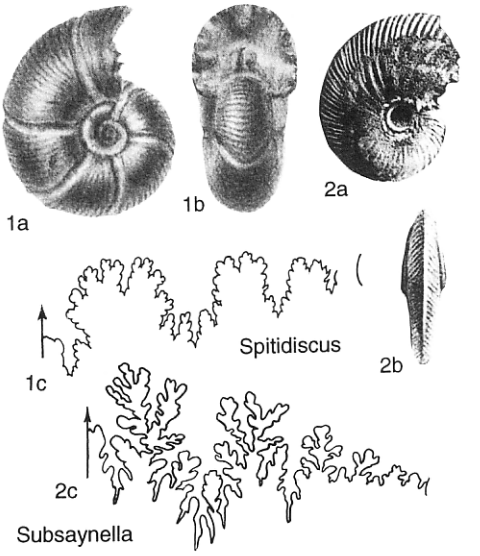


FIG. 49. Desmoceratidae (p. 69–71)

Barremites KILIAN, 1913, p. 333 [**Ammonites difficilis* ORBIGNY, 1841, p. 135; M] [=*Miodesmoceras* WRIGHT, 1955, p. 568 (type, *Haploceras lechicum* UHLIG, 1883, p. 227(100); OD); *Raspailiceras* WRIGHT, 1956a, p. 74, *nom. nov. pro Raspailites* WRIGHT, 1955, p. 568, *non* JEANNET, 1951, p. 192 (type, *A. cassida* RASPAIL, 1831, p. 115; OD); *Nabdalsiceras* BRESKOVSKI, 1977, p. 892 (type, *A. nabdalsa* COQUAND, 1880, p. 367; OD); *Falloticeras* BRESKOVSKI, 1977, p. 892, *non* PARONA & BONARELLI, 1897, p. 89 (type, *Desmoceras falloti* KILIAN, 1910c, p. 258; OD); *Cassidoiceras* DIMITROVA, 1967, p. 131 (*non Cassidoides,* p. 132, *pro errore*) (type, *Haploceras cassidoides* UHLIG, 1883, p. 230(103); OD)]. Moderately to very involute; fairly inflated, with rounded umbilical margin, to very compressed, with sharp umbilical margin; constrictions straight, sinuous, or slightly falcate on internal molds, forming collars on shell; with intermediate, feeble lirae to moderately distinct ribs. The variable Barremian populations have been much split by authors, but there seems to be no significant morphological gap between supposed genera. *Lower Cretaceous (Upper Hauterivian–Upper Barremian):* Europe, northern Africa, Japan, Mexico, Colombia.——FIG. 50, *1a,b.* **B. difficilis* (ORBIGNY), Barremian, France; ×0.75 (Orbigny, 1840–1842).——FIG. 50, *1c,d. B. raspaili* KILIAN, Barremian, France; ×0.75 (Orbigny, 1840–1842).——FIG. 50, *1e,f. B. chaputi* DIMITROVA, Barremian, France; ×1 (Chaput, 1921).

Plesiospitidiscus BREISTROFFER, 1947b, p. 80(64) [**Ammonites ligatus* ORBIGNY, 1841, p. 126; OD]

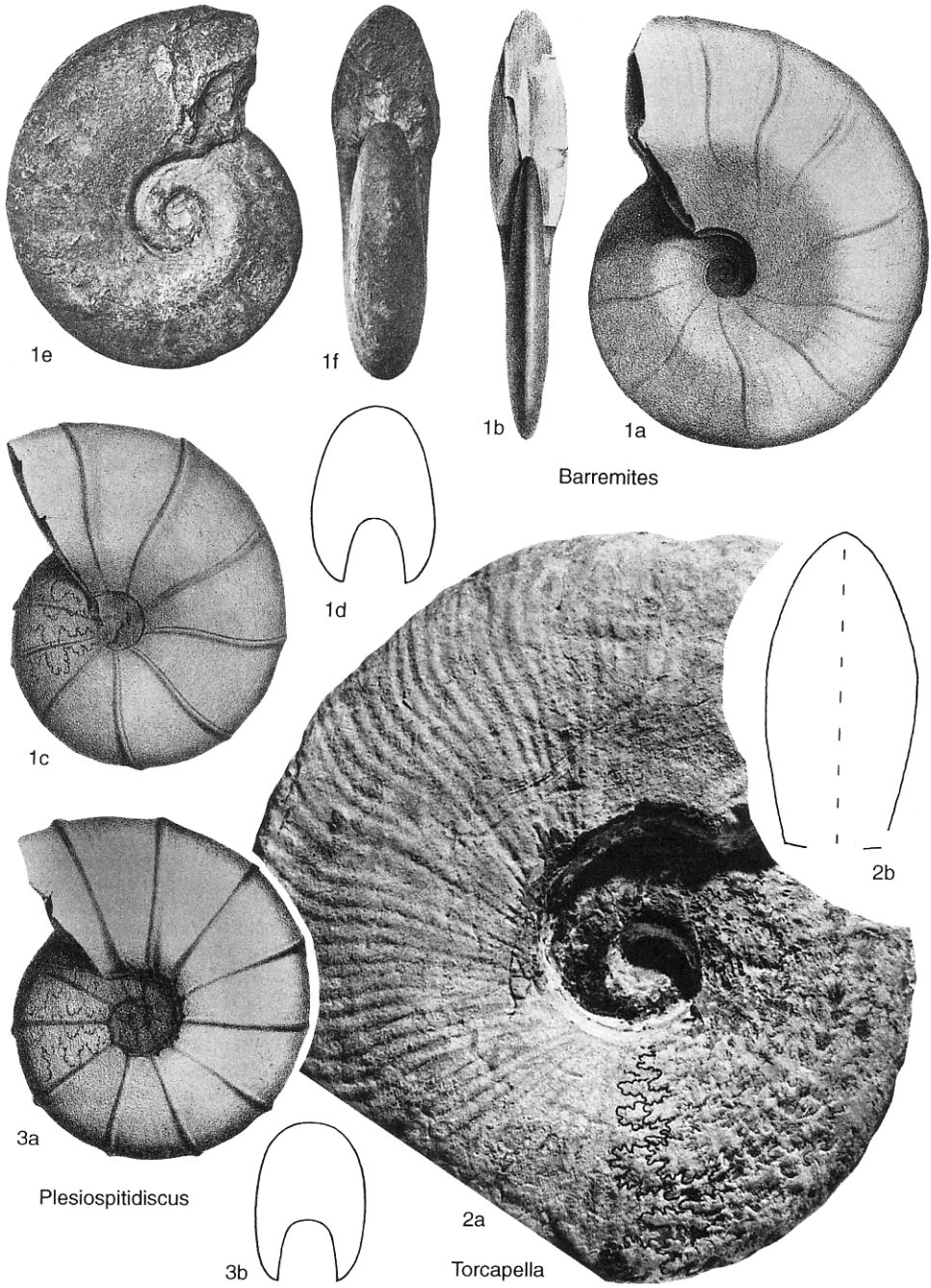


FIG. 50. Desmoceratidae (p. 69–71)

[=*Reboulites* DIMITROVA, 1967, p. 134 (type, *Puzosia issarpayensis* KILIAN & REBOUL, 1915, p. 248; OD)]. Compressed, with flat sides; ribs straight and radial; constrictions on internal molds do not truncate fine secondary ribs on outer part of sides. Doubtfully distinct from *Barremites*. *Lower Cretaceous (Upper Hauterivian):* France, Bulgaria, Mexico.——FIG. 50,*3a,b*. **P. ligatus* (ORBIGNY), France; ×1 (Orbigny, 1840–1842).

Subsaynella SPATH, 1923d, p. 31 [**Ammonites sayni* PAQUIER, 1900, p. v; OD]. Rather involute, compressed, with slightly convex sides, whorl sec-

tion tending to become lanceolate; venter broadly or narrowly rounded in early forms but may be acute in later species; dense, fine ribs weak on midsides but becoming stronger and branching and curving forward on outer part; constrictions shallow. *Lower Cretaceous (Upper Hauterivian–Barremian):* England, France, central Europe, northern Africa, Madagascar.——FIG. 49,*2a–c.* **S. sayni* (PAQUIER), Upper Hauterivian, France; *a,b,* ×1; *c,* enlarged (Kilian, 1907–1913).

Torcapella BUSNARDO, 1970a, p. 95 [**Ammonites fabrei* TORCAPEL, 1884, p. 109(1); OD]. Involute, high-whorled, with more or less convex sides and narrowly rounded to sharp venter, rarely a true oxycone; umbilical shoulder sharp and wall steep; after early, less compressed, smooth stage, falcoid, single or branching, dense to rather distant ribs covering sides. Suture variable. *Lower Cretaceous (Lower Barremian):* Spain, France, Romania, Bulgaria, Algeria.——FIG. 50,*2a,b.* **T. fabrei* (TORCAPEL), France; ×0.5 (Busnardo, 1970b).

Subfamily PSEUDOSAYNELLINAE Casey, 1961

[Pseudosaynellinae CASEY, 1961d, p. 169]

Young forms strongly ribbed, constricted, without tubercles, tending to oxyconic whorl section. *Lower Cretaceous (Lower Aptian–Upper Aptian).*

Pseudosaynella SPATH, 1923d, p. 66 [**Ammonites bicurvatus* MICHELIN, 1838, p. 101; OD]. Small oxycones with flexuous to falcoid ribs and constrictions; later whorls smooth. Suture with numerous, descending auxiliaries. *Lower Cretaceous (Lower Aptian–Upper Aptian):* western Europe, ?Japan.——FIG. 51,*1a,b. P. raresulcata* (ORBIGNY), Lower Aptian, France; ×1 (Casey, 1961d).——FIG. 51,*1c.* **P. bicurvata* (MICHELIN), Lower Aptian, France; enlarged (Casey, 1961d).

Aioloceras WHITEHOUSE, 1926, p. 206 [**Cleoniceras argentinum* BONARELLI in BONARELLI & NÁGERA, 1921, p. 24; OD]. Venter narrowly arched; inner whorls with sharp, falcoid ribs; later whorls smooth. Doubtfully distinct from *Pseudosaynella. Lower Cretaceous (Upper Aptian):* Australia (Queensland), Argentina (Patagonia).——FIG. 51,*2a,b.* **A. argentinum* (BONARELLI), Patagonia; ×1 (Bonarelli & Nágera, 1921).

Subfamily PUZOSIINAE Spath, 1922

[Puzosiinae SPATH, 1922b, p. 126] [=Melchioritinae, *nom. correct.* WRIGHT & KENNEDY, 1984, p. 54, *pro* Melcioritinae BRESKOVSKI, 1977, p. 892; Abrytusitinae, *nom. correct.* WRIGHT & KENNEDY, 1984, p. 54, *pro* Abritusitinae BRESKOVSKI, 1977, p. 893]

Includes the largest ammonite known. Generally more or less evolute, round- or oval-whorled; sides flat or convex, normally with strong constrictions at least on outer part of sides but some smooth. In typical later genera suture finely divided, having strongly retracted suspensive lobe. Morphology of earlier genera very uniform and transitions gradational; sutures simpler, with less obviously retracted suspensive lobe. Boundary with Barremitinae is uncertain. *Lower Cretaceous (Middle Hauterivian)–Upper Cretaceous (Lower Maastrichtian).*

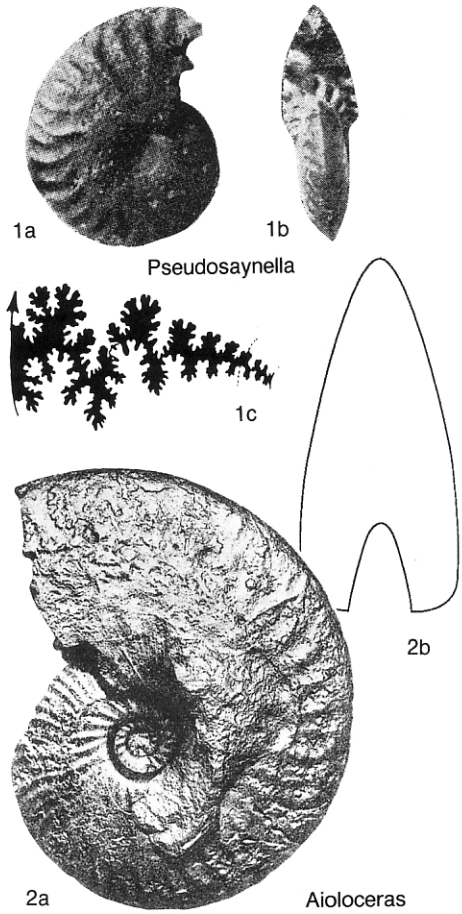


FIG. 51. Desmoceratidae (p. 71)

Valdedorsella BREISTROFFER, 1947b, p. 76(60) [**Desmoceras akuschaense* ANTHULA, 1899, p. 104(50); OD] [=*Puezalpella* DIMITROVA, 1967, p. 140 (type, *Desmoceras uhligi* HAUG, 1889, p. 201; OD); *Weavericeras* H. A. LEANZA & WIEDMANN, 1980, p. 960 (type, *Latidorsella vacaensis* WEAVER, 1931, p. 439; OD)]. Inflated with broad, rounded venter; whorl section oval to depressed; radial constrictions more or less straight, with prominent, rounded rib behind; normally rather weak ribs between constrictions, at least on early whorls. The genus is here taken to cover a variety of species that

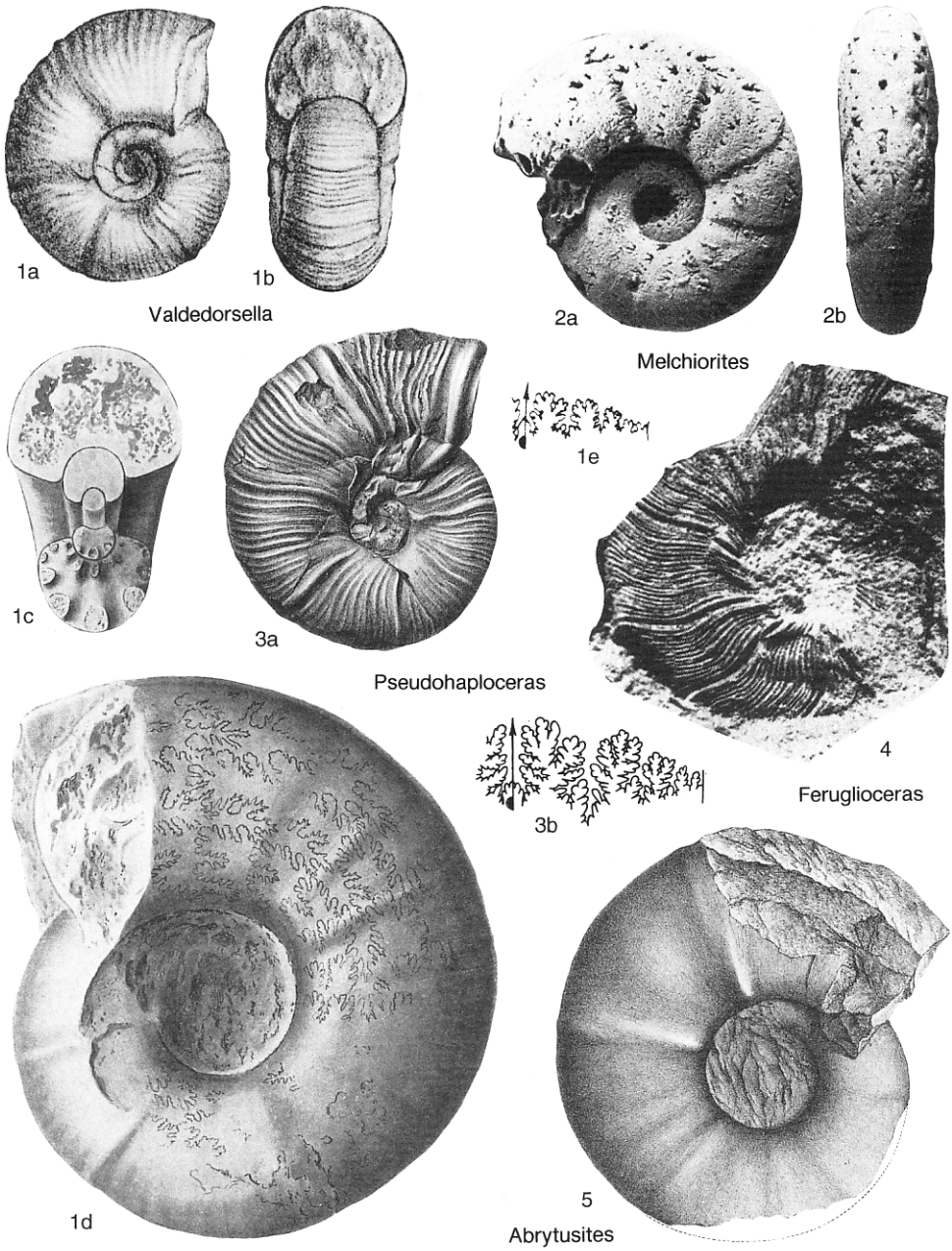


FIG. 52. Desmoceratidae (p. 71–75)

differ little and then only in degree of evolution and whorl section. *Lower Cretaceous (Middle Hauterivian–Upper Aptian):* southeastern Europe, Caucasus, northern Africa, Madagascar, Japan, Alaska, Colombia, Argentina.——FIG. 52,*1a–c.* **V. akuschaensis* (ANTHULA), Upper Aptian, Caucasus; ×1 (Anthula, 1899).——FIG. 52,*1d,e. V. vacaensis* (WEAVER), Middle Hauterivian, Argentina; *d,* holotype, ×0.5; *e,* paratype, ×0.5 (Weaver, 1931).

Abrytusites NIKOLOV & BRESKOVSKI, 1969, p. 92 [**Pachydiscus neumayri* HAUG, 1889, p. 204; OD]. Inflated, with constrictions; rather thick ribs springing irregularly, singly or in pairs, from indistinct umbilical bullae. Inner whorls closely resemble type species of *Valdedorsella,* from which it is probably indistinguishable. *Lower Cretaceous (Barremian):* central Europe.——FIG. 52,*5.* **A. neumayri* (HAUG), Austria; ×0.4 (Haug, 1889).

Pseudohaploceras HYATT, 1900, p. 570 [**Ammonites liptoviensis* ZEUSCHNER, 1856, p. 181; OD] [=*Pleurohaploceras* RIEDEL, 1938, p. 14, *lapsus; Caseyella* C. M. CANTU-CHAPA, 1976, p. 15 (type, *Uhligella reesidei* HUMPHREY, 1949, p. 152; OD)]. Moderately involute, slightly to moderately compressed, with convex sides; constrictions regular, straight or sinuous, collared in some; fairly fine, distinct, sharp or rounded, branching ribs between constrictions, extending from umbilical edge and crossing venter. Offshoot of early *Valdedorsella*. *Lower Cretaceous (Barremian–Aptian):* Europe, Egypt (Sinai), Japan, Mexico, Colombia.——FIG. 52,*3a,b.* **P. liptoviense* (ZEUSCHNER), Barremian, Austria; *a,* ×0.5; *b,* enlarged (Uhlig, 1883).

Feruglioceras A. F. LEANZA, 1967a, p. 156 [**F. piatnitzkyi;* OD]. Compressed, with subtabulate venter; frequent constrictions flexuous, separated by 15 or more, extemely fine, irregularly branching ribs. *Lower Cretaceous (Lower Albian):* Argentina (Patagonia).——FIG. 52,*4.* **F. piatnitzkyi;* ×1 (A. F. Leanza, 1967a).

Umsinenoceras KENNEDY, WRIGHT, & KLINGER, 1979, p. 30 [**U. linguatuberculatum;* OD]. Small, compressed, rather evolute, with dense, fine, flexuous ribs; ribs prorsiradiate, single or branching on umbilical shoulder, and strongly projected ventrolaterally, where they may split, then weakening to lirae and forming a tonguelike projection on venter; ventrolateral clavi small, irregularly situated; flexuous constrictions narrow on the test, wider on molds running parallel to the ribs; body chamber with rounded venter and concave ribs. Suture with retracted suspensive lobe. *Lower Cretaceous (Middle Albian):* South Africa (Zululand).——FIG. 53,*1a–d.* **U. linguatuberculatum; a–c,* ×1; *d,* ×2 (Kennedy, Wright, & Klinger, 1979).

Kennicottia IMLAY, 1959, p. 183 [**K. bifurcata;* OD]. Rather involute; similar to *Pseudohaploceras* but with more regular and more regularly bifurcating ribs and weaker constrictions and associated flared ribs. *Lower Cretaceous (Lower Albian):* Alaska.——FIG. 53,*2a–c.* **K. bifurcata; a,b,* ×1; *c,* ×2 (Imlay, 1959).

Callizoniceras SPATH, 1923d, p. 35 [**Desmoceras hoyeri* KOENEN, 1902, p. 60; OD]. Small, rather evolute forms with more or less rounded whorl section, which may heighten on outer whorls; typically having strong, rounded, branching ribs and deep, steep-sided, collared constrictions. Suture rather simple. *Lower Cretaceous (Upper Barremian–Lower Albian):* England, Germany, Alaska, Greenland.

C. (**Callizoniceras**). Ribs regular; ribs and constrictions slightly sinuous. *Lower Cretaceous (Upper Barremian–Aptian):* England, Germany, Greenland.——FIG. 54,*1a,b.* **C. (C.) hoyeri* (KOENEN), Upper Barremian, northern Germany; ×1 (Koenen, 1902).

C. (**Wollemanniceras**) BREISTROFFER, 1947b, p. 37(21), 86(70) [**Desmoceras keilhacki* WOLLEMANN, 1907, p. 36; OD]. Falcoid constrictions projecting on venter; main ribs thick on inner part of sides, then splitting into riblets and fading on venter. *Lower Cretaceous (Lower Albian):* Germany, Alaska.——FIG. 54,*4a,b.* **C. (W.) keilhacki* (WOLLEMANN), Germany; *a,* ×1; *b,* ×3 (Wollemann, 1907).

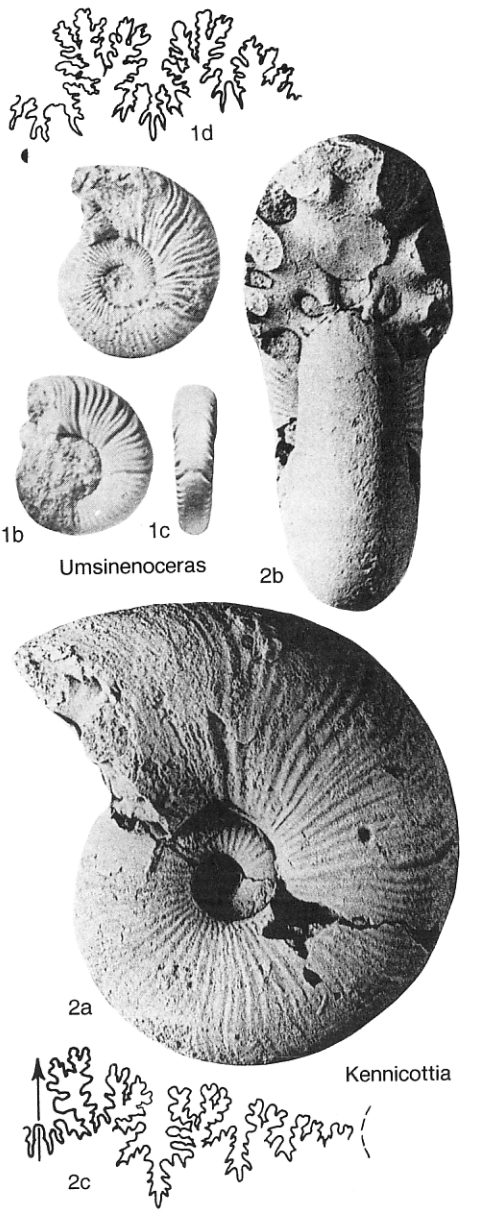


FIG. 53. Desmoceratidae (p. 73)

Melchiorites SPATH, 1923d, p. 33 [**Ammonites melchioris* TIETZE, 1872, p. 135; M]. Whorl section round, subquadrate, or compressed, with convex or flat sides; early whorls with sinuous, radial or oblique constrictions, projected on venter, but without ribs; later whorls with rather feeble ribs on outer part of sides and venter. Suture with auxiliaries not or only slightly retracted. *Lower Cretaceous*

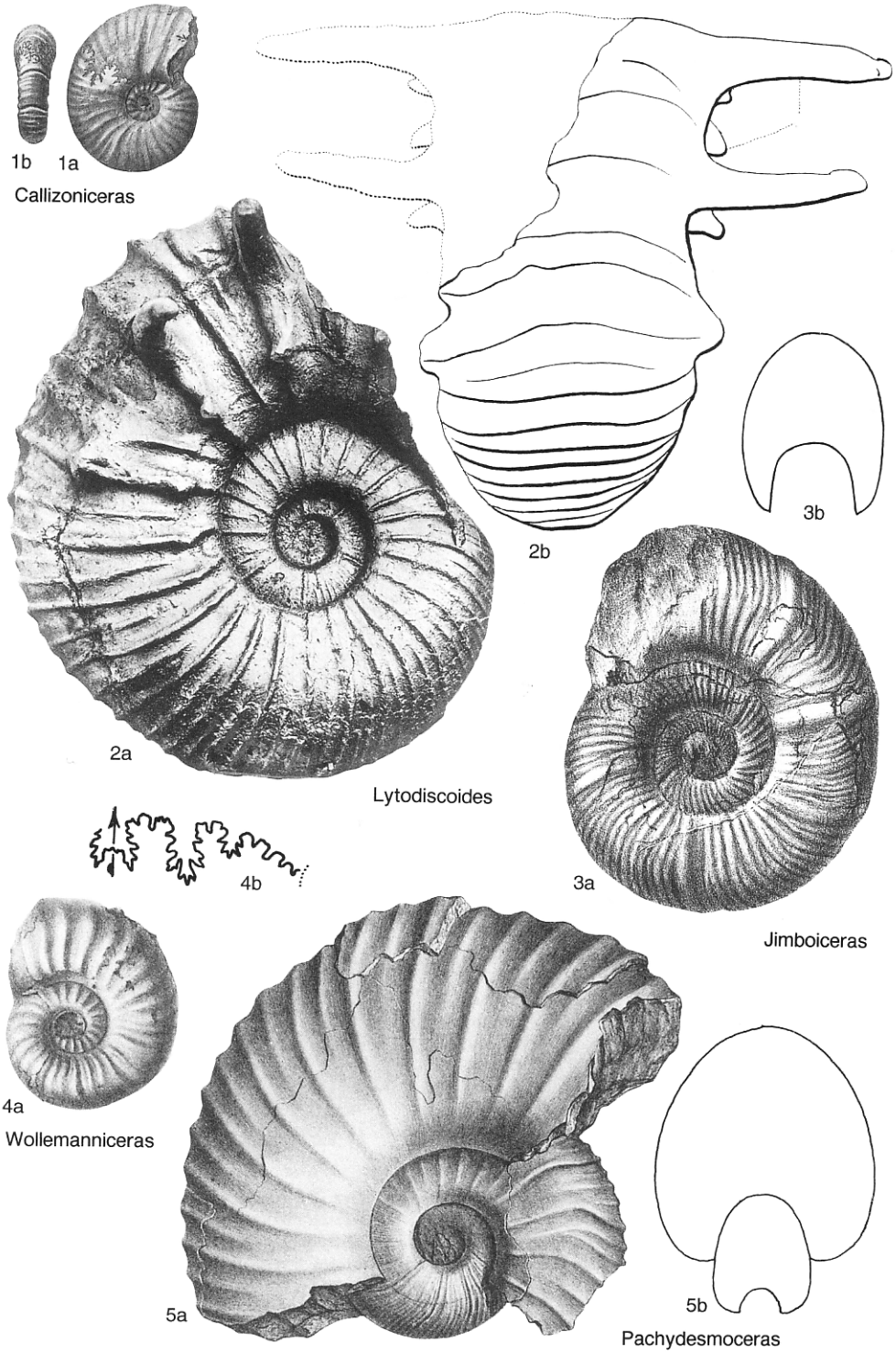


FIG. 54. Desmoceratidae (p. 73–78)

(Upper Barremian–Lower Albian): Europe, northern Africa, Madagascar, California.——FIG. 52,*2a,b.* **M. melchioris* (TIETZE), lectotype, Upper Barremian or Lower Aptian, Czech Republic; ×1 (Vašiček, 1972).

Puzosia BAYLE, 1878, pl. 45, 46 (explanations) [**Ammonites planulatus* J. de C. SOWERBY, 1827b, p. 136; SD H. DOUVILLÉ, 1879, p. 91] [=*Pleuropachydiscus* HYATT, 1900, p. 571 (type, *Ammonites hoffmanni* GABB, 1869, p. 211; OD); ?*Puzosiella* EGOIAN, 1969, p. 174 (type, *P. minuta;* OD)]. Macroconchs large but only microconchs and nuclei known of most species. Whorl section round to compressed; fine ribs and constrictions, parallel to the ribs, generally present. In general more evolute than *Melchiorites,* with more linguiform projection of constrictions on venter and more complex suture with more strongly retracted suspensive lobe. *Lower Cretaceous (?Upper Aptian, Lower Albian)–Upper Cretaceous (Upper Campanian):* worldwide.

P. (Puzosia) [=*Matsumotoceras* HOEPEN, 1968a, p. 158 (type, *M. donlisteri;* OD); ?*Hyperpuzosia* MATSUMOTO, 1988, p. 26 (type, *H. tamon;* OD)]. Ribs distinct only on outer part of side. Microconchs may have coarser, stronger ribs on body chamber and some indication of former lappets (e.g., by lip on forward edge of constriction); on last whorl of macroconchs ribs and constrictions may weaken with age or be replaced by very coarse, distant ribbing or tubercles. [*Hyperpuzosia* with very large, variable ventrolateral nodes comprises macroconchs probably of a feebly ornamented species of *P. (Puzosia).*] *Lower Cretaceous (?Upper Aptian, Lower Albian)–Upper Cretaceous (Upper Campanian):* worldwide.——FIG. 55,*1a–c. P. (P.) planulata* (J. de C. SOWERBY), Cenomanian, Germany; *a,b,* nucleus of macroconch, ×0.75; *c,* ×0.5 (Schlüter, 1871–1876).——FIG. 55,*1d. ?P. (P.) tamon* (MATSUMOTO, KAWASHITA, & TAKAHASHI in MATSUMOTO), macroconch, Lower Albian, Japan; ×0.2 (Matsumoto, 1988).

P. (Anapuzosia) MATSUMOTO, 1954, p. 71 (1938b, p. 193, *nom. nud.*) [**Puzosia buenaventura* ANDERSON, 1938, p. 185; OD]. Whorl section round to oval; close to moderately distant ribs arising at or near umbilical margin; secondaries branching or intercalated at midflank; ribs and constrictions sinuous. Body chamber (of ?macroconchs) with strong, distant radial ribs only. *Lower Cretaceous (Lower Albian)–Upper Cretaceous (Upper Cenomanian):* western Europe, Ukraine (Crimea), Angola, Madagascar, California, Venezuela, Ecuador, Brazil, Japan.——FIG. 55,*2a,b.* **P. (A.) buenaventura,* Lower Albian, California; macroconch, ×0.5 (Anderson, 1938).

P. (Bhimaites) MATSUMOTO, 1954, p. 113 [**Ammonites bhima* STOLICZKA, 1865, p. 137; OD]. More or less compressed, with convex or flat sides and prorsiradiate, curved constrictions strongly projected on shoulders; ribs, if present, only on venter. Sutures may have asymmetrically bifid L. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Upper Turonian):* England, France, Spain, ?northern Africa, Angola, South Africa (Zululand), Madagascar, southern India, Japan, Venezuela.——FIG. 56,*2a–c.* **P. (B.) bhima* (STOLICZKA), Upper Albian, southern India; ×1 (Stoliczka, 1865).

P. (Mesopuzosia) MATSUMOTO, 1954, p. 79 (1938b, p. 193, *nom. nud.*) [**M. pacifica;* OD] [=*Pteropuzosia* MATSUMOTO, 1988, p. 27 (type, *P. kawashitai;* OD)]. Similar in form to *P. (Puzosia)* but with stronger, more or less regular, dense ribs, starting at umbilical margin; last whorl smooth. [*Pteropuzosia* comprises macroconchs with very variable, large, coarse ribs to extreme winglike bulges on body chamber.] *Upper Cretaceous (Lower Turonian–Upper Campanian):* Austria, Angola, Madagascar, southern India, Alaska, California, Venezuela, Japan.——FIG. 56,*1a–c.* **P. (M.) pacifica* (MATSUMOTO), Turonian, Japan; *a,b,* ×0.75; *c,* microconch, ×0.5 (Matsumoto, 1988).——FIG. 56,*1d. P. (M.) yubarensis* (JIMBO), Coniacian, Japan; macroconch, ×0.1 (Matsumoto, 1988).

Pachydesmoceras SPATH, 1922b, p. 127 [**Ammonites denisonianus* STOLICZKA, 1865, p. 121; OD]. Commonly very large; inner whorls with oval section and frequent, sigmoid constrictions sharply bent forward at midflank with raised rib in front and fine riblets between; outer whorls with more inflated section and coarse, long and short, well-spaced ribs, more or less projected on outer one-third of side. At least one species with aperture of macroconchs preceded by large bulge. Suture as in *Puzosia. Lower Cretaceous (Upper Albian)–Upper Cretaceous (Upper Turonian):* France, Spain, Germany, Switzerland, Romania, Yugoslavia, western Africa, South Africa (Zululand), Madagascar, Iran, southern India, Japan, New Zealand.——FIG. 54,*5a,b. P. kossmati* (MATSUMOTO), Lower Turonian, southern India; ×0.5 (Kossmat, 1895–1898).

Lytodiscoides SPATH, 1922b, p. 126 [**Pachydiscus conduciensis* CHOFFAT, 1903, p. 18; OD]. Very large; whorl section round; main ribs strong, slightly curved, with intercalated long and short ribs; on distal part of body chamber every other main rib bearing a vast ventrolateral and a large umbilical spine. Probably macroconch of some species of *Pachydesmoceras. Lower Cretaceous (Upper Albian):* France, Mozambique, South Africa (Zululand).——FIG. 54,*2a,b.* **L. conduciensis* (CHOFFAT), Upper Albian, Mozambique; ×0.125 (Choffat, 1903).

Epipuzosia MATSUMOTO, 1988, p. 26 [**E. maya;* OD]. Macroconchs only recognized; similar to *Pachydesmoceras,* but ribs much weaker and with blunt, low ventrolateral tubercles on end of phragmocone and body chamber. *Upper Cretaceous (?Upper Cenomanian):* England, Switzerland. *Upper Cretaceous (Lower Turonian):* Japan.

Jimboiceras MATSUMOTO, 1954, p. 95 (SHIMIZU, 1935a, p. 180, *nom. nud.*) [**Desmoceras planulatiforme* JIMBO, 1894, p. 27(173); OD]. Roundwhorled; early whorls with distinct, fine, prorsiradiate, and curved ribs (some bifurcating) and strongly

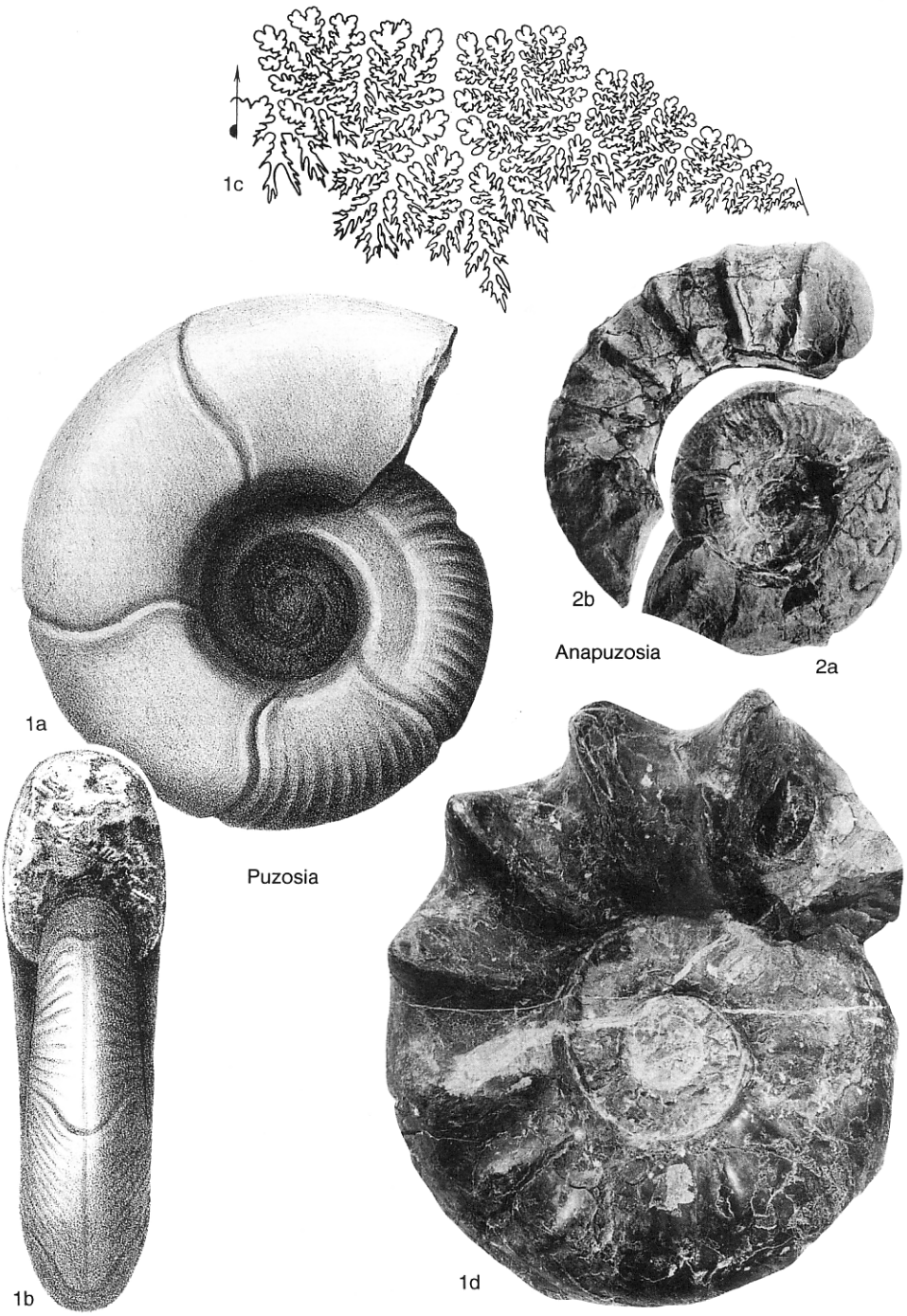


FIG. 55. Desmoceratidae (p. 75)

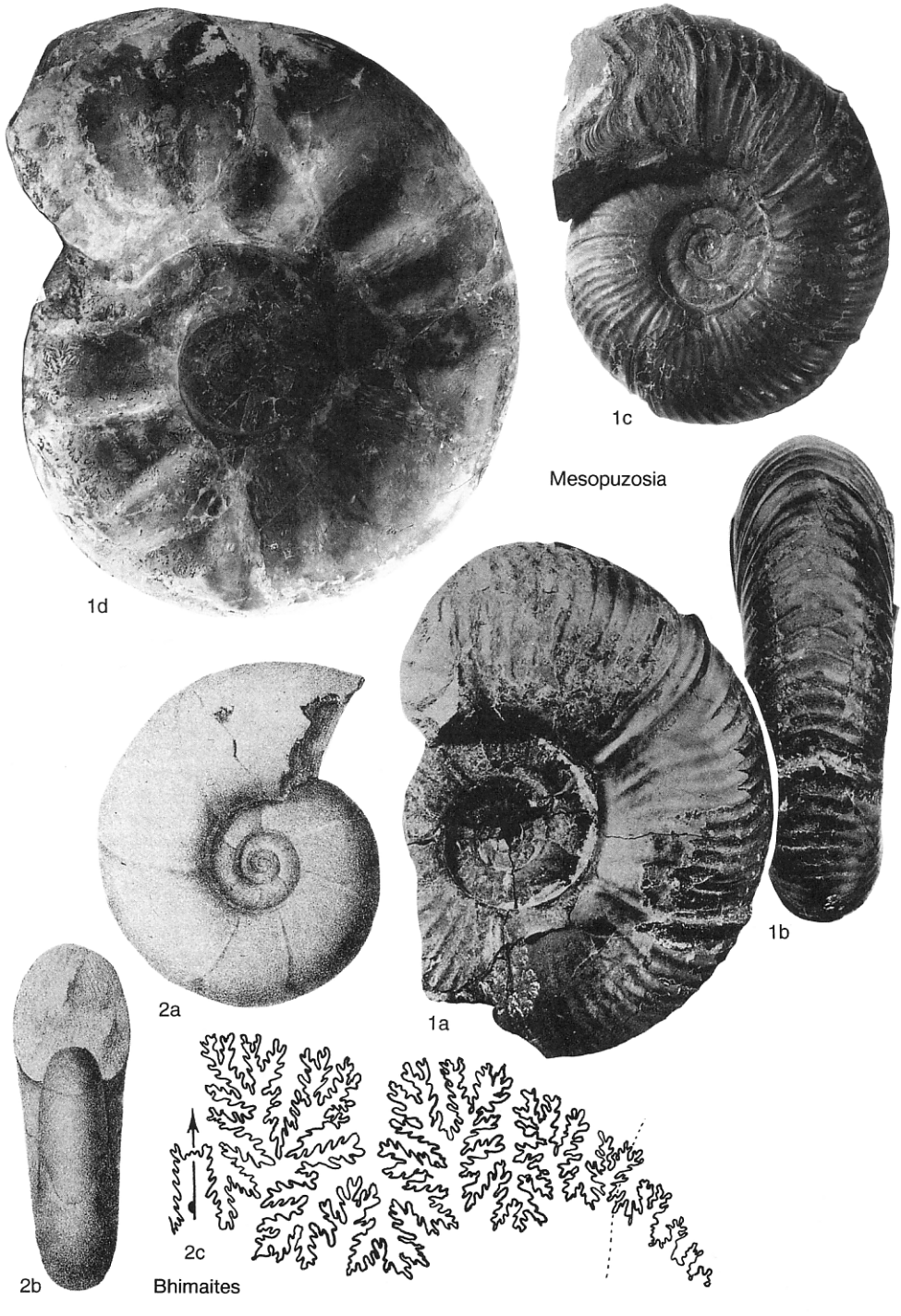


FIG. 56. Desmoceratidae (p. 75)

collared constrictions; later whorls with strong, rectiradiate, periodic ribs. *Upper Cretaceous (Turonian–Lower Santonian):* Antarctica (Seymour Island), Germany, Madagascar, Japan.——FIG. 54,*3a,b.* **J. planulatiforme* (JIMBO), Turonian, Japan; ×0.5 (Jimbo, 1894).

Achilleoceras HOEPEN, 1951c, p. 345 [**A. erasmusi;* OD]. Only single giant macroconch known. Inner whorls much as in *Austiniceras;* body chamber with dense minor ribs, irregular rodlike spines as in *Lytodiscoides,* and strong, serrated siphonal crest. Possibly macroconch of an early *Austiniceras. Lower Cretaceous (Upper Albian):* South Africa (Zululand).——FIG. 57,*1a,b.* **A. erasmusi;* ×0.1, (Hoepen, 1951c).

Parapuzosia NOWAK, 1913, p. 363 [**Sonneratia daubreei* GROSSOUVRE, 1894, p. 154; SD SPATH, 1922b, p. 126]. Very large; moderately involute; high-whorled; compressed with flat sides to rather inflated with convex sides; early whorls constricted, but sooner or later constrictions replaced by strong major ribs with short secondaries or intercalatories on outer one-third of side. *Upper Cretaceous (Upper Cenomanian–Campanian):* Europe, northern Africa, South Africa, Japan, Sakhalin, USA, Mexico, Curaçao, Argentina.

P. (**Austiniceras**) SPATH, 1922b, p. 127 [**Ammonites austeni* SHARPE, 1855, p. 28; OD]. Major ribs very distant until body chamber, where they approximate. *Upper Cretaceous (Upper Cenomanian, ?Upper Turonian):* Europe.——FIG. 58*a,b.* **P. (A.) austeni* (SHARPE), Upper Cenomanian, England; holotype, ×0.67 (Kennedy, 1971).

P. (**Parapuzosia**). Major ribs more or less close from early stage; body chamber of macroconchs becoming smooth. Macroconchs of late representatives include largest ammonites known, reaching diameter of 2.5 m. *Upper Cretaceous (?Coniacian, Lower Santonian–Campanian):* distribution as for genus.——FIG. 59,*2.* **P. (P.) daubreei* (GROSSOUVRE), Lower Santonian, France; ×0.5 (Grossouvre, 1894).

P. (**Grandidiericeras**) COLLIGNON, 1961, p. 17 [**G. grandidierorum;* OD]. Compressed, with narrow venter; thick, close ribs arising on umbilical wall or intercalated; constrictions weak or absent. Body chamber of macroconchs smooth and inflated. *Upper Cretaceous (Coniacian):* Japan. *Upper Cretaceous (Middle Campanian):* Madagascar.——FIG. 59,*1a,b.* **P. (G.) grandidierorum* (COLLIGNON), Middle Campanian, Madagascar; ×0.5 (Collignon, 1961).

Kitchinites SPATH, 1922b, p. 127 [**Holcodiscus pondycherryanus* KOSSMAT, 1897, p. 40(147); OD] [=*Neopuzosia* MATSUMOTO, 1954 (Oct.), p. 89 (March, 1954, *nom. nud.*) (type, *K. japonicus* SPATH, 1922b, p. 127; OD)]. Rather small, more or less compressed and high-whorled, with slightly convex or flat sides and distant, deep constrictions slightly truncating ribs in some and bending sharply forward on venter; at first smooth between constrictions, then with fine, close ribs, and later with strong, rounded ribs; ribs straight or flexuous, rectiradiate or prorsiradiate and, in some, strongly projected on venter. Later species tend to be more compressed with weaker ornament. *Upper Cretaceous (Santonian–Lower Maastrichtian):* Austria, Angola, Madagascar, southern India, Pacific Russia, Sakhalin, Japan, Western Australia, New Zealand, California, Chile, Argentina, Antarctica.——FIG. 57,*2a–c.* **K. pondycherryanus* (KOSSMAT), Campanian, southern India; ×1 (Kossmat, 1897).——FIG. 57,*2d,e. K. japonica* SPATH, Santonian, southern Sakhalin; *d,* ×0.75; *e,* enlarged (Matsumoto, 1954).

Subfamily SILESITOIDINAE Breistroffer, 1953

[Silesitoidinae BREISTROFFER, 1953b, p. 74]

Small, rather evolute forms, superficially like Silesitidae but without the characteristic ribbing of that family. *Lower Cretaceous (Upper Aptian–Middle Albian).*

Pseudosilesites EGOIAN, 1969, p. 179 [**P. seranoniformis;* OD]. Middle stage with flexuous ribs branching near umbilical edge; later with branching point moving outwards to ventrolateral shoulders; constrictions present. *Lower Cretaceous (Upper Aptian):* western Caucasus.——FIG. 60,*3a–c.* **P. seranoniformis; a,b,* ×1; *c,* ×5 (Mikhailova, 1972).

Silesitoides SPATH, 1925e, p. 103 [**Silesites escragnollensis* JACOB, 1908, p. 43; OD] [=*Jacobella* PASSENDORFER, 1930b, p. 637 (*non* JEANNET, 1908, p. 205), obj.]. Whorl section round or oval; smooth at first, later with distant, rigid ribs that may branch on outer third. *Lower Cretaceous (Lower Albian–Middle Albian):* France, Balearic Islands, Poland, northern Africa.——FIG. 60,*2.* **S. escragnollensis* (JACOB), Lower Albian, France; ×1 (Jacob, 1908).

Parasilesites IMLAY, 1959, p. 184 [**P. bullatus;* OD] [=*Pseudosilesitoides* BREISTROFFER, 1951, p. 267, *nom. nud.*]. Like *Silesitoides* but ribbing on outer whorl sinuous and branching from umbilical bullae. *Lower Cretaceous (Lower Albian–Middle Albian):* France, Balearic Islands, Sardinia, Poland, Alaska, Venezuela.——FIG. 60,*1a,b.* **P. bullatus,* Lower Albian, Alaska; *a,* ×1; *b,* ×2 (Imlay, 1959).

Subfamily BEUDANTICERATINAE Breistroffer, 1953

[Beudanticeratinae BREISTROFFER, 1953b, p. 74]

Mainly compressed, high-whorled, and rather involute; smooth or with distinct ribs that may be raised into umbilical swellings; with or without constrictions. *Lower Cretaceous (Upper Barremian–Upper Albian).*

Although similar to earlier Barremitinae, most readily separable; the smooth forms

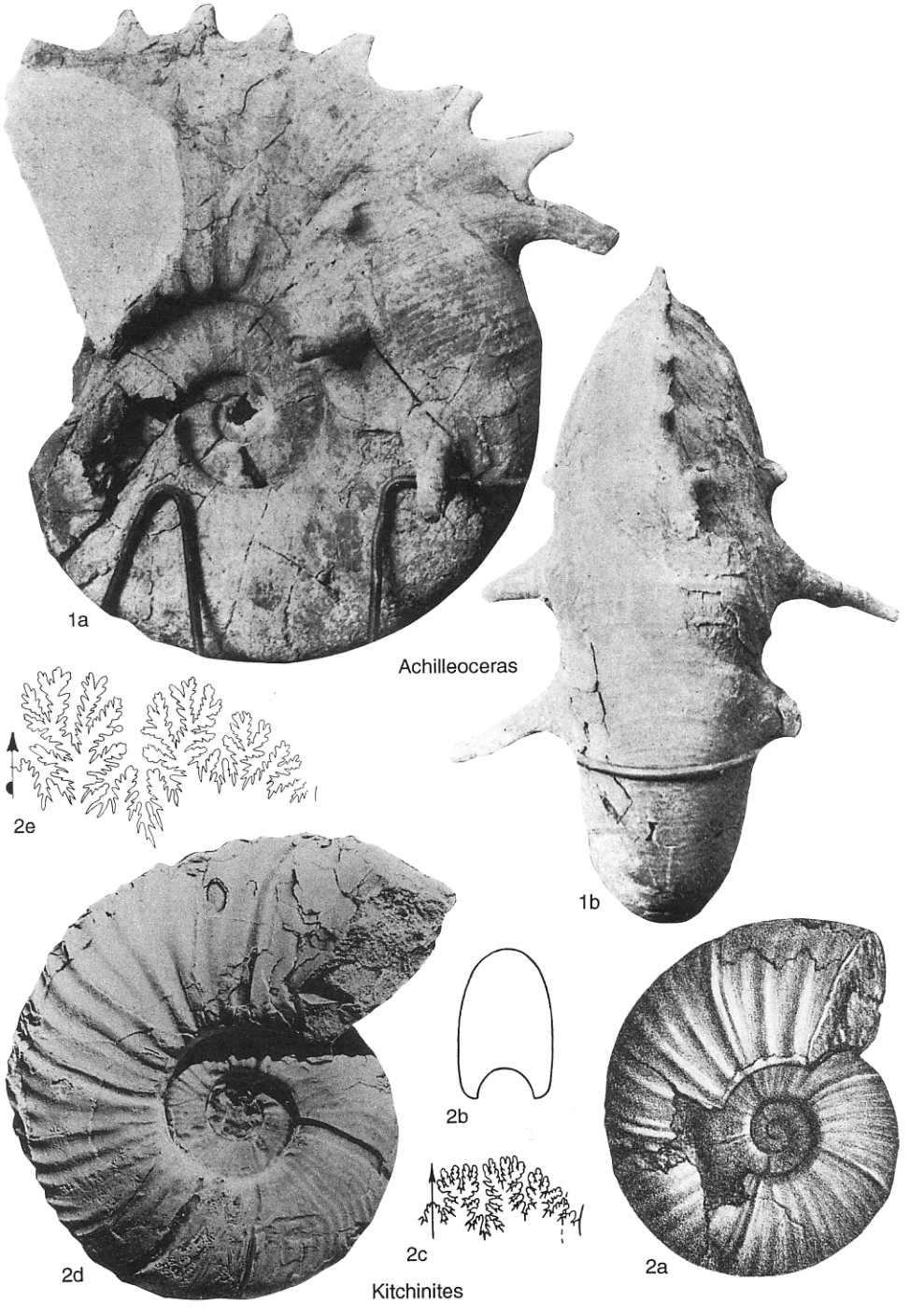


FIG. 57. Desmoceratidae (p. 78)



FIG. 58. Desmoceratidae (p. 78)

may include derivatives not only of *Uhligella* but also of various Cleoniceratidae. BREISTROFFER, 1947b; CASEY, 1954a; WRIGHT, 1955.

Zuercherella CASEY, 1954a, p. 112 [**Desmoceras zuercheri* JACOB & TOBLER, 1906, p. 9; OD] [=*Corteziceras* ETAYO SERNA, 1979, p. 27 (type, *C. cortezi;* OD)]. Similar in shape to its descendant *Uhligella* but with fine, sinuous ribs arising some distance above umbilical edge. *Lower Cretaceous (Upper Barremian–Upper Aptian):* Europe, northern Africa, eastern Africa, Mexico, Colombia.——FIG. 61,*2a,b.* **Z. zuercheri* (JACOB), Upper Aptian, Switzerland; ×1 (Jacob & Tobler, 1906).

Uhligella JACOB, 1907, p. 293 [**Desmoceras clansayense* JACOB, 1905, p. 403; SD KILIAN, 1907, p. 63]. High-whorled, with venter broadly or narrowly rounded, sides slightly convex to flat, and section typically broadest near umbilical edge; constrictions irregular and shallow; early whorls with strong or weak, sinuous, rounded main ribs distinctly raised into umbilical bullae, with several intercalated ribs; outer whorls smooth. *Lower Cretaceous (Upper Aptian–Middle Albian):* Europe, northern Africa, Venezuela.——FIG. 61,*3a–c.* **U. clansayensis* (JACOB), Lower Albian, France; *a,* paratype, ×1 (Jacob, 1905); *b,c,* holotype, ×1 (Casey, 1961d).

Beudanticeras HITZEL, 1902, p. 875 [**Ammonites beudanti* BRONGNIART in CUVIER & BRONGNIART, 1822, p. 95, 99, 394; OD]. Rather to very involute

and compressed; sides convex to flat; venter more or less narrowly arched but not acute; with or without shallow but distinct, prorsiradiate and sinuous, falcate or biconcave constrictions; smooth or with weak ribs; no tubercles. Suture finely divided. Probably includes offshoots of various more ornamented genera. *Lower Cretaceous (Lower Albian–Upper Albian):* Europe, Egypt (Sinai), Australia (Queensland), Japan, Alaska, British Columbia, Texas, Argentina (Patagonia), Greenland.

B. (Beudanticeras) [=*?Rapidoplacenticeras* ALABUSHEV, 1988, p. 110 (type, *Proplacenticeras sutherlandbrowni* MCLEARN, 1972, p. 56; OD)]. Moderately involute; umbilicus stepped, not funnel-shaped; whorl section generally slender. [*Rapidoplacenticeras* has slightly more complex saddle L/E but probably belongs here.] Occurrence and distribution as for genus.——FIG. 62,*1a–c.* **B. (B.) beudanti* (BRONGNIART), Upper Albian, England; *a,b,* ×0.75; *c,* ×2 (Casey, 1961a).

B. (Grantziceras) IMLAY, 1961, p. 56 (1960b, p. 105, *nom. nud.*) [**B. (G.) multiconstrictum;* OD] [=*?Pseudorbulites* CASEY, 1961d, p. 145 (BREISTROFFER, 1953b, p. 74, *nom. nud.*) (type, *Uhligella convergens* JACOB, 1908, p. 29; OD)]. Involute, with stout, elliptical whorl section and deep, funnel-shaped umbilicus; test striated; frequent constrictions falcoid to biconcave. *Lower Cretaceous (Lower Albian):* ?France, Spitsbergen, Alaska.——FIG. 62,*2a–c.* **B. (G.) multiconstrictum*, Alaska; *a,b,* ×0.75; *c,* ×1 (Imlay, 1961). ——FIG. 62,*2d,e. B. (G.)? convergens* (JACOB), France; ×1 (Casey, 1961d).

Boliteceras WHITEHOUSE, 1928a, p. 203 [**Ammonites daintreei* R. ETHERIDGE, 1872, p. 346; OD]. Rather involute and inflated, with broad, shallow, sinuous constrictions and fine, very feeble ribs; venter more broadly rounded than in *Beudanticeras.* A doubtful genus. *Lower Cretaceous (Upper Albian):* Australia (Queensland).——FIG. 61,*4. B. perlatum* WHITEHOUSE; ×0.5 (Whitehouse, 1928a).

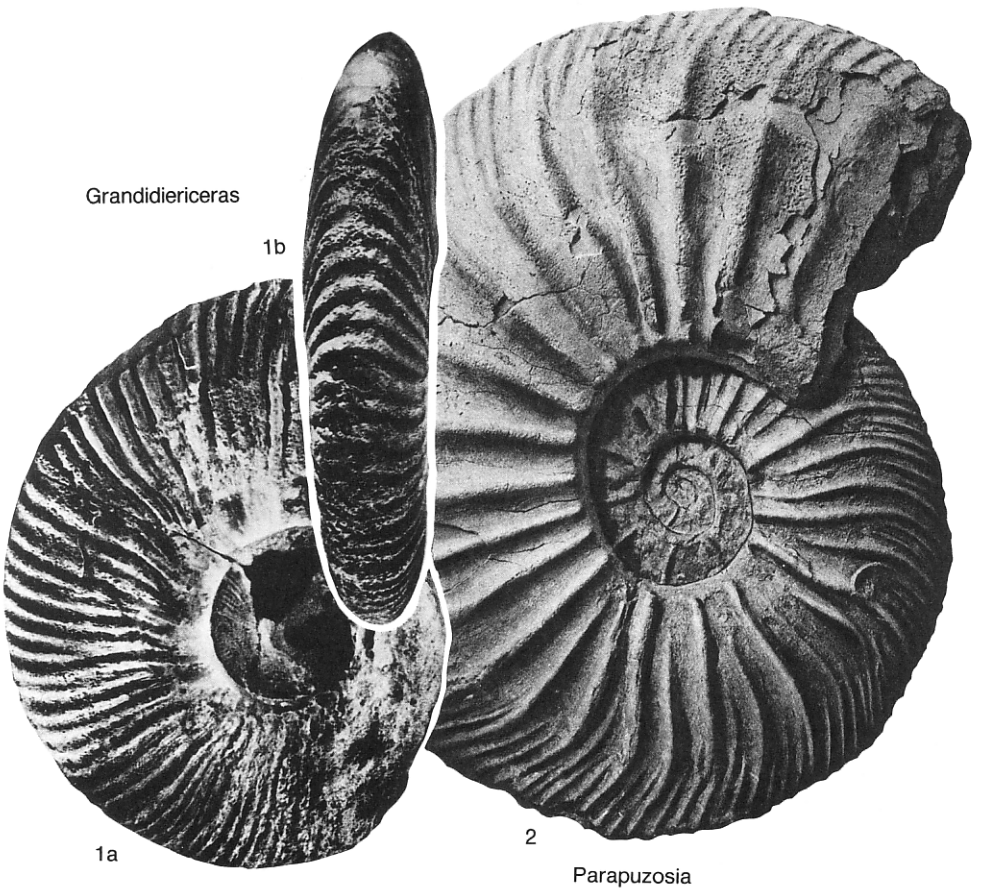


FIG. 59. Desmoceratidae (p. 78)

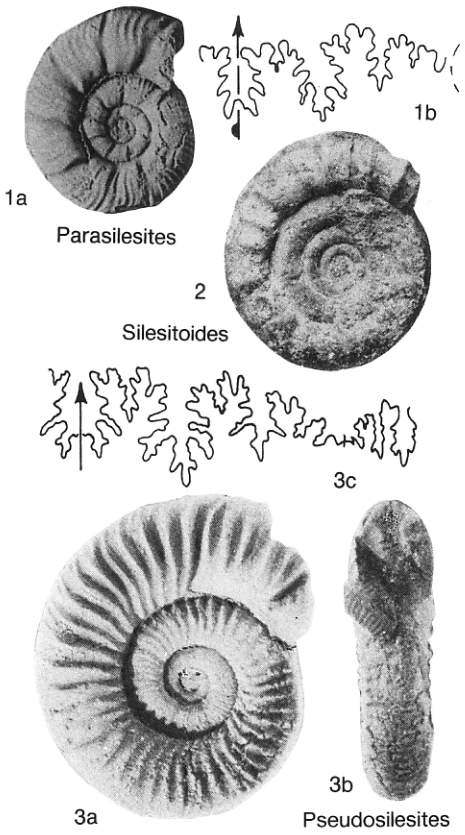


FIG. 60. Desmoceratidae (p. 78)

Cophinoceras WHITEHOUSE, 1928a, p. 204, *non* HYATT, 1900, p. 522, erroneous subsequent spelling of *Kophinoceras* HYATT, 1884, p. 285 [**C. ogilviei;* OD] [=*Beudantiella* BREISTROFFER, 1947b, p. 99(83)]. Similar to oval-whorled species of *Beudanticeras* but with sparse, nearly straight, prorsiradiate main ribs and short intercalatories. *Lower Cretaceous (Upper Albian):* Australia (Queensland).——FIG. 61,*1a,b.* **C. ogilviei;* ×0.3 (Whitehouse, 1928a).

Subfamily DESMOCERATINAE Zittel, 1895

[*nom. transl.* MATSUMOTO, 1938b, p. 190, *ex* Desmoceratidae ZITTEL, 1895, p. 426]

Involute, with little or no ornament except for collared constrictions and in some forms weak intermediate ribs on outer part of whorl; in one group venter tending to narrow, finally forming a keel. Suture with finely frilled elements and auxiliaries in regularly descending series, not retracted as in Puzosiinae. Microconchs with lappets. MATSUMOTO, 1954; WRIGHT, 1955. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Upper Maastrichtian).*

Desmoceras ZITTEL, 1885, p. 465 [**Ammonites latidorsatus* MICHELIN, 1838, p. 101; SD BÖHM, 1895, p. 364] [=*Latidorsella* JACOB, 1907, p. 295, obj.; *Phyllodesmoceras* SPATH, 1925e, p. 100 (type, *Ammonites valdedorsatus* REYNÈS, 1876, p. 93; OD); *Lunatodorsella* BREISTROFFER, 1947b, p. 76(60) (type, *Puzosia chirichensis* PERVINQUIÈRE, 1907, p. 152; OD)]. Moderately to very involute, with cadicone, depressed-rounded, subquadrate, or oval section; with or without straight to sigmoid constrictions forming strong, rounded ribs on shell; with dense striae or feeble ribs between constrictions on outer part of side and venter. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Lower Turonian):* Europe, Africa, Madagascar, southern India, Japan, Australia (Queensland), New Zealand, Alaska, British Columbia, California, Texas, Venezuela.

D. (Desmoceras). Whorl section cadicone to subquadrate; constrictions present or not. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Cenomanian):* distribution as for genus.——FIG. 63,*5a–c.* **D. (D.) latidorsatum* (MICHELIN), Middle Albian, France; *a,b,* ×0.75; *c,* enlarged (Orbigny, 1840–1842).

D. (Pseudouhligella) MATSUMOTO, 1938a, p. 22 [**Desmoceras dawsoni* var. *japonica* YABE, 1904, p. 35; OD]. Less involute than *D. (Desmoceras);* whorl section oval; constrictions and lirae biconcave. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Turonian):* France, Nigeria, Japan, New Zealand, Alaska, British Columbia, California.——FIG. 63,*3a–c.* **D. (P.) japonica* (YABE), ?Cenomanian, Japan; ×0.5 (Yabe, 1904).

Microdesmoceras MATSUMOTO & MURAMOTO in MATSUMOTO, MURAMOTO, & INOMA, 1972, p. 378 [**M. tetragonum;* OD]. Dwarf; nearly smooth; with simple suture; whorl section depressed at first but squarish on outer whorl. Coiling slightly scaphitoid. Internal mold with weak, sigmoid lirae and 4 feeble constrictions. *Upper Cretaceous (Cenomanian):* Japan.——FIG. 64,*1a–d.* **M. tetragonum; a–c,* ×1.3; *d,* ×4 (Matsumoto, Muramoto, & Inoma, 1972).

Moremanoceras COBBAN, 1971, p. 5 [**Tragodesmoceras scotti* MOREMAN, 1942, p. 208; OD]. Differs from *Desmoceras* in tendency to develop siphonal keel and in shorter and wider sutural elements with few auxiliaries. *Upper Cretaceous (Upper Cenomanian):* Wyoming, Texas, New Mexico, Colorado, Arizona.——FIG. 63,*1a,b.* **M. scotti* (MOREMAN), Texas; *a,* ×1; *b,* ×2 (Cobban, 1971).

Bassites COBBAN, 1987a, p. 1 [**B. reesidei;* OD]. Rather large derivative of *Moremanoceras* with weak, dense, flat ribs, no constrictions, and simple sutures. *Upper Cretaceous (Lower Turonian):* Kansas.

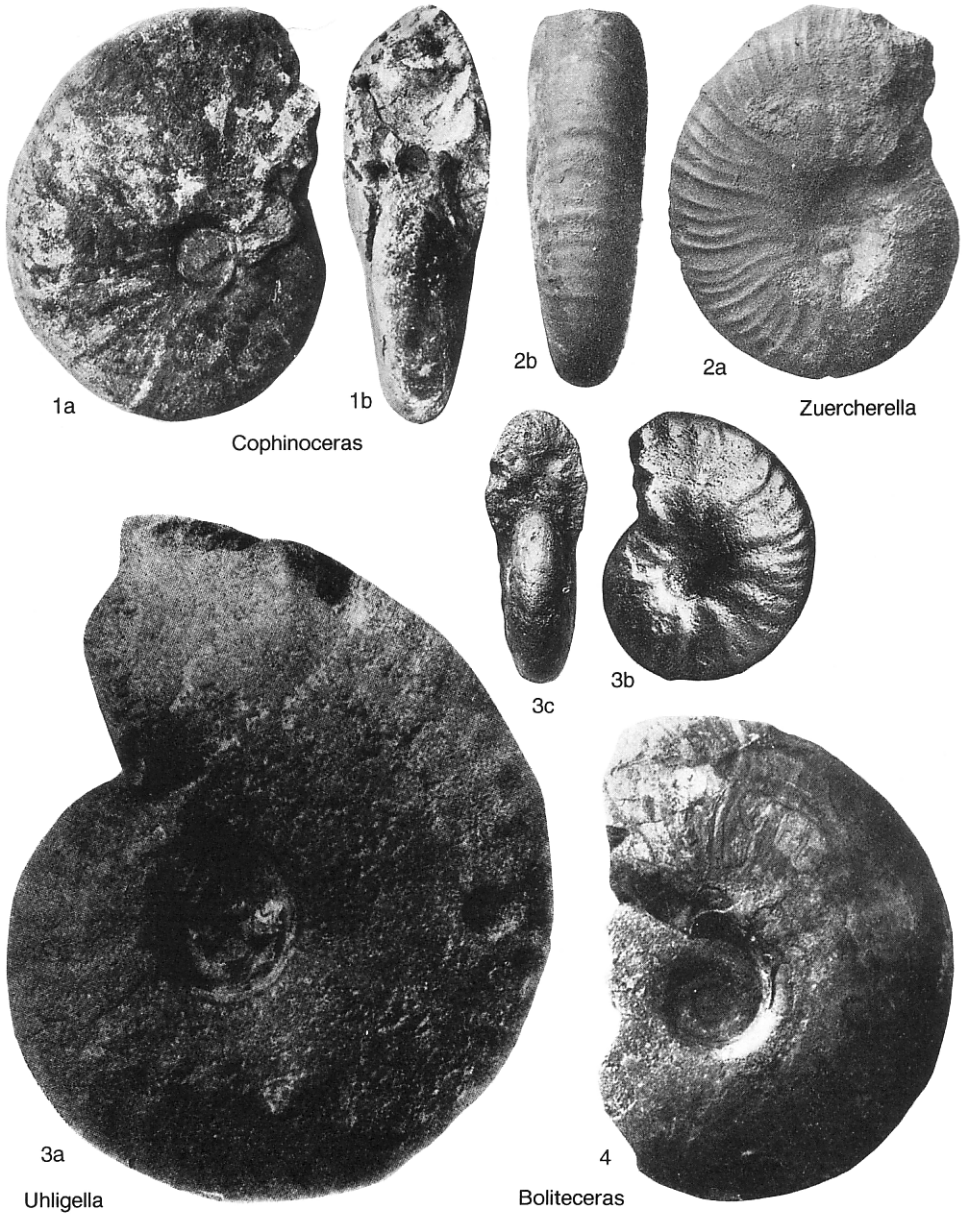


FIG. 61. Desmoceratidae (p. 80–82)

——FIG. 63,*2a–c.* **B. reesidei;* ×0.5 (Cobban, 1987a).

Tragodesmoceroides MATSUMOTO, 1942a, p. 24 [**T. subcostatus;* OD]. Very involute, moderately inflated; falcoid constrictions and sharp, dense, falcoid ribs or lirae on outer part of side strongly projected on venter; midline of venter tending to be raised. *Upper Cretaceous (Turonian–Lower Santonian):* Madagascar, USA, Japan.——FIG. 63,*4a,b.* **T. subcostatus,* Turonian, Japan; ×1 (Matsumoto, 1942a).

Damesites MATSUMOTO, 1942a, p. 24 (1938b, p. 193, *nom. nud.*), ICZN Opinion 555, 1959, Generic Name No. 1349 [**Desmoceras damesi* JIMBO, 1894, p. 26(172); OD; ICZN Specific Name No. 1630] [=*Kotoceras* YABE, 1927, p. 36, ICZN Rejected Name No. 1264, *non* KOBAYASHI, 1934, p. 391, obj.; *Neokotoceras* ANDERSON, 1958, p. 218 (type,

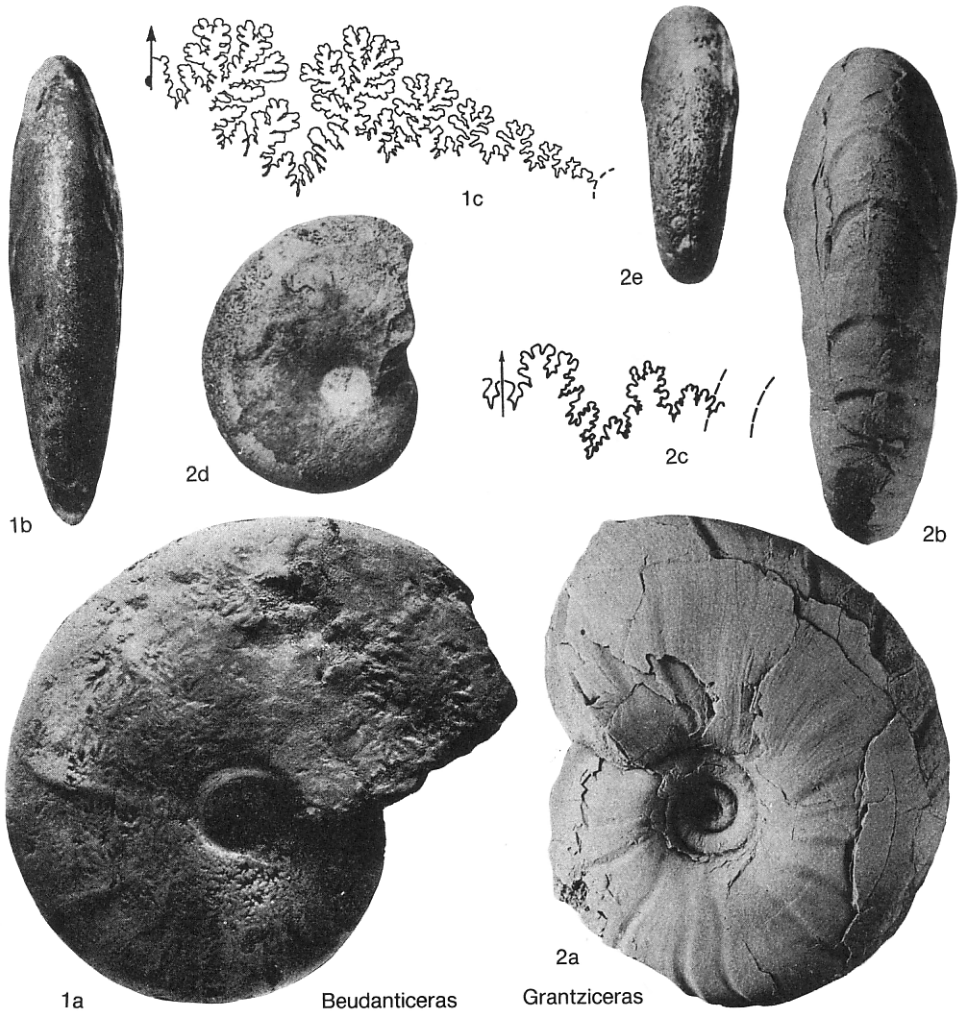


FIG. 62. Desmoceratidae (p. 81)

N. fresnoense; OD)]. Very involute, more or less compressed; sides flat and keel distinct; with falcoid, sinuous or concave constrictions and, in some species, fine ribs. *Upper Cretaceous (Cenomanian–Campanian):* Austria, Angola, Madagascar, southern India, Western Australia, Japan, British Columbia, USA.——FIG. 64,*2a,b. D. sugata* (FORBES), ?Santonian, southern India; ×1 (Kossmat, 1895–1898).——FIG. 64,*2c–e. D. semicostatus* MATSUMOTO, Santonian, Japan; ×1 (Obata & others, 1978).

Onitshoceras REYMENT, 1954b, p. 248 [**O. matsumotoi;* OD]. Moderately involute and inflated; whorl section subquadrate; numerous, thin, irregular ribs rising near umbilicus and strengthening on venter. Suture with very narrow lobes and one or more saddles projecting beyond line of suture. *Upper Cretaceous (Coniacian):* ?France, Nigeria.——FIG. 65,*1. *O. matsumotoi,* Coniacian, Nigeria; ×2 (Reyment, 1954b).

Desmophyllites SPATH, 1929, p. 270, *nom. nov. pro Schlueteria* GROSSOUVRE, 1894, p. 216, *non* FRITSCH in FRITSCH & KAFKA, 1887, p. 33 [**Desmoceras larteti* SEUNES, 1891, p. 19; SD SPATH, 1921b, p. 46, *pro Schlueteria*] [=*Schluetericeras* COLLIGNON, 1938, p. 92, *non* HYATT, 1903, p. 110, obj.]. Very involute, inflated to compressed, with rounded venter; with sinuous to falcoid or biconcave constrictions strongly projected and slightly collared on venter; shell smooth or finely striate. *Upper Cretaceous (Santonian–Upper Maastrichtian):* Ireland, France, Spain, Austria, northern Africa, southeastern Africa, Madagascar, southern India, Japan, Alaska, British Columbia, California.——FIG. 65,*2a,b. *D. larteti* (SEUNES), Upper Maastrichtian, France; ×1 (Seunes, 1891).

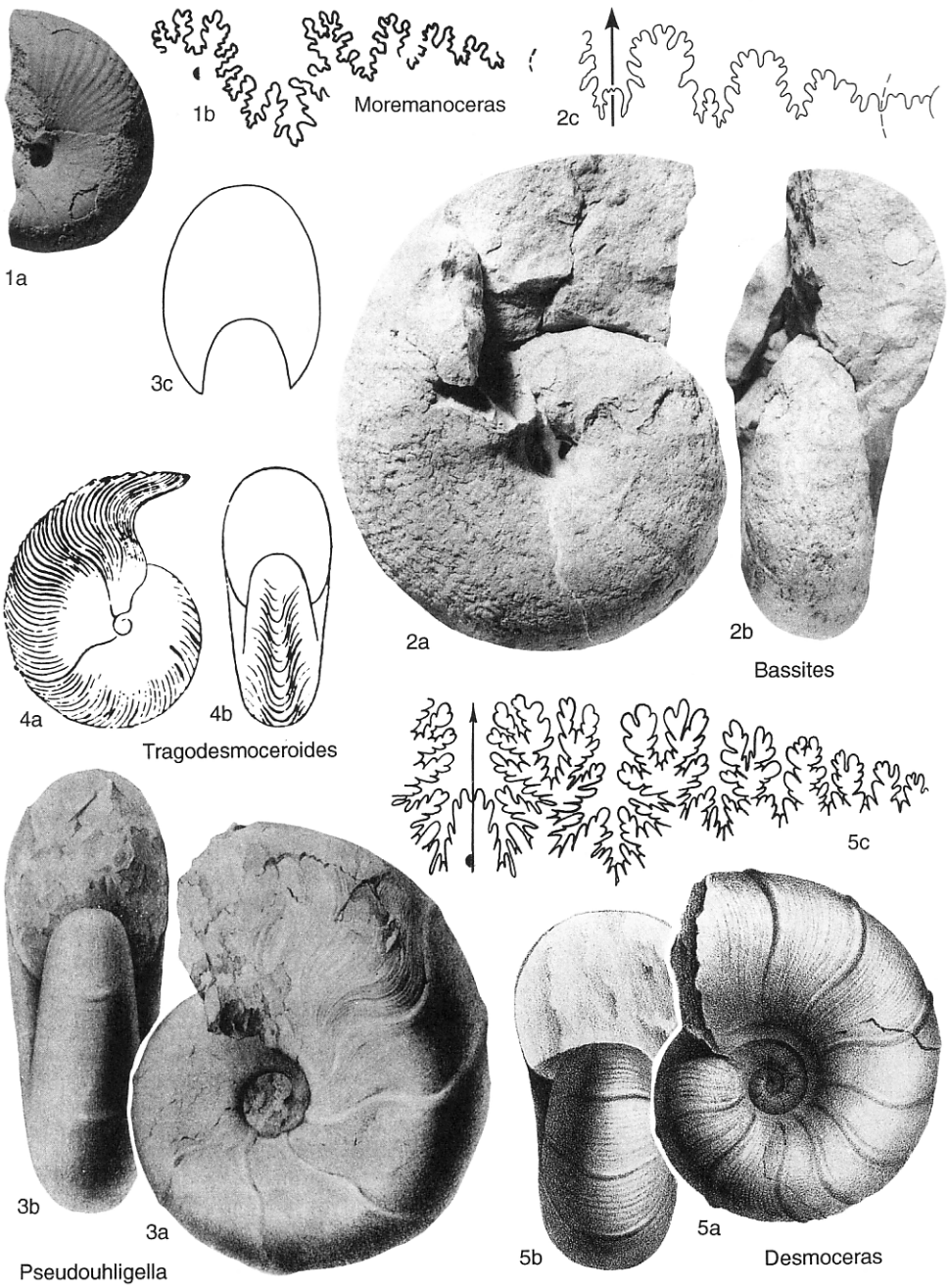


FIG. 63. Desmoceratidae (p. 82–83)

Subfamily HAUERICERATINAE Matsumoto, 1938

[Hauericeratinae MATSUMOTO, 1938b, p. 193]

Rather evolute to rather involute; whorl section high, with flat sides; venter rounded (at least initially), then typically fastigiate, and later with sharp, high, septicarinate keel. Smooth or with weak tubercles on shoulders. Microconchs with lappets. Suture with suspensive lobe retracted or not. *Upper Cretaceous (Coniacian–Maastrichtian).*

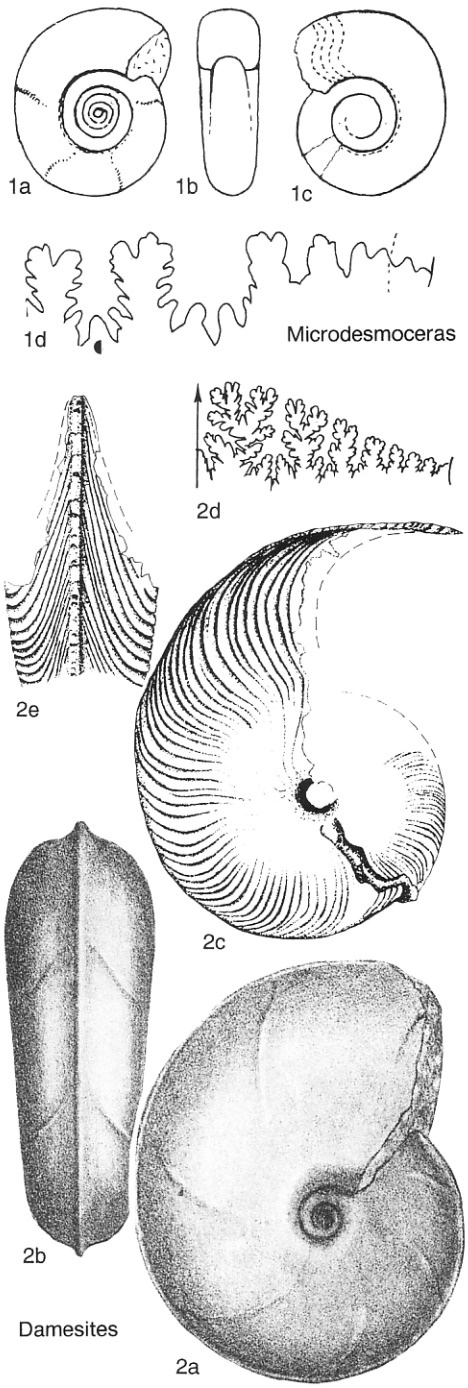


FIG. 64. Desmoceratidae (p. 82–84)

Origin is doubtful, either in Desmoceratinae close to point of origin of Muniericeratidae or in *Parapuzosia* of Puzosiinae.

Hauericeras GROSSOUVRE, 1894, p. 219 [**Ammonites pseudogardeni* SCHLÜTER, 1872, p. 54; OD] [=*Schlueteria* ROLLIER, 1922, p. 359, obj., *non* FRITSCH in FRITSCH & KAFKA, 1887, p. 33; *Pseudogardenia* TOMLIN, 1930, p. 23, obj.; *Gardeniceras* MATSUMOTO & OBATA, 1955, p. 134 (type, *Ammonites gardeni* BAILY, 1855, p. 450; OD)]. Characters as for subfamily. [Separation of *Gardeniceras* as subgenus for the less involute forms seems unnecessary.] *Upper Cretaceous (Coniacian–Maastrichtian):* Europe, South Africa, Madagascar, southern India, Japan, Western Australia, Victoria.——FIG. 66*a–d.* **H. pseudogardeni* (SCHLÜTER), Lower Campanian, Germany; macroconch, ×0.25 (Schlüter, 1871–1876).——FIG. 66*e. H. angustum* YABE, Santonian, Japan; microconch, ×0.5 (Obata & others, 1978).

?Oiophyllites SPATH, 1953, p. 21 [**O. decipiens;* OD]. Rather involute, very compressed, with narrowly rounded venter and almost flat sides; umbilical edge rounded; surface smooth except for sinuous striae. Suture simple and tending to have phylloid folioles. May be related to *Hauericeras. Upper Cretaceous (Campanian):* Antarctica (Graham Land), ?Angola.

Family SILESITIDAE Hyatt, 1900

[Silesitidae HYATT, 1900, p. 570]

Evolute, with oval or compressed whorl section; whorl height increasing slowly; inner whorls smooth, with constrictions; middle and later whorls with distant, broad or dense, fine ribs. Suture distinctly concave, with auxiliaries tending to curve forward in advance of first lateral saddle. FALLOT, 1921; UHLIG, 1883. *Lower Cretaceous (Barremian–Lower Albian).*

Probably derived from early *Barremites.*

Silesites UHLIG, 1883, p. 233, *nom. nov. pro Beneckeia* UHLIG, 1882a, p. 88, *non* MOJSISOVICS, 1882, p. 183 [**Ammonites seranonis* ORBIGNY, 1841, p. 361; OD]. Whorl section oval; constrictions regular and moderately deep; ribs radial and straight on inner part of sides but strongly projected on outer, forming chevrons on venter; a small tubercle may occur where rib bends below shoulder. *Lower Cretaceous (Barremian):* southern and central Europe, northern Africa, California, Argentina (Patagonia), Antarctica (Alexander Island).——FIG. 67,*4a,b.* **S. seranonis* (ORBIGNY), France; ×1 (Kilian, 1889a).

Neosilesites BREISTROFFER, 1951, p. 267 [**Silesites seranonis* var. *balearensis* FALLOT, 1920, p. 55; OD] [=*Neposiella* MAHMOUD, 1953, p. 286 (BREISTROFFER, 1952b, p. 2635, *nom. nud.)* (type, *Silesites nepos* H. DOUVILLÉ, 1917, p. 109)]. Sides flat or convex; venter broadly rounded; with sparse or dense, sharp primary ribs splitting on outer part of sides into fine secondaries that pass over venter. *Lower Cretaceous (Upper Aptian–Lower Albian):* Balearic Islands, Austria, Tunisia, Egypt (Sinai), Madagascar.——

FIG. 67,*1a–c.* **N. balearensis* (FALLOT), Upper Aptian, Balearic Islands; *a,b,* ×1 (Fallot, 1920); *c,* ×10 (Wiedmann, 1966b).——Fig. 67,*1d. N. nepos* (H. DOUVILLÉ), Lower Albian, Sinai; ×1 (H. Douvillé, 1917).

Neoastieria EGOIAN, 1969, p. 149 [**N. reliqua;* OD]. More inflated than *Neosilesites,* with distinct, oblique tubercles at point where distant primary ribs branch into fine secondaries, thus giving almost coronate whorl section. *Lower Cretaceous (Upper Aptian):* Caucasus.——FIG. 67,*3a,b.* **N. reliqua;* ×2 (Egoian, 1969).

Miyakoceras OBATA, 1967, p. 130 [**M. tanohatense;* OD]. Small; ribs fine, dense, sinuous, single or branching, occasionally with ventrolateral tubercle; frequent, strong constrictions with enlarged rib behind. Suture with rather shallow, irregular elements. *Lower Cretaceous (Upper Aptian):* Japan.——FIG. 67,*2a–c.* **M. tanohatense; a,b,* ×2; *c,* ×5 (Obata, 1967).

Family KOSSMATICERATIDAE Spath, 1922

[*nom. transl.* SPATH, 1923d, p. 35, *ex* Kossmaticeratinae SPATH, 1922b, p. 134]

Compressed to inflated, rather involute to evolute, with fine to coarse, radial or prorsiradiate ribs interrupted on venter or not; ribs typically truncated by still more oblique constrictions; tubercles present or not. Microconchs lappeted. *Lower Cretaceous (Upper Aptian, Lower Albian)–Upper Cretaceous (Upper Maastrichtian).*

A late Aptian to Turonian group of genera, Marshallitinae, is derived from Puzosiinae, probably *Pseudohaploceras;* a later Turonian to Maastrichtian group is conventionally separated as the subfamily Kossmaticeratinae. MATSUMOTO (1991) points out that the inner whorls of earliest Kossmaticeratinae resemble contemporary Puzosiinae more than they do latest Marshallitinae, but there is no clear morphological distinction between Marshallitinae and Kossmaticeratinae, and they are here regarded as successive subfamilies of Kossmaticeratidae.

Subfamily MARSHALLITINAE Matsumoto, 1955

[Marshallitinae MATSUMOTO, 1955b, p. 119]

An early group of variable kossmaticeratids, more or less homeomorphous with the later Kossmaticeratinae. *Lower Cretaceous (?Upper Aptian, ?Lower Albian, Upper Albian)–Upper Cretaceous (Turonian).*

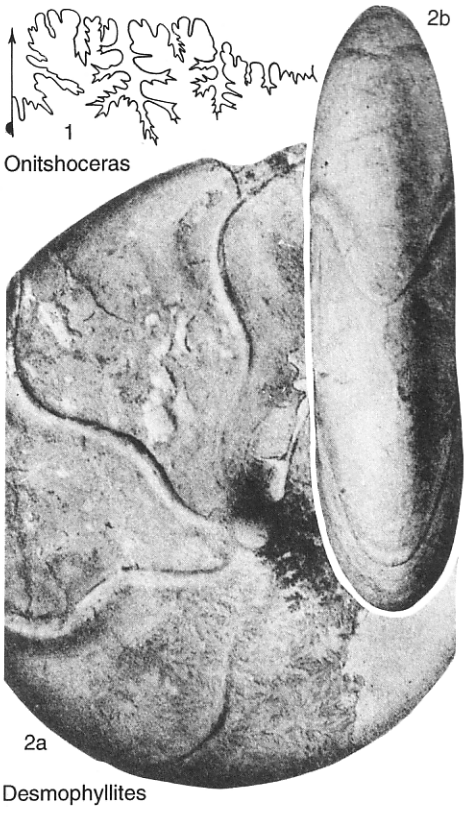


FIG. 65. Desmoceratidae (p. 84)

Hulenites MATSUMOTO, 1955b, p. 122 [**Puzosia reesidei* ANDERSON, 1938, p. 187; OD]. Like compressed *Puzosia* but more involute, with flexuous ribs and prorsiradiate constrictions more distinct; internal mold may show spiral depression; venter tending to flatten and ribs to weaken on it. *Lower Cretaceous (?Upper Aptian, Albian):* Alaska, California.——FIG. 68,*4.* **H. reesidei* (ANDERSON), Albian, California; ×1 (Anderson, 1938).

Marshallites MATSUMOTO, 1955b, p. 119 (1954, p. 15, *nom. nud.*) [**M. compressus;* OD]. Varying from compressed, high-whorled, and involute to inflated and more evolute; ribs fine and flexuous, springing in bundles from weak umbilical bullae and truncated by frequent, prorsiradiate constrictions. Very much like *Maorites* (Campanian), but umbilical tubercles weaker. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Upper Cenomanian):* South Africa (Zululand), southern India, Japan, ?New Zealand, Alaska, British Columbia.——FIG. 68,*2a–c.* **M. compressus,* Cenomanian, Japan; *a,b,* ×1; *c,* ×2 (Matsumoto, 1955b).

Eomarshallites MEDINA & RINALDI, 1986, p. 17 [**E. espinosum;* OD]. Like *Marshallites,* but juvenile whorls with small ventrolateral tubercles, thus resembling Turonian *Holcodiscoides. Lower Cretaceous (Upper Albian):* Argentina (Patagonia).——FIG.

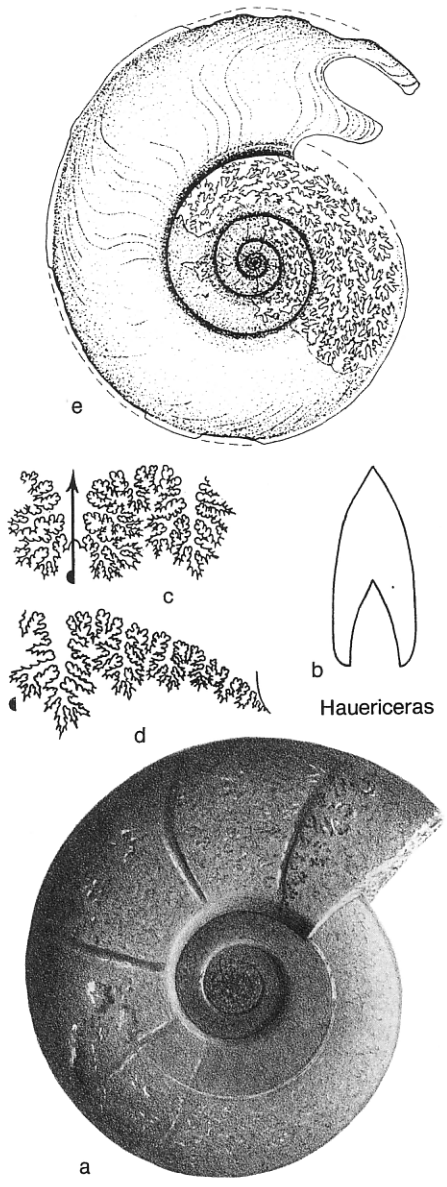


FIG. 66. Desmoceratidae (p. 86)

68,*3a,b.* **E. espinosum,* holotype; ×1 (Medina & Rinaldi, 1986).

Yeharites MATSUMOTO, 1991, p. 8 [**Y. kobayashii* MATSUMOTO & TAKAHASHI in MATSUMOTO, 1991, p. 46; OD]. Moderately compressed, with sharply rounded shoulders and more or less flat venter; ribs on outer whorl strong, of variable length, mostly single, crossing venter transversely. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian):* Japan, British Columbia.——FIG. 69,*7a,b.* **Y. kobayashii,* Japan; ×0.7 (Matsumoto, 1991).

Yakushiceras MATSUMOTO, 1991, p. 10 [**Y. takahashii;* OD]. Rather evolute; whorl section compressed, suboval; venter flattened; ribs predominantly single, dense on inner whorls, distant on outer, with feeble or no umbilical bullae, but all with subdued ventrolateral tubercles. *Upper Cretaceous (Lower Cenomanian):* Japan.——FIG. 68,*6a,b.* **Y. takahashii;* holotype; ×1 (Matsumoto, 1991).

Maccarthyites MATSUMOTO, 1959, p. 67 [**M. gracilis;* OD]. Compressed, moderately involute; venter on later whorls tending to be fastigiate; most of phragmocone with few or no ribs but with strong, collared constrictions; last whorl with mainly single ribs of varying length, distinctly raised siphonally. *Upper Cretaceous (Cenomanian):* Japan, Alaska.——FIG. 69,*6a,b.* **M. gracilis,* Alaska; ×2 (Matsumoto, 1959).

Protokossmaticeras COLLIGNON, 1964, p. 19 [**P. madagascariense;* OD]. Similar to some *Marshallites,* but inner whorls inflated and with more distinct umbilical tubercles. Perhaps synonymous. *Lower Cretaceous (?Upper Albian):* southern India. *Upper Cretaceous (Lower Cenomanian):* Madagascar, Japan.——FIG. 69,*4a,b.* **P. madagascariense* COLLIGNON, Lower Cenomanian, Madagascar; ×1 (Collignon, 1964).

Holcodiscoides SPATH, 1922b, p. 124 [**Ammonites cliveanus* STOLICZKA, 1866, p. 157; OD]. Less involute and densely ribbed than *Marshallites* and with subquadrate whorl section; sides flat; venter of outer whorl bordered by rather sparse ventrolateral tubercles. *Upper Cretaceous (Turonian):* southern India.——FIG. 68,*5a–c.* **H. cliveanus* (STOLICZKA); ×1 (Stoliczka, 1863–1865).

?Moffitites IMLAY, 1959, p. 181 [**M. robustus;* OD]. Very inflated, with depressed whorl section; primary ribs close, regular, and slightly flexuous, branching at midflank into fine secondaries that tend to become lirae on venter; no umbilical tubercles. Suture with auxiliaries not retracted. *Lower Cretaceous (Lower Albian):* Alaska.——FIG. 69,*3a–c.* **M. robustus; a,b,* ×1; *c,* ×2 (Imlay, 1959).

Eogunnarites WRIGHT & MATSUMOTO, 1954, p. 125 (MATSUMOTO, 1942b, p. 149, *nom. nud.*) [**Olcostephanus unicus* YABE, 1904, p. 28; OD] [=?*Sounnaites* MATSUMOTO & INOMA in MATSUMOTO, 1991, p. 110 (type, *Eogunnarites alaskensis* MATSUMOTO, 1959, p. 66; OD)]. Rather involute to rather evolute; depressed; umbilicus deep, with angular edge; fine, slightly curved ribs springing singly or bundled in threes and fours from weak to prominent umbilical tubercles; additional ribs intercalated; constrictions regular, each truncating 3 or 4 ribs. Microconchs with coarse ribs on outer whorl, which may develop ventrolateral tubercles or be strongly flared towards the aperture. [*Sounnaites,* for large forms with weak or no umbilical tubercles on inner whorls, probably comprises macroconchs of *Eogunnarites.*] *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Cenomanian):* southern India,

eastern Russia, Japan, Alaska.——FIG. 69,*2a,b.* **E. unicus* (YABE), Cenomanian, Japan; ×1 (Wright & Matsumoto, 1954).——FIG. 69,*2c,d. E. alaskensis* (MATSUMOTO), Cenomanian, Alaska; ×0.4 (Matsumoto, 1959).

Mikasaites MATSUMOTO, 1956, p. 174 [**M. orbicularis;* OD]. Similar to some *Eogunnarites* but with slightly angular venter and strong, close siphonal tubercles, at which the fine ribs mostly reunite. *Upper Cretaceous (Lower Cenomanian):* eastern Russia, Japan. ——FIG. 69,*5a,b.* **M. orbicularis* MATSUMOTO; ×1.5 (Matsumoto, 1956).

Eomadrasites MATSUMOTO, 1955b, p. 132 (1954, p. 15, *nom. nud.*) [**E. nipponicus;* OD]. Less depressed and inflated than *Eogunnarites* and with sparse, irregular, large inner lateral, ventrolateral, and siphonal tubercles and irregular ribs, some looped. *Upper Cretaceous (Cenomanian):* Japan.——FIG. 69,*1a,b.* **E. nipponicus;* ×1 (Matsumoto, 1955b).

Wellmanites WRIGHT, 1957a, p. 808 [**W. zelandicus;* OD]. Small to medium-sized; rather evolute with depressed-rounded whorl section or with somewhat flattened sides; 4 or 5 deep constrictions to a whorl, with high collars, rectiradiate on sides, then projected; 1 to 3 long, sharp lateral spines and feeble ribs between each pair of constrictions; adult body chamber with large ventrolateral and siphonal spines. *Lower Cretaceous (Cenomanian):* Japan, New Zealand, Alaska.——FIG. 68,*1a–c.* **W. zelandicus,* New Zealand; *a,b,* holotype; *c,* paratype, all ×1 (Henderson, 1973).——FIG. 68,*1d. W. japonicus* MATSUMOTO, TAKAHASHI, & SANADA, Upper Cenomanian, Japan; holotype, ×1 (Matsumoto, 1991).

[**Jacobitoides** MATSUMOTO, 1954, p. 15 (*nom. nud.*)].

Subfamily KOSSMATICERATINAE Spath, 1922

[Kossmaticeratinae SPATH, 1922b, p. 134] [=Brahmaitinae COLLIGNON, 1977, p. 20]

A very variable group, probably but not certainly derived from Marshallitinae; many genera in the two subfamilies are homeomorphous. *Upper Cretaceous (Upper Turonian–Maastrichtian).*

Kossmaticeras GROSSOUVRE, 1901, p. 719 [**Ammonites theobaldianus* STOLICZKA, 1866, p. 161; SD DIENER, 1925, p. 96] [=*Pseudoholcodiscus* KILIAN & REBOUL, 1909, p. 19, *nom. nud.; Madrasites* KILIAN & REBOUL, 1909, p. 28 (type, *Ammonites theobaldianus* STOLICZKA, 1866, p. 161; SD WRIGHT, herein)]. Moderately evolute; whorl section oval to compressed; ribs more or less dense, fairly strong, simple, branched or intercalated; ribs arising from weak to strong umbilical tubercles, commonly strengthening on body chamber. Suture moderately indented. *Upper Cretaceous (Upper Turonian–Campanian):* Austria, South Africa, Western Australia,

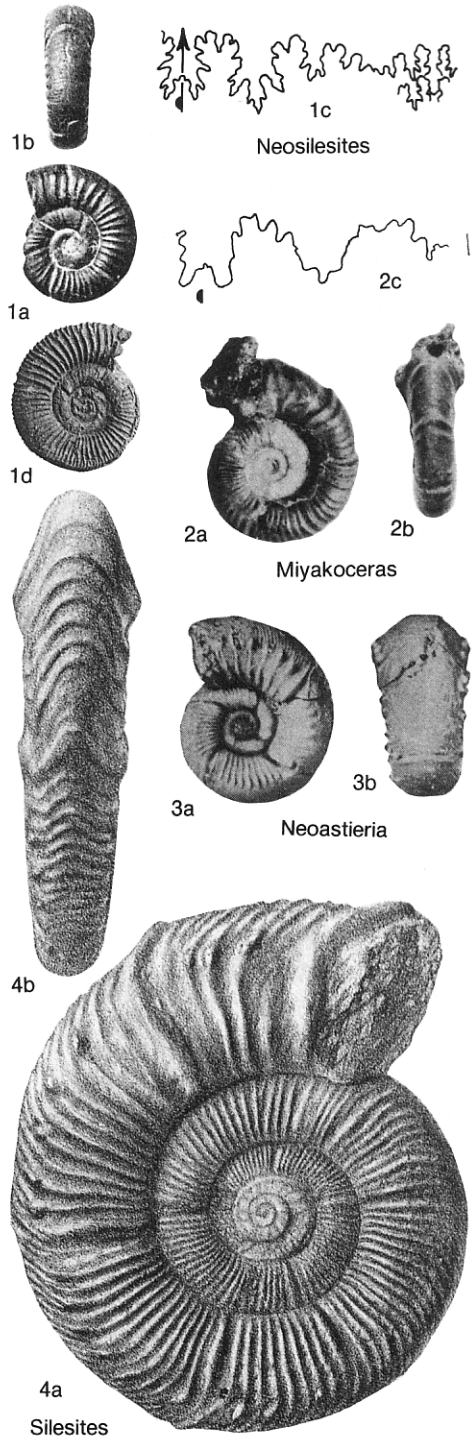


FIG. 67. Silesitidae (p. 86–87)

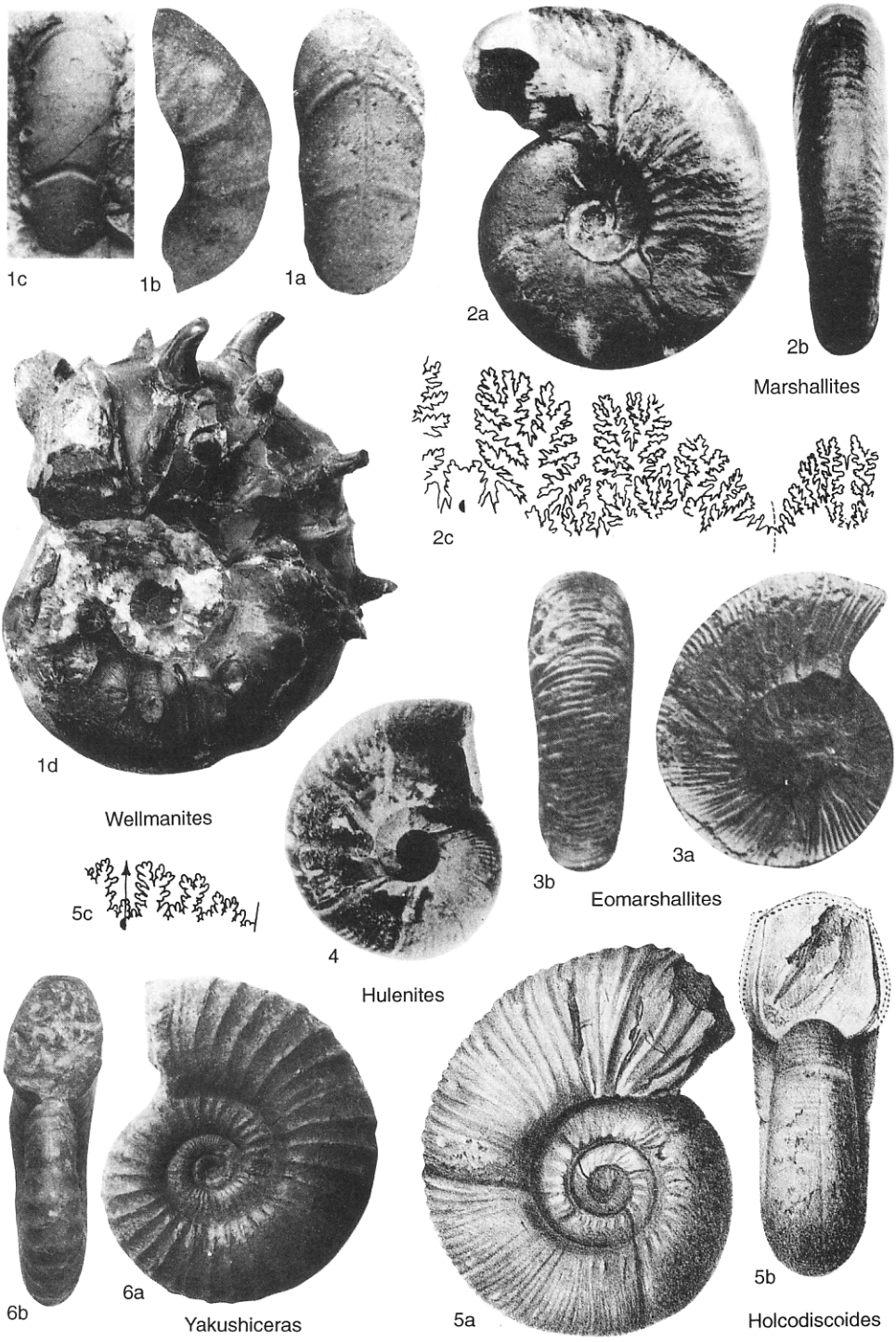


FIG. 68. Kossmaticeratidae (p. 87–89)

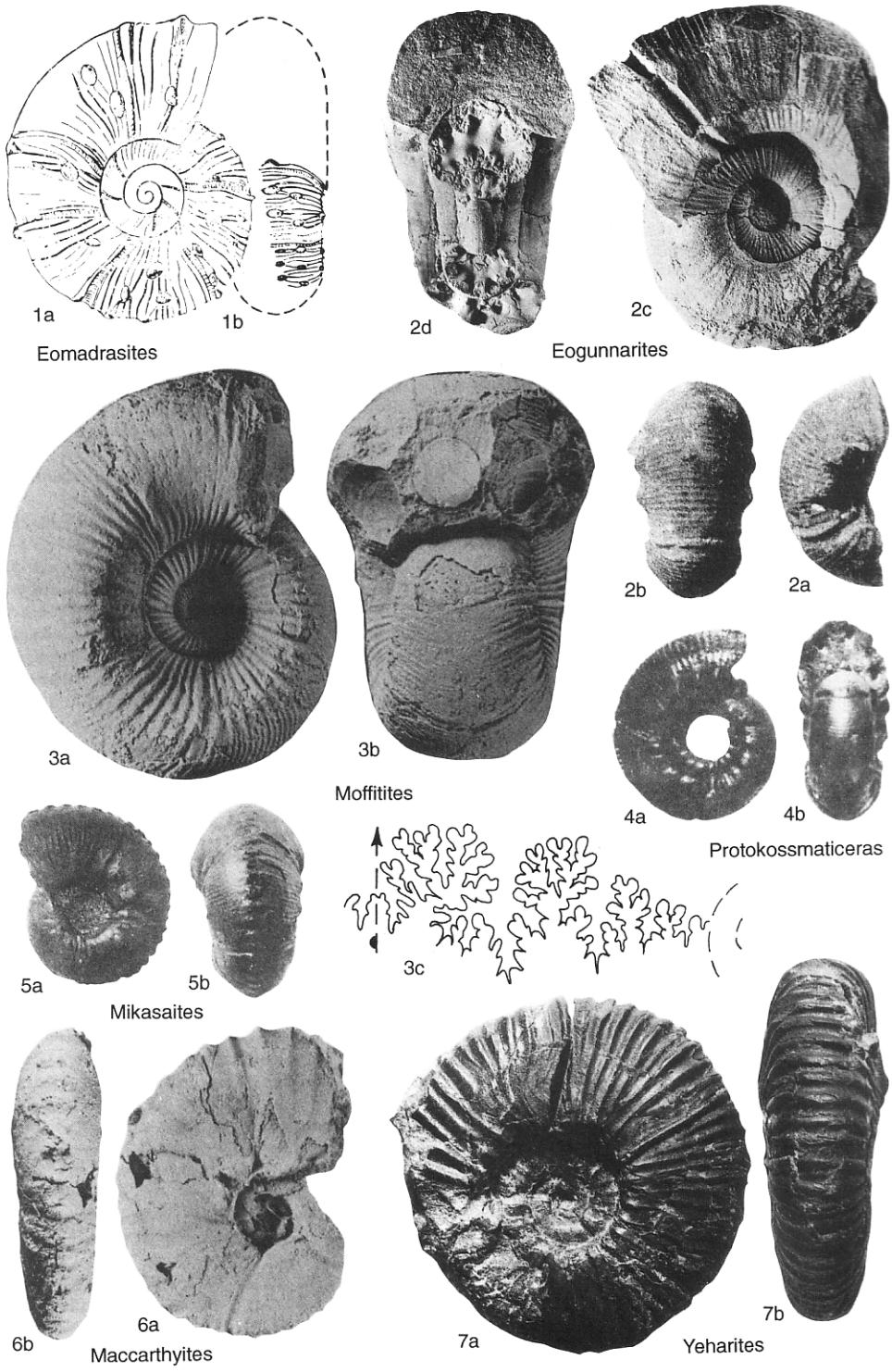


FIG. 69. Kossmaticeratidae (p. 88–89)

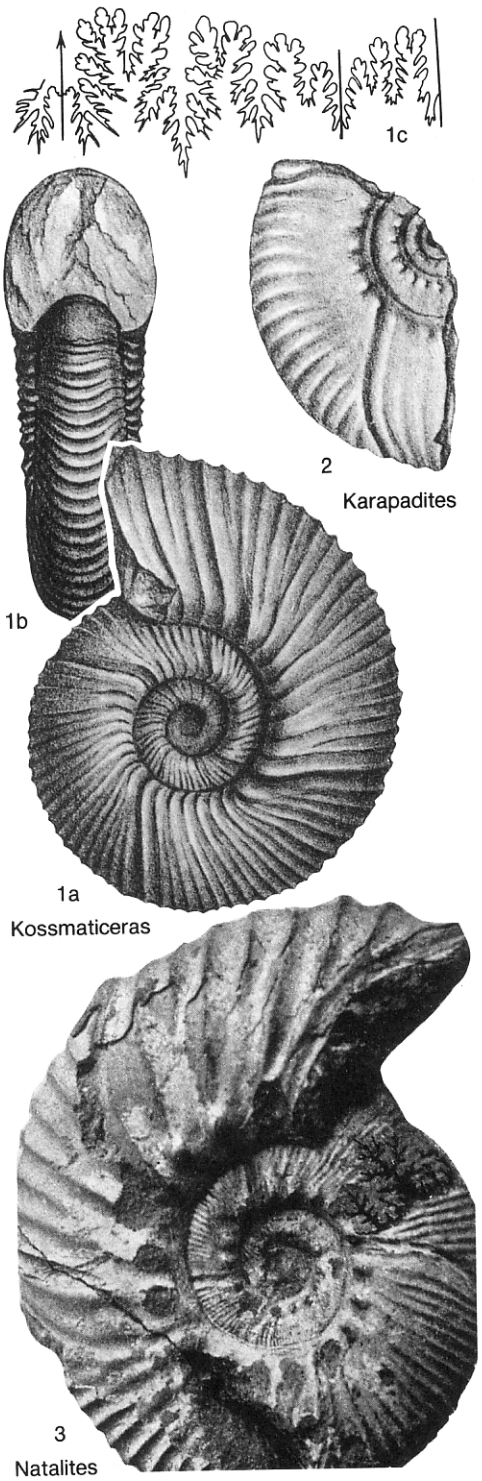


FIG. 70. Kossmaticeratidae (p. 89–92)

Madagascar, southern India, Japan, New Zealand, Argentina (Patagonia), Antarctica (Graham Land).

K. (Kossmaticeras). Umbilical tubercles very weak; whorl section generally oval. *Upper Cretaceous (Upper Turonian–Santonian):* Austria, South Africa, Madagascar, southern India, Japan, New Zealand.——FIG. 70,*1a–c.* **K. (K.) theobaldianum* (STOLICZKA), Santonian, southern India; ×1 (Kossmat, 1895–1898).

K. (Natalites) COLLIGNON, 1954, p. 6 [**Madrasites natalensis* SPATH, 1922b, p. 134; OD; =*Holcodiscus africanus* HOEPEN, 1920, p. 146] [=*Kaiparaites* MATSUMOTO, 1955b, p. 142 (type, *Madrasites multicostatus* MARSHALL, 1926, p. 164; OD)]. Whorl section round to compressed; umbilical tubercles distinct to prominent. *Upper Cretaceous (Coniacian, Campanian):* South Africa, southern India, Western Australia, Japan, New Zealand, Argentina (Patagonia), Antarctica (Graham Land).——FIG. 70,*3.* **K. (N.) africanus* (HOEPEN), Campanian, South Africa (Pondoland); ×1 (Spath, 1922b).

K. (Karapadites) COLLIGNON, 1954, p. 6 [**Holcodiscus karapadensis* KOSSMAT, 1897, p. 41(148); OD] [=*Karapadites* MATSUMOTO, 1955b, p. 143, obj.]. Sides flat; ribs absent or weak on midsides, at least in early and middle growth, but distinct umbilical tubercles invariably present. *Upper Cretaceous (Upper Campanian):* Madagascar, southern India.——FIG. 70,*2.* **K. (K.) karapadense* (KOSSMAT), southern India; ×1 (Kossmat, 1895–1898).

Yokoyamaoceras WRIGHT & MATSUMOTO, 1954, p. 128 (SHIMIZU, 1935a, p. 198, *nom. nud.*) [**Holcodiscus kotoi* JIMBO, 1894, p. 33(179); OD]. Small, evolute, and compressed, with flat venter; in middle growth fine, flexuous ribs ending at small ventrolateral tubercles but crossing venter on body chamber. Like *Holcodiscoides,* but inner whorls without umbilical tubercles. Some or all described species are microconchs, presumably of contemporary *Kossmaticeras,* but dimorphic pairs have not been recognized. *Upper Cretaceous (?Turonian, Coniacian):* ?southern India, Japan.——FIG. 71,*2a,b.* **Y. kotoi* (JIMBO), Coniacian, Japan; ×1 (Wright & Matsumoto, 1954).——FIG. 71,*2c. Y.* aff. *minimum* MATSUMOTO, Coniacian, Japan; microconch, ×1 (Obata & others, 1978).

Grossouvreites KILIAN & REBOUL, 1909, p. 26 [**Ammonites gemmatus* HUPÉ, 1854, p. 35; OD]. Ribs very fine and dense in young, springing in bundles from umbilical tubercles, later coarse. Perhaps a subgenus of *Kossmaticeras. Upper Cretaceous (Campanian):* Chile, Antarctica (Graham Land).——FIG. 71,*4a,b.* **G. gemmatus* (HUPÉ), Chile; ×0.75 (Steinmann, 1895).

Gunnarites KILIAN & REBOUL, 1909, p. 26 [**Olcostephanus antarcticus* WELLER, 1903, p. 417; SD DIENER, 1925, p. 101]. Like *Kossmaticeras (Natalites)* but with ribs stronger, more regular, invariably crenulate; compressed with fine ribs to round-whorled with coarse ribs. *Upper Cretaceous (Campanian):* southern India, New Zealand, Ant-

arctica (Graham Land).——FIG. 71,*3a,b.* **G. antarcticus* (WELLER), Graham Land; ×0.7 (Spath, 1953).

Maorites MARSHALL, 1926, p. 173 [**Kossmaticeras tenuicostatum* MARSHALL, 1917, p. 445; OD]. Involute, compressed, high-whorled, with flat sides; with very dense, fine, flexuous ribs and distinct umbilical tubercles; ribs either fine throughout or becoming very coarse. Suture very finely divided. *Upper Cretaceous (Campanian):* South Africa (Zululand), Madagascar, southern India, New Caledonia, New Zealand, Argentina, Antarctica (Graham Land).

M. (**Maorites**). Ribs fine throughout. Occurrence and distribution as for genus.——FIG. 71,*1a,b.* **M. (M.) tenuicostatum* (MARSHALL), New Zealand; *a,* ×0.7; *b,* ×1.5 (Marshall, 1926).

M. (**Caledonites**) COLLIGNON, 1977, p. 14 [**C. neocaledonicus;* OD]. Inner whorls as in *M. (Maorites),* but outer developing coarse ribs springing in bundles from large umbilical spines. Occurrence as for genus: New Caledonia.

Pseudokossmaticeras SPATH, 1922b, p. 126 [**Ammonites pacificus* STOLICZKA, 1866, p. 160; OD]. Round-whorled, with rectiradiate, single ribs in adult; subdued umbilical tubercles persisting. *Upper Cretaceous (?Upper Campanian, Lower Maastrichtian–Upper Maastrichtian):* Germany, Austria, Poland, Ukraine, Armenia, Turkey, Madagascar, southern India, USA, Argentina (Patagonia).——FIG. 72,*1a–c.* **P. pacificum* (STOLICZKA), Maastrichtian, southern India; ×1 (Stoliczka, 1866).

Neograhamites SPATH, 1953, p. 27 [**N. kiliani;* OD]. Small; at first with fine (later with coarse) straight ribs branching from umbilical tubercles. *Upper Cretaceous (Campanian):* South Africa (Pondoland), New Caledonia, New Zealand, Argentina (Patagonia), Antarctica (Graham Land).——FIG. 72,*3.* **N. kiliani,* Graham Land; ×1 (Spath, 1953).

Jacobites KILIAN & REBOUL, 1909, p. 26 [**J. anderssoni;* OD]. Inner whorls as in *Kossmaticeras* but more inflated; in some forms coronate, with large lateral spines. Outer whorls with more or less flat, parallel sides and broad, fastigiate venter, with regular or irregular tuberculate or flared ribs. *Upper Cretaceous (Campanian):* New Caledonia, New Zealand, Antarctica (Graham Land).

J. (**Jacobites**) [=*Neomadrasites* MARSHALL, 1926, p. 171 (type, *N. nodulosus;* OD); *Aucklandites* MARSHALL, 1927, p. 358 (type, *Acanthoceras ultimum* MARSHALL, 1926, p. 158; OD)]. Ribs fine, tending to be angulate or tuberculate on shoulder and some also on siphonal line; ribs may or may not coarsen on body chamber. Occurrence and distribution as for genus.——FIG. 72,*2a.* **J. (J.) anderssoni,* Graham Land; ×1 (Kilian & Reboul, 1909).——FIG. 72,*2b. J. (J.) nodulosus* (MARSHALL), New Zealand; ×1 (Henderson, 1970).

J. (**Tainuia**) MARSHALL, 1926, p. 185 [**T. aucklandica;* OD]. Outer whorls with coarse ribs, most with umbilical and all with 3 lateral, ventrolateral, and siphonal tubercles. Occurrence as for genus: New Zealand.——FIG. 72,*5a,b.* **J. (T.) aucklandica* (MARSHALL); ×0.5 (Henderson, 1970).

Brahmaites KOSSMAT, 1897, p. 44(151) [**Ammonites brahma* FORBES, 1846, p. 100; SD YABE & SHIMIZU, 1924, p. 79] [=*Anabrahmaites* YABE & SHIMIZU, 1924, p. 79 (type, *Ammonites vishnu* FORBES, 1846, p. 100; OD); *Subbrahmaites* YABE & SHIMIZU, 1924, p. 79 (type, *S. sachalinensis;* OD)]. Evolute; inner whorls depressed and coronate as in some *Jacobites,* with fine ribs with or without (*Anabrahmaites*) umbilical tubercles; outer whorl section becoming round, with ribs weakening, reduced in some species to elongated umbilical tubercles, and rejuvenating on body chamber but interrupted ventrally; constrictions prorsiradiate, with strong collar behind, on outer whorl generally raised into siphonal tubercle. *Upper Cretaceous (Lower Maastrichtian–Upper Maastrichtian):* France, Spain, Armenia, Madagascar, southern India, Sakhalin.——FIG. 72,*4a–c.* **B. brahma* (FORBES), southern India; *a,b,* ×0.75; *c,* ×1 (Kossmat, 1895–1898).

Family CLEONICERATIDAE Whitehouse, 1926

[Cleoniceratidae WHITEHOUSE, 1926, p. 206] [=Vnigriceratinae SAVELIEV, 1973, p. 132; Lemuroceratinae OWEN, 1988, p. 216]

Round-whorled to compressed and high-whorled; venter rounded, subtabulate, or acute; ribs Y-shaped to falcoid; primaries single or branching at umbilical edge, with or without umbilical bullae, branching again at midflank or beyond; some forms secondarily smooth; constrictions present throughout or absent, commonly several close together before aperture. Microconchs small, commonly with venter of body chamber broadening and coiling inward; macroconchs rather large, with ornament weakening on outer whorl. Suture with wide, more or less asymmetrical L and up to 6 auxiliary lobes in high-whorled forms. *Lower Cretaceous (Lower Albian,* tardefurcata *Zone–Middle Albian,* dentatus *Zone).*

Freboldiceras, probably derived from *Callizoniceras* (Puzosiinae), gave rise to *Arctohoplites* and thence *Leconteites; Anadesmoceras* and *Cleoniceras* probably constituted one early side branch and *Cymahoplites* and *Lemuroceras* another.

The family has generally been placed in Hoplitaceae because of resemblances to Sonneratiinae, but since it apparently originated in Puzosiinae rather than in *Uhligella*

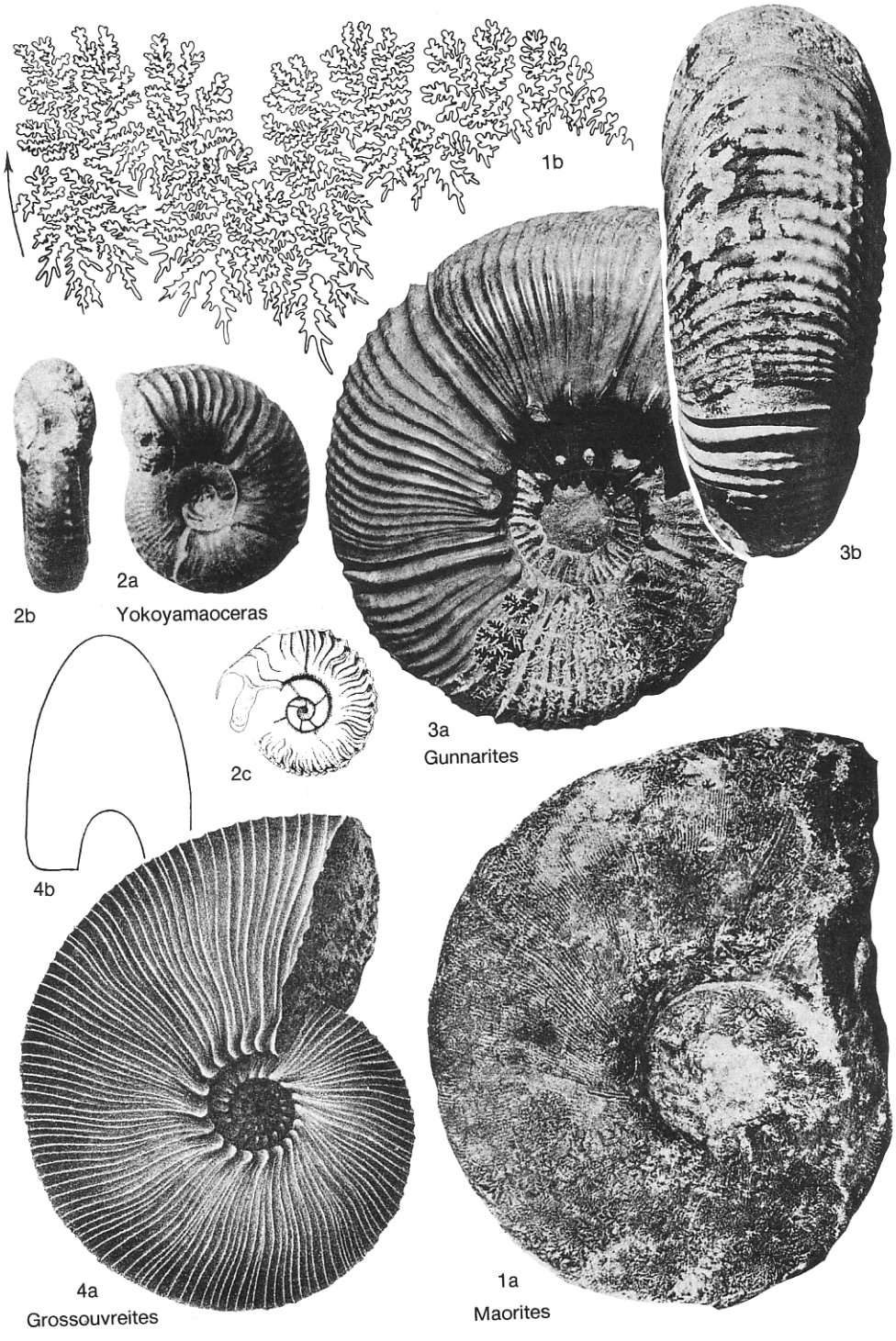


FIG. 71. Kossmaticeratidae (p. 92–93)

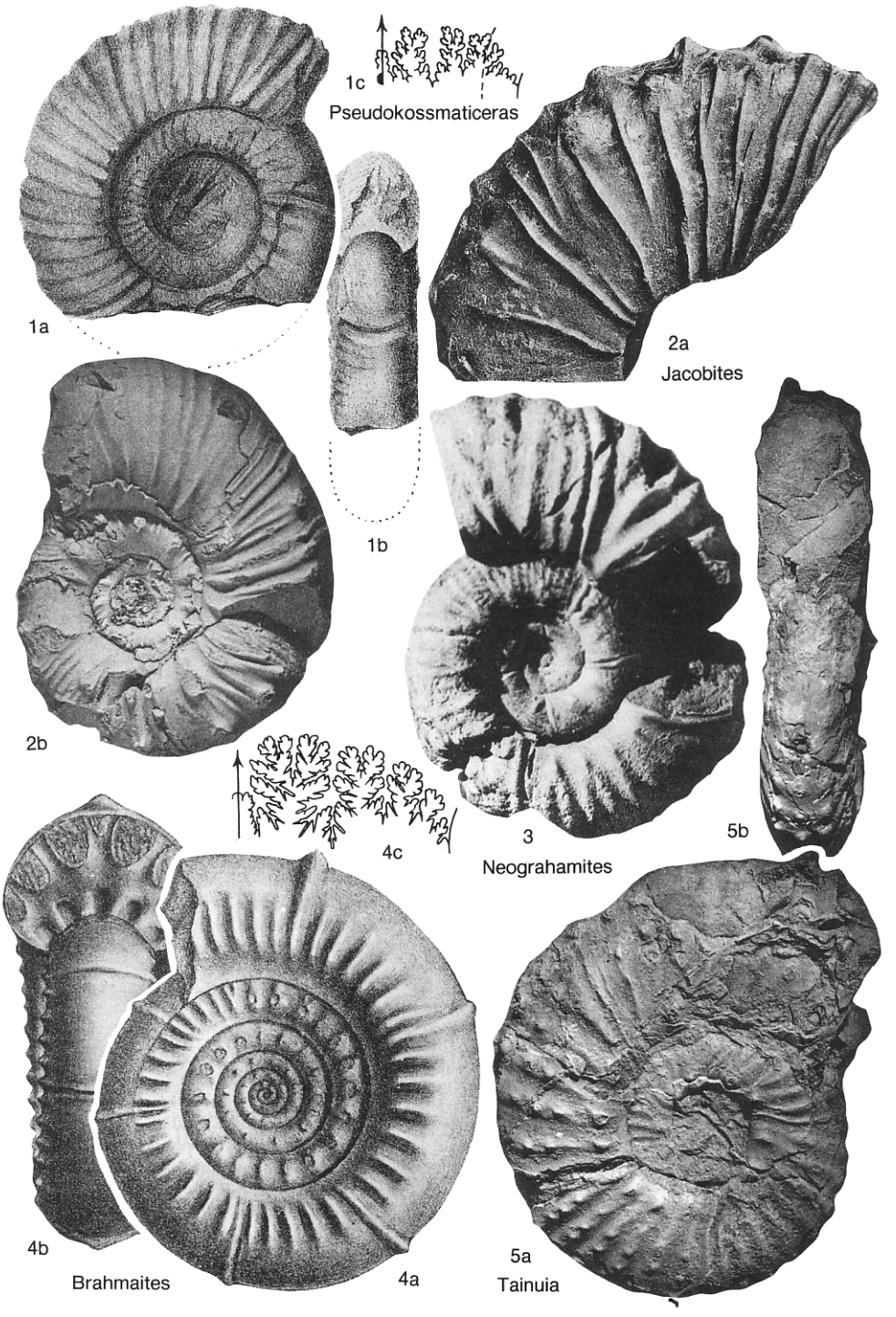


FIG. 72. Kossmaticeratidae (p. 93)

(Beudanticeratinae), the presumed source of Hoplitaceae, it is better placed in Desmoceratoceae.

Freboldiceras IMLAY, 1959, p. 182 [**F. singulare;* OD]. More or less compressed, with convex sides converging to rounded venter; primary ribs distant, sinuous, prorsiradiate, weakening rapidly on shoulders; secondaries feeble, intercalated or not; body chamber with a few, broad, shallow constrictions. Includes transitions to *Arcthoplites. Lower Cretaceous (Lower Albian,* tardefurcata *Zone):* Spitsbergen, Alaska, Arctic Canada, northern Greenland.——FIG. 73,*1a–c.* **F. singulare,* Alaska; *a,b,* ×1; *c,* ×2 (Imlay, 1959).

Arcthoplites SPATH, 1925a, p. 76 [**Ammonites jachromensis* NIKITIN, 1888, p. 57; OD] [=*Subarcthoplites* CASEY, 1954a, p. 111 (type, *Lemuroceras belli* MCLEARN, 1945, p. 10; OD); *Bellidiscus* SAVELIEV, 1973, p. 115 (type, *B. probus;* OD)]. Slightly compressed, with rounded to weakly flattened venter; primary ribs distant, high, remaining single or branching high up sides or with intercalated short secondaries; ribs slightly prorsiradiate, straight to weakly biconcave. More compressed and higher-whorled species need not be separated as *Subarcthoplites* or *Bellidiscus. Lower Cretaceous (Lower Albian):* central Russia, Transcaspia, Iran, Spitsbergen, Arctic Canada, northern and eastern Greenland.——FIG. 73,*2a–c.* **A. jachromensis* (NIKITIN), central Russia; *a,b,* ×1; *c,* enlarged (Nikitin, 1888).——FIG. 73,*2d,e. A. belli* (MCLEARN), Arctic Canada; ×1 (Imlay, 1961).——FIG. 73,*2f–h. A. probus* (SAVELIEV), Transcaspia; ×1 (Saveliev, 1973).

Leconteites CASEY, 1954a, p. 110 (BREISTROFFER, 1951, p. 266, *nom. nud.*) [**Desmoceras lecontei* ANDERSON, 1902, p. 95; OD] [=*Puzosigella* CASEY, 1954a, p. 110 (type, *Pachydiscus sacramenticus* ANDERSON, 1902, p. 105; OD); *Vnigriceras* SAVELIEV, 1973, p. 143 (type, *V. emendatum;* OD); *V. (Astrodiscus)* SAVELIEV, 1973, p. 145 (type, *V. (A.) insegestum;* OD)]. Small to medium-sized, variable, and compressed to rather inflated; umbilicus from 17 to 30 percent of diameter; umbilical shoulder sharply rounded to angular; primary ribs sinuous, arising singly on umbilical wall or in twos or threes from umbilical bullae, projected towards venter, weakening or disappearing at venter; secondaries branching or intercalated at midflank; constrictions, if present, with or without collars. Suture finely or coarsely frilled. *Lower Cretaceous (Lower Albian,* tardefurcata *Zone):* Alaska, British Columbia, Oregon, California.——FIG. 74,*1a–c.* **L. lecontei* (ANDERSON), California; *a,b,* ×1; *c,* ×3.5 (Jones, Murphy, & Packard, 1965).——FIG. 74,*1d,e. L. sacramenticus* (ANDERSON), California; ×0.5 (Anderson, 1938).

Brewericeras CASEY, 1954a, p. 112 [**Ammonites breweri* GABB, 1864, p. 62; OD]. Compressed, with flat or moderately inflated sides; coiling eccentric. Derivative of *Leconteites* distinguished by absence of umbilical tubercles and paired ribs, rarity of constrictions, and narrower stems to saddles of suture. Varying from smooth to strongly ribbed; ribs falcate and strongest on outer part. *Lower Cretaceous (Lower Albian,* mammillatum *Zone):* ?Spitsbergen, Japan, Alaska, British Columbia, Oregon, California.——FIG. 74,*2a.* **B. breweri* (GABB), California; ×0.35 (Jones, Murphy, & Packard, 1965).——FIG. 74,*2b. B. hulenense* (ANDERSON), California; ×3 (Jones, Murphy, & Packard, 1965).

Anadesmoceras CASEY, 1954a, p. 107 [**A. strangulatum;* OD] [=*Carloscaceresiceras* ETAYO SERNA, 1979, p. 25 (type, *C. caceresi;* OD)]. More compressed than *Leconteites;* body chamber with periphery coiling inward and whorl section becoming subrectangular; shell with bundled striae; fine umbilical bullae and weak ribs on inner whorls, rarely throughout; aperture of microconchs may be preceded by wide, sinuous constrictions or folds. *Lower Cretaceous (Lower Albian,* tardefurcata *to lower* mammillatum *Zone):* England, Denmark, Transcaspia, northern Greenland, Colombia.——FIG. 74,*3a.* **A. strangulatum,* England; ×1 (Casey, 1954a).——FIG. 74,*3b–e. A. emendatum* (SAVELIEV), Transcaspia; ×1 (Saveliev, 1973).

Cleoniceras PARONA & BONARELLI, 1897, p. 83 [**Ammonites cleon* ORBIGNY, 1850a, p. 124; OD] [=*Eocleoniceras* SAVELIEV, 1992, p. 84 (type, *C. (E.) remotum;* OD)]. Rather involute, compressed; venter arched to acute, rarely flat; typically with strong, sigmoid to falcoid ribs at some growth stage, single or springing in pairs from distinct umbilical bullae, commonly branching again or intercalated at midflank, tending to disappear on outer whorls of macroconchs, and commonly weak on venter. *Lower Cretaceous (Lower Albian,* tardefurcata *Zone–Middle Albian):* western Europe, Transcaspia, Madagascar, northwestern India, Alaska, British Columbia.

C. (Cleoniceras). Umbilical tubercles present at some stage; venter not tabulate. Occurrence and distribution as for genus.——FIG. 75,*4a–c.* **C. (C.) cleon* (ORBIGNY), Lower Albian, France; *a,b,* ×1; *c,* ×2 (Casey, 1966).

C. (Anacleoniceras) MIRZOEV, 1969, p. 38 [**Anacleoniceras caseyi;* OD] [=*Cleonella* DESTOMBES, 1970, p. 2063 (type, *Cleoniceras dimorphum* CASEY, 1966, p. 568; OD), *nom. nud.*]. Small; venter flattening on body chamber and ribs generally coarsening; umbilical tubercles prominent and ribs falcoid. Probably microconchs of *C. (Cleoniceras).* Occurrence and distribution as for genus.——FIG. 75,*3a,b.* **C. (A.) caseyi* (MIRZOEV), Lower Albian, Turkmenistan; ×1 (Mirzoev, 1969).

C. (Grycia) IMLAY, 1961, p. 64 [**C. (G.) sablei;* OD] [=?*Paracleoniceras* COLLIGNON, 1963, p. 85 (type, *Cleoniceras besairiei* COLLIGNON, 1949b, p. 86; OD)]. Lacking umbilical tubercles at any stage. *Lower Cretaceous (Lower Albian, ?Middle Albian):* Spitsbergen, ?Madagascar, Alaska.——FIG. 75,*2a–c.* **C. (G.) sablei,* Lower Albian,

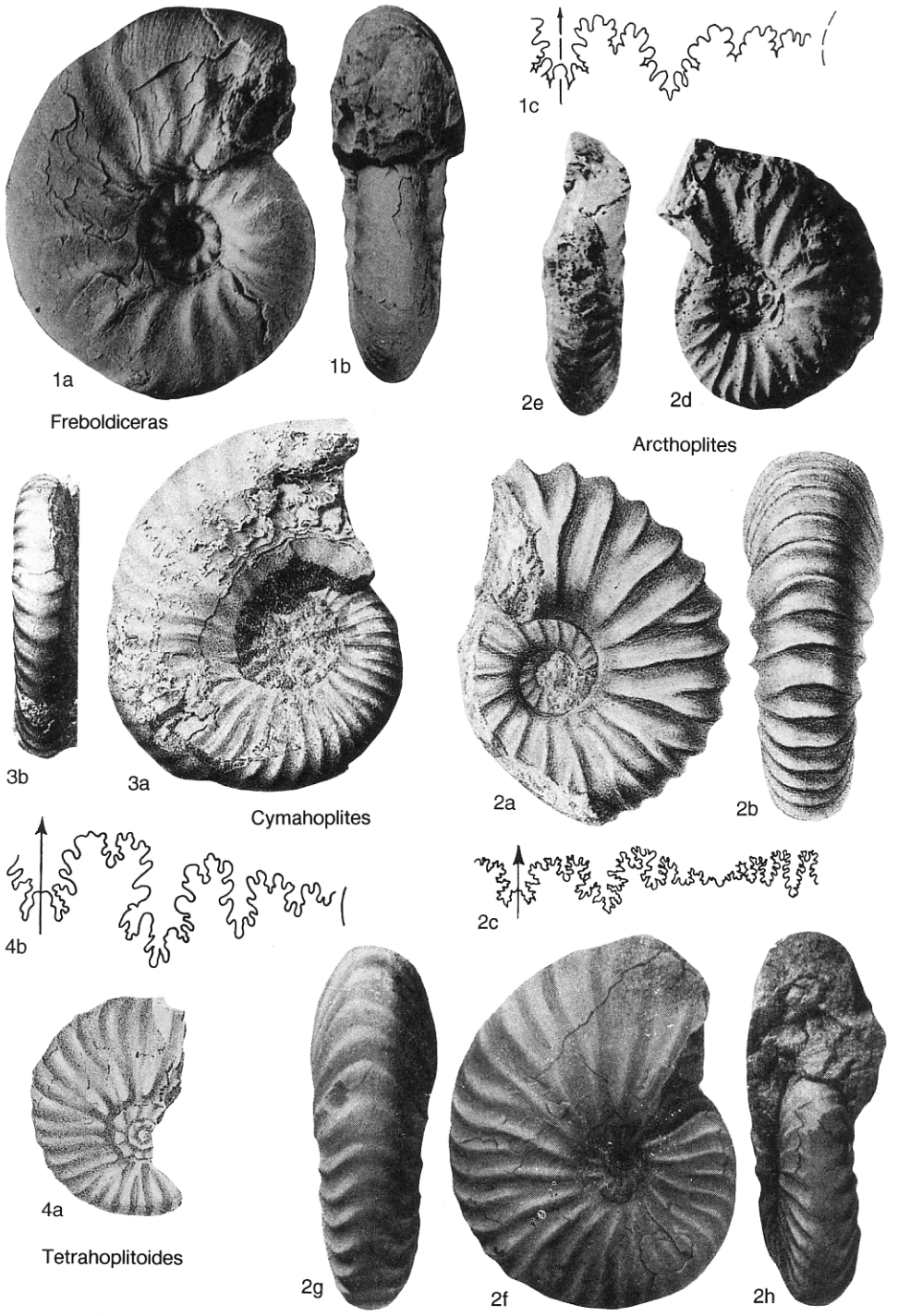


FIG. 73. Cleoniceratidae (p. 96–100)

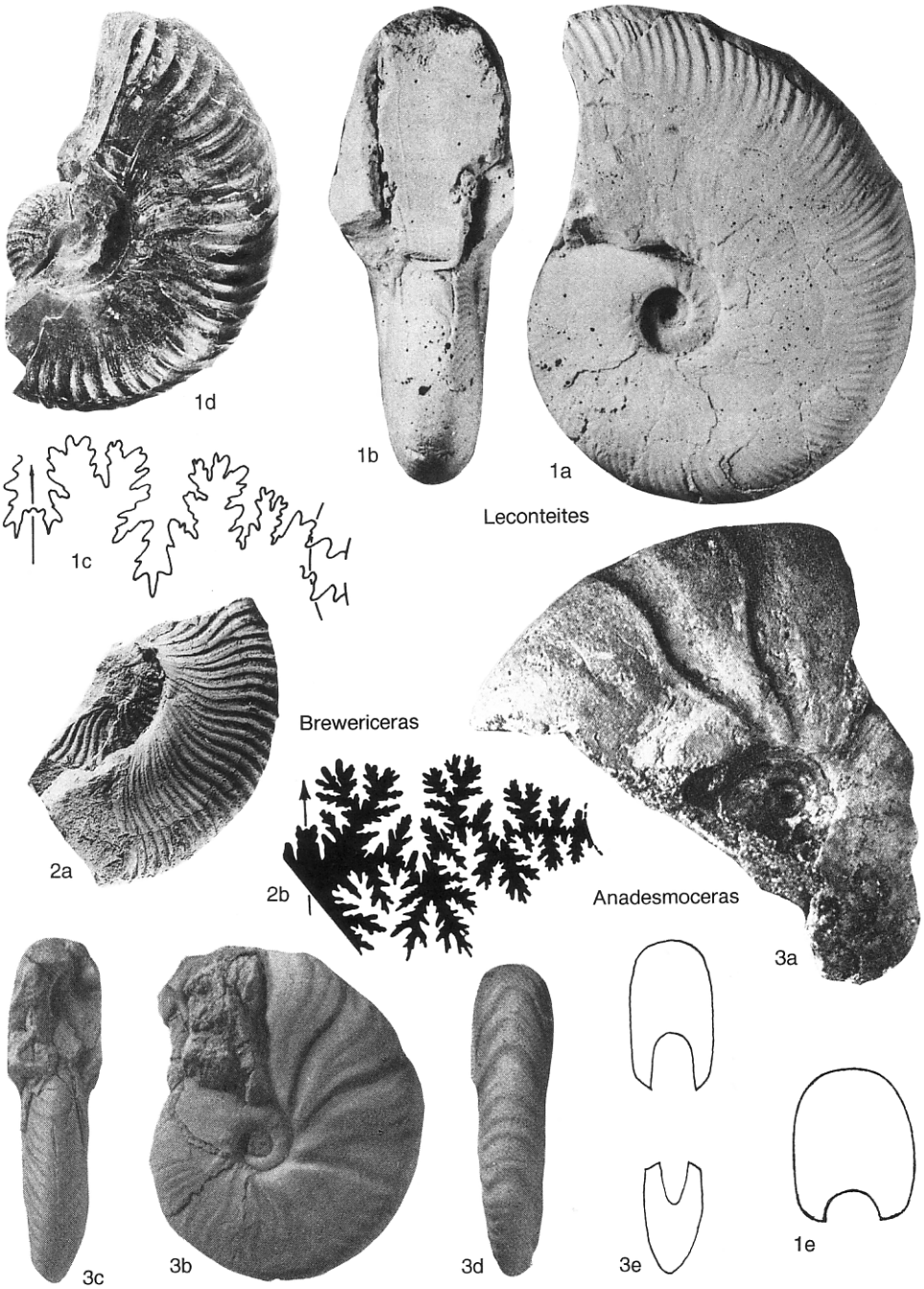


FIG. 74. Cleoniceratidae (p. 96)

Alaska; *a,b,* ×0.75; *c,* ×1 (Imlay, 1961).—— FIG. 75,*2d,e. C. (?G.) besairiei* (COLLIGNON), Middle Albian, Madagascar; ×1 (Collignon, 1949b).

C. (**Neosaynella**) CASEY, 1954a, p. 106 [**C. (N.) inornatum;* OD]. No ornament except obscure crescents on outer part of sides; umbilical rim sharp; venter narrowly tabulate in early stages,

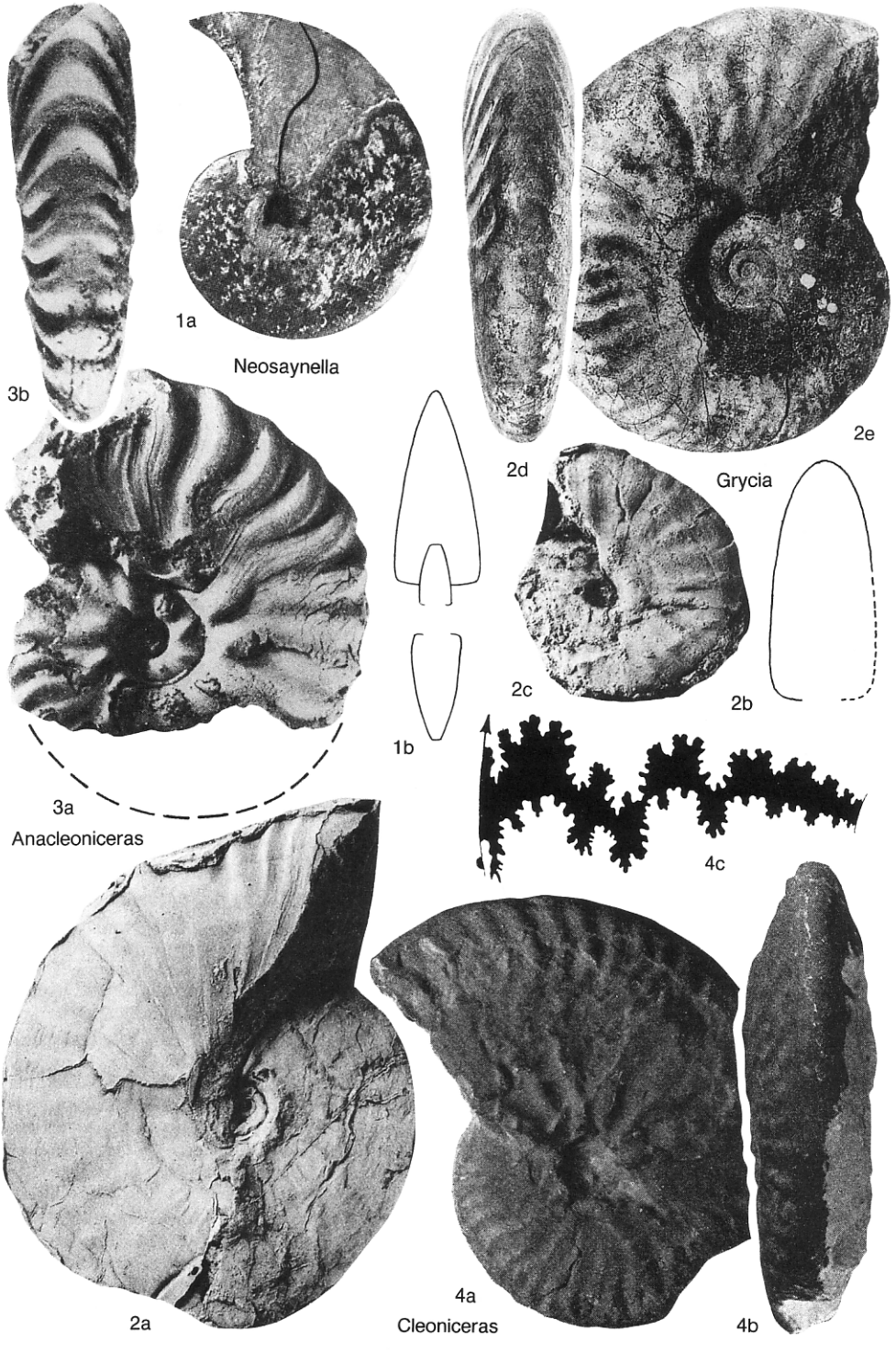


FIG. 75. Cleoniceratidae (p. 96–100)

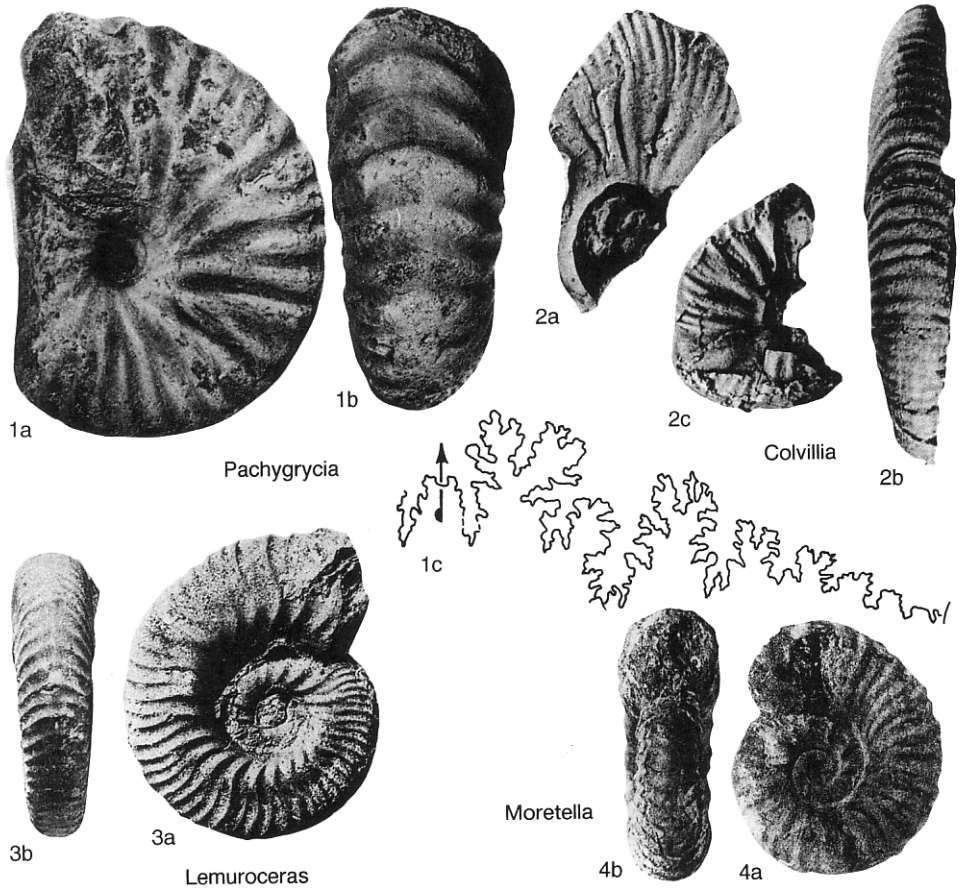


FIG. 76. Cleoniceratidae (p. 100–101)

then acute, and finally rounded. *Lower Cretaceous (Lower Albian,* mammillatum *Zone):* England, France, Transcaspia, Alaska.——FIG. 75,*1a,b.* **C. (N.) inornatum,* England; ×1 (Casey, 1954a).

Tetrahoplitoides CASEY, 1954a, p. 115, *nom. nov. pro Coloboceras* CRICKMAY, 1927, p. 511, *non* TROUESSART, 1889, p. 233 [**Sonneratia stantoni* ANDERSON, 1902, p. 105; OD]. Like compressed *Tetrahoplites,* but venter more angular and ribs tending to weaken on midsides and venter. Probably derived from inflated *Leconteites* and only a homeomorph of compressed *Tetrahoplites. Lower Cretaceous (Lower Albian):* California.——FIG. 73,*4a,b.* **T. stantoni* (ANDERSON); *a,* ×1; *b,* ×2 (Anderson, 1902).

Cymahoplites SPATH, 1922a, p. 110 [**Ammonites kerenskianus* BOGOSLOVSKII, 1902, p. 32; M] [=*Vjasemskiceras* SAZONOVA, 1961, p. 22, obj.]. Compressed, with flat sides and well-rounded venter; early whorls with fine, fairly close, sinuous ribs starting at right angles to umbilical edge, some branching one-third up side, and crossing venter with forward bend and slight flattening; points of branching raised into slight bullae; outer whorls more or less smooth. *Lower Cretaceous (Lower Albian,* mammillatum *Zone):* England, Transcaspia.——FIG. 73,*3a,b.* **C. kerenskianus* (BOGOSLOVSKII), Russia; ×1 (Bogoslovskii, 1902).

Lemuroceras SPATH, 1942, p. 687 [**Pseudohaploceras aburense* SPATH, 1933a, p. 801; OD]. Compressed, evolute; ribs of varying strength; finer-ribbed species very similar to *Cymahoplites,* but ribs more oblique on umbilical edge; venter more quadrate and secondary ribs more numerous than in some otherwise similar, boreal *Arcthoplites. Lower Cretaceous (Lower Albian,* mammillatum *Zone):* Madagascar, Pakistan.——FIG. 76,*3a,b.* **L. aburense* (SPATH), Pakistan; ×1 (Spath, 1933a).

Moretella COLLIGNON, 1963, p. 101 [**Pseudosonneratia madagascariensis* COLLIGNON, 1949b, p. 81; OD]. Small, with round or quadrate whorl section; ribs running obliquely from umbilical seam, generally branching a little above umbilical margin, and thickening markedly on venter. Probably dwarf, inflated offshoot of *Lemuroceras. Lower Cretaceous*

(Lower Albian): Madagascar.——FIG. 76,*4a,b.* **M. madagascariensis* (COLLIGNON); ×1 (Collignon, 1949b).

?Pachygrycia JELETZKY & STELCK, 1981, p. 3 [**P. canadensis;* OD]. Whorl section and ornament as in *Sonneratia,* but suture with wide L and 6 auxiliary lobes. *Lower Cretaceous (Lower Albian):* northern Canada.——FIG. 76,*1a–c.* **P. canadensis; a,b,* ×1; *c,* ×2.5 (Jeletzky & Stelck, 1981; courtesy of the Geological Survey of Canada).

Colvillia IMLAY, 1961, p. 57 [**C. kenti;* OD]. Moderately involute, compressed, with convex sides and narrowly arched venter; primary ribs long, thick, splitting about midflank into 2 or 3 secondaries that are projected on shoulders; constrictions present, strongest on venter. Suture with wide E/L and L, but other elements narrow. *Lower Cretaceous (Lower Albian):* Alaska.——FIG. 76,*2a,b.* **C. kenti;* ×1 (Imlay, 1961).——FIG. 76,*2c. C. crassicostata* IMLAY; ×1 (Imlay, 1961).

Family PACHYDISCIDAE Spath, 1922

[*nom. transl.* SPATH, 1923d, p. 39, *ex* Pachydiscinae SPATH, 1922b, p. 132]

Moderate-sized to large; rather involute to evolute; inflated and depressed to compressed and high-whorled. Distinguished from Desmoceratidae primarily by strong ribbing at some stage of growth; ribbing normally crossing venter without interruption and showing tendency to strong tuberculation at least on umbilical shoulder. Suture much as in Desmoceratinae, with smaller, less asymmetric L and narrower, generally less retracted umbilical lobes than Puzosiinae. Microconchs without lappets; from the Turonian onward there is a series of small forms with simple apertures and prominent umbilical, ventrolateral, and even siphonal tubercles; most, if not all, are microconchs of contemporary genera. GROSSOUVRE, 1894; COLLIGNON, 1952; MATSUMOTO, 1954, 1955c; WRIGHT, 1955. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Upper Maastrichtian).*

The family arose in the Late Albian, probably from Desmoceratinae.

Eopachydiscus WRIGHT, 1955, p. 570 [**Pachydiscus laevicaniculatus* LASSWITZ, 1904, p. 236; OD; =*Ammonites marcianus* SHUMARD, 1854, p. 209]. Large, rather inflated to compressed, and moderately involute; venter more or less narrowly rounded; inner whorls having frequent, strong but shallow constrictions with collared ribs, with or without intermediate ribs; distinct umbilical bullae sometimes present; ribs and constrictions becoming increasingly projected on shoulders with age; outer whorls smooth or with distant, barlike ribs on inner part of side. Suture with broad, open, minutely frilled elements and auxiliaries in regularly descending series. KENNEDY, WRIGHT, & CHANCELLOR, 1983. *Lower Cretaceous (Upper Albian):* southern India, New Mexico, Colorado, Texas.——FIG. 77,*2.* **E. marcianus* (SHUMARD), Texas; ×0.75 (Lasswitz, 1904).

?Chimbuites CASEY & GLAESSNER in GLAESSNER, 1958, p. 213 [**C. sinuosocostatus;* OD]. Moderately compressed, with broadly rounded venter; strong, thick primary ribs forming umbilical bullae; three or more secondaries of varying strength branching from umbilical bullae and strongly projected on shoulders. Suture with rather wide, plump elements. *Upper Cretaceous (Upper Cenomanian):* New Guinea, Bathurst Island.——FIG. 78,*1a,b.* **C. sinuosocostatus,* New Guinea; *a,* ×0.75; *b,* ×1 (Glaessner, 1958).

Lewesiceras SPATH, 1939b, p. 296 [**Ammonites peramplus* MANTELL, 1822, p. 200; OD]. Early whorls with ribs and constrictions much as in early whorls of *Eopachydiscus* but with more or less strong umbilical tubercles and with ribs more sinuous and persisting to a later stage; later whorls tending to become smooth, more compressed, and higher-whorled. Sutures well spaced, with simple and massive elements, and rather less finely frilled than in *Eopachydiscus. Upper Cretaceous (Lower Cenomanian–Upper Turonian, ?Coniacian):* Europe, northern Africa, Madagascar, central Asia, southern India, Japan, Montana.——FIG. 78,*2a,b. L. mantelli* WRIGHT & WRIGHT, Upper Turonian, England; ×1 (Sharpe, 1853–1857).

Tongoboryceras HOUŠA, 1967, p. 42 [**Lewesiceras tongoboryense* COLLIGNON, 1952, p. 23; OD]. Inflated, with broadly rounded venter; inner whorls smooth with strong constrictions forming angle on venter; outer whorls with nearly uniform, strong ribs; umbilical tubercles moderately strong to absent. Sutures interlocking, with long, slender, deeply incised elements. *Upper Cretaceous (Upper Turonian–Coniacian):* England, France, ?Spain, Austria, Madagascar, Japan.——FIG. 79,*1a,b.* **T. tongoboryense* (COLLIGNON), Lower Coniacian, Madagascar; ×1 (Collignon, 1955).

Menabonites HOUŠA, 1967, p. 41 [**Pachydiscus anapadensis* KOSSMAT, 1895, p. 155(52); OD]. Differs from *Lewesiceras* in retaining depressed whorl section and umbilical tubercles to a later stage and from *Tongoboryceras* in having, at least on outer whorls, ventrolateral tubercles on primary and some secondary ribs. *Upper Cretaceous (Turonian–Coniacian):* France, Madagascar, India.——FIG. 79,*2a,b.* **M. anapadensis* (KOSSMAT), Turonian, India, ×0.75 (Stoliczka, 1865).

Pseudojacobites SPATH, 1922b, p. 121 [**Pachydiscus farmeryi* CRICK, 1910, p. 345; OD] [=*Pseudopuzosia* SPATH, 1926a, p. 80 (type, *Desmoceras marlowense* NOBLE, 1911, p. 398; OD); *Rotalinites* SHIMIZU, 1935a, p. 181 (type, *Ammonites rotalinus* STOLICZKA, 1864, p. 65; OD)]. Depressed, evolute,

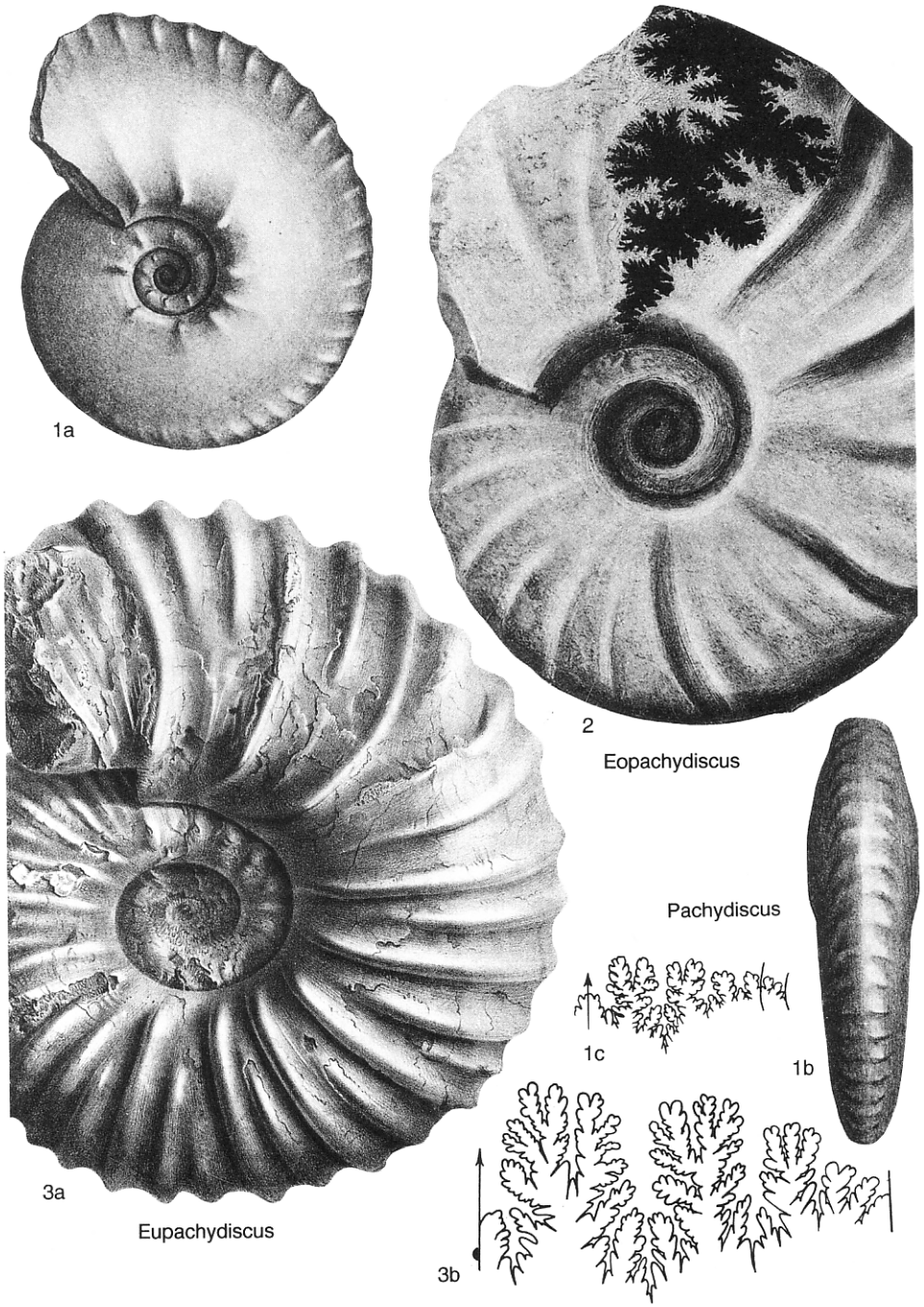


FIG. 77. Pachydiscidae (p. 101–107)

with strong constrictions crossing the wide venter almost transversely, each preceded by a strong, rounded rib springing from an umbilical bulla; weak or no intermediate ribs; outer whorls with strong umbilical, ventrolateral, and siphonal septispinate tubercles. Sutures slightly interlocking; elements long and narrow, with sharp subdivisions. *Upper Cretaceous (Upper Turonian–Coniacian):* En-

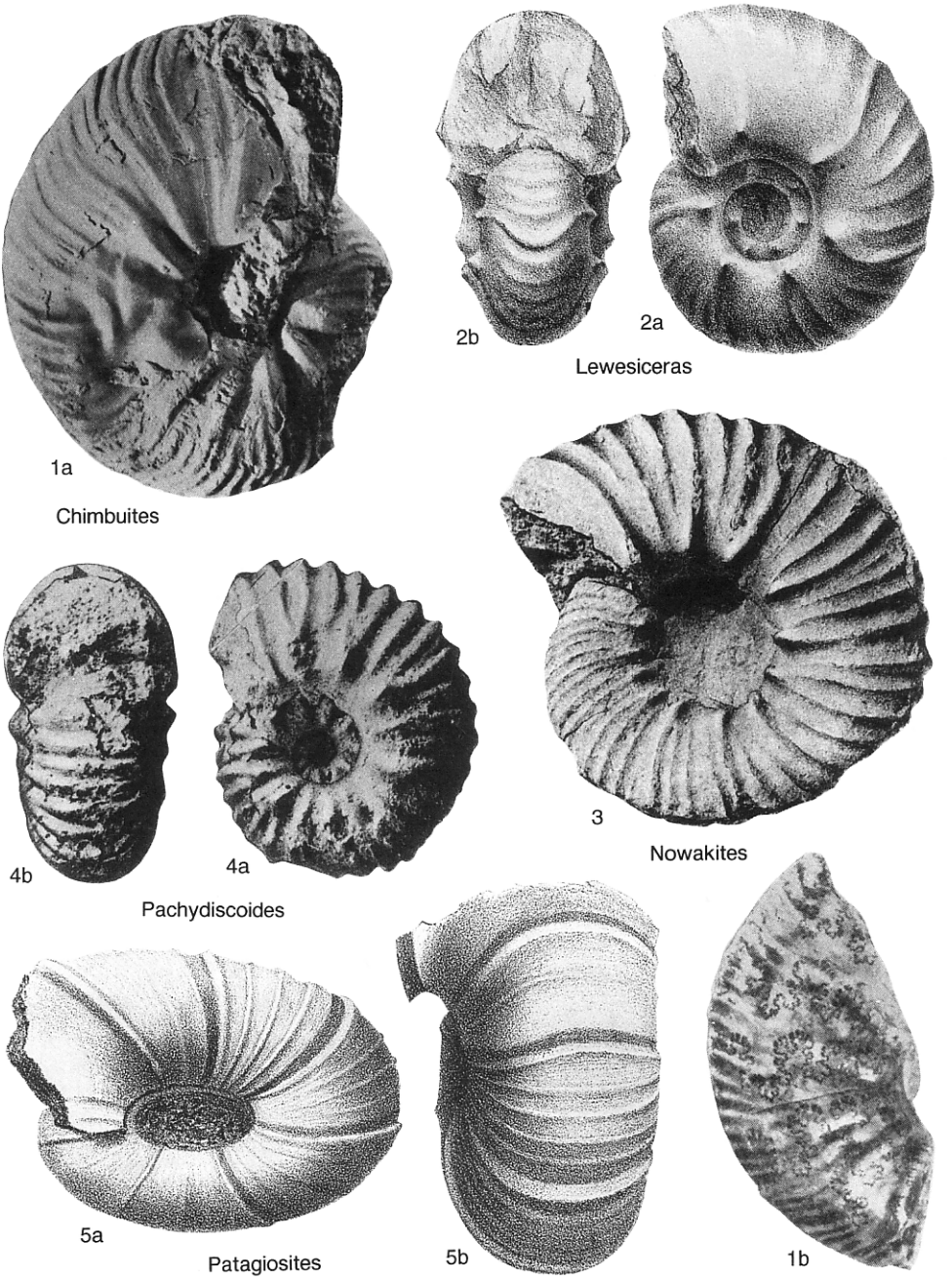


FIG. 78. Pachydiscidae (p. 101–105)

gland, Madagascar, southern India.——FIG. 79,*3a–e.* **P. farmeryi* (CRICK), Upper Turonian, England; ×1 (Wright, 1979).

Pachydiscoides SPATH, 1922b, p. 124 [**Sonneratia janeti* GROSSOUVRE, 1894, p. 145; OD]. Moderately involute; whorl section nearly circular to high and oval; prominent umbilical bullae giving rise to pairs of very strong, coarse, straight ribs; a few intercalated ribs present. *Upper Cretaceous (Coniacian–Santonian):* France, Spain, northern Africa, Madagascar.——FIG. 78,*4a,b.* **P. janeti* (GROSSOUVRE), Coniacian, France; ×1 (Grossouvre, 1894).

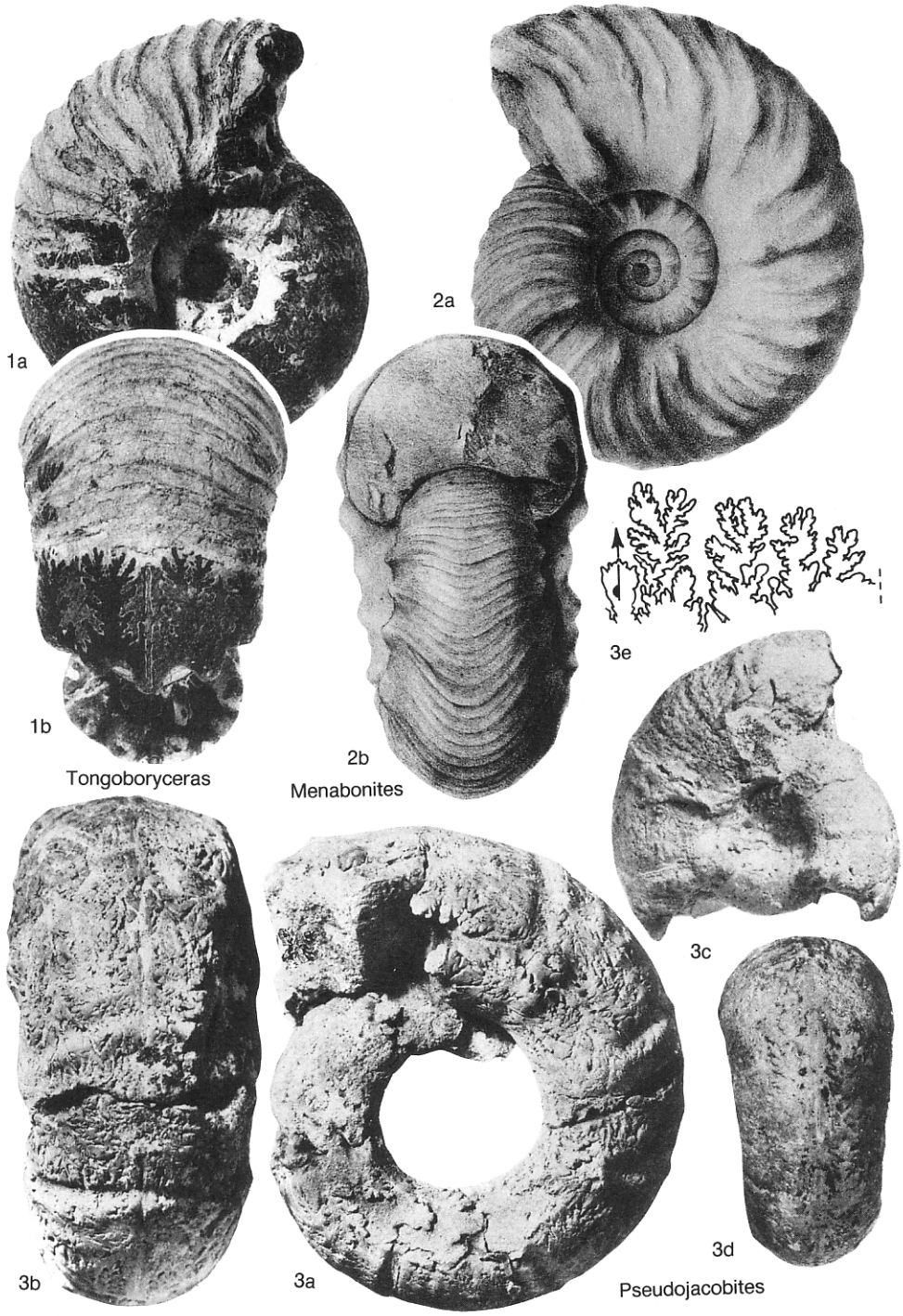


FIG. 79. Pachydiscidae (p. 101–103)

Tuberodiscoides COLLIGNON, 1966, p. 31 [**T. termierorum;* OD]. Extreme development of *Pachydiscoides* with flat sides and fastigiate venter; coarse ribs springing mainly in pairs from very large umbilical tubercles are produced into sharp ventrolateral angle and end in a distinct siphonal tubercle. *Upper Cretaceous (Lower Santonian):* Madagascar.——FIG. 80,*2a,b.* **T. termierorum;* ×1 (Collignon, 1966).

Nowakites SPATH, 1922b, p. 124 [**Pachydiscus carezi* GROSSOUVRE, 1894, p. 190; OD]. Moderately involute; whorl section circular to oval; prominent, sharp, main ribs springing in pairs from weak umbilical bullae and curving forward to venter, with several intercalatories of unequal length between these pairs; broad, shallow constrictions on inner whorls only. Suture with massive lobes. *Upper Cretaceous (Coniacian–Santonian):* France, Spain, Germany, Austria, Armenia, southern India, Japan. ——FIG. 78,*3.* **N. carezi* (GROSSOUVRE), Coniacian, France; ×1 (Grossouvre, 1894).

Canadoceras SPATH, 1922b, p. 125 [**Ammonites newberryanus* MEEK, 1876, p. 47; OD] [=*Pseudopachydiscus* YABE & SHIMIZU, 1926, p. 172 (type, *Pachydiscus kossmati* YABE, 1909, p. 417, *nom. nud.;* OD)]. Rather evolute, more or less compressed probable derivative of *Nowakites.* Strong, equal, sharp, branching or intercalated ribs beginning a little above umbilical shoulder; distinct, rather oblique constrictions, accompanied by collared ribs with umbilical tubercles, persisting to a late stage; ornament weakening on umbilical part of outer whorl. *Upper Cretaceous (Upper Santonian–Campanian):* South Africa (Pondoland), Madagascar, Japan, Alaska, British Columbia, California, Brazil. ——FIG. 80,*1a–c.* **C. newberryanum* (MEEK), Campanian, British Columbia; *a,b,* ×0.5 (Spath, 1922b); *c,* ×0.75 (Usher, 1952).

Teshioites MATSUMOTO, 1955c, p. 173 [**T. ryugasensis;* OD]. Microconch, probably of *Canadoceras,* with ventrolateral tubercles on body chamber. *Upper Cretaceous (Upper Campanian):* ?France, Japan, Sakhalin.——FIG. 81,*1a,b.* **T. ryugasensis,* Japan; ×0.5 (Matsumoto, 1955c).

Patagiosites SPATH, 1953, p. 38 [**Ammonites patagiosus* SCHLÜTER, 1867, p. 22; OD]. Distinct constrictions persisting to fairly late stage; without definite umbilical tubercles; after early whorls at least, ribs weak and irregular or absent. *Upper Cretaceous (Lower Santonian–Maastrichtian):* northwestern Europe, Austria, Alaska, Argentina (Patagonia), Antarctic Peninsula (Graham Land).——FIG. 78,*5a,b.* **P. patagiosus* (SCHLÜTER), Campanian, Germany; distorted, ×1 (Schlüter, 1871–1876).

Menuites SPATH, 1922b, p. 123 [**Ammonites menu* FORBES, 1846, p. 111; OD] [=*Anapachydiscus* YABE & SHIMIZU, 1926, p. 172 (type, *Pachydiscus (Parapachydiscus) fascicostatus* YABE in YABE & SHIMIZU, 1921, p. 57; OD); *Neopachydiscus* YABE & SHIMIZU, 1926, p. 173 (type, *Pachydiscus naumanni* YOKOYAMA, 1890, p. 187; OD); *Besaireites* COLLIGNON, 1931b, p. 19 (type, *Kossmaticeras pseudorotalinus*

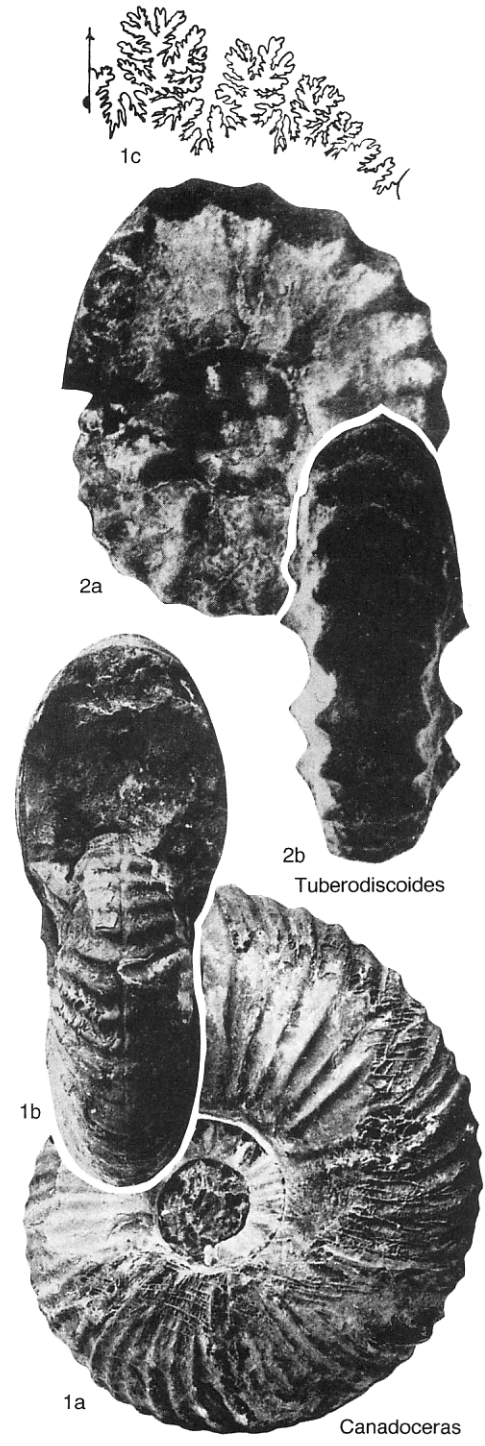


FIG. 80. Pachydiscidae (p. 105)

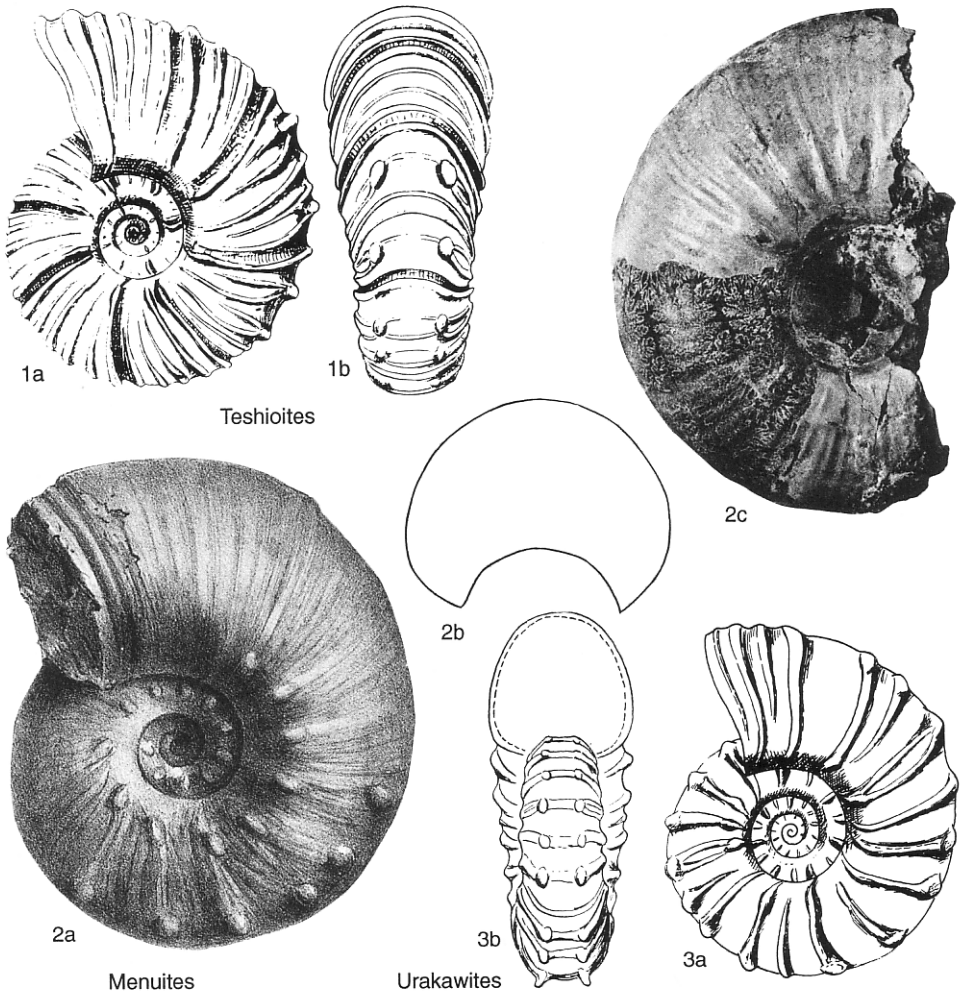


FIG. 81. Pachydiscidae (p. 105–107)

COLLIGNON, 1931b, p. 18; M); *Hoepenites* COLLIGNON, 1952, p. 9 (type, *Pachydiscus patagonicus* PAULCKE, 1907, p. 232; OD); *Cobbanoscaphites* COLLIGNON, 1969, p. 51 (type, *C. menabensis;* OD)]. Very inflated to rather compressed; moderately involute; smooth and constricted at first, then with umbilical bullae and fine, straight or slightly curved ribs. Macroconchs large; body chamber with ribs coarsening or disappearing. Microconchs small, with rounded umbilical and ventrolateral tubercles on outer whorl and with constricted, simple aperture. *Upper Cretaceous (?Coniacian, Santonian–Upper Maastrichtian):* virtually worldwide.——FIG. 81,*2a,b.* **M. menu* (FORBES), Campanian, southern India; microconch, ×1 (Stoliczka, 1863–1866).——FIG. 81,*2c. M. fascicostatus* (YABE & SHIMIZU), Santonian, Japan; macroconch, ×0.75 (Yabe & Shimizu, 1926).

Eupachydiscus SPATH, 1922b, p. 124 [**Ammonites isculensis* REDTENBACHER, 1873, p. 122; OD] [=*Mesopachydiscus* YABE & SHIMIZU, 1926, p. 172 (type, *Pachydiscus haradai* JIMBO, 1894, p. 29(168); OD)]. Whorl section inflated and depressed, almost round in later whorls; early whorls with rather fine, distant, narrow but prominent ribs springing in pairs from umbilical tubercles; in midgrowth coarse, distant ribs appear which, with their umbilical tubercles, may become even stronger on last whorl. *Upper Cretaceous (Coniacian–Campanian):* Europe, Madagascar, Japan, New Zealand, British Columbia.——FIG. 77,*3a,b.* **E. isculensis* (REDTENBACHER), Coniacian, Austria; *a,* ×0.5; *b,* ×0.75 (Redtenbacher, 1873).

Urakawites MATSUMOTO, 1955c, p. 167 [**Pachydiscus rotalinoides* YABE, 1915, p. 21; OD]. Less depressed and more strongly ribbed than *Menuites.* Micro-

conch, probably of *Eupachydiscus. Upper Cretaceous (Campanian):* ?Germany, ?Angola, Japan, Sakhalin, British Columbia.——FIG. 81,*3a,b.* **U. rotalinoides* (YABE), Japan; ×0.5 (Matsumoto, 1955c).

Pachydiscus ZITTEL, 1884, p. 466 [**Ammonites neubergicus* HAUER, 1858, p. 12; SD GROSSOUVRE, 1894, p. 177; ICZN Opinion 1519, 1989 (given precedence over *Ammonites chrishna* FORBES, 1846, p. 103)]. Compressed, high-whorled, with flat or convex sides; ribs tending to differentiate into short umbilicals and separate ventrolaterals, the latter tending to be interrupted on venter or to disappear. *Upper Cretaceous (Campanian–Upper Maastrichtian):* worldwide.

P. **(Pachydiscus)** [=*Parapachydiscus* HYATT, 1900, p. 570 (type, *Ammonites gollevillensis* ORBIGNY, 1850a, p. 212; OD); *Joaquinites* ANDERSON, 1958, p. 218 (type, *J. fascicostatus;* OD)]. Ribs persisting. Occurrence and distribution as for genus.——FIG. 77,*1a–c. P. (P.) compressus* SPATH, Campanian, southern India; ×0.75 (Kossmat, 1895–1898).

P. **(Neodesmoceras)** MATSUMOTO, 1947, p. 39 (1938b, p. 193, *nom. nud.*) [**P. (N.) japonicus;* OD]. Ribs disappearing early, leaving shell almost smooth. *Upper Cretaceous (Maastrichtian):* Madagascar, southern India, Japan, Alaska, California.

Family MUNIERICERATIDAE Wright, 1952

[Muniericeratidae WRIGHT, 1952, p. 222] [=Pseudoschloenbachiinae HOEPEN, 1968b, p. 186]

Moderately involute, with more or less fastigiate whorl section; generally with sinuous ribs tending to be tuberculate at umbilical and ventrolateral shoulders; midlateral tubercles may also occur. Suture with rather shallow and coarsely denticulate elements, the number of auxiliary lobes decreasing with time. *Upper Cretaceous (Lower Turonian–Lower Campanian).*

Tragodesmoceras appears to be derived from some Desmoceratinae, either *Tragodesmoceroides* or *Pseudouhligella,* and leads to *Muniericeras* and thence to *Pseudoschloenbachia,* which evolved rapidly into an abundance of closely related forms, here grouped in 10 subgenera, probably too much subdivided. Separation of *Tragodesmoceras* and *Muniericeras* and the rest into two subfamilies seems unnecessary.

Tragodesmoceras SPATH, 1922b, p. 127 [**Desmoceras clypealoides* LEONHARD, 1897, p. 57; OD]. Involute, with convex or flat sides and narrowly rounded venter; strong, slightly sinuous ribs arising at umbilical edge, carrying no tubercles, and crossing venter without interruption; periodic constrictions and enlarged ribs may be present. *Upper Cretaceous (Lower Turonian–Upper Santonian):* France, Sweden, Germany, Madagascar, Kansas, Colorado, California, Oregon.——FIG. 82,*1a,b.* **T. clypealoides* (LEONHARD), Upper Turonian, Germany; ×1 (Leonhard, 1897).——FIG. 82,*1c. T. carlilense* COBBAN, Upper Turonian, Colorado; ×1 (Cobban, 1971).

Muniericeras GROSSOUVRE, 1894, p. 156 [**M. lapparenti;* OD] [=*Praemuniericeras* COLLIGNON, 1966, p. 13 (type, *P. proprium;* OD); *Morrisites* HOEPEN, 1968b, p. 185 (type, *M. louwi;* OD)]. More evolute and fastigiate than *Tragodesmoceras,* without periodic, enlarged ribs, and with ribs sharper, more distant and more strongly projected on shoulders; ribs may branch at umbilical margin and again on shoulders; umbilical and in some species ventrolateral tubercles occur; venter sharp and crenulate. Separation of species with ribs weakening or absent between ventrolateral tubercles and keel seems unnecessary. *Upper Cretaceous (Coniacian–Upper Santonian):* France, Germany, Austria, South Africa (Zululand), Madagascar.——FIG. 82,*2a,b.* **M. lapparenti,* Coniacian, France; ×1 (Grossouvre, 1894).

Texasia REESIDE, 1932, p. 14 [**Ammonites dentatocarinatus* F. A. ROEMER, 1852, p. 33 (C. F. ROEMER, 1849, p. 417, *nom. nud.*); SD WRIGHT, 1957b, p. 432] [=*Lehmaniceras* COLLIGNON, 1966, p. 50 (type, *L. sornayi;* OD)]. Moderately involute; whorl section high, nearly rectangular or oval; with large umbilical tubercles, from which straight ribs branch in twos and threes, each rib with large ventrolateral clavus and extending across fastigiate venter to end in siphonal clavus; ribs weakening on outer whorls, but tubercles remaining. *Upper Cretaceous (Middle Santonian–Lower Campanian):* Spain, Madagascar, Texas.——FIG. 82,*3a–c.* **T. dentatocarinata* (ROEMER), Santonian, Texas; *a,b,* ×1; *c,* ×2 (Reeside, 1932).——FIG. 82,*3d,e. T. sornayi* (COLLIGNON), Middle Santonian, Madagascar; ×1 (Collignon, 1966).

Pseudoschloenbachia SPATH, 1921a, p. 236 [**Ammonites umbulazi* BAILY, 1855, p. 456; OD]. Small to moderately large; more or less evolute; typically with parallel sides and fastigiate venter, distinct umbilical tubercles, and sinuous branching ribs; in later radiation inflated and square-whorled, cordate, or lanceolate forms occur; ribs and tubercles may coarsen or disappear, or ribs may break up into fine riblets. *Upper Cretaceous (Middle Santonian–Lower Campanian):* Spain, Egypt, Syria, southeastern Africa, Madagascar, southern India, British Columbia, Texas, Mississippi.

P. **(Pseudoschloenbachia).** Compressed with keel high, finely or coarsely crenulate, and generally well separated from rib endings; keel may be smooth on some internal molds; umbilical tubercles, commonly obliquely clavate, giving rise to 2 or more, sinuous to falcate ribs ending in ventrolateral tubercles; constrictions may occur.

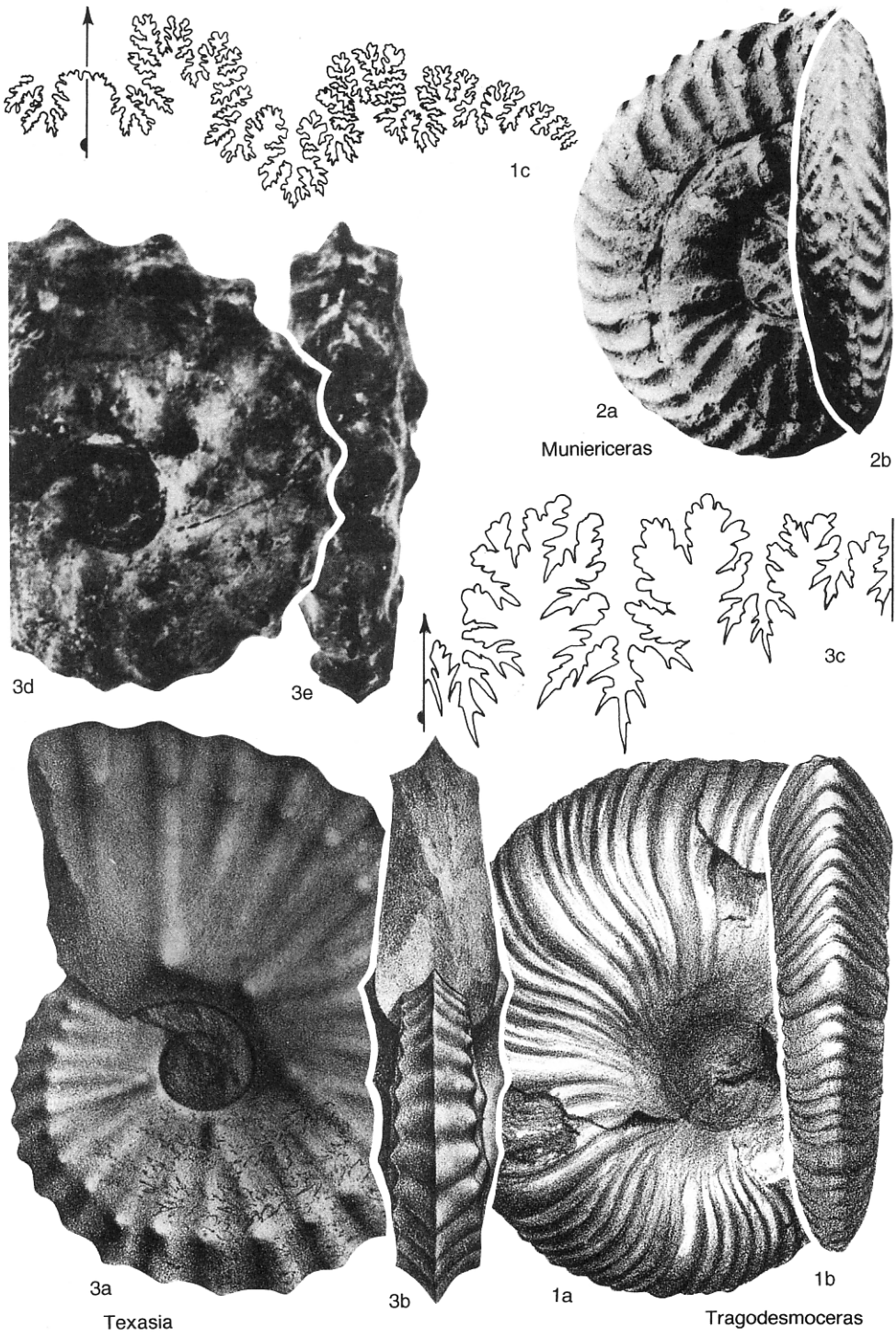


FIG. 82. Muniericeratidae (p. 107)

Some species almost smooth. Occurrence and distribution as for genus.——FIG. 83,*1a,b. *P. (P.) umbulazi* (BAILY), Upper Santonian, South Africa (Pondoland); ×1 (Hoepen, 1921).——FIG. 83,*1c. P. (P.) griesbachi* (HOEPEN), Upper Santonian, South Africa (Pondoland); ×1 (Hoepen, 1921).

P. (**Fournierella**) COLLIGNON, 1966, p. 118 [**Schloenbachia fournieri* GROSSOUVRE, 1894, p. 112; OD]. Differs from *P. (Pseudoschloenbachia)* in having on body chamber wide constrictions between flat plateaus comprising one or more bundles of ribs. Occurrence as for genus: France, Madagascar.——FIG. 83,*4a,b. *P. (F.) fournieri* (GROSSOUVRE), Santonian, France; ×0.75 (Grossouvre, 1894).

P. (**Vendegiesiella**) COLLIGNON, 1969, p. 101 [**P. (V.) spinosa;* OD]. Differs from *P. (Fournierella)* only in tendency of major ribs forming plateaus to be replaced by bundles of riblets and for midlateral tubercles to appear irregularly. *Upper Cretaceous (Lower Campanian):* Madagascar.——FIG. 83,*3a,b. *P. (V.) spinosa;* ×0.5 (Collignon, 1969).

P. (**Besairiella**) COLLIGNON, 1969, p. 110 [**P. (B.) besairiei;* OD]. Compressed to rather inflated; large; umbilical tubercles giving rise to short, straight primary ribs that are raised into a lateral tubercle and branch at lateral tubercle into 2 or more secondary ribs, each bearing a ventrolateral clavus and sweeping forward on venter; irregular intercalatory ribs present; on body chamber most tubercles disappearing and ribs replaced by bundles of riblets. *Upper Cretaceous (Lower Campanian):* Madagascar, southern India.——FIG. 84,*3. *P. (B.) besairiei,* Madagascar; ×0.5 (Collignon, 1969).

P. (**Hourcqiella**) COLLIGNON, 1969, p. 123 [**P. (H.) bererensis;* OD]. With low, distant ribs tending to obsolescence and ending in round to clavate ventrolateral tubercles; keel consisting of high, more or less distant clavi not corresponding exactly with ribs. *Upper Cretaceous (Lower Campanian):* Madagascar.——FIG. 84,*5. *P. (H.) bererensis;* ×0.75 (Collignon, 1969).

P. (**Condamyella**) COLLIGNON, 1969, p. 134 [**P. (C.) condamyi;* OD]. Rather inflated; whorl section more or less subquadrate; ribbing tending to consist of bundles of fine riblets superimposed on folds. *Upper Cretaceous (Lower Campanian):* Madagascar.——FIG. 84,*1a,b. *P. (C.) condamyi;* ×0.5 (Collignon, 1969).

P. (**Buehrierella**) COLLIGNON, 1969, p. 145 [**P. (B.) buehreri;* OD] [=*Termierella* COLLIGNON, 1969, p. 175 (type, *P. (T.) lenticularis;* OD)]. Compressed-oval to triangular in section, with strong to extreme umbilical tubercles giving rise to broad folds; entire test from early stage covered by fine, falciform riblets. *Upper Cretaceous (Lower Campanian):* Madagascar.——FIG. 84,*6a,b. *P. (B.) buehreri;* ×0.5 (Collignon, 1969).

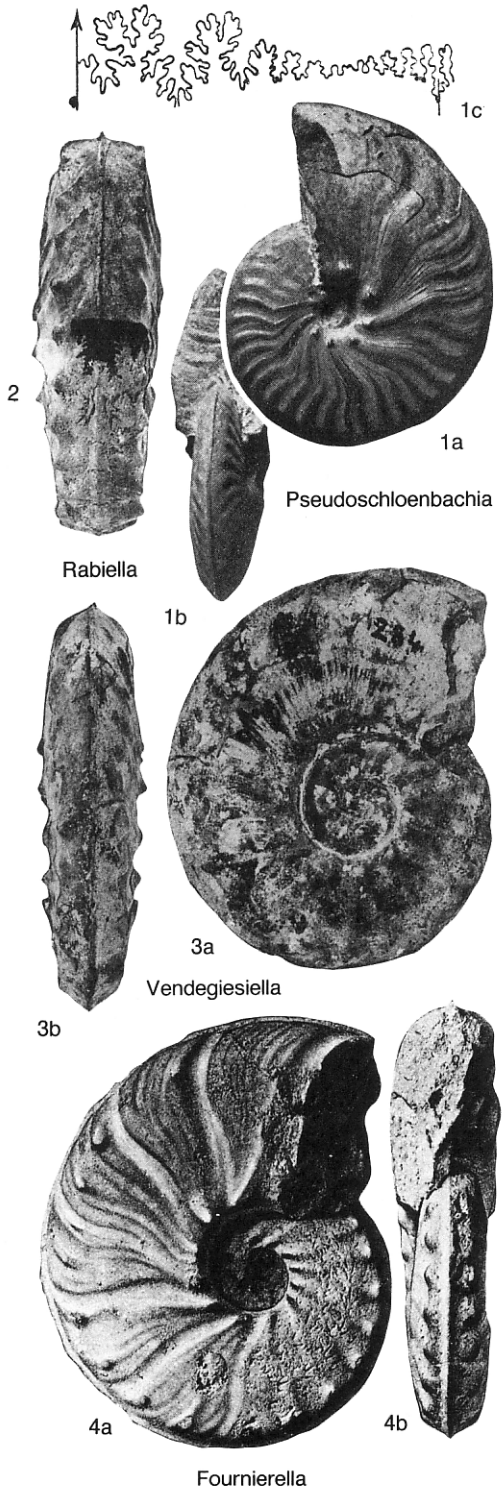


FIG. 83. Muniericeratidae (p. 107–111)

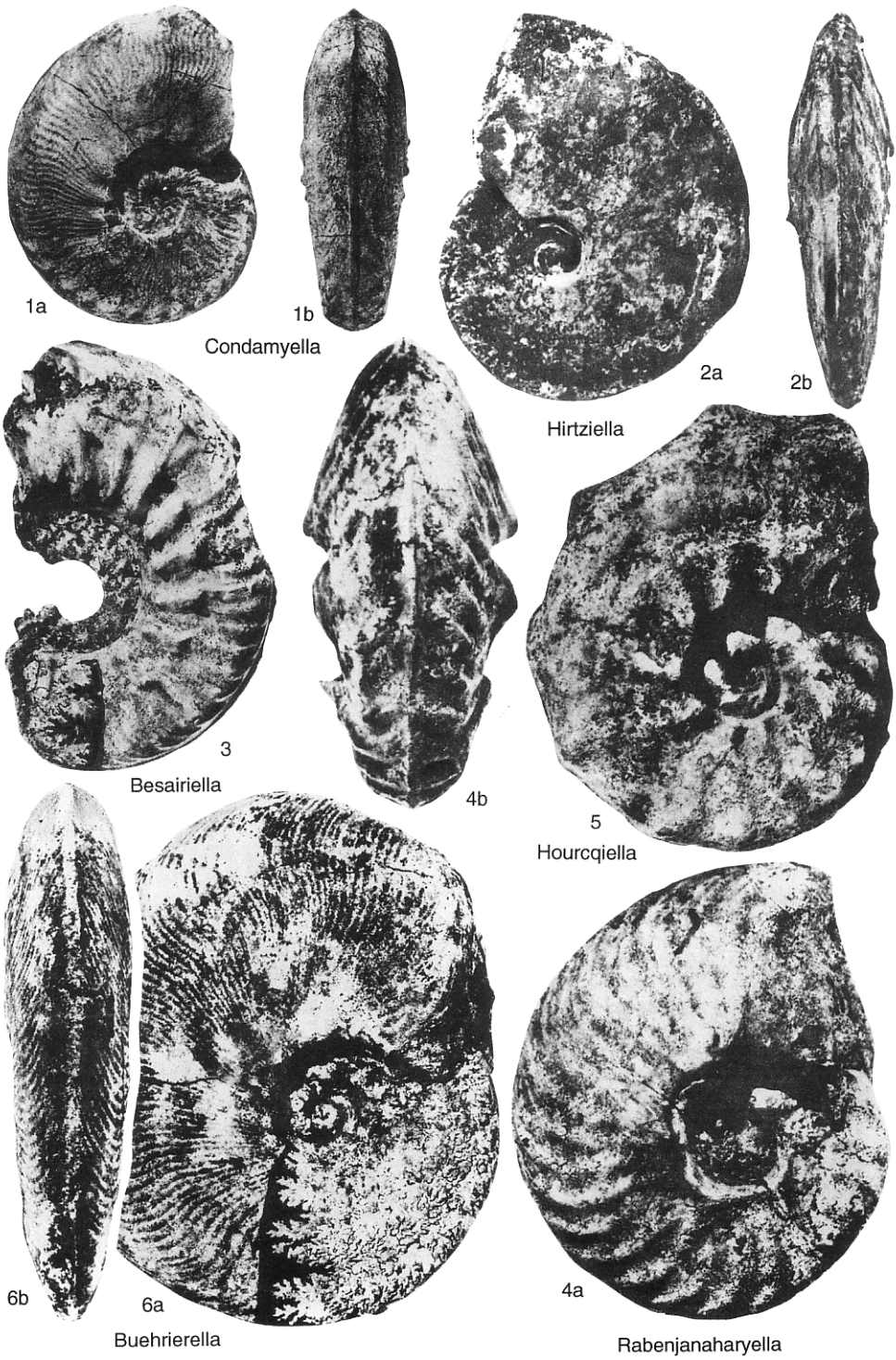


FIG. 84. Muniericeratidae (p. 109–111)

P. (**Rabiella**) COLLIGNON, 1969, p. 157 [**P. (R.) orthogona;* OD]. Stout, with subquadrate whorl section and distant, strong, single or branching ribs bearing umbilical and ventrolateral tubercles, much as in *M. (Mortoniceras)*; body chamber with converging sides and fine, falciform riblets. *Upper Cretaceous (Lower Campanian):* Madagascar.——FIG. 83,*2. *P. (R.) orthogona;* ×0.5 (Collignon, 1969).

P. (**Rabenjanaharyella**) COLLIGNON, 1969, p. 166 [**P. (R.) rhomboidalis;* OD]. Stout, with more or less triangular whorl section and coarse, falcoid ribs springing singly or in pairs from large to very large umbilical tubercles; body chamber with fine riblets. *Upper Cretaceous (Lower Campanian):* Madagascar.——FIG. 84,*4a,b. *P. (R.) rhomboidalis;* ×0.75 (Collignon, 1969).

P. (**Hirtziella**) COLLIGNON, 1969, p. 183 [**P. (H.) inornata;* OD]. Compressed; entirely or virtually smooth, with traces only of umbilical and ventrolateral tubercles; keel very finely denticulate. *Upper Cretaceous (Lower Campanian):* Madagascar.——FIG. 84,*2a,b. *P. (H.) inornata;* ×0.75 (Collignon, 1969).

Superfamily PULCHELLIACEAE H. Douvillé, 1890

[*nom. transl.* DRUSHCHITS in LUPPOV & DRUSHCHITS, 1958, p. 106, *ex* Pulchelliidae HYATT, 1903, p. 136, *nom. correct. pro* Pulchelliidés H. DOUVILLÉ, 1890, p. 287]

A compact group of small to moderate-sized forms; very involute to moderately evolute; smooth or with ribs ranging from fine and thin to broad and flat; various tubercles developing; venter rounded, sulcate, or keeled. Suture with wide, shallow, feebly denticulate elements, in some ceratitic. Origin uncertain but probably in Desmoceratidae, Barremitinae. *Lower Cretaceous (Upper Hauterivian–Upper Aptian).*

Family PULCHELLIIDAE H. Douvillé, 1890

[*nom. correct.* HYATT, 1903, p. 136, *pro* Pulchelliidés H. DOUVILLÉ, 1890, p. 287] [=Heinziidae HYATT, 1903, p. 128]

Characters as for superfamily. *Lower Cretaceous (Upper Hauterivian–Upper Aptian).*

Psilotissotia HYATT, 1900, p. 590 [**Pulchellia chalmasi* NICKLÈS, 1890, p. 16; OD]. Involute, compressed, with entire or tuberculate keel; smooth at first, then broad, shallow folds may develop. *Lower Cretaceous (Upper Hauterivian–Lower Aptian):* Spain, France, Switzerland, Algeria, Colombia.——FIG. 85,*1a–c.* **P. chalmasi* (NICKLÈS), Barremian, Spain; *a,* ×2; *b,* ×1.5; *c,* ×5 (Nicklès, 1890).

Lopholobites HYATT, 1900, p. 590 [**Neolobites? cotteaui* NICKLÈS, 1894, p. 54; OD]. Similar to *Psilotissotia,* but venter rounded, not keeled, and saddles and lobes almost entire. *Lower Cretaceous (Barremian):* Spain.——FIG. 85,*3. **L. cotteaui* (NICKLÈS); ×2 (Nicklès, 1890–1894).

Nicklesia HYATT, 1903, p. 138 [**Ammonites dumasianus* ORBIGNY, 1842b, p. 69; OD] [=*Nicklesiella* BÜRGL, 1956, p. 55 (type, *Pulchellia (Nicklesiella) leivaensis* BÜRGL, 1956, p. 55; OD); *Semipulchellia* BÜRGL, 1956, p. 57 (type, *P. (Semipulchellia) communis;* OD)]. Very involute; smooth at first, later with broad, flat ribs and narrower interspaces crossing the rounded or slightly flattened venter without interruption. Forms transitional to *Pulchellia* have flat or shallowly sulcate venters on inner whorls (*Nicklesiella, Semipulchellia*). *Lower Cretaceous (Barremian):* southern and central Europe, northern Africa, Colombia.——FIG. 85,*2a,b. *N. dumasiana* (ORBIGNY), Colombia; ×0.5 (Orbigny, 1842b).——FIG. 85,*2c–e. N. communis* (BÜRGL), Colombia; ×1 (Bürgl, 1956).

Buergliceras ETAYO SERNA, 1968, p. 63 [**B. buerglii;* OD]. Similar to *Nicklesia,* except ribs ending in large ventrolateral clavi alternating with very large siphonal clavi. *Lower Cretaceous (Barremian):* Colombia.——FIG. 85,*5a–c. *B. buerglii; a,* side, ×1; *b,* periphery, ×1; *c,* section, ×1 (Etayo Serna, 1968).

Pulchellia UHLIG, 1883, p. 246(122) [**Ammonites galeatus* BUCH, 1839, p. 5; SD GIGNOUX, 1921, p. 147]. Involute to evolute; compressed and flat-sided to rather inflated with convex sides; ribs ranging from coarse, broad, and flat to dense, fine, and sharp; ribs branching, or long and short, or more or less uniform and single, forming blunt to sharp ventrolateral clavi, always opposite, and continuing strongly or feebly across flat or sulcate venter; inner ventrolateral tubercles and umbilical bullae may be present. Variation within the genus seems to be continuous in all characters except degree of involution. *Lower Cretaceous (Upper Hauterivian–Upper Barremian):* southern and central Europe, northern Africa, ?Japan, California, Venezuela, Colombia, Chile.

P. (**Pulchellia**) [=*Caicedia* BÜRGL, 1956, p. 66 (type, *Ammonites caicedi* KARSTEN, 1858, p. 107; OD); *Hettneria* BÜRGL, 1956, p. 70 (type, *P. selecta* GERHARDT, 1897b, p. 142; OD)]. Involute; umbilicus about 10 percent of diameter. Occurrence and distribution as for genus.——FIG. 86,*1a,b. *P. (P.) galeata* (BUCH), Barremian, Colombia; ×1 (Riedel, 1938).——FIG. 86,*1c,d. P. (P.) caicedi* (KARSTEN), Barremian, Colombia; ×1 (Karsten, 1858).——FIG. 86,*1e–g. P. (P.) orbignyi* BÜRGL, Barremian, Colombia; ×0.75 (Orbigny, 1842b).

P. (**Heinzia**) SAYN, 1891a, p. 153(19) [**Ammonites provincialis* ORBIGNY, 1850a, p. 99; SD ROMAN, 1938, p. 469] [=*Gerhardtia* HYATT, 1903, p. 135 (type, *Ammonites galeatoides* KARSTEN, 1858, p. 107; OD)]. Evolute; umbilicus about one-fourth diameter. Occurrence and distribution as for genus.——FIG. 86,*2a,b. *P. (H.) provincialis* (ORBIGNY), Barremian, France; ×1 (Cottreau,

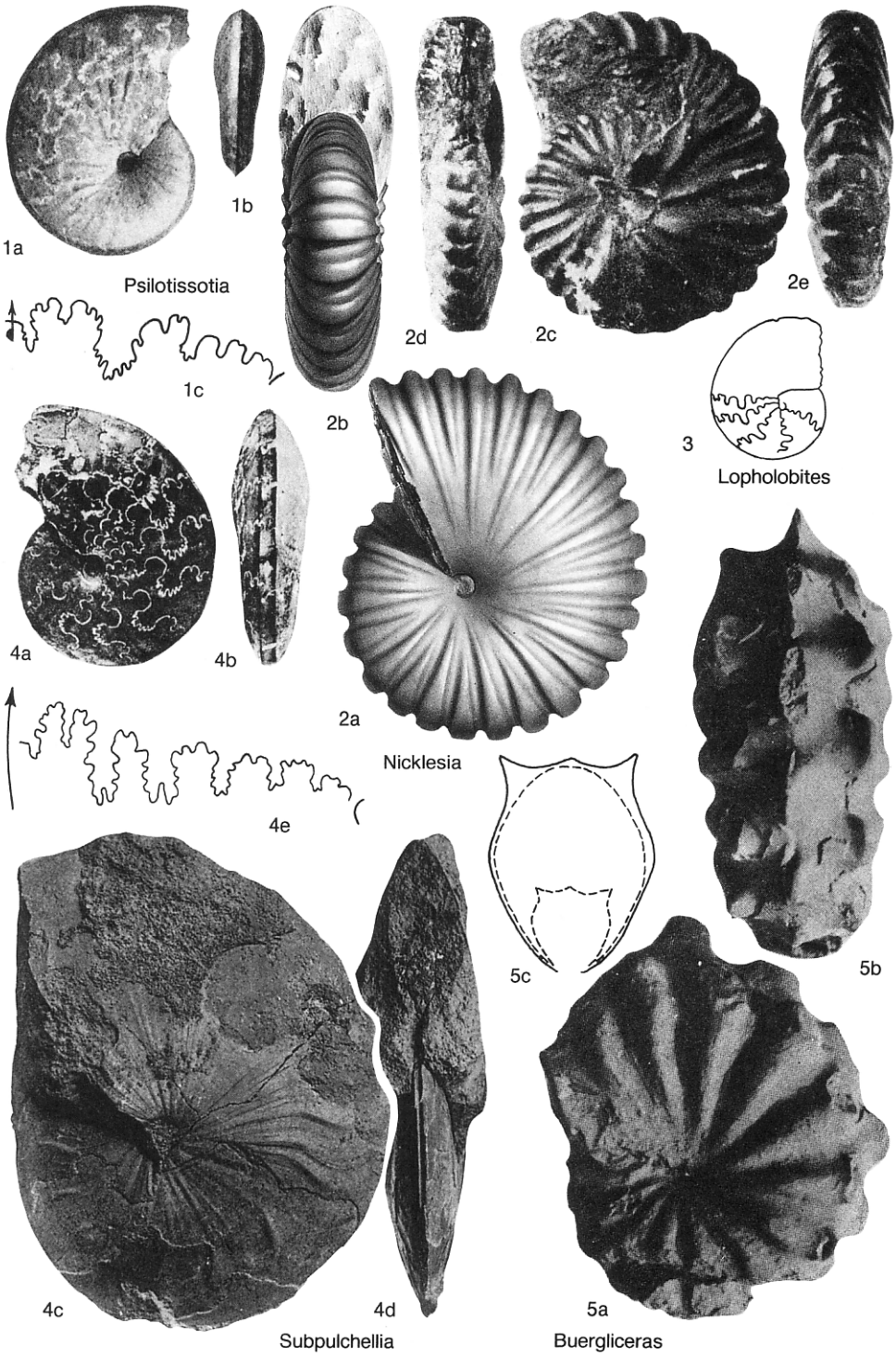


FIG. 85. Pulchelliidae (p. 111–114)

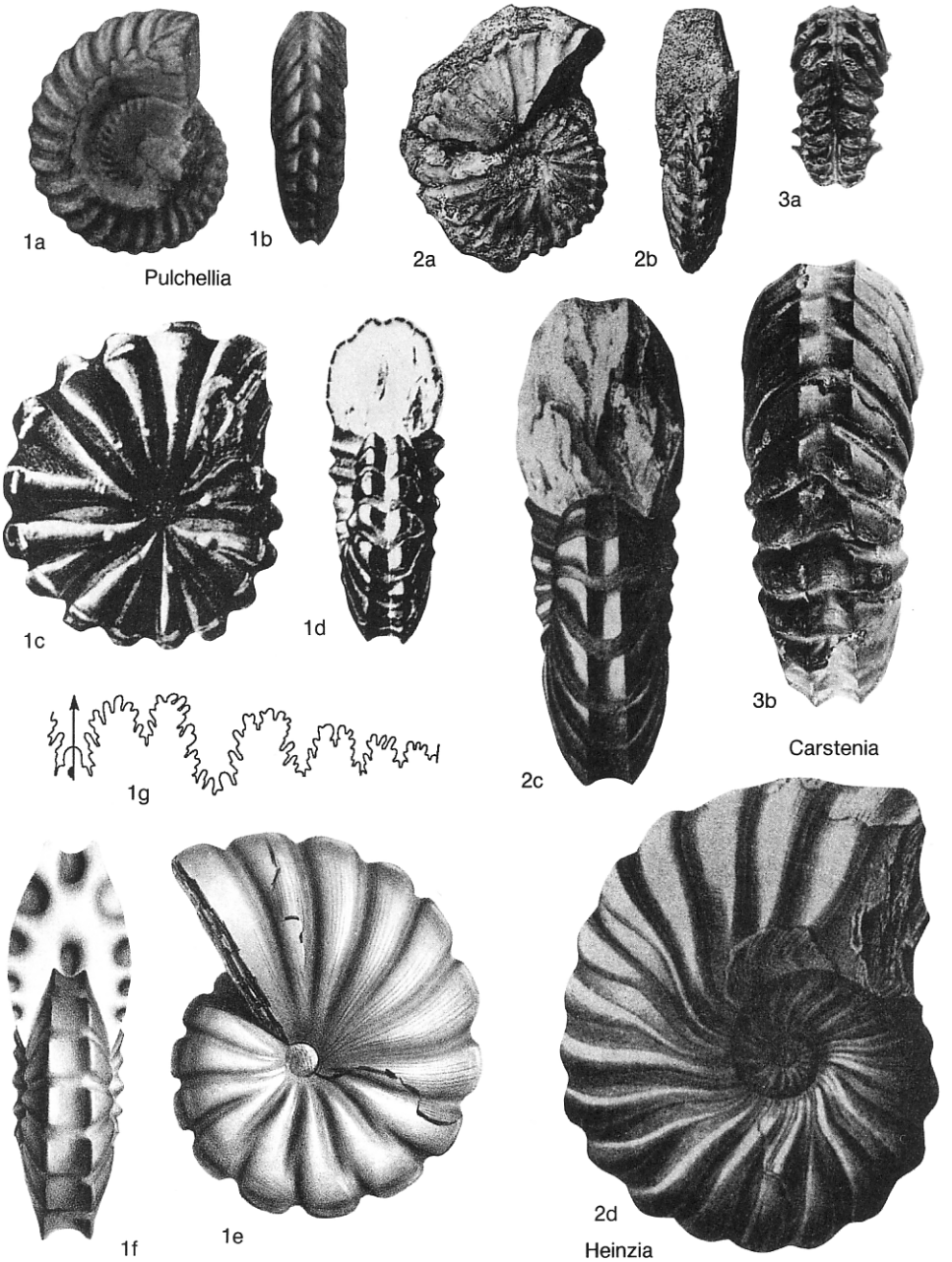


FIG. 86. Pulchelliidae (p. 111–113)

1937).——FIG. 86,*2c,d. P. (H.) galeatoides* (KARSTEN), Barremian, Colombia; ×0.75 (Karsten, 1858).

P. (**Carstenia**) HYATT, 1903, p. 133 [**Ammonites lindigi* KARSTEN, 1858, p. 108; OD] [=*Karstenia* SAYN, 1904, p. 123, *nom. van.*]. Relatively evolute; whorl section inflated at all stages; from a small diameter, ribs strong with prominent inner and outer ventrolateral clavi and large lateral tubercles; on last part of outer whorl, ribs broader and only outermost tubercle remaining. *Lower Cretaceous (Barremian):* Colombia.——FIG. 86,*3a,b. *P. (C.) lindigi* (KARSTEN); *a*, ×1; *b*, ×0.75 (Collet, 1924).

Coronites HYATT, 1903, p. 130 [**Heinzia coronatoides* SAYN, 1891a, p. 160(30); OD]. Only very small

nuclei known. Evolute; whorl section coronate; ribs dense, strong, and both single and branching, with or without large umbilical tubercles; venter with narrow groove. *Lower Cretaceous (Barremian):* Algeria.

Subpulchellia HYATT, 1903, p. 139 [**S. castellanensis;* OD] [=*Mogharaeceras* BREISTROFFER, 1940, p. 135(65) (type, *Knemiceras priscum* H. DOUVILLÉ, 1917, p. 122; OD)]. Very involute, compressed, and flat-sided; venter narrow, concave, and bordered by continuous, sharp ridges; surface smooth except for irregular, weak folds and striae. *Lower Cretaceous (Barremian–Upper Aptian):* Spain, France, Egypt (Sinai).——FIG. 85,*4a,b. S. oehlerti* (NICKLÈS), Barremian, Spain; ×2 (Nicklès, 1894).——FIG. 85,*4c–e. S. prisca* (H. DOUVILLÉ), Lower Aptian, Sinai; *c,d,* macroconch, ×1; *e,* suture showing adventive lobe in saddle E/L, ×2 (H. Douvillé, 1917).

[**Psilopulchellia** HYATT, 1903, p. 136 (*nom. nud.*) was mentioned by its author as the primitive member of the family, but no species were mentioned. The species selected by ROMAN, 1938, p. 468, as type is a *Pulchellia.*]

Superfamily HOPLITACEAE H. Douvillé, 1890

[*nom. correct.* WRIGHT & WRIGHT, 1951, p. 21, *pro* Hoplitida SPATH, 1922a, p. 95, *nom. transl. ex* Hoplitidae H. DOUVILLÉ, 1890, p. 290] [=Placenticeratacеae HYATT, 1900, *nom. correct.* CASEY, 1960a, p. 208, *pro* Placenticeratida HYATT, 1900, p. 584; ?Engonoceratacеae HYATT, 1900, *nom. transl.* BASSE, 1952b, p. 658, *ex* Engonoceratidae HYATT, 1900, p. 585]

Derivatives, probably monophyletic, of *Uhligella* (Desmoceratidae, Beudanticeratinae) developing strong ornament typically comprising branched ribs springing from umbilical tubercles. Many with flat or grooved venter bordered by ventrolateral clavi. Nature of dimorphism not yet fully known, but microconchs probably having simple apertures. Sutures of desmoceratid type except in Placenticeratidae and Engonoceratidae, in which elements are multiplied and develop special features. SPATH, 1923–1943; WRIGHT, 1955; CASEY, 1965. *Lower Cretaceous (Upper Aptian)–Upper Cretaceous (Upper Maastrichtian).*

Family HOPLITIDAE H. Douvillé, 1890

[*nom. correct.* BÖHM, 1895, p. 365 (not HYATT, 1900, as incorrectly stated in Opinion 353), *pro* Hoplitidés H. DOUVILLÉ, 1890, p. 290; ICZN Opinion 353, 1955, Family-Group Name No. 10]

Compressed to inflated; typically with ribs springing from distinct umbilical tubercles, interrupted or not on flat or rounded venter. Suture as in Desmoceratidae. *Lower Cretaceous (Upper Aptian, Lower Albian)–Upper Cretaceous (Lower Cenomanian).*

Particularly characteristic of central and northern European Middle Albian; few genera found south of the equator.

Subfamily SONNERATIINAE Destombes, Juignet, & Rioult, 1973

[Sonneratiinae DESTOMBES, JUIGNET, & RIOULT, 1973, p. 70] [=Otohoplitinae SAVELIEV, 1992, p. 24]

The trend is from strong, frequently single ribbing and arched venter to ribs branching from umbilical tubercles, with ventrolateral angulation or tubercles and flat venter. Later whorls of macroconchs may be more or less smooth, or have only obscure ribs, or strong ribbing may persist. Suture generally with relatively narrow L. *Lower Cretaceous (Upper Aptian,* jacobi *Zone, Lower Albian–Middle Albian).*

Sonneratiinae is the primitive subfamily of Hoplitidae, from which the rest were derived. *Sonneratia* is not known before the Lower Albian *mammillatum* Zone, but *Farnhamia* of the *?acuticostata* Zone has inner whorls closely resembling *Sonneratia. Bucaillella* of the *?jacobi* Zone has a hoplitoid suture and is best placed here (DESTOMBES, JUIGNET & RIOULT, 1973), though with some doubt.

?Bucaillella DESTOMBES, JUIGNET, & RIOULT, 1973, p. 71 [**B. cayeuxi;* OD]. Evolute; inflated but increasing only slowly in width; ribs strong, rather thin, high, single or branching high up on sides, and arising on umbilical wall but not forming umbilical tubercles; venter evenly rounded in young and may be slightly flattened in adults, but ribs not interrupted. Body chamber reduced in cross section. Suture typically hoplitoid. *Lower Cretaceous (Upper Aptian,* jacobi *Zone):* northeastern France.——FIG. 87,*3a–c.* **B. cayeuxi; a,b,* ×0.75; *c,* ×5 (Destombes, Juignet, & Rioult, 1973).

Farnhamia CASEY, 1954a, p. 107 [**F. farnhamensis;* OD]. Large; rather evolute; inner whorls first rounded in section, later subquadrate, with strong, blunt ribs rising in twos and threes from umbilical bullae and bent forward on venter; in middle growth, long and short nontuberculate ribs may occur; outer whorls smooth or with weak to moderate folds. Affiliation to *Arcthoplites* (OWEN, 1988, p. 215) seems doubtful. *Lower Cretaceous (Lower*

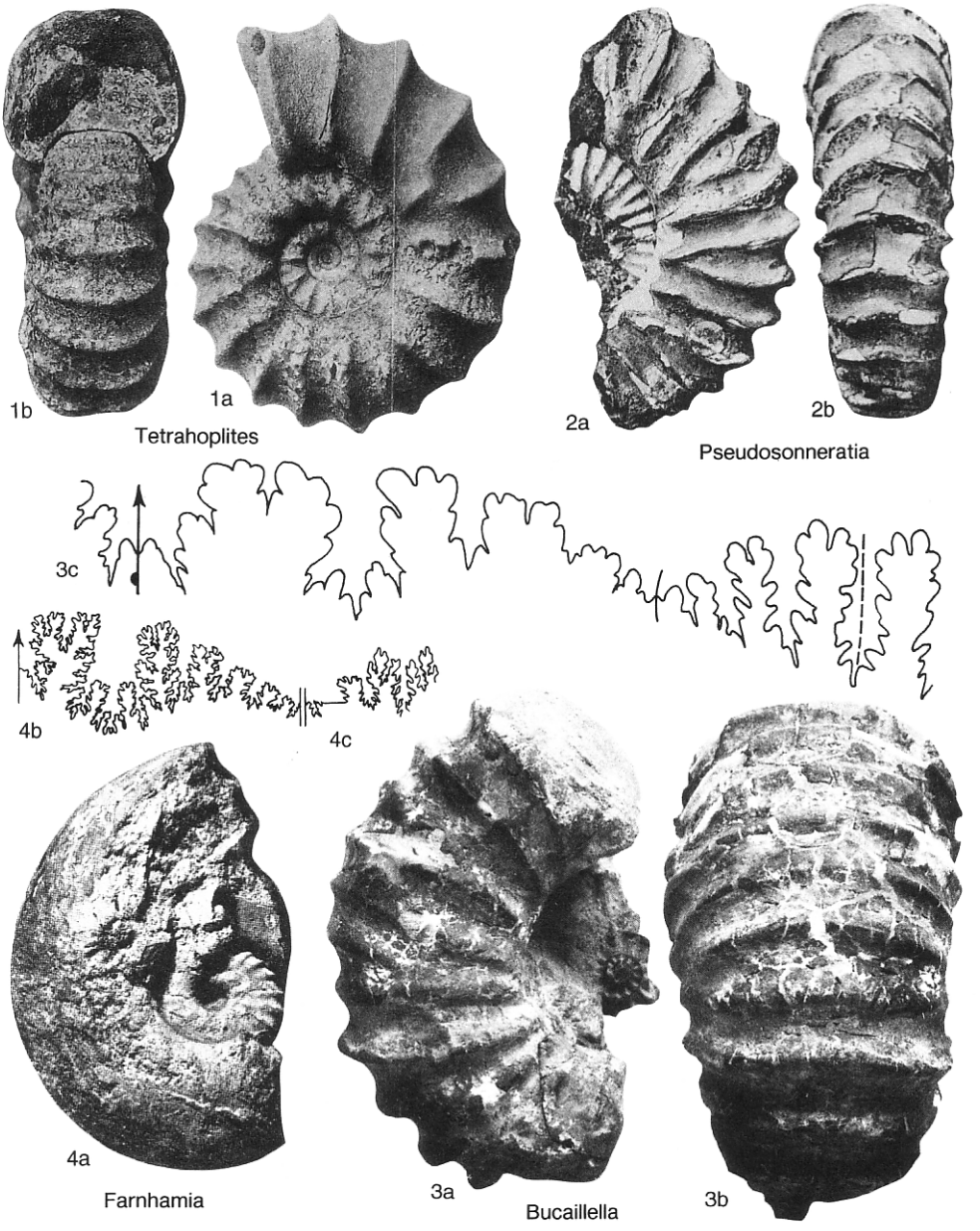


FIG. 87. Hoplitidae (p. 114–117)

Albian, tardefurcata *Zone):* England.——FIG. 87,*4a–c.* **F. farnhamensis; a,* ×0.25; *b,c,* ×0.5 (Casey, 1954a).

Sonneratia BAYLE, 1878, explanation to pl. 60, fig. 5–6 [**Ammonites dutempleanus* ORBIGNY, 1850a, p. 123; M] [=*Eosonneratia* SAVELIEV, 1973, p. 80 (type, *S. (E.) vnigri;* OD); *Globosonneratia* SAVELIEV, 1973, p. 83 (type, *S. (G.) globulosa* SAVELIEV, 1973, p. 83; OD; =*S. perinflata* BREISTROFFER, 1947b, p. 84(68))]. More or less involute and inflated, with arched venter; ribs strong and rounded, long and short or branching at umbilical swellings, and crossing venter without thickening on shoulders. Suture much as in *Farnhamia* but with longer L. *Lower*

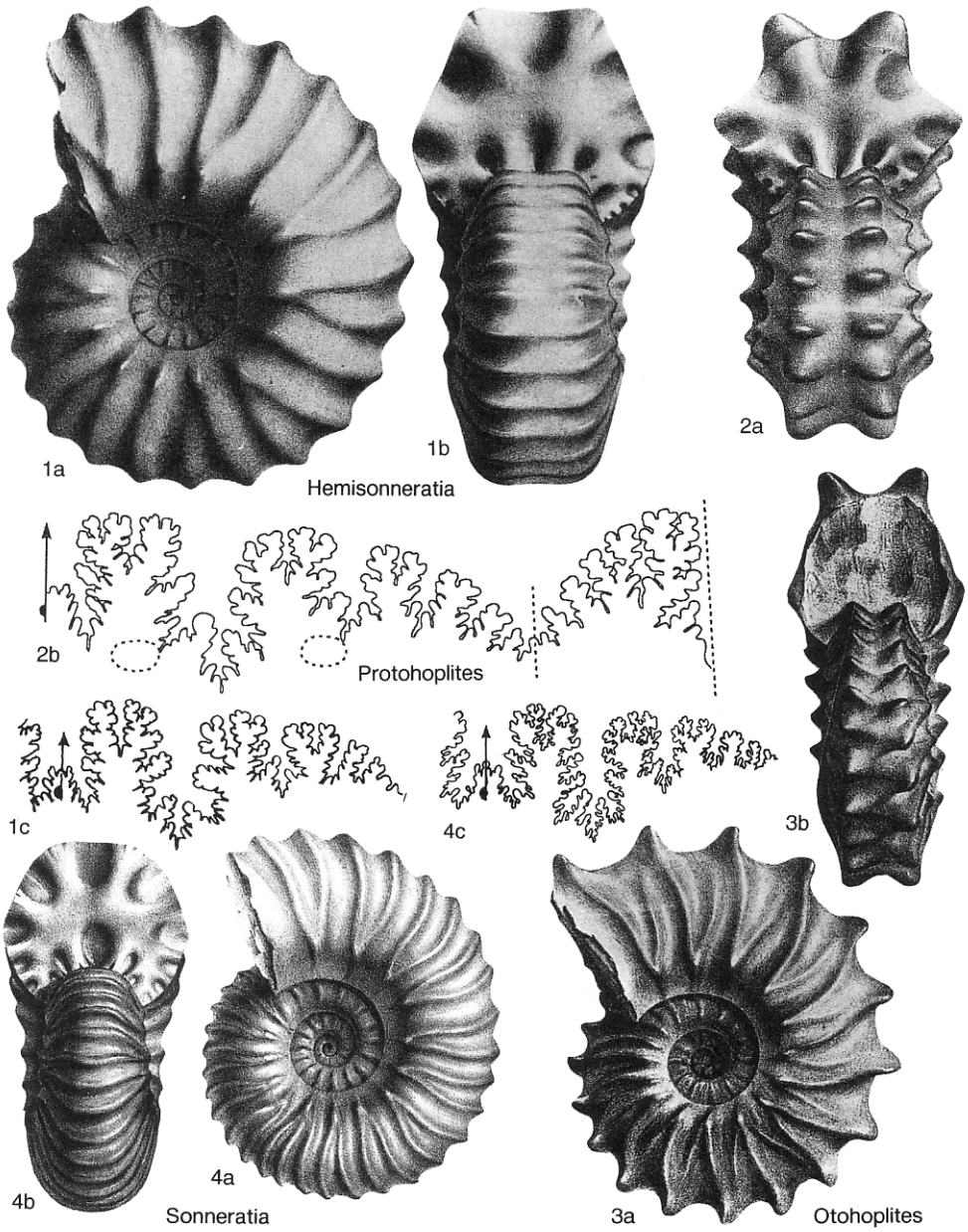


FIG. 88. Hoplitidae (p. 115–117)

Cretaceous (Lower Albian): Europe, Transcaspia. ——FIG. 88,*4a–c.* **S. dutempleana* (ORBIGNY), France; *a,b,* ×0.5; *c,* ×0.75 (Orbigny, 1840–1842).

Tetrahoplites CASEY, 1952, p. 134 [**Sonneratia subquadrata* SINZOW, 1907, p. 476; OD]. Whorl section subquadrate, inflated to rather compressed; ribs sigmoid or concave throughout, rising mostly in pairs from blunt umbilical bullae, and bent forward but not thickened on venter. Suture as in *Farnhamia* but with longer median element in L. *Lower Cretaceous (Lower Albian):* England, France, Transcaspia.——FIG. 87,*1a,b.* **T. subquadratus* (SINZOW), Transcaspia; ×0.75 (Sinzow, 1907).

Pseudosonneratia SPATH, 1925a, p. 76 [**P. typica;* OD]. Slightly inflated to rather compressed and high-whorled, with slight flattening of sides and narrow venter. Sinuous ribs branching from umbilical bullae or alternately long and short, crossing

venter without interruption and with strong forward sweep. *Lower Cretaceous (Lower Albian,* mammillatum *Zone):* England, France, Switzerland, Bornholm, Spitsbergen, Transcaspia.——FIG. 87,*2a,b.* **P. typica,* France; ×0.75 (Jacob, 1908).

Protohoplites SPATH, 1923d, p. 65 [**Ammonites archiacianus* ORBIGNY, 1841, p. 244; OD]. Moderately evolute; whorl section subhexagonal and depressed or compressed; venter depressed, bordered by long bullae opposite tubercles; umbilical tubercles prominent. Suture with rather narrow L and retracted toward umbilicus. Adult last whorl with rounded venter and coarse, single or branching, sigmoid ribs. *Lower Cretaceous (Lower Albian–Middle Albian):* Europe.

P. **(Hemisonneratia)** CASEY, 1952, p. 135 (BREISTROFFER, 1952a, p. 153, *nom. nud.*) [**Ammonites puzosianus* ORBIGNY, 1841, p. 265; OD]. Ribs merely thickened on shoulders. Occurrence and distribution as for genus.——FIG. 88,*1a–c.* **P. (H.) puzosianus* (ORBIGNY), Middle Albian, France; ×0.75 (Orbigny, 1840–1842).

P. **(Protohoplites).** Ribs raised into strong ventrolateral tubercles. Occurrence and distribution as for genus.——FIG. 88,*2a,b.* **P. (P.) archiacianus* (ORBIGNY), Middle Albian, France; *a,* ×0.75; *b,* enlarged (Orbigny, 1840–1842).

Otohoplites STEINMANN, 1925, p. 361 [**Ammonites raulinianus* ORBIGNY, 1841, p. 238; SD CASEY, 1952, p. 135]. Rather inflated to compressed, with looped or zigzagging ribs ending in oblique ventrolateral clavi, generally with ribs zigzagging across venter; adult body chamber of macroconchs smooth, with rounded venter. *Lower Cretaceous (Lower Albian,* mammillatum *Zone):* Europe, Transcaspia.——FIG. 88,*3a,b.* **O. raulinianus* (ORBIGNY), France; ×0.75 (Orbigny, 1840–1842).

Subfamily ANAHOPLITINAE Breistroffer, 1947

[*nom. transl.* WRIGHT, herein, *ex* Anahoplitidae BREISTROFFER, 1947b, p. 100(84)] [=Pleurohoplitinae SAVELIEV, 1992, p. 26]

Compressed; high-whorled, with flat venter. Suture much incised, tending to become asymmetrical in later forms as siphon moves to ventrolateral angle. *Lower Cretaceous (?Lower Albian, Middle Albian–Upper Albian).*

Anahoplitoides, derived from compressed *Pseudosonneratia (Isohoplites),* is placed here with a query since it may not be the direct ancestor of the Middle Albian, *dentatus* Zone species of *Anahoplites.*

?Anahoplitoides CASEY, 1961b, p. 599 [**Saynella splendens* (J. SOWERBY) var. *gigas* SINZOW, 1915, p. 20; OD] [=*Pochialayniceras* ALABUSHEV & ALABUSHEVA, 1988, p. 29 (type, *Hoplites yakounensis* WHITEAVES, 1900, p. 280; OD)]. Inner whorls like a costate *Anahoplites* but with ventrolateral tubercles opposite; outer whorls, at least of macroconchs, with smooth venter. *Lower Cretaceous (Lower Albian):* England, Transcaspia, eastern Siberia, British Columbia.——FIG. 89,*1a–c.* **A. gigas* (SINZOW); *a,b,* ×0.25; *c,* ×1 (Casey, 1961b).

Anahoplites HYATT, 1900, p. 584 [**Ammonites splendens* J. SOWERBY, 1815, p. 1; OD] [=*Lepthoplites* SPATH, 1925d, p. 144 (type, *L. falcoides;* SD SPATH, 1928a, p. 231)]. Rather involute, compressed, with flat sides and flat, rarely sulcate venter; flexuous ribs and striae normally ending in fine, dense ventrolateral nodes; umbilical tubercles weak. Suture with short and wide L, much incised. Siphuncle and suture normally asymmetrical in later stages. *Lower Cretaceous (Middle Albian–Upper Albian):* Europe, Transcaspia.——FIG. 89,*2a–c. A. planus* (MANTELL), Middle Albian, England; *a,b,* ×1; *c,* ×1.5 (Spath, 1923–1943).——FIG. 89,*2d. A. cantabrigensis* SPATH, Upper Albian, England; ×1 (Spath, 1923–1943).

Pleurohoplites SPATH, 1921a, p. 237 [**Ammonites renauxianus* ORBIGNY, 1840, p. 113; OD]. Less involute than *Anahoplites;* whorl section compressed to very inflated; venter rounded to subcarinate; strong ribs branching from umbilical tubercles, not looped, and ending in ventrolateral nodes or swellings or continuous to siphonal line. *Lower Cretaceous (Upper Albian):* Europe.

P. **(Pleurohoplites).** Compressed; venter subcarinate; sides more or less flat. Occurrence and distribution as for genus.——FIG. 89,*4a,b.* **P. (P.) renauxianus* (ORBIGNY), France; ×0.5 (Orbigny, 1840–1842).

P. **(Arrhaphoceras)** WHITEHOUSE, 1927, p. 109 [**Ammonites woodwardi* SEELEY, 1865, p. 236; OD] [=*Praeschloenbachia* SCHOLZ, 1973, p. 124 (type, *Schloenbachia (P.) briacensis* SCHOLZ, 1973, p. 124; OD)]. Inflated, with rounded venter; ribs crossing venter almost without interruption; umbilical tubercles prominent; ventrolateral bullae appearing on inner whorls and may persist. Specimens with persistent ventrolateral bullae may also have a low, rounded keel and are transitional to *Schloenbachia,* but separation as *Praeschloenbachia* seems unnecessary. Occurrence and distribution as for genus.——FIG. 89,*3a–c. P. (A.) studeri* (PICTET & CAMPICHE), Switzerland; *a,b,* ×1; *c,* enlarged (Pictet & Campiche, 1860).

Subfamily HOPLITINAE H. Douvillé, 1890

[*nom. transl.* WRIGHT, 1952, p. 220, *ex* Hoplitidae, *nom. correct.* BÖHM, 1895, p. 365 (not HYATT, 1900, as incorrectly stated in ICZN Opinion 353), *pro* Hoplitidés H. DOUVILLÉ, 1890, p. 290; ICZN Opinion 353, 1955, Family-Group Name No. 10] [=Semenovitinae MIRZOEV, 1967, p. 63; Euhoplitinae SAVELIEV, 1992, p. 26; Discohoplitinae SAVELIEV, 1992, p. 27]

Venter flat, grooved, or slightly rounded; ribs interrupted on venter, with peripheral endings alternate; ribs branching from umbilical tubercles and commonly ending in

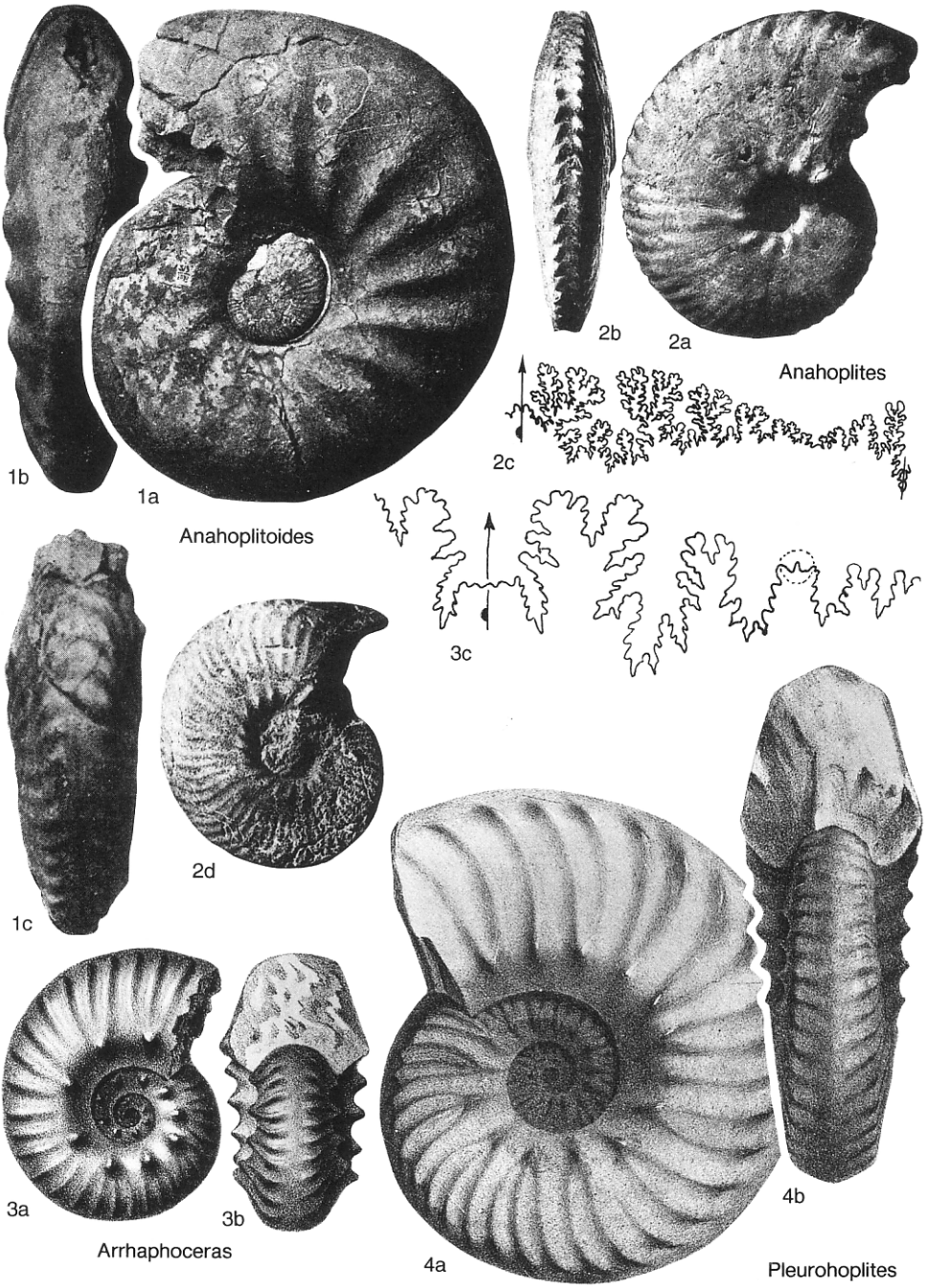


FIG. 89. Hoplitidae (p. 117)

prominent ventrolateral clavi; ribs repeatedly tending to unite in pairs at clavi. A stock appeared early in the Middle Albian with a steep-sided, narrow groove within the ventral sulcus. At the end of the Albian, smooth, raised venters appeared, which foreshadowed the sharply keeled Schloenbachiidae of the Cenomanian. Large individuals with adult

body chamber nearly smooth and with rounded venter are presumed to be macroconchs. SPATH, 1923–1943; CASEY, 1965. *Lower Cretaceous (Middle Albian)–Upper Cretaceous (Lower Cenomanian).*

Hoplites NEUMAYR, 1875a, p. 681 (1875b, p. 925), ICZN Opinion 353, 1955, Generic Name No. 876 [**Ammonites dentatus* J. SOWERBY, 1821, p. 3; ICZN Specific Name No. 489] [=*Odonthoplites* BREISTROFFER, 1947b, p. 100(84), ICZN Rejected Name No. 296 (type, *Hoplites canavarii* PARONA & BONARELLI, 1897, p. 93); *Daghestanites* GLAZUNOVA, 1953, p. 45, *nom. nud.*]. Whorl section compressed-rectangular to depressed-trapezoidal; prominent ribs branching from strong umbilical bullae and interrupted on venter, their ends prominent and opposite or alternate; some with zigzagging ribs; rib endings are normally thickened or raised into ventrolateral tubercles, which in most are oblique clavi. *Lower Cretaceous (Middle Albian):* Europe, Transcaspia, Mexico.

H. (Isohoplites) CASEY, 1954a, p. 112 [**Parahoplites steinmanni* JACOB, 1907, p. 255; OD]. High-whorled and compressed, with ribs depressed on venter; ribs opposite, at least on inner whorls. Transitional from *Pseudosonneratia.* Occurrence as for genus: England, France, Switzerland, Poland, Spitsbergen.——FIG. 90,*4a,b.* **H. (I.) steinmanni* (JACOB), France; ×1 (Casey, 1965).

H. (Hoplites). Ribs interrupted and alternate on venter. Occurrence and distribution as for genus.——FIG. 90,*3a,b.* **H. (H.) dentatus* (J. SOWERBY), England; ×1 (Spath, 1923–1943).

Epihoplites SPATH, 1925a, p. 81 [**Ammonites denarius* J. de C. SOWERBY, 1826, p. 78; OD]. Compressed to rather inflated; strong, rounded ribs branching in twos or threes from sharp umbilical tubercles; venter flat or slightly concave. *Lower Cretaceous (Middle Albian–Upper Albian):* Europe, Transcaspia.

E. (Epihoplites). Ribs ending rather inconspicuously on shoulders. Occurrence and distribution as for genus.——FIG. 91,*5a,b. E. (E.) trifidus* SPATH, Upper Albian, France; ×1 (Orbigny, 1840–1842).

E. (Metaclavites) CASEY, 1965, p. 461 [**Hoplites denarius* var. *compressus* PARONA & BONARELLI, 1897, p. 94; OD] [=*Gazdaganites* MIRZOEV, 1969, p. 41 (type, *G. gazdaganensis;* OD)]. Differs from *E. (Epihoplites)* in that the ribs end in ventrolateral clavi more or less parallel to siphuncle. *Lower Cretaceous (Upper Albian):* England, France, Turkmenistan.——FIG. 91,*6a,b.* **E. (M.) compressus* (PARONA & BONARELLI), France; ×1 (Orbigny, 1840–1842).

Semenoviceras WRIGHT, herein, *nom. nov. pro Semenovites* GLAZUNOVA, 1960, p. 93, *non* TARBINSKII, 1932, p. 194 [**Hoplites michalskii* SEMENOV, 1899, p. 120; OD]. Differs from *Epihoplites (Metaclavites)* in having simpler suture, prolonged smooth stage, and more flexuous ribs. *Lower Cretaceous (Upper Albian):* England, Russia, Iran.——FIG. 90,*2a–c.* **S. michalskii* (SEMENOV), Mangyshlak; ×1 (Semenov, 1899).

Dimorphoplites SPATH, 1925a, p. 81 [**Ammonites biplicatus* MANTELL, 1822, p. 91; OD]. Rather compressed, with venter flat to slightly sulcate; ribs strong, usually looped, persisting to end of body chamber; ventrolateral clavi more or less parallel to siphuncle. *Lower Cretaceous (Middle Albian–Upper Albian):* Europe, Transcaspia, Greenland.——FIG. 90,*1a,b.* **D. biplicatus* (MANTELL), Middle Albian, England; ×1 (Spath, 1923–1943).

Callihoplites SPATH, 1925a, p. 81 [**Ammonites catillus* J. de C. SOWERBY, 1827a, p. 123; OD]. Compressed or square whorl section; inner whorls with umbilical bullae and ventrolateral clavi with or without looped ribs between; body chamber typically smooth, with rounded venter, but some late forms probably ornamented to end (?microconchs). *Lower Cretaceous (Upper Albian):* Europe.——FIG. 91,*1a,b. C.* sp. aff. *C. patella* SPATH, Upper Albian, England; ×1——FIG. 91,*1c, C. patella* SPATH, Upper Albian, England; ×1 (Spath, 1923–1943).

Euhoplites SPATH, 1925a, p. 82 [**E. truncatus;* OD]. More or less evolute; compressed to inflated; venter flat or concave, typically with deep groove above siphuncle; strong ribs zigzagging between umbilical tubercles and prominent, parallel ventrolateral clavi, but ribs or tubercles or both may be absent. *Lower Cretaceous (Middle Albian–Upper Albian):* Europe, Greenland.——FIG. 91,*2a,b.* **E. truncatus* SPATH, Middle Albian, France; ×1 (Spath, 1923–1943).

Discohoplites SPATH, 1925a, p. 83 [**Ammonites coelonotus* SEELEY, 1865, p. 237; OD]. Compressed to moderately inflated; involute to evolute; venter grooved but not flat; typically with falcoid ribs and umbilical but no ventrolateral tubercles. *Lower Cretaceous (Upper Albian):* western Europe, Hungary, Transcaspia.——FIG. 91,*4a–f. D. subfalcatus* (SEMENOW); *a,b,* England, ×1 (Spath, 1923–1943); *c,d,* Transcaspia, ×1 (Pictet & Campiche, 1858–1860); *e,f,* Spain, microconch with aperture, ×1 (Wiedmann & Kaufmann, 1978).

Hyphoplites SPATH, 1922a, p. 110 [**Ammonites falcatus* MANTELL, 1822, p. 117; OD] [=*Drepanites* BENETT, 1831, p. 3, *non* MOJSISOVICS, 1893, p. 495 (suppressed by ICZN Opinion 1609)]. Differs from *Discohoplites* in having flat and grooved venter, falcate ribs, and, in most species, 1 or 2 rows of ventrolateral tubercles. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian):* Europe, Israel, Transcaspia.——FIG. 91,*3a,b.* **H. falcatus* (MANTELL), Lower Cenomanian, England; ×1 (Sharpe, 1853–1857).

Subfamily GASTROPLITINAE Wright, 1952

[Gastroplitinae WRIGHT, 1952, p. 220]

Primitive arched venter broadening; whorl section may become square. Ribs mostly branching in pairs from thin, oblique umbilical bullae and may become flattened.

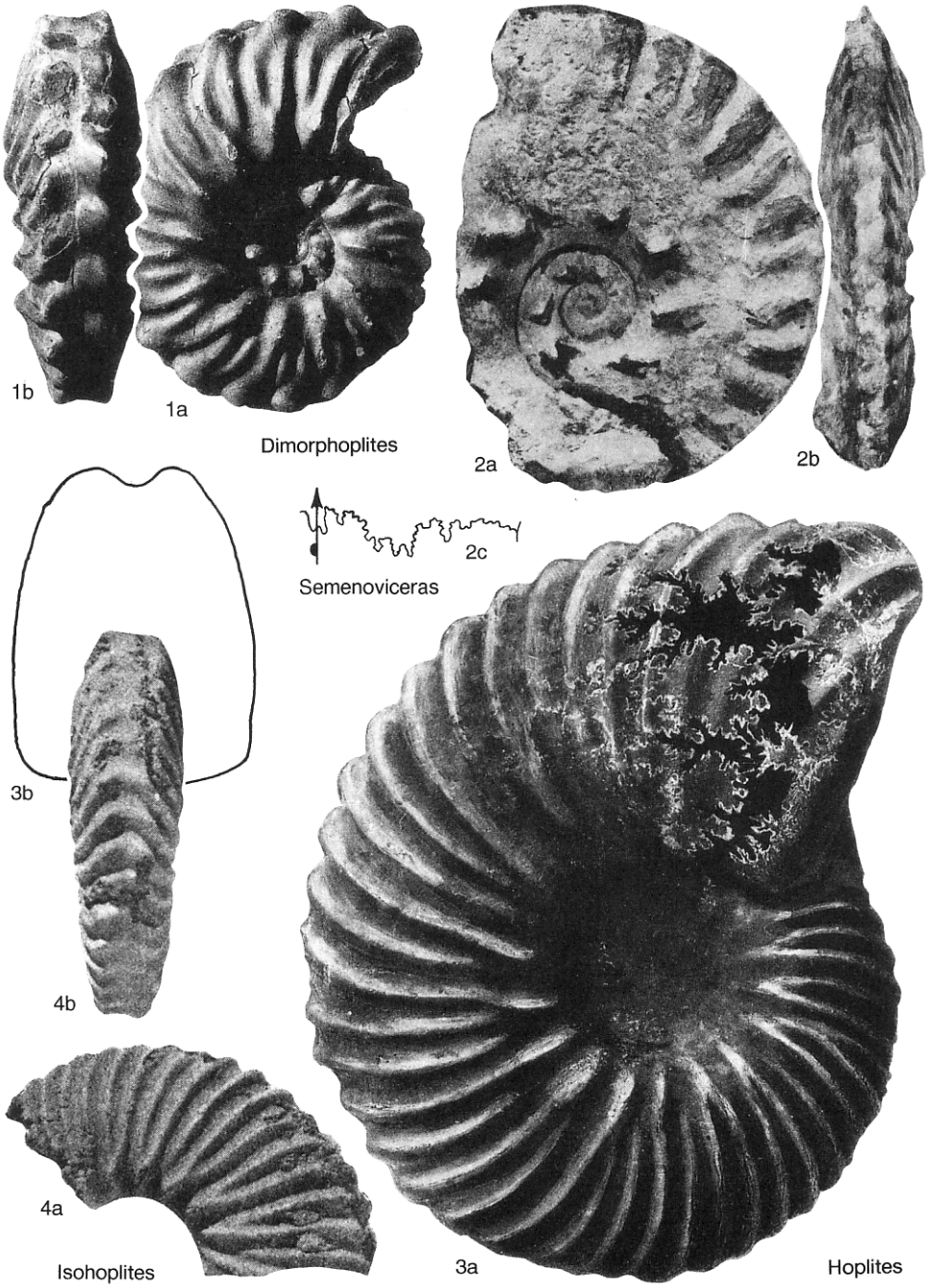


FIG. 90. Hoplitidae (p. 119)

Ventrolateral tubercles and later siphonal tubercles or keel tending to appear. Sutures very variable within species and individuals in proportion of elements and degree of incision, but normally L wide and divided by one or two large folioles. *Lower Cretaceous (Lower Albian)–Upper Cretaceous (?Cenomanian).*

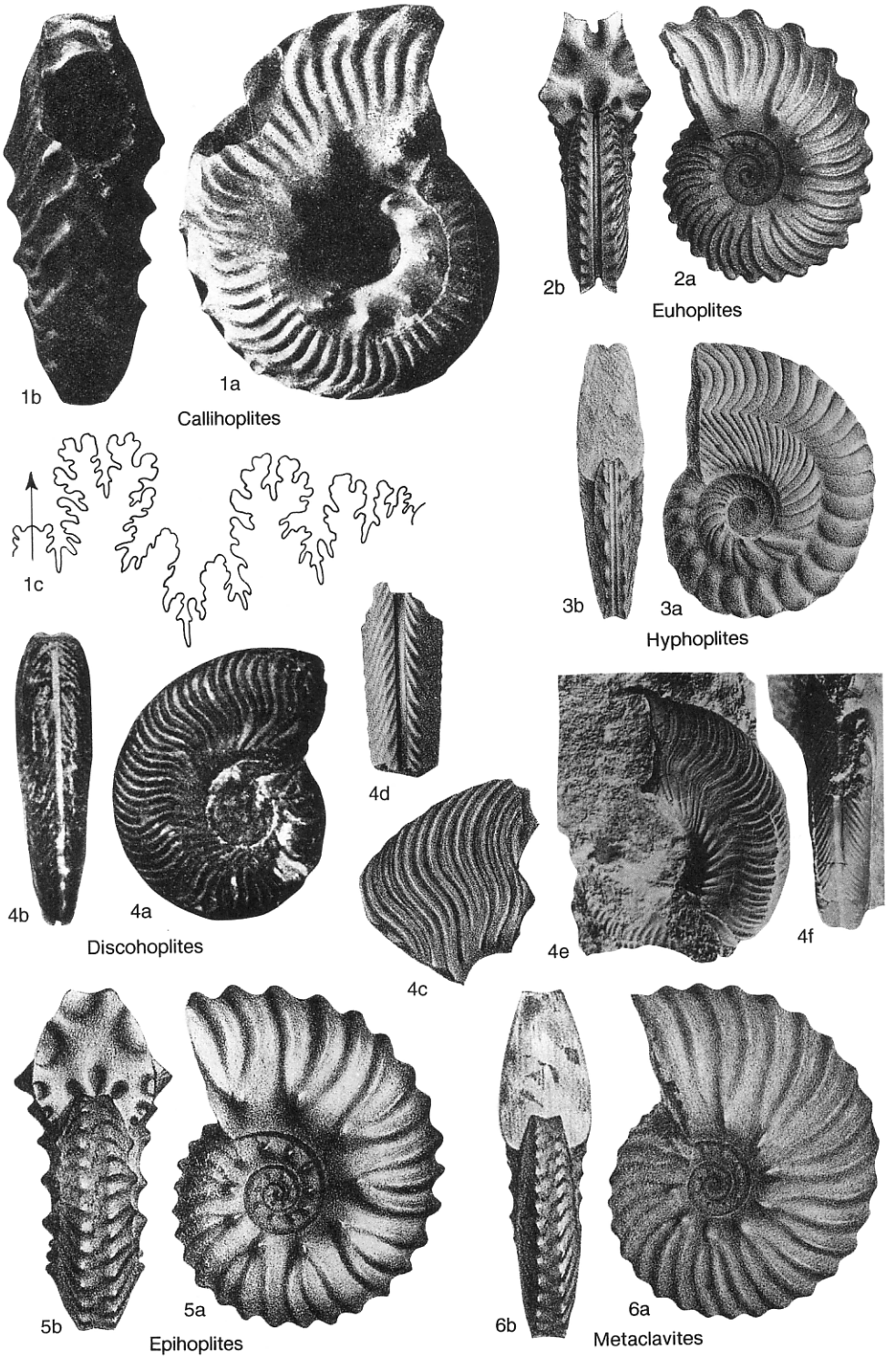


FIG. 91. Hoplitidae (p. 119)

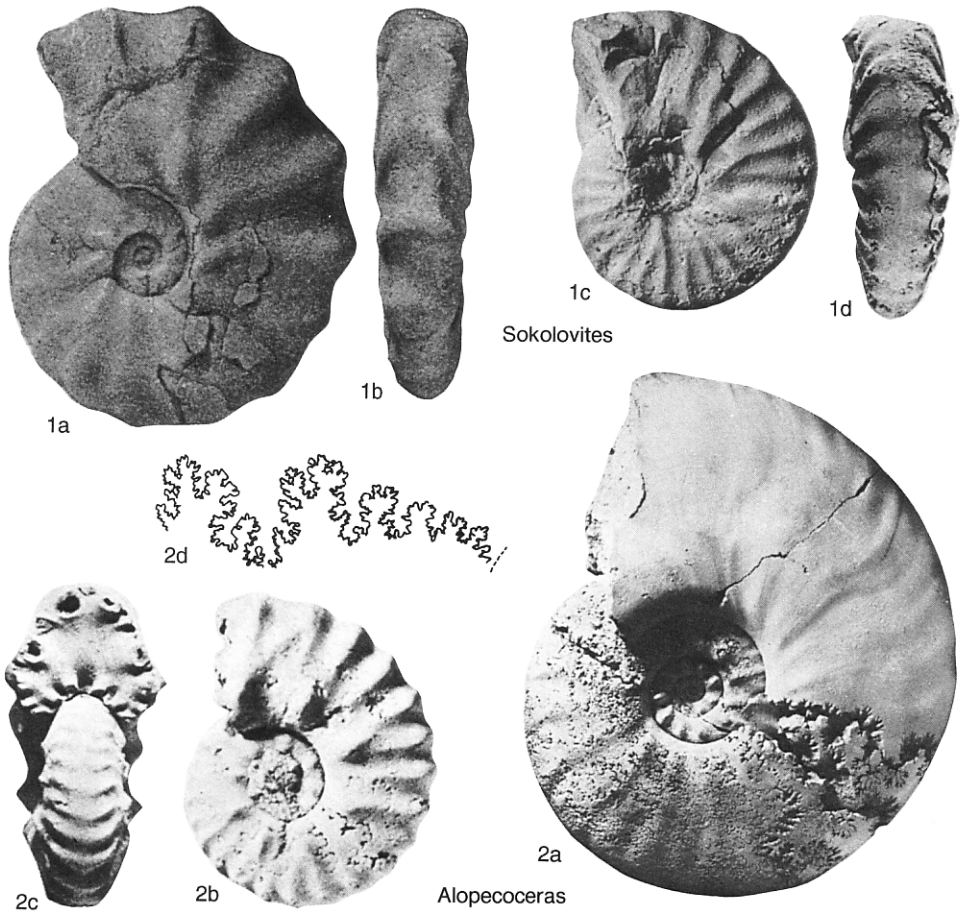


FIG. 92. Hoplitidae (p. 122–124)

Perhaps derived from compressed *Tetrahoplites* (Sonneratiinae), but resemblances to *Arcthoplites* suggest possible alternative origin in Cleoniceratidae. The subfamily is found mostly in boreal America.

Sokolovites CASEY, 1966, p. 552 [**S. subdragunovi;* OD] [=?*Cleogastroplites* JELETZKY, 1980, p. 4 (type, *C. aberrans;* OD)]. Moderately involute, flat-sided, with sparse primary and secondary ribs forming ventrolateral bulges and on later whorls crossing venter more or less transversely. *Lower Cretaceous (Lower Albian):* Transcaspia, ?Spitsbergen, Arctic Canada.——FIG. 92,*1a,b.* **S. subdragunovi,* Mangyshlak; ×1 (Casey, 1966).——FIG. 92,*1c,d.* ?*S. aberrans* (JELETZKY), Arctic Canada; ×1 (Jeletzky, 1980; courtesy of the Geological Survey of Canada).

Pseudopulchellia IMLAY, 1961, p. 65 [**P. pattoni;* OD] [=?*Stelckiceras* JELETZKY, 1980, p. 12 (type, *Placenticeras (perezianum?* var.*) liardense* WHITEAVES, 1889, p. 189; OD)]. Involute, compressed, and high-whorled, with subparallel or converging sides; venter narrowly rounded until last whorl, then broadening; flexuous ribs, rounded or flat-topped, may widen and strengthen ventrolaterally. Similar at some stages to *Gastroplites (Paragastroplites)* but initially lacking umbilical bullae and with venter flat only on last whorl. *Lower Cretaceous (Middle Albian):* Alaska, northern Canada.——FIG. 93,*2a.* **P. pattoni,* Alaska; *a,* ×1 (Imlay, 1961).——FIG. 93,*2b–d. P. imlayi,* northern Canada; ×1 (Jeletzky, 1980; courtesy of the Geological Survey of Canada).——FIG. 93,*2e. P.? liardense* (WHITEAVES); ×0.25 (Jeletzky, 1980; courtesy of the Geological Survey of Canada).

Gastroplites MCLEARN, 1930, p. 7 [**Hoplites canadensis* WHITEAVES, 1893a, p. 118; OD]. More or less involute, compressed, with rounded venter in early stages; later becoming broader, with flat venter; ribs coarse, more or less prominent, variably high and narrow, rounded, or flattened, branching above umbilical edge, tending to form bullae, cross-

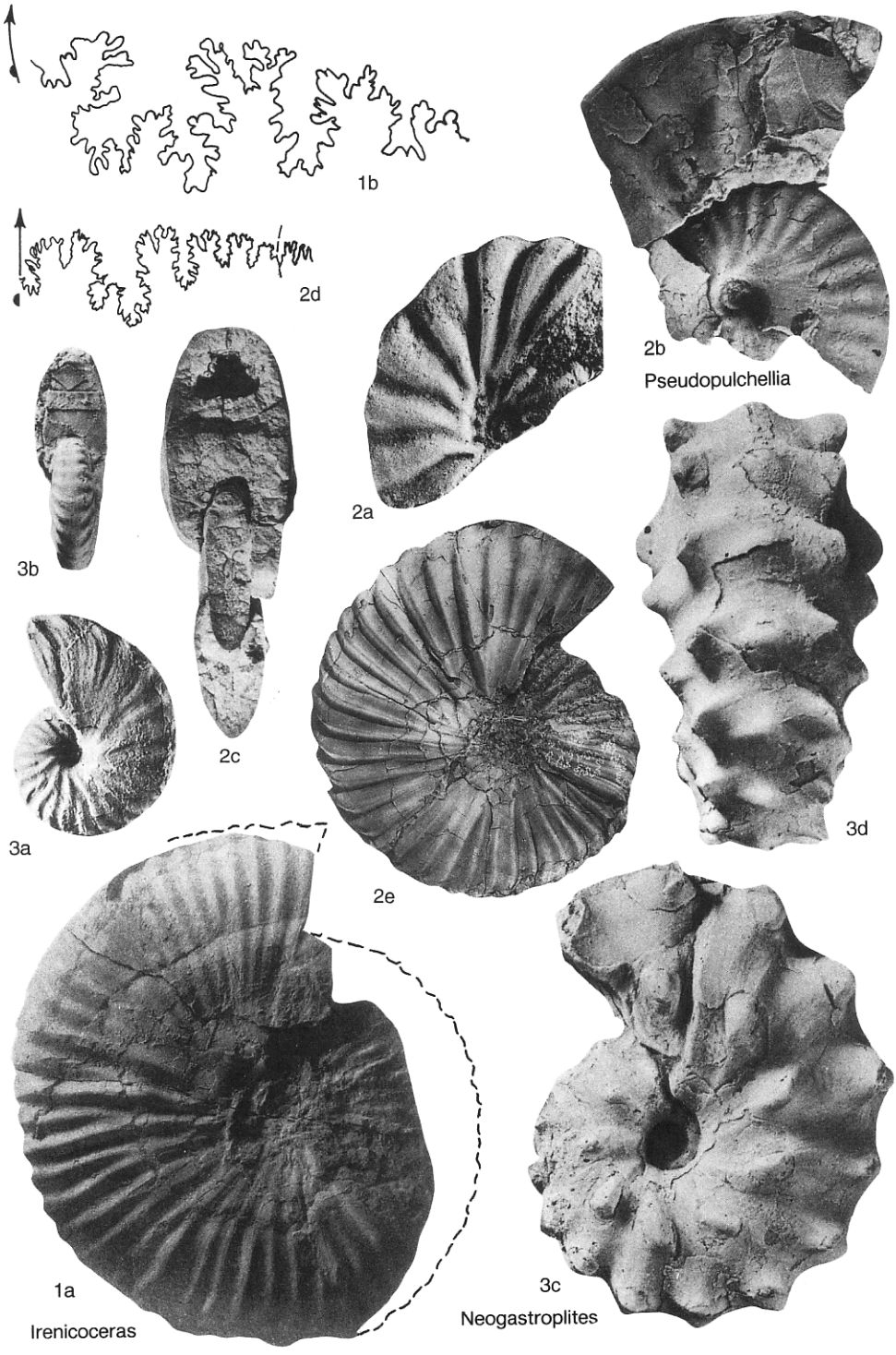


FIG. 93. Hoplitidae (p. 122–124)

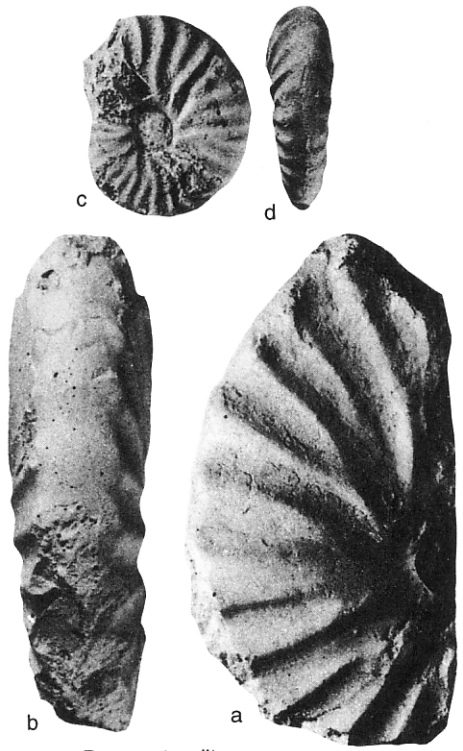


FIG. 94. Hoplitidae (p. 124)

ing venter with slight forward bend or straight or interrupted, with incipient ventrolateral tubercles. Macroconchs with diameter of 120 to 150 mm, smooth body chamber, and, in some species, smooth penultimate whorl; microconchs with diameter of 50 to 60 mm and with ribs persisting to end. Suture rather simple with shallow elements to finely incised with long elements. *Lower Cretaceous (Middle Albian):* England, ?Spitsbergen, Alaska, British Columbia, Saskatchewan, Alberta, Arctic Canada.

G. (Paragastroplites) IMLAY, 1961, p. 62 [**G. spiekeri* MCLEARN, 1931, p. 5; OD]. More involute than *G. (Gastroplites),* with venter more or less arched; smooth or nearly so on early and middle whorls; sides convergent; ribs strong, flattened or not, in adult crossing venter in slight forward bend. Occurrence as for genus: Alaska, British Columbia, Alberta.——FIG. 94*a–d.* **G. (P.) spiekeri* MCLEARN; *a,b,* British Columbia, ×1; *c,d,* Alaska; ×1 (Imlay, 1961).

G. (Gastroplites) [=*Pseudogastroplites* JELETZKY, 1980, p. 5 (type, *P. arcticus;* OD); *Anagastroplites* JELETZKY, 1980, p. 8 (type, *A. tozeri;* OD); *Stotticeras* JELETZKY, 1980, p. 10 (type, *S. crowense;* OD)]. Less involute than *G. (Paragastroplites);* venter flat, with ribs crossing uninterrupted, transversely or slightly bowed. Suture with short and wide to rather long elements. [*Stotticeras,* large with smooth body chamber, comprises macroconchs.] Occurrence as for genus: England, Spitsbergen, Alaska, northern Canada, British Columbia, Saskatchewan, Alberta.——FIG. 95*a–e.* **G. (G.) canadensis* (WHITEAVES), British Columbia; *a,b,* ×1 (McLearn, 1930); *c,d,* holotype, ×1 (Jeletzky, 1964; courtesy of the Geological Survey of Canada); *e,* ×0.5 (Jeletzky, 1964; courtesy of the Geological Survey of Canada).——FIG. 95*f,g. G. (G.) arcticus* (JELETZKY), northern Canada; ×1 (Jeletzky, 1980; courtesy of the Geological Survey of Canada).——FIG. 95*h,i. G. (G.) tozeri* (JELETZKY), northern Canada; ×1 (Jeletzky, 1980; courtesy of the Geological Survey of Canada).——FIG. 95*j,k. G. (G.) crowensis* (JELETZKY), northern Canada; *j,* ×1; *k,* enlarged (Jeletzky, 1980; courtesy of the Geological Survey of Canada).

Irenicoceras WARREN & STELCK, 1958, p. 38 [**I. bahani;* OD]. Large, flat-sided, and compressed, with strong, branching ribs persistent to end. Suture very irregular, generally with rather long elements. *?Lower Cretaceous (said to be Lower Cenomanian but probably Upper Albian):* Alberta.——FIG. 93,*1a,b.* **I. bahani; a,* ×0.25; *b,* ×1 (Warren & Stelck, 1958).

Neogastroplites MCLEARN, 1931, p. 7 [**Buchiceras (?) cornutum* WHITEAVES, 1885, p. 239; OD] [=*Beattonoceras* WARREN & STELCK, 1958, p. 41 (type, *B. beattonense;* OD)]. Inflated forms up to 175 mm in diameter; compressed forms up to 600 mm; each successive species varies from compressed and flat-sided forms with smooth outer whorls through equally compressed, strongly ribbed, and almost untuberculate forms to moderately to very inflated forms with strong ribs, distant, bullate or spinate midlateral tubercles where the ribs branch, spinate or clavate ventrolateral tubercles, and with or without siphonal swelling or distinct siphonal tubercles (REESIDE & COBBAN, 1960). Differs from the earlier *Gastroplites* primarily in having the venter more or less arched, commonly with distinct siphonal swelling or tubercles. Striaptychus. *Lower Cretaceous (Upper Albian); Upper Cretaceous (?Cenomanian):* British Columbia, Saskatchewan, Utah, Wyoming, Montana.——FIG. 93,*3a–d.* **N. cornutus* (WHITEAVES), Upper Albian, Wyoming; *a,b,* compressed form, ×1; *c,d,* inflated form, ×1 (Reeside & Cobban, 1960).

?Alopecoceras KENNEDY & KLINGER, 1978, p. 58 [**A. ankeritterae;* OD]. Inner whorls with trapezoidal section and conical or bullate umbilical tubercles giving rise to pairs of ribs with intercalatories; all ribs bearing conical ventrolateral tubercles; ribs thickened and transverse across venter. Later whorls compressed, with narrowly rounded venter and feeble, falcoid ribs and constrictions. *Lower Cretaceous (Middle Albian):* South Africa (Zululand). ——FIG. 92,*2a–d.* **A. ankeritterae; a,* ×0.5; *b–d,* ×1 (Kennedy & Klinger, 1978).

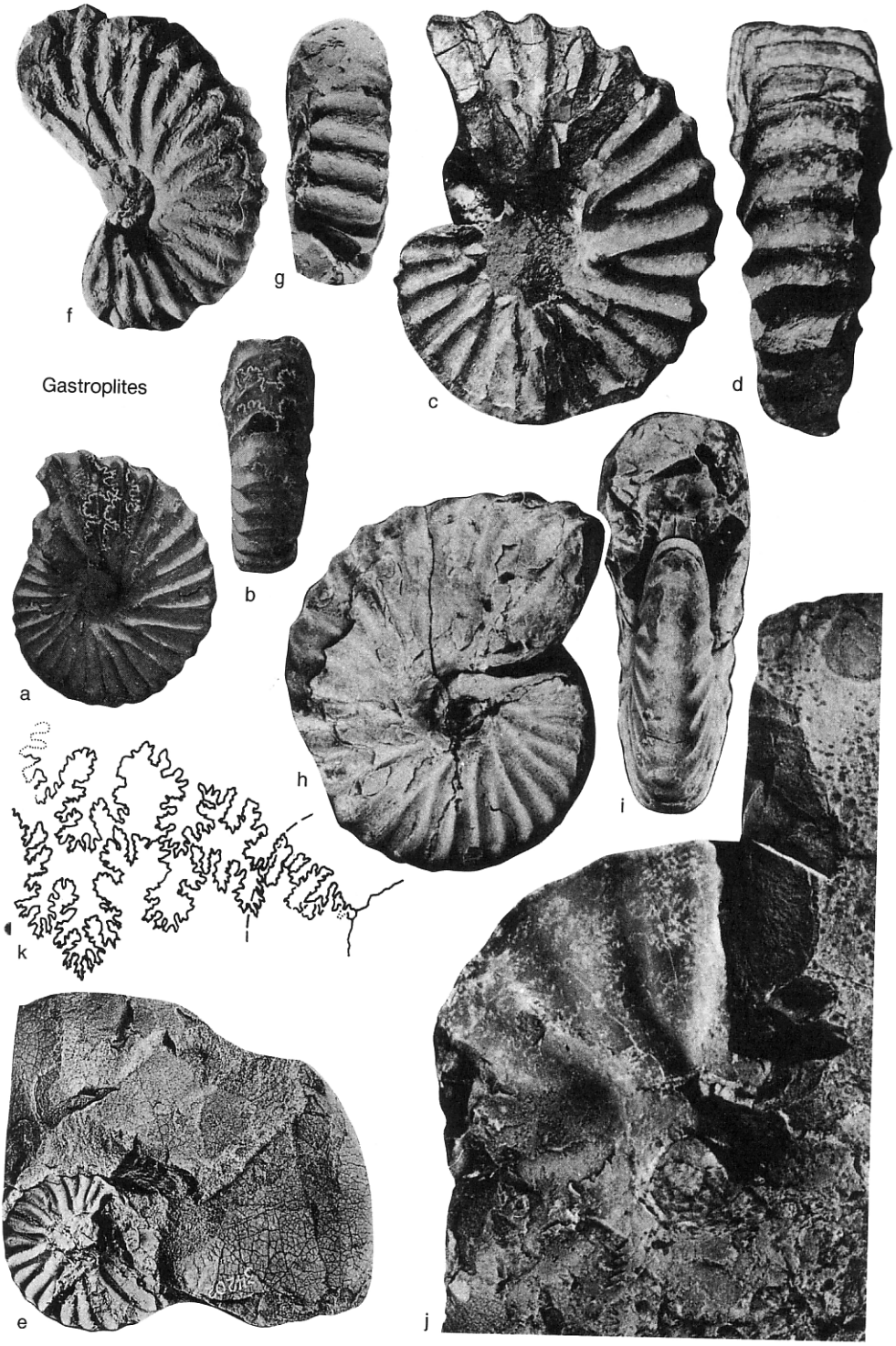


FIG. 95. Hoplitidae (p. 124)

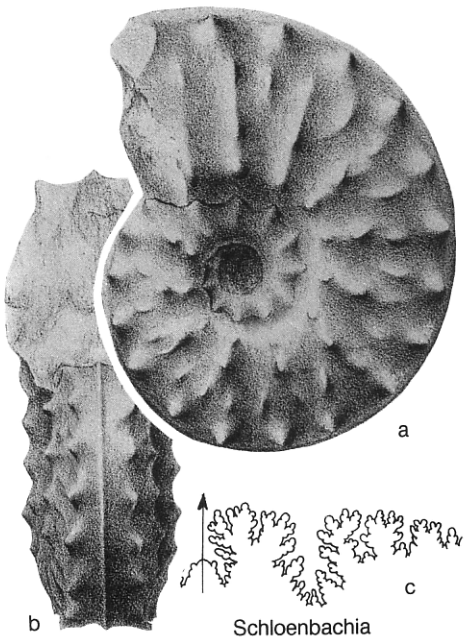


FIG. 96. Schloenbachiidae (p. 126)

Family SCHLOENBACHIIDAE Parona & Bonarelli, 1897

[*nom. correct.* WRIGHT & WRIGHT, 1951, p. 22, *pro* Schloenbachidae PARONA & BONARELLI, 1897, p. 89]

Evolute to rather involute, compressed to inflated; normally with distinct keel, irregular ribs, and at least umbilical and ventrolateral tubercles; suture as in Hoplitidae. *Upper Cretaceous (Lower Cenomanian–Upper Cenomanian).*

The family was derived from Hoplitidae, from which it is distinguished only by its generally sharp keel and tendency to multituberculation.

Schloenbachia NEUMAYR, 1875b, p. 887 [**Ammonites varians* J. SOWERBY, 1817b, p. 169; SD H. DOUVILLÉ, 1890, p. 290] [=*Hystrichoceras* HYATT, 1900, p. 589 (type, *Ammonites coupei* BRONGNIART in CUVIER & BRONGNIART, 1822, p. 391; OD; =?*Ammonites varians* J. SOWERBY); *Saltericeras* ATABEKIAN, 1960, p. 187 (type, *Ammonites salteri* SHARPE, 1856, p. 50; OD; holotype is a malformed *Schloenbachia*)]. Involute and compressed to evolute and inflated; keel strong to very weak; some compressed forms nearly smooth, but ribs generally distinct, well-spaced, and irregular, with umbilical, ventrolateral, and, in many forms, lateral tubercles. *Upper Cretaceous (Lower Cenomanian–Upper Cenomanian):* Europe, Transcaspia, Greenland.——FIG. 96*a–c.* **S. varians* (J. SOWERBY), Lower Cenomanian, England; ×1 (Sharpe, 1857).

Family PLACENTICERATIDAE Hyatt, 1900

[Placenticeratidae HYATT, 1900, p. 585] [=Hypengonoceratinae CHIPLONKAR & GHARE, 1976, p. 2; Baghiceratinae CHIPLONKAR & GHARE, 1976, p. 3]

Moderate-sized to large; inner whorls at least generally involute, compressed, with narrow, flat or grooved venter and little or no ornament; outer whorls similar or evolute and more or less inflated, with strong ornament. Suture with adventive and auxiliary elements; the external saddle and first lateral lobe becoming very wide and developing a number of more or less equal, new elements; saddles and lobes may be short and more or less rounded or long, narrow-necked, and much frilled. Of the Albian genera, *Hypengonoceras,* despite some resemblances to Engonoceratidae, seems to belong here, while *Hengestites* and *Karamaites* are clearly derived from Hoplitidae. HYATT, 1903; IL'IN, 1959; MIRZOEV, 1967; WOLLEBEN, 1967; MIKHAILOVA, 1974b; MARCINOWSKI, 1980; KENNEDY & WRIGHT, 1983. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Upper Maastrichtian).*

Hengestites CASEY, 1960a, p. 201 [**H. applanatus;* OD]. Large, high-whorled, and involute, with angular umbilical rim and narrow venter; early whorls with faint, flexuous riblets ending in alternating ventrolateral clavi; later shell smooth and venter sulcate with carinate edges, then tabulate. Suture with shallow ventral lobe, broad, bifid or asymmetrically trifid first lateral lobe, and bifid and subphylloid saddles; a deep adventive lobe dividing external saddle unequally, ventral part being much smaller. *Lower Cretaceous (Upper Albian):* England.——FIG. 97,*2a,b.* **H. applanatus; a,* ×0.5; *b,* ×1 (Casey, 1960a).

Placenticeras MEEK, 1876, p. 462 [**Ammonites placenta* DEKAY, 1828, p. 278; OD] [=*Placentoceras* MEEK, 1871a, p. 429, *nom. oblit.; Diplacomoceras* HYATT, 1900, p. 585 (*Diplacmoceras* HYATT, 1903, p. 242, *nom. van.*) (type, *Ammonites bidorsatus* F. A. ROEMER, 1841, p. 88; OD); *Stantonoceras* JOHNSON, 1903, p. 208 (type, *S. pseudocostatum;* OD; =*Ammonites guadaloupae* C. F. ROEMER, 1849, p. 416); *Proplacenticeras* SPATH, 1926, p. 79 (type, *Placenticeras fritschi* GROSSOUVRE, 1894, p. 124; OD); *Pseudoplacenticeras* SPATH, 1926a, p. 79 (type, *Ammonites milleri* HAUER, 1866, p. 304; OD); *Gissarites* IL'IN, 1958, p. 727 (type, *G. kysylchense;* OD); *Parastantonoceras* COLLIGNON, 1965a, p. 17

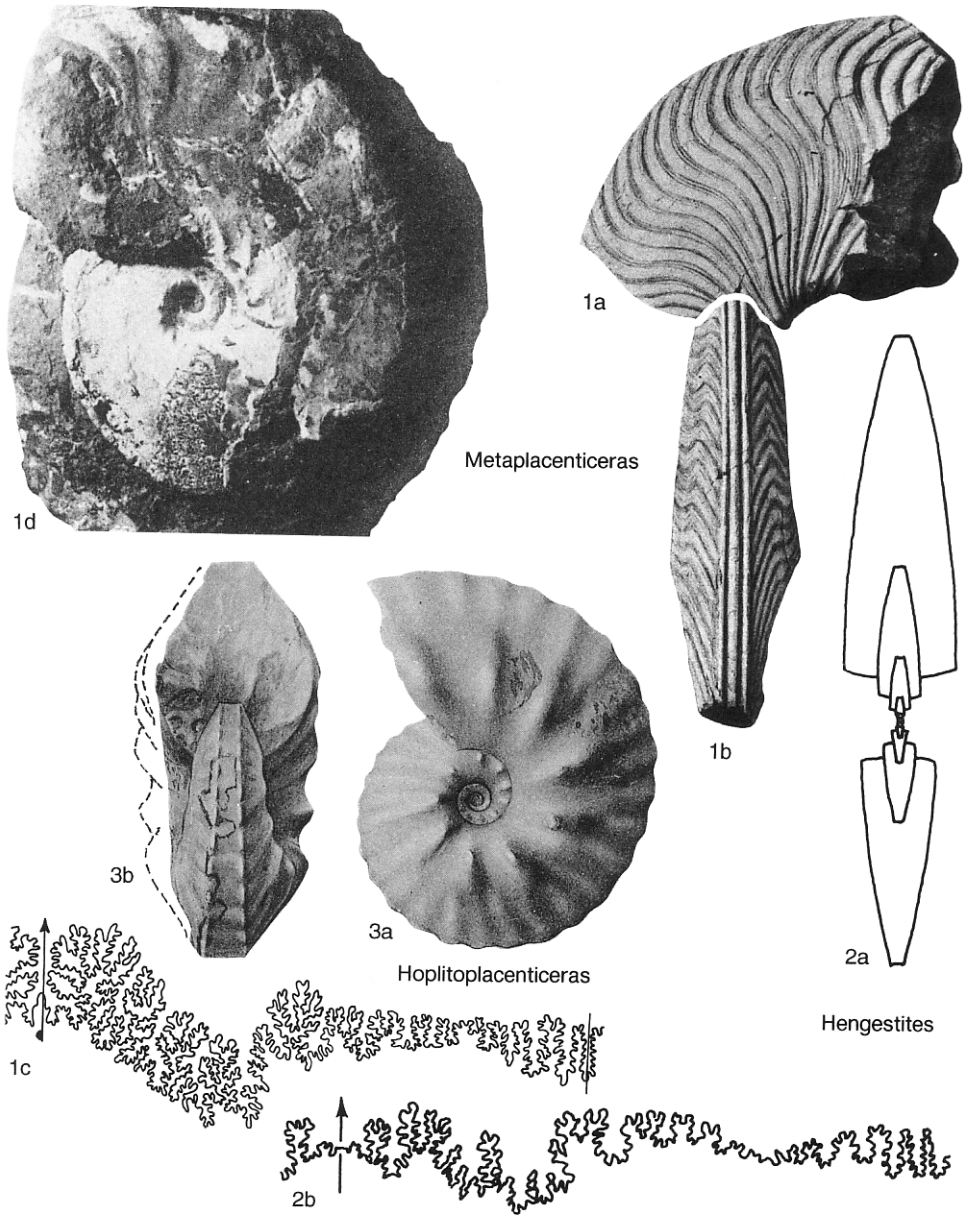


FIG. 97. Placenticeratidae (p. 126–130)

(type, *P. murphyi;* OD); *Karamaites* M. I. SOKOLOV in CASEY, 1965, p. 461 (M. I. SOKOLOV, 1961, p. 152, *nom. nud.*) (type, *Placenticeras? grossouvrei* SEMENOV, 1899, p. 97; OD); *Karamaiceras* M. I. SOKOLOV, 1967, p. 138 (type, *K. kolbajense;* OD); *Turkmenites* IL'IN, 1975, p. 154 (type, *Placenticeras gouerdakensis* LUPPOV, 1963, p. 144; OD); *Kopetdagites* IL'IN, 1975, p. 159 (type, *K. kopetdagensis;* OD); *Mediasiceras* IL'IN, 1975, p. 159 (type, *M. beliakovae;* OD); *Beschtubeites* IL'IN, 1975, p. 162 (type, *B. beschtubensis;* OD); *Asiatostantonoceras* IL'IN, 1975, p. 172 (type, *Stantonoceras tagamense;* OD); *Baghiceras* CHIPLONKAR & GHARE, 1976, p. 3 (type, *B. ambai;* OD); *Malwiceras* CHIPLONKAR & GHARE, 1976, p. 4 (type, *M. variabilis;* OD); *Placentoscaphites* CHIPLONKAR & GHARE, 1977, p. 68 (type, *P. dangerfeldi;* OD); *Sancarlosia* CHIPLONKAR & GHARE, 1978, p. 79 (type, *Placenticeras sancarlosense* HYATT, 1903, p. 200; OD)]. Populations show great variability,

ranging from compressed, involute forms with convergent, slightly convex sides, narrow, tabulate venter, no to weak, falcoid ribs, long umbilical bullae, and inner and more numerous outer ventrolateral tubercles to forms with similar inner whorls, but outer becoming more evolute, rectangular to square in section, with more prominent umbilical and ventrolateral tubercles, the inner of which, originally midlateral, may move outwards to form the ventrolateral margin while the outer may disappear. In any population macroconchs comprise the larger, more compressed, and more feebly ornamented forms. The relative size of sutural elements varies slightly with time; early species tend to have the 4th lateral lobe smaller than the 5th. *Placenticeras* was formerly distinguished from *Karamaites* by progressive increase in number of sutural elements, by development of strong dimorphism with strongly ornamented microconchs, and by progressive outward migration of umbilical tubercles to midlateral and of midlateral to inner ventrolateral position. However, strongly ornamented microconchs are now known from Cenomanian and there seem to be no valid grounds for dividing the slowly evolving series. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Campanian):* France, Spain, Germany, Poland, eastern Africa, Madagascar, Israel, central Asia, southern India, British Columbia, USA, Mexico, Colombia.——FIG. 98*a,b. P. grossouvrei* SEMENOV, Cenomanian, Mangyshlak; ×0.75 (Semenov, 1899).——FIG. 98*c. P. mediasiaticum* (LUPPOV), Cenomanian, central Asia; ×2 (Marcinowski, 1980).——FIG. 99*a,b.* **P. placenta* (DE-KAY), Campanian, New Jersey; ×1 (Hyatt, 1903).——FIG. 99*c–e. P. fritschi* GROSSOUVRE, Coniacian, France; ×1 (Grossouvre, 1894).——FIG. 99*f–h. P. guadaloupae* (ROEMER), Campanian, Texas; ×0.5 (F. A. Roemer, 1852).——FIG. 99*i,j. P. bidorsatum* (ROEMER), Lower Campanian, Germany; ×0.75 (Müller & Wollemann, 1906).

Metaplacenticeras SPATH, 1926a, p. 79 [**Placenticeras pacificum* SMITH, 1900, p. 187; OD] [=*Paraplacenticeras* MATSUMOTO, 1953, p. 149 (type, *Placenticeras subtilistriatum* JIMBO, 1894, p. 25(171); OD]. Compressed, flat-sided, with weak to strong, falcoid to falcate ribs; venter tricarinate, at least in middle growth. Suture line follows that of ribs. SMITH, 1900; MATSUMOTO, 1953. *Upper Cretaceous (?Santonian, Campanian):* Japan, California.——FIG. 97,*1a–c.* **M. pacificum* (J. P. SMITH), California;

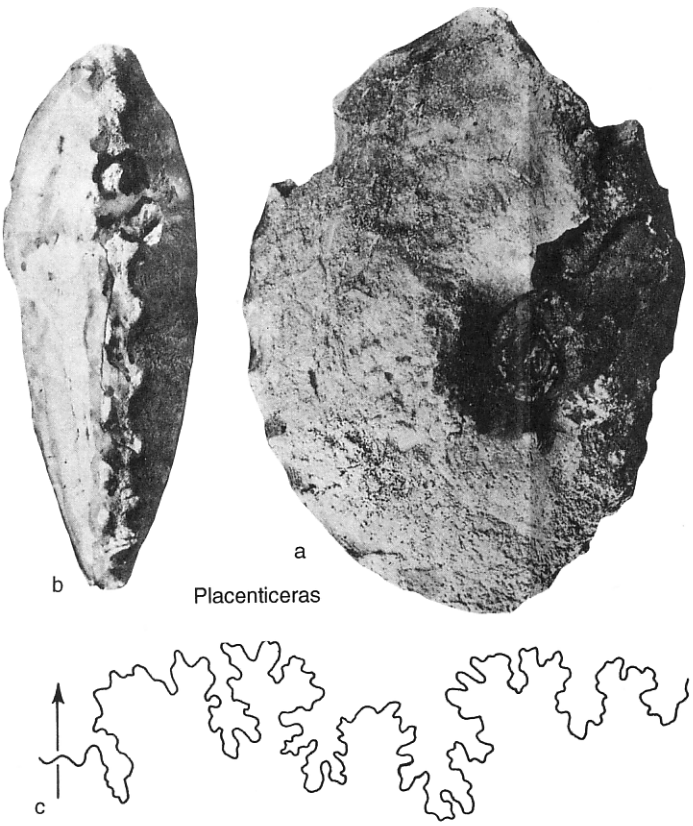


FIG. 98. Placenticeratidae (p. 126–128)

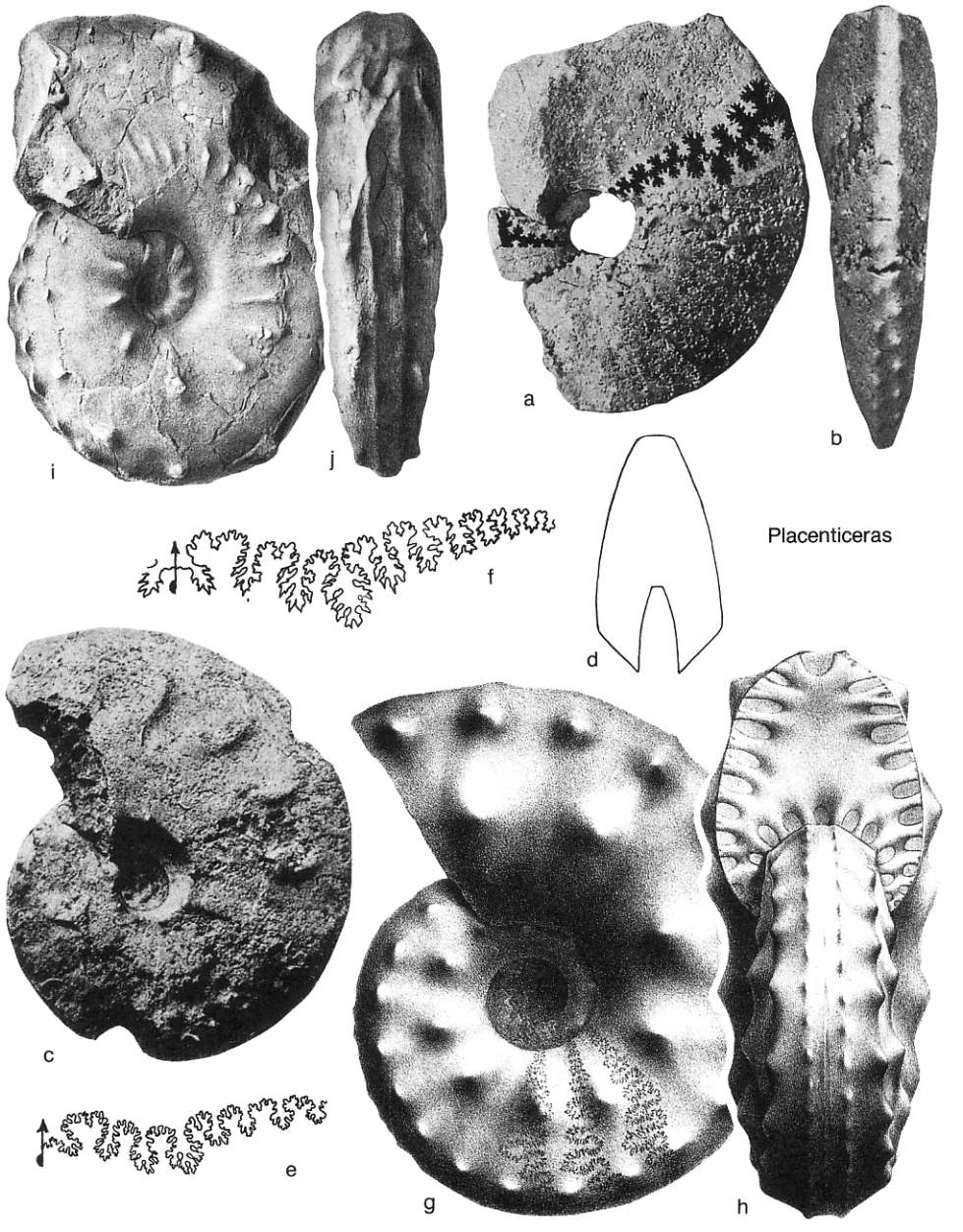


FIG. 99. Placenticeratidae (p. 126–128)

a,b, ×0.75; *c,* ×1 (Reeside, 1926).——FIG. 97,*1d. M. subtilistriatum* (JIMBO), Japan; ?microconch, ×1 (Matsumoto, 1953).

Hoplitoplacenticeras PAULCKE, 1907, p. 183, ICZN Opinion 554, 1959, Generic Name No. 1348 [**Hoplites plasticus* PAULCKE, 1907, p. 186; ICZN Specific Name No. 1629] [=*Dechenoceras* KAYSER, 1924, p. 175, *nom. nud.*]. Rather evolute; whorl section compressed and parallel-sided to trapezoidal; venter flat; with prominent ribs varying from coarse and rounded to dense and fine; ribs nearly straight, with inner and outer ventrolateral tubercles, of which outer may be large and clavate; ribs crossing venter transversely and may have trace of siphonal tubercle. *Upper Cretaceous (Upper Campanian–Upper Maastrichtian):* France, The

Netherlands, Germany, western Africa, Egypt, South Africa (Natal), Madagascar, central Asia, British Columbia, Wyoming, Texas, Argentina (Patagonia).——FIG. 97,*3a,b.* **H. plasticus* PAULCKE, Campanian, Patagonia; ×0.75 (Paulcke, 1907).

?Family ENGONOCERATIDAE Hyatt, 1900

[Engonoceratidae HYATT, 1900, p. 585] [=Knemiceratidae HYATT, 1903, p. 144; Neolobitinae LUPPOV & MIKHAILOV in LUPPOV & DRUSHCHITS, 1958, p. 125]

Typically compressed, more or less flat-sided, and involute, with venter flat at least in some stage; single or branching, irregular ribs may occur with umbilical, lateral, or ventrolateral tubercles. Suture with numerous auxiliary and adventive elements; saddles tending to simplify, being characteristically entire. More strongly ornamented forms giving rise to a succession of very compressed, smooth forms with narrow, bicarinate venters. Smooth offshoots are difficult to distinguish morphologically. Some genera closely resemble Pulchelliidae but are probably not closely related, and their origin remains uncertain. HYATT, 1903; SPATH, 1923–1943; CASEY, 1960–1980. *Lower Cretaceous (?Upper Aptian, Lower Albian)–Upper Cretaceous (Upper Cenomanian).*

Knemiceras BÖHM, 1898, p. 200 [**Ammonites syriacus* BUCH, 1850, p. 20; OD] [=*Glottoceras* HYATT, 1875, p. 372 (type, *Buchiceras attenuatum* HYATT, 1875, p. 372; M; genus was abandoned by HYATT, 1900, 1903, presumably on the incorrect basis that it was homonym of *Glossoceras* BARRANDE, 1867, p. 94, but was revived by BREISTROFFER, 1952b, p. 2633 and should be treated as *nom. oblit.*); *Cnemidoceras* HAUG, 1900, p. 24, *nom. van.; Cnemioceras* HAUG, 1900, p. 85, *nom. van.; Knemoceras* KRAUSE, 1902, p. 7, *nom. van.; Glossoceras* R. DOUVILLÉ, 1907, p. 150, *non* BARRANDE, 1867, p. 94, *pro Glottoceras* HYATT; *Iranoknemiceras* COLLIGNON, 1981, p. 258 (type, *K. uhligi* (CHOFFAT) var. *douvillei* BASSE, 1940, p. 431; OD)]. Compressed to moderately inflated; sides flat and parallel or converging; venter flat or slightly concave; ribs moderately to very strong, sparse, rounded or flat, arising singly or in pairs from stout umbilical tubercles; ribs may branch again at midlateral tubercles, ending in ventrolateral clavi or crossing venter. Suture with frilled lobes and slightly frilled, rarely entire saddles; commonly irregular. *Lower Cretaceous (?Upper Aptian, Lower Albian–Upper Albian):* southwestern Europe, northern Africa, Syria, Saudi Arabia, Iran, Ecuador, Colombia, Peru, Venezuela.——FIG. 100,*3a,b.* **K. syriacum* (BUCH), Upper Albian, Syria; ×1 (Basse, 1940).

Parengonoceras SPATH, 1924b, p. 508 [**Ammonites ebrayi* LORIOL, 1882, p. 7; OD]. Early whorls with flat sides converging to narrow, flat venter and with indistinct ribs ending in ventrolateral clavi; later whorls with subrectangular section and with 1, then 2 rows of lateral bullae appearing; finally ventrolateral clavi disappearing and venter becoming rounded. CASEY, 1978. *Lower Cretaceous (Lower Albian–Middle Albian):* England, France, Algeria, Venezuela, Colombia, Peru.——FIG. 100,*1a–c.* **P. ebrayi* (LORIOL), Middle Albian, France; *a,b,* ×0.25; *c,* ×1 (Loriol, 1882).

Hypengonoceras SPATH, 1922a, p. 112 [**Placenticeras warthi* KOSSMAT, 1895, p. 188(92); OD]. Large, with converging, flat sides and narrow, flat or concave venter; sparse, low, falcoid ribs ending in alternating ventrolateral clavi. Suture with large, pincerlike bifid folioles or normally incised. More probably a derivative of *Parengonoceras* than an early placenticeratid. KLINGER & KENNEDY, 1989. *Lower Cretaceous (Upper Albian):* France, Spain, Mozambique, South Africa (Zululand), Madagascar, Israel, southern India, Sakhalin.——FIG. 101,*3.* **H. warthi* (KOSSMAT), southern India; ×0.75 (Kossmat, 1895–1898).

Platiknemiceras BATALLER, 1954, p. 174 [**Knemiceras (Platiknemiceras) bassei;* OD] [=*Platyknemiceras* BATALLER, 1959, p. 1–77, *nom. null.*]. Suture as in *Knemiceras* but very compressed and involute, with no ornament except fine, flexuous striae; venter narrow, grooved, and later tabulate. *Lower Cretaceous (Lower Albian–Middle Albian):* France, Spain, Algeria, Iran, Lebanon, Egypt (Sinai), Japan, Texas, Peru, Colombia.——FIG. 100,*5a,b.* **P. bassei,* Lower Albian, Spain; *a,* ×1; *b,* ×1 (Casey, 1961c).——FIG. 100,*5c. P.* sp., Lower Albian, Peru; *c,* ×1 (Casey, 1961c).

Engonoceras NEUMAYR & UHLIG, 1881, p. 140(12) [**Ammonites pierdenalis* BUCH, 1850, p. 31; SD PERVINQUIÈRE, 1907, p. 200] [=?*Engonhoplitoides* BASSE, 1940, p. 441 (type, *E. khenchelaensis;* OD)]. Involute; inner whorls very compressed, with narrow, flat or sulcate venter; later flexuous striae normally replaced by weak, flat, flexuous or straight ribs ending in small ventrolateral clavi placed alternately and, in some shells, joined across venter by zigzagging ribs; umbilical and lateral tubercles may be present, and venter of last whorl may be rounded. Suture with more elements than *Knemiceras* and with saddles normally all entire except that outermost are bifid; external lobe normally with strongly divergent branches. *Lower Cretaceous (Middle Albian)–Upper Cretaceous (Cenomanian):* England, France, northern Africa, Syria, USA, Mexico, Colombia.——FIG. 100,*4a–c. E. serpentinum* (CRAGIN), Upper Albian, Texas; ×1 (Hyatt, 1903).

Protengonoceras HYATT, 1903, p. 153 [**Engonoceras gabbi* BÖHM, 1898, p. 197; OD]. Like *Engonoceras* but lacking tubercles at any stage and having ribs

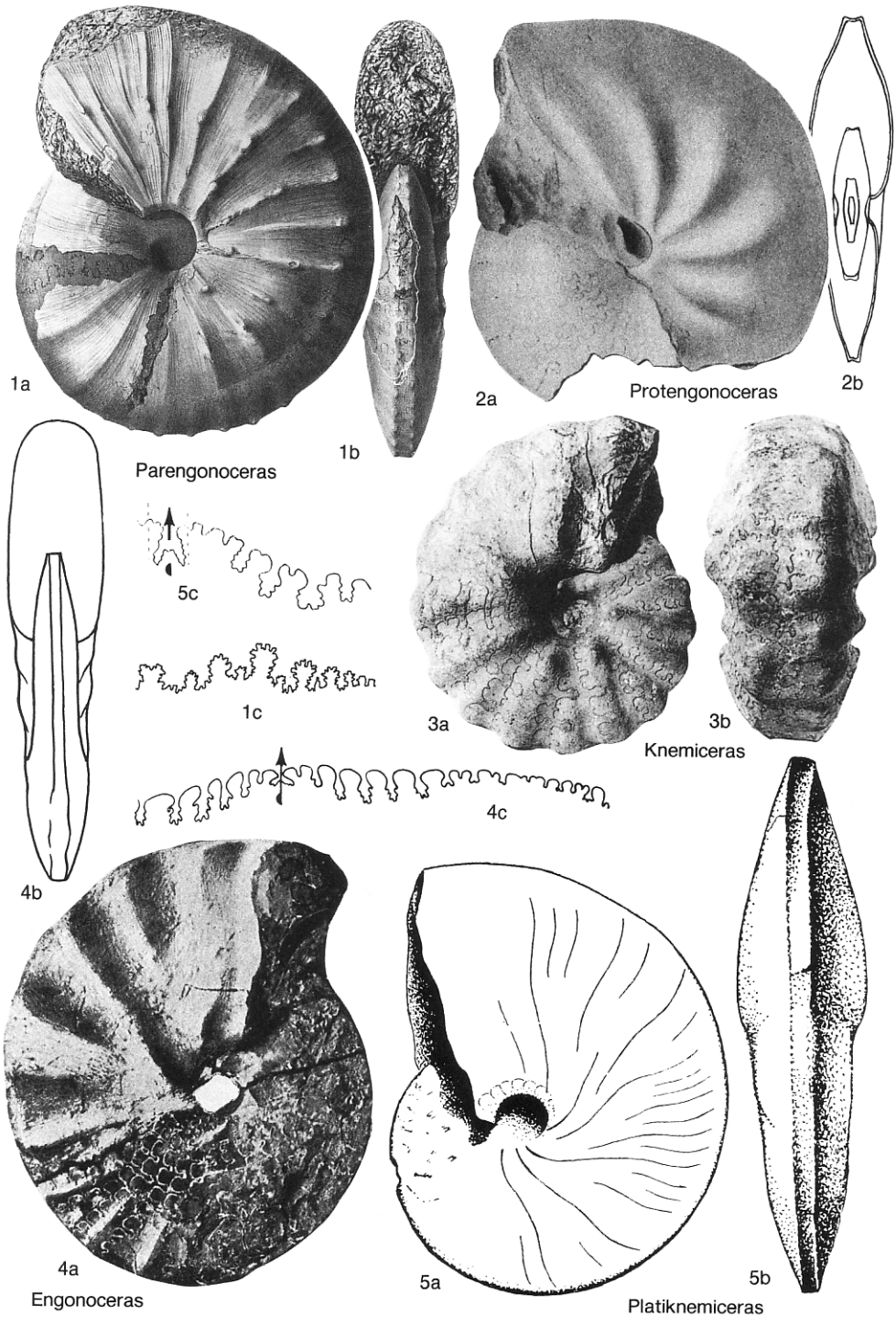


FIG. 100. Engonoceratidae (p. 130–132)

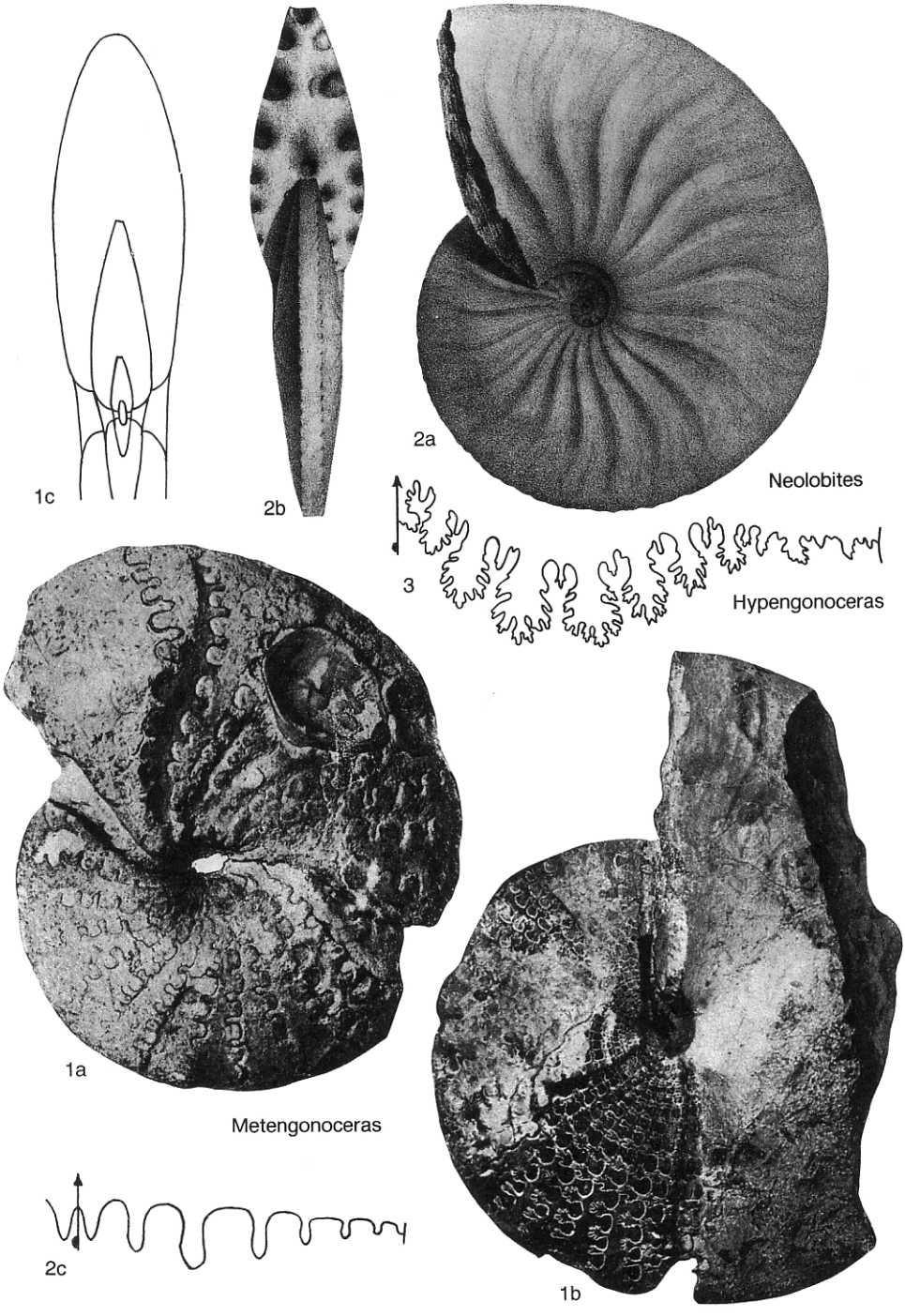


FIG. 101. Engonoceratidae (p. 130–133)

only on body chamber. *Lower Cretaceous (Middle Albian):* Texas.——FIG. 100,*2a,b* **P. gabbi* (BÖHM); ×0.75 (Hyatt, 1903).

Metengonoceras HYATT, 1903, p. 179 [**M. inscriptum;* SD ROMAN, 1938, p. 491] [=*Epengonoceras* SPATH, 1924b, p. 508 (type, *Sphenodiscus dumbli* CRAGIN,

1893, p. 243; OD)]. Compressed, with flat to slightly concave sides; venter fairly broad on inner whorls but soon narrowing until acute on internal mold, though still with very narrow, flat or concave area on shell, and finally becoming rounded; with very weak ribs or smooth; ventrolateral tubercles rarely present. *Lower Cretaceous (?Middle Albian, Upper Albian)–Upper Cretaceous (Upper Cenomanian):* France, western Africa, ?Madagascar, Texas. ——FIG. 101,*1a.* **M. inscriptum* HYATT, Upper Albian, Texas; ×1 (Hyatt, 1903).——FIG. 101,*1b,c. M. dumbli* (CRAGIN), Cenomanian, Texas; ×1 (Hyatt, 1903).

Neolobites FISCHER, 1882 in 1880–1887, p. 389 [**Ammonites vibrayeanus* ORBIGNY, 1841, p. 322; M]. Similar to *Engonoceras* in shape, but may be less involute; some species developing strong lateral and ventrolateral tubercles as in *Parengonoceras.* Distinguished by suture with fewer elements, all entire. *Upper Cretaceous (Cenomanian):* France, northern Africa, Syria, Saudi Arabia, Peru, Bolivia.——FIG. 101,*2a–c.* **N. vibrayeanus* (ORBIGNY), France; *a,b,* ×0.75; *c,* enlarged (Orbigny, 1840–1842).

Superfamily ACANTHOCERATACEAE Grossouvre, 1894

[*nom. correct.* WRIGHT & WRIGHT, 1951, p. 24, *pro* Acanthoceratida HYATT, 1900, p. 585, *nom. transl. et correct. ex* Acanthoceratidés GROSSOUVRE, 1894, p. 22] [H. DOUVILLÉ is quoted by some as author, but the work in which the name appeared was not published.]

Typically strongly ribbed forms with tendency to develop prominent tubercles, but including a wide variety of other types. *Lower Cretaceous (Lower Albian)–Upper Cretaceous (Maastrichtian).*

Not enough is yet known of the initial appearance and phylogeny in the Lower Albian of the families here included to be sure of their relations. Leymeriellidae, confined to the *tardefurcata* Zone, was certainly derived from *Callizoniceras* (BRINKMANN, 1937). Lyelliceratidae, of which the earliest genus is *Tegoceras,* is first known early in the *mammillatum* Zone; it has significant resemblances to Leymeriellidae and was probably derived from it, despite an apparent time gap. It was the source of the dominant Cenomanian Acanthoceratidae, whose various subfamilies gave rise to most of the strongly ornamented ammonites of the rest of the Cretaceous as well as to a wide range of secondarily smooth forms.

Brancoceratinae and Mojsisovicziinae have less certain origins. Both are first known in the Lower Albian *mammillatum* Zone. *Parabrancoceras* resembles *Silesitoides* and *Callizoniceras* (Desmoceratidae, Puzosiinae) but has stronger ribs. The earliest known mojsisovicziid is already a high-keeled *Oxytropidoceras.* Inner whorls of various brancoceratids have acute venters, and there are many later members of the two subfamilies that closely resemble each other. There is a notorious lack of continuous deposits at crucial horizons in the Tethyan Lower Albian, and it seems probable that Mojsisovicziinae evolved from unknown Brancoceratinae before the *mammillatum* Zone. Whether the origin of these subfamilies is distinct from that of the Leymeriellidae-Lyelliceratidae line is still quite uncertain. They are therefore here still grouped in Acanthoceratacea.

Family LEYMERIELLIDAE Breistroffer, 1951

[*nom. transl.* WRIGHT, 1955, p. 571, *ex* Leymeriellinae BREISTROFFER, 1951b, p. 266]

Small, compressed, evolute, and uncoiling with growth; most with single ribs, flattened or grooved, but some with branching ribs; ribs interrupted or not on venter; umbilical or lateral and clavate ventrolateral tubercles present or not. Suture rather simple, with bifid saddles, deep, parallel-sided ventral lobes, trifid lateral lobes, and no umbilical retraction. *Lower Cretaceous (Lower Albian–Middle Albian).*

The subdivisions of the suture on either side of the umbilical seam derive ontogenetically from the splitting of the internal umbilical lobe, U1, as in the Hoplitidae, rather than from the splitting of the saddle between U1 and U2, as in the Lyelliceratidae (Fig. 102) (MIKHAILOVA, 1973). Even so, the probability is that the Leymeriellidae, derived from the desmoceratid *Callizoniceras* (BRINKMANN, 1937), is more closely related to the Lyelliceratidae, here treated as its descendants, than to the Hoplitidae and is to be placed in Acanthocerataceae. CASEY, 1978.

Proleymeriella BREISTROFFER, 1947b, p. 37(21), 86(70) [**Parahoplites schrammeni* JACOB, 1907, p. 302; OD]. Whorl section oval; simple, strong ribs pass-

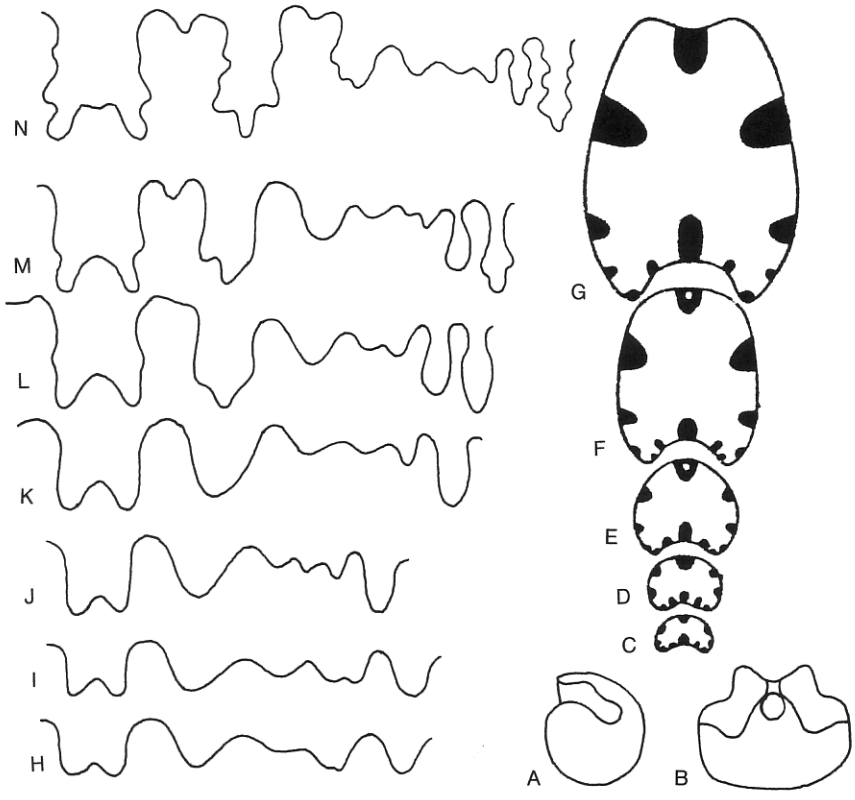


FIG. 102. Ontogenetic development of *Leymeriella tardefurcata* (ORBIGNY), Lower Albian, Mangyshlak; highly magnified (after Mikhailova, 1973).

ing over narrowly rounded venter, forming chevrons; constrictions present throughout. Grades into *Leymeriella;* distinction is analogous to that between *Pseudosonneratia* and *Hoplites. Lower Cretaceous (Lower Albian):* Germany, Spitsbergen.——FIG. 103,*3a,b.* **P. schrammeni* (JACOB), Germany; ×1 (Jacob, 1908).

Leymeriella JACOB, 1907, p. 311 [**Ammonites tardefurcatus* ORBIGNY, 1841, p. 248; SD SPATH, 1925a, p. 75]. Venter flat or sulcate; ribs single but grooved on outer part. *Lower Cretaceous (Lower Albian–Middle Albian):* Europe, Transcaspia, Iran.

L. (Leymeriella). No umbilical or lateral tubercles; no constrictions; no ribs on umbilical wall. Occurrence and distribution as for genus.——FIG. 103,*1a,b.* **L. (L.) tardefurcata* (ORBIGNY), France; ×1 (Jacob, 1908).

L. (Neoleymeriella) SAVELIEV, 1973, p. 184 [**L. (Leymeriella) consueta* CASEY, 1957, p. 53; OD]. With umbilical or lateral tubercles at least on early whorls; shallow constrictions on outer whorls; ribs commonly present on umbilical wall. Occurrence and distribution as for genus.——FIG. 103,*4a–c.* **L. (N.) consueta,* England; ×1 (Casey, 1978).

Epileymeriella BREISTROFFER, 1947b, p. 87(71) [**Parahoplites hitzeli* JACOB, 1907, p. 256; OD] [=*Revilites* CASEY, 1978, p. 621 (type, *Hoplites (Leymeriella) revili* JACOB, 1908, p. 53 (1907, p. 303, *nom. nud.*); OD)]. Differs from *Leymeriella* in that venter is narrowly rounded and ribs branch near the umbilical edge, then branch again, crossing venter in chevrons; constrictions like those of *Proleymeriella* may appear on outer whorl. [Separation of the more evolute, finely and densely ribbed species as a subgenus of *Revilites* seems unnecessary.] *Lower Cretaceous (Lower Albian):* England, France, Bornholm, Japan.——FIG. 103,*2a,b.* **E. hitzeli* (JACOB), France; ×1 (Jacob, 1908).——FIG. 103,*2c,d. E. revili* (JACOB), France; ×1 (Jacob, 1908).

Family BRANCOCERATIDAE Spath, 1934 (1900)

[Brancoceratidae SPATH, 1934, p. 465 (-inae, p. 443), *nom. nov. pro* Hystatoceratidae HYATT, 1900, p. 590. Brancoceratidae was introduced as a replacement name because *Hystatoceras* HYATT, 1900, p. 590 was regarded as a junior synonym of *Brancoceras* STEINMANN, 1881, p. 133. Since Brancoceratidae has been widely accepted, it is retained and takes the date of Hystatoceratidae under provisions of Article 40(b) of the Code.]

Typically rather evolute, with round, oval, or quadrate whorl section, ventral keel, strong ribs, and at least umbilical tubercles. Many genera with spiral striations or notches on ribs. *Lower Cretaceous (Lower Albian)–*

Upper Cretaceous (Lower Cenomanian).

The primitive subfamily, Brancoceratinae, normally has no keel in the adult, but it may appear cenogenetically. Mojsisovicziinae have a prominent keel and strong, flat to flared ribs, with or without tubercles. Mortoniceratinae include both involute, compressed forms without tubercles and evolute, square-whorled forms with strong tubercles. Except in some Brancoceratinae with almost pseudoceratitic sutures, there is little sutural variation that does not depend on whorl shape. Since a very large number of species is included in the family, there is a tendency to split it unduly, but the range of morphological difference is comparatively small and the species are mostly short-lived.

Subfamily BRANCOCERATINAE Spath, 1934 (1900)

[see under Brancoceratidae] [=Eriloceratidae HOEPEN, 1955c, p. 377]

Generally small, evolute, with round, oval, square, or rectangular whorl section; venter may be sharp or distinctly keeled on inner whorls but only exceptionally so on outer; ribs usually strong, rounded or sharp, continuous over venter; in later genera tubercles appearing, first at umbilicus, then at shoulders. Suture simple, pseudoceratitic in some. *Lower Cretaceous (Lower Albian–Upper Albian).*

Brancoceras STEINMANN, 1881, p. 133 [**Ammonites senequieri* ORBIGNY, 1841, p. 292; SD HYATT, 1900, p. 590] [=*Hystatoceras* HYATT, 1900, p. 590, obj.]. Small; early whorls smooth, with round or acute venter; later whorl section compressed-oval, with strong, single, straight or slightly flexuous, rounded or sharp ribs crossing venter transversely or in chevrons; on outer whorls venter rounded, fastigiate, or even carinate. Suture simple. *Lower Cretaceous (Lower Albian–Middle Albian):* England, France, Poland, India, ?Colombia, Peru, Venezuela.

B. (Brancoceras) [=*Paroxytropidoceras* BREISTROFFER, 1951b, p. 267, *nom. nud.* (type, *Brancoceras carinatum* COLLIGNON, 1949b, p. 96; OD)]. Smooth stage may persist; venter of inner whorls acute; venter of outer may be fastigiate or even carinate (*Paroxytropidoceras*); ribs acutely chevroned on venter in some species. Occurrence as for genus: England, France, India.——FIG. 104,*4a–c*. **B. (B.) senequieri* (ORBIGNY), France; *a,b*, ×0.75; *c*, enlarged (Orbigny, 1840–1842).

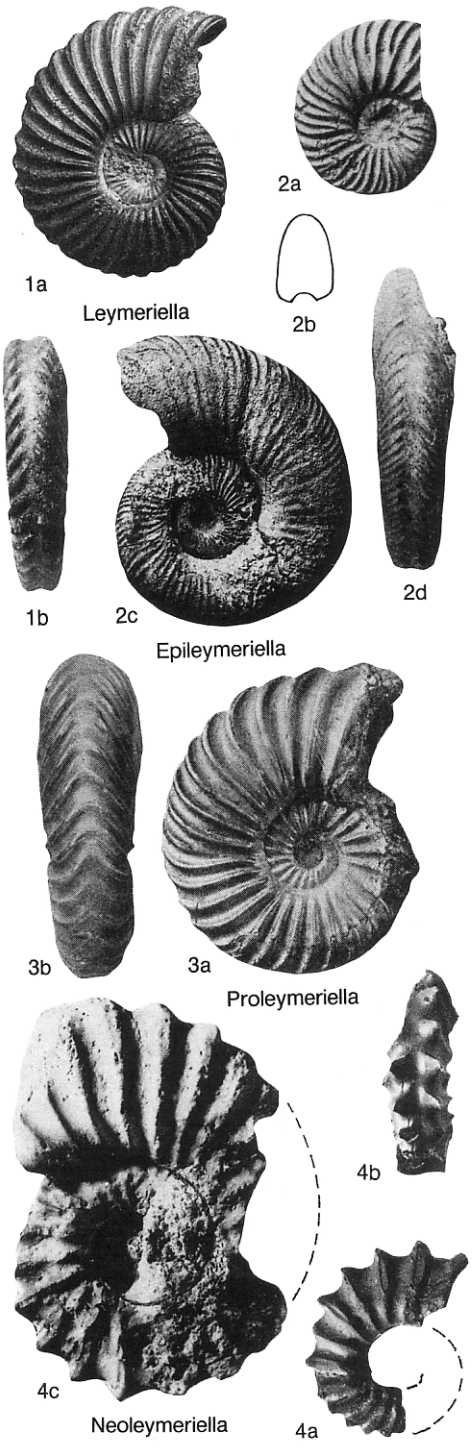


FIG. 103. Leymeriellidae (p 133–134).

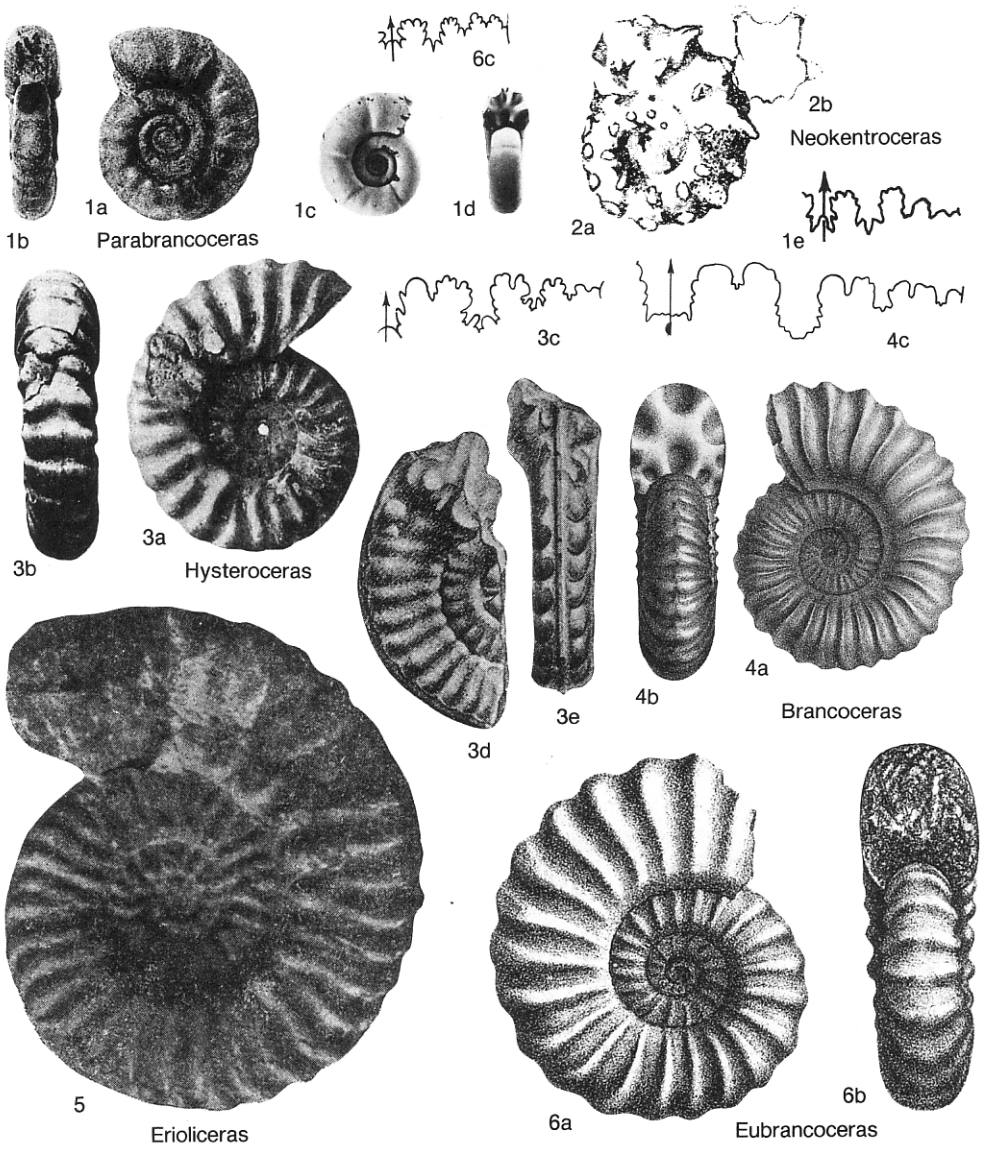


FIG. 104. Brancoceratidae (p. 135–137)

B. (Eubrancoceras) BREISTROFFER, 1951b, p. 267 [**Brancoceras aegoceratoides* STEINMANN, 1881, p. 133; OD] [=?*Rinconiceras* ETAYO SERNA, 1979, p. 78 (type, *R. rinconi;* OD)]. Venter of early whorls not acute; ribs more or less sharp to blunt; constrictions may occur. Occurrence as for genus: Poland, ?Colombia, Peru, Venezuela.——FIG. 104,*6a–c.* **B. (E.) aegoceratoides,* Lower Albian, Peru; ×1 (Steinmann, 1881).

Parabrancoceras BREISTROFFER, 1951b, p. 267 [**Brancoceras besairiei* COLLIGNON, 1949b, p. 89; OD]. Very evolute, with distant, broad ribs, at least until body chamber, and wide, shallow constrictions. *Lower Cretaceous (Lower Albian):* Spain, Madagascar.——FIG. 104,*1a–e.* **P. besairiei* (COLLIGNON); *a,b,* Madagascar, ×1 (Collignon, 1949b); *c–e,* Spain, *c,d,* ×2; *e,* ×5.6 (Wiedmann, 1966b).

Hysteroceras HYATT, 1900, p. 590 [**Ammonites varicosus* J. de C. SOWERBY, 1824, p. 74; OD] [=*Spathiceras* WHITEHOUSE, 1927, p. 110 (type, *Hystrichoceras antipodeum* R. ETHERIDGE, Jr., 1902, p. 47; OD); *Terascoceras* HOEPEN, 1944, p. 173 (type, *T. cariniferum;* OD); *Komeceras* HOEPEN, 1944, p. 180 (type, *K. acuticostatum;* OD); *Askoloboceras* HOEPEN, 1944, p. 185 (type, *A. fastigatum;* OD); *Petinoceras* HOEPEN, 1944, p. 186

(type, *P. recuperator;* OD)]. Keel commonly persisting to the ribbed stage; ribs branching or long and short, with umbilical and in some forms blunt ventrolateral tubercles; ribbing varies from sharp and high to broad and flat, but subdivision on this basis is not justified. [Reputed age of *Spathiceras* as Upper Albian to Lower Cenomanian is unfounded.] *Lower Cretaceous (Middle Albian–Upper Albian):* Europe, Australia (Northern Territory), Africa, Madagascar, Iran, Pakistan, Mexico, Venezuela, Curaçao, Greenland.——FIG. 104,*3a–c.* **H. varicosum* (J. de C. SOWERBY), Upper Albian, England; *a,b,* ×1; *c,* ×2.5 (Spath, 1923–1943).——FIG. 104,*3d,e. H. antipodeum* (ETHERIDGE), Upper Albian, Australia (Northern Territory); ×1.5 (R. Etheridge, Jr., 1902).

Erioliceras HOEPEN, 1955c, p. 378 [**E. tenuis;* OD] [=?*Omocyrtoceras* HOEPEN, 1955c, p. 380 (type, *O. errabundum;* OD); ?*Tetragonoceras* HOEPEN, 1955c, p. 382 (type, *T. robustum;* OD)]. Small, evolute, with square or rectangular whorl section; keel strong at first, weakening, and disappearing before end of last whorl; ribs single or branching, typically sinuous, thickened on shoulders, and tending to overhang backward. *Lower Cretaceous (Upper Albian):* South Africa (Zululand).——FIG. 104,*5.* **E. tenuis;* ×1 (Hoepen, 1955c).

Neokentroceras SPATH, 1921a, p. 306, ICZN Opinion 1254, 1983, Generic Name No. 2196 [**N. curvicornu* SPATH, 1922a, p. 139 (1921a, p. 306, *nom. nud.*); ICZN Specific Name No. 2863]. Small; outer whorls as in *Hysteroceras;* inner whorls with very strong umbilical tubercles; weak or no lateral tubercles; large, clavate, normally irregular, ventrolateral tubercles; and ribs weak or absent. *Lower Cretaceous (Upper Albian):* western Africa, ?Brazil.——FIG. 104,*2a,b.* **N. curvicornu,* Angola; inner whorls, ×1 (Spath, 1922a).

Subfamily MOJSISOVICZIINAE Hyatt, 1903

[*nom. transl.* WRIGHT, 1952, p. 221, *ex* Mojsisoviczііdae HYATT, 1903, p. 24] [=Dipoloceratidae SPATH, 1921a, p. 277; Cechenoceratidae HOEPEN, 1941, p. 61; Drepanoceratidae HOEPEN, 1941, p. 89]

Derivatives of Brancoceratinae, in which the keel tends to become stabilized as an adult feature and the ribs begin to differentiate. In some forms the keel appears early in ontogeny and is then lost; in others it only appears late. Apparently, there are two main stocks (both derived from *Mojsisoviczia* or one from the other): one compressed and high-whorled, which left no descendants, and the other more evolute, with round or square whorl section, which by acquisition of tubercles led to Mortoniceratinae. The boundary between subfamilies is arbitrarily taken at the point when large umbilical and ventrolateral tubercles are stabilized in the adult. *Lower Cretaceous (Lower Albian–Upper Albian).*

Mojsisoviczia STEINMANN, 1881, p. 142 [**M. duerfeldi;* OD; =*Ammonites ventanillensis* GABB, 1869, p. 273] [=*Dipoloceroides* BREISTROFFER, 1947b, p. 90(74) (type, *Ammonites delaruei* ORBIGNY, 1841, p. 296; OD)]. Macroconchs up to 100 mm in diameter; evolute and smooth in young, with round whorl section; later with prominent, sharp keel and strong, straight or slightly curved, single ribs, which may expand in breadth on shoulders or form large midlateral and ventrolateral tubercles. Microconchs 25 to 35 mm in diameter; smooth at first, then with feeble ribs and slight to moderate keel; finally smooth and without keel but generally with a few constrictions. The lectotype (GEBHARD, 1983) of *M. duerfeldi* is a microconch here held to be of the associated *M. ventanillensis* (GABB). KENNEDY & COOPER, 1977; GEBHARD, 1983. *Lower Cretaceous (Middle Albian):* Europe, South Africa (Zululand), Pakistan, Texas, Mexico, Colombia, Peru, Venezuela, Greenland.——FIG. 105,*1,a–e.* **M. ventanillensis* (GABB), Peru; *a,b,* lectotype of *M. duerfeldi,* ×1 (Gebhard, 1983); *c–e,* ×1 (Douglas, 1921).——FIG. 105,*1f,g. M. delaruei* (ORBIGNY), France; ×1 (Cooper, 1982).

Falloticeras PARONA & BONARELLI, 1897, p. 89 [**Ammonites proteus* ORBIGNY, 1842a, p. 624; OD]. Closely resembles the smooth microconchs of *Mojsisoviczia,* but early whorls have weak ribs and keel declines at maturity. More probably a progenetic dwarf offshoot of *Mojsisoviczia* (KENNEDY & COOPER, 1977), rather than a microconch of any species of *Mojsisoviczia* (GEBHARD, 1983). *Lower Cretaceous (lower Middle Albian):* England, France, South Africa (Zululand), Peru.——FIG. 105,*2a–c.* **F. proteus* (ORBIGNY), France; *a,b,* ×1; *c,* ×6 (Kennedy & Cooper, 1977).

Oxytropidoceras STIELER, 1920, p. 346 [**Ammonites roissyanus* ORBIGNY, 1841, p. 302; OD] [=*Pseudophacoceras* SPATH, 1921a, p. 281, obj.]. Moderately to very compressed and high-whorled, with high keel; ribs single to branching, narrow and high, rounded or flat, with or without tubercles; keel may appear well before ribs; ribs may be effaced later. Suture generally with oblique outer slope on first lateral saddle. *Lower Cretaceous (Lower Albian–Upper Albian):* Europe, Morocco, Angola, South Africa (Zululand), Madagascar, Pakistan, California, Texas, Peru, Colombia, Venezuela, Brazil, Mexico.

O. (Oxytropidoceras) [=*Manuaniceras* SPATH, 1925c, p. 182 (type, *Pseudophacoceras manuanense* SPATH, 1921a, p. 281; OD)]. Moderately to very high-whorled and compressed; rather involute; ribs coarse to fine, high and narrow to flat, mostly branching at various levels, and without tubercles. *Lower Cretaceous (Lower Albian–Middle Albian):* Europe, Angola, South Africa (Zululand), Madagascar, Pakistan, Texas, Peru, Colombia, Brazil.——FIG. 106,*2a–c.* **O.*

(O.) roissyanum (ORBIGNY), France; *a,b,* ×0.75; *c,* enlarged (Orbigny, 1840–1842).——FIG. 106,*2d,e. O. (O.) manuanense* (SPATH), Zululand; ×1 (Spath, 1921a).

O. (Mirapelia) COOPER, 1982, p. 291 [**Ammonites mirapelianum* ORBIGNY, 1850a, p. 124; OD]. Whorl section varying from only a little higher than wide to moderately compressed; ribs single, coarse to rather fine, and markedly flattened and broadened on shoulders. *Lower Cretaceous (Middle Albian):* England, France, Angola, Madagascar, California, Texas, Colombia, Peru, Brazil.——FIG. 106,*1a,b. *O. (M.) mirapelianum* (ORBIGNY), France; ×0.5 (Cooper, 1982).

O. (Venezoliceras) SPATH, 1925c, p. 182 [**O. venezolanum* STIELER, 1920, p. 394; OD] [=*Lophoceras* HOEPEN, 1931, p. 40, *non* HYATT, 1893, p. 466 (type, *L. umsinense;* OD); *Tarfayites* COLLIGNON, 1967, p. 19 (1963, p. 142, *nom. nud.*) (type, *O. (Tarfayites) bituberculatum;* OD)]. Ribs straight or slightly sinuous, typically coarse, high, steep in front, shallow behind, but may be flat at some growth stage; high umbilical to midlateral bullae on some ribs and bullate to slightly clavate ventrolateral tubercles on all. *Lower Cretaceous (Middle Albian–Upper Albian):* Morocco, South Africa (Zululand), Madagascar, Texas, Mexico, Venezuela, Peru.——FIG. 107,*2a,b. *O. (V.) venezolanum,* Venezuela, neotype; ×1 (Renz, 1982).

O. (Laraiceras) RENZ, 1968, p. 650 [**O. (L.) laraense;* OD]. With alternate, long and short, coarse ribs; long ribs with umbilical, midlateral, and ventrolateral tubercles. *Lower Cretaceous (Upper Albian):* Venezuela.——FIG. 107,*3a,b. *O. (L.) laraense;* ×0.5 (Renz, 1982).

O. (Benavidesites) COOPER, 1982, p. 295 [**Venezoliceras harrisoni* BENAVIDES-CÁCERES, 1956, p. 460; OD]. Ribs fine and bifurcating at first, then coarsening, with midlateral tubercles on outer whorls. *Lower Cretaceous (Middle Albian):* Texas, Venezuela, Peru.——FIG. 106,*3a. *O. (B.) harrisoni* (BENAVIDES-CÁCERES), Peru; ×0.5 (Benavides-Cáceres, 1956).——FIG. 106,*3b. O. (B.) acutocarinatum* (SHUMARD), Texas; ×0.5 (K. Young, 1966).

O. (Adkinsites) SPATH, 1931a, p. 350 [**Ammonites belknapi* MARCOU, 1858, p. 34; OD] [=*Androiavites* COLLIGNON, 1936, p. 186 (type, *O. (A.) besairiei;* OD)]. Ribs coarse, variable, straight or curved; inner whorls at least with strong umbilical and weak ventrolateral tubercles. *Lower Cretaceous (Middle Albian–Upper Albian):* Europe, Madagascar, Texas.——FIG.

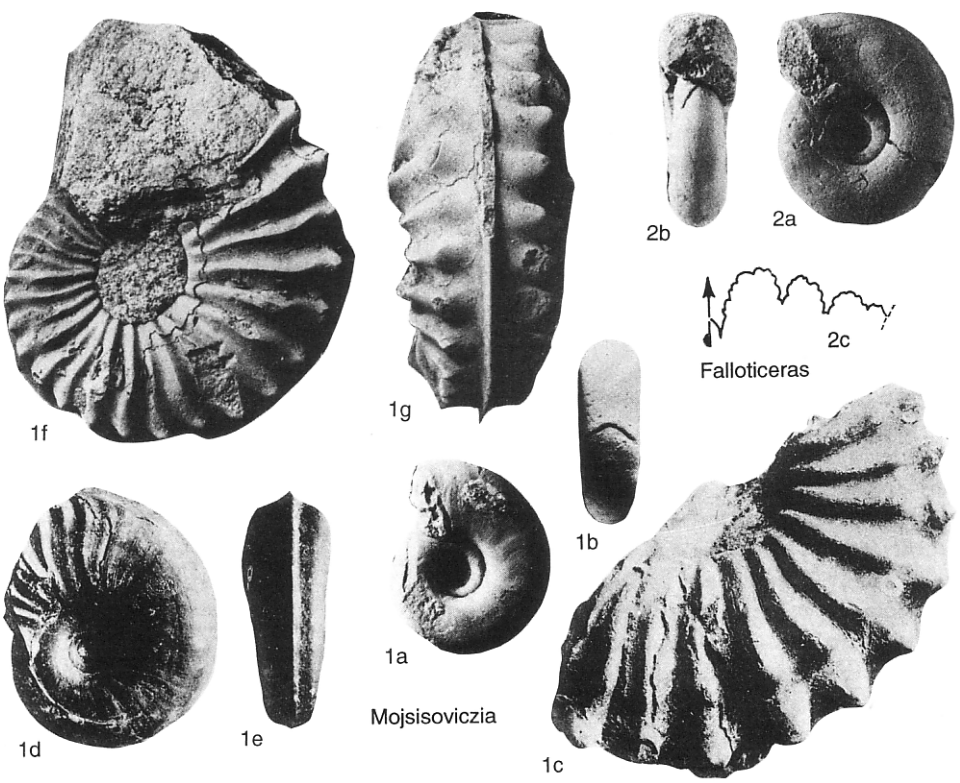


FIG. 105. Brancoceratidae (p. 137)

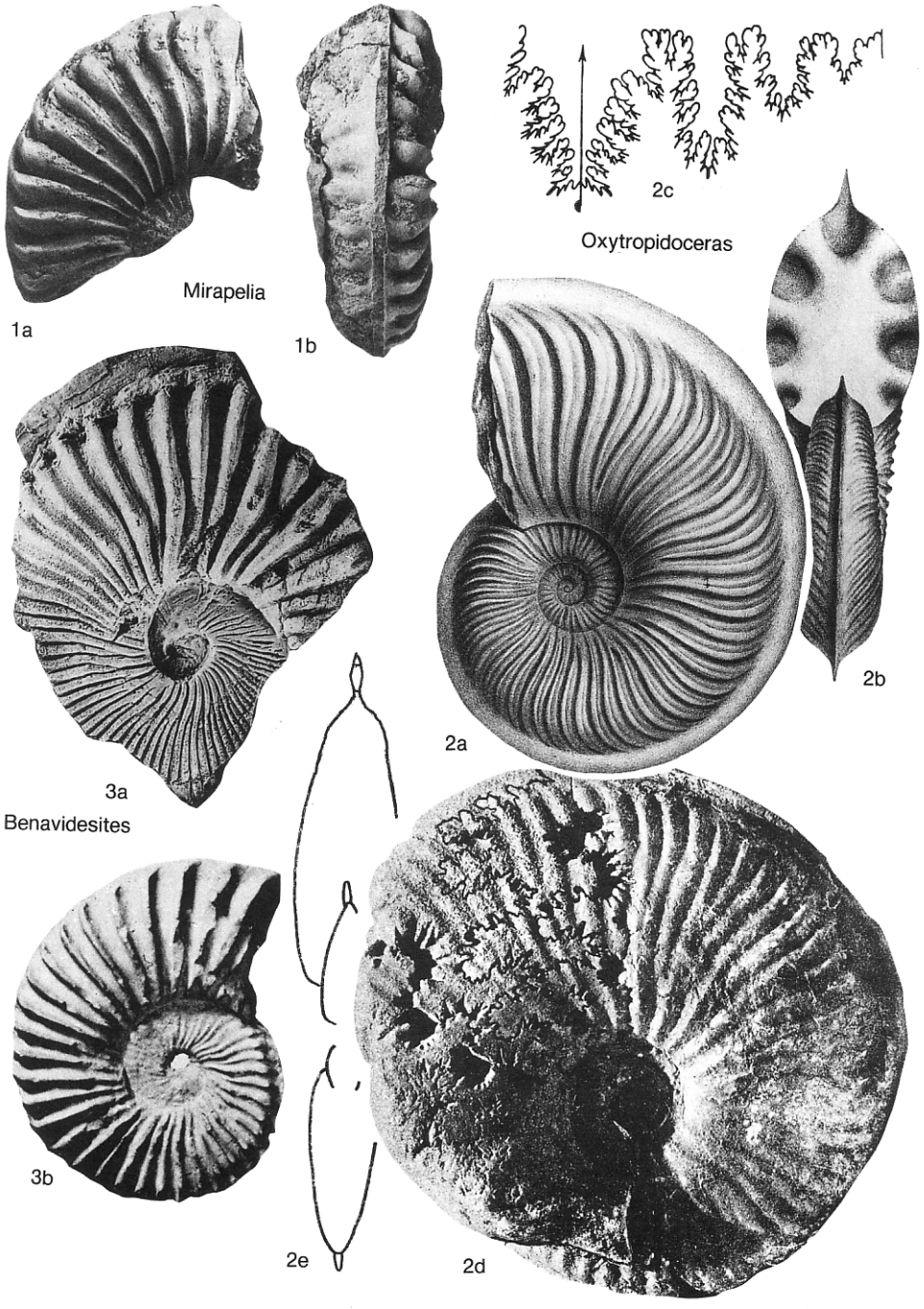


FIG. 106. Brancoceratidae (p. 137–138)

107,*1. O. (A.) bravoense* (BÖSE), Texas; ×1 (K. Young, 1966).

Dipoloceras HYATT, 1900, p. 589 [**Ammonites cristatus* BRONGNIART in CUVIER & BRONGNIART, 1822, pl. O, fig. 9; OD]. Rather evolute; typically inflated or depressed; keel prominent, commonly below level of ventrolateral ends of ribs; ribs dense to distant, rounded to sharp, typically a mixture of single and branched, the latter flared at point of branching; umbilical and ventrolateral tubercles present in

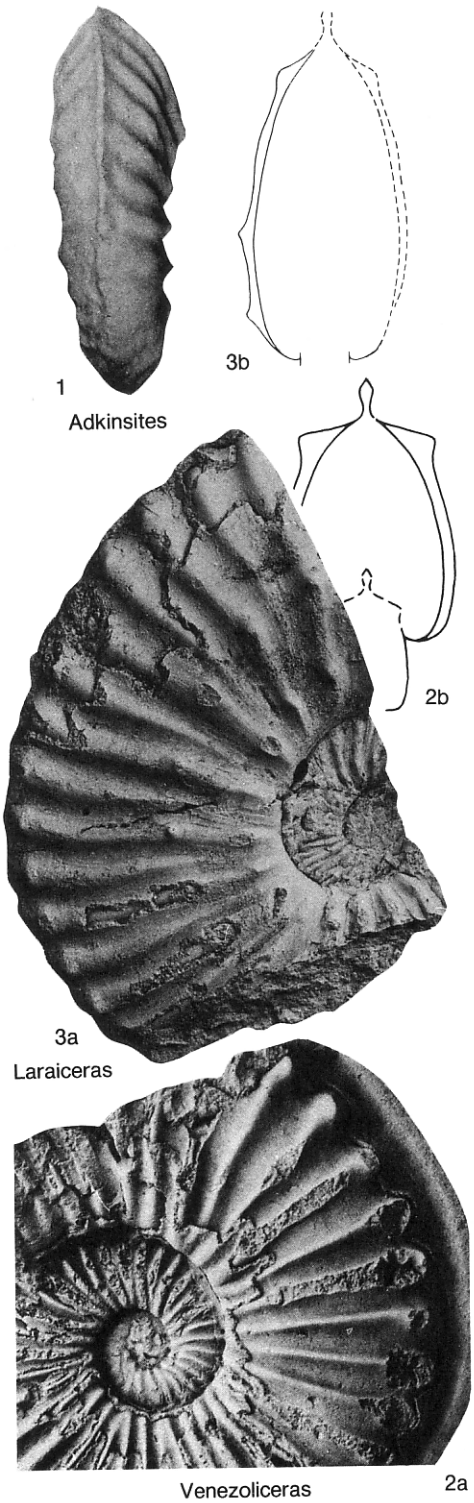


FIG. 107. Brancoceratidae (p. 138–139)

some. Sutures with plump, broad, finely indented saddles. *Lower Cretaceous (Middle Albian–Upper Albian):* Europe, South Africa (Zululand), Madagascar, Japan, Texas, ?Curaçao.

D. (Dipoloceras) [=*Cechenoceras* HOEPEN, 1941, p. 61 (type, *C. reversum;* OD)]. Whorl section round or depressed; umbilical and ventrolateral tubercles absent or insignificant. Occurrence and distribution as for genus.——FIG. 108,*1a–c.* **D. (D.) cristatum* (BRONGNIART in CUVIER & BRONGNIART), Middle Albian, France; *a,b,* ×1; *c,* ×2 (Orbigny, 1840–1842).

D. (Rhytidoceras) HOEPEN, 1931, p. 42 [**R. elegans;* OD] [=*Ricnoceras* HOEPEN, 1941, p. 59 (type, *R. pandai;* OD); *Diplasioceras* HOEPEN, 1946a, p. 203 (type, *D. fallax;* OD); *Euspectroceras* HOEPEN, 1946a, p. 202 (type, *E. strigile;* OD); ?*Mortoniceratoides* COOPER, 1982, p. 296 (type, *Mortoniceras rigidum* SPATH, 1933b, p. 413; OD)]. Inner whorls tending to be flat-sided, with distinct umbilical and weak ventrolateral tubercles and with ribs a mixture of branched and flexuous and single and straight; strong, spiral notching may occur (*Euspectroceras*). Occurrence and distribution as for genus.——FIG. 108,*2a,b.* **D. (R.) elegans* (HOEPEN), Upper Albian, Zululand; ×0.5 (Hoepen, 1941).

?Menuthengonoceras COLLIGNON, 1963, p. 130 [**M. komihevitraense;* OD]. Based on single fragment of discoidal, high-whorled form with shouldered venter and high keel. COLLIGNON (1963) compared the suture of *Menuthengonoceras* with *Hypengonoceras,* but the fragment seems as likely to belong to Mojsisovicziinae as to Engonoceratidae. *Lower Cretaceous (Middle Albian):* Madagascar.

Subfamily MORTONICERATINAE H. Douvillé, 1912

[*nom. transl.* SPATH, 1934, p. 465, *ex* Mortoniceratidae SPATH, 1925c, p. 182, *nom. correct. pro* Mortoniceratinés H. DOUVILLÉ, 1912, p. 295] [=Inflaticeratidae SPATH, 1925c, p. 181; Pervinquieriidae SPATH, 1926a, p. 79; Arestoceratidae HOEPEN, 1942, p. 117; Cainoceratidae HOEPEN, 1942, p. 127]

Moderately involute to very evolute; whorl section more or less rounded, square, or compressed, with low to high keel; ribs branching or long and short, at least in early whorls, but may be single and equal on body chamber or earlier; ribs low and rounded, or flat, or high and rounded, but not high and sharp; at least umbilical tubercles occurring, normally also inner ventrolateral, and frequently lateral and outer ventrolateral; some species with up to 5 tubercles on a rib; spiral striation or notching of ribs common; aperture simple (in probable macroconchs) or with rostrum directed forward, upward, or backward (in probable microconchs).

Suture generally with squarish, symmetrical, deeply and sharply indented saddles. HOEPEN, 1941–1951; SPATH, 1923–1943. *Lower Cretaceous (Middle Albian)–Upper Cretaceous (Lower Cenomanian).*

As the synonymies of subfamily and genera show, both the nomenclature and scale of classification of the group have been in doubt. A large number of species with many of the same basic characters vary in detail and in combination of whorl section, number and shape of tubercles at different growth stages, and in strength and direction of ribs. An attempt is made here to classify them in accord with the scale accepted in allied groups. The subfamily is derived from Mojsisovicziinae along one or several closely allied lines and remains very uniform.

Mortoniceras MEEK, 1876, p. 448 [**Ammonites vespertinus* MORTON, 1834, p. 40; OD (despite many authors, a valid species)] [for synonyms see subgenera]. More or less evolute, with square, rectangular, or trapezoidal costal whorl section; ribs normally strong but may weaken or strengthen on body chamber; with prominent umbilical and normally with inner ventrolateral tubercles at least and, at some growth stage, 1 or 2 lateral and an outer ventrolateral tubercle also may occur; keel high or low. *Lower Cretaceous (Middle Albian–Upper Albian):* Europe, Africa, India, North America, South America, Madagascar.

M. (**Mortoniceras**) [=*Pervinquieria* BÖHM, 1910, p. 152 (type, *Ammonites inflatus* J. SOWERBY, 1817c, p. 170; M); *Inflaticeras* STIELER, 1920, p. 346 (type, *Ammonites inflatus* J. SOWERBY, 1817c, p. 170; OD); *Subschloenbachia* SPATH, 1921a, p. 284 (type, *Ammonites rostratus* J. SOWERBY, 1817b, p. 163; OD); *Leonites* SPATH, 1932, p. 388 (type, *Ammonites leonensis* CONRAD, 1857, p. 160; OD); *Ophryoceras* HOEPEN, 1942, p. 91 (type, *O. jugosum;* OD); ?*Ameleceras* HOEPEN, 1942, p. 115 (type, *A. abjectum;* OD); *Rusoceras* HOEPEN, 1946a, p. 238 (type, *R. nothum;* OD); *Collignonia* HOEPEN, 1951b, p. 295 (type, *Pervinquieria (C.) undulatocostata* HOEPEN, 1951b, p. 295; OD); *Styphloceras* HOEPEN, 1951b, p. 300 (type, *Pervinquieria (S.) nodosocostata* HOEPEN, 1951b, p. 300; OD); *Omocrateceras* HOEPEN, 1951b, p. 313 (type, *Pervinquieria (O.) planiventer* HOEPEN, 1951b, p. 313; OD); *Subpervinquieria* MIRZOEV, 1969, p. 46 (type, *Pervinquieria (S.) luppovi* MIRZOEV, 1969, p. 46; OD)]. Ribs moderately fine to very coarse, normally branching at umbilical tubercles on early whorls, later single; with umbilical and inner ventrolateral tubercles; mediolateral tubercles typically weak, present or not; outer ventrolateral tubercle commonly percep-

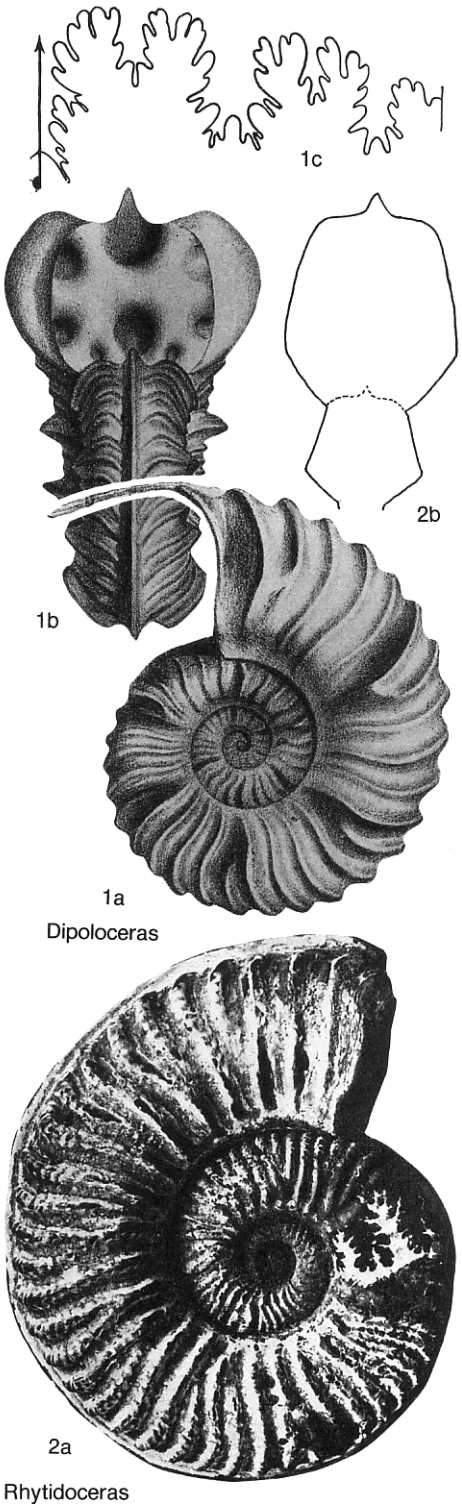


FIG. 108. Brancoceratidae (p. 140)

tible at some stage and in some species, e.g., *M. (M.) rostratum* (J. SOWERBY), and may be strong for a short stage, foreshadowing *M. (Durnovarites);* in a few species all tubercles weak and ribs dominant; rostrum (questionably of microconchs) raised and straight to recoiled. Occurrence and distribution as for genus except that it does not reach the extreme top of the Albian. ——FIG. 109*a–d.* **M. (M.) vespertinum* (MORTON), Upper Albian, Texas; *a,b,* holotype, ×0.25; *c,d,* ×0.5 (new).——FIG. 109*e–g. M. (M.) inflatum* (J. SOWERBY); *e,* Upper Albian, England, ×0.7; *f,* Upper Albian, England, ×1 (Spath, 1923–1943); *g,* Upper Albian, France, ×1 (Orbigny, 1840–1842).——FIG. 109*h. M. (M.) rostratum* (J. SOWERBY), Upper Albian, France; ×0.5 (Scholz, 1979).

M. (Boesites) K. YOUNG, 1968, p. 71 [**Pervinquieria romeri* HAAS, 1942, p. 73; OD]. Very evolute, with umbilical and ventrolateral bullae but no lateral tubercles; ribs strong and distant, equal or long and short, but not bifurcating. Barely distinct from some bituberculate *M. (Mortoniceras). Lower Cretaceous (Upper Albian):* Angola, Texas, Mexico.

M. (Deiradoceras) HOEPEN, 1931, p. 52 [**Inflaticeras prerostratum* SPATH, 1921a, p. 284; OD] [=*Drepanoceras* HOEPEN, 1931, p. 46, *non* STEIN, 1878, p. 25 (type, *D. undatum;* OD); *Mimeloceras* HOEPEN, 1944, p. 196, *nom. nov. pro Mimoceras* HOEPEN, 1941, p. 85, *non* HYATT, 1884, p. 309 (type, *Mimoceras binodosum;* OD)]. Whorl section depressed to slightly compressed, subquadrate, with sharp keel; very strong umbilical and ventrolateral tubercles with costal whorl section concave between; midlateral tubercles may be visible at some stage; early whorls tending to have rounded venter as in *Dipoloceras;* rostrum projected in continuation of coiling of shell. *Lower Cretaceous (Upper Albian):* western Europe, Africa, Venezuela.——FIG. 110,*3.* **M. (D.) prerostratum* (SPATH), South Africa (Zululand); ×0.75 (Spath, 1921a).

M. (Durnovarites) SPATH, 1932, p. 380 [**Subschloenbachia perinflata* SPATH, 1922a, p. 113; M; SPATH (1932, p. 380) designated the type as follows: "*M. (D.) subquadratum,* nov. Plate xxxvii, figs. 6a,b (Diagnosis below)"; however, the diagnosis did not appear until 1933 (p. 429) and, after 1931, mere reference to a figure was insufficient to validate a species. Thus, *M. (D.) subquadratum* was in 1932 a *nom. nud.* SPATH (1933b, p. 429) quoted the type species of *Durnovarites* as *M. (D.) perinflatum* (SPATH) without comment.] [=*Reyreiceras* COLLIGNON, 1979, p. 34 (type, *R. reyrei;* OD)]. Whorl section square to depressed-trapezoidal; from early stage at least 4 nearly equally spaced tubercles on each rib, the outer one as prominent as the others and tending to be clavate. *Lower Cretaceous (Upper Albian):* Europe, Africa, Madagascar, Texas.——FIG. 110,*2a,b.* **M. (D.) perinflatum* (SPATH), France; ?microconch, ×0.5 (Scholz, 1979).——FIG. 110,*2c,d. M. (D.) subquadratum,* England; ×1 (Spath, 1923–1943).

M. (Angolaites) SPATH, 1932, p. 380 [**Pervinquieria gregoryi* SPATH, 1922a, p. 127; OD] [=?*Praeangolaites* COLLIGNON, 1979, p. 41 (type, *P. galvaoi;* OD)]. Rather compressed; with single ribs at all stages; at first with umbilical tubercles; later also with prominent inner and outer ventrolateral tubercles. *Lower Cretaceous (Upper Albian):* western Africa.——FIG. 110,*1a,b.* **M. (A.) gregoryi* (SPATH), Angola; ×0.5 (Spath, 1922a).

M. (Drakeoceras) K. YOUNG, 1957, p. 19 [**D. drakei;* OD]. Compressed to rather inflated; normally with branching ribs at some stage and with double ventrolateral tubercles as in *M. (Angolaites). Lower Cretaceous (Upper Albian):* Angola, Texas.——FIG. 110,*5a,b.* **M. (D.) drakei* (YOUNG), Texas; ×0.75 (K. Young, 1957).

M. (Pagoceras) HOEPEN, 1951b, p. 324 [**P. amplificatum;* OD] [=*Poikiloceras* HOEPEN, 1951b, p. 329 (type, *P. firmum;* OD)]. Moderate-sized, with markedly fastigiate venter becoming increasingly acute with age. *Lower Cretaceous (Upper Albian):* South Africa (Zululand).——FIG. 110,*4a,b.* **M. (P.) amplificatum* (HOEPEN); ×0.5 (Hoepen, 1951b).

Goodhallites SPATH, 1932, p. 381 [**Ammonites goodhalli* J. SOWERBY, 1820, p. 100; OD] [=*Letheceras* HOEPEN, 1942, p. 138 (type, *L. complanatum;* OD); *Cainoceras* HOEPEN, 1942, p. 149 (type, *C. liberum;* OD); *Lethargeceras* HOEPEN, 1942, p. 149 (type, *L. incommodum;* OD); *Aidoceras* HOEPEN, 1946b, p. 248 (type, *A. jubatum;* OD)]. More or less compressed and high-whorled, with high keel; inner whorls generally finely ribbed, with rather weak umbilical, ventrolateral, and rarely midlateral tubercles or none; outer whorls normally with strong ornament, tubercles becoming more prominent with age, but final part may be nearly smooth. *Lower Cretaceous (Upper Albian):* Europe, Africa, Madagascar, southern India, Australia (Queensland), Texas, Venezuela.——FIG. 111,*3a,b.* **G. goodhalli* (J. SOWERBY), England; *a,* ×0.67; *b,* ×0.5 (Spath, 1923–1943).——FIG. 111,*3c,d. G. liber* (HOEPEN), South Africa (Zululand); ×1 (Hoepen, 1942).

Arestoceras HOEPEN, 1942, p. 118 [**A. collinum;* OD] [=?*Tetagmenoceras* HOEPEN, 1942, p. 122 (type, *T. tumulosum* HOEPEN, 1942, p. 123; SD WRIGHT, herein)]. Early whorls as in some early, less tuberculate species of *M. (Mortoniceras),* but ornament tending to disappear, whorl height to increase, and venter to become fastigiate rather than keeled. Perhaps a subgenus of *Goodhallites. Lower Cretaceous (Upper Albian):* South Africa (Zululand).——FIG. 111,*2.* **A. collinum;* ×0.75 (Hoepen, 1942).

Neoharpoceras SPATH, 1921a, p. 282 [**Ammonites hugardianus* ORBIGNY, 1841, p. 291; OD]. Compressed; more involute than *Prohysteroceras* and with more rounded venter and lower keel; ribs dense and sinuous, without tubercles. Suture florid. *Lower Cretaceous (Upper Albian):* western Europe.——FIG.

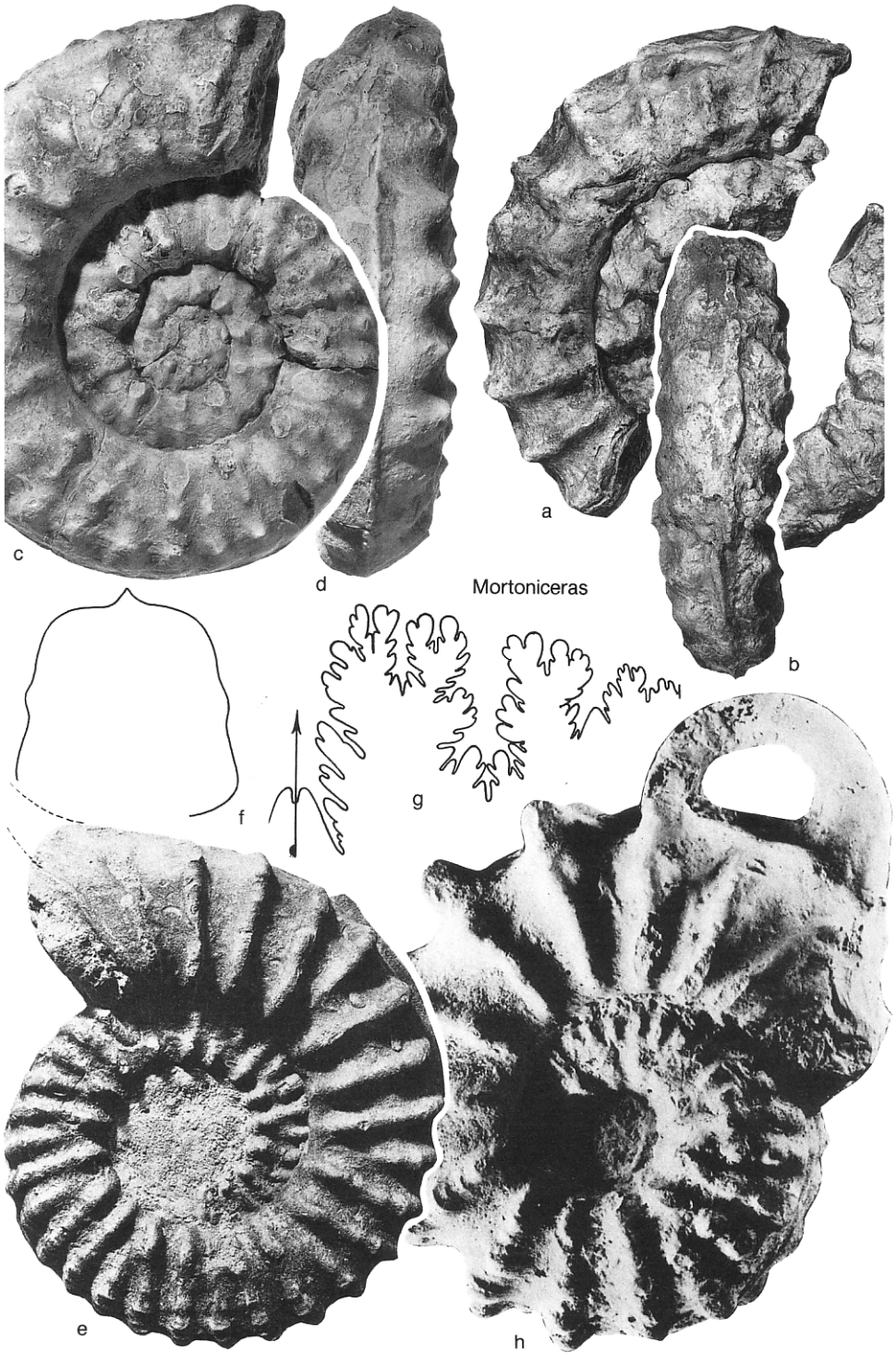


FIG. 109. Brancoceratidae (p. 141–142)

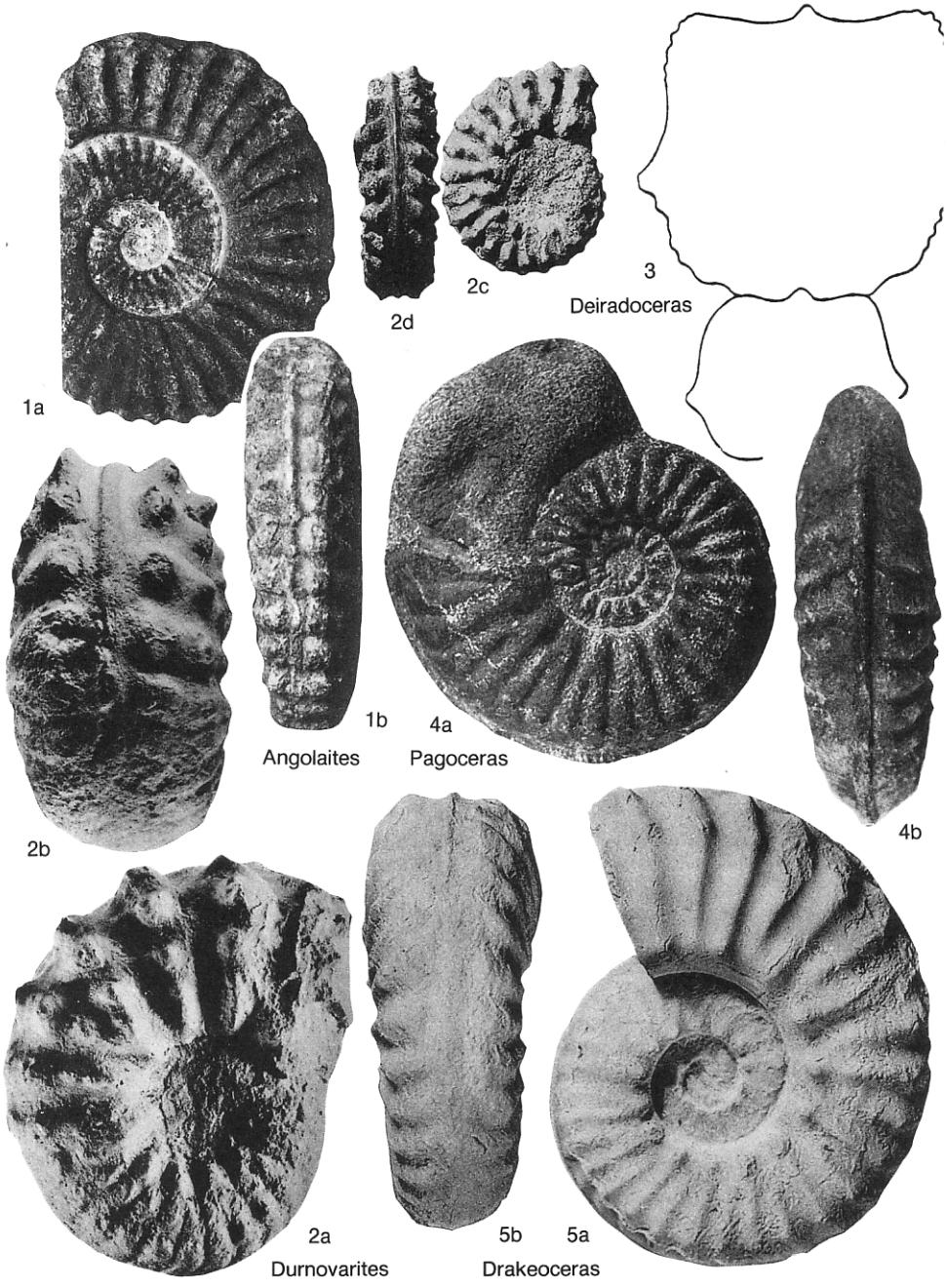


FIG. 110. Brancoceratidae (p. 142)

111,*1a,b.* **N. hugardianum* (ORBIGNY), France; ×0.75 (Orbigny, 1840–1842).

Prohysteroceras SPATH, 1921a, p. 286, ICZN Opinion 1254, 1983, Generic Name No. 2195 [**P. wordiei* SPATH, 1922a, p. 143 (1921a, p. 286, *nom. nud.*); ICZN Specific Name No. 2862]. Rather evolute and moderately compressed; ribs fine, close, sinuous, and branching; tubercles weak or absent; rostrum prominent, directed upward. *Lower Cretaceous (Upper Albian):* England, Angola.——FIG. 111,*4a–c.* **P. wordiei,* Angola; *a,* ×0.7; *b,* ×1; *c,* ×2.5 (Spath, 1922a).

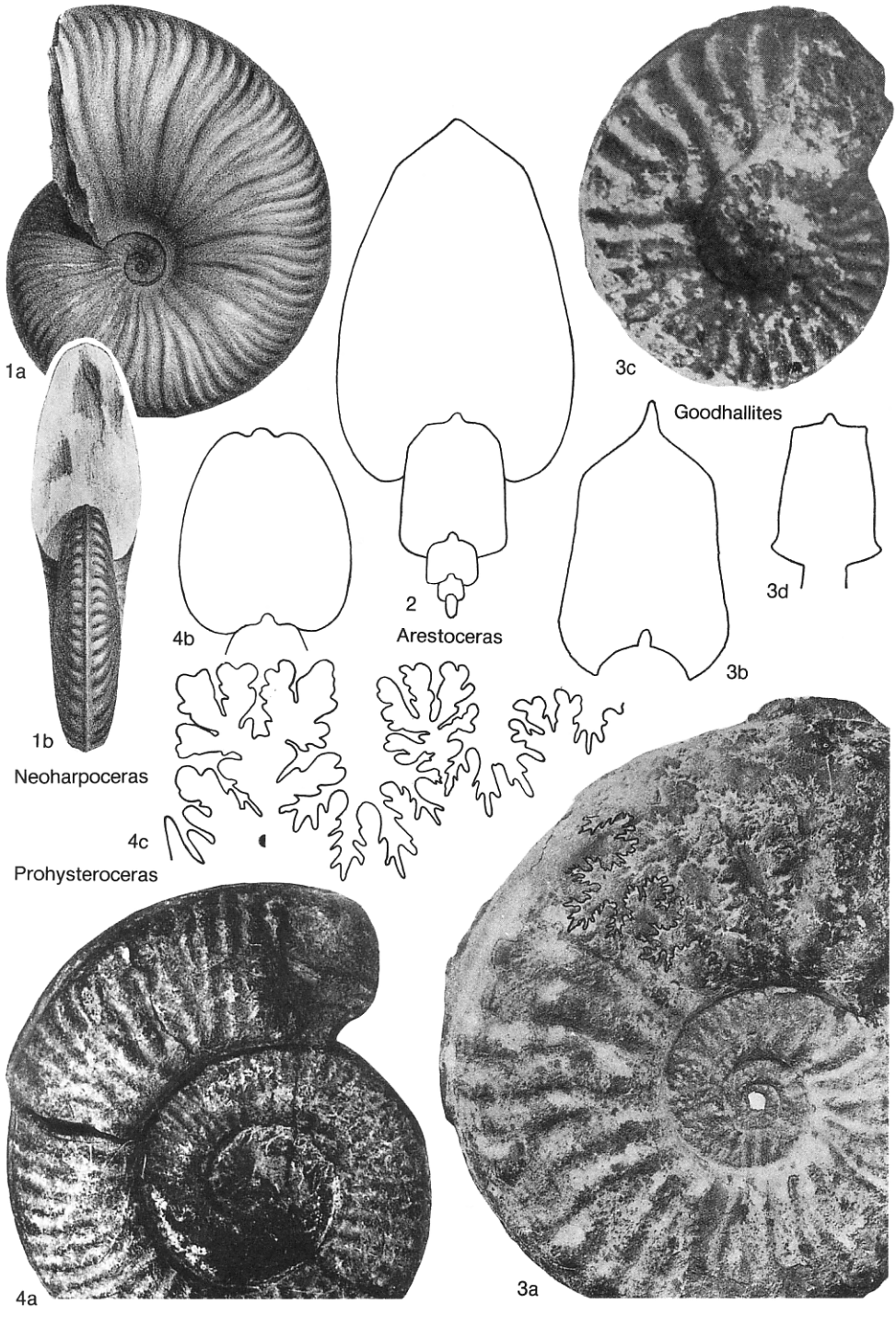


FIG. 111. Brancoceratidae (p. 142–144)

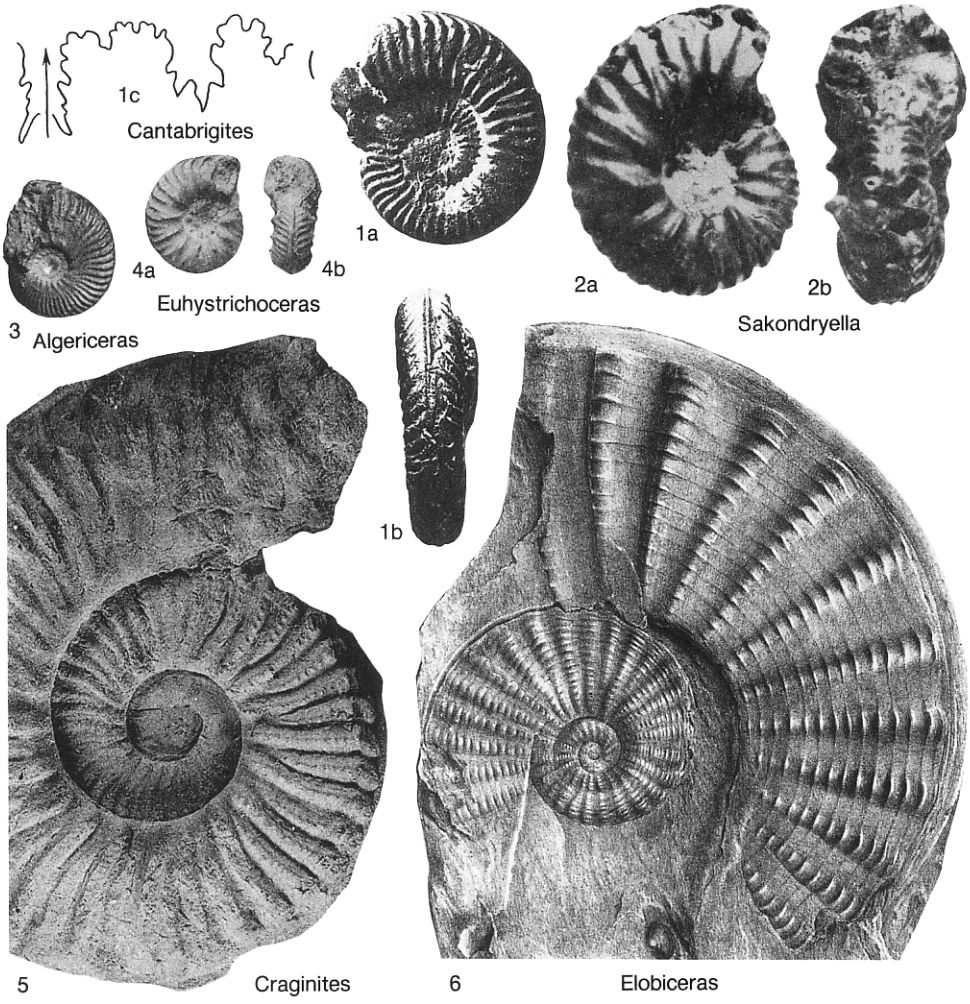


FIG. 112. Brancoceratidae (p. 146–147)

Elobiceras SPATH, 1921a, p. 306 [**Schloenbachia elobiensis* SZAJNOCHA, 1885, p. 235; OD]. Rather evolute and compressed, with numerous clavi or spiral notches on the ribs. *Lower Cretaceous (Upper Albian):* Angola, southern India, Nigeria, Texas.

E. (**Craginites**) K. YOUNG, 1957, p. 14 [**Schloenbachia leonensis* var. *serratescens* CRAGIN, 1893, p. 241; OD]. With alternate, long and short, flexuous ribs. Occurrence as for genus: Texas.——FIG. 112,*5*. **E. (C.) serratescens* (CRAGIN); ×1 (K. Young, 1957).

E. (**Elobiceras**). Ribs single, rectiradiate. Occurrence as for genus: Angola, Nigeria, southern India.——FIG. 112,*6*. **E. (E.) elobiense* (SZAJNOCHA), Angola; ×0.5 (Szajnocha, 1885).

Cantabrigites SPATH, 1933b, p. 436 (1932, p. 380, *nom. nud.*) [**Mortoniceras (C.) cantabrigense* SPATH, 1932, p. 380; OD]. Small; generally with branching ribs at first, tending to become single, mostly nontuberculate. Suture much simplified. May be closer to *Hysteroceras* (Brancoceratinae). *Lower Cretaceous (Upper Albian):* England, France, Switzerland.——FIG. 112,*1a–c*. **C. cantabrigense* SPATH, England; *a,b,* ×1; *c,* ×2 (Spath, 1923–1943).

Algericeras SPATH, 1925c, p. 182 [**Ammonites boghariensis* COQUAND, 1880, p. 35; OD] [=*Prionocycloides* SPATH, 1925c, p. 182 (type, *Ammonites proratus* COQUAND, 1880, p. 32; OD)]. Small; compressed to inflated, with rounded shoulders and keel; ribs fine or coarse, sharp and branching. Seems to be derived from *Cantabrigites.* KENNEDY & WRIGHT, 1981. *Upper Cretaceous (Lower Cenomanian):* northern Africa, Madagascar, Mexico.

A. (**Algericeras**). Keel nodate at first, then entire. Occurrence as for genus: northern Africa.——FIG. 112,*3*. **A. (A.) boghariense* (COQUAND), Tunisia; ×2 (Pervinquière, 1907).

A. (**Sakondryella**) COLLIGNON, 1964, p. 21

[**Euhystrichoceras (S.) madagascariense* COLLIGNON, 1964, p. 21; OD; =*Euhystrichoceras remolinense* BÖSE, 1928, p. 247]. Keel with strong crenulations throughout. Occurrence as for genus: Madagascar, Mexico.——FIG. 112,*2a,b.* **A. (S.) remolinense* (BÖSE), Madagascar; ×1 (Collignon, 1964).

Euhystrichoceras SPATH, 1923b, p. 143 [**Ammonites nicaisei* COQUAND, 1862, p. 323; OD]. Small; rather evolute; compressed to inflated, with flat or convex sides and strong, entire keel; irregular ribs springing in twos and threes from sharp umbilical tubercles and curving forward on venter; shorter ribs intercalated; ventrolateral tubercles may occur and if so lautiform ribbing may develop. KENNEDY & WRIGHT, 1981. *Upper Cretaceous (Lower Cenomanian):* England, northern Africa, Nigeria, Madagascar, Mexico.——FIG. 112,*4a,b.* **E. nicaisei* (COQUAND), Tunisia; ×1 (Pervinquière, 1907).

Family LYELLICERATIDAE Spath, 1921

[Lyelliceratidae SPATH, 1921a, p. 286]

Small to moderate-sized; compressed to inflated; moderately to very evolute; ribs straight to sigmoid, uniform to long and short, rarely branched, crossing venter transversely or in chevrons, zigzagging or interrupted, and with or without tubercles. Suture rather simple; with bifid saddles; deep, parallel-sided ventral lobe; trifid lateral lobes; and no umbilical retraction. *Lower Cretaceous (Lower Albian)–Upper Cretaceous (Lower Cenomanian).*

Probably derived from *Leymeriellidae.*

Subfamily LYELLICERATINAE Spath, 1921

[Lyelliceratinae SPATH, 1921a, p. 286]

Evolute, with strong tuberculation. *Lower Cretaceous (Lower Albian–Middle Albian).*

Tegoceras HYATT, 1903, p. 84 [**Ammonites mosensis* ORBIGNY, 1841, p. 237; OD] [=*Rauliniceras* H. DOUVILLÉ, 1911, p. 85 (type, *Hoplites gladiator* BAYLE, 1878, pl. 45, fig. 1–2; OD); *Seunesiceras* BREISTROFFER, 1953b, p. 74, *nom. nud.*]. Moderately involute to evolute; whorl section compressed, subrectangular to subhexagonal; venter flat or slightly convex; ribs simple, thick, and rounded, with wide interspaces and emphasized or tuberculate one-third up side; ribs forming nodes on shoulder and alternating across venter with zigzagging ventral ribs or clavate on shoulder with smooth venter. Mature body chamber smooth, with rounded venter. Suture with short elements that may be broken into fingerlike denticulations. *Lower Cretaceous (Lower Albian–Middle Albian):* western Europe, Madagascar, Pakistan, Venezuela.——FIG. 113,*1a–d.* **T. mosense* (ORBIGNY), Lower Albian; *a–c,* holotype, France, ×1; *d,* England, ×1 (Casey, 1978). ——FIG. 113,*1e,f.* *T. camatteanum* (ORBIGNY), Middle Albian, France; ×1 (Orbigny, 1840–1842).

Prolyelliceras SPATH, 1930b, p. 65 [**P. peruvianum;* OD] [=*Ralphimlayites* ETAYO SERNA, 1979, p. 81 (type, *R. apuloensis;* OD)]. Slightly compressed and high-whorled, with flexuous ribs continuous across venter or in some flattened on it; ventrolateral and siphonal clavi subordinate to ribs. Some species (*Ralphimlayites*) also have inner ventrolateral tubercles during middle growth and may not lose tubercles completely on body chamber. Grades into *Lyelliceras* and separation may not be necessary. *Lower Cretaceous (Lower Albian):* Tunisia, Colombia, Peru.——FIG. 113,*3a–c.* *P. prorsocurvatum* (GERHARDT), Colombia; *a,b,* ×0.75; *c,* ×2 (Gerhardt, 1897b).

Lyelliceras SPATH, 1922a, p. 107 [**Ammonites lyelli* ORBIGNY, 1841, p. 255; OD]. Moderately to very evolute; whorl section slightly compressed to circular; normally having straight radial ribs with 2 or 3 rows of lateral clavi and one row of siphonal clavi, but siphonal clavi effaced in some forms; tubercles normally dominant over ribs; ribs continuing straight over venter or zigzagging. *Lower Cretaceous (Lower Albian–Middle Albian):* western Europe, Madagascar, Pakistan, Mexico, Colombia, Peru, Venezuela.——FIG. 113,*2a–c.* **L. lyelli* (ORBIGNY), Middle Albian, France; *a,b,* ×0.75; *c,* enlarged (Orbigny, 1840–1842).

Subfamily STOLICZKAIINAE Breistroffer, 1953

[Stoliczkaiinae BREISTROFFER, 1953b, p. 74]

More involute than Lyelliceratinae, with ribs tending to become dominant over tubercles. *Lower Cretaceous (Middle Albian)–Upper Cretaceous (Lower Cenomanian).*

Neophlycticeras SPATH, 1922a, p. 107 [**Ammonites brottianus* ORBIGNY, 1841, p. 290; OD] [=*Faraudiella* BREISTROFFER, 1947b, p. 88(72) (type, *Ammonites gardonicus* HÉBERT & MUNIER-CHALMAS, 1875, p. 113; OD; =*Ammonites blancheti* PICTET & CAMPICHE, 1859, p. 188); *Eotropitoides* CASEY, 1965, p. 462 (type, *N. jayeti* BREISTROFFER, 1936, p. 65, *nom. nud.;* OD)]. Moderately to very involute; more or less compressed, with sides flat or convex and ribs flat or broadly rounded; venter sharp and crenulate or rounded with row of siphonal tubercles. [*Eotropitoides* as a subgenus for compressed forms with ribbing effaced at midside and siphonal tubercles tending to form a keel seems unnecessary; the incipient forbesiceratoid adventive lobe on the outer side of the first lateral saddle also appears in typical *Neophlycticeras.*] *Lower Cretaceous (Middle Albian–Upper Albian):* western Europe, Morocco, Madagascar, ?Japan, Colombia, Peru,

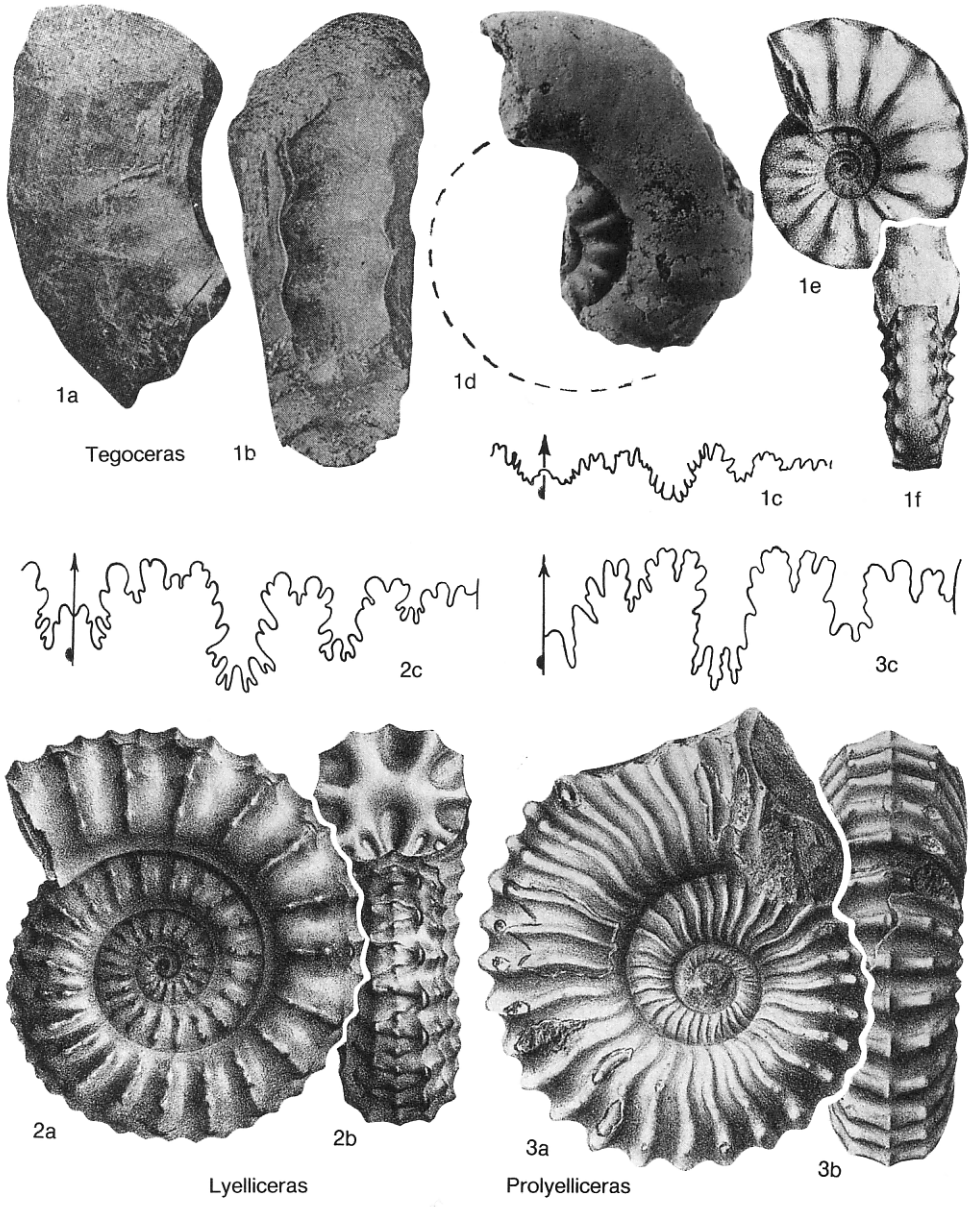


FIG. 113. Lyelliceratidae (p. 147)

Venezuela.——FIG. 114,*1a,b. *N. brottianum* (ORBIGNY), Middle Albian, France; ×1; *c,* enlarged (Orbigny, 1840–1842).——FIG. 114,*1d–f. N. blancheti* (PICTET & CAMPICHE), Upper Albian, Switzerland; *d,e,* ×1; *f,* enlarged (Pictet & Campiche, 1858–1864).

Protissotia COLLIGNON, 1932, p. 12 [**Tissotia (Protissotia) madagascariensis;* OD; =*Ammonites itierianus* ORBIGNY, 1841, p. 367]. Dwarf offshoot of *Neophlycticeras;* sides flat, with or without marked umbilical and ventrolateral nodes; sutures tending to be slightly pseudoceratitic. *Lower Cretaceous (Upper Albian):* western and central Europe, Madagascar, Venezuela.——FIG. 115,*4a–d. *P. itierianus* ORBIGNY, Venezuela; *a–c,* ×1; *d,* ×2 (Renz, 1970).

Cenisella DELAMETTE & LATIL, 1989, p. 57 [**Ammonites bonettianus* PICTET, 1847, p. 306; OD]. Early

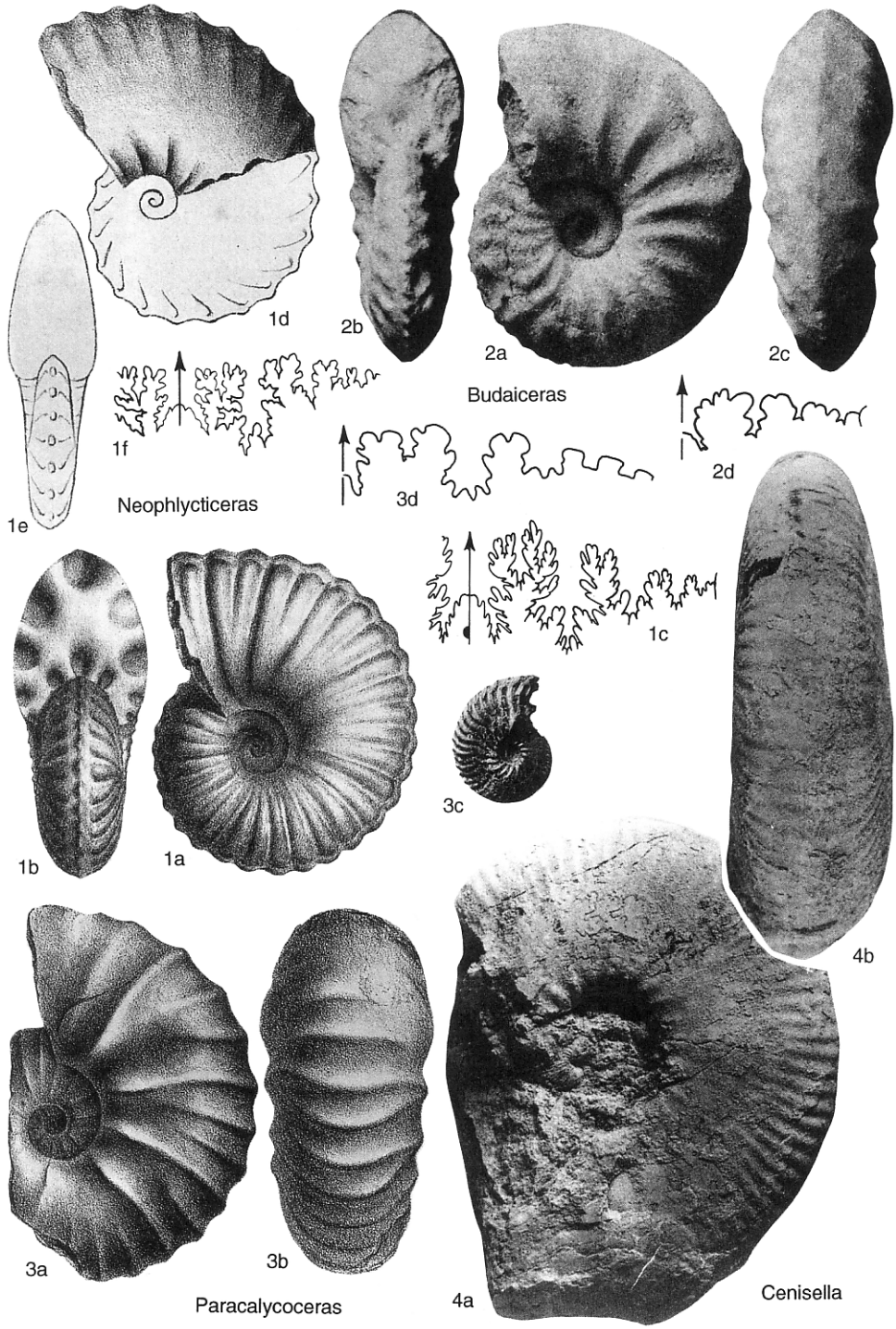


FIG. 114. Lyelliceratidae (p. 147–151)

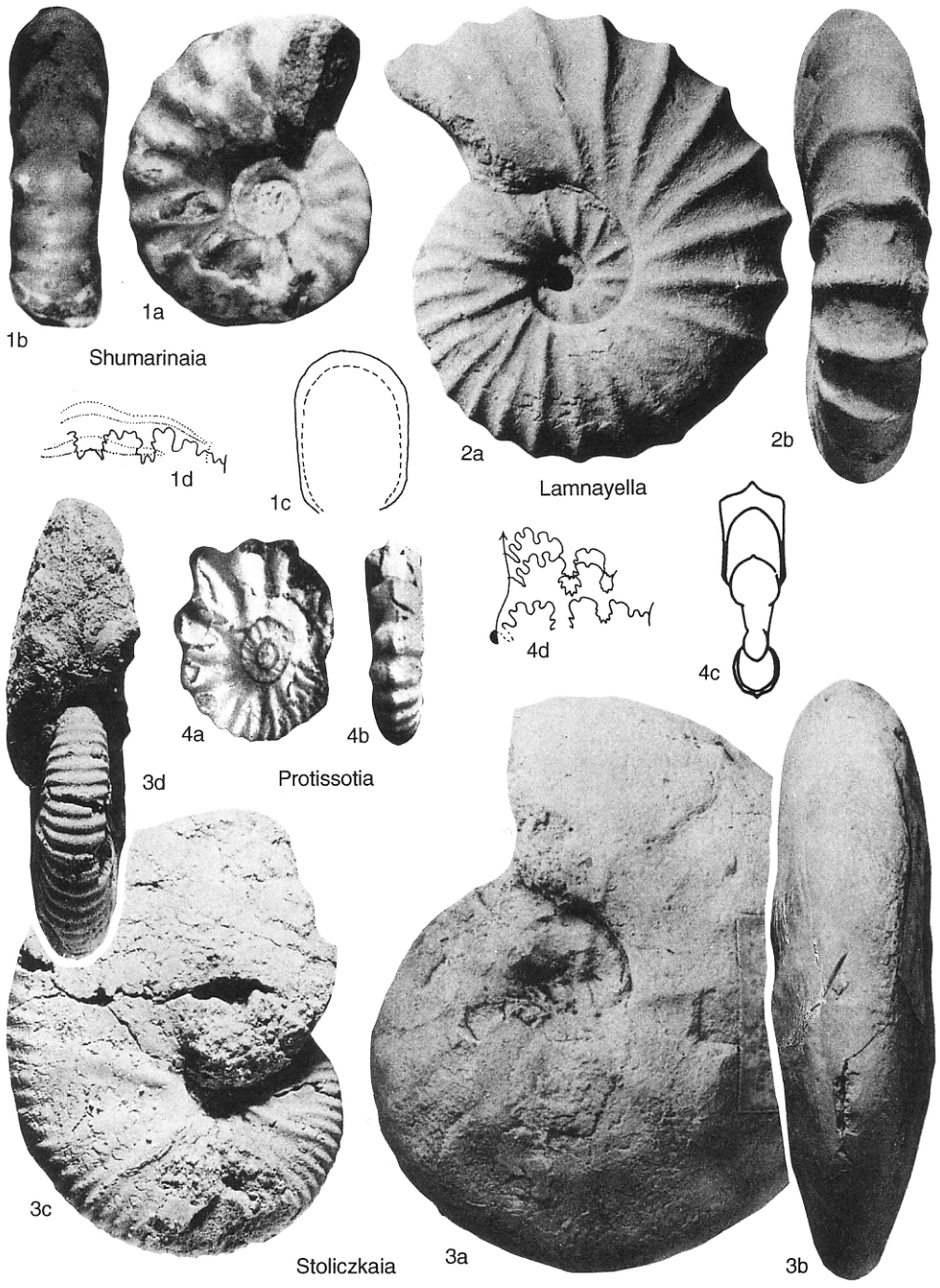


FIG. 115. Lyelliceratidae (p. 148–151)

whorls as in *Neophlycticeras,* but ventral tubercles soon disappearing and fine, dense ribs tending to arise in bundles from umbilical tubercles. *Lower Cretaceous (Upper Albian):* France.——FIG. 114,*4a,b.* **C. bonnetiana* (PICTET); ×0.8 (Delamette & Latil, 1989).

Budaiceras BÖSE, 1928, p. 255 [**B. mexicanum;* OD; =*Barroisiceras hyatti* SHATTUCK, 1903, p. 36]. Differs

from *Neophlycticeras* only in the more or less prominent ventrolateral clavi and in the siphonal clavi being up to twice as numerous as the ventrolateral. *Upper Cretaceous (Lower Cenomanian):* France, Texas, Mexico.——FIG. 114,*2a–d.* **B. hyatti* (SHATTUCK), Texas; ×1 (K. Young, 1979).

Stoliczkaia NEUMAYR, 1875a, p. 931 [**Ammonites dispar* ORBIGNY, 1841, p. 142; SD DIENER, 1925, p. 179]. Rather involute; umbilical seam egresses in adult; whorl section high and compressed to subquadrate; primary ribs straight or slightly curved, rounded, with numerous intercalatories or branched secondaries; ribs normally fine in young and coarsening, in some species suddenly, with age, then weakening or disappearing on body chamber (in questionable macroconchs) or persisting (in questionable microconchs); venter in young flat, fastigiate, or rounded, with 1, 2, or 3 tubercles; later ribs tending to cross and thicken on venter and tubercles to weaken or disappear. Suture with well-rounded folioles, tending to simplify. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian):* Europe, northern and western Africa, Madagascar, southern India, Japan, Texas, Arizona, Brazil, Mexico.

S. (**Stoliczkaia**) [=*Villoutreysia* CASEY, 1965, p. 435 (type, *S. (V.) villoutreysi;* OD)]. Except in young, venter flat or rounded; juvenile ventrolateral and siphonal tubercles not normally persisting; ribs weakening or not on body chamber. *Lower Cretaceous (Upper Albian):* distribution as for genus.——FIG. 115,*3a–d.* **S. (S.) dispar* (ORBIGNY); *a,b,* France, lectotype, ×0.5; *c,d,* England, ×0.75 (Wright & Kennedy, 1978).

S. (**Shumarinaia**) MATSUMOTO & INOMA, 1975, p. 276 [**S. (S.) hashimotoi;* OD]. Small, moderately evolute, and compressed, with early onset of distant, wide ribs, in some species to the exclusion of any fine-ribbed stage; on early part of body chamber, ribs angulate or raised into blunt tubercles on shoulder. Suture simple. Superficially resembles some Brancoceratinae. *Lower Cretaceous (Upper Albian):* England, Tunisia, Nigeria, Madagascar, southern India, Japan, Brazil.——FIG. 115,*1a–d.* **S. (S.) hashimotoi*, Japan; *a,b,* ×1; *c,d,* ×2 (Matsumoto & Inoma, 1975).

S. (**Lamnayella**) WRIGHT & KENNEDY, 1978, p. 394 [**S. (L.) juigneti;* OD]. Medium-sized; venter fastigiate, feebly trituberculate in young, and evenly rounded when mature; feeble umbilical bullae giving rise to single, rarely paired, strong, narrow, high, distant, slightly flexed, and prorsiradiate ribs; 1 to 3 shorter ribs intercalated during early to middle growth; most ribs on body chamber long, strong, and distant. *Upper Cretaceous (Lower Cenomanian):* England, France, Romania, southern India, Japan, Texas, Mexico.——FIG. 115,*2a,b.* **S. (L.) juigneti,* France; ×1 (Wright & Kennedy, 1978).

Ojinagiceras COBBAN & KENNEDY, 1989, p. 138 [**O. ojinagaense;* OD] [=*Ojianagiceras* COBBAN & KENNEDY, 1989, p. 138, *pro errore,* as indicated by origin and name and consistent spelling throughout paper]. Progenetic dwarf offshoot, probably of *Stoliczkaia.* Very small, involute, and compressed; venter fastigiate on early whorls, rounding and flattening later; at first with strong, conical ventrolateral tubercles and flank ribs; later with primary ribs single or branching from umbilical bullae, with one or two intercalated secondaries; all ribs crossing rounded venter; ornament weakening at end of body chamber. *Upper Cretaceous (Lower Cenomanian):* Texas.

Paracalycoceras SPATH, 1925c, p. 197 [**Ammonites wiestii* SHARPE, 1857, p. 47; OD] [=*Cottreauites* COLLIGNON, 1929, p. 44 (type, *Acanthoceras (Prionotropis) subvicinale* BOULE, LEMOINE, & THEVENIN, 1907, p. 11(31); OD)]. Inner whorls involute and compressed; ribs sinuous; primaries prorsiradiate and branching at midflank or with short intercalatories; with inner and outer ventrolateral tubercles, the inner very weak, and with feeble siphonal tubercles or slight ridge. Outer whorls more evolute and inflated, with broad, distant primary and short intercalated ribs crossing venter without interruption in concave curve; ribs rursiradiate on outer part of sides. Suture with 5 lateral lobes. *Upper Cretaceous (Lower Cenomanian):* England, ?Poland, Algeria, Madagascar, Texas.——FIG. 114,*3a,b.* **P. wiestii* (SHARPE), England; ×0.75 (Sharpe, 1857).——FIG. 114,*3c,d. P. subvicinale* (BOULE, LEMOINE, & THEVENIN), Madagascar; *c,* ×1; *d,* ×4 (Boule, Lemoine, & Thevenin, 1907).

Zuluscaphites HOEPEN, 1955a, p. 360 [**Z. orycteropusi;* OD] [=*Huescarites* LATIL, 1990, p. 31 (type, *H. companyi;* OD)]. Rather small; whorl section inflated, increasing rapidly, then decreasing before last suture; with long and short ribs; with siphonal tubercles on at least part of shell. *Lower Cretaceous (Upper Albian):* France, Spain, South Africa (Zululand).

Family FLICKIIDAE Adkins, 1928

[*nom. correct.* WRIGHT, 1957b, p. 409, *pro* Flickidae ADKINS, 1928, p. 217]

Dwarf derivatives of Lyelliceratidae, Stoliczkaiinae, retaining ornament in one subfamily and losing it and tending to very simple, even goniatitic sutures in another. WRIGHT & KENNEDY, 1979; KENNEDY & WRIGHT, 1984. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Upper Cenomanian).*

Subfamily SALAZICERATINAE Kennedy & Wright, 1984

[Salaziceratinae KENNEDY & WRIGHT, 1984, p. 166]

Strong ornament retained; elements of mature suture not entire. *Lower Cretaceous*

(Upper Albian)–Upper Cretaceous (Lower Cenomanian).

Salaziceras BREISTROFFER, 1936, p. 64 [**Ammonites salazacensis* HÉBERT & MUNIER-CHALMAS, 1875, p. 114; OD] [=*Salazaciceras* BREISTROFFER, 1940, p. 127(57), *nom. van.; Noskytes* SCHOLZ, 1979, p. 97 (1978, p. 604, *nom. nud.*) (type, *S. (N.) bakonyense* SCHOLZ, 1979, p. 97; OD)]. Moderately involute, inflated, with deep umbilicus; weak to strong umbilical bullae giving rise to more or less straight, coarse, rounded ribs. Suture with simple but still slightly incised elements. Microconchs have ventrolateral tubercles on body chamber and aperture with rostrum and lateral lappets. SCHOLZ, 1979. *Lower Cretaceous (Upper Albian):* England, France, Hungary, Morocco, Nigeria.——FIG. 116,*2a–c.* **S. salazacense* (HÉBERT & MUNIER-CHALMAS), France; *a,b,* ×2; *c,* enlarged (Wright & Kennedy, 1979).

Neosaynoceras BREISTROFFER, 1947b, p. 92(76) [**Saynoceras gazellae* PERVINQUIÈRE, 1907, p. 115; OD]. Globular and involute, with sharp umbilical, ventrolateral, and siphonal tubercles connected in adult by sharp ribs; body chamber incompletely known, but early part with umbilical bulge as in some *Scaphites;* phragmocone an approximate homeomorph of *Saynoceras.* Derived from *Salaziceras* by extension of the tuberculation of some forms of that genus. KENNEDY & WRIGHT, 1984. *Upper Cretaceous (Lower Cenomanian):* Tunisia, Madagascar.——FIG. 116,*1a–d.* **N. gazellae* (PERVINQUIÈRE), Tunisia; *a–c,* ×2; *d,* ×4.25 (Kennedy & Wright, 1984).

Subfamily FLICKIINAE Adkins, 1928

[*nom. transl.* KENNEDY & WRIGHT, 1984, p. 166, *ex* Flickiidae ADKINS, 1928, p. 217]

Ornament tending to disappear and suture to simplify, becoming goniatitic in some. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian, ?Upper Cenomanian).*

Ficheuria PERVINQUIÈRE, 1910, p. 35 [**F. kiliani;* OD]. Very involute and globular, with umbilical shoulder tending to be angular. Suture with very feebly indented elements. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian):* Hungary, northern Africa, Japan.——FIG. 116,*3a–c.* **F. kiliani,* Upper Albian, Algeria; *a,b,* ×1; *c,* ×4 (Pervinquière, 1910).——FIG. 116,*3d. F. pernoni* DUBOURDIEU, Upper Albian, Algeria; ×4 (Dubourdieu, 1953).

Flickia PERVINQUIÈRE, 1907, p. 212 [**F. simplex;* OD]. Moderately evolute and rather compressed, with narrowly arched venter; surface smooth or with flexuous striae strengthening into ribs on body chamber. Suture with entire elements. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian):* northern Africa, Tanzania, South Africa (Zululand), Madagascar, Texas.——FIG. 116,*4a–c.* **F. simplex,* Upper Albian, Tunisia; *a,b,* ×2; *c,* ×4 (Pervinquière, 1910).

Adkinsia BÖSE, 1928, p. 232 [**A. adkinsi;* OD; =*Flickia? bosquensis* ADKINS, 1920, p. 87]. More involute and inflated than *Flickia* but less so than *Ficheuria;* with distinct umbilical tubercles and in some rather strong ribs on body chamber. Suture with entire elements. *Upper Cretaceous (Lower Cenomanian):* Texas.——FIG. 116,*5.* **A. bosquensis* (ADKINS); ×2 (Böse, 1928).

?Litophragmatoceras KENNEDY & COBBAN, 1988a, p. 537 [**L. incomptum;* OD]. Differs from *Flickia* in falcoid growth lines and body chamber with crowded, broad and narrow, flexuous, simple ribs separated by constriction-like interspaces. *Upper Cretaceous (Upper Cenomanian):* Arizona.——FIG. 116,*6a–c.* **L. incomptum; a,b,* ×2; *c,* ×5 (Kennedy & Cobban, 1988a; reprinted with the permission of Cambridge University Press).

Family FORBESICERATIDAE Wright, 1952

[*nom. transl.* WRIGHT, 1955, p. 573, *ex* Forbesiceratinae WRIGHT, 1952, p. 220]

Very involute, compressed, and high-whorled, with flat or slightly convex sides; venter narrow and fastigiate or flat or sulcate, with 0, 1, 2, or 3 keels; smooth or with fine ribs; midlateral tubercles rarely present; ventrolateral tubercles commonly present. Suture with long, narrow elements; saddles tending to be phylloid, lobes to be bifid; with adventive lobe in first lateral saddle foreshadowed in ancestral *Neophlycticeras. Lower Cretaceous (Upper Albian)–Upper Cretaceous (Cenomanian).*

Paradolphia CASEY, 1965, p. 461 [**P. prisca;* OD]. Very involute, compressed, and flat-sided, with fastigiate venter and faintly nodate keel. Shoulders showing faint, prorsiradiate ribs. Suture with long, subphylloid saddles, narrow lobes, bifid first lateral lobe, and oblique, incipient adventive lobe in external saddle. *Lower Cretaceous (Upper Albian):* England, France.——FIG. 116,*8a–c.* **P. prisca; a,b,* ×1; *c,* ×3.5 (Casey, 1965).

Forbesiceras KOSSMAT, 1897, p. 18(125), *nom. nov. pro Discoceras* KOSSMAT, 1895, p. 179(83), *non* BARRANDE, 1867, p. 177 [**Ammonites largilliertianus* ORBIGNY, 1841, p. 320; SD DIENER, 1925, p. 180] [=*Cenomanites* HAUG, 1898, p. 78, obj.; *Neopulchellia* COLLIGNON, 1929, p. 29 (type, *Pulchellia (Neopulchellia) gignouxi* COLLIGNON, 1929, p. 30; SD WRIGHT, herein)]. More discoidal than *Paradolphia;* ribs generally present and rectiradiate, sigmoid, or falcate, forming slight nodes on shoulders and normally crossing venter

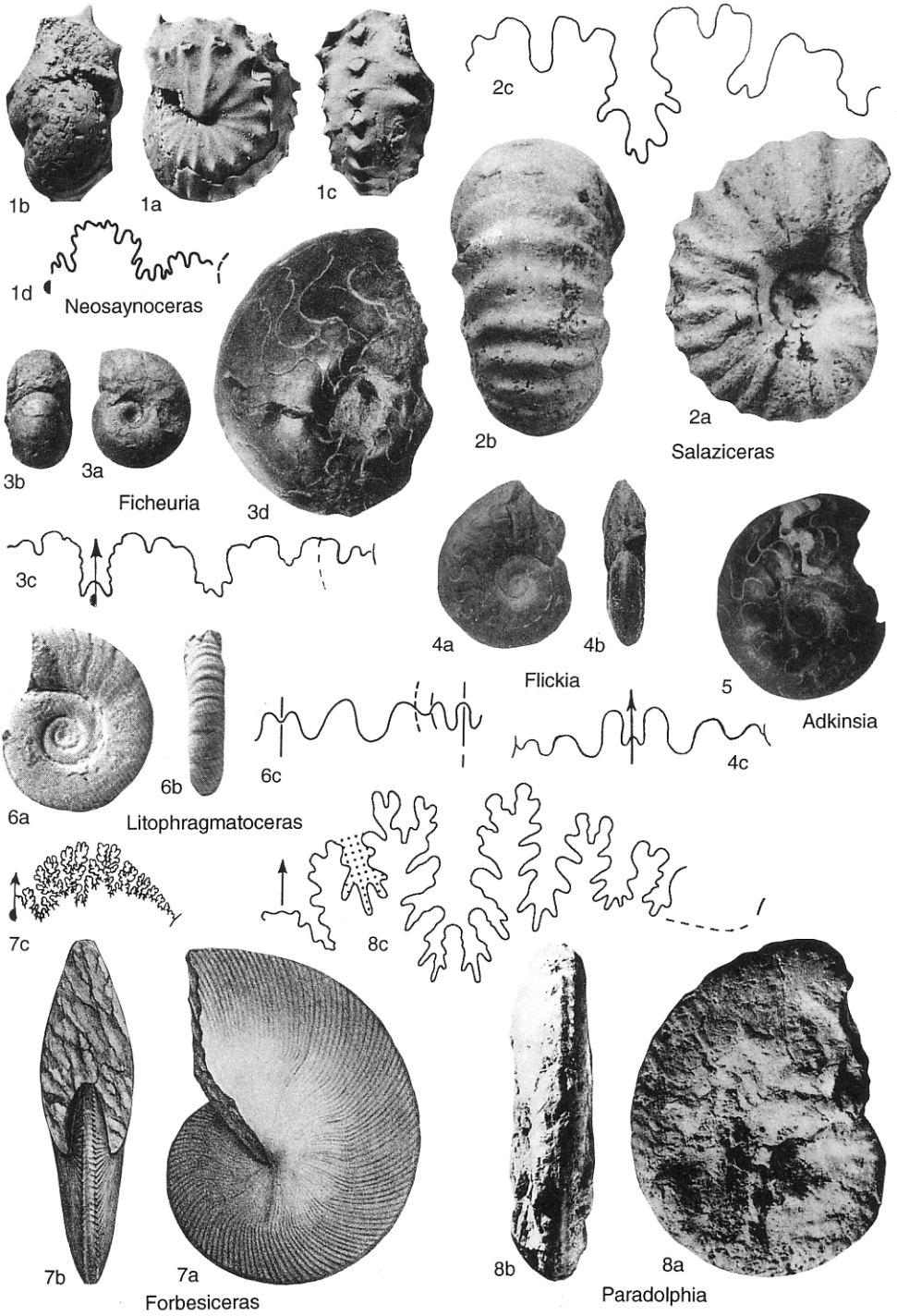


FIG. 116. Flickiidae (p. 152–154)

transversely; midlateral tubercles may be present. Suture markedly phylloid; adventive lobe as large as second lateral. *Upper Cretaceous (Lower Cenomanian–Upper Cenomanian):* Europe, Africa, Madagascar, southern India, Texas.——FIG. 116,*7a–c.* **F. largilliertianum* (ORBIGNY), southern India; ×0.5 (Kossmat, 1895–1898).

Family ACANTHOCERATIDAE Grossouvre, 1894

[*nom. correct.* HYATT, 1900, p. 585, *pro* Acanthoceratidés GROSSOUVRE, 1894, p. 22 (H. DOUVILLÉ is quoted by some as author, but the work in which the name appeared was not published)]

Strong tuberculation, at least umbilical and ventrolateral, in most genera; in some, however, ribs dominant, while in others, ornament may be weak or absent on outer whorls. Most genera evolute. Whorl section ranging from compressed to very depressed. Dimorphic in size only, with no apertural modification in microconchs. Suture with few special characteristics or variations, though in some later genera sutural detail tending to simplify as in successor families. *Upper Cretaceous (Lower Cenomanian–Coniacian).*

The family represents a burst of radiation during the Cenomanian from the rather limited Lyelliceratidae.

Subfamily MANTELLICERATINAE Hyatt, 1903

[*nom. transl.* WRIGHT & WRIGHT, 1951, p. 24, *ex* Mantelliceratidae HYATT, 1903, p. 105; ICZN Opinion 557, 1959, Family-Group Name No. 267] [=Utauriceratinae MATSUMOTO in MATSUMOTO, MURAMOTO, & TAKAHASHI, 1969, p. 291]

Involute to rather evolute; round-whorled or compressed, rarely depressed; generally having prominent ribs with at least outer ventrolateral tubercles. *Upper Cretaceous (Lower Cenomanian).*

Mantelliceras seems to have been derived paedomorphically from bituberculate-ventered species of *Stoliczkaia,* but exact order of appearance of genera and relationships are obscure because of worldwide lack of known ammonite deposits at the Albian-Cenomanian boundary.

Mantelliceras HYATT, 1903, p. 113, ICZN Opinion 557, 1959, Generic Name No. 1353 [**Ammonites mantelli* J. SOWERBY, 1814a, p. 119; OD; ICZN Specific Name No. 1634] [=*Couloniceras* BUSNARDO, 1966a, p. 223 (type, *Ammonites couloni* ORBIGNY, 1850a, p. 147; OD); *Promantelliceras* THOMEL, 1972, p. 31 (type, *Mantelliceras picteti* HYATT, 1903, p. 114; OD); *Neomantelliceras* THOMEL, 1972, p. 42 (type, *Ammonites mantelli tuberculata* MANTELL, 1822, p. 114; OD); *Bunburyiceras* THOMEL, 1972, p. 46 (type, *Mantelliceras cantianum* SPATH, 1926a, p. 82; OD)]. Involute to rather evolute; compressed to inflated; ribs irregularly branching or long and short, straight to slightly sinuous, high and narrow to subdued; ribs may broaden toward ventrolateral shoulder; normally having distinct umbilical and outer ventrolateral tubercles, commonly also a midlateral row at least on inner whorls, and also, in some specimens, inner ventrolateral tubercles; in multituberculate forms the umbilical tubercle generally less prominent than midlateral tubercle. Ribs tending to broaden and tubercles to weaken on body chamber, where umbilical seam egresses markedly. Strongly dimorphic, with macroconchs up to twice the diameter of microconchs. Suture rather deeply incised, with rectangular external saddle, long and variably trifid L, and up to 4 umbilical lobes in external suture, commonly retracted. WRIGHT & KENNEDY, 1984. *Upper Cretaceous (Lower Cenomanian):* Europe, northern and eastern Africa, Madagascar, southern India, Texas, Brazil.——FIG. 117,*4a–c.* **M. mantelli* (J. SOWERBY), England; ×1 (Sharpe, 1853–1857).

Utauriceras WRIGHT, 1956b, p. 392 [**Ammonites vicinale* STOLICZKA, 1864, p. 84; OD]. Inner whorls differing from compressed *Mantelliceras* only in greater involution, more flexuous ribs, and 1 or more additional auxiliary lobes in the suture. Body chambers unknown; the genus may be closely related to *Graysonites.* CASEY, 1960b; KENNEDY & HANCOCK, 1971. *Upper Cretaceous (Lower Cenomanian):* Madagascar, southern India.——FIG. 117,*1a–c.* **U. vicinale* (STOLICZKA), southern India; *a,b,* ×0.5; *c,* ×1 (Matsumoto & Sarkar, 1966).

Graysonites K. YOUNG, 1958, p. 171 [**G. lozoi;* OD]. Inner whorls as in compressed *Mantelliceras;* outer with coarse, distant ribs, large umbilicolateral bullae, and strong to extreme ventrolateral horns. External saddle asymmetrical, with outer element narrow; several retracted auxiliaries. *Upper Cretaceous (Lower Cenomanian):* Spain, Japan, California, Texas, Brazil.——FIG. 118*a–f.* **G. lozoi,* Texas; *a,b,* ×0.3; *c,d,* ×1; *e,* ×0.5; *f,* ×0.75 (K. Young, 1958).

Sharpeiceras HYATT, 1903, p. 111 [**Ammonites laticlavius* SHARPE, 1855, p. 31; OD] [=*Tlahualiloceras* KELLUM & MINTZ, 1962, p. 275 (type, *T. tlahualiloense;* OD)]. Evolute; whorl section compressed-oval to quadrate; ribs fine to coarse, typically but not invariably single, with umbilical, lateral, and inner and outer ventrolateral tubercles on every rib and rarely an additional outer lateral tubercle; venter slightly concave or flat, with feeble siphonal ridge in some specimens; adult body chamber quadrate, with large ventrolateral tubercles or (?secondarily deformed) smooth and fastigiate.

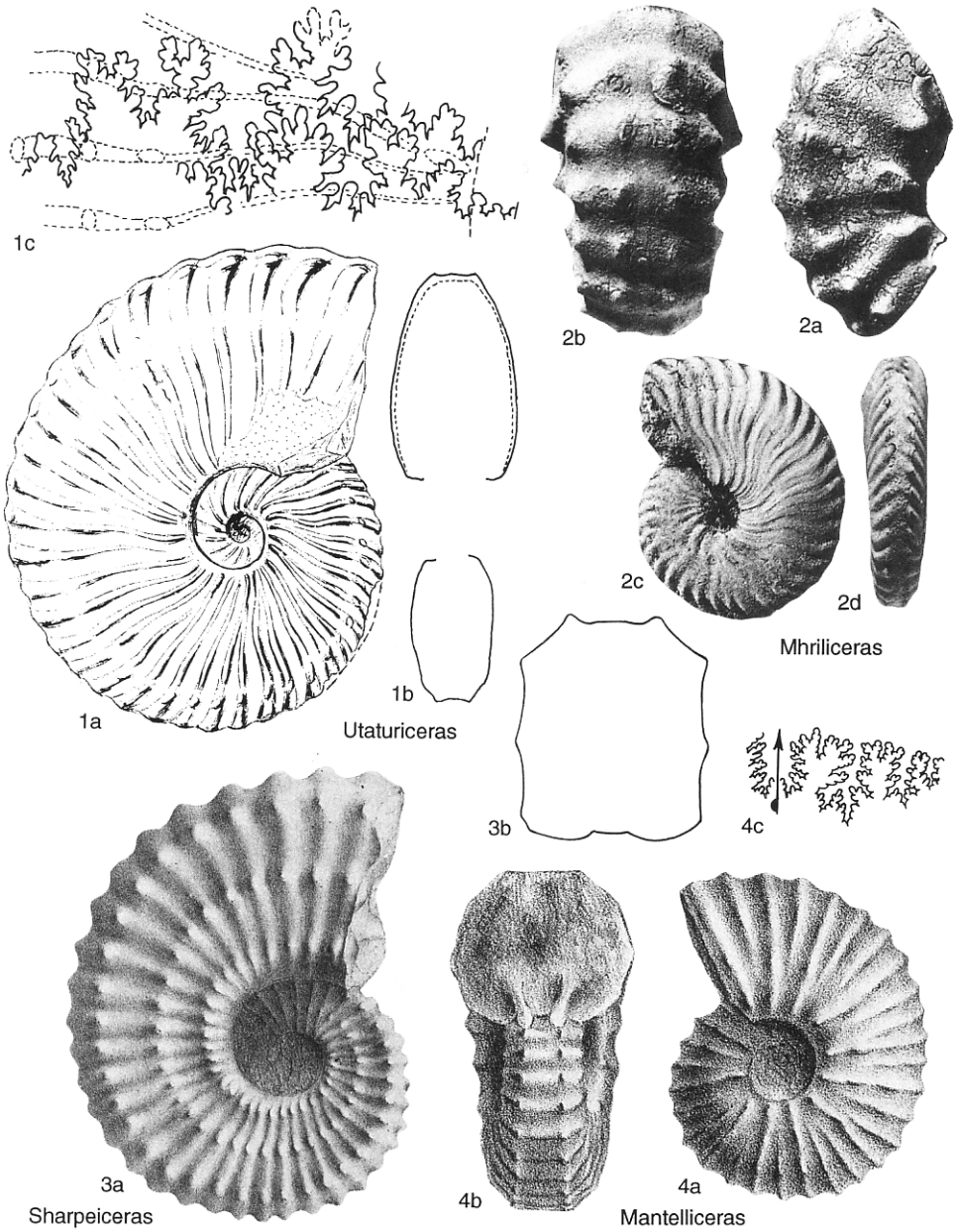


FIG. 117. Acanthoceratidae (p. 154–156)

Suture with long, narrow, more or less symmetrically bifid L. *Upper Cretaceous (Lower Cenomanian):* western Europe, Poland, northern and eastern Africa, Madagascar, Syria, Iran, southern India, Japan, Texas, Venezuela.——FIG. 117,*3a,b.* **S. laticlavium* (SHARPE), England; ×0.5 (Sharpe, 1855).

Mhriliceras KENNEDY & WRIGHT, 1985, p. 514 [**Mammites lapparenti* PERVINQUIÈRE, 1907, p. 312; OD]. Compressed and involute to inflated and evolute; the former having dense, flexuous ribs with evanescent inner and persistent outer ventrolateral tubercles; the latter having strong umbilical bullae giving rise to pairs of coarse ribs with strong, conical inner and clavate outer ventrolateral tubercles. Approximate homeomorphs of Upper Cenomanian *Metoicoceras* and Lower Turonian *Mammites. Upper*

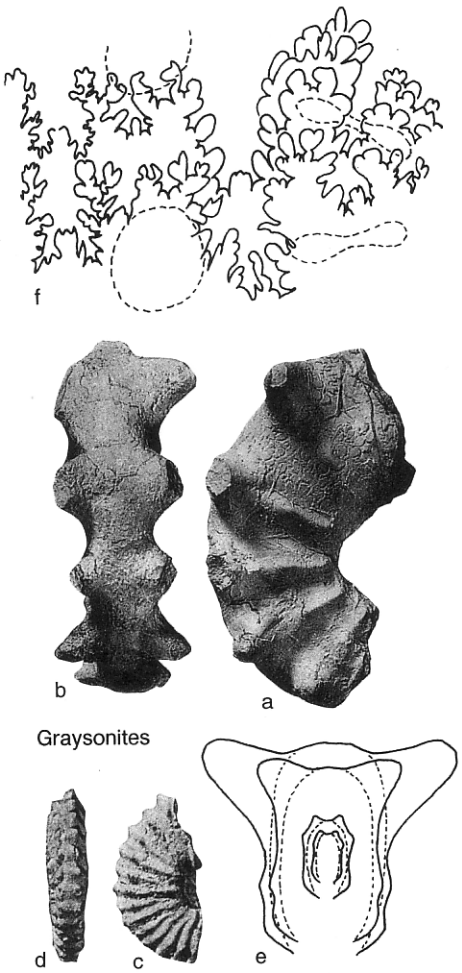


FIG. 118. Acanthoceratidae (p. 154)

Cretaceous (Lower Cenomanian): England, France, Israel, Tunisia, Nigeria, Madagascar.——FIG. 117,*2a–d.* **M. lapparenti* (PERVINQUIÈRE); *a,b,* Tunisia, ×1; *c,d,* Madagascar, ×1 (Kennedy & Wright, 1985).

Subfamily ACANTHOCERATINAE Grossouvre, 1894

[*nom. transl.* WRIGHT & WRIGHT, 1951, p. 28, *ex* Acanthoceratidae, HYATT, 1900, p. 585, *nom. correct. pro* Acanthoceratidés GROSSOUVRE, 1894, p. 22]

Some with tubercles dominant, others with ribs dominant, but all with siphonal tubercles at some stage. *Upper Cretaceous (Lower Cenomanian–Middle Turonian).*

Acanthoceras appears to have been derived from *Acompsoceras* at the beginning of the Middle Cenomanian, but its exact relationship with *Calycoceras,* which appeared at the same time, is obscure.

Acompsoceras HYATT, 1903, p. 111 [**Ammonites bochumensis* SCHLÜTER, 1871, p. 1; OD; =*Ammonites renevieri* SHARPE, 1857, p. 44] [=*Pseudacompsoceras* SPATH, 1925c, p. 197 (type, *P. vectense;* OD)]. Moderately evolute to involute; more or less compressed; inner whorls with moderate to strong ribs typically branching or long and short, strong umbilical bullae, inner and outer ventrolateral and commonly feeble siphonal tubercles, or faintly nodate ridge; lateral tubercles appearing in middle growth in some individuals; umbilical and clavate outer ventrolateral tubercles persisting, with tabulate or slightly raised venter, but other tubercles weakening; body chamber smooth. Suture with deeply divided external saddle and well-rounded folioles that at maturity may be phylloid. *Upper Cretaceous (Lower Cenomanian):* western Europe, northern Africa, Madagascar, Syria, USA, Brazil.——FIG. 119,*4a–c.* **A. renevieri* (SHARPE), Germany; *a,b,* ×0.375; *c,* ×0.5 (Schlüter, 1871–1876).——FIG. 119,*4d. A. sarthacense* (GUÉRANGER), England; ×1 (Sharpe, 1857).

Acanthoceras NEUMAYR, 1875b, p. 929 [**Ammonites rhotomagensis* BRONGNIART in CUVIER & BRONGNIART, 1822, p. 83; SD GROSSOUVRE, 1894, p. 27] [=*Metacanthoplites* HYATT, 1900, p. 589, obj.; *Alternacanthoceras* MARCINOWSKI, 1979, p. 61 (type, *Protacanthoceras jukesbrownei* SPATH, 1926a, p. 82; OD)]. Early whorls with round to square whorl section and with umbilical, inner and outer (generally clavate) ventrolateral, and siphonal tubercles; distinct ribs, if present, branching or long and short. Later whorls with ribs, single and uniform or long and short, sometimes weakening; umbilical tubercles may enlarge and move up side, ventrolaterals may fuse to form large horn, while siphonals may disappear, leaving broad, flat venter. [*Alternacanthoceras* for species with long and short ribs persisting to late stage seems unnecessary.] *Upper Cretaceous (Lower Cenomanian–Upper Cenomanian):* Europe, Africa, Iran, southern India, Japan, northern Australia, USA, Peru.——FIG. 119,*3a–c.* **A. rhotomagense* (BRONGNIART in CUVIER & BRONGNIART), Lower Cenomanian, France; *a,b,* lectotype, ×1; *c,* topotype, ×1 (Kennedy & Hancock, 1970).

Cunningtoniceras COLLIGNON, 1937a, p. 40 [**Ammonites cunningtoni* SHARPE, 1855, p. 35; OD] [=?*Guerangericeras* THOMEL, 1972, p. 119 (type, *Ammonites confusus* GUÉRANGER, 1867, p. 5; OD)]. Derivatives of *Acanthoceras* with multituberculate venter caused by secondary ribs branching from inner ventrolateral tubercles or intercalated and bearing outer ventrolateral and siphonal tubercles; inner ventrolateral tubercles tending to move outward to level of venter and to form large, laterally directed horns. Although an approximate homeomorph of *Euomphaloceras, Cunningtoniceras* retains general build of *Acanthoceras,* as well as suture with square external saddle. *Upper Cretaceous*

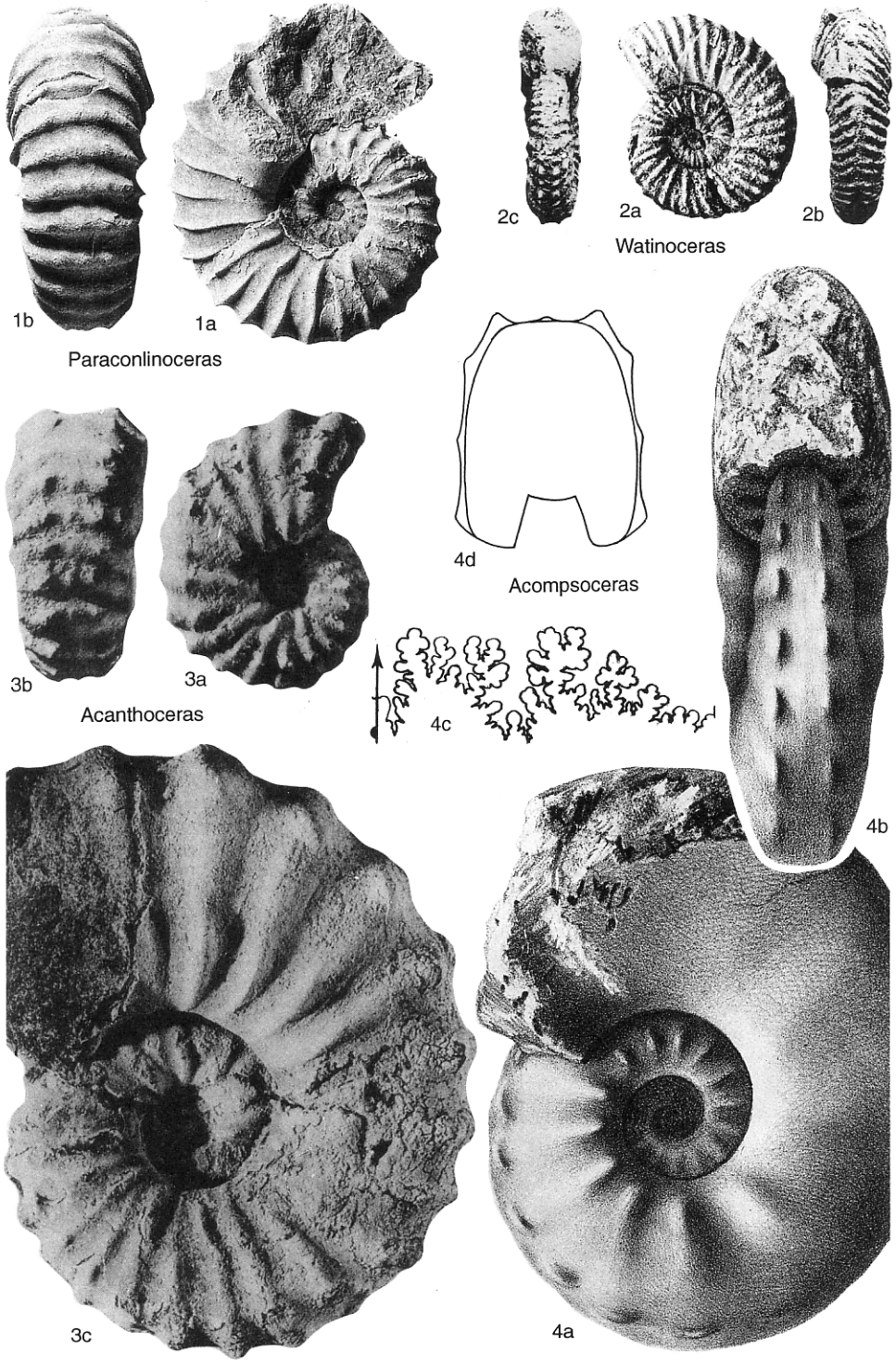


FIG. 119. Acanthoceratidae (p. 156–162)

(Middle Cenomanian, ?Upper Cenomanian): Europe, northern Africa, South Africa (Zululand), Madagascar, southern India, Bathurst Island, Japan.——FIG. 120,*5a,b.* **C. cunningtoni* (SHARPE), Middle Cenomanian, England, holotype; ×0.5 (Kennedy, 1971).

Protacanthoceras SPATH, 1923b, p. 144 [**Ammonites bunburianus* SHARPE, 1853, p. 25; OD]. Dwarf with macroconchs and microconchs differing primarily in size; rather involute to evolute; compressed to inflated; with more or less prominent umbilical and inner ventrolateral tubercles; outer ventrolateral and siphonal tubercles tending to form 3 close rows of clavi on broad or narrow venter, clavi generally uniting on outer part of body chamber to form chevronlike ribs. Suture with plump, round, only moderately indented elements. WRIGHT & KENNEDY, 1980. *Upper Cretaceous (Lower Cenomanian–Upper Cenomanian):* England, France, Madagascar, USA (Western Interior).——FIG. 121,*2a,b.* **P. bunburianum* (SHARPE), Upper Cenomanian, England; ×1 (Jukes-Browne & Hill, 1896).

Conlinoceras COBBAN & SCOTT, 1972, p. 60 [**Calycoceras (Conlinoceras) gilberti* COBBAN & SCOTT, 1972, p. 60; OD]. Early whorls with weak ornament similar to that of *Acanthoceras;* mature whorls circular to compressed in section, with distant, high ribs crossing venter and almost no umbilical tubercles. *Upper Cretaceous (Middle Cenomanian):* USA (Gulf Coast, Western Interior).——FIG. 122,*3a,b.* **C. gilberti* (COBBAN & SCOTT), Colorado; ×0.75 (Cobban & Scott, 1972).

Paraconlinoceras KENNEDY & COBBAN, 1990a, p. 114 [**Eucalycoceras leonense* ADKINS, 1928, p. 240; OD]. Dwarf derivative of *Conlinoceras* with inner whorls like *Acanthoceras,* but outer like *Calycoceras (Gentoniceras),* from which it differs in the clavate ventrolateral tubercles of inner whorls. *Upper Cretaceous (Middle Cenomanian):* USA (Gulf Coast, Western Interior).——FIG. 119,*1a,b.* **P. leonense* (ADKINS), Wyoming; ×1 (Kennedy & Cobban, 1990a).

Dunveganoceras WARREN & STELCK, 1940, p. 149 [**Acanthoceras albertense* WARREN, 1930a, p. 21; OD]. Medium-sized to large; early whorls with umbilical bullae, conical inner and clavate outer ventrolateral tubercles; siphonal tubercles present at first but disappearing early, leaving venter flat or concave; ventral tubercles steeper in front than behind; outer whorls with dominant, rounded ribs and rounded, flat, or fastigiate venter, with or without ventrolateral horns or bulges. *Upper Cretaceous (Middle Cenomanian–Upper Cenomanian):* Canada, USA (Gulf Coast, Western Interior), Brazil.

D. (Plesiacanthoceras) HAAS, 1964, p. 610, *nom. nov. pro Paracanthoceras* HAAS, 1963, p. 2, *non* FURON, 1935, p. 59 [**Metoicoceras wyomingense* REAGAN, 1924, p. 181; OD]. Differs from *Acanthoceras* only in early loss of siphonal tubercles, asymmetry of tubercles in side view, and exaggerated ventrolateral horns on last whorl. *Upper Cretaceous (Middle Cenomanian):* USA (Gulf Coast, Western Interior).——FIG. 121,*3a,b.* **D. (P.) wyomingense* (REAGAN), Montana; ×0.5 (Cobban, 1987b).

D. (Dunveganoceras). Outer whorl without exaggerated ventrolateral horns. *Upper Cretaceous (Upper Cenomanian):* Canada, USA (Western Interior), Brazil.——FIG. 121,*6a–c. D. (D.) albertense montanense,* Montana; *a,b,* ×1; *c,* ×0.25 (Cobban, 1952b).

Plesiacanthoceratoides KENNEDY & COBBAN, 1990a, p. 136 [**Protacanthoceras vetula* COBBAN, 1987b, p. 21; OD]. Progenetic dwarf derivative of *Plesiacanthoceras;* homeomorph of *Protacanthoceras.* Constrictions present or not. *Upper Cretaceous (Middle Cenomanian–Upper Cenomanian):* Wyoming, Montana, Texas.

Paracompsoceras COBBAN, 1971, p. 10 [**P. landisi;* OD]. Inner whorls with strong tubercles as in *Acanthoceras;* outer whorls smooth and moderately compressed, with slightly flattened sides and venter. *Upper Cretaceous (Upper Cenomanian):* New Mexico.——FIG. 120,*1a–c.* **P. landisi;* ×1 (Cobban, 1971).

Kennediella COOPER, 1979, p. 124 [**Pseudotissotia inopinata* KENNEDY & BAYLISS, 1977, p. 902; OD]. Evolute, with rounded-quadrate whorl section and broad, flat venter with 3 continuous, low, rounded keels; slight umbilical bulges but no ribs. Based on single fragment. Close homeomorph of *Pseudotissotia* but probably descended from smooth form of *Acanthoceras. Upper Cretaceous (Upper Cenomanian):* England.——FIG. 120,*4a,b.* **K. inopinata* (KENNEDY & BAYLISS); ×1 (Kennedy & Bayliss, 1977).

Tarrantoceras STEPHENSON, 1955, p. 59 [**T. rotatile;* OD; =*Mantelliceras sellardsi* ADKINS, 1928, p. 239]. Small, compressed, and evolute; with ribs close to distant, rectiradiate, straight or slightly sinuous, branching from umbilical tubercles or long and short, and transverse across arched or flat venter; early whorls with umbilical bullae, inner and close outer ventrolateral tubercles, and slight siphonal tubercles. Suture with short, broad, and rather simple saddles, the second lateral commonly projecting beyond the rest. *Upper Cretaceous (Upper Cenomanian):* England, France, Turkestan, southern India, Japan, Texas, Colorado, ?Colombia, ?Venezuela.

T. (Tarrantoceras). Tubercles persisting up to body chamber, on which inner ventrolateral and, later, outer ventrolateral tubercles may disappear. Occurrence as for genus: Texas, Colorado, ?Colombia, ?Venezuela.——FIG. 122,*1a–c.* **T. (T.) sellardsi* (ADKINS), Texas; ×1 (Stephenson, 1955).

T. (Sumitomoceras) MATSUMOTO in MATSUMOTO, MURAMOTO, & TAKAHASHI, 1969, p. 280 [**S. faustum;* OD]. Siphonal tubercles disappearing early, then ventrolaterals; on body chamber ribs crossing arched venter without weakening; interspaces between some long ribs are deeper than the rest, forming shallow constrictions. Occurrence as for genus: England, France, Turkestan, southern India, Japan, Texas.——FIG. 122,*4a–c.* **T. (S.) faustum* MATSUMOTO in MATSUMOTO, MURAMOTO, & TAKAHASHI, Japan; ×1 (Matsumoto, Muramoto, & Takahashi, 1969).

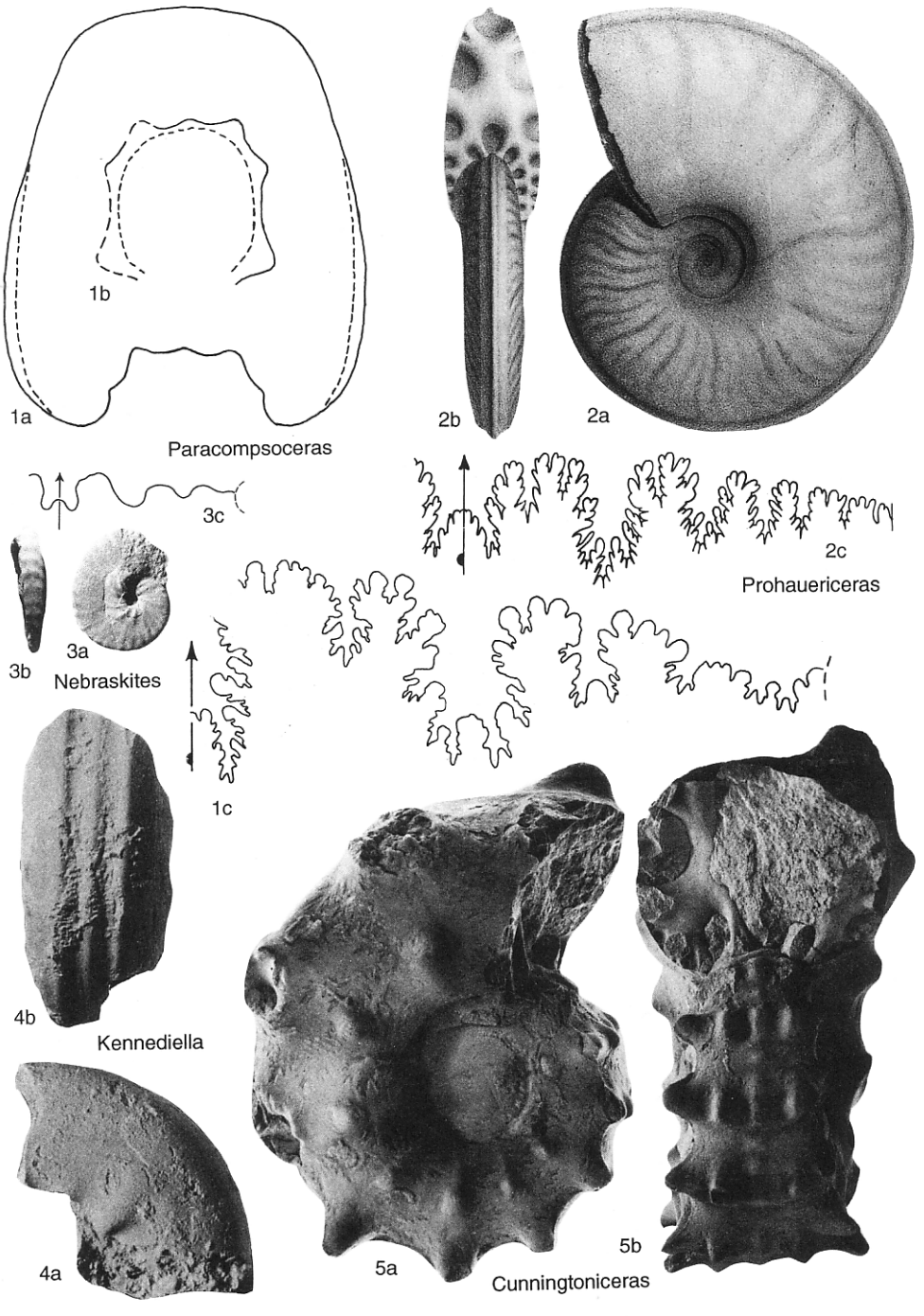


FIG. 120. Acanthoceratidae (p. 156–162)

Kastanoceras KENNEDY & COBBAN, 1990b, p. 394 [**K. spinigerum;* OD]. Minute, progenetic dwarf derivative of *Tarrantoceras*. Coronate, with feeble ribs, large inner ventrolateral spines, and feeble outer ventrolateral and siphonal clavi. *Upper Cretaceous (Middle Cenomanian):* Montana.——FIG. 121,*5a,b*. **K. spinigerum;* ×2 (Kennedy & Cobban, 1990b).

Microsulcatoceras KENNEDY & COBBAN, 1990b, p. 400

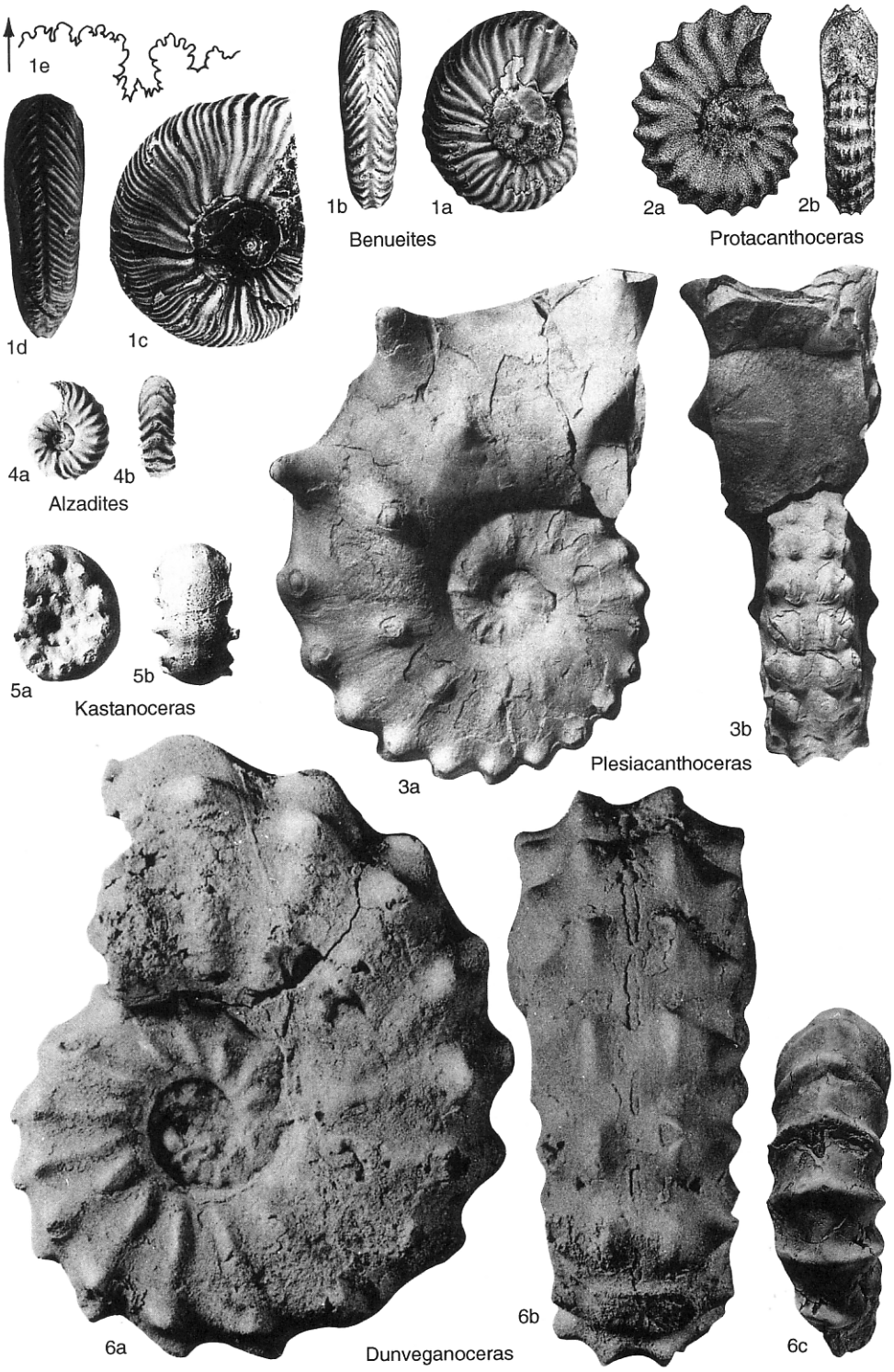


FIG. 121. Acanthoceratidae (p. 158–162)

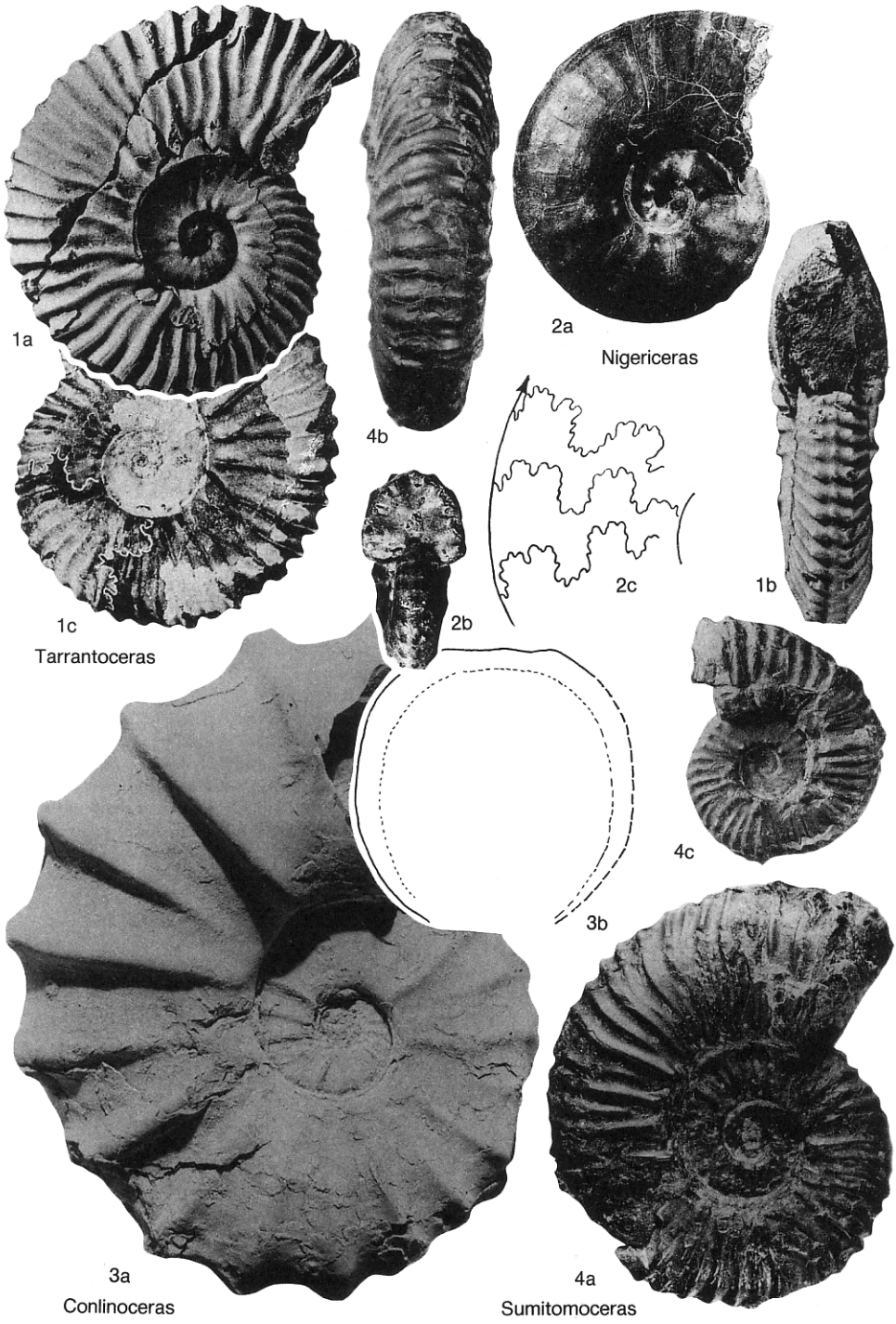


FIG. 122. Acanthoceratidae (p. 158–167)

[**M. puzosiiforme;* OD]. Progenetic dwarf derivative, probably of *Tarrantoceras (Sumitomoceras)*. Involute, with flexuous constrictions, umbilical and inner ventrolateral tubercles, and ribs crossing venter uninterrupted. *Upper Cretaceous (Upper Cenomanian):* Montana, Texas, ?New Mexico.

Alzadites KENNEDY & COBBAN, 1990b, p. 396 [**A. alzadensis;* OD]. Small, with or without constrictions, and with minute umbilical bullae, prorsiradiate ribs, and inner and outer ventrolateral and siphonal tubercles. Progenetic dwarf derivative of some genus of Acanthoceratinae, resembling *Protacanthoceras. Upper Cretaceous (Middle Cenomanian–Upper Cenomanian):* Utah, Wyoming, Montana.——FIG. 121,*4a,b. A. westonensis* KENNEDY & COBBAN, Upper Cenomanian, Wyoming; ×1 (Kennedy & Cobban, 1990b).

Thomelites WRIGHT & KENNEDY in JUIGNET, KENNEDY, & WRIGHT, 1973, p. 231 [**Jeanrogericeras sornayi* THOMEL in PORTHAULT, THOMEL, & VILLOUTREYS, 1967, p. 431; OD]. Evolute, inflated to compressed, with sides parallel as far as inner ventrolateral tubercle, then converging to narrow venter. Ribs weak to strong, branching in twos or threes from umbilical tubercles or intercalated; inner ventrolateral tubercle on inner whorls at least, at which ribs may branch; all ribs with outer ventrolateral clavi; siphonal tubercle on inner whorls at least. Suture with external saddle deeply divided; folioles phylloid or simple and rounded. *Upper Cretaceous (Upper Cenomanian–Lower Turonian):* England, France, Israel, ?southern India, Texas, South Dakota, Brazil.——FIG. 123,*1a,b. *T. sornayi* (THOMEL), England; ×0.75 (Juignet, Kennedy, & Wright, 1973).

Neocardioceras SPATH, 1926a, p. 81 [**Ammonites juddii* BARROIS & GUERNE, 1878, p. 46; OD]. Small, evolute, and compressed to round in section; with fine, rather high, flexuous ribs, long and short or branching from small umbilical bullae; each rib may bear fine inner and outer ventrolateral tubercles; one row of close, round siphonal tubercles tending to form nodate keel; tubercles may disappear on outer whorls, leaving fine, sharp ribs. Probably derived from late *Thomelites. Upper Cretaceous (Upper Cenomanian–Lower Turonian):* England, France, Spain, Montana, ?Brazil.——FIG. 123,*3a–f. *N. juddii* (BARROIS & GUERNE), Upper Cenomanian, England; *a–d, N. j. juddii,* ×1 (Wright & Kennedy, 1981); *e,f, N. j. barroisi* (WRIGHT & KENNEDY), ×1 (Wright & Kennedy, 1981).

Watinoceras WARREN, 1930b, p. 66 [**W. reesidei;* OD; =*Acanthoceras amudariense* ARKHANGELSKY, 1916, p. 48] [=*Arkhangelskiceras* IL'IN, 1957, p. 425, obj.]. Small to medium-sized; early whorls compressed, with inner and outer ventrolateral tubercles on fine ribs and flat or weakly rounded venter; in later whorls venter may become concave between rows of ventrolateral clavi or rounded with ribs crossing in chevrons; ornament may coarsen with age. *Upper Cretaceous (Lower Turonian):* England, Morocco, Nigeria, Turkestan, Alberta, USA, Venezuela.——FIG. 119,*2a–c. *W. amudariense* (ARKHANGELSKY), Turkestan; *a,b,* one specimen, ×1; *c,* another, ×1 (Arkhangelsky, 1916).

Nebraskites KENNEDY & COBBAN, 1988b, p. 582 [**N. haresiceratiforme;* OD]. Progenetic dwarf offshoot, perhaps of *Watinoceras*. Very involute and flat-sided, with narrow, tabulate venter; feeble umbilical bullae giving rise to pairs of ribs with incipient inner and clavate outer ventrolateral tubercles joined across venter by a low rib; ribs single on body chamber, strengthening near aperture. *Upper Cretaceous (Middle Turonian):* Nebraska.——FIG. 120,*3a–c. *N. haresiceratiforme; a,b,* ×1; *c,* ×5 (Kennedy & Cobban, 1988b).

Benueites REYMENT, 1954a, p. 153 [**B. benueensis;* OD]. Small, rather evolute, and compressed; with flat sides, sloping shoulders, and narrow venter commonly with deep, narrow sulcus on early whorls and later with shallow sulcus, slightly concave or flat. Apparently dimorphic; one form with fine, sigmoid ribs, and only slight umbilical and outer ventrolateral tubercles; the other with coarse ribs and generally with umbilical and inner and outer ventrolateral tubercles. *Upper Cretaceous (Lower Turonian):* France, Morocco, Cameroon, Nigeria, Trinidad, Venezuela, Colombia, northeastern Brazil.——FIG. 121,*1a–c. *B. benueensis; a,b,* Trinidad; ×2 (Reyment, 1971); *c,* Nigeria; ×2 (Reyment, 1954a).——FIG. 121,*1d,e. B. spinosus* (REYMENT), Trinidad; ×2 (Reyment, 1971).

Quitmaniceras POWELL, 1963, p. 313 [**Q. reaseri;* OD]. Rather evolute, compressed; generally with keel entire or serrate in young and on later whorls narrowly rounded, fastigiate, or narrowly tabulate; ribbing irregular, generally falcoid, and single, indistinctly branched, or intercalated; main ribs may have an umbilical bulla, a blunt or sharp inner ventrolateral bulla, and a small outer ventrolateral clavus. Suture with rather shallow, oblique elements. Probably derived from compressed *Protacanthoceras. Upper Cretaceous (Lower Turonian):* Texas, Mexico.——FIG. 123,*4a–c. *Q. reaseri,* Mexico; ×1 (Powell, 1963).

?Prohauericeras NOWAK, 1913, p. 370 [**Ammonites goupilianus* ORBIGNY, 1841, p. 317; SD DIENER, 1925, p. 140]. Moderately involute, compressed; sides flat to slightly convex; venter rounded-fastigiate, developing a distinct, rounded keel; with rather feeble, flexuous, long and short ribs. Suture with 6 external lobes. Inner whorls perhaps belonging to this genus show traces of ventrolateral tubercles and may indicate an origin in *Quitmaniceras. Upper Cretaceous (Middle Turonian):* France.——FIG. 120,*2a–c. *P. goupilianum* (ORBIGNY); *a,b,* ×0.75; *c,* enlarged (Orbigny, 1841).

Calycoceras HYATT, 1900, p. 589, ICZN Opinion 557, 1959, Generic Name No. 1352 [**Ammonites navicularis* MANTELL, 1822, p. 198; ICZN Specific Name No. 1633] [=*Metacalycoceras* SPATH, 1926a, p. 83, ICZN Rejected Name No. 1265, obj.]. Rather evolute, with whorl section depressed and subcircular, oval, polygonal, or subquadrate; ribs strong, generally straight, continuous over rounded or flat but not concave venter; on early whorls at

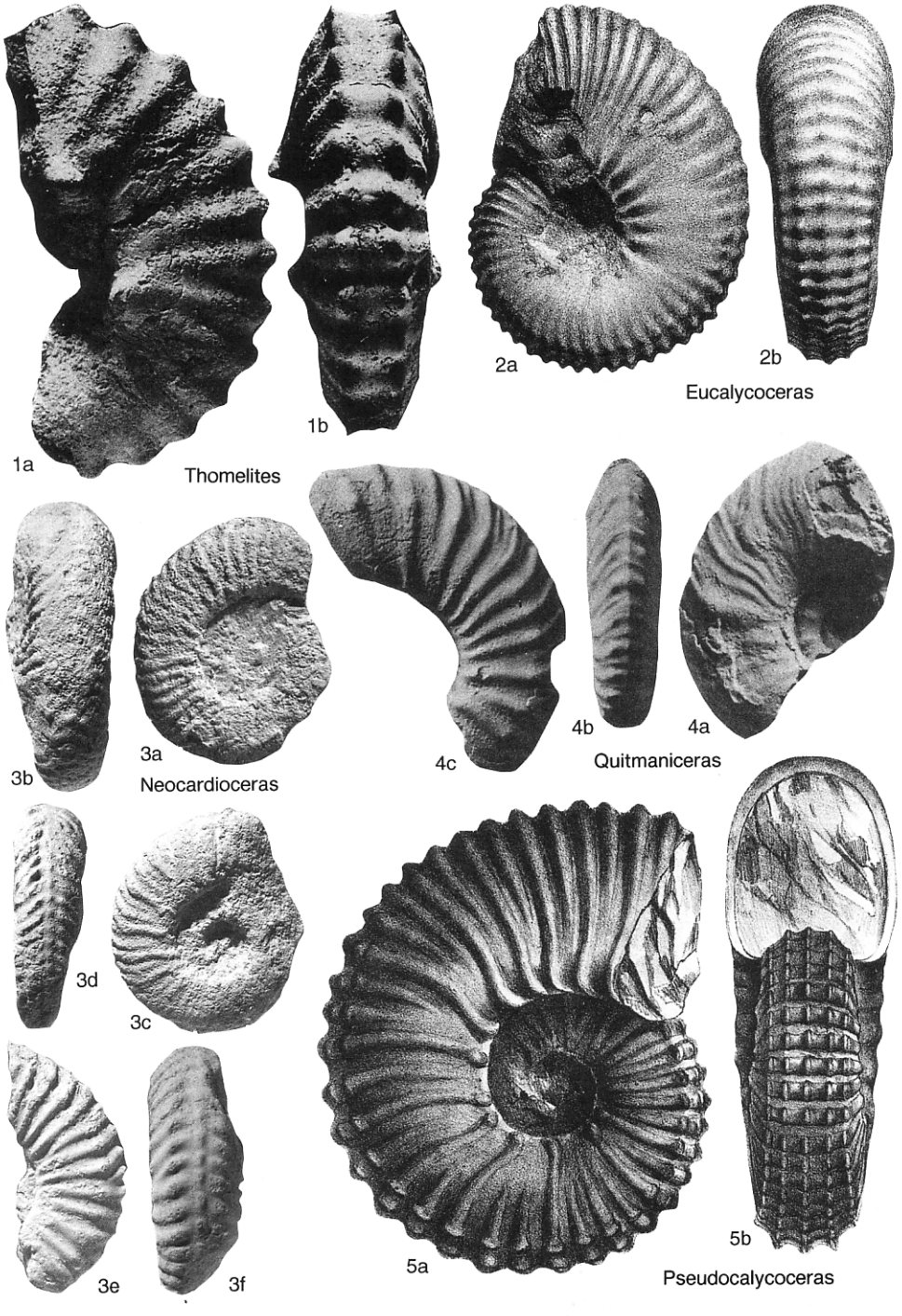


FIG. 123. Acanthoceratidae (p. 162–167)

least umbilical, ventrolateral, siphonal, and, in most specimens, midlateral tubercles; in multituberculate forms umbilical tubercle more prominent than midlateral; tubercles may disappear with age and may or may not be rejuvenated on last part of shell. Marked dimorphism in size apparently general. Contrary to the situation in *Mantelliceras,* a number of subgenera are here accepted because there are significant morphological and, to some extent, time gaps between species groups. *Upper Cretaceous (Cenomanian):* Europe, Africa, Madagascar, Syria, Iran, southern India, Papua New Guinea, Japan, USA, Argentina.

C. (**Gentoniceras**) THOMEL, 1972, p. 65 [**Ammonites gentoni* BRONGNIART in CUVIER & BRONGNIART, 1822, p. 183; OD] [=*Subeucalyceras* THOMEL, 1972, p. 113 (1969, p. 650, *nom. van.*) (type, *Acanthoceras baylei* PERVINQUIÈRE, 1907, p. 81; OD; =*Acanthoceras sarthacense* BAYLE, 1878, pl. 72, fig. 1–2)]. Small, evolute, with strongly tuberculate inner whorls; siphonal tubercles normally disappearing early, then ventrolaterals; umbilical tubercles may persist; body chamber with strong, well-spaced ribs; ribs single, or branching at umbilical tubercles or edge, or long and short, and uninterrupted on evenly rounded venter. Strongly dimorphic; macroconchs commonly twice the size of microconchs. Occurrence as for genus: Europe, Africa, Madagascar, southern India, Japan, California, South Dakota.——FIG. 124,*1a–d.* **C. (G.) gentoni* (BRONGNIART in CUVIER & BRONGNIART); *a,b,* lectotype, Middle Cenomanian, France, ×1; *c,d,* macroconch, Upper Cenomanian, England, ×1 (Kennedy, 1971).

C. (**Calycoceras**). Medium-sized to large; whorl section normally depressed and may be polygonal; ribs more or less distant and coarse; all tubercles except umbilical normally absent in middle growth, but weak outer ventrolaterals may persist and be rejuvenated on body chamber. Occurrence as for genus: distribution as for genus.——FIG. 125*a–f.* **C. (C.) naviculare* (MANTELL); *a–d,* Upper Cenomanian, England; *a,b,* holotype, ×0.7; *c,d,* ×1 (Kennedy, 1971); *e,f,* Upper Cenomanian, Angola, ×0.75 (H. Douvillé, 1931).

C. (**Newboldiceras**) THOMEL, 1972, p. 105 [**Acanthoceras newboldi* KOSSMAT, 1897, p. 4(11); OD; =*Acanthoceras asiaticum* JIMBO, 1894, p. 31(177)] [=*Mourreiceras* THOMEL, 1972, p. 118 (type, *N. (M.) mourrei;* OD); *Pseudacanthoceras* THOMEL, 1972, p. 153 (type, *Acanthoceras tapara* WRIGHT, 1963, p. 605)]. Large; whorl section tending to be polygonal with marked ventrolateral facet or subquadrate throughout; outer ventrolateral and in many cases inner ventrolateral and siphonal tubercles persisting. [Although *Pseudacanthoceras* resembles *Acanthoceras* in developing clavate ventrolateral and siphonal tubercles and in its rectangular whorl section, it probably comprises extreme *Newboldiceras.*] Occurrence as for genus: Europe, Africa, Madagascar, India, Japan, California.——FIG. 124,*3a–c.* **C. (N.) asiaticum* (JIMBO), Middle Cenomanian, southern India; *a,b,* ×0.5; *c,* ×1 (Kossmat, 1897).

C. (**Proeucalycoceras**) THOMEL, 1972, p. 81 [**C. (Eucalycoceras) besairiei* COLLIGNON, 1937a, p. 37(13); OD] [=?*Haugiceras* THOMEL, 1972, p. 96 (type, *Acanthoceras haugi* PERVINQUIÈRE, 1907, p. 270; OD)]. Inner whorls relatively compressed; sides and venter commonly flat; ribs dense, fine, and flexuous, with weak to strong umbilical bullae and weak outer ventrolateral clavi; inner ventrolateral and siphonal tubercles present initially but disappearing early; whorl section tending to become square, with blunt, well-rounded ribs. Occurrence as for genus: western Europe, northern Africa, Madagascar, Oman, southern India, Texas.——FIG. 124,*2a,b.* **C. (P.) besairiei,* Middle Cenomanian, Madagascar; ×1 (Collignon, 1937a).——FIG. 124,*2c,d. C. (P.) choffati* (KOSSMAT), Middle Cenomanian, southern India; ×0.75 (Kossmat, 1897).

C. (**Hourcqiceras**) COLLIGNON, 1939, p. 19 [**C. (H.) hourcqi;* OD]. More or less similar in form and ornament to *C. (Gentoniceras)* but with persistent constrictions and exceptionally thick shell. [*Tunesites,* if Cenomanian, may be a senior synonym, but it is probably Turonian.] *Upper Cretaceous (Upper Cenomanian):* Madagascar.

?**Tunesites** PERVINQUIÈRE, 1907, p. 255 [**T. salammbo* PERVINQUIÈRE, 1907, p. 255; SD ROMAN, 1938, p. 441]. The syntypes are minute nuclei, almost smooth but for marked constrictions with feebly tuberculate, raised rib behind. If, as stated by PERVINQUIÈRE, they are Cenomanian, *Tunesites* may be a senior synonym of *Calycoceras (Hourcqiceras).* If, as seems more likely, they are Turonian, *Tunesites* may be a senior synonym of *Romaniceras.* At present a *nomen dubium.* KENNEDY, WRIGHT, & HANCOCK, 1980a. *Upper Cretaceous (Cenomanian or Turonian).*

Eucalycoceras SPATH, 1923b, p. 144, ICZN Opinion 557, 1959, Generic Name No. 1354 [**Ammonites pentagonus* JUKES-BROWNE in JUKES-BROWNE & HILL, 1896, p. 156; OD; ICZN Specific Name No. 1635] [=*Pseudomantelliceras* THOMEL, 1972, p. 35 (type, *Acanthoceras (Mantelliceras) pervinquierei* COLLIGNON, 1931b, p. 42; OD)]. High-whorled and rather compressed; at first venter flat and may be bituberculate, but later arched and trituberculate; ribs dense and narrow to flat and distant, with sharp umbilical, inner and outer ventrolateral, and, at least on outer whorls, pointed or bullate siphonal tubercles; tubercles may disappear on body chamber and ribs become flat and steep behind. *Upper Cretaceous (Upper Cenomanian):* England, France, Spain, Madagascar, Israel, southern India, Japan, Texas.——FIG. 123,*2a,b.* **E. pentagonum* (JUKES-BROWNE in JUKES-BROWNE & HILL), England; ×0.5 (Jukes-Browne & Hill, 1896).

Pseudocalycoceras THOMEL, 1969, p. 650 [**Ammonites harpax* STOLICZKA, 1864, p. 72; OD] [=*Neocalyco-*

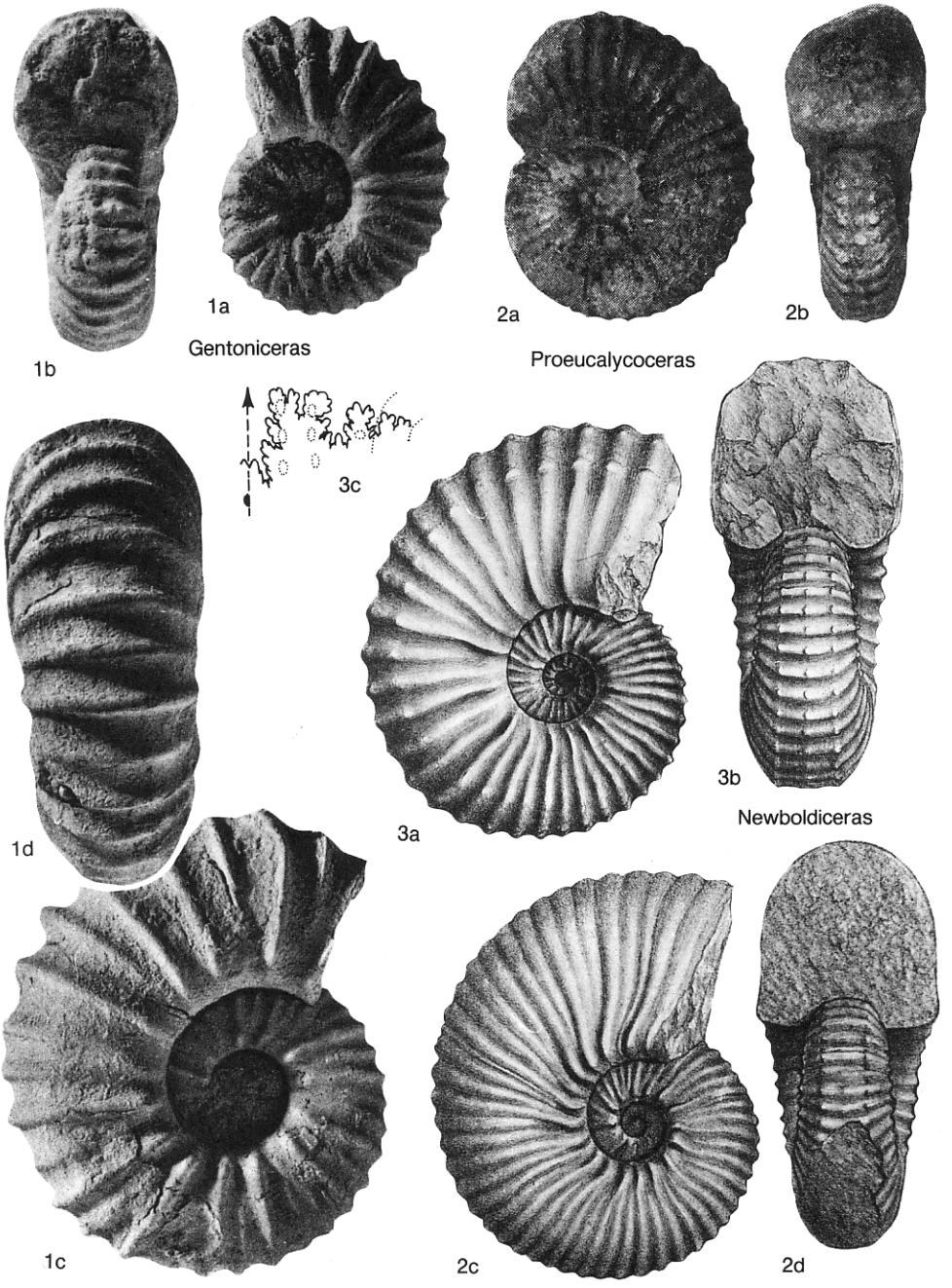


FIG. 124. Acanthoceratidae (p. 164)

ceras THOMEL, 1969, p. 651, *nom. nud.*]. Slightly compressed to slightly depressed; ribs flexuous to convex and prorsiradiate, more or less regularly branching or long and short; primaries arising from umbilical bullae, characteristically twisted; all ribs with inner ventrolateral nodes or clavi and outer ventrolateral and siphonal clavi; on latter part of body chamber ribs narrow, approximate, and generally recurved; tubercles disappearing. MATSUMOTO & KAWANO, 1975. *Upper Cretaceous (Upper*

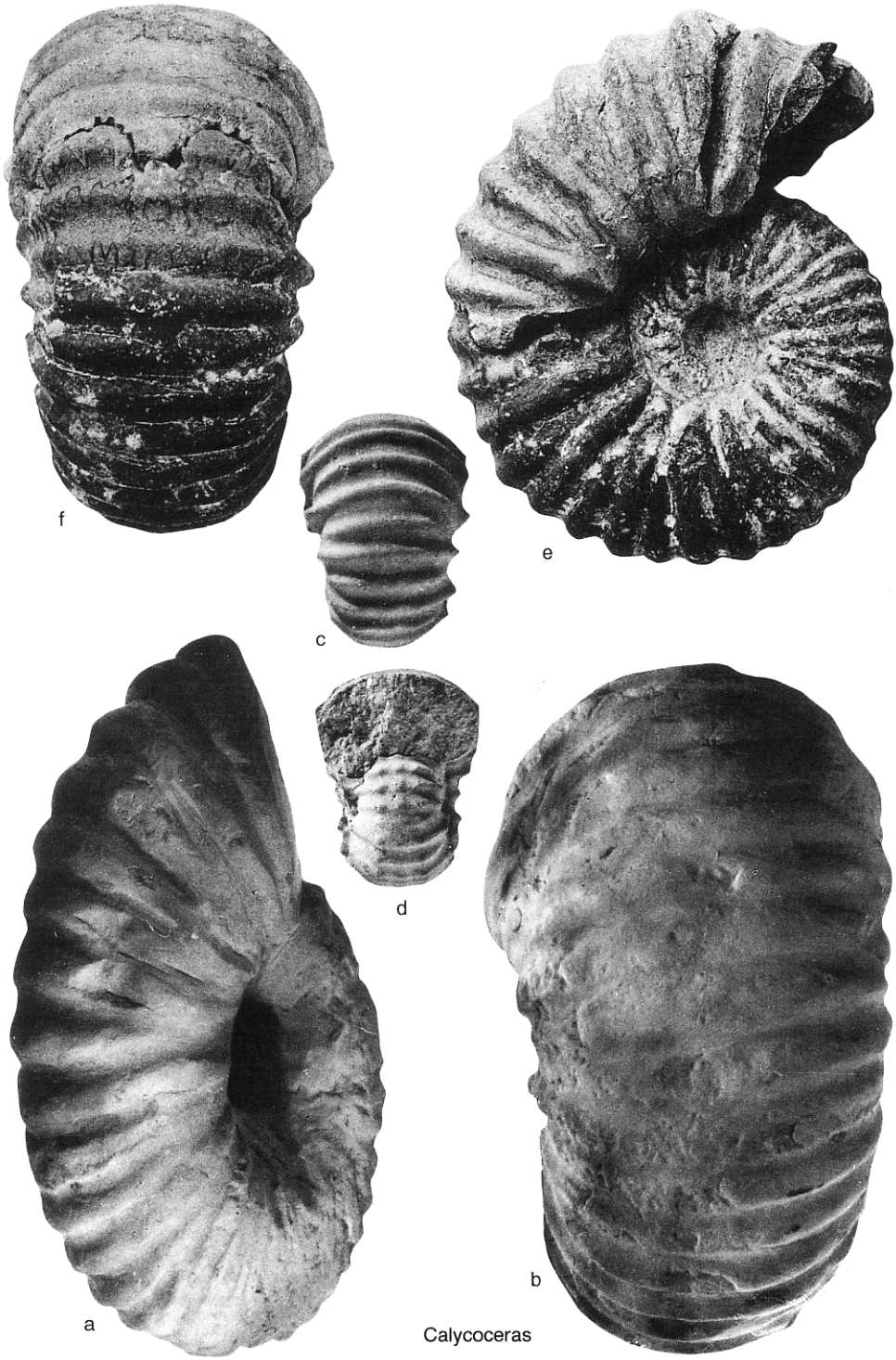


FIG. 125. Acanthoceratidae (p. 164)

Cenomanian): western Europe, Romania, northern Africa, Angola, Madagascar, Syria, Israel, southern India, Texas, Colorado, Brazil.——FIG. 123,*5a,b.* **P. harpax* (STOLICZKA), southern India; ×0.75 (Stoliczka, 1864).

Nigericeras SCHNEEGANS, 1943, p. 118 [**N. gignouxi;* OD; =*Acanthoceras(?) gaddeni* CHUDEAU, 1909, p. 71]. Acanthoceratine ornament of ribs and umbilical, inner and outer ventrolateral, and siphonal tubercles persisting to varying diameters up to 40 mm; thereafter, shell smooth except for strong to weak folds, which may be rursiradiate; weak siphonal ridge may be present; whorl section oval, round, or quadrate. Suture simplifying. *Upper Cretaceous (Upper Cenomanian):* England, western Africa, Israel, Turkestan, Colorado, Texas.——FIG. 122,*2a–c.* **N. gignouxi,* Niger; *a,* ×0.75; *b,* ×0.5; *c,* ×1 (Schneegans, 1943).

Subfamily EUOMPHALOCERATINAE Cooper, 1978

[Euomphaloceratinae COOPER, 1978, p. 102]

Derivatives of *Calycoceras,* mostly with constrictions in early stages or throughout. *Upper Cretaceous (Upper Cenomanian–Lower Coniacian).*

Lotzeites WIEDMANN, 1960, p. 731 [**Acanthoceras aberrans* KOSSMAT, 1895, p. 202(106); OD]. Extreme development of *C. (Calycoceras),* with inner whorls generally similar but distinguished by broader, flatter venter with strong ventral constrictions; main ribs with prominent umbilical and inner ventrolateral tubercles, at which ribs branch and cross venter transversely; untuberculate secondaries are intercalated on body chamber. Distinguished from *Euomphaloceras* by more rapidly increasing whorl breadth and absence of outer ventrolateral tubercles. *Upper Cretaceous (Upper Cenomanian):* England, southern India.——FIG. 126,*3a,b.* **L. aberrans* (KOSSMAT), southern India; ×1 (Kossmat, 1895).

Euomphaloceras SPATH, 1923b, p. 143 [**Ammonites euomphalus* SHARPE, 1855, p. 31; OD] [=*Kanabiceras* REESIDE & WEYMOUTH, 1931, p. 11 (type, *Acanthoceras? kanabense* STANTON, 1894, p. 181; OD; =*Scaphites? septemseriatus* CRAGIN, 1893, p. 240); *Burroceras* COBBAN, HOOK, & KENNEDY, 1989, p. 37 (type, *B. clydense;* OD)]. Very evolute; whorl section square to depressed-octagonal; prominent umbilical and ventrolateral tubercles on some or all main ribs; ribs branching at ventrolateral tubercles and carrying 3 rows of small, bullate to clavate tubercles on broad venter; shallow ventral constrictions on early whorls, variously persistent; ribs may be transverse or in chevrons on venter. Suture having narrow external saddle with oblique dorsal slope and wide, splayed first lateral lobe. [*Burroceras* with slightly prolonged, early, smooth stage and flatter-sided adult whorls is transitional to *Pseudaspidoceras* but does not need separation.] *Upper Cretaceous (Upper Cenomanian):* western Europe, northern Africa, Angola, Madagascar, Syria, southern India, Japan, USA (Western Interior, California), Brazil.——FIG. 126,*1a–c.* **E. euomphalum* (SHARPE), England; ×1 (Crick, 1899).——FIG. 126,*1d,e. E. septemseriatum* (CRAGIN), Texas; ×0.5 (Moreman, 1942).

Paraburroceras COBBAN, HOOK, & KENNEDY, 1989, p. 40 [**P. minutum;* OD]. Progenetic dwarf offshoot of *Euomphaloceras ("Burroceras").* Almost smooth until last part of phragmocone. *Upper Cretaceous (Upper Cenomanian):* New Mexico.

Morrowites COBBAN & HOOK, 1983, p. 9 [**Mammites wingi* MORROW, 1935, p. 467; OD]. Larger, in some species at least with early whorls smooth except for feebly tuberculate ribs bordering constrictions. Suture with external saddle normally much narrower than widely splayed first lateral lobe. Adult whorls similar to *Mammites,* but early constrictions and suture indicate close relationship to *Euomphaloceras. Upper Cretaceous (Lower Turonian):* Europe, western Africa, Madagascar, USA (Western Interior).——FIG. 127,*2a–d. M. subdepressus* COBBAN & HOOK, New Mexico; *a–c,* ×1; *d,* ×0.5 (Cobban & Hook, 1983).

Kamerunoceras REYMENT, 1954b, p. 250 [**Acanthoceras eschii* SOLGER, 1904, p. 124; OD] [=*Schindewolfites* WIEDMANN, 1960, p. 736 (type, *S. inaequicostatus;* OD); ?*Polyaspidoceras* MATSUMOTO, 1978, p. 18 (type, *P. shimizui;* OD)]. Very evolute; whorl section circular to subquadrate, becoming higher with age; ribs single, straight to sinuous, irregular, and very distant until body chamber where there may be strengthening intercalatories. Early whorls with weak umbilical bullae, with or without weak lateral tubercles, and with inner and stronger outer ventrolateral and irregular, weak to strong, clavate siphonal tubercles. Tubercles persisting or weakening, with ribs becoming dominant. Probably derived from *Euomphaloceras* by increase in whorl height, flattening of sides, and reduction of secondary ribs with their tubercles. *Upper Cretaceous (Lower Turonian):* England, France, Spain, northern and western Africa, Madagascar, Israel, Japan, Texas, Colorado, ?Colombia, Venezuela, Brazil.——FIG. 126,*2a,b.* **K. eschii* (SOLGER), Cameroon; nucleus, ×1 (Kennedy & Wright, 1979).——FIG. 126,*2c–e. K. turoniense* (ORBIGNY), France; *c,d,* ×0.25; *e,* ×1.5 (Pervinquière, 1903a).——FIG. 126,*2f–h. K. inaequicostatus* (WIEDMANN), Spain; ×1 (Wiedmann, 1964).

Pseudaspidoceras HYATT, 1903, p. 106 [**Ammonites footeanus* STOLICZKA, 1864, p. 101; OD] [=*Ampakabites* COLLIGNON, 1965a, p. 29 (type, *Kamerunoceras (Ampakabites) auriculatum* COLLIGNON, 1965a, p. 29; OD)]. Early whorls slightly inflated to slightly compressed; more or less flat-sided; distant primary ribs with umbilical bullae, strong inner and weaker outer ventrolateral tubercles; irregular, weak, branching or intercalated secondary ribs bearing outer ventrolateral tubercles only; flat venter with or without slight, transverse constrictions. Later whorl height increasing, with

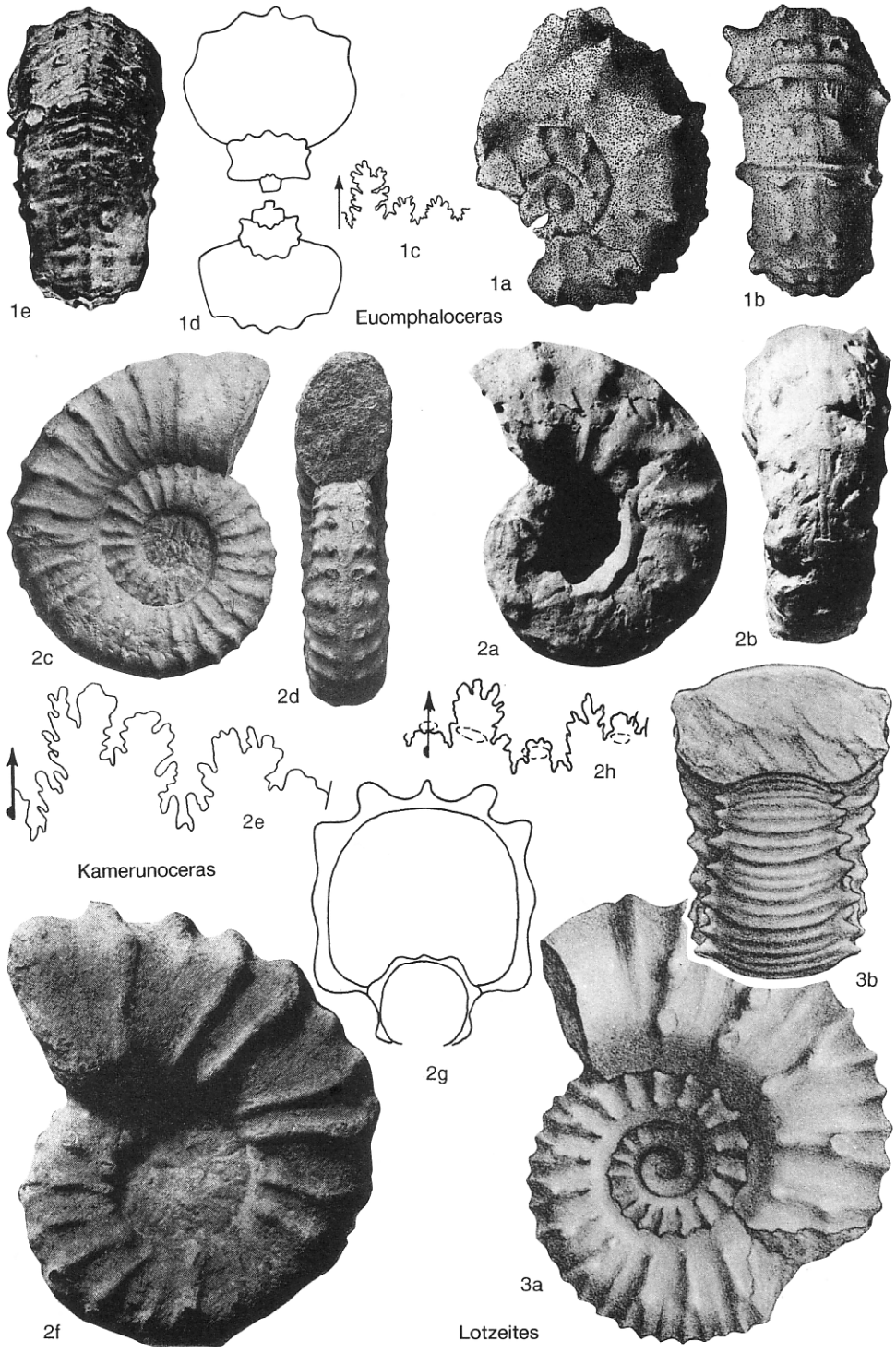


FIG. 126. Acanthoceratidae (p. 167)

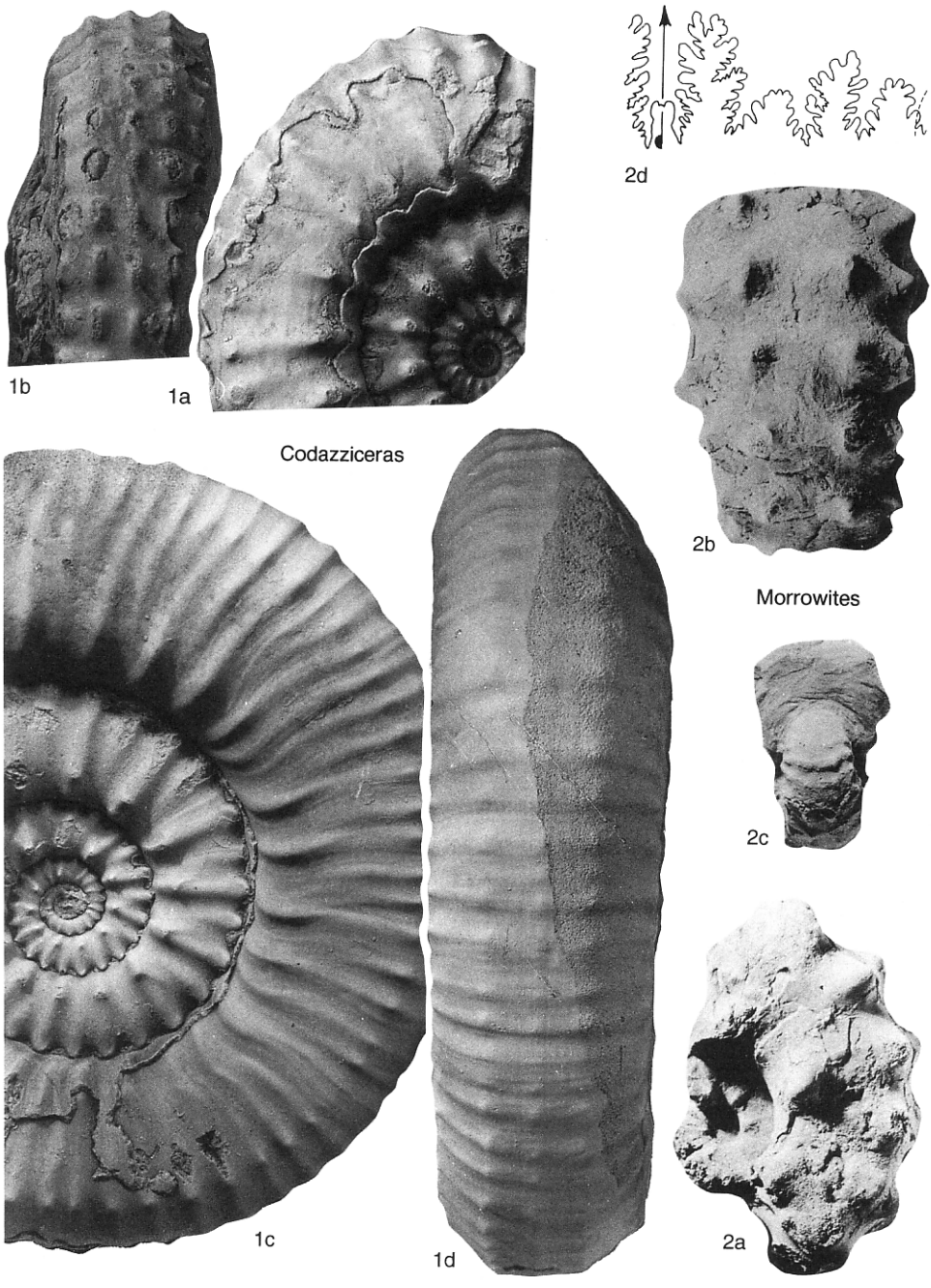


FIG. 127. Acanthoceratidae (p. 167–171)

square or rectangular section; ribs weaken and may be looped on sides; outer ventrolateral tubercles weakening or disappearing. Suture with moderately short to long elements. *Upper Cretaceous (Lower Turonian–Middle Turonian):* western Europe, western Africa, Egypt, Madagascar, Oman, southern India, Texas, Venezuela, Brazil.——FIG. 128,*1a–c.* **P. footeanum* (STOLICZKA), Lower Turonian, southern India; *a,* ×0.25; *b,* ×1; *c,* enlarged (Stoliczka, 1863–1866).——FIG. 128,*1,d,e. P. auriculatum*

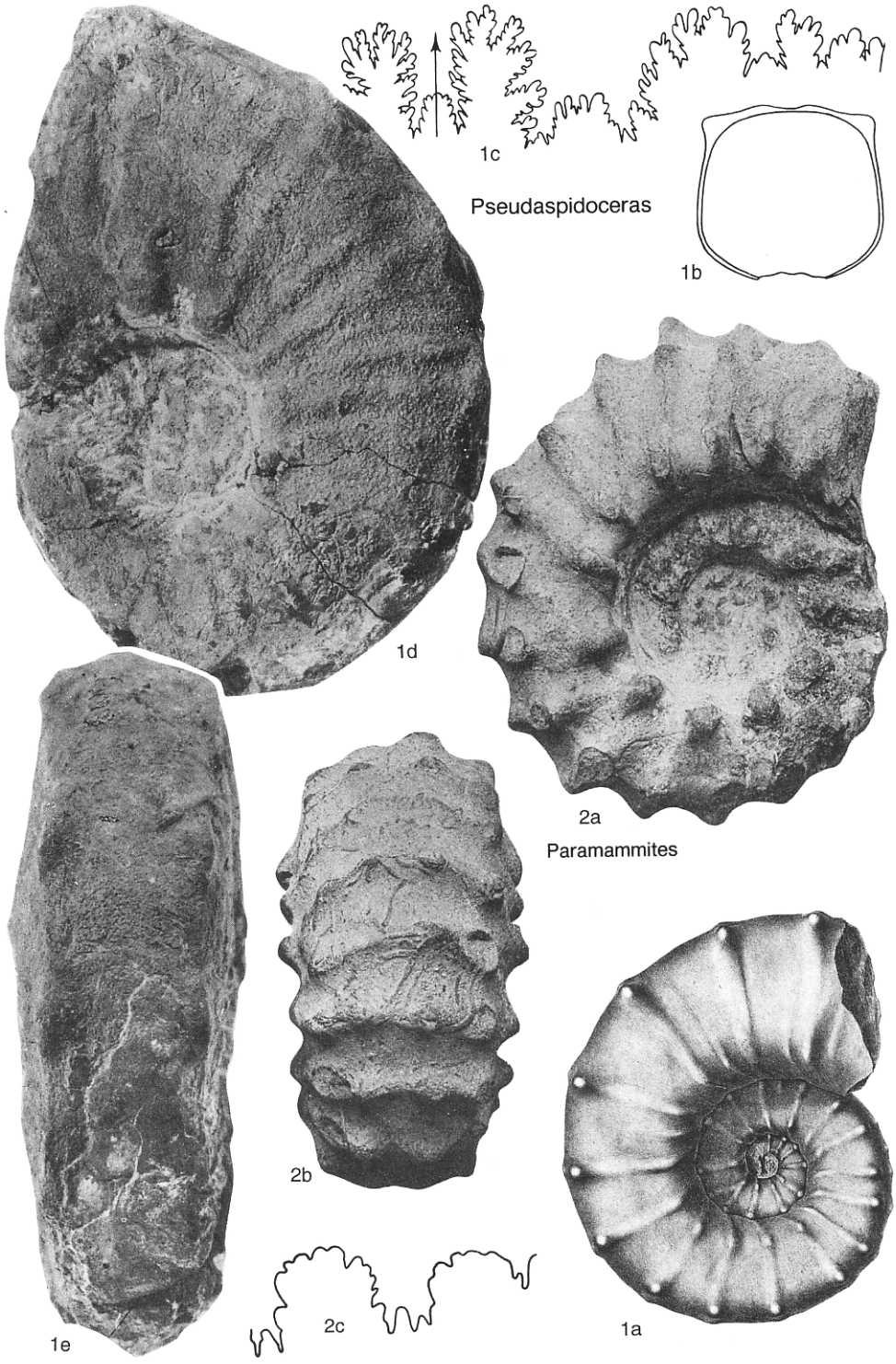


FIG. 128. Acanthoceratidae (p. 167–171)

(COLLIGNON), Lower Turonian, Madagascar; ×0.75 (Collignon, 1965a).

?Paramammites FURON, 1935, p. 58 [**Vascoceras polymorphum* PERVINQUIÈRE, 1907, p. 336; SD REYMENT, 1954b, p. 255]. Variable, rather involute to evolute; whorl section compressed to depressed, rounded to subquadrate; at first with very prominent umbilical bullae and weak inner and strong, spinate outer ventrolateral tubercles; later, ribs may strengthen and all tubercles approximate in size and spacing; later still, ribs become dominant and ventrolateral tubercles disappear; ribs, when present, may cross venter or be interrupted. *Upper Cretaceous (Lower Turonian):* France, Spain, northern Africa, Venezuela.——FIG. 128,*2a–c.* **P. polymorphum* (PERVINQUIÈRE), Tunisia; ×1 (Pervinquière, 1907).

Romaniceras SPATH, 1923b, p. 144 [**Ammonites deverianus* ORBIGNY, 1841, p. 356; OD] [=*Kossmatia* YABE, 1927, p. 42, *non* UHLIG, 1907, p. 470 (type, *Acanthoceras pseudodeverianum* JIMBO, 1894, p. 32(178); M; =*Ammonites deverianus* ORBIGNY); *Proromaniceras* WIEDMANN, 1960, p. 734 (type, *Acanthoceras pseudodeverianum* JIMBO, 1894, p. 32(178); OD; =*Ammonites deverianus* ORBIGNY)]. Rather evolute; whorl section circular, oval, or subquadrate; early whorls with constrictions and associated ribs; later whorls with strong ribs and 9 to 13 rows of more or less equal tubercles, equidistant or not; ventrolateral and siphonal tubercles may be clavate. On mature whorls some or all tubercles disappearing and ribs mainly long and strong, uninterrupted on venter. KENNEDY, WRIGHT, & HANCOCK, 1980a. *Upper Cretaceous (Lower Turonian–Upper Turonian):* western Europe, Czech Republic, northern and western Africa, Madagascar, Syria, Japan, California, Texas, Mexico, Venezuela.

R. (Romaniceras). Whorl section oval, round, or depressed; with 9 more or less equidistant tubercles, the ventrolateral and siphonal in some cases clavate. *Upper Cretaceous (Upper Turonian):* western Europe, northern and western Africa, Madagascar, Syria, Japan.——FIG. 129,*3a–c.* **R. (R.) deverianum* (ORBIGNY), France; ×0.5 (Kennedy, Wright, & Hancock, 1980a).

R. (Neomphaloceras) MATSUMOTO & OBATA, 1982, p. 71 [**Yubariceras pseudomphalum* MATSUMOTO, 1975, p. 146; OD]. Phragmocone with ribs differentiated into primaries and intercalated secondaries. Somewhat resembles *Euomphaloceras. Upper Cretaceous (Lower Turonian–Middle Turonian):* Japan.——FIG. 129,*4a,b.* **R. (N.) pseudomphalum* (MATSUMOTO); ×1 (Matsumoto & Suekane, 1987).

R. (Yubariceras) MATSUMOTO, SAITO, & FUKADA, 1957, p. 26 [**Y. yubarense;* OD; =*Ammonites ornatissimus* STOLICZKA, 1864, p. 75]. Whorl section rounded or square; with 11 rows of tubercles and with constrictions up to diameter of 40 mm; ribs may be doubled on venter as in *Euomphaloceras. Upper Cretaceous (Lower Turonian–Upper Turonian):* England, France, Tunisia, Madagascar, Lebanon, Israel, southern India, Japan, California, Texas, Mexico, Venezuela.——FIG. 129,*5a–c.* **R. (Y.) ornatissimum* (STOLICZKA), Middle Turonian, Japan; ×0.4 (Matsumoto, Saito, & Fukada, 1957).

R. (Obiraceras) MATSUMOTO, 1975, p. 150 [**R. (O.) ornatum;* OD]. More or less square-whorled; secondary ribs, with no or weak tubercles, persisting to end; on later whorls inner and outer ventrolateral tubercles doubled. Occurrence as for genus: Japan, New Mexico.——FIG. 129,*2a,b.* **R. (O.) ornatum;* ×0.5 (Matsumoto, 1975).

R. (Shuparoceras) MATSUMOTO, 1975, p. 110 [**R. (S.) yagii;* OD]. High-whorled, with 9 tubercles (the midlateral weak) and frequent, strong constrictions throughout. *Upper Cretaceous (Upper Turonian):* Japan.——FIG. 129,*1a,b.* **R. (S.) yagii;* ×0.5 (Matsumoto, 1975).

Codazziceras ETAYO SERNA, 1979, p. 83 [**Lyelliceras scheibei* RIEDEL, 1938, p. 55; OD]. Very evolute, serpenticone; early whorls rounded, smooth, with constrictions; later whorls with whorl section square to rectangular, becoming rounded on body chamber; with strong ribs branching from umbilical tubercles, bearing inner and outer ventrolateral and siphonal tubercles; all tubercles tending to disappear on body chamber, which resembles inner whorls of *Pedioceras. Upper Cretaceous (Lower Coniacian):* Australia, Colombia.——FIG. 127,*1a–d.* **C. scheibei* (RIEDEL), Colombia; ×1′(new).

Subfamily MAMMITINAE Hyatt, 1900

[*nom. transl.* WRIGHT & WRIGHT, 1951, p. 27, *ex* Mammitidae HYATT, 1900, p. 588] [=Buchiceratidae HYATT, 1903, p. 26; Metoicoceratidae HYATT, 1903, p. 115; Fallotitinae WIEDMANN, 1960, p. 741; Mitoniainae RENZ & ALVAREZ, 1979, p. 975]

Moderately to very involute; inner whorls typically with trapezoidal whorl section, rather sparse ribs, and bullate or spinate umbilical and clavate inner and outer ventrolateral tubercles; siphonal line may be slightly raised but venter normally lacking keel or row of siphonal tubercles. On outer whorl ornament may strengthen to extremes or may disappear. Suture tending to simplify. *Upper Cretaceous (Upper Cenomanian–Coniacian).*

Phylogeny seems to be from *Plesiacanthoceras* (Acanthoceratinae) to *Metoicoceras* to *Spathites (Jeanrogericeras)* to *S. (Spathites)* to *Buchiceras;* a further branch from *S. (Jeanrogericeras)* leads to *Mammites* and to *Pseudaspidoceras, Paramammites,* and *Metasigaloceras.*

Metoicoceras HYATT, 1903, p. 115 [**Ammonites swallovi* SHUMARD, 1860, p. 591; SD SHIMER & SHROCK, 1944, p. 56]. Venter on phragmocone flat,

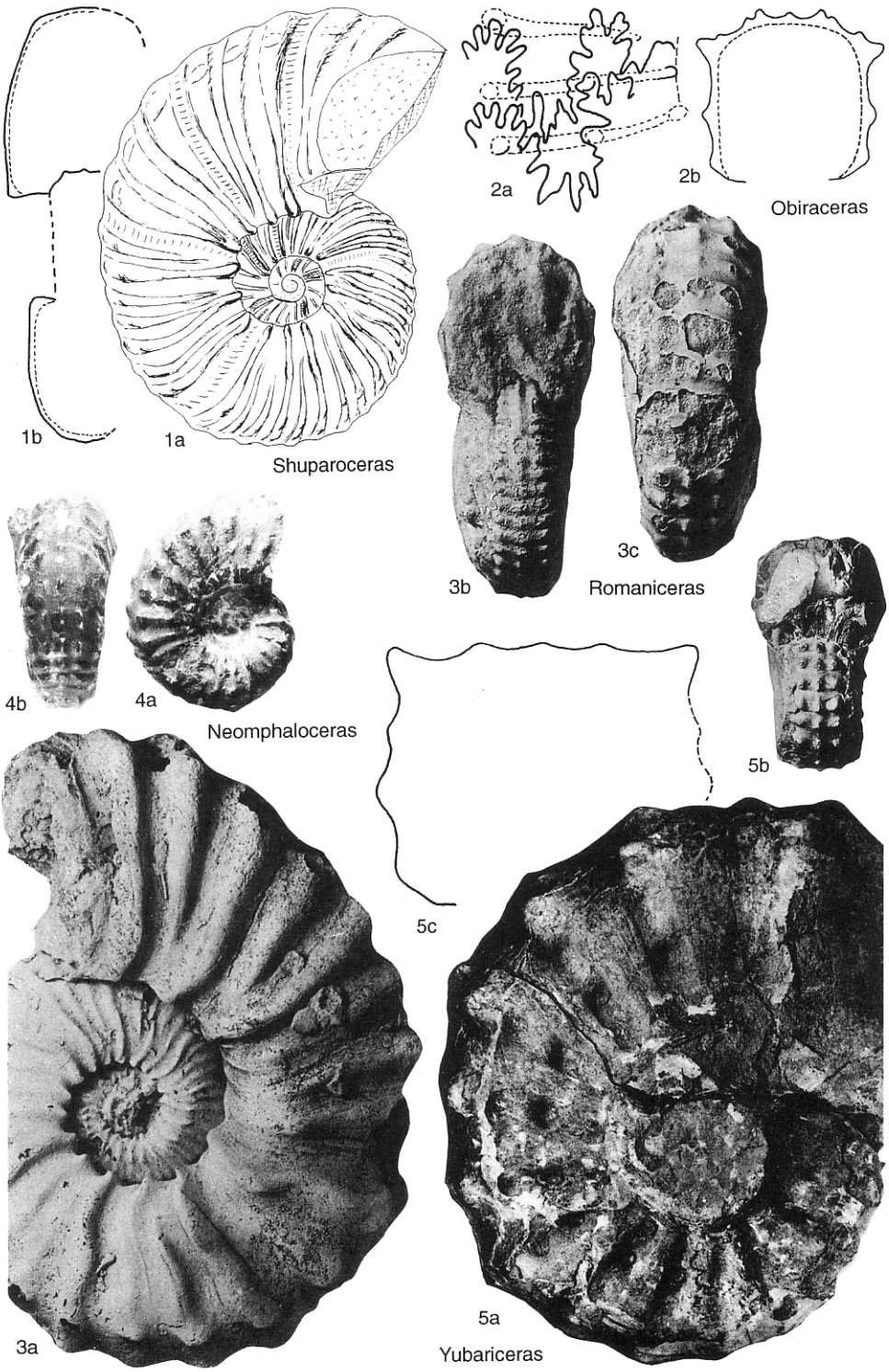


FIG. 129. Acanthoceratidae (p. 171)

on body chamber generally rounded; ribs straight to slightly flexuous, tending to become flat on outer part of sides; inner and outer ventrolateral tubercles present, former weakening and disappearing before end of phragmocone. Macroconchs tending to be more involute and feebly ornamented and microconchs more evolute and strongly ornamented. Differs from its presumed ancestor *Plesiocanthoceras* mainly in its simpler suture, pseudoceratitic in some, and absence of row of siphonal tubercles (except on early whorls of earliest species). Includes smooth or ribbed, compressed, involute forms and coarsely ornamented, evolute forms. *Upper Cretaceous (upper Middle Cenomanian–middle Upper Cenomanian):* Europe, northern and western Africa, Madagascar, Israel, Iran, southern India, USA, Peru, Brazil.——FIG. 130,*1a,b.* **M. swallovi* (SHUMARD), Texas; *a,* ×0.75; *b,* ×0.5 (Hyatt, 1903).

Cryptometoicoceras KENNEDY & COBBAN, 1990b, p. 409 [**C. mite;* OD]. Progenetic dwarf offshoot of *Metoicoceras praecox.* Sides flat, almost smooth; conical outer ventrolateral tubercles appearing transiently at beginning of body chamber, followed by plain ribs crossing venter. *Upper Cretaceous (Upper Cenomanian):* Wyoming.

Nannometoicoceras KENNEDY, 1988, p. 63 [**Metoicoceras acceleratum* HYATT, 1903, p. 127; OD]. Dwarf offshoot of *Metoicoceras.* Very involute, compressed, with flat sides and tabulate venter. *Upper Cretaceous (Upper Cenomanian):* Montana, Texas.——FIG. 131,*1a–d.* **N. acceleratum* (HYATT), Texas; *a,b,* macroconch, ×1; *c,d,* microconch, ×1 (Kennedy, 1988).

Buccinammonites KENNEDY & COBBAN, 1990b, p. 413 [**B. minimus;* OD]. Adult with diameter of 4.5 mm; very involute, depressed; sparse, coarse ribs ending in strong inner ventrolateral tubercles persisting to first part of body chamber, then becoming crowded with minute tubercles; aperture strongly flared. Suture with very simple bifid elements. Probably derived from *Metoicoceras* or ally. *Upper Cretaceous (Upper Cenomanian):* Montana.——FIG. 131,*2,a,b.* **B. minimus;* ×3 (Kennedy & Cobban, 1990b).

Spathites KUMMEL & DECKER, 1954, p. 310 [**S. chispaensis;* OD; =*Pseudotissotia? coahuilensis* JONES, 1938, p. 123]. Moderately to very involute; inner whorl with whorl section widest at umbilical shoulder; flat sides converging to sharp ventrolateral shoulder and broad, flat venter; blunt umbilical tubercles giving rise to pairs of low, rounded, distant ribs, each rib having 2 ventrolateral tubercles, inner one on or near the angle. Body chamber with blunt ribs or smooth. Suture simple with more or less bifid saddles. *Upper Cretaceous (Lower Turonian–Upper Turonian):* England, France, Portugal, Spain, southern Germany, Tunisia, Tadzhikistan, Texas.

S. (**Jeanrogericeras**) WIEDMANN, 1960, p. 740 [**Ammonites reveliereanus* COURTILLER, 1867, p. 4; OD] [=*Fallotites* WIEDMANN, 1960, p. 741 (type, *Vascoceras subconciliatum* CHOFFAT, 1898, p. 64; OD)]. Body chamber oval to rounded-depressed, smooth or with persistent distant ribbing. *Upper Cretaceous (Lower Turonian):* England, France, Portugal, Spain, southern Germany, Tunisia, Tadzhikistan.——FIG. 132*a–c.* **S. (J.) reveliereanus* (COURTILLER), France; *a,* ×1; *b,c,* ×0.6 (Pervinquière, 1903).——FIG. 132*d,e. S. (J.) subconciliatus* (CHOFFAT), Portugal; ×0.75 (Choffat, 1898).

S. (**Ingridella**) WIEDMANN, 1960, p. 749 [**Vascoceras malladae* FALLOT, 1931, p. 5; OD]. Evolute, with regular coiling; inner whorls with distinct but subdued inner and outer ventrolateral tubercles, very feeble ribs, and sparse, very large, rounded umbilical tubercles; umbilical tubercles persisting to outer whorl, where other ornament disappears, leaving a depressed-rounded whorl section. *Upper Cretaceous (Lower Turonian):* Spain.——FIG. 133,*2a,b.* **S. (I.) malladae* (FALLOT); ×0.5 (Wiedmann, 1964).

S. (**Spathites**) [=*Amblydiscus* ADKINS, 1933b, p. 238, *nom. nud.; Spathitoides* WIEDMANN, 1960, p. 754 (type, *Neoptychites (Spathitoides) sulcatus;* OD)]. Very involute; body chamber almost smooth, with whorl section subquadrate and venter broad. [Despite its slightly different body chamber and suture, *Spathitoides* seems not to be distinct.] Occurrence as for genus: Spain, Texas.——FIG. 133,*1a–d.* **S. (S.) coahuilensis* (JONES), Lower Turonian, Texas; *a,b,* ×1; *c,d,* ×2 (Kummel & Decker, 1954).——FIG. 133,*1e–g. S. (S.) sulcatus* (WIEDMANN), Lower Turonian, Spain; ×0.5 (Wiedmann, 1964).

Buchiceras HYATT, 1875, p. 369 [**B. bilobatum;* OD] [=*Roemeroceras* HYATT, 1903, p. 30 (type, *Ammonites bilobatus* GABB, 1877, p. 270, *non* HYATT, 1875, p. 370; SD DIENER, 1925, p. 216; =*Roemeroceras gabbi* HYATT, 1903, p. 30)]. Moderately to very involute; variable; whorl section more or less square; venter varying from broad and flat to rounded; early whorls with rounded keel that weakens and may disappear; low bulging ribs branching from umbilical tubercles. Suture variable; saddles broad, simple, feebly indented, tending to be entire; up to 3 auxiliary saddles. Despite resemblances to some other stocks, *Buchiceras* seems to be descended from *Spathites* by loss of one row of ventrolateral tubercles and appearance of weak keel. *Upper Cretaceous (Coniacian):* northern Africa, Israel, Peru.——FIG. 130,*3a,b.* **B. bilobatum,* Peru; ×1 (Brüggen, 1910).

Mammites LAUBE & BRUDER, 1887, p. 229 [**Ammonites nodosoides* SCHLÜTER, 1871, p. 19; M (all 3 species described in LAUBE & BRUDER, 1887, are believed to be synonymous; earliest type designation is ROMAN, 1938, p. 449)] [=*Schluetericeras* HYATT, 1903, p. 111 (type, *S. laubei;* OD; =*M. nodosoides*)]. Inner whorls trapezoidal to almost rectangular or square, with moderate to very strong tuberculation; venter slightly concave, flat, or with slight siphonal ridge. Outer whorls with fewer tubercles and with inner and outer ventrolaterals fused, in most species, into large horns directed sideways or obliquely upward. Suture moderately incised, variable, with first lateral lobe narrower than external saddle. *Upper Cretaceous (Lower Turonian–Upper Turonian):*

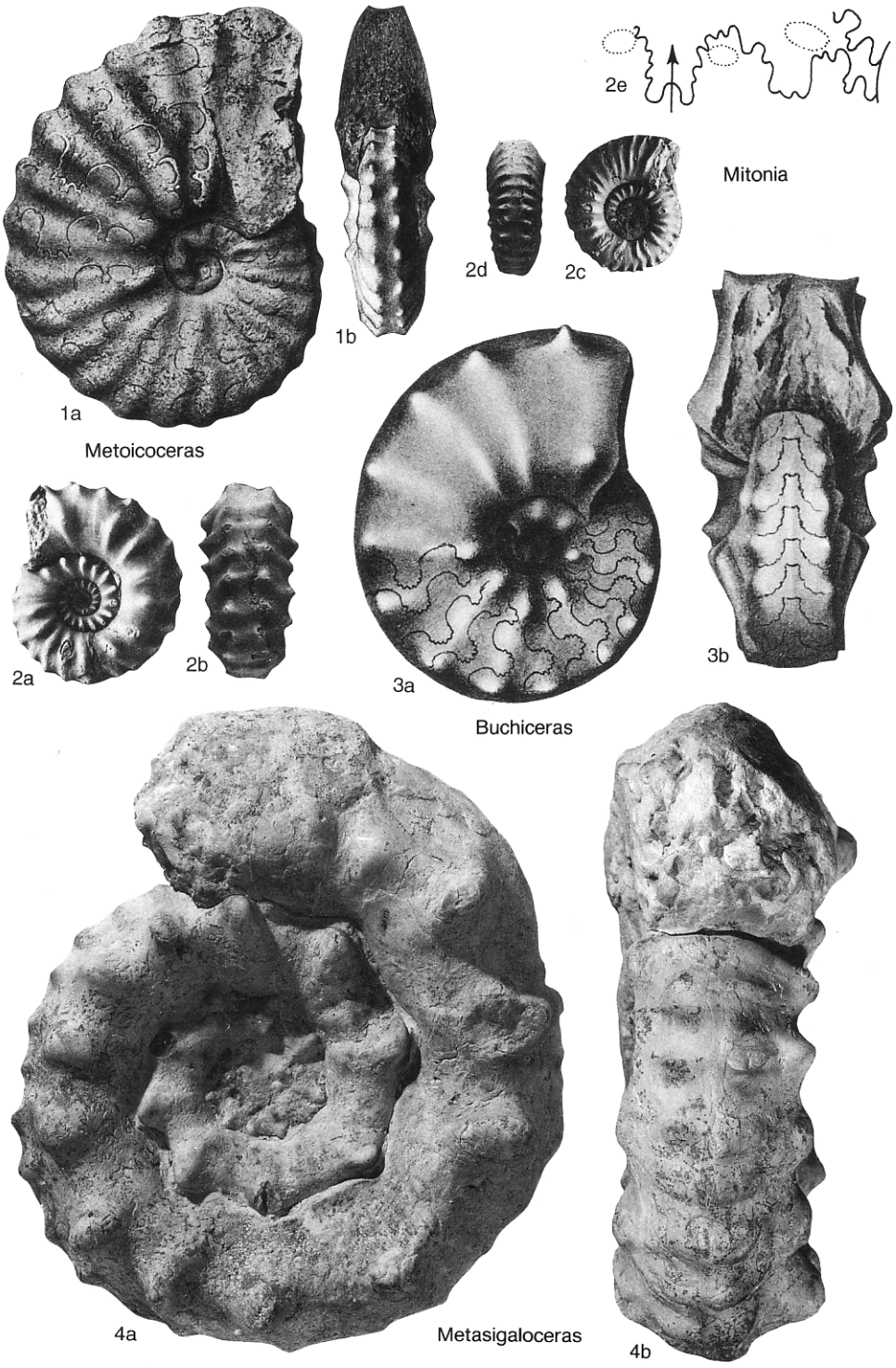


FIG. 130. Acanthoceratidae (p. 171–175)

Europe, northern Africa, western Africa, Madagascar, Syria, Israel, Turkestan, southern India, Texas, Colorado, Montana, Mexico, Colombia, Peru, Venezuela, Brazil.——FIG. 134,*a–d.* **M. nodosoides* (SCHLÜTER), Lower Turonian, Czech Republic; *a,b,* lectotype, ×0.4; *c,d,* topotype, ×0.4 (Wright & Kennedy, 1981).

Rhamphidoceras KENNEDY & COBBAN, 1990c, p. 667 [**R. saxatile;* OD]. Progenetic dwarf offshoot, probably of *Mammites.* Differs from *Mitonia* by larger ribs and absence of ventral tubercles. *Upper Cretaceous (Lower Turonian):* Texas.——FIG. 131,*3,a,b.* **R. saxatile,* holotype; ×2 (Kennedy & Cobban, 1990c).

Metasigaloceras HYATT, 1903, p. 106 [**Ammonites rusticus* J. SOWERBY, 1817c, p. 171; OD]. Early whorls similar to those of *Mammites;* later whorls very evolute, with trapezoidal whorl section and very large, blunt lateral tubercles giving rise to broad, low ribs ending in low ventrolateral tubercles; venter flat and smooth. *Upper Cretaceous (Lower Turonian):* England, France, Turkestan.——FIG. 130,*4a,b.* **M. rusticum* (J. SOWERBY), England; ×0.2 (Wright & Kennedy, 1981).

Mitonia RENZ & ALVAREZ, 1979, p. 975 [**M. venezolana;* OD]. Dwarfs (less than 32 mm in diameter); ornament as in adult *Metasigaloceras,* but tubercles weaker and ribs stronger on body chamber. Suture rather simple. *Upper Cretaceous (Lower Turonian):* Venezuela.——FIG. 130,*2a–e.* **M. venezolana; a,b,* ?macroconch, ×1; *c,d,* ?microconch, ×1; *e,* ×5 (Renz & Alvarez, 1979).

Family VASCOCERATIDAE H. Douvillé, 1912

[*nom. correct. et transl.* SPATH, 1925c, p. 198, *ex* Vascoceratinés H. DOUVILLÉ, 1912, p. 300] [=Neoptychitinae COLLIGNON, 1965a, p. 70]

Derivatives of Acanthoceratidae that rapidly lose ribbing and tuberculation and are smooth or retain only sparse, blunt umbilical or ventrolateral tubercles or short, coarse ribs. Suture generally with shallow, irregular, and slightly indented elements, but some genera with longer, well-indented elements. Whorl section and degree of involution very variable, even within species. Typically Tethyan in occurrence. *Upper Cretaceous (Upper Cenomanian–Upper Turonian).*

Vascoceras CHOFFAT, 1898, p. 51 [**V. gamai;* OD] [=*Pachyvascoceras* FURON, 1935, p. 58 (type, *P. crassum;* SD REYMENT, 1954b, p. 257); *Paracanthoceras* FURON, 1935, p. 59 (type, *Vascoceras (P.) chevalieri;* OD); *Paravascoceras* FURON, 1935, p. 60 (type, *Vascoceras cauvini* CHUDEAU, 1909, p. 68; OD); *Broggiiceras* BENAVIDES-CÁCERAS, 1956, p. 469 (type, *B. ohlssoni;* OD); *Greenhornoceras* COBBAN & SCOTT, 1972, p. 84 (type, *V. (G.) birchbyi* COBBAN & SCOTT, 1972, p. 84; OD); *Provascoceras* COOPER, 1979, p. 123 (type, *Ammonites diartianus* ORBIGNY, 1850a, p. 146; OD); *Nannovascoceras* RENZ & ALVAREZ, 1979, p. 978 (type, *M. intermedium;* OD)]. Very variable; early whorls involute to evolute, depressed to compressed; with strong constrictions; ribs bordering constrictions may have umbilical bullae; intermediate ribs, if present, mainly on outer part. Later whorls evolute, moderately compressed to cadicone, smooth or with ventrolateral bulges strengthening into strong, prorsiradiate ribs on outer part of sides and venter, but without regular umbilical tubercles. Suture irregular, with wide, shallow, feebly indented elements. *Upper Cretaceous (Upper Cenomanian; ?Lower Turonian):* France, Portugal, Spain, Israel, northern and western Africa, Oman, Japan, Texas, Mexico, Colombia, Venezuela, Peru, Brazil.——FIG. 135*a–c.* **V. gamai,* Upper Cenomanian, Portugal; ×0.5 (Choffat, 1898).——

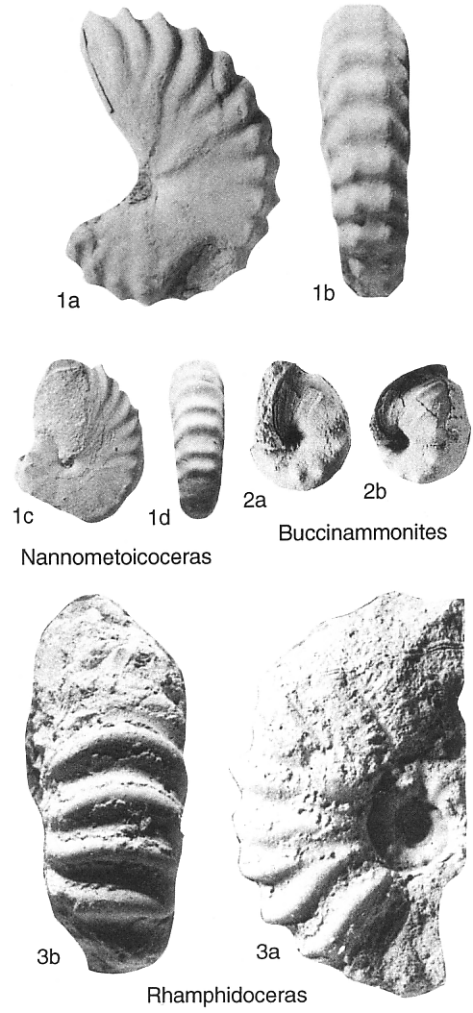


FIG. 131. Acanthoceratidae (p. 173–175)

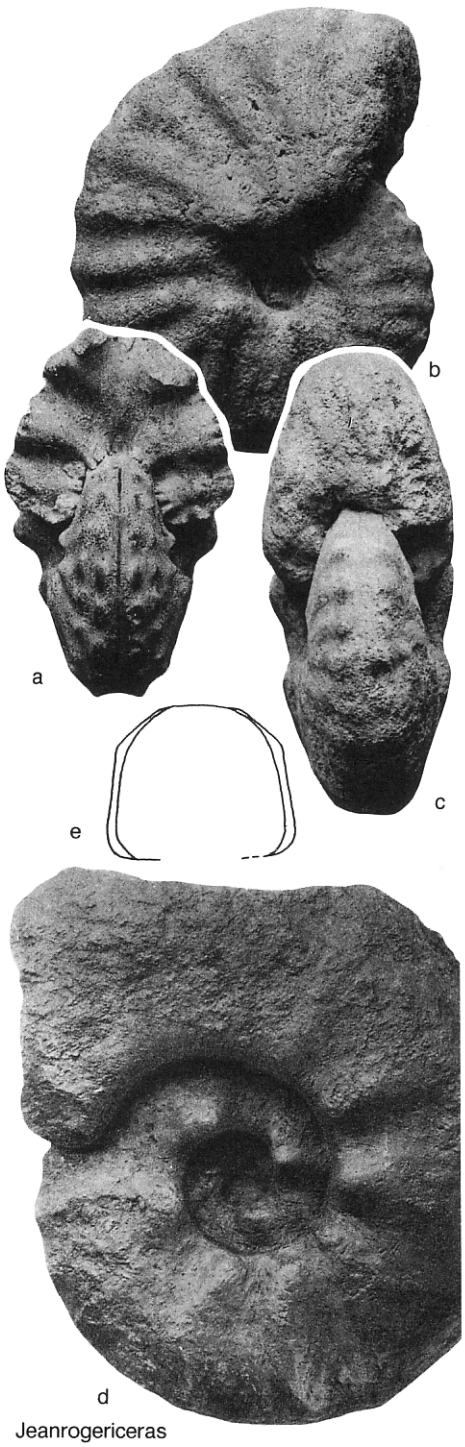


FIG. 132. Acanthoceratidae (p. 173)

FIG. 135*d. V. chevalieri* (FURON), Upper Cenomanian, Niger; ×0.5 (Furon, 1935).

Ezilloella REYMENT, 1954b, p. 263 [**E. ezilloensis;* OD]. Similar to some evolute *Vascoceras* but with more compressed inner whorls, narrowly arched to subcarinate venter, broad bulges on sides, and feeble ventrolateral and siphonal tubercles on outer whorl. *Upper Cretaceous (Lower Turonian):* Nigeria.

Neoptychites KOSSMAT, 1895, p. 168(72) [**Ammonites telinga* STOLICZKA, 1865, p. 125; SD SOLGER, 1904, p. 105; =*Ammonites cephalotus* COURTILLER, 1860, p. 248] [=*Betiokytes* COLLIGNON, 1965a, p. 56 (type, *Hemitissotia (B.) besairiei;* OD); *Pseudoneoptychites* A. F. LEANZA, 1967b, p. 202 (type, *P. andinus;* OD); *Franciscoites* ETAYO SERNA, 1979, p. 87 (type, *Ammonites toroanus* KARSTEN, 1858, p. 109; OD)]. Very involute, with minute umbilicus covered by a callosity or not (*Betiokytes*); whorl section compressed to very inflated, widest at rounded umbilical edge; venter narrowly rounded or slightly flattened; inner whorls variable, at first smooth except for sparse constrictions and associated collars, then with many, broad, low ribs bearing umbilical bullae in some species (*Pseudoneoptychites*), and finally smooth. Suture much as in *Vascoceras. Upper Cretaceous (Lower Turonian–Upper Turonian):* France, Spain, northern Africa, Nigeria, Madagascar, Syria, Israel, southern India, Japan, Colorado, Texas, Mexico, Trinidad, Venezuela, Colombia, Brazil.——FIG. 136,*2a,b.* **N. cephalotus* (COURTILLER), Lower Turonian, Tunisia; ×0.25 (Pervinquière, 1907).——FIG. 136,*2c,d. N. andinus* (A. F. LEANZA), Lower Turonian, Venezuela; ×1 (A. F. Leanza, 1967b).

Fagesia PERVINQUIÈRE, 1907, p. 319 [**Olcostephanus superstes* KOSSMAT, 1897, p. 26(133); OD] [=*Plesiovascoceras* SPATH, 1925c, p. 198 (type, *Ammonites catinus* MANTELL, 1822, p. 198; OD)]. Typically cadicones with strong, blunt umbilical tubercles, from which branch 2 or 3 strong, rounded ribs that may persist or be lost at early stage; inner whorls may retain distinct ventrolateral tubercles. Suture regular, with long, narrow, much indented elements and asymmetrically trifid to bifid L. *Upper Cretaceous (Lower Turonian):* western Europe, northern Africa, Nigeria, Madagascar, Oman, southern India, Japan, California, Montana, Texas, New Mexico, Mexico, Colombia, Venezuela.——FIG. 136,*1a–c.* **F. superstes* (KOSSMAT), Lower Turonian, southern India; ×0.5 (Kossmat, 1895–1898).——FIG. 136,*1d,e. F. catinus* (MANTELL), Lower Turonian, Montana; *d,* ×0.25; *e,* ×0.5 (Reeside, 1923).

Infabricaticeras COBBAN, HOOK, & KENNEDY, 1989, p. 51 [**I. lunaense;* OD]. Whorl section trapezoidal, with massive umbilical tubercles and single or branched, low ribs with intercalatories, all ribs ending in low ventrolateral tubercles or swellings. Derived from *Fagesia* or *Vascoceras* by prolongation of coarse juvenile ornamentation to adult stage. *Upper Cretaceous (Lower Turonian):* New Mexico, ?Spain.

Rubroceras COBBAN, HOOK, & KENNEDY, 1989, p. 54 [**R. alatum;* OD]. Inner whorls coarsely ribbed,

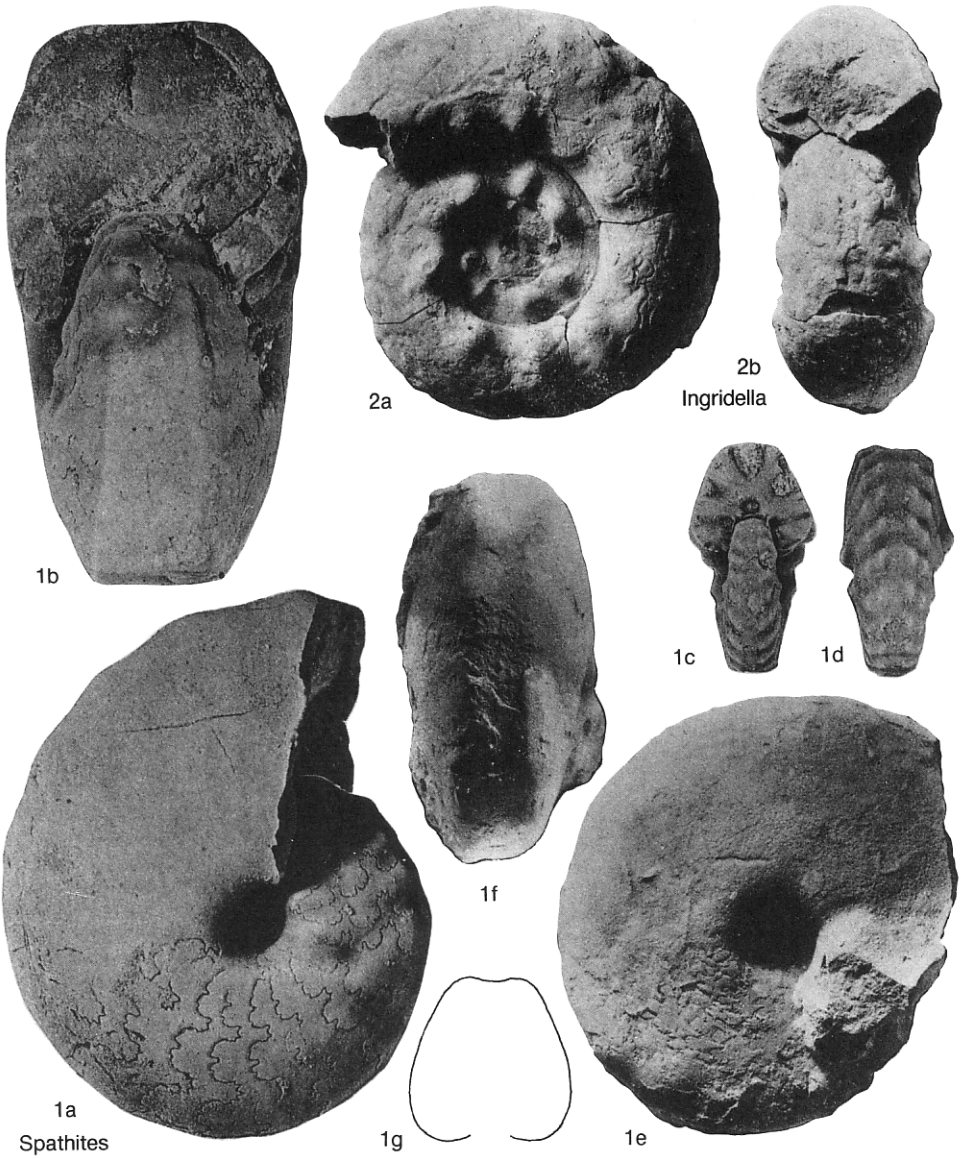


FIG. 133. Acanthoceratidae (p. 173)

with weakly trituberculate, rounded venter; body chamber with very coarse, rounded ribs angulate on shoulder. *Upper Cretaceous (Upper Cenomanian):* New Mexico.——FIG. 136,*3a,b.* **R. alatum;* ×1 (Cobban, Hook, & Kennedy, 1989).

?**Microdiphasoceras** COBBAN, HOOK, & KENNEDY, 1989, p. 53 [**M. novimexicanum;* OD]. Progenetic dwarf derivative, probably of some vascoceratid. Involute, compressed, with trituberculate, fastigiate venter. *Upper Cretaceous (Upper Cenomanian):* New Mexico.——FIG. 136,*4a,b.* **M. novimexicanum;* ×1 (Cobban, Hook, & Kennedy, 1989).

Family PSEUDOTISSOTIIDAE Hyatt, 1903

[Pseudotissotiidae HYATT, 1903, p. 34]

Generally involute, with degenerate acanthoceratine ornament, the ventrolateral and siphonal tubercles tending to form keels, but all ornament may disappear on outer whorls. *Upper Cretaceous (Lower Turonian–Coniacian).*

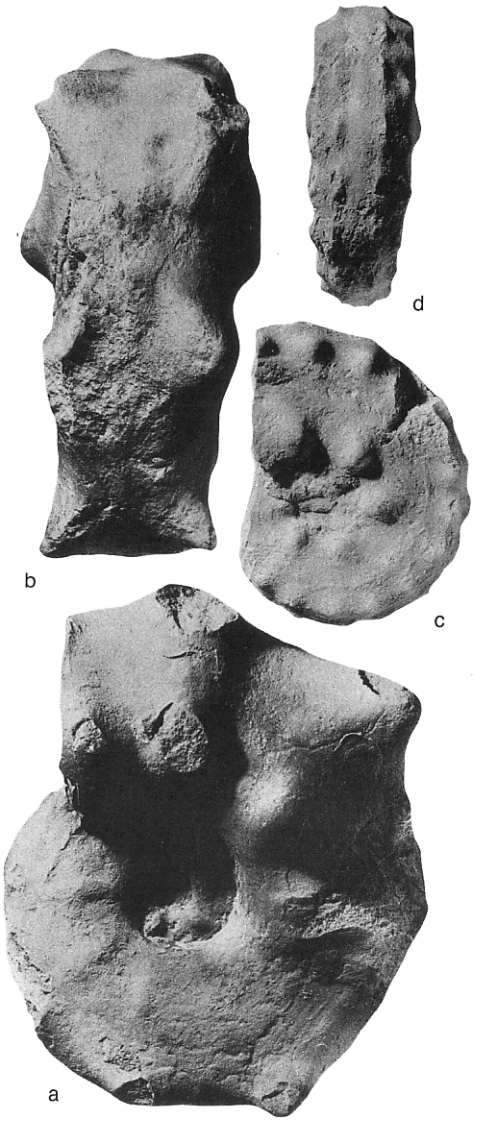


FIG. 134. Acanthoceratidae (p. 173–175)

Subfamily PSEUDOTISSOTIINAE Hyatt, 1903

[*nom. transl.* WRIGHT, 1952, p. 221, *ex* Pseudotissotiidae HYATT, 1903, p. 34] [=Hemitissotiinae PARNES, 1964, p. 13]

Moderately to very involute; whorl section compressed with flat sides to globose or triangular; venter varying from oxyconic to rounded-fastigiate; primitively with ventrolateral and siphonal rows of tubercles tending to become keels; siphonal keel may be lost or become dominant over ventrolateral keels or tubercles; umbilical tubercles normally present at some stage; ribs broad and sparse or absent. Suture variable, tending to simplify. *Upper Cretaceous (Lower Turonian–Coniacian).*

Thomasites PERVINQUIÈRE, 1907, p. 339 [**Pachydiscus rollandi* PERON, 1889, p. 25; SD DIENER, 1925, p. 103] [=*Gombeoceras* REYMENT, 1954a, p. 150 (type, *Vascoceras gongilense* WOODS, 1911, p. 282; OD); *Koulabiceras* ATABEKIAN, 1966, p. 75 (type, *Pseudotissotia koulabica* KLER, 1908, p. 157; OD); *Ferganites* STANKIEVICH & POJARKOVA, 1969, p. 94 (type, *Pseudotissotia koulabica* KLER, 1908, p. 157, objective junior synonym of *Koulabiceras*)]. Involute and globose when young; later whorl section becoming bluntly triangular, with 4 or 5 umbilical tubercles to each whorl, each giving rise to 2 or 3 faint, broad ribs that end in slight, blunt ventrolateral tubercles; a row of siphonal tubercles, commonly weak, also present; finally all ornament disappearing; aperture may be (always?) constricted. Suture variable, with moderately long to short, simplifying elements. *Upper Cretaceous (Lower Turonian):* England, Spain, northern and western Africa, Madagascar, Syria, Israel, Oman, Turkestan, Texas, Peru.——FIG. 137,*1a–c.* **T. rollandi* (PERON), Tunisia; *a,b,* ×1; *c,* enlarged (Pervinquière, 1907).——FIG. 137,*1d,e. T. gongilense* (WOODS), Nigeria; ×0.75 (Woods, 1911).

Pseudotissotia PERON, 1897, p. 26 [**Ammonites galliennei* ORBIGNY, 1850a, p. 190; SD PERVINQUIÈRE, 1907, p. 349] [=*Bauchioceras* REYMENT, 1954a, p. 157 (type, *Hoplitoides nigeriensis* WOODS, 1911, p. 284; OD); ?*Discovascoceras* COLLIGNON, 1957, p. 123(11) (type, *D. tesselitense;* OD); *Furoniceras* COLLIGNON, 1957, p. 129(17) (type, *F. trumpyi;* OD)]. Compressed to slightly depressed; whorl section more or less rectangular or trapezoidal, with flat venter; inner whorls with 2 or 3 fairly persistent keels, the ventrolateral ones clavate and the siphonal ones nodate in depressed, strongly ornamented individuals, and all keels entire in compressed, smooth individuals; sparse, broad ribs on inner whorls may persist; outer whorls tending to be rounded in section. Suture with 4 saddles, normally feebly denticulate, but inner ones may be entire. Appears to be derived from *Thomasites* but may occur earlier. *Upper Cretaceous (Lower Turonian–Middle Turonian):* France, Spain, northern and western Africa, Syria, Israel, Texas, Mexico, Central America, Colombia, Brazil.——FIG. 137,*2a,b.* **P. galliennei* (ORBIGNY), Middle Turonian, Tunisia; ×0.5 (Peron, 1896–1897).——FIG. 137,*2c,d. P. nigeriensis* (WOODS), Lower Turonian, Nigeria; ×0.75 (Woods, 1911).

Wrightoceras REYMENT, 1954a, p. 159 [**Bauchioceras (W.) wallsi;* OD] [=*Imlayiceras* A. F. LEANZA, 1967b, p. 196 (type, *I. washbournei;* OD); ?*Herrickiceras* COBBAN & HOOK, 1980, p. 22 (type, *Placenticeras costatum* HERRICK & JOHNSON, 1900, p. 214; OD)].

Involute, with sides generally inflated on inner part in young but later similar or subparallel; venter concave, with sharp ventrolateral keels or slight clavi; feeble siphonal ridge may be present; inner whorls typically with weak ribs. [*Herrickiceras* differs only in having falciform ribbing and is probably unnecessary.] *Upper Cretaceous (Lower Turonian–Middle Turonian):* Spain, Tunisia, Nigeria, Oman, New Mexico, Texas, Mexico, Venezuela, Colombia.——FIG. 138,*2a,b.* **W. wallsi* (REYMENT), Lower Turonian, Nigeria; ×1 (Reyment, 1954a).

Eotissotia BARBER, 1957, p. 53 [**E. simplex;* OD]. Involute, compressed, and smooth. Venter tabulate, then rounded, and finally narrowly arched. Suture with first lateral saddle broad and weakly denticulate, second and third entire and oblique. *Upper Cretaceous (Lower Turonian):* Nigeria, Oman.——FIG. 137,*3a,b.* **E. simplex;* ×1 (Barber, 1957).

Donenriquoceras WIEDMANN, 1960, p. 758 [**D. forbesiceratiforme;* OD]. Very involute and compressed, with venter tabulate or broadly rounded and later narrowly arched; smooth except for fine, opposite ventrolateral clavi. Suture with the 3 outer saddles divided by deep lobules but with simple folioles. Differs from *Eotissotia* only in the suture and the ventrolateral clavi. *Upper Cretaceous (Lower Turonian):* Spain.——FIG. 138,*3a–c.* **D. forbesiceratiforme; a,b,* ×0.75; *c,* ×1 (Wiedmann, 1960).

Choffaticeras HYATT, 1903, p. 37 [**Pseudotissotia meslei* PERON, 1897, p. 33; OD]. Compressed to inflated, lanceolate to cordate in section, some with biconcave flanks and bell-shaped section; venter sharp to bluntly rounded, with subdued siphonal keel, with or without weak ventrolateral keels or rows of tubercles; inner whorls smooth or with dense ribs and umbilical and ventrolateral tubercles; ribs and tubercles disappearing at varying diameters. Suture very variable in detail and in number and position of elements in external suture line; first lateral saddle deeply indented, others feebly. Presumably derived from *Pseudotissotia* by raising of siphonal line. *Upper Cretaceous (Lower Turonian):* Spain, France, northern and western Africa, Syria, Israel, Jordan, Madagascar, Colorado.

C. (**Choffaticeras**). Distinct ventrolateral keels or rows of tubercles on early whorls. Occurrence and distribution as for genus.——FIG. 139,*1a–c.* **C. (C.) meslei* (PERON), Algeria; *a,* ×0.5; *b,* ×0.25; *c,* ×0.5 (Peron, 1896–1897).

C. (**Leoniceras**) H. DOUVILLÉ, 1911, p. 86 [**Pseudotissotia (Choffaticeras) luciae* PERVINQUIÈRE, 1907, p. 354; OD]. Whorl section more or less lanceolate; without perceptible tubercles or ventrolateral keels even on inner whorls. Occurrence and distribution probably as for genus.——FIG. 139,*2a–c.* **C. (L.) luciae* (PERVINQUIÈRE), Tunisia; ×0.5 (Pervinquière, 1907).

Hemitissotia PERON, 1897, p. 73 [**H. cazini;* OD] [=*Heterammonites* COQUAND, 1880, p. 39, *nom. dub.; Plesiotissotia* PERON, 1897, p. 79 (type, *P. michaleti;* OD); *Allotissotia* PARNES, 1964, p. 14 (type, *Hemitissotia galeppei* PERVINQUIÈRE, 1907, p. 359; OD)]. More or less compressed and lanceolate, with sharp venter; sparse, rounded, branching ribs may be present on early whorls or throughout (*Plesiotissotia*). Suture simplifying, generally irregular, with 1 or more inner saddles entire. Little if any significant difference from *Choffaticeras (Leoniceras). Upper Cretaceous (Coniacian):* Austria, southern Europe, northern Africa, Israel.——FIG. 138,*1a.* **H. cazini,* Algeria; slightly enlarged (adapted from Peron, 1896–1897).——FIG. 138,*1b,c. H. michaleti* (PERON), Algeria; ×1 (Peron, 1896–1897).——FIG. 138,*1d–f. H. galeppei* PERVINQUIÈRE, Tunisia; *d,e,* ×0.5; *f,* ×1 (Pervinquière, 1907).

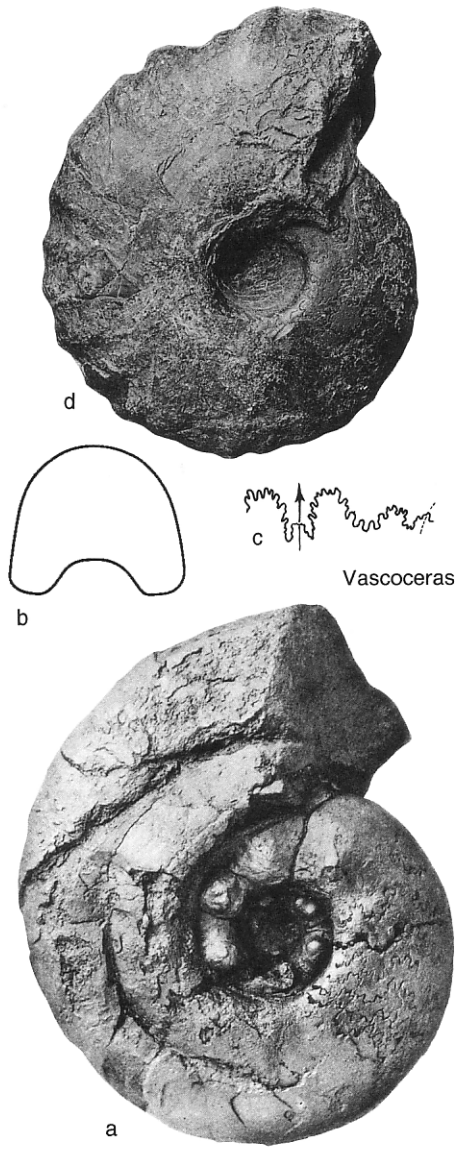


FIG. 135. Vascoceratidae (p. 175–176)

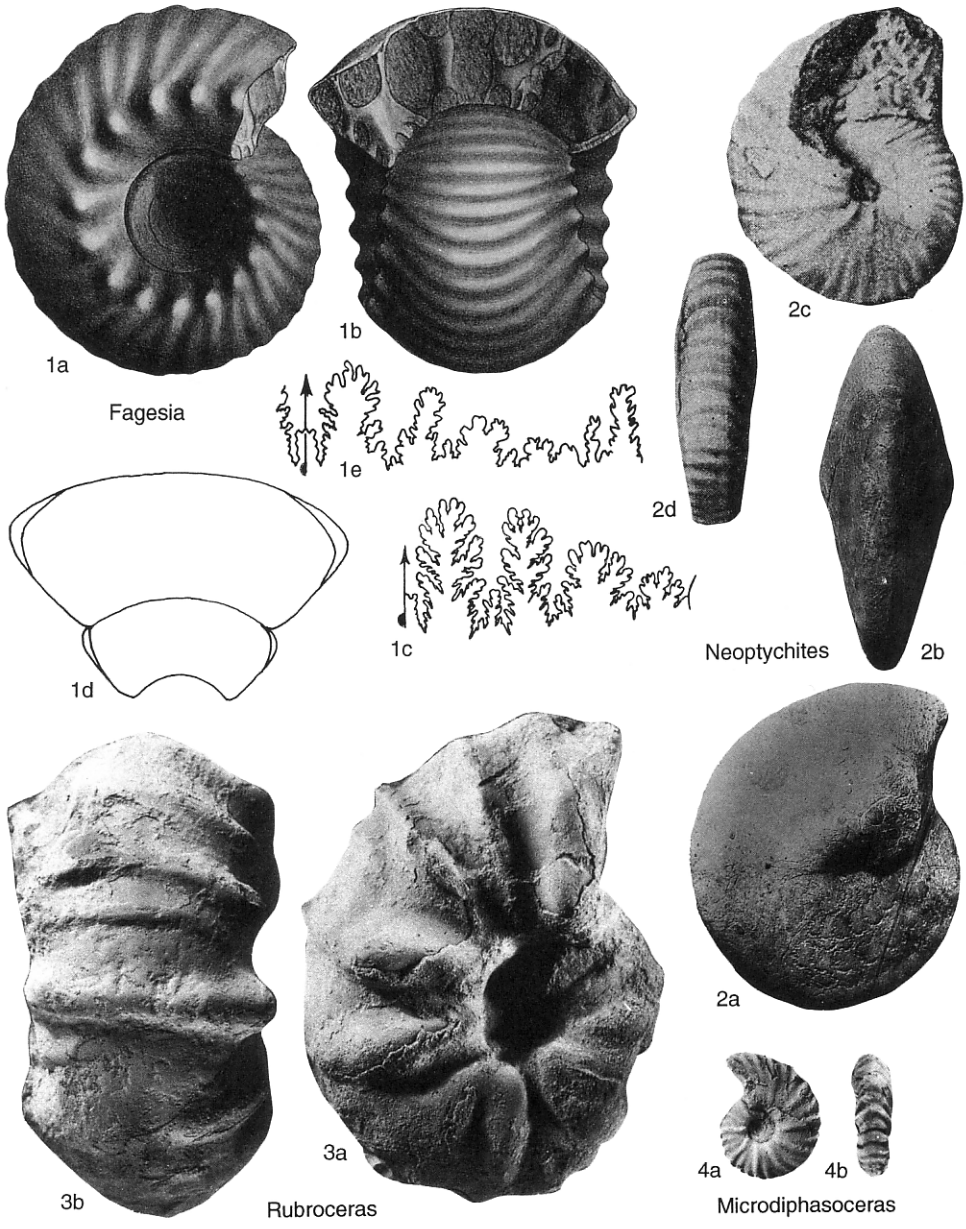


FIG. 136. Vascoceratidae (p. 176–177)

Subfamily HOURCQIINAE Renz, 1982

[*nom. transl.* MATSUMOTO & TOSHIMITSU, 1984, p. 243, *ex* Hourcqiidae RENZ, 1982, p. 103]

Strongly ornamented, with coarse ribs, umbilical and ventrolateral tubercles, and blunt keel. Suture with long, well-indented elements. *Upper Cretaceous (Upper Turonian, ?Coniacian).*

Masiaposites COLLIGNON, 1965a, p. 69 [**M. carinatus;* OD]. Rather involute, high-whorled, with distinct ventrolateral shoulders and blunt keel; inner part of side more or less strongly inflated and separated by spiral depression from outer part; umbilical

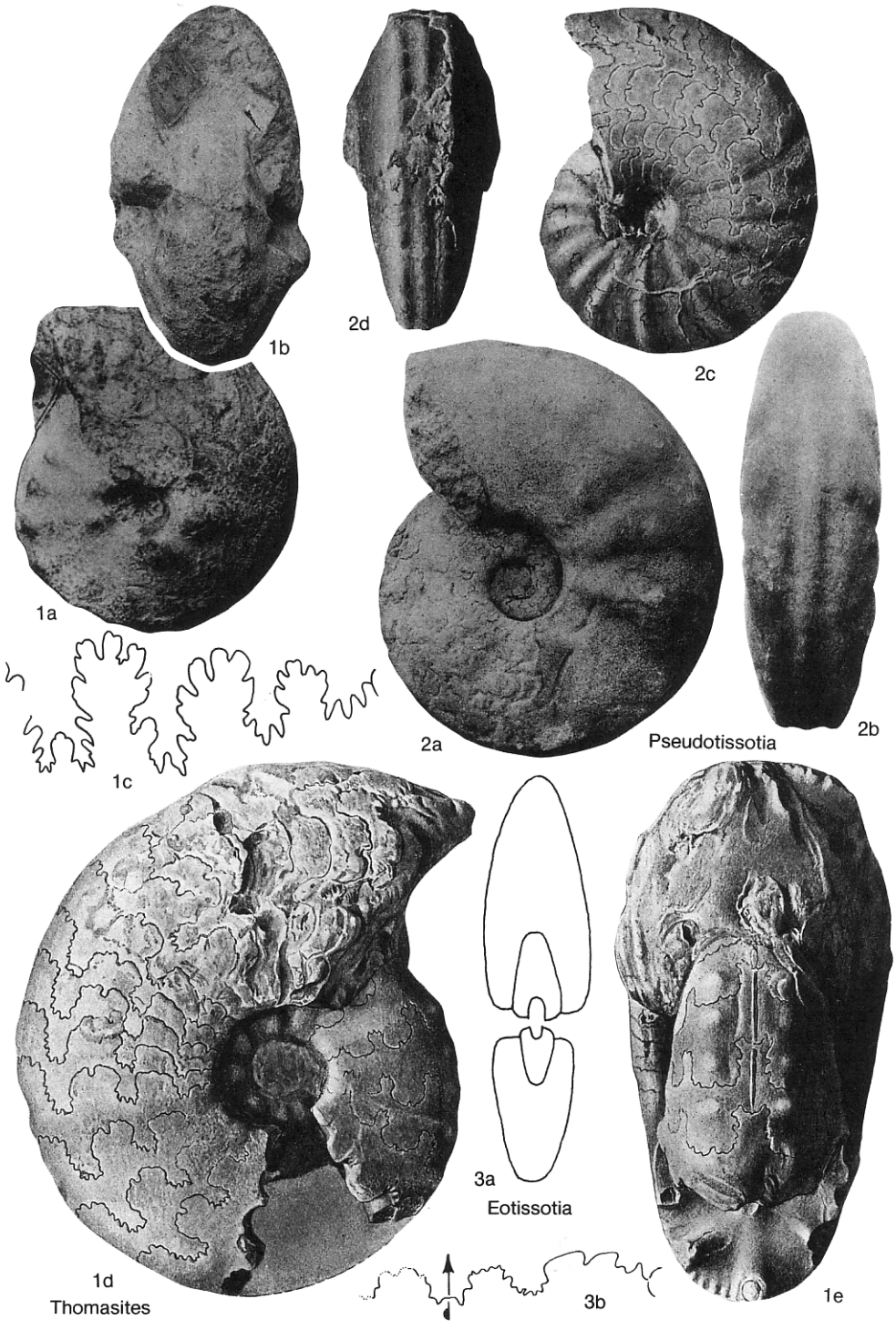


FIG. 137. Pseudotissotiidae (p. 178–179)

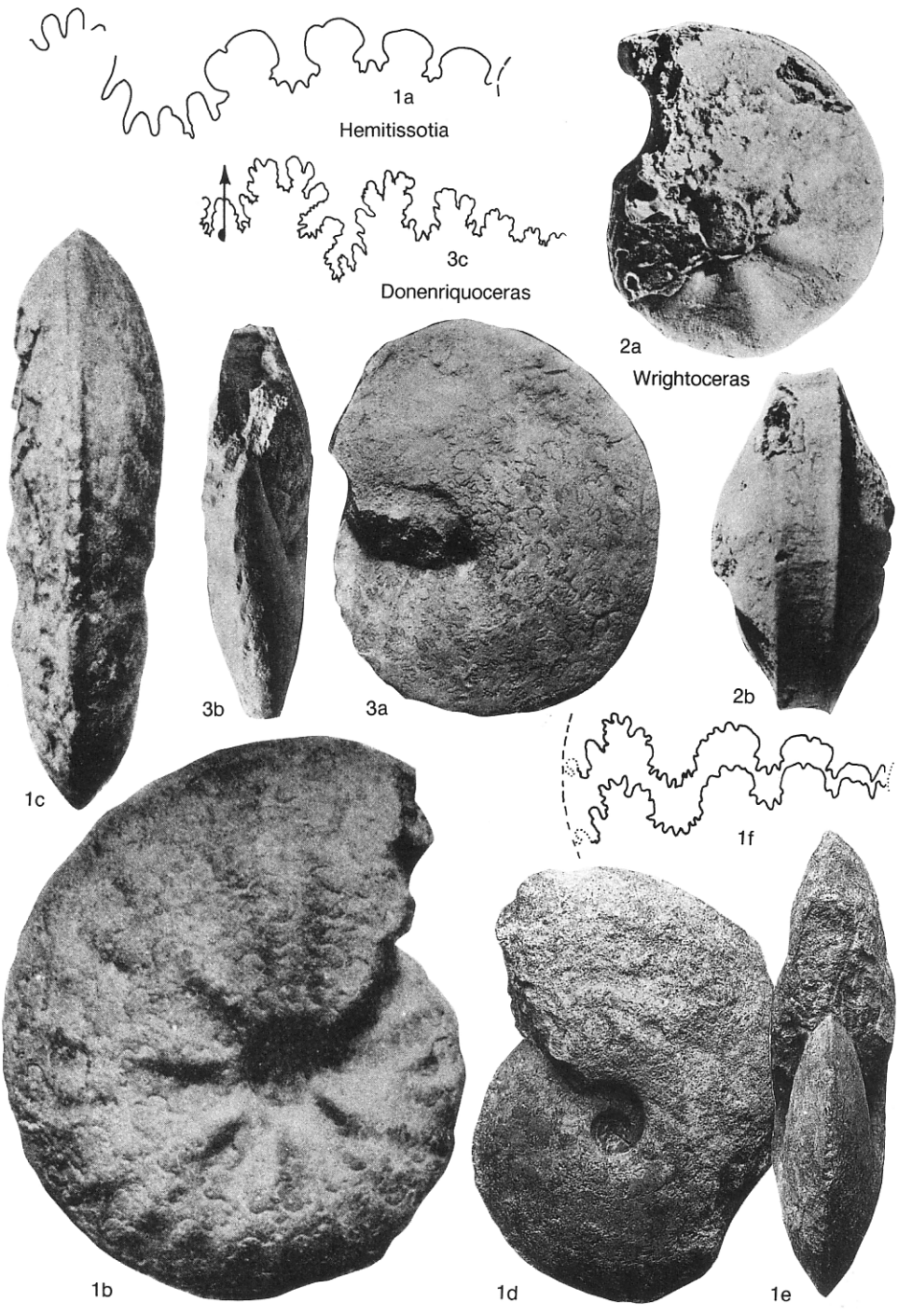


FIG. 138. Pseudotissotiidae (p. 178–179)

tubercles weak to strongly rounded; strong ventrolateral tubercles sometimes present. Suture with narrow, elongate elements, the lobes asymmetric.

Upper Cretaceous (Upper Turonian): Madagascar.
——FIG. 140,*2a,b.* **M. carinatus;* ×0.75 (Collignon, 1965a).

Hourcqia COLLIGNON, 1965a, p. 77 [**H. mirabilis;* OD]. Moderately involute, with strong, coarse ribs, rounded siphonal keel, and rounded to bullate umbilical and slightly clavate ventrolateral tubercles; in adults a marked depression at midflank may interrupt ribs. Suture with more massive lobes than in *Masiaposites. Upper Cretaceous (Upper Turonian, ?Coniacian):* ?France, Madagascar, Sakhalin, New Mexico, Venezuela.——FIG. 140,*1a,b. H. ingens* COLLIGNON, Upper Turonian, Madagascar; ×0.75 (Collignon, 1965a).——FIG. 140,*1c–e. H. pacifica* MATSUMOTO, ?Coniacian, Sakhalin; *c,d,* ×0.85; *e,* ×2 (Matsumoto, 1970b).

Family COLLIGNONICERATIDAE Wright & Wright, 1951

[Collignoniceratidae WRIGHT & WRIGHT, 1951, p. 30, *nom. nov. pro* Prionotropidae ZITTEL, 1895, p. 430 (*ex Prionotropis* MEEK, 1876, p. 453, *non* FIEBER, 1853, p. 127; =*Collignoniceras* BREISTROFFER, 1947a, unpaged)] [=Prionocyclidae BREISTROFFER, 1947a, unpaged (*ex Prionocyclus* MEEK, 1871b, p. 298, ineligible as family type)]

Typically rather involute to evolute; compressed; oval or square-whorled, with serrate or entire keel and ribs bearing 1 to 5 tubercles. *Upper Cretaceous (Upper Cenomanian–Middle Campanian).*

The nominate subfamily was probably derived from *Thomelites* and late in the Turonian gave rise in a short time to 3 other subfamilies, 2 of which persisted to the Campanian. These subfamilies might be treated as families but are closely related.

Subfamily COLLIGNONICERATINAE Wright & Wright, 1951

[*nom. transl.* WRIGHT, 1957b, p. 426, *ex* Collignoniceratidae WRIGHT & WRIGHT, 1951, p. 30]

Compressed; rectangular to square-whorled, with coarsely to finely serrate keel and more or less prominent umbilical and inner and outer ventrolateral tubercles; ventrolateral tubercles may fuse in adult into large horns; in some forms all ornament weakening with age. *Upper Cretaceous (Upper Cenomanian–Upper Coniacian).*

Cibolaites COBBAN & HOOK, 1983, p. 16 [**C. molenaari;* OD]. Moderately compressed to slightly inflated; venter flat or fastigiate; primary ribs bearing strong, rounded or bullate umbilical tubercles; secondaries branching or intercalated; all ribs bearing single ventrolateral and siphonal clavi. Suture rather irregular, with simplified outline. Transitional from *Thomelites* to *Collignoniceras. Upper Cretaceous (Upper Cenomanian–Lower Turonian):* England, France, western Germany, New Mexico.——FIG.

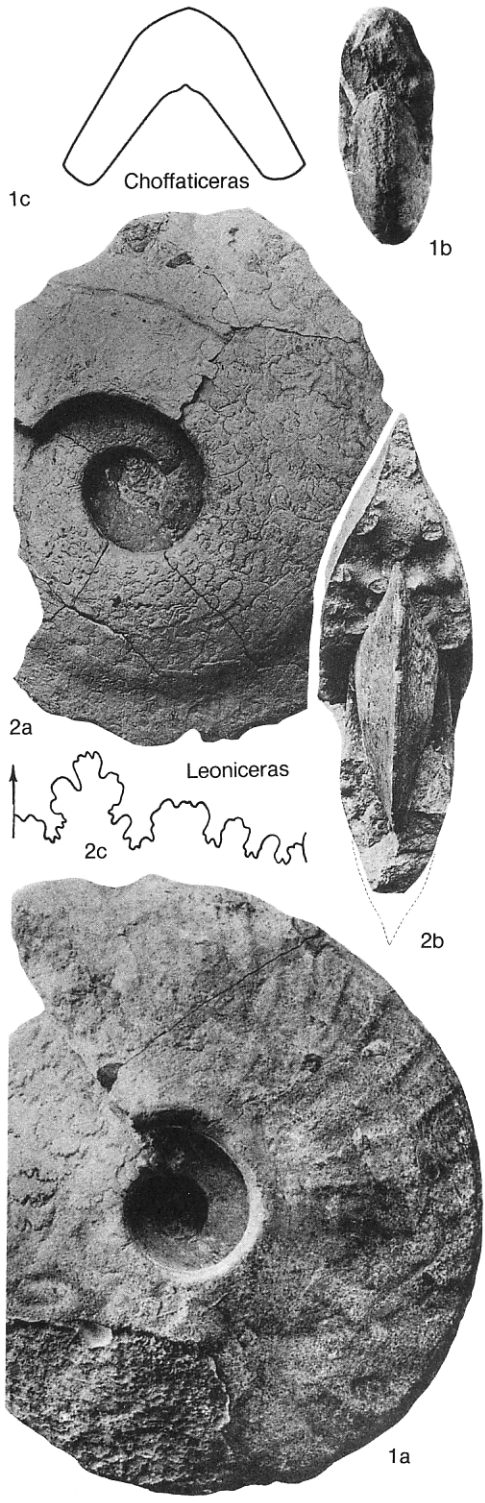


FIG. 139. Pseudotissotiidae (p. 179)

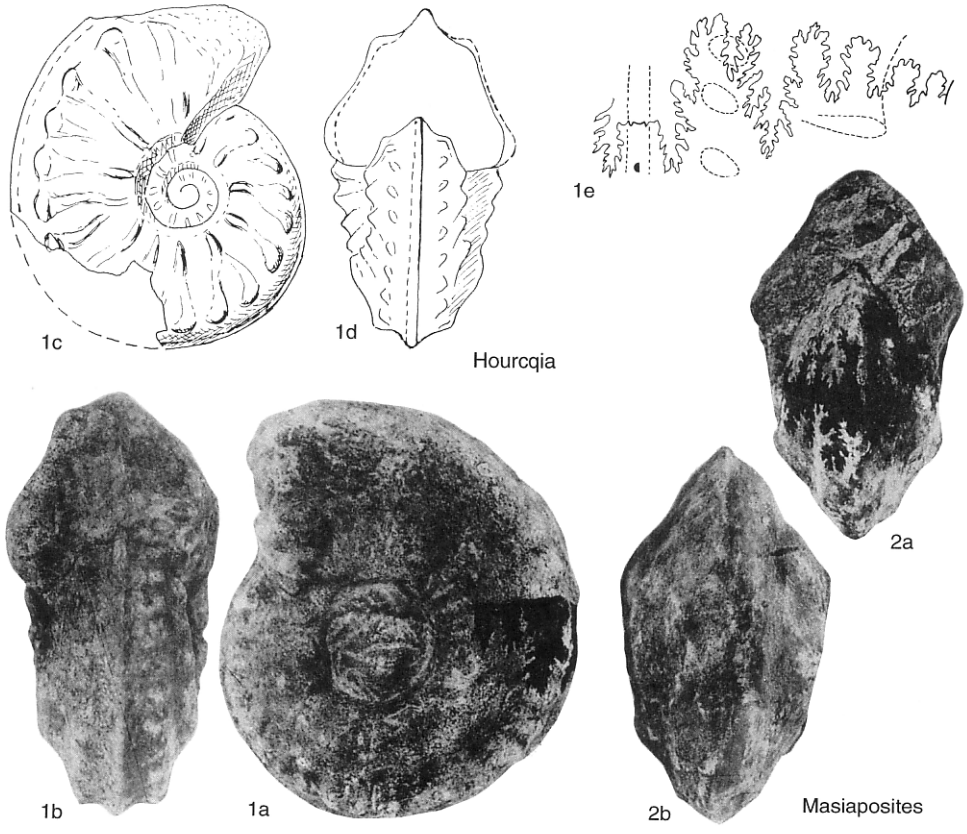


FIG. 140. Pseudotissotiidae (p. 180–183)

141,*5a,b.* **C. molenaari*, Lower Turonian, New Mexico; ×1 (Cobban & Hook, 1983).

Collignoniceras BREISTROFFER, 1947a, unpaged, ICZN Opinion 861, 1968, Generic Name No. 1798 (*non* HOEPEN, 1955b, p. 361), *nom. nov. pro Prionotropis* MEEK, 1876, p. 453, *non* FIEBER, 1853, p. 127 [**Ammonites woollgari* MANTELL, 1822, p. 197; OD; ICZN Specific Name No. 2251] [=*Selwynoceras* WARREN & STELCK, 1940, p. 151, ICZN Generic Name No. 1799 (type, *Prionotropis borealis* WARREN, 1930a, p. 25; OD)]. Compressed in early stages; siphonal tubercles rounded or high and clavate, forming a serrate keel, the serrations corresponding in number with the ribs; ribs straight or slightly sinuous, with weak umbilical and strong inner and outer ventrolateral tubercles; later whorls may be squarer in section, with an exaggerated ventrolateral horn that may absorb even the umbilical tubercle. [*Prionotropis borealis* WARREN, the type species of *Selwynoceras,* is a typical, though small, species of *Collignoniceras.*] KENNEDY, WRIGHT, & HANCOCK, 1980b. *Upper Cretaceous (Turonian):* Europe, Turkestan, Japan, Bathurst Island, Canada, USA, Mexico, Colombia.——FIG. 141,*3a,b.* **C. woollgari* (MANTELL), England; ×0.5 (Sharpe, 1853–1857).

Lecointriceras KENNEDY, WRIGHT, & HANCOCK, 1980b, p. 588 [**Ammonites fleuriausianus* ORBIGNY, 1841, p. 350; OD]. Whorl section trapezoidal at first, then square; sparse, conical umbilical tubercles giving rise to pairs of low, broad ribs, each with rounded inner and clavate outer ventrolateral tubercles; venter at first fastigiate with siphonal clavi, but later broadening and flattening and ventrolateral tubercles fusing into a single tubercle; end of body chamber tubular and smooth. *Upper Cretaceous (Lower Turonian):* western and central Europe.——FIG. 141,*4a–d.* **L. fleuriausianum* (ORBIGNY), France; *a,b,* ×1; *c,d,* ×0.4 (Kennedy, Wright, & Hancock, 1980b).

Subprionocyclus SHIMIZU, 1932, p. 2 [**Prionocyclus hitchinensis* BILLINGHURST, 1927, p. 516; OD] [=*Oregoniceras* ANDERSON, 1958, p. 263 (1943, p. 185, *nom. nud.*) (type, *Schloenbachia oregonensis* ANDERSON, 1902, p. 122; OD); *Ledoceras* BASSE DE MÉNORVAL, 1963, p. 871 (type, *L. massoni;* OD)]. Small; compressed to square-whorled; involute to rather evolute; prominent keel finely or coarsely serrate according to the ribbing; ribs sharp at first but may be flat on outer whorls, springing in pairs from weak umbilical tubercles or intercalated; outer ventrolateral clavi on all ribs and inner at least at

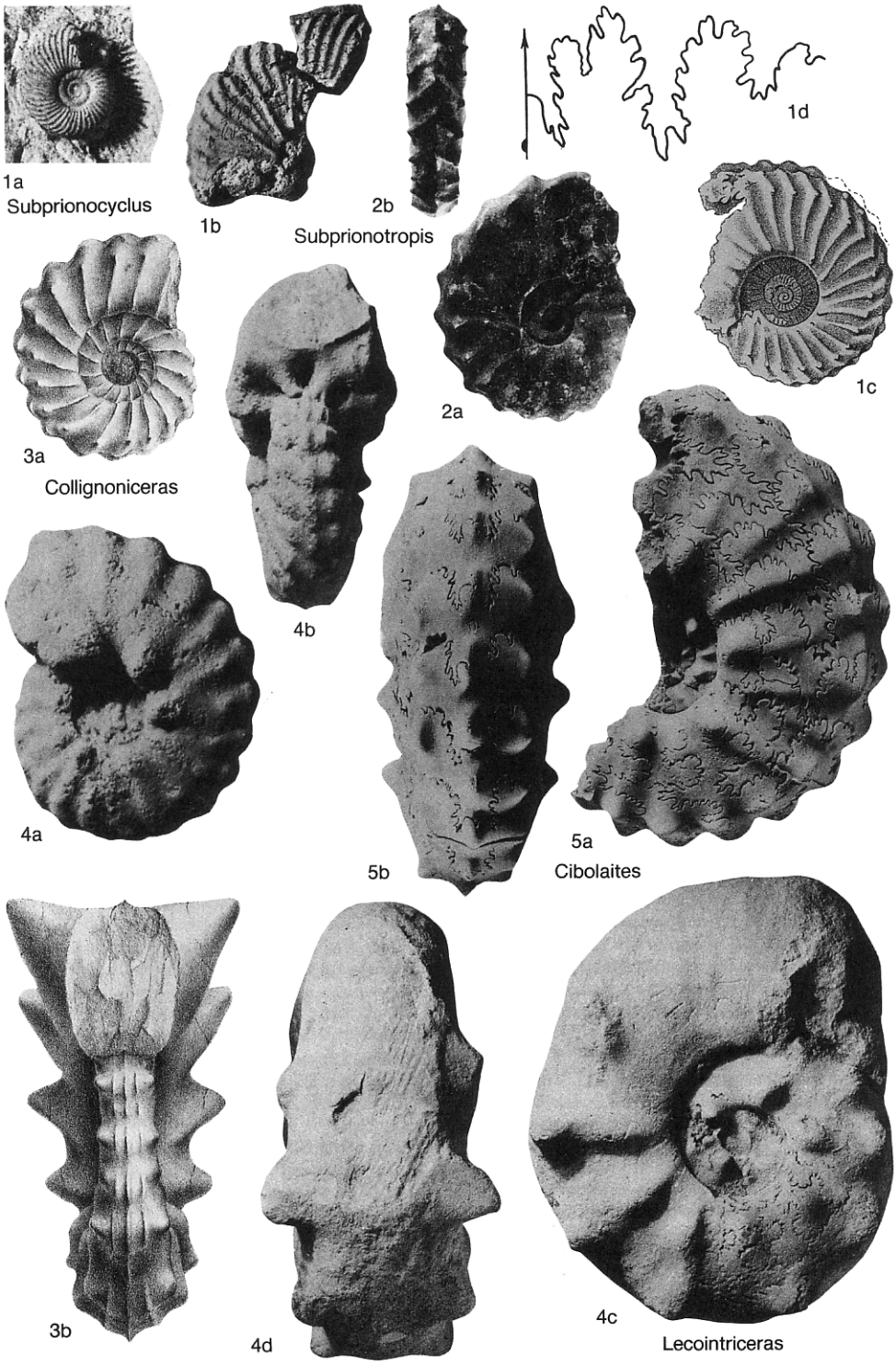


FIG. 141. Collignoniceratidae (p. 183–186)

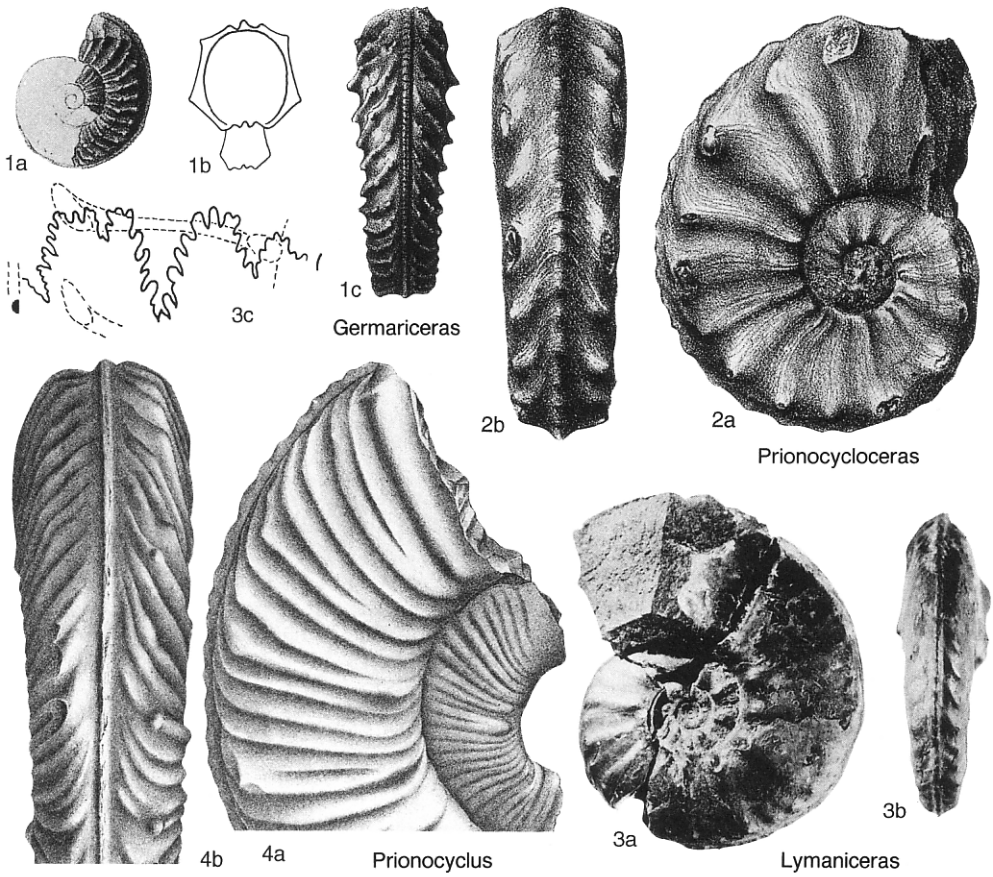


FIG. 142. Collignoniceratidae (p. 186–187)

some growth stage. Outer side of saddle E/L may be obliquely trifid. *Upper Cretaceous (Upper Turonian):* western Europe, Angola, Japan, California, Oregon, Brazil.——FIG. 141,*1a,b.* **S. hitchinensis* (BILLINGHURST), England; ×1 (Wright, 1979).——FIG. 141,*1c,d. S. neptuni* (GEINITZ), England; *c,* ×1; *d,* enlarged (Woods, 1896).

Lymaniceras MATSUMOTO, 1965a, p. 29 [**L. planulatum;* OD]. Small; involute; high-whorled and compressed; with nearly parallel sides, fastigiate venter, and finely crenate, narrow keel; ribs alternately long and short, the long ones rising from umbilical bullae; each rib having a small ventrolateral tubercle homologous with inner ventrolateral in *Prionocyclus,* of which *Lymaniceras* appears to be a local offshoot. Suture with shallow, simple minor elements. *Upper Cretaceous (Upper Turonian):* Japan.——FIG. 142,*3a–c.* **L. planulatum; a,b,* ×1; *c,* ×3 (Matsumoto, 1965a).

Subprionotropis BASSE, 1950, p. 250 [**S. colombianus;* OD]. Small; moderately involute; sides flat and parallel or widest at shoulders; ribs rather strong, distant, branching in pairs from sharp umbilical tubercles and joining sharp ventrolateral tubercles to distant siphonal clavi in chevrons across fastigiate venter; feeble tubercles may appear between ventrolateral and siphonal tubercles. *Upper Cretaceous (Upper Turonian–Lower Coniacian):* South Africa (Pondoland), Japan, Colombia, Venezuela. ——FIG. 141,*2a,b.* **S. colombianus,* Lower Coniacian, Colombia; ×1 (Basse, 1950).

Prionocyclus MEEK, 1871b, p. 298 [**Ammonites serratocarinatus* MEEK, 1871a, p. 429, *non* STOLICZKA, 1864, p. 57; =*Prionocyclus wyomingensis* MEEK, 1876, p. 452; SD]. Differs from *Collignoniceras* in its generally denser and finer ribs, which are irregular in strength and length on outer whorl and dominant over tubercles at least at some stage; venter rather broad, with ribs joining keel, which has more serrations than there are ribs. *Upper Cretaceous (Turonian):* Germany, Croatia, Tunisia, Angola, Japan, USA, Mexico.——FIG. 142,*4a,b.* **P. wyomingensis,* Wyoming; ×0.75 (White, 1880).

Germariceras BREISTROFFER, 1947a, unpaged [**Ammonites germari* REUSS, 1845, p. 22; OD]. Differs from square-whorled species of *Subprionocyclus* in its fine ribs with sharp tubercles and its keel with more serrations than there are ribs. Perhaps a synonym of

Prionocyclus, from which it differs only in thinness of the ribs. *Upper Cretaceous (Upper Turonian, ?Lower Coniacian):* central Europe.——FIG. 142,*1a–c.* **G. germari* (REUSS), Upper Turonian, Czech Republic; *a,* ×1; *b,c,* ×2 (Fritsch, 1872).

Prionocycloceras SPATH, 1926a, p. 80 [**Prionocyclus guayabanus* GERHARDT, 1897b, p. 197; OD] [=*Donjuaniceras* BASSE, 1950, p. 245 (type, *D. longispinata;* OD)]. Evolute; whorl section more or less rectangular, with angular to sharply rounded shoulders; keel mainly distinct with grooves on either side but may weaken on outer whorls; keel with crenulations more numerous than ribs; ribs generally simple but may be intercalated, typically distant, rursiradiate at shoulder, strongly projected on venter, crossing keel as riblets; ventrolateral tubercles may be double, but inner ones dominant and enlarging into a septate horn. *Upper Cretaceous (Coniacian):* Spain, Armenia, northern Africa, Madagascar, Texas, Venezuela, Colombia, Brazil. ——FIG. 142,*2a,b.* **P. guayabanum* (GERHARDT), Colombia; ×1 (Gerhardt, 1897b).

[**Spathinella** SHIMIZU, 1935a, p. 197 (*nom. nud.*)].

Subfamily BARROISICERATINAE Basse, 1947

[Barroisiceratinae BASSE, 1947b, p. 159(63)] [=Diaziceratinae BASSE, 1947b, p. 159(63)]

Very evolute to very involute; compressed to inflated; with crenulate, rarely entire, keel weakening and disappearing on outer whorls in some; fine to strong ribs rising from umbilical tubercles, forming ventrolateral clavi and bending forward to keel; one stock with and the other without midlateral tubercles; some forms may be smooth after early whorls. Suture with variable number of short and moderately incised saddles; external saddle commonly with oblique outer slope and in some obliquely trifid. Derived from later Collignoniceratinae, the Barroisiceratinae may be distinguished by the absence at any stage of an inner ventrolateral tubercle and, generally, by the sparseness of the ribs. KENNEDY, WRIGHT, & KLINGER, 1983. *Upper Cretaceous (Upper Turonian–Upper Santonian).*

Niceforoceras BASSE, 1948, p. 694 [**N. columbianum;* OD]. Involute; compressed, with flat or slightly convex sides; venter rounded with weak crenulations corresponding in number to ribs or fastigiate with stronger crenulations; umbilical wall vertical; more or less distinct umbilical tubercles giving rise to fine, sinuous ribs or striae ending in single ventrolateral clavi. Close to *Barroisiceras* and probably synonymous. *Upper Cretaceous (Coniacian):* Venezuela, Colombia.——FIG. 143,*3a,b. N. umbulaziforme* BASSE, Colombia; ×1 (Basse, 1948).

Barroisiceras GROSSOUVRE, 1894, p. 50, *nom. nov. pro Barroisia* GROSSOUVRE, 1894, p. 50, *non* MUNIER-CHALMAS, 1882, p. 425 [**Ammonites haberfellneri* HAUER, 1866, p. 301; SD SOLGER, 1904, p. 163] [=*Subbarroisiceras* BASSE, 1947a, p. 71 (type, *S. mahafalense;* OD); *Reesidites* WRIGHT & MATSUMOTO, 1954, p. 130 (MATSUMOTO, 1942b, p. 197, *nom. nud.*) (type, *Barroisiceras minimum* HAYASAKA & FUKADA, 1951, p. 325; OD); *Basseoceras* COLLIGNON, 1965b, p. 73 (type, *B. colnacapi;* OD); *Itwebeoceras* HOEPEN, 1968b, p. 184 (type, *I. lornae;* OD); *Buenoceras* ETAYO SERNA, 1979, p. 101 (type, *B. loboi;* OD)]. Rather involute to rather evolute; compressed to moderately inflated; high-whorled, with flat to slightly convex sides and fastigiate venter; dense to sparse, bullate to spinate umbilical tubercles giving rise to 2 or 3 straight to slightly sinuous, narrow to broad ribs; additional ribs may be intercalated; each rib bearing a distinct ventrolateral and siphonal clavus; ornament weakening on body chamber and may disappear except for fine striae and traces of siphonal tubercles. Primitive forms (e.g., *B. minimus*) differ from *Subprionocyclus* only in the absence of inner ventrolateral tubercles at any stage. REYMENT, 1975. *Upper Cretaceous (Upper Turonian–Lower Coniacian):* England, Spain, Germany, Austria, northern and western Africa, South Africa (Zululand), Madagascar, Armenia, Japan, Texas, Venezuela, Colombia, Peru.——FIG. 144*a,b.* **B. haberfellneri* (HAUER), ?Upper Turonian, Austria; ×1 (Redtenbacher, 1873).——FIG. 144*c–e. B. minimum* HAYASAKA & FUKADA, Upper Turonian, Japan; *c,d,* ×0.5; *e,* ×2.5 (Matsumoto, 1965a).——FIG. 144*f,g. B. mahafalense* (BASSE), Lower Coniacian, Madagascar; ×0.4 (Basse, 1947a).——FIG. 144*h,i. B. colnacapi* (COLLIGNON), Lower Coniacian, Madagascar; ×0.75 (Collignon, 1965b).

?Kondiloceras FUCINI, 1901, p. 14 [**K. manciatii;* OD]. Described as from Lower Jurassic, Sinemurian, but from a collection without stratigraphical information; the single specimen appears to be a poorly preserved *Barroisiceras* and name should be treated as a *nomen dubium.*

Forresteria REESIDE, 1932, p. 14 [**Barroisiceras (Forresteria) forresteri* REESIDE, 1932, p. 17; SD WRIGHT, 1957b, p. 432; =*Acanthoceras (Prionotropis) alluaudi* BOULE, LEMOINE, & THEVENIN, 1907, p. 12(32)]. Whorl section and ornament variable but readily distinguished from those of *Barroisiceras* by presence on inner whorls of at least mediolateral tubercle, which later may disappear or fuse with umbilical or ventrolateral tubercle. *Upper Cretaceous (Lower Coniacian):* France, Germany, Tunisia, western Africa, South Africa (Zululand), Madagascar, New Caledonia, Israel, Japan, Utah, Wyoming, Colombia, Peru, Venezuela, Brazil.

F. **(Forresteria)** [=*Solgerites* REESIDE, 1932, p. 14 (type, *Barroisiceras brancoi* SOLGER, 1904, p. 174; OD); *Eboroceras* BASSE, 1947a, p. 73 (type, *E. magnumbilicatum;* OD); *?Zumpangoceras* BASSE,

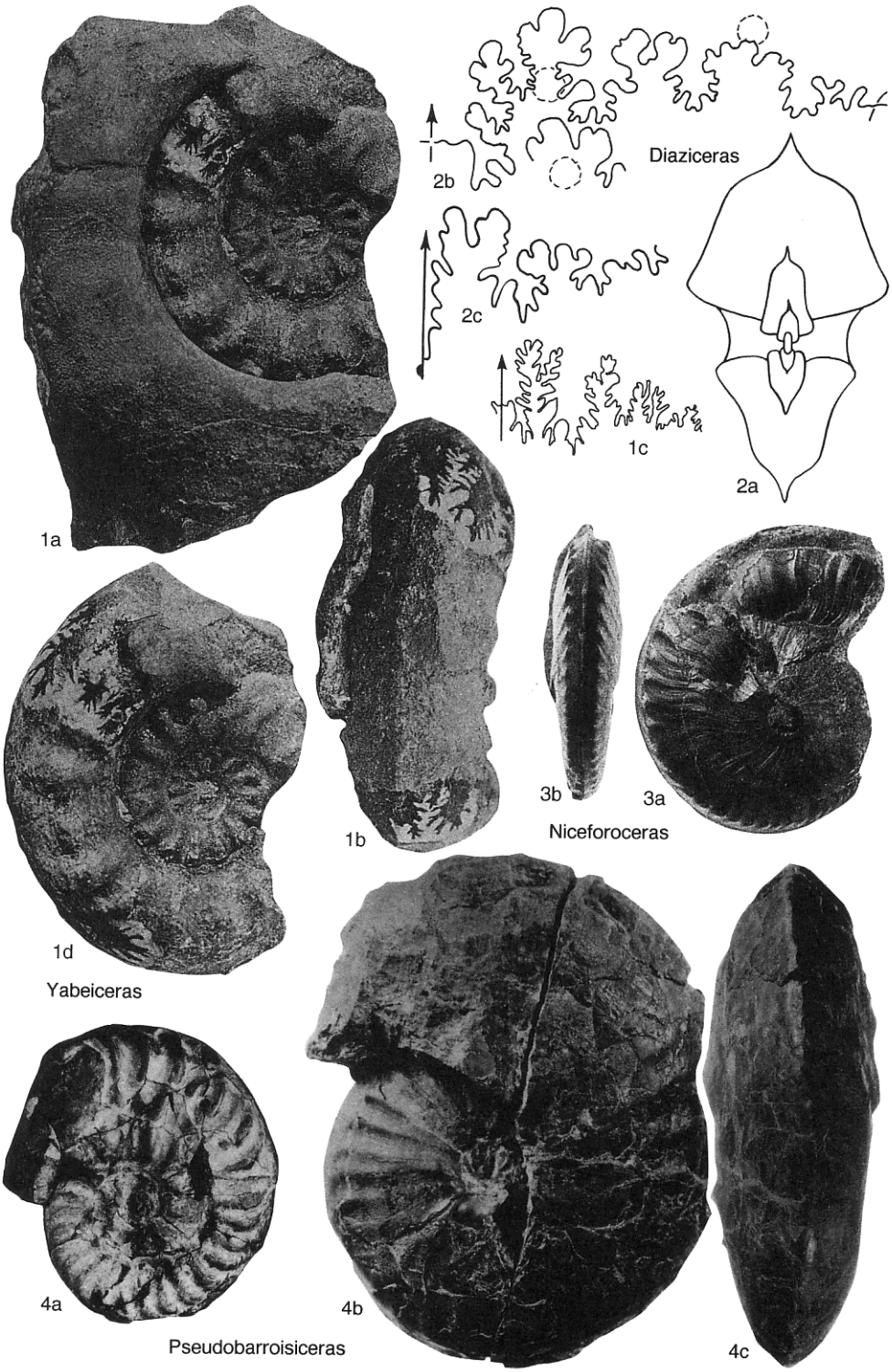


FIG. 143. Collignoniceratidae (p. 187–189)

1947b, p. 144(48) (type, *Z. burkhardti;* OD), on basis of lectotype of type species designated by ETAYO SERNA, 1979, p. 99; *Collignonella* HOEPEN, 1957, p. 350, *nom. nov. pro Collignoniceras* HOEPEN, 1955b, p. 361, *non* BREISTROFFER, 1947a, unpaged (type, *C. hammersleyi;* OD); *Neokanabiceras* COLLIGNON, 1965b, p. 42 (type, *N. madagascariense;* OD; =*?Barroisiceras (F.) hobsoni* REESIDE, 1932, p. 18); *Basseoceras* HOEPEN, 1968a, p. 162, *non* COLLIGNON, 1965b, p. 73 (type, *B. krameri;* M); *Eedenoceras* HOEPEN, 1968a, p. 171 (type, *E. multicostatum;* OD); *Muramotoa* MATSUMOTO, 1969, p. 315 (type, *F. (M.) yezoensis* MATSUMOTO, 1969, p. 315; OD)]. Midlateral tubercle disappearing or fusing eventually with ventrolateral; whorl section moderately to very inflated. *Upper Cretaceous (Lower Coniacian):* South Africa (Zululand), Madagascar, Israel, Japan, Wyoming, Utah, Colombia, Peru, Brazil.——FIG. 145,*2a–c.* **F. (F.) alluaudi* (BOULE, LEMOINE, & THEVENIN), Madagascar; ×1 (Reeside, 1932).

F. (Harleites) REESIDE, 1932, p. 14 [**Barroisia haberfellneri* var. *harlei* GROSSOUVRE, 1894, p. 56; OD; =*Ammonites petrocoriensis* COQUAND, 1859, p. 995] [=*Alstadenites* REESIDE, 1932, p. 14 (type, *Ammonites alstadenensis* SCHLÜTER, 1876, p. 151; SD KENNEDY, WRIGHT, & KLINGER, 1983, p. 259); *Reesideoceras* BASSE, 1947b, p. 132(36) (type, *R. gallicum;* OD)]. Less inflated than *F. (Forresteria);* ribbing very weak to strong; mediolateral tubercle fusing on later whorls with umbilical; keel disappearing on outer whorl leaving venter flat to concave, bordered by ventrolateral clavi. *F. (H.) harlei* is at the smooth end of a wide range of variation. [Species *F. (H.) alstadenensis* and *F. (H.) gallicum* are junior subjective synonyms of *F. (H.) petrocoriensis.*] *Upper Cretaceous (Lower Coniacian):* France, Spain, Germany, Tunisia, Israel, Cameroon, Madagascar, New Caledonia, ?Utah, Colombia, Peru, Venezuela.——FIG. 145,*1a–e.* **F. (H.) petrocoriensis* (COQUAND); *a,b,* syntype of *harlei* GROSSOUVRE, France, ×1; *c,d,* syntype of *gallicum* BASSE, ×1 (Grossouvre, 1894); *e,* lectotype of *alstadenensis* SCHLÜTER, Germany, ×1 (Schlüter, 1871–1876).

Yabeiceras TOKUNAGA & SHIMIZU, 1926, p. 199 [**Y. orientale;* OD]. Very evolute. Inner whorls depressed and like *Forresteria,* but tubercles blunter; later whorls with ventrolateral tubercles disappearing and keel becoming smooth; finally all ornament disappearing on high body chamber. MATSUMOTO & others, 1964. *Upper Cretaceous (Coniacian):* ?Spain, South Africa, Madagascar, Japan.——FIG. 143,*1a–d.* **Y. orientale,* Japan; ×1 (Tokunaga & Shimizu, 1926).

Pseudobarroisiceras SHIMIZU, 1932, p. 1 [**P. nagaoi;* OD]. Rather involute and compressed, with flat sides, fastigiate venter, and entire keel; ribs flexed on inner whorls but straighter on outer, arising in twos or threes from feeble umbilical tubercles, with some intercalated and bearing one, rounded ventrolateral tubercle or swelling; ribs disappearing near keel. *Upper Cretaceous (Coniacian):* ?France, Japan.——FIG. 143,*4a–c.* **P. nagaoi,* Japan; *a,* ×1; *b,c,* ×0.75 (Matsumoto, 1970b).

Diaziceras SPATH, 1921a, p. 217 [**D. tissotiaeforme;* OD]. Compressed to inflated, with fastigiate venter and entire, high, sharp keel; umbilical tubercles sparse and prominent, giving rise to pairs of weak ribs ending in weak to strong, pointed to clavate ventrolateral tubercles. Suture with shallow, plump, only slightly indented elements; first lateral saddle obliquely trifid. *Upper Cretaceous (Upper Santonian):* Austria, South Africa (Zululand), Madagascar.——FIG. 143,*2a–c.* **D. tissotiaeforme,* Zululand; *a,* ×1; *b,c,* ×2 (Spath, 1921a).

Subfamily PERONICERATINAE Hyatt, 1900

[*nom. transl.* WRIGHT, 1957b, p. 428, *ex* Peroniceratidae HYATT, 1900, p. 589] [=Gauthiericeratidae HOEPEN, 1955b, p. 367]

Evolute to involute, with oval, trapezoidal, or subquadrate whorl section; keel losing its close relationship with ribbing and either nodate or entire; lateral keels tending to develop, producing tricarinate venter; typically with umbilical and ventrolateral tubercles only, joined by ribs, but may have up to 4 tubercles on a rib. *Upper Cretaceous (Coniacian).*

Many genera have been established on slight differences, including that between the two types of suture characteristic of *Gauthiericeras* and *Peroniceras;* it is doubtful whether this is as important as is commonly held.

Peroniceras GROSSOUVRE, 1894, p. 93 [**P. moureti;* OD; =*Ammonites tridorsatus* SCHLÜTER, 1867, p. 26] [=*Gloriaceras* ETAYO SERNA, 1979, p. 96 (type, *G. correai;* OD)]. Very evolute to rather involute, with oval, trapezoidal, or square whorl section; venter having 3 entire keels, at least during middle growth, with siphonal one as high as or higher than the others; regular, rounded or conical umbilical tubercles joined to a slightly larger number of similar ventrolateral ones by short, straight or slightly curved, single or branching ribs. Suture varying from simple with short elements, as in Collignoniceratinae, to complex with long, deeply incised elements; L generally more or less bifid; U2 small and tucked under saddle L/U. *Upper Cretaceous (Coniacian):* Europe, southeastern Africa, Madagascar, southern India, Mexico, Colombia, Venezuela.

P. (Peroniceras) [=*Fraudatoroceras* HOEPEN, 1965, p. 35 (type, *F. besairei;* OD); *Cobbanoceras* MATSUMOTO, 1965b, p. 219 (type, *C. tanakai;* OD)]. Very evolute; ornament persisting to end. Occurrence and distribution as for genus.——FIG. 146,*2a–c.* **P. (P.) tridorsatus* (SCHLÜTER), France;

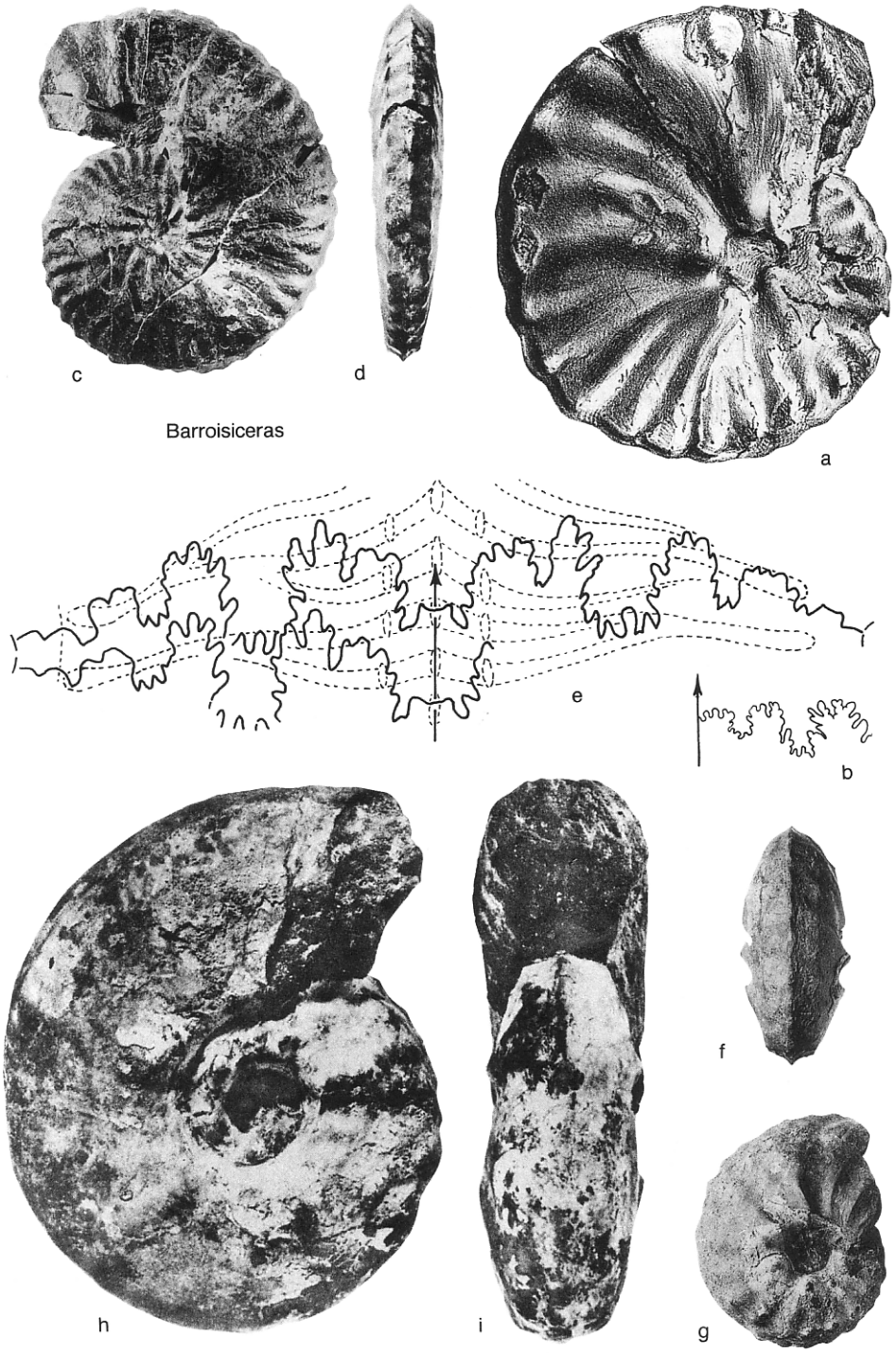


FIG. 144. Collignoniceratidae (p. 187)

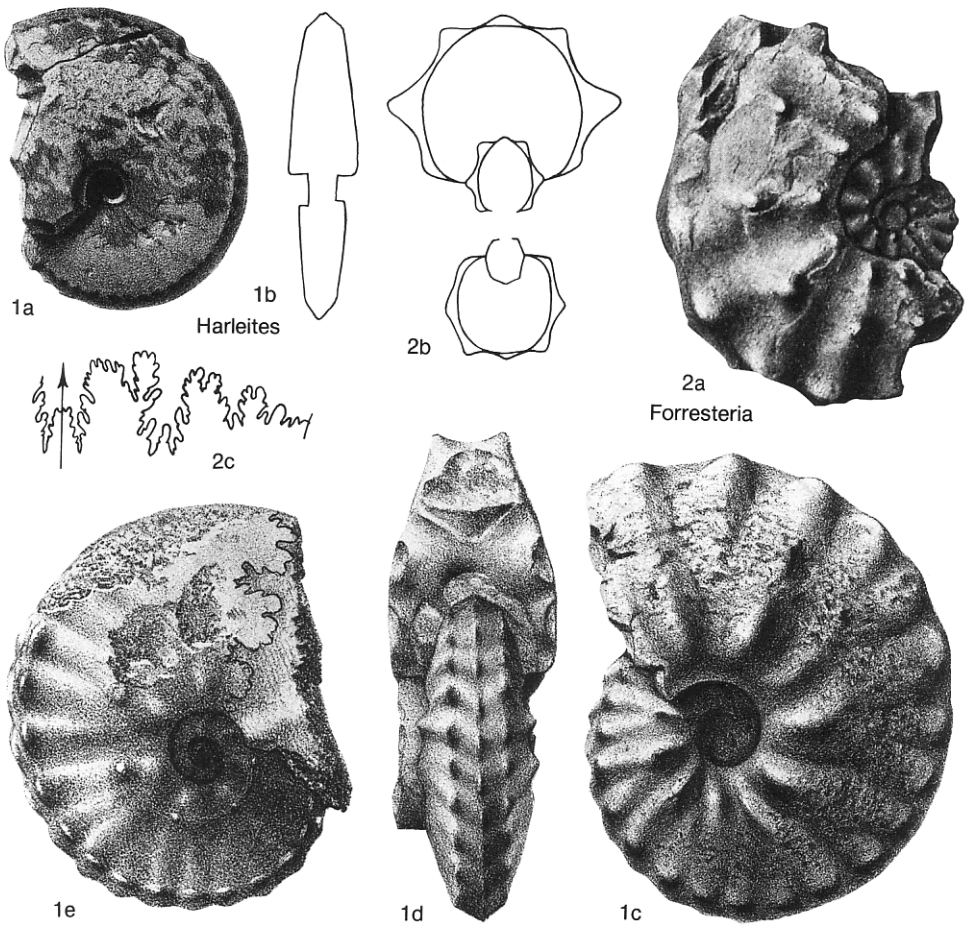


FIG. 145. Collignoniceratidae (p. 187–189)

×1 (Grossouvre, 1894).——FIG. 146,*2d,e. P. (P.) tanakai* (MATSUMOTO), Japan; ×1 (Matsumoto, 1965b).

P. (Zuluiceras) HOEPEN, 1965, p. 9 [**P. (Z.) zulu;* OD] [=*Zuluites* HOEPEN, 1965, p. 23 (type, *P. (Z.) modestum* HOEPEN, 1965, p. 23; OD); *Sornayceras* MATSUMOTO, 1965b, p. 226 (type, *S. proteus;* OD)]. Increasingly involute; side keels disappearing; siphonal keel may be serrate; ribs tending to be dominant over tubercles; last whorl in most species high, inflated, rounded, and smooth. Suture simple or complex. Occurrence as for genus: Romania, South Africa (Zululand), Japan.——FIG. 146,*1a.* **P. (Z.) zulu,* Zululand; ×0.25 (Hoepen, 1965).——FIG. 146,*1b. P. (Z.) modestum,* Zululand; ×1 (Hoepen, 1965).——FIG. 146,*1c,d. P. (Z.) proteus* (MATSUMOTO), Japan; *c,* ×1; *d,* ×2 (Matsumoto, 1965b).

Ishikariceras MATSUMOTO, 1965b, p. 235 [**I. binodosum;* OD]. Very evolute; inner whorls subquadrate, with straight, mostly single ribs, umbilical and strong ventrolateral tubercles, and siphonal keel with shallow grooves on either side but no or very weak side keels; outer whorls oval in section, almost smooth, with shallow constrictions and weak keel. Suture rather simple. *Upper Cretaceous (Coniacian):* Madagascar, Japan.——FIG. 147,*1a,b.* **I. binodosum; a,* ×1; *b,* ×2 (Matsumoto, 1965b).

Gauthiericeras GROSSOUVRE, 1894, p. 87 [**Ammonites margae* SCHLÜTER, 1867, p. 29; OD] [=*Ciryella* WIEDMANN, 1960, p. 763 (type, *Gauthiericeras (Ciryella) vascogoticum* WIEDMANN, 1960, p. 763; OD); *Andersonites* HOEPEN, 1965, p. 29 (type, *A. listeri;* OD); *Fluminites* HOEPEN, 1965, p. 31 (type, *F. albus;* OD); *Hluhluweoceras* HOEPEN, 1965, p. 33 (type, *H. fugitivum;* OD); *Falsebayites* HOEPEN, 1965, p. 34 (type, *F. peregrinus;* OD)]. Rather evolute; whorl section trapezoidal to subquadrate; keel feebly nodate or entire, with distinct groove on either side; strong ribs springing at first in pairs, later

normally singly, from single or double umbilical bullae and ending in strong ventrolateral clavi; midlateral tubercles may be present and, if so, ribs branch there. Suture with rather simple, shallowly incised elements; saddles more or less square; L not distinctly bifid. [*Ciryella,* for very evolute species with slight lateral keels, transitional to *Peroniceras,* seems unnecessary.] *Upper Cretaceous (Upper Coniacian):* France, Spain, central Europe, northern, eastern, and western Africa, Madagascar, New

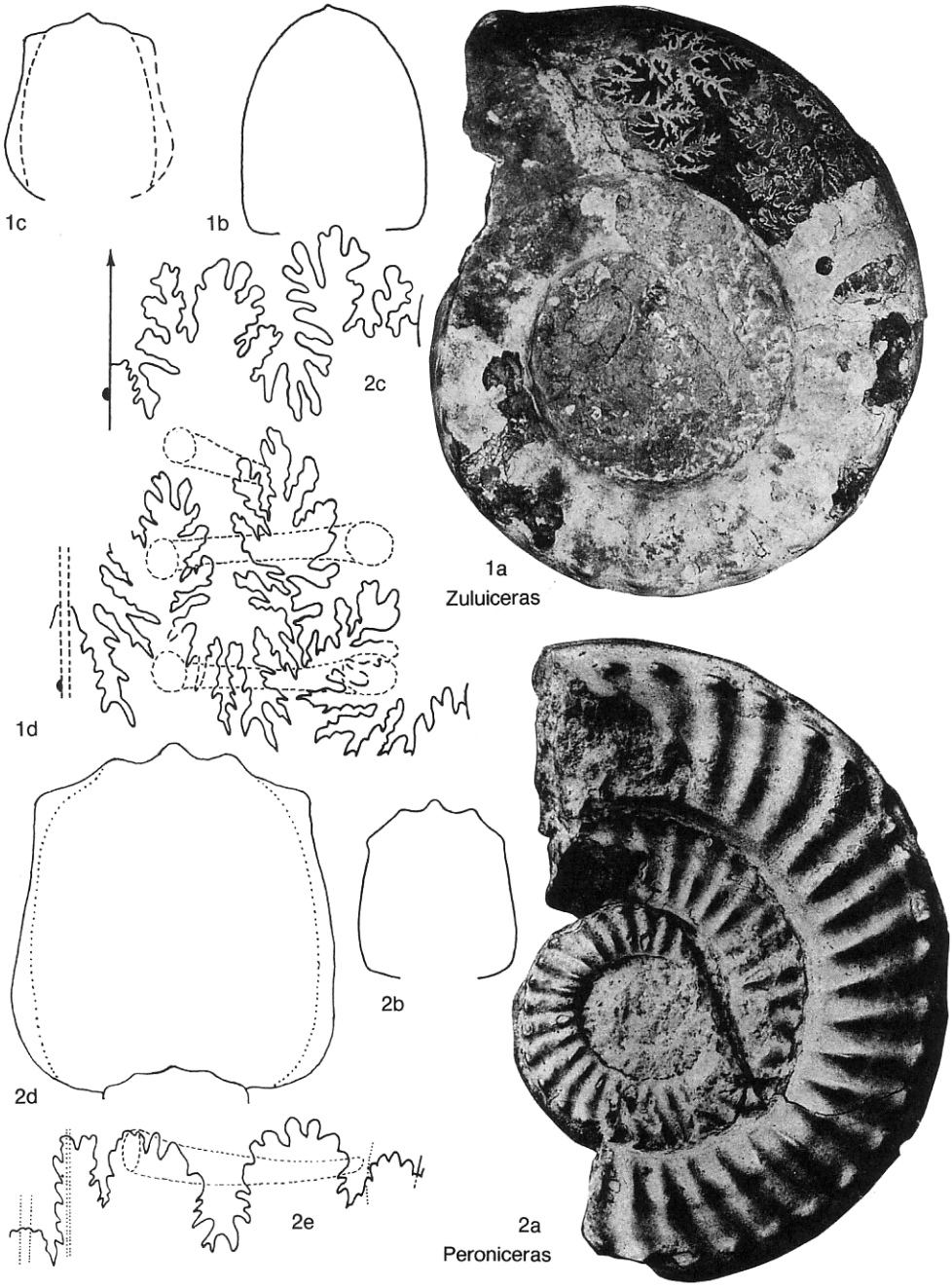


FIG. 146. Collignoniceratidae (p. 189–191)

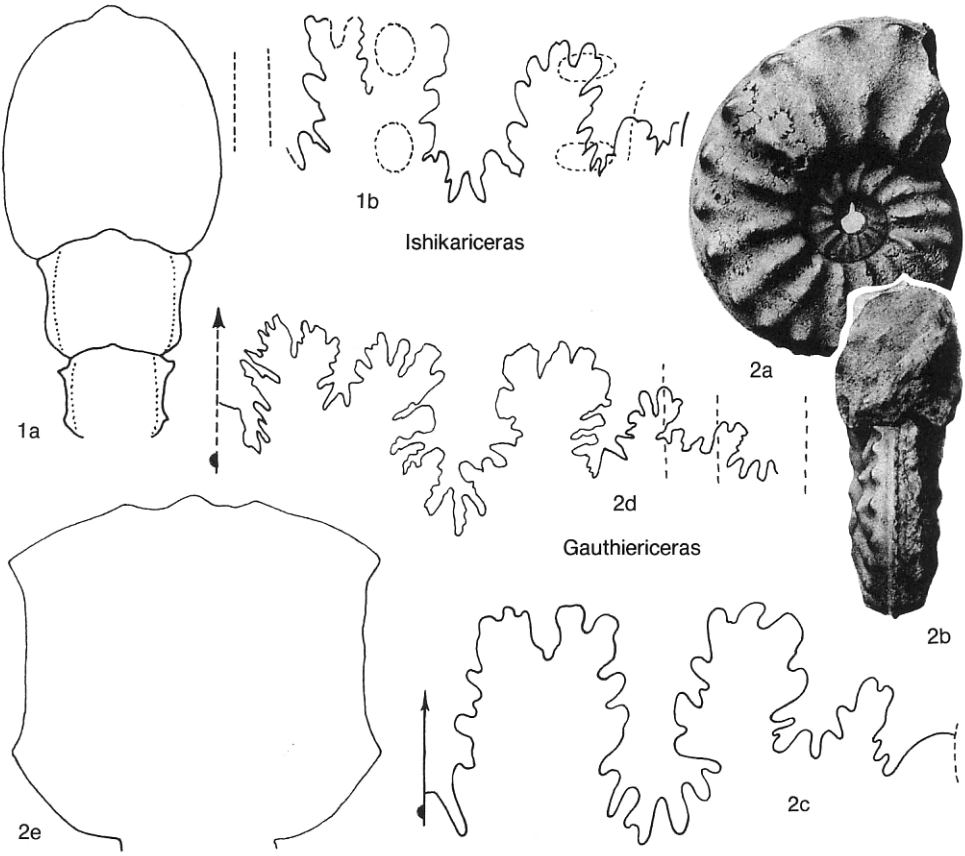


FIG. 147. Collignoniceratidae (p. 191–193)

Caledonia, Mexico, Colombia, Peru, Venezuela, Argentina.——FIG. 147,*2a–c*. **G. margae* (SCHLÜTER), Upper Coniacian, France; *a,b*, ×0.5; *c*, ×2 (Grossouvre, 1894).——FIG. 147,*2d,e*. *G. listeri* (HOEPEN), Upper Coniacian, South Africa (Zululand); *d*, ×1; *e*, ×0.75 (Hoepen, 1965).

Subfamily TEXANITINAE Collignon, 1948

[*nom. transl.* WRIGHT, 1957b, p. 429, *ex* Texanitidae COLLIGNON, 1948, p. 54(9)] [=Menabitinae COOPER, 1991, p. 9]

Evolute to moderately involute; whorl section compressed to inflated; typically with strong ribs bearing 3 to 6 prominent tubercles and with rather subdued, entire keel, but all ornament may weaken on outer whorls. Spinaptychi occur in *Texanites. Upper Cretaceous (Lower Coniacian–Middle Campanian).*

Confusion has arisen from homeomorphy with Albian Mortoniceratinae. Texanitinae was derived from *Subprionocyclus* by the transformation of the row of siphonal tubercles in the latter into a keel.

Protexanites MATSUMOTO, 1955a, p. 38 [**Mortoniceras bourgeoisi* GROSSOUVRE, 1894, p. 73 (*ex* ORBIGNY, 1850a, p. 212); OD]. Evolute to rather involute; whorl section more or less square; ribs simple, branched, or long and short, with umbilical, ventrolateral, and clavate ventral tubercles and rarely with midlateral tubercle on outer whorls; keel entire or weakly undulate. *Upper Cretaceous (Lower Coniacian–Middle Santonian):* France, Spain, Italy, Algeria, South Africa (Zululand), Tunisia, Nigeria, Madagascar, Israel, Japan, Sakhalin, western and southern USA, Peru, Venezuela.

P. **(Protexanites)**. After early smooth stage, ribs trituberculate throughout. Weak undulations on keel of some species recall the serrated keel of *Subprionocyclus. Upper Cretaceous (Lower Coniacian–Lower Santonian):* western and central Europe, Algeria, South Africa (Zululand), Madagascar, Israel, Japan, Sakhalin, western and southern USA, Venezuela, Peru.——FIG.

148,*3a,b.* **P. (P.) bourgeoisi* (GROSSOUVRE), Coniacian, France; ×1 (Grossouvre, 1894).

P. (Anatexanites) MATSUMOTO, 1970a, p. 239 [**Mortoniceras fukazawai* YABE & SHIMIZU, 1925, p. 130; OD]. Ribs on later whorls with fourth (lateral) tubercle. Probable macroconch of *P. (Protexanites). Upper Cretaceous (Santonian):* Tunisia, Nigeria, Japan.——FIG. 148,*2. P. (A.) orientalis* (YABE & SHIMIZU), Japan; ×1 (Yabe & Shimizu, 1925).

P. (Miotexanites) MATSUMOTO, 1970a, p. 245 [**P. (M.) minimus;* OD]. Small; ribs weak and ventrolateral tubercle absent until outer whorl. *Upper Cretaceous (Upper Coniacian–Lower Santonian):* Japan.——FIG. 148,*1a,b.* **P. (M.) minimus;* ×1 (Matsumoto, 1970a).

Aneuretoceras KENNEDY & COBBAN, 1991, p. 52 [**A. variabile;* OD]. Progenetic dwarf derivative of *P. (Protexanites);* inner whorls smooth, with siphonal ridge; outer whorls with flexuous lirae or ribs forming blunt chevrons on venter. *Upper Cretaceous (Upper Coniacian):* Wyoming.

Haboroceras TOSHIMITSU, 1988, p. 150 [**H. haboroense;* OD]. Progenetic dwarf offshoot, probably of *Protexanites (Miotexanites).* Compressed, keeled, and almost smooth, with terminal constriction and simplified suture. *Upper Cretaceous (Upper Santonian–Lower Campanian):* Japan.——FIG. 149,*3a–c.* **H. haboroense; a,b,* ×2; *c,* ×5 (Toshimitsu, 1988).

Pleurotexanites MATSUMOTO, 1970a, p. 232 [**Protexanites superbus* COLLIGNON, 1966, p. 64; OD]. Differs from *Protexanites* in having more ventral than ventrolateral tubercles, a siphonal row of tubercles instead of a keel, and attenuated tubercles and ribs on the last whorl. *Upper Cretaceous (Middle Santonian):* South Africa (Zululand), Madagascar.——FIG. 148,*4a,b.* **P. superbus* (COLLIGNON); ×0.75 (Collignon, 1966).

Paratexanites COLLIGNON, 1948, p. 45(102) [**Mortoniceras zeilleri* GROSSOUVRE, 1894, p. 67; OD] [=*Parabevahites* COLLIGNON, 1948, p. 63(18) (type, *Ammonites serratomarginatus* REDTENBACHER, 1873, p. 110; OD)]. Whorl section subquadrate;

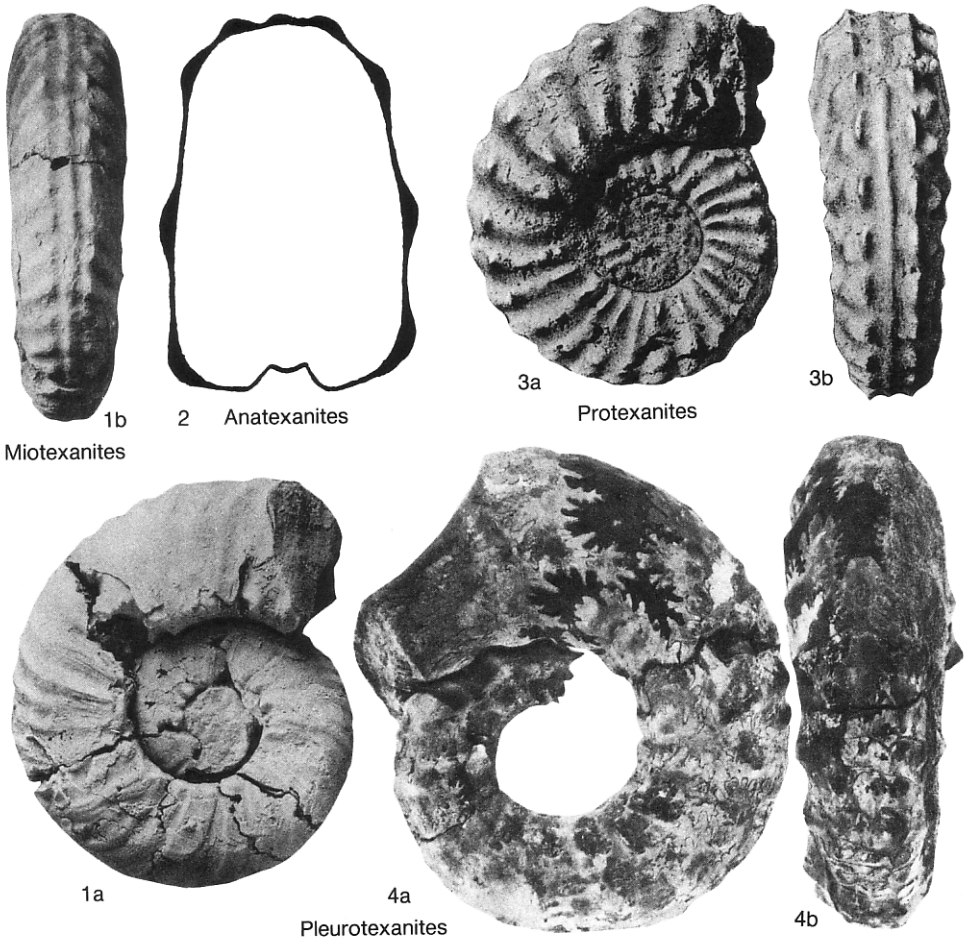


FIG. 148. Collignoniceratidae (p. 193–194)

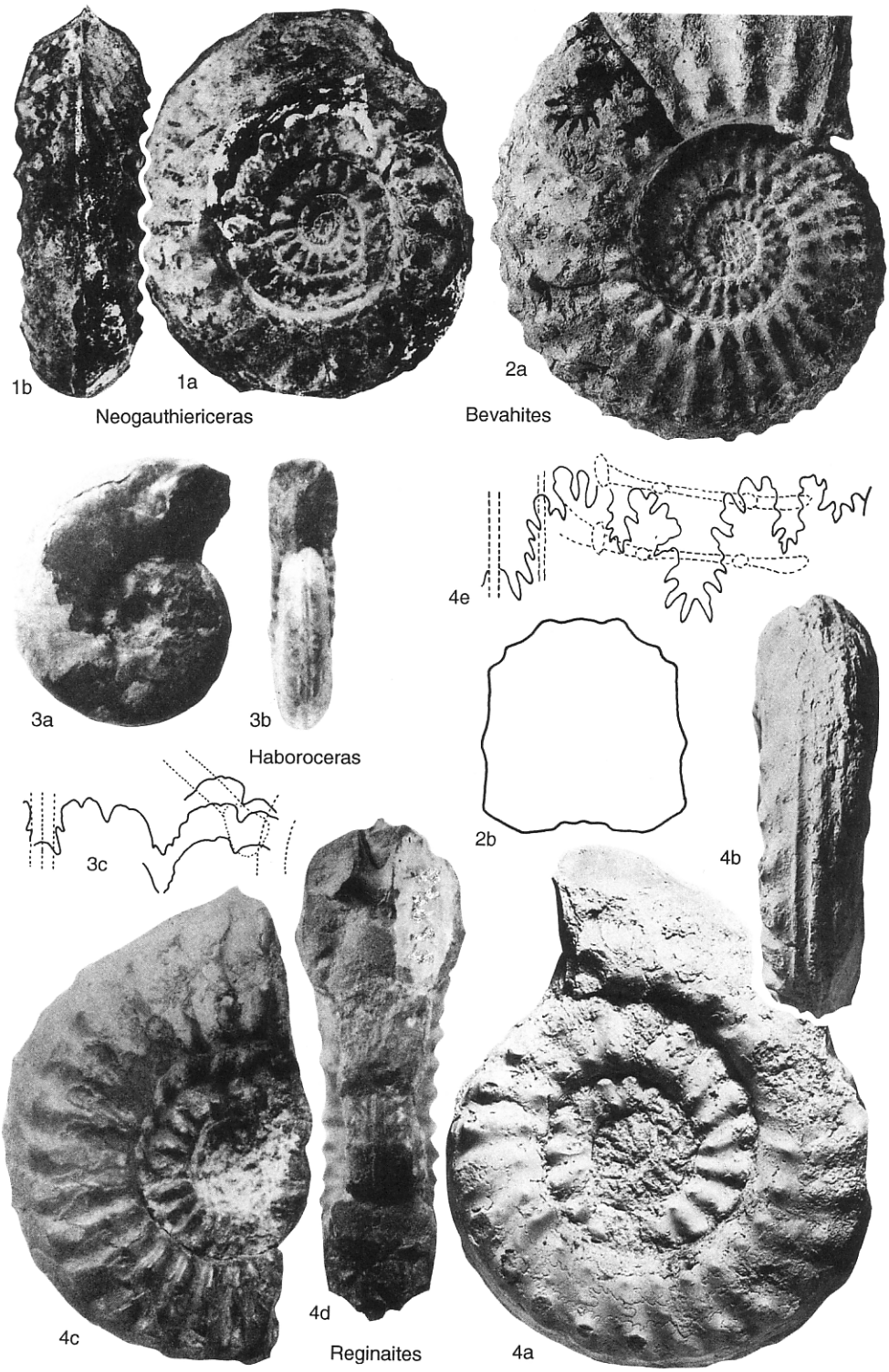


FIG. 149. Collignoniceratidae (p. 194–197)

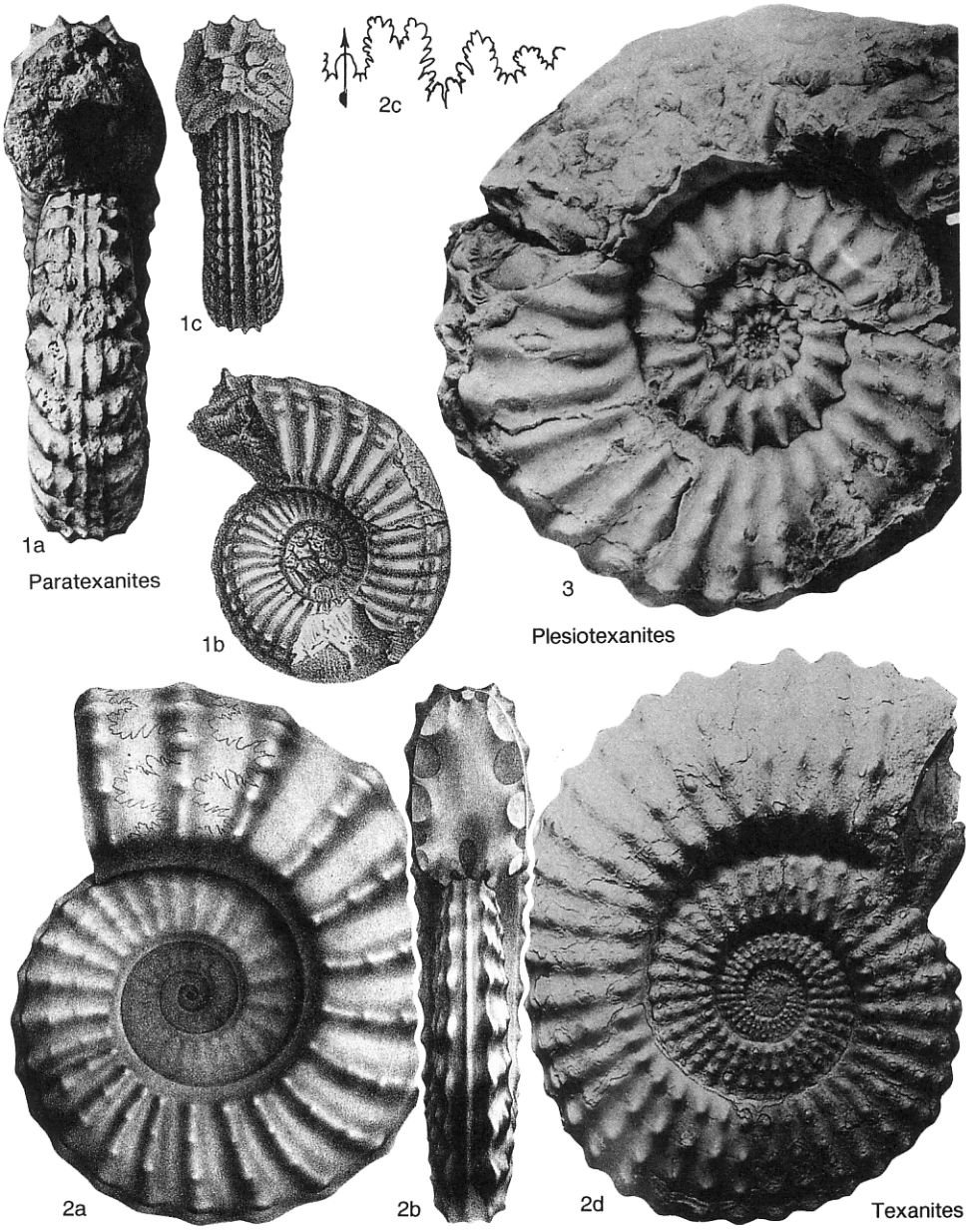


FIG. 150. Collignoniceratidae (p. 194–197)

with strong umbilical, inner and outer ventrolateral, and ventral tubercles; ribs simple, at least on outer whorls; keel entire or undulating. *Upper Cretaceous (Lower Coniacian–Middle Santonian):* France, Spain, Germany, Austria, Tunisia, South Africa (Zululand), Madagascar, Japan, Texas.——FIG. 150,*1a.* **P. zeilleri* (GROSSOUVRE), Coniacian, France; ×0.5 (Grossouvre, 1894).——FIG. 150,*1b,c. P. serratomarginatus* (REDTENBACHER), Coniacian, Austria; ×1 (Redtenbacher, 1873).

Texanites SPATH, 1932, p. 379 [**Ammonites texanus* F. A. ROEMER, 1852, p. 31; OD]. Generally large, compressed, and high-whorled, with sides flat on inner part, then converging to narrow venter with entire keel, but some species are subquadrate; ribs dense, strong, straight or slightly flexuous, first with 3 then with 5 or 6 tubercles, 2 lateral ones being added to those in *Protexanites;* intercalated ribs rare. Spinaptychi are associated with *Texanites.* KENNEDY & KLINGER, 1972. *Upper Cretaceous (Upper*

Coniacian–Lower Campanian): western and central Europe, Africa, Madagascar, Syria, southern India, southwestern Asia, Japan, USA, South America.

T. (**Texanites**) [=*Neoselwynoceras* COLLIGNON, 1966, p. 133 (type, *N. paradoxum;* OD, pathological)]. Five tubercles from an early stage, equally spaced. Occurrence and distribution as for genus.——FIG. 150,*2a–c.* **T. (T.) texanus* (ROEMER), Santonian, Texas; ×0.5 (Roemer, 1852).——FIG. 150,*2d. T. (T.) texanus ?hispanica* (COLLIGNON), Santonian or Campanian, South Africa (Pondoland); ×0.5 (Klinger & Kennedy, 1980a).

T. (**Plesiotexanites**) MATSUMOTO, 1970a, p. 267 [**Mortoniceras kawasakii* KAWADA, 1929, p. 4; OD]. Trituberculate stage persisting to variable extent; on the quinquetuberculate whorls, lateral tubercles subordinate to ribs and outer lateral and ventrolateral tubercles approximating. *Upper Cretaceous (Lower Santonian–Lower Campanian):* Germany, western Africa, South Africa, Madagascar, Japan, British Columbia, USA.——FIG. 150,*3.* **T. (P.) kawasakii* (KAWADA), Middle Santonian, Japan; ×0.75 (Matsumoto, 1970a).

T. (**Eutexanites**) KLINGER & KENNEDY, 1980b, p. 322 [**Plesiotexanites (E.) sextuberculatus* KLINGER & KENNEDY, 1980b, p. 322; OD]. With 6 tubercles on each side, extra one formed by division of umbilical tubercle. *Upper Cretaceous (Lower Santonian):* South Africa (Zululand).

Reginaites REYMENT, 1957, p. 65 [**Peroniceras (R.) quadrituberculatum* REYMENT, 1957, p. 65; OD] [=*Reymentites* MATSUMOTO, 1965b, p. 238 (type, *R. hataii;* OD); ?*Cocuyites* ETAYO SERNA, 1985, p. 24 (type, *C. cocuyensis;* OD)]. Evolute; tricarinate; with distant ribs; early whorls with umbilical and ventrolateral tubercles; later ventrolateral tubercles dividing and feeble lateral tubercles may appear. Suture simple. *Upper Cretaceous (?Coniacian, Santonian–Campanian):* Austria, Nigeria, South Africa (Zululand), Japan, New Mexico.——FIG. 149,*4a,b.* **R. quadrituberculatum* (REYMENT), Coniacian or Santonian, Nigeria; ×0.5 (Klinger & Kennedy, 1980a).——FIG. 149,*4c–e. R. hataii* (MATSUMOTO), Coniacian or Santonian, Japan; *c,d,* ×1; *e,* ×2 (Matsumoto, 1965b).

Neogauthiericeras COLLIGNON, 1969, p. 185 [**N. zafimahovai;* OD]. Evolute, with markedly fastigiate venter; strong, conical umbilical tubercles joined by rather feeble ribs to very strong ventrolateral tubercles that are absent on body chamber. *Upper Cretaceous (Upper Santonian–Lower Campanian):* Madagascar, Texas.——FIG. 149,*1a,b.* **N. zafimahovai,* Lower Campanian, Madagascar; ×0.5 (Collignon, 1969).

Submortoniceras SPATH, 1926a, p. 79 [**Mortoniceras woodsi* SPATH, 1921a, p. 232; OD] [=*Butticeras* ANDERSON, 1958, p. 272 (type, *B. buttense;* OD); ?*Jimenesites* CARRASCO, 1967, not seen; *Antsirasirella* COLLIGNON, 1969, p. 201 (type, *S. (A.) stellata* COLLIGNON, 1969, p. 201; OD)]. Rather involute to evolute; ribs sparse or dense, with 5 tubercles from early stage but weakening; typically all ornament except umbilical tubercles lost on outer whorl and venter becomes rounded. *Upper Cretaceous (Upper Santonian–Middle Campanian):* South Africa (Zululand), Madagascar, Japan, British Columbia, USA, Mexico, Antarctica.

S. (**Submortoniceras**). Rather involute; ornament relatively persistent. Occurrence and distribution as for genus.——FIG. 151,*1a–c.* **S. (S.) woodsi* (SPATH), Campanian, Zululand; *a,b,* ×0.75; *c,* ×1 (Spath, 1921a).

S. (**Ankilizatella**) COLLIGNON, 1971, p. 50 [**Texanites (A.) ankilizatensis;* OD]. Very compressed, evolute; ornament reduced at early stage to numerous umbilical and inner and outer ventrolateral tubercles. *Upper Cretaceous (Middle Campanian):* Madagascar.——FIG. 151,*2a,b.* **S. (A.) ankilizatense* (COLLIGNON); ×0.75 (Collignon, 1971).

Bevahites COLLIGNON, 1948, p. 63(18) [**B. quadratus;* OD]. Whorl section more or less square to compressed; quinquetuberculate stage reached early, with 2 ventrolateral tubercles close together while ventral tubercles move nearer keel; lateral tubercles and many intercalated ribs also occurring, making many more outer tubercles than umbilical. *Upper Cretaceous (Lower Santonian–Middle Campanian):* France, South Africa (Zululand), Madagascar, Mississippi, Texas, Mexico.——FIG. 149,*2a,b.* **B. quadratus,* ?Upper Santonian, Madagascar; ×0.75 (Collignon, 1948).

Menabites COLLIGNON, 1948, p. 64(19) [**M. menabensis* COLLIGNON, 1948, p. 7(64); SD WRIGHT, 1957b, p. 432 (diagnosis published in fascicle 13; first valid species referred to in fascicle 14)]. Differs from *Bevahites* in persistence of early trituberculate stage to a diameter of 100 mm or more. *Upper Cretaceous (?Upper Santonian, Lower Campanian–Middle Campanian):* France, Tunisia, South Africa (Zululand), Madagascar, Japan, Texas, Mississippi, Alabama, Delaware, New Jersey, Oklahoma, Mexico.

M. (**Menabites**). Rather compressed, with strong, fairly dense ribs; quinquetuberculate stage reached more quickly than in other subgenera. *Upper Cretaceous (Lower Campanian–Middle Campanian):* Madagascar, Texas, Mexico.——FIG. 152,*3a,b.* **M. (M.) menabensis,* Campanian, Madagascar; ×1 (Collignon, 1948).

M. (**Bererella**) COLLIGNON, 1948, p. 64(19) [**M. (B.) bererensis;* OD]. Rather compressed, with sparse, weak ribs but strong, stout tubercles. *Upper Cretaceous (Middle Campanian):* Madagascar.

M. (**Australiella**) COLLIGNON, 1948, p. 64(19) [**Mortoniceras australe* BESAIRIE, 1930, p. 638; OD] [=*Austinites* ADKINS, 1933a, p. 407, *nom. nud.*]. Inflated, with broad, rounded venter and rarely more than 3 rows of tubercles, the ventral tubercles more numerous than inner ones; middle whorls with large, coarse inner ventrolateral tubercles. In adults of large, coronate species, keel and outer tubercles may disappear, the venter becoming broadly rounded and inner ventrolateral tubercles very large. Occurrence as for genus: South Africa (Zululand), Madagascar,

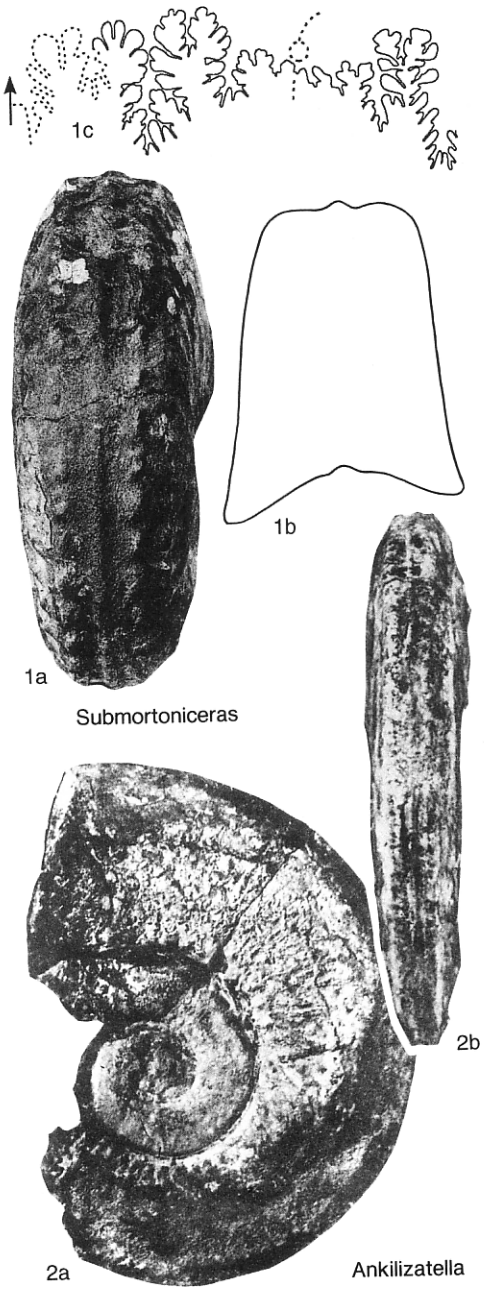


FIG. 151. Collignoniceratidae (p. 197)

Japan, Texas.——FIG. 152,*2a,b.* **M. (A.) australe* (BESAIRIE), Middle Campanian, Madagascar; ×1 (Collignon, 1948).

M. (Delawarella) COLLIGNON, 1948, p. 64(19) [**Ammonites delawarensis* MORTON, 1830, p. 244; OD]. Rather involute; outer ventrolateral tubercles appearing earlier than in *M. (Menabites);* inner whorls like *M. (Australiella),* but section soon becoming higher than wide; all ornament weakening with age and whorl section then becoming rounded. *Upper Cretaceous (Middle Campanian):* France, Tunisia, Madagascar, Texas, Oklahoma, Delaware, New Jersey.——FIG. 152,*1a–c.* **M. (D.) delawarensis* (MORTON), New Jersey; *a,b,* ×1; *c,* enlarged (Whitfield, 1892).

Cryptotexanites KENNEDY & COBBAN, 1993b, p. 842 [**C. paedomorphicus;* OD]. Progenetic dwarf derivative of some texanitine, differing from *Haboroceras* in having feebler ribbing and lacking umbilical bullae, with no keel or constrictions on body chamber. *Upper Cretaceous (Lower Campanian):* Delaware.

Defordiceras K. YOUNG, 1963, p. 118 [**D. hazzardi;* OD]. Keel disappearing. Probably pathological specimens. *Upper Cretaceous (Santonian):* ?Japan, Texas.

Family TISSOTIIDAE Hyatt, 1900

[Tissotiidae HYATT, 1900, p. 590]

Compressed to globular, with at least at some stage serrated or continuous keel and ventrolateral rows of tubercles. Suture normally with denticulate lobes and entire, rounded saddles, but first lateral lobe may be divided by adventive lobe. *Upper Cretaceous (Upper Turonian–Coniacian).*

Almost certainly derived by saltatory evolution of suture from *Barroisiceras* by way of *Tissotioides.*

Tissotioides REYMENT, 1958b, p. 48 [**Ammonites haplophyllus* REDTENBACHER, 1873, p. 100; OD] [=*Tissotioides (Reymentoceras)* WIEDMANN, 1960, p. 760 (type, *T. (R.) hispanicus;* OD)]. Having suture of *Tissotia* but ornament of *Barroisiceras* with siphonal clavi. [*Reymentoceras* as subgenus for species that lose ventrolateral and siphonal tubercles on body chamber seems unnecessary.] *Upper Cretaceous (Lower Coniacian):* France, Spain, Austria.——FIG. 153,*3a–c.* **T. haplophyllus* (REDTENBACHER); *a,b,* France, ×0.75 (Grossouvre, 1894); *c,* Austria, ×2 (Reyment, 1958b).

Metatissotia HYATT, 1903, p. 45 [**Buchiceras fourneli* BAYLE, 1878, pl. 40, fig. 3; SD ROMAN, 1938, p. 479] [=*Dordiella* REYMENT, 1958c, p. 59 (type, *D. bakundu;* OD)]. Venter more or less flat in early stages, with sharp keel and rows of ventrolateral tubercles formed by ends of fairly strong ribs; later stages with keel rising to form angular venter, ribs disappearing, and umbilical and ventrolateral tubercles persisting. [*Dordiella,* distinguished only by slightly more divided first lateral saddle and slightly incised second lateral saddle, seems unnecessary.] *Upper Cretaceous (Coniacian):* France, Spain, northern and western Africa, Borneo, Peru.——FIG. 153,*1a–c.* **M. fourneli* (BAYLE); *a,b,* Peru, ×0.5 (Knechtel, Richards, & Rathbun, 1947); *c,* France,

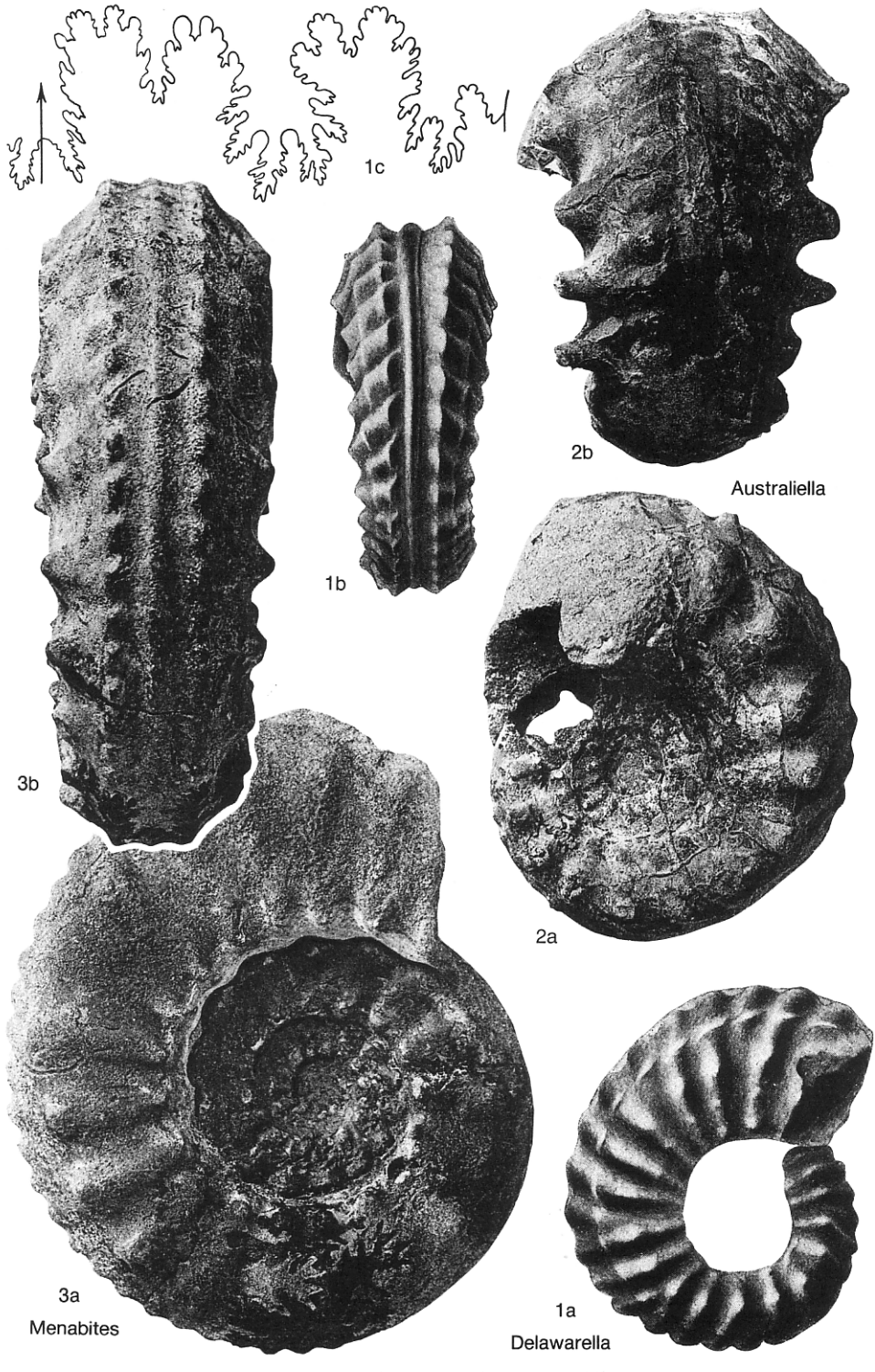


FIG. 152. Collignoniceratidae (p. 197–198)

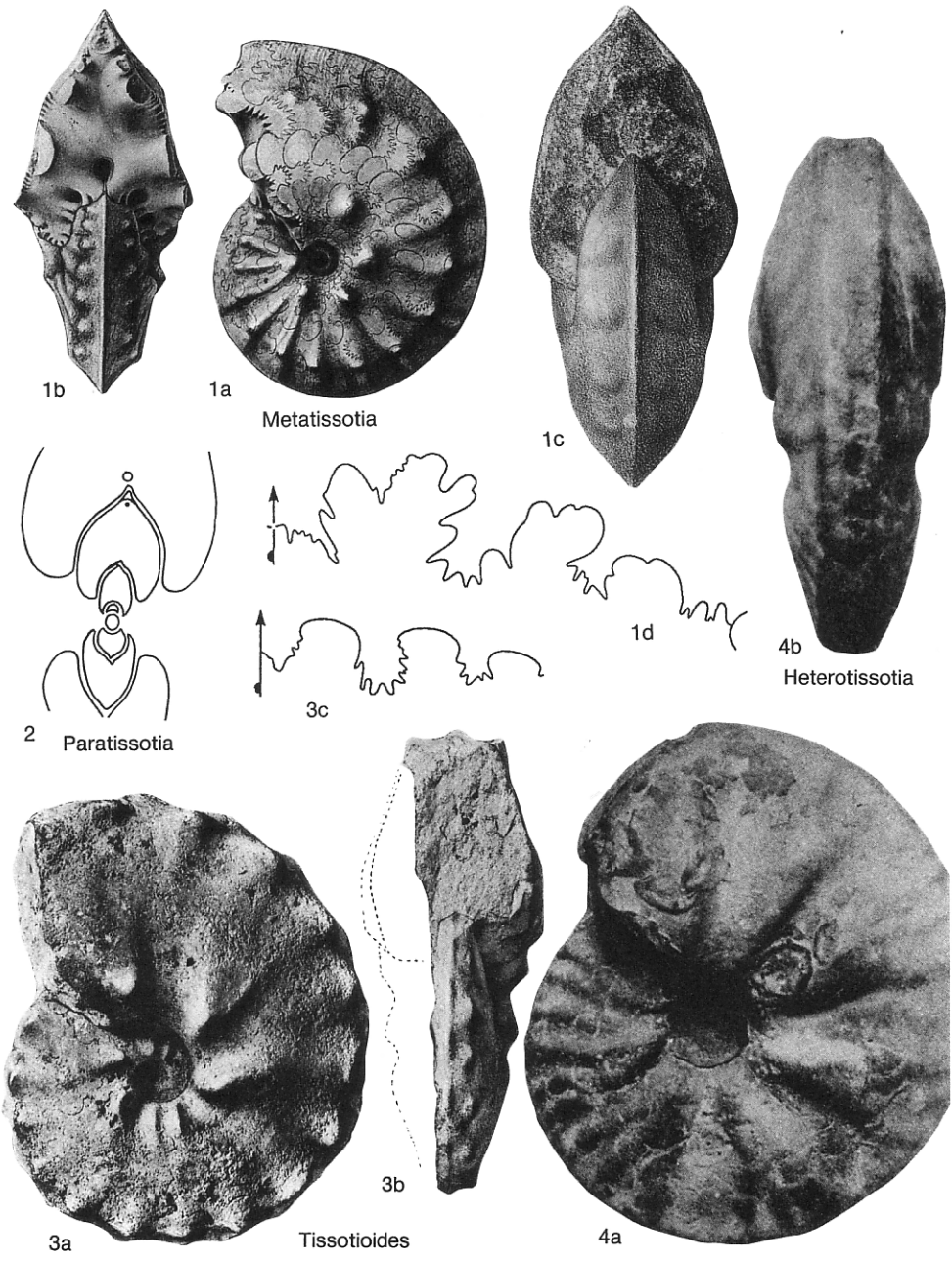


FIG. 153. Tissotiidae (p. 198–201)

×1 (Bayle, 1878).——FIG. 153,*1d. M. bakundu* (REYMENT), Nigeria; ×1 (Reyment, 1958c).

Tissotia H. DOUVILLÉ, 1890, p. 285 [**Buchiceras tissoti* BAYLE, 1878, pl. 40, fig. 1; OD]. Very involute; more or less inflated; early stages with low, branching ribs, siphonal keel, and ventrolateral keels or rows of tubercles, all of which may disappear. Suture with first lateral saddle divided into 2 equal saddles, one or both of which may have a few indentations, but these and other saddles usually entire. *Upper Cretaceous (Coniacian):* France, Spain, central Europe, northern and western Africa, Borneo.

T. (Tissotia). Retains more or less subquadrate whorl section throughout growth; venter flat, with 3 feeble keels separated by sulci that disap-

pear on outer whorls. Occurrence as for genus: France, Spain, central Europe, northern and western Africa, Borneo.——FIG. 154,*2a,b.* **T. (T.) tissoti* (BAYLE), France; *a,* ×0.67; *b,* ×1 (Bayle, 1878).

T. (Subtissotia) HYATT, 1903, p. 43 [**T. tissoti* var. *inflata* PERON, 1897, p. 68; SD ROMAN, 1938, p. 479]. Early whorls globular, with low siphonal keel and rows of ventrolateral tubercles very close to keel; later whorls smooth, with rounded venter. Occurrence as for genus: northern Africa.——FIG. 154,*1.* **T. (S.) inflata;* ×0.75 (Peron, 1896–1897).

?Heterotissotia PERON, 1897, p. 81 [**H. neoceratites;* OD]. Involute; sides flat or inflated; venter flat or concave, with angular or keeled shoulders and weak siphonal keel; ribs strong but low, rounded, and branching, with or without umbilical, midlateral, and inner and outer ventrolateral tubercles. Suture with first lateral saddle deeply bifid; 3 other saddles normally entire. Except in suture, *Heterotissotia* may resemble some *Pseudotissotia. Upper Cretaceous (Upper Turonian–Coniacian):* Israel, northern Africa, Somalia, Peru.——FIG. 153,*4a,b.* **H. neoceratites,* Coniacian, Algeria; ×1 (Peron, 1896–1897).

Paratissotia HYATT, 1903, p. 50 [**P. regularis;* OD]. Omitting or passing very quickly through stage of fastigiate venter with keel and rows of ventrolateral tubercles that characterizes *Tissotia,* and quickly becoming compressed with acute venter without tubercles but with rather weak ribs. *Upper Cretaceous (Coniacian):* France, northern and western Africa, Peru.——FIG. 153,*2.* **P. regularis,* Peru; ×0.75 (Hyatt, 1903).

Family COILOPOCERATIDAE Hyatt, 1903

[Coilopoceratidae HYATT, 1903, p. 88] [=Hoplitoidinae WRIGHT, 1952, p. 221, *nom. correct. pro* Hoplitoidinés H. DOUVILLÉ, 1912, p. 305]

Moderately to very involute; compressed to inflated; either flat-sided with flat venter becoming narrowly rounded in adult or lanceolate or cordate in section with more or less sharp venter; at some stage, broad, low, rounded ribs springing in pairs from low umbilical tubercles or bulges. Suture with narrow first lateral saddle and very broad, shallow first lateral lobe divided by one or more accessory saddles; folioles and auxiliary saddles tending to have entire endings. *Upper Cretaceous (Lower Turonian–Upper Turonian).*

Hoplitoides closely resembles early *Pseudotissotia,* from which it was probably derived. *Coilopoceras* seems to have been derived from *Hoplitoides.* Members of *Coilopoceras* reported from the Cenomanian seem to be Turonian.

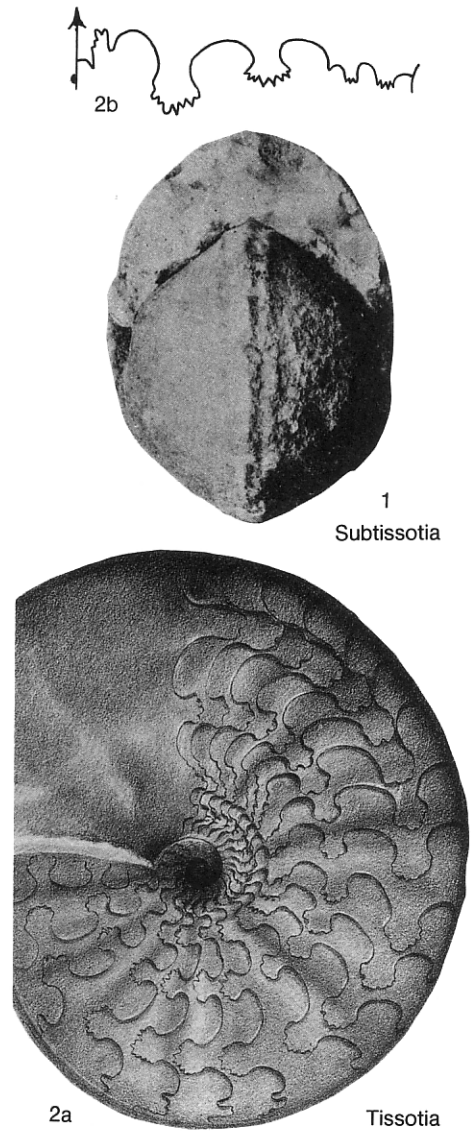


FIG. 154. Tissotiidae (p. 200–201)

Hoplitoides KOENEN, 1898, p. 53 [**H. latesellatus* KOENEN, 1898, p. 56; OD; =*Neoptychites? ingens* KOENEN, 1897, p. 12]. Early whorls with sulcate or flat venter and variable, sparse ribs branching from insignificant umbilical tubercles and fading on shoulder; slight to moderately strong, generally clavate tubercles may be present on shoulder; later whorls smooth, with narrowly rounded venter. Suture very variable and irregular, with wide first lateral lobe divided by 1 or 2 large folioles or accessory saddles. *Upper Cretaceous (Turonian):* Spain, northern and western Africa, Madagascar, Lebanon, Israel, Jordan, New Mexico, Mexico, Trinidad, Venezuela, Colombia, Peru.——FIG. 155,*2a.* **H. ingens*

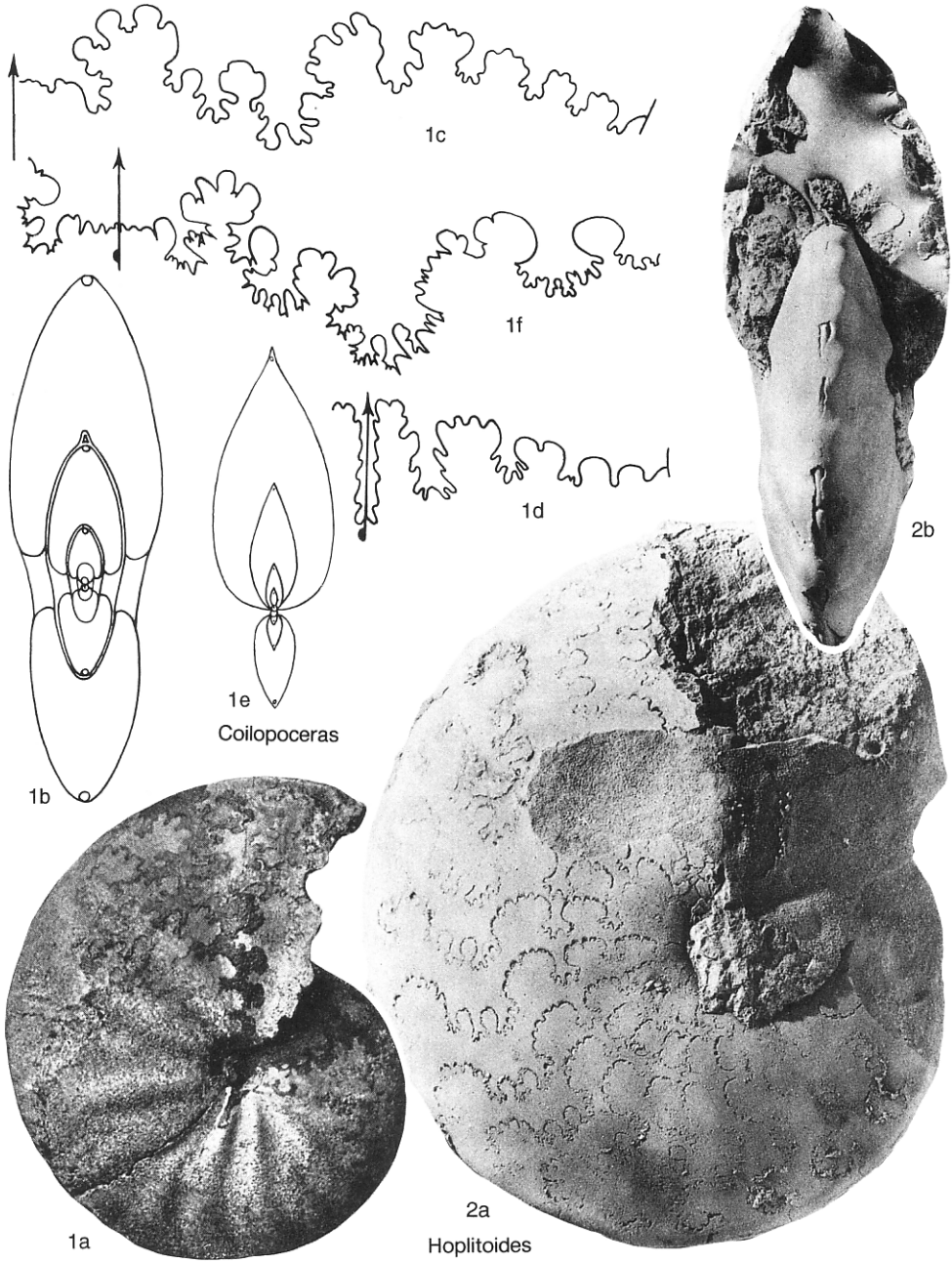


FIG. 155. Coilopoceratidae (p. 201–203)

(KOENEN), Lower Turonian, Nigeria; ×0.75 (Reyment, 1955).——FIG. 155,*2b. H. gibbosulus bipartitus* (SOLGER), Lower Turonian, Nigeria; ×0.75 (Reyment, 1955).

Erichsenites MAGALHÃES, 1953, p. 6 [**Hoplitoides mirabilis* PERVINQUIÈRE, 1907, p. 218; OD]. Generally similar to *Wrightoceras,* but with tabulate venter, and suture as in Coilopoceratidae with very broad L. Differing from *Hoplitoides* only in persistence of tabulate venter to body chamber, *Erichsenites* may better be considered a subgenus of *Hoplitoides. Upper Cretaceous (Lower Turonian):* France, northern Africa, Venezuela, Brazil.——FIG. 156*a–c.* **E. mirabilis* (PERVINQUIÈRE), Tunisia; *a,b,* ×0.5; *c,* ×2 (Pervinquière, 1907).

Coilopoceras HYATT, 1903, p. 91 [**C. colleti;* OD]

[=*Namadoceras* VREDENBURG, 1907, p. 121 (type, *N. scindiae;* OD); *Glebosoceras* REYMENT, 1954a, p. 161 (type, *G. glebosum;* OD); *Vredenburgia* CHIPLONKAR & GHARE, 1976, p. 7 (type, *V. khadluensis;* OD)]. Large, with diameter up to 800 mm; involute; compressed to inflated; lanceolate to cordate in section, with more or less sharp venter; variable, broad, low ribs may persist; in inflated forms (*Glebosoceras*) ribs raised into large bulges on inner part of side on outer whorls; in some such forms ribs may be strongly projected ventrolaterally, but this is probably not significant. Suture variable; accessory saddle may be larger than the second lateral, which with auxiliary saddles tends to become entire in outline. *Upper Cretaceous (Middle Turonian–Upper Turonian):* France, Spain, northern and western Africa, Madagascar, Lebanon, Israel, Baluchistan, Colorado, Wyoming, Texas, New Mexico, Mexico, Trinidad, Venezuela, Ecuador, Colombia, Peru.——FIG. 155,*1a–d.* **C. colleti,* Upper Turonian, New Mexico; ×1 (Hyatt, 1903). ——FIG. 155,*1e,f. C. glebosum* (REYMENT), Turonian, Nigeria; *e,* approximately ×0.2; *f,* ×1 (Reyment, 1954a).

Family SPHENODISCIDAE Hyatt, 1900

[Sphenodiscidae HYATT, 1900, p. 585] [=Libycoceratidae ZABORSKI, 1982, p. 306]

Involute; compressed; generally with weak lateral and ventrolateral tubercles or smooth; venter sharp or narrowly rounded. A few, less compressed and broader-ventered forms are probably microconchs. Suture with narrow-necked, entire or frilled, and in some cases phylloid saddles; first lateral saddle divided by 1 or 2 adventive lobes; many auxiliary elements. *Upper Cretaceous (Coniacian–Maastrichtian).*

Generic distinction has usually been made on details of sutures, but these are variable and reliance on them can be misleading. Origin of the family is probably in Collignoniceratidae, through Lenticeratinae, with its obliquely trifid first lateral saddle. Coilopoceratidae are superficially similar but have a widening and subdivided first lateral lobe rather than saddle.

Subfamily LENTICERATINAE Hyatt, 1900

[*nom. transl.* WRIGHT, 1952, p. 221, *ex* Lenticeratidae HYATT, 1900, p. 590] [=Eulophoceratidae HYATT, 1903, p. 83]

Involute; venter sharp or narrowly rounded; whorl section ranging from lanceolate to stoutly cordate; smooth or with broad, flat ribs. Suture with elements of disparate size and varying number of auxiliary saddles; first lateral saddle very wide and normally trifid with outer part markedly oblique to siphonal line. *Upper Cretaceous (Coniacian–Lower Campanian).*

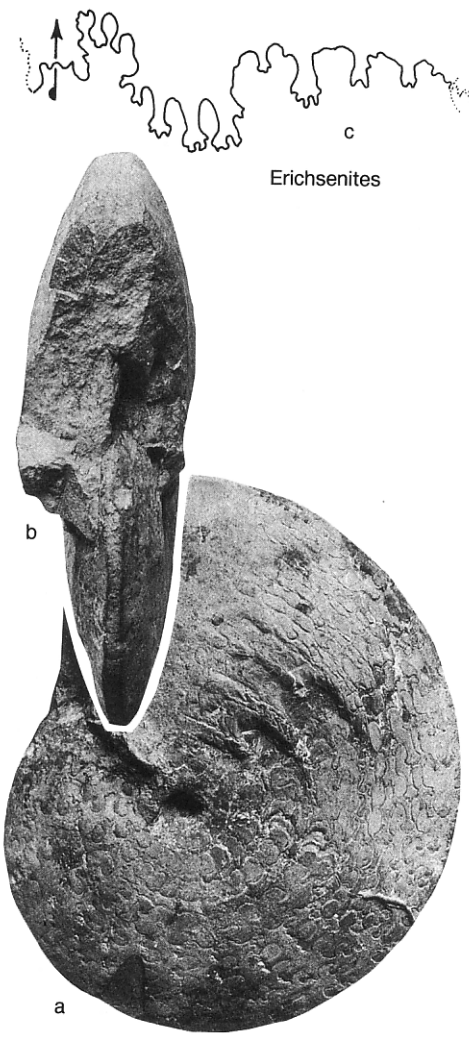


FIG. 156. Coilopoceratidae (p. 202)

Lenticeras GERHARDT, 1897a, p. 81 [**Ammonites andii* GABB, 1877, p. 275; OD]. Very involute, with more or less cordate whorl section; low, rounded ribs branching in pairs from umbilical bulges and disappearing below venter. External saddle of suture broad, markedly oblique. *Upper Cretaceous (Coniacian–Lower Santonian):* Spain, Peru, Venezuela.——FIG. 157,*2a–c.***L. andii* (GABB), Coniacian, Peru; *a,b,* ×0.75; *c,* ×1 (Gerhardt, 1897a).

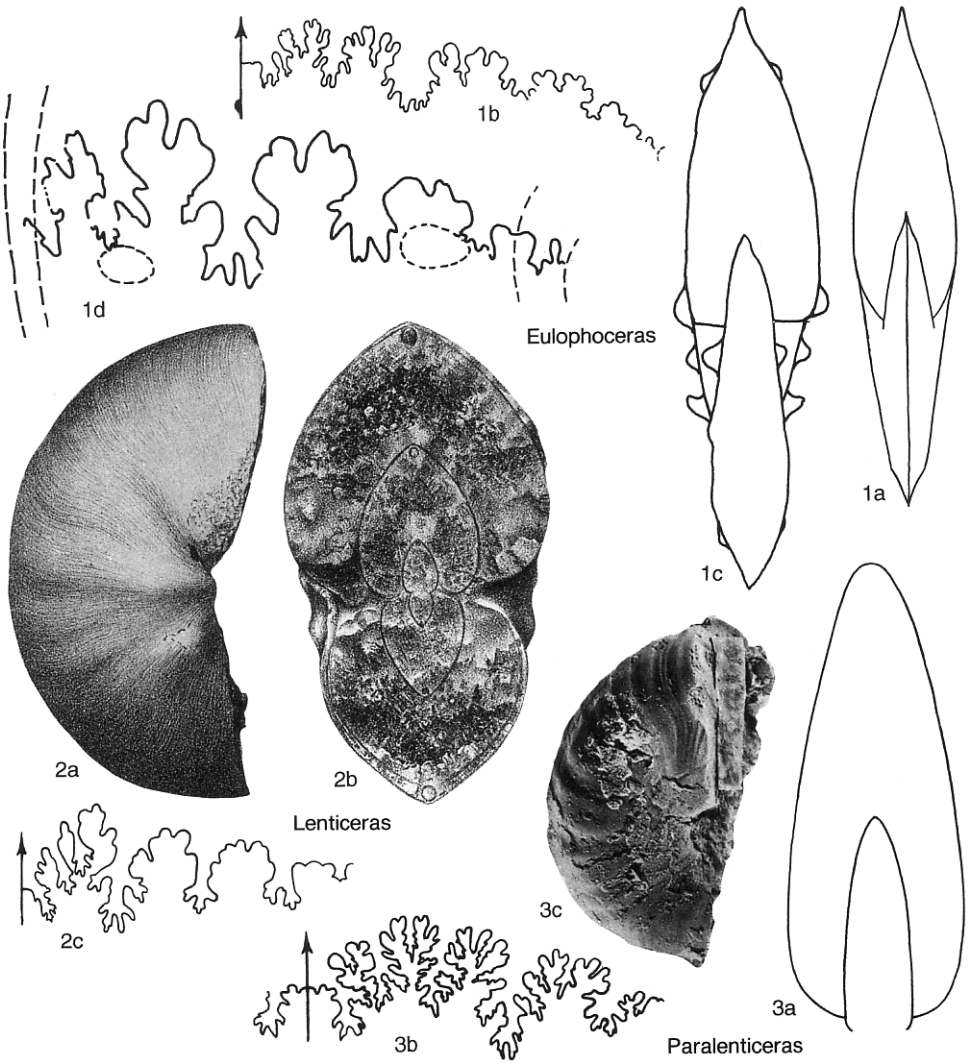


FIG. 157. Sphenodiscidae (p. 203–205)

Paralenticeras HYATT, 1900, p. 590 [**Amaltheus sieversi* GERHARDT, 1897a, p. 79; OD]. Suture much as in *Lenticeras,* but elements deeper and saddles more finely divided. Compressed; inner whorls with flat ribs, fastigiate venter, and sharp keel; outer whorls with weak ribs on inner part of sides, otherwise with dense striae, recurved siphonally. *Lenticeras* and *Paralenticeras* may be inflated and compressed members of the same genus. *Upper Cretaceous (Upper Coniacian–Lower Santonian):* Colombia, Peru, Venezuela, Haiti.——FIG. 157,*3a,b.* **P. sieversi* (GERHARDT), Lower Santonian, Haiti; ×1 (Reeside, 1947).——FIG. 157,*3c. P. spathi* (REYMENT), Upper Coniacian, Venezuela; ×2.5 (Reyment, 1958a).

Eulophoceras HYATT, 1903, p. 85 [**E. natalense;* OD] [=*Praelibycoceras* H. DOUVILLÉ, 1912, p. 315 (type, *Lenticeras jullieni* PERVINQUIÈRE, 1910, p. 70; OD); *Pelecodiscus* HOEPEN, 1921, p. 30 (type, *P. umzambiensis;* OD); *Spheniscoceras* SPATH, 1921a, p. 242 (type, *S. africanum;* SD SPATH, 1922b, p. 142); *Skoumalia* SUMMESBERGER, 1979, p. 146 (type, *S. austriaca;* OD)]. Involute; compressed; lanceolate or with fastigiate venter; smooth or with fine, convex ribs or low, rounded ribs and ventrolateral nodes. Suture irregular, with several auxiliary saddles and obliquely trifid first lateral saddle tending to become more complex; folioles commonly fingerlike. HOURCQ, 1949. *Upper Cretaceous (Upper Coniacian–Lower Campanian):* Spain, Austria, Algeria, Nigeria, southeastern Africa, Madagascar, Syria, southern India, Peru, Venezuela.——FIG. 157,*1a,b. E. jacobi* HOURCQ, Upper Santonian, Madagascar;

×1 (Hourcq, 1949).——FIG. 157,*1c,d. E. austriaca* (SUMMESBERGER), Austria, *c*, ×1; *d*, enlarged (Summesberger, 1979).

Subfamily SPHENODISCINAE Hyatt, 1900

[*nom. transl.* WRIGHT, herein, *ex* Sphenodiscidae HYATT, 1900, p. 585]

Suture with elements, including the adventive and auxiliary, tending to form a single, even series and to develop simple, rounded outlines to folioles. Compressed; involute; mostly smooth, but some with lateral and ventrolateral tubercles and fastigiate or broad, flat venter. *Upper Cretaceous (Upper Coniacian–Maastrichtian).*

Manambolites HOURCQ, 1949, p. 111 [**M. piveteaui;* OD] [=*Mzezzemceras* BASSE, 1954, p. 868 (type, *Coahuilites (Mzezzemceras) pervinquieri* BASSE, 1954, p. 868; OD)]. Whorl section lanceolate or with fastigiate venter; body chamber with flat sides or inflated; smooth or with feeble, outer crescents and falcate striae. Suture having irregular first lateral saddle with large adventive lobe and having outer or both parts of saddle indented, outer indentation tending to become second adventive lobe. *Upper Cretaceous (Lower Campanian–Maastrichtian):* Angola, Madagascar, Israel, Iran, Pakistan (Baluchistan).

M. (**Praemanambolites**) COLLIGNON, 1969, p. 213 [**P. hourcqui;* OD]. Body chamber expanded, then retracted as in *Neoptychites;* keel persisting to end. *Upper Cretaceous (Lower Campanian):* Madagascar.——FIG. 158,*3a,b. *M. (P.) hourcqui* (COLLIGNON); ×0.25 (Collignon, 1969).

M. (**Manambolites**). Body chamber with flat sides and rounded venter. Occurrence and distribution as for genus.——FIG. 158,*2a,b. *M. (M.) piveteaui,* Maastrichtian, Madagascar; ×1 (Hourcq, 1949).

Sphenodiscus MEEK, 1871b, p. 298 [**Ammonites lobatus* TUOMEY, 1856, p. 168; OD; =*Ammonites lenticularis* OWEN, 1852, p. 579, *non* G. M. YOUNG & BIRD, 1828, p. 269, fig. 5] [=*Austrosphenodiscus* OLSSON, 1944, p. 266(108) (type, *Sphenodiscus pleurisepta* var. *peruviana* GERTH, 1928b, p. 237; OD)]. Generally smooth, involute, and compressed, tending to be oxyconic; some species with weak lateral and ventrolateral tubercles. All saddles of suture normally indented, but some auxiliaries may be entire; first lateral saddle normally with 2 distinct adventive lobes as big as first lateral lobe, but in early species outer one may be smaller; folioles generally but not uniformly with long, narrow necks and kidney-shaped ends. *Upper Cretaceous (Upper Campanian–Maastrichtian):* The Netherlands, France, Poland, Israel, Jordan, Saudi Arabia, Madagascar, southern India, USA, Mexico, Venezuela.——FIG. 159,*4a,b. *S. lobatus* (TUOMEY), Mississippi; ×0.4 (Hyatt, 1903).

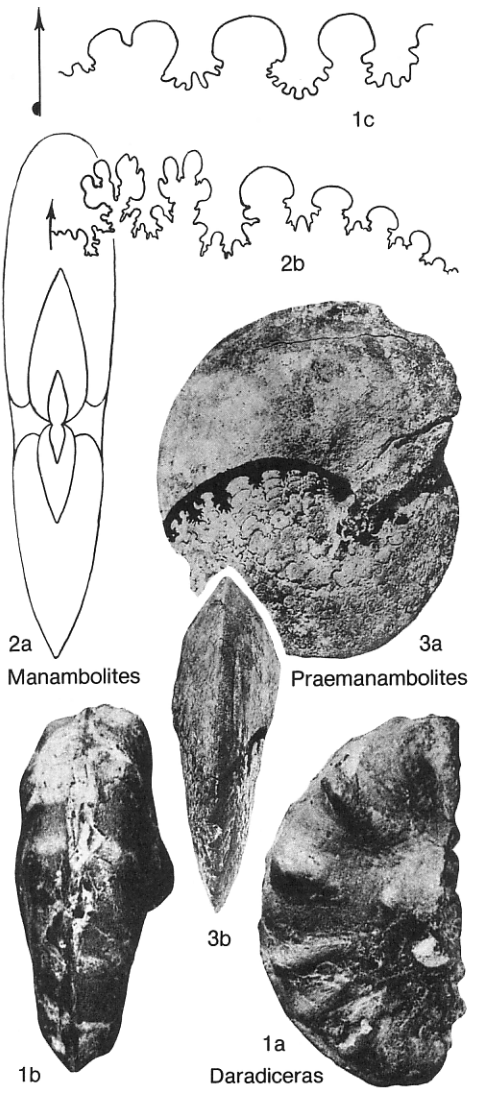


FIG. 158. Sphenodiscidae (p. 205–206)

Coahuilites BÖSE, 1928, p. 279 [**C. sheltoni;* OD]. Sides flat and parallel; venter at first fastigiate or rounded, then broad and flat; ribs rather prominent, branching from pointed tubercles above umbilical edge and ending in ventrolateral clavi. Suture as in *Sphenodiscus* but simpler. Probable microconch of *Sphenodiscus. Upper Cretaceous (?Upper Campanian, Maastrichtian):* Tunisia, Israel, Mexico, Peru, Colombia, Venezuela.——FIG. 159,*5a,b. C. cavinsi* BÖSE, Lower Maastrichtian, Mexico; ×1 (Böse, 1928).

Indoceras NOETLING, 1897, p. 71 [**I. baluchistanense;* OD]. Inner whorls with feeble outer crescents, ventrolateral ridges, and subacute keel; outer whorls smooth, with rounded venter. All saddles entire,

except first lateral divided by an accessory lobe. *Upper Cretaceous (Maastrichtian):* Iran, Pakistan (Baluchistan).——FIG. 159,*2a–c.* **I. baluchistanense,* Baluchistan; ×1 (Noetling, 1897).

Libycoceras HYATT, 1900, p. 585 [**Engonoceras ismaeli* ZITTEL, 1895, p. 451; OD (=*Ammonites ismaelis* ZITTEL, 1883, p. 74, *nom. nud.*)] [=*Paciceras* OLSSON, 1944, p. 268(110) (type, *P. pacificum;* OD)]. Venter fastigiate or lanceolate but may become broadly rounded on body chamber; smooth or with faint, broad ribs, some with lateral and ventrolateral tubercles, fading on outer whorl. First lateral saddle of suture with one adventive lobe, usually as long as first lateral lobe, or with incipient second adventive lobe; all saddles normally entire but may be feebly indented. *Upper Cretaceous (Upper Campanian–Lower Maastrichtian):* Libya, Chad, Nigeria, Egypt, Israel, Saudia Arabia, Japan, Colombia, Peru.——FIG. 159,*3a–c.* **L. ismaeli* (ZITTEL), Upper Campanian or Lower Maastrichtian, Libya; *a,* ×0.5; *b,* ×0.4; *c,* ×0.75 (Zittel, 1895).

Daradiceras SORNAY & TESSIER, 1949, p. 246 [**D. gignouxi;* OD]. Venter sharp, becoming broad and flat with age, but keel persisting; bulging, falcoid ribs joining 8 umbilical to 16 ventrolateral tubercles; large bulge at base of outer whorl enveloping umbilicus. Analogous to *Coahuilites,* and perhaps a microconch. *Upper Cretaceous (Maastrichtian):* Senegal.——FIG. 158,*1a–c.* **D. gignouxi* (SORNAY & TESSIER); *a,b,* ×0.5; *c,* enlarged (Sornay & Tessier, 1949).

?Nubidites WIEDMANN & KULLMAN, 1979, p. 249 [**N. omarai;* OD]. Small oxycone; suture with all elements entire and 4 adventive lobes. Collected loose in area of Carboniferous but with some Middle Jurassic and Upper Cretaceous not far away. If Upper Cretaceous, perhaps a progenetic offshoot of some sphenodiscoid. *?Upper Cretaceous:* Egypt.——FIG. 159,*1a–c.* **N. omarai; a,b,* ×3.2; *c,* ×10 (Wiedmann & Kullman, 1979).

Suborder ANCYLOCERATINA Wiedmann, 1966

[Ancyloceratina WIEDMANN, 1966b, p. 54]

Heteromorphs or secondary ammoniticones. Primary suture quinquelobate followed by quadrilobate (most Ancyloceratataceae, all Scaphitaceae), or quadrilobate throughout (some Ancyloceratataceae, possibly all Turrilitaceae), or unstable—quinquelobate or quadrilobate followed by quinquelobate—with elements multiplying subsequently (Douvilleiceratataceae, Deshayesitaceae). DOGUZHAEVA and MIKHAILOVA (1982) assigned Ancyloceratataceae to Ammonitida and Turrilitaceae to Lytoceratida on the grounds that the Ancyloceratataceae have a quinquelobate initial suture and a trifid L, while the Turrilitaceae have a quadrilobate primary suture and bifid L. Phyletic transitions from trifid to bifid L, however, are known, and no ammoniticone Lytoceratina are known to have a quadrilobate primary or later sutures, so that it seems more natural to assume that the quadrilobate suture evolved once and that the quadrilobate primary was derived from the quinquelobate primary followed by quadrilobate of Ancyloceratataceae. The position of the siphuncle (central or ventral) in earliest stages is here not considered significant (MATSUKAWA, 1987).

Criocones and baculicones appear suddenly in the Lower Tithonian and turricones in the Upper Tithonian. Their origins are uncertain. Derivation from Lytoceratina would require loss of one element in the early sutures and conversion of bifid L to trifid; there are no known intermediate forms in the Tithonian or earlier. Despite the stratigraphic gap between Middle Callovian and Lower Tithonian, the Spiroceratataceae remain a conceivable ancestor. WIEDMANN, 1966b; KULLMANN & WIEDMANN, 1970; MIKHAILOVA, 1976a, 1976b; DOGUZHAEVA & MIKHAILOVA, 1982. *Upper Jurassic (Lower Tithonian)–Upper Cretaceous (Upper Maastrichtian).*

Superfamily ANCYLOCERATACEAE Gill, 1871

[*nom. transl.* WRIGHT, 1957b, p. 207, *ex* Ancyloceratidae GILL, 1871, p. 3] [=Protancyloceratataceae, *nom. transl.* DIMITROVA, 1970, p. 90, *ex* Protancyloceratidae BREISTROFFER, 1947a, unpaged; Crioceratataceae, *nom. transl.* WRIGHT, 1957b, p. 208, *ex* Crioceratitidae WRIGHT, 1952, p. 218, *nom. correct. ex* Crioceratidae GILL, 1871, erroneously attributed to HYATT, 1900. It was thought in 1957 that Ancyloceratidae dated from MEEK, 1876, whereas Crioceratidae dated from HYATT, 1900. In fact, both dated from GILL, 1871, and change at the superfamily level was unnecessary. However, Ancyloceratataceae has entered into general use and is therefore maintained here.]

Most members with heteromorphic coiling. Lateral lobe generally trifid, but bifid L developing independently in several stocks. Late Jurassic cyrtocones (*Protancyloceras*) apparently gave rise both to straight forms (*Bochianites*) and, later, to more closely coiled forms (*Leptoceras* and Crioceratitinae). These produced both involute forms that led to Douvilleiceratataceae and Deshayesitaceae

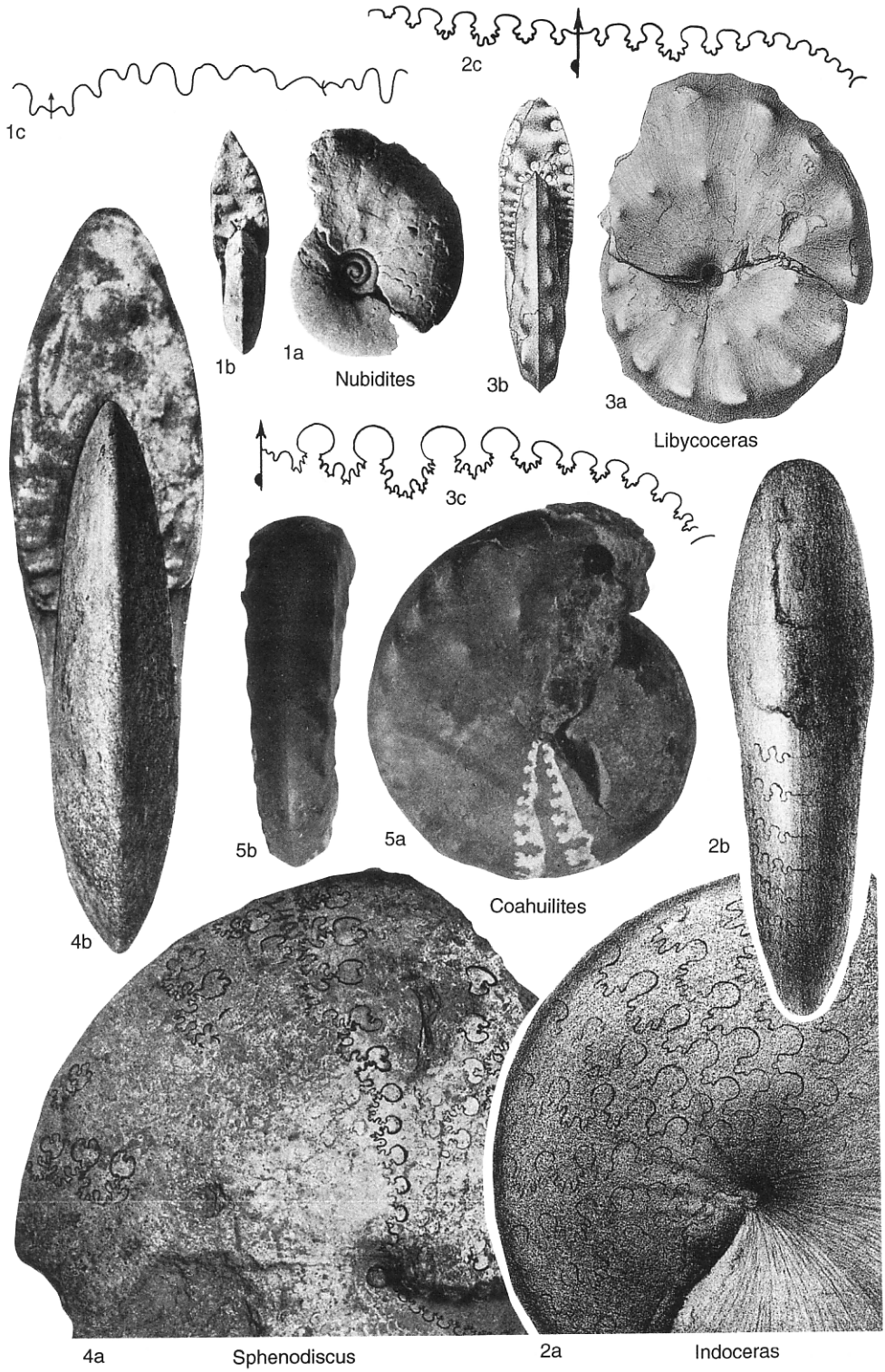


FIG. 159. Sphenodiscidae (p. 205–206)

and also genera with hooked body chambers (Ancyloceratinae). Helical forms appeared in the Berriasian (*Cochlocrioceras*), the Barremian (Heteroceratidae), and the Aptian (Helicancylinae). *Upper Jurassic (Lower Tithonian)–Upper Cretaceous (?Lower Cenomanian).*

Family BOCHIANITIDAE Spath, 1922

[*nom. transl.* BREISTROFFER, 1947a, unpaged, *ex* Bochianitinae SPATH, 1922b, p. 147] [=?Baculinidae GILL, 1871, p. 3 (see Bochianitinae, *Baculina*)]

Loosely coiled to straight; normally with oblique ribs; rarely smooth; tubercles occurring rarely. Suture with trifid lateral lobes. The first *Protancyloceras* and *Bochianites* occur together; which one is derived from the other is uncertain, as is origin of either, but probability is that *Protancyloceras* is phylogenetically primitive. *Upper Jurassic (Lower Tithonian)–Lower Cretaceous (Lower Aptian).*

Subfamily PROTANCYLOCERATINAE Breistroffer, 1947

[*nom. transl.* WRIGHT, 1952, p. 218, *ex* Protancyloceratidae BREISTROFFER, 1947a, unpaged] [=Leptoceratinae MANOLOV, 1962, p. 531]

Loosely coiled, rarely helical; strongly ribbed; a few with tubercles. *Upper Jurassic (Lower Tithonian)–Lower Cretaceous (Upper Valanginian–Upper Hauterivian).*

Protancyloceras SPATH, 1924a, p. 86 [**Ancyloceras guembeli* ZITTEL, 1886, p. 115; OD]. Coiled in very open spiral; whorl section round, oval, or subquadrate; ribs fine on early whorls, typically coarse on later, prorsiradiate to radial, forming chevrons or interrupted on venter; ventrolateral tubercles may occur and pairs of ribs may join at them. Suture with irregularly bifid saddles and trifid lobes. *Upper Jurassic (Lower Tithonian)–Lower Cretaceous (Lower Valanginian):* France, central Europe, Ukraine (Crimea), northern Africa, Madagascar, Kurdistan, Mexico, Peru, Cuba.——FIG. 160,*2a–c. P. kurdistanense* SPATH, Tithonian, Kurdistan; ×1 (Spath, 1950).

Juddiceras SPATH, 1924a, p. 84 [**Crioceras curvicosta* KOENEN, 1902, p. 326; OD]. Known only in slightly curved fragments, but probably loosely crioconic; ribs prominent, rather distant, slightly concave, and irregularly stronger or weaker. Lectotype of type species untuberculate; associated specimens with a pair of ventral tubercles on stronger ribs may be microconchs or a different species (or possibly a different genus). *Lower Cretaceous (Upper Valanginian):* Germany, Hungary.——FIG. 160,*3a,b. *J. curvicostum* (KOENEN), Germany; ×1 (Kemper, Rawson, & Thieuloy, 1981).——FIG. 160,*3c,d. ?J. ?curvicostum* (KOENEN); ×0.5 (Koenen, 1902).

?Pseudomoutoniceras AUTRAN, DELANOY, & THOMEL, 1986, p. 1063 [**Toxoceras annulare* ORBIGNY, 1842b, p. 480; OD]. Ribs continuous over venter; periodic, strongly collared constrictions. Suture relatively simple. *Lower Cretaceous (Upper Hauterivian):* France, Switzerland.——FIG. 161,*3. *P. annulare* (ORBIGNY), France; ×0.5 (Autran, Delanoy, & Thomel, 1986).

Leptoceras UHLIG, 1883, p. 260(136) [**Ancyloceras brunneri* OOSTER, 1860, p. 37; SD ROMAN, 1938, p. 354] [=*Protoleptoceras* NIKOLOV, 1966b, p. 839 (type, *P. jelevi;* OD)]. Small; coiling cyrtocone or criocone and regular or elliptical, with body chamber generally uncoiling; ribs single, rectiradiate or rursiradiate, and crossing venter transversely; no tubercles. Suture with wide, bifid saddles; L generally symmetrically trifid at first, later asymmetric. *Lower Cretaceous (Upper Berriasian–Valanginian):* central and southern Europe, Colombia.——FIG. 161,*4. *L. brunneri* (OOSTER), Upper Berriasian, Switzerland; ×1.5 (Thieuloy, 1966b).

Vinalesites THIEULOY, 1966b, p. 287 [**Hamulina? rosariensis* IMLAY, 1942, p. 1457; OD] [=*Pseudoanahamulina* JUDOLEY & FURRAZOLA-BERMÚDEZ, 1968, p. 54, obj.]. Coiling loosely ancyloceratoid, with short initial spire, long more or less straight shaft, and open hook; ribs simple, slightly prorsiradiate, strengthening on hook. *Upper Jurassic (Middle Tithonian):* Cuba.——FIG. 161,*2a,b. *V. rosariensis* (IMLAY); ×1 (Wiedmann, 1973a).

Cochlocrioceras SPATH, 1950, p. 123 [**C. turriculatum;* OD]. Differs from *Protancyloceras* in its helically coiled inner whorls; ribs interrupted on venter. *Upper Jurassic (Tithonian):* Kurdistan.——FIG. 161,*1a–c. *C. turriculatum;* ×1 (Spath, 1950).

Parapedioceras COLLIGNON, 1962a, p. 21 [**P. colcanapi;* OD]. Based on a single ancyloceratoid terminal hook. Whorl section high and rectangular; ribs distant, simple, slightly convex, and rursiradiate, with feeble inner and outer ventrolateral tubercles. *Lower Cretaceous (Lower Valanginian):* Madagascar.——FIG. 160,*1a,b. *P. colcanapi;* ×0.75 (Collignon, 1962a).

Subfamily BOCHIANITINAE Spath, 1922

[Bochianitinae SPATH, 1922a, p. 147] [=Baculinidae GILL, 1871, p. 3, *nom. oblit.* (taxonomic status of *Baculina,* see below, is doubtful)]

Straight forms, with prorsiradiate annular ribs or smooth. *Upper Jurassic (Lower Tithonian)–Lower Cretaceous (Lower Aptian).*

Bochianites LORY, 1898, p. 133 [**Baculites neocomiensis* ORBIGNY, 1842a, p. 560; OD]. With prorsiradiate, annular ribs or smooth. Suture with short elements; U much reduced, no larger than lobule in L. *Upper Jurassic (Lower Tithonian)–Lower*

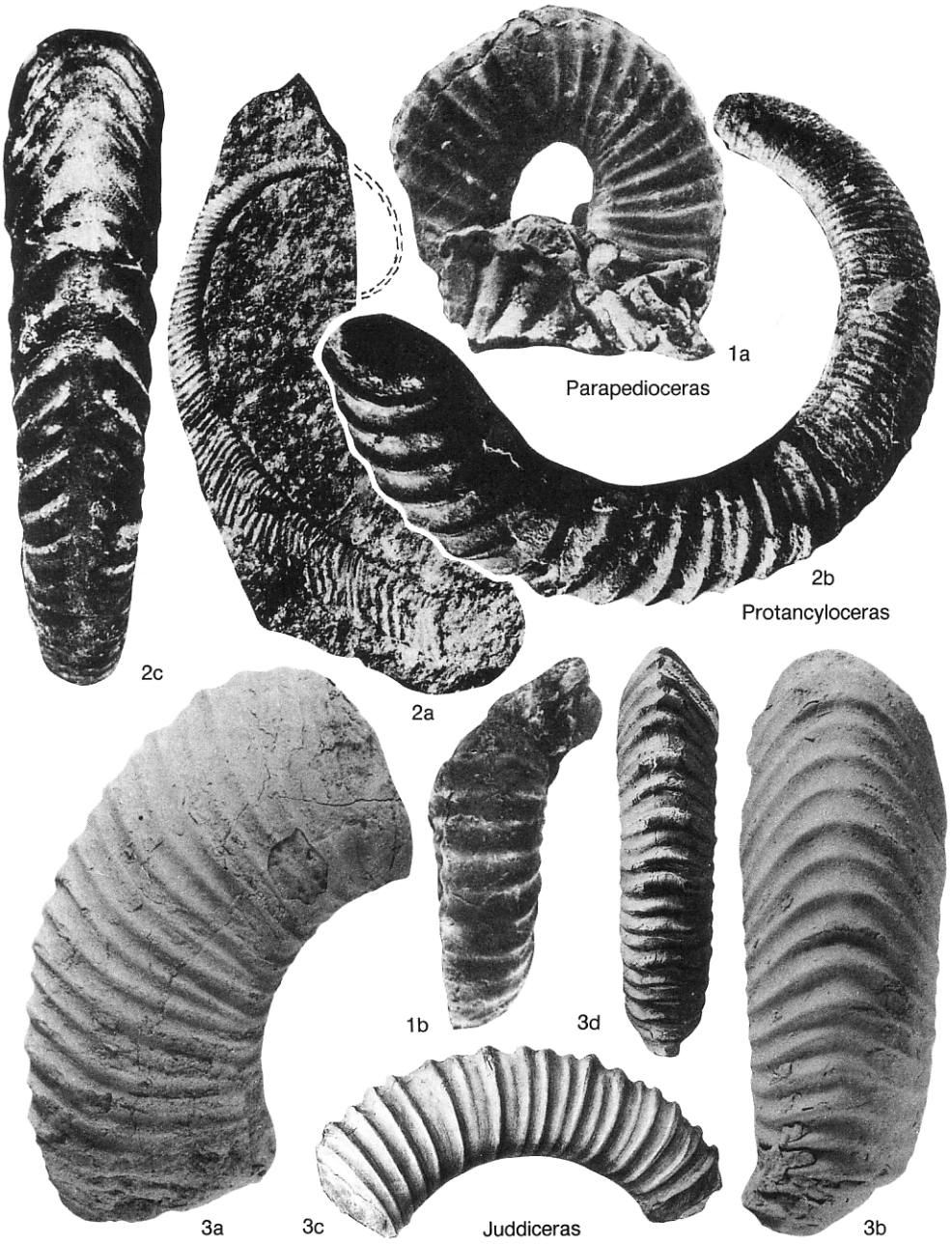
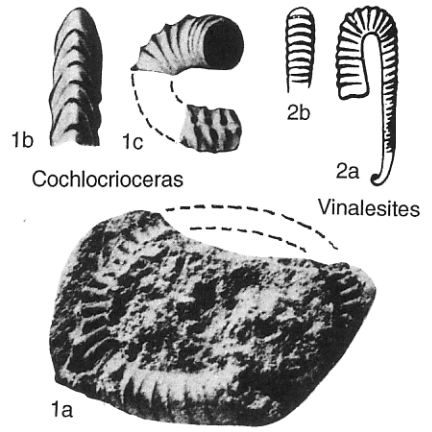
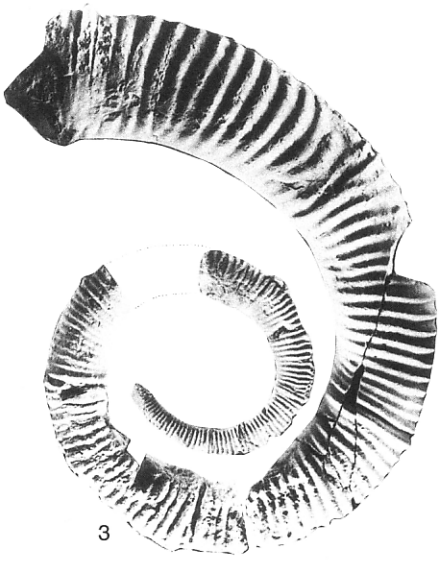


FIG. 160. Bochianitidae (p. 208)

Cretaceous (Barremian): Europe, Cape Verde Islands, northern and southeastern Africa, Madagascar, Himalayas, Indonesia, eastern Siberia, California, Mexico, Russia (Alexandra Land), eastern Greenland.——FIG. 162,*3a–c.* **B. neocomiensis* (ORBIGNY), Upper Valanginian, France; *a,b,* restored, ×1; *c,* enlarged (Orbigny, 1842a).

Umgazaniceras KLINGER & KENNEDY, 1979, p. 12 [**U. thieuloyi;* OD]. With distinct, oblique dorsolateral and ventrolateral oblique clavi joined by simple or looped ribs or striae with intercalated ribs or striae. *Lower Cretaceous (Upper Valanginian):* South Africa.——FIG. 162,*2a–d.* **U. thieuloyi; a–c,* ×3; *d,* ×9.5 (Klinger & Kennedy, 1979).





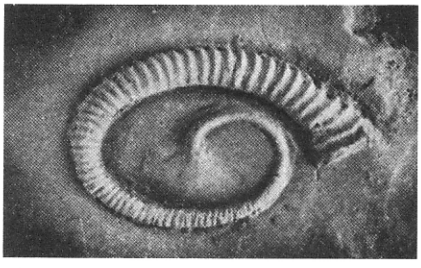


FIG. 161. Bochianitidae (p. 208)

Baculina ORBIGNY, 1850a, p. 66 (1849, p. 288, *nom. nud.*) [**B. rouyana;* OD]. Smooth; suture pseudoceratitic, with almost entire outlines. Only one specimen known; presumably derived from *Bochianites,* but relationships uncertain. *Lower Cretaceous (Valanginian):* France.——FIG. 162,*1a,b.* **B. rouyana; a,* ×2; *b,* ×4 (Cottreau, 1934).

Janenschites DURAND DELGA, 1954, p. 137 [**Bochianites janenschi* ZWIERZYCKI, 1914, p. 83; OD]. Suture with long and narrow elements, more denticulate than in *Bochianites.* Doubtfully distinct from *Bochianites. Lower Cretaceous (Barremian):* Lake Tanganyika.

Kabylites DURAND DELGA, 1954, p. 136 [**Bochianites superstes* PERVINQUIÈRE, 1910, p. 22; OD]. Differs from *Bochianites* only in having suture with U more or less the same size as L. *Lower Cretaceous (Barremian–Lower Aptian):* France, Germany, northern Africa.——FIG. 162,*4.* **K. superstes* (PERVINQUIÈRE), Barremian, Algeria; ×1 (Pervinquière, 1910).

Family ANCYLOCERATIDAE Gill, 1871

[Ancyloceratidae GILL, 1871, p. 3]

Either coiled in a loose or tight, more or less equiangular spiral (criocone) or with an initial spire followed by curved or straight shaft and terminal hook (ancyloceratoid). In several phyletic lines, the tendency is to tighter, normal ammonitic coiling. Whorl section ranging from circular to square or polygonal; tending to develop strong, periodic ribs with umbilical, lateral, and ventrolateral spines, separated by few to many, fine, untuberculate ribs. Ornament rarely constant through growth. Probably strongly dimorphic throughout, but presumed microconchs have rarely been matched with macroconchs; many are here still grouped in a subfamily Heliancylinae. Sutures florid, with trifid lobes or simplifying. Probably derived by incoiling from *Protancyloceras.* Present division into subfamilies is probably artificial. *Lower Cretaceous (Upper Valanginian–Upper Aptian, ?Lower Albian).*

Subfamily CRIOCERATITINAE Gill, 1871

[*nom. transl.* WRIGHT, 1957b, p. 208, *ex* Crioceratitidae WRIGHT, 1952, p. 218, *nom. correct. ex* Crioceratidae GILL, 1871, p. 3] [=Toxoceratidae GILL, 1871, p. 3; Pedioceratidae HYATT, 1900, p. 587; Himantoceratidae DIMITROVA, 1970, p. 79]

Typically coiled in a regular, plane, loose or tight spiral, but some having irregularly hooked body chambers and possible microconchs having ancyloceratoid coiling (see also Helicancylinae); ribbing generally dense; major ribs tuberculate and minor ones

untuberculate; constrictions present or not. *Lower Cretaceous (Upper Valanginian–Lower Aptian).*

Menuthiocrioceras COLLIGNON, 1949a, p. 75 [**Crioceras (M.) lenoblei;* OD]. Whorls touching; whorl section becoming more inflated with growth; venter flat to a late stage; ribs nearly straight and radial at first, then sinuous and finally biconcave, fairly fine and dense; up to 8 plain ribs occurring between enlarged trituberculate ribs. *Lower Cretaceous (Upper Valanginian–Upper Hauterivian):* Madagascar.——FIG. 163,*2a,b. M. hourcqui* COLLIGNON; inner whorls, ×1 (Collignon, 1949a).

Aegocrioceras SPATH, 1924a, p. 76 [**Hamites capricornu* F. A. ROEMER, 1841, p. 92; OD] [=?*Bejucoceras* A. CANTU-CHAPA, 1976, p. 65 (type, *B. simplecostatum;* OD)]. Loosely to tightly coiled, generally in regular, plane spiral; ribs mostly equal and single, crossing venter more or less transversely, uninterrupted except on early whorls in some species; ventrolateral and rarely lateral tubercles may be present on some or all ribs in early stages. RAWSON, 1975b. *Lower Cretaceous (Lower Hauterivian–Upper Hauterivian):* northern Europe, ?Mexico.——FIG. 163,*1a–c. A. bicarinatum* (G. M. YOUNG & BIRD), Lower Hauterivian, England; *a,b,* ×1 (Pavlow, 1892); *c,* enlarged (Rawson, 1975b).

Eocrioceratites WIEDMANN, 1973a, p. 312 [**Protancyloceras rebillyi* COLLIGNON, 1962a, p. 20; OD]. Main ribs, with 3 tubercles, separated by 1 secondary with no or only feeble lateral tubercle; coiling probably in regular spiral. Doubtfully distinct from *Crioceratites. Lower Cretaceous (Upper Valanginian):* Madagascar.——FIG. 163,*3a,b. *E. rebillyi* (COLLIGNON); ×0.75 (Collignon, 1962a).

Crioceratites LÉVEILLÉ, 1837, p. 313 [**C. duvalii;* SD DIENER, 1925, p. 191] [=*Crioceras* ORBIGNY, 1842a, p. 457 (illegitimate emendation); ?*Hoplitocrioceras* GIOVINE, 1950, p. 49 (type, *H. gentilii;* OD)]. Typically coiled in equiangular spiral, but spiral angle may increase with age; whorl section oval to subquadrate, with more or less trapezoidal top; ribs generally dense, rounded, straight to flexuous, single or bundled at umbilical edge, and untuberculate; stronger major ribs strengthened on shoulders or with ventrolateral or umbilical, lateral, and ventrolateral spines; constrictions may be present. [*Toxoceras* and *Himantoceras* for very loosely coiled forms seem unnecessary.] *Lower Cretaceous (Upper Valanginian–Upper Barremian):* Europe, southern Russia, Turkey, South Africa (Zululand), Madagascar, Japan, California, Mexico, South America.

C. (Crioceratites) [=*Toxoceras* ORBIGNY, 1842a, p. 472 (type, *Toxoceras requienianum* ORBIGNY, 1842a, p. 477; SD DIENER, 1925, p. 192); *Himantoceras* THIEULOY, 1965, p. 206 (type, *H. trinodosum;* OD); *Binelliceras* SARKAR, 1977, p. 258 (type, *Ancyloceras binelli* ASTIER, 1851, p. 14; OD)]. Generally with many minor ribs; major ribs with 1 to 3 generally small tubercles; constrictions present or not. Occurrence and distribution as for genus.——FIG. 164,*5a–c. C. (C.) nolani* (KILIAN), Upper Hauterivian, France; *a,b,* ×0.25; *c,* ×0.5 (Orbigny, 1840–1842).——FIG. 164,*5d. C. (C.) trinodosum* (THIEULOY), Upper Valanginian, France; ×0.5 (Thieuloy, 1965).——FIG. 164,*5e. C. (C.) binelli* (ASTIER), Upper Hauterivian, France; ×1 (Thomel, 1964).

C. (Paracrioceras) SPATH, 1924a, p. 79 [**Ammonites (Crioceras) occultum* SEELEY, 1865, p. 246; OD]

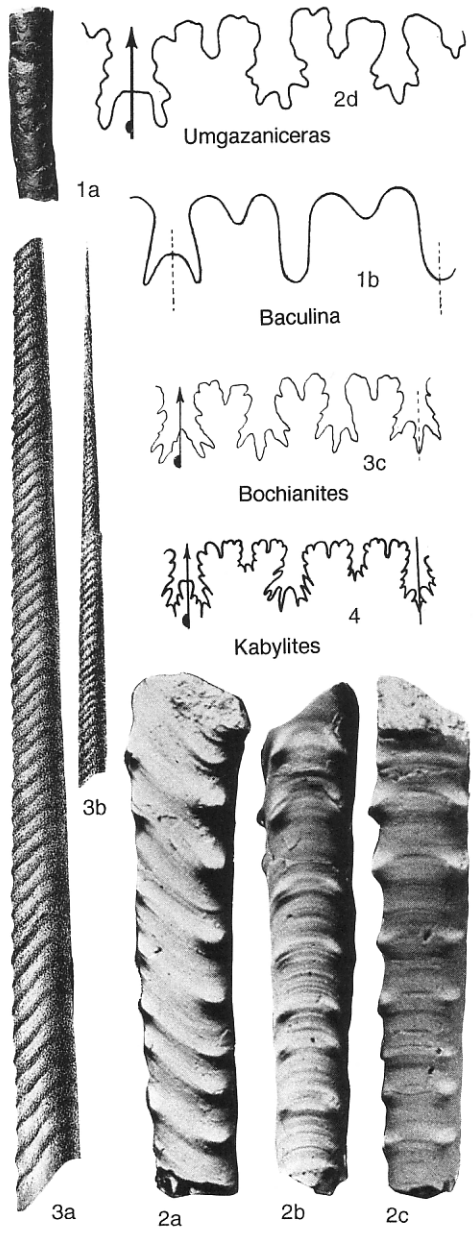


FIG. 162. Bochianitidae (p. 208–210)

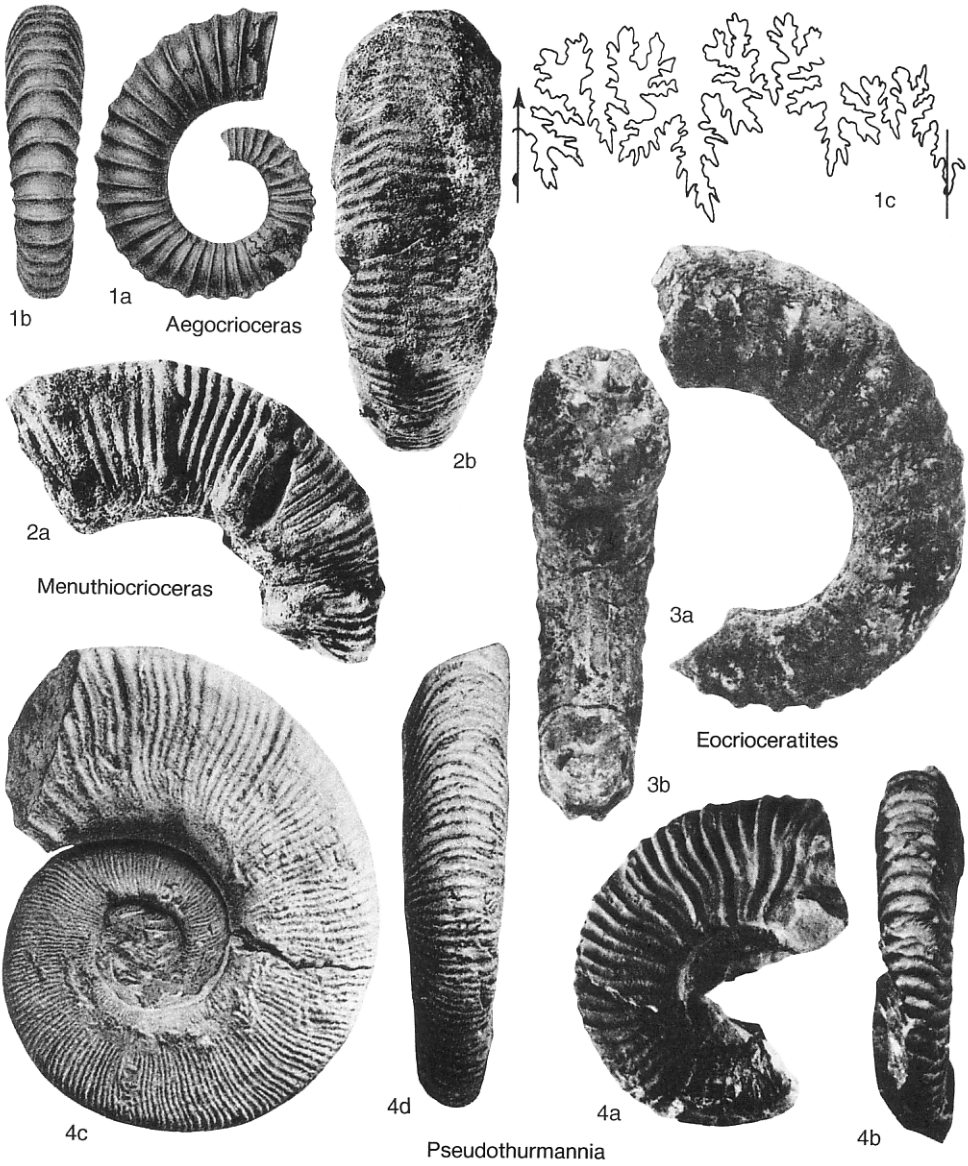


FIG. 163. Ancyloceratidae (p. 211–214)

[=*Emericiceras* SARKAR, 1954b, p. 619(2) (type, *Crioceratites emerici* LÉVEILLÉ, 1837, p. 314; OD)]. Differs from *C. (Crioceratites)* mainly in having more frequent, stronger, periodic ribs, with stronger spines, fewer to no minor ribs, and in greater tendency of later whorls to uncoil; tubercles may weaken and lateral tubercles disappear on body chamber (of questionable microconchs). *Lower Cretaceous (Upper Hauterivian–Upper Barremian):* Europe, South Africa (Zululand), Japan, South America.——FIG. 164,*3a–c*. **C. (P.) occultum* (SEELEY), Barremian, England; *a*, ×1; *b,c*, ×0.75 (Rawson, 1975a).

C. (**Sornayites**) WIEDMANN, 1962b, p. 140 [**Emericiceras paronai* SARKAR, 1955, p. 97; OD]. Similar to *C. (Paracrioceras)* but with ammonitic coiling. *Lower Cretaceous (Upper Barremian):* France, northern Italy, Carpathians, southern Russia.

C. (**Spathicrioceras**) SARKAR, 1955, p. 160 [**S. sornayi;* OD] [=*Sapthicrioceras* (*errore pro Spathicrioceras*) SARKAR, 1954b, p. 620, *nom.*

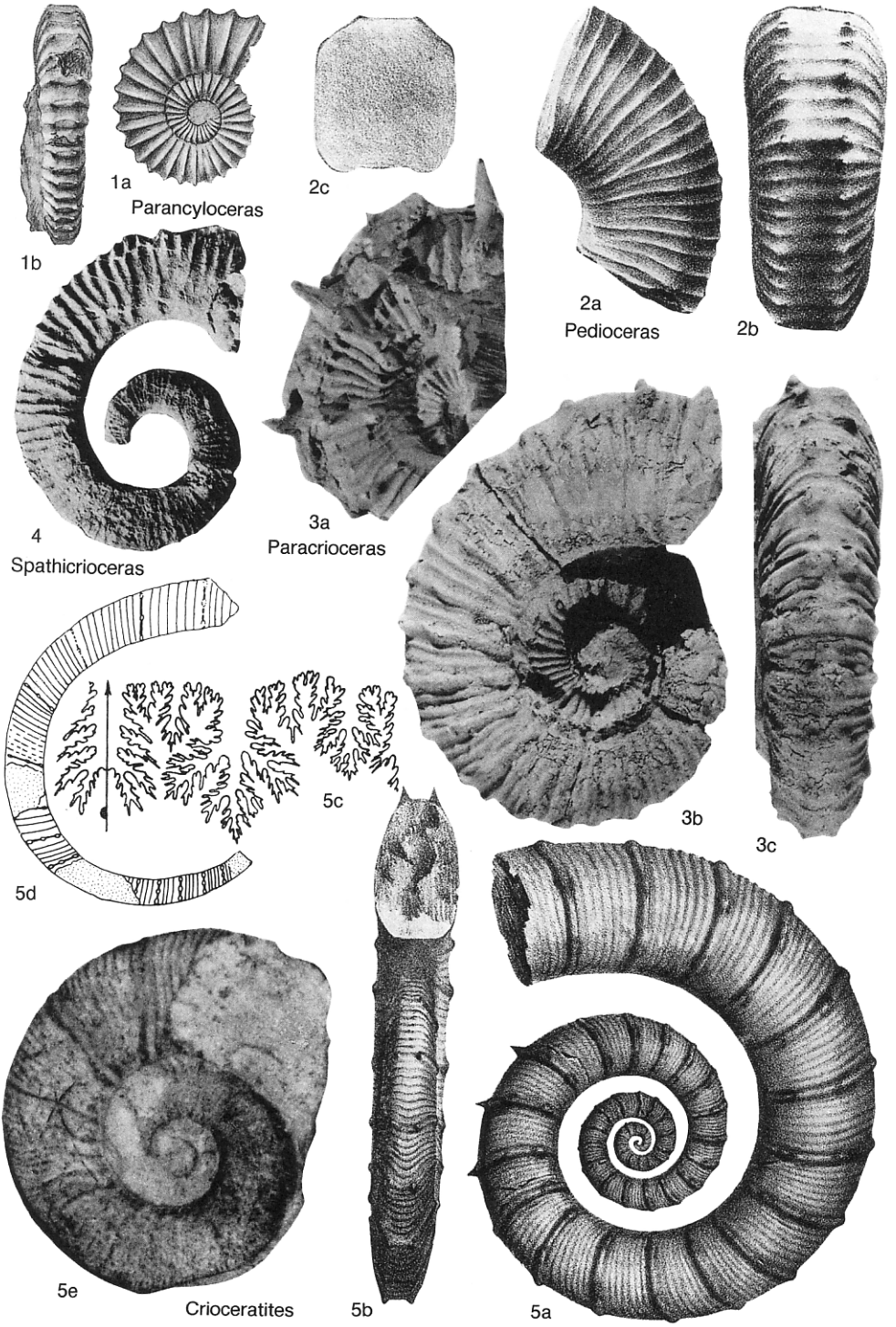


FIG. 164. Ancyloceratidae (p. 211–215)

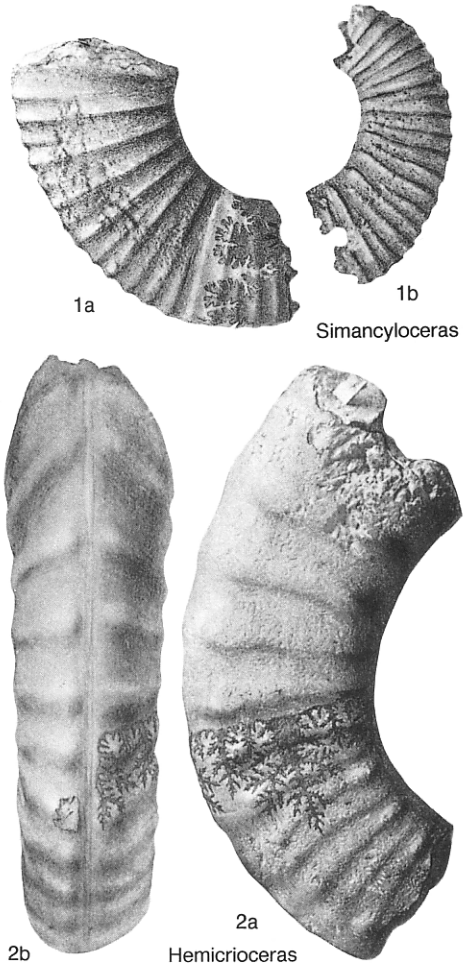


FIG. 165. Ancyloceratidae (p. 214)

nud.]. Small; early whorls with major ribs having umbilical and lateral tubercles and separated by 2 or 3 minor ribs. Later whorls foreshadow *Pseudothurmannia,* with strong, uniform, distant, and untuberculate ribs branching at umbilical edge. *Lower Cretaceous (Hauterivian):* southern and central Europe.——FIG. 164,*4.* **C. (S.) sornayi* (SARKAR), France; ×1 (Sarkar, 1955).

Megacrioceras DELANOY, AUTRAN, & THOMEL, 1987, p. 312 [**Ancyloceras doublieri* JAUBERT, 1854, p. 326; OD]. After early whorls, equiangular spiral straightening into long shaft, probably with terminal hook; periodic, collared constrictions with dense, fine ribs between; no tubercles. Probably macroconch, perhaps of *Paraspinoceras* (see Helicancylinae). *Lower Cretaceous (Upper Hauterivian):* France, Switzerland.

Pseudothurmannia SPATH, 1923d, p. 66 [**Ammonites angulicostatus* ORBIGNY, 1841, p. 146; OD] [=*Balearites* SARKAR, 1954a, p. 98 (type, *Crioceras baleare* NOLAN, 1894, p. 193; OD); ?*Georgioceras* WILCKENS, 1947, p. 21 (type, *G. kohllarseni;* OD)]. Whorls not in contact to slightly involute; compressed, with flat or slightly convex sides; venter arched to flat; ribs flexuous, branching from umbilical tubercles or further up sides, fine and dense throughout (*Balearites*) or becoming coarse and distant on outer whorls; weak ventrolateral tubercles may occur on body chamber, lateral tubercles rarely. *Upper Cretaceous (Upper Hauterivian–Lower Barremian):* southern and central Europe, Turkey, Georgia, ?Russia (Alexandra Land).——FIG. 163,*4a,b.* **P. angulicostata* (ORBIGNY), Lower Barremian, France; ×1 (Lapeyre, 1974).——FIG. 163,*4c,d. P. baleare* (NOLAN), Upper Hauterivian, Balearic Islands; ×1 (Nolan, 1894).

Pedioceras GERHARDT, 1897b, p. 170 [**P. cundinamarcae* GERHARDT, 1897b, p. 172; SD HYATT, 1903, p. 108] [=?*Pseudocrioceras* SPATH, 1924a, p. 78 (type, *Scaphites abichii* SIMONOVICH & BATSEVICH, 1873, p. 29; OD)]. Early whorls (which may be shallowly helical) involute, subquadrate in section; ribs equal, straight or sinuous, mainly single, angulate or with inner and outer ventrolateral tubercles, weakened or not on venter; later ribs differentiated into minor plain and major trituberculate ribs; outer whorls with looser coiling and weaker and more distant ribbing. *Lower Cretaceous (Barremian–Lower Aptian):* France, Caucasus, California, Mexico, Colombia.——FIG. 164,*2a–c.* **P. cundinamarcae,* Barremian, Colombia; inner whorls, ×1 (Gerhardt, 1897b).

Hemicrioceras SPATH, 1924a, p. 85 [**Crioceras rude* KOENEN, 1902, p. 311; OD]. Large; coiling questionably crioconic; at first with straight ribs not continuous across venter; later alternate ribs with and without umbilical tubercles but probably all with subdued inner and outer ventrolateral tubercles; later still, all ribs similar and tubercles weaker. Should probably include a wide range of large criocones with early stages having few or no tubercles and later stages with subdued trituberculation and broad, blunt ribs. *Lower Cretaceous (Barremian):* England, Germany.——FIG. 165,*2a,b.* **H. rude* (KOENEN), Germany; ×1 (Koenen, 1902).

Simancyloceras KEMPER, 1973b, p. 43 [**S. stolleyi;* OD]. Coiling ancyloceratid; with rather coarse, rounded primary ribs and short intercalatories; typically untuberculate, but some species having weak umbilical and ventrolateral bulges on hook. Perhaps a microconch of *Hemicrioceras. Lower Cretaceous (Upper Barremian):* Germany.——FIG. 165,*1a,b.* **S. stolleyi;* ×1 (Koenen, 1902).

Parancyloceras SPATH, 1924a, p. 79 [**Crioceras bidentatum* KOENEN, 1902, p. 329; OD]. Coiled either in plane spiral (with whorls just touching or not in contact) or straightening (possibly then hooked) after a few coiled whorls; ribs uniform, distant, sharp, equal, steep, radial or oblique, with more or less distinct outer and (in some species) also inner ventrolateral tubercles; ribs may be

doubled between outer tubercles. *Lower Cretaceous (Upper Barremian):* England, Germany.——FIG. 164,*1a,b. P. bidentatum* (KOENEN), Germany; ×1 (Koenen, 1902).

Spinocrioceras KEMPER, 1973b, p. 47 [**S. polyspinosum;* OD]. Inner whorls presumably having sharp umbilical, midlateral, and inner ventrolateral tubercles and feebler outer ventrolateral tubercles on equal ribs; umbilical, midlateral, and inner ventrolateral tubercles persisting. *Lower Cretaceous (Upper Barremian):* Germany.——FIG. 166,*3. *S. polyspinosum;* ×0.5 (Kemper, 1973b).

?**Acantholytoceras** SPATH, 1923d, p. 21 [**Hamites (Pictetia) longispinus* UHLIG, 1883, p. 222(96); OD] [=?*Pseudocrioceratites* EGOIAN, 1969, p. 171 (type, *P. pseudoelegans;* OD)]. Crioconic, with whorls well separated; whorl section oval; distant, periodic, enlarged ribs with very long, hollow umbilical, lateral, and ventrolateral spines; other ribs very fine. Suture (attributed to this species by UHLIG) florid, with slightly asymmetrically bifid L. Relationships doubtful until better material is available. *Lower Cretaceous (Barremian):* Austria. *Lower Cretaceous (?Aptian):* Caucasus.——FIG. 166,*2. *A. longispinum* (UHLIG), Barremian, Austria; ×0.5 (Uhlig, 1883).

?**Shasticrioceras** ANDERSON, 1938, p. 203 [**S. poniente;* SD WRIGHT, 1957b, p. 208]. Medium-sized to large; whorls just touching or not; compressed, with slightly convex sides and flat venter; ribs sinuous or biconcave, rarely branching or intercalated, each with round or clavate ventrolateral tubercle; ribs may become coarse and distant on body chamber. Suture with wide-necked L. *S. anglicum* DOYLE (1963, p. 575), Lower Hauterivian, England, is loosely coiled and has L with narrow neck but probably belongs here. *Lower Cretaceous (?Lower Hauterivian, Lower Barremian–Upper Barremian):* ?England, Japan, California.——FIG. 166,*1. *S. poniente,* Upper Barremian, California; ×1 (Anderson, 1938).

[**Neohoplites** GERTH, 1921, p. 144 (*nom. nud.*)].

Subfamily ANCYLOCERATINAE Gill, 1871

[*nom. transl.* WRIGHT, 1957b, p. 210, *ex* Ancyloceratidae GILL, 1871, p. 3]

Typically large forms with early whorls forming a more or less regular, open, plane spire followed by curved or straight shaft and terminal hook, commonly with trituberculate main ribs and fine intermediaries. Suture normally florid, with trifid L. *Lower Cretaceous (Lower Barremian–Upper Aptian, ?Lower Albian).*

The trend along several phylogenetic lines is to increasingly close coiling, differentiation of ornament on the hook, and loss of trituberculation, at least in middle growth.



FIG. 166. Ancyloceratidae (p. 215)

In other lines the shaft straightens and lengthens to produce ptychoceratoid coiling. Small forms with similar coiling and ornament are here grouped as Helicancylinae but may be a collection of microconchs of Crioceratitinae and Ancyloceratinae. Origin appears to lie in *Crioceratites (Paracrioceras).* THOMEL, 1964.

Ancyloceras ORBIGNY, 1842a, p. 491 [**A. matheronianum* ORBIGNY, 1842a, p. 497; SD HAUG, 1889, p. 212] [=*Hoplancyloceras* NOWAK, 1913, p. 382, *nom. nud.*]. Open, plane spiral followed by long shaft and terminal hook; ribs straight, radial or prorsiradiate, with periodic, enlarged trituberculate ribs at least on early whorls and hook. Known with *Praestriaptychus. Lower Cretaceous (Lower Barremian–Lower Aptian):* Europe, southeastern Africa, Madagascar, Japan, California, Colombia.

A. (**Ancyloceras**). Trituberculate major ribs throughout. Occurrence and distribution as for genus.——FIG. 167,*2. *A. (A.) matheronianum,* Lower Aptian, France; ×0.125 (Orbigny, 1840–1842).

A. (**Audouliceras**) THOMEL, 1964, p. 55 [**Ancyloceras audouli* ASTIER, 1851, p. 22; OD]. Initial spire with more or less irregular, wide spines disappearing early or late; shaft long, at least some part with no major trituberculate ribs; hook may be much inflated, with very strong ribs and spines. *Lower Cretaceous (Upper Barremian–Lower Aptian):* western and central Europe, Mozambique, South Africa (Zululand), California.——FIG. 167,*1a,b. *A. (A.) audouli,* ?Barremian, France; ×0.25 (Klinger & Kennedy, 1977).

A. (**Jaubertites**) SARKAR, 1955, p. 98 (1954b, p. 619(2), *nom. nud.*) [**J. dubius;* OD]. Only rather closely coiled spires known, with dense, fine ribs and, periodically, wide umbilical, lateral, and ventrolateral spines irregularly overriding several ribs. Possibly a senior synonym of *Audouliceras.* At present a *nomen dubium. Lower Cretaceous (Lower Barremian):* France.

A. (**Tonoceras**) HYATT, 1900, p. 537 [**Ancyloceras duvalianum* ORBIGNY, 1842a, p. 500; OD]. Differs from *A. (Ancyloceras)* in its shorter, curved shaft and prominent, clavate lateral and ventrolateral tubercles. Doubtful taxon; KILIAN and REBOUL, 1915 regarded type species as a *Crioceratites* from the Upper Hauterivian. *Lower Cretaceous (Lower Aptian):* France.

?Moutoniceras SARKAR, 1954b, p. 620(3) [**Toxoceras moutonianum* ORBIGNY, 1850a, p. 101; OD]. Very large, with loose, crioconic spire followed by long shaft and hook; ribs simple, projected, and in some interrupted on venter; dorsal intercalated ribs present in some species; inner and outer ventrolateral tubercles may be present at end of spire and beginning of shaft; constrictions commonly present on spire. Suture florid. Perhaps should be placed in Crioceratitinae. *Lower Cretaceous (Barremian):* France, central Europe, Colombia.——FIG. 168,*2a–c. **M. moutonianum* (ORBIGNY), France; *a,b,* ×0.5 (Cottreau, 1937); *c,* ×0.25 (Sarkar, 1955).

Acanthoptychoceras MANOLOV, 1962, p. 529 [**A. spinatocostatum;* OD]. Based on fragment of straight shaft and large terminal hook with strong trituberculate ribs. Possibly a *Hamulina* but more probably *Lithancylus* or *Audouliceras.* At present a *nomen dubium. Lower Cretaceous (Lower Barremian):* Bulgaria, ?Colombia.

Lithancylus CASEY, 1960c, p. 16 [**Hamites grandis* J. DE C. SOWERBY, 1828, p. 187; OD]. Probably with small initial coil followed by long, slender shaft as in *Hamulina* with fine, oblique ribbing and terminal hook and short final shaft with coarse, trituberculate major ribs. Probably derived from *Ancyloceras (Audouliceras)* by lengthening of shaft and reduction of spire. *Lower Cretaceous (Barremian–Lower Aptian):* England, Austria, Mozambique, Australia (Queensland), California, Argentina (Patagonia), Antarctica (Alexander Island).——FIG. 167,*3. L. tirolensis* CASEY, Upper Barremian, Austria; ×0.5 (Casey, 1960c).

Shastoceras ANDERSON, 1938, p. 212 [**S. californicum;* OD]. Very large; spire rather compressed, with feeble ribs that may have bullate ventrolateral tubercles; shaft becoming more inflated, smooth or with faint oblique ribs; hook inflated, rounded, and smooth, with a few enlarged ribs at end. *Lower Cretaceous (Lower Aptian):* California.——FIG. 167,*4. **S. californicum;* ×0.2 (Anderson, 1938).

Peltocrioceras SPATH, 1924a, p. 85 [**Crioceras deeckei* FAVRE, 1908, p. 636; OD]. Rather close, crioconic coiling; ribs more or less uniform, fine at first, coarsening gradually, all trituberculate. *Lower Cretaceous (?Upper Aptian):* Argentina (Patagonia).——FIG. 168,*3. **P. deeckei* (FAVRE); ×0.125 (Urreta, 1985).

Australiceras WHITEHOUSE, 1926, p. 208 [**Crioceras jacki* R. ETHERIDGE, Jr., 1880, p. 305; OD] [=*Colombiaticeras* ROYO Y GOMEZ, 1945, p. 469 (type, *C. bolivari;* OD); *Proaustraliceras* KAKABADZE, 1977, p. 132 (type, *Hamites gigas* J. DE C. SOWERBY, 1828, p. 188; OD)]. Coiling in early species more or less ancyloceratoid, with closely coiled spire and distinct hook; later species closely coiled criocones; initial whorls with trituberculate ribs, middle whorls with fine, mainly untuberculate ribs, and body chamber normally with enlarged, trituberculate ribs. [Subgeneric distinction based on minor coiling and sutural differences seems unnecessary.] *Lower Cretaceous (Lower Aptian–Upper Aptian):* England, France, Germany, Caucasus, South Africa (Zululand), Madagascar, Pakistan, Japan, Australia, California, Colombia.——FIG. 169,*1a. **A. jacki* (ETHERIDGE), Lower Aptian, Australia (Queensland); inner whorls, ×0.75 (Whitehouse, 1926). ——FIG. 169,*1b. *A. gigas* (J. DE C. SOWERBY), Lower Aptian, England; ×0.25 (Casey, 1960c).

Pseudoaustraliceras KAKABADZE, 1981, p. 114 [**Crioceras ramososeptatum* ANTHULA, 1899, p.

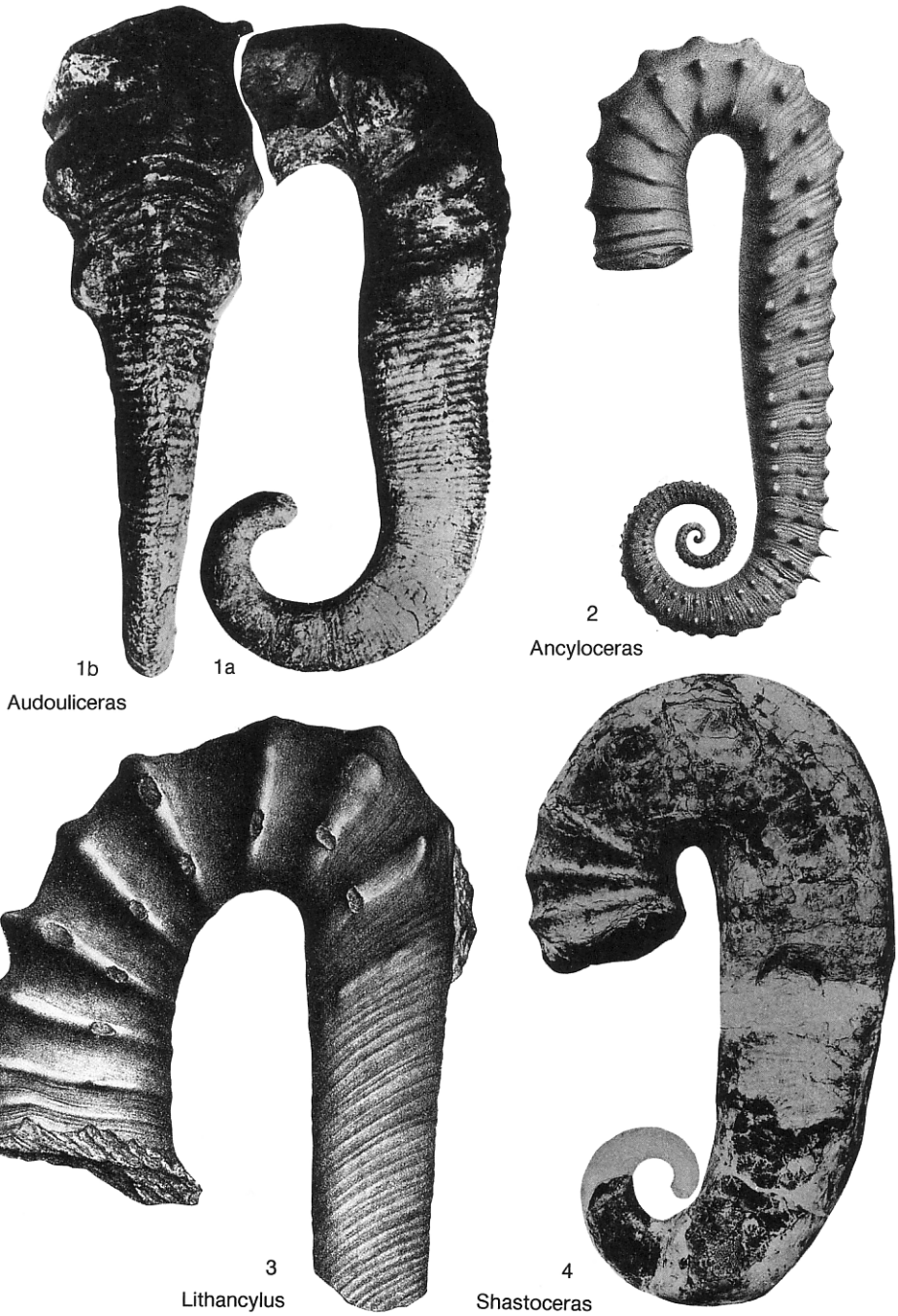


FIG. 167. Ancyloceratidae (p. 216)

127(73); OD]. Differs from *Australiceras* only in early whorls having dense, equal ribs without tubercles. Doubtfully distinct. *Lower Cretaceous (Aptian):* Georgia, Angola, Madagascar, Colombia.

Tropaeum J. DE C. SOWERBY, 1837, p. 535 [**T. bowerbanki;* OD (*nom. nud.*); =*Crioceratites bowerbanki* J. DE C. SOWERBY, 1840, p. 410]. Very large; differs from *Australiceras* by progressive loss of

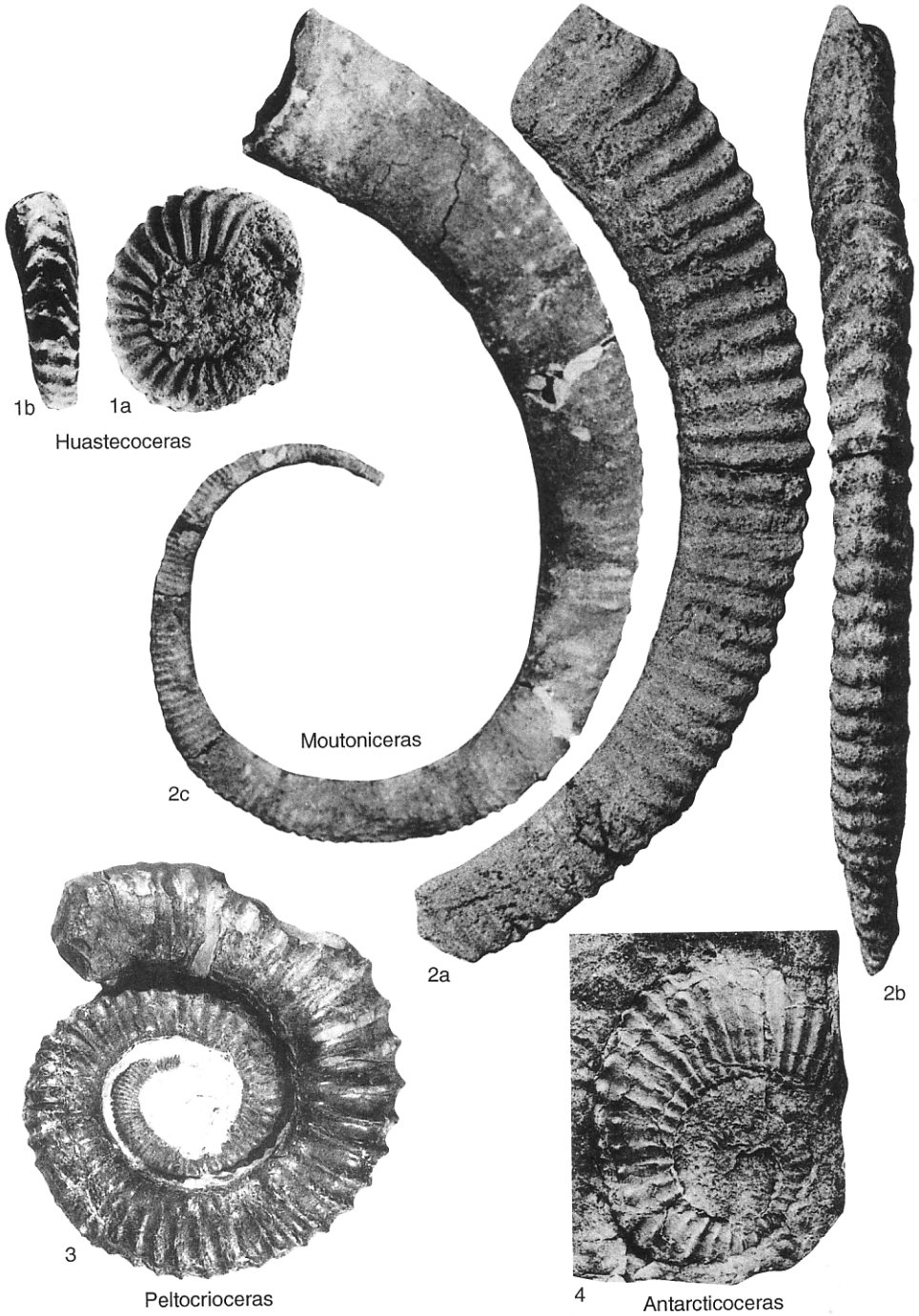


FIG. 168. Ancyloceratidae (p. 216–222)

tubercles; earliest whorls with some trituberculate ribs; then all ribs fine and dense, normally no more than slightly angulate on shoulders, until last whorl, on which they may become coarse and distant.

Lower Cretaceous (Lower Aptian–Upper Aptian): Europe, Russia, western and southeastern Africa, Madagascar, India, Australia, Alaska, California, Argentina (Patagonia), Greenland.

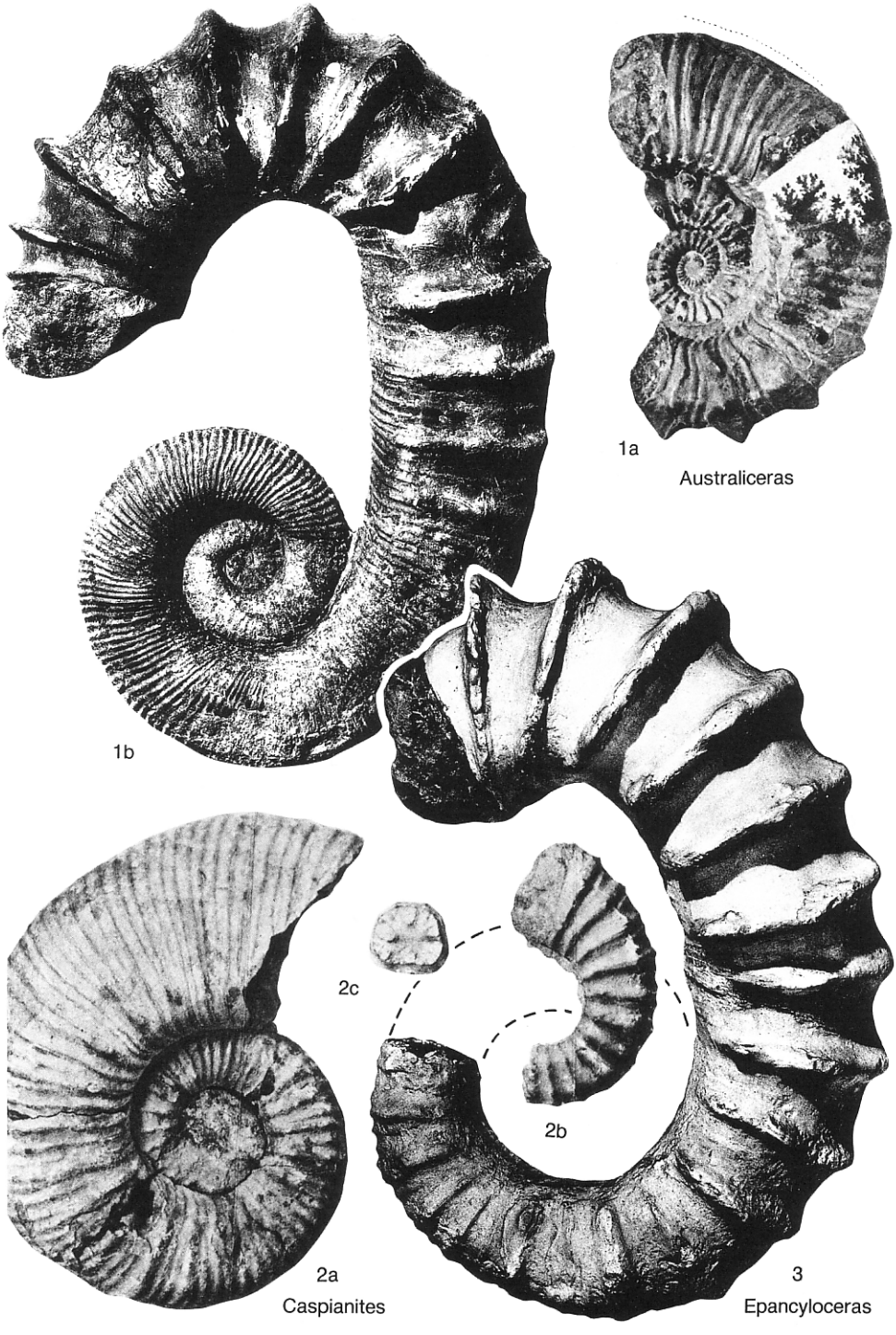


FIG. 169. Ancyloceratidae (p. 216–222)

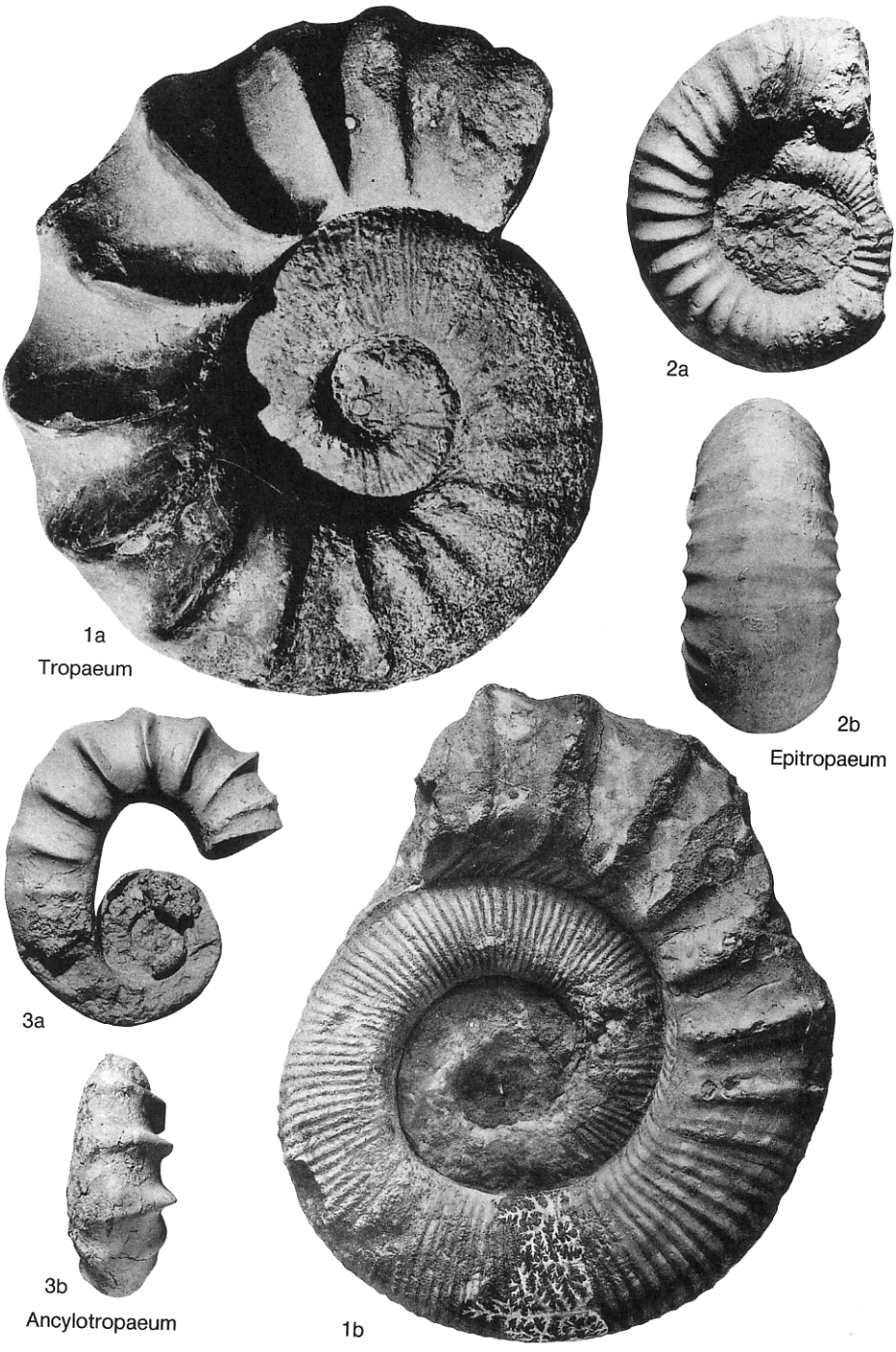


FIG. 170. Ancyloceratidae (p. 220–221)

T. (**Epitropaeum**) KAKABADZE, 1977, p. 132 [**T. subarcticum* CASEY, 1960c, p. 40; OD]. Body chamber with prolonged contraction and with uniform ribbing tending to disappear on venter. *Lower Cretaceous (Upper Aptian):* western Europe, Russia, South Africa (Zululand).——FIG.

170,*2a,b.* **T. (E.) subarcticum,* England; ×0.1 (Casey, 1980).

T. (Tropaeum) [=?*Australotropaeum* URRETA, 1985, p. 192 (type, *T. (A.) magnum;* OD)]. Body chamber just in contact or uncoiled, with short contraction and bold, distant ribbing. Occurrence and distribution as for genus.——FIG. 170,*1a.* **T. (T.) bowerbanki* (J. DE C. SOWERBY), Lower Aptian, England; ×0.25 (Casey, 1960c).——FIG. 170,*1b. T. (T.) drewi* CASEY, Lower Aptian, Germany; ×0.25 (Koenen, 1902).

T. (Ancylotropaeum) CASEY, 1980, p. 639 [**T. (A.) baylissi;* OD]. Body chamber a massive hook with depressed-suboctagonal section and bold, feebly trituberculate ribs. *Lower Cretaceous (Upper Aptian):* England.——FIG. 170,*3a,b.* **T. (A.) baylissi;* ×0.1 (Casey, 1980).

Helicancyloceras KLINGER & KENNEDY, 1977, p. 325 [**Heteroceras (Argvethites?) vohimaranitraense* COLLIGNON, 1962b, p. 14; OD] [=*Nonyaniceras* KLINGER & KENNEDY, 1977, p. 327 (type, *Helicancyloceras (N.) nonyani;* OD)]. Medium-sized, with initial, shallow, open helix followed by closely coiled, planispiral whorls; helix with strong, rounded ribs; ribs regular with slight ventral interruption and small ventrolateral tubercles to irregular with strong lateral and ventrolateral tubercles on all or some; outer whorls untuberculate. Probably derivative of *Tropaeum. Lower Cretaceous (Upper Aptian):* South Africa (Zululand), Madagascar.——FIG. 171*a–c.* **H. vohimaranitraense* (COLLIGNON), Zululand; *a,* ×0.5; *b,c,* ×1 (Klinger & Kennedy, 1977).——FIG. 171*d,e. H. nonyani* (KLINGER & KENNEDY), Zululand; ×1 (Klinger & Kennedy, 1977).

Ammonitoceras DUMAS, 1876, p. 405 [**A. ucetiae;* OD]. Criocone; body chamber may touch preceding whorl or not; whorl section depressed and coronate, as in some *Cheloniceras;* with periodic, septate umbilical and lateral spines, from which ribs may branch, and, in young, feeble ventrolateral tubercles; body chamber with coarse, single ribs as in *Tropaeum.* Suture with narrow E, very narrow E/L, and long, asymmetrically trifid L. *Lower Cretaceous (Lower Aptian–Upper Aptian):* England, France, Transcaspia, Turkey, southeastern Africa.——FIG. 172*a.* **A. ucetiae* DUMAS, Lower Aptian, France; ×0.2 (Casey, 1960c).——FIG. 172*b,c. A. lahuseni* (SINZOW), Upper Aptian, Mangyshlak; ×0.2 (Sinzow, 1906).——FIG. 172*d. A.* aff. *lahuseni* (SINZOW), Lower Aptian, southern Russia; ×0.5 (Vasilievskij, 1909).

Epancyloceras SPATH, 1930a, p. 454 [**E. hythense;* OD]. Much as in *Ammonitoceras* but with short, curved shaft, hook, and strong ventrolateral tubercles on early and adult whorls. Holotype of type species is malformed. *Lower Cretaceous (Lower Aptian):* England, ?France, Switzerland.——FIG. 169,*3.* **E. hythense,* England; ×0.2 (Casey, 1960c).

Caspianites CASEY, 1961a, p. 56 [**Crioceras (Ammonitoceras) wassiliewskyi* RENNGARTEN, 1926, p. 30; OD]. Differs from *Ammonitoceras* in its more delicate ornament and persistent ventral tubercles.

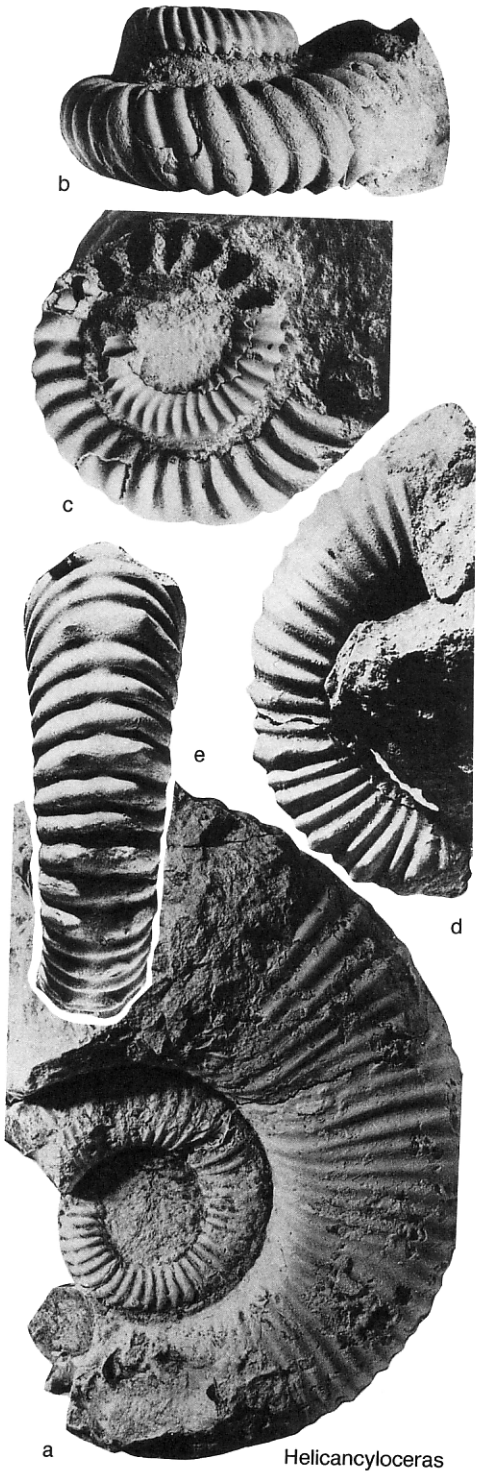


FIG. 171. Ancyloceratidae (p. 221)

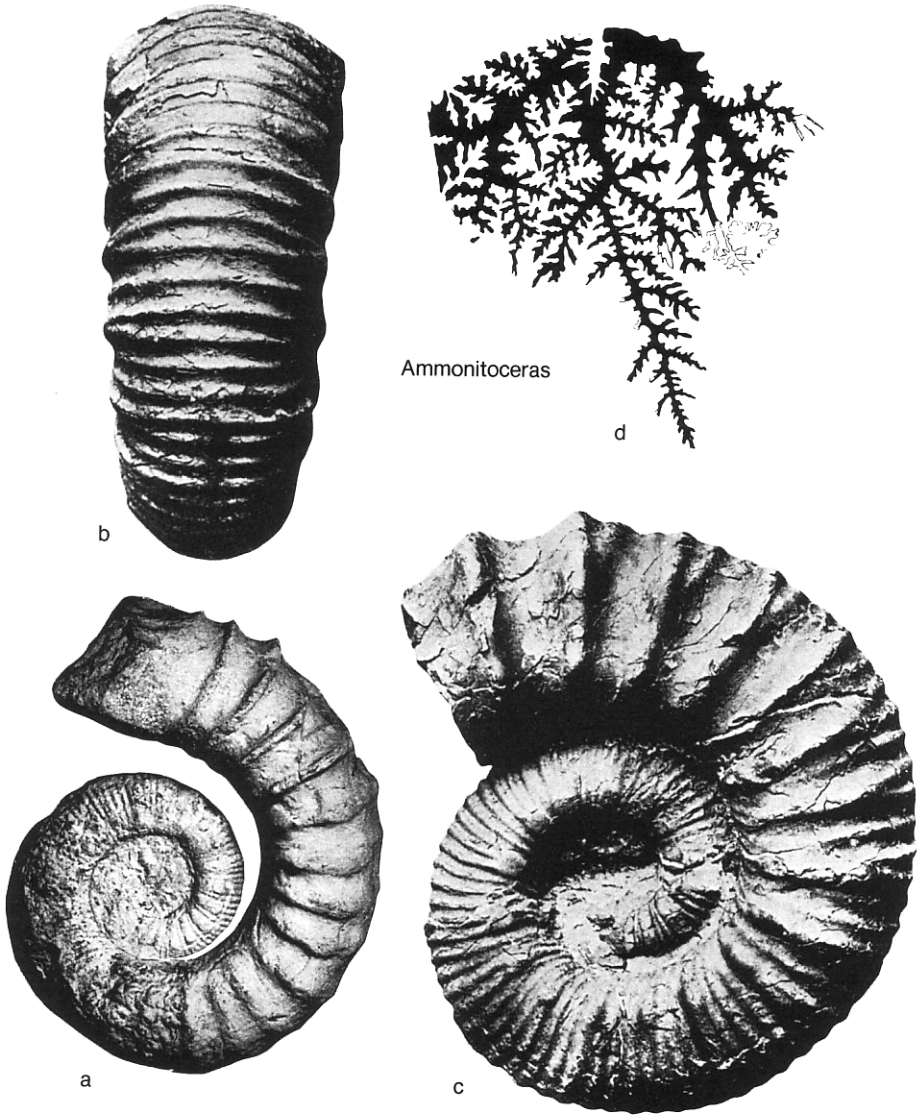


FIG. 172. Ancyloceratidae (p. 221)

On nucleus, all primary ribs trituberculate; intermediaries confined to venter. *Lower Cretaceous (Aptian):* England, Transcaspia.——FIG. 169,*2a–c.* **C. wassiliewskyi* (RENNGARTEN), Transcaspia; ×1 (Sinzow, 1908).

?Antarcticoceras THOMSON, 1974, p. 20 [**A. antarcticum;* OD]. Small criocone with regular, distant, simple ribs; at first with umbilical and inner and outer ventrolateral tubercles; later with umbilical tubercles moving up sides and then disappearing. Comparable to inner whorls of *Caspianites. Lower Cretaceous (?Lower Albian):* Antarctica (Alexander Island).——FIG. 168,*4.* **A. antarcticum;* ×1 (Thomson, 1974).

?Huastecoceras C. M. CANTU-CHAPA, 1976, p. 12 [**Crioceras trispinosoides* BURCKHARDT, 1925, p. 42; OD]. Criocone; ribs strong, flexuous, with umbilical and inner ventrolateral tubercles; ribs bending forward strongly from inner to outer ventrolateral tubercles, forming chevrons on venter. Perhaps close to *Caspianites. Lower Cretaceous (Upper Aptian):* Mexico.——FIG. 168,*1a,b.* **H. trispinosoides* (BURCKHARDT); ×1 (C. M. Cantu-Chapa, 1976).

Subfamily HELICANCYLINAE Hyatt, 1894

[*nom. transl.* Casey, 1961a, p. 76, *ex* Helicancylidae Hyatt, 1894, p. 565] [=Protacrioceratidae Dimitrova, 1970, p. 85; Epacrioceratidae Egoian, 1974, p. 939]

Small; coiling variable, with or without distinct shaft and terminal hook; initial whorls in some cases shallowly helical; ornament generally differentiated between spire and hook. *Lower Cretaceous (Upper Hauterivian–Upper Aptian).*

Not a natural subfamily but a collection of small forms and microconchs of various late Crioceratitinae and Ancyloceratinae. Possible microconchs of earlier Crioceratitinae are merely rather smaller forms of those species with differentiated ornament on the body chamber; the hooked form only appears in late Hauterivian.

Acrioceras Hyatt, 1900, p. 587 [**Ancyloceras tabarelli* Astier, 1851, p. 453(19); OD] [=*Mesocrioceras* Breistroffer, 1951a, p. 54, *nom. nud.* (no designation of type species, no differentia)]. Small; spire of 1 or 2 loosely coiled whorls followed by short or long, straight or curved shaft, terminal hook, and short or long final shaft; ribs generally fine and untuberculate, but sometimes major ribs enlarged and carrying 1 to 3 tubercles; ribs single on spire and shaft but may branch from umbilical tubercles on hook and final shaft; dorsum tending to become flat and dorsolateral margin to become angular on shaft and hook. *Lower Cretaceous (Upper Hauterivian–Lower Aptian):* western and central Europe, Caucasus, Madagascar, Japan, California.

A. **(Acrioceras).** With long, straight shaft and tuberculate major ribs on spire and shaft. Occurrence and distribution as for genus.——Fig. 173,*1.* **A. (A.) tabarelli* (Astier), Lower Barremian, France; ×1 (Sarasin & Schöndelmayer, 1902).

A. **(Protacrioceras)** Sarkar, 1955, p. 101 [**Ancyloceras ornatum* Orbigny, 1850a, p. 101; OD]. Short, curved shaft; tuberculate major ribs; ornament hardly differentiated on hook. *Lower Cretaceous (Upper Hauterivian–Lower Barremian):* France, central Europe, Madagascar.——Fig. 173,*3.* **A. (P.) ornatum* (Orbigny), Lower Barremian, France; ×1 (Sarkar, 1955).

A. **(Paraspinoceras)** Sarkar, 1955, p. 101 (Breistroffer, 1952c, p. 54, virtual *nom. nud.* for lack of differentia) [**Ancyloceras pulcherrimum* Orbigny, 1842a, p. 495; OD]. Shaft long; major ribs, if present, untuberculate; whorl height increasing rapidly. *Lower Cretaceous (Upper Hauterivian–Lower Barremian):* France, central Europe.——Fig. 173,*2.* **A. (P.) pulcherrimum* (Orbigny), Upper Hauterivian or Lower Barremian; ×0.75 (Thomel, 1964).

A. **(Dissimilites)** Sarkar, 1954b, p. 618(1) [**Hamites dissimilis* Orbigny, 1842a, p. 529; OD]. Straight shaft having tritubercular major ribs and long final shaft with ribs branching from distinct umbilical tubercles. *Lower Cretaceous (Barremian–Lower Aptian):* France, Austria, Romania, California.——Fig. 173,*4.* **A. (D.) dissimilis* (Orbigny), Barremian, Austria; ×1 (Uhlig, 1883).

A. **(Epacrioceras)** Egoian, 1974, p. 940 [**E. rarum;* OD]. Spire with trituberculate main ribs, shaft without. Doubtfully distinct. *Lower Cretaceous (Aptian):* Caucasus.——Fig. 173,*5a,b.* **A. (E.) rarum* (Egoian); ×1 (Egoian, 1974).

Lytocrioceras Spath, 1924a, p. 84 [**Ancyloceras jauberti* Astier, 1851, p. 455(25); OD]. Loosely coiled, with long shafts and irregular hook; whorl section increasing very slowly; periodic, tuberculate ribs on spire, but otherwise all ribs equal, dense, fine, and straight. *Lower Cretaceous (Barremian):* France, Switzerland.——Fig. 174,*1.* **L. jauberti* (Astier), France; diagram, ×0.3 (Trueman, 1941).

Hoplocrioceras Spath, 1924a, p. 78 [**Hamites phillipsi* Phillips, 1829, p. 124; OD] [=?*Aspinoceras* Anderson, 1938, p. 207 (type, *A. hamlini;* OD); *Subaspinoceras* Thomel, Delanoy, & Autran, 1987, p. 216 (type, *Ancyloceras mulsanti* Astier, 1851, p. 448(18); OD)]. Variably open spire followed by curved shaft and gently rounded hook; ribs irregularly long and short; no tubercles. [Horizon of *Aspinoceras* is uncertain but probably Hauterivian rather than Valanginian as stated by Anderson.] Rawson, 1975a. *Lower Cretaceous (Upper Hauterivian–Lower Barremian):* western Europe, California.——Fig. 175,*3a–d.* **H. phillipsi* (Phillips), Lower Barremian, England; ×0.75 (Rawson, 1975a).——Fig. 175,*3e. H. dilatatum* (Orbigny), Lower Barremian, France; ×0.75 (Orbigny, 1840–1842).

Toxoceratoides Spath, 1924a, p. 78 [**Toxoceras royerianum* Orbigny, 1842a, p. 481; OD]. Small initial spire followed by more or less curved shaft and short final hook; ornament as in *Ancyloceras,* but final hook with close, narrow, sharp ribs branching in twos or threes from umbilical tubercles. *Lower Cretaceous (Upper Barremian–Lower Aptian):* Europe, western Asia, eastern Africa, South Africa (Zululand), ?Australia (Queensland), California, Argentina (Patagonia), Antarctica.——Fig. 176,*2a–c.* **T. royerianus* (Orbigny), Lower Aptian, France; ×1 (Casey, 1961a).

Tonohamites Spath, 1924a, p. 85 [**T. decurrens;* OD] [=?*Colomboceratoides* Etayo Serna, 1979, p. 20 (type, *Toxoceratoides (Colomboceratoides) renzoni;* OD)]. Like *Toxoceratoides* but tuberculation reduced and less persistent, in some cases confined to venter, and ribs blunter, not branching on final hook. *Lower Cretaceous (Lower Aptian–Upper Aptian):* England, Spain, Germany, ?Georgia, South

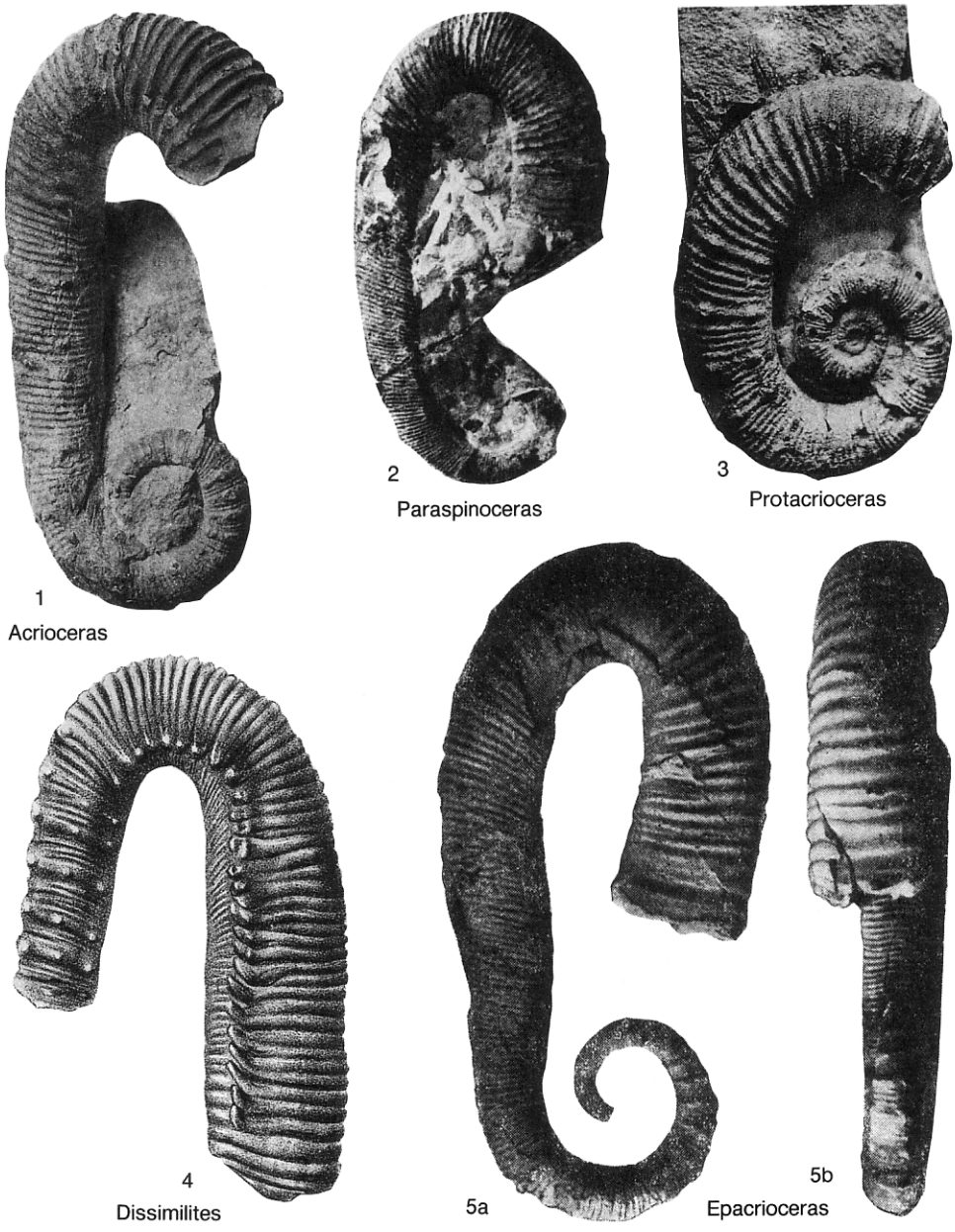


FIG. 173. Ancyloceratidae (p. 223)

Africa (Zululand), Madagascar, Argentina (Patagonia), ?Colombia.——FIG. 176,*1a,b.* **T. decurrens,* Lower Aptian, England; ×1 (Casey, 1960c).

Helicancylus GABB, 1869, p. 140 [**Ptychoceras aequicostatum* GABB, 1864, p. 74; M] [=*Hamiticeras* ANDERSON, 1938, p. 215 (type, *H. pilsburyi;* OD)]. With long, subparallel shafts, presumably after initial spire; ribs on main shaft alternately simple and uni- or trituberculate; ribs on final shaft sharp and distant, without tubercles. [The type species by monotypy of *Helicancylus* is *Ptychoceras aequicostatum* GABB, 1864. GABB indicated that he had an unspecified number of specimens attributed to this species; he figured one (pl. 13, fig. 20), which consists of part of a body chamber hook and straight shaft. ANDERSON (1938, p. 217), referring to this specimen, wrote: "The holotype of this species, a fragment of the body chamber only, is in the Mu-

seum of Paleontology, University of California." This may be taken as a valid lectotype designation. ANDERSON illegitimately placed this species in his new genus *Hamiticeras,* restricting *Helicancylus* to a form with strongly trituberculate, helical early whorls, which he named *H. gabbi.* According to ANDERSON, *aequicostatus* has weak ventrolateral tubercles irregularly on the ribs of the main shaft, compared with the strongly trituberculate alternate ribs of *Hamiticeras pilsburyi* ANDERSON, the designated type species of *Hamiticeras.* However, *aequicostatus* and *pilsburyi* agree well, and I regard them as congeneric. *Hamiticeras* is thus a subjective synonym of *Helicancylus.*] *Lower Cretaceous (Aptian):* Switzerland, Romania, Caucasus, California, Argentina (Patagonia).——FIG. 174,*2a,b.* **H. aequicostatus* (GABB), California; ×1 (Anderson, 1938).——FIG. 174,*2c. H. pilsburyi* (ANDERSON), California; ×0.5 (Anderson, 1938).

Luppovia BOGDANOVA, KAKABADZE, & MIKHAILOVA in KAKABADZE, BOGDANOVA, & MIKHAILOVA, 1978, p. 83 [**L. dostshanensis;* OD]. Small; perforate spire followed by straight shaft and probably hook; spire with single ribs having small umbilical, lateral, and ventrolateral spines; on shaft ribs may branch at umbilical tubercle. Suture with trifid or bifid lobes. *Lower Cretaceous (Upper Aptian):* Turkmenistan (Kopet-Dag).——FIG. 175,*1a,b.* **L. dostshanensis;* ×1 (Kakabadze, Bogdanova, & Mikhailova, 1978).

Epanisoceras COLLIGNON, 1962b, p. 15 [**Protanisoceras raulinianiforme* BREISTROFFER in COLLIGNON, 1937b, p. 126(22); OD]. Based on fragments of loosely coiled forms with principal, trituberculate ribs separated by 12 fine, close intermediaries. Suture with asymmetrically trifid lateral and umbilical lobes. *Lower Cretaceous (Upper Aptian):* Madagascar.——FIG. 175,*2.* **E. raulinianiforme* (BREISTROFFER); ×1 (Collignon, 1962b).

Subfamily LEPTOCERATOIDINAE Thieuloy, 1966

[Leptoceratoidinae THIEULOY, 1966b, p. 290; Karsteniceratinae IMMEL, 1987, p. 118]

Very small, loosely coiled forms with more or less annular, simple ribs, with or without ventrolateral tubercles, and very simple sutures. Homeomorphs of *Leptoceras* and allies (Tithonian and Berriasian Protancyloceratinae). *Lower Cretaceous (Barremian–Lower Aptian).*

Leptoceratoides THIEULOY, 1966b, p. 289 [**Crioceras (Leptoceras) pumilum* UHLIG, 1883, p. 270(146); OD]. Small, irregular criocones; approximate homeomorphs of *Leptoceras;* ribs simple, annular; occasional enlarged ribs with constrictions. Suture with wide saddles and rather simple, trifid lobes. *Lower Cretaceous (Barremian):* central and southern Europe, Cape Verde Islands, northern Africa, Japan.——FIG. 177,*3.* **L. pumilum* (UHLIG), Austria; ×1 (Uhlig, 1883).

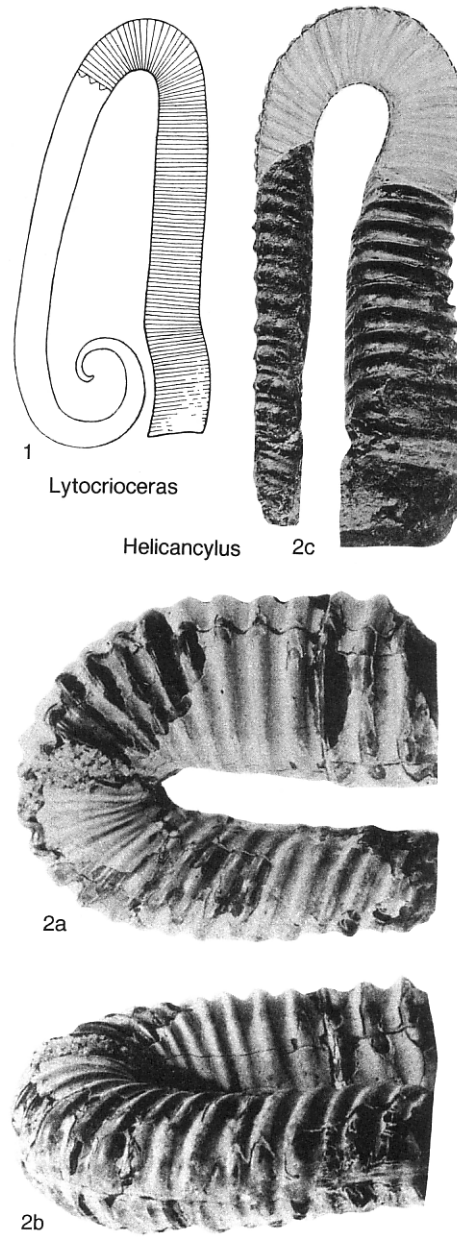


FIG. 174. Ancyloceratidae (p. 223–225)

Hamulinites PAQUIER, 1900, appendix p. vi [**Hamulina munieri* NICKLÈS, 1894, p. 59; OD] [=*Eoleptoceras* MANOLOV, 1962, p. 532 (type, *Crioceras (Leptoceras) parvulum* UHLIG, 1883, p. 273(147); OD); *Wrightites* MANOLOV, 1962, p. 534, obj.; *Tzankoviceras* MANOLOV, 1962, p. 533 (type, *Crioceras (Leptoceras) assimile* UHLIG, 1883, p. 274(148); OD)]. Coiling more or less ancyloceratoid; ribs equal, annular, and simple; homeomorph

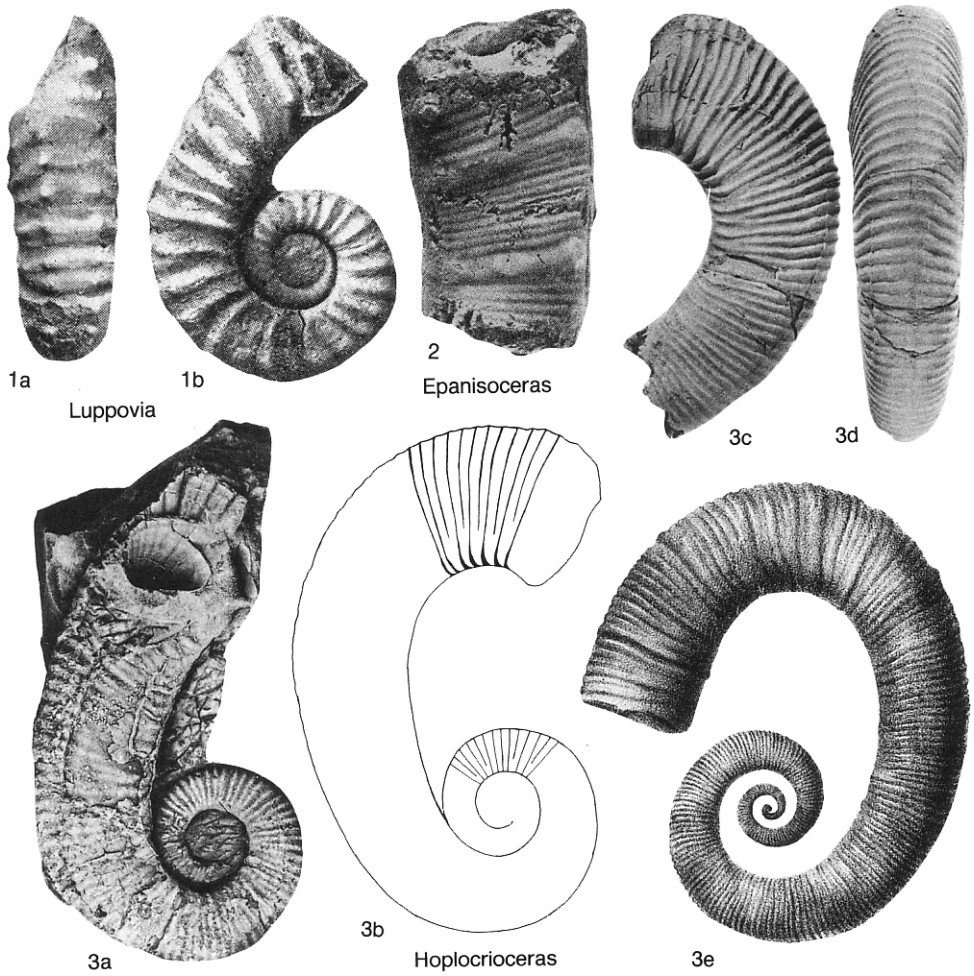


FIG. 175. Ancyloceratidae (p. 223–225)

of *Vinalesites. Lower Cretaceous (Barremian):* France, Spain, Austria, Romania.——FIG. 177,*2a,b. *H. munieri* (NICKLÈS), Spain; ×2 (Nicklès, 1894).——FIG. 177,*2c–e. H. parvulum* (UHLIG), Austria; *c,d,* ×1; *e,* enlarged (Uhlig, 1883).

Karsteniceras ROYO Y GOMEZ, 1945, p. 460 [**Ancyloceras beyrichi* KARSTEN, 1858, p. 103; OD]. Like *Leptoceratoides* but with bullate ventrolateral tubercles on every rib. Suture with fingerlike lobes and feebly bifid, square saddles. *Lower Cretaceous (Barremian–Lower Aptian):* central Europe, Colombia.——FIG. 177,*4a–d. *K. beyrichi* (KARSTEN), Colombia; *a,* ×1; *b,* ×4 (Royo y Gomez, 1945); *c,d,* ×1 (Etayo Serna, 1968).

Orbignyceras ROYO Y GOMEZ, 1945, p. 462 [**O. veleziense;* OD] [=*Veleziceras* WRIGHT, 1957b, p. 210 (unnecessary *nom. nov.* since *Orbignyceras* is not a homonym of *Orbignyiceras* GÉRARD & CONTAUT, 1936, p. 34), obj.]. Straight or slightly curved shafts alone known; with fairly prominent, oblique ribs without tubercles. Suture much as in *Karsteniceras. Lower Cretaceous (Barremian):* Czech Republic, Colombia.——FIG. 177,*1a,b. O. uhligi* (VAŠIČEK), Czech Republic; *a,* reconstruction; *b,* enlarged (Vašiček, 1972).

Family HETEROCERATIDAE Spath, 1922

[*nom. transl.* SPATH, 1924a, p. 86, *ex* Heteroceratinae SPATH, 1922a, p. 148] [=Colchiditinae KAKABADZE, 1967, p. 441]

Initial whorls helically coiled, followed by long or short, straight shaft and final hook or by more or less plane spiral, loosely or tightly coiled. Ribs normally fairly dense, weak to strong throughout; ventrolateral tubercles may be present and rarely umbilical and lateral also. Perhaps no more than a subfamily

of Ancyloceratidae. *Lower Cretaceous (Lower Barremian–Lower Aptian).*

Uhligia KOENEN, 1904, p. 57 [**Crioceras minutum* NEUMAYR & UHLIG, 1881, p. 196(67); OD]. Earliest known part straight, then curved to a hook, followed by second curved shaft and final hook; ribs fine, weak, and irregular, with many short intercalatories; no tubercles. Possibly transitional from some Helicancylinae to *Heteroceras*. May be a junior synonym of *Hemibaculites*. *Lower Cretaceous (Lower Barremian):* Germany.——FIG. 178,*1a–c.* **U. minuta* (NEUMAYR & UHLIG); ×1 (Koenen, 1902).

Heteroceras ORBIGNY, 1849, p. 291 [**Turrilites emericianus* ORBIGNY, 1842a, p. 580; SD MEEK, 1876, p. 477] [=*Lindigia* KARSTEN, 1858, p. 103 (type, *L. helicoceroides;* OD)]. More or less tightly coiled helix is followed by long, slightly curved shaft; ribs concave on helix but straight and radial later, commonly some biplicate or triplicate; tubercles present or not. [The type species designated by MEEK (1876, p. 477), *Turrilites emericianus* ORBIGNY, 1842a, p. 580, was based on fragments of spire only. KILIAN (1889a, p. 687) placed it in the synonymy of the later *Heteroceras astierianum* ORBIGNY, 1851, p. 219, but on p. 688 said that *emericianus* was probably the same as *astierianum* but that it was uncertain. KAKABADZE & THIEULOY (1991, p. 94) concluded that in accordance with Article 70(b) of the Code *astierianum* was the type species of *Heteroceras*. However, Article 70(b) refers only to possible action by the Commission under the Plenary Powers to replace a misidentified type species; *T. emericianus* was not misidentified, although it might be regarded as unidentifiable. Pending any application to the Commission, *T. emericianus* remains the type species of *Heteroceras*.] *Lower Cretaceous (Barremian):* France, central Europe, Caucasus, South Africa (Zululand), Japan, California, Peru.

H. (Heteroceras). No tubercles. Occurrence and distribution as for genus.——FIG. 178,*4. H. (H.) tardieui* KILIAN, France; ×0.38 (Kilian, 1907–1913).

H. (Argvethites) ROUCHADZÉ, 1933, p. 233 [**H. (A.) lashense;* OD]. Venter of shaft and hook flat, in some bearing paired ventral tubercles; ribs on shaft may join pairs of ventral tubercles. Occurrence as for genus: Caucasus, ?Czech Republic.——FIG. 178,*3a,b.* **H. (A.) lashense,* Caucasus; ×1 (Rouchadzé, 1933).

Hemibaculites HYATT, 1900, p. 586 [**Toxoceras obliquatum* ORBIGNY, 1842a, p. 486; OD]. Type specimen of type species lost; it was perhaps a fragment of the shaft of a *Heteroceras* or *Uhligia*. DRUSHCHITS (1960, pl. 41, fig. 1) figured an initial helix and shaft that may belong to *Hemibaculites*. *Lower Cretaceous (Barremian):* France.

Colchidites DJANÉLIDZÉ, 1926, p. 254 [**C. colchicus;* M] [=*Santandericeras* ROYO Y GOMEZ, 1945, p. 468 (type, *S. apolinari;* OD)]. Differs from *Heteroceras* in having one or more planispiral whorls, more or less tightly coiled, with the axis of coiling at a right angle to that of the helix, between the initial helix and the final shaft and hook; macroconchs probably having 1 planispiral whorl, microconchs 2 or more; whorl height increasing rather fast; tubercles absent or weak. *Lower Cretaceous (Barremian):* France, Bulgaria, Ukraine (Crimea), Caucasus, Transcaspia, Turkmenistan, South Africa (Zululand), Colombia, Argentina.——FIG. 179,*2.* **C. colchicus,* Caucasus; ×0.5 (Djanélidzé, 1926).

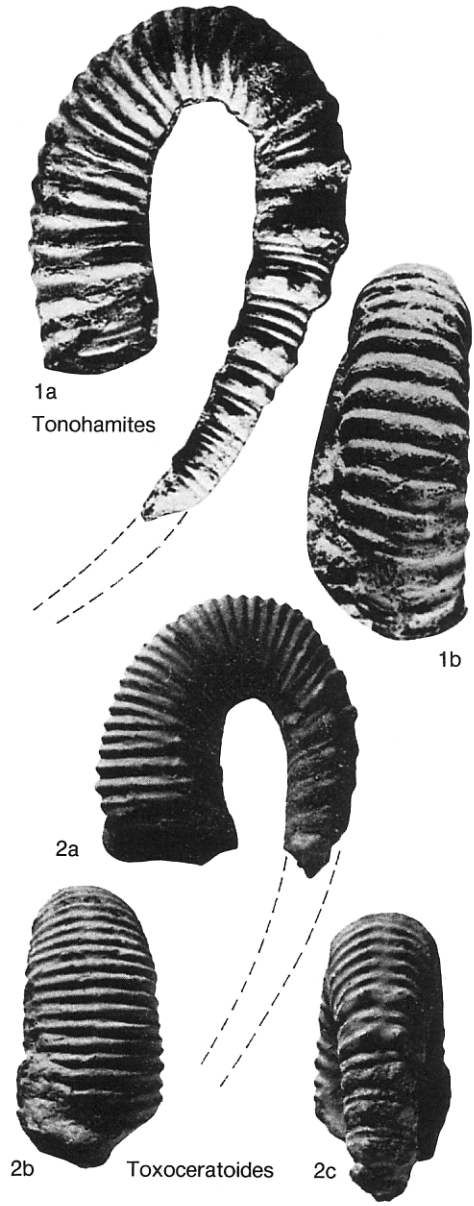


FIG. 176. Ancyloceratidae (p. 223–224)

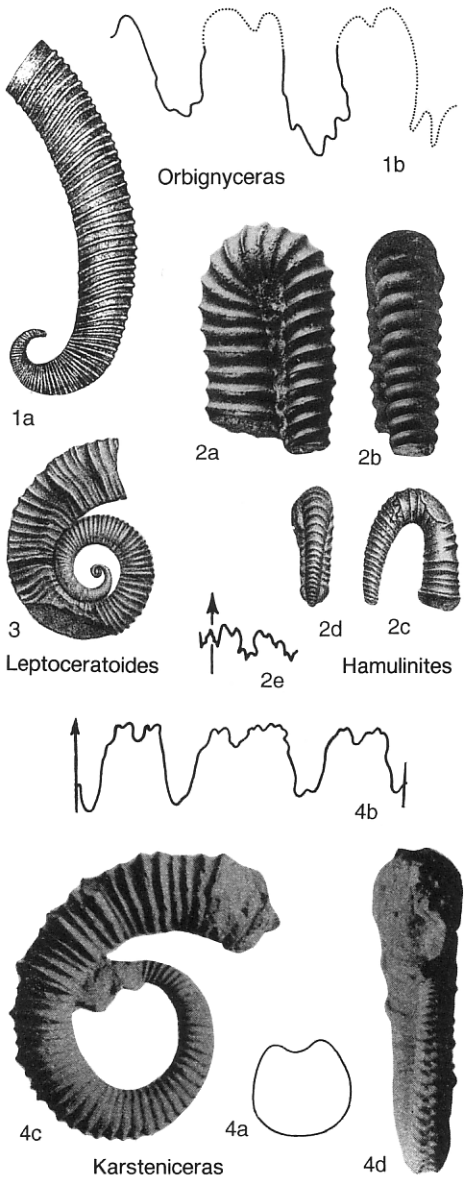


FIG. 177. Ancyloceratidae (p. 225–226)

Martelites CONTE, 1989, p. 43 [**M. marteli;* OD]. Large, neotenous descendants of *Colchidites* without the uncoiling shaft. *Lower Cretaceous (Lower Aptian):* France, Caucasus.——FIG. 179,*3. M. sarasini* (ROUCHADZÉ), Caucasus; ×0.75 (Rouchadzé, 1933).

Imerites ROUCHADZÉ, 1933, p. 255 [**Heteroceras giraudi* KILIAN, 1889b, p. 435; OD; =*Crioceras cristatum* ORBIGNY, 1842a, p. 467] [=*Atopoceras* JAUBERT in KILIAN, 1889a, p. 685, *nom. nud.; Escragnolleites* SARKAR, 1954b, p. 620(3), obj.; *Paraimerites* KAKABADZE, 1967, p. 440 (type, *Imerites densecostatus* RENNGARTEN, 1926, p. 36; OD); *Eristavia* KAKABADZE, 1971a, p. 44 (1967, p. 440, *nom. nud.*, no type species) (type, *Colchidites (Imerites) dichotomus* ERISTAVI, 1955, p. 128; OD)]. Small; whorl height increasing slowly; ribbing distant, with single (*Paraimerites*) or inner and outer ventrolateral tubercles on ribs at some stage doubled between dorsum and inner ventrolateral tubercle (*Eristavia*), or single and more or less straight throughout. *Lower Cretaceous (Barremian):* France, Caucasus, Transcaspia, Turkmenistan, South Africa (Zululand).——FIG. 178,*2a,b. *I. cristatus* (ORBIGNY), France; ×1 (Kilian, 1889b). ——FIG. 178,*2c,d. I. favrei* ROUCHADZÉ, Turkmenistan; ×1 (Tovbina, 1963).

Kutatissites KAKABADZE, 1970, p. 734 [**K. bifurcatus;* OD] [=?*Simionescites* AVRAM, 1976, p. 77 (type, *S. princeps;* OD)]. Short helix, more or less wrapped in planispiral whorls; trituberculate main ribs on helix; minor ribs, if present, with no or only ventrolateral tubercles; ribs may branch at umbilical or midlateral tubercle and tend to be interrupted on venter; tubercles on spire weakening and may disappear, but umbilical tubercles normally persisting and ribs may again become trituberculate near aperture. [The larger *Simionescites* are probably macroconchs of *Kutatissites.*] *Lower Cretaceous (Upper Barremian–Lower Aptian):* France, Romania, Georgia, Colombia.——FIG. 179,*1a,b. *K. bifurcatus,* Upper Barremian, Georgia; ×0.75 (Kakabadze, 1970).——FIG. 179,*1c. ?K. princeps* (AVRAM), Lower Aptian, Romania; ×0.25 (Avram, 1976).

Family HEMIHOPLITIDAE Spath, 1924

[Hemihoplitidae SPATH, 1924a, p. 84]

Whorls overlapping slightly; venter flat; ribs simple and straight, rarely branched; umbilical and ventral tubercles may occur. Suture with lobes generally trifid but sometimes bifid. *Lower Cretaceous (Upper Hauterivian–Upper Barremian).*

Derived from *Pseudothurmannia* (Ancyloceratidae, Crioceratitinae) and perhaps from other crioceratine genera with similar suture. Hemihoplitidae are separated from Crioceratitinae only because ammonitic coiling is fully realized and the last traces of crioceratine ribbing have disappeared.

Hemihoplites SPATH, 1924a, p. 84 [**Ammonites feraudianus* ORBIGNY, 1841, p. 324] [=*Matheronites* RENNGARTEN, 1926, p. 27 (type, *Ammonites soulieri* MATHERON, 1879 in 1878–1880, pl. C-21, fig. 1; OD); *Ornicephalites* SKWARKO & THIEULOY, 1989, p. 31 (type, *Pseudothurmannia (O.) indonesiana;* OD)]. Evolute; compressed; whorl section rectangular; ribs simple or branching or long and short, well spaced, straight or slightly flexuous, crossing

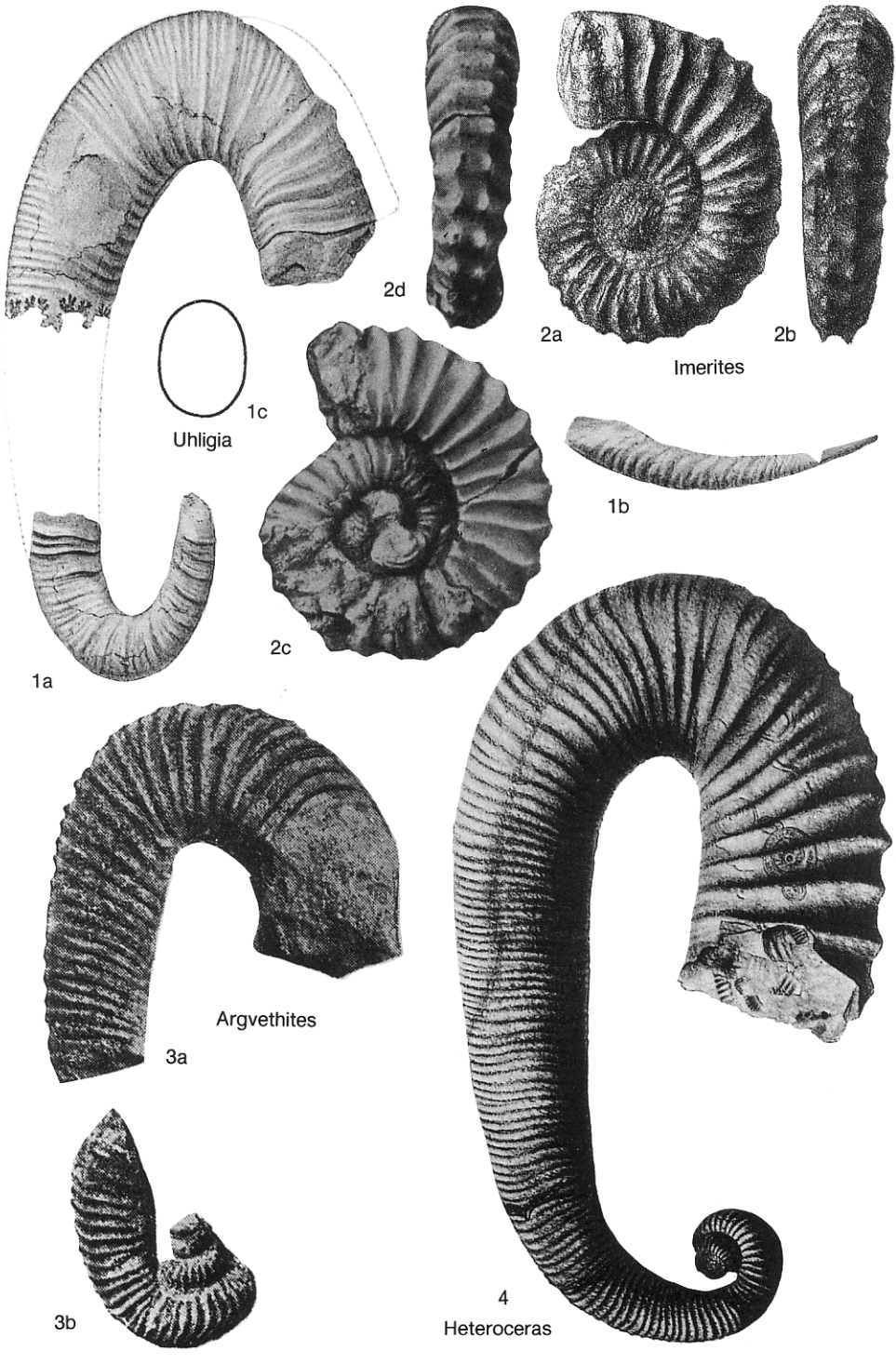


FIG. 178. Heteroceratidae (p. 227–228)

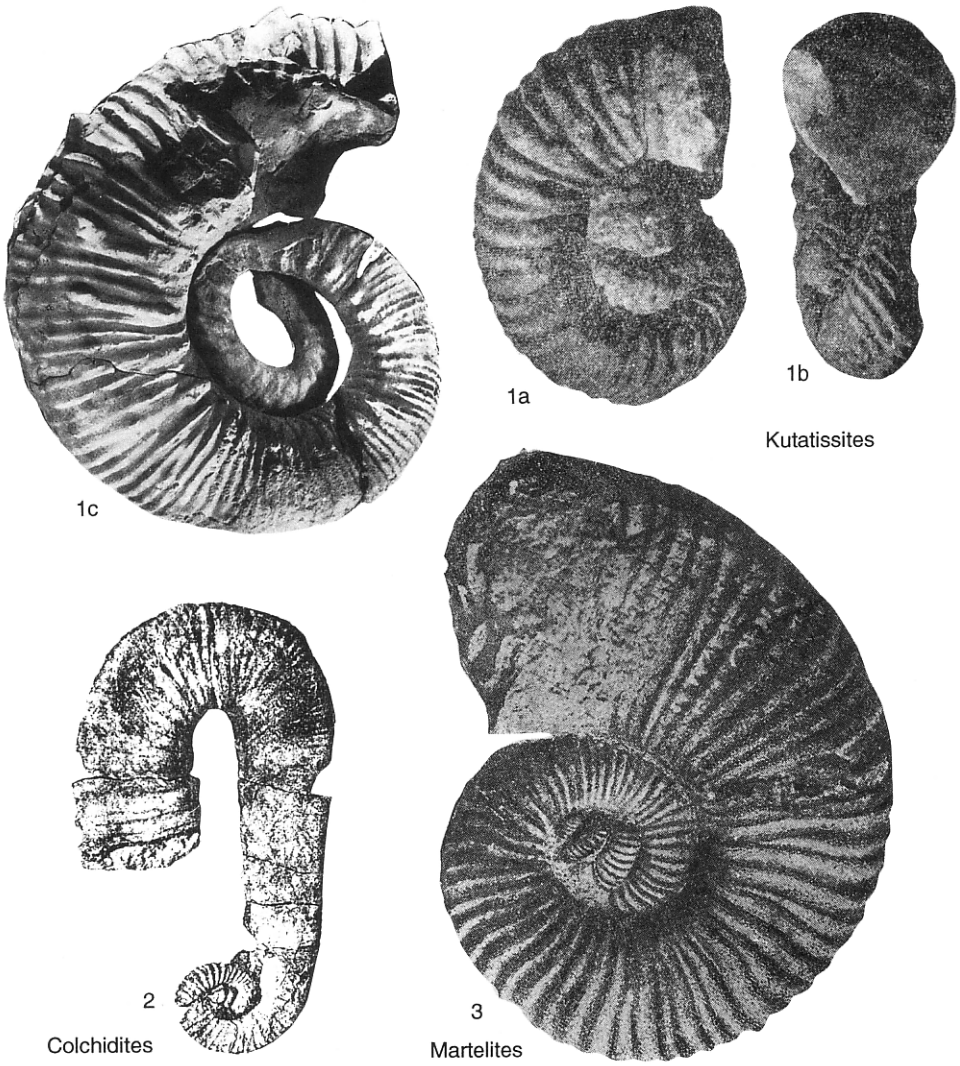


FIG. 179. Heteroceratidae (p. 227–228)

flat venter transversely, typically with distinct umbilical and ventrolateral tubercles. *Lower Cretaceous (Upper Hauterivian–Barremian):* France, Balearic Islands, Georgia, Antarctica (Alexander Island). ——FIG. 180,*2a–c.* **H. feraudianus* (ORBIGNY), Barremian, France; *a,b,* ×1 (new); *c,* enlarged (Orbigny, 1840–1842).

Camereiceras DELANOY, 1990, p. 74 [**Matheronites limentinus* THIEULOY, 1979, p. 307; OD]. Juvenile stage with strong, clavate umbilical, inner ventrolateral, and outer ventrolateral tubercles; in midgrowth inner ventrolaterals disappearing and umbilicals becoming bullate. Adult whorls with strong, untuberculate ribs. *Lower Cretaceous (Middle Barremian):* France, Austria.

?Pascoeites SPATH, 1933a, p. 827 [**P. budavadensis;* OD]. Apparently intermediate between *Pseudothurmannia* and *Hemihoplites* and perhaps synonymous with one or the other. *Lower Cretaceous (?Barremian):* western India.——FIG. 180,*1a,b.* **P. budavadensis; a,* ×1; *b,* ×3 (Spath, 1933a).

Family HAMULINIDAE Gill, 1871

[Hamulinidae GILL, 1871, p. 3] [=Anahamulinidae BREISTROFFER, 1951a, p. 54]

Initial stages unknown; long main shaft followed by hook and shorter, close, parallel or slightly divergent final shaft. Suture with subtrifid or bifid L; U normally reduced or undifferentiated in adult. *Lower Cretaceous (Lower Barremian–Upper Barremian).*

Despite coiling probably not closely related to Ptychoceratidae but derived by lengthening of shafts from some ancyloceratine forms, as in case of later approximately homeomorphous *Lithancylus.*

Hamulina ORBIGNY, 1850a, p. 66 [**H. astieriana* ORBIGNY, 1850a, p. 102; SD ROMAN, 1938, p. 47]. May be large; whorl section generally increasing rapidly; short final shaft straight or curved; main shaft with dense, fine, prorsiradiate minor ribs and distant, periodic, weakly trituberculate major ribs; minor ribs weakening or disappearing on hook and final shaft, major ribs strengthening and approximating. Suture finely divided. *Lower Cretaceous (Lower Barremian–Upper Barremian):* southern and central Europe, California.——FIG. 181,*4a,b.* **H. astieriana* ORBIGNY, Barremian, France; *a,* ×0.2 (Orbigny, 1852); *b,* ×0.25 (Thomel, 1964).——FIG. 181,*4c. H. silesiaca* UHLIG, Barremian, Austria; ?×1 (Uhlig, 1883).

Anahamulina HYATT, 1900, p. 571 [**Hamulina subcylindrica* ORBIGNY, 1850a, p. 102; OD]. Medium-sized, with long main shaft rapidly or slowly increasing in diameter, bending sharply, commonly with constriction at bend, to a shorter, parallel or divergent final shaft; ribs fine, dense, equal, untuberculate; ribs annular and prorsiradiate on first shaft, radial and stronger on second. Suture less florid than in *Hamulina. Lower Cretaceous (Barremian):* southern and central Europe, Japan, California.——FIG. 181,*1a–c.* **A. subcylindrica* (ORBIGNY), Austria; ×1 (Uhlig, 1883).

Family PTYCHOCERATIDAE Gill, 1871

[Ptychoceratidae GILL, 1871, p. 3]

With 3 close, parallel, straight shafts; smooth or with distant, coarse ribs mainly on venter and final hook. Suture with trifid or bifid lobes; U may split into two lobes in adult sutures. MIKHAILOVA, 1974a. *Lower Cretaceous (?Upper Valanginian, Upper Hauterivian–Upper Albian).*

Ptychoceratidae are probably derived from an undescribed Tithonian genus of Bochianitidae; the direct ancestor is more likely to be one of ancyloceratoid coiling than the baculitoid *Bochianites* with a single, straight shaft.

Euptychoceras BREISTROFFER, 1952c, p. 50 [**Ptychoceras meyrati* OOSTER, 1860, p. 82; OD] [=?*Pseudoptychoceras* ETAYO SERNA, 1979, p. 21 (type, *P. gilberti;* OD)]. With long, straight, slowly increasing initial shaft, followed by rather longer second shaft that is parallel and barely or not touching, and finally by third shaft that may slightly overlap first; smooth or with rather weak ribbing, except that broad, scalelike ribs may occur on last shaft. Suture with trifid L. [The slightly more strongly ribbed *Pseudoptychoceras* probably belongs here. *E. teschenense* UHLIG, 1902, p. 63 (Upper Valanginian) may be generically distinct.] *Lower Cretaceous (?Upper Valanginian, Upper Hauterivian–Barremian, ?Upper Aptian):* southern and central Europe, California, ?Colombia.——FIG. 181,*2.* **E. meyrati* (OOSTER), Barremian, Switzerland; ×0.5 (Sarasin & Schöndelmayer, 1902).

Ptychoceras ORBIGNY, 1842a, p. 554 [**P. emericianum;* SD DIENER, 1925, p. 77] [=*Diptychoceras* GABB, 1869, p. 143 (type, *P. gabbi* PERVINQUIÈRE, 1907, p. 91, *nom. nov. pro D. laeve* GABB, 1869, *non* MATHERON, 1842, p. 266); *Mastigohamites* BREISTROFFER, 1947b, p. 100(84), *nom. nov. pro*

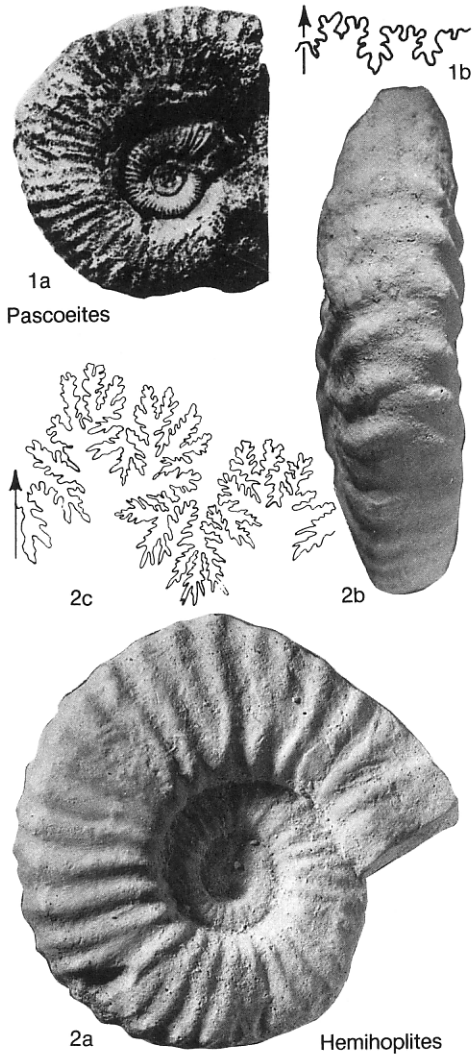


FIG. 180. Hemihoplitidae (p. 228–230)

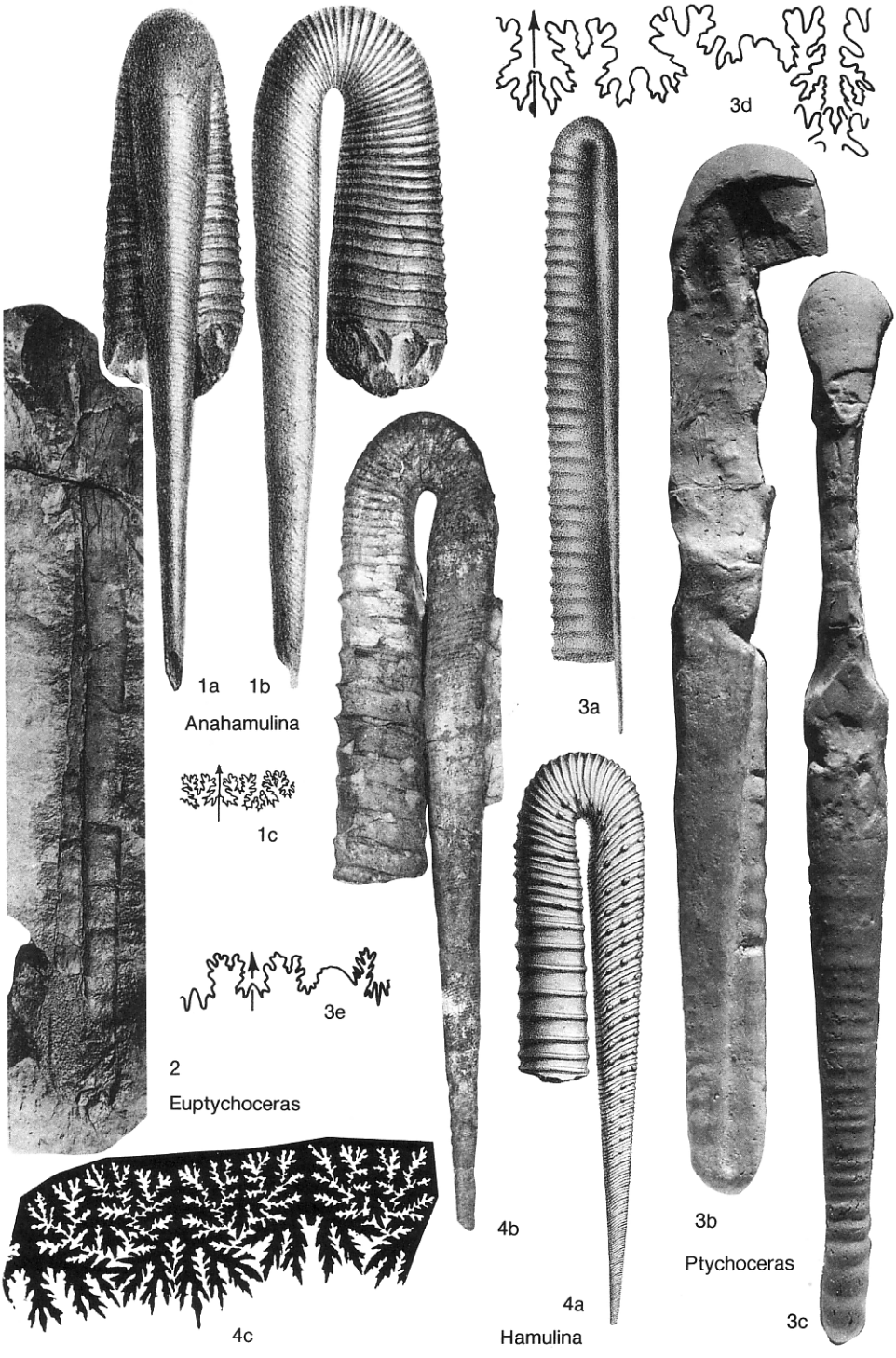


FIG. 181. Hamulinidae and Ptychoceratidae (p. 231–233)

Mastigoceras BÖHM, 1926, p. 202, *non* HANDSCHIN, 1924, p. 22 (type, *Hamites adpressus* J. SOWERBY, 1814b, p. 140; OD); ?*Tricoloceras* WHITEHOUSE, 1928b, p. 278 (type, *Ptychoceras? closteroides* R. ETHERIDGE, Jr., 1904, p. 110)]. Differs from *Euptychoceras,* by initial shaft closely pressed into dorsum of second shaft; suture with bifid lobes but trifid lobes may occur. Shell may have been covered by mantle in life (DOGUZHAEVA & MUTVEI, 1989). [*Diptychoceras* could be distinguished only on the presence of feeble constrictions. The slight difference in the way in which U of suture of *P. adpressum* accommodates to the sharpened edge of the dorsal impression does not justify the separation of *Mastigohamites.*] *Lower Cretaceous (Upper Aptian–Upper Albian):* England, France, Caucasus, Madagascar, southern India, ?Australia (Queensland), New Zealand, Alaska, British Columbia, California, Mexico.——FIG. 181,*3a–d.* **P. emericianum* (ORBIGNY), Upper Aptian, France; *a,* first and part of second shaft, ×1 (Orbigny, 1840–1842); *b,c,* ×0.75 (new); *d,* ×4 (Wiedmann, 1962a).——FIG. 181,*3e. P. adpressum* (J. SOWERBY), Upper Albian, England; *e,* ×4 (Spath, 1923–1943).

Family LABECERATIDAE Spath, 1925

[Labeceratidae SPATH, 1925c, p. 191; ICZN Opinion No. 556, 1959, Family-Group Name No. 266] [=Aleteceratidae WHITEHOUSE, 1926, p. 231; Myloceratidae SPATH, 1939c, p. 601]

Early whorls with coiling open, shallowly helical or planispiral; later whorls in contact or not; shell ending in hook; whorl section slightly inflated to very compressed; all genera with fine, branching ribs passing over venter; some genera also with umbilical or ventrolateral tubercles or both. Suture with bifid saddles and trifid lobes. *Lower Cretaceous (?Middle Albian, Upper Albian); ?Upper Cretaceous (?Lower Cenomanian).*

The family includes forms closely resembling some Helicancylinae and with its trifid lobes is best placed in Ancyloceratacea. This is a southern-hemisphere family; northern species referred here may belong to Anisoceratidae.

Labeceras SPATH, 1925c, p. 191, ICZN Opinion 556, 1959, Generic Name No. 1351 [**L. bryani* WHITEHOUSE, 1926, p. 227; ICZN Specific Name No. 1632] [=*Myloceras* SPATH, 1925c, p. 192 (type, *Crioceras ammonoides* R. ETHERIDGE, Jr., 1909, p. 151; OD); *Aleteceras* WHITEHOUSE, 1926, p. 231 (type, *Crioceras plectoides* R. ETHERIDGE, Jr., 1909, p. 152; OD); *Flindersites* WHITEHOUSE, 1926, p. 236 (type, *F. baccatus;* OD); *Ellipsoceras* COLLIGNON, 1950b, p. 79 (type, *E. expansum;* OD); *Abadieceras* COLLIGNON, 1950b, p. 81 (type, *A. altissimum;* OD); *Euhemihoplites* COLLIGNON, 1964, p. 38 (type, *E. paradoxus;* OD); *Calliscaphites* A. F. LEANZA, 1970, p. 202 (type, *C. andinus;* OD); *Paraleptoceras* LEANZA, 1970, p. 209 (type, *P. singulare;* OD)]. There is little doubt that *Labeceras,* here selected against *Myloceras* of the same date, comprises microconchs and *Myloceras* macroconchs of the same genus. Macroconchs much larger than microconchs; spire open at first, then closely coiled and with terminal hook; whorl section moderately to highly compressed, with flat venter; generally with strong ventrolateral spines. Microconchs with open spire of a few whorls followed by curved shaft and final hook with inturned aperture; ribs fine, concave, and prorsiradiate, normally branching; no ventrolateral tubercles, but ribs may be raised into umbilical tubercles on shaft and hook. *Lower Cretaceous (Upper Albian); ?Upper Cretaceous (?Lower Cenomanian):* southeastern Africa, Madagascar, Australia (Queensland), South Australia, ?New Zealand, New Guinea, Argentina (Patagonia).——FIG. 182,*1a–c. L. ammonoides* (ETHERIDGE), Upper Albian, Queensland, macroconch; *a,b,* ×0.43; *c,* ×0.75 (McNamara, 1978).——FIG. 182,*1d. L. serotinum* SPATH, Upper Albian, Mozambique, macroconch; ×0.5 (Spath, 1925c).——FIG. 182,*1e–g. L. plasticum* SPATH, Upper Albian, Mozambique, microconch; *e,* ×1; *f,* ×1.5; *g,* ×4 (Spath, 1925c).

?Hamitoides SPATH, 1925c, p. 191 [**Hamites studerianus* PICTET, 1847, p. 393; OD]. Nature of coiling uncertain, since only fragments known; whorl section circular to oval; ribs branching irregularly at umbilical edge or on sides; in many shells ribs forming tubercle at point of branching. Suture inadequately known, with bifid saddles and trifid lobes. *Lower Cretaceous (Middle Albian–Upper Albian):* France, Switzerland, Poland, Mozambique, Madagascar, Pakistan.——FIG. 182,*2.* **H. studerianus* (PICTET), Upper Albian, France; ×1 (Pictet, 1847).

?Family MACROSCAPHITIDAE Hyatt, 1900

[Macroscaphitidae HYATT, 1900, p. 571] [=Cicatritidae SPATH, 1927a, p. 64]

Evolute, ammoniticonic macroconchs and scaphitoid microconchs having dense, simple, rarely branched ribs with or without spines. Adult suture quadrilobate, florid, with bifid L and U. *Lower Cretaceous (Barremian–Upper Aptian).*

It is uncertain whether the family was derived by recoiling from some member of quadrilobate Ancyloceratina or represents an independent quadrilobate derivative from quinquelobate Lytoceratacea. *Cicatrites* differs from the others only in its suture with somewhat asymmetrical elements and family separation seems unnecessary.

Macroscaphites MEEK, 1876, p. 414 [**Scaphites yvani* PUZOS, 1832, p. 355; SD ROMAN, 1938, p. 38] [=*Costidiscus* UHLIG, 1882a, p. 87 (type, *Ammonites recticostatus* ORBIGNY, 1841, p. 134; OD)]. Macroconchs medium-sized to large, coiled normally; microconchs small, with septate whorls as in macroconchs, then with straight or recurved shaft and final hook; radial ribs dense, strong, straight, and in some species thickened on umbilical edge or tuberculate; some ribs also with small but distinct ventrolateral tubercles; constrictions normally present, with slightly enlarged ribs on either side. Suture with more or less symmetrical L. *Lower Cretaceous (Barremian–Lower Aptian):* southern and central Europe, northern Africa, Egypt (Sinai), Mexico. ——FIG. 183,*1a–e. M. recticostatus* (ORBIGNY), Barremian, Silesia; *a,b,* macroconch, ×0.75; *c,d,* macroconch, ×1; *e,* microconch, ×0.75 (Uhlig, 1883).

Cicatrites ANTHULA, 1899, p. 100 [**C. abichi;* OD]. Very evolute, with depressed whorl section; umbilical spine bases regular and flat, each covering 3 of the dense, straight ribs. Suture with irregular elements and asymmetrical L. *Lower Cretaceous (Lower Aptian–Upper Aptian):* France, Caucasus.——FIG. 183,*2a–c. *C. abichi,* Upper Aptian, Caucasus; ×1 (Anthula, 1899).

Superfamily TURRILITACEAE Gill, 1871

[*nom. transl.* WRIGHT, 1957b, p. 214, *ex* Turrilitidae GILL, 1871, p. 3. Turrilitaceae was established as superfamily (WRIGHT, 1957b, p. 214) to replace Hamitaceae (*nom. transl.* WRIGHT & WRIGHT, 1951, p. 13) because Turrilitidae was thought to date from MEEK, 1876, p. 477, whereas Hamitidae was attributed to HYATT, 1900, p. 586. In fact, both date from GILL, 1871, p. 3, and the change at superfamily level was unnecessary. However, Turrilitaceae has entered into general use and is therefore maintained here.] [=Diplomocerataceae BRUNNSCHWEILER, 1966, p. 14]

Comprises a series of families, directly or indirectly derived from Anisoceratidae or Hamitidae, with almost every known form of heteromorph coiling. Includes ribbed, tuberculate, and smooth genera. The suture, quadrilobate throughout in contrast with the initially quinquelobate suture of Ancyloceratidae, generally has bifid lateral lobes, but trifid lobes may occur in early genera. Anisoceratidae may range from Upper Aptian; if so, Hamitidae would be derived from Anisoceratidae rather than the other way around, as commonly held. Early Anisoceratidae tending to have subtrifid L and trifid U, both becoming bifid later in phylogeny. Separation of Turrilitaceae from Ancyloceratidae seems justified by a renewed evolutionary radiation having stabilized quadrilobate suture with generally bifid lobes throughout. However, given the transitions and variability in early sutures now known, it is here held that Turrilitaceae were derived from Ancyloceratidae and did not have a separate origin in Lytoceratina. DOGUZHAEVA & MIKHAILOVA, 1982. *Lower Cretaceous (?Upper Aptian, Lower Albian)–Upper Cretaceous (Upper Maastrichtian).*

Family ANISOCERATIDAE Hyatt, 1900

[Anisoceratidae HYATT, 1900, p. 587] [=Algeritidae SPATH, 1925c, p. 190; Phlycticrioceratidae SPATH, 1926a, p. 80]

Loosely coiled; early whorls typically irregularly helical; later whorls with several, more or less straight shafts in one plane, but some are helical throughout. Ventrolateral tubercles normally on at least some ribs and commonly lateral tubercles as well (*Phlycticrioceras* has sharp siphonal tubercles). Constrictions in some late forms. Suture moderately florid to simple; lobes generally bifid but trifid lobes may occur; even in helicoid forms suture not markedly asymmetrical. *Lower Cretaceous (?Upper Aptian, Lower Albian)–Upper Cretaceous (Santonian, ?Campanian).*

Protanisoceras SPATH, 1923a, p. 75 [**Hamites raulinianus* ORBIGNY, 1842a, p. 546; OD]. Coiled in open spiral, in one plane or slightly helicoid, with terminal hook or with several more or less straight shafts; ribs rectiradiate, weak or absent on dorsum, with ventrolateral and in some species midlateral tubercles on some or all ribs; ribs joining tubercles across venter may be flattened but not doubled; in later species tubercles may be septispinate. Suture rather simple with bifid saddles, subtrifid or bifid L, and small trifid U. [*P. cuerdai* WIEDMANN, 1962b, p. 106, Upper Aptian, Spain, with bifid L, known only in small fragments, probably belongs here.] *Lower Cretaceous (?Upper Aptian, Lower Albian–Middle Albian):* western and central Europe, Madagascar, India, Peru.

P. (**Protanisoceras**). Shaft and body chamber hook coiled in same plane. Occurrence and distribution as for genus.——FIG. 184,*2a–c. *P. (P.) raulinianum* (ORBIGNY), Lower Albian, France; *a,b,* ×1 (Orbigny, 1840–1842); *c,* ×2 (Casey, 1961a).

P. (**Torquistylus**) CASEY, 1961a, p. 113 [**Prohelicoceras anglicum* SPATH, 1939c, p. 562; OD]. Bluntly ribbed, with body chamber rolled over to one side, twisting ribs. *Lower Cretaceous (Lower Albian):* western Europe, Madagascar. ——FIG. 184,*1a–c. *P. (T.) anglicum* (SPATH), England; *a,b,* reconstruction, *c,* ×2 (Casey, 1961a).

P. (**Heteroclinus**) CASEY, 1961a, p. 98 [**Hamites*

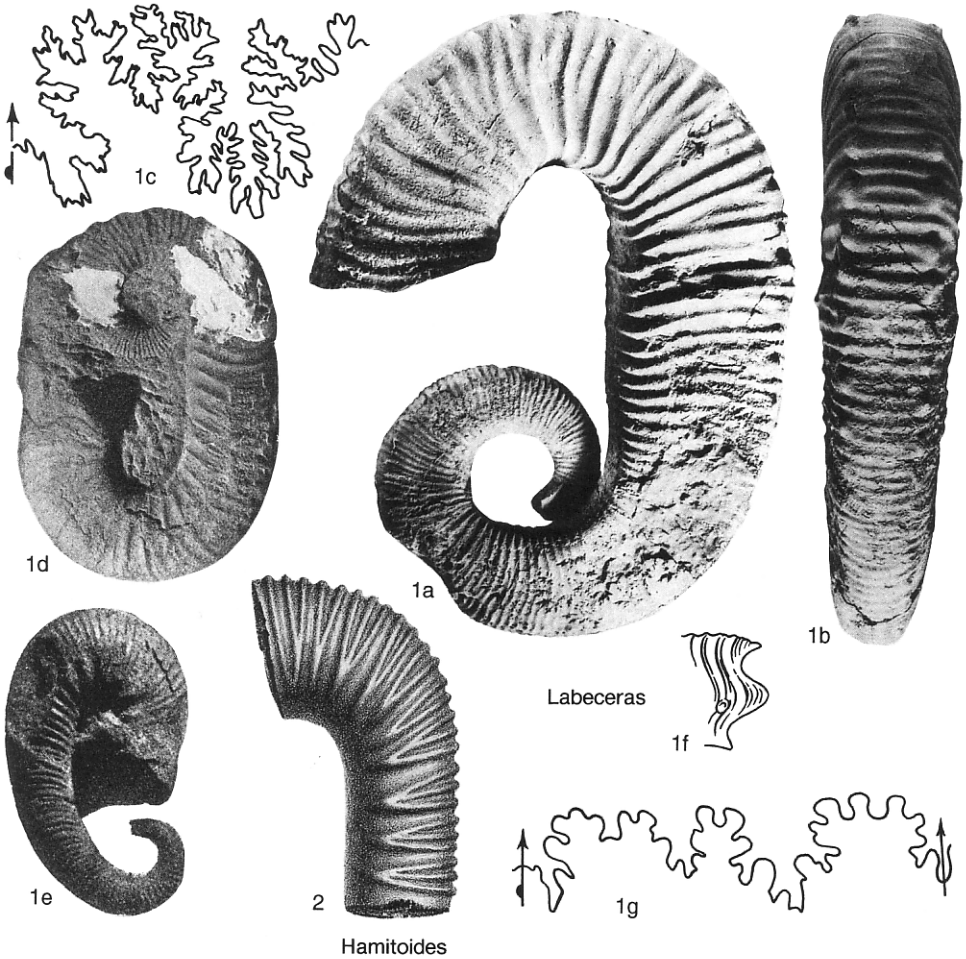


FIG. 182. Labeceratidae (p. 233)

nodosus J. SOWERBY, 1818a, p. 30; OD]. Like *P. (Protanisoceras)* but with more or less prolonged, helicoid beginning, slightly fibulate lateral ribs and tubercles, and larger umbilical lobe in suture. *Lower Cretaceous (Middle Albian):* western Europe.——FIG. 184,*3*. **P. (H.) nodosum* (J. SOWERBY), England; crushed, ×0.75 (Spath, 1923–1943).

Rencurelites THIEULOY, 1964, p. 114 [**Protanisoceras (R.) ambiguum* THIEULOY, 1964, p. 114; OD]. Differs from *Protanisoceras* in having spire with simple, untuberculate ribs, but body chamber with prominent dorsolateral (umbilical) tubercles and ribs branching irregularly at these or further up side. *Lower Cretaceous (Lower Albian):* southeastern France.——FIG. 185,*1a–e*. **R. ambiguum; a–d,* ×1; *e,* ×2 (Thieuloy, 1964).

Metahamites SPATH, 1930b, p. 57 [**Hamites sablieri* ORBIGNY, 1842a, p. 543; OD]. With 3 subparallel shafts; ribbing on phragmacone oblique, fine or almost obsolete; ribs of phragmocone on and between periodic, strong folds or with periodic, large flat spine bases covering several ribs; on body chamber ribs bolder and distant; tubercles, if persisting, covering only 1 rib. Suture more florid than in *Protanisoceras. Lower Cretaceous (Lower Albian–Middle Albian):* western Europe, Madagascar, India, Colombia.——FIG. 186,*1a,b. M. elegans* (ORBIGNY), Middle Albian, France; ×0.75 (Orbigny, 1840–1842).——FIG. 186,*1c. M. gignouxi* COLLIGNON, Lower Albian, Madagascar; ×0.75 (Collignon, 1949b).

Rossalites CASEY, 1961a, p. 115 [**Protanisoceras? superbum* COLLIGNON, 1949b, p. 53; OD]. Large; straight shafts and terminal hook alone known; phragmacone like *Metahamites* but with weak tubercles at midside, from which ribs run in pairs to rejoin at ventrolateral spine bases; body chamber hook with large lateral bulges. Suture florid, with reduced U. *Lower Cretaceous (Lower Albian):* England, France, Madagascar.——FIG. 185,*6a–c*. **R. superbus* (COLLIGNON), Madagascar; ×0.5

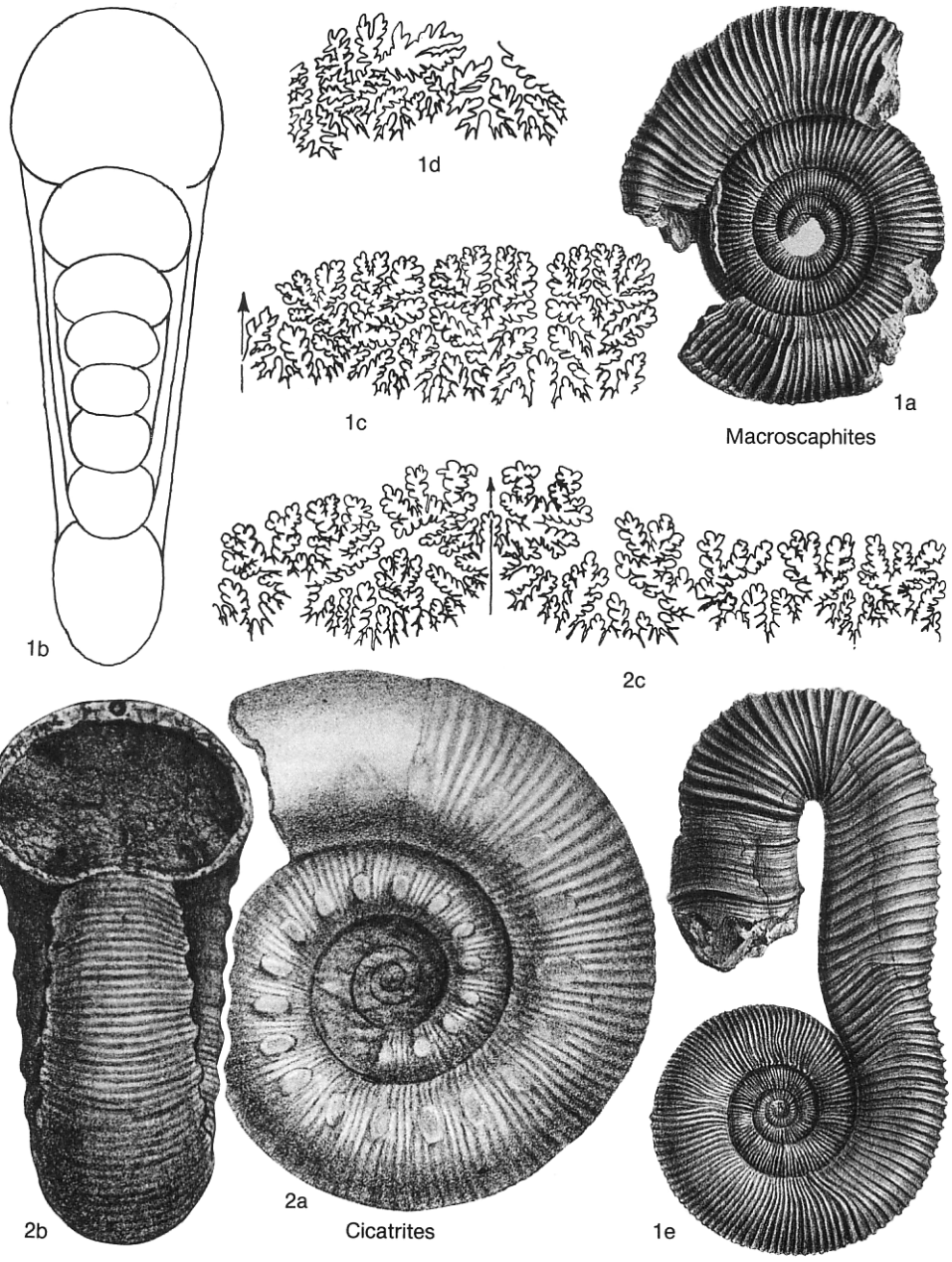


FIG. 183. Macroscaphitidae (p. 234)

(Collignon, 1949b).——FIG. 185,*6d. R. oweni* CASEY, England; ×1 (Casey, 1961a).

Ephamulina COLLIGNON, 1963, p. 27 [**Anisoceras? trituberculatum* COLLIGNON, 1949b, p. 52; OD]. Coiled in more or less regular, open spiral, perhaps with terminal hook; whorl section subhexagonal to circular; close, fine ribs periodically with triple spine bases or septispinate tubercles covering 2 or 3 ribs. Suture with very large, widely splayed, bifid first lateral lobe and much reduced, trifid umbilical lobe. *Lower Cretaceous (Lower Albian–Middle Albian):* Madagascar.——FIG. 186,*2a,b.* **E. trituberculatum* (COLLIGNON), Lower Albian; ×0.75 (Collignon, 1963).

Prohelicoceras SPATH, 1925c, p. 190 [**Helicoceras thurmanni* PICTET & CAMPICHE, 1861, p. 118; OD]. Coiling twisted at all stages; with sharp, annular ribs; in some species, ribs normally with

paired midlateral and ventrolateral tubercles, between which ribs may be looped irregularly. *Lower Cretaceous (Lower Albian–Middle Albian):* western Europe, Madagascar.——FIG. 185,*2a,b*. **P. thurmanni* (PICTET & CAMPICHE), Middle Albian, Switzerland; ×1 (Pictet & Campiche, 1861).

Anisoceras PICTET, 1854, p. 705 [**Hamites saussureanus* PICTET, 1847, p. 374; OD]. Differs from *Protanisoceras* primarily in its more helicoid coiling, fibulate ribbing, and more complex suture with regularly bifid L and U; occasional subtrifid lobes occur. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Upper Turonian):* Europe, northern and eastern Africa, Madagascar, Pakistan, India, New Zealand, Alaska, Texas, Mexico.——FIG. 187,*3a–c*. **A. saussureanum* (PICTET), Upper Albian, France; *a,b*, ×1; *c*, enlarged (Pictet, 1847).

Appurdiceras WHITEHOUSE, 1926, p. 229 [**Ancyloceras cordycepoides* R. ETHERIDGE, Jr., 1905, p. 14; OD]. Coiling ancyloceratoid; whorl section subcircular; shaft with strong ventrolateral tubercles covering 1 to 3 ribs; umbilical tubercles appearing only on intermediate ribs; ribs branching at umbilical tubercles and may also do so at midside. *Lower Cretaceous (Upper Albian):* South Australia.——FIG. 187,*4a–c*. **A. cordycepoides* (ETHERIDGE); ×1 (McNamara, 1980).

Prophlyctichrioceras CLARK, 1965, p. 33 [**Hamites tanima* ADKINS & WINTON, 1920, p. 20; OD]. Based on slightly curved fragments with rounded to compressed section; primary ribs very coarse, with irregular, fine secondary ribs on and between them; primary ribs bearing large ventrolateral and siphonal tubercles, between which secondaries are doubled. The few specimens may be malformed *Anisoceras*. *Lower Cretaceous (Upper Albian):* Sardinia, Texas.——FIG. 185,*4a,b*. **P. tanima* (ADKINS & WINTON); ×2 (Clark, 1965).

Idiohamites SPATH, 1925c, p. 189 [**Hamites tuberculatus* J. SOWERBY, 1818b, p. 50; OD]. Coiling rather irregular, in one plane; ribs radial or oblique, with a pair of ventral tubercles joined normally only by single rib on venter; lateral tubercles rarely present. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Middle Cenomanian):* western and central Europe, northern Africa, Madagascar, New Zealand, Texas.——FIG. 187,*2a–c*. *I. dorsetensis* SPATH, Upper Albian, England; *a,b*, ×1; *c*, enlarged (Spath, 1923–1943).——FIG. 187,*2d*. *I. spiniger* (J. SOWERBY), Upper Albian, England; ×0.4 (Spath, 1923–1943).

Algerites PERVINQUIÈRE, 1910, p. 46 [**A. sayni;* OD]. At first coiled in one plane, with perforate umbilicus, then whorls just in contact, then uncoiling to nearly straight shaft and terminal hook; phragmocone and beginning of body chamber with regular or occasional, branched or intercalated ribs, generally all tuberculate ventrolaterally, and with constrictions. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian):* England, northern Africa.——FIG. 187,*1a–c*. **A. sayni; a,b*, ×1; *c*, ×4 (Pervinquière, 1910).

Allocrioceras SPATH, 1926a, p. 80 [**Crioceras ellipticum* WOODS, 1896, p. 84, *non Hamites ellipticus* MANTELL, 1822, p. 122; OD; =*Hamites angustus* J. de C. SOWERBY in DIXON, 1850, p. 346 (*non A. woodsi* SPATH, 1939c, p. 598)]. Similar to the more finely ribbed and sharply tuberculate species of *Idiohamites,* but early whorls at least distinctly helical and twisted. *Upper Cretaceous (Upper Cenomanian–Lower Coniacian):* western Europe, South Af-

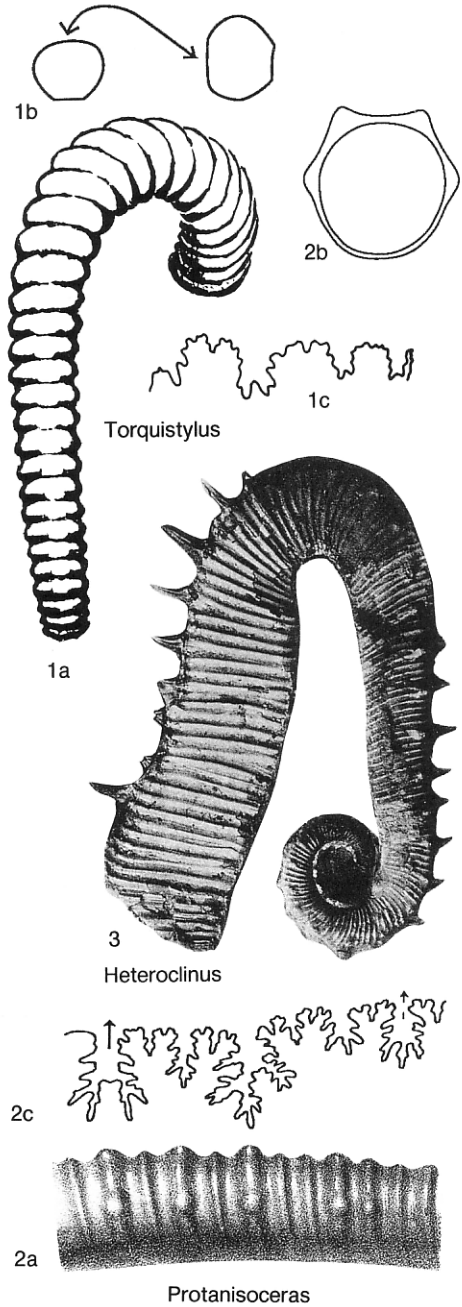


FIG. 184. Anisoceratidae (p. 234–235)

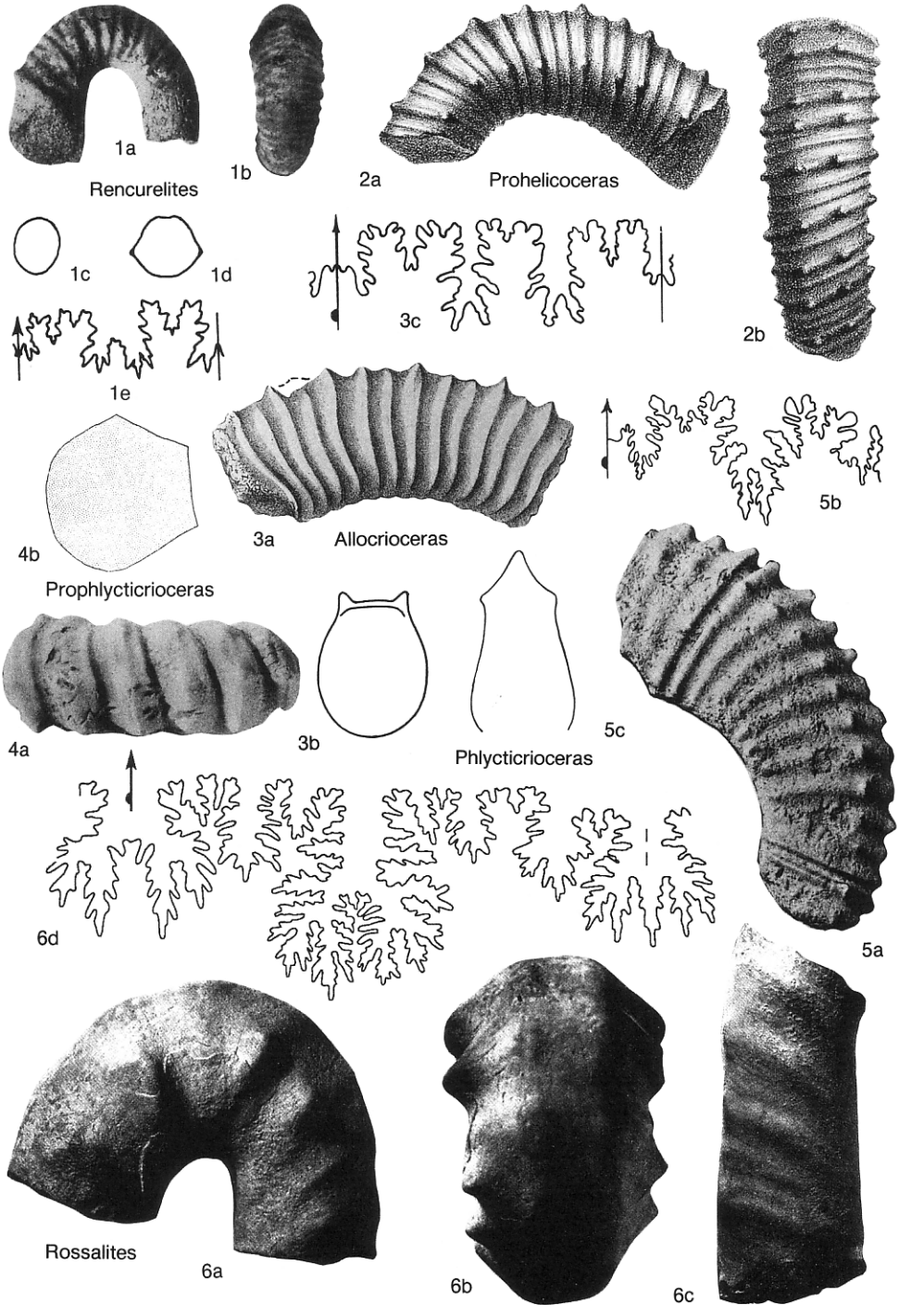


FIG. 185. Anisoceratidae (p. 235–239)

rica (Zululand), USA.——FIG. 185,*3a–c*. **A. angustum* (J. de C. SOWERBY), Upper Turonian, England; *a,b*, ×0.75; *c*, enlarged (Billinghurst, 1927).

Phlycticrioceras SPATH, 1926a, p. 80 [**Ancyloceras? douvillei* GROSSOUVRE, 1894, p. 254; OD; =*Hamites trinodosus* GEINITZ, 1850 in 1849–1850, p. 118 (=?*Hamites triseriatus* ROMINGER, 1847, p. 659, *nom. dub., nom. oblit.*)]. Questionably planispiral but with straight parts; ribs sharp, straight, more or less rursiradiate, with strong ventrolateral and siphonal tubercles; siphonal tubercles forming serrate keel; collared constrictions normally present. *Upper Cretaceous (Coniacian–Santonian, ?Campanian):* France, Germany, Madagascar, Wyoming, Texas, Mexico.——FIG. 185,*5a–c*. **P. trinodosus* (GEINITZ), Coniacian, France; *a,b*, ×1; *c*, ×2 (Grossouvre, 1894).

Family HAMITIDAE Gill, 1871

[Hamitidae GILL, 1871, p. 3]

Coiling rather irregular, typically in open, plane spiral ending in 2 or 3 more or less parallel shafts; early part may be helical. Section circular to compressed; ribs annular or interrupted on dorsum; no tubercles.

The earliest hamitids, some with subtrifid L, appear in the upper Lower Albian and are presumably derived from early Anisoceratidae by loss of tubercles. SPATH, 1923–1943; CASEY, 1960–1980. *Lower Cretaceous (Lower Albian)–Upper Cretaceous (Upper Turonian).*

Hamites PARKINSON, 1811, p. 145 [**H. attenuatus* J. SOWERBY, 1814b, p. 137; SD DIENER, 1925, p. 65] [=*Torneutoceras* HYATT, 1900, p. 586, obj.; *Stomohamites* BREISTROFFER, 1940, p. 155(85) (type, *H. virgulatus* BRONGNIART in CUVIER & BRONGNIART, 1822, pl. O, fig. 6; OD); *Hamitella* BREISTROFFER, 1947b, p. 100(84), *nom. nov. pro Helicoceras* ORBIGNY, 1842a, p. 611, *non* KOENIG, 1825 in 1820–1825, p. 19 (type, *H. annulatum* ORBIGNY, 1842a, p. 611; SD DIENER, 1925, p. 88)]. Typically with 3 well-separated, subparallel shafts, but initial spiral or even helical coiling may persist; whorl section circular, depressed or compressed; straight, rectiradiate or oblique ribs typically fine and dense to coarse and distant, but may be obsolescent. Suture florid to rather simple, with wide, bifid L and smaller, trifid or subbifid U. Forms with strong apertural collar and constriction (*Stomohamites*) are microconchs; their sutures are not consistently different. *Lower Cretaceous (Lower Albian)–Upper Cretaceous (Upper Cenomanian):* Europe, Africa, Madagascar, India, Australia (Northern Territory), New Zealand, USA, Mexico.

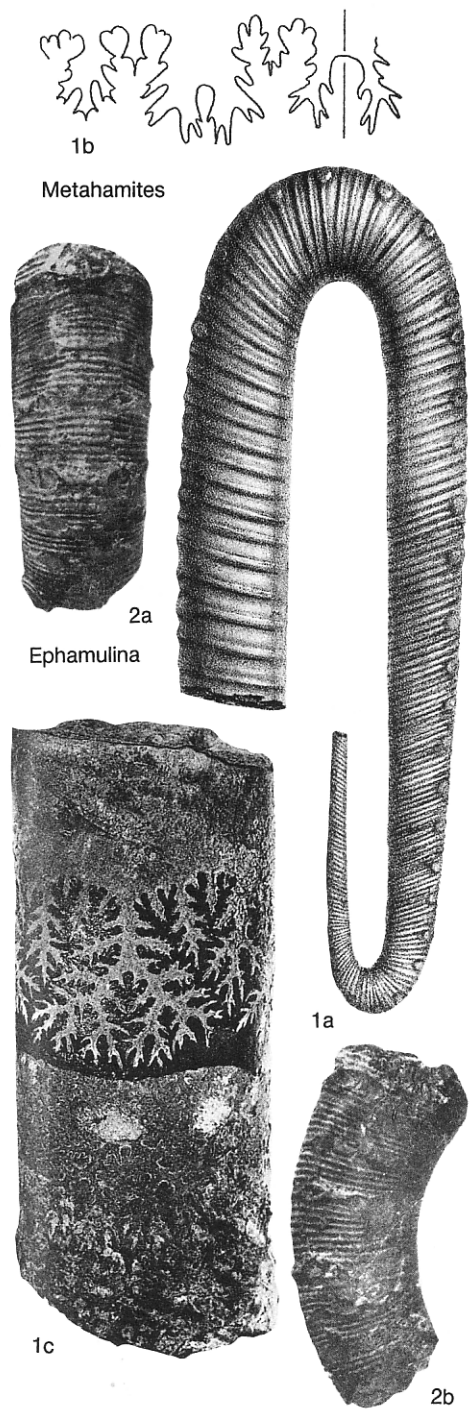


FIG. 186. Anisoceratidae (p. 235–236)

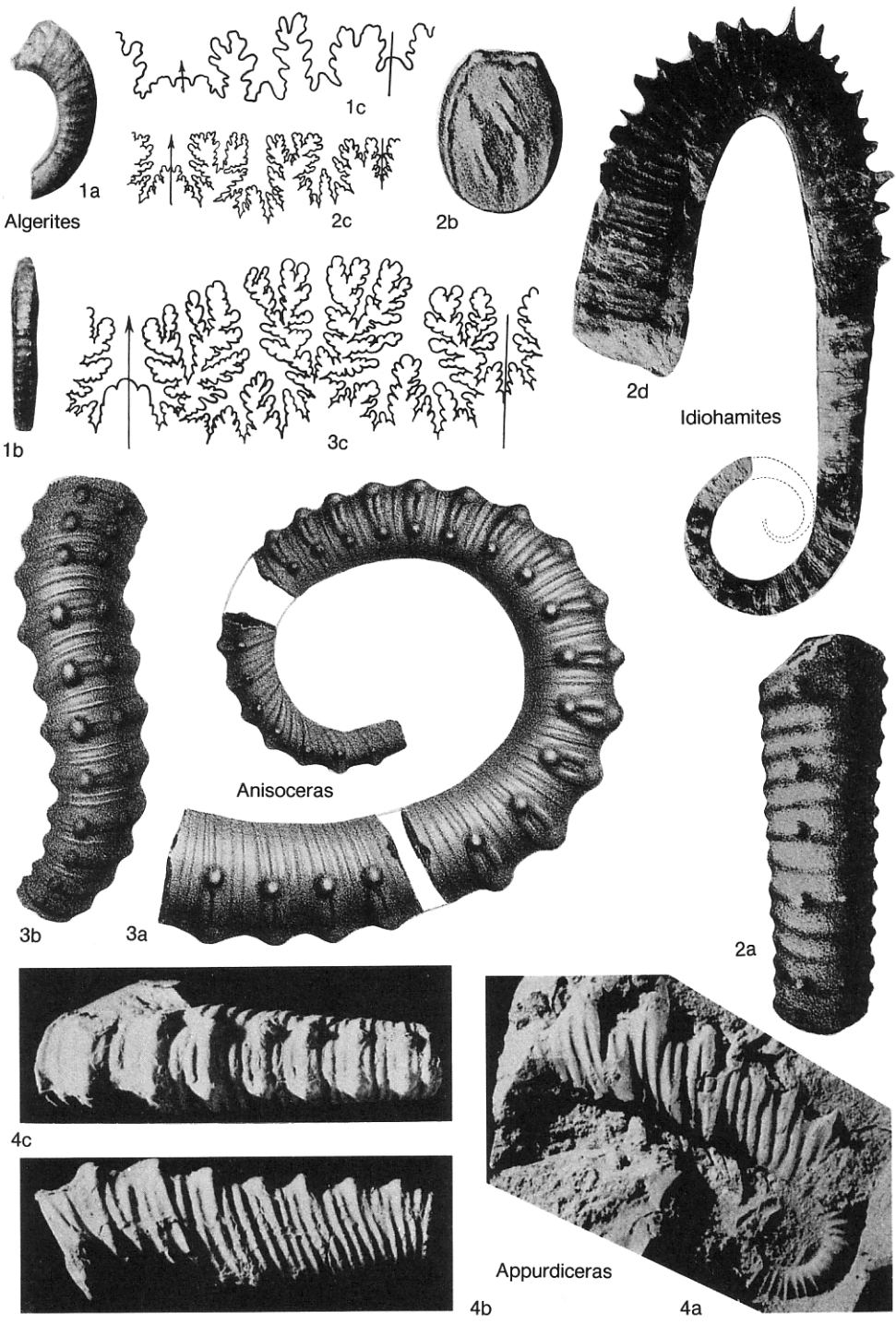


FIG. 187. Anisoceratidae (p. 237)

H. (Hamites). Ribs always present. Occurrence and distribution as for genus.——FIG. 188,*3a–c.* **H. (H.) attenuatus,* Middle Albian, England; *a,b,* ×1; *c,* enlarged (Spath, 1923–1943).——FIG. 188,*3d–g. H. (H.) duplicatus* PICTET & CAMPICHE, Upper Albian, France; *d,e,* microconch, ×1 (Pictet, 1847); *f,g,* ×3 (Spath, 1923–1943).

H. (Psilohamites) SPATH, 1941, p. 654 [**Hamites bouchardianus* ORBIGNY, 1842a, p. 540; OD]. Almost smooth; only straight shafts known. *Lower Cretaceous (Upper Albian):* western Europe.——FIG. 188,*5a,b.* **H. (P.) bouchardianus,* Upper Albian, France; *a,* ×1; *b,* enlarged (Orbigny, 1840–1842).

H. (Lytohamites) CASEY, 1961a, p. 92 [**L. similis;* OD]. With straight shafts; ribs rather fine, oblique; suture florid. *Lower Cretaceous (Upper Albian):* western Europe.——FIG. 188,*4a,b.* **H. (L.) similis* (CASEY), England; *a,* ×1; *b,* ×2 (Spath, 1923–1943).

Hemiptychoceras SPATH, 1925c, p. 189 [**Ptychoceras gaultinum* PICTET, 1847, p. 363; OD] [=*Protobaculites* COLLIGNON, 1964, p. 9 (type, *Baculites (P.) ambiguus;* OD)]. Similar to *Hamites,* but 3 shafts closely pressed together and ribs on second bend may be scalelike, changing density on final shaft; constrictions may be present. *Lower Cretaceous (Upper Albian):* western and central Europe, South Africa (Zululand), Japan.——FIG. 188,*7.* **H. gaultinum* (PICTET), France; ×1 (Pictet, 1847).

Scaphamites WIEDMANN & MARCINOWSKI, 1985, p. 451 [**S. passendorferi;* OD]. Coiled in shallow helix followed by shaft and terminal hook and twisted throughout; ribs mainly simple. *Lower Cretaceous (Albian, precise horizon uncertain):* Poland.——FIG. 188,*2a,b.* **S. passendorferi;* reconstruction, ×1 (Wiedmann & Marcinowski, 1985).

Puebloites COBBAN & SCOTT, 1972, p. 45 [**Helicoceras? corrugatum* STANTON, 1894, p. 165; OD]. Coiled in shallow helix, regular or elliptical. Body chamber tending to be depressed in section and to bulge adapically. Ribs generally oblique. *Upper Cretaceous (Lower Turonian):* France, Spain, Austria, Colorado.——FIG. 188,*6a,b.* **P. corrugatus* (STANTON); ×1 (Cobban & Scott, 1972).——FIG. 188,*6c. P. spiralis* COBBAN & SCOTT; ×1 (Cobban & Scott, 1972).

Metaptychoceras SPATH, 1926a, p. 80 [**Ptychoceras smithi* WOODS, 1896, p. 74; OD]. Small; much like *Hemiptychoceras* but with finer ribs and no constrictions after the first shaft. Perhaps a subgenus of *Hemiptychoceras. Upper Cretaceous (Lower Turonian–Upper Turonian):* England, Spain, South Dakota, Texas, Colombia.——FIG. 188,*1a,b.* **M. smithi* (WOODS), Upper Turonian, England; ×2 (Wright, 1979).

Family UNCERTAIN

Plesiohamites BREISTROFFER, 1947b, p. 93(77) [**Hamites multicostatus* BROWN, 1837 in 1837–1849, p. 3; OD]. A *nomen dubium* since the holotype is specifically and generically indeterminable. *H. multicostatus* auctt. is synonymous with the Upper Albian *Hamites (Lytohamites) similis* CASEY, 1961a, p. 92. *Cenomanian:* England.

Family TURRILITIDAE Gill, 1871

[Turrilitidae GILL, 1871, p. 3] [=Pseudhelicoceratinae BREISTROFFER, 1953a, p. 1350]

Helical forms, dextral or sinistral, loosely or tightly coiled; typically regular, but later whorls may be unstable; apical angle normally acute; in early species siphon in middle of exposed side, later migrating to upper margin or even upper internal angle of whorl; with strong ribs or tubercles or both; rarely smooth. Suture asymmetrical to accord with helical coiling; lobes primitively bifid but variable, tending to trifidity. *Lower Cretaceous (Middle Albian)–Upper Cretaceous (Upper Cenomanian).*

Two genera appeared in lower Middle Albian, *Proturrilitoides* (without tubercles) and *Pseudhelicoceras* (with tubercles). The former seems at first sight to be derived from a helical hamitid and the latter from *Protanisoceras,* suggesting subfamily division on this basis. However, the ornament of *Pseudhelicoceras* is not very close to that of contemporary anisoceratids, and it is at least possible that the family is monophyletic and that *Pseudhelicoceras* was derived from *Proturrilitoides,* which certainly has some tuberculate derivatives.

Proturrilitoides BREISTROFFER, 1940, p. 150(80) [**Turrilites astierianus* ORBIGNY, 1842a, p. 578; OD]. Whorl section more or less circular, with siphuncle at middle of exposed part; apical angle variable; umbilicus wide; aperture slightly constricted and collared; ribs more or less dense, radial or prorsiradiate, strong and simple, without tubercles. *Lower Cretaceous (Middle Albian):* France, Poland.——FIG. 189,*1.* **P. astierianus* (ORBIGNY), Middle Albian, France; ×1 (Orbigny, 1840–1842).

Turrilitoides SPATH, 1923a, p. 75 [**Turrilites hugardianus* ORBIGNY, 1842a, p. 588; OD]. More tightly coiled than *Proturrilitoides,* with apical angle more acute, whorl section oval or angular, and sides flatter; siphuncle at upper margin of side; aperture with strong constriction, collared on both sides. *Lower Cretaceous (Upper Albian):* Europe, Madagascar, Pakistan.——FIG. 189,*3a,b. T. densicostatus* PASSENDORFER, Upper Albian, England; *a,* ×1; *b,* ×2 (Spath, 1937b).

Ostlingoceras HYATT, 1900, p. 587 [**Turrilites puzosianus* ORBIGNY, 1842a, p. 587; OD]. Very

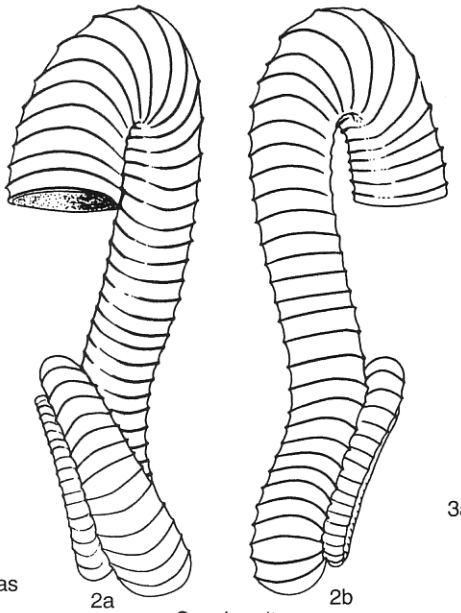


1a



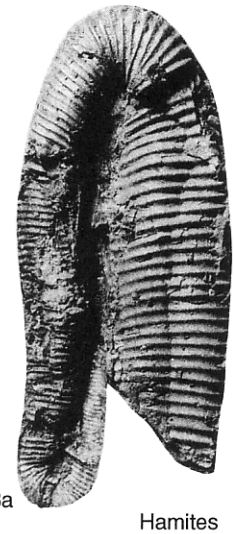
1b

Metaptychoceras



2a 2b

Scaphamites



3a

Hamites



3e



3d



3b



3c



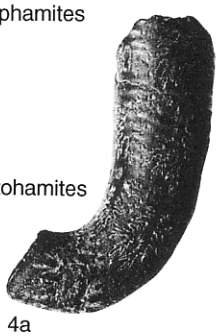
3f



3g



4b



Lytohamites

4a



5b

Psilohamites



5a



6b

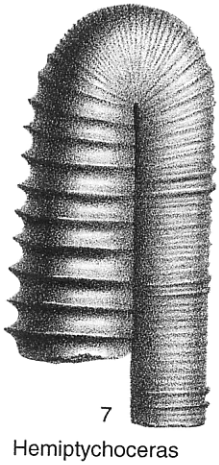


6a



6c

Puebloites



7

Hemiptychoceras

FIG. 188. Hamitidae (p. 239–241)

closely coiled, with acute apical angle; whorl section more angular and flat-sided than in *Turrilitoides;* ribs dense, straight or slightly flexuous, with up to 3 tubercles at lower end. Derived from *Proturrilitoides* in parallel with *Turrilitoides. Lower Cretaceous (Middle Albian)–Upper Cretaceous (Lower Cenomanian):* Europe, northern Africa, South Africa (Zululand), Madagascar, Japan, Texas.

O. (Parostlingoceras) BREISTROFFER, 1953a, p. 1350 [**Turrilites moutonianus* ORBIGNY, 1842a, p. 584; OD]. Ribs rather irregular, angulate or weakly tuberculate at lower angle of side. *Lower Cretaceous (Middle Albian):* France, Poland.

O. (Ostlingoceras). Ribs regular, with 2 or 3 distinct tubercles at lower end of each. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian):* distribution as for genus.——FIG. 189,*4.* **O. (O.) puzosianum* (ORBIGNY), Upper Albian, France; ×1 (Orbigny, 1842a).

Neostlingoceras KLINGER & KENNEDY, 1978, p. 14 [**Turrilites carcitanensis* MATHERON, 1842, p. 267; OD]. Shell form as in *Ostlingoceras* but with median row of sparse tubercles more numerous than lower rows; analogue of *Hypoturrilites. Upper Cretaceous (Lower Cenomanian–Upper Cenomanian):* Europe, northern Africa, South Africa, Madagascar, Iran, southern India, Japan, New Mexico, Colorado, Wyoming.——FIG. 189,*5.* **N. carcitanense* (MATHERON), England; ×1 (Kennedy, 1971).

Raynaudia DUBOURDIEU, 1953, p. 44 [**Turrilites (Carthaginites) raynaudiensis* COLLIGNON, 1932, p. 19; OD]. Smooth; siphuncle at external upper angle of whorl. Suture simplified. *Lower Cretaceous (Upper Albian):* Madagascar.——FIG. 189,*2.* **R. raynaudiensis* (COLLIGNON); ×2 (Collignon, 1932).

Carthaginites PERVINQUIÈRE, 1907, p. 101 [**Turrilites (Carthaginites) kerimensis;* OD]. Differs from *Raynaudia* in having a spiral groove along the middle of the side, with or without single row of small tubercles, and siphuncle at inner upper angle of whorl. *Upper Cretaceous (Lower Cenomanian–Upper Cenomanian):* England, northern Africa, Wyoming, New Mexico.——FIG. 190,*2.* **C. kerimensis* (PERVINQUIÈRE), Tunisia; ×2 (Pervinquière, 1907).

Pseudhelicoceras SPATH, 1922a, p. 112 [**Turrilites robertianus* ORBIGNY, 1842a, p. 585; OD] [=*Spiroceras* MEEK, 1876, p. 486, *non* QUENSTEDT, 1858 in 1856–1858, p. 407 (type, *Turrilites robertianus* ORBIGNY, 1842a, p. 585; M); *Subhelicoceras* BREISTROFFER, 1953a, p. 1349 (type, *Turrilites bituberculatus* ORBIGNY, 1842a, p. 582; OD); *Parahelicoceras* BREISTROFFER, 1953a, p. 1350 (type, *Turrilities catenatus* ORBIGNY, 1842a, p. 574; OD)]. Apical angle moderately to very acute; coiling loose or tight; ribbing variable, simple or branching, radial or prorsiradiate, with 2 or 4 tubercles (which may cover several ribs) and with or without intermediate nontuberculate ribs; siphuncle at or near middle of exposed side. *Lower Cretaceous (Middle Albian–Upper Albian):* western and central Europe, South Africa (Zululand), Madagascar, British Columbia, California, Texas.——FIG. 190,*1a–c.* **P. robertianum* (ORBIGNY), Upper Albian, France; *a,b,* ×1; *c,* enlarged (Orbigny, 1840–1842).

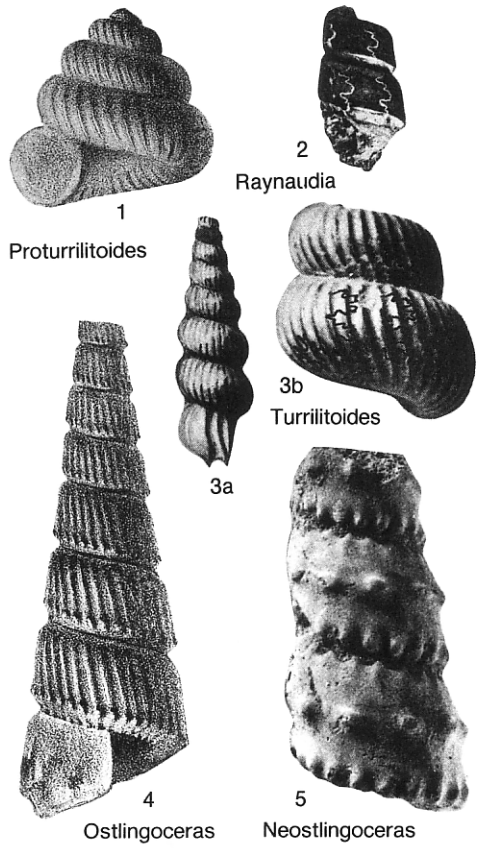


FIG. 189. Turrilitidae (p. 241–243)

Mariella NOWAK, 1916, p. 10 (not invalidated, despite the statements of many authors, by *Mariaella* PFEIFFER in GRAY, 1855, p. 62, nor by *Mariella* MOERCH, 1865, p. 269, an error for *Mariaella* GRAY) [**Turrilites bergeri* BRONGNIART in CUVIER & BRONGNIART, 1822, p. 395; OD] [=*Paraturrilites* BREISTROFFER, 1947b, p. 96(80) (type, *Turrilites gresslyi* PICTET & CAMPICHE, 1861, p. 132; OD); *Hemiturrilites* BREISTROFFER, 1953a, p. 1350 (type, *Turrilites elegans* ORBIGNY, 1842a, p. 577; OD); *Bergericeras* WIEDMANN, 1962a, p. 224, obj.]. Apical angle variable, generally large; closely coiled; whorl section more or less circular; ribs slightly oblique, rather feeble, each with 4 more or less equal tubercles. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian):* Europe, northern Africa, South Africa (Zululand), Madagascar, Iran, southern India, New Zealand, Texas, Mexico, Argentina.

M. (Mariella). Tubercles more or less equidistant; intercostal section rounded. Differentiation of size and spacing of rows of tubercles leads to *Turrilites* and of numbers in rows to

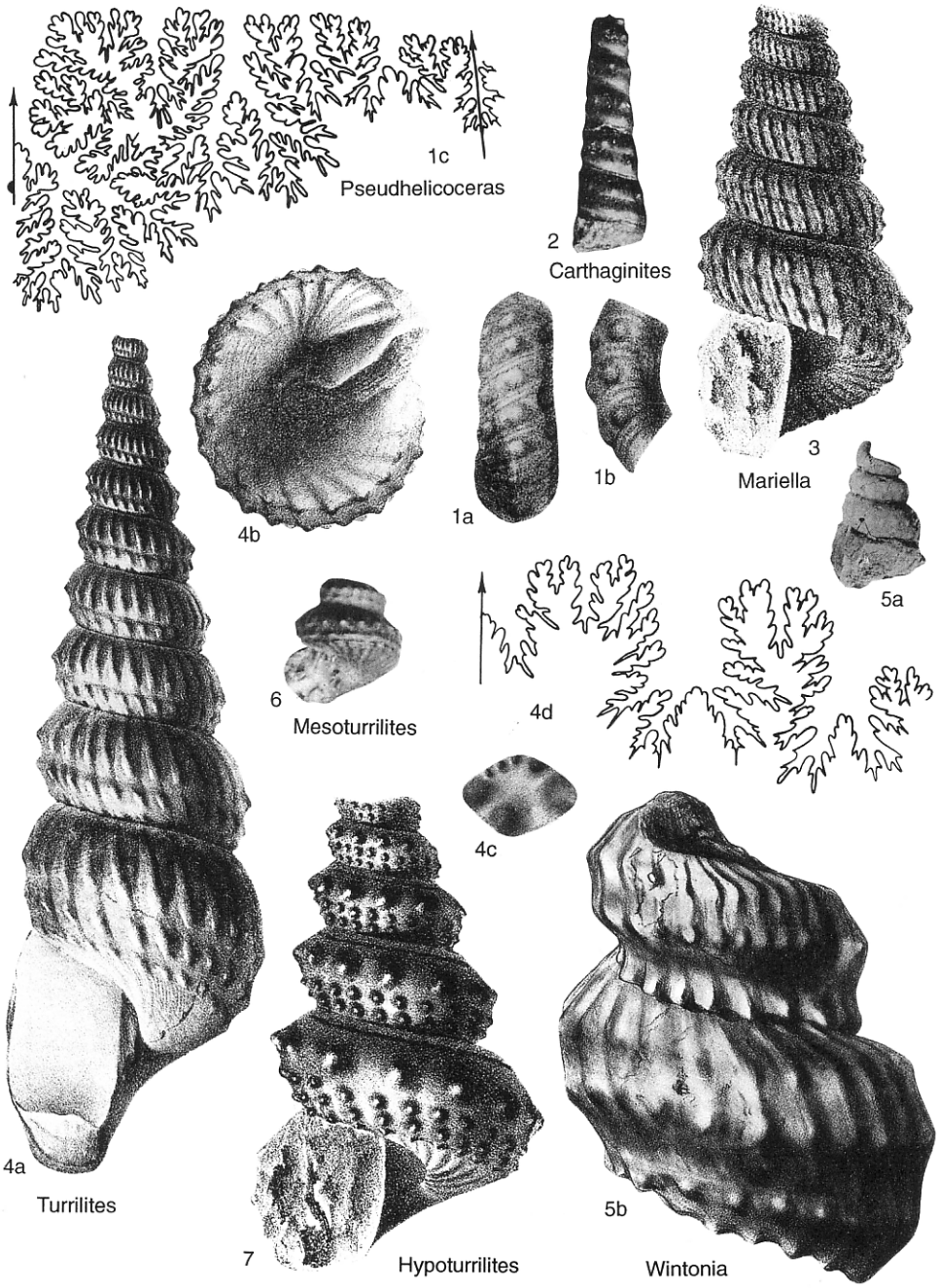


FIG. 190. Turrilitidae (p. 243–245)

Hypoturrilites. Occurrence and distribution as for genus.——FIG. 190,*3*. **M. (M.) bergeri* (BRONGNIART in CUVIER & BRONGNIART), Upper Albian, France; ×1 (Orbigny, 1840–1842).

M. (Wintonia) ADKINS, 1928, p. 213 [**W. graysonensis;* OD; =*Turrilites bosquensis* ADKINS, 1920, p. 76] [=*Plesioturrilites* BREISTROFFER, 1953a, p. 1351 (type, *Turrilites brazoensis* ROEMER, 1852, p. 37; OD)]. Upper and lower pairs of tubercles separated by marked spiral furrow; body chamber uncoiling. Initial straight shaft, said to characterize *Wintonia,* is artifact of

fossilization. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian):* Madagascar, southern India, California, Texas, Mexico.——FIG. 190,*5a.* **M. (W.) bosquensis* (ADKINS), Lower Cenomanian, Texas; initial straight shaft, ×2 (Clark, 1965).——FIG. 190,*5b. M. (W.) brazoensis* (ROEMER), Lower Cenomanian, Texas; ×0.5 (Lasswitz, 1904).

Hypoturrilites DUBOURDIEU, 1953, p. 44 (SHIMIZU, 1935a, p. 195, *nom. nud.*) [**Turrilites gravesianus* ORBIGNY, 1842a, p. 596; OD; ICZN pending] [=*Eohypoturrilites* SCHOLZ, 1973, p. 123 (type, *Turrilites mantelli* SHARPE, 1857, p. 63; OD)]. May be large; ribs almost absent; tubercles in midflank row fewer and generally much larger than remainder; test with long spines (tubercles on molds). *Upper Cretaceous (Cenomanian):* Europe, Africa, India, Australia (Northern Territory), New Zealand, Japan, Texas, Argentina.——FIG. 190,*7.* **H. gravesianus* (ORBIGNY), France; ×1 (Orbigny, 1840–1842).

Mesoturrilites BREISTROFFER, 1953a, p. 1351 [**Turrilites aumalensis* COQUAND, 1862, p. 323; OD]. Apical angle rather large, with 4 rows of tubercles or of ribs and tubercles, the upper row consisting of short ribs or large, round tubercles, the second and third rows of spirally elongated tubercles or semi-continuous ridges separated by a groove, and the fourth row of weak, elongate tubercles on lower whorl surface. *Upper Cretaceous (Lower Cenomanian):* England, Germany, Poland, Algeria, Tunisia, Turkmenistan.——FIG. 190,*6.* **M. armalense* (COQUAND), Algeria; ×1 (Pervinquière, 1910).

Turrilites LAMARCK, 1801, p. 102 [**T. costatus;* OD] [=*Euturrilites* BREISTROFFER, 1953a, p. 1351 (type, *T. scheuchzerianus* BOSC, 1801, p. 190; OD); *Turbinites* DUBOURDIEU, 1953, p. 42, *non* MARTIN, 1809, pl. 38 (type, *T. scheuchzerianus* BOSC, 1802, p. 190; OD)]. Apical angle moderately to very acute; tightly coiled; whorl section flattened or angular; ribs simple or depressed in the middle or with 2 to 4 bullate or spinate tubercles. Derived from *Mariella,* from which distinction may be difficult. *Upper Cretaceous (Cenomanian):* Europe, Africa, Oman, India, Japan, USA, Mexico.——FIG. 190,*4a–d.* **T. costatus,* Lower Cenomanian, France; *a,b,* ×0.75; *c,* ×0.5; *d,* enlarged (Orbigny, 1840–1842).

Family NOSTOCERATIDAE Hyatt, 1894

[Nostoceratidae HYATT, 1894, p. 568] [=Jouaniceratidae WRIGHT, 1952, p. 218; Bostrychoceratinae SPATH, 1953, p. 16; Hyphantoceratinae SPATH, 1953, p. 16; Emperoceratinae SPATH, 1953, p. 17; Proavitoceratinae SPATH, 1953, p. 17, *errore pro* Pravitoceratinae]

Helicoid forms with coiling commonly irregular in early or late stages or both or throughout. Ribs prominent, with or without tubercles; constrictions common. Suture normally florid. *Upper Cretaceous (Turonian–Maastrichtian).*

Although shell form is variable, the genera are closely related and division into subfamilies is unnecessary. The family seems to have been derived from Albian *Turrilitoides,* but the boundary with Turrilitidae is uncertain owing to lack of ammonoids in Upper Cenomanian and Lower Turonian rocks.

Nostoceras HYATT, 1894, p. 569 [**N. stantoni;* OD; =*Ancyloceras? approximans* CONRAD, 1856, p. 266]. A series from Turonian to Maastrichtian of mostly tightly coiled, turrilitoid forms with body chamber incipiently U-shaped and pendent; apical angle acute to obtuse; ribs simple, close or distant, and flexuous; normally with deep, collared constrictions. In the Campanian, rapid morphological radiation produced interconnected but varying species with coiling tight or loose, apical angle acute or obtuse, ribs fine or coarse, simple or variously looped, and tuberculation lacking, weak, or strong, regular or irregular. Some faunas contain only a few morphotypes, others a wide range of intergrading forms. A selection of these are listed here as subgenera but are mostly no more than examples in a variable plexus. *Upper Cretaceous (Turonian–Lower Maastrichtian):* Europe, Africa, Madagascar, southern India, Japan, Canada, USA, Western Australia, central Asia.

N. (Eubostrychoceras) MATSUMOTO, 1967, p. 332 [**E. indopacificum;* OD]. Initially J-shaped, then turricone; whorls typically touching but in some specimens free; body chamber twisted to face obliquely upward but still touching preceding whorl; ribs mostly simple; no tubercles; collared constrictions throughout, more or less parallel to ribs. *Upper Cretaceous (Turonian–Santonian):* western Europe, northern Africa, Madagascar, southern India, Japan, ?Oregon, Wyoming, New Mexico, Texas.——FIG. 191,*4a,b.* **N. (E.) indopacificum* (MATSUMOTO), Coniacian, Japan; ×1 (Matsumoto, 1967).

N. (Yezoceras) MATSUMOTO, 1977, p. 316 [**Y. nodosum;* OD]. Similar to early *N. (Eubostrychoceras)* but with siphuncle at base of whorl and body chamber, retroversed or not, with up to 4 large tubercles on periodic ribs. *Upper Cretaceous (Lower Coniacian–Upper Coniacian):* ?Germany, Japan.——FIG. 191,*7.* **N. (Y.) nodosum* (MATSUMOTO), Lower Campanian, Japan; ×1 (Matsumoto, 1977).

N. (Bostrychoceras) HYATT, 1900, p. 588 [**Turrilites polyplocus* ROEMER, 1841, p. 92; OD] [=*Mobergoceras* SCHMID & ERNST, 1975, p. 342 (type, *Turrilites junior* MOBERG, 1885, p. 31; OD)]. Apical angle acute to obtuse; whorls more or less circular in section, sometimes touching; body chamber tending to be free and U-shaped; ribs typically simple, close or distant, and untuberculate; small tubercles may occur on later whorls or throughout on simple or looped ribs. [*Mobergoceras* for acutely conical species with

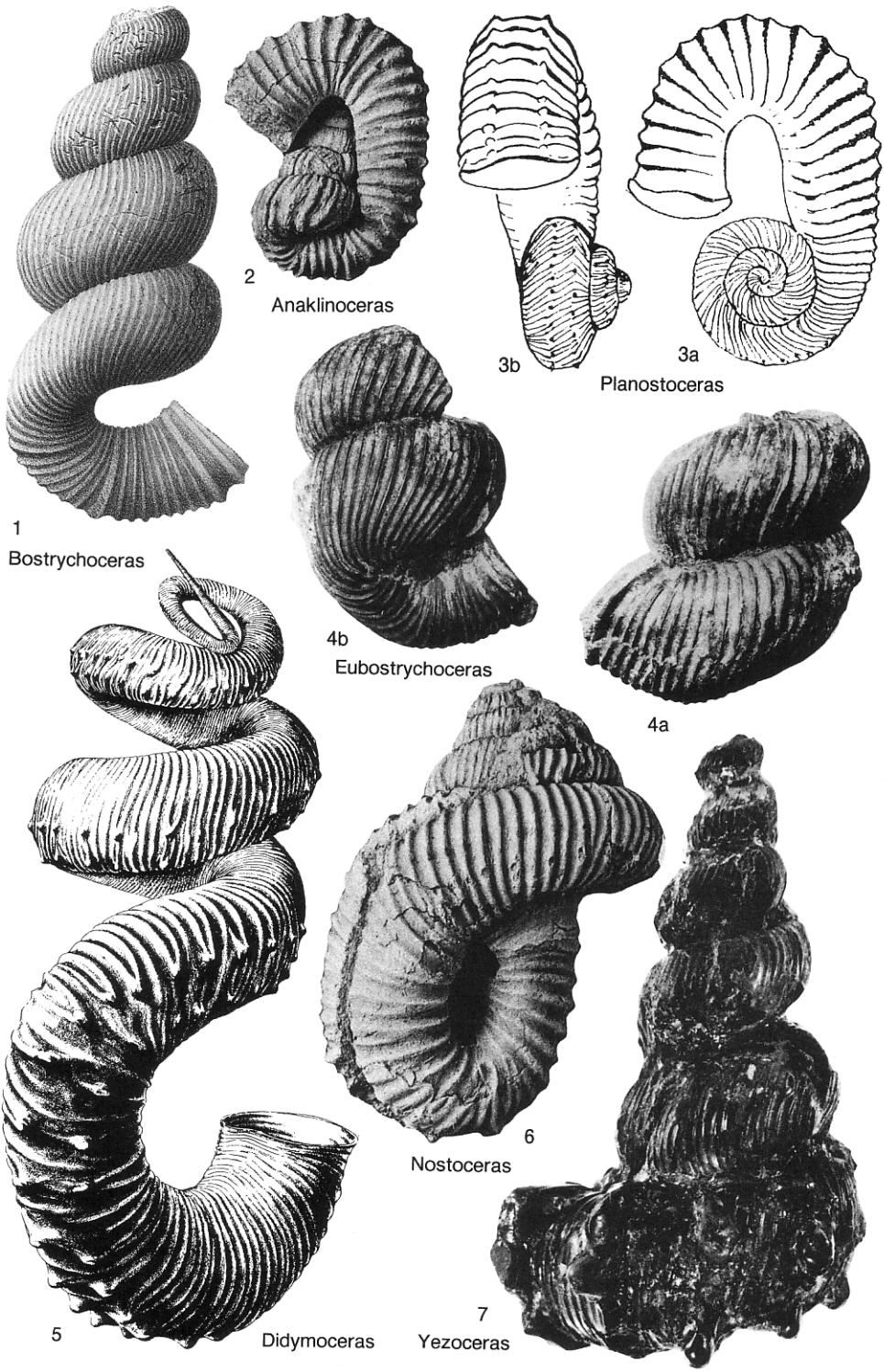


FIG. 191. Nostoceratidae (p. 245–247)

distant ribs seems unnecessary.] *Upper Cretaceous (Campanian–Lower Maastrichtian):* Europe, northern Africa, Madagascar, southern India, Japan, Western Australia, Texas, Mexico.——FIG. 191,*1.* **N. (B.) polyplocum* (ROEMER), Campanian, northern Germany; ×0.5 (Schlüter, 1871–1876).

N. (**Nostoceras**). Apical angle rather to very obtuse; whorls circular to polygonal in section, in contact until body chamber; body chamber U-shaped, hanging free; 2 or more rows of distinct, small or large tubercles throughout on simple or looped, close or distant ribs. *Upper Cretaceous (Campanian):* Ukraine, western and southeastern Africa, Madagascar, central Asia, Canada, USA.——FIG. 191,*6.* **N. (N.) approximans* (CONRAD), Texas; ×1 (Stephenson, 1941).

N. (**Didymoceras**) HYATT, 1894, p. 573 [**Ancyloceras? nebrascense* MEEK & HAYDEN, 1857, p. 71; OD] [=*?Cirroceras* CONRAD, 1868, p. 730 (type, *Ammonceratites conradi* MORTON, 1843, p. 109; OD), *nom. dub.* because holotype of type species is indeterminable (HOWARTH, 1965); *Emperoceras* HYATT, 1894, p. 575 (type, *E. beecheri;* OD)]. Loosely and irregularly coiled at first, even hamitoid; then helicoid with whorls just or not touching; body chamber pendent, U-shaped; ribs numerous, irregularly branching and looped, some with 2 rows of ventral tubercles. *Upper Cretaceous (Campanian):* ?Germany, Austria, Angola, Israel, Alaska, Colorado, North Dakota, Delaware.——FIG. 191,*5.* **N. (D.) nebrascense* (MEEK & HAYDEN), Colorado; restored, ×0.5 (Scott & Cobban, 1965).

N. (**Anaklinoceras**) STEPHENSON, 1941, p. 414 [**A. reflexum;* OD]. Final part bent up one side of spire and down other. *Upper Cretaceous (Campanian):* Texas.——FIG. 191,*2.* **N. (A.) reflexum* (STEPHENSON); ×1 (Stephenson, 1941).

N. (**Planostoceras**) LEWY, 1967, p. 168 [**N. (P.) rehavami;* OD]. Apical angle generally obtuse; plane of body chamber at right angles to axis of spire. *Upper Cretaceous (Upper Campanian):* Israel, ?Angola.——FIG. 191,*3a,b.* **N. (P.) rehavami,* Israel; ×0.5 (Lewy, 1967; courtesy of Laser Pages Publishing, Ltd.).

Didymoceratoides KENNEDY & COBBAN, 1993a, p. 90 [**D. binodosum;* OD]. Early, low, open helix followed by loose, elliptical whorls; with distant, sharp, rursiradiate ribs bearing small ventrolateral tubercles. Progenetic derivative of *Didymoceras,* losing the latter's tightly coiled later helix. *Upper Cretaceous (Middle Campanian):* Arkansas, Texas.

Nipponites YABE, 1904, p. 20 [**N. mirabilis;* OD]. Coiled initially in loose helix, then in succession of U's in 3 dimensions, forming a tangle; with or without final retroversal hook; ribs single and regular; constrictions present, may be flared on final whorl. *Upper Cretaceous (Upper Turonian–Lower Santonian):* Madagascar, Japan, Kamchatka, Sakhalin, Oregon.——FIG. 192,*3a,b.* **N. mirabilis,* Coniacian, Japan; *a,* ×0.75; *b,* diagram of coiling, ×0.5 (Yabe, 1904).

Hyphantoceras HYATT, 1900, p. 587 [**Heteroceras* ("*roissyanum* SCHLÜTER," error for) *reussianum* ORBIGNY, 1850a, p. 216; OD] [=*Euhyphantoceras* SHIMIZU, 1935a, p. 181 (type, *E. maestrichtiense;* OD); *Orientoceras* SHIMIZU, 1935a, p. 198 (type, *Heteroceras? orientale* YABE, 1904, p. 19); *Ankinatsytes* COLLIGNON, 1965b, p. 16 (type, *A. yabei;* OD)]. Heterostrophic; spire loosely and commonly irregularly coiled; body chamber U-shaped or irregular; whorl section circular to oval; ribs dense, slightly oblique, weak, nontuberculate; periodic ribs thin and flared, normally with 2 or 4 tubercles; no constrictions. Markedly dimorphic in size. Suture with long, deeply divided elements. [*Ankinatsytes,* said to differ only in suture, has suture of same general plan.] *Upper Cretaceous (Upper Turonian–Santonian):* Europe, northern Africa, South Africa (Zululand), Madagascar, southern India, New Zealand, Japan, Venezuela.

H. (**Hyphantoceras**). Flared ribs all single. Occurrence and distribution as for genus.——FIG. 192,*2a,b.* **H. (H.) reussianum* (ORBIGNY), Upper Turonian, England; *a,* ×1; *b,* ×2 (Woods, 1896).

H. (**Madagascarites**) COLLIGNON, 1966, p. 26 [**M. andimakensis;* OD]. With midlateral and ventrolateral tubercles joined by doubled ribs. The type species at least is coiled in loose spire embraced by U-shaped body chamber. *Upper Cretaceous (Middle Santonian):* ?Austria, South Africa (Zululand), Madagascar, Japan.——FIG. 192,*4.* **H. (M.) andimakensis* (COLLIGNON); ×0.5 (Colligon, 1966).

Muramotoceras MATSUMOTO, 1977, p. 334 [**M. yezoense;* OD]. Initially straight, then helical, and then helical in reversed sense; body chamber may uncoil; ribbing at first fine and simple, later very distant and flared, with indistinct umbilical and distinct, septispinate ventrolateral tubercles. *Upper Cretaceous (Middle Turonian):* Japan.——FIG. 192,*1a–c.* **M. yezoense; a,b,* ×1.2; *c,* ×3 (Matsumoto, 1977).

Jouaniceras BASSE, 1939, p. 43 [**Heteroceras? sicardi* GROSSOUVRE, 1894, p. 223; OD]. Initial whorls tightly helical, then with plane spiral whose axis is at right angles to that of initial spire; on plane part at least ribs distant, thin, and high. *Upper Cretaceous (Santonian, ?Lower Campanian):* France, Algeria, Japan.

J. (**Jouaniceras**). Planispiral whorls tightly coiled; some ribs may be flared. *Upper Cretaceous (Santonian):* France, Algeria.——FIG. 193,*3a–c.* **J. (J.) sicardi* (GROSSOUVRE), France; *a,c,* ×2; *b,* ×1 (Basse, 1939).

J. (**Ainoceras**) MATSUMOTO in MATSUMOTO & KANIE, 1967, p. 350 [**A. kamuy;* OD]. Like *J. (Jouaniceras)* but with the planispiral whorls loosely coiled. *Upper Cretaceous (?Lower Campanian):* Japan.——FIG. 193,*1a,b.* **J. (A.) kamuy* (MATSUMOTO & KANIE), Hokkaido; *a,* ×1; *b,* suture, ×5 (Matsumoto & Kanie, 1967).

Tridenticeras WIEDMANN, 1962a, p. 193 [**Turrilites tridens* SCHLÜTER, 1876, p. 136; OD]. Turricone; 1

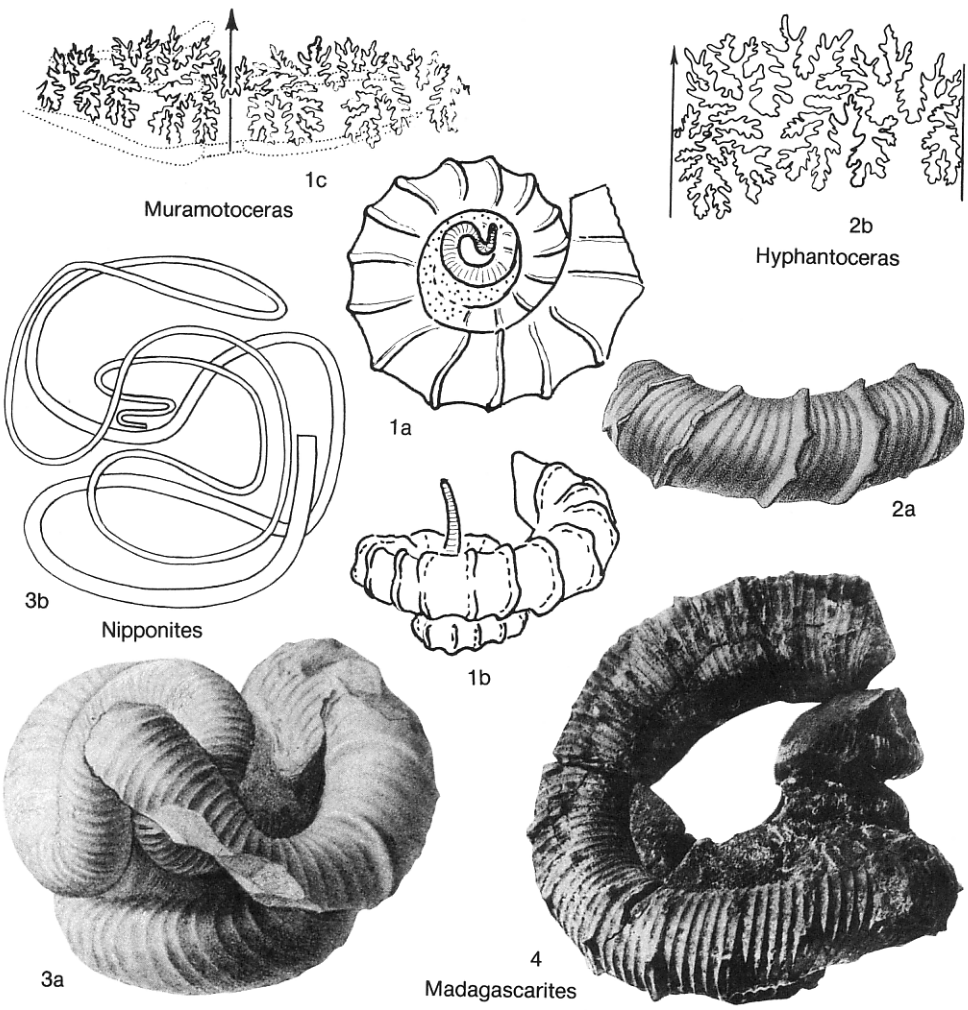


FIG. 192. Nostoceratidae (p. 247)

or 2 weak, untuberculate ribs between main ribs; main ribs with 3 visible tubercles, the lower 2 close together, and perhaps a fourth in the suture between the whorls. Presumably a recoiled *Hyphantoceras. Upper Cretaceous (Coniacian):* Germany, Spain, Texas.——FIG. 193,*4.* **T. tridens* (SCHLÜTER), Germany; ×1 (Wiedmann, 1962a).

Pravitoceras YABE, 1902, p. 6 [**P. sigmoidale;* OD]. Initially helical, then apical angle increasing until whorls regularly coiled in one plane and just touching; body chamber S-shaped; whorl section more or less circular; ribs on early whorls distant, nearly straight, all or alternate ones with sharp ventrolateral tubercles; later whorls with ribs slightly flexuous and dense, fewer with tubercles; constrictions irregular and shallow. *Upper Cretaceous (Campanian):* Japan.——FIG. 193,*2a,b.* **P. sigmoidale; a,* ×0.5 (Matsumoto & others, 1981); *b,* ×0.4 (Yabe, 1902).

[**Neoturrilites** SHIMIZU, 1935a, p. 180 (*nom. nud.*)].

Family DIPLOMOCERATIDAE Spath, 1926

[Diplomoceratidae SPATH, 1926a, p. 81] [=Neocrioceratinae SPATH, 1953, p. 17]

Variable offshoots of Nostoceratidae tending to lose helical coiling. Initial stage commonly (perhaps always) straight, smooth, and with constrictions (TANABE, OBATA, & FUTAKAMI, 1981). Extreme ptychoceratoid forms develop. Typically with sharp, annular,

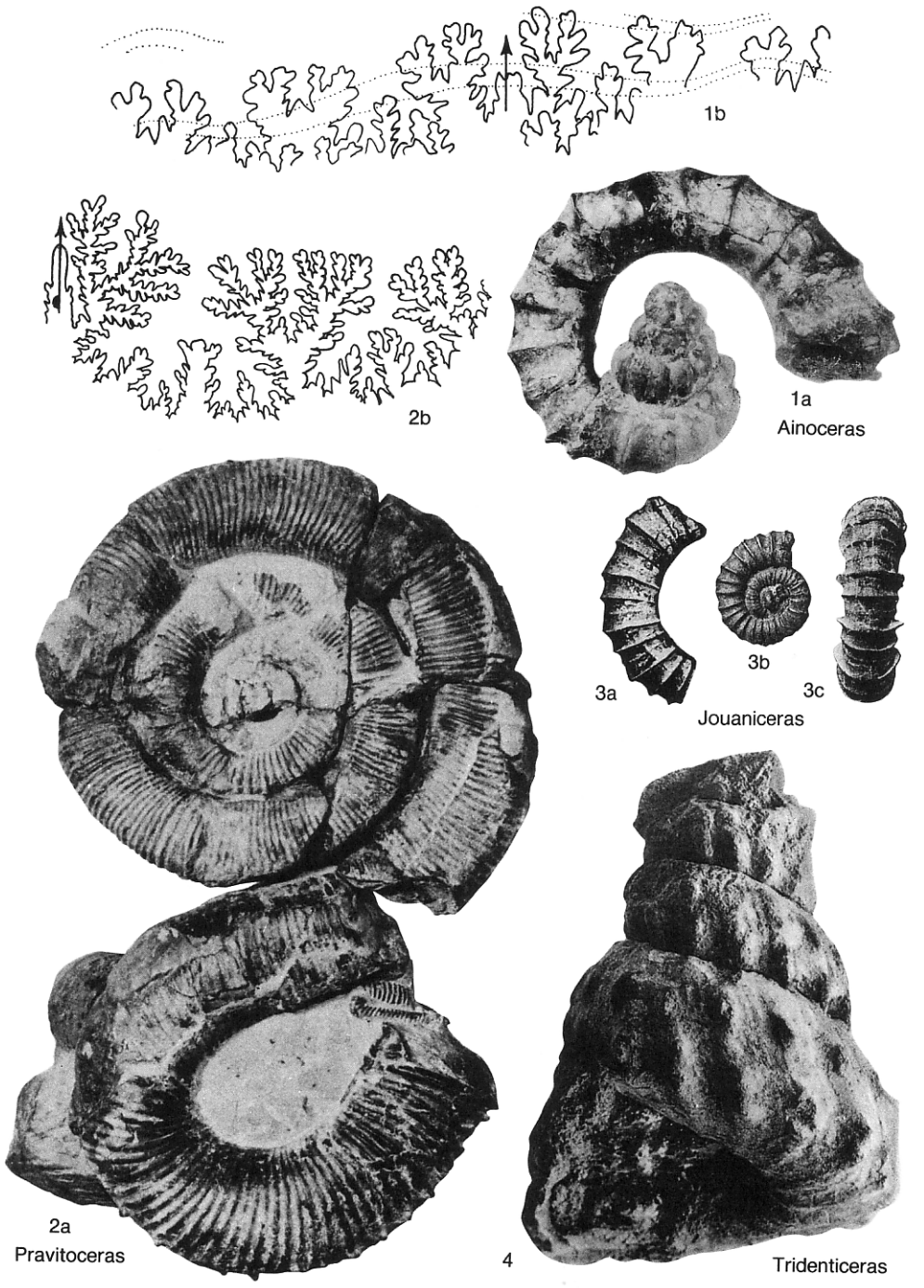


FIG. 193. Nostoceratidae (p. 247–248)

nontuberculate ribs, but ventrolateral spines occurring in some genera. Suture florid in Diplomoceratidae, as in Nostoceratidae, but tending to simplify in the Polyptychoceratinae. *Upper Cretaceous (Turonian–Upper Maastrichtian).*

Subfamily DIPLOMOCERATINAE Spath, 1926

[Diplomoceratinae SPATH, 1926a, p. 81] [=Scalaritinae WARD, 1976, p. 455]

Coiling mostly crioconic or elliptical; suture florid. *Upper Cretaceous (Turonian–Maastrichtian).*

Scalarites WRIGHT & MATSUMOTO, 1954, p. 115 (MATSUMOTO, 1938b, p. 193, *nom. nud.*) [**Helicoceras scalare* YABE, 1904, p. 9; OD] [=*Trianglites* MATSUMOTO, 1977, p. 350 (type, *T. antiquus;* OD)]. Very open, shallowly helicoid spire followed by loose, irregular coiling in one plane; section more or less circular; ribs simple, annular, with sparse, flared ribs or constrictions or both. [*Trianglites,* based on one specimen, differs only in coiling.] *Upper Cretaceous (Turonian–Coniacian):* France, Bornholm, Japan.——FIG. 194,*1a.* **S. scalare* (YABE), Turonian, Japan; diagrammatic, ×0.5 (Wright & Matsumoto, 1954).——FIG. 194,*1b. S. antiquus* (MATSUMOTO), Turonian, Japan; ×0.9 (Matsumoto, 1977).

Glyptoxoceras SPATH, 1925f, p. 30 [**Hamites rugatus* FORBES, 1846, p. 117; OD] [=*Neohamites* BRUNNSCHWEILER, 1966, p. 48 (type, *N. giraliensis;* OD)]. Initial helix followed by loose, regular or elliptical coiling, normally with more or less straight shaft and hook in questionable microconchs; section circular to oval; ribs annular, sharp, straight, close or distant; a few collared constrictions present. *Upper Cretaceous (Santonian–Upper Maastrichtian):* Europe, South Africa (Zululand), southern India, central Asia, Japan, Canada, USA, Venezuela, Brazil.——FIG. 194,*2a–c. G. indicum* (FORBES), Campanian, southern India; ×1 (Kossmat, 1895).——FIG. 194,*2d. G. subcompressum* (FORBES), Campanian, Vancouver Island; ×0.5 (Ward & Westermann, 1976).

Neoglyptoxoceras COLLIGNON, 1969, p. 35 [**N. magnificum;* OD] [=?*Epiglyptoxoceras* COLLIGNON, 1969, p. 35 (type, *E. abnorme;* OD)]. Macroconchs large, more or less regularly crioconic; microconchs smaller, ancyloceratoid in coiling; ribs strong, thin, well-spaced, rursiradiate. Suture with massive auxiliary lobe in ?second lateral saddle. [*Epiglyptoxoceras,* apparently based on a single pathological specimen without such a massive auxiliary lobe, is probably a synonym.] *Upper Cretaceous (Lower Campanian–Middle Campanian):* England, France, Germany, Austria, Ukraine, Madagascar.——FIG. 194,*3.* **N. magnificum,* Lower Campanian, Madagascar; ×0.5 (Collignon, 1969).

Neancycloceras SPATH, 1926a, p. 80 [**Ancyloceras bipunctatum* SCHLÜTER, 1872, p. 98; OD]. Differs from open-whorled, distant-ribbed species of *Neoglyptoxoceras* in its bituberculate periphery. *Upper Cretaceous (Campanian):* Europe, Angola, South Africa (Zululand).——FIG. 194,*4.* **N. bipunctatum* (SCHLÜTER), Germany; ×0.75 (Schlüter, 1871–1876).

Smedaliceras K. YOUNG, 1963, p. 47 [**S. durhami;* OD]. Coiling ?crioconic; ribs fairly sharp, dense, periodically with midlateral bulla and siphonal node, not necessarily on same rib. Suture simplified. *Upper Cretaceous (Lower Campanian):* Texas.——FIG. 194,*5a–d.* **S. durhami;* ×1 (K. Young, 1963).

Chesapeakella KENNEDY & COBBAN, 1993b, p. 884 [**C. nodatum;* OD]. Probably open criocone or low, open helix; with distant ribs bearing a bullate siphonal tubercle. *Upper Cretaceous (Lower Campanian):* Delaware.

Diplomoceras HYATT, 1900, p. 571 [**Baculites cylindracea* DEFRANCE, 1816, p. 160; OD] [=*Eudiplomoceras* BRUNNSCHWEILER, 1966, p. 18 (type, *E. raggatti;* OD)]. Loose, helicoid spire at least in some specimens, followed by 2 or 3 subparallel, straight or curved shafts or crioconic whorls; section circular to oval; ribs fine, dense, rather subdued, and single, weaker on inside than outside of shell; collared constriction at aperture. Suture very florid. *Upper Cretaceous (Campanian–Upper Maastrichtian):* Europe, South Africa (Zululand), Madagascar, southern India, Japan, New Zealand, Alaska, British Columbia, Antarctica (Graham Land).——FIG. 195,*3a,b. D. notabile* WHITEAVES, Campanian, British Columbia; *a,* ×0.5; *b,* ×1 (Usher, 1952).

Exiteloceras HYATT, 1894, p. 576 [**Ancyloceras jenneyi* WHITFIELD, 1880, p. 452; SD DIENER, 1925, p. 88] [=*Axonoceras* STEPHENSON, 1941, p. 422 (type, *A. compressum;* OD); *Exicrioceras* ANDERSON, 1958, p. 207 (type, *E. ortigalitense;* OD)]. Coiling more or less elliptical, almost in one plane, at least until beginning of U-shaped body chamber; whorl section oval to trapezoidal; ribs simple at first, later some branching, looped or intercalated, all or some with ventrolateral spines. [*Axonoceras* was based on inner whorls or juveniles.] *Upper Cretaceous (Campanian):* Israel, Angola, Delaware, North Dakota, Texas, Colombia.——FIG. 195,*1a–d.* **E. jenneyi* (WHITFIELD), North Dakota; *a,b,* ×0.5; *c,* ×2 (Whitfield, 1880); *d,* restored, ×0.5 (Scott & Cobban, 1965).——FIG. 195,*1e,f. E.* sp., Texas; ×1.5 (Stephenson, 1941).

Neocrioceras SPATH, 1921b, p. 51 [**Crioceras spinigerum* JIMBO, 1894, p. 38(184); OD (as "*Neocrioceras* cf. *spinigerum* Jimbo sp.")] [=*Cyrtohamites* SHIMIZU, 1933, p. 14, obj.]. Initially ?helicoid, then more or less crioconic, and finally gently arcuate; section circular to depressed; ribs dense, rather prorsiradiate, some with lateral and ventrolateral tubercles, the latter opposite or alternating on venter; ribs commonly looped between tubercles. *Upper Cretaceous (Middle Turonian–Campanian):* Spain, Austria, ?South Africa (Pondoland), Japan.——FIG. 195,*2a–c.* **N. spinigerum* (JIMBO), Santonian, Japan; *a,b,* ×1; *c,* enlarged (Shimizu, 1933).

Subfamily POLYPTYCHOCERATINAE Matsumoto, 1938

[*nom. transl.* WIEDMANN, 1962a, p. 185, *ex* Polyptychoceratidae MATSUMOTO, 1938b, p. 193]

Tending to planispiral coiling, mostly with one or more straight shafts after initial

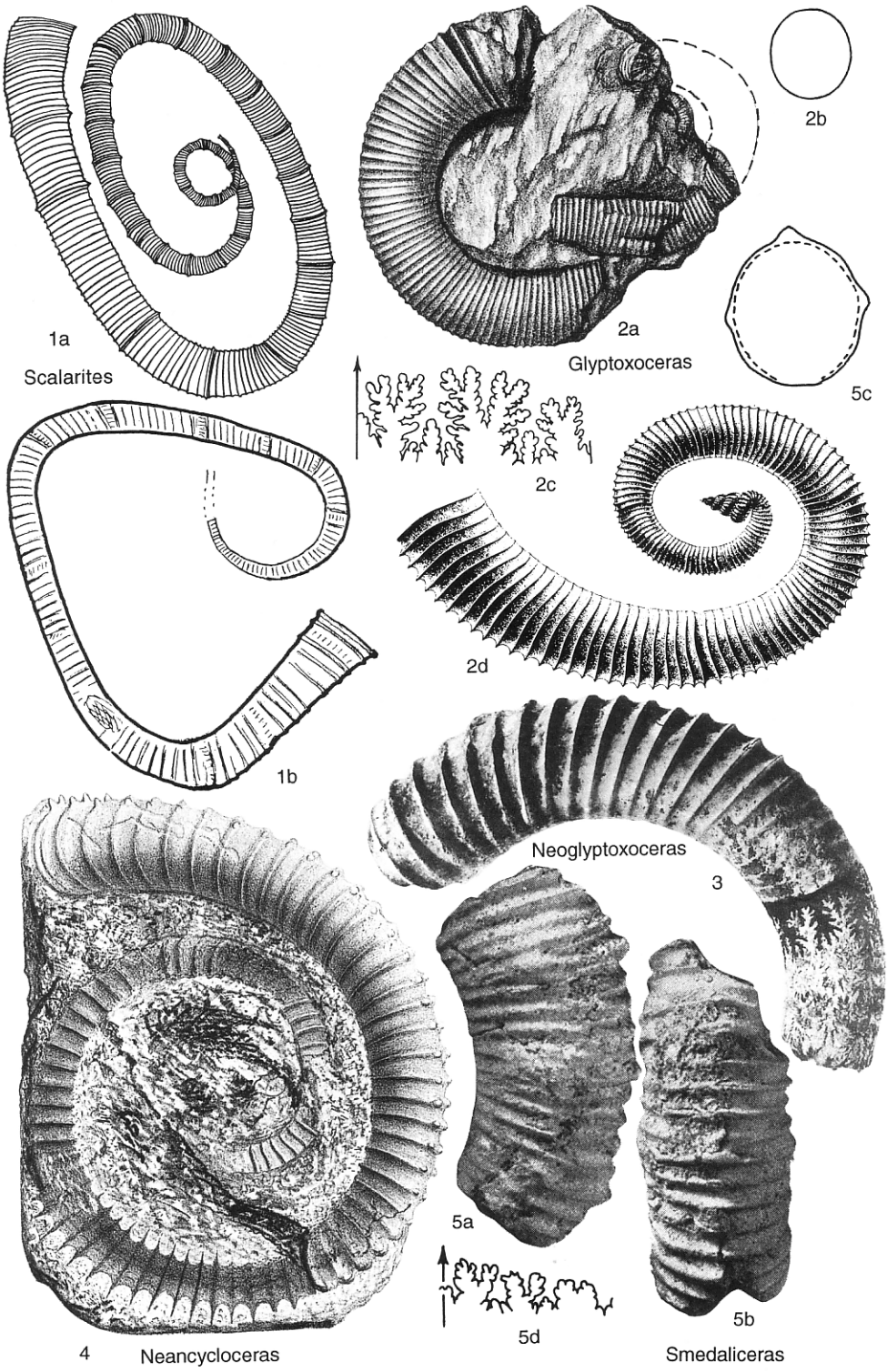


FIG. 194. Diplomoceratidae (p. 250)

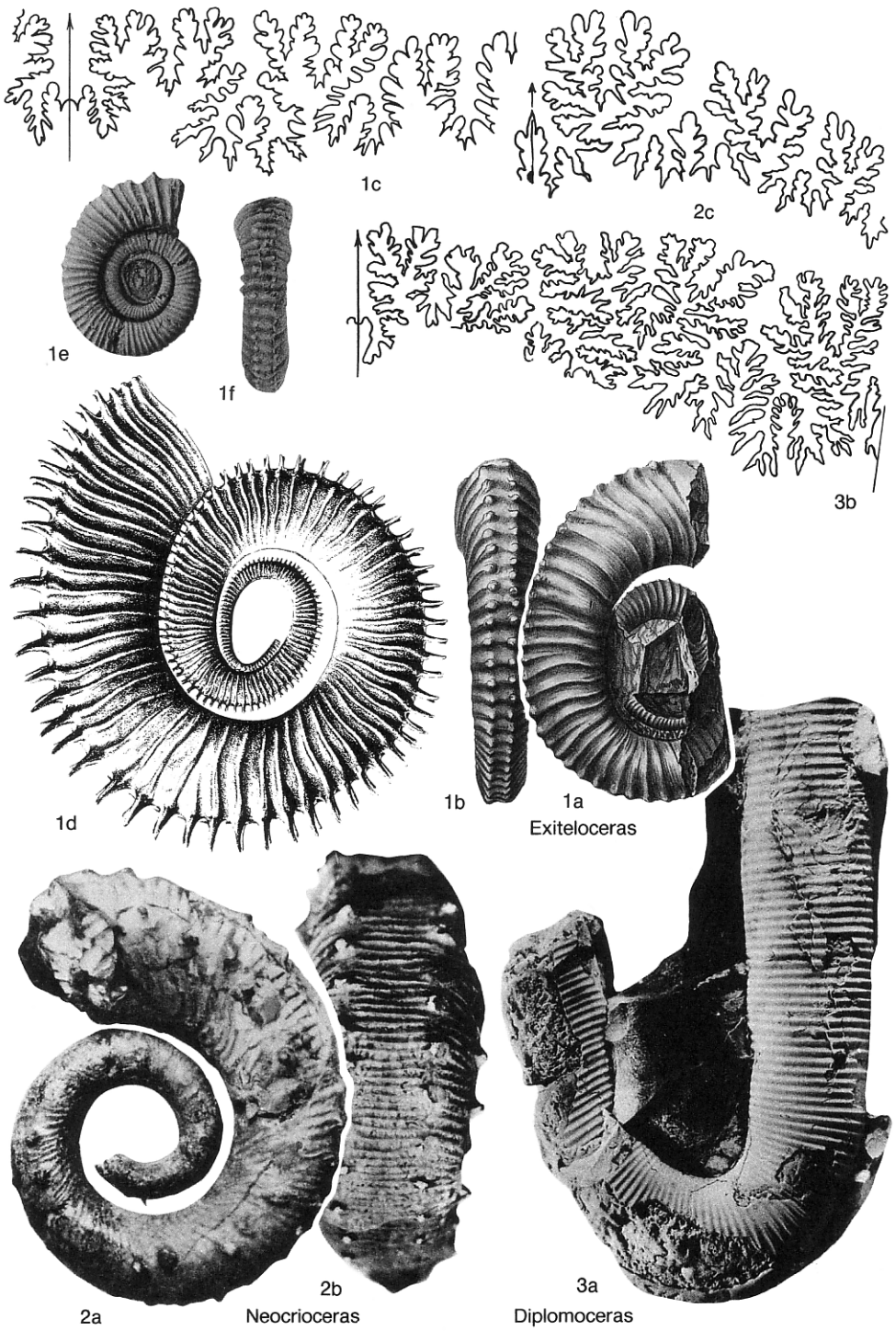


FIG. 195. Diplomoceratidae (p. 250)

curved part; suture tending to simplify. Perhaps derived from *Hyphantoceras,* but some forms resemble *Anisoceras* or *Idiohamites* in some features. *Upper Cretaceous (Upper Turonian–Upper Maastrichtian).*

Pseudoxybeloceras WRIGHT & MATSUMOTO, 1954, p. 119 (MATSUMOTO, 1938b, p. 193, *nom. nud.*) [**Hamites quadrinodosus* JIMBO, 1894, p. 39(185); OD]. Early part variable, then coiled in one plane with up to 5 subparallel, slightly curved to straight, close or distant shafts; ribs fine to rather coarse, radial or prorsiradiate, with outer and sometimes inner ventrolateral spines on all or some ribs; periodic ribs may be differentiated or enlarged. *Upper Cretaceous (Upper Turonian–Upper Campanian):* Europe, South Africa, Madagascar, Japan, Sakhalin, New Zealand, British Columbia, Washington, California.

P. (**Schlueterella**) WIEDMANN, 1962a, p. 205 [**Ancyloceras pseudoarmatum* SCHLÜTER, 1872, p. 99; OD] [=*Christophoceras* COLLIGNON, 1969, p. 47 (type, *C. ramboulai;* OD); *Kawashitaceras* MATSUMOTO, 1984c, p. 341 (type, *Neocrioceras dentatum* MATSUMOTO & OBATA, 1981, p. 115; OD)]. Periodic ribs enlarged, looped between inner and outer ventrolateral spines and across venter; spines sometimes present on intermediate ribs. [*Kawashitaceras* differs only in having the tubercles clavate and denticulate on top.] *Upper Cretaceous (Upper Turonian–Middle Campanian):* England, ?France, ?Sweden, Spain, Germany, Poland, Austria, Romania, South Africa (Zululand), Madagascar, Japan.——FIG. 196,*1a,b.* **P. (S.) pseudoarmatum* (SCHLÜTER), Campanian, Germany; ×0.5 (Schlüter, 1872). ——FIG. 196,*1c,d.* *P. (S.) ramboulai,* Lower Campanian, Madagascar; ×0.5 (Collignon, 1969).

P. (**Pseudoxybeloceras**). Ribs uniform; inner and outer ventrolateral spines on all ribs. *Upper Cretaceous (Upper Turonian–Campanian):* Austria, Romania, South Africa (Zululand, Pondoland), Japan, Sakhalin, New Zealand.——FIG. 196,*2a–d.* **P. (P.) quadrinodosum* (JIMBO), Campanian, Japan; *a,b,* diagrammatic, ×0.5 (Wright & Matsumoto, 1954); *c,d,* Upper Campanian, Romania; ×0.5 (Szász, 1974).

P. (**Parasolenoceras**) COLLIGNON, 1969, p. 44 [**Parasolenoceras splendens;* OD] [=*Cyphoceras* WARD & MALLORY, 1977, p. 611 (type, *Ancyloceras? lineatum* GABB, 1869, p. 139; OD)]. All ribs with outer ventrolateral tubercles only, but there may be slight swellings at inner ventrolateral position; several ribs may be united at slightly enlarged ventrolateral spine, but ribs are not markedly enlarged. *Upper Cretaceous (Coniacian–Upper Campanian):* Ireland, France, Germany, Austria, Madagascar, Japan, New Zealand, British Columbia, Washington, California.——FIG. 196,*4a,b.* **P. (P.) splendens,* Campanian, Madagascar; ×0.5 (Collignon, 1969).——FIG. 196,*4c.* *P. (P.) nanaimoense* (WARD & MALLORY), Campanian, British Columbia; restored, ×0.5 (Ward & Mallory, 1977).

P. (**Lewyites**) MATSUMOTO & MIYAUCHI in MATSUMOTO, 1984a, p. 64 [**Idiohamites(?) oronensis* LEWY, 1969, p. 127; OD]. With ventrolateral tubercles on periodic ribs, which may be bundled at the tubercles. Homeomorph of *Idiohamites. Upper Cretaceous (Campanian):* Israel, Texas.——FIG. 196,*3.* **P. (L.) oronensis* (LEWY), Israel; ×0.7 (Lewy, 1969; courtesy of Laser Pages Publishing, Ltd.).

Polyptychoceras YABE, 1927, p. 44 [**Ptychoceras pseudogaultinum* YOKOYAMA, 1890, p. 181; OD]. Typically with 3 parallel shafts, touching in some, followed by more or less open hook; ribs oblique, nontuberculate on first shaft, later tending to become radial; constrictions on first and in some on later shafts. Suture simple, with rather long, bifid elements, except for trifid I. *Upper Cretaceous (Coniacian–Campanian):* Spain, Germany, Austria, southern India, Japan, British Columbia, Argentina.

P. (**Polyptychoceras**) [=*Dihamites* MATSUMOTO, 1977, p. 354 (type, *D. obiriaensis;* OD); *Heteroptychoceras* MATSUMOTO, 1977, p. 356 (type, *H. obatai;* OD)]. Ribs remaining simple and sharp throughout. [*Dihamites* and *Heteroptychoceras* seem to be members of this subgenus with aberrant coiling.] Occurrence and distribution as for genus.——FIG. 197,*3a–d.* **P. (P.) pseudogaultinum* (YOKOYAMA), Santonian, Japan; *a,c,d,* ×1; *b,* enlarged (Yokoyama, 1890).——FIG. 197,*3e.* *P. (P.) obstrictum* (JIMBO), Santonian, Japan; diagrammatic, ×0.5 (Wright & Matsumoto, 1954).

P. (**Subptychoceras**) SHIMIZU, 1935a, p. 180 [**Hamites (Polyptychoceras) yubarensis* YABE, 1927, p. 44; OD]. Ribs on last 2 shafts and hook in groups on broad, low bulges. *Upper Cretaceous (Campanian):* Japan, British Columbia.——FIG. 197,*5.* **P. (S.) yubarense* (YABE), Campanian, British Columbia, Japan; diagrammatic, ×0.4 (Wright & Matsumoto, 1954).

P. (**Phylloptychoceras**) SPATH, 1953, p. 16 [**Ptychoceras sipho* FORBES, 1846, p. 118; OD] [=*Neocyrtochilus* ANDERSON, 1958, p. 189 (type, *N. bryani;* OD)]. Ribs blunt and distant on last shaft, grading to striae on hook. Suture with slightly phylloid folioles. *Upper Cretaceous (Campanian):* southern India, California, Chile.——FIG. 197,*6a–c.* **P. (P.) sipho* (FORBES), southern India; *a,b,* ×0.5 (Howarth, 1965); *c,* enlarged (Stoliczka, 1863–1866).

Cyrtoptychoceras KENNEDY & HENDERSON, 1992b, p. 710 [**Hamites undulatus* FORBES, 1846, p. 118; OD]. Apparently consisting of single, feebly curved shaft, but initial part unknown; ribbing and aperture as in *Polyptychoceras (Phylloptychoceras),* from which it was probably derived. *Upper Cretaceous (Upper Maastrichtian):* southern India.

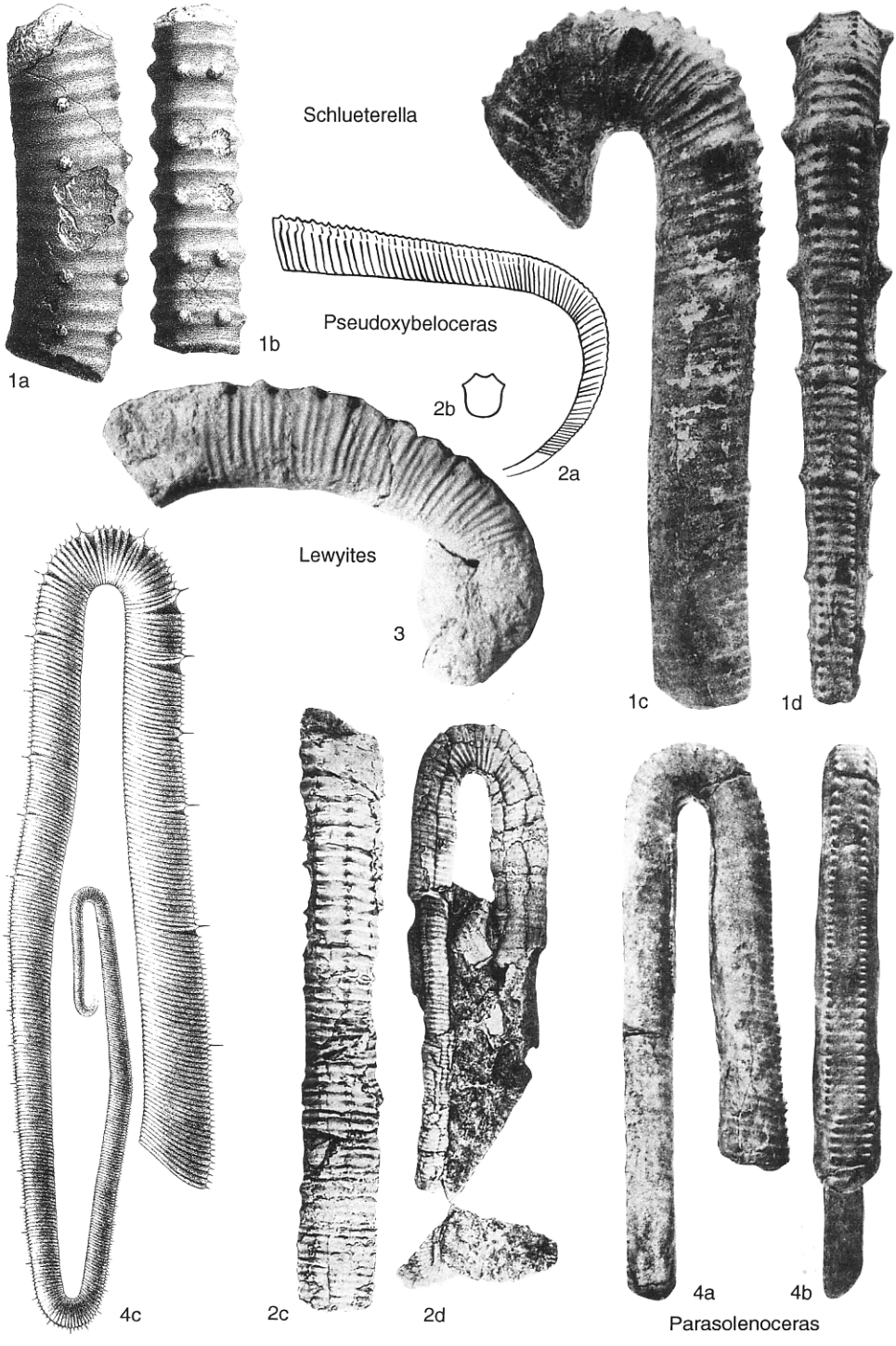


FIG. 196. Diplomoceratidae (p. 253)

Rhyoptychoceras MATSUMOTO, 1977, p. 352 [**R. mikasaense;* OD]. Coiling a unique form of twisted ptychoceratoid; ornament as in *Scalarites. Upper Cretaceous (Coniacian):* Japan.——FIG. 197,*1a–d.* **R. mikasaense; a–c,* ×1; *d,* ×2 (Matsumoto, 1977).

Ryugasella WRIGHT & MATSUMOTO, 1954, p. 122 (MATSUMOTO, 1942b, p. 167, *nom. nud.*) [**R. ryugasensis;* OD]. Broadly curved at first, then straight, and finally with short hook; with dense, annular, prorsiradiate, nontuberculate ribs and few, oblique constrictions. *Upper Cretaceous (?Upper Turonian, Santonian–Campanian):* Japan, Sakhalin, Antarctica (Graham Land).——FIG. 197,*4a,b.* **R. ryugasensis,* Campanian, Sakhalin; *a,* ×0.75; *b,* enlarged (Wright & Matsumoto, 1954).

Astreptoceras HENDERSON, 1970, p. 28 [**Ptychoceras zelandicum* MARSHALL, 1926, p. 157; OD]. Straight fragments alone known; subcircular in section, with strong, oblique constrictions; smooth at first, later with weak ribs. Suture simple, with all elements bifid. *Upper Cretaceous (Campanian):* New Zealand.——FIG. 197,*8a,b.* **A. zelandicum* (MARSHALL); *a,* ×2, *b,* ×5 (Henderson, 1970).

Masonites HENDERSON, 1970, p. 29 [**M. biannulatus;* OD]. Straight at first, then an open, elliptical planispire; section more or less circular; dense, fine, annular ribs and frequent, collared constrictions. Suture with very simple, short, square, bifid elements. *Upper Cretaceous (Campanian):* New Zealand.——FIG. 197,*7a,b.* **M. biannulatus; a,* ×2, *b,* ×7 (Henderson, 1970).

Solenoceras CONRAD, 1860, p. 284 [**Hamites annulifer* MORTON, 1842, p. 213; OD] [=*Oxybeloceras* HYATT, 1900, p. 588 (type, *Ptychoceras crassum* WHITFIELD, 1880, p. 459; OD)]. Generally small; initial few spiral whorls followed by 2, straight or slightly curved, parallel shafts; section circular to oval; first shaft normally constricted; aperture constricted and collared; ribs straight, radial or rursiradiate, with small ventrolateral spines; ribs may be weak or interrupted on venter. *Upper Cretaceous (Campanian–Maastrichtian):* northern Europe, Israel, central Asia, Angola, South Africa (Zululand), Madagascar, USA, Antarctica (Graham Land).——FIG. 197,*2a,b. S. multicostatum* (STEPHENSON), Campanian, Texas; ×2 (Stephenson, 1941).

Family BACULITIDAE Gill, 1871

[Baculitidae GILL, 1871, p. 3] [=Eubaculitinae BRUNNSCHWEILER, 1966, p. 4]

Minute initial coil of 1 or 2 whorls followed by straight or slightly curved, single shaft (one genus crioconic); whorl section circular, oval, pear-shaped, or with acute venter; surface smooth or with flexuous striae or ribs, which may be enlarged into tubercles on sides or venter. Aperture of macroconchs oblique and simple; microconchs with or without collar and with large or small lappets. Suture with all elements more or less bifid, except for internal and rarely external lobes; varying in floridity and detail. Rugaptychi present in *Baculites* at least. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Upper Maastrichtian).*

Rather small forms appear in the Upper Albian, probably representing hamitids that have straightened, lost their ribs, and developed oblique apertures, rather than direct descendants of more or less homeomorphous Bochianitidae, which are last known in the Aptian. There is little important change until the Santonian, when some species a meter long or more occur. In the Campanian and Maastrichtian there are forms up to 2 meters long, and the family reaches the maximum of its limited diversity. Baculitids of all ontogenetic stages are commonly found in very large numbers. NOWAK, 1908; SPATH, 1926a, 1941.

Lechites NOWAK, 1908, p. 350 [**Baculites gaudini* PICTET & CAMPICHE, 1861, p. 112; OD]. Section circular or oval; no distinct constrictions; ribs low, prorsiradiate, close or distant, regular or not, generally single, may be grouped in twos and threes or even amalgamated to form scalelike swellings; with ventrolateral tubercles in some; aperture faces dorsum with slight collar and constriction. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Lower Cenomanian):* Europe, northern Africa, South Africa (Zululand), Madagascar, southern India, Japan, Mexico.

L. **(Lechites).** Without tubercles. Occurrence and distribution as for genus.——FIG. 198,*3a–e.* **L. (L.) gaudini* (PICTET & CAMPICHE), Upper Albian, England; *a–c,* ×1 (Spath, 1941); *d,e,* ×1 (Cooper & Kennedy, 1977).

L. **(Tuberolechites)** COOPER & KENNEDY, 1977, p. 654 [**L. (T.) regifex;* OD]. Ventrolateral tubercles on every rib. *Lower Cretaceous (Upper Albian):* England.——FIG. 198,*4a,b.* **L. (T.) regifex;* ×1 (Cooper & Kennedy, 1977).

Sciponoceras HYATT, 1894, p. 578 [**Hamites baculoides* MANTELL, 1822, p. 123; OD] [=*Cyrtochilus* MEEK, 1876, p. 392, *non* JAKOWLEW, 1875, p. 252, obj.; *Cyrtochilella* STRAND, 1929, p. 8, obj.]. With strong, prorsiradiate constrictions; with or without ribs on phragmocone, but ribs generally present on body chamber; aperture differing from that of *Lechites* in having strong folds and high collar. Suture more finely divided than in *Lechites.* In latest species ribs are rursiradiate on inner one-third and prorsiradiate on outer two-thirds, with faint

tubercle at bend, thus foreshadowing *Baculites*. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Upper Turonian):* Europe, northern Africa, Madagascar, southern India, USA, Argentina.——FIG. 198,*2a–c*. **S. baculoides* (MANTELL), Cenomanian, England; *a,* lateral view of body chamber, venter to right, ×1 (Crick, 1896); *b,c,* ×0.75 (Kennedy, 1971).

Baculites LAMARCK, 1799, p. 80 [**Baculites vertebralis* LAMARCK, 1801, p. 103; SD MEEK, 1876, p. 391]

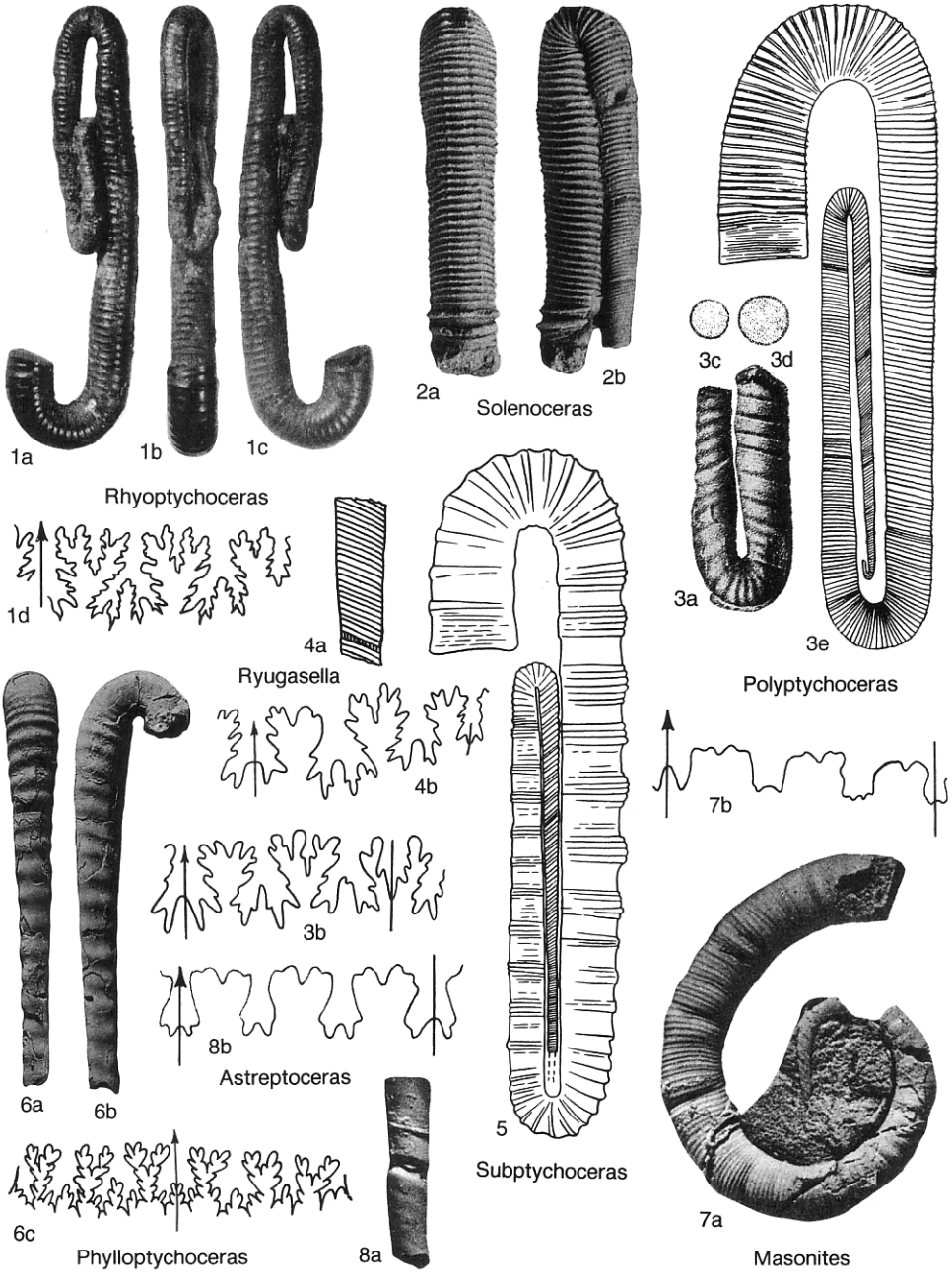


FIG. 197. Diplomoceratidae (p. 253–255)

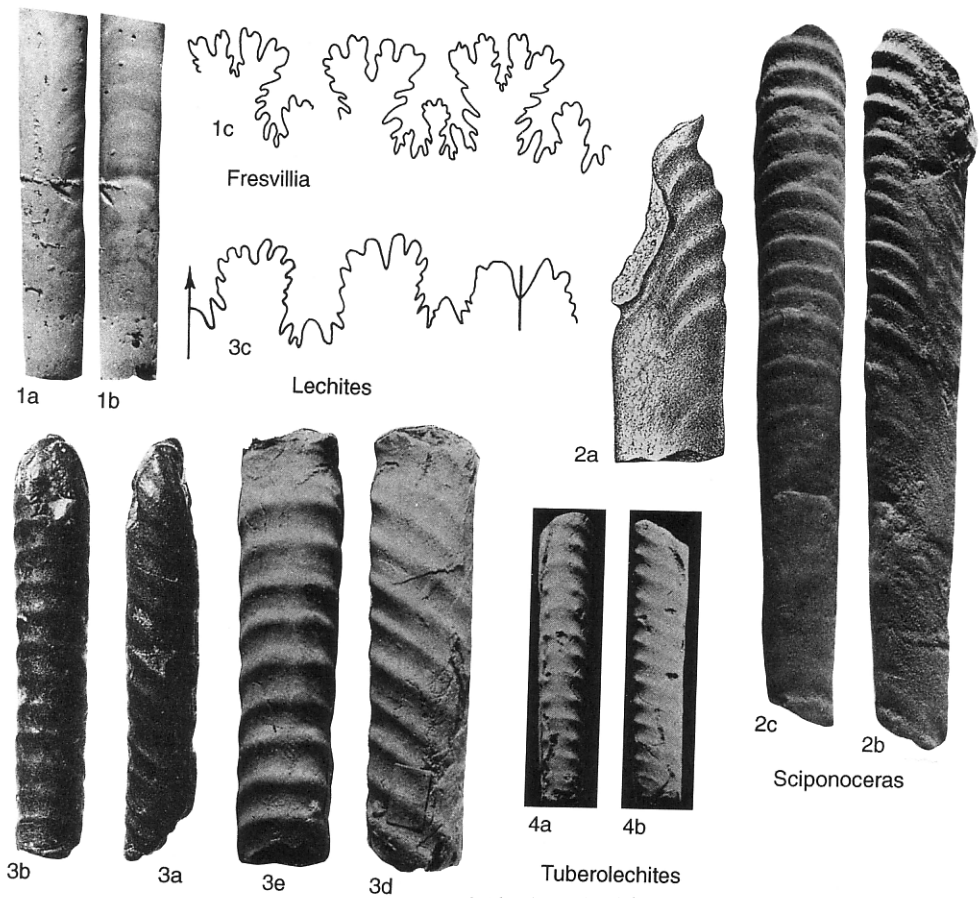


FIG. 198. Baculitidae (p. 255–258)

[=*Homaloceratites* HUPSCH, 1768, p. 110, *non binom.; Euhomaloceras* SPATH, 1926a, p. 80 (type, *Baculites incurvatus* DUJARDIN, 1837, p. 232; OD)]. Shell straight to slightly curved, up to 2 meters long; smooth or with sinuous lirae or weak ribs rursiradiate on inner part of side and prorsiradiate on outer part; in some species with crescentic bulla or large, rounded tubercle at bend in the ribs; no constrictions. Suture more florid than in *Sciponoceras. Upper Cretaceous (Upper Turonian–Upper Maastrichtian):* worldwide.——FIG. 199,*3a–c. *B. vertebralis,* Maastrichtian, The Netherlands; *a,b,* ×1; *c,* enlarged (Binkhorst, 1861).——FIG. 199,*3d,e. B. incurvatus* DUJARDIN, Santonian, France; ×0.75 (Orbigny, 1840–1842).

Pseudobaculites COBBAN, 1952b, p. 759 [**P. nodosus;* OD]. Differs from *Baculites* in its more rapidly expanding section and broad, much divided, asymmetric saddles. *Upper Cretaceous (Coniacian):* Wyoming, Utah.——FIG. 199,*2. *P. nodosus,* Wyoming; ×2 (Cobban, 1952b).

Eubaculites SPATH, 1926a, p. 80 [**Baculites vagina ootacodensis* STOLICZKA, 1866, p. 199; OD] [=*Giralites* BRUNNSCHWEILER, 1966, p. 33 (type, *G. latecarinatus;* OD); *Eubaculiceras* BRUNNSCHWEILER, 1966, p. 36 (type, *E. compressum;* OD); *Cardabites* BRUNNSCHWEILER, 1966, p. 38 (type, *C. tabulatus;* OD)]. Straight or slightly curved; section pear-shaped; venter fastigiate or with tabulate keel from varying stage and smooth, ribbed, or crenulate; sides smooth or with ribs normally faint toward venter but stronger on inner part; ribs may form long, curved bullae; row of inner lateral tubercles may occur. Suture with plump, minutely frilled elements. [Minute differences in suture of *Giralites, Eubaculiceras,* and *Cardabites* do not justify generic splitting.] *Upper Cretaceous (?Upper Campanian, Maastrichtian):* The Netherlands, France, Austria, Mozambique, South Africa (Zululand), Madagascar, southern India, Western Australia, Japan, British Columbia, USA, Chile, Argentina.——FIG. 199,*1a,b. *E. ootacodensis* (STOLICZKA), Lower Maastrichtian, southern India; ×0.5 (Kossmat, 1895).——FIG. 199,*1c. E. vagina* (FORBES), Lower Maastrichtian, southern India; *c,* ×1 (Kossmat, 1895).

Fresvillia KENNEDY, 1986b, p. 61 [**F. constricta;* OD]. Whorl section circular; with constrictions, strongest on venter; feeble ribbing and growth lines strongly prorsiradiate. *Upper Cretaceous (Lower Maastrichtian–Upper Maastrichtian):* France, southern India, Alaska, California, ?Western Australia.——FIG. 198,*1a–c.* **F. constricta,* Upper Maastrichtian, France; *a,b,* ×1; *c,* enlarged (Kennedy, 1986b).

Boehmoceras RIEDEL, 1931, p. 690 [**Ancyloceras krekeleri* WEGNER, 1905, p. 210; SD WRIGHT, 1957b, p. 220]. Loose criocone; whorl height increasing rapidly; with straight to strongly curved primary ribs, which may form large bulges, splitting into several secondaries on outer part of sides; keel entire, rounded to serrate. *Upper Cretaceous (Middle Santonian–Upper Santonian):* France, northern Germany, Bornholm, Austria, Texas, Mississippi, Alabama.——FIG. 199,*4a–c.* **B. krekeleri* (WEGNER), Upper Santonian, northern Germany; *a,* ×1; *b,c,* enlarged (Summesburger, 1979).——FIG. 199,*4d. B. loescheri* RIEDEL, Upper Santonian, Austria; ×1 (Summesburger, 1979).

Superfamily SCAPHITACEAE Gill, 1871

[*nom. transl.* WRIGHT & WRIGHT, 1951, p. 13, *ex* Scaphitidae GILL, 1871, p. 3]

Coiled in loose or tight, plane spiral followed by long or short shaft and terminal hook, but shaft tending to shorten and hook may wrap around spire. Ornament varying, from almost none to strong ribs and numerous rows of tubercles. Suture initially quinquelobate followed by quadrilobate, but in later genera one or more auxiliary lobes appearing in saddle U/L (the pseudolobes of WIEDMANN, 1965); L bifid or trifid. Synaptychi have been found in several species. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Maastrichtian).*

Family SCAPHITIDAE Gill, 1871

[Scaphitidae GILL, 1871, p. 3]

Markedly dimorphic; in Otoscaphitinae microconchs have long lateral lappets; in Scaphitinae microconchs lack such lappets. Throughout the family microconchs have the umbilicus less occluded by the inner seam of the shaft than macroconchs. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Maastrichtian).*

Macroconchs of Otoscaphitinae became increasingly involute with time and those of late members are indistinguishable in characters of generic significance from those of contemporary and earlier Scaphitinae. It therefore seems more probable that basal Upper Albian Scaphitinae diverged from early Otoscaphitinae than that the two stocks had independent origins as held by WIEDMANN (1965).

Subfamily OTOSCAPHITINAE Wright, 1953

[Otoscaphitinae WRIGHT, 1953, p. 474 (Name retained under ICZN Article 40, although *Otoscaphites* is synonym of *Yezoites*)] [=Worthoceratidae MATSUMOTO in MATSUMOTO & YOKOI, 1987, p. 45]

Small; spire generally evolute except in some late macroconchs; umbilicus of macroconchs not concealed by beginning of shaft in early forms but increasingly concealed in later forms; shaft very to moderately long; ornament commonly weaker than in contemporary Scaphitinae. Macroconchs with simple aperture, constricted in some; microconchs with longer shafts, less inflated body chambers, and long lappets. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Santonian or Campanian).*

Worthoceras ADKINS, 1928, p. 218 [**Macroscaphites platydorsus* SCOTT, 1924, p. 18; OD]. Small; with very evolute spire, long, straight shaft, and terminal hook; microconchs with long lappets on aperture and with whorl section of shaft and hook hardly expanding; macroconchs with simple aperture and whorl section expanding noticeably; generally smooth or with fine lirae, rarely with distinct ribs. Suture with generally bifid saddles; lobes very simple, trifid or merely pointed in early forms, tending to become bifid in later forms; saddle U/L not markedly enlarged and no auxiliary lobe. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Upper Turonian):* western and central Europe, northern Africa, New Zealand, Texas.——FIG. 200*a,b.* **W. platydorsum* (SCOTT), holotype, ?macroconch, Upper Albian, Texas; *a,* ×5 (Scott, 1924); *b,* ×10 (Adkins, 1928).——FIG. 200*c–f. W. vermiculus* (SHUMARD), Upper Cenomanian, Texas; *c,* microconch, ×2 (new); *d–f,* macroconch, ×2 (Wiedmann, 1965).

Yezoites YABE, 1910, p. 167 [**Scaphites perrini* ANDERSON, 1902, p. 114; SD DIENER, 1925, p. 213] [=*Otoscaphites* WRIGHT, 1953, p. 475 (type, *Ammonites? bladenensis* SCHLÜTER, 1871, p. 30; OD); *Hyposcaphites* WIEDMANN, 1965, p. 436 (type, *Scaphites stephanoceroides* YABE, 1909, p. 442; =?*S. perrini* ANDERSON)]. Whorl section compressed to inflated, even coronate; almost smooth to strongly

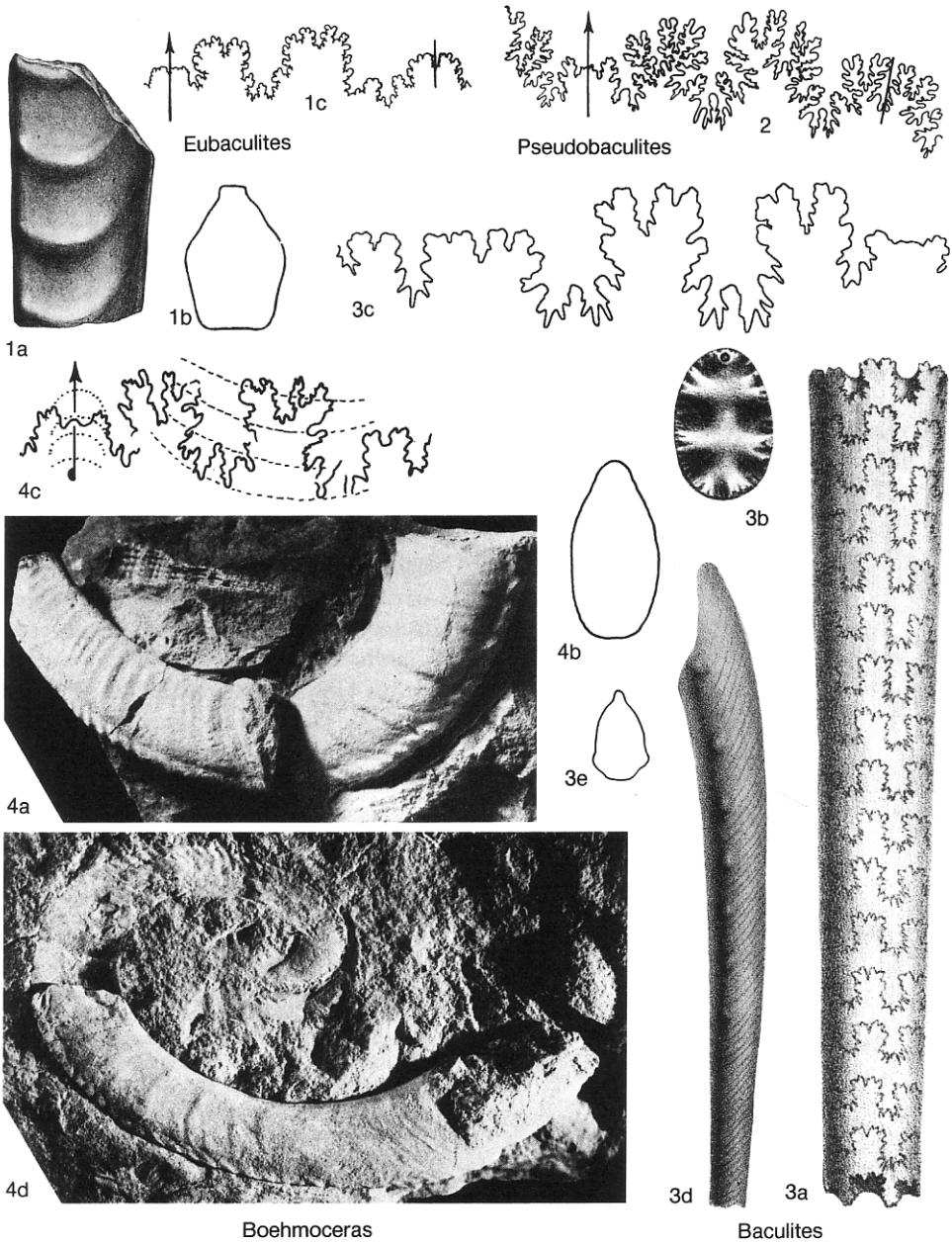


FIG. 199. Baculitidae (p. 256–258)

ribbed, with or without midlateral or ventrolateral tubercles; ribs commonly convex. Macroconchs with more or less straight inner margin on shaft, occluding umbilicus only slightly to largely; aperture with slight to strong constriction and collar. Microconchs with inner margin of shaft nearly straight to well curved, not occluding the umbilicus; aperture constricted and collared with long lappets. Suture with elements more incised than in *Worthoceras;* L irregularly bifid; saddle U/L wide and becoming subdivided by auxiliary lobe. *Upper Cretaceous (Lower Cenomanian–Santonian):* Europe, South Africa, Japan, New Zealand, Alaska, Oregon, California, Texas, Montana, Mexico.——FIG. 201*a–d.*

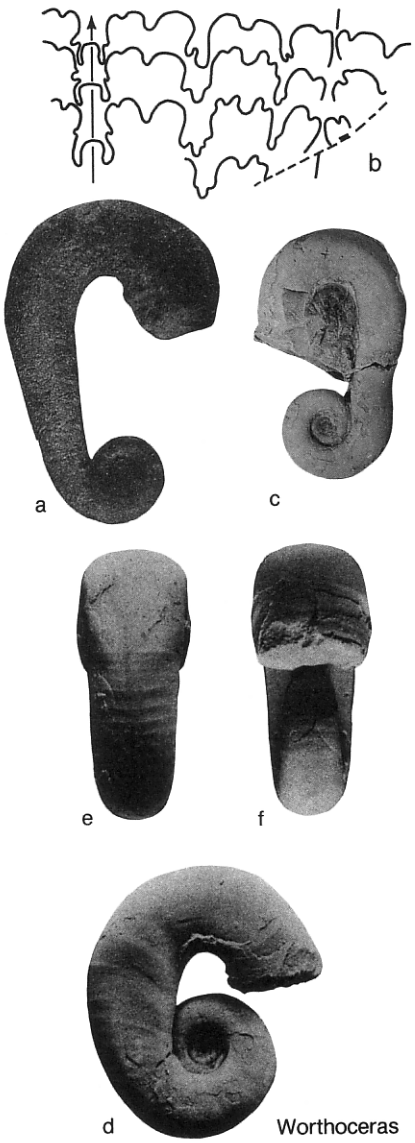


FIG. 200. Scaphitidae (p. 258)

Y. seabeensis (COBBAN & GRYC), Lower Turonian, Alaska; *a,b,* macroconch, ×1; *c,d,* microconch, ×1 (Cobban & Gryc, 1961).——FIG. 201*e–h. Y. puerculus* (JIMBO), Upper Turonian, Japan; *e,f,* macroconch, ×2; *g,h,* microconch, ×2 (Tanabe, 1977).——FIG. 201*i–k. Y. bladenensis* (SCHLÜTER), Upper Turonian; *i,* Germany, enlarged, ×2 (Wiedmann, 1965); *j,k,* England, microconch, ×2 (new).——FIG. 201,*l. Y. stephanoceroides* (YABE), Upper Turonian, Japan; holotype, ×1 (Jimbo, 1894).

Eorhaeboceras ALABUSHEV, 1989, p. 39 [**E. derivatum;* OD]. Based on small, incomplete specimens like *Yezoites;* distinction uncertain. *Upper Cretaceous (Santonian or Campanian):* Kamchatka.

Subfamily SCAPHITINAE Gill, 1871

[*nom. transl.* WRIGHT, 1953, p. 473, *ex* Scaphitidae GILL, 1871, p. 3]

Microconchs without lappets or with dorsal lappet only; inner margin of shaft generally concave, not straight or convex, and occluding less of umbilicus than in macroconchs. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Upper Maastrichtian).*

One stock, including *Eoscaphites, Scaphites, Hoploscaphites* and derivatives, originated by the beginning of the Late Albian, probably from early *Worthoceras.* Possibly another originated in North America in early Turonian from inflated *Yezoites* and included many species assigned to *Scaphites, Clioscaphites,* and a group of endemic North American genera. The two stocks, if in fact different, are highly convergent and have not been satisfactorily differentiated.

Eoscaphites BREISTROFFER, 1947b, p. 93(77) [**Ammonites? circularis* J. de C. SOWERBY, 1836, p. 337; OD]. Initial whorls with umbilical perforation; later whorls more involute, followed by shaft and terminal hook; whorl section increasing rapidly; dorsal impression lacking on inner whorls or throughout; ribs fine and dense, single or branching, reclined, strengthening on body chamber; no distinct tubercles. Suture quadrilobate throughout later ontogeny. *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Middle Cenomanian):* England, France, Algeria.——FIG. 202,*1a–c.* **E. circularis* (J. de C. SOWERBY), Upper Albian, England; *a,b,* ×1; *c,* enlarged (Spath, 1923–1943).——FIG. 202,*1d,e. E. subcircularis* (SPATH), Upper Albian, France; ×1 (Wiedmann, 1965).

Scaphites PARKINSON, 1811, p. 145 [**Scaphites equalis* J. SOWERBY, 1813, p. 53; SD MEEK, 1876, p. 413] [=*Anascaphites* HYATT, 1900, p. 572 (type, *S. ventricosus* MEEK & HAYDEN, 1863, p. 22; OD); *Jahnnites* HYATT, 1900, p. 572 (type, *S. geinitzii* var. *binodosus* JAHN, 1891, p. 180, *non S. binodosus* ROEMER, 1841, p. 90; OD); *Holcoscaphites* NOWAK, 1911, p. 564, obj.; *Metascaphites* WIEDMANN, 1962a, p. 212 (type, *Scaphites (?) thomasi* PERVINQUIÈRE, 1907, p. 121; OD)]. Compressed to very inflated; spire more or less involute; early whorls in contact; shaft short to moderately long; hook not curved over spire; aperture constricted

and commonly collared, in some with long dorsal lappet; ribs on spire normally long and short or branching; ribs on shaft single or branching, commonly at ventrolateral tubercles; umbilical and ventrolateral tubercles may be present on shaft and hook. Suture with L initially bifid but becoming asymmetric in Upper Turonian and later trifid; saddle U/L very wide and divided by 1 or more auxiliary lobes (pseudolobes of WIEDMANN). [The holotype of *S. (?) thomasi* PERVINQUIÈRE, type species of *Metascaphites* WIEDMANN, appears to be a fragment of a late form of *S. equalis.*] *Lower Cretaceous (Upper Albian)–Upper Cretaceous (Campanian):* northern hemisphere, Madagascar, Bathurst Island, Australia (Queensland), New Zealand, Argentina.——FIG. 202,*3a–e.* **S. equalis* (J. SOWERBY), Cenomanian, France; *a,b,* macroconch, ×1; *c,* enlarged (Orbigny, 1840–1842); *d,e,* microconch, ×1 (Wiedmann, 1965).

Clioscaphites COBBAN, 1952a, p. 34 [**C. montanensis;* OD]. Very involute, inflated; hook closely pressed to spire. Suture with L more or less trifid. *Upper Cretaceous (Santonian–Campanian):* USA.——FIG. 202,*2a,b. C. vermiformis* (MEEK & HAYDEN), Santonian, Montana; ×1 (Cobban, 1952a).

Desmoscaphites REESIDE, 1927a, p. 16 [**D. bassleri;* OD]. Differs from *Clioscaphites* principally in having inner whorls with strong, rounded ribs and constrictions. *Upper Cretaceous (Upper Santonian–Campanian):* USA.——FIG. 202,*4a–c.* **D. bassleri,* Upper Santonian, Montanta; *a,* ×0.75; *b,* ×1; *c,* enlarged (Reeside, 1927a).

Argentoscaphites BLASCO DE NULLO, NULLO, & PROSERPIO, 1980, p. 477 [**A. mutans, nom. correct.* WRIGHT, herein, *pro mutantibus,* which contravenes ICZN Article 11(g)(i); OD]. Differs from *Scaphites* only in having inner whorls with tabulate venter bounded by slight ventrolateral tubercles. *Upper Cretaceous (Upper Santonian* or *Lower Campanian):* Argentina.——FIG. 203,*2a,b.* **A. mutans;* ×1.1 (Blasco de Nullo, Nullo, & Proserpio, 1980).

Pteroscaphites WRIGHT, 1953, p. 474 [**Scaphites auriculatus* COBBAN, 1952a, p. 30; OD]. Very small; whorl section depressed, coronate, the lateral angles prolonged onto body chamber; aperture with sides and ventral edge normally pinched to form projecting points; ribs prorsiradiate on inner flanks, turning back at the lateral angle. Dimorphic in fashion comparable to that of *Scaphites* and *Clioscaphites* and therefore not microconchs of those genera; probably a series of progenetic dwarf offshoots of successive species of *Scaphites* and *Clioscaphites* (LANDMAN, 1989). *Upper Cretaceous (Upper Turonian–Santonian):* Montana, North Dakota.——FIG. 203,*4a,b.* **P. auriculatus* (COBBAN), Coniacian, Montana; ×4 (new).

Hoploscaphites NOWAK, 1911, p. 565 [**Scaphites constrictus* J. SOWERBY, 1817d, p. 189; SD BIRKELUND, 1965, p. 102] [=*Mesoscaphites* ATABEKIAN, 1979, p. 523 (type, *Scaphites (Hoploscaphites) elatensis* LEWY, 1969, p. 129; OD), *nom. nud.* for lack of differentia; *Jeletzkytes* RICCARDI, 1983, p. 14 (type, *Scaphites (Ammonites?) nodosus* OWEN, 1852, p. 581; OD)]. Compressed with flat sides to inflated with convex sides; venter flat or rounded, generally with strong, clavate or spinate ventrolateral tubercles at least on shaft and hook; shaft normally short. Not readily distinguished from later *Scaphites.* [Separation of the large and inflated species of the *nodosus* group as *Jeletzkytes* seems unnecessary, given the great variation within most

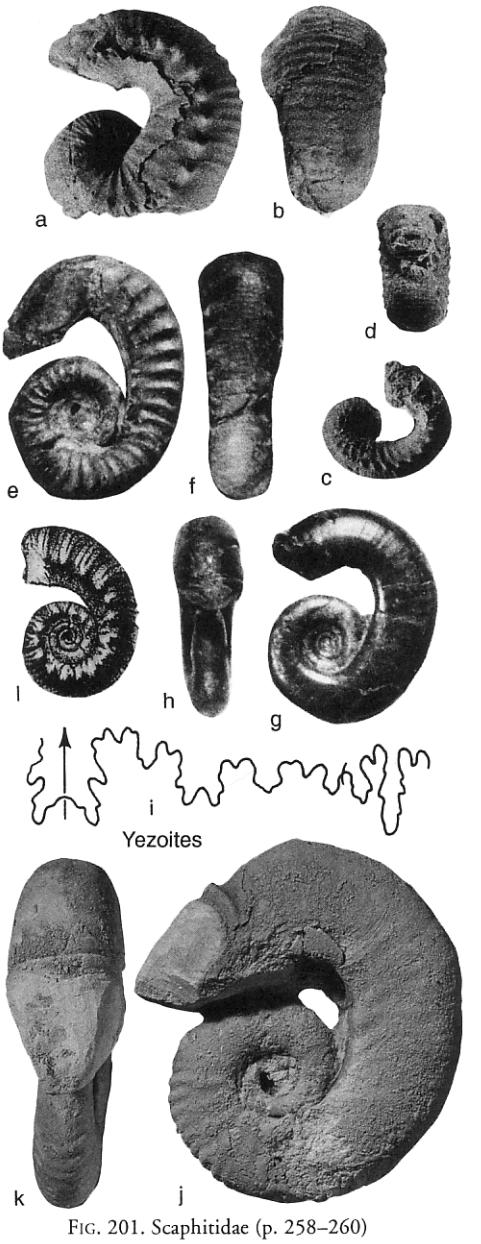


FIG. 201. Scaphitidae (p. 258–260)

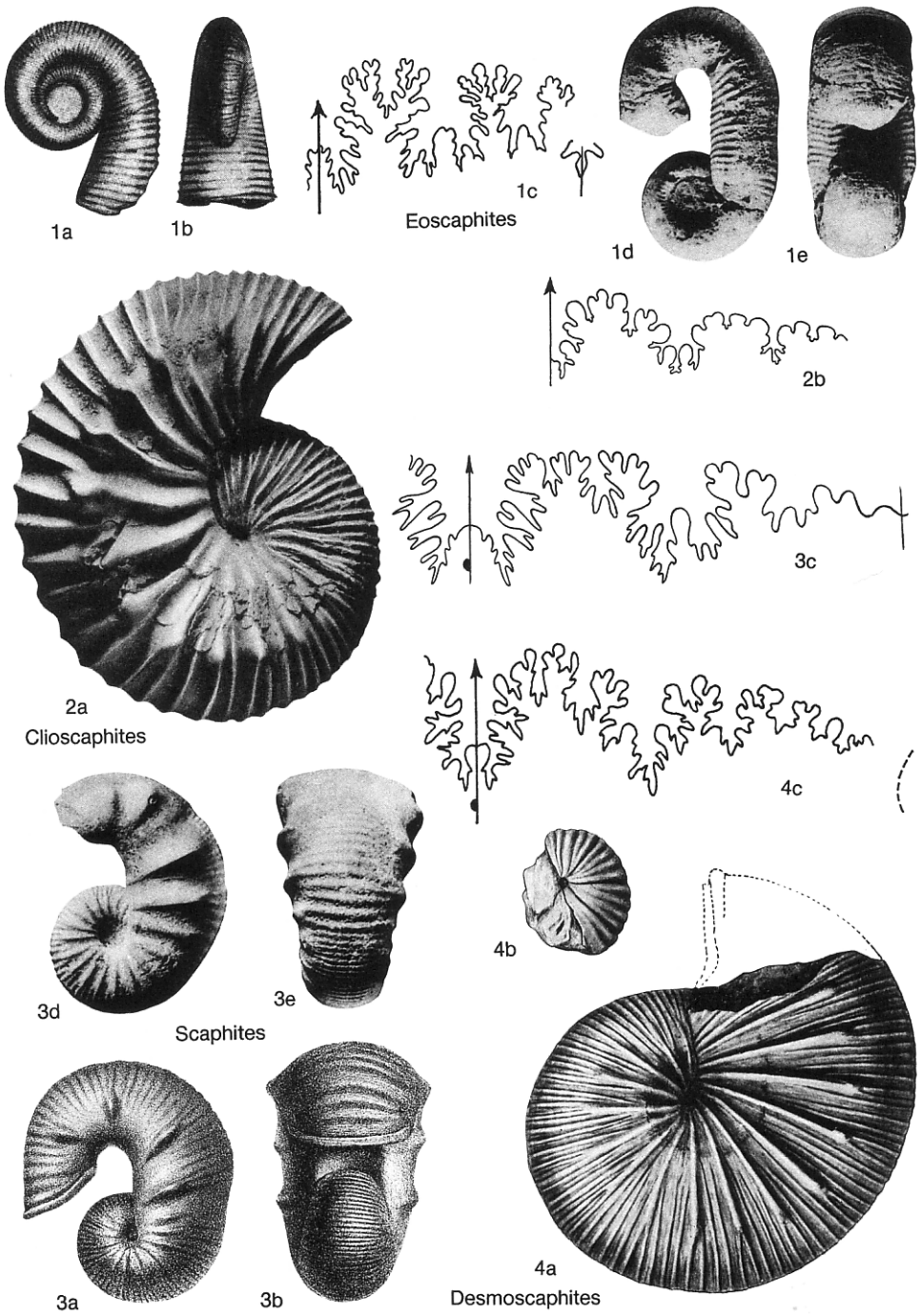


FIG. 202. Scaphitidae (p. 260–261)

scaphitid species.] *Upper Cretaceous (Campanian–Upper Maastrichtian):* Europe, South Africa, Israel, Canada, USA, Chile, Antarctica (Graham Land), Greenland.——FIG. 204,*2a,b.* **H. constrictus* (J. SOWERBY), Maastrichtian, France; *a,* ×1; *b,* enlarged (Orbigny, 1840–1842).

Discoscaphites MEEK, 1871a, p. 429 [**Ammonites conradi* MORTON, 1834, p. 39; OD]. Small to large,

compressed to inflated; shaft distinct and straight to short and curved, embracing the spire; finely or coarsely ribbed; multituberculate on shaft and hook or also on spire. *Upper Cretaceous (Campanian–Maastrichtian):* Belgium, Sweden, central and eastern Europe, northern Africa, Israel, Canada, USA.

D. (Trachyscaphites) Cobban & Scott, 1964, p. 6 [**T. redbirdensis;* OD]. Small to moderate sized; shaft and hook distinct; tubercles aligned or not. *Upper Cretaceous (Campanian):* France, Belgium, Sweden, central and eastern Europe, Israel, central Asia, USA (Western Interior, Texas, New Jersey).——Fig. 204,*1a,b.* **D. (T.) redbirdensis* (Cobban & Scott), Wyoming; ×0.5 (Cobban & Scott, 1964).

D. (Discoscaphites). Small to large; shaft generally embracing spire, with straight or curved inner margin; tubercles always aligned. *Upper Cretaceous (Maastrichtian):* USA.——Fig. 204,*3a–c.* **D. (D.) conradi* (Morton), Alabama; *a,b,* macroconch, ×1; *c,* microconch, ×1 (Jeletzky & Waage, 1978).——Fig. 204,*3d–f. D. (D.) cheyennensis* (Owen), North Dakota; *d,e,* macroconch, ×0.5; *f,* ×1.5 (Meek, 1876).

Acanthoscaphites Nowak, 1911, p. 565 [**Scaphites tridens* Kner, 1850, p. 10; SD Diener, 1925, p. 205]. Large and inflated, with fine ribs and only umbilical tubercles until body chamber, which also has ventrolateral and typically siphonal rows of large, blunt tubercles connected by irregular ribs. *Upper Cretaceous (Campanian):* central and eastern Europe.——Fig. 203,*1a,b.* **A. tridens trispinosus* (Geinitz), Poland; *a,* ×0.5; *b,* ×1 (Nowak, 1911).

Rhaeboceras Meek, 1876, p. 462 [**Phylloceras? halli*

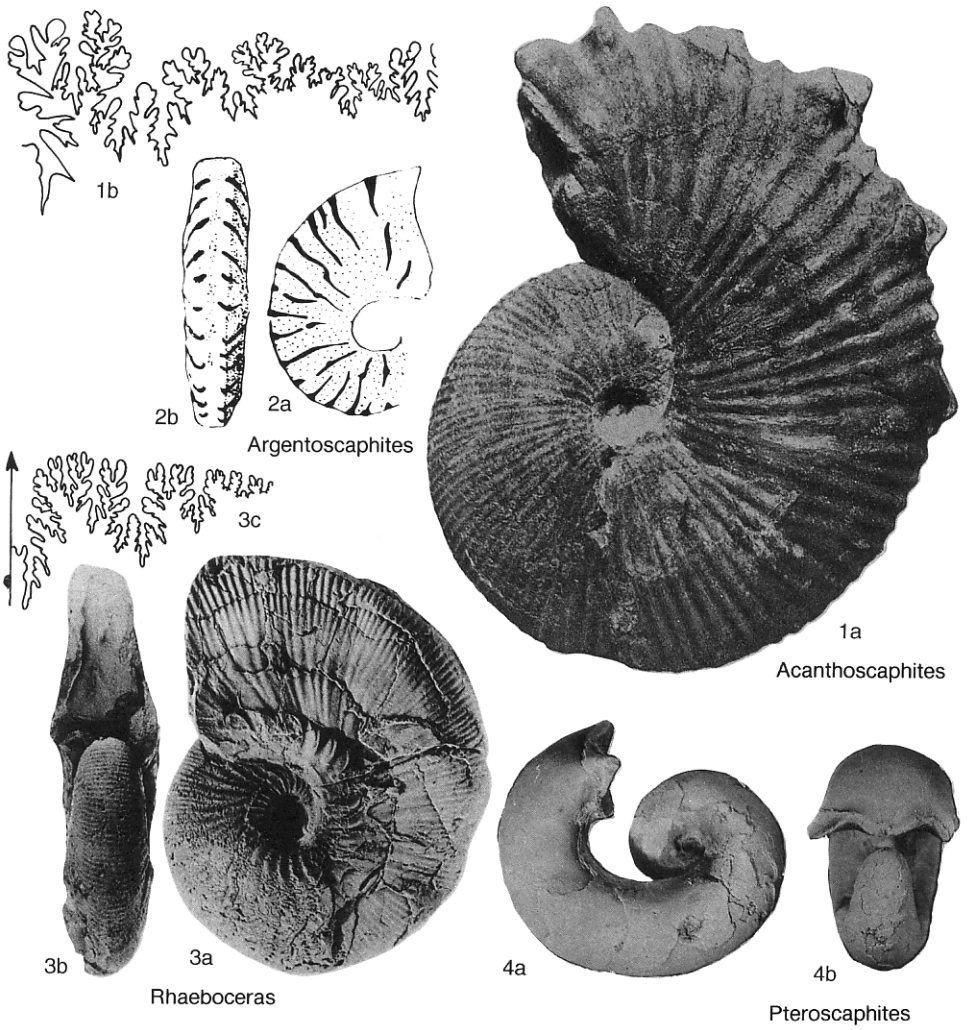


Fig. 203. Scaphitidae (p. 261–265)

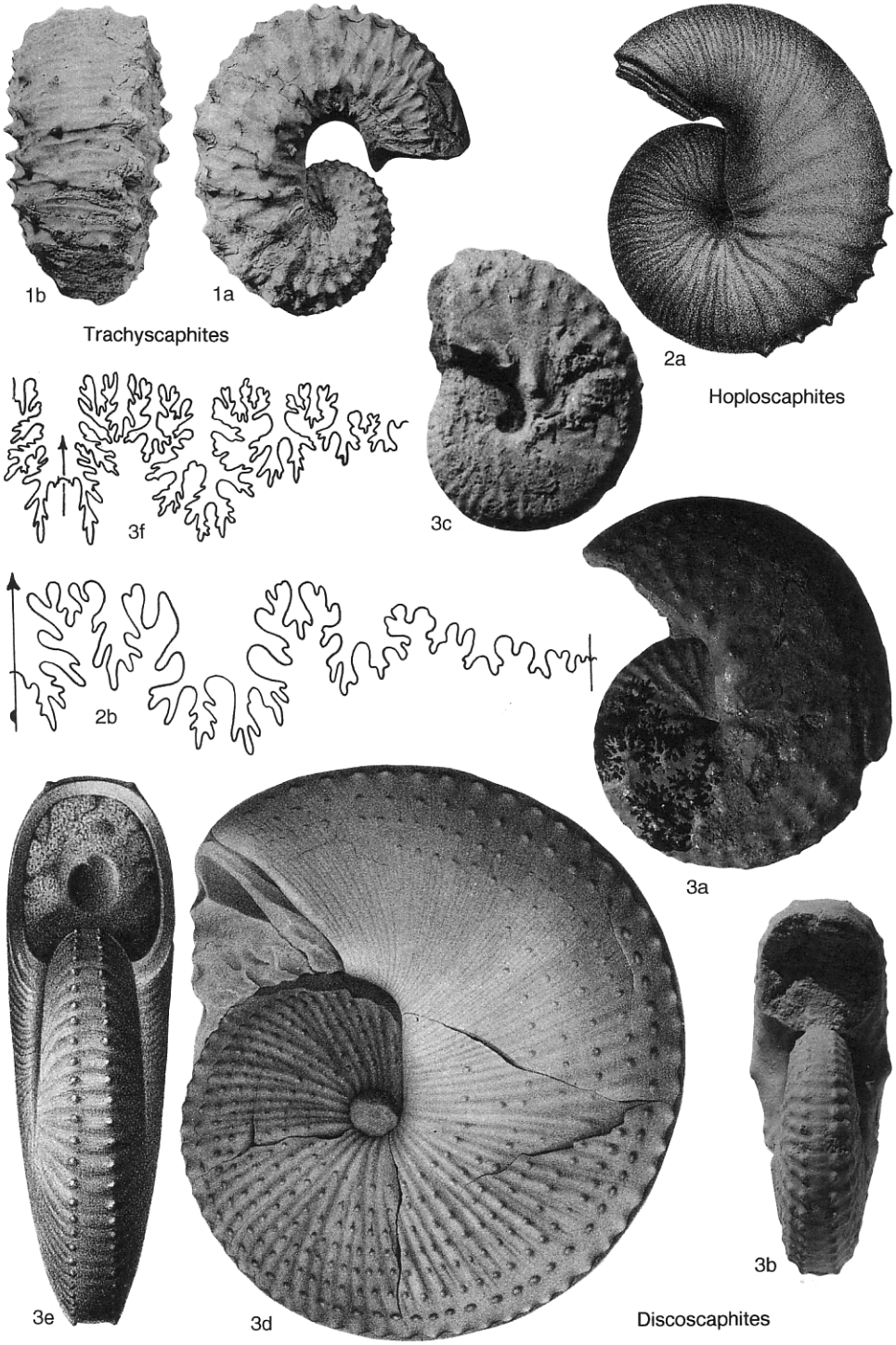


FIG. 204. Scaphitidae (p. 261–263)

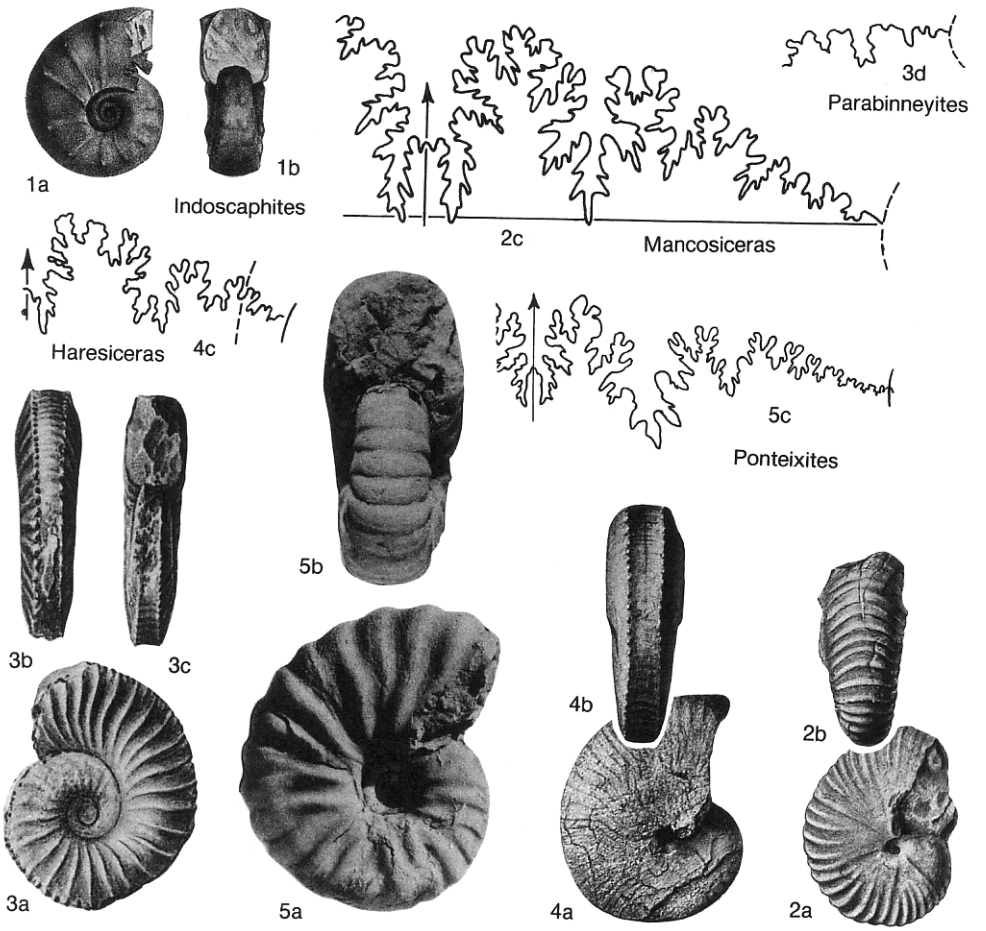


FIG. 205. Scaphitidae (p. 265–266)

MEEK, 1876, p. 70 (=*Ammonites halli* MEEK & HAYDEN, 1857, p. 70, *nom. nud.*); OD] [=*Amopalus* OWEN, 1852, p. 579, *nom. oblit.*]. Medium-sized to very large, up to 300 mm in diameter; venter coiled normally, umbilical seam egressing on last quarter of whorl; rather compressed to very inflated; primary ribs fine to coarse, branching into dense, prorsiradiate secondaries; no tubercles. Suture complex, with long, narrow elements; lobes bifid or asymmetrically trifid. RICCARDI, 1983. *Upper Cretaceous (Campanian):* Alberta, Saskatchewan, USA (Western Interior), ?Russia.——FIG. 203,*3a–c.* **R. halli* (MEEK), Montana, holotype; *a,b,* ×0.5 (Riccardi, 1983); *c,* ×0.75 (Meek, 1876).

Ponteixites WARREN, 1934, p. 95 [**P. robustus;* SD RICCARDI, 1983, p. 42]. Small; coiling ammonitic; ribs fine to very coarse, slightly flexuous, well rounded, branching or long and short; ribs may flatten on venter; no tubercles. Suture with shorter and wider elements than *Rhaeboceras. Upper Cretaceous (Upper Campanian–Lower Maastrichtian):* Saskatchewan.——FIG. 205,*5a–c.* **P. robustus,* Lower Maastrichtian; *a,b,* holotype, ×1; *c,* enlarged (Riccardi, 1983; courtesy of the Geological Survey of Canada).

Indoscaphites SPATH, 1953, p. 14 [**Ammonites cunliffei* FORBES, 1846, p. 109; OD]. Compressed, with flat venter and very short shaft; primary ribs distant, single, joining distinct umbilical and ventrolateral clavi from early stage on spire. Western Australian form with fine, sinuous ribs (BRUNNSCHWEILER, 1966) may be *Haresiceras. Upper Cretaceous (Maastrichtian):* southern India.——FIG. 205,*1a,b.* **I. cunliffei* (FORBES); ×2 (Stoliczka, 1864).

Haresiceras REESIDE, 1927c, p. 17 [**H. placentiforme;* OD]. Coiling barely scaphitoid; very involute; with flat sides and venter, at least on body chamber; ribs moderately strong to very fine, sinuous. Suture with long, asymmetrical L and many auxiliaries. *Upper Cretaceous (Upper Santonian–Lower Campanian):* ?Western Australia, USA (Western Interior), Greenland.

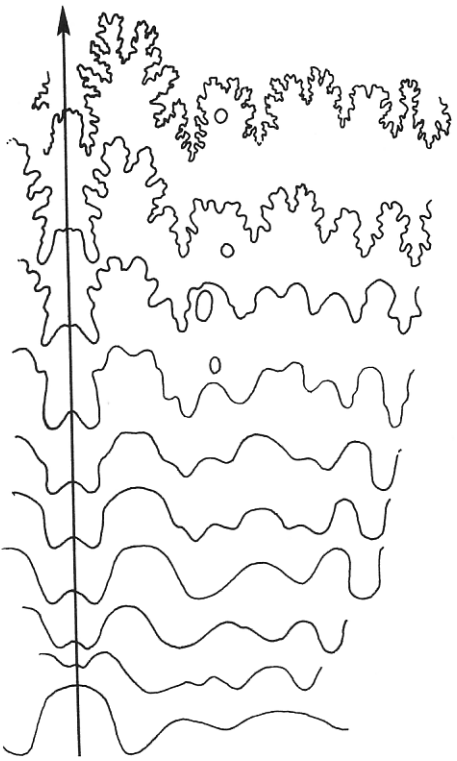


FIG. 206. Sutural ontogeny of *Eodouvilleiceras* showing quadriblobate suture (fourth from base of figure) following quinquelobate suture (second from base) (Mikhailova, 1976c).

H. (Mancosiceras) COBBAN, 1964, p. 17 [**Puzosia (Latidorsella) mancosensis* REESIDE, 1927a, p. 15; OD]. Inner whorls constricted; spire with rounded venter; ventrolateral nodes on body chamber only; ribs fairly strong. *Upper Cretaceous (Upper Santonian):* Utah, Wyoming, Montana, New Mexico.——FIG. 205,*2a–c.* **H. (M.) mancosense* (REESIDE), New Mexico; *a,b,* ×1; *c,* ×4 (Reeside, 1927c).

H. (Haresiceras). Venter flat or concave from an early stage, bordered by rows of fine, rounded ventrolateral nodes; ribs more or less fine, slightly sinuous, crossing venter transversely. *Upper Cretaceous (Lower Campanian):* USA (Western Interior), Greenland.——FIG. 205,*4a–c.* **H. (H.) placentiforme,* Wyoming; *a,b,* ×1; *c,* ×2 (Reeside, 1927c).

Parabinneyites A. F. LEANZA, 1964, p. 84, *nom. nov. pro Patagoniceras* A. F. LEANZA, 1963, p. 207, *non* WETZEL, 1960, p. 249 [**Leopoldia paynensis* FAVRE, 1908, p. 638; OD]. Inner whorls rather evolute, with last whorl just in contact with previous one; with slightly convex sides and wide, flat to slightly concave venter; primary ribs regular, distant, sinuous, forming small ventrolateral nodes and crossing venter transversely; between primary ribs are 1 or 2 intercalatories consisting of little more than ventrolateral nodes and ventral ribs. Probably allied to *Haresiceras.* BLASCO DE NULLO, NULLO, & PROSERPIO, 1980. *Upper Cretaceous (Lower Campanian):* Argentina.——FIG. 205,*3a–d.* **P. paynensis* (FAVRE); *a–c,* ×1 (Favre, 1908); *d,* enlarged (A. F. Leanza, 1963).

Superfamily DOUVILLEICERATACEAE Parona & Bonarelli, 1897

[*nom. transl.* LUPPOV in LUPPOV & DRUSHCHITS, 1958, p. 116, *ex* Douvilleiceratidae PARONA & BONARELLI, 1897, p. 101]

Early forms have perforate umbilicus and appear to be incoiling criocones. Coiling rapidly becoming ammoniticonic, and sutural lobes U and L widening and subdividing. Early sutures unstable; primary suture may be quinquelobate or quadrilobate followed by quinquelobate; in either case succeeding lines quadrilobate before normal differentiation begins (Fig. 206). MIKHAILOVA, 1976c. *Lower Cretaceous (Barremian–Middle Albian).*

Family DOUVILLEICERATIDAE Parona & Bonarelli, 1897

[Douvilleiceratidae PARONA & BONARELLI, 1897, p. 101]

Evolute; whorl section ranging from depressed to circular or polygonal; ribs strong, with various combinations of umbilical, lateral, or ventrolateral tubercles. Suture with massive saddle L/E, wide L subdivided into 2 lobes, and no to few auxiliaries. *Lower Cretaceous (Barremian–Middle Albian).*

Subfamily ROLOBOCERATINAE Casey, 1961

[Roloboceratinae CASEY, 1961d, p. 176]

Venter broadly rounded at all stages; generally only 1 row of tubercles on each side, not septate. Suture tending to simplify. *Lower Cretaceous (Barremian–Lower Aptian).*

Paraspiticeras KILIAN, 1910a, p. 7 [**Aspidoceras percevali* UHLIG, 1883, p. 238(114); SD SPATH, 1921a, p. 316]. Initial coil open, then evolute, with round or depressed, rapidly enlarging whorls; ribs strong, rounded, crossing venter with slight forward bend; more or less prominent lateral tubercles and (in some forms) umbilical tubercles on inner whorls; tubercles tending to weaken or disappear on

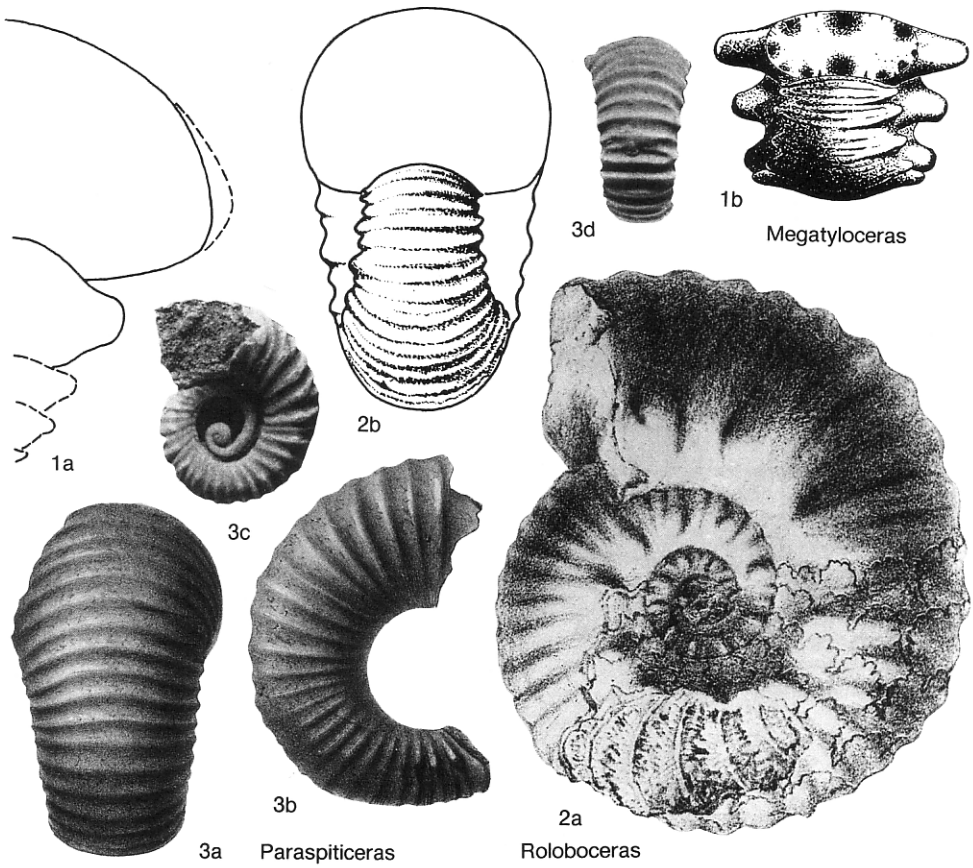


FIG. 207. Douvilleiceratidae (p. 266–267)

outer whorls. Suture quadrilobate throughout. *Lower Cretaceous (Barremian):* France, Spain, Austria.——FIG. 207,*3a,b.* **P. percevali* (UHLIG), Austria; ×0.5 (Uhlig, 1883).——FIG. 207,*3c,d. P. schindewolfi* WIEDMANN, Spain; inner whorls, ×5 (Wiedmann, 1960).

Roloboceras CASEY, 1954a, p. 114 [**Ammonites hambrovi* FORBES, 1845, p. 354; OD]. Whorl section semicircular; ribs thick, blunt, tending to form large bulges where they branch at umbilical edge. *Lower Cretaceous (Lower Aptian):* northwestern Europe.——FIG. 207,*2a,b.* **R. hambrovi* (FORBES), England; *a,* lectotype, ×1; *b,* paralectotype, ×1 (Forbes, 1845).

Megatyloceras HUMPHREY, 1949, p. 149, ICZN Opinion 428, 1956, Generic Name No. 1022 [**Douvilleiceras coronatum* ROUCHADZÉ, 1933, p. 195; OD; ICZN Specific Name No. 1041]. Whorl section coronate, with single, very large midlateral tubercle. *Lower Cretaceous (Lower Aptian):* England, France, Georgia.——FIG. 207,*1a.* **M. coronatum* (ROUCHADZÉ), Georgia; ×0.5 (Casey, 1961d).——FIG. 207,*1b. M. ricordeanum* (ORBIGNY), France; ×1 (Casey, 1961d).

Subfamily CHELONICERATINAE Spath, 1923

[*nom. transl.* BREISTROFFER, 1953b, p. 74, *ex* Cheloniceratidae SPATH, 1923d, p. 64] [=Diadochoceratinae KVANTALIANI, 1978, p. 399]

Differs from Roloboceratinae in having 2 rows of septate tubercles on each side; later forms also developing ventral tubercles. *Lower Cretaceous (Lower Aptian–Upper Aptian).*

Prochelonicera SPATH, 1923d, p. 64 [**Ammonites stobieckii* ORBIGNY, 1850a, p. 113; OD]. Rather evolute; whorl section circular to oval, enlarging less rapidly than in *Paraspiticeras;* ribs more or less equal, branching at umbilical or midlateral tubercles in middle growth; tubercles later disappearing. Probably synonymous with *Cheloniceras. Lower Cretaceous (Lower Aptian):* France, Germany, Poland, Russia, Texas.——FIG. 208,*6. P. albrechtiaustriae* (UHLIG), France; ×0.3 (Kilian, 1907–1913).

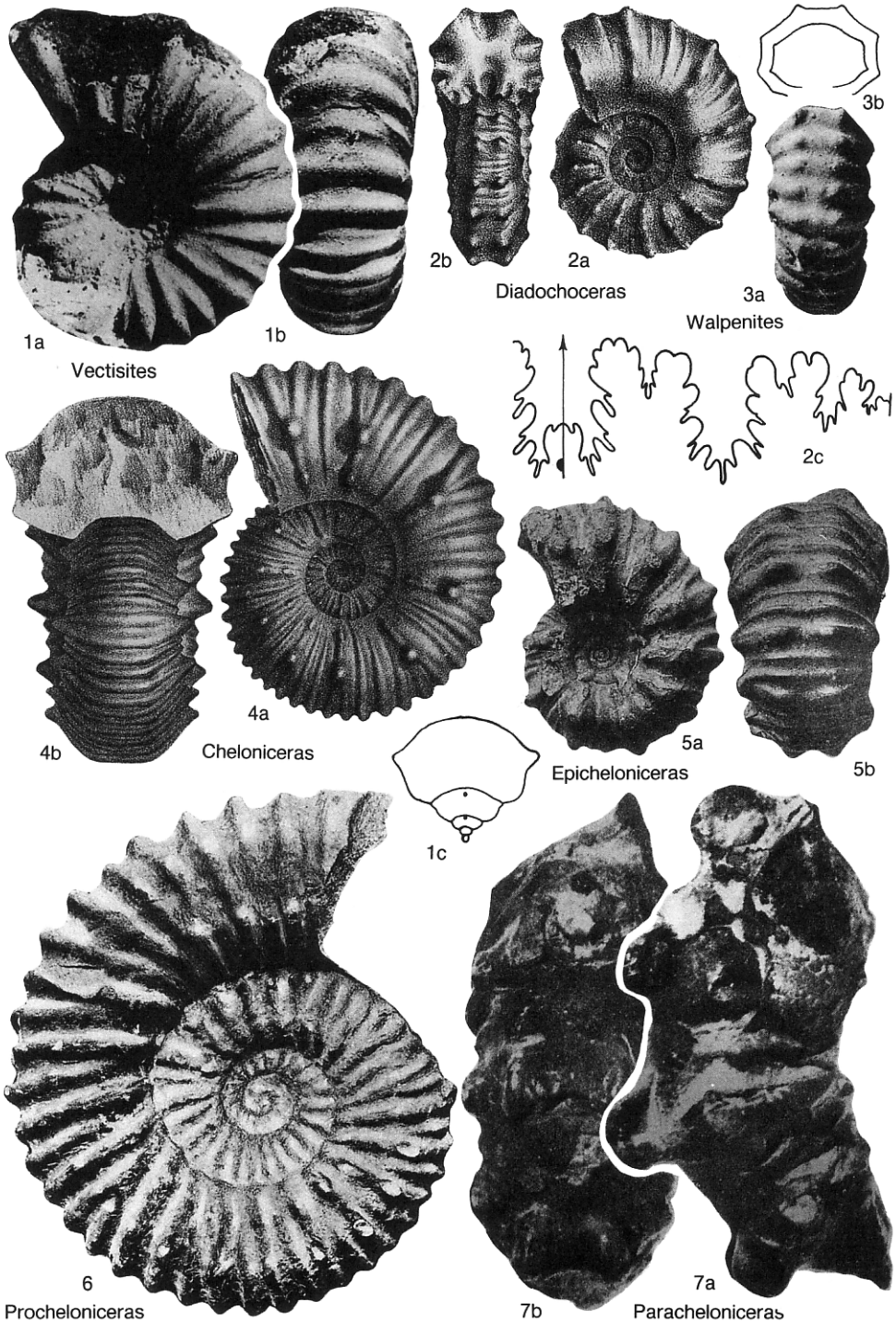


FIG. 208. Douvilleiceratidae (p. 267–269)

Cheloniceras HYATT, 1903, p. 101, ICZN Opinion 428, 1956, Generic Name No. 1021 [**Ammonites cornuelianus* ORBIGNY, 1841, p. 364; ICZN Specific Name No. 1040]. Moderately evolute; whorl section circular to depressed; at some stage with lateral and umbilical tubercles; ribs branching at lateral tubercles and intercalated; shoulders rounded, angulate, or with tubercles. In late stages lateral tubercles disappearing and ribs branching from umbilical tubercles. Suture with long E and very broad, asymmetrically bifid L. *Lower Cretaceous (Upper Aptian):* Europe, eastern Africa, South Africa, Madagascar, Egypt (Sinai), Iran, Japan, California, Texas, Mexico, South America.

C. (**Cheloniceras**). Umbilical and lateral tubercles only; shoulders rounded or angulate but not with tubercles. Occurrence and distribution as for genus.——FIG. 208,*4a,b.* **C. (C.) cornuelianum* (ORBIGNY), France; ×0.75 (Orbigny, 1841).

C. (**Epicheloniceras**) CASEY, 1954a, p. 113 [**Douvilleiceras tschernyschewi* SINZOW, 1906, p. 182; OD]. Major ribs depressed on siphon and with distinct ventrolateral tubercles until later whorls. Occurrence and distribution as for genus.——FIG. 208,*5a,b.* **C. (E.) tschernyschewi* (SINZOW), Transcaspia; ×1 (Sinzow, 1906).

C. (**Paracheloniceras**) COLLIGNON, 1962b, p. 42 [**Epicheloniceras (P.) wrighti* COLLIGNON, 1962b, p. 42; OD]. Differs from *C. (Epicheloniceras)* only in its large, earlike outer tubercles and in ribs on body chamber being in some species broad and flat as in *Colombiceras.* Occurrence as for genus: Madagascar.——FIG. 208,*7a,b.* **C. (P.) wrighti* (COLLIGNON); ×1 (Collignon, 1962b).

Diadochoceras HYATT, 1900, p. 587 [**Ammonites nodosocostatus* ORBIGNY, 1841, p. 258; OD] [=*Paracanthoplites* STOYANOW, 1949, p. 118 (type, *P. meridionalis;* OD); *Nodosohoplites* EGOIAN, 1965, p. 145 (type, *N. subplanatus;* OD); *Vergunniceras* THOMEL, 1980, p. 171, 180 (type, *Ammonites pretiosus* ORBIGNY, 1841, p. 193; OD)]. Moderately to very evolute; whorl section polygonal; primary ribs bearing umbilical, lateral, and ventrolateral tubercles; weaker secondaries with or without ventrolateral tubercles. Resembling *Epicheloniceras,* but generally more evolute and with weaker ribs. *Lower Cretaceous (Upper Aptian):* France, Georgia, Madagascar, Arizona, Mexico.——FIG. 208,*2a–c.* **D. nodosocostatum* (ORBIGNY), France; *a,b,* ×1; *c,* enlarged (Orbigny, 1840–1842).

Walpenites CASEY, 1962, p. 259 [**W. tardespinatus;* OD]. Dwarf; evolute; inner whorls as in *Cheloniceras,* but body chamber with double ventral rows of sharp tubercles. *Lower Cretaceous (Upper Aptian):* England.——FIG. 208,*3a,b.* **W. tardespinatus,* Isle of Wight; *a,* venter, ×2; *b,* whorl sections of body chamber and inner whorls, ×1 (Casey, 1962).

Vectisites CASEY, 1962, p. 256 [**V. caprotinus;* OD] [=*Zambranoites* ETAYO SERNA, 1979, p. 38 (type, *V. (Z.) zambranoi* ETAYO SERNA, 1979, p. 38; OD)]. Dwarf, with whorl section depressed-oval or subcircular, ribs simple; a single row of septate lateral spines in young. [*Zambranoites* for species with ribs depressed on midline of venter seems unnecessary.] *Lower Cretaceous (Upper Aptian):* England, France, Colombia.——FIG. 208,*1a–c.* **V. caprotinus,* Isle of Wight; *a,* side, ×1; *b,* periphery, ×1; *c,* section of inner whorls, ×2 (Casey, 1962).

Subfamily DOUVILLEICERATINAE Parona & Bonarelli, 1897

[*nom. transl.* SPATH, 1922a, p. 111, *ex* Douvilleiceratidae PARONA & BONARELLI, 1897, p. 101]

Ribs at early stage with umbilical, lateral, and ventrolateral tubercles as in *Cheloniceras (Epicheloniceras);* in later stages ribs typically multituberculate, with tubercles in some species very large, commonly strigate, sooner or later disappearing, leaving plain ribs on outer whorl. *Lower Cretaceous (Upper Aptian–Middle Albian).*

Eodouvilleiceras CASEY, 1961d, p. 191 [**Douvilleiceras horridum* RIEDEL, 1938, p. 29; OD]. Ribs simple, with mammillate ventral tubercles, but these and the lateral and umbilical tubercles undivided until an advanced stage. *Lower Cretaceous (Upper Aptian):* ?France, Turkmenistan, Japan, California, Venezuela, Colombia.——FIG. 209,*1a,b.* **E. horridum* (RIEDEL), Colombia; ×1 (Casey, 1961d).

Douvilleiceras GROSSOUVRE, 1894, p. 26, ICZN Opinion 422, 1956, Generic Name No. 1014 [**Ammonites mammillatus* SCHLOTHEIM, 1813, p. 111; ICZN Specific Name No. 764] [=*Trinitoceras* SCOTT, 1940, p. 1016 (type, *T. rex;* OD)]. Ribs unbranched at first, with strong umbilical and ventrolateral tubercles, then with numerous tubercles, uniform or not, and finally with no tubercles. *Lower Cretaceous (Lower Albian–Middle Albian):* Europe, Madagascar, Egypt (Sinai), India, Siberia, USA, Peru, Colombia.——FIG. 209,*2a.* **D. mammillatum* (SCHLOTHEIM), Lower Albian, England; ×1 (Spath, 1923–1943).——FIG. 209,*2b. D. monile* (J. SOWERBY), Lower Albian, England; ×3.5 (Spath, 1923–1943).

Family TROCHLEICERATIDAE Breistroffer, 1951

[Trochleiceratidae BREISTROFFER, 1951b, p. 267]

Small; compressed and smooth to inflated with strong straight ribs; venter generally depressed or grooved. Suture quadrilobate throughout. *Lower Cretaceous (Upper Aptian–Lower Albian).*

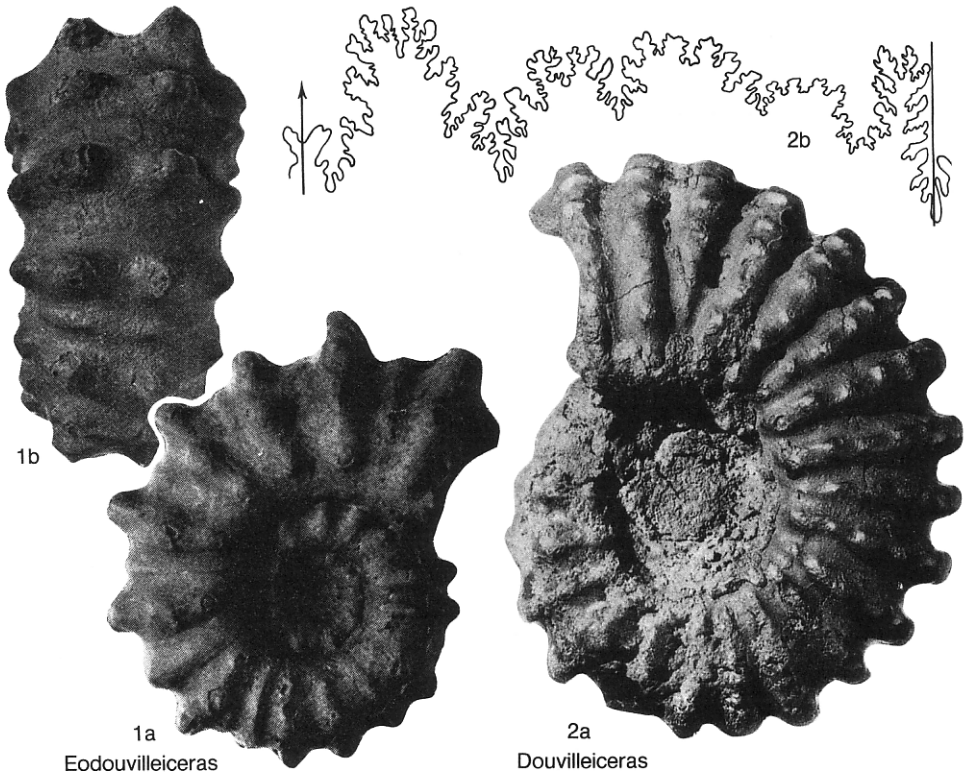


FIG. 209. Douvilleiceratidae (p. 269)

Trochleiceras FALLOT & TERMIER, 1923, p. 74 [**Waagenia? balearensis* FALLOT, 1920, p. 58; OD] [=*Magneticeras* COLLIGNON, 1950a, p. 48 (type, *M. magneti;* OD); *Juamportoceras* ETAYO SERNA, 1979, p. 31 (type, *T. (J.) hoffstetteri* ETAYO SERNA, 1979, p. 31; OD)]. Moderately evolute and compressed; venter rounded to flat, with deep to obsolescent, narrow median furrow; smooth or with feeble riblets. Suture with shallow and feebly indented elements. [*Juamportoceras* as subgenus for species with weak to absent sulcus is probably unnecessary.] *Lower Cretaceous (Upper Aptian–Lower Albian):* Balearic Islands, Madagascar, Colombia.——FIG. 210,*1a,b. T. magneti* (COLLIGNON), Lower Albian, Madagascar; ×2 (Collignon, 1950a).——FIG. 210,*1c–e. T.* aff. *termieri* COLLIGNON, Upper Aptian, Madagascar; outer whorl, ×1 (Collignon, 1962b).

Pseudoleymeriella CASEY, 1957, p. 35 [**Hoplites haidaquensis* WHITEAVES, 1893b, p. 444; OD]. Evolute; whorl section more or less rounded; ribs simple, strong, irregularly long and short, straight to slightly flexuous, and interrupted by deep, narrow siphonal furrow. *Lower Cretaceous (Upper Aptian):* Spain, Madagascar, Japan, British Columbia.——FIG. 210,*3a,b. *P. haidaquensis* (WHITEAVES), British Columbia; ×1 (Casey, 1957).——FIG. 210,*3c. P. iberica* WIEDMANN, Spain; ×10 (Wiedmann, 1966b).

Family ASTIERICERATIDAE Breistroffer, 1953

[Astiericeratidae BREISTROFFER, 1953b, p. 74]

Dwarf, scaphitoid forms with strong ribs and large umbilicolateral tubercles. Suture has wide L subdivided into 2 lobes as in Douvilleiceratidae. *Lower Cretaceous (Middle Albian).*

Astiericeras PARONA & BONARELLI, 1897, p. 101 [**Scaphites astierianus* ORBIGNY, 1842a, p. 526, 624; OD]. At first with umbilical and ventrolateral tubercles, then (after nontuberculate stage) with large, round umbilicolateral tubercles emphasizing coronate whorl section; with short to moderately long shaft ending in hook, transversely oval in section, with ribs strong, slightly rursiradiate, simple or branching from small tubercles. Microconchs 25–30 mm long; macroconchs about twice as long (KENNEDY, 1986c). Suture with L subdivided into 2 trifid lobes. *Lower Cretaceous (Middle Albian):*

France.——FIG. 210,*2a–c.* **A. astierianum* (ORBIGNY); *a,b,* ×1 (Parona & Bonarelli, 1897); *c,* enlarged (Wiedmann, 1965).

Superfamily DESHAYESITACEAE Stoyanow, 1949

[*nom. transl.* WIEDMANN, 1966b, p. 46, *ex* Deshayesitinae STOYANOW, 1949, p. 123]

Ammoniticone by reversionary recoiling; probably derived from Heteroceratidae. Marked size dimorphism. *Lower Cretaceous (Upper Barremian–Lower Albian).*

Family DESHAYESITIDAE Stoyanow, 1949

[*nom. transl.* WRIGHT, 1955, p. 564, *ex* Deshayesitinae STOYANOW, 1949, p. 123]

Typically compressed; ribs strong, branching or long and short, crossing rounded venter or, in later forms with flat venter, may be interrupted; tubercles present in a few forms. Suture with first subdivision of umbilical lobe remaining next to saddle U/L, giving formula I U2 U3 U1 L E. MIKHAILOVA, 1976b. *Lower Cretaceous (Upper Barremian–Upper Aptian; ?Lower Albian).*

Subfamily DESHAYESITINAE Stoyanow, 1949

[Deshayesitinae STOYANOW, 1949, p. 123]

If present, tubercles are only umbilical and ventrolateral. *Lower Cretaceous (Upper Barremian–Upper Aptian; Lower Albian).*

Turkmeniceras TOVBINA, 1962, p. 84 [**T. turkmenicum;* OD]. Umbilicus perforate, but later stages rather involute. Suture with broad, shallow lobes. *Lower Cretaceous (Upper Barremian):* Turkmenistan.——FIG. 211,*3a.* **T. turkmenicum;* ×1 (Tovbina, 1963).——FIG. 211,*3b,c. T. geokderense* TOVBINA; ×1 (Tovbina, 1963).

Prodeshayesites CASEY, 1961b, p. 592 [**Ammonites fissicostatus* PHILLIPS, 1829, p. 123; OD] [=*Paradeshayesites* KEMPER, 1967, p. 124 (type, *Hoplitides laeviusculus* KOENEN, 1902, p. 224; OD)]. Very compressed, with flat sides and arched or even fastigiate venter; evolute, with coiling loosening in middle growth; ribs strong throughout, in chevrons on venter, and tending to weaken on midline. Suture with broad, shallow elements and asymmetrical L. [*Paradeshayesites* may comprise macroconchs.] *Lower Cretaceous (Lower Aptian):* England, France, Germany.——FIG. 211,*2a–c.* **P. fissicostatus* (PHILLIPS), England; *a,b,* ×1; *c,* enlarged (Casey, 1964).——FIG. 211,*2d,e. P. laeviusculus* (KOENEN), Germany; inner whorls, ×1 (Kemper, 1967).

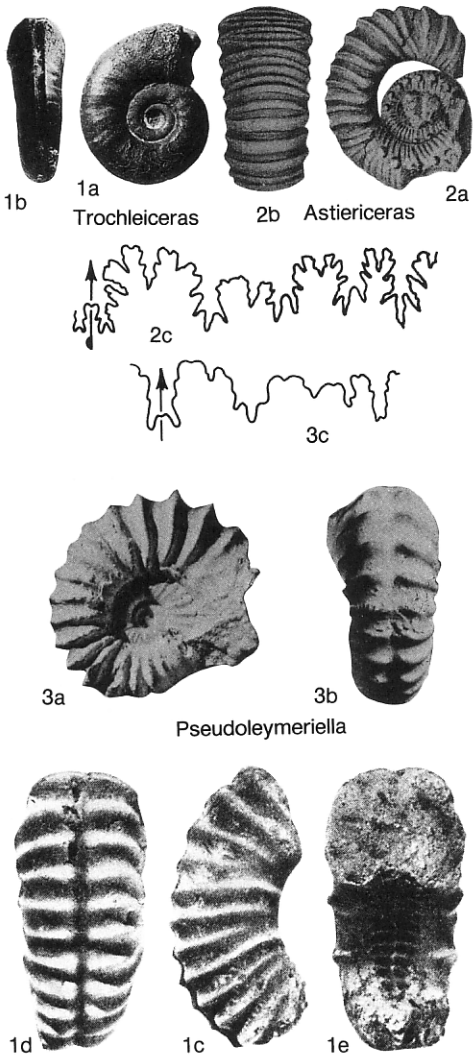


FIG. 210. Trochleiceratidae and Astiericeratidae (p. 270–271)

Deshayesites KAZANSKY, 1914, p. 99 [**Ammonites deshayesi* ORBIGNY, 1840, p. 85] [=*Parahoplitoides* SPATH, 1922a, p. 111, obj.]. Moderately involute, with slight loosening of coiling with growth; compressed; sides and venter slightly convex to flat; ribs consisting of sigmoid primaries and branching or intercalated secondaries; ribbing may fade at middle growth but if so strengthens on body chamber; no distinct tubercles. *Lower Cretaceous (Lower Aptian):* Europe, Sardinia, Georgia, Greenland.——FIG. 211,*1a–c.* **D. deshayesi* (ORBIGNY), France; *a,b,* ×1; *c,* enlarged (Casey, 1964).

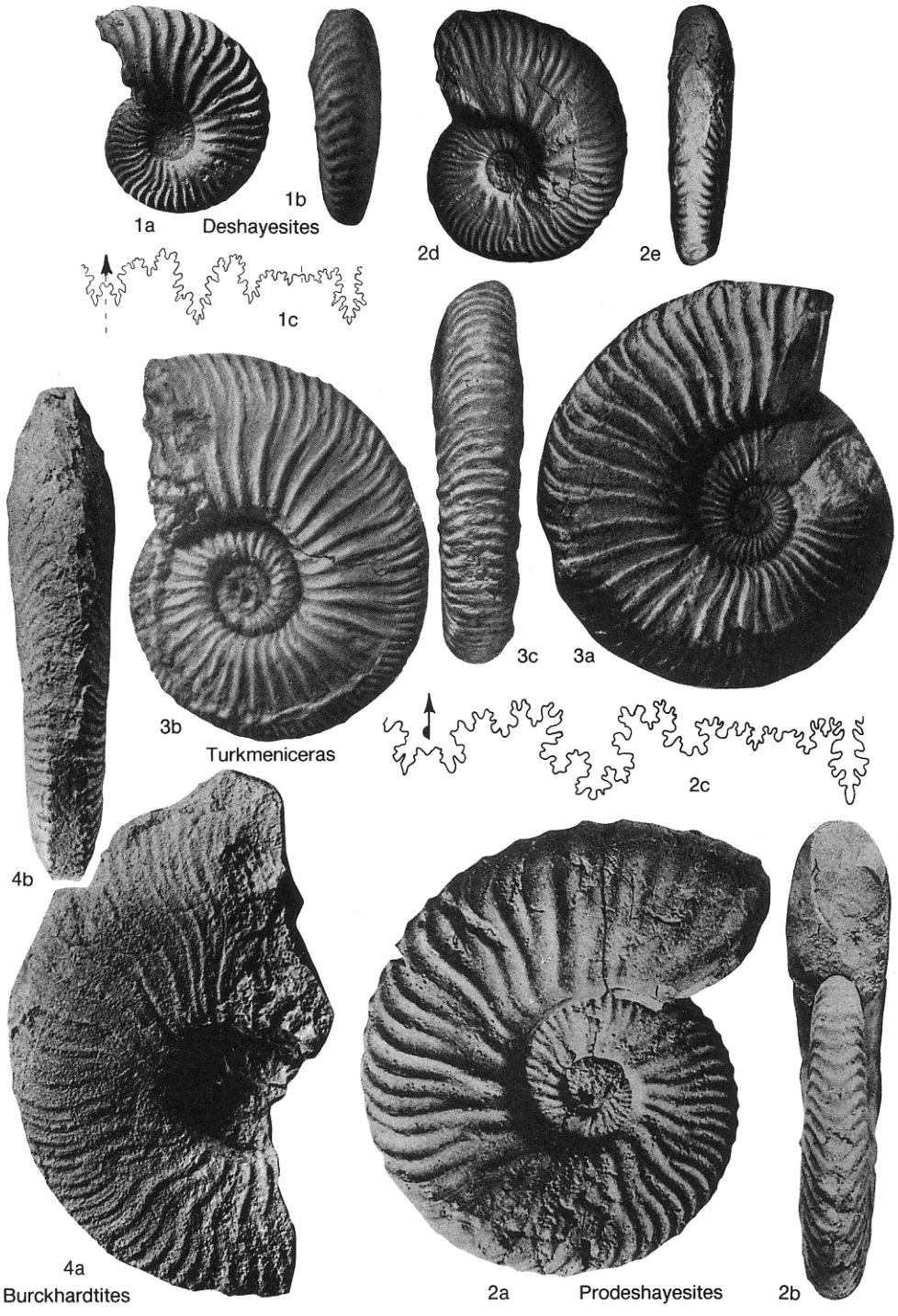


FIG. 211. Deshayesitidae (p. 271–273)

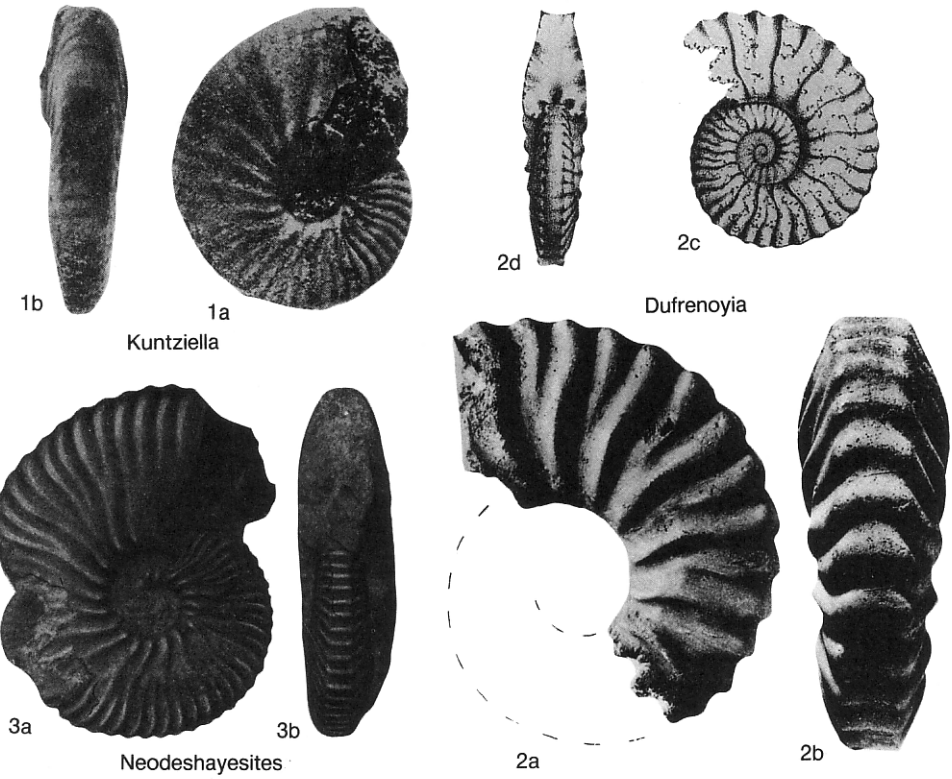


FIG. 212. Deshayesitidae (p. 273)

Neodeshayesites CASEY, 1964, p. 289 [**Deshayesites stutzeri* RIEDEL, 1938, p. 37; OD]. Like *Dufrenoyia* in early stage except that it has umbilical rather than ventrolateral tubercles; later with straight, high ribs on arched venter; lateral ribs tend to be biconcave. *Lower Cretaceous (Lower Albian):* Colombia, Venezuela.——FIG. 212,*3a,b.* **N. stutzeri* (RIEDEL), Colombia; ×1 (Riedel, 1938).

Dufrenoyia KILIAN & REBOUL, 1915, p. 37 [**Ammonites furcatus* J. de C. SOWERBY, in FITTON, 1836, p. 339; OD] [=*Dufrenoya* KILIAN & REBOUL, 1915, p. 178; *Stenhoplites* SPATH, 1922a, p. 110 (type, *Ammonites dufrenoyi* ORBIGNY, 1840, p. 100; OD); *Juandurhamiceras* ETAYO SERNA, 1979, p. 42 (type, *D. (J.) juandurhami* ETAYO SERNA, 1979, p. 42; OD)]. Compressed, with sides and venter flat; ribs more or less sinuous, fine or coarse, commonly broad and flat, branching or long and short, interrupted at first on venter, later continuous, raised in at least some growth stage into ventrolateral clavi. In macroconchs up to 400 mm in diameter, angularity of shoulders lost, but venter remaining flat and ribs strengthening. Derived directly from *Deshayesites*. [*Juandurhamiceras* for species with *Colombiceras*-like ribbing at end of body chamber seems unnecessary.] *Lower Cretaceous (Lower Aptian–Upper Aptian; ?Lower Albian):* Europe, Japan, Texas, Mexico, Venezuela, Colombia.——FIG. 212,*2a,b.* **D. furcata* (J. de C. SOWERBY), Lower Aptian, England; ×1 (Casey, 1964).——FIG. 212,*2c,d. D. dufrenoyi* (ORBIGNY), Upper Aptian, France; ×1 (Orbigny, 1840–1842).

Kuntziella COLLIGNON, 1962b, p. 64 [**Deshayesites (Kuntziella) kuntzi;* OD]. Like early *Dufrenoyia* but with higher whorls, flatter sides, and no ventrolateral tubercles in young. *Lower Cretaceous (Upper Aptian):* Madagascar.——FIG. 212,*1a,b.* **K. kuntzi;* ×1 (Collignon, 1962b).

Burckhardtites HUMPHREY, 1949, p. 130 [**Neocomites nazasensis* BURCKHARDT, 1925, p. 14; OD]. Differs from *Dufrenoyia* in more rapidly increasing whorl height and fine, irregular, biconcave ribs. *Lower Cretaceous (Upper Aptian):* Mexico.——FIG. 211,*4a,b.* **B. nazasensis* (BURCKHARDT); ×1 (Humphrey, 1949).

Subfamily MATHOCERATINAE Casey, 1964

[Mathoceratinae CASEY, 1964, p. 289] [=Venezuellinae KVANTALIANI, 1980, p. 123]

Apparently small, with distinct umbilical, midlateral, ventrolateral, or siphonal tu-

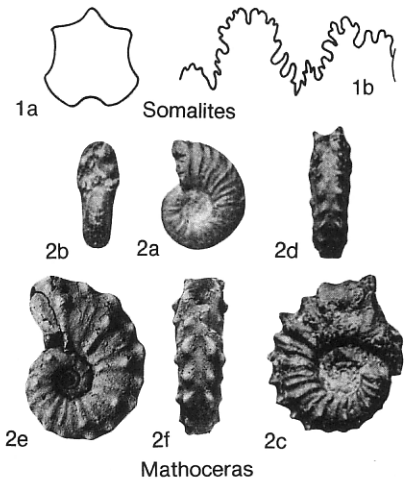


FIG. 213. Deshayesitidae (p. 274)

bercles and reduced suture. *Lower Cretaceous (Upper Aptian).*

Cloioceras WHITEHOUSE, 1927, p. 118 [**Hoplites ruspolii* MAYER-EYMAR, 1893, p. 258; OD]. Differs from more strongly ribbed species of *Deshayesites* by its sharper and thinner simple ribs, which are raised into slight inner and outer ventrolateral tubercles. *Lower Cretaceous (Upper Aptian):* Somalia.

Somalites TAVANI, 1949, p. 46 [**S. vertebralis;* OD]. Evolute; early ribs slightly flexuous, simple; later some tuberculate; finally all with large umbilical, ventrolateral, and siphonal tubercles. *Lower Cretaceous (Upper Aptian):* Somalia.——FIG. 213,*1a,b.* **S. vertebralis; a,* ×1; *b,* ×2 (Tavani, 1949).

Mathoceras CASEY, 1964, p. 289 [**Hoplites (Kilianella?) matho* PERVINQUIÈRE, 1907, p. 185; OD] [=*Venezuella* KVANTALIANI, 1980, p. 123 (type, *Mathoceras venezolanum* RENZ, 1978, p. 681; OD); *Renziella* KVANTALIANI, 1980, p. 123 (type, *Mathoceras laeve* RENZ, 1978, p. 684; OD)]. Compressed, with alternating clavi bordering flat or sulcate venter and sharp umbilical and lateral tubercles. [*Venezuella* and *Renziella* are Upper Aptian (RENZ, 1978; STOYKOVA, 1990) and not Lower Albian as KVANTALIANI argued.] *Lower Cretaceous (Upper Aptian):* Balearic Islands, Bulgaria, Tunisia, Venezuela.——FIG. 213,*2a–d.* **M. matho* (PERVINQUIÈRE), Tunisia; ×1 (Pervinquière, 1907).——FIG. 213,*2,e,f. M. venezolanum* RENZ, Venezuela; ×1 (Renz, 1982).

?Family PARAHOPLITIDAE Spath, 1922

[Parahoplitidae SPATH, 1922a, p. 111]

Moderately involute; at least later whorls high and with broadly rounded venter; ribs strong, without tubercles. Suture with trifid L; auxiliary lobes derived from saddle U/L, giving formula 1 U L3 L2 L1 E. MIKHAILOVA, 1976a, 1976b. *Lower Cretaceous (Upper Aptian–Lower Albian).*

Perhaps derived from Deshayesitidae by way of *Dufrenoyia* (CASEY, 1965), but taxonomic position is uncertain (MIKHAILOVA, 1979); it was treated as a distinct superfamily by some (e.g., SCHINDEWOLF, 1968, p. 48(740)). The doubtful *Procolombiceras* SHARIKADZE, 1979, p. 381 (type, *P. aptum;* OD), if really Lower Aptian as stated, might be transitional from Deshayesitidae.

Subfamily ACANTHOHOPLITINAE Stoyanow, 1949

[Acanthohoplitinae STOYANOW, 1949, p. 95] [=Colombiceratinae TOVBINA, 1979, p. 112]

Rather evolute; whorl section depressed to coronate in early stages and later higher than wide, with flat to convex sides. Early whorls generally having umbilical or lateral tubercles; primary ribs typically branching at lateral tubercles; ventrolateral tubercles may also occur. Suture has well-differentiated auxiliaries. *Lower Cretaceous (Upper Aptian–Lower Albian).*

Colombiceras SPATH, 1923d, p. 64 [**Ammonites crassicostatus* ORBIGNY, 1840, p. 64; OD]. Early whorls with flat-topped ribs angulate at shoulders, branching at midflank, where one tubercle may be present, or at umbilical shoulder; later whorls compressed, with flat sides and flat to subrounded venter and less flat-topped ribs; some species losing flatness of ribs and tuberculation at early stage, then resembling *Parahoplites.* Suture with deep, subrectangular E, trifid L, bifid saddles, and simplified auxiliaries. *Lower Cretaceous (Upper Aptian):* England, France, Sardinia, Romania, Georgia, Madagascar, Texas, Mexico, Colombia.

C. (**Colombiceras**). Lateral tubercles present in early stages. Occurrence and distribution as for genus.——FIG. 214,*3a,b.* **C. (C.) crassicostatum* (ORBIGNY), France; ×1 (Orbigny, 1840–1842).

C. (**Egoianiceras**) AVRAM, 1974, p. 5 [**C. crassicostatum angulatum* EGOIAN, 1969, p. 163; OD] [=?*Riedelites* ETAYO SERNA, 1979, p. 70 (type, *R. esthersernae;* OD)]. Lateral tubercles absent. Doubtfully necessary. Occurrence as for genus: Romania, Colombia.

Gargasiceras CASEY, 1954a, p. 114 [**Ammonites gargasensis* ORBIGNY, 1841, p. 199; OD]. Rather

evolute; sides and venter flat; umbilical margins and shoulders rounded; ribs thin on sides, tending to be flattened on venter; on inner whorls major ribs raised into thin flange, above which ribs branch at minute tubercle; ribs depressed on siphon; later ribs more uniform and venter rounded. *Lower Cretaceous (Upper Aptian):* France, Mexico, Peru, Colombia.

G. (**Gargasiceras**). Ribs persistent, remaining transverse across venter. Occurrence and distribution as for genus.——FIG. 214,*2a,b.* **G. (G.) gargasense* (ORBIGNY), France; ×1 (Orbigny, 1841).

G. (**Pseudogargasiceras**) COLLIGNON, 1962b, p. 61 [**G. (P.) enigmaticum;* OD]. Small, evolute, and compressed; inner whorls with very fine ribs; ribs later reduced to obtuse chevrons on venter. *Lower Cretaceous (Upper Aptian):* Madagascar. ——FIG. 214,*1a,b.* **G. (P.) enigmaticum;* ×1 (Collignon, 1962b).

Acanthohoplites SINZOW, 1907, p. 499 [**Parahoplites aschiltaensis* ANTHULA, 1899, p. 117(63); SD ROMAN, 1938, p. 348] [=*Acanthoplites* R. DOUVILLÉ, 1912a, p. 260, *nom. van.* (illegitimate emendation); *Protacanthoplites* TOVBINA, 1970, p. 57 (type, *Parahoplites abichi* ANTHULA, 1899, p. 118(64); OD); *Chaschupseceras* KVANTALIANI, 1968, p. 62 (type, *C. abchasicum;* OD)]. Early whorls coronate and much as in *Cheloniceras;* later whorls round, then oval in section; primary ribs with or without umbilical bullae, at first branching at prominent lateral tubercles, which later disappear, and then branching at umbilical edge alone or also at midflank. [*Chaschupseceras* seems to show only minor differences in ornament (KVANTALIANI & SHARIKADZE, 1983).] *Lower Cretaceous (Upper Aptian):* Europe, Georgia, Transcaspia, eastern Africa, Madagascar, Japan, California, Arizona, Mexico.——FIG. 215,*2a–c.* **A. aschiltaensis* (ANTHULA), Caucasus; *a,* ×1; *b,* ×0.5; *c,* ×1 (Anthula, 1899).

Nolaniceras CASEY, 1961b, p. 598 [**Hoplites nolani* SEUNES, 1887, p. 564; OD]. Similar to compressed *Hypacanthoplites* but with close, fine ribs, rounded venter only slightly flattened in young, and no ventrolateral tubercles; lateral tubercles only briefly present and minute. *Lower Cretaceous (Lower Albian):* England, France, Georgia, Algeria, Madagascar, Iran.——FIG. 215,*1a,b.* **N. nolani* (SEUNES), France; ×1 (Seunes, 1887).

Hypacanthoplites SPATH, 1923d, p. 64 [**Acanthoceras milletianum* (ORBIGNY) var. *plesiotypica* FRITEL, 1906, p. 245; OD] [=?*Cuchillites* SCOTT, 1940, p. 1050 (type, *C. evolutus;* OD); *Sinzowites* GLAZUNOVA, 1949, p. 22 (type, *Parahoplites jacobi* COLLET, 1907, p. 520; OD)]. Up to 400 mm in diameter; whorl section depressed in initial stage and sometimes in later stages; early whorls hexagonal or rectangular in section, with flat or concave venter and angular shoulders; primary ribs straight or flexuous, tuberculate at umbilical margin, and branching at lateral tubercle; secondary ribs intercalated or

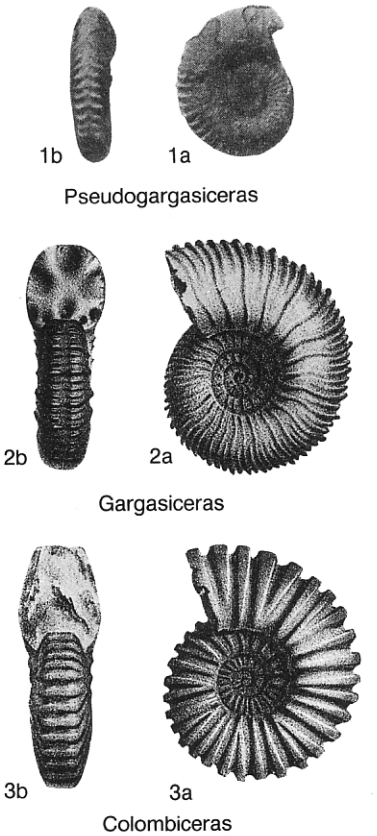


FIG. 214. Parahoplitidae (p. 274–275)

branching; all ribs nodose on shoulders; later tubercles disappearing and venter becoming rounded; test thickened on crest of ribs. *Lower Cretaceous (Upper Aptian–Lower Albian):* Europe, northern Africa, Madagascar, Iran, California, Texas.——FIG. 215,*4a–c.* **H. plesiotypicus* (FRITEL), Germany; *a,b,* ×1; *c,* ×2 (Collet, 1907).

Rhytidoplites SCOTT, 1940, p. 1034 [**R. robertsi;* OD]. Ribs dense, wider than interspaces; outer whorls with distant, sinuous primary ribs separated by 2 to 4 intercalatories on outer third of side. *Lower Cretaceous (Upper Aptian):* Texas, Mexico. ——FIG. 215,*3a,b.* **R. robertsi,* Mexico; ×1 (C. M. Cantu-Chapa, 1976).

Penaceras A. CANTU-CHAPA, 1963, p. 54 [**Hypacanthoplites? rursiradiatus* HUMPHREY, 1949, p. 142; OD] [=*Pegnaceras* ETAYO SERNA, 1979, p. 55, *nom. van.* (illegitimate emendation)]. Like *Colombiceras,* but primary ribs recti- or rursiradiate on inner half of side, then branching and rursiradiate, flattening toward venter; on early whorls periodic ribs enlarged. Perhaps synonymous with *Colombiceras. Lower Cretaceous (Upper Aptian):* Mexico.——FIG. 215,*5a,b.* **P. rursiradiatus* (HUMPHREY); ×1 (Humphrey, 1949).

Subfamily PARAHOPLITINAE Spath, 1922

[*nom. transl.* ROMAN, 1938, p. 346, *ex* Parahoplitidae SPATH, 1922a, p. 111]

Whorl section oval or rectangular; ribs strong, straight or sinuous, uninterrupted over venter, alternately long and short or branching at slight umbilical swellings, but no distinct tubercles at any stage. Tending to be smooth at large diameters. Suture with rather simple auxiliaries in umbilical region. *Lower Cretaceous (Upper Aptian).*

Parahoplites ANTHULA, 1899, p. 111 [**P. melchioris;* OD] [=*Stoyanowiceras* ETAYO SERNA, 1979, p. 67 (type, *Ammonites treffryanus* KARSTEN, 1858, p. 109; OD)]. Ribs normally sinuous throughout, bent forward on venter; may weaken or disappear on body chamber. *Lower Cretaceous (Upper Aptian):* Europe,

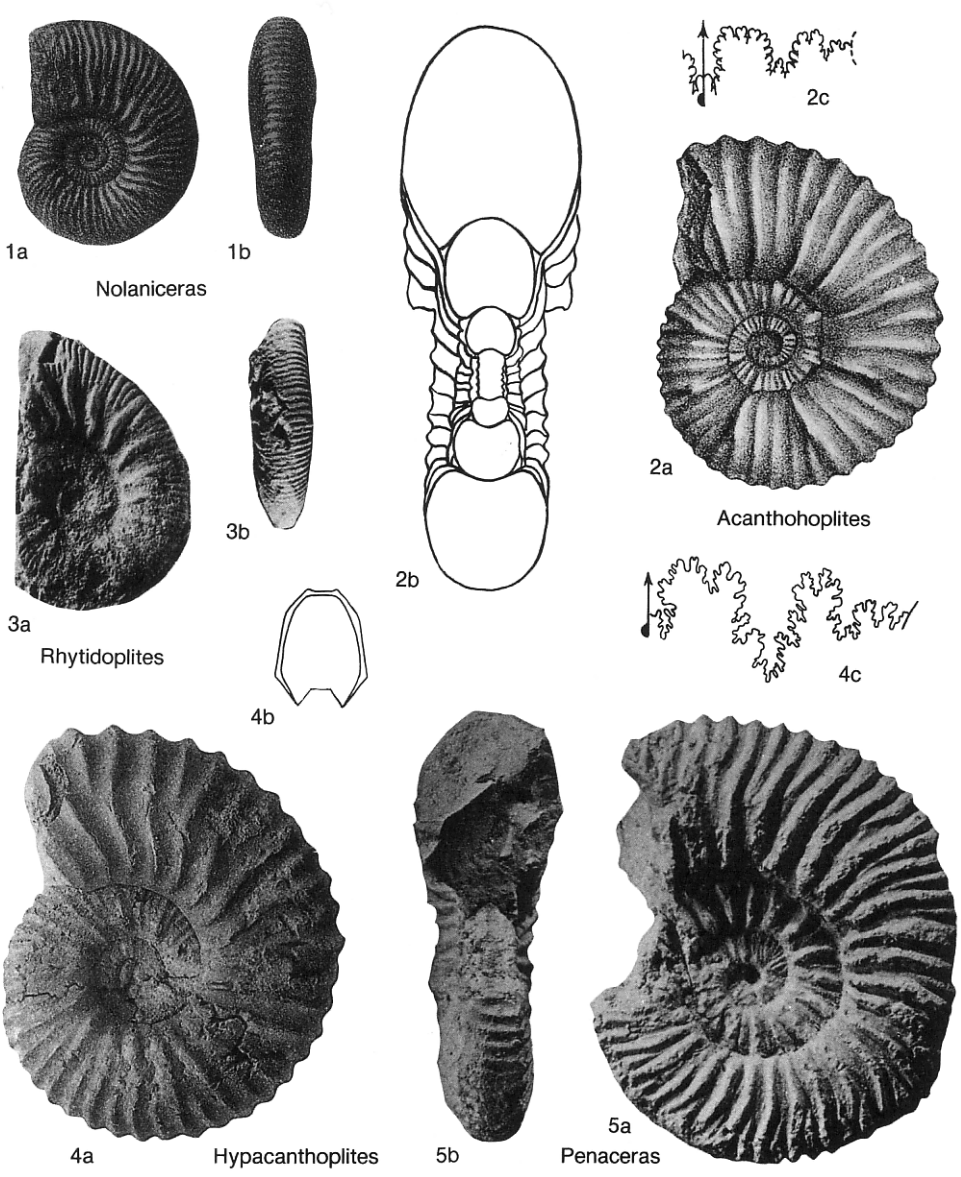


FIG. 215. Parahoplitidae (p. 275)

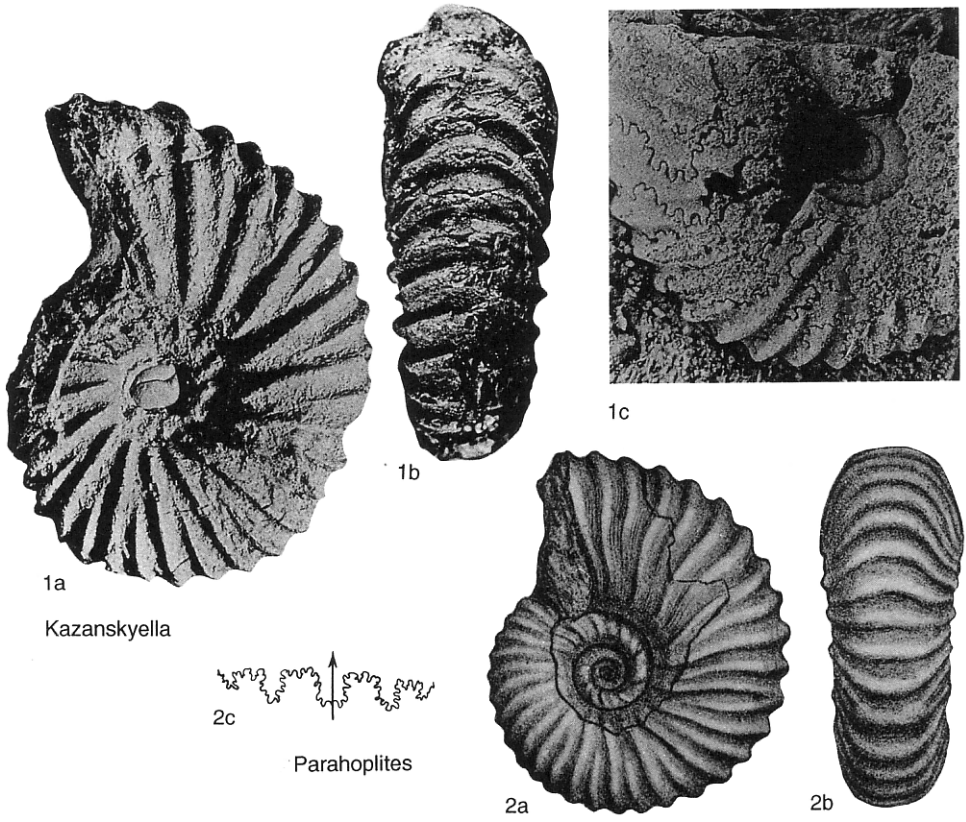


FIG. 216. Parahoplitidae (p. 276–277)

Transcaspia, Iran, Arizona, Texas, Colombia, Peru.——FIG 216,*2a–c.* **P. melchioris,* Caucasus; ×1 (Anthula, 1899).

Kazanskyella STOYANOW, 1949, p. 99 [**K. arizonica;* OD] [=*Sinzowiella* STOYANOW, 1949, p. 101 (type, *S. spathi;* OD)]. Differs from *Parahoplites* in its rigid ribbing and wide, asymmetric L in suture. *Lower Cretaceous (Upper Aptian):* Caucasus, Texas, Arizona.——FIG. 216,*1a–c.* **K. arizonica,* Arizona; *a,b,* ×1; *c,* ×2 (Stoyanow, 1949).

Quitmanites SCOTT, 1940, p. 1048 [**Q. ceratitosus;* OD]. Very evolute; whorl section round. Suture with very wide L with 6 fingerlike folioles. Perhaps an aberrant *Kazanskyella. Lower Cretaceous (Upper Aptian):* Texas.

EXPLANATION OF CORRELATION CHART

The table that follows sets out the stages and substages of the Cretaceous and of the uppermost Jurassic. In order to clarify the usage adopted, zones are also given. The lists of zones are synthesized from those in current use or proposed. For parts of the Lower Cretaceous, in which provincialism was extreme, separate lists for different regions are given. Generic names of zonal index species of ammonites have been amended to accord with the classification used in this volume.

It must be emphasized that these tables do not attempt to give zonal systems for all parts of the world but merely to explain the system of stages in the classic areas in which most of the taxa in the genus and family groups were originally defined. There is not yet a fully agreed-upon system of zones; active discussion continues, particularly over the lower part of the Lower Cretaceous and the highest part of the Upper Cretaceous.

Exact correlation between regions should not be assumed. Indeed, on either side of the Jurassic-Cretaceous boundary, correlation is so uncertain that separate stage names, Volgian and Ryazanian, continue to be employed for boreal regions.

TABLE 1. *Correlation Chart of the Cretaceous.*

	Mediterranean and Submediterranean	Northwestern Europe [belemnite zones for Maastrichtian and Campanian]
Upper Cretaceous	Maastrichtian — Upper: *Anapachydiscus terminus*, *Anapachydiscus fresvillensis*; Lower: *Pachydiscus epiplectus*	Upper: *Belemnella casimirovensis*, *Belemnella junior*; Lower: *Belemnella occidentalis*, *Belemnella lanceolata*
	Campanian — Upper: *Nostoceras hyatti*, *Bostrychoceras polyplocum*, *Hoplitoplacenticeras marroti*; Lower: *Menabites delawarensis*, *Placenticeras bidorsatum*	Upper: *Belemnitella langei*, *Belemnitella minor*, *Belemnitella mucronata*; Lower: *Gonioteuthis quadrata*, *Gonioteuthis granulatoquadrata*
	Santonian — *Placenticeras polyopsis* [There is no satisfactory ammonite subdivision of the Santonian. The stage is more or less equivalent in Aquitaine to a zone of *Placenticeras polyopsis*.]	
	Coniacian	Upper: *Paratexanites serratomarginatus*, *Gauthiericeras margae*; Lower: *Peroniceras tridorsatum*, *Forresteria petrocoriensis*
	Turonian	Upper: *Subprionocyclus neptuni*, *Collignoniceras woollgari*; Lower: *Mammites nodosoides*, *Watinoceras coloradoense*
	Cenomanian	Upper: *Neocardioceras juddii*, *Metoicoceras geslinianum*, *Calycoceras guerangeri*; Middle: *Acanthoceras jukesbrownei*, *Acanthoceras rhotomagense*; Lower: *Mantelliceras dixoni*, *Mantelliceras mantelli*
Lower Cretaceous	Albian	Upper: *Stoliczkaia dispar*, *Mortoniceras inflatum*; Middle: *Euhoplites lautus*, *Euhoplites loricatus*, *Hoplites dentatus*; Lower: *Douvilleiceras mammillatum*, *Leymeriella tardefurcata*
	Aptian — Upper: *Hypacanthoplites jacobi*, *Acanthoplites nolani*; Middle: *Parahoplites melchioris*, *Cheloniceras subnodosocostatum*; Lower: *Dufrenoyia furcata*, *Deshayesites deshayesi*, *Deshayesites weissi*, *Deshayesites tuarkyricus*	Upper: *Hypacanthoplites jacobi*, *Parahoplites nutfieldiensis*, *Cheloniceras martinoides*; Lower: *Tropaeum bowerbanki*, *Deshayesites deshayesi*, *Deshayesites forbesi*, *Prodeshayesites fissicostatus*
	Barremian — Upper: *Martelites sarasini*, *Heteroceras giraudi*, *Hemihoplites feraudianus*, *Heinzia sartousiana*, *Ancyloceras vandenheckii*; Lower: *Holcodiscus caillaudianus*, *Subpulchellia nicklesi*, *Spitidiscus hugii*	Upper: *Parancyloceras bidentatum*, *Hemicrioceras rude*, *Crioceratites sparsicostata*, *Crioceratites denckmanni*; Lower: *Crioceratites elegans*, *Hoplocrioceras fissicostatum*, *Crioceratites rarocinctum*

TABLE 1. *(Continued).*

		Mediterranean and Submediterranean	Northwestern Europe
Lower Cretaceous	Hauterivian	Upper: *Pseudothurmannia angulicostata*, *Balearites balearis*, *Plesiospitidiscus ligatus*, *Subsaynella sayni* Lower: *Lyticoceras nodosoplicatum*, *Crioceratites loryi*, *Acanthodiscus radiatus*	Upper: *Simbirskites marginatus*, *Simbirskites gottschei*, *Simbirskites spetonensis* Lower: *Simbirskites inversum*, *Lyticoceras regale*, *Lyticoceras noricum*, *Lyticoceras amblygonium*
	Valanginian	Upper: *Neocomites pachydicranus*, *Saynoceras verrucosum* Lower: *Neocomites campylotoxus*, *Thurmanniceras pertransiens*, *Thurmanniceras otopeta*	Upper: *Olcostephanus densicostatus*, *Stoicoceras tuberculatum*, *Dichotomites bidichotomoides*, *Dichotomites triptychoides*, *Dichotomites crassus*, *Dichotomites polytomus*, *Dichotomites hollwedensis* Lower: *Polyptychites hapkei*, *Polyptychites clarki*, *Polyptychites multicostatus*, *Polyptychites pavlowi*, *Platylenticeras involutum*, *Platylenticeras heteropleurum*, *Platylenticeras robustum*
	Berriasian	Upper: *Subthurmannia boissieri* Lower: *Subthurmannia occitanica*, *Berriasella euxinus*	Ryazanian Upper: *Peregrinoceras albidum*, *Surites stenomphalus*, *Surites icenii* Lower: *Hectoroceras kochi*, *Runctonia runctoni*
Upper Jurassic	Tithonian	Upper: *Durangites spp.*, *Micracanthoceras microcanthum* Lower: *Micracanthoceras ponti*, *Semiformiceras fallauxi*, *Semiformiceras semiforme*, *Neochetoceras darwini*, *Hybonoticeras hybonotum*	Upper Volgian: *Subcraspedites lamplughi*, *Subcraspedites preplicomphalus*, *Subcraspedites primitivus* Portlandian: *Paracraspedites oppressus*, *Titanites giganteus*

TABLE 1. *(Continued).*

Volga Basin and Russian Platform	Northern Siberia
Hauterivian Upper { *Simbirskites decheni* Lower { *Simbirskites versicolor*	Lower { *Homolsomites bojarkensis*
Valanginian Upper { *Polyptychites keyserlingi* Lower { *Nikitinoceras hoplitoides* *Pseudogarnieria undulatoplicatilis*	Upper { *Dichotomites bidichotomus* Lower { *Polyptychites stubendorfi* *Polyptychites astieriptychus* *Polyptychites quadrifidus* *Tollia klimovskiensis*
Ryazanian Upper { *Surites spasskensis* Lower { *Riasanites ryazanensis*	Upper { *Surites mesezhnikovi* *Surites analogus* Lower { *Hectoroceras kochi* *Chetaites sibiricus*
Volgian Upper { *Craspedites nodiger* *Craspedites subditus* *Kashpurites fulgens* Middle { *Epivirgatites nikitini* *Virgatites virgatus* *Dorsoplanites panderi* Lower { *Howaiskya pseudoscythica* *Howaiskya sokolovi* *Howaiskya klimovi*	Upper { *Chetaites chetae* *Craspedites taimyrensis* *Craspedites okensis*

RANGES OF TAXA

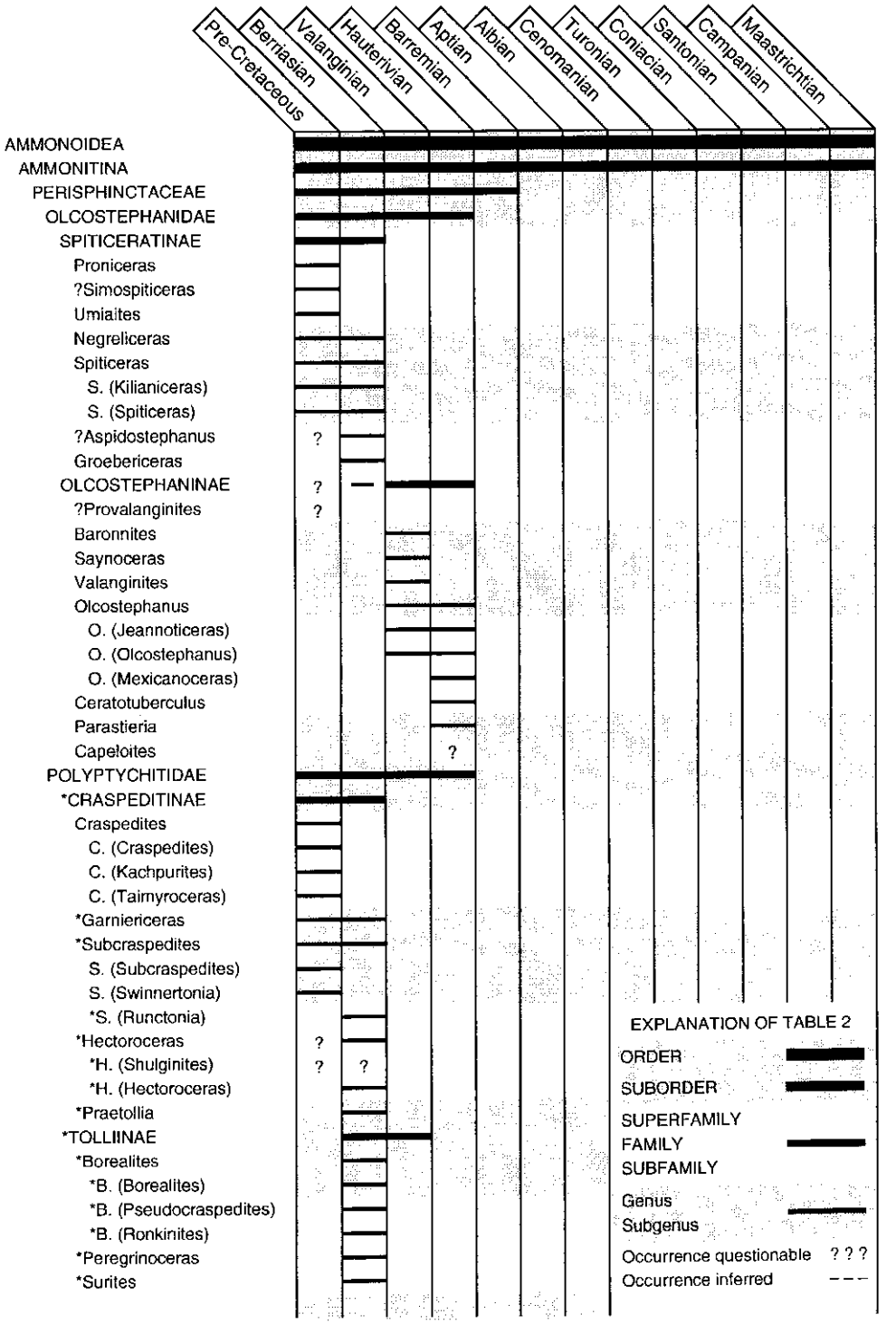
The stratigraphic distribution of the Cretaceous Ammonoidea recognized in this volume is shown graphically in the range chart (Table 2). Genera and subgenera belonging to the largely Jurassic Phylloceratina and Lytoceratina (Lytocerataceae) are only listed herein (see p. 1) and are not included in the range chart. Stratigraphic information about these taxa can be obtained from the text. Similarly, taxa designated in the text as *nomina dubia* or *nomina nuda* are not included in the chart.

The stratigraphic ranges older than the Cretaceous have been grouped into a single category, "pre-Cretaceous." For more detailed stratigraphic information, see the systematic section of the volume. Taxa that are preceded by an asterisk (e.g., *Garniericeras*) occur in the Ryazanian rather than the Berriasian, as indicated on the chart. As was discussed elsewhere, these two time units are not perfectly congruent, although they are largely correlative.

The following chart was compiled using software developed for the Paleontological Institute by Kenneth C. Hood and David W. Foster.

It must be emphasized that the order of taxa in this chart is governed entirely by their stratigraphic range and, within that, by alphabetical order and differs in some cases from the taxonomic order in the systematic part of the volume. No taxonomic conclusions should be drawn from the position of taxa in this chart.

TABLE 2. *Stratigraphic Distribution of the Cretaceous Ammonoidea.*



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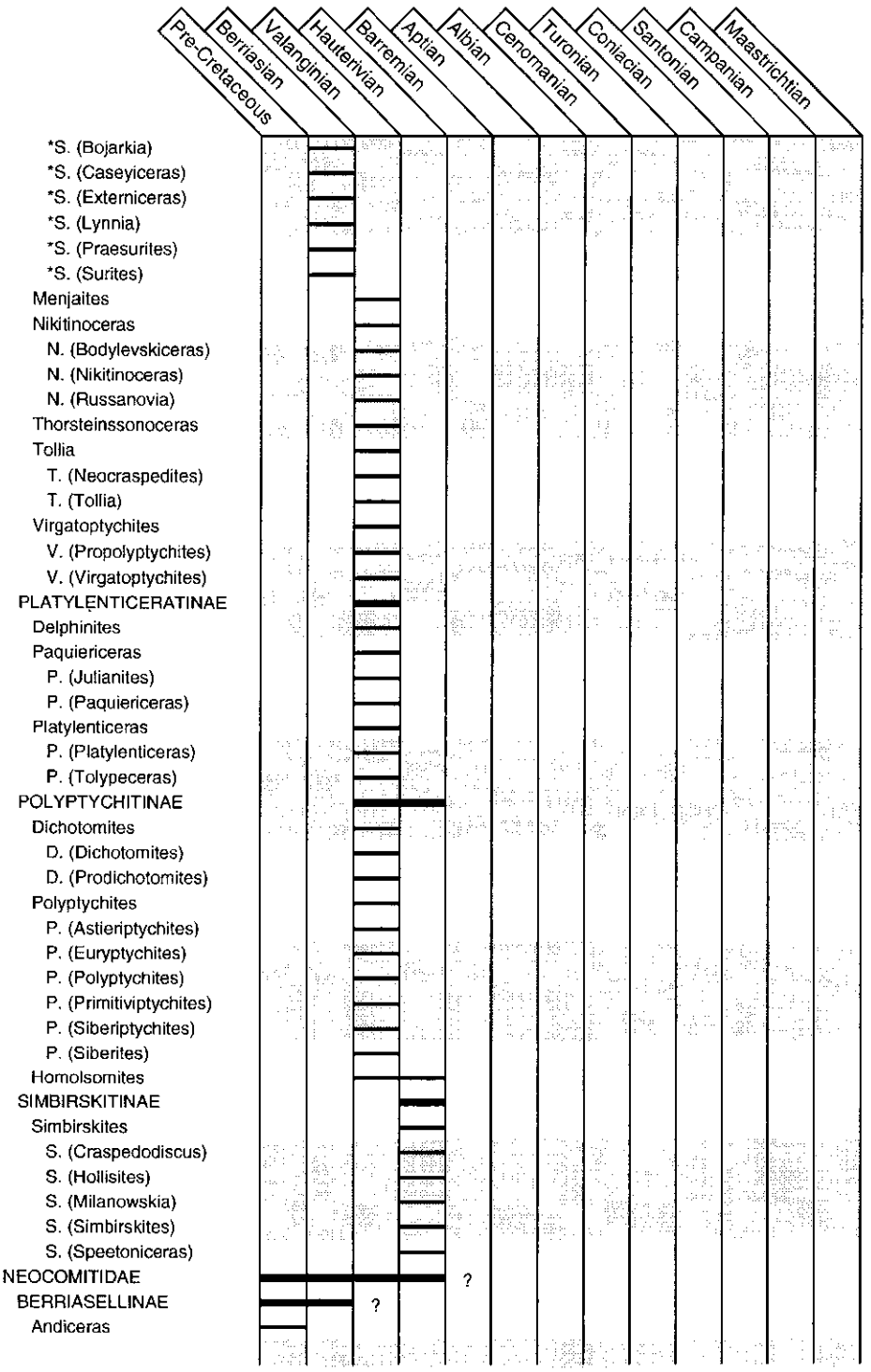

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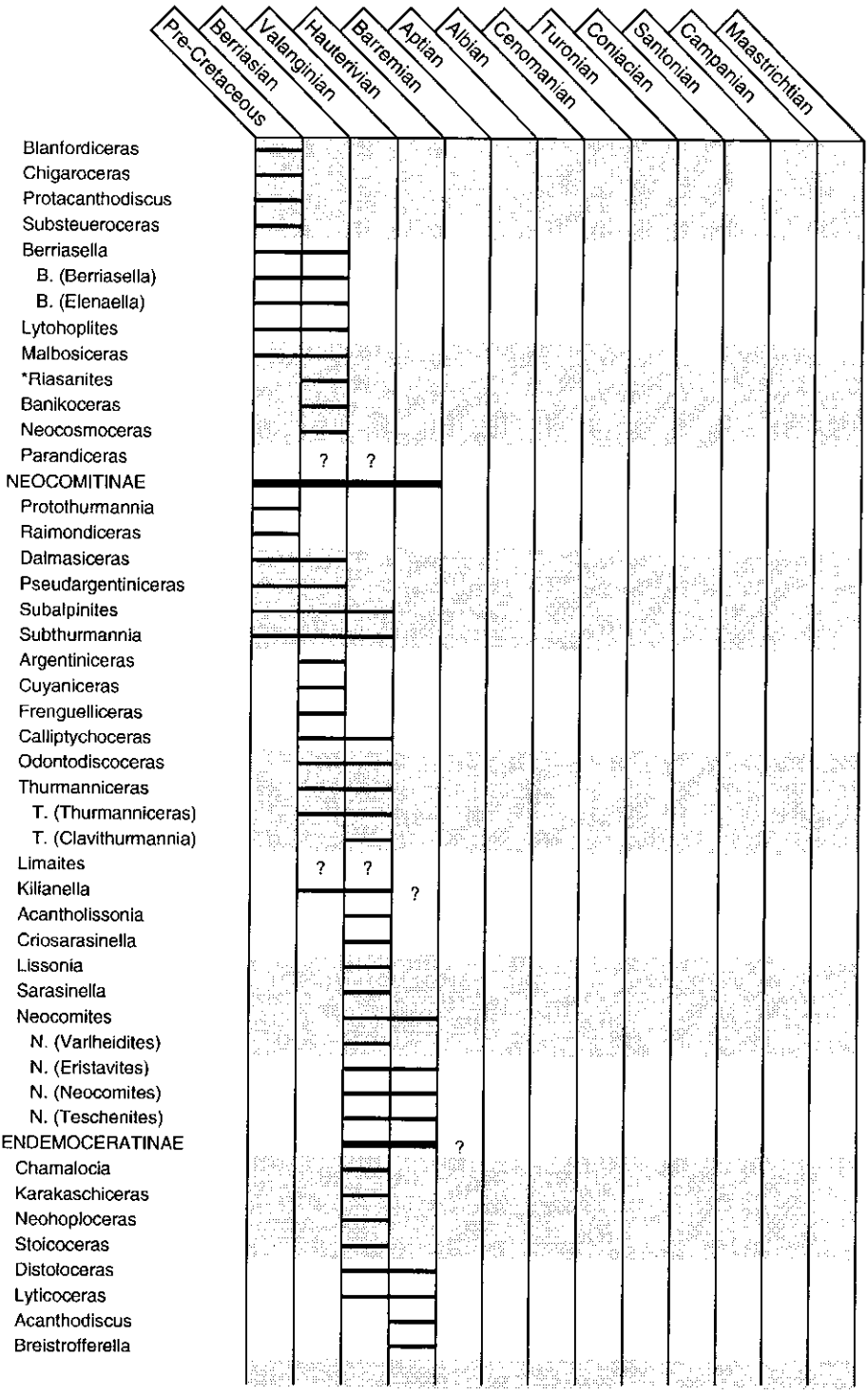

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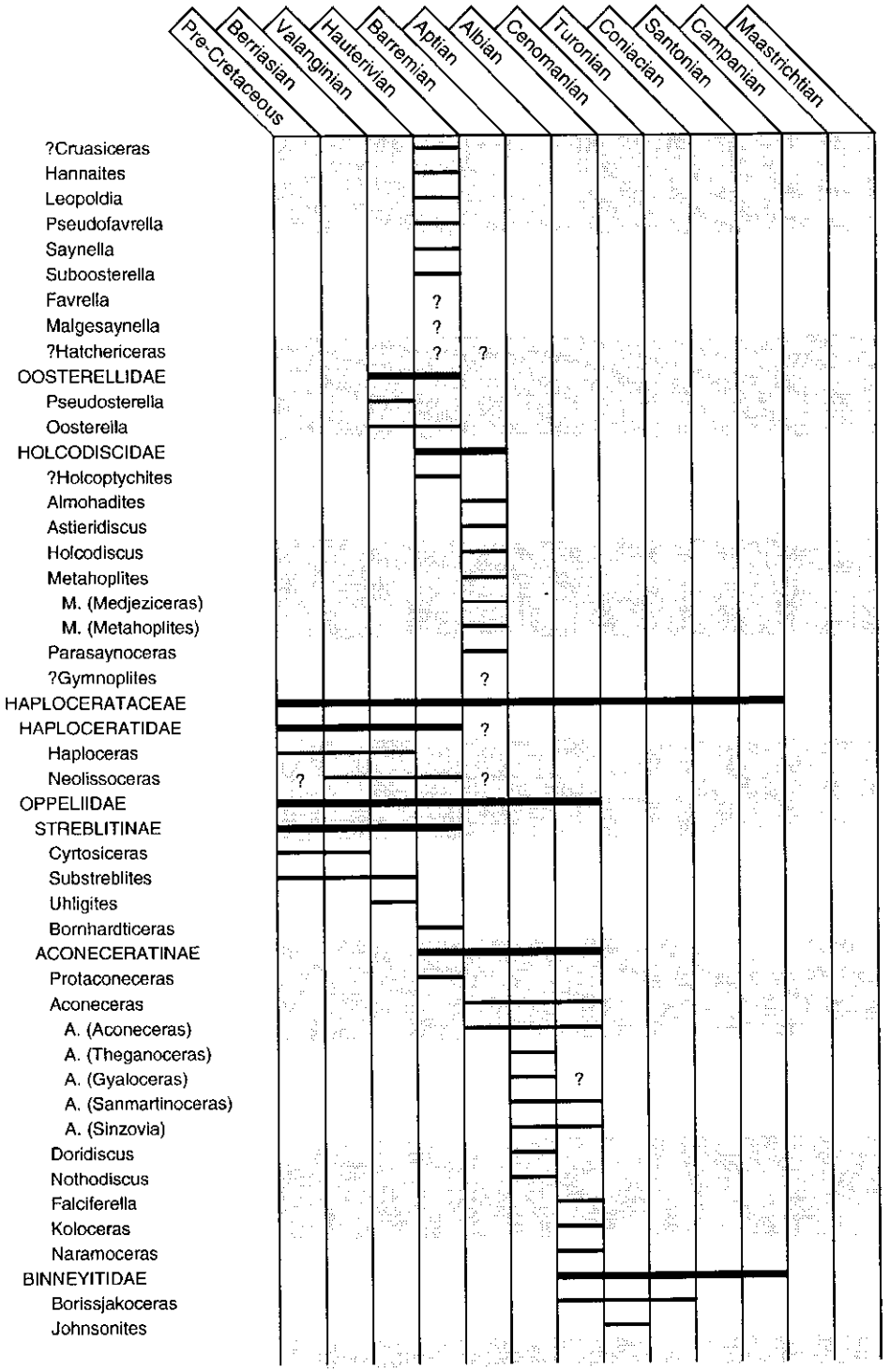

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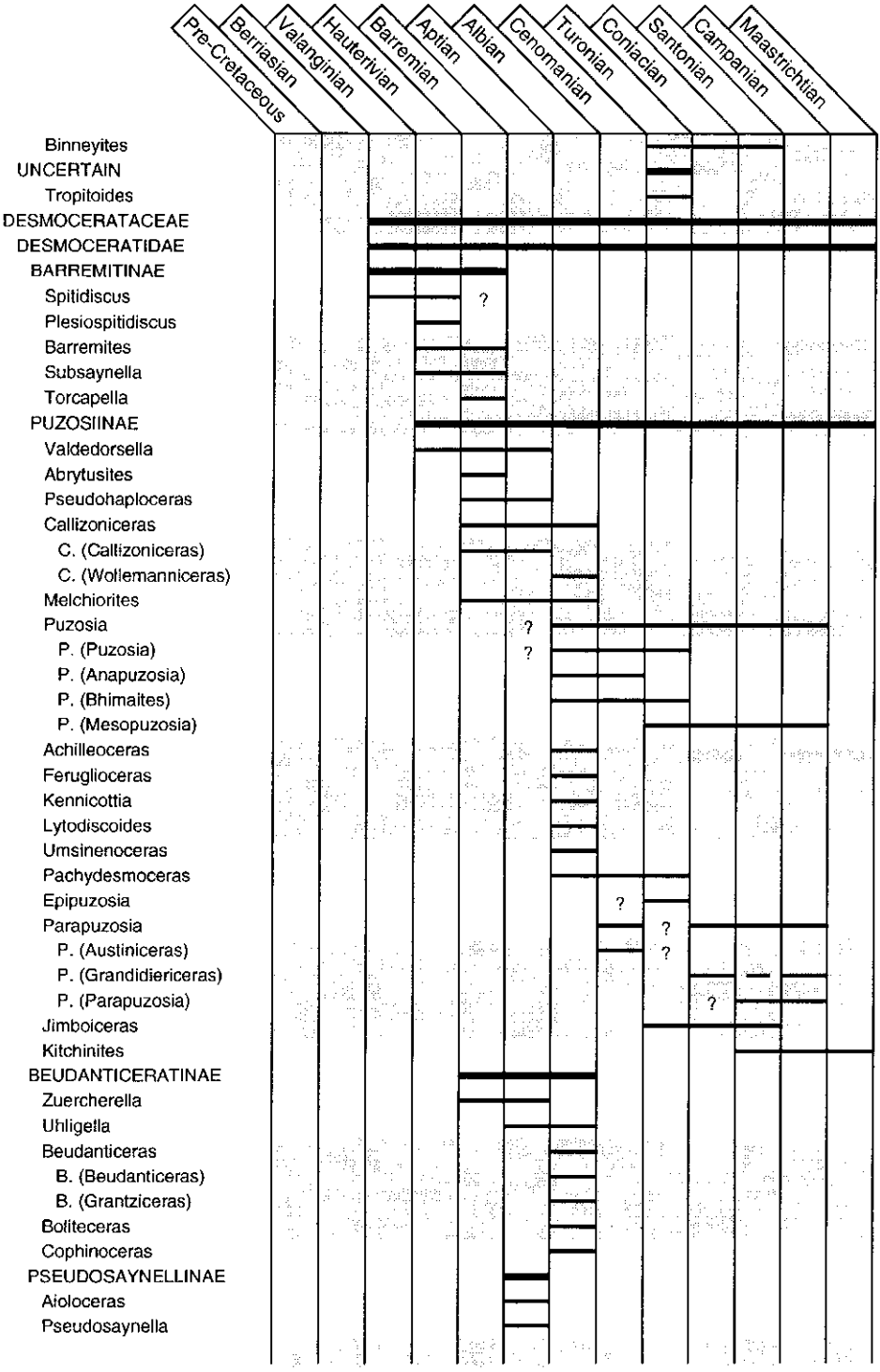

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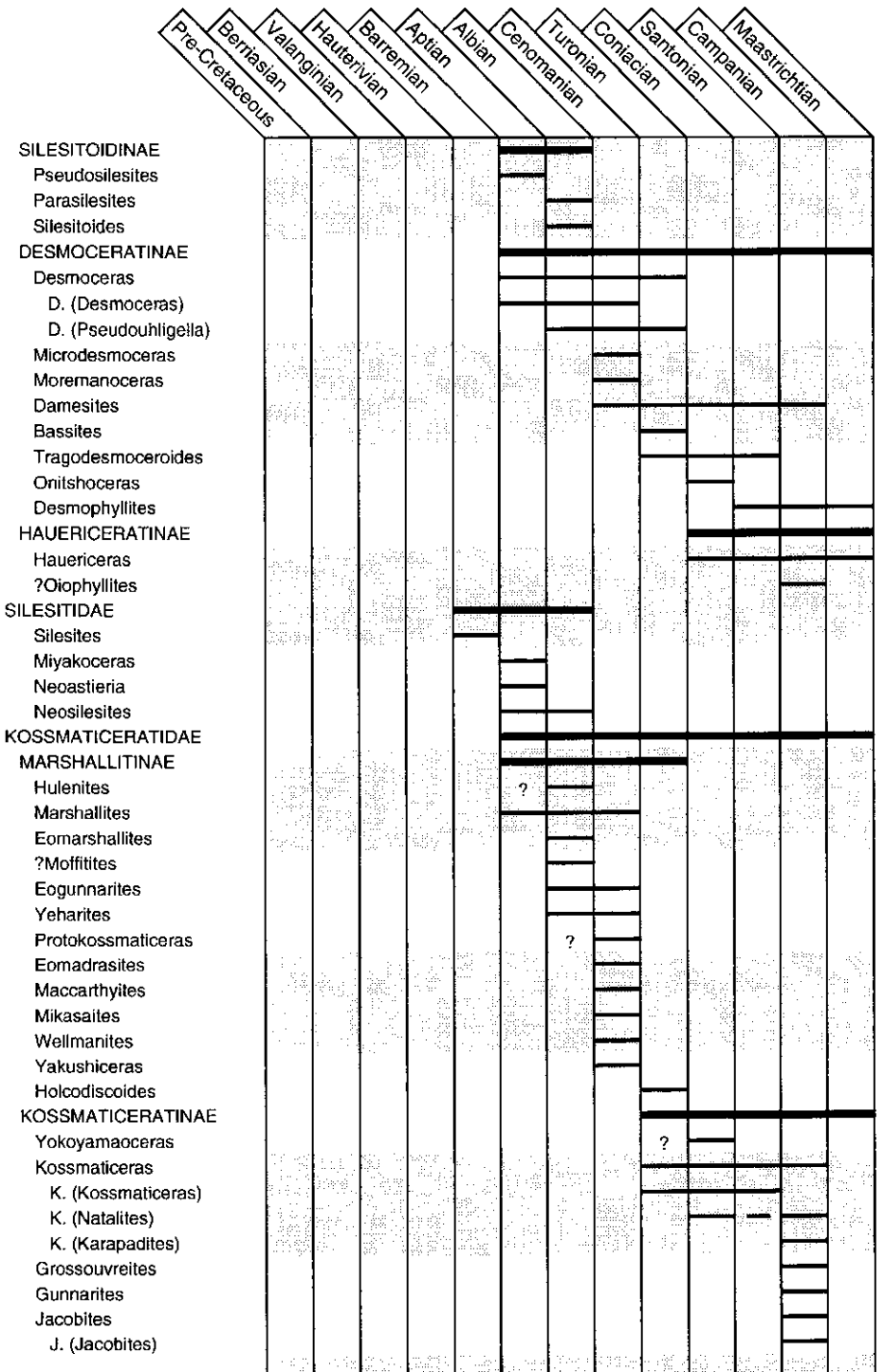

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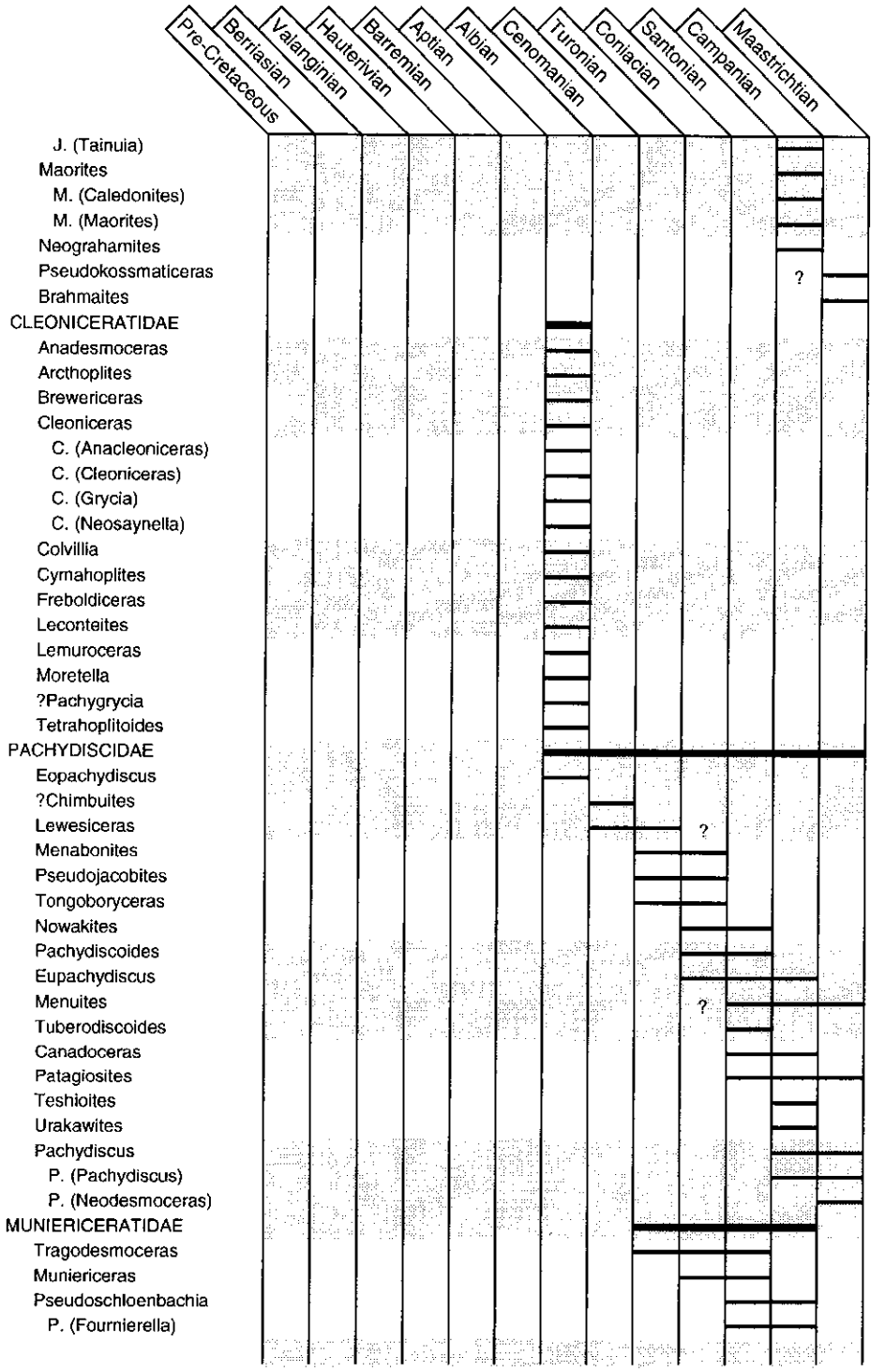

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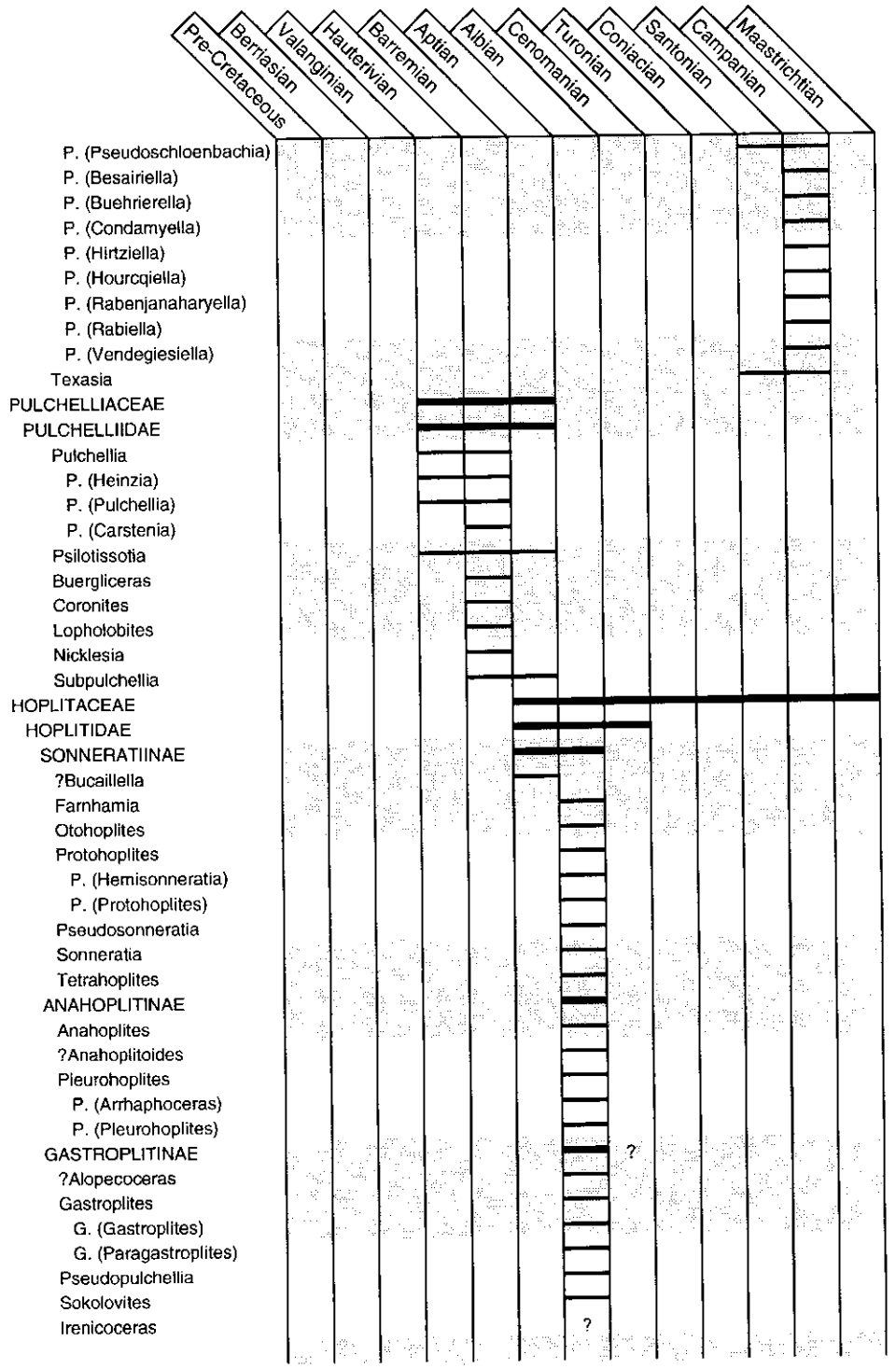

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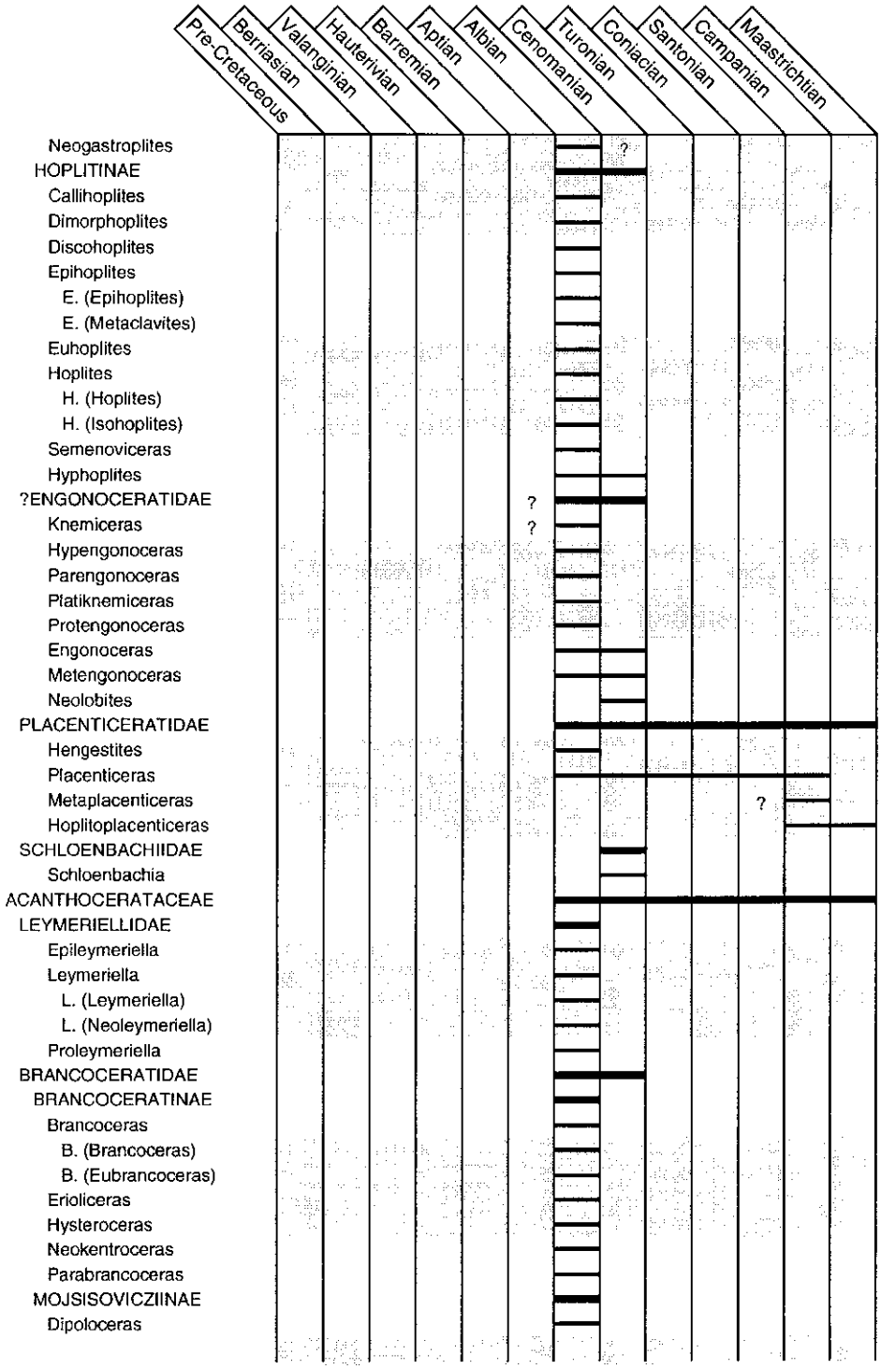

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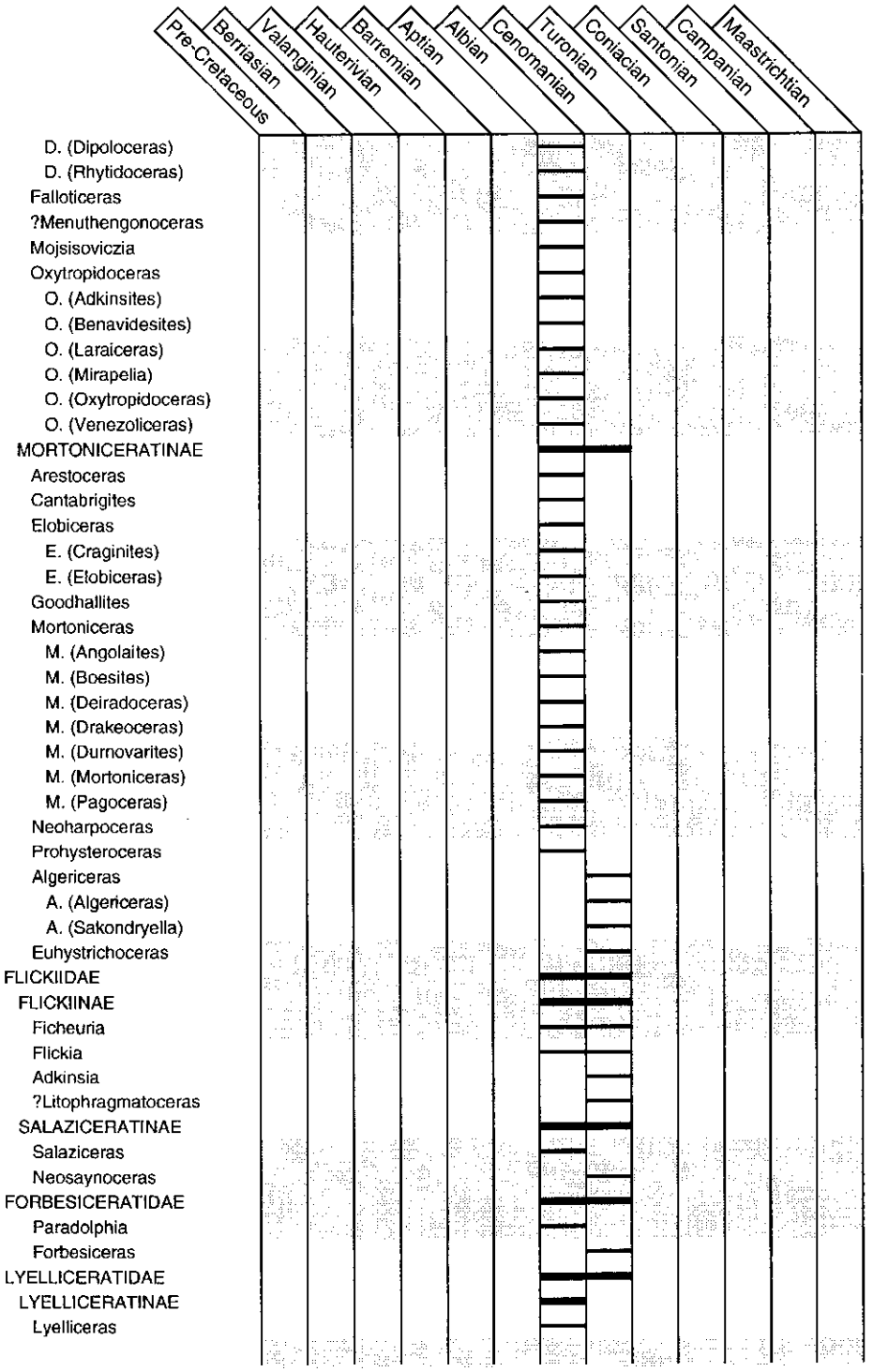

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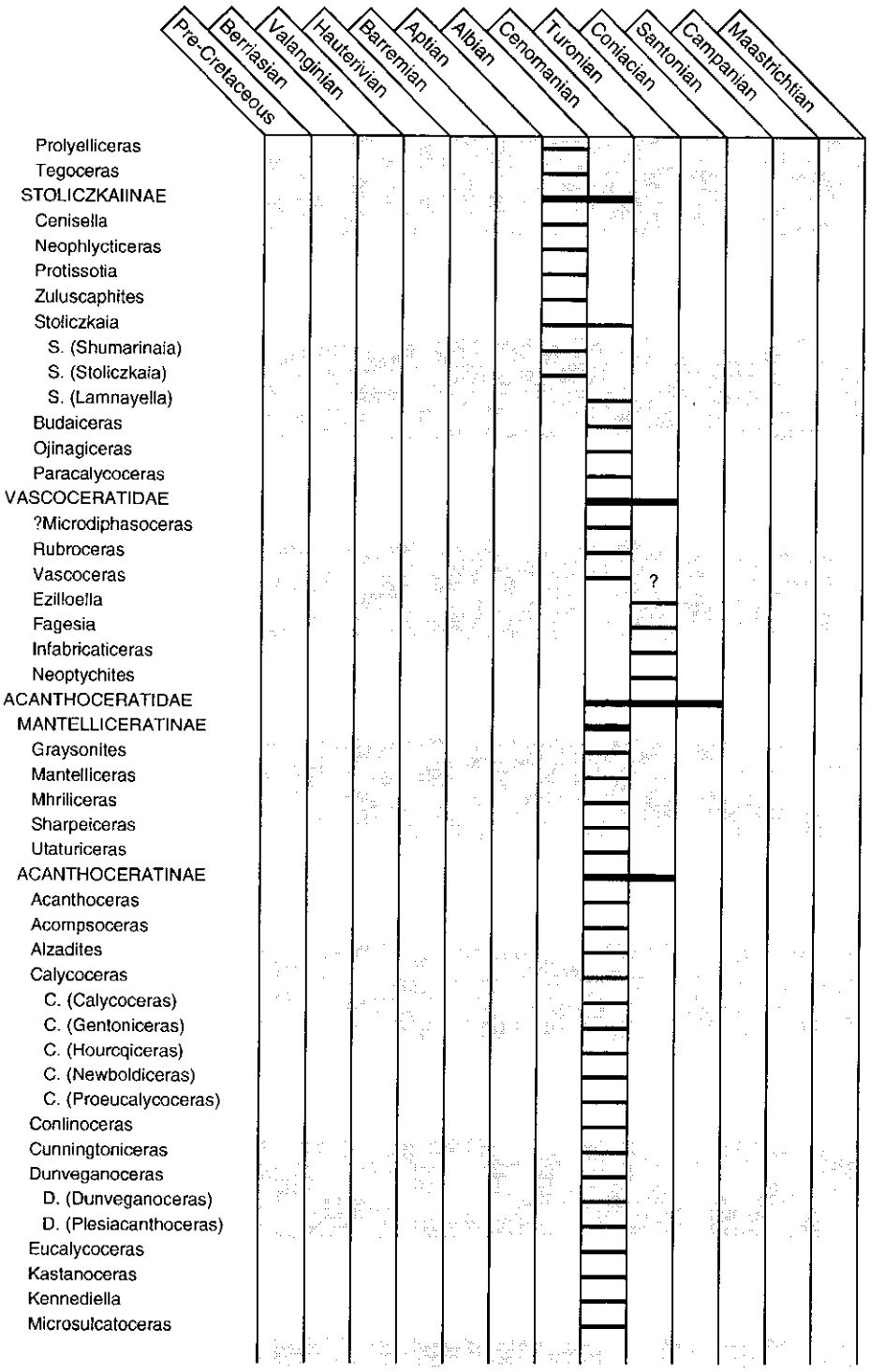

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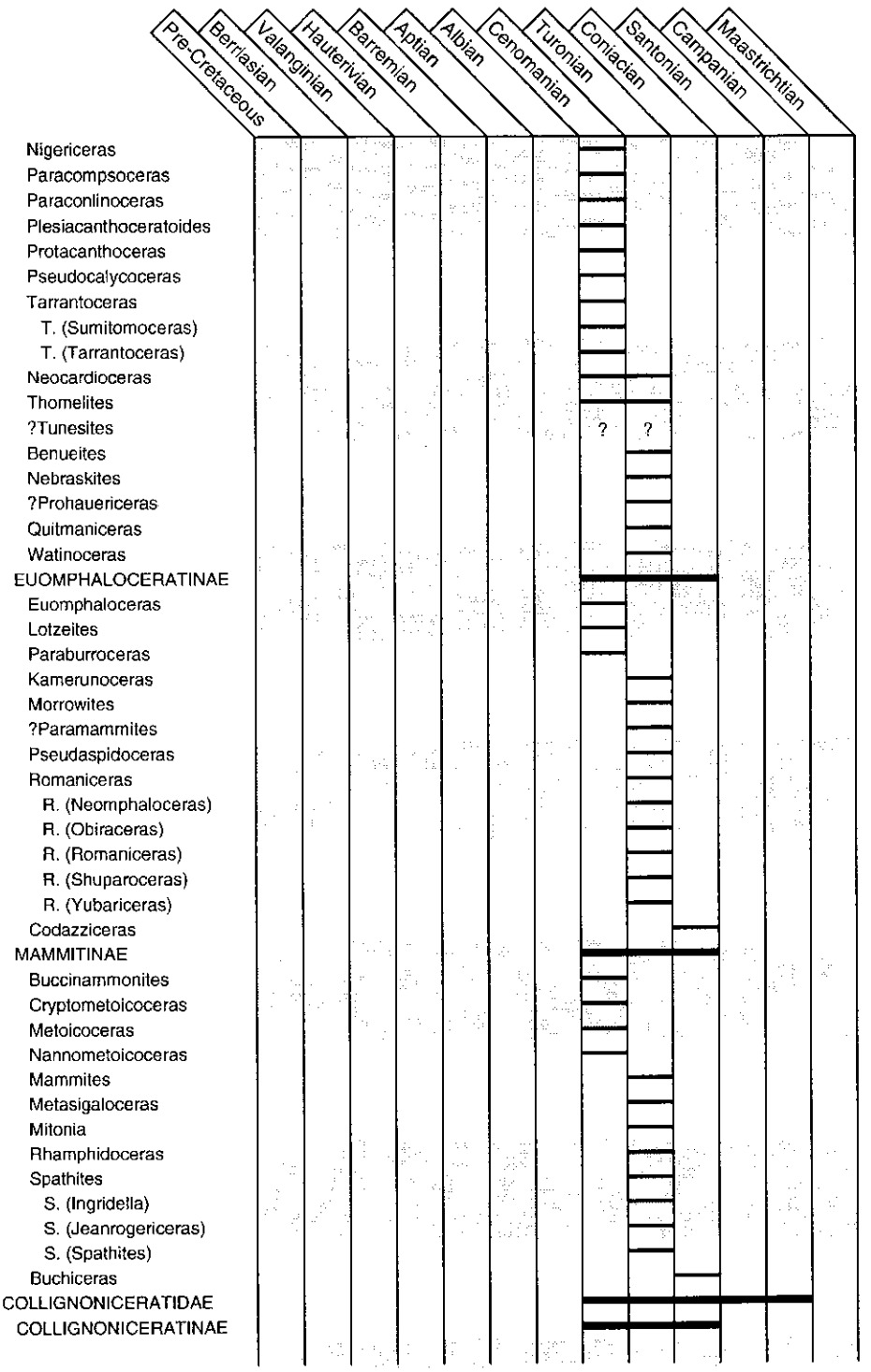

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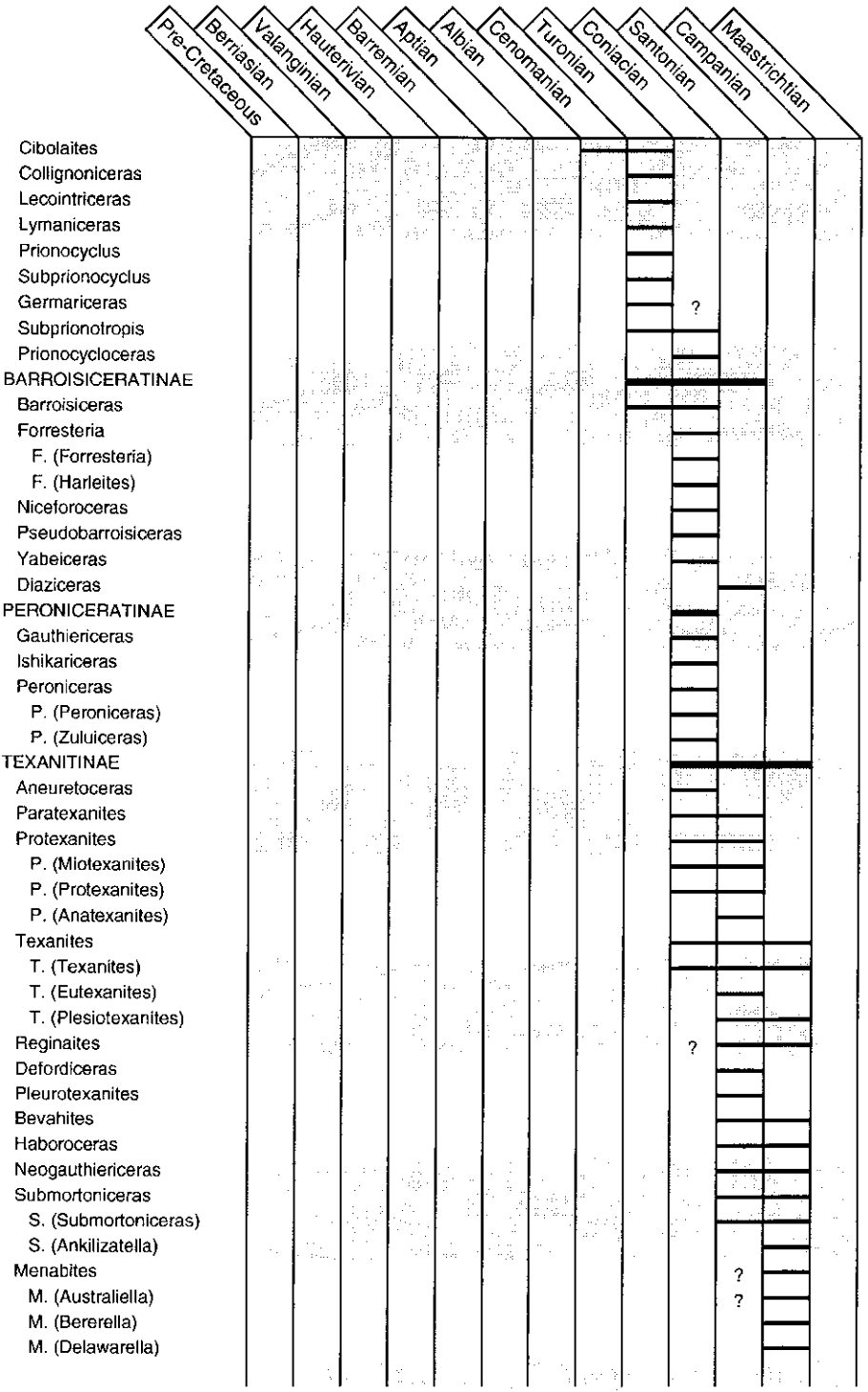

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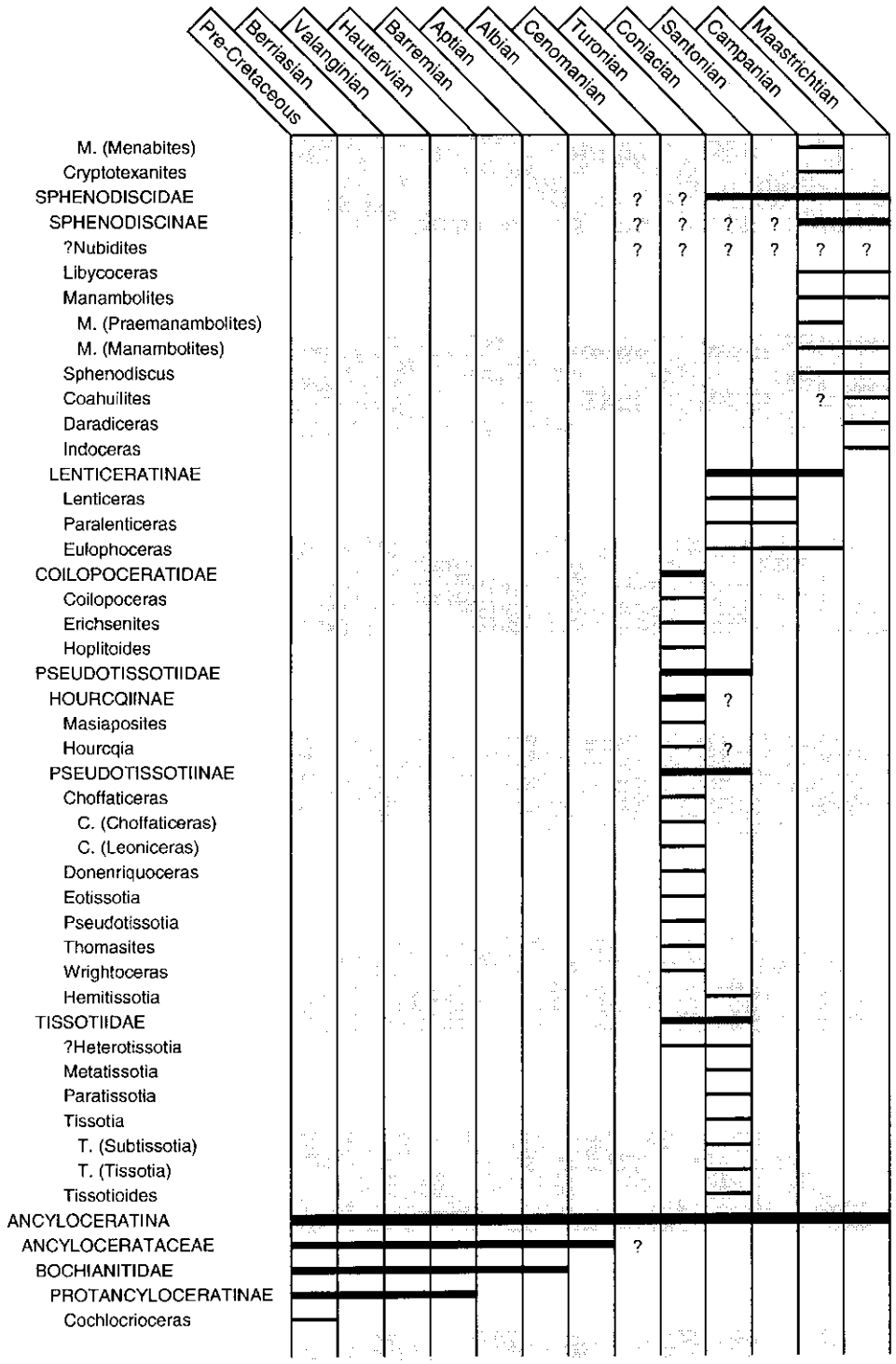

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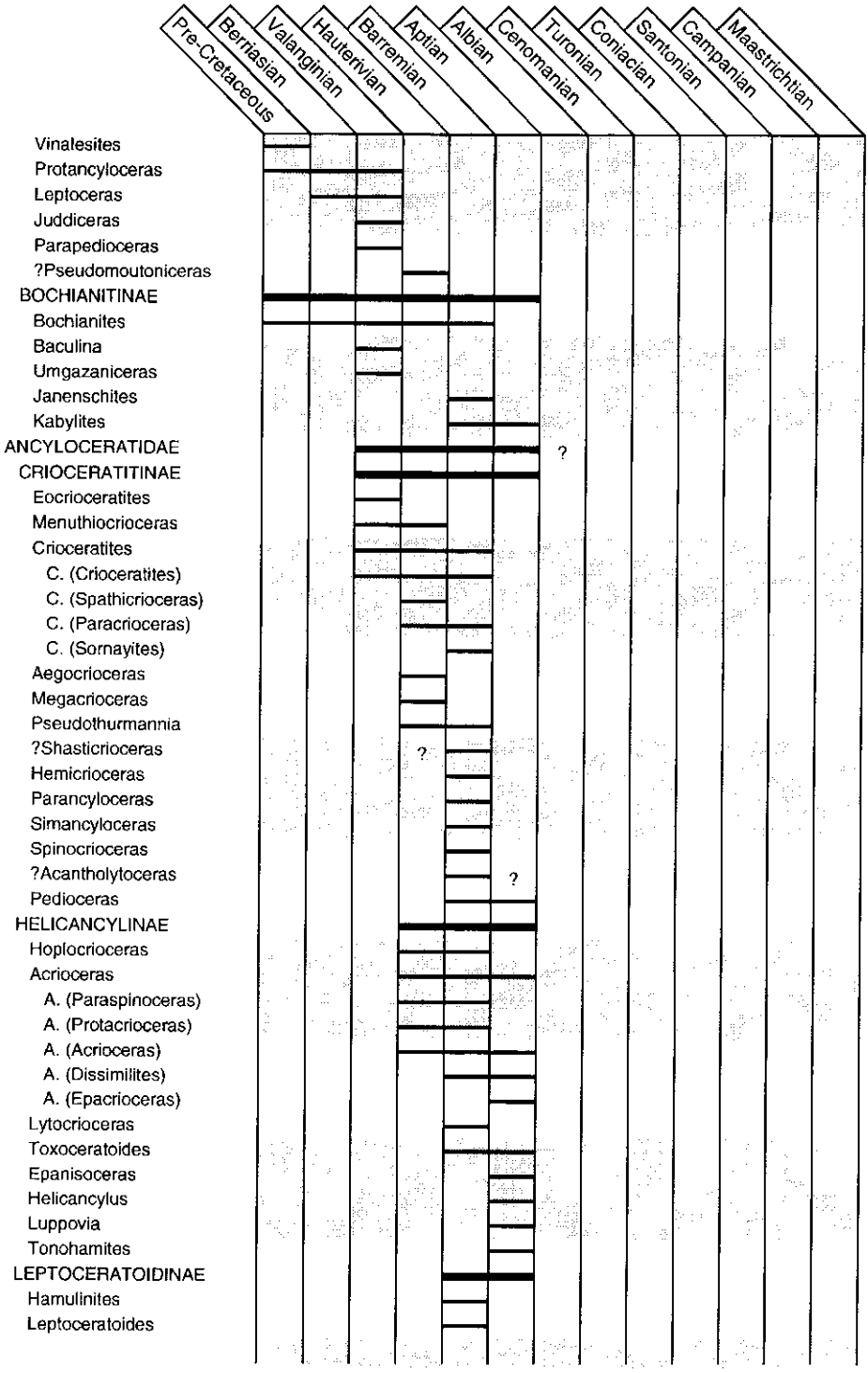

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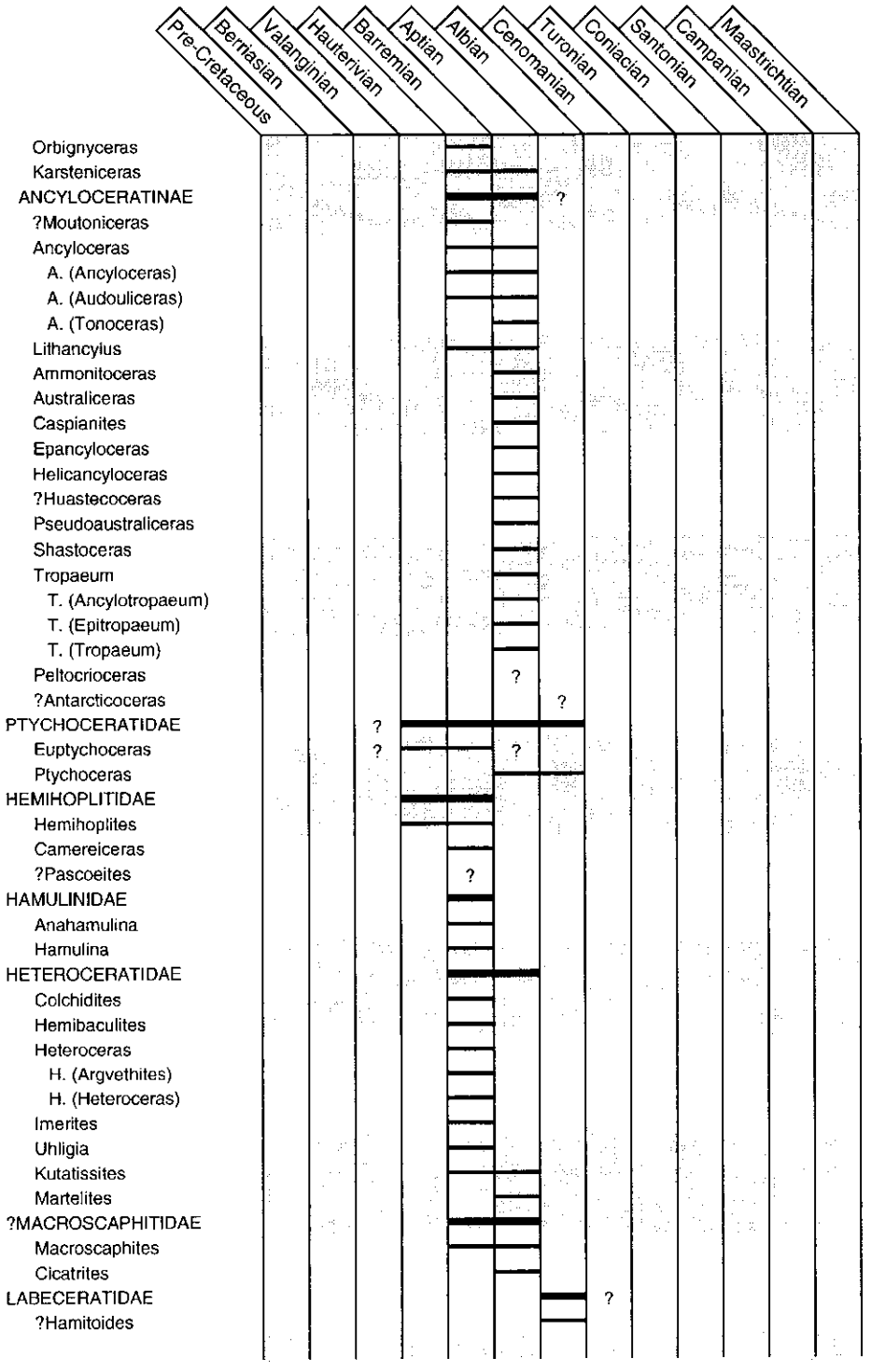

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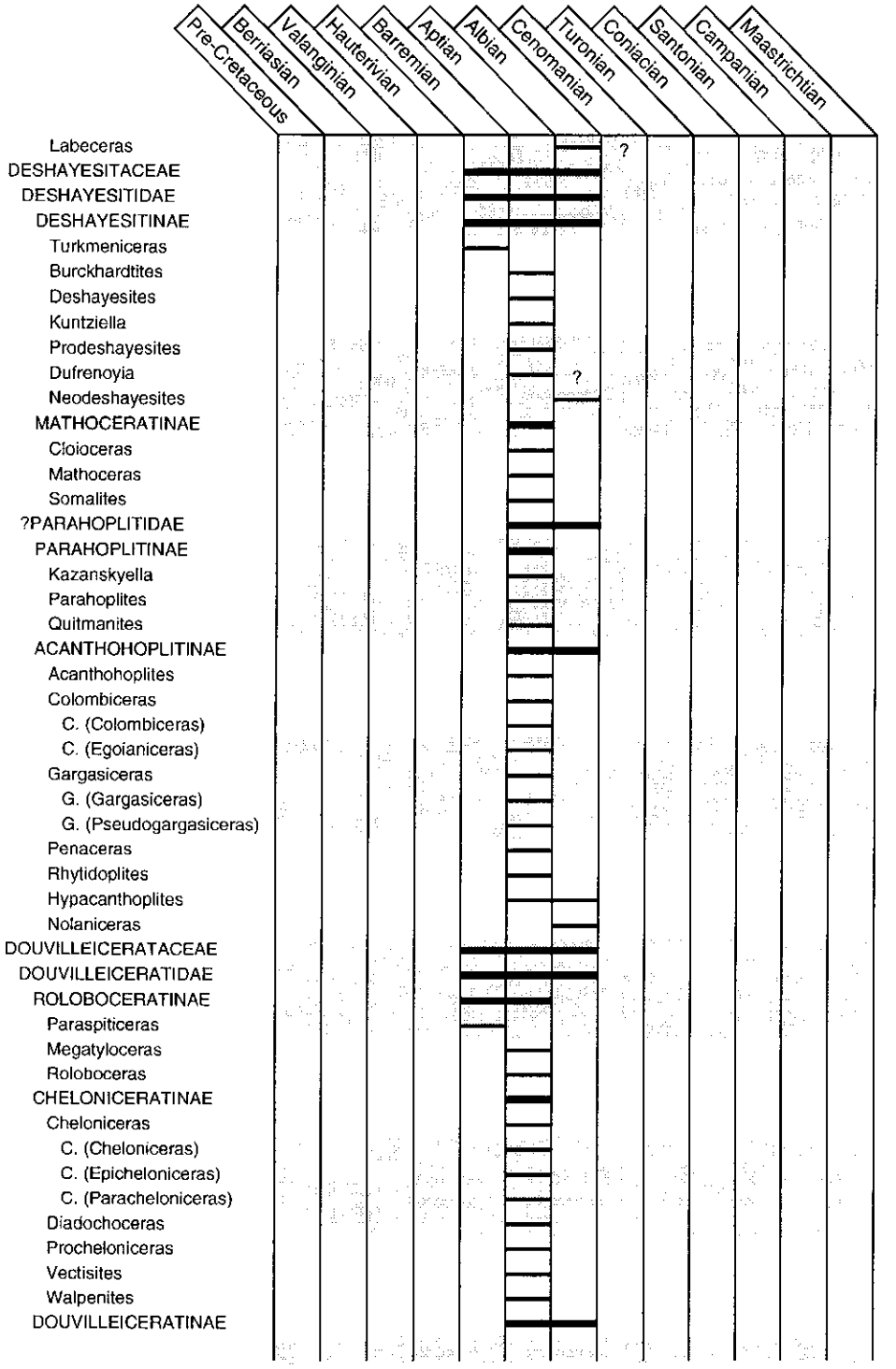

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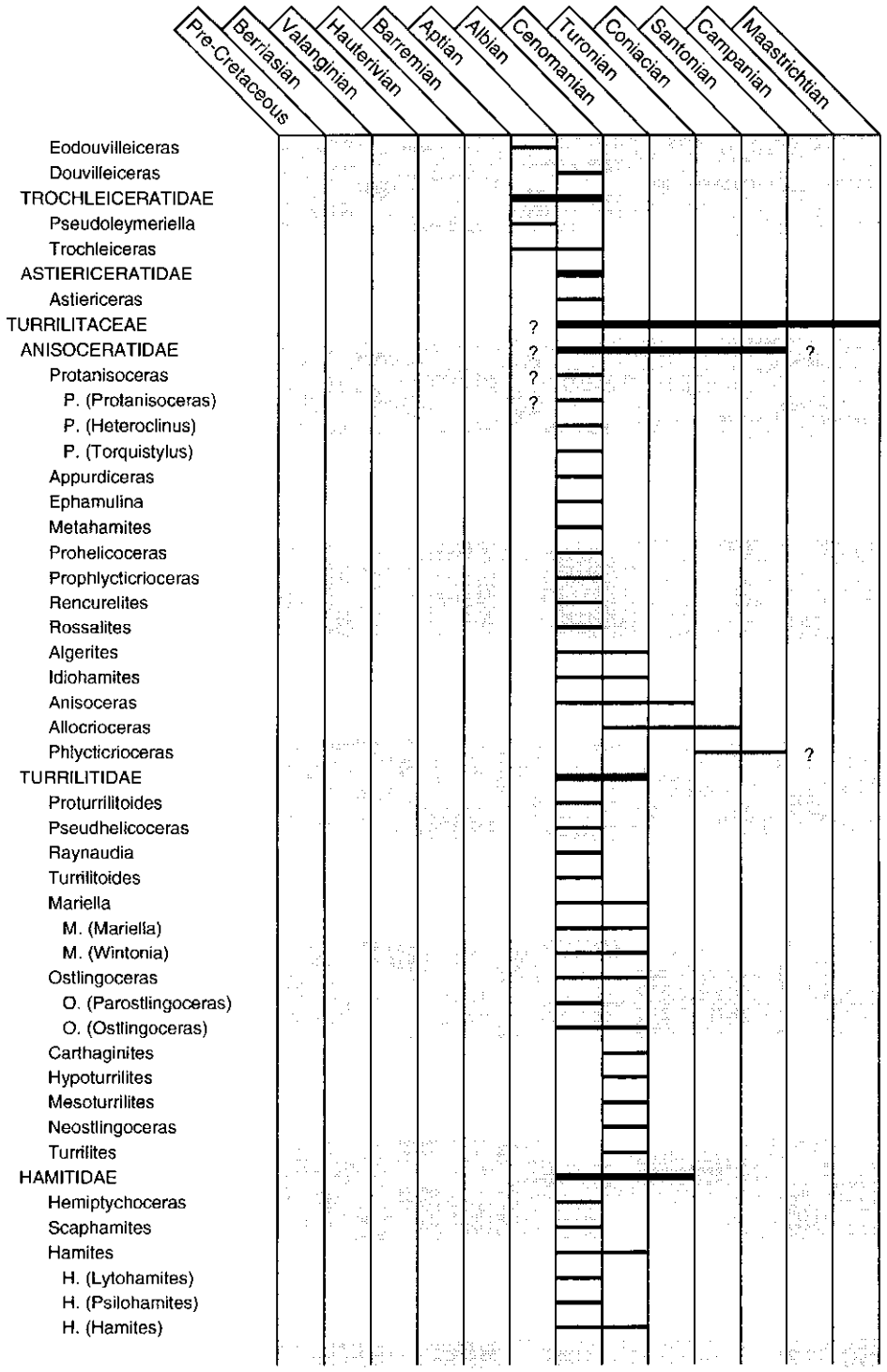

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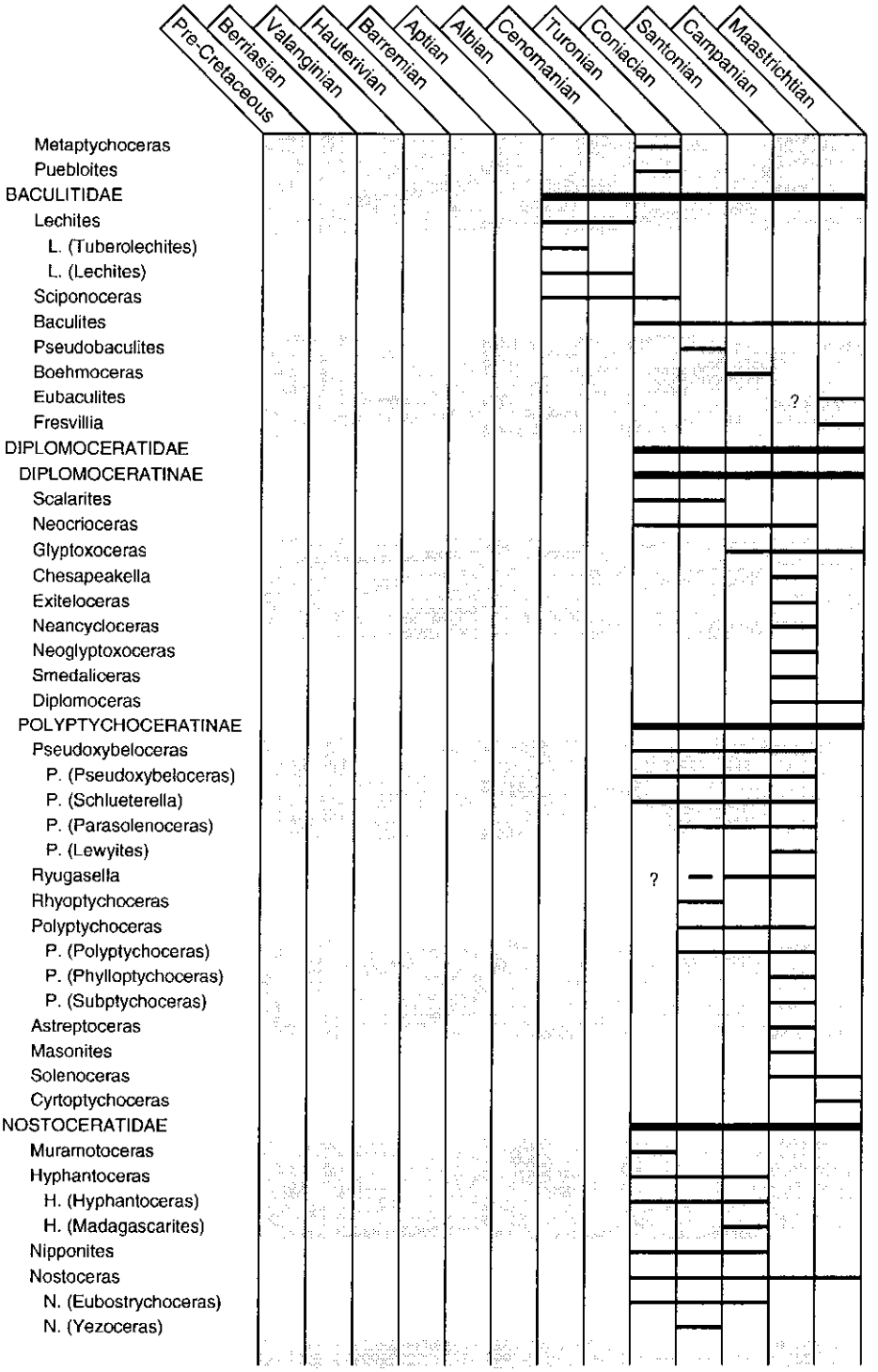

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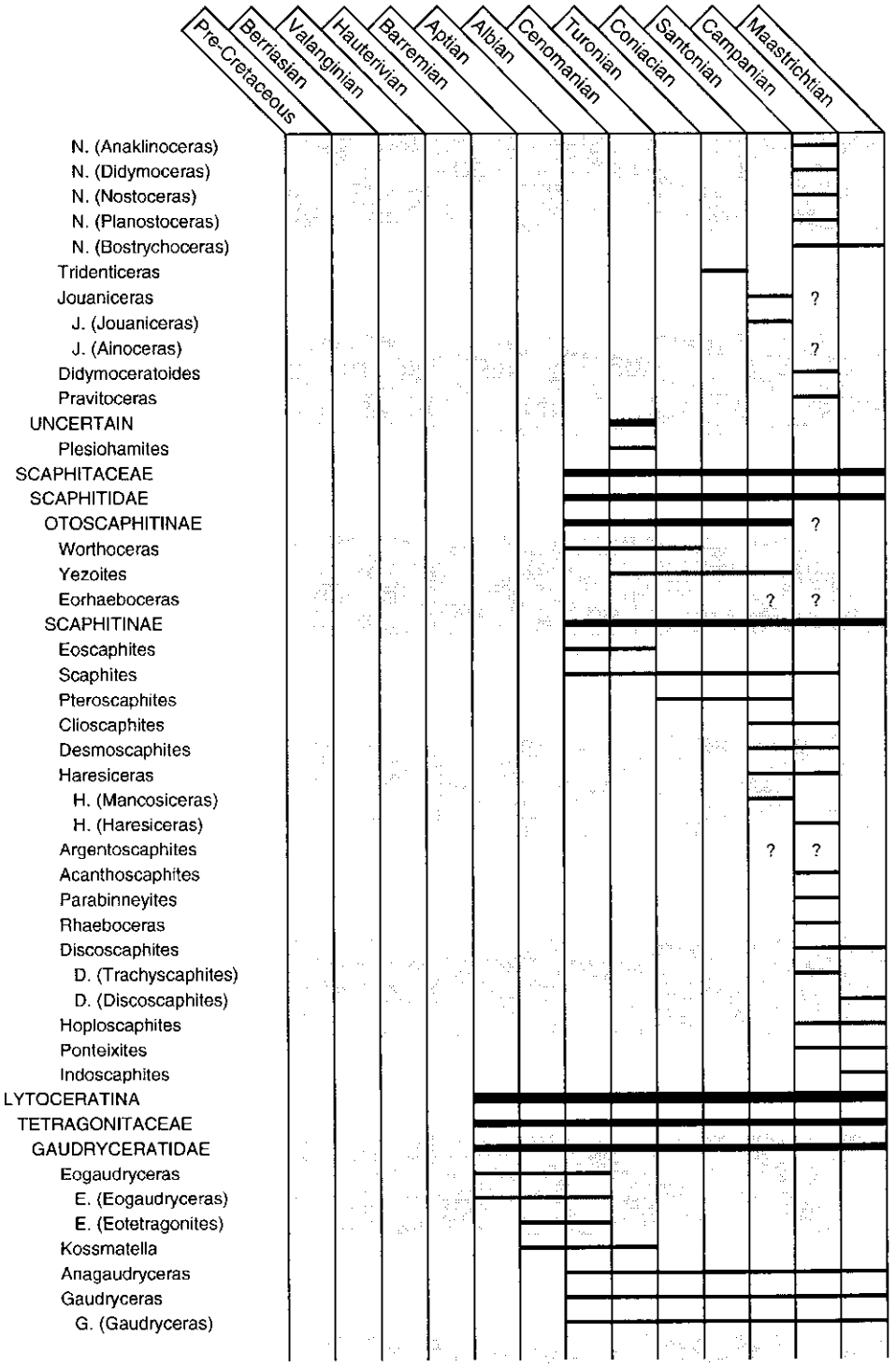

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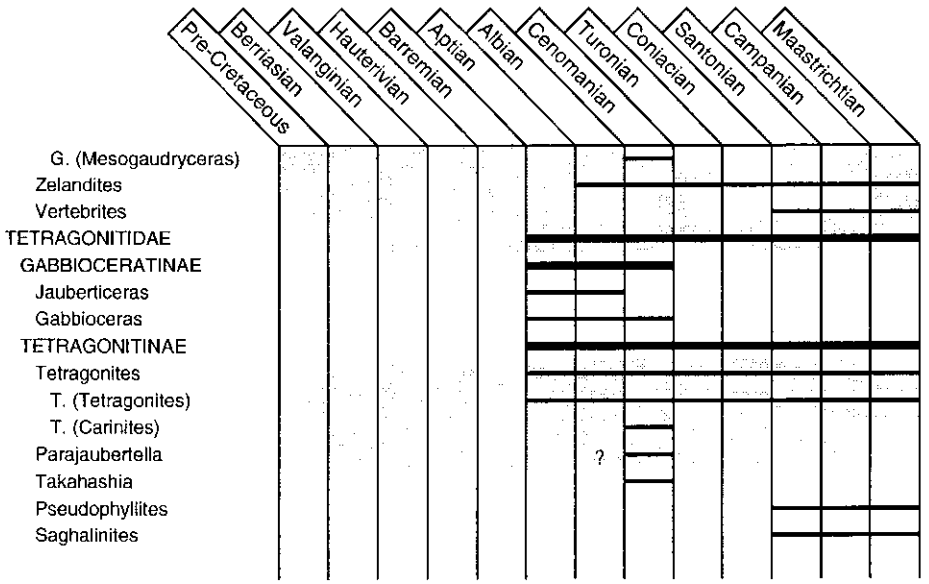

GLOSSARY OF MORPHOLOGICAL TERMS

accessory (lobe or saddle). Secondary or minor element of sutures.

acute (periphery). With sides of shell meeting at sharp angle without shoulders.

adapertural. See adoral.

adapical. Toward apex of shell; backward direction.

adoral. Toward mouth of ammonoid or aperture of shell; forward direction (syn., adapertural).

adoral septum. See last septum.

adventitious (or adventive) lobe. Lobe of suture formed secondarily by subdivision of 1st lateral saddle.

aigrettes (French). See feather structure.

ammonitella. The earliest formed part of the ammonoid shell, consisting of the protoconch plus the first whorl, ending at the primary constriction and believed to represent the stage of growth at which the animal hatched.

ammonitic (suture). With all lobes and saddles of suture denticulate or frilled.

ammoniticone. Coiled in a plane, normally equiangular spiral with whorls in contact or overlapping.

anaptychus. Lower mandible, formerly interpreted as an operculum.

ancyloceratoid. See ancylocone.

ancylocone. Coiled in an initial crioconic spire followed by straight or curved shaft and terminal hook (syn., ancyloceratoid).

aperture. Open end of body chamber of shell (syn., mouth).

apical chamber. See protoconch.

approximated (ribs). Crowded together.

approximated (sutures). Crowded together toward body chamber, usually taken to indicate maturity of growth.

aptychus. One of a symmetrical pair of plates forming or replacing the lower mandible of some ammonoids from the Middle Jurassic onwards.

auricle. See lappet.

auxiliary (lobe or saddle). Lateral lobe or saddle of suture springing from umbilical lobe or saddle between second lateral and umbilical seam.

baculicone. Shell that is straight apart from small, initial, coiled portion (as in *Baculites*).

bicarinate. With two keels on venter.

biconcave (rib). With two distinct portions concave toward aperture.

biconvex (rib). With two distinct portions convex toward aperture.

bidichotomous. Rib that bifurcates, each branch of which then bifurcates again.

bifurcate (rib). Dividing into two branches toward venter (syn., biplicate).

biplicate. See bifurcate.

bisulcate. With two longitudinal grooves.

body chamber. Large, undivided space in shell extending adapically from aperture to last septum, inhabited by living animal (syn., chamber, living chamber).

bulla. Tubercle that is elongated radially (adj., bullate).

bundled (ribs). United in bunches or sheaves at or near umbilical edge, usually at a tubercle (see fasciculate).

cadicone. Depressed, barrel-shaped shell with more or less evolute coiling, wide venter, and craterlike umbilicus (as in *Cadoceras*).

camera. Compartment between two adjacent septa, comprising one of the spaces into which entire shell between protoconch and body chamber is divided by the septa (syn., chamber).

capricorn. Shell encircled by distant, blunt ribs and subequal, rounded interspaces, resembling a goat's horn (as in *Androgynoceras capricornus*).

carina. See keel.

carinate. Bearing a keel.

ceratitic (suture). With rounded, unbroken saddles and denticulate lobes (as in *Ceratites;* syn., unipolar).

chamber. See body chamber, camera.

chevron. V-shaped ridge on shell surface, commonly on venter.

clavus. Tubercle elongated in direction of coiling (longitudinally) (adj., clavate).

collared (aperture). Encircled by flared rib and constriction directly behind peristome.

compressed (whorl section). Higher than wide.

concave (side or venter). Broadly impressed; concave rib, bowed away from aperture.

conch. Complete shell of ammonoid less the protoconch.

connecting ring. Porous section of siphuncle between two adjacent septal necks, believed to have been originally of chiefly organic composition.

constricted (aperture). Encircled by constriction directly behind peristome.

constriction. Depression encircling a whorl.

contracted (peristome). With diameter smaller than that of body chamber.

convergent (whorl sides). Converging toward venter.

convex (rib). Bowed toward aperture.

coronate. With whorl section resembling a crown viewed from side.

costa. See rib.

crioconic. Coiled in plane, equiangular spiral, loose or tight, with whorls not in contact.

cruciform. Cross-shaped.

cuneiform. Wedge-shaped.

cyrtocone. Shell curved without completing a single whorl.

dense (ribs). Closely spaced.

dependent. See retracted.

depressed (whorl section). Wider than high.

dimensions. Dimensions of normally coiled (planispiral) shells are conventionally given in the following order: diameter, whorl height, whorl thickness, umbilical diameter. Measurements are given in millimeters. The last three measurements are usually expressed as percentages of the diameter.

dimorphic. Descriptive term for ammonoid species comprising two distinct shell forms, usually of

different sizes and termed the macroconch and microconch, the two forms being commonly regarded as female and male.

diphyllic (saddle). Terminating in two, equally-sized folioles.

distant (ribs). Widely spaced.

divergent (whorl sides). Diverging toward venter.

dorsal lobe. Median primary lobe of suture on dorsum, which is internal in normally coiled conchs (syn., internal lobe).

dorsolateral area. Side of impressed area on each flank of dorsum in involute shells.

dorsum. Dorsal side of conch (opposite ventral), generally grading into dorsolateral areas; in slightly involute shells equivalent to impressed area but in deeply involute shells refers only to portion of conch adjacent to venter of preceding whorl.

dwarf. An imprecise term sometimes applied to representatives of a taxon that are appreciably smaller than the norm for the taxon. See also progenetic dwarf.

ear. See lappet.

ellipticone. Shell with elliptical coiling of last whorl or half whorl.

evolute. With whorls overlapping little or not at all and therefore having a wide umbilicus. (As commonly used, evolute and involute are relative terms, since a shell form called evolute in one family may be classed as involute in another.)

excentric (umbilicus). Characterized by abrupt opening out of spiral described by umbilical seam or by the tendency of this spiral to close while the peripheral spiral is relatively unchanged (syn., excentrumbilicate).

excentrumbilicate. See excentric (umbilicus).

external lobe. See ventral lobe.

external saddle. See lateral saddle (1st) and ventral saddle.

external suture. Part of suture (in coiled forms only) that is exposed on outside of whorls between the umbilical seams.

falcate (rib). Sickle-shaped.

falcoid (rib). Approaching sickle-shaped.

fasciculate (ribbing). With ribs bunched or bundled to form sheaves.

fastigiate. With roof-shaped venter, periphery of shell being sharp but not keeled.

feather structure. Pattern of diverging fine lines occasionally seen on the whorl side of the shell (syn., aigrettes).

fibulate (ribs). Adjacent ribs branching and reuniting (syn., lautiform; see looped).

fillet. Longitudinal, raised, smooth band on venter or whorl side.

flank. See whorl side.

flare. Random annulation or very distinct rib that usually marks location of a former peristome and denotes a temporary halt in growth.

flared peristome. With diameter larger than that of body chamber.

flared rib. Swollen so as to stand in higher relief than average ribs.

floored (hollow keel). Divided from chambers by a partition (septum) external to the siphuncle.

foliole. Minor element of saddle of a suture.

goniatitic (suture). With most or all lobes and saddles of suture entire (not denticulate or frilled), the only common exception being the ventral lobe, which is subdivided.

growth lines. Striae encircling whorl marking growth increments of shell.

gyrocone. Loosely coiled shell that completes only a single whorl approximately.

helical, -icoid. Coiled in regular, three-dimensional spiral form with constant spiral angle, as in most gastropods.

heteromorph. Ammonoid shell of any form except planispiral with whorls in contact.

impressed area. Part of whorl between umbilical seams that is in contact with preceding whorl.

initial chamber. See protoconch.

intercalatory (rib). Secondary rib not attached to primary rib.

intercosta. See interspace.

internal lobe. See dorsal lobe.

internal suture. Part of suture located within impressed area between umbilical seams.

interspace. Area between adjacent ribs (syn., intercosta).

involute. With whorls overlapping considerably and hence with narrow umbilicus (see evolute).

isocostate. With ribs uniform in kind and density throughout ontogeny.

keel. Continuous, distinct, longitudinal ridge on venter; may be either solid or hollow, those of hollow type being floored (septicarinate) or without floor so as to open inward to chambers (syn., carina).

labial ridge. Linear elevation of shell corresponding to former apertural border (peristome).

lanceolate. Spear-shaped, referring to form of suture lobes or cross-section of acute periphery of shell.

lappet. Simple or necked (spatulate) projection of peristome on whorl sides or venter (called ventral lappet when located on venter); also called ear or auricle.

last septum. Septum separating body chamber from adjoining camera at any stage of growth (syn., adoral septum).

lateral lobes. Primary lobes of external suture other than ventral lobe; **1st lateral lobe** is next to ventral lobe, usually on whorl side but in depressed whorls commonly on venter; **2nd lateral lobe** is next to 1st lateral, commonly on whorl side and morphogenetically part of umbilical lobe.

lateral saddles. Primary saddles of external suture other than ventral saddle; **1st lateral saddle** (external saddle) separates ventral lobe from 1st lateral lobe; **2nd lateral saddle** (often called 1st lateral saddle) separates 1st and 2nd lateral lobes.

lateral sinus. Notch or re-entrant in peristome on whorl sides.

lateral sulcus. Spiral groove on whorl sides.

lautiform (ribs). See fibulate and looped.

leiostracous. Smooth-shelled. Commonly applied to the Lytoceratina and Phylloceratina in contrast to the trachyostracous Ammonitina.

lipped (peristome). With liplike extension of shell set at an angle to the apertural rim.

lira. Fine, raised line on shell surface.
living chamber. See body chamber.
lobe. Element of suture directed backward (adapically).
lobule. Minor element of sutural lobe.
longitudinal. In direction of shell growth, generally equivalent to spiral.
looped (ribs). United on ventrolateral angle, usually at a tubercle (syn., lautiform; see fibulate).
macroconch. The larger of the two shell forms in a dimorphic (*q.v.*) species, often with a plain aperture.
mature (shell). Showing such features as modification of coiling, apertural features (lappets, rostrum), or approximated septa, commonly regarded as indicating that a shell had reached its final size.
median saddle. See ventral saddle.
microconch. The smaller of the two shell forms in a dimorphic (*q.v.*) species, sometimes with an aperture bearing lateral lappets or a ventral rostrum.
monophyllic (saddle). Terminating in a single foliole.
mouth. See aperture.
nepionic constriction. See primary constriction.
node. Large, blunt, or formless tubercle.
oblique whorl height. See whorl height.
occluded (umbilicus). So narrow or closed that inner whorls are not visible.
operculum. A structure, the function of which was to close the aperture of the shell.
ornament. Such features of shell exterior as ribs, tubercles, bullae, clavi, spines, and striations.
overlap. Extent to which a whorl covers the preceding whorl.
oxycone. Discoidal shell with acute periphery and very narrow or occluded umbilicus (as in *Oxynoticeras*).
parabola. Collective term to describe rib, node, or constriction of parabolic form.
parabolic node. Small node or tubercle near ventrolateral angle of whorl, associated with an earlier cessation of growth and independent of ordinary tuberculation.
perforate (umbilicus). See umbilical perforation.
peristome. Edge of aperture of body chamber; border of mouth.
phragmocone. Camerated part of shell.
phylloid. Leaf-shaped or balloonlike, commonly referring to saddle endings (folioles) of sutures (as in *Phylloceras*).
pila. See rib.
planispiral. Coiled in a plane spiral (cf. heteromorph).
planulate. Moderately evolute, compressed shell with open umbilicus and bluntly rounded venter (as in *Perisphinctes*).
platycone. Shell with flattened form, without implication as to width of umbilicus or shape of venter.
plicate(d). With vague, coarse, radial folds on whorl side.
polygyral. Having many whorls.
polymorphic. Descriptive term for species believed to include more than two different shell forms (cf. dimorphic).
polyptychitine, -itoid (ribs). Branching at umbilical edge and again at midflank.
polyschizotomous (ribs). Branching at umbilical edge and then again repeatedly towards venter.
primary constriction. Constriction at the end of the first whorl of the ammonoid shell, marking the end of the ammonitella, *q.v.* (syn., nepionic constriction).
primary rib. Plain stem or simple inward part of a branched rib.
progenetic dwarf. Descriptive term for small species evolved by paedomorphosis, sexually mature at the size of juveniles of the ancestral species.
projected (rib). Swung forward (adaperturally) at or near venter.
prorsiradiate (rib). With generally forward (adapertural) inclination from umbilical edge toward venter.
protoconch. First chamber of shell, closed by proseptum; sometimes called initial chamber or apical chamber.
pseudoceratitic (suture). Approximating to ceratitic in form in ammonoids other than Ceratitina.
ptychoceratoid. Coiled in successive, straight, parallel shafts, in contact or not.
radial. Direction outward from center of umbilicus, at right angles to axis of coiling and growth (syn., transverse).
radius. See shell radius, umbilical radius.
rectiradiate (rib). Straight, radial, bending neither forward nor backward.
retracted (suspensive lobe). Bent backward (adapically) on approaching umbilical edge and in umbilical area (syn., dependent).
rib. Radially (more or less) directed ridge on shell; sometimes called costa or pila.
rostrum. Pointed projection of peristome on venter; may continue spiral line or coiling or diverge from it.
runcinate. See tabulate.
rursiradiate (rib). Inclined backward (adapically) proceeding from umbilical area toward venter.
saddle. Element of suture directed forward (adaperturally).
saltatory. Of evolution proceeding in large jumps.
scaphiticone, scaphitoid. Shell with normally coiled inner whorls succeeded by a straight section and then a hooked body chamber (as in *Scaphites*).
secondary rib. Outer part of branched rib, ventral to branching point.
septal lobe. Lobe formed on adoral face of preceding septum.
septal neck. Tubular extension of septum forming part of siphuncle, termed prochoanitic if directed forward (adaperturally) and retrochoanitic if directed backward (adapically). See also connecting ring.
septal suture. See suture.
septate (keel, ribs). Hollow keel or ribs separated from the cavity of the shell by a partition.
septate (whorl). Divided into camerae by transverse septa (see phragmocone).
septicarinate. Having a hollow, floored keel.
septum. Transverse partition dividing shell into camerae, attached to inside of shell wall along suture line.
serpenticone. Very evolute, many-whorled shell with whorls hardly overlapping, like coiled snake or rope (as in *Skirroceras*).

serrated (keel). Toothed or notched.

shell. Complete hard parts of ammonoid, including protoconch and conch but excluding aptychus and beaks or jaw structures.

shell radius. Distance from origin of spiral to a point on the periphery in normally coiled ammonoids.

shoulder. Ventrolateral, blunt angle of whorl.

sigmoid(al) (rib). S-shaped, sinuous, flexuous.

simple (peristome). Devoid of lappets or rostrum.

simple (rib). Unbranched.

simple (suture). Not appreciably subdivided.

sinus. Re-entrant curve or notch in any part of peristome.

sipho, siphon, siphonal tube. See siphuncle.

siphuncle. Narrow, longitudinal tube passing through camerae and septa from protoconch to base of body chamber. Consists of septal necks and connecting rings, *q.v.* (syn., sipho, siphon, siphonal tube).

spatulate (lappet). Spoon-shaped, stalked, bud-shaped.

sphaerocone. Involute globular shell with small or occluded umbilicus which commonly opens out suddenly along last whorl (as in *Sphaeroceras*).

spine. Sharp projection on surface of shell. Commonly hollow or septate.

stria. Minute groove on shell surface, especially on otherwise smooth shell.

strigate. Shell surface finely ridged or furrowed longitudinally (as in *Strigoceras*).

sulcate. With longitudinal groove on venter.

sulcus. Groove on shell surface, usually referring to longitudinal groove on venter.

suspensive lobe. Visible external part of umbilical lobe of suture on exposed part of whorl, comprising portion from which auxiliaries spring.

sutural elements. Major undulations of suture alternately directed forward (adaperturally) as saddles and backward (adapically) as lobes.

suture. Line of junction of septum with shell wall, visible only when this wall is removed (syn., septal suture, suture line).

suture line. See suture.

tabulate (venter). Truncated or flattened (syn., runcinate).

test. Fossil shell substance; material of the shell as opposed to the fossil as an object.

torticone. Shell coiled in irregular, three-dimensional spiral with progressive twisting of conch.

trachyostracous. Literally rough-shelled. Commonly applied to the ornamented Ammonitina (cf. leiostracous).

transverse. See radial.

tricarinate. Bearing three keels on venter.

trifurcate (rib). Dividing into three branches (syn., triplicate).

triplicate. See trifurcate.

tubercle. Projection or pimple on shell surface or on internal mold, commonly representing base of a spine.

umbilical angle. Generally blunt angle between whorl side and umbilical area (syn., umbilical border, umbilical edge, umbilical shoulder).

umbilical area. Inner part of whorl on each side, between umbilical angle and umbilical seam; called umbilical wall if it rises somewhat vertically from spiral plane and umbilical slope if it rises gently (syn., umbilical slope, umbilical wall).

umbilical border. See umbilical angle.

umbilical callus. Plug of test that more or less fills umbilicus.

umbilical edge. See umbilical angle.

umbilical lobe. Large primary lobe of suture centered on or near umbilical seam and thus forming part of both external and internal sutures.

umbilical perforation. Vacant space around axis of coiling and connecting umbilici.

umbilical radius. Distance from origin of spiral to a point on the umbilical seam in normally coiled ammonoids.

umbilical seam. Helical line of overlap of successive whorls, comprising *line of involution* analogous to suture of gastropods (syn., umbilical suture).

umbilical shoulder. See umbilical angle.

umbilical slope. See umbilical area.

umbilical suture. See umbilical seam.

umbilical wall. See umbilical area.

umbilical width. Diameter of umbilicus usually measured between umbilical seams.

umbilicus. External depression on each side of shell centered on axis of coiling, its rim being the umbilical angle or edge.

uncoiled. Colloquial term for heteromorph shells.

unipolar. See ceratitic.

variocostate. Ribbing style changing radically in the course of ontogeny.

venter. Peripheral part of shell in exogastric forms. In heteromorphs, the homologous area (syn., ventral area).

ventral area. See venter.

ventral lappet. See lappet.

ventral lobe. Median primary lobe of suture located on venter, external in normally coiled shells and therefore sometimes called external lobe.

ventral saddle. Median saddle of suture located on venter, external in normally coiled shells and therefore sometimes called external saddle (syn., median saddle).

ventrolateral angle. Angle between venter and whorl side, called shoulder if blunt or vaguely defined (syn., ventrolateral edge).

ventrolateral edge (or margin). See ventrolateral angle.

virgatotome. Type of ribbing in which three to six, straight secondaries may branch off in succession from forward (adapertural) side of a primary rib (as in *Virgatites*).

volution. See whorl.

whorl. Complete turn of shell through 360° (syn., volution).

whorl breadth. See whorl thickness.

whorl flank. See whorl side.

whorl height. Height of whorl measured at right angles to maximum width, comprising distance from middle of venter to middle of dorsum plus depth of impressed area; in practice, oblique whorl height commonly is used, consisting of distance from umbilical seam to middle of venter.

whorl section. Transverse section of a whorl.

whorl side. Lateral wall of whorl between umbilical seam and venter (syn., flank, whorl flank).

whorl thickness. Maximum horizontal distance between points located between ribs or spines on opposite whorl sides. Also termed whorl breadth, whorl width.

whorl width. See whorl thickness.

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INDEX

Abadicceras 233
ABRITUSITINAE 71
Abrytusites **72**
ABRYTUSITINAE 71
Acanthoceras **156**, 158, 164
ACANTHOCERATACEAE 1, 67, **133**
ACANTHOCERATIDA 133
ACANTHOCERATIDAE 133, **154**, 156, 175
ACANTHOCERATIDES 133, 154, 156
ACANTHOCERATINAE **156**, 162, 171
Acanthodiscus 61, **64**
Acanthohoplites **275**
ACANTHOHOPLITINAE 274
Acantholissonia 57, **58**
Acantholytoceras **215**
Acanthoplites 275
Acanthoptychoceras **216**
Acanthoscaphites **263**
Achilleoceras **78**
Acompsoceras **156**
Aconeceras 13, **14**
ACONECERATIDAE 12
ACONECERATINAE 1, 12, 16, 17
Acrioceras **223**
Adkinsia **152**
Adkinsites **138**
Adobofoloceras 1
Adolphia 14
Adolphites 14
Aegocrioceras **211**
Aidoceras 142
Ainoceras **247**
Aioloceras 71
Aleteceras 233
ALETECERATIDAE 233
Algericeras **146**
Algerites **237**
ALGERITIDAE 234
Allocrioceras **237**
Allotissotia 179
Almohadites **48**
Alopecoceras **124**
Alstadenites 189
Alternacanthoceras 156
Alzadites **162**
Amblydiscus 173
Ameleceras 141
AMMONITIDA 206
AMMONITINA 1, 9
Ammonitoceras **221**
Ammonoceras 2
Ammonoceratites 2
AMMONOIDEA 1
Amoebites 42
Amopalus 265
Ampakabites 167
Amundiptychites 31
Anabrahmaites 93
Anacleoniceras **96**
Anadesmoceras 93, **96**
Anagastroplites 124
Anagaudryceras **3**, 8
Anahamulina **231**
ANAHAMULINIDAE 230
Anahoplites **117**
ANAHOPLITINAE **117**
Anahoplitoides **117**
Anaklinoceras **247**
Anapachydiscus 105
Anapuzosia 75
Anascaphites 260
Anatexanites **194**
Anazelandites 5
Ancyloceras **216**, 223
ANCYLOCERATACEAE **206**, 233, 234
ANCYLOCERATIDAE 206, **210**, 215, 227, 228
ANCYLOCERATINA 1, **206**, 233
ANCYLOCERATINAE 208, **215**, 216, 223
Ancylotropaeum **221**
Andersonites 191
Andesites 55
Andiceras **50**
Androiavites 138
Aneuretoceras **194**
Angolaites **142**
Anisoceras **237**, 253
ANISOCERATIDAE 233, **234**
Ankilizatella **197**
Ankinatsytes 247
Antarcticoceras **222**
Antsirasirella 197
Aphroditiceras 1
Appurdiceras 237
Arcthoplites 96, 100, 114, 122
Arctohoplites 93
Arestoceras **142**
ARESTOCERATIDAE 140
Argentiniceras 55
Argentoscaphites **261**
Argonauticeras 2
Argvethites 227
Arkhangelskiceras 162
Arnoldia 61
Arrhaphoceras 117
Asiatostantonoceras 127
Askoloboceras 136
Aspidostephanus **43**
Aspinoceras 223
Astieria 46
Astiericeras **270**
ASTIERICERATIDAE **270**
ASTIERIDISCIDAE 48
Astieridiscus **48**, 49
Astieriptychites **31**
Astreptoceras **255**
Astrodiscus 96
ATAXIOCERATIDAE 18
Atopoceras 228
Aucklandites 93
Audouliceras **216**
AULACOSTEPHANIDAE 17
Austiniceras **78**
Austinites 197
Australiceras **216**, 217
Australiella **197**, 198
Australotropaeum 221
Austrosphenodiscus 205
Axonoceras 250

Baculina 208, **210**
BACULINIDAE 208
Baculites 255, **256**, 257
BACULITIDAE **255**
Baghiceras 127
BAGHICERATINAE 126
Balearites 214
Banikoceras **54**
Baronnites **46**
Barremites 67, **69**, 86
BARREMITINAE **69**, 71, 78, 111
Barroisia 187
Barroisiceras **187**, 198
BARROISICERATINAE **187**
Basseoceras 187, 189
Bassites **82**
Bauchioceras 178
Beattonoceras 124
Bejucoceras 211
Bellidiscus 96
Benavidesites **138**
Beneckeia 86
Benueites **162**
Bererella **197**
Bergericeras 243
Berriasella **50**, 51
BERRIASELLIDAE 50
BERRIASELLINAE 35, **50**, 55
Besaireites 105
Besairieceras 61
Besairiella **109**
Beschtubeites 127
Betiokytes 176
Beudanticeras **80**, **81**, 82
BEUDANTICERATINAE **78**, 96, 114
Beudantiella 82
Bevahites **197**
Bhimaites 75
Biasaloceras 2
Bidichotomites 31
Bihenduloceras 43
Binelliceras 211
Binneyites 16

BINNEYITIDAE 1, **15**, 16
Blanfordia 50
Blanfordiceras **50**
Bochianites 206, **208**, 210, 231
BOCHIANITIDA **208**, 231, 255
BOCHIANITINAE **208**
Bodylevskiceras **29**
Bodylevskites 26
Boehmoceras **258**
Boesites **142**
Bogoslovskia 23
Bojarkia **25**
Boliteceras **81**
Boncheviceras 55
Borealites **22**
Borissjakoceras **16**
Bornhardticeras **12**
Bostrychoceras **245**
BOSTRYCHOCERATINAE 245
Bradfordia 11
Brahmaites **93**
BRAHMAITINAE 89
Brancoceras 134, **135**
BRANCOCERATIDAE **134**, 135
BRANCOCERATINAE 133, **135**, 137, 146, 151
Breistrofferella **64**
Brewericeras **96**
Broggiiceras 175
Bucaillella **114**
Buccinammonites 173
Buchiceras 171, **173**
BUCHICERATIDAE 171
Budaiceras **150**
Buehrierella **109**
Buenoceras 187
Buergliceras **111**
Bunburyiceras 154
Burckhardtites **273**
Burroceras 167
Busnardoites 60
Butticeras 197

CADOCERATINAE 17
Caicedia 111
Cainoceras 142
CAINOCERATIDAE 140
Caledonites **93**
Californiceras 38
Callihoplites **119**
Calliphylloceras 2
CALLIPHYLLOCERATINAE 2
Calliptychoceras **58**
Calliscaphites 233
Callizoniceras **73**, 93, 133
Calycoceras 156, **162**, **164**, 167
Camereiceras **230**
Canadoceras **105**
Cantabrigites **146**
Capeloites **46**
Capitanioceras 2
Cardabites 257
Carinites **6**
Carinolytoceras 2
Carinophylloceras 1
Carloscaceresiceras **96**
Carstenia **113**
Carthaginites **243**
Caseyella 73
Caseyiceras **25**
Caspianites **221**, 222
Cassidoiceras 69
CASSIDOICERATINI 69
Cassidoites 69
Cechenoceras 140
CECHENOCERATIDAE 137
Cenisella **148**
Cenomanites 152
Ceratotuberculus **46**
Chamalocia **61**
Chandomirovia **23**
Chapericeras 51
Chaschupseceras 275
Cheloniceras 221, 267, **269**, 270, 275
CHELONICERATIDAE 267
CHELONICERATINAE **267**
Chesapeakella **250**
Chigaroceras **52**
Chimbuites **101**
Choffaticeras **179**
Christophoceras 253
Cibolaites **183**
Cicatrites 233, **234**
CICATRITIDAE 233
Cirroceras 247
Ciryella 191, 192
Clavithurmannia **58**
Cleogastroplites 122
Cleonella 96
Cleoniceras 93, **96**
CLEONICERATIDAE 80, **93**, 122
Clioscaphites 260, **261**
Cloioceras **274**
Cnemidoceras 130
Cnemioceras 130
Coahuilites **205**, 206
Cobbanoceras 189
Cobbanoscaphites 106
Cochlocrioceras **208**
Cocuyites 197
Codazziceras **171**
Coilopoceras 201, **202**
COILOPOCERATIDAE **201**, 203
Colchidites **227**, 228
COLCHIDITINAE 226
Collignonella 189
Collignonia 141
Collignoniceras 183, **184**, 186, 189
COLLIGNONICERATIDAE **183**, 203
COLLIGNONICERATINAE **183**, 187, 189
Coloboceras 100
Colombiaticeras 216
Colombiceras 269, 273, **274**, 275
COLOMBICERATINAE 274
Colomboceratoides 223
Colvillia **101**
Condamyella **109**
Conlinoceras **158**
Cophinoceras **82**
Coronites **113**
Corteziceras 80
Cosmolytoceras 2
Costamenjaites 29
Costidiscus 234
Cottreauites 151
Couloniceras 154
Craginites **146**
Craspedites **18**, 19, 21, 23, 34
CRASPEDITIDAE 18
CRASPEDITINAE 17, **18**, 22
Craspedodiscus 34, **39**
Craspedonites 18
Crenilytoceras 2
Crioceras 211
CRIOCERATACEAE 206
CRIOCERATIDAE 206, 210
Crioceratites **211**, 212, 216
CRIOCERATITIDAE 206, 210
CRIOCERATITINAE 206, **210**, 216, 223, 228
Criosarasinella **60**
Cruasiceras **64**
Cryptometoicoceras **173**
Cryptotexanites **198**
Cuchillites 275
Cunningtoniceras **156**
Cuyaniceras **58**
Cymahoplites 93, **100**
Cyphoceras 253
Cyrtochilella 255
Cyrtochilus 255
Cyrtohamites 250
Cyrtoptychoceras **253**
Cyrtosiceras **12**

Daghestanites 119
Dalmasiceras **55**
Damesites **83**
Daradiceras **206**
Dechenoceras 129
Defordiceras **198**
Deiradoceras **142**
Delawarella **198**
Delphinella 50

Delphinites **36**
DESHAYESITACEAE 206, **271**
Deshayesites **271**, 273, 274
DESHAYESITIDAE **271**, 274
DESHAYESITINAE **271**
Desmoceras 67, 69, **82**
DESMOCERATACEAE 1, 67, 96
DESMOCERATIDAE 67, **69**, 82, 101, 111, 114, 133
DESMOCERATINAE **82**, 86, 101, 107
Desmophyllites **84**
Desmoscaphites **261**
Diadochoceras **269**
DIADOCHOCERATINAE 267
Diaziceras **189**
DIAZICERATINAE 187
Dichotomites 26, 29, **31**, 34, 36
Dicostella 61
Didymoceras **247**
Didymoceratoides **247**
Dihamites 253
Dimorphoplites **119**
Dinolytoceras 2
Diplacmoceras 126
Diplacomoceras 126
Diplasioceras 140
Diplomoceras **250**
DIPLOMOCERATACEAE 234
DIPLOMOCERATIDAE **248**, 249
DIPLOMOCERATINAE **250**
Dipoloceras **139**, 140, 142
DIPOLOCERATIDAE 137
Dipoloceroides 137
Diptychoceras 231, 233
Discoceras 152
Discohoplites **119**
DISCOHOPLITINAE 117
Discoscaphites **262**, **263**
Discovascoceras 178
Dissimilites **223**
DISTICHOCERATINAE 11
Distoloceras **64**
Dobrodgeiceras 47
Donenriquoceras **179**
Donjuaniceras 187
Dordiella 198
Doridiscus **14**
Dorsoplanites 17, 22
DORSOPLANITINAE 17
Douvilleiceras **269**
DOUVILLEICERATACEAE 206, **266**
DOUVILLEICERATIDAE **266**, 269
DOUVILLEICERATINAE **269**
Drakeoceras 142
Drepanites 119
Drepanoceras 142
DREPANOCERATIDAE 137
Dufrenoya 273
Dufrenoyia **273**, 274
Dunveganoceras **158**
Durnovarites 142

Eboroceras 187
Eedenoceras 189
Egoianiceras 274
Elenaella **50**
Eleniceras 61
Elleficeras 31
Ellipsoceras 233
Elobiceras **146**
Emericiceras 212
Emperoceras 247
EMPEROCERATINAE 245
Endemoceras 61, 69
ENDEMOCERATIDAE 61
ENDEMOCERATINAE 50, **61**, 69
Endemoceratinae 50
Engonhoplitoides 130
Engonoceras **130**, 133
ENGONOCERATACEAE 114
ENGONOCERATIDAE 114, 126, 130, 140
Eocleoniceras 96
Eocrioceratites **211**
Eodesmoceras 67, 69
EODESMOCERATINAE 69
Eodouvilleiceras 266, **269**
Eoepigoniceras 6
Eofalciferella 14
Eogaudryceras **3**, 6
Eogunnarites **88**, 89
Eohypoturrilites 245
Eoleptoceras 225
Eomadrasites **89**
Eomarshallites **87**
Eopachydiscus **101**
Eorhaeboceras **260**
Eoscaphites **260**
Eosonneratia 115
Eotetragonites **3**
Eotissotia 179
Eotropitoides 147
Epacrioceras **223**
EPACRIOCERATIDAE 223
Epancyloceras **221**
Epanisoceras **225**
Epengonoceras 132
Ephamulina **236**
Epicheloniceras **269**, 270
Epigaudryceras 3
Epiglyptoxoceras 250
Epigoniceras 6
Epihoplites **119**
Epileymeriella **134**
Epiphylloceras 1
Epipuzosia 75
Epitropaeum **220**
Erdenella 55
Erichsenites **202**
Erioliceras **137**
ERIOLICERATIDAE 135
Eristavia 228
Eristavites **60**
Escragnolleites 228
Eubaculiceras 257
Eubaculites **257**
EUBACULITINAE 255
Eubostrychoceras **245**
Eubrancoceras **136**
Eucalycoceras **164**
Eudiplomoceras 250
Euhemihoplites 233
Euomphaloceras **167**
Euhomaloceras 257
Euhoplites **119**
EUHOPLITINAE 117
Euhyphantoceras 247
Euhystrichoceras **147**
Eulophoceras **204**
EULOPHOCERATIDAE 203
Eulytoceras 2
Euomphaloceras 156, **167**, 171
EUOMPHALOCERATINAE **167**
Eupachydiscus **106**
Euphylloceras 1
Euptychoceras **231**, 233
Euryptychites **31**
Euspectroceras 140
Eutexanites **197**
Euthymiceras 53, 54
Euturrilites 245
Exicrioceras 250
Exiteloceras **250**
Externiceras **25**
Ezilloella **176**

Fagesia 176
Falciferella **14**, 16
Falloticeras 69, **137**
Fallotites 173
FALLOTITINAE 171
Falsebayites 191
Faraudiella 147
Farnhamia **114**, 115, 116
Fauriella 55
Favrella **62**
Ferganites 178
Feruglioceras 73
Ficheuria **152**
Fimbrilytoceras 2
Flickia **152**
FLICKIDAE 151
FLICKIIDAE **151**, 152
FLICKIINAE 152
Flindersites 233
Fluminites 191
Forbesiceras **152**

FORBESICERATIDAE 152
FORBESICERATINAE 152
Forresteria 187, 189
Fournierella **109**
Franciscoites 176
Fraudatoroceras 189
Freboldiceras 93, **96**
Frenguelliceras **55**
Fresvillia **258**
Furoniceras 178

Gabbioceras 8, **9**
GABBIOCERATINAE **9**
Gardeniceras 86
Gargasiceras 274, **275**
Garnieria 20, 35
Garniericeras **20**
GARNIERICERATINAE 18
Gastroplites **122**, **124**
GASTROPLITINAE **119**
Gaudryceras **3**
GAUDRYCERATIDAE 2
GAUDRYCERATINAE 2
Gauthiericeras 189, **191**
GAUTHIERICERATIDAE 189
Gazdaganites 119
Gentoniceras 158, **164**
Georgioceras 214
Gerhardtia 111
Germariceras **186**
Giralites 257
Gissarites 126
Glebosoceras 203
Globosonneratia 115
Glochiceras 10
Gloriaceras 189
Glossoceras 130
Glottoceras 130
Glyptoxoceras **250**
Gombeoceras 178
Goodhallites **142**
Goretophylloceras 1
Gorodzovia 39
Grandidiericeras **78**
Grantziceras **81**
Graysonites **154**
Greenhornoceras 175
Groebericeras **43**
Grossouvreites **92**
Grycia **96**
Guderianites 6
Guerangericeras 156
Gunnarites **92**
Gyaloceras **14**
Gymnoplites **49**
Gyrophyllites 2

Haboroceras **194**, 198
HAMITACEAE 234
Hamitella 239
Hamites **239**, **241**
Hamiticeras 224, 225
HAMITIDAE 234, **239**
Hamitoides **233**
Hamulina 216, 231
HAMULINIDAE **230**
Hamulinites **225**
Hannaites **64**
Hannoverites 39
Haploceras **10**
HAPLOCERATACEAE 1, **9**, 67
HAPLOCERATIDAE 1, **9**, 10
Haresiceras **265**, 266
Harleites **189**
Hatchericeras **64**
Hauericeras **86**
HAUERICERATINAE **85**
Haugiceras 164
HECTICOCERATINAE 11
Hectoroceras 18, 21, **22**
Hegaratella 50
Heinzia **111**
HEINZIIDAE 111
HELIANCYLINAE 210
HELICANCYLIDAE 223
HELICANCYLINAE 208, 210, 214, 216, **223**, 227, 233
Helicancyloceras **221**
Helicancylus 224, 225
Helicoceras 239
Hemibaculites 227
Hemicrioceras **214**
Hemigaudryceras 3
Hemihoplites **228**, 230
HEMIHOPLITIDAE **228**
Hemilytoceras 2
Hemiptychoceras **241**
Hemisonneratia **117**
Hemitetragonites 2
Hemitissotia **179**
Hemitissotiinae 178
Hemiturrilites 243
Hengestites **126**
Herrickiceras 178, 179
Hertleinia 36
Hertleinites 36
Heterammonites 179
Heteroceras **227**
HETEROCERATIDAE 208, **226**, 271
HETEROCERATINAE 226
Heteroclinus **234**
Heterophylloceras 1
Heteroptychoceras 253
Heterotissotia **201**
Hettneria 111
HILDOCERATINAE 9
Himalayites 47
Himantoceras 211
HIMANTOCERATIDAE 210
Hirtziella **111**
Hluhluweoceras 191
Hoepenites 106
HOLCODISCIDAE **48**
Holcodiscoides 87, **88**, 92
Holcodiscus **48**, 49
Holcophylloceras 2
Holcoptychites **48**
Holcoscaphites 260
HOLCOSTEPHANIDAE 42
Holcostephanus 46
Hollisites **36**
Hollwediceras 31
Homaloceratites 257
Homolsomites 26, **31**
Hoplancyloceras 216
HOPLITACEAE 1, 67, 93, 96, **114**
Hoplites **119**, 134
HOPLITIDA 114
HOPLITIDAE 114, 117, 126, 133
Hoplitides 64
HOPLITIDÉS 114, 117
HOPLITINAE **117**
Hoplitocrioceras 211
Hoplitoides **201**, 202
HOPLITOIDINAE 201
HOPLITOIDINÉS 201
Hoplitoplacenticeras **129**
Hoplocrioceras **223**
Hoploscaphites 260, **261**
Hourcqia **183**
Hourcqiceras **164**
Hourcqiella **109**
HOURCQIIDAE 180
HOURCQIINAE **180**
Huastecoceras **222**
Huescarites 151
Hulenites **87**
Hypacanthoplites 275, 277
Hypengonoceras 126, **130**, 140
HYPENGONOCERATINAE 126
Hyperpuzosia 75
Hyphantoceras **247**, 248, 253
HYPHANTOCERATINAE 245
Hyphoplites **119**
Hypogaudryceras 5
HYPOGAUDRYCERATINAE 2
Hypolissoceras 10
Hypophylloceras 1
Hyporbulites **1**
Hyposcaphites 258
Hypoturrilites 243, 244, 245
Hystatoceras 134, 135
HYSTATOCERATIDAE 134
Hysteroceras **136**, 137, 146
Hystrichoceras 126

Idiohamites **237**, 253
Imerites **228**
Imlayiceras 178
Indoceras **205**
Indoscaphites **265**
Infabricaticeras **176**
Inflaticeras 141
INFLATICERATIDAE 140

Ingridella **173**
Iranoknemiceras 130
Irenicoceras **124**
Ishikariceras **191**
Isohoplites 117, **119**
Itwebeoceras 187

Jabronella 55
Jacobella 78
Jacobites **93**
Jacobitoides 89
Jahnnites 260
Janenschites **210**
Jaubertella 9
Jauberticeras **9**
Jaubertites **216**
Jeannoticeras **46**
Jeanrogericeras 171, 173
Jeanthieuloyites 46
Jeletzkytes 261
Jimboiceras **75**
Jimenesites 197
Joaquinites 107
Johnsonites **16**
Jouaniceras **247**
JOUANICERATIDAE 245
Juamportoceras 270
Juandurhamiceras 273
Juddiceras **208**
Julianites **36**

Kabylites 210
Kachpurites **19**, 21
Kaiparaites 92
Kallilytoceras 2
Kamerunoceras **167**
Kanabiceras 167
Karakaschiceras **61**
Karamaiceras 127
Karamaites 126-128
Karapadites **92**
Karstenia 113
Karsteniceras **226**
KARSTENICERATINAE 225
Kastanoceras 159
Kawashitaceras 253
Kazanskyella **277**
Kennediella **158**
Kennicottia **73**
Keyserlingyceras 29
Kilianella **58**
Kilianiceras 43
Kitchinites **78**
Knemiceras **130**
KNEMICERATIDAE 130
Knemoceras 130
Koloceras 14
Komeceras 136
Kondiloceras **187**
Kopetdagites 127
Kophinoceras 82
Kossmatella 6
KOSSMATELLINAE 2
Kossmatia 171
Kossmaticeras **89**, **92**, 93
KOSSMATICERATIDAE **87**
KOSSMATICERATINAE 87, **89**
Kotoceras 83
Koulabiceras 178
Kuntziella **273**
Kutatissites **228**

Labeceras **233**
LABECERATIDAE **233**
Lamnayella **151**
Laraiceras **138**
Latidorsella 82
Laugeites 18
Lavizzaroceras 1
Lechites 255
Lecointriceras **184**
Leconteites 93, **96**, 100
Ledoceras 184
Lehmaniceras 107
Lemuroceras 93, **100**
LEMUROCERATINAE 93
Lemurostephanus 46
Lenticeras **203**, 204
LENTICERATIDAE 203
LENTICERATINAE **203**
Leoniceras **179**
Leonites 141
Leopoldia **64**
LEOPOLDIINAE 61
Lepthoplites 117
Leptoceras 206, **208**, 225
LEPTOCERATINAE 208
Leptoceratoides **225**, 226
LEPTOCERATOIDINAE **225**
Leptotetragonites 2
Lethargeceras 142
Letheceras 142
Lewesiceras **101**
Lewyites **253**
Leymeriella **134**
LEYMERIELLIDAE **133**, 147
LEYMERIELLINAE 133
Libycoceras **206**
LIBYCOCERATIDAE 203
Limaites **58**
Lindigia 227
Lissoceras 11
LISSOCERATIDAE 9, 10
Lissonia 61
Lithancylus **216**, 231
Litophragmatoceras **152**
Lobolytoceras 2
Lophoceras 138
Lopholobites **111**
Lotzeites 167
Lunatodorsella 82
Luppovella 58
Luppovia **225**
Luppoviceras 29
Lyelliceras **147**
LYELLICERATIDAE 133, 147, 151, 154
LYELLICERATINAE 147
Lymaniceras **186**
Lynnia **25**
Lyticoceras **61**, 64
Lytoceras 2
LYTOCERATACEAE 1, 2, 67, 233
LYTOCERATIDA 206
LYTOCERATIDAE 2, 67
LYTOCERATINA 1, 2, 9, 206, 234
LYTOCERATINAE 2
Lytocrioceras **223**
Lytodiscoides **75**, 78
Lytohamites **241**
Lytohoplites 55

Maccarthyites **88**
Macrocephalites 30
MACROCEPHALITINAE 17
Macrophylloceras 1
Macroscaphites **234**
MACROSCAPHITIDAE **233**
Madagascarites **247**
Maderia 46
Madrasites 89
Magneticeras 270
Malbosiceras **50**
Malgesaynella **64**
Malwiceras 127
Mammites 155, 167, 171, **173**, 175
MAMMITIDAE 171
MAMMITINAE **171**
Manambolites **205**
Mancosiceras **266**
Mantelliceras **154**, 164
MANTELLICERATIDAE 154
MANTELLICERATINAE **154**
Manuaniceras 137
Maorites 87, **93**
Mariaella 243
Mariella **243**
Marshallites **87**, 88
MARSHALLITINAE 87, 89
Martelites **228**
Martelliceras 2
Masiaposites **180**, 183
Masonites **255**
Mastigoceras 233
Mastigohamites 231, 233
Matheronites 228
Mathoceras **274**
MATHOCERATINAE **273**
Matsumotoceras 75
Mazenoticeras 50
Mediasiceras 127
Medjeziceras **49**
Megacrioceras **214**
Megatyloceras **267**
Melchiorites 73, 75

MELCHIORITINAE 71
MELCIORITINAE 71
Menabites **197**, 198
MENABITINAE 193
Menabonites **101**
Menjaites 22, **29**
MENJAITINAE 22
Menuites **105**, 106
Menuthengonoceras **140**
Menuthiocrioceras **211**
Mesocrioceras 223
Mesogaudryceras **3**
Mesopachydiscus 106
Mesopuzosia 75
Mesoscaphites 261
Mesoturrilites **245**
Metacalycoceras 162
Metacanthoplites 156
Metaclavites **119**
Metahamites **235**
Metahaploceras 10
Metahoplites **49**
METAHOPLITIDAE 48
Metalytoceras 2
Metaplacenticeras **128**
Metaptychoceras **241**
Metascaphites 260, 261
Metasigaloceras 171, 175
Metatissotia **198**
Metengonoceras **132**
Metoicoceras 155, 171, 173
METOICOCERATIDAE 171
Meunieria 12
Mexicanoceras **46**
Mhriliceras **155**
Microdesmoceras **82**
Microdiphasoceras 177
Microsulcatoceras 159
Mikasaites **89**
Milanowskia 38, **39**
Mimeloceras 142
Mimoceras 142
Miodesmoceras 69
Miotexanites **194**
Mirapelia **138**
Mitonia **175**
MITONIAINAE 171
Miyakoceras **87**
Mobergoceras 245
Moffitites **88**
Mogharaeceras 114
Mojsisovics 86
Mojsisoviczia **137**
MOJSISOVICZIIDAE 137
MOJSISOVICZIINAE 133, 135, **137**, 140, 141
Moremanoceras **82**
Moretella **100**
Morrisites 107
Morrowites **167**
Mortoniceras 111, **141**, 142
MORTONICERATIDAE 140
MORTONICERATINAE 135, 137, **140**, 193
MORTONICERATINÉS 140
Mortoniceratoides 140
Mosquites 18
Mourreiceras 164
Moutoniceras **216**
Moffitites 88
Muniericeras **107**
MUNIERICERATIDAE 86, **107**
Muramotoa 189
Muramotoceras **247**
Murphyella 3
Myloceras 233
MYLOCERATIDAE 233
Mzezzemceras 205

Nabdalsiceras 69
Namadoceras 203
Nannometoicoceras **173**
Nannovascoceras 175
Naramoceras **14**
Natalites **92**
Neancycloceras **250**
Nebraskites **162**
Negreliceras **43**
Neoastieria 49, **87**
Neocalliphylloceras 2
Neocalycoceras 164
Neocardioceras **162**
Neocomites 58, **60**
NEOCOMITIDAE 1, **49**
NEOCOMITINAE 49, 50, 55, 61
Neocosmoceras **53**, 55, 58
Neocraspedites **26**
Neocrioceras **250**
NEOCRIOCERATINAE 248
Neocyrtochilus 253
Neodeshayesites **273**
Neodesmoceras **107**
Neoepigoniceras 6
Neogastroplites **124**
Neogaudryceras 3
Neogauthiericeras **197**
Neoglochiceras 10
Neoglyptoxoceras **250**
Neograhamites **93**
Neohamites 250
Neoharpoceras **142**
Neohoplites 215
Neohoploceras **61**
Neokanabiceras 189
Neokentroceras **137**
Neokotoceras 83
Neoleymeriella **134**
Neolissoceras **10**
Neolobites **133**
NEOLOBITINAE 130
Neomadrasites 93
Neomantelliceras 154
Neomphaloceras 171
Neopachydiscus 105
Neophlycticeras **147**, 148, 150, 151, 152
Neophylloceras 1
Neopolyptychites 31
Neoptychites 176, 205
NEOPTYCHITINAE 175
Neopulchellia 152
Neopuzosia 78
Neosaynella **98**
Neosaynoceras **152**
Neoselwynoceras 197
Neosilesites **86**, 87
Neostlingoceras **243**
Neotollia 26
Neocurrilites 248
Neposiella 86
Neumayriceras 2
Newboldiceras **164**
Niceforoceras **187**
Nicklesia 42, **111**
Nicklesiella 111
Nigericeras **167**
Nikitinoceras **26**, 29
Nipponites **247**
Nodosohoplites 269
Nolaniceras 275
Nonyaniceras 221
Noskytes 152
Nostoceras **245**, 247
NOSTOCERATIDAE **245**, 248, 249
Nothodiscus **14**
Nowakites **105**
Nubidites 206

Obiraceras **171**
OCHETOCERATINAE 11, 12
Octagoniceras 53
Odonthoplites 119
Odontodiscoceras **58**
Oiophyllites **86**
Ojianagiceras 151
Ojinagiceras **151**
OLCOSTEPHANIDAE 1, 18, 35, 42
OLCOSTEPHANINAE 42, **43**, 48
Olcostephanini 42
Olcostephanus 31, 42, 44, **46**, 48, 67
Omocrateceras **141**
Omocyrtoceras 137
Onitshoceras **84**
Oosterella 42
OOSTERELLIDAE 42
OOSTERELLINAE 42
Ophiceras 2
Ophryoceras 141
OPPELIDAE 10
OPPELIIDAE 1, **10**

OPPELIIDÉS 10
OPPELIINAE 10, 11
Orbignyceras **226**
Orbignyiceras 226
Orcholytoceras 2
Oregoniceras 184
Orientoceras 247
Ornicephalites 228
Ostlingoceras **241**, **243**
Otohoplites **117**
OTOHOPLITINAE 114
Otoscaphites 258
OTOSCAPHITINAE **258**
Oxybeloceras 255
Oxycerites 11
OXYNOTICERATINAE 17
Oxytropidoceras 133, **137**

PACHYCERATIDAE 17
Pachydesmoceras **75**
PACHYDISCIDAE 67, **101**
PACHYDISCINAE 101
Pachydiscoides **103**, 105
Pachydiscus **107**
Pachygrycia **101**
Pachyvascoceras 175
Paciceras 206
Pagoceras **142**
Palaeodichotomites 31
PALAEOHOPLITIDAE 49
Paquiericeras 35, **36**
Parabevahites 194
Parabinneyites **266**
Parabrancoceras 133, **136**
Paraburroceras **167**
Paracalycoceras **151**
Paracanthoceras 158, 175
Paracanthoplites 269
Parachelioniceras **269**
Paracleoniceras 96
Paracompsoceras **158**
Paraconlinoceras **158**
Paracrioceras **211**, 212, 216
Paradeshayesites 271, 272
Paradolphia **152**
Paradontoceras 50
Paragastroplites 122, **124**
Paragaudryceras 3
Parahelicoceras 243
Parahoplites 274, 276, 277
PARAHOPLITIDAE 276
PARAHOPLITINAE 276
Parahoplitoides 271
Paraimerites 228
Parajaubertella **8**
Parakilianella 58
Paralenticeras **204**
Paraleptoceras 233
Paramammites **171**
Parancyloceras **214**
Parandiceras **50**
Parapachydiscus 107
Parapedioceras 208
Paraphylloceras 1
Paraplacenticeras 128
Parapuzosia **78**, 86
Parasaynoceras **49**
Parasilesites 78
Parasolenoceras **253**
Paraspinoceras **223**
Paraspiticeras **266**, 267
Parastantonoceras 126
Parastieria **46**
Paratexanites **194**
Paratissotia **201**
Paratollia 26
Paraturrilites 243
Paravascoceras 175
Parengonoceras **130**, 133
Parodontoceras 50
Parostlingoceras **243**
Paroxytropidoceras 135
Partschiceras 1
Partschiphylloceras 1
Pascoeites **230**
Patagiosites **105**
Patagoniceras 62, 266
Pavlovia 36
Pavlovites 39
Pectinatites 22
Pedioceras 171, **214**
Pedioceratidae 210
Pegnaceras **275**
Pelecodiscus 204
Peltocrioceras **216**
Penaceras **275**
Peregrinoceras **26**
PEREGRINOCERATINAE 22
PERISPHINCTACEAE 1, 17, 50, 67
Perisphinctes 25
Peroniceras **189**, 192
PERONICERATIDAE 189
PERONICERATINAE **189**
Pervinquieria 141
PERVINQUIERIIDAE 140
Petinoceras 136
Pfluckeria 57
Phlycticrioceras 234, **239**
Phylloceras 1
PHYLLOCERATACEAE 1
PHYLLOCERATIDAE 1, 67
PHYLLOCERATINA 1, 9
PHYLLOCERATINAE 1
Phyllodesmoceras 82
Phyllopachyceras 1
Phylloptychoceras **253**
Pictetia 2
Picteticeras 50
Placenticeras **126**, 128
PLACENTICERATACEAE 114
PLACENTICERATIDA 114
PLACENTICERATIDAE 114, **126**
Placentocerus 126
Placentoscaphites 127
Planostoceras **247**
Platiknemiceras **130**
Platyknemiceras 130
Platylenticeras 17, 20, 35
PLATYLENTICERATINAE 35, 42
Plesiacanthoceras 158, 171
Plesiacanthoceratoides **158**
Plesiocanthoceras 173
Plesiohamites **241**
Plesiospitidiscus 69
Plesiotexanites **197**
Plesiotissotia 179
Plesioturrilites 244
Plesiovascoceras 176
Pleurohaploceras 73
Pleurohoplites **117**
PLEUROHOPLITINAE 117
Pleuropachydiscus 75
Pleurotexanites **194**
Pochialayniceras 117
Poikiloceras 142
Polyaspidoceras 167
Polyptychites 17, 18, 26, 28, 29, **30**, **31**
POLYPTYCHITIDAE 1, **17**, 18
POLYPTYCHITINAE 17, 26, 29, 35, 36
Polyptychoceras **253**
POLYPTYCHOCERATIDAE 250
POLYPTYCHOCERATINAE 249, **250**
Pomeliceras 50, 55
Ponteixites **265**
Praeangolaites 142
Praelibycoceras 204
Praemanambolites **205**
Praemuniericeras 107
Praenegreliceras 43
Praeoppelia 11
Praeschloenbachia 117
Praestriaptychus 216
Praesurites **23**
Praetollia **21**
Pravitoceras **248**
PRAVITOCERATINAE 245
Primitiviptychites **31**
PRIONOCYCLIDAE 183
Prionocycloceras **187**
Prionocycloides 146
Prionocyclus 183, **186**, 187
PRIONOTROPIDAE 183
Prionotropis 183, 184
Proaustraliceras 216
PROAVITOCERATINAE 245
Prochelioniceras **267**
Procliviceras 1
Proclivioceras 1

Procolombiceras 274
Prodeshayesites **271**
Prodichotomites **31**
Proeucalycoceras **164**
Prohauericeras **162**
Prohelicoceras **236**
Prohysteroceras 142, **144**
Proleopoldia 36
Proleymeriella **133**, 134
Prolyelliceras **147**
Promantelliceras 154
Proniceras **43**, 47
Pronjaites 22
Prophlycticrioceras **237**
Proplacenticeras 126
Propolyptychites **26**, 29
Proromaniceras 171
Protacanthoceras **158**, 162
Protacanthodiscus 51, 54
Protacanthoplites 275
Protaconeceras **13**
Protacrioceras **223**
PROTACRIOCERATIDAE 223
Protancyloceras 206, **208**, 210
PROTANCYLOCERATACEAE 206
PROTANCYLOCERATIDAE 206, 208
PROTANCYLOCERATINAE **208**, 225
Protanisoceras **234**, 235, 237, 241
Protengonoceras **130**
Protetragonites 2
Protexanites **193**, 194, 196
Protissotia **148**
Protobaculites 241
Protohoplites 117
Protokossmaticeras **88**
Protoleptoceras 208
Protothurmannia **55**
Proturrilitoides **241**, 243
Provalanginites **47**
Provascoceras 175
Pseudacanthoceras 164
Pseudacompsoceras 156
Pseudargentiniceras **55**
Pseudaspidoceras **167**, 171
Pseudhelicoceras 241, **243**
PSEUDHELICOCERATINAE 241
Pseudoanahamulina 208
Pseudoargentiniceras 55
Pseudoaustraliceras **216**
Pseudobaculites **257**
Pseudobarroisiceras **189**
Pseudoblanfordia 50
Pseudocalycoceras **164**
Pseudocraspedites **22**
Pseudocrioceras 214
Pseudocrioceratites 215
Pseudoeuryptychites 31
Pseudofavrella **64**
Pseudogardenia 86
Pseudogargasiceras **275**
Pseudogarnieria 36
Pseudogastroplites 124
Pseudogaudryceras 3
Pseudohaploceras **73**, 87
Pseudohatchericeras 64
Pseudoholcodiscus 89
Pseudojacobites **101**
Pseudokossmaticeras **93**
Pseudoleymeriella **270**
Pseudomantelliceras 164
Pseudomoutoniceras **208**
Pseudoneocomites 55
Pseudoneoptychites 176
Pseudopachydiscus 105
Pseudophacoceras 137
Pseudophyllites 7, 8
Pseudophylloceras 1
Pseudoplacenticeras 126
Pseudoptychoceras 231
Pseudopulchellia **122**
Pseudopuzosia 101
Pseudorbulites 81
Pseudosaynella **71**
PSEUDOSAYNELLINAE **71**
Pseudoschloenbachia **107**, 109
PSEUDOSCHLOENBACHIINAE 107
Pseudosilesites **78**
Pseudosilesitoides 78
Pseudosonneratia **116**, 117, 119, 134
Pseudosterella 42
Pseudotetragonites 2
Pseudothurmannia **214**, 228, 230
Pseudotissotia 158, **178**, 179, 201
PSEUDOTISSOTIIDAE **177**, 178
PSEUDOTISSOTIINAE **178**
Pseudouhligella **82**, 107
Pseudoxybeloceras **253**
Psilohamites **241**
Psilopulchellia **114**
Psilotissotia **111**
Pterolytoceras 2
Pteropuzosia 75
Pteroscaphites **261**
Ptychoceras **231**
PTYCHOCERATIDAE **231**
Ptychophylloceras 2
Puebloites **241**
Puezalpella 71
Pulchellia **111**, 114
PULCHELLIACEAE 1, **111**
PULCHELLIIDAE **111**, 130
PULCHELLIIDÉS 111
Puzosia 67, 69, **75**, 87
Puzosiella 75
Puzosigella 96
PUZOSIINAE 71, 82, 86, 87, 93, 101, 133

Quitmaniceras **162**
Quitmanites **277**

Rabenjanaharyella **111**
Rabiella **111**
Raimondiceras **57**, 58
Ralphimlayites 147
Rapidoplacenticeras 81
Raspailiceras 69
Raulíniceras 147
Raspailites 69
Raynaudia **243**
Reboulites 70
Reesideoceras 189
Reesidites 187
Reginaites **197**
Reineckeia 36, 39
Rencurelites **235**
Renevierites 64
Renziella 274
Retowskiceras 51
Revilites 134
Reymentites 197
Reymentoceras 198
Reyreiceras 142
Rhacoceras 1
Rhaeboceras **263**, 265
Rhamphidoceras 175
Rhyoptychoceras **255**
Rhytidoceras **140**
Rhytidoplites **275**
Riasanites **50**
Ricnoceras 140
Riedelites 274
Rinconiceras 136
Ringnesiceras 31
Rodighieroites 64
Roemeroceras 173
Rogersites 46
Roloboceras **267**
ROLOBOCERATINAE **266**, 267
Romaniceras 164, **171**
Ronkinites **22**
Rossalites **235**
Rotalinites 101
Rotundites **46**
Rubroceras **176**
Runctonia **18**
Rusoceras 141
Russanovia **29**
Ryugasella **255**

Sabydites 29
Saghalinites **6**
Sakondryella **146**
Salazaciceras 152
Salaziceras **152**

SALAZICERATINAE 151
Salfeldiella 2
Saltericeras 126
Sancarlosia 127
Sanmartinoceras 14
Santandericeras 227
Sapthicrioceras 212
Sarasinella 58
Satoites 46
Saturnoceras 2
Saynella 64
Saynoceras 46, 152
Scalarites 250, 255
SCALARITINAE 250
Scaphamites 241
SCAPHITACEAE 206, 258
Scaphites 152, 260, 261
SCAPHITIDAE 258, 260
SCAPHITINAE 258, 260
Schindewolfites 167
Schloenbachia 117, 126
SCHLOENBACHIDAE 126
SCHLOENBACHIIDAE 118, 126
Schlueterella 253
Schlueteria 84, 86
Schluetericeras 84, 173
Sciponoceras 255, 257
Selwynoceras 184
Semenoviceras 119
Semenovites 119
SEMENOVITINAE 117
Semipulchellia 111
Seunesiceras 147
Sharpeiceras 154
Shasticrioceras 215
Shastoceras 216
Shulginites 22
Shumarinaia 151
Shuparoceras 171
Siberiptychites 30
Siberites 31
Silesites 86
SILESITIDAE 78, 86
Silesitoides 78, 133
SILESITOIDINAE 78
Simancyloceras 214
Simbirskites 17, 34, 36, 38
SIMBIRSKITIDAE 36
SIMBIRSKITINAE 36
Simionescites 228
SIMOCERATIDAE 43
Simospiticeras 43
Sinzovia 14
Sinzowiella 277
Sinzowites 275
Skoumalia 204
Smedaliceras 250
Sokolovites 122
Solenoceras 255
Solgeria 64
Solgerites 187
Somaliceras 43
Somalites 274
Sonneratia 101, 114, 115
SONNERATIINAE 93, 114, 122
Sornayceras 191
Sornayites 212
Sounnaites 88
Sowerbyceras 2
Spathiceras 136, 137
Spathicrioceras 212
Spathinella 187
Spathites 171, 173
Spathitoides 173
Speetoniceras 38
Spheniscoceras 204
SPHENODISCIDAE 203, 205
SPHENODISCINAE 205
Sphenodiscus 205
Spinocrioceras 215
Spiroceras 243
SPIROCERATACEAE 206
Spiticeras 43
SPITICERATIDAE 42
SPITICERATINAE 42, 43
Spitidiscus 67, 69
Stantonoceras 126
Stchirowskiceras 23
Stelckiceras 122
Stenhoplites 273
Stenoceras 50
Stephanoceras 36
STEPHANOCERATINAE 17
Stoicoceras 61
Stoliczkaia 151, 154
STOLICZKAIINAE 147, 151
Stomohamites 239
Stotticeras 124
Stoyanowiceras 276
Strambergella 55
Streblites 12
Strebliticeras 12
STREBLITIDAE 11
STREBLITINAE 1, 11, 13
Styphloceras 141
Subalpinites 55
Subarcthoplites 96
Subaspinoceras 223
Subastieria 46
Subbarroisiceras 187
Subbrahmaites 93
Subcraspedites 18, 22, 36
Subeucalycoceras 164
Subhelicoceras 243
Submortoniceras 197
Suboosterella 64
Subpervinquieria 141
Subpolyptychites 23
Subprionocyclus 184, 186, 187, 193
Subprionotropis 186
Subptychoceras 253
Subpulchellia 114
Subsaynella 70
Subschloenbachia 141
Subspeetoniceras 38
Substeueroceras 50
Substreblites 12
Subtemnoptychites 29
Subthurmannia 55
Subthurmanniceras 55
Subtissotia 201
Sumitomoceras 158, 162
Suridiscus 23
Surites 22, 23, 25, 26, 28
Suritidae 22
Swinnertonia 18

Taimyroceras 19, 34
Tainuia 93
Takahashia 8
Taraisites 46
Taraisitinae 43
TARAMELLICERATINAE 10, 11
Tarfayites 138
Tarrantoceras 158, 159, 162
Tatroceras 2
Tatrophylloceras 2
Tauricoceras 50
Tegoceras 133, 147
Telegdiceras 2
Temnoptychites 26
Terascoceras 136
Termierella 109
Teschenites 60
Teshioites 105
Tetragmenoceras 142
TETRAGONITACEAE 1, 2
Tetragonites 6, 8
TETRAGONITIDAE 2, 6
TETRAGONITINAE 6
Tetragonoceras 137
Tetrahoplites 100, 116, 122
Tetrahoplitoides 100
Texanites 193, 196, 197
TEXANITIDAE 193
TEXANITINAE 193
Texasia 107
Theganoceras 14
Thomasites 178
Thomelites 162, 183
Thorsteinssonoceras 29
Thurmanniceras 58
Thurmannites 58
Thysanoceras 2
Thysanolytoceras 2
Thysanotoceras 38
Tingriceras 6
Tirnovella 55, 56
Tissotia 198, 200, 201
TISSOTIIDAE 198
Tissotioides 198
Tlahualiloceras 154

Toljaiceras 22
Tollia 17, 25, **26**, 29, 34, 36
TOLLIINAE **22**
TOLLINAE 22
Tolypeceras **36**
Tongoboryceras **101**
Tonoceras **216**
Tonohamites **223**
TORCAPELINAE 69
Torcapella 71
TORCAPELLINAE 69
Torneutoceras 239
Torquistylus **234**
Toxoceras 211
TOXOCERATIDAE 210
Toxoceratoides **223**
Trachylytoceras 2
Trachyscaphites **263**
Tragodesmoceras **107**
Tragodesmoceroides **83**, 107
Transcaspiites 53
Trautscholdiceras 18
Trianglites 250
Tricoloceras 233
Tridenticeras **247**
Trinitoceras 269
Trochleiceras **270**
TROCHLEICERATIDAE **269**
Tropaeum **217**, **221**
Tropitoides **17**
Tuberodiscoides **105**
Tuberoiechites **255**
Tunesites **164**
Turbinites 245
Turkmeniceras **271**
Turkmenites 127
TURRILITACEAE 206, **234**
Turrilites 243, **245**
TURRILITIDAE 234, **241**, 245
Turrilitoides **241**, 243, 245
Tzankoviceras 225

Uhligella 78, **80**, 93, 114
Uhligia **227**
Uhligites **12**
Umgazaniceras **209**
Umiaites **43**
Umsinenoceras **73**
Urakawites **106**
Uraturiceras **154**
UTATURICERATINAE 154

Valanginites **46**, 47, 48
Valdedorsella 67, **71**, 72, 73
Valentolytoceras 2
Varlheidites **60**
Varunaites 5
Vascoceras **175**, 176
VASCOCERATIDAE 175
Vascoceratinés 175
Vectisites **269**
Veleziceras 226
Vendegiesiella **109**
Venezoliceras **138**
Venezuella 274
VENEZUELLINAE 273
Vergunniceras 269
Vertebrites **4**
VERTEBRITINAE 2
Villoutreysia 151
Vinalesites **208**, 226
Virgatoptychites **26**, 29
Vitaliites 18

Vjasemskiceras 100
Vnigriceras 96
VNIGRICERATINAE 93
Volgidiscus 18
Vredenburgia 203

Walpenites **269**
Watinoceras **162**
Weavericeras 71
Wellmanites **89**
Wellsia 29, 34
Wintonia **244**
Wollemanniceras 73
Worthoceras **258**, 259, 260
WORTHOCERATIDAE 258
Wrightites 225
Wrightoceras **178**, 202

Xeinophylloceras 1

Yabeiceras **189**
Yakushiceras **88**
Yeharites **88**
Yezoceras **245**
Yezoites **258**, 260
Yokoyamaoceras **92**
Yubariceras 171

Zambranoites 269
Zelandites 5
Zetoceras 1
Zuercherella **80**
Zuluiceras **191**
Zuluites 191
Zuluscaphites **151**
Zumpangoceras 187