Treatise on Invertebrate Paleontology

Part L

Mollusca 4

Revised

Volume 2: Carboniferous and Permian Ammonoidea (Goniatitida and Prolecanitida)

William M. Furnish, Brian F. Glenister,
Jürgen Kullmann, and Zhou Zuren

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This volume is dedicated to the memory of
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Parts of the *Treatise* are distinguished by assigned letters with a view to indicating their systematic sequence while allowing publication of units in whatever order each is made ready for the press. Copies can be obtained from the Paleontological Institute, The University of Kansas, 1475 Jayhawk Blvd., Room 119, Lawrence, Kansas 66045-7613, USA, www.paleo.ku.edu.

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EDITORIAL PREFACE

PAUL A. SELDEN
[The University of Kansas]

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 small group with a synoptic view of the taxa being monographed. Two or perhaps three specialists worked together, sometimes co-opting others for coverage of highly specialized taxa. Recently, however, both new *Treatise* volumes and revisions of existing ones have been undertaken increasingly by teams of specialists led by a coordinating author. This volume, Part L, Revised, Ammonoidea, Volume 2, has been prepared by a team of specialists, each taking equal part in the work involved in this producing this revision. Editorial matters specific to this volume are discussed near the end of this editorial preface.

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 1999 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, revised the *Code* in 1999 to enhance further nomenclatorial stability, specifying that the revised *Code* should take effect at the start of 2000. Among other requirements, the revised *Code* is clear in Chapter 14 that the type genus of family-level taxa must be specified. In this volume we have continued the practice that has characterized most previous volumes of the *Treatise*, namely that the type genus of all family-level taxa is the first listed and diagnosed. In spite of the revisions, 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 every original or subsequent spelling is correct.

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. They call for correction. For example, a name originally published with a diacritical mark, apostrophe, dieresis, 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 further revisions of the *Code* wherein rules are emplaced that 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 (an unfortunate impediment to stability and retrieval of information); 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), 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 names having their own status in nomenclature, with author and date of their publication. They are junior, objective synonyms of the name in its original form.

Subsequent spellings, if unintentional, are defined as incorrect subsequent spellings. They have no status in nomenclature, 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 authors have used fewer terms for such names. The reader is referred 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,* Article 12) 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 pre-existing available name (*Code,* Article 13.1), or (4) for genus-group names, were unaccompanied by definite fixation of a type species by original designation or indication (*Code,* Article 13.2). *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.

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 *brögger*i 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 databases, 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 databases 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 (but see *Code,* Article 58).

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 to be made often arbitrarily.

FAMILY-GROUP NAMES

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 nominate subfamily (*sensu stricto*), which is based on the same type genus as the family. Finally, the author and date set down for the nominate 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* (Article 29.2) specifies the suffixes for tribe (-ini), subfamily (-inae), family (-idae) and superfamily (-oidea), the formerly widely used ending (-acea) for superfamily having been disallowed. All these family-group categories are defined as coordinate (*Code*, Article 36.1): "A name established for a taxon at any rank in the family group is deemed to have been simultaneously established for nominal taxa at other ranks in the family group; all these taxa have the same type genus, and their names are formed from the stemof the name of the type genus (Art. 29.3] with appropriate change of suffix [Art. 34.1]. The name has the same authorship and date at every rank." Such changes of rank and concomitant changes of endings as elevation of a subfamily to family rank or of a family to superfamily rank, if introduced subsequent to designation of the original taxon or 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, as in the following example.

Family HEXAGENITIDAE Lameere, 1917

[*nom. transl.* Demoulin, 1954, p. 566, *ex* Hexagenitinae Lameere, 1917, p. 74]

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.* For example:

Superfamily AGNOSTOIDEA M'Coy, 1849

[*nom. transl.* Shergold, Laurie, & Sun, 1990, p. 32, *ex* Agnostinae M'Coy, 1849, p. 402]

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.

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 all family-group categories, to the stem of the name belonging to the nominotypical 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 published as name giver to a family-group taxon. Once fixed, the family-group name remains tied to the 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), in which case ". . . it must be replaced either by the next oldest available name from among its synonyms [Art. 23.3.5], including the names of its subordinate family-group taxa, or, if there is no such synonym, by a new name based on the valid name . . . of the former type genus." Authorship and date attributed to the replacement family-group name are determined by first publication of the changed family-group name. Recommendation 40A of the *Code,* however, specifies that for subsequent application of the rule of priority, the family-group name ". . . should be cited with its original author and date (see Recommendation 22A.2.2), followed by the date of its priority as determined by this Article; the date of priority should be enclosed in parentheses." 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 11.7). 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 from time to 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 kingdom) 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 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. Beyond mere tidying up, 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 is not coordinate with superfamily Bellerophontacea McCoy, 1851 or family Bellerophontidae McCoy, 1851).

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 a *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 signals 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 nominate 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 & others, 1964, p. 128, *ex* order Endoceroidea Teichert, 1933, p. 214]

Order ENDOCERIDA Teichert, 1933

[*nom. correct.* Teichert in Teichert & others, 1964, p. 165, *pro* order Endoceroidea Teichert, 1933, p. 214]

TAXONOMIC EMENDATION

Emendation has two distinct meanings as regards zoological nomenclature. These are alteration of a name itself in various ways for various reasons, as has been reviewed, and alteration of the taxonomic scope or concept for which a name is used. The *Code* (Article 33.1 and Glossary) concerns itself only with the first type of emendation, applying the term to intentional, either justified or unjustified changes 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 zoologists, including paleontologists, 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 must accompany 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 alteration of a taxonomic concept is introduced 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 a 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 an 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, date, and page of original publication, except 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 is given also, as follows.

Actinocyathus d'Orbigny, 1849, p. 12 [**Cyathophyllum crenulate* Phillips, 1836, p. 202; M; =*Lonsdaleia floriformis* (Martin), 1809, pl. 43; validated by ICZN Opinion 419].

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, 1864, 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 have been removed. Where other mandatory changes are required, these are introduced later in the text, typically in the description of a figure.

Fixation of Type Species Originally

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.

Fixation of Type Species Subsequently

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 publication date and page number of 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 becomes automatically 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 GURICH, 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 through 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 invalid (*Code,* Article 13.3). 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–Holocene cheilostomate bryozoans. Bassler in 1911 introduced the new name *Hallophora* to replace Hall's homonym. The *Treatise* style of entry is given below.

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 is made generally of the existence of a junior homonym.

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 published separately, 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 name that was introduced last 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 encountered, such synonymous homonyms are distinguished in the *Treatise* as in dealing with 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 RICHTER & 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 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* LINNE, 1758, p. 795, see SMITH & TREMBERTH, 1929, p. 368] [=*Patrophontes* LANG & SMITH, 1927, p. 456 (type, *Madrepora truncata* LINNE, 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 the 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.

OTHER EDITORIAL MATTERS

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 USSR, 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 political world had settled down. In addition, such terms as central Europe and western Europe are likely to mean different things to different people. Some 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.

Other geographic terms can also have varying degrees of formality. In general, *Treatise* policy is to use adjectives rather than

nouns to refer to directions. Thus we have used *southern* and *western* in place of *South* and *West* unless a term has been formally defined as a geographic entity (e.g., South America or West Virginia). Note that we have referred to western Texas rather than West Texas, which is said to be not a state but a state of mind.

NAMES OF AUTHORS: TRANSLATION AND TRANSLITERATION

Chinese scientists have become increasingly active in systematic paleontology in the past two decades. Chinese names cause anguish among 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, has been spelled more recently 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 under more than one name 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, however, often reverse the order, putting the family name last as is the Western custom. Thus, for example, Dr. Yi-Maw Chang, formerly of 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. In the *Treatise,* authors' names are used in the text and listed in the references as they appear in the source being cited.

Several systems exist for transliterating the Cyrillic alphabet into the roman alphabet. On the recommendation of skilled bibliographic librarians, we have adopted the American Library Association/Library of Congress romanization table for Russian and other languages using the Cyrillic alphabet.

MATTERS SPECIFIC TO THIS VOLUME

Authorship entails both credit and responsibility. As the knowledge of paleontology grows and paleontologists become more specialized, preparation of *Treatise* volumes must necessarily involve larger and larger teams of researchers, each focusing on increasingly narrow aspects of the higher taxon under revision. In this volume, we have taken special pains to acknowledge authorship of small subsections. Readers citing the volume are encouraged to pay close attention to the actual authorship of a section or subsection.

Stratigraphic ranges of taxa listed in the systematic descriptions herein have been compiled from the ranges of lower taxa. In all instances, we have used the *range-through* method of describing ranges. In instances, therefore, where the work of paleontology is not yet finished, some ranges of higher taxa will not show gaps between the ranges of their subtaxa and may seem to be more complete than the data warrant. In this volume, stratigraphic range charts typical of previous *Treatise* volumes present a much more precise picture of the biostratigraphy of the ammonoids (see Table 1, p. 220 herein).

ACKNOWLEDGMENTS

The Paleontological Institute's Assistant Editor for Text, Jill Hardesty, and the Assistant Editor for Illustrations, Jane Kerns, have faced admirably the formidable task of moving this volume through the various

stages of editing and into production. In this they have been ably assisted by other members of the editorial team, including Mike Cormack with his outstanding computer skills, and Denise Mayse with her work on reference checking and general support.

This editorial preface and other, recent ones are extensive revisions of the prefaces prepared for previous *Treatise* volumes by former editors, including the late Raymond C. Moore, the late Curt Teichert, Richard A. Robison, and the late Roger L. Kaesler. 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.

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Robison, R. A., and C. Teichert. 1979. Treatise on Invertebrate Paleontology. Part A, Introduction. The Geological Society of America and The University of Kansas. Boulder & Lawrence. 569 p.

Paul A. Selden
Lawrence, Kansas
February 17, 2009

STRATIGRAPHIC DIVISIONS

The major divisions of the geological time scale are reasonably well established throughout the world, but minor divisions (e.g., subseries, stages, and substages) are more likely to be provincial in application. The stratigraphic units listed here represent an authoritative version of the stratigraphic column for all taxonomic work relating to the revision of Part L (any provincial terms are presented in brackets in taxonomic descriptions). They are adapted from the International Stratigraphic Chart, compiled by the International Commission on Stratigraphy (ICS; ©2008).

Cenozoic Erathem
- **Quaternary System**
  - Holocene Series
  - Pleistocene Series
- **Neogene System**
  - Pliocene Series
  - Miocene Series
- **Paleogene System**
  - Oligocene Series
  - Eocene Series
  - Paleocene Series

Mesozoic Erathem
- **Cretaceous System**
  - Upper Cretaceous Series
  - Lower Cretaceous Series
- **Jurassic System**
  - Upper Jurassic Series
  - Middle Jurassic Series
  - Lower Jurassic Series
- **Triassic System**
  - Upper Triassic Series
  - Middle Triassic Series
  - Lower Triassic Series

Paleozoic Erathem
- **Permian System**
  - Lopingian Series
  - Guadalupian Series
  - Cisuralian Series
- **Carboniferous System**
  - Pennsylvanian Series
    - Gzhelian Stage
    - Kasimovian Stage
    - Moscovian Stage
    - Bashkirian Stage
  - Mississippian Series
    - Serpukhovian Stage
    - Visean Stage
    - Tournaisian Stage
- **Devonian System**
  - Upper Devonian Series
  - Middle Devonian Series
  - Lower Devonian Series
- **Silurian System**
  - Pridoli Series
  - Ludlow Series
  - Wenlock Series
  - Llandovery Series
- **Ordovician System**
  - Upper Ordovician Series
  - Middle Ordovician Series
  - Lower Ordovician Series
- **Cambrian System**
  - Furongian Series
  - Series 3
  - Series 2
  - Terreneuvian Series

COORDINATING AUTHORS' PREFACE

Jürgen Kullmann and Zhou Zuren

[University of Tübingen, Germany; and Nanjing Institute of Geology and Palaeontology]

In 1938, the first volume of a comprehensive treatment of every valid taxon (especially genus and species) in invertebrate paleozoology was published in the *Handbuch der Paläozoologie* by Otto H. Schindewolf (1938–1944). This very ambitious work resulted only in a few parts being issued: Graptolithina, Gastropoda, and Hydrozoa; it was stopped by World War II. Less than ten years later, Raymond C. Moore in Lawrence, Kansas, founded the *Treatise on Invertebrate Paleontology,* with the first volume, part G, Bryozoa, being issued in December 1953. In his Editorial Preface, R. C. Moore (1953, p. vii) defined the intent of the *Treatise*: "The aim of the *Treatise on Invertebrate Paleontology,* as originally conceived and consistently pursued, is to present the most comprehensive and authoritative, yet compact statement of knowledge concerning invertebrate fossil groups that can be formulated by collaboration of competent specialists."

The first volume dedicated solely to the Ammonoidea was published in 1957. It covered not only the different groups of ammonoid cephalopods, but included also chapters on morphology, evolution, paleoecology, and geographic distribution. The chapter on Paleozoic Ammonoidea was authored by A. K. Miller and W. M. Furnish, and embraces the treatment by O. H. Schindewolf (Clymeniida) and B. Kummel (Permian constituents of Ceratitida).

Between 1954 and 1965, more than 100 new genera were established worldwide. Therefore, in February 1967, plans to revise *Treatise* Part L were discussed in Lawrence, Kansas. At this meeting, W. M. Furnish, B. F. Glenister, J. Kullmann, and B. Kummel agreed upon exact assignments, based on taxonomy or stratigraphy. W. M. Furnish and B. F. Glenister would be responsible for all families occuring in the Permian except Xenodiscidae. J. Kullmann would work mostly with simpler Goniatitina, M. R. House would handle the bulk of Devonian forms, and O. H. Schindewolf the clymeniids. Despite a considerable expansion of the introductory portion, a single chapter would be processed by editor C. Teichert, who was appointed as coordinator of the volume. Originally, spring 1970 was considered as the target date for completion of manuscripts. The first to present a manuscript was Schindewolf in 1971, and the others were expected at latest by 1975.

Curt Teichert worked as coordinator of the ammonoid *Treatise* revision for more than a decade. Though not a specialist, Teichert was recognized for his wide and deep knowledge of the Cephalopoda and regarded as a superb generalist. A number of revised editions of parts of the *Treatise* were directed and edited by him, beginning with Part V, Graptolithina (1970). Teichert resigned from the *Treatise* editorship at end of 1976, but he continued working for the *Treatise* for several more years. A broad correspondence with the involved specialists ensured that things went smoothly, although slowly.

Several so-called first drafts were assembled. The Devonian chapter of 138 pages and more than 100 plates, by M. House; the Carboniferous part, 277 pages and 75 plates by Kullmann; the Permian part, 100 pages and more than 100 plates by Furnish and Glenister; and orthocone ammonoids, by R. T. Becker.

A great event for the *Treatise* was the international gathering in 1979 in London at the Systematics Association Symposium on the Ammonoidea, the first international symposium ever held to discuss scientific problems of the group. On this occasion, *Treatise* authors summarized in "Keynote Lectures" their views on the classification and evolution of the group. The final session of the symposium addressed the biostratigraphic

usefulness of the ammonoids and the problem of correlation and distribution.

The advent of the computer with its enormous storage and retrieval capacity allowed another step to be taken to provide access to the treasures of information about fossils, including information about taxa insufficiently described and figured from earlier times. In 1990 the Database System GONIAT (and later GONIAT Online 2007) was founded, based on *Treatise* classification. After 15 years of work, about 4000 valid species and more than 700 genera and subgenera of about 120 families have been included, and approximately 7500 localities are described. The information provided in GONIAT is intensively used for the present volume. GONIAT can be found at www.goniat.org. Updates of the entire database system provided by Svetlana V. Nikolaeva, Scientific Editor, Bulletin of Zoological Nomenclature, International Commission on Zoological Nomenclature, The National Museum London, SW7 58D, U.K. (s.nikolaeva@nhm.ac.uk); technical assistance provided by Peter S. Kullmann, Humboldtstr. 32, D-70771 Leinfelden-Echterdingen, Germany (info@elementec.de).

In 2004, W. M. Furnish, B. F. Glenister, J. Kullmann, and Zhou Zuren decided to put together the Carboniferous and Permian parts and asked the Editorial Office at the Paleontological Institute of the University of Kansas in Lawrence to accept both unified parts for the *Treatise* series of revised parts. The uninterrupted evolutionary lines between the Carboniferous and Permian made possible a similar treatment of taxonomic descriptions and literature.

The present volume reflects a considerable amount of paleontological research of the last century. In 1988 Zhou Zuren joined the Iowa group of scientists specializing in Permian ammonoids. The new interpretation of the sutural pattern of the early stages of coiling, EALUI [German] and VLU:ID [Russian] instead of $ELU_{2:}U_1$:I or VUU[1]:ID in Prolecanitida may be of great consequence for the evaluation of phylogeny (p. 185 herein). It has led to the idea of a much closer affinity of the orders Prolecanitida and Goniatitida. Many representatives of aberrant endemics, mainly the pseudohaloritaceans, kufengoceratins, and paragastrioceratids reported from South China, suggest a widespread ecological differentiation among Permian ammonoids. The combination of these special faunas with special environments has led to a new understanding of ammonoid provincialism. Dimorphism is known to be a common phenomenon in the Permian period. A regressive evolution pattern existed in some late Paleozoic ammonoid families: a kind of terminal paedomorphosis has been verified in many genera and their family groups. As is explained in one of the old *Treatise* prefaces: the making of a reasonably complete inventory of present knowledge may be expected to yield needed foundation for future research, and it is hoped that the *Treatise* will serve this end.

ACKNOWLEDGMENTS

Many colleagues have supported our investigations with significant contributions to systematic descriptions and by providing essential illustrations. A large number of individuals and institutions have generously helped in bringing together extensive information on the Carboniferous and Permian ammonoids. The authors wish to express special thanks to R. T. Becker, Münster; V. E. Ruzhentsev,† B. I. Bogoslovskii,† M. F. Bogoslovskaia, and T. B. Leonova, Moscow; J. Dzik, Warzawa; M. R. House,† Hull; D. Weyer, and D. Korn, Berlin; L. F. Kuzina, Moscow; Liang Xi-luo and Ruan Yiping,† Nanjing; Sheng Huaibin, Beijing; Claude Spinosa, Boise; W. W. Nassichuk, Calgary; W. B. Saunders, Boston; W. L. Manger, Fayetteville; L. K. Meeks, Warrensburg; S. V. Nikolaeva, London and Moscow, the Palaeontographical Society, London; J. D. Price, formerly University of Hull; A. L. Titus, Kanab; H. W. J. van Amerom, Heerlen; W. H. C. Ramsbottom, Sheffield; and D. M. Work, Augusta.

REPOSITORIES AND THEIR ABBREVIATIONS

Abbreviations and locations of museums and institutions holding type material, which are used throughout the systematic sections of this volume, are listed below.

AM: Australian Museum, Sydney, Australia
AMF: Australian Museum, Sydney, Australia
AMNH: American Museum of Natural History, New York, USA
ANU: Australian National University, Canberra, Australia
AU: Geology Department, Auckland University, Auckland, Australia
BAU: Buenos Aires University, Buenos Aires, Argentina
BGS, GSM, IGS: British Geological Survey (formerly Geological Survey Museum; Institute of Geological Sciences, London) Keyworth, Nottinghamshire, United Kingdom
BMNH: The Natural History Museum, London, United Kingdom [formerly British Museum (Natural History)]
BMR: see CPC
Br: see TAGI Br
BSM: Bavarian State Museum, Munich, Germany
BU: Department of Geology, Birmingham University, Birmingham, United Kingdom
BUM: Bristol University Museum, Bristol, United Kingdom
CAGS: Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China
CAS: California Academy of Sciences, Types Collections, San Francisco, California, USA
CB: Muséum d'Histoire Naturelle, Geneva, Switzerland
CEGH: see CORD-PZ
CFP UA: Compagnie Française Petroles, Paris, France
CGS: Czech Geological Survey, Prague, Czech Republic
CIGMR: Chengdu Institute of Geology and Mineral Resources, Chengdu, China
CMB: City Museum and Art Gallery, Bristol, UK
CMNH: Carnegie Museum, Pittsburgh, USA
CNIGR: Central Scientific Geological Exploration Museum (Tschernyshev Museum), St. Petersburg, Russia
CORD-PZ: Universidad Nacional de Córdoba, Argentina
CPC: Commonwealth Palaeontological Collections, Australian Geological Survey Organisation, Canberra, Australia
CRMGE: Central Research Museum of Geological Explorations, St. Petersburg, Russia
D, EM, ENSM, FSI, FSL, SSL, TA: Université Claude Bernard, Lyon I, Villeurbanne, France
DNGM: Servicio Nacional Minero Geológico, Buenos Aires, Argentina
DP, DPO: Departamento de Geología, Oviedo University, Oviedo, Spain
DPO: see DP
DPUCM: Departamento de Paleontologia, Universidad Complutense, Madrid, Spain
EM: see D
ENSM: see D
FD: Geological College of Eastern China, Fuzhou, China
FSI: see D
FSL: see D
GB: Xian Institute of Geology and Mineral Resources, Xian, China
GBA: Geologisches Bundesanstalt Museum, Vienna, Austria
GIB: Geological Institute, Bonn, Germany
GIBAS: Geological Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
GIN KAZ: Institute of Geology, Kazakh Academy of Sciences, Alma-Ata, Kazakhstan
GIN TAD: Institute of Geology, Dushanbe, Tadzhikistan
GIN UZ: Institute of Geology, Uzbek Academy of Sciences, Tashkent, Uzbekistan
GIUS: Department of Earth Sciences, Silesian University, Sosnowiec, Poland
GLAHM: Hunterian Museum, Glasgow University, Scotland, United Kingdom
GMC, IV: Geological Museum of China, Beijing, China
GMG: State Museum of Georgia (named after S. N. Djanashia), Academy of Sciences of the Georgian SSR, Tbilisi
GMUT: see TUG
GM YaRGTS: Geological Museum of the Regional Geological Centre, Yakutsk, Yakutia
GPIBo: Palaontological Institute, Bonn, Germany
GPIT: Institut für Geowissenschaften, Tübingen, Germany
GPZ: Department of Geology and Palaeontology, Zagreb, Croatia
GSC: Geological Survey of Canada, Ottawa, Ontario, Canada
GSE: see IGS GSE
GSI: Geological Survey of India, Calcutta, India
GSM: see BGS
GSQ: Geological Survey, Queensland, Australia
GSV: Geological Survey of Victoria, Australia
GSWA: Geological Survey of Western Australia, Perth, Australia
GS YA: see CGS
HB: Bureau of Geology and Mineral Resources of Hunan Province, Hunan, China
HGI: Hungarian Geological Institut, Budapest, Hungary
HIGS: Hangzhou Institute for Geological Science, Hangzhou, China
HM: see GLAHM

HNHMB: Hungarian Natural History Museum, Budapest, Hungary
HUB: see MB
I: New York State Geological Survey, Albany, New York, USA
ICPSB: Institute of Geology, University of Padua, Italy
IG: Palaeontological Collections of L'Institut Royal des Sciences Naturelles de Belgique, Brussels
IGAS: Institute of Geology, Chinese Academy of Sciences, Beijing, China
IGiG: Institute of Geology and Geophysics, Siberian Branch, Academy of Sciences, Akademgorodok, Russia
IGM: Instituto de Geología, Universidad Autónoma de México, Ciudad Univesitaria, México City, Mexico
IGN: Institute of Geological Sciences, Kiev, Ukraine
IGN SO RAN: Geological Museum of the Institute of Geological Sciences of Yakutia Sakha Scientific Centre, Siberian Division, Russian Academy of Sciences, Yakutsk, Yakutia
IGNA: Geological Museum of the Institute of Geological Sciences, Almaty, Kazakhstan
IGR: Institute of Geology, University of Rennes, Rennes, France
IGS GSE: Institute of Geological Sciences, Edinburgh, United Kingdom
IGS GSM: see BGS
IMGPT: Geological-Paleontological Institute and Museum of Tübingen University, Germany
Inst. Geol.: Geological Institute, Bishkek, Kyrgyzstan
IO: P. P. Shirshov Institute of Oceanology, Moscow, Russia
IV: see GMC
IPW: Institut für Paläontologie der Universität (Geozentrum), Vienna, Austria
IRScNB: Palaeontological Collections of L'Institut Royal des Sciences Naturelles de Belgique, Brussels
JCF: James Cook University, Townsville, Queensland, Australia
KAS, MANK: Geological Museum of Institute of Geological Sciences, Almaty, Kazakhstan
KHGU: Kharkov State University, Ukraine
KIGLGU: Geology Faculty of Leningrad State University, Paleontology-Stratigraphy Museum, St. Petersburg, Russia
L: National Museum, Prague, Czech Republic, Barrande specimens
LGE: St. Petersburg State University, St. Petersburg, Russia
LGI: Leningrad Geological Institute, Leningrad, Russia
LM: see LO
LMT: Loodus Museum, Tallinn, Estonia
LO (formerly LM): Lund University Museum, Sweden
LPB: Laboratoire de Paléontologie, Université de Bretagne Occidentale, Brest, France
LS: Linnean Society of London, United Kingdom
MANK: see KAS
MB (formerly HUB): Humboldt University, Berlin, Germany
M.Ch: Museum Chabarovsk, Verkhoyan, eastern Siberia, Russia
MBHR: Museum of Dr. B. Horák, Rokycany, Czech Republic
MCMB: Department of Geology, University of Beijing, Beijing, China
MCZ: Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA
MDSGF: Museo del Dipartimento di Scienze Geolgiche dell'Università di Ferrara, Ferrara, Italy
MDSGF: Museo del Dipartimento di Scienze Geolgiche dell'Università di Ferrara, Ferrara, Italy
MDTF: see MDSGF
MFLV: Museo dei Fossili della Lessinia, Verona, Italy
MFMGB: Museum of the Faculty of Mining and Geology, Belgrade University, Belgrade, Yugoslavia
MG: Institute of Geology, Ashkhabad, Turkmenistan
MGBW: Museum of the Geologische Bundesanstalt of Wien, Austria
MGRI: Moscow Geological Prospecting Institute, Moscow, Russia
MGSB: Museo Geológico del Seminario de Barcelona, Barcelona, Spain
MGU: Moscow State University, Russia
MGUH: Geological Museum, Copenhagen, Denmark
MGUP: Museum of Geology, University of Palermo, Sicily, Italy
MIP: see MLP
MLP: Invertebrate Paleontology Department, La Plata Natural Sciences Museum, La Plata, Argentina
MM: Geological Survey, Prague, Czech Republic
MM: Moravian Museum, Brno, Czech Republic
MMF: Geological and Mining Museum, Department of Mines, Sydney, Australia
MNB: see MB
MNHN: Muséum National d'Histoire Naturelle, Paris, France
MONZ: see NMNZ
MPL: see MLP
MPM: Milwaukee Public Museum, Milwaukee, Wisconsin, USA
MPUM: Museo di Paleontologia del Dipartimento di Scienze della Terra dell'Università degli Studi di Milano, Italy
MUGT: see GIN TAD
Muz IG: Geological Museum of the Geological Institute, Warsaw, Poland
MV: see NMVP
NHM: Natural History Museum, London, UK
NHMB: Natural History Museum, Basel, Switzerland (Naturhistorisches Museum Basel)
NHMW: Natural History Museum in Vienna, Naturhistorisches Museum, Wien, Austria
NIGP: Nanjing Institute of Geology and Palaeontology, Academia Sinica, Nanjing, China
NM: National Museum, Prague, Czech Republic
NMING: National Museum of Ireland, Dublin, Ireland
NMNZ: Te Papa, Museum of New Zealand, Wellington, New Zealand

NMVP: Victoria Museum, Melbourne, Victoria, Australia
NMW: National Museum of Wales, Cardiff, United Kingdom
NMV P: Department of Invertebrate Palaeontology, Museum of Victoria, Australia
NS: Northeastern Institute of Geology, Inner Mongolia
NUF: Department of Geology, University of Newcastle, New South Wales, Australia
NYSM: New York State Museum, Albany, USA
NZGS: New Zealand Geological Survey, Lower Hutt, New Zealand (presently called Institute of Geological and Nuclear Sciences)
NZOI: New Zealand Oceanographic Institute, National Institute of Water and Atmospheric Research, Wellington, New Zealand
OKGS: Oklahoma Geological Survey, Norman, Oklahoma, USA
OMR: District Museum, Rokycany, Czech Republic
OMR VH: see OMR
OSU: Orton Geological Museum, Ohio State University, Columbus, Ohio, USA
OU: University of Oklahoma, Norman, USA
OUM: Oxford University Museum, United Kingdom
OU NZ: Geology Department, Otago University, Dunedin, New Zealand
PAN: see PIN
PCZCU: Department of Biology, Západočeská univerzita, Plzeň, Czech Republic
PIN: Palaeontological Institute, Russian Academy of Sciences, Moscow, Russia
PIN RAS: see PIN
PIW: Paleontological Institute, Würzburg University, Würzburg, Germany
PKUM: Geological Museum of Beijing University, China
PM (formerly PMU): Palaeontological Museum, Uppsala University, Uppsala, Sweden
PMNUF: Paleontological Museum, University of Naples 'Federico II', Naples, Italy
PMO: Paleontologisk Museum, University of Oslo, Norway
PMU: see PM
PRI: Paleontological Research Institute, Ithaca, New York, USA
PUC: Princeton University Collections, Princeton, New Jersey, USA
PUM: Geology, Peking University, Beijing, China
QMF: Queensland Museum, South Brisbane, Australia
RCCBYU: Research Center for the Chengjiang Biota, Yunnan University, Yunnan, China
RGF VR: Institute of Regional Geology and Paleontology, Faculty of Mining and Geology, University of Belgrade, Belgrade, Serbia **RM, RMS:** Swedish Museum of Natural History, Stockholm, Sweden
ROM: Royal Ontario Museum, Toronto, Ontario, Canada
RX: Rowley Collection, University of Illinois, Urbana, Illinois, USA
SAM.P: South Australian Museum, Adelaide, South Australia
SBNML: National Museum, Prague, Czech Republic
SGU: Geological Survey of Sweden, Uppsala, Sweden
SIGM: Shenyang Institute of Geology and Mineral Resources, Shenyang, Liaoning, China
SM (formerly SMA): Sedgwick Museum, University of Cambridge, United Kingdom
SMF: Senckenbergische Museum, Frankfurt, Germany
SNM: Slovakian National Museum, Bratislava, Slovakia (Slovenské Narodné Múzeum, Bratislava)
SSL: see D
SUI: University of Iowa, Department of Geology, Iowa City, USA
SUP: Palaeontological collections, University of Sydney, New South Wales, Australia
T: Paleontological Museum, University of Naples, Naples, Italy
TA: see D
TAGI BR: Geological Museum, Institute of Geology, Tallinn Technical University, Tallinn, Estonia
TBR: see TF
TF: Geological Survey Division, Department of Mineral Resources, Bangkok, Thailand
TsGM: see CNIGR
TsNIGRA: see CNIGR
TUBr: Paläontologische Sammlung, Institut für Geowissenschaften, Universität Tübingen, Germany
TUG: Museum of Geology, University of Tartu, Tartu, Estonia
UA: Geology Department, University of Alberta, Edmonton, Canada
UC: Field Museum of Natural History, Chicago, Illinois, USA
UCF: The University, Calgary, Canada
UCLA: University of California at Los Angeles, Los Angeles, California,
USA
UCM: University of Canterbury, Christchurch, New Zealand
UCMP: University of California, Museum of Paleontology, USA
UD: University of Dijon, Dijon, France
UHR: Hokkaido University, Sapporo, Japan
UI: University of Illinois, Urbana, Illinois, USA
UL: Department of Geology and Palaeontology, University of Ljubljana, Slovenia
UM: Museum of Paleontology, University of Michigan, Ann Arbor, Michigan, USA
UMC (formerly UMO): University of Missouri, Columbia, Missouri, USA
UMMF: Department of Geology, University of Montpellier, Montpellier, France
UMUT: University Museum of the University of Tokyo, Tokyo, Japan
UND: University of Notre Dame, Indiana, USA
U.N.E: University of New England, Armidale, Australia
UPS: Université de Paris-Sud, France

UQF: University of Queensland, Department of Geology, Brisbane, Australia
USNM: United States National Museum, Washington, D.C., USA
UT: Department of Geology, University of Texas, Austin, Texas, USA
UTC: Department of Geology, University of Toronto, Toronto, Canada
UTGD: University of Tasmania Geology Department, Hobart, Tasmania, Australia
U.W.A.: University of Western Australia, Nedlands, Western Australia
VH: see OMR
VSEGEI: Russian Geology Institute, St. Petersburg, Russia
XAGM: Xi'an Institute of Geology and Mineral Resources, Shaanxi, China
XB: Palaeontological Collections of the Xi'an Institute of Geology and Mineral Resources, Chinese Academy of Geological Sciences, Xi'an, Shaanxi Province, China
XIGMR: Xi'an Institute of Geology and Mineral Resources, Shaanxi, China
YaTGU: Geological Museum, Yakutsk, Yakutia
YIGM: Yichang Institute of Geology and Mineral Resources, Yichang, China
YPM: Yale University, Peabody Museum of Natural History, New Haven, Connecticut, USA
ZI: Zhejiang Institute of Geology and Mineralogy, Zhejiang, China
ZPAL Br: Institute of Palaeobiology, Polish Academy of Sciences, Warsaw, Poland

CARBONIFEROUS AND PERMIAN AMMONOIDEA (GONIATITIDA AND PROLECANITIDA)

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Order GONIATITIDA Hyatt, 1884

[*nom. transl.* RUZHENTSEV, 1957, p. 56, *ex* suborder Goniatitinae HYATT, 1884 in 1883–1884, p. 307]

Conch form very variable, predominantly involute, with narrow or even closed umbilicus; some forms evolute, with wide umbilicus. Umbilici always imperforate. Position of the siphuncle ventral throughout the whole order except for the superfamily Pseudohaloritoidea, which displays a variable position of the siphuncle, mostly subcentral or within the septal flexure. Some genera (*Kirsoceras, Agathiceras,* and *Maximites*) start with a central or at least subventral position of the siphuncle on an early growth stage and change the position to ventral during ontogeny. The basic suture consists of six or eight lobes in the suborder Tornoceratina (basic sutural formula: EALI or EALUI [German], VLU:D or VLU:ID [Russian]), the ventral lobe being simple, in some advanced forms bifid or trifid. The suborder Goniatitina possesses regularly a subdivided ventral lobe, usually with a median saddle and small median lobe (basic sutural formula: $(E_1E_mE_1)$ALUI [German], (V_1V_1)LU:ID [Russian]); in the suborder Tornoceratina the mode of subdivided ventral lobe is restricted to some advanced forms in the Famennian superfamily Praeglyphioceratoidea and the Carboniferous families Voehringeritidae, Karagandoceratidae, and Maximitidae. Additional adventitious and umbilical lobes may be present. Advanced forms display complicated subdivisions of the suture line as well as digitalized lobes and saddles. *Middle Devonian (Eifelian)–Lopingian (Changhsingian).*

[In the following text, sutural formulae marked with [German] are given in the suture-symbol terminology of WEDEKIND (1913a, 1916), while formulae marked with [Russian] correspond to the symbol terminology of RUZHENTSEV (1949b). For comparison, see KULLMANN & WIEDMANN, 1970; WIEDMANN & KULLMANN, 1981.]

Suborder TORNOCERATINA Wedekind, 1918

[*nom. correct.* RUZHENTSEV, 1957, p. 56, *pro* Tornoceracea WEDEKIND, 1918, p. 103]

Ventral lobe usually simple, undivided (exceptions: several representatives of the above mentioned families).

The suborder comprises six superfamilies, three of which are restricted to the Devonian period: Tornoceratoidea ARTHABER, 1911; Dimeroceratoidea HYATT, 1884 in 1883–1884; and Praeglyphioceratoidea RUZHENTSEV, 1957. The root stock of most Carboniferous and Permian ammonoids embody the superfamily Prionoceratoidea HYATT, 1884 in 1883–1884, the only Devonian superfamily containing taxa that crossed the Devonian–Carboniferous boundary. The superfamily Karagandoceratoidea LIBROVICH, 1957, is restricted to the Mississippian, and the superfamily Pseudohaloritoidea RUZHENTSEV, 1957, appeared in the Pennsylvanian and is predominantly distributed in the Permian period. *Middle Devonian (Eifelian)–Lopingian (Changhsingian).*

Superfamily TORNOCERATOIDEA Arthaber, 1911

[*nom.transl. et correct.* RUZHENTSEV, 1957, p. 56, *ex* Tornoceratea ARTHABER, 1911, p. 177]

Restricted to the Devonian period. *Middle Devonian (Eifelian)–Upper Devonian (Famennian).*

Superfamily DIMEROCERATOIDEA Hyatt, 1884

[*nom. transl.* Bartzsch & Weyer, 1988a, p. 136, *ex* Dimerocerae Hyatt, 1884 in 1883–1884, p. 330]

Restricted to the Devonian period. *Upper Devonian (Famennian).*

Superfamily PRAEGLYPHIOCERATOIDEA Ruzhentsev, 1957

[Praeglyphioceratoidea Ruzhentsev, 1957, p. 57]

Restricted to the Devonian period. *Upper Devonian (Famennian).*

PRIONOCERATOIDEA

Jürgen Kullmann

[University of Tübingen, Germany]

Superfamily PRIONOCERATOIDEA Hyatt, 1884

[*nom. transl.* Bartzsch & Weyer, 1988a, p. 136, *ex* Prionocerae Hyatt, 1884 in 1883–1884, p. 328]

Shell surface mostly smooth, rarely with ribbing or ventrolateral furrows, keels, grooves, and spiral ornamentation. Growth lines convex or biconvex. Constrictions common, either restricted to flanks or crossing venter. Sutures with primary ventral, lateral, and dorsal lobes, in addition with prominent and usually pointed adventitious and umbilical lobes. Ventral lobe in general simple, V-shaped, narrow, or pouched; lateral lobe small and close to umbilicus; sutural formula: EALUI [German], VLU:ID [Russian]. Only the Carboniferous side-branch family Voehringeritidae comprises forms with a subdivided ventral lobe and median saddle. *Upper Devonian (Famennian [Platyclymenia Zone])–Mississippian (Serpukhovian).*

Family PRIONOCERATIDAE Hyatt, 1884

[*nom. correct.* Bogoslovskii, 1971, p. 180, *pro* Prionocerae Hyatt, 1884 in 1883–1884, p. 328] [=Aganididae J. P. Smith, 1903, p. 112; =Imitoceratidae Ruzhentsev, 1950, p. 87; =Prionoceratinae Korn, 1994, p. 37; =Balviinae Korn in Korn & Klug, 2002, p. 276]

Adult conch form involute, with narrow or closed umbilicus. Shell surface mostly smooth. Early growth stages usually involute, rarely first whorls evolute. Close relationship to family Gattendorfiidae, some genera are transitional. *Upper Devonian (Famennian [Platyclymenia Zone])–Mississippian (Serpukhovian).*

Prionoceras Hyatt, 1884 in 1883–1884, p. 328 [**Goniatites divisus* Münster, 1832, p. 24; OD; *non* Buckman, 1920, p. 155] [=*Haugiceras* Cossmann, 1900, p. 43, *nom. subst.,* obj.; =*Postprolobites* Wedekind, 1913b, p. 87 (type, *P. yakowlewi,* SD Wedekind, 1918, p. 157, =*Goniatites divisus* Münster, 1832, p. 43; for discussion, see Schindewolf, 1923, p. 402)]. Conch form subdiscoidal to subglobular, involute, with punctiform umbilicus. Growth lines fine and linear with hyponomic sinus. Adult whorls with 3–4 weak constrictions, beginning at umbilicus, rather deep on flanks, usually not crossing venter. Ventral lobe with diverging or parallel sides. Four species (one questionable). *Upper Devonian (middle Famennian [upper Platyclymenia Zone]):* Great Britain, Germany, Austria, Spain, Algeria, Morocco, ?Czech Republic, Russia (South Urals), Kazakhstan (South Urals, Karaganda), Iran, China (Inner Mongolia), ?Canada.——Fig. 1,*1a–c.* **P. divisum* (Münster); *a–b,* Ouarurut, Saoura Valley, Algeria, magnification not indicated (Petter, 1959); *c,* suture, Beul, Rhenish Massif, Germany, GÖT 372-13, ×5 (Korn, 1994).

Balvia Lange, 1929, p. 60 [**Gattendorfia globularis* Schmidt, 1924, p. 120; OD] [=*Kenseyoceras* Selwood, 1960, p. 169 (type, *K. (K.) rostratum* Selwood, 1960, p. 171, =*Prionoceras biforme* Schindewolf, 1937, p. 32, OD); =*Kenseyoceras (Mayneoceras)* Selwood, 1960, p. 171 (type, *Glatziella nucleus* Schmidt, 1924, p. 119, M); =*Effenbergia* Korn in Korn & Klug, 2002, p. 195 (type, *Balvia lens* Korn, 1992, p. 35, OD)]. Conch very

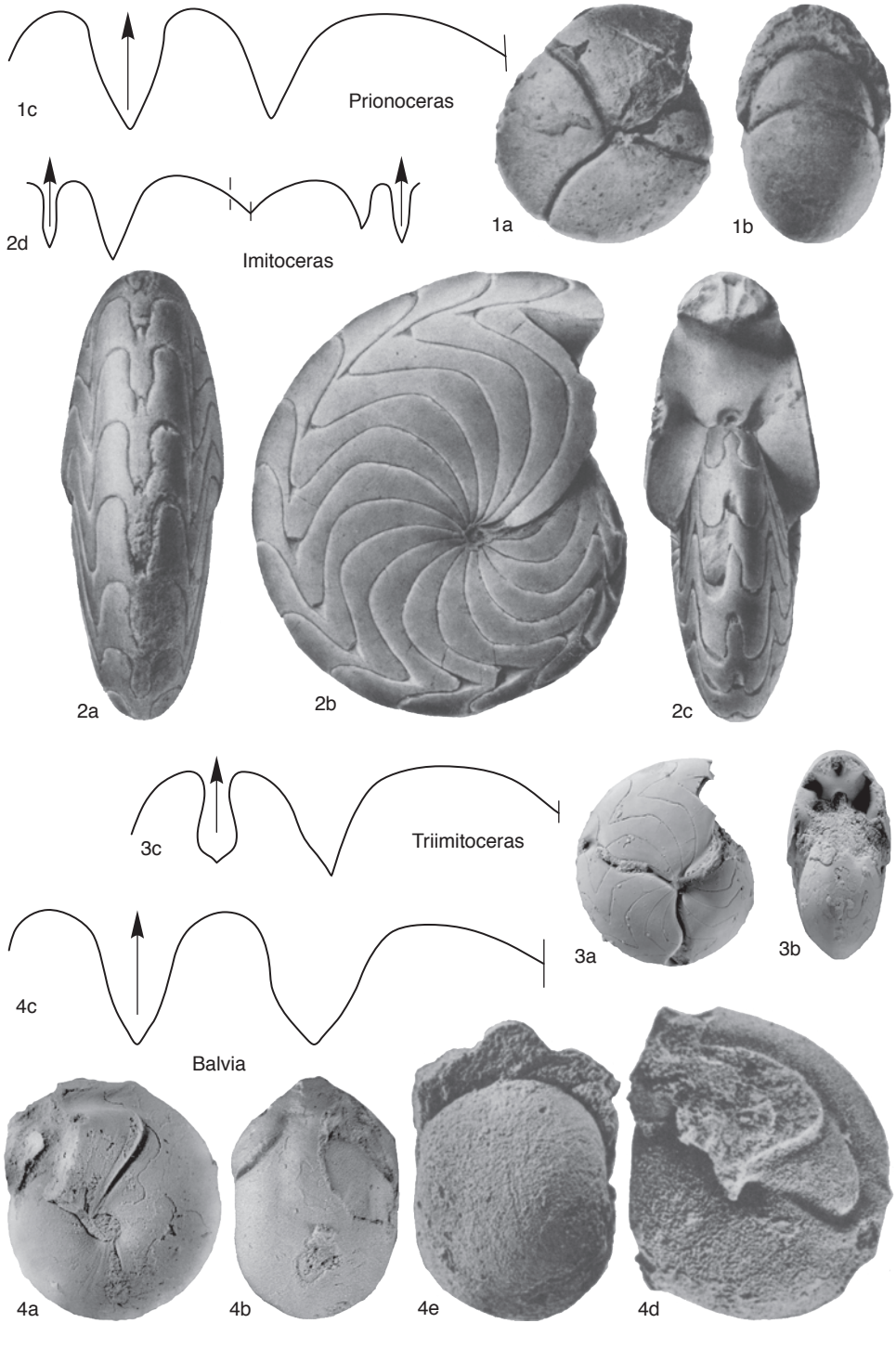

FIG. 1. Prionoceratidae (p. 2–6).

small, lenticular to subglobose, completely involute, with closed umbilicus. Early whorls slightly evolute. Growth lines fine, prorsiradiate, concave-convex, with well-developed ventrolateral salient and hyponomic sinus. Flanks with one or several weak constrictions combined with a parallel wall on apertural side, which usually swing forward at venter to form grooves bounding a median keel. Apertural modifications may be present. Suture similar to *Prionoceras*. About ten species. [Some authors (Becker, 1996) regard *Kenseyoceras* and *Mayneoceras* as subgenera of *Balvia* with transitional characteristics: *Balvia (Kenseyoceras)* displays a biform conch, *Imitoceras*-like early whorls; later, after a single constriction a strong keel and ventral rostrum is formed. Apertural modification is terminated by a constriction. *Balvia (Mayneoceras)* is thought to contain species with regularly spaced constrictions that pass into sulci bordering median keel; parabolic ears are developed periodically. The differences are regarded herein as being of nongeneric significance. *Effenbergia* was erected for forms with constrictions restricted to flanks only.] *Upper Devonian (upper Famennian [Wocklumeria Zone]):* Great Britain, Germany, Austria, Poland, China (Guilin, Guizhou), Algeria, Morocco, USA (Indiana).——Fig. 1,*4a–c. *B. globularis* (Schmidt); *a–b,* Müssenberg, Rhenish Massif, Germany, Bed 31, SMF 60169, ×3; *c,* suture, Fezzou, Morocco, GPIT 1748/14, ×12 (Korn, 1994).——Fig. 1,*4d–e. B. biformis* (Schindewolf), Stourscombe, Cornwall, England; *d,* holotype of *Kenseyoceras rostratum* Selwood, GSM 87058, ×4.5; *e,* topotype, GSM 87061, ×3 (Selwood, 1960).

?Cunitoceras Weyer, 1972b, p. 339 [**C. schindewolfi;* OD; =*Imitoceras globosum* Schindewolf, 1951a, p. 46, *non* Schindewolf, 1923, p. 335, obj.]. Conch form lenticular or globose, completely involute; umbilicus very narrow or closed. Ventral lobe wide, funnel shaped. One species and one questionable species. *Mississippian (upper Tournaisian):* Germany, Spain, USA (Michigan, Missouri).——Fig. 2,*2a–b. *C. schindewolfi,* holotype, Erdbach limestone, Iberg-Winterberg, Bad Grund, Harz Mountains, Germany, Collection Fuhrmann, Clausthal; *a,* ×1.4; *b,* suture, reversed image, ×1.5 (Schindewolf, 1951a).

Imitoceras Schindewolf, 1923, p. 325 [**Ammonites rotatorius* de Koninck, 1844, p. 565; SD Schindewolf, 1926b, p. 70; =*Goniatites ixion* Hall, 1860, p. 125 (see Schindewolf, 1923, p. 326)] [=*Aganides* de Montfort, 1808, p. 30, *nom. nud.;* =*Brancoceras* Hyatt, 1884 in 1883–1884, p. 325 (type, *Goniatites ixion* Hall, 1860, p. 125, OD), *non* Steinmann, 1881, p. 133]. Conch form discoidal to globular. Young stages with narrow umbilicus; adult shell form usually with relatively high aperture and very narrow or punctiform umbilicus. Growth lines usually fine, linear, rarely coarse. Constrictions may be present. Ventral lobe narrow, more or less parallel sided or slightly pouched; adventitious lobe asymmetric. Many species. [The assignment of several species to *Imitoceras* is uncertain.] *Mississippian (middle Tournaisian–upper Tournaisian):* Belgium, Germany, Austria, Algeria, Russia, China (Xizang, Yunnan), Australia (West Australia), Canada (Alberta, British Columbia), USA (Arkansas, Iowa, Illinois, Indiana, Michigan, Ohio, Kentucky, Montana, ?New Mexico, Nevada).——Fig. 1,*2a–d. *I.* aff. *rotatorium* (de Koninck), Rockford, Jackson County, Indiana, Rockford limestone, Osagean; *a–c*, ×0.9; *d,* suture, ×0.8 (Miller, Furnish, & Schindewolf, 1957).

Irinoceras Ruzhentsev, 1947c, p. 281 [**I. arcuatum* Ruzhentsev, 1947c, p. 283; OD]. Thickly discoidal, involute, with narrow or punctiform umbilicus. Growth lines coarse, rectilinear, convex, with deep hyponomic sinus. No ribs, constrictions, grooves, or spiral ornamentation. Ventral lobe pouched. Ten species. [The illustrated species is closely related to the holotype and is the same age.] *Mississippian (upper Tournaisian–Serpukhovian):* Ireland, France, Spain, Germany, Serbia, South Urals, Tajikistan, China (Xinjiang), Algeria, Morocco, Australia (New South Wales, Queensland), Canada (British Columbia), USA (Arkansas, Michigan).——Fig. 2,*5a–d. I. stevanovici* Kullmann, holotype, Družetić, Serbia, Serpukhovian, MHN S9; *a–c*, ×2; *d*, suture at 12 mm diameter, ×1.4 (Stevanović & Kullmann, 1962).

Mimimitoceras Korn, 1988a, p. 606 [**M. trizonatum* Korn, 1988a, p. 607; OD]. Conch form lenticular to globose, involute, with narrow to punctiform umbilicus. Inner whorls subglobose, with extreme narrow umbilicus. Growth lines rectilinear, mostly convex, with shallow hyponomic sinus. Several constrictions per whorl, sometimes aperturally combined with wall on flanks, type species with three constrictions and triangularly coiled. Many species. [This genus is closely related to *Balvia*.] *Upper Devonian (Famennian [Clymenia–Wocklumeria Zone])–Mississippian (lower Tournaisian):* Great Britain, Germany, Austria, Italy, Poland, France, Spain, Italy, Algeria, Morocco, Russia (South Urals), China (Guizhou, Xinjiang), USA (Ohio).——Fig. 2,*1a–c. *M. trizonatum; a–b*, holotype, Reigern, Rhenish Massif, Germany, Wocklum limestone, *Wocklumeria* Zone, upper Famennian, SMF 51250, ×3; *c*, paratype, suture at 13.6 diameter, whorl height at 7.2 mm, SMF 51251, ×7.3 (Korn, 1988a).

Paragattendorfia Schindewolf, 1924, p. 105 [**P. humilis;* OD] [=*Globimitoceras* Korn, 1993a, p. 585 (type, *Imitoceras globiforme* Vöhringer, 1960, p. 145, OD)]. Conch form lenticular to thickly discoidal, involute, with narrow, but open umbilicus. Increase of whorl height during ontogeny slow, with low aperture height on all stages; width of umbilicus increasing slightly during ontogeny in most species. Growth lines usually fine, rectilinear, crossing venter with or without hyponomic sinus. Constrictions absent in most species. Ventral lobe small, V-shaped, rarely parallel sided. Six species and four questionable species. [For discussion, see Bartzsch & Weyer, 1987, p. 64. *Globimitoceras* was erected for species with narrow umbilicus

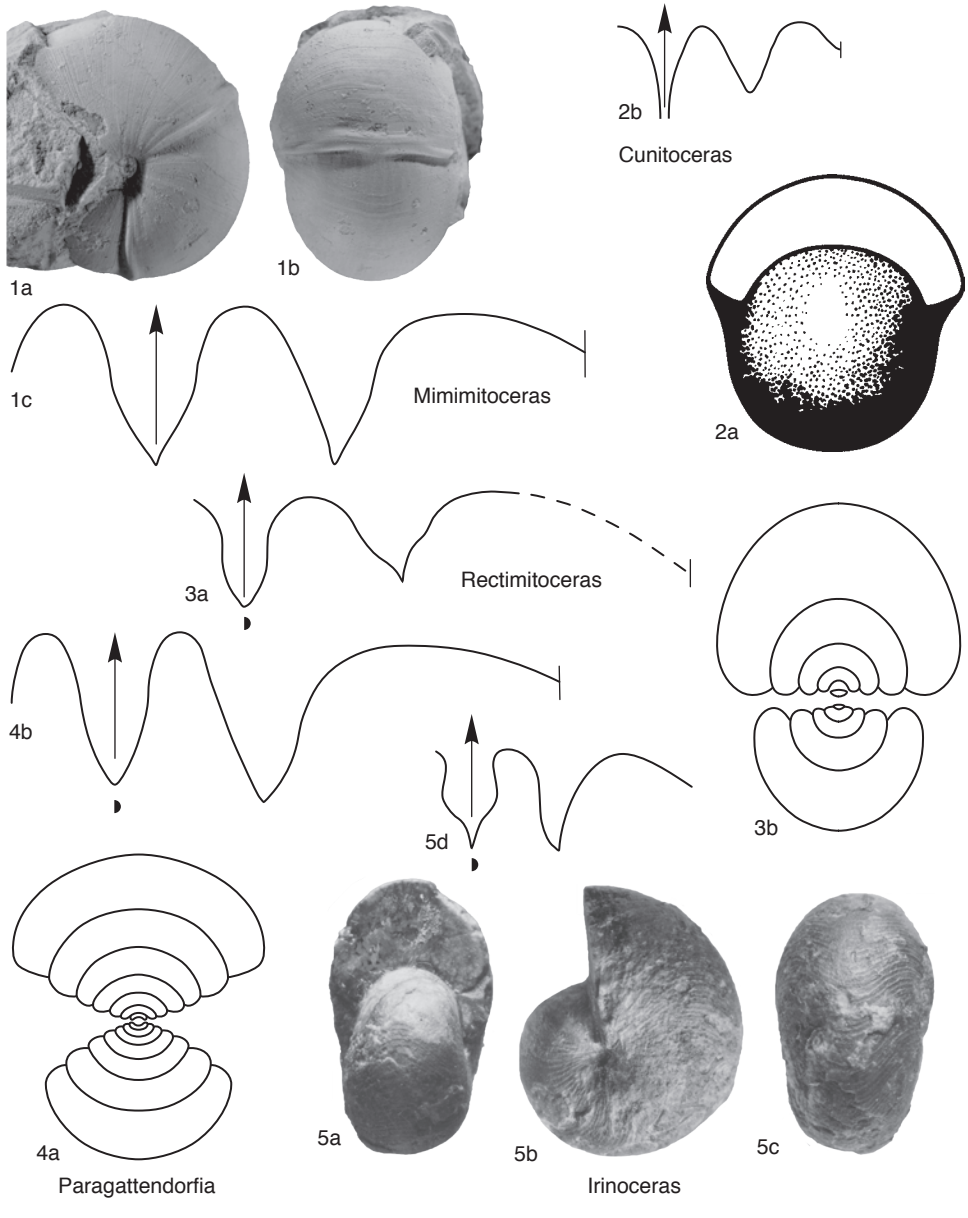

FIG. 2. Prionoceratidae (p. 4–6).

during almost the entire ontogeny. There are no suitable illustrations of the holotype available.] *Mississippian (lower Tournaisian):* Germany, France, Morocco, China (Guizhou).——FIG. 2,*4a–b. P. patens* VÖHRINGER, Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, lower Tournaisian; *a*, cross section of topotype, GPIT 1130/80, ×2.2 (Vöhringer, 1960); *b*, suture of holotype, GPIT 1130/78, ×6 (Korn, 1994).

Rectimitoceras BECKER, 1996, p. 34 [**Goniatites linearis* MÜNSTER, 1832, p. 22; OD]. Conch involute throughout ontogeny. Median and adult stages without constrictions. Ventral lobe lanceolate and at least as deep as the asymmetric and wide adventitious lobe. More than ten species. *Upper Devonian (upper Famennian [Platyclymenia–Wocklumeria Zone]), Mississippian (?Tournaisian):* Austria, Great Britain, Germany, Spain, Morocco, Russia (North

and South Urals), Kazakhstan (South Urals, Karaganda), China (Guizhou).——Fig. 2,*3a. *R. lineare* (Münster), suture of holotype at 22 mm diameter, Schübelhammer, Frankenwald, Germany, *?Clymenia* Zone, upper Famennian, BSM AS VII 23, image reversed, ×3.4 (Becker, 1996).——Fig. 2,*3b. R. substriatum* (Münster), cross section, Hönnetal railway cut, bed 4, Rhenish Massif, Germany, *Gattendorfia* Zone, lower Tournaisian, GPIT 1130/162, at 15 mm diameter, ×2.9 (Vöhringer, 1960).

Triimitoceras Korn & others, 2003, p. 78 [**T. epiwocklumeriforme* Korn & others, 2003, p. 79; OD]. Conch pachycone to discoidal, with triangularly coiled juvenile stage. Umbilicus extremely narrow. Three deep constrictions present on steinkerns of early and middle stages. Suture with slightly pouched ventral lobe and large, V-shaped adventitious lobe that is considerably deeper than ventral lobe. One species. *Mississippian (upper Tournaisian):* Morocco.——Fig. 1,*3a–c. *T. epiwocklumeriforme*, holotype, Taouz, Jebel Ouaoufilal, east of Ksar Bouhamed, Tafilalt, Oued Znaïgui Formation, MB C.3910; *a–b,* ×2; *c,* suture at 13.4 mm diameter, whorl width 6.7 mm, whorl height 7.7 mm, ×4.4 (Korn & others, 2003).

Family GATTENDORFIIDAE Bartzsch & Weyer, 1987

[*nom. transl.* Kullmann, herein, *ex* Gattendorfiinae Bartzsch & Weyer, 1987, p. 61] [=Acutimitoceratinae Korn, 1994, p. 37]

Adult conch form moderately involute or evolute; inner whorls always evolute. Shell surface with rursiradiate growth lines or ribbing, without furrows and keels. *Upper Devonian (upper Famennian)–Mississippian (upper Tournaisian [Kinderhookian–Osagean]).*

Gattendorfia Schindewolf, 1920, p. 123 [**Goniatites subinvolutus* Münster, 1839, p. 23; OD]. Conch form lenticular to thickly discoidal, with broadly rounded, rarely flattened venter. Early whorls evolute, later moderately evolute. Umbilicus wide to moderately wide, rarely becoming narrow during ontogeny. Fine or coarse growth lines are convex, with hyponomic sinus, sometimes crenulate. Ornamentation in some forms reticulate, rarely with faint ribs; several constrictions may be present. Suture with paralell-sided ventral lobe; lateral lobe on or close to umbilical wall. Many species. *Mississippian (lower Tournaisian):* Great Britain, France, Germany, Austria, Poland, Russia and Kazakhstan (South Urals), Kazakhstan (Karaganda), China (Guizhou, Xinjiang), USA (Indiana, ?Missouri, Montana, New Mexico, ?Nevada, Utah).——Fig. 3,*1a–e. *G. subinvoluta* (Münster), Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone; *a–b,* GPIT 1130/86; *c*, GPIT 1130/85, ×1; *d*, suture, suture at 33 mm diameter, GPIT 1130/86, ×2.9 (Vöhringer, 1960); *e*, cross section at 30 mm diameter, GPIT 1130/86, ×1.1 (Vöhringer, 1960).

Acutimitoceras Librovich, 1957, p. 263 [**Imitoceras acutum* Schindewolf, 1923, p. 338; OD]. Shell form lenticular to pachycone, venter rounded, rarely oxycone. Early ontogenetic stages evolute; middle and adult stages with narrow umbilicus. Growth lines mostly fine and linear, constrictions variable in number and position. Suture line usually with parallel-sided, relatively deep ventral lobe; adventitious lobe as deep as ventral lobe. [This genus is transitional to *Nicimitoceras. Sulcimitoceras* and *Hasselbachia* are regarded herein as synonyms of *Acutimitoceras (Stockumites);* see below). The ranges of subgenera *Stockumites* and *Streeliceras* are practically identical, and *Acutimitoceras* is restricted to the lower Tournaisian.] *Upper Devonian (upper Famennian [upper Wocklumeria Zone])–Mississippian (lower Tournaisian).*

A. (Acutimitoceras). Shell form oxyconic at middle and adult stages. Ventral lobe deep and often wide, adventitious lobe asymmetric. Three species. *Mississippian (lower Tournaisian):* Austria, Germany, China (Guizhou).——Fig. 3,*4. *A. (A.) acutum* (Schindewolf), cross section, Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, GPIT 1130/54, ×2.1 (Vöhringer, 1960).

A. (Stockumites) Becker, 1996, p. 36 [**Imitoceras intermedium* Schindewolf, 1923, p. 333; OD] [=*Sulcimitoceras* Kuzina, 1985, p. 46 (type, *S. yatskovi* Kuzina, 1985, p. 47, OD); ?=*Hasselbachia* Korn & Weyer, 2003, p. 95 (type, *Imitoceras multisulcatum* Vöhringer, 1960, p. 141, OD)]. Shell form compressed to globular, always with rounded venter; ventral lobe deep and narrow. More than 10 species, without special characteristics; descriptions need special biometric investigations. [*Sulcimitoceras* was erected for small discoidal forms with intraventral ridges or furrows developed in intermediate ontogenetic stages similar to Homoceratinae (compare Fig. 52,*1–3,* p. 87–89); this character is not regarded herein as being of generic significance. *Hasselbachia* was erected for species with small conchs and low apertures regarded herein as being of specific rather than generic significance. The illustrated species is based on original material.] *Upper Devonian (upper Famennian [upper Wocklumeria Zone])–Mississippian (lower Tournaisian):* Austria, France, ?Great Britain, Ireland, Spain, Germany, Poland, Russia and Kazakhstan (South Urals), Kazakhstan (Karaganda), Mongolia, China (Guilin, Guizhou), Morocco, Australia (New South Wales), USA (?Illinois, ?Iowa, ?Ohio, ?Nevada, Missouri), Canada (Alberta). ——Fig. 3,*5a–b. A. (S.) antecedens* (Vöhringer), Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, lower Tournaisian, GPIT 1130/61; *a*, suture, reversed, ×2.9; *b*, cross section, ×2.3 (Vöhringer, 1960).

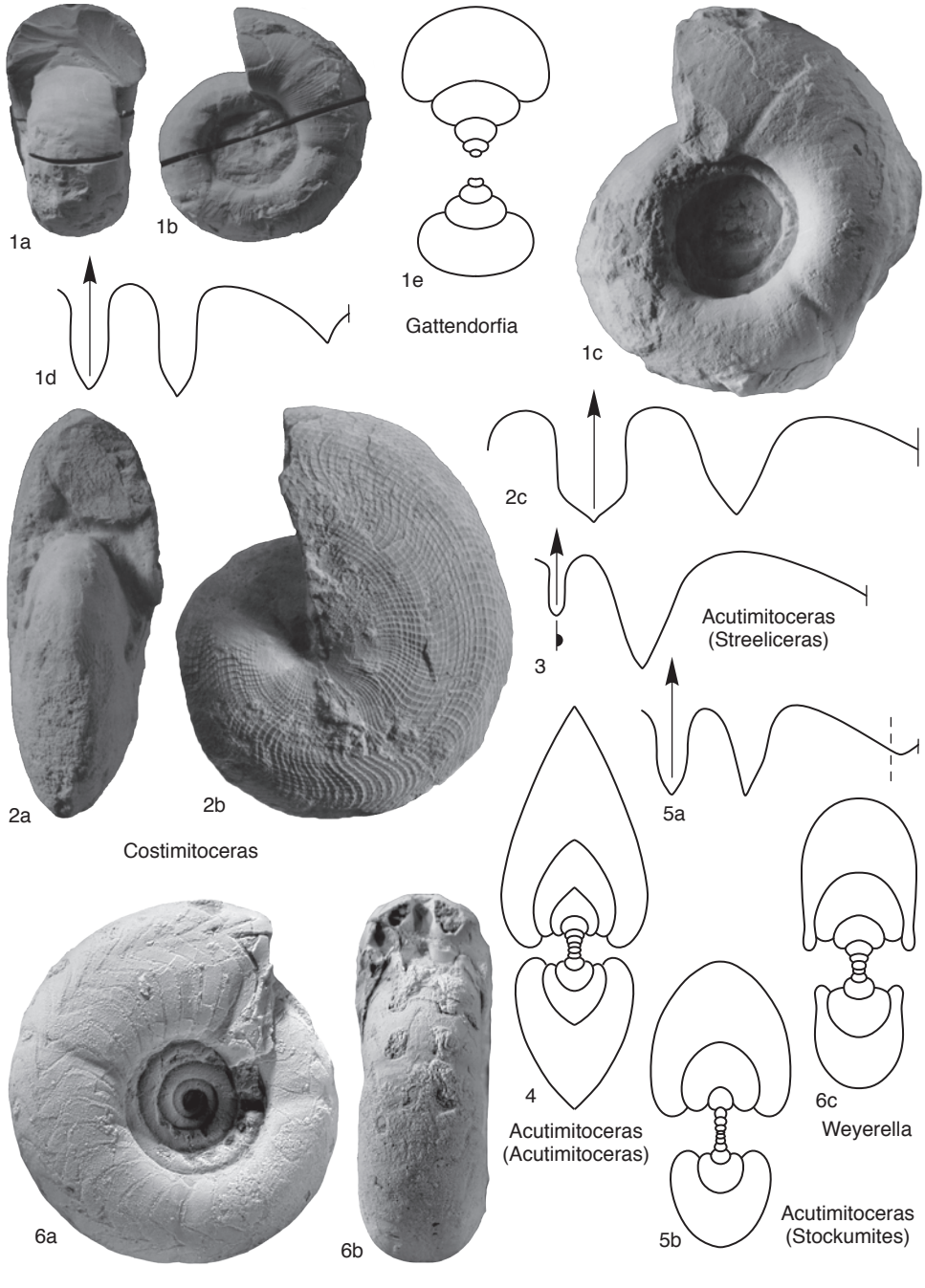

FIG. 3. Gattendorfiidae (p. 6–8).

A. (Streeliceras) BECKER, 1996, p. 37 [**Imitoceras heterolobatum* VÖHRINGER, 1960, p. 136; OD]. Shell form discoidal, adult stages with closed umbilicus. Ventral lobe significantly shorter than adventitious lobe. Seven species. *Upper Devonian (upper Famennian [upper Wocklumeria Zone])–Mississippian (lower Tournaisian):* Germany, Poland, China (Guizhou).——FIG. 3,3. **A. (S.)*

heterolobatum (Vöhringer), suture, reversed, Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, lower Tournaisian, GPIT 1130/165, ×1.8 (Vöhringer, 1960).

Costimitoceras Vöhringer, 1960, p. 148 [**C. ornatum;* OD]. Conch form as in *Acutimitoceras*, but with riblike transversal striae and prominent spiral lires producing reticulate sculpture. Two species. *Mississippian (lower Tournaisian):* Germany, China (Guizhou).——Fig. 3,*2a–c. *C. ornatum,* holotype, Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, GPIT 1130/81; *a–b*, ×2; *c*, suture, ×4.3 (Korn, 1994).

Gattenpleura Weyer, 1976, p. 843 [**G. bartzschi* Weyer, 1976, p. 846; OD]. Conch form and suture line similar to *Gattendorfia*, but with prominent schizotomous ribs on flanks and venter. Late whorls overlapping preceding whorls. Two species. *Mississippian (lower Tournaisian):* Germany, ?Poland. ——Fig. 4,*4a–c. *G. bartzschi,* Saalfeld, quarry Pfaffenberg southwest, Thüringen, Germany, *Gattendorfia* Zone; *a,* holotype, MB.C.766.1, ×1 (Weyer, 1976); *b,* cross section, MB.C.766.6, ×1.1; *c,* suture at 13.5 mm diameter, whorl height 4.6 mm, ×5 (Bartzsch & Weyer, 1988b).

Kazakhstania Librovich, 1940, p. 67 [**Gattendorfia (Kazakhstania) karagandaensis* Librovich, 1940, p. 68; OD]. Conch thin-discoidal, on all growth stages evolute, with wide umbilicus. Growth lines fine or coarse, several constrictions in most species. Ventral lobe long, slightly bell shaped, adorally narrowed. Five species. *Mississippian (middle Tournaisian–upper Tournaisian):* Great Britain, Kazakhstan (Karaganda), Mongolia, USA (Arkansas, Indiana, Michigan, Ohio, Kentucky).——Fig. 4,*1a–b. *K. karagandaensis,* holotype, Ak-Bas-tau Mountains, North Kazakhstan, middle Tournaisian, CNIGR 48/5450; *a*, ×1; *b*, suture, whorl height at 9 mm, ×3.4 (Librovich, 1940).

?Nicimitoceras Korn, 1993a, p. 585 [**Imitoceras subacre* Vöhringer, 1960, p. 120; OD] [?=*Acutimitoceras (Acrimitoceras)* Ruan, 1995a, p. 348 (type, *Imitoceras acre* Vöhringer, 1960, p. 121, OD)]. Conch form similar to *Acutimitoceras,* early evolute stage restricted; umbilicus narrow or punctiform on adult stages. Ventral lobe relatively small and V-shaped, rarely parallel sided; adventitious lobe deeper than ventral lobe, acute, comparatively wide. Three species. [This genus is transitional to *Acutimitoceras* and may be its junior synonym.] *Mississippian (lower Tournaisian):* Germany, China(Guizhou).——Fig. 4,*3a–b. *N. subacre* (Vöhringer), Hönnetal railway cut, Rhenish Massif, *Gattendorfia* Zone, Germany; *a,* suture of holotype, reversed, GPIT 1130/5, ×2.9; *b,* cross section of paratype, GPIT 1130/8, ×2.1 (Vöhringer, 1960).

Weyerella Bockwinkel & Ebbighausen, 2006, p. 116 [**W. protecta* Bockwinkel & Ebbighausen, 2006, p. 117; OD]. Conch form of early whorls evolute as in *Gattendorfia*, late whorls similar to *Gattenpleura,* after adult change of proportions overlapping preceding whorls. Four species. *Mississippian (lower Tournaisian):* Germany, Morocco, China (Guizhou).——Fig. 3,*6a–b. *W. protecta,* Tafilalt, Morocco, *Gattendorfia* Zone, holotype, MB.C.3837.1, lateral and dorsal views, ×2.5 (Bockwinkel & Ebbighausen, 2006).——Fig. 3,*6c. W. concava* (Vöhringer), cross section of paratype, Hönnetal railway cut, *Gattendorfia* Zone, Rhenish Massif, Germany, GPIT 1130/107, ×2 (Vöhringer, 1960).

?Zadelsdorfia Weyer, 1972b, p. 344 [**Gattendorfia asiatica* Librovich, 1940, p. 49; OD] [?=*Acutimitoceras (Follimitoceras)* Ruan, 1995a, p. 348 (type, *Imitoceras (Imitoceras) folliforme* Ruan, 1981a, p. 70, OD)]. Conch form similar to *Gattendorfia;* at early growth stages evolute, but later rather involute, with small umbilicus. Constrictions present in some species. Ventral lobe slightly bell shaped, orad narrowed. More than ten species. [This genus is closely related and transitional to *Gattendorfia* and may be its younger synonym.] *Mississippian (middle Tournaisian):* Germany, Portugal, Morocco, Kazakhstan (Karaganda), China (Xinjang, Xizang), USA (?Arkansas, Iowa, ?Indiana, Michigan, Missouri, Ohio).——Fig. 4,*2a–c. *Z. asiatica* (Librovich), holotype, Karaganda region, North Kazakhstan, CNIGR 19/5450; *a–b*, ×1; *c*, suture, whorl height at 30 mm, ×1 (Librovich, 1940).

Family PSEUDARIETITIDAE Bartzsch & Weyer, 1987

[*nom. transl.* Kullmann, herein, *ex* Tribus Pseudarietitini Bartzsch & Weyer, 1987, p. 61]

Adult conch moderately involute or evolute. Shell surface with concave coarse ribs that do not cross venter; ventrolateral furrows and keel may be present. *Mississippian (lower Tournaisian).*

Pseudarietites Frech, 1902, p. 62 [**P. silesiacus* Frech, 1902, p. 63; M] [=*Pseudoarietites* Wedekind, 1918, p. 131, *nom. van.*]. Thin discoidal, evolute, with wide umbilicus. Flanks with prominent linear ribs. Venter with keel and usually two furrows, rarely oxycone. Growth lines with shallow ventral sinus; no constrictions. Ventral lobe parallel sided, adventitious lobe deep and rounded, lateral lobe shallow, centering on umbilical seam. Six species. *Mississippian (lower Tournaisian):* Germany, Austria, Poland, China (Guizhou), Australia.——Fig. 5,*2a. *P. silesiacus,* holotype, Wroclaw UWR 17773s, ×2.4 (Dzik, 1997).——Fig. 5,*2b–c. P. westfalicus* (Schmidt), Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone; *b*, suture, GPIT 1130/119, ×8.3; *c*, cross section, hypotypoid, GPIT 1130/121, ×1.8 (Vöhringer, 1960).

Paprothites Bartzsch & Weyer, 1987, p. 62 [**Pseudarietites westfalicus dorsoplanus* Schmidt, 1924, p. 152; OD]. Conch form as in *Pseudarietites*, but with broadly rounded ventral side, without keel and ventral furrows. Six species. *Mississippian (lower Tournaisian):* Germany, Poland,

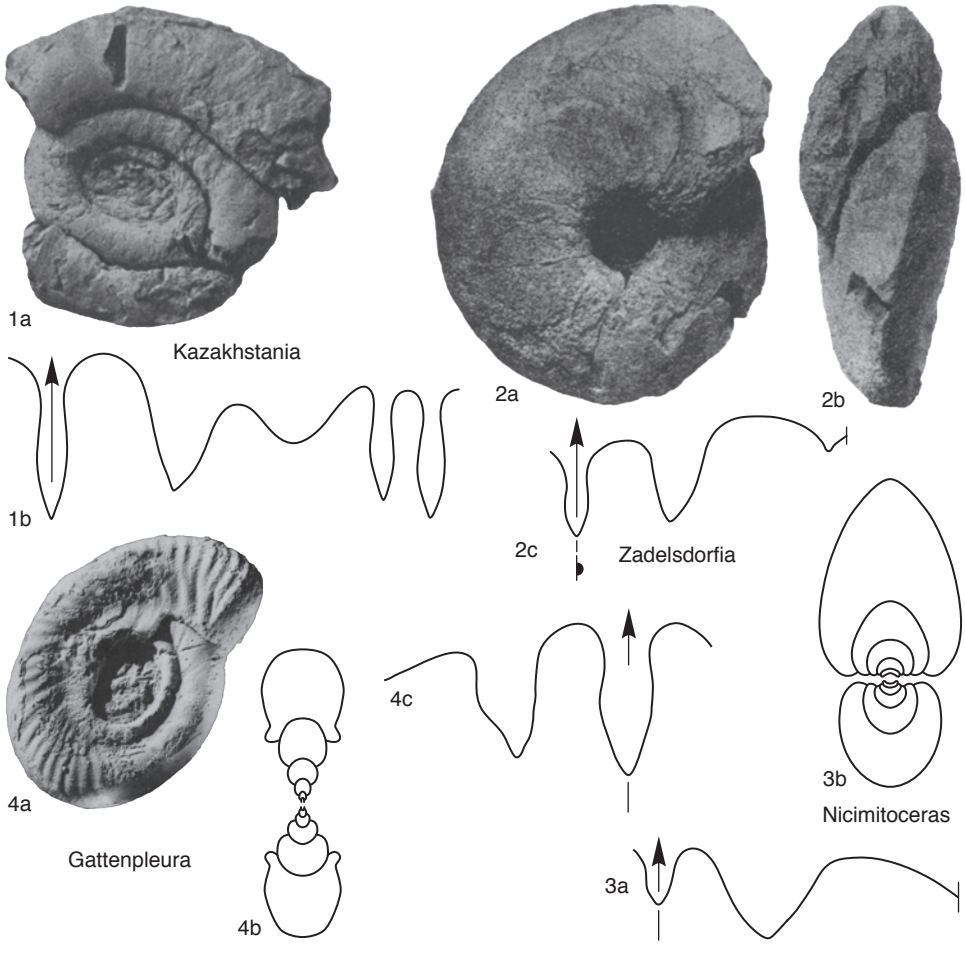

FIG. 4. Gattendorfiidae (p. 8).

China (Guizhou).——FIG. 5,*4a–c*. **P. dorsoplanus* (SCHMIDT), Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, GPIT 1130/120; *a–b,* GPIT 1130/116, ×3 (Korn, 1994); *c,* cross section, GPIT 1130/117, ×4.2 (Vöhringer, 1960).

Paralytoceras FRECH, 1902, p. 83 [**Clymenia crispa* TIETZE, 1871, p. 135; M]. Conch form discoidal, evolute, with moderately wide umbilicus. Venter at later stages broadly rounded or oxycone and always with separate keel. Growth striae lamellate or sometimes crenulate; simple riblets present. Ventral lobe wide, inconspicuous ventral saddle questionable; ventrolateral saddle rounded, adventitious lobe deep. Five species. [This genus is supposedly close to the root group of Karagandoceratoidea; for discussion, see WORK & MAPES, 2002, p. 910.] *Mississippian (lower Tournaisian):* Germany, Poland, China (Guizhou), Australia (?Queensland).——FIG. 5,*3a–b*. **P. crispum* (TIETZE), holotype, Dzikowiez limestones, Lower Silesia, Poland, MB.C.4692; *a*, side view, ×1.5; *b*, suture, whorl height at 12 mm (Weyer, 1965).

Family VOEHRINGERITIDAE Bartzsch & Weyer, 1988

[*nom. transl.* KULLMANN, herein, *ex* Tribus Voehringeritini BARTZSCH & WEYER, 1988a, p. 136]

Ventral lobe wide, orad diverging, bifid, with small median saddle, no increase of sutural elements in umbilical area. Sutural formula: $(E_1E_mE_1)$ALUI [German], (V_1V_1) LU:ID [Russian]. [*Voehringerites* MANGER,

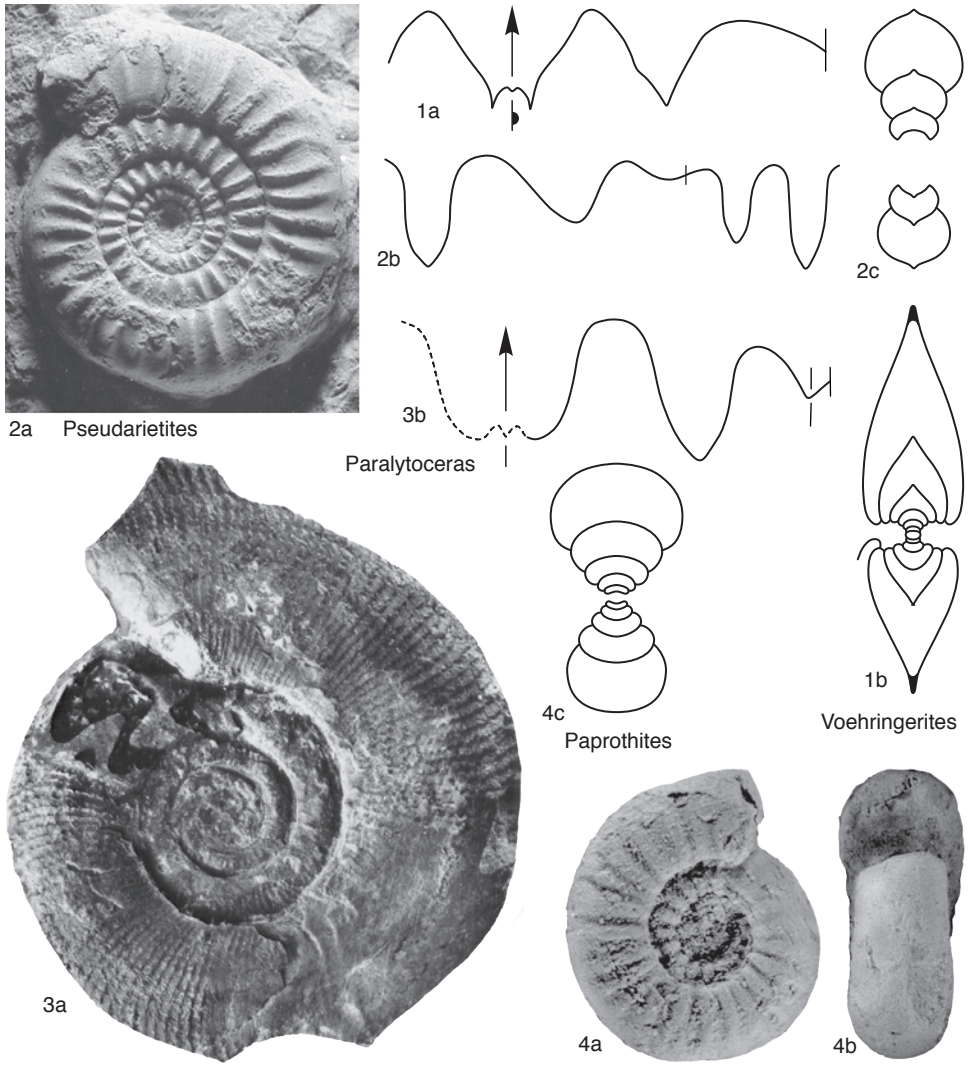

FIG. 5. Pseudarietitidae and Voehringeritidae (p. 8–10).

the only genus known so far, is thought to arise from keeled forms of the Gattendorfiidae (BARTZSCH & WEYER, 1988a, p. 138), e.g., *Acutimitoceras acutum* (SCHINDEWOLF). The mode of subdivision of the ventral lobe resembles the development in early representatives of the suborder Goniatitina, in contrast to the mode of the Devonian Praeglyphioceratoidea and the Carboniferous Karagandoceratoidea with their trifid partition of the parallel-sided ventral lobe.] *Mississippian (lower Tournaisian).*

Voehringerites MANGER, 1971, p. 35 [**Karagandoceras peracutum* VÖHRINGER, 1960, p. 168; OD]. Early whorls thinly discoidal and evolute; later stages moderately involute, with narrow umbilicus and keel. Ventral lobe bifid; median lobe inconspicuous. Lateral saddle strongly asymmetric. Adventitious lobe relatively small, asymmetric. One species. *Mississippian (lower Tournaisian):* Germany. ——FIG. 5,*1a–b.* **V. peracutum* (VÖHRINGER), holotype, Hönnetal railway cut, Rhenish Massif, *Gattendorfia* Zone, GPIT 1130/127; *a*, suture, reversed, at diameter of 21.5 mm, whorl height 12 mm, whorl width 6.8 mm, ×4.3 (Korn, 1994); *b*, cross section, ×2.3 (Vöhringer, 1960).

KARAGANDOCERATOIDEA

JÜRGEN KULLMANN

[University of Tübingen, Germany]

Superfamily KARAGANDOCERATOIDEA Librovich, 1957

[*nom. transl.* KULLMANN, herein, *ex* Karagandoceratidae LIBROVICH, 1957, p. 264]

Ventral lobe complex, with tendency to increase suture elements in ventral and umbilical areas. Conch form discoidal to lenticular; adult stages narrowly rounded or oxycone and with separate keel. Ventral lobe wide, subdivided at least at its base. Root group possibly the advanced pseudoarietitid *Paralytoceras.* [For discussion, see WORK & MAPES, 2002, p. 910, and BECKER & WEYER, 2004, p. 25.] *Mississippian (Tournaisian–Serpukhovian).*

Family KARAGANDOCERATIDAE Librovich, 1957

[Karagandoceratidae LIBROVICH, 1957, p. 264]

No increase of suture elements in the umbilical area. Ventral lobe wide, subdivided in the mode of Praeglyphioceratoidea by trifid partition of the ventral portion of suture: E > ($E_2E_1E_2$) [German], V > ($V_2V_1V_2$) [Russian], in contrast to the mode of *Voehringerites* (Voehringeritidae) or Muensteroceratidae with bifid subdivision of the ventral lobe: E > (E_1E_1) > ($E_1E_mE_1$) [German], V > (V_1V_1) [Russian]. [The group is probably derived as in *Voehringerites:* similarly but independently from one or several stocks within the Prionoceratoidea. *Karagandoceras* is thought to have evolved from *Imitoceras acre* VÖHRINGER, possibly via *Paralytoceras* (BARTZSCH & WEYER, 1988a, p. 134). Some authors include the family in superfamily Prionoceratoidea HYATT (for discussion, see BECKER & WEYER, 2004).] *Mississippian (Tournaisian [Kinderhookian–Osagean]).*

Karagandoceras LIBROVICH, 1940, p. 88 [**K. galeatum* LIBROVICH, 1940, p. 90; OD]. Conch form lenticular, involute, with acute ventral margin. Ventral lobe wide, its sides subparallel to divergent; height of saddles within ventral lobe variable, median part of ventral lobe relatively wide. Adventitious lobe very broad and deep, asymmetric. Lateral lobe centers on umbilical wall. Sutural formula: ($E_2E_1E_2$) AL:UI [German], ($V_2V_1V_2$)LU:ID [Russian]. One species. *Mississippian (lower Tournaisian–middle Tournaisian):* ?Germany, *lower Tournaisian;* Kazakhstan (Karaganda), *middle Tournaisian.*——FIG. 6,*2a–c.* **K. galeatum,* holotype, Ak-Bas-tau Mountains, North Kazakhstan, middle Tournaisian, CNIGR 61/5450; *a–b*, side view, ×4; *c*, suture, ×3.3 (Librovich, 1940).

Bartzschiceras BECKER & WEYER, 2004, p. 26 [**B. mirandum;* OD]. Conch form oxyconic as in *Acutimitoceras* and *Nicimitoceras*, but ventral lobe with incipient and beginning tripartition, in general incipiently trifid. Ventrolateral saddle subangular, elevated, and narrow, adventitious lobe asymmetric and acute, dorsal saddle on flanks highly arched. One species. *Mississippian (lower Tournaisian):* Germany, France.——FIG. 6,*3.* **B. mirandum,* holotype, suture, La Serre Bed 3C2, Montagne Noire, France, MB.C.3733, whorl height at 26.5 mm, ×1.8 (Becker & Weyer, 2004).

Masonoceras WORK & MANGER, 2002, p. 574 [**M. kentuckiense* WORK & MANGER, 2002, p. 575; OD]. Conch thinly subdiscoidal to discoidal with acute ventral margin in late ontogeny. Wide, trifid ventral lobe with moderately high median saddle and asymmetric ventral prongs; narrow, asymmetrically rounded lateral saddle; exceptionally deep, asymmetric lateral lobe; small, rounded umbilical lobe. Three species. *Mississippian (upper Tournaisian [lower Osagean]):* USA (Kentucky, Ohio, Missouri), Australia (New South Wales).——FIG. 6,*1a–c.* **M. kentuckiense,* holotype, Morhead, northeastern Kentucky, Nancy Member, Borden Formation, SUI 95340; *a*, side view; *b*, apertural view, ×3.5; *c*, suture, diameter at 17.1 mm, whorl height 10.3 mm, magnification not stated (Work & Manger, 2002).

Family PRODROMITIDAE Arthaber, 1911

[Prodromitidae ARTHABER, 1911, p. 177] [=Qiannanitidae BECKER, 1993, fig. 7.7]

Suture line changing from relatively simple to highly complex structure; total number of umbilical lobes from 10 to over 50, in some forms irregularly subdivided or denticulate. [Some authors regard this family or some of the genera as belonging to the order Prolecanitida; for discussion,

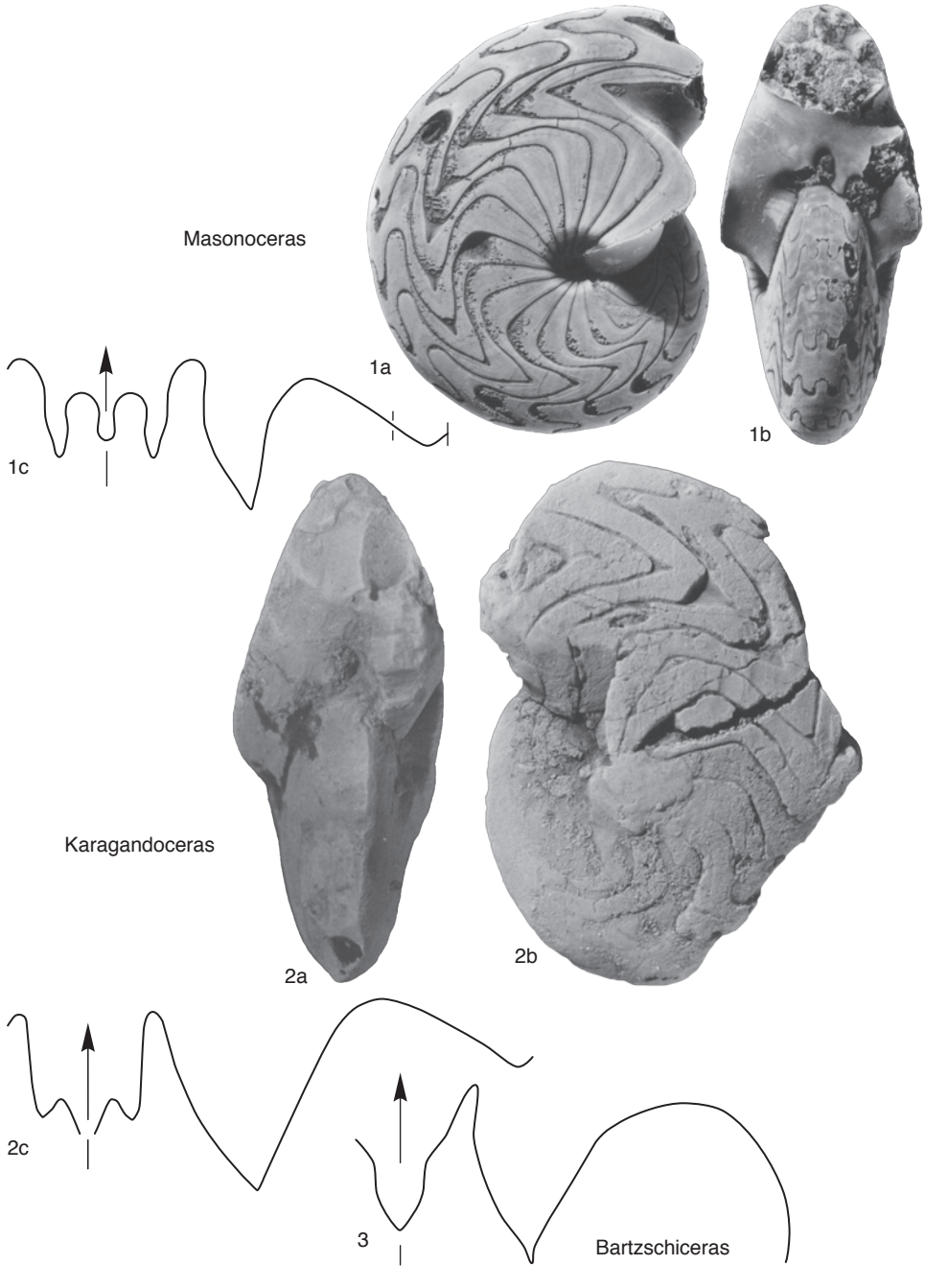

FIG. 6. Karagandoceratidae (p.11).

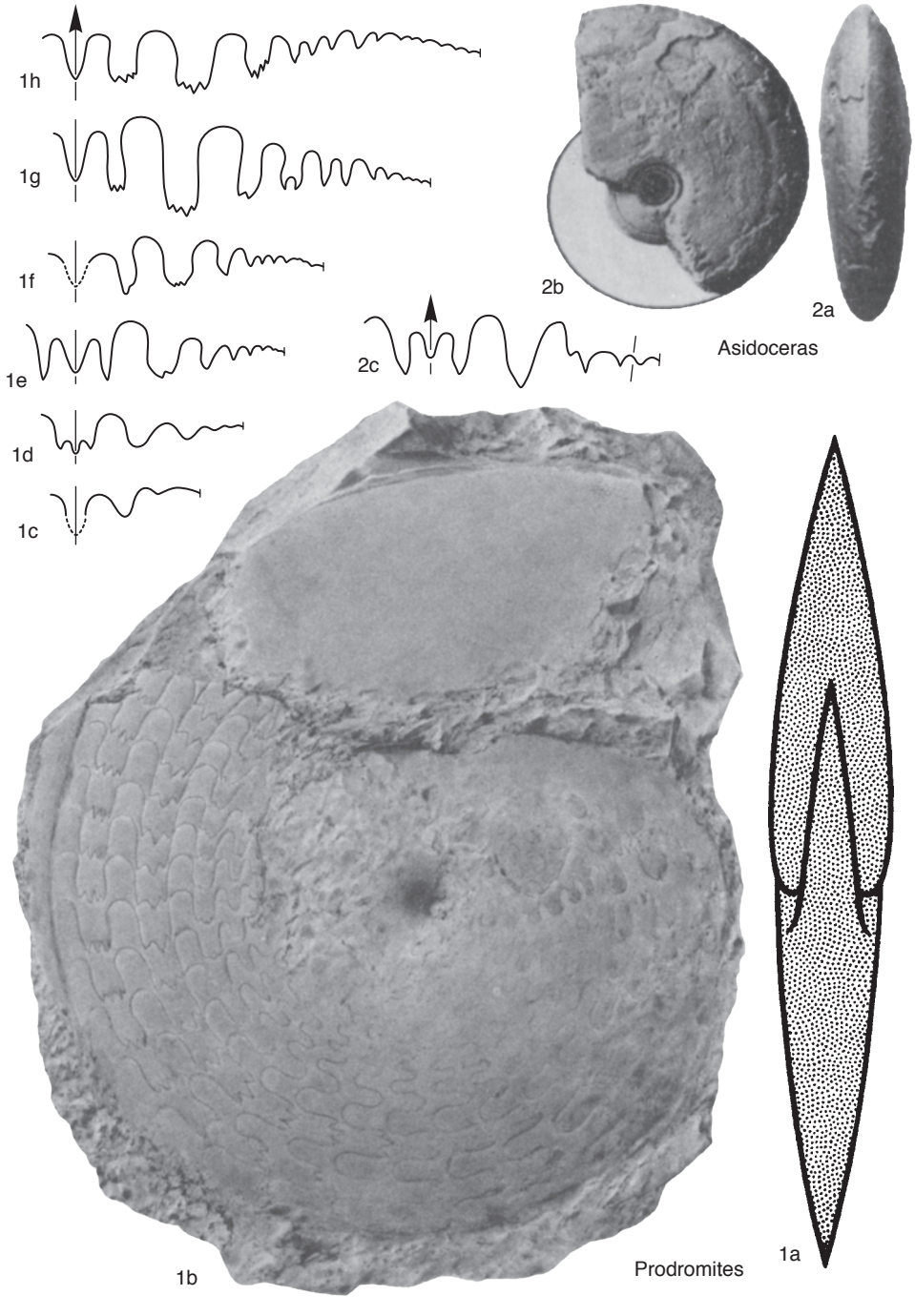

FIG. 7. Prodromitidae (p. 14).

see WORK, MAPES, & THOMPSON, 1988. The family grouping may be artificial; the relationship of genera cannot be proven because of lack of ontogenetic sequences.] *Mississippian (Tournaisian–Serpukhovian [Kinderhookian–Osagean]).*

Prodromites SMITH & WELLER, 1901, p. 255 [**Goniatites gorbyi* MILLER, 1891, p. 90; OD]. Conch thinly lenticular with keeled venter and very small umbilicus. Several lobes adjacent to venter denticulated. Sutural formula: $E_1E_mE_1$?L?U_2...U_1 [German], $V_2V_1V_2UU^1U^2$... [Russian]. One species. [The ontogenetic development of this genus is incompletely known.] *Mississippian (Tournaisian [Kinderhookian–Osagean]):* ?Canada (Alberta), USA (Iowa, Illinois, Indiana, Missouri).——FIG. 7,*1a–h. *P. gorbyi* (MILLER); *a–b,* holotype, Pin Hook bridge, Pettis County, Missouri, Chouteau limestone, Kinderhookian, WMUC 6208, ×1 (Miller, Furnish, & Schindewolf, 1957); *c–h,* ontogeny of sutures, enlarged (Miller & Collinson, 1951).

?Acrocanites SCHINDEWOLF, 1922, p. 15 [**A. multilobatus;* OD]. Conch form similar to *Prodromites*, but with moderately wide umbilicus. Six or seven regular lanceolate lobes on flanks. Two species. [The ontogenetic development of the suture is unknown. WEYER (1972a) assumed a trifid ventral lobe similar to the homeomorphic *Neopharciceras kurbatovi,* with the sutural formula $E_1E_mE_1LU_{2-7}$... (German), $V_2V_1V_2UU^1U^2$.... (Russian).] *Mississippian (middle Tournaisian–upper Tournaisian):* Belgium, Germany, Algeria.——FIG. 8,*3a–b. *A. multilobatus,* holotype, Geodes horizon, Zadelsdorf, Thuringia, Germany, ?middle Tournaisian, Museum Gera; *a*, side view of internal mold, ×3; *b*, suture, ×5 (Schindewolf, 1939b).

?Asidoceras RUZHENTSEV, 1975, p. 37 [**A. nikolaevi* RUZHENTSEV, 1975, p. 38; OD]. Conch form similar to *Qiannanites*, but umbilicus narrow, whorls highly involute. Ventrolateral grooves present, no prominent sculpture. Ventral lobe deeply subdivided, with rather deep median lobe and acute prongs, adjacent lobe acute; saddle between both lobes rounded. Four small acute lobes of different size on dorsal portion of flanks and near umbilicus. One species. [This genus is based on a single specimen of an isolated exposure of Mississippian age. The ontogenetic development of the suture is unknown, and the systematic relationship is uncertain.] *Mississippian (series not specified):* Russia (Kolyma).——FIG. 7,*2a–c. *A. nikolaevi,* holotype, Beresovka River, Kolyma Range, Siberia, PIN 3088/17; *a–b*, ×1.25; *c*, suture, whorl height at 17 mm, ×1.6 (Ruzhentsev, 1975).

Eoprodromites WORK, MAPES, & THOMPSON, 1988, p. 775 [**E. kinderhooki* WORK, MAPES, & THOMPSON, 1988, p. 776; OD].Conch form similar to *Prodromites*, with narrow umbilicus. Early and intermediate stages exhibit dorsolateral plications. Lateral and wide umbilical lobe irregularly subdivided; asymmetric. Sutural formula: $(E_1E_mE_1)$?L?U_2U_1I [German], $(V_2V_1V_2)UU^1$:ID [Russian]. One species. *Mississippian (Tournaisian [Kinderhookian]):* USA (Missouri).——FIG. 8,*1a–d. *E. kinderhooki,* Clarence Cannon Dam, Salt River, north of Perry, Ralls County, Hannibal Shale; *a–c,* topotype, SUI 62420, ×3 (Work & Mapes, 2002); *d,* suture of holotype, SUI 54746, diameter at 29.2 mm and whorl height at 18 mm (Work, Mapes, & Thompson, 1988).

Paraqiannanites KUZINA, 2000, p. 18 [**P. boreus* KUZINA, 2000, p. 19; OD]. Conch discoidal, oxycone, and involute as in *Qiannanites;* umbilicus narrow but open. Ornamentation consisting of thin, closely spaced, irregularly dichotomizing and intercalating ribs. Ventral lobe deeply subdivided, with acute prongs, median saddle almost half as high as entire lobe, with rounded median lobe; first lateral saddle rounded, adventitious lobe deep and acute. Two acute lobes at umbilical wall. Sutural formula: $(E_1E_mE_1)ALU_2$:U_1I [German], $(V_2V_1V_2)$ LU^1:UID [Russian]. One species. [This genus may be related to *Stenocyclus* SCHINDEWOLF; for discussion, see KUZINA, 2000, p. 18.] *Mississippian (upper Tournaisian):* Russia (Pai Khoi).——FIG. 8,*4a–e. **P. boreus,* holotype, Peyakha River, left tributary of the Kara River, Komi region, Slova Formation, Tournaisian-Visean boundary beds, PIN 2775/510; *a–b,* ×1; *c,* ×1.5; *d*, ventral view, ×3; *e*, suture, whorl height at 19 mm, whorl width 9.5 mm, ×7 (Kuzina, 2000).

Qiannanites RUAN, 1981a, p. 133[140] [**Q. acutus* RUAN, 1981a, p. 134; OD]. Conch discoidal, oxycone, involute; umbilicus moderately narrow, aperture rather high. Growth striae and faint ribs slightly biconvex, almost radiate; ribbing dense, with crenistriate denticulation. Ventral lobe deeply subdivided, with acute prongs; first lateral saddle subacute, adventitious lobe acute. Two small umbilical lobes near umbilicus; one rounded at umbilical seam. Sutural formula: $(E_1E_mE_1)$AL?U_2:? [German], $(V_2V_1V_2)$L?U^1?U^2: ? [Russian]. One species. [The ontogenetic development of the suture is unknown, and the systematic relationship of the genus is uncertain.] *Mississippian (lower Tournaisian):* China (Guizhou), ?Poland.——FIG. 8,*2a–c. **Q. acutus,* holotype, Wangyu, Laowapu, Huishui region, Guizhou, China, Wangyu Formation, NIGP 33614; *a–b,* ×1; *c,* suture, reversed, ×1.1 (Ruan, 1981a).

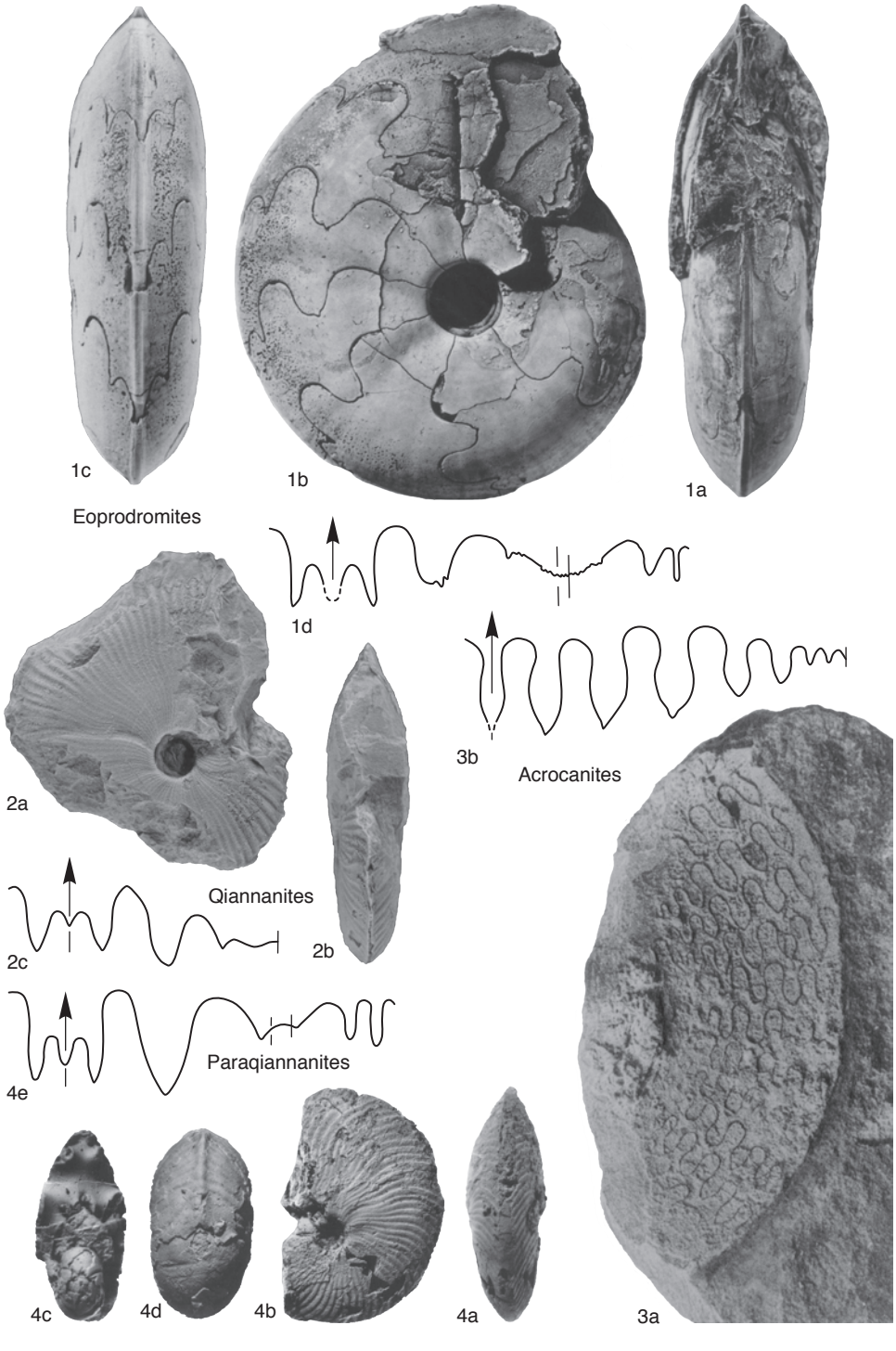

FIG. 8. Prodromitidae (p. 14).

PSEUDOHALORITOIDEA

BRIAN F. GLENISTER,[1] WILLIAM M. FURNISH,[2] and ZHOU ZUREN[3]

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Superfamily PSEUDOHALORITOIDEA Ruzhentsev, 1957

[*nom. transl.* BECKER & KULLMANN, 1996, p. 738, *ex* Pseudohaloritidae RUZHENTSEV, 1957, p. 57] [=Schouchangoceratacеae ZHAO & ZHENG, 1977, p. 225; =Cheiloceratacеae GLENISTER & FURNISH, 1981, p. 63, *partim*; FREST, GLENISTER, & FURNISH, 1981, p. 8]

Conch small to intermediate sized, very small to closed umbilicus, smooth or with longitudinal lirae or transverse ribs. Mature aperture modified in some forms. Siphuncle usually subcentral or situated within dorsal septal flexure in most ontogenetic stages, but ventral-marginal position in earliest ontogeny suggests common phylogenetic origin within the Goniatitida. External lobes smooth to serrate, sutural formula VLU:ID [Russian], EALUI [German]. Two families, Maximitidae and Pseudohaloritidae, based on position of siphuncle and form of ventral lobe. *Middle Pennsylvanian (Moscovian)–Lopingian (Changhsingian).*

Family MAXIMITIDAE Ruzhentsev, 1960

[Maximitidae RUZHENTSEV, 1960d, p. 197]

Small pseudohaloritoideans characterized by incipiently to weakly bifid ventral lobe and siphuncle close to venter in all but juvenile whorls. Sutural formula: (V_1V_1) LU:ID [Russian], E_1E_1ALUI [German]. *Middle Pennsylvanian (Moscovian)–Upper Pennsylvanian (Kasimovian).*

Maximites MILLER & FURNISH, 1957a, p. 1045 [**Imitoceras cherokeense* MILLER & OWEN, 1939, p. 145; OD]. Conch small (to 1 cm diameter), broadly subdiscoidal, involute, and lacking prominent ornament. Lateral and ventrolateral sinuses in growth lines accentuated near maturity to form ventrolateral lappets. Siphuncle subcentral in juvenile whorls, close to venter subsequently. Ventral lobe superficially bifid, with low median saddle. Five species. [The ontogenetic modification of ventral lobe to a distinctive, rectangular, shallowly bifid form coincided with the migration of the siphuncle from subcentral to subventral and with the crowding of the septa, which may represent the mechanical response to proximity of the siphuncle and the ventral shell.] *Middle Pennsylvanian (Moscovian)–Upper Pennsylvanian (Kasimovian):* USA (Missouri, Oklahoma), Canada (Arctic Archipelago: Ellesmere Island), Ukraine (Donetz Basin), northern China (Ningxia).——FIG. 9*a–e*. **M. cherokeensis* (MILLER & OWEN), lectotype, SUI 13484B, Cherokee Formation, Middle Pennsylvanian, Missouri; *a,* cross section, ×8; *b*, diameter at 4 mm (Miller & Furnish, 1957a); *c–e,* ×8 (Frest, Glenister, & Furnish, 1981).

Family PSEUDOHALORITIDAE Ruzhentsev, 1957

[Pseudohaloritidae RUZHENTSEV, March 1957, p. 57] [=Thalassoceratidae CHAO, 1954, p. 17, *partim*; RUZHENTSEV, 1960d, p. 205; RUZHENTSEV in BOGOSLOVSKII, LIBROVICH, & RUZHENTSEV, 1962, p. 370; =Pseudohaloritidae MILLER & FURNISH, November 1957a, p. 1044, junior synonym and homonym; =Shouchangoceratacеae ZHAO & ZHENG, 1977, p. 225; ZHOU, 1985, p. 182; ZHOU, 1987, p. 301]

Small- to medium-sized pseudohaloritoideans with closed umbilicus and conspicuously modified mature aperture, smooth or with variously developed coarse longitudinal lirae or transverse ribs. Siphuncle usually subcentral or situated within dorsal septal flexure. External lobes smooth to serrate. Sutural formula: VLU:ID [Russian], EALUI [German]. [The three subfamilies are based on the advent and extent of sutural serration. Most genera were endemics of isolated biotopes within a restricted South China Sea. Dimorphism is common, and the family is incompletely analyzed.] *Upper Pennsylvanian (Kasimovian)–Lopingian (Changhsingian).*

Subfamily PSEUDOHALORITINAE Ruzhentsev, 1957

[*nom. transl.* GLENISTER, NASSICHUK, & FURNISH, 1979, p. 236, *ex* Pseudohaloritidae RUZHENTSEV, 1957, p. 57] [=Pseudohaloritidae ZHAO & ZHENG, 1977, p. 233, *partim*; ZHOU, 1985, p. 182; ZHOU, 1987, p. 303]

Pseudohaloritids with serrations restricted to lobe bases. *Cisuralian (Kungurian).*

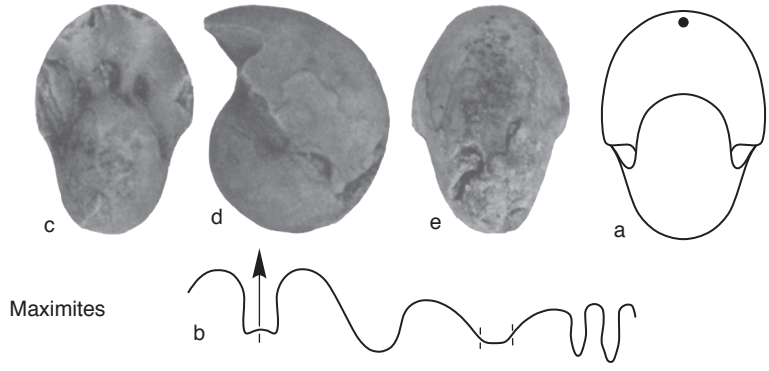

FIG. 9. Maximitidae (p. 16).

Pseudohalorites YABE, 1928, p. 19*, partim*, pl. 6,*1–2;* YABE in YABE & HAYASAKA, 1920, p. 13, *partim*, pl. 19,*16, nom. nud.;* CHAO, 1954, p. 16, *partim*, pl. 6,*13–14,* pl. 7,*1–4* [**P. subglobosus;* OD] [=*Hunanites* CHAO, 1940, p. 71, *partim* (type, *H. hsiehi,* OD)]. Conch moderate size (4 cm maturity), globular to subglobular, umbilicus closed. Juvenile whorls characterized by deeply incised constrictions; transverse ribs only on later whorls, fasciculate to varying degrees. Mature aperture conspicuously modified; ventrolateral salients weak to incipient; ventral sinus broad, shallow. Siphuncle proportionally large (diameter one-fifth to one-third chamber height), retrochoanitic, usually subcentral or situated within dorsal septal flexure but ventral-marginal in first and second whorls. Protoconch large, subdivided by a septum similar to *Tornoceras.* Ventral, lateral, and umbilical lobes serrated; internal lobes smooth. Five species. *Cisuralian (Kungurian):* southern China (Hunan).——FIG. 10*a–l.* **P. subglobosus,* Chihsian Mudstone; *a–c,* ×1.5 (new); *d–f,* ×2; *g–i,* ×1.5 (Zhou, 1985); *j,* diameter at 23 mm (Miller & Furnish, 1957a); *k,* diameter at 16 mm (new); *l,* diameter at 22 mm (Zhou, 1985).

Zhonglupuceras ZHOU, 1985, p. 188 [**Pseudohalorites celestris* YABE, 1928, p. 21; OD; =*P. celestris* YABE in YABE & HAYASAKA, 1920, p. 13, pl. 19,*17–18, nom. nud.;* =*P. celestris* var. *densistriatus* CHAO, 1954, p. 19 is interpreted as microconch] [=*Hunanites* CHAO, 1940, p. 71, *partim*, pl. 10,*10–16* (type, *H. hsiehi*, OD); =*Zhaolorites* BARTZSCH & WEYER, 1988a, p. 139, obj.]. Similar to *Pseudohalorites* in conch form, but more compressed and lacking constrictions in juvenile stages. Microconch is two-thirds diameter of macroconch, displays extreme modification of mature aperture. Ventral lobe lanceolate or tongue shaped. Four species. *Cisuralian (Kungurian)*: southern China (Hunan), USA (Texas), Oman.——FIG. 11*a–g.* **Z. celestre* (YABE), Chihsian Mudstone, central Hunan; *a–c,* macroconch, ×1.5; *d–f,* microconch, ×1.5; *g,* height at 10 mm, diameter at approximately 18 mm (Zhou, 1985).

Subfamily SHOUCHANGOCERATINAE Zhao & Zheng, 1977

[*nom. transl.* GLENISTER, NASSICHUK, & FURNISH, 1979, p. 236, *ex* Shouchangoceratidae ZHAO & ZHENG, 1977, p. 225]

Pseudohaloritids characterized by smooth lobes. [Genera are differentiated primarily on sculpture.] *Upper Pennsylvanian (Kasimovian)–Lopingian (Changhsingian).*

Shouchangoceras ZHAO & ZHENG, 1977, p. 226 [**S. shouchangense;* OD]. Conch compressed and of moderate size (to 5 cm). Ultimate one-third of mature body chamber flat, forming weakly geniculate lateral profile. Mature aperture conspicuously constricted. Prominent transverse ribs form shallow dorsolateral sinus and deeper rounded sinus on venter; coarse longitudinal lirae produce reticulate sculpture in some growth stages. Siphuncle situated within flexure of dorsal lobe. Five species. [*Shouchangoceras reticulatum* ZHAO & ZHENG may be the macroconch of the type species of *Sangzhanites* (*S. aberrans;* ZHOU & others, 1995, Acta Palaeontologica Sinica 34(5):547, pl. 1,*1–13*).] *Guadalupian:* southern China (Zhejiang, Jiangxi, Jiangsu, Fujian, Hubei, Guangdong), USA (western Texas).——FIG. 12,*1a–b.* **S. shouchangense,* Dingjiashan Formation, western Zhejiang; *a,* ×1; *b,* height at 11 mm, diameter at approximately 20 mm (Zhao & Zheng, 1977).——FIG. 12,*1c–e. S. subglobosum,* Hutang Formation, eastern Jiangxi, ×1 (Zhao & Zheng, 1977).

Aulacaganides ZHOU, 1985, p. 188 [**A. hunanicus;* OD]. Resembles the more common shouchangoceratin *Neoaganides* in conch form; differs in presence of deep ventrolateral sulcus and in long, narrow, angular form of lateral lobe. One species. *Cisuralian (Kungurian):* southern China (Hunan).——FIG. 12,*2a–c.* **A. hunanicus,* Dangchong Formation;

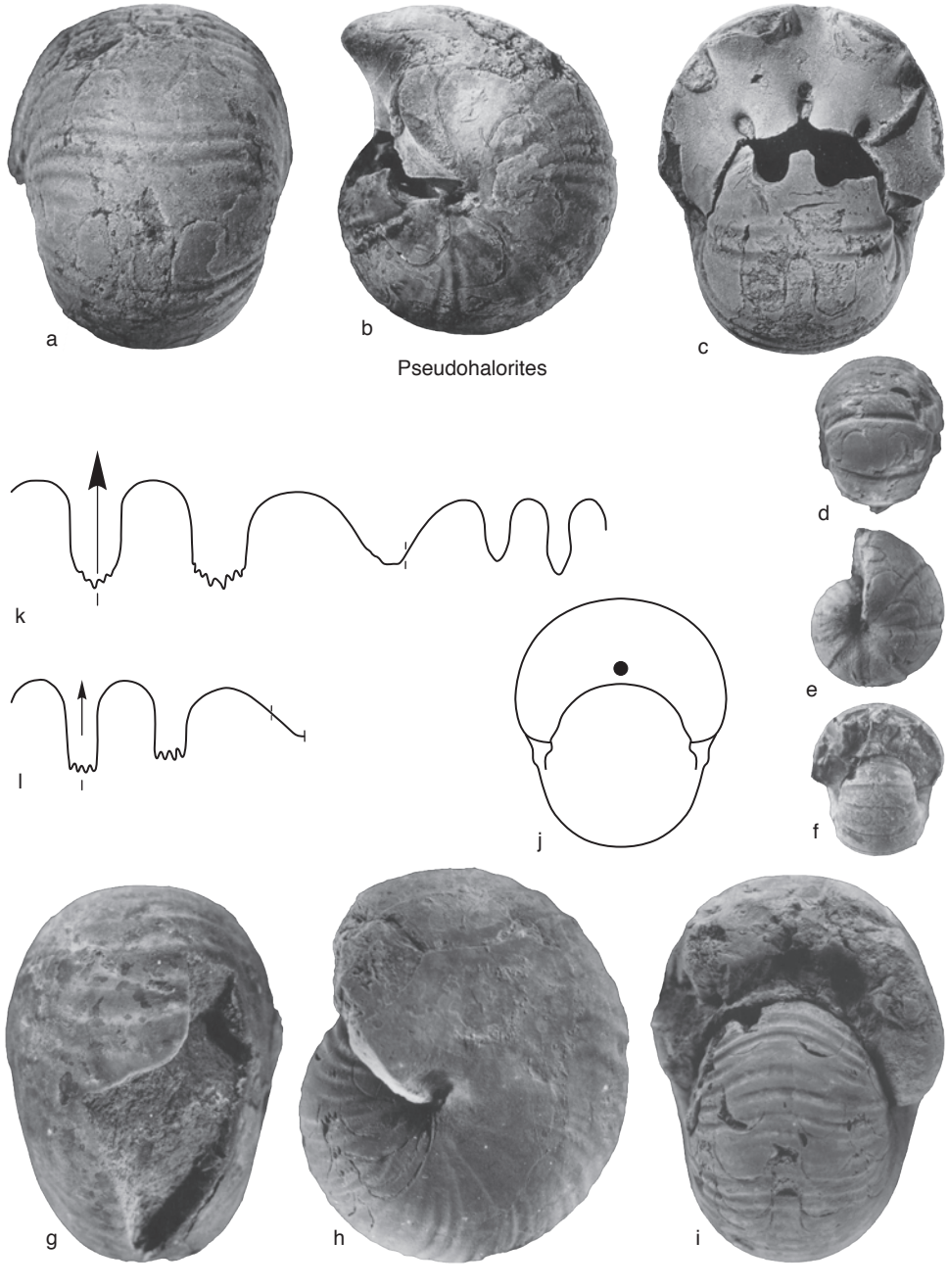

FIG. 10. Pseudohaloritidae (p. 17).

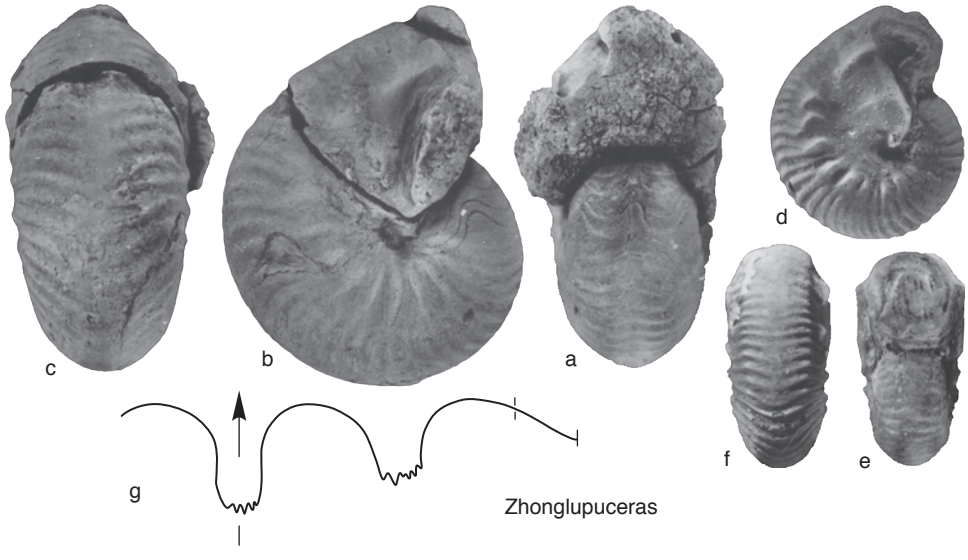

FIG. 11. Pseudohaloritidae (p. 17).

a–b, ×3; *c,* height at 9 mm, diameter approximately 13 mm (Zhou, 1985).

Elephantoceras ZHAO & ZHENG, 1977, p. 232 [**E. spinonodosum;* OD]. Similar to *Erinoceras*, but nodes coarser. Characterized by ventrolateral lappets. Two species. *Guadalupian:* southern China (Zhejiang, Jiangxi).——FIG. 12,*4a–d. *E. spinonodosum,* lower Dingjiashan Formation, western Zhejiang; *a–c*, ×2; *d,* width at 6 mm, diameter approximately 8 mm (Zhao & Zheng, 1977).

Erinoceras ZHAO & ZHENG, 1977, p. 231 [**E. ellipticum;* OD] [?=*Linwuceras* XU in XU & WEI, 1977, p. 559 (type, *L. hunanense,* OD)]. Conch small (to 2 cm) with strongly divergent ventral margin in ultimate one-third of mature body chamber. Strong longitudinal lirae and transverse ribs intersect to produce coarsely nodose surface. External lateral lobe may be distinctively narrow. Two named species may represent dimorphs. *Guadalupian:* southern China (Zhejiang, Hunan, ?Guangdong).——FIG. 12,*3a–d. *E. ellipticum,* Dingjiashan Formation, western Zhejiang; *a–c*, ×2; *d*, height at 6 mm, diameter approximately 10 mm (Zhao & Zheng, 1977).

Lianyuanoceras ZHOU, 1985, p. 187 [**L. shenjiachongense;* OD]. Discoidal shouchangoceratins characterized by combination of fine growth lines and longitudinal lirae in early growth stages, and coarse transverse ribs with weak longitudinal lirae in late stages. All lobes rounded. One species. *Cisuralian (Kungurian):* southern China (Hunan).——FIG. 12,*5a–c. *L. shenjiachongense,* Chihsian Mudstone; *a–b,* ×1.5; *c,* height at 8 mm, diameter approximately 14 mm (Zhou, 1985).

Neoaganides PLUMMER & SCOTT, 1937, p. 350 [**N. grahamensis;* OD]. Conch subdiscoidal to subglobular; mature diameter commonly 1–2 cm, but Cisuralian forms may exceed 5 cm. Lacking coarse ribs; growth lines form shallow reentrant on flanks and deeper sinus on venter. Siphuncle subcentral, ventrad of dorsal septal flexure. Many species. *Upper Pennsylvanian (Kasimovian)–Lopingian (Changhsingian):* USA (Texas, Oklahoma, Kansas, Iowa, Ohio), Southern Urals, northern Iran, southern China (Hunan, Jiangxi, Hubei).——FIG. 13,*1a–d. *N. grahamensis,* Virgilian, Texas; *a–c*, ×5.5 (Frest, Glenister, & Furnish, 1981); *d*, diameter at 3 mm (Miller & Furnish, 1957a).

Qinglongites ZHENG, 1981, p. 108 [**Q. curvatus;* OD]. Similar to *Sosioceras* in conch form and mature modifications; Runzelschicht also comparable, but with longitudinal lineation. V-shaped ventral lobe is unknown in other pseudohaloritids. Four species. *Lopingian (Changhsingian):* southern China (Guizhou).——FIG. 14,*1a–d. *Q. curvatus*, Dalong Formation; *a–c,* ×1.5; *d,* diameter at 17.5 mm (Zheng, 1981).

Sangzhites ZHAO & ZHENG, 1977, p. 230 [**S. aberrans;* OD]. Conch globular, intermediate in size (3 cm); both longitudinal lirae and transverse ribs are coarse, ribs being particularly prominent on ultimate volution. Mature aperture has pair of dorsolateral lappets and longer pair in ventrolateral position. Suture and siphuncle as in *Shouchangoceras.* Two

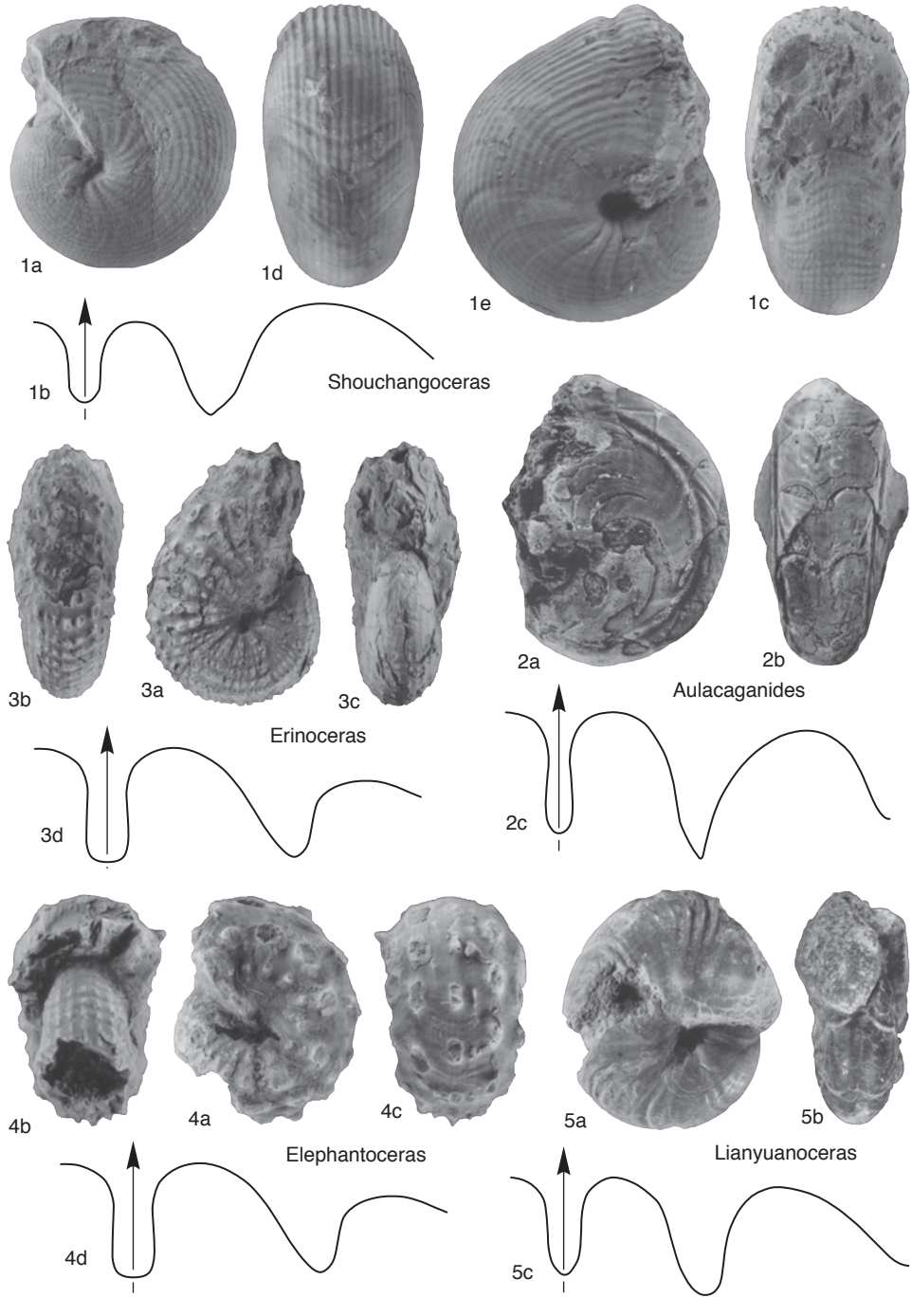

FIG. 12. Pseudohaloritidae (p. 17–19).

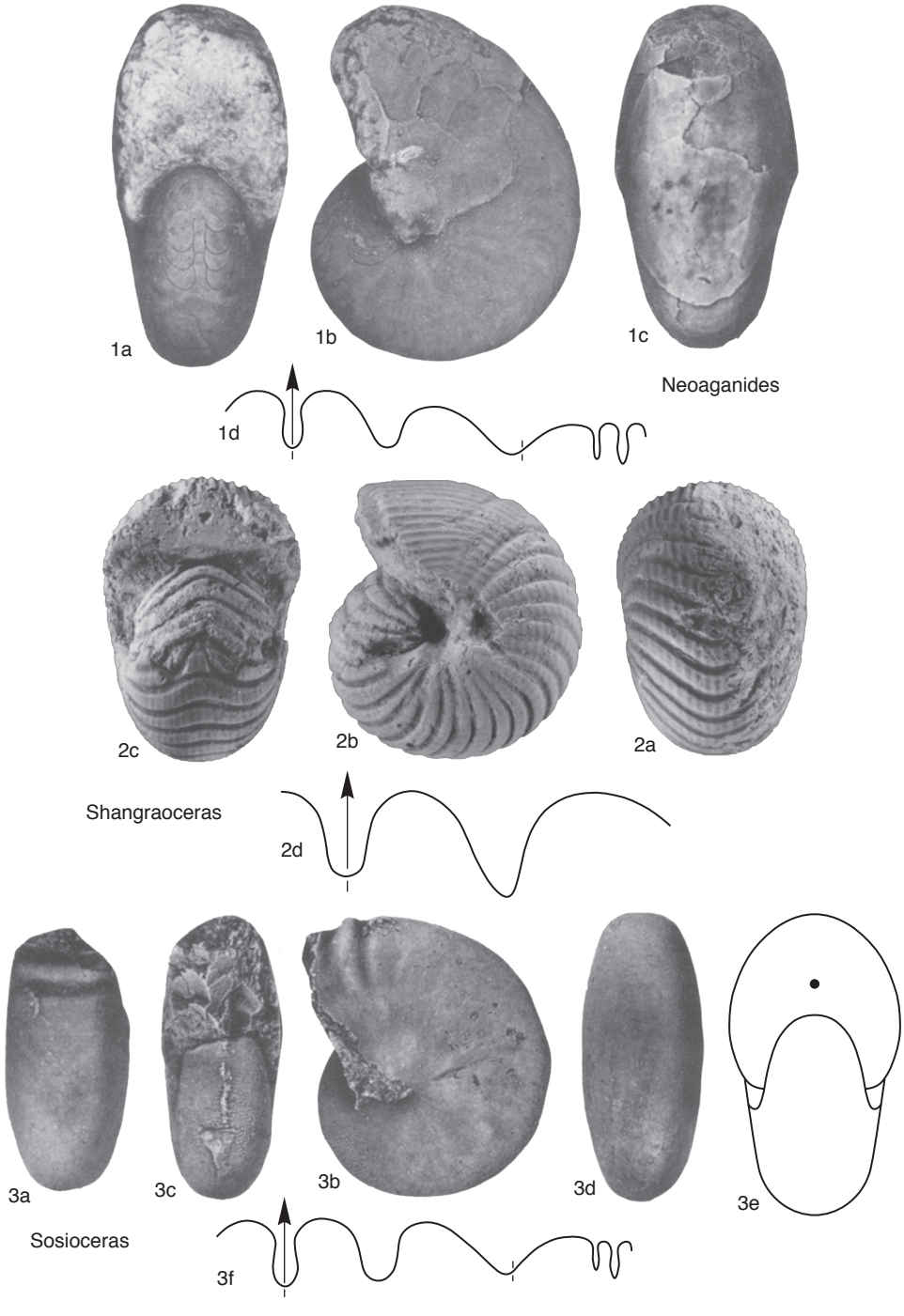

FIG. 13. Pseudohaloritidae (p. 19–22).

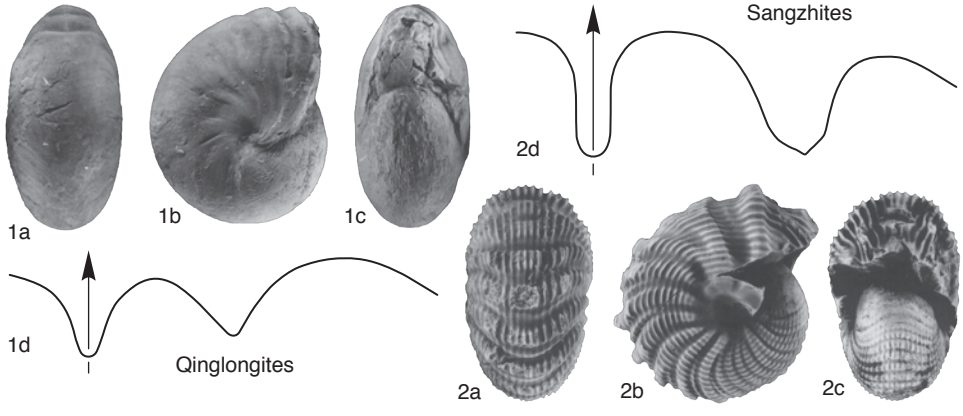

FIG. 14. Pseudohaloritidae (p. 19–22).

species. *Guadalupian:* southern China (Zhejiang, Hunan).——FIG. 14,*2a–d. *S. aberrans,* Maokou Formation, northwestern Hunan; *a–c,* ×1; *d,* height at 8 mm, diameter approximately 14 mm (Zhao & Zheng, 1977).

Shangraoceras ZHAO & ZHENG, 1977, p. 227 [**S. robustum;* OD]. Similar to *Shouchangoceras* in conch form and suture, but perhaps distinguishable by more prominent and wide transverse ribs (wider, flatter tops). Two named species may represent dimorphs. *Guadalupian:* southern China (Jiangxi, Zhejiang, Hunan).——FIG. 13,*2a–d. *S. robustum,* Hutang Formation, eastern Jiangxi; *a–c,* ×1; *d,* diameter approximately 26 mm (Zhao & Zheng, 1977).

Sosioceras FREST, GLENISTER, & FURNISH, 1981, p. 26 [**Brancoceras pygmaeum* GEMMELLARO, 1888, p. 26; OD]. Diminutive, subdiscoidal shouchangoceratins, less than 2 cm conch diameter; mature modifications comprise prominent double constrictions near aperture, and flat venter in body chamber. Dorsal Runzelschicht commonly displays raised axial ridge. One species. *Guadalupian (Wordian):* Italy (Sicily).——FIG. 13,*3a–f. *S. pygmaeum* (GEMMELLARO), Sosio limestone; *a–d,* ×4 (Frest, Glenister, & Furnish, 1981); *e,* diameter at 6 mm; *f,* diameter at 5 mm (Miller & Furnish, 1957a).

Subfamily YINOCERATINAE Ruzhentsev, 1960

[Yinoceratinae RUZHENTSEV, 1960d, p. 207] [=Lanceoloboceratidae CHAO in ZHAO & ZHENG, 1977, p. 234; ZHOU, 1979, p. 391; =Lanceolobocerati nae GLENISTER, NASSICHUK, & FURNISH, 1979, p. 236; FREST, GLENISTER, & FURNISH, 1981, p. 41; ZHOU, 1985, p. 183, 194; ZHOU, 1987, p. 303]

Pseudohaloritids characterized by total serration of all lobes and saddles in external suture. [Component taxa appear to display extreme intraspecific variation in both strength of sculpture and degree of serration of sutural elements, but existing collections do not permit confident taxonomic analysis.] *Cisuralian (Kungurian)–Guadalupian.*

Yinoceras CHAO, 1954, p. 19 [**Y. lenticulare;* OD] [=*Shaoyangoceras* ZHOU, 1979, p. 390 (type, *S. jiangjiachongense,* OD); FREST, GLENISTER, & FURNISH, 1981, p. 42; ZHOU, GLENISTER, & FURNISH, 2002, p. 428]. Conch subglobular, characterized by strong transverse ribs that trace shallow ventral sinus; longitudinal sculpture variable but inconspicuous. Digitation of sutural elements highly irregular and variable. Three species. [The lenticular shape of the monotype of *Y. lenticulare* is considered to be a result of preservational deformation. Illustrated external sutures (Fig. 15,*2d–e*) differ in details of serration. Such differences are due partly to preservation but also reflect extreme intraspecific variation.] *Cisuralian (Kungurian):* southern China (Hunan).——FIG. 15,*2a–e. *Y. lenticulare,* Chihsia Mudstone, Dangchong Formation; *a–c,* ×2 (Zhou, 1979); *d,* diameter at 17 mm; *e,* NIGP 7156, diameter at 10 mm (adapted from Chao, 1954).

Lanceoloboceras CHAO in ZHAO & ZHENG, 1977, p. 234 (CHAO, 1957 (ms), *nom. nud.*) [**L. reticulatum;* OD]. Similar to *Yinoceras* in conch form, but ribs forming deeper ventral sinus; ribs and lirae subequal in size, producing subdued reticulate sculpture. Serration of suture more regular than in *Yinoceras* and ventral lobe broader. One species. *Guadalupian:* southern China (Sichuan).——FIG. 15,*1a–d. *L. reticulatum,* ?Maokou Formation; *a–c,* ×1; *d,* diameter at 43 mm (Zhao & Zheng, 1977).

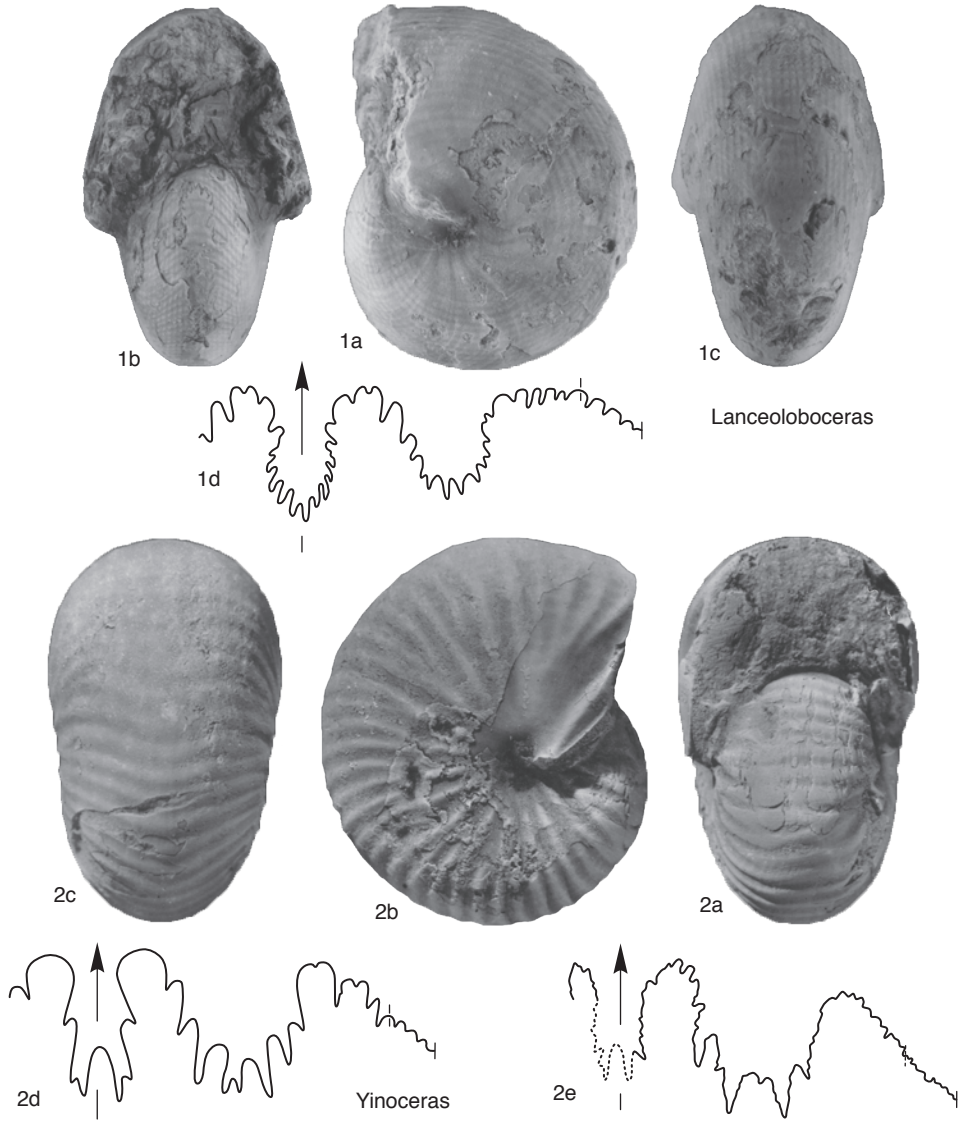

FIG. 15. Pseudohaloritidae (p. 22).

Suborder GONIATITINA Hyatt, 1884

[*nom. correct.* Miller & Furnish, 1954, p. 687, *pro* Goniatitinae Hyatt, 1884 in 1883–1884, p. 307]

Conch form in general thickly discoidal to globular, rarely lenticular or oxycone. Ventral lobe subdivided by median saddle usually embracing a small median lobe. Basic sutural formula ($E_1E_mE_1$)AL:UI [German], (V_1V_1)LU:ID [Russian]; advanced genera with extremely complicated subdivision, mainly of adventitious, lateral, or umbilical lobes. Derived from Prionoceratidae or Karagandoceratidae. *Mississippian (Tournaisian [upper Kinderhookian])–Lopingian (Wuchiapingian).*

PERICYCLOIDEA

Jürgen Kullmann

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Superfamily PERICYCLOIDEA Hyatt, 1900

[*nom. transl.* Ruzhentsev, 1960d, p. 200, *ex* Pericyclidae Hyatt, 1900, p. 551]

Conch shape variable. Shell surface smooth or with faint or prominent transverse sculpture; constrictions may be present. Ventral lobe commonly narrow or moderately wide, median saddle relatively low. Adventitious lobe on ventrolateral portion of flanks; lateral lobe usually smaller than other lobes. Sutural formula: ($E_1E_mE_1$)AL:UI [German], (V_1V_1)LU:ID] [Russian]. *Mississippian (Tournaisian–Serpukhovian [upper Kinderhookian–upper Chesterian]).*

Family PERICYCLIDAE Hyatt, 1900

[Pericyclidae Hyatt, 1900, p. 551]

With prominent transverse sculpture; some species with spiral ornamentation or tubercles. Ornament highly variable, ranging from fine to coarse ribs. Ventral lobe with parallel or orad diverging sides. First lateral saddle rounded or subacute, but rarely acute; lateral lobe acute. [The phylogenetic relationship of this family is uncertain and may be an artificial grouping.] *Mississippian (Tournaisian–lower Visean [Kinderhookian–Osagean]).*

Subfamily PERICYCLINAE Hyatt, 1900

[*nom. transl.* Miller, Furnish, & Schindewolf, 1957, p. 58, *ex* Pericyclidae Hyatt, 1900, p. 551]

Ventral lobe with subparallel, parallel, or convergent sides. First lateral saddle broad and rounded. *Mississippian (Tournaisian–lower Visean [Kinderhookian–Osagean]).*

Pericyclus Mojsisovics, 1882, p. 141 [**Goniatites princeps* de Koninck, 1844, p. 579; SD Hyatt, 1884 in 1883–1884, p. 330] [=*Trapezopericyclus* Turner, 1948, p. 51 (type, *Pericyclus trapezoidalis* Crick, 1899, p. 432, OD); for discussion, see Schindewolf, 1951b, p. 306]. Conch form discoidal to thickly discoidal with narrow to wide umbilicus. Sculpture consisting of prominent simple or (rarely) dichotomous ribs, split close to umbilicus; one species with spiral ornamentation. Ventral lobe with parallel sides and low median saddle; first lateral saddle broadly rounded. Six species, one questionable. [For discussion about this genus, see Turner, 1948, p. 50; Schindewolf, 1951a, p. 77; Gordon, 1965, p. 174.] *Mississippian (upper Tournaisian):* Belgium, Great Britain, Ireland, Russia (Komi, South Urals), Algeria, Morocco, China (Xinjiang), USA (Arkansas).——Fig. 16,*1a–c.* **P. princeps* (de Koninck), holotype, Calcaire de Calonne, Vaulx, Belgium, upper Tournaisian; *a–b,* ×1.5; *c*, suture, magnification not stated (Delépine, 1940).——Fig. 16,*1d. P. latumbilicatus* Kuzina, holotype, Silova-Yakha River, Pai-Khoy, Silova Formation, upper Tournaisian, PIN 2775/501, suture at 7 mm whorl height, 8 mm whorl width, ×10 (Kuzina, 2000).

Asiacyclus Librovich in Bogoslovskii, Librovich, & Ruzhentsev, 1962, p. 366 [**Pericyclus asiaticus* Librovich, 1940, p. 122; OD]. Conch form narrowly umbilicate. Sculpture consisting of

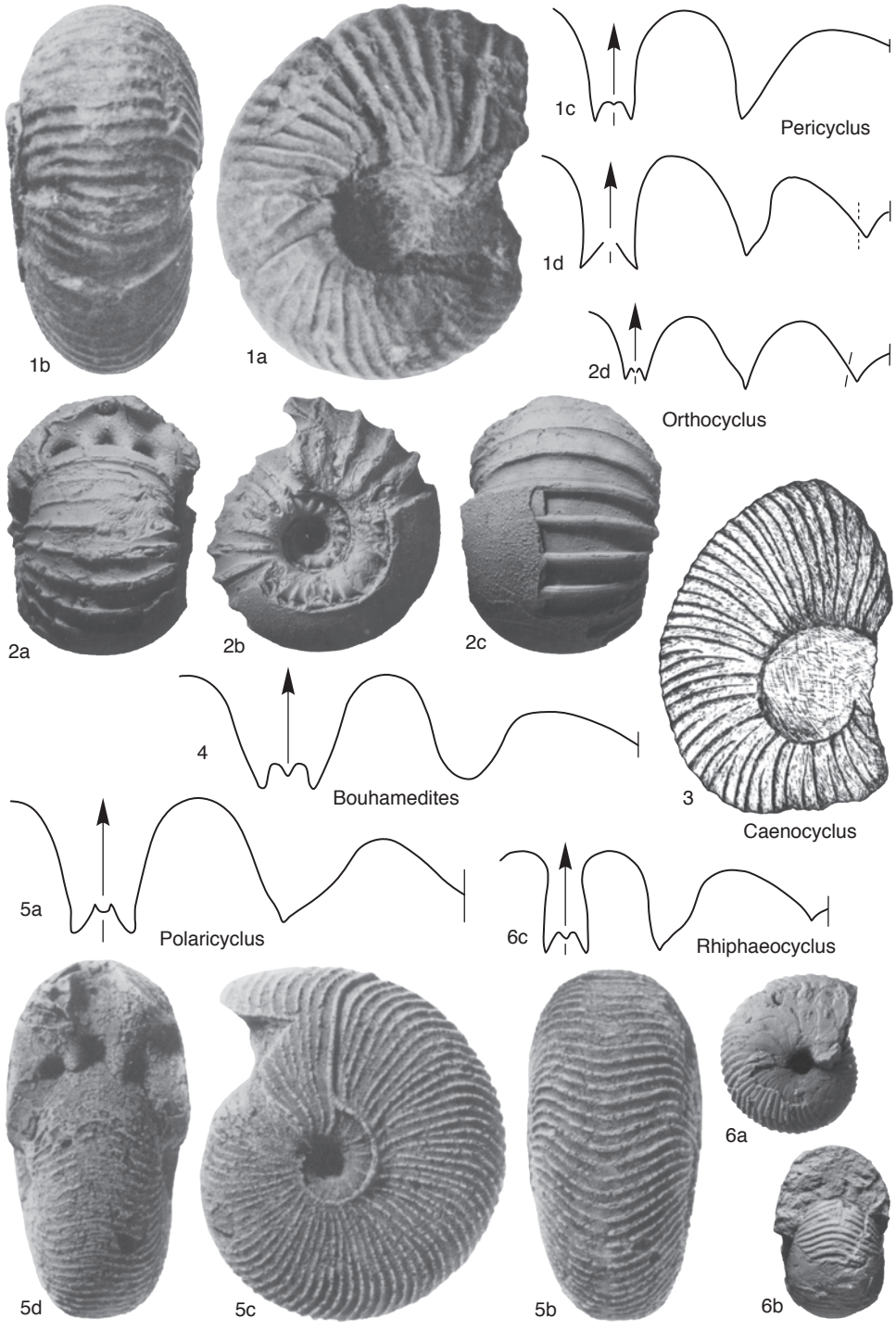

FIG. 16. Pericyclidae (p. 24–28).

many faint simple ribs, sometimes dichotomizing. Constrictions and faint spiral ornamentation may be present. Suture as in *Pericyclus*. Nine species. *Mississippian (upper Tournaisian):* Great Britain, Ireland, Kazakhstan (Karaganda).——Fig. 17,*7. *A. asiaticus* (Librovich), holotype, River Malenki Chiderty, Kazakhstan, CNIGR 92/5450, ×1 (Librovich, 1940).

?Bouhamedites Korn & others, 2003, p. 86 [**B. enigmaticus* Korn & others, 2003, p. 87; OD]. Conch thickly discoidal, with almost closed umbilicus. Ornament with about 80 smooth riblets forming a shallow lateral and deeper sinus across venter. Adventitious lobe rounded. One species. [The type species, the only known specimen and being less than 10 mm in diameter, may represent a juvenile specimen of unknown affinity.] *Mississippian (Tournaisian):* Morocco.——Fig. 16,*4. *B. enigmaticus,* holotype, Taouz, Jebel Ouaoufilal, east of Ksar Bouhamed, Tafilalt, Oued Znaïgui Formation, MB C.3987, suture at 8.9 mm diameter, whorl height 4.9 mm, whorl width 5.6 mm, ×7.8 (Korn & others, 2003).

?Caenocyclus Schindewolf, 1922, p. 17 [**Pericyclus (Caenocyclus) perisphinctoides* Schindewolf, 1922, p. 16; M]. Conch form discoidal, with wide umbilicus. Sculpture with prominent polyschizotomous ribs. Suture unknown. One species. [Only the poorly preserved holotype of the type species is known; assignment to the family is uncertain, and the genus may be a junior synonym of *Pericyclus* or *Ammonellipsites*.] *Mississippian (?middle Tournaisian):* Germany.——Fig. 16,*3. *C. perisphinctoides*, holotype, Geodes horizon, Zadelsdorf, Thuringia, ×1 (Schindewolf, 1926b).

Goniocycloides Work & Nassichuk in Work, Nassichuk, & Richards, 2000, p. 35 [**G. ochakensis;* OD]. Conch form and ornamentation as in *Goniocyclus,* but ventral lobe attenuate and with relatively high median saddle reaching about one-third of its entire length. First lateral saddle asymmetric and narrowly rounded. One species. *Mississippian (upper Tournaisian [middle Osagean]):* Canada (British Columbia).——Fig. 17,*4a–c. *G. ochakensis,* holotype, eastern side of Ochak Mountain, east-central British Columbia, Mount Head Formation, GSC 103185; *a–b*, ×2.5; *c*, paratype, suture, GSC 103187, diameter at 16 mm (Work, Nassichuk, & Richards, 2000).

Goniocyclus Gordon, 1986, p. 21 [**Goniatites blairi* Miller & Gurley, 1896, p. 35; OD] [=*Nematocyclus* Gordon, 1986, p. 28, *nom. nud.* (type, *Pericyclus (Goniocyclus) filaris* Gordon, 1986, p. 26, M)]. Conch form discoidal, ventral side broadly or narrowly rounded, umbilicus usually wide. Ribs rursiradiate, bending backward on outer flanks and meeting in acute or slightly obtuse angle. Spiral ornamentation in some species; no constrictions. Suture as in *Pericyclus,* with very low ventral lobe and concave-outward sides. Many species. [For discussion about this genus, see Work, 2002, p. 187.] *Mississippian (middle Tournaisian):* Germany, Portugal, Morocco, Russia (Moscow Basin, South Urals), USA (Idaho, Missouri, Montana, New Mexico, Nevada).——Fig. 17,*1a–d. *G. blairi* (Miller & Gurley), Alamo Peak, about 7.9 km southeast of Alamogordo, Otero County, New Mexico, Caballero Formation, middle Kinderhookian, USNM 377536; *a–c*, ×2; *d*, suture at 6 mm whorl height, ×7.8 (Gordon, 1986).

Hammatocyclus Schindewolf, 1951a, p. 81 [**Pericyclus (Hammatocyclus) homoceratoides* Schindewolf, 1951a, p. 82; OD]. Similar to *Pericyclus*, conch form thickly discoidal, with moderately wide umbilicus. Sculpture in early stages with nodes and small ribs on umbilical margin, later smooth; constrictions may be present. Six species. *Mississippian (middle Tournaisian–lower Visean [Osagean]):* Belgium, Great Britain, Germany, Russia (North Urals), Algeria, USA (Montana, ?Utah).——Fig. 17,*3. *H. homoceratoides*, suture of holotype, reversed, Erdbach limestone, Iberg-Winterberg, Bad Grund, Harz Mountains, Germany, upper Tournaisian, Collection Fuhrmann, Clausthal, ×2.1 (Schindewolf, 1951a).

Neopericyclus Popov, 1965b, p. 45 [**N. kokdzharensis* Popov, 1965b, p. 46; OD]. Similar to *Ammonellipsites*, but with ornamentation consisting of faint polyschizotomous ribs, which split close to umbilicus. Four species. *Mississippian (upper Tournaisian):* France, Germany, Ireland, Algeria, Morocco, Kyrgyzstan (Tian Shan).——Fig. 17,*2a–b. *N. kokdzharensis*, holotype, Kok-Dzhar River, Tian Shan, Kyrgyzstan, Akchetash Formation, IG ANK 2766/86, ×1 (Popov, 1968).——Fig. 17,*2c. N. hauchecornei* (Holzapfel), suture, Erdbach limestone, Iberg, Harz Mountains, Germany, Collection Fuhrmann, Clausthal, reversed, ×1.1 (Schindewolf, 1951a).

Orthocyclus Kuzina, 2000, p. 21 [**Ammonellipsites ? raricostatus* Kuzina, 1980, p. 71; OD]. Conch form subglobular, with low aperture; umbilicus moderately wide. Straight coarse ribbing widely spaced. Ventral lobe has a very low median saddle and lobe with roundly diverging sides. First lateral saddle broadly rounded, adventitious lobe moderately deep and at tip narrowly rounded. Two species. *Mississippian (upper Tournaisian):* Russia (Komi, South Urals).——Fig. 16,*2a–d. *O. raricostatus* (Kuzina), holotype, Silova-Iakha River, Pai-Khoy, Silova Formation, PIN 2775/198; *a–c,* ×1.5; *d,* suture at 8.4 mm whorl height and whorl width 18.1, ×2.4 (Kuzina, 2000).

Parahammatocyclus Riley, 1996, p. 78 [**P. chaigleyensis;* OD]. Similar to *Hammatocyclus*, but tubercles restricted to early and middle growth stages. Ventral lobe with divergent sides; first lateral saddle rounded and deep. One species. *Mississippian (lower Visean):* Great Britain.——Fig. 17,*5. *P. chaigleyensis,* suture, reversed image, Hodder Mudstone Formation, Arundian, BGS RH1631, at 3.5 mm whorl height, 5.8 mm whorl width (Riley, 1996).

Polaricyclus Riley, 1990b, p. 139 [**Fascipericyclus polaris* Gordon, 1957, p. 33; OD]. Conch form similar to *Ammonellipsites*, pachyconic, with narrow umbilicus. Sculpture with prominent simple or

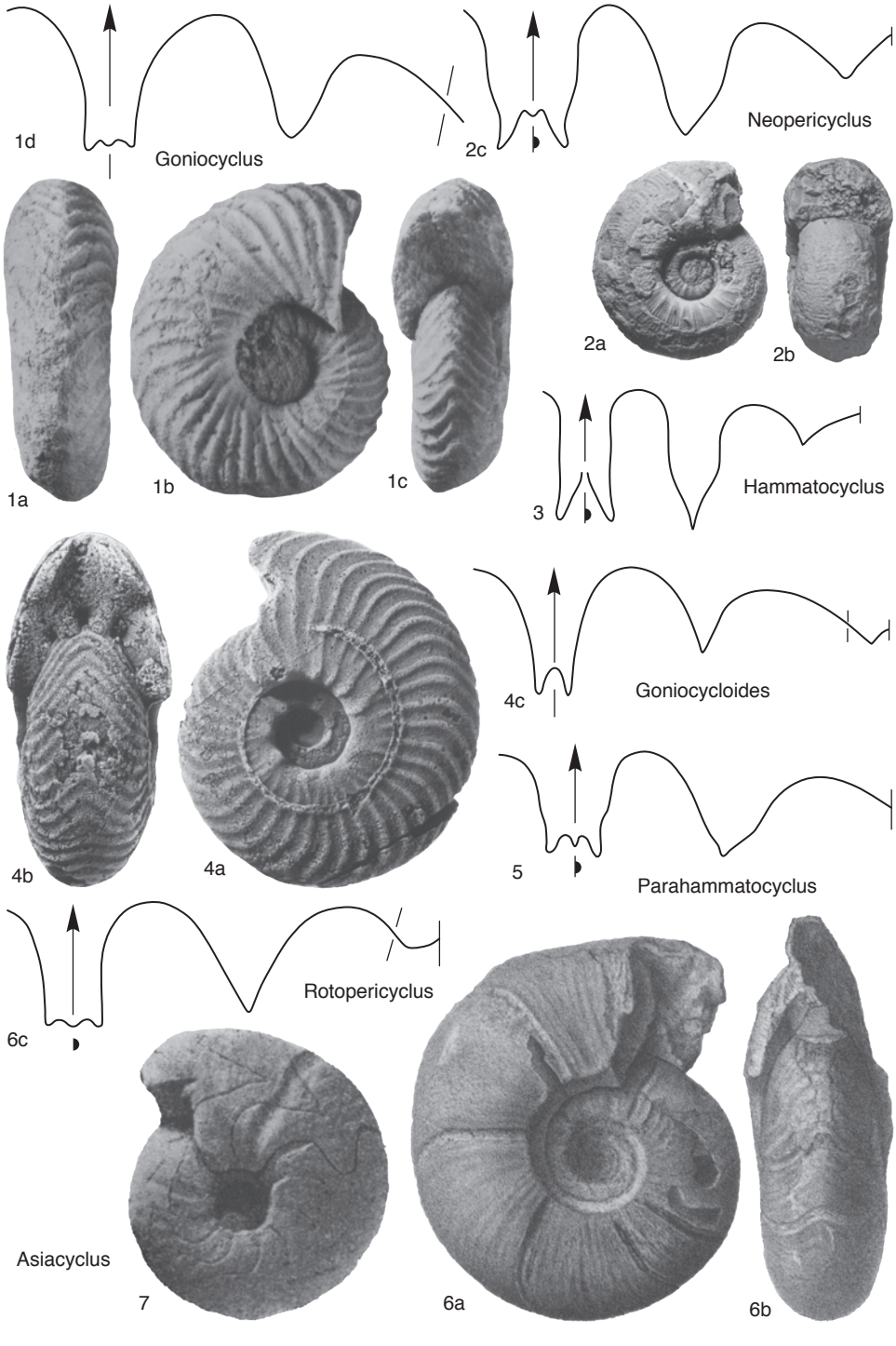

FIG. 17. Pericyclidae (p. 24–28).

dichotomous ribs. Ventral lobe with orad diverging sides, median saddle low; first lateral saddle broadly rounded. Five species. *Mississippian (upper Tournaisian–lower Visean [Osagean]):* Great Britain, Russia (South Urals); Canada (British Columbia), USA (Alaska, Kansas), *lower Visean.*——Fig. 16,*5a. *P. polaris* (Gordon), suture, Kiligwa River, De Long Mountains, Brooks Range, northern Alaska, Kuna Formation, middle or upper Osagean, USNM 118953, enlarged, diameter at about 16 mm (Work, Nassichuk, & Richards, 2000).——Fig. 16,*5b–d. P. canadensis* Work & Nassichuk in Work, Nassichuk, & Richards, Ochak Mountain, British Columbia, Canada, lower Head Formation, lower Visean, ×2.5 (Work, Nassichuk, & Richards, 2000).

Rhiphaeocyclus Kuzina, 1973, p. 23 [**R. mutabilis;* OD]. Conch form globular at early growth stages, at maturity discoidal; involute, umbilicus very narrow, later closed. Distinct ribs at immature stages, smooth at maturity. Suture similar to *Pericyclus;* ventral lobe at orad part slightly narrowing, first lateral saddle broadly rounded, and lateral lobes wide. One species. *Mississippian (upper Tournaisian):* ?Ireland, Russia (North Urals).——Fig. 16,*6a–c. *R. mutabilis,* Kozhim River, Kos'vin Formation, North Urals, Russia; *a–b,* paratype, PIN 2775/105, ×1.5; *c*, holotype, suture, PIN 2775/101, whorl height at 14.2 mm, whorl width 13.2 mm, ×2.3 (Kuzina, 1973).

Rotopericyclus Turner, 1948, p. 50 [**Pericyclus rotuliformis* Crick, 1899, p. 434; OD]. Similar to *Hammatocyclus*, but with narrow umbilicus and prominent ribs on later stages. Small tubercles may be at edge of umbilicus. Ventral lobe with vertical and parallel flanks. Four species, one questionable. *Mississippian (middle Tournaisian–lower Visean [upper Kinderhookian]):* Belgium, Great Britain, Ireland, Algeria, Morocco, Kyrgyzstan (Tian Shan), USA (Idaho, Nevada).——Fig. 17,*6a–b. *R. rotuliformis* (Crick), Mississippian Limestone, upper Tournaisian, Ireland, ×0.7 (Foord, 1903).——Fig. 17,*6c. R. pinyonensis* Gordon, suture, whorl height at 5.8 mm, reversed, Chainman Shale, middle Canyon Formation, Elko County, Nevada, ×5.6 (Gordon, 1986).

Subfamily AMMONELLIPSITINAE Riley, 1996

[Ammonellipsitinae Riley, 1996, p. 69]

Early growth stage widely umbilicate. Ventral lobe with divergent sides. First lateral saddle subacute or acute. *Mississippian (upper Tournaisian–lower Visean [Osagean]).*

Ammonellipsites Parkinson, 1822, p. 164 [**Ellipsolites funatus* Sowerby, 1814, p. 81; SD Schindewolf, 1951b, p. 309] [=*Kaypericyclus* Turner, 1948, p. 51 (type, *Pericyclus kayseri* Schmidt, 1925, p. 554, OD); =*Eurycyclus* Schindewolf, 1951a, p. 86 (type, *Pericyclus kochi* Holzapfel, 1889, p. 35, OD); for extensive discussion see Schindewolf, 1951b, p. 308; Gordon, 1965, p. 172]. Conch form thickly discoidal to globular, with wide or moderately narrow umbilicus. Sculpture with prominent, usually simple ribs; constrictions may be present. Ventral lobe with diverging sides, median saddle elevated to a fourth or a third of entire ventral lobe. First lateral saddle narrowly rounded or subacute. Many species. [No suitable illustrations of the type species are available.] *Mississippian (upper Tournaisian–lowermost Visean [Osagean]):* France, Germany, Ireland, Poland, Russia (North Urals), Spain, Algeria, Morocco, China (Xizang), Kyrgyzstan (Tian Shan), Australia (New South Wales), USA (Kansas).——Fig. 18,*4a–c. A. kochi* (Holzapfel); *a–b,* Liebstein, Erdbach limestone, Rhenish Massif, Germany, upper Tournaisian, ×1 (Holzapfel, 1889); *c,* suture, Casa de la Vega formation, Guadalmez, Sierra Morena, Spain, upper Tournaisian, MGUV 7564, ×2.4 (Pardo Alonso & Kullmann, 2002).

Fascipericyclus Turner, 1948, p. 50 [**Goniatites fasciculatus* McCoy, 1844, p. 13; OD] [=*Schizocyclus* Schindewolf, 1951a, p. 78, obj.]. Sculpture with prominent dichotomous ribs. Ventral lobe with diverging sides, median saddle low. First lateral saddle subacute or acute. Two species. *Mississippian (upper Tournaisian):* Belgium, Great Britain, France, Ireland, Morocco, Kyrgyzstan (Tian Shan), Russia (South Urals).——Fig. 18,*5a–b. *F. fasciculatus* (McCoy), Les Pauquys, north of Waulsort, Calcaire Waulsortien, Belgium, ×1 (Delépine, 1940).

Helicocyclus Schindewolf, 1951a, p. 79 [**Pericyclus (Helicocyclus) gracillimus;* OD]. Conch form discoidal, mostly with wide umbilicus. Sculpture consisting of faint, densely spaced, usually unsplit ribs, crossing flanks and venter radially; no umbilical nodes. Growth lines linear, with weak ventral salient. Ventral lobe with subparallel and slightly sinuous sides, in some species somewhat divergent. Four species. *Mississippian (upper Tournaisian–lower Visean):* Germany, Morocco, *upper Tournaisian;* Great Britain, Russia (North Urals), Kyrgyzstan (Tian Shan), *lower Visean.*——Fig. 18,*3a–b. *H. gracillimus,* holotype, Iberg-Winterberg, Bad Grund, Harz Mountains, Germany, Erdbach limestone, upper Tournaisian, Collection Fuhrmann, Clausthal; *a,* ×4.5 (Schindewolf, 1951a); *b,* suture, ×9 (Schindewolf, 1951a).

Stenocyclus Schindewolf, 1951a, p. 78 [**Pericyclus (Pericyclus) carinatus* Schindewolf, 1926b, p. 81; OD]. Conch form discoidal, with narrow umbilicus, sometimes with keeled venter. Sculpture consisting of faint, regular dichotomous ribs. Ventral lobe with sides diverging orad; first lateral saddle narrowly rounded. Four species. [The type species may be regarded as a juvenile form of *Paraqiannanites;* for discussion, see Kuzina, 2000, p. 18.] *Mississippian (upper Tournaisian–lower Visean):* Belgium, Great Britain, France, Germany, Russia (South Urals), Kyrgyzstan (Tian Shan).——Fig. 18,*1a–c. *S. carinatus* (Schindewolf), holotype, Zadelsdorf, Geodes horizon, Thuringia,

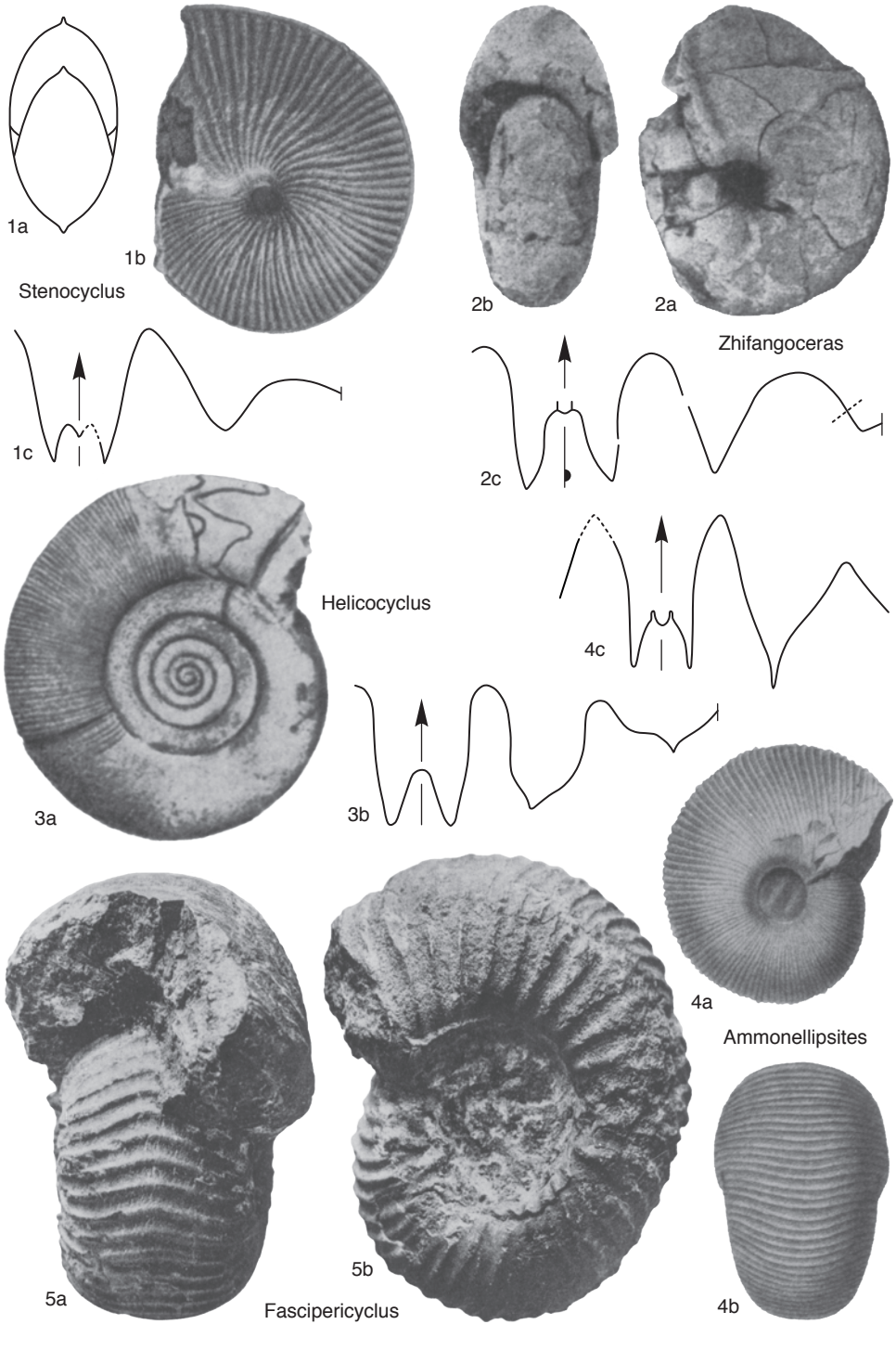

FIG. 18. Pericyclidae (p. 28–30).

Germany, ?middle Tournaisian; *a,* outline of ventral side, ×3 (Schindewolf, 1926b); *b,* side view, ×3.75 (Schindewolf, 1939b); *c,* suture, magnification not stated (Schindewolf, 1926b).

?Zhifangoceras SHENG, 1984, p. 288 [**Z. subglobosum;* OD]. Conch form subdiscoidal, with narrow umbilicus. Surface smooth or with weak and wide ribs or faint wrinkles on living chamber; spiral ornamentation may be present. Suture goniatitic: ventral lobe relatively wide, with apicad acute prongs and median saddle usually less than half as high as entire lobe; ventrolateral saddle acute, subacute, or subangular. Adventitious lobe subtriangular, with almost straight sides. Four species. [The phylogenetic relationship is uncertain; this genus may represent a link between Pericyclidae and Goniatitidae or may even belong to the superfamily Goniatitoidea.] *Mississippian (upper Tournaisian–lower Visean):* China (Xinjiang).——FIG. 18,*2a–b. *Z. subglobosum,* holotype, Donggulu Spring, Zhifang area, East Junggar, Donggulubasitao Formation, upper Tournaisian, no.C3043, ×1 (Sheng, 1984).——FIG. 18,*2c. Z. zhifangense* SHENG, holotype, suture, reversed image, Donggulu Spring, Zhifang area, East Junggar, Donggulubasitao Formation, upper Tournaisian, no.C3045, whorl height at 16.8 mm, whorl width 18.8 mm, ×2.7 (Sheng, 1984).

Family INTOCERATIDAE Kuzina, 1971

[Intoceratidae KUZINA, 1971, p. 39]

Conch form discoidal, involute, with narrow umbilicus; ventral side may be oxycone. Ornamentation consisting of distinct growth lines, rarely with weak lirae in ventrolateral area. Ventral portion of suture primitive; ventral lobe with diverging sides, at its base very narrow, bifid, or with small median lobe. First lateral saddle broadly rounded and wide. Adventitious lobe rounded, in some genera rather small. *Mississippian (middle Tournaisian–lower Visean).*

Intoceras KUZINA, 1971, p. 39 [**I. uralense* KUZINA, 1971, p. 40; OD]. Conch discoidal, small; umbilicus narrow. Growth lines form broad and moderately deep ventral sinus. Constrictions may be present. Ventral lobe extremely narrow at its base; median saddle low, without incision. Adventitious lobe rounded. Five species. *Mississippian (upper Tournaisian–lower Visean):* Russia (North Urals).——FIG. 19,*4a–c. *I. uralense*, holotype, right bank of Kozhim River, Kos'vin Formation, upper Tournaisian, PIN 2775/106; *a–b,* ×1.5; *c,* suture, whorl height at 8 mm, whorl width 8.5 mm, ×2.5 (Kuzina, 1971).

Aquilonites KUZINA, 1974, p. 23 [**A. angustilobatus;* OD]. Conch form discoidal, involute, with very narrow umbilicus. Ornamentation consisting of biconvex growth lines, sometimes with weak lirae. Ventral lobe very narrow, with straight, almost parallel, or slightly sigmoidal sides; adventitious lobe short and broadly rounded. Two species. [This genus may not belong to Intoceratidae because of its advanced suture.] *Mississippian (middle Tournaisian–lower Visean):* Russia (North Urals).——FIG. 19,*2a–c. *A. angustilobatus,* holotype, Kozhim River, Komi, Kos'vin Formation, upper Tournaisian, PIN 2775/190; *a–b*, ×1; *c,* suture, whorl height at 9 mm ,whorl width 9.5 mm (Kuzina, 1974).

Oxintoceras KUZINA, 1974, p. 28 [**O. thaumastum;* OD]. Conch form discoidal, oxycone, involute, with very narrow umbilicus. Ventral lobe extremely wide, with widely diverging sides; median saddle broad, with small median lobe. Adventitious lobe very small and rounded. One species. [Only the holotype is known for this genus.] *Mississippian (lower Visean):* Russia (North Urals).——FIG. 19,*3a–d. *O. thaumastum,* holotype, Kozhim River, Komi, Nortnich Formation, PIN 2775/188; *a–b,* ×1; *c,* outline of last whorl, ×0.9; *d,* suture, whorl height at 25.5 mm, whorl width 10.0 mm, ×3.4 (Kuzina, 1974).

Quasintoceras KUZINA, 1974, p. 25 [**Q. bogoslovskyi* KUZINA, 1974, p. 27; OD]. Conch form discoidal, small, involute, with very narrow umbilicus. Growth lines biconvex. Ventral lobe with extremely diverging sides. Adventitious lobe small, rounded, much less deep than ventral lobe. Two species. *Mississippian (lower Visean):* Russia (North Urals).——FIG. 19,*1a–c. *Q. bogoslovskyi*, holotype, Kozhim River, Komi, Nortnich Formation, PIN 2775/187; *a–b,* ×1.5; *c,* suture, whorl height at 11 mm, whorl width 7.8 mm, ×8.3 (Kuzina, 1974).

Family MUENSTEROCERATIDAE Librovich, 1957

[*nom. transl. et correct.* RUZHENTSEV, 1957, p. 57, *ex* Münsteroceratinae LIBROVICH, 1957, p. 263] [=Kozhimitidae KUZINA, 1974, p. 19; =Furnishoceratidae WORK & NASSICHUK in WORK, NASSICHUK, & RICHARDS, 2000, p. 46]

Conch form discoidal to thickly discoidal, involute, mostly with narrow to closed umbilicus. No prominent sculpture, in general linear to biconvex, simple, rarely crenistriate growth lines, sometimes combined with faint spiral ornamentation. Ventral lobe commonly with parallel or subparallel sides, rarely orad diverging; median lobe and saddle low. First lateral saddle usually rounded, sometimes subacute. [Kozhimitidae was erected for genera with conch form and sculpture similar to Girtyoceratidae but with muensteroceratid sutures. Furnishoceratidae is based on the character of the first lateral lobe, which is unusually

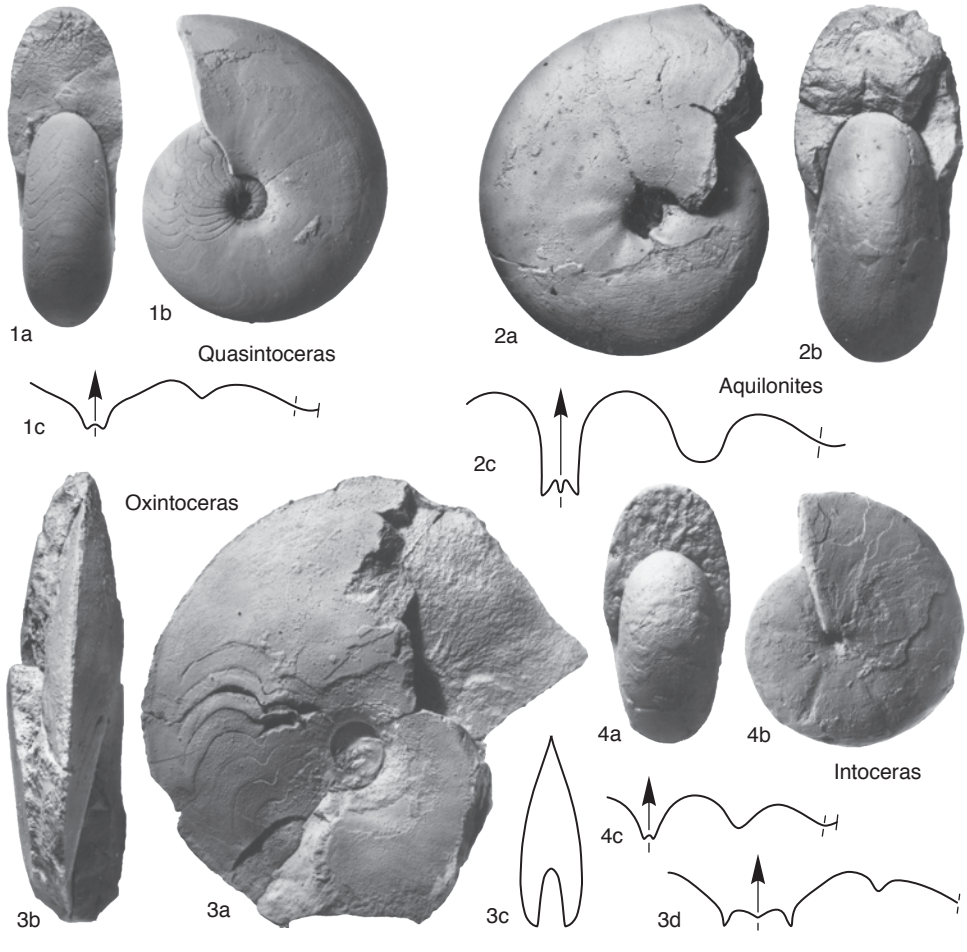

FIG. 19. Intoceratidae (p. 30).

deep and fanglike.] *Mississippian (middle Tournaisian–Serpukhovian [Kinderhookian–Chesterian]).*

Muensteroceras HYATT, 1884 in 1883–1884, p. 326 [**Goniatites Oweni* var. *parallela* HALL, 1860, p. 101; OD] [=*Pronannites* HAUG, 1898, p. 40 (type, *Goniatites inconstans* DE KONINCK, 1880, p. 120, OD, *non* PHILLIPS, 1841, p. 123, =*Muensteroceras koninckianum* SCHINDEWOLF, 1951a, p. 64, *nom. subst.*); =*Karakoramoceras* MILLER, 1931, p. 422 (type, *K. stoliczkai* MILLER, 1931, p. 423, OD); for discussion, see KULLMANN, 1961, p. 258]. Conch form discoidal to thickly discoidal; umbilicus moderately wide to narrow. Growth lines weak to strong, mostly biconvex and with ventrolateral salient. No coarse ornamentation. Ventral lobe narrow or moderately wide, its sides being more or less parallel; median saddle low, median lobe small. Many species, several species poorly known. *Mississippian (middle Tournaisian–lower Visean [Kinderhookian–Osagean]):* Russia (South Urals, North Urals), Kazakhstan (Karaganda), Belgium, Great Britain, Germany, Ireland, ?France, Spain, Algeria, Morocco, Poland, Kazakhstan, Kyrgyzstan (Tian Shan), China (Xinjiang), India (?Kashmir), Australia (New South Wales), USA (Arkansas, Alaska, Illinois, Indiana, ?Iowa, Kentucky, Michigan, Missouri, Virginia).——FIG. 20,*2a–d.* **M. parallelum* (HALL), Rockford, Jackson County, Indiana, Rockford limestone, Osagean; *a–c,* ×1 (Miller, Furnish, & Schindewolf, 1957); *d,* suture, based on small specimen, ×1.5 (Miller & Collinson, 1951; redrawn from Smith, 1903).

Beyrichoceratoides BISAT, 1924, p. 88 [**Goniatites implicatus* PHILLIPS, 1836, p. 235; OD] [?=*Eoglyphioceras* BRÜNING, 1923a, p. 264 (type, *Goniatites truncatus* PHILLIPS, 1836, p. 234, SD KORN, 1988b, p. 39)]. Conch form discoidal, with extremely narrow umbilicus. Growth lines noncrenulate,

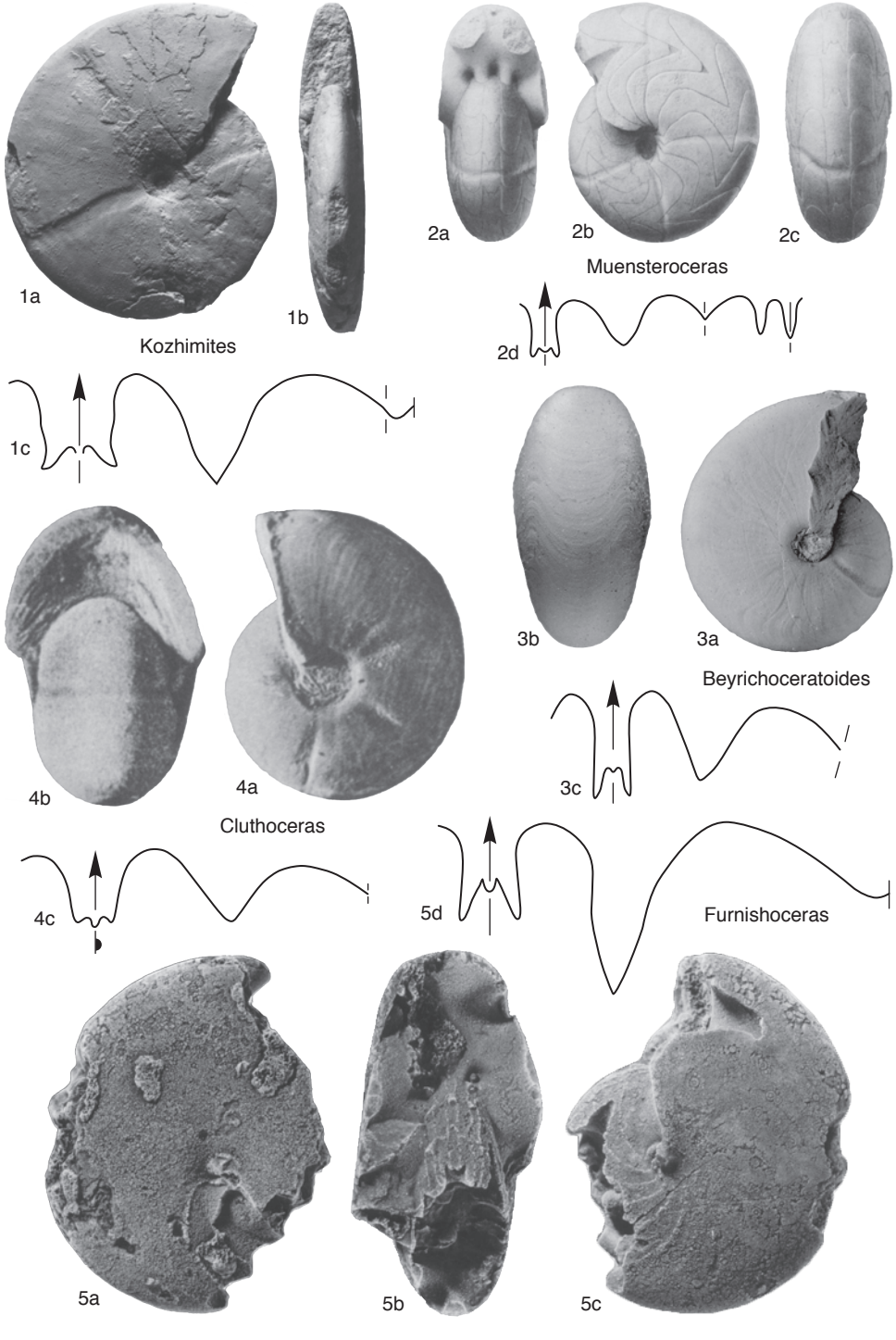

FIG. 20. Muensteroceratidae (p. 31–34).

biconvex, usually fine, with well-developed ventrolateral salient and deep hyponomic sinus; no spiral ornamentation. Constrictions may be present. Ventral lobe relatively narrow, with parallel, straight sides, and moderately low median saddle. First lateral saddle broadly rounded; adventitious lobe deep, almost symmetrical. Eight species. [Some authors regard *Eoglyphioceras* Brüning, 1923b, as being valid, instead of *Beyrichoceratoides* Bisat, 1924. Both genera were established on the basis of identical characteristics and arguments, naming the same species group (*truncatus* and *implicatus*) as being typical for the genus. Brüning (1923b) proposed to replace *Beyrichoceras* and *Muensteroceras* as an amalgamation of the former genera by erecting *Eoglyphioceras* with an unclear diagnosis; for discussion, see Ruzhentsev & Bogoslovskaia, 1971, p. 120; Riley, 1996, p. 31; S. V. Nikolaeva, personal communication, 2004.] *Mississippian (upper Tournaisian–upper Visean):* Great Britain, Ireland, Belgium, Germany, Czech Republic, Poland, Bulgaria, Algeria, Morocco, Russia (North Urals), USA (Kentucky).——Fig. 20,*3a–c. *B. implicatus* (Phillips), Oese, Rhenish Massif, Germany, lower *Goniatites* Zone, upper Visean, WMN 10009; *a–b,* ×2; *c,* suture of holotype *B. truncatus* Phillips, BMNH C240a, Bolland, Yorkshire, England, whorl height at 14.6 mm, ×1.6 (Korn, 1988b).

Cluthoceras Currie, 1954, p. 560 [**C. truemani;* OD]. Conch form small, ellipsoidal, with narrow umbilicus. Ornamentation with faint spirals. Constrictions present. Suture line primitive; sides of ventral lobe subparallel at its base, orad roundly diverging. Median lobe and saddle inconspicuous. More than ten species. [The phylogenetic relationship of *Cluthoceras* is uncertain. Some species may be based on juvenile specimens.] *Mississippian (upper Visean–Serpukhovian):* Great Britain, Poland, Algeria, China (Ningxia, Gansu), USA (Arkansas, Oklahoma).——Fig. 20,*4a–c. *C. truemani*, holotype, Index Limestone Shales, Scotland, *Eumorphoceras* Zone, Serpukhovian; *a–b*, Bishopbriggs, GLAHM 11161, ×3; *c*, suture, reversed, Kirkintilloch, GLAHM 11251, enlarged (Currie, 1954).

Dzhaprakoceras Popov, 1965a, p. 140 [**Muensteroceras tianshanicum* Librovich, 1927, p. 33; OD] [=*Muensteroceratoides* Popov, 1965b, p. 36 (type, *M. aksuensis* Popov, 1965b, p. 37, OD); =*Ouaoufilalites* Korn & others, 2003, p. 83 (type, *O. ouaoufilalensis* Korn & others, 2003, p. 84, OD)]. Conch form discoidal, rarely thickly discoidal, with narrow or very narrow umbilicus. Growth lines fine and biconvex, no spiral ornamentation; constrictions present in several species. Ventral lobe relatively wide, with subparallel or lyrately bent sides, orad slightly narrowed. Adventitious lobe somewhat pouched, pointed, usually larger than ventral lobe. More than ten species. [*Dzhaprakoceras* was placed in the family Maxigoniatitidae by Korn, Klug, and Mapes (1999, p. 348) because of the sinuous shape of the ventral lobe. *Muensteroceratoides* differs in minute details of the shape of the ventral lobe and strength of the growth striae. *Ouaoufilalites* exhibits a ventral lobe with slightly divergent sides and higher median lobe, regarded herein as being of specific significance.] *Mississippian (upper Tournaisian–lower Visean):* Great Britain, Ireland, Germany, Belgium, Russia (Novaia Zemlia, North Urals), Spain, Algeria, Morocco, China (Xinjiang, Yunnan), Mongolia, Iran, Kyrgyzstan (Tian Shan), USA (Arkansas, Kansas, Utah), Canada (British Columbia).——Fig. 21,*1a–c. *D. tianshanicum* (Librovich), upper Tournaisian; *a–b*, Kok-Dzhar, Eastern Moldo-Too, Reef Limestone, Tian Shan, Kyrgyzstan, VSEGEI 2789/86, ×1 (Popov, 1968); *c,* suture, Kaindy-Kardaly River, Dzhapry Formation, VSEGEI 2679/212, whorl height at 14 mm, whorl width 19 mm, enlarged, magnification not stated (Popov, 1968).

Eurites Kuzina, 1973, p. 21 [**E. latus* Kuzina, 1973, p. 22; OD]. Conch form thickly discoidal, with moderately narrow or wide umbilicus; adult whorl width exceeding two-thirds diameter. Ornamentation and suture line similar to *Muensteroceras.* More than ten species. *Mississippian (upper Tournaisian–lower Visean):* Belgium, Germany, Ireland, Wales, Portugal, Spain, Morocco, Algeria, Russia (North Urals), Canada, USA (Alaska).——Fig. 21,*2a. *E. latus,* suture of holotype, Kara River, North Urals, Russia, Kara Formation, upper Tournaisian, PIN 2775/167, whorl height at 11.8 mm, whorl width 28.6 mm, ×1.8 (Kuzina, 1980).——Fig. 21,*2b. E. corpulentissimus* (Schindewolf), Iberg-Winterberg, Bad Grund, Harz Mountains, Erdbach Limestone, Germany, lower Visean, Collection Fuhrmann, Clausthal, ×1.1 (Schindewolf, 1951a).

Furnishoceras Work & Nassichuk in Work, Nassichuk, & Richards, 2000, p. 46 [**F. heterolobatum;* OD]. Conch form subdiscoidal, with closed umbilicus and rounded venter; no constrictions. Ventral lobe with parallel flanks; median saddle almost half as high as entire lobe, prongs bluntly pointed. Ventrolateral saddle broadly rounded. First lateral lobe asymmetric and exceptionally deep, narrowly acuminate; umbilical lobe rounded. One species. *Mississippian (lower Visean [middle Osagean]):* Canada.——Fig. 20,*5a–d. *F. heterolobatum*; *a–c*, holotype, Mount Head Formation, east-central British Columbia, GSC 103227, ×3; *d*, paratype, suture, GSC 103232, diameter at 17 mm, magnification not stated (Work, Nassichuk, & Richards, 2000).

Itimaites Korn & Ebbighausen in Klug & others, 2006, p. 14 [**I. parabolicus* Korn & Ebbighausen in Klug & others, 2006, p. 15; OD]. Juvenile stage of conch pachycone with wide umbilicus, adult stage subdiscoidal with narrow umbilicus. Suture with broadly rounded ventrolateral saddle, median saddle reaching half height of entire ventral lobe, and asymmetric adventitious lobe. One species. [This genus is closely related to *Xinjiangites* and may be its junior synonym.] *Mississippian (?upper Visean):* Morocco.——Fig. 21,*4. *I. parabolicus*, holotype, Zrigat formation, southeastern Tafilalt,

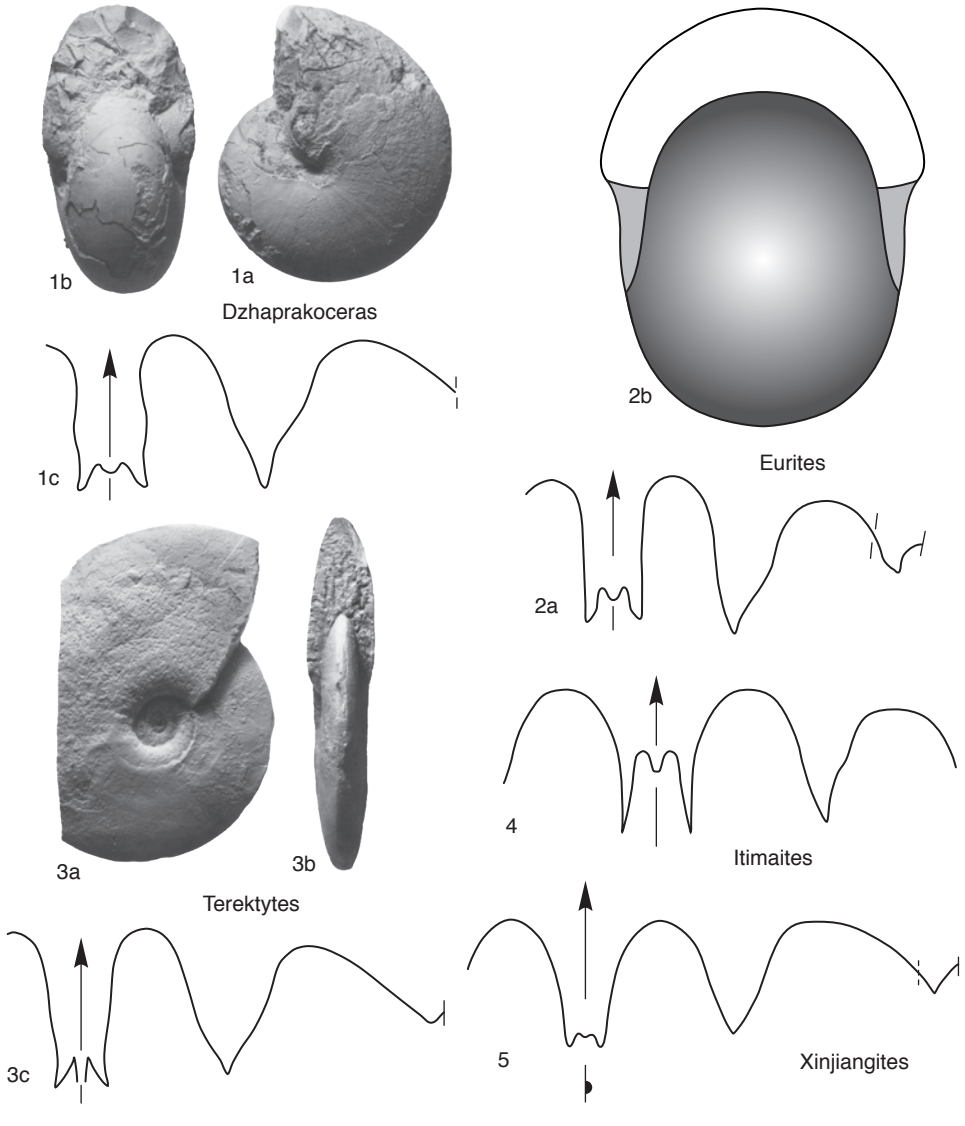

FIG. 21. Muensteroceratidae (p. 33–35).

MB.C.9086.1, diameter at about 55 mm, whorl height 21.5 mm, whorl width 24.8 mm, ×1.4 (Klug & others, 2006).

Kozhimites KUZINA, 1971, p. 43 [**K. planus;* OD]. Conch form discoidal, with very narrow umbilicus. Sculpture consisting of weakly curved lamellae; broad and fairly deep constrictions form unusual, high, ventral salient on internal mold. Ventral lobe wide, with almost parallel, slightly sinuous sides and rather low, broad median saddle. One species, one questionable species. [The phylogenetic relationship is uncertain for this genus, and it may belong to Girtyoceratidae.] *Mississippian (lower Visean):* Russia (North Urals), ?Wales. ——FIG. 20,*1a–c. *K. planus,* holotype, Kozhim River, Kos'vin Formation, North Urals; *a–b*, ×1; *c*, suture, PIN 2775/95, whorl height at 15 mm, whorl width 7.4 mm, ×2.8 (Kuzina, 1971).

?Nautellipsites PARKINSON, 1822, p. 164 [**Ellipsolites ovatus* SOWERBY, 1814, p. 83; M (for discussion of

status, see SPATH, 1934, p. 15)]. [Type species is poorly known. This genus may be a senior synonym of *Muensteroceras* or *Beyrichoceras.* For discussion, see MILLER and GARNER, 1955, p. 144; GORDON, 1965, p. 175. No illustrations of sufficiently preserved material are available for the holotype.] *Mississippian (Visean):* Ireland.

Terektytes LIBROVICH, 1957, p. 263 [**Muensteroceras acutum* LIBROVICH, 1940, p. 112; OD]. Conch form discoidal, with very narrow umbilicus. Ventral side narrowly rounded, later oxycone. Shell surface unknown. Ventral lobe very narrow, with weakly diverging sides and low median saddle. Adventitious lobe same length as ventral lobe. One or questionably two species. *Mississippian (upper Tournaisian):* ?Ireland, Kazakhstan (Karaganda). ——FIG. 21,*3a–c.* **T. acutus* (LIBROVICH), Terekty River, Karaganda, Kazakhstan, Terekty beds, PIN 3111/1; *a–b,* ×1; *c,* suture, whorl height at 15 mm, whorl width 6 mm, ×2.9 (Kuzina, 1971).

Xinjiangites RUAN, 1995b, p. 419 [**X. applanatus;* OD]. Conch form similar to *Muensteroceras,* discoidal and involute, with rounded ventral side and narrow umbilicus. Growth lines weak, convex. No coarse ornament. Ventral lobe narrow, with low median saddle. Sides of ventral lobe divergent and concave. Adventitious lobe V-shaped and acute. Seven species. [This genus is closely related to *Itimaites* and may be its senior synonym.] *Mississippian (middle Tournaisian–lower Visean):* USA (Missouri), Belgium, Great Britain, Ireland, Spain, Russia, China, Australia (New South Wales).——FIG. 21,*5.* **X. applanatus,* holotype, suture, reversed, Xinjiang, Eregennaren Hoboksar, China, Haishantou Formation, middle Tournaisian, Nanjing 108711, whorl width at 15.2 mm, ×2.5 (Ruan, 1995b).

Family MAXIGONIATITIDAE Korn, Klug, & Mapes, 1999

[Maxigoniatitidae KORN, KLUG, & MAPES, 1999, p. 348]

Conch involute, mainly subdiscoidal; ornamentation fine, with biconvex, sometimes crenulated growth lines or fine spiral lines, but no ribbing. Ventral lobe V-shaped, with sinuous flanks and moderately low median saddle; prongs inflexed outward, their apical points diverging apicad. *Mississippian (Tournaisian–Visean).*

Maxigoniatites KORN, KLUG, & MAPES, 1999, p. 350 [**Goniatites maximus saourensis* PAREYN, 1961, p. 146; OD]. Conch large, moderately evolute in early growth stage, involute in adult stage. Four species. *Mississippian (Visean):* Great Britain, Germany, Belgium, Portugal, Spain, Morocco, Algeria, Australia (Queensland).——FIG. 22,*1a–c.* **M. saourensis* (PAREYN), 12 km southeast of Dar Kaoua Oasis, Morocco, ?lower upper Visean; *a–b,* GPIT 1851-26, ×1; *c,* suture, GPIT 1851-25, whorl height at 16.5 mm, whorl width 24.6 mm, ×1.6 (Korn, Klug, & Mapes, 1999).

Beyrichoceras FOORD, 1903, p. 219 [**Goniatites obtusus* PHILLIPS, 1836, p. 234; SD BISAT, 1924, p. 84]. Conch form discoidal, with very narrow umbilicus, similar to *Bollandoceras.* Ornamentation sometimes crenulate, constrictions may be present. Ventral lobe relatively wide, its sides orad divergent, sometimes slightly sinuous. First lateral saddle narrowly rounded to subacute; adventitious lobe V-shaped and symmetrical, with convex sides, pointed. Many species. [*Beyrichoceras* is regarded by some authors as belonging to Muensteroceratidae.] *Mississippian (Visean [Beyrichoceras Zone–lower Goniatites Zone, Meramecian]):* Belgium, Great Britain, Germany, Ireland, Poland, Russia (Novaia Zemlia), South Urals, Iran, Kazakhstan (Karaganda), Portugal, Spain, Algeria, Morocco, USA (Alaska, Missouri).——FIG. 22,*4.* **B. obtusum* (PHILLIPS), suture of holotype, Black Hall, Bolland, Pendleside Limestone, England, lower *Goniatites* Zone, upper Visean, ×3.3 (Bisat, 1924).

Bollandites BISAT, 1952, p. 164 [**Beyrichoceratoides castletonensis* BISAT, 1924, p. 92; OD]. Conch form discoidal to thickly discoidal; umbilicus moderately wide to narrow. Ornamentation consisting of noncrenulate biconvex transverse striae, relatively strong in some species. Constrictions and ventral grove may be present; no spiral ornamentation. Ventral lobe with very low median saddle and rather narrow, at its base as in *Muensteroceras;* sides subparallel in apicad half, diverging orad. Tips of branches of ventral lobe not diverging. First lateral saddle broadly rounded. Adventitious lobe symmetrical and wide, with more or less sinuous sides including a broad angle, lying almost in line with basis of ventral lobe. Twelve species. *Mississippian (Tournaisian–Visean):* Belgium, Germany, England, Wales, Ireland, Portugal, Algeria, Poland, Russia (North Urals), Ukraine, China (Yunnan), Australia (New South Wales, Queensland), USA (Alaska). ——FIG. 22,*3a–b.* **B. castletonensis* (BISAT), upper Visean, upper *Beyrichoceras* Zone, England; *a,* Cracoe Reef Limestone, Elbolton, BGS 53584, ×3 (Bisat, 1934); *b,* suture, diameter at 20 mm, Treak Cliff, Castleton, ×3.6 (Bisat, 1924).

Bollandoceras BISAT, 1952, p. 164 [**Beyrichoceras submicronotum* BISAT, 1934, p. 291; OD; =*Goniatites micronotus* PHILLIPS, 1836, p. 234, subj.]. Conch form discoidal to thickly discoidal; umbilicus narrow to punctiform. Ornamentation consisting of noncrenulate biconvex transverse striae; no spirals. Constrictions present in most species. Ventral lobe rather narrow at its base, with low median saddle. Sides of ventral lobe subparallel at the base as in *Beyrichoceras,* but diverging orad with wide angle; first lateral saddle rounded to spatulate. Adventitious lobe moderately wide and sometimes with small basal nipple. Four species. [This genus is transitional to *Beyrichoceras* but lacks spiral ornamentation. Sufficiently preserved material of the type

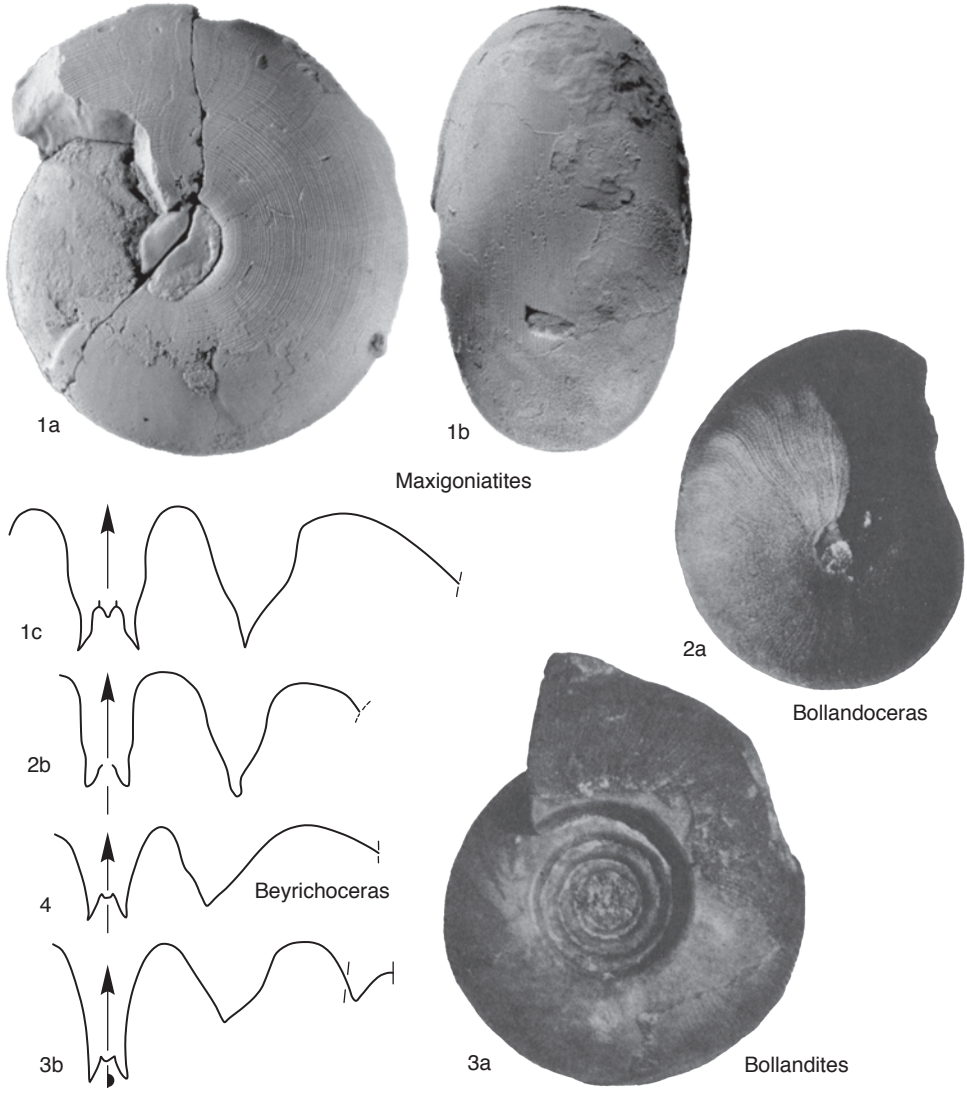

FIG. 22. Maxigoniatitidae (p. 35–36).

species was published after deadline for submission of manuscripts.] *Mississippian (Tournaisian–Visean):* Germany, Russia (North Urals), China (Yunnan), Belgium, Great Britain, Ireland, Morocco, Algeria, Ukraine, Kazakhstan (Karaganda), Kyrgyzstan (Tian Shan), Mongolia, Australia (Queensland), USA (Alaska).——FIG. 22,*2a. B. micronotoide* (BISAT), Grassington, England, upper Visean, upper *Beyrichoceras* Zone, BGS 53531, ×3 (Bisat, 1934).——FIG. 22,*2b. B. hodderense* (BISAT), Ashnott, Crag Beck, England, upper Visean, upper *Beyrichoceras* Zone, BGS Ro5190, suture, whorl height at 12.2 mm, whorl width 13.6 mm, reversed, magnification not stated (Riley, 1996).

NOMISMOCERATOIDEA

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Superfamily NOMISMOCERATOIDEA Librovich, 1957

[*nom. transl.* RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 161, *ex* Nomismoceratidae LIBROVICH, 1957, p. 265]

Conch form generally small, thin-discoidal, vermiculate, with wide umbilicus; advanced genera thickly discoidal and rather involute. Some forms with tetragonal or irregular coiling of inner whorls. Shell surface smooth or ornamented with simple or divaricate ribs. Growth lines with ventrolateral salient and well-developed ventral sinus. Longitudinal lirae or ventrolateral grooves may be present. Ventral lobe moderately wide, with rather low median saddle. First lateral saddle and adventitious lobe rounded, rarely pointed. Sutural formula ($E_1E_mE_1$)ALUI [German], (V_1V_1)LU:ID [Russian]. *Mississippian (upper Tournaisian–upper Serpukhovian).*

Family NOMISMOCERATIDAE Librovich, 1957

[Nomismoceratidae LIBROVICH, 1957, p. 265]

Shell surface smooth. No tetragonal coiling of inner whorls. *Mississippian (upper Tournaisian–upper Serpukhovian [Meramecian–Chesterian]).*

Nomismoceras HYATT, 1884 in 1883–1884, p. 330 [**Goniatites spirorbis* PHILLIPS, 1836, p. 237; SD FOORD & CRICK, 1897, p. 212; =*Goniatites vittiger* PHILLIPS, 1836, p. 237, subj.]. Conch form discoidal or lenticular. Ventral side rounded, in adult stage frequently flattened. Umbilicus extremely wide to moderately wide. Ornamentation fine or coarse, prorsiradiate, biconvex, and with long ventrolateral salient. Ventrolateral grooves and constrictions may be present; no spiral ornamentation. Ventral lobe relatively wide and V-shaped, with low median saddle; adventitious lobe symmetrical and deep, usually rounded. Six species. *Mississippian (upper Visean–lower Serpukhovian):* Belgium, Great Britain, Germany, Czech Republic, Ireland, France, Algeria, Poland, Russia (Novaia Zemlia), Ukraine, South Urals, Uzbekistan, China (Xizang), ?Laos, USA (Arkansas).——FIG. 23,*1a–b. *N. vittiger* (PHILLIPS), South Urals, Kazakhstan; *a,* suture, Dombar Hills, upper Visean, PIN 455/5798, whorl height at 4 mm, whorl width 2.4 mm, ×7.8; *b,* cross section, Kzyl-Shin Canyon, lower Serpukhovian, PIN 1721/500, ×5 (Ruzhentsev & Bogoslovskaia, 1971).——FIG. 23,*1c. N. frechi* SCHMIDT, side view, Weitengrund, Rhenish Massif, Germany, upper Visean, ×2 (Schmidt, 1925).

Beleutoceras RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 164 [**B. carinatum* RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 165; OD]. Conch form discoidal, venter on adult stage oxycone. Umbilicus moderately wide. Ornamentation as in *Nomismoceras,* coarse, prorsiradiate, biconvex, and with long ventrolateral salient, but with spiral ornamentation. Ventral lobe relatively wide and V-shaped, with moderately high median saddle; adventitious lobe symmetrical, wide, and acute. One species. *Mississippian (lower Serpukhovian):* Kazakhstan (Karaganda).——FIG. 23,*2. *B. carinatum,* cross section, Zhide river, PIN 2493/6, ×5 (Ruzhentsev & Bogoslovskaia, 1971).

?Cavilentia RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 166 [**C. tenuicula;* OD] [?=*Applanoceras* YANG, 1986, p. 261 (type, *A. epichare,* OD)]. Conch form discoidal, with narrowly rounded venter, umbilicus moderately wide. Ornamentation with fine growth lines, no constrictions, grooves, or spiral lirae. Ventral lobe wide, with low median saddle; first lateral saddle broadly rounded, adventitious lobe deep and rounded. One or two species. [The holotype may be an immature specimen; its relationship is uncertain. *Applanoceras* is also based on very small specimens that differ in their subacute adventitious lobe.] *Mississippian (upper Serpukhovian):* Russia (Novaia Zemlia, South Urals), China (?Ningxia).——FIG. 23,*3a–b. *C. tenuicula,* Verkha Island, Novaia Zemlia, Russia, Verkha limestone, PIN 4279/160; *a,* cross section, ×2.7; *b*, suture, whorl height at 7.0 mm, whorl width 3.6 mm, ×6.5 (Kuzina & Yatskov, 1999).

Eonomismoceras KUZINA, 1974, p. 28 [**E. shevyrevi* KUZINA, 1974, p. 29; OD]. Conch small, discoidal, with wide umbilicus; venter rounded. Growth lines biconvex, with strong ventrolateral salient. Ventral lobe rather narrow, with almost parallel sides. Adventitious lobe deep, almost subacute. Only type species. [This genus is transitional to *Pseudonomismoceras* and *Nomismoceras* and may be a junior synonym of one of these genera.] *Mississippian (lower Visean):* Great Britain, Russia (North Urals).——FIG. 23,*5a–c. *E. shevyrevi*, Kos'vin Formation, Kozhim River, Komi, North Urals; *a–b*, holotype, PIN 2775/349, ×1.5; *c*, suture, PIN 2775/348, whorl height at 3.0 mm, whorl width 3.1 mm, ×9.9 (Kuzina, 1974).

Pseudonomismoceras FRECH, 1899, p. 285 [**P. silesiacus* FRECH, 1899, p. 310; M]. Conch form thin-discoidal, vermicular, with extremely wide umbilicus. Strong growth lines, with ventrolateral salient crossing venter without ventral sinus; weak

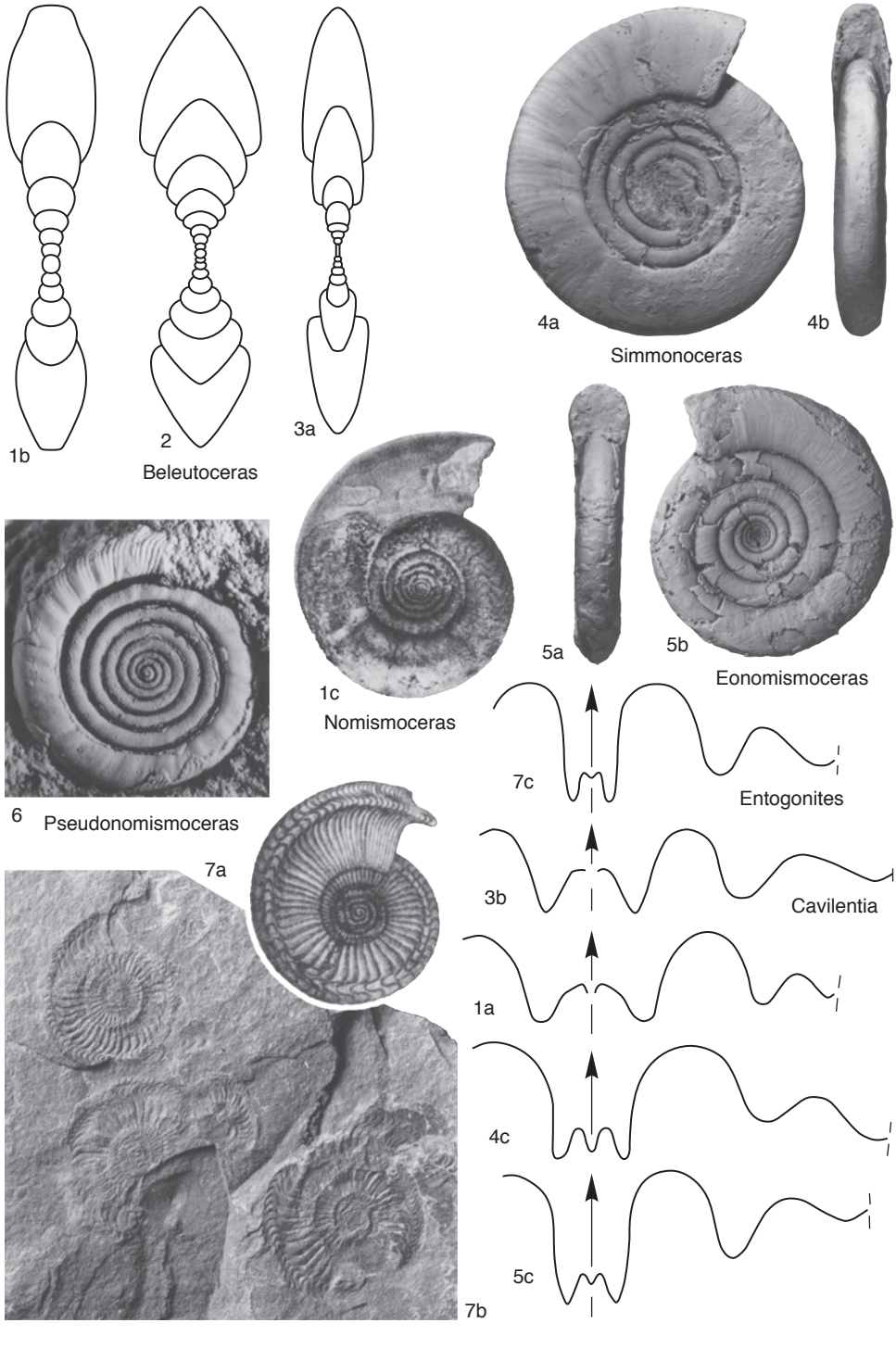

FIG. 23. Nomismoceratidae and Entogonitidae (p. 37–39).

ribbing on flanks of last whorl. Three species. [The type species is poorly known: the holotype, the only known specimen, measures 8 mm in diameter; the suture is only partly known.] *Mississippian (upper Tournaisian–Visean):* Germany, Poland, Australia (Queensland).——Fig. 23,*6. *P. silesiacus*, holotype, Hausdorf, Lower Silesia, Poland, upper Visean, ×5 (Weyer, new).

Simmonoceras Kuzina, 1974, p. 29 [**S. atratum* Kuzina, 1974, p. 30; OD]. Conch discoidal, moderately involute, with rather wide umbilicus. Sculpture consisting of weak riblets; constrictions present. Ventral lobe relatively wide, but not deep, with rounded sides. Adventitious lobe very small and rounded. [Only the holotype of the type species is known for this genus.] *Mississippian (?upper Tournaisian):* Russia (North Urals).——Fig. 23,*4a–c. *S. atratum,* holotype, Tschernyi river basin, Komi, Nortrich Formation, PIN 2775/356; *a–b,* ×1.5; *c,* suture, whorl height at 5.5 mm, whorl width 4.2 mm, ×5.9 (Kuzina, 1974).

Family ENTOGONITIDAE Ruzhentsev & Bogoslovskaia, 1971

[Entogonitidae Ruzhentsev & Bogoslovskaia, 1971, p. 166]

Shell surface with prominent dichotomizing ribs. Inner whorls tetragonal. *Mississippian (upper Visean).*

Entogonites Kittl, 1904b, p. 322, *nom. nov. pro Tetragonites* Kittl, 1904a, p. 677, *non* Kossmat, 1895, p. 131 [**Tetragonites grimmeri* Kittl, 1904a, p. 677; M] [=*Kittliella* Frech, 1906, p. 41, *nom. nov. pro Tetragonites* Kittl, 1904a, p. 677, *non* Kossmat, 1895, p. 131, *nom. van.;* =*Brannerоceratoides* Kullmann, 1962, p. 88 (type, *Gastrioceras (B.) tetragonum,* OD)]. Conch form thin-discoidal, evolute, with moderately wide umbilicus; venter well rounded. Inner whorls tetragonal. Sculpture consisting of prominent ribs, dichotomizing on flanks or ventrolateral, with ventrolateral salient and deep ventral sinus. Ventral lobe relatively narrow and parallel sided, with a low median saddle and roundly diverging sides; first lateral saddle broadly rounded. Adventitious lobe small and deep, narrowly rounded. Three species. [The suture of the type species is unknown for this genus.] *Mississippian (upper Visean):* Bosnia, Serbia, Great Britain, Ireland, Germany, Czech Republic, Poland, Morocco, USA (Alaska, Utah).——Fig. 23,*7a–b. *E. grimmeri* (Kittl), Prača, Sarajewo, Bosnia, lower upper Visean; *a,* side view (Kittl, 1904a); *b,* slab with specimens, MGBW 1900H, ×1.8 (Kullmann, new).——Fig. 23,*7c. E. borealis* Gordon, suture, Alapah limestone, Kirktagiak River, Brooks Range, Alaska, Meramecian, USNM 118984, diameter at 12 mm, ×6 (Gordon, 1957).

DIMORPHOCERATOIDEA

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Superfamily DIMORPHOCERATOIDEA Hyatt, 1884

[*nom. transl. et correct.* Miller & Furnish, 1954, p. 687, *ex* Dimorphocerae Hyatt, 1884 in 1883–1884, p. 330]

Conch form in general thickly discoidal to discoidal, rarely lenticular; umbilicus moderately narrow or closed. Ventral lobe wide, with relatively narrow prongs; height of median saddle rarely exceeding half the height of entire ventral lobe. Branches of ventral and adventitious lobes may be subdivided or denticulate, but not tridentate. *Mississippian (upper Tournaisian)–Pennsylvanian (Moscovian).*

Family DIMORPHOCERATIDAE Hyatt, 1884

[*nom. correct.* Miller & Furnish, 1954, p. 687, *ex* Dimorphocerae Hyatt, 1884 in 1883–1884, p. 330]

Conch completely involute. Sculpture consisting only of growth lines, sometimes with delicate spiral ornamentation. Ventral lobe becoming extremely wide by subdivision. Adventitious lobe simple (subfamily Dimorphoceratinae) or subdivided (subfamily Glyphiolobinae). *Mississippian*

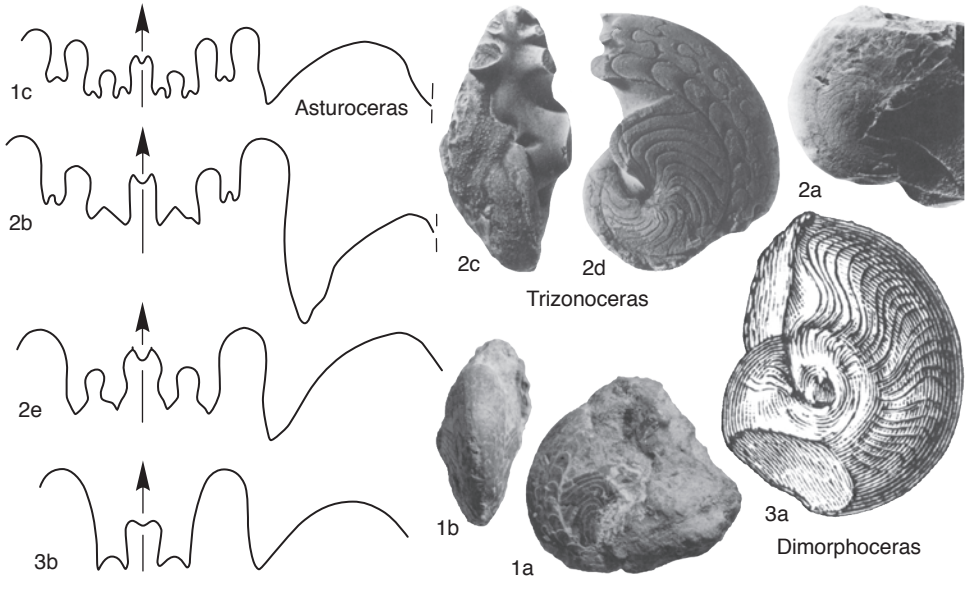

FIG. 24. Dimorphoceratidae (p. 40).

(?upper Tournaisian, Visean)–Pennsylvanian (Moscovian).

Subfamily DIMORPHOCERATINAE Hyatt, 1884

[*nom. transl. et correct.* RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 60, *pro* Dimorphocerae HYATT, 1884 in 1883–1884, p. 330]

Only ventral lobe subdivided. Adventitious lobe simple, pointed. *Mississippian (?upper Tournaisian, Visean–Serpukhovian).*

Dimorphoceras HYATT, 1884 in 1883–1884, p. 331 [**Goniatites Gilbertsoni* PHILLIPS, 1836, p. 236; SD FOORD & CRICK, 1897, p. 219]. Ventral lobe with bidentate branches. Five species. *Mississippian (?upper Tournaisian, Visean):* Germany, USA (Alaska), ?Belgium, Great Britain, Ukraine, Algeria, Morocco.——FIG. 24,*3a–b.* **D. gilbertsoni* (PHILLIPS); *a,* holotype, Yorkshire, England, ?upper Visean, Gilbertson Collection BMNH, ×2 (Foord & Crick, 1897); *b,* suture, Bowland Shales, upper Visean, ×2.8 (Moore, 1930).

Asturoceras RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 60 [**Trizonoceras subdivisum* KULLMANN, 1962, p. 29; OD]. Similar to *Trizonoceras*, but ventral lobe consisting of six bifid branches. Sutural formula: ($E_{1d}E_{1vd}E_{1v2}E_mE_{1v2}E_{1vd}E_{1d}$)AL:UI [German], $V_{1.1}(V_{1.2.1}V_{1.2.1}V_{1.2.1})V_{1.1}$LU:ID [Russian]. Two species. *Mississippian (upper Serpukhovian):* Great Britain, Spain.——FIG. 24,*1a–c.* **A. subdivisum* (KULLMANN), holotype, Perlora, Tudela Veguín quarry, grey limestones, Arnsbergian, Spain, GPIT 1206/99; *a–b*, ×1; *c*, suture, ×3 (Kullmann, 1962).

Trizonoceras GIRTY, 1909, p. 70 [**T. typicale;* OD]. Similar to *Dimorphoceras*, but ventral lobe developing four branches regularly; ventrad ones always bifid, dorsad elements may be bifid. Basic sutural formula: ($E_{1d}E_{1v}E_mE_{1v}E_{1d}$)AL:UI [German], ($V_{1.1}V_{1.2}V_{1.2}V_{1.1}$)LU:ID [Russian]. Many species. *Mississippian (upper Visean–Serpukhovian):* Ireland, Algeria, Russia (Novaia Zemlia), Kazakhstan (South Urals), Tajikistan, China (Guangxi, Ningxia), USA (Arkansas, Oklahoma).——FIG. 24,*2a–b.* **T. typicale*, holotype, Caney Shales, Antler, Oklahoma, middle Chesterian, USNM 119598; *a*, side view, ×6; *b*, suture, diameter at 8.4 mm, ×9 (Manger & Pareyn, 1979).——FIG. 24,*2c–d. T. horreitense* MANGER & PAREYN, holotype, Ain el Mizab Formation, Djebel Horreit, Algeria, UA 77-217-1, ×3 (Manger & Pareyn, 1979).——FIG. 24,*2e. T. kathleenae* (MOORE), suture, northeastern slope of Dough Mountain, 3.2 km south-southwest of Kiltyclogher, County Leitrim, Ireland, upper Visean, GSM Z1.5643, corrected by RUZHENTSEV & BOGOSLOVSKAIA (1969a, fig. 1b), ×3.3 (Moore, 1958).

Subfamily GLYPHIOLOBINAE Ruzhentsev & Bogoslovskaia, 1969

[Glyphiolobinae RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 61]

Conch thickly discoidal to subglobose. Not only ventral lobe, but also adventitious lobe subdivided. Subdivisions sometimes irregular or denticulate. *Mississippian (upper Visean)–Pennsylvanian (Moscovian).*

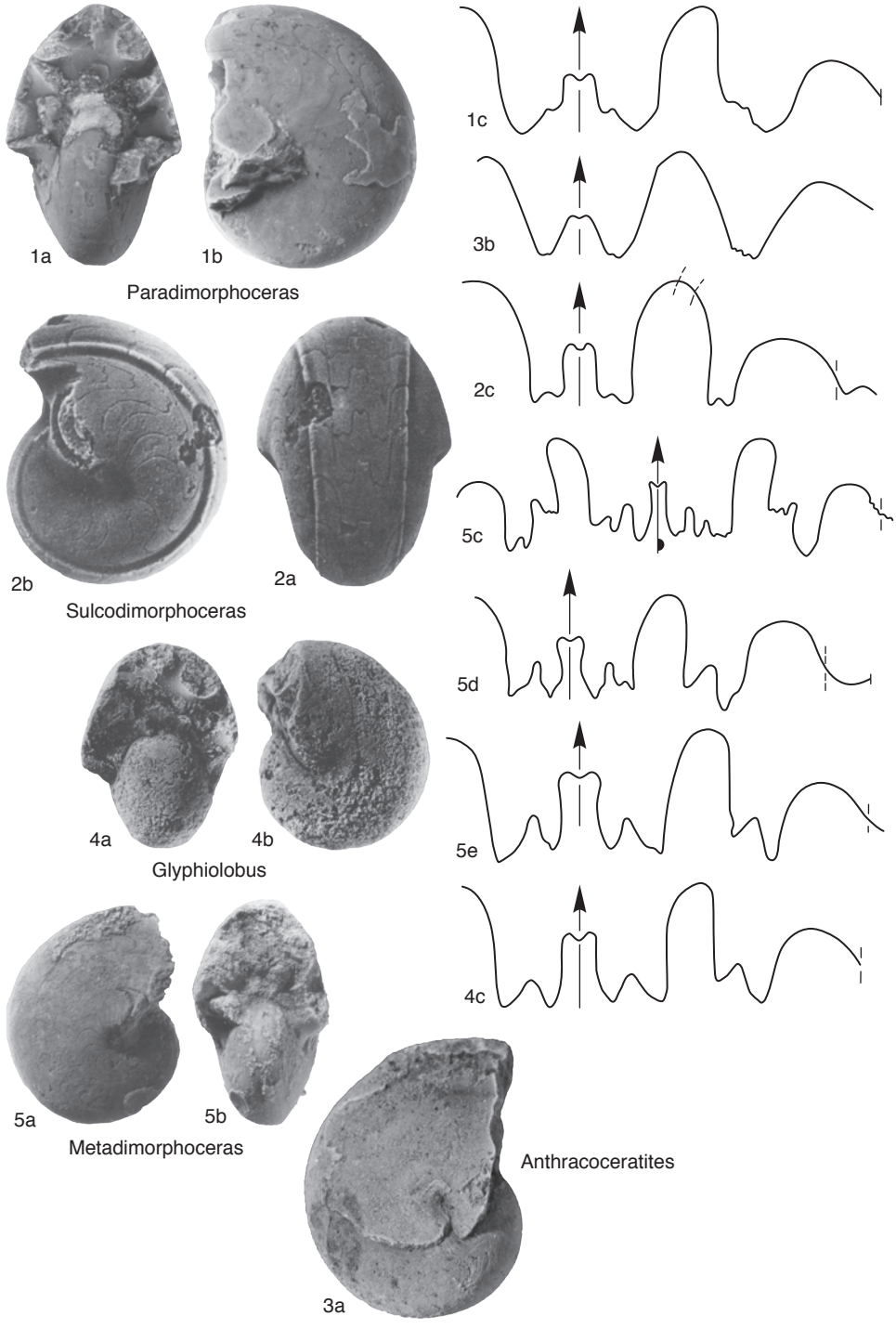

FIG. 25. Dimorphoceratidae (p. 42).

Glyphiolobus GORDON, 1965, p. 280 [**Trizonoceras lepidum* GIRTY, 1909, p. 71; OD] [=*Currieoceras* MANGER, 1988, p. 32 (type, *Dimorphoceras marioni* MOORE, 1939, p. 120, OD)]. Ventral and adventitious lobes both twice subdivided; no denticulation. Sutural formula: $(E_{1d}E_{1v}E_mE_{1v}E_{1d})(A_vA_d)$L:UI [German], $(V_{1.1}V_{1.1}V_{1.1}V_{1.1})(L_2L_1)$U:ID [Russian]. Many species. [This genus is transitional to *Metadimorphoceras* and may be its junior synonym; for discussion, see MANGER and QUINN, 1972, p. 305. *Currieoceras* was established for species with bifid ventral prongs and lateral lobe, in which the subdivisions are low and restricted to the tips of sutural elements; these characters are regarded herein as being of specific rather than generic significance.] *Mississippian (upper Visean)–Pennsylvanian (lower Bashkirian [Yeadonian]):* Belgium, Czech Republic, Great Britain, Ireland, Germany, Poland, Ukraine, Portugal, Russia (South Urals, Novaia Zemlia), China (Gansu, Xinjiang, Ningxia), Kazakhstan (South Urals), Tajikistan, Uzbekistan, USA (Arkansas, Kentucky, Nevada, Oklahoma).——FIG. 25,*4a–c. *G. lepidus* (GIRTY), holotype, Caney Shale, Oklahoma, upper Chesterian, GSNM 119599; *a,* apertural view, ×9.7; *b,* side view, ×10.2; *c,* suture, diameter at 6.3 mm, ×7.8 (Manger, new).

Anthracoceratites RAMSBOTTOM, 1970, p. 57 [**A. deansi;* OD]. Growth lines biconvex; rather prominent ventrolateral salient on flanks. Lobes have tendency to become denticulate. Eight species. [The assignment of this genus to the family Dimorphoceratidae is questionable; for discussion, see RUZHENTSEV and BOGOSLOVSKAIA, 1978, p. 129.] *Pennsylvanian (Bashkirian–Moscovian [Duckmantian]):* Belgium, Great Britain, Germany, Netherlands, Portugal, Russia (South Urals), Ukraine (Donets), Algeria, Morocco, Uzbekistan.——FIG. 25,*3a–b. *A. deansi; a,* holotype, side view, Rombalds Moor, England, Yorkshire, borehole depth 140 m, IGSL LZ 3597, Marsdenian, ×4; *b,* suture of holotype, diameter at 10 mm, magnification not stated (Ramsbottom, 1970).

Metadimorphoceras MOORE, 1958, p. 222 [**Goniatites splendidus* BROWN, 1841, p. 215; OD]. Similar to *Glyphiolobus*, but with tertiary subdivision of ventrad and dorsad portions of ventral lobe. Many species. Adventitious lobe deeper than ventral lobe. [Some authors (e.g., RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 192; RUAN, 1981b, p. 208) regard *Metadimorphoceras* as a junior synonym of *Paradimorphoceras* RUZHENTSEV, 1947a.] *Mississippian (upper Visean [Arnsbergian])–Pennsylvanian (lower Bashkirian [Kinderscoutian]):* Great Britain, Belgium, Germany, Ireland, Portugal, Algeria, Morocco, Czech Republic, Poland, Russia (Novaia Zemlia), Russia and Kazakhstan (South Urals), China (Gansu, Guangxi, Guizhou, Ningxia), Tajikistan (Pamirs), Uzbekistan, USA (Arkansas).——FIG. 25,*5a–c. *M. splendidum* (BROWN), holotype, lower Bashkirian, Kinderscoutian, Millstone Grit, R_1, Manchester Museum L10242, England; *a–b,* ×3 (Manger, new); *c,* suture, diameter at 9.7 mm, magnification not stated (Manger, 1988).——FIG. 25,*5d. M. wiswellense* (MOORE), suture, upper Fayetteville Shale, Town Branch, Fayetteville, Arkansas, Chesterian, SUI 35058, ×5.3 (Manger & Quinn, 1972).——FIG. 25,*5e. M. pseudodiscrepans* (MOORE), Batesville, Arkansas, Ruddel Member, Moorefield Shale, Chesterian, SUI 35065, suture, diameter at 8.9 mm, ×6 (Manger & Quinn, 1972).

?Paradimorphoceras RUZHENTSEV, 1947a, p. 522 [**Goniatites looneyi* PHILLIPS, 1836, p. 236; OD]. Conch form similar to *Anthracoceras*. Branches of ventral lobe bifid; adventitious lobe irregularly subdivided. Adventitious lobe never deeper than ventral lobe. One species, one questionable. [Judging from the neotype, selected by MOORE, 1939, p. 123 and officially confirmed by MOORE, 1958, p. 222, the type species may have closer affinities to anthracoceratids than to dimorphoceratids (W. L. MANGER, personal communication, 1985)]. *Mississippian (Serpukhovian):* Belgium, Great Britain, China (?Xinjiang).——FIG. 25,*1a–c. *P. looneyi* (PHILLIPS), lectotype (MOORE, 1958, p. 222), Crimsworth Dean near Hebden Bridge, Yorkshire, England, Millstone grit, Kinderscoutian, IGS (GSM) 70235; *a–b,* ×6; *c,* suture, ×10 (Manger, new).

Sulcodimorphoceras MANGER & PAREYN, 1979, p. 663 [**S. sedraense;* M]. Conch form subglobular, with very small umbilicus. Sculpture consisting of two ventrolateral sulci separated by a narrow, rounded ridge. Ventral lobe with shallowly bifid ventral prongs and bifid adventitious lobe. One species. [Only the holotype is known and is an immature specimen 5.4 mm in diameter.] *Mississippian (lower Serpukhovian):* Algeria.——FIG. 25,*2a–c. *S. sedraense,* holotype, Ain el Mizab Formation, Gadet Sedra, Cirque d'El Guelmouna, UA 77-217-3; *a–b,* ×7.5; *c,* suture, diameter at 5 mm, ×9.2 (Manger & Pareyn, 1979).

Family GIRTYOCERATIDAE Wedekind, 1918

[*nom. transl.* RUZHENTSEV, 1957, p. 57, *ex* Girtyoceratinae WEDEKIND, 1918, p. 139, *nom. nov. pro* Adelphoceratidae WEDEKIND, 1914, p. 10, *nom. oblit.*]

Conch form subdiscoidal to subglobular, moderately to completely involute, with moderately wide to small umbilicus. Sculpture variable within wide range: transverse striae prominent or weak, usually with ventrolateral salient and ventral sinus. Constrictions common. Longitudinal lirae or ventrolateral grooves may be present. Ventral lobe moderately wide to wide, with diverging sides; first lateral saddle usually well rounded, rarely pointed. Sutural formula: $(E_1E_mE_1)$AL:UI [German], (V_1V_1)LU:ID [Russian]. *Mississippian (upper Tournaisian)–Pennsylvanian (lower Bashkirian).*

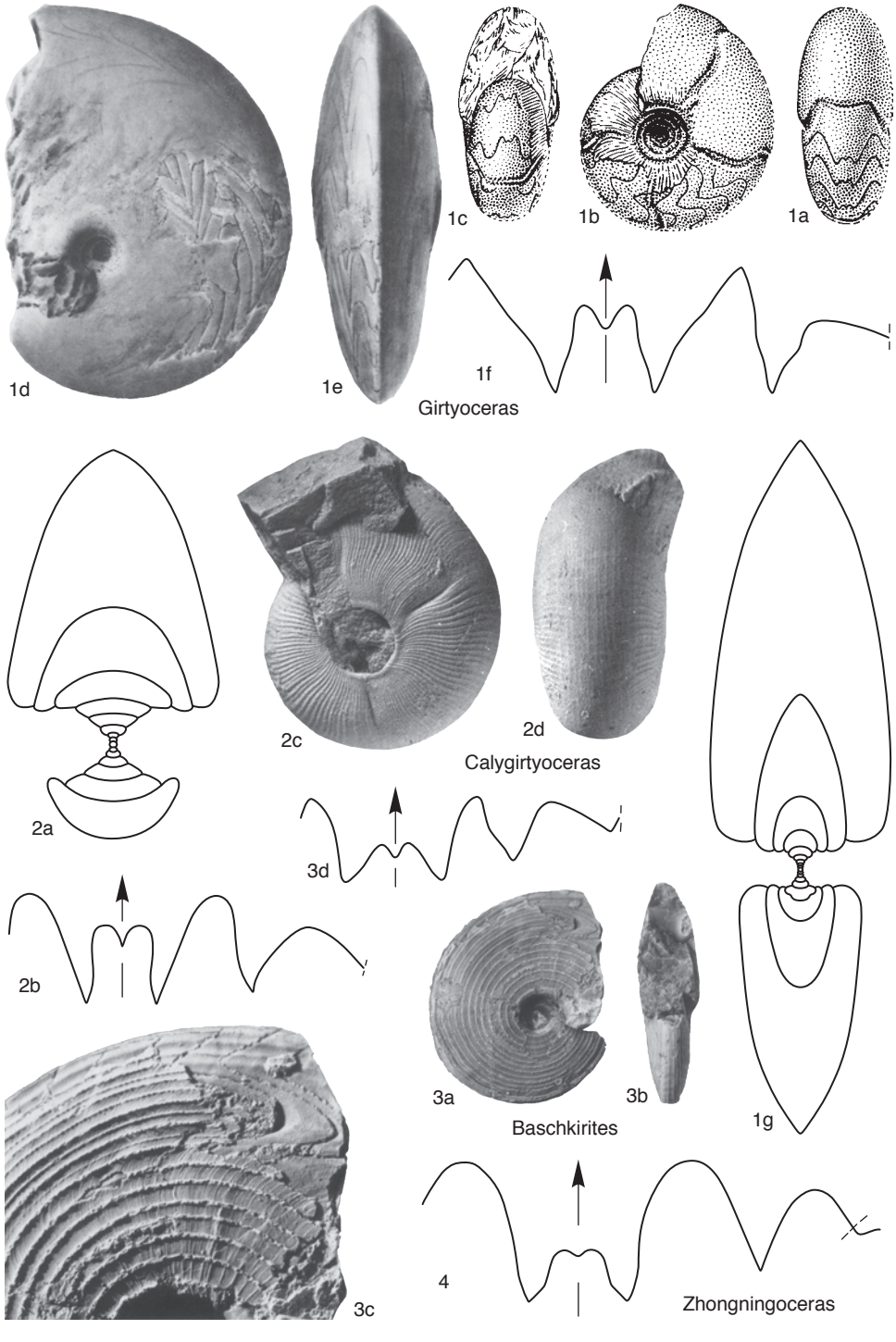

FIG. 26. Girtyoceratidae (p. 44–48).

Subfamily GIRTYOCERATINAE Wedekind, 1918

[Girtyoceratinae Wedekind, 1918, p. 139] [=Baschkiritinae Ruzhentsev, 1960d, p. 204]

Ventral lobe with widely diverging sides, in advanced genera generally wide. Adventitious lobe pointed, asymmetric. [Baschkiritinae comprise advanced genera with moderately involute shell form and subacute or acute sutural elements.] *Mississippian (upper Tournaisian)–Pennsylvanian (lower Bashkirian).*

Girtyoceras Wedekind, 1918, p. 140, *nom. nov. pro Adelphoceras* Girty, 1909, p. 64, *non* Hyatt, 1883–1884, p. 285 [**Adelphoceras meslerianum* Girty, 1909, p. 66; OD] [=*Sagittoceras* Hind, 1918, p. 446 (type, *S. acutum,* M), for discussion, see Gordon, 1965, p. 227; =*Dryochoceras* Morgan, 1924, p. 185 (type, *D. brainerdi,* M), for discussion, see Miller, 1934b, p. 31; =*Cowdaleoceras* Bisat, 1952, p. 166 (type, *C. difficile,* OD, *teste* Riley, 1990a, p. 152); =*Jeminayceras* Wang, 1983, p. 520 (type, *J. heishantouense,* OD)]. Conch form in young stages with wide umbilicus and low whorl section, later with small umbilicus; tendency to form an acute venter in relatively young stages. Shell surface in young stages commonly smooth, later temporarily ribs or umbilical nodes; constrictions may be present. No ventrolateral grooves. Ventral lobe wide, with rounded or straight diverging sides; median saddle reaching about half height of ventral lobe. First lateral saddle narrowly rounded, sometimes spatulate. Adventitious lobe moderately deep, pointed, and relatively wide. Many species. [*Cowdaleoceras* was erected for forms with a moderately high ventral lobe, its sides being subparallel at the base, but with a diverging orad with wide angle; the first lateral saddle is spatulate, with subacute tip. These characters are regarded herein as being of specific significance. *Jeminayceras* is based on two small, poorly preserved specimens that exhibit a relatively high umbilical shoulder.] *Mississippian (upper Visean–lower Serpukhovian):* Great Britain, Belgium, France, Germany, Czech Republic, Poland, Russia (Novaia Zemlia, North Urals), Spain, Portugal, Algeria, Morocco, Ukraine, South Urals, Kazakhstan (Karaganda), China (Yunnan, Ningxia, Xinjiang), Australia (New South Wales), USA (Alaska, Arkansas, Georgia, Montana, Nevada, Oklahoma, Texas, Utah).——Fig. 26,*1a–g.* **G. meslerianum* (Girty); *a–c,* Chesterian, Oklahoma, USA, ×2.5; *d–e,* Chesterian, Texas, USA, ×0.8 (Miller, Furnish, & Schindewolf, 1957); *f,* suture, Caney Formation, Delaware Creek Member, Oklahoma, SUI 10932, diameter at 81 mm, ×0.8; *g,* cross section, Caney Formation, Delaware Creek Member, Wapanucka, Oklahoma, SUI 10932, ×1 (McCaleb, Quinn, & Furnish, 1964).

Baschkirites Librovich, 1957, p. 250 [**B. discoidalis* Librovich, 1957, p. 251; OD]. Conch discoidal, with narrow umbilicus in adult stage. Growth lines fine, prorsiradiate, with long ventrolateral salient; ventrolateral grooves common. Simple, sometimes granose spiral ornamentation on entire shell. Ventral lobe wide and V-shaped, with moderately high median saddle; first lateral saddle rounded or subacute, adventitious lobe deep and acute. Seven species. [Some authors (e.g., Bogoslovskaia, Kuzina, & Leonova, 1999) assign *Baschkirites* to Nomismoceratoidea.] *Pennsylvanian (lower Bashkirian):* Great Britain, Belgium, Germany, Ireland, Portugal, Russia (South Urals), Uzbekistan, USA (Arkansas).——Fig. 26,*3a–d.* **B. discoidalis,* holotype, Malaia Ik River, Bashkortostan, Russia; *a–b,* ×1.5; *c,* ×4; *d,* suture, whorl height at 11 mm, ×1.9 (Librovich, 1957).

Calygirtyoceras Korn, Klug, & Mapes, 1999, p. 353 [**C. darkaouaense* Korn, Klug, & Mapes, 1999, p. 354; OD]. Early stage widely umbilicate, with sharp umbilical margin forming a calyx, intermediate stage with rounded flanks and venter. Adult conch large and oxyconic. No ventrolateral grooves. Median saddle of ventral lobe exceeding half the entire height, ventrolateral saddle broadly rounded, adventitious lobe deep and acute. Four species. [This genus is similar to *Pseudogirtyoceras* Wagner-Gentis and may be its junior synonym.] *Mississippian (upper Visean):* Great Britain, Germany, Morocco, China (Yunnan), USA (Alaska).——Fig. 26,*2a–b.* **C. darkaouaense*, southeast of Dar Kaoua Oasis, Morocco, upper Visean; *a,* cross section, GPIT 1851-88, ×1.5; *b,* suture, GPIT 1851-89, ×1 (Korn, Klug, & Mapes, 1999).——Fig. 26,*2c–d. C. moorei* (Nicolaus), Hillershausen, Rhenish Massif, Germany, Goniatitenknollen, *Goniatites* Zone alpha 2, upper Visean, WMN 11047, ×2.5 (Korn, 1990).

Cousteauceras Korn, 1988b, p. 73 [**Sagittoceras costatum* Ruprecht, 1937, p. 271; OD]. Conch form small, discoidal, umbilicus closed. Ornamentation fine, with radiate and biconvex growth lines, partly forming riblets. Ventrolateral grooves present. Two or three species. *Mississippian (upper Visean–lower Serpukhovian [Pendleian]):* Great Britain, Germany, Ireland.——Fig. 27,*1.* **C. costatum* (Ruprecht), lectotype, Frenkhausen, Rhenish Massif, Germany, Go γ 2, uppermost Visean, GÖT 423-12, side view of internal mold, ×2.5 (Korn, 1988b).

Edmooroceras Elias, 1956, p. 132 [**Eumorphoceras plummeri* Miller & Youngquist, 1948, p. 665; OD]. Conch form and ornamentation similar to *Eumorphoceras*, but with a subangular and nodose umbilical edge; umbilicus usually narrow, rarely moderately wide. Many species. [This genus is closely related to *Eumorphoceras* and *Girtyoceras* and is probably a junior synonym of the former genus. For discussion, see Saunders, 1973, p. 44.] *Mississippian (upper Visean–lower Serpukhovian):* Great Britain, Germany, Ireland, Czech

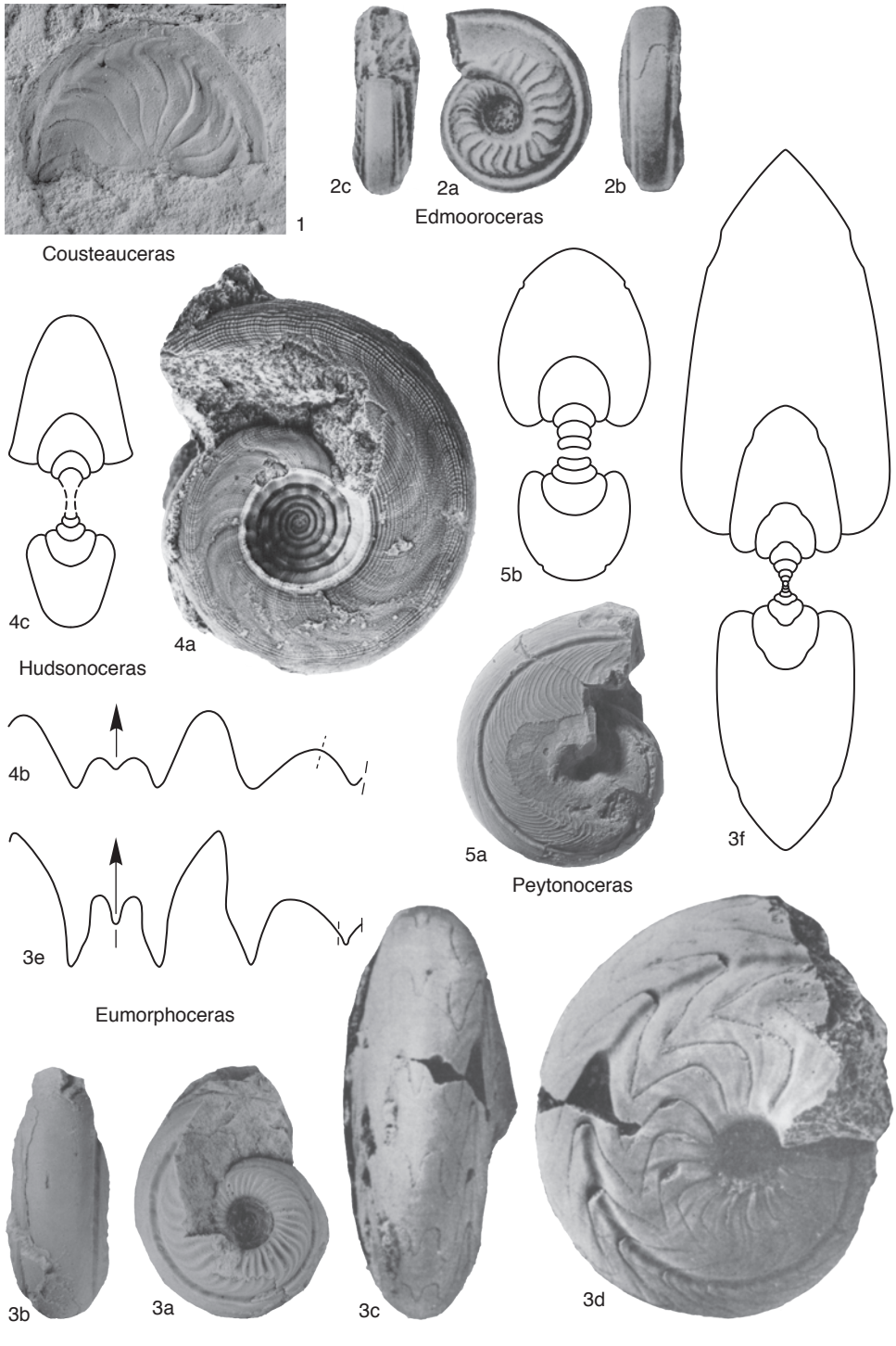

FIG. 27. Girtyoceratidae (p. 44–46).

Republic, Kazakhstan (South Urals), Algeria, China (Guangxi, Ningxia), USA (Arkansas, Oklahoma, Texas).——Fig. 27,*2a–c*. **E. plummeri* (Miller & Youngquist), south-southeast of San Saba, Barnett Shale, Chesterian, Texas; *a–b*, holotype; *c*, side view of paratype, east of San Saba, ×2 (Miller & Youngquist, 1948).

Eumorphoceras Girty, 1909, p. 67 [**E. bisulcatum* Girty, 1909, p. 68; OD] [=*Mediologoceras* Kullmann, 1962, p. 23 (type, *M. mediolobum,* OD)]. Conch form similar to *Girtyoceras*, but acute venter appearing at a late stage; ventrolateral grooves always present. Strong ribs beginning usually at second whorl, late stage smooth; no spiral ornamentation. Suture line often with subacute first lateral saddle; lateral lobe deep and acute. Many species. [*Mediologoceras* was erected for forms with narrowly rounded venter, acute saddles, and a deep median lobe.] *Mississippian (Serpukhovian):* Belgium, Great Britain, Ireland, Germany, Poland, Russia (Novaia Zemlia, South Urals), Kazakhstan (South Urals), Spain, Algeria, China (Gansu, Guangxi), Tajikistan, Uzbekistan, USA (Arkansas, California, Nevada, Oklahoma, Texas, Utah).——Fig. 27,*3a–f*. **E. bisulcatum,* Caney Shale, Sandy Creek, Johnson County, Oklahoma, USA, upper Chesterian; *a–b,* holotype, USNM 119596, ×3 (Gordon, 1965); *c–d,* Leslie, Searcy County, Arkansas, USA, upper Chesterian, SUI 11523, ×2; *e,* suture, ×0.4; *f,* cross section, ×1.2 (McCaleb, Quinn, & Furnish, 1964).

Hudsonoceras Moore, 1946, p. 433, *non* Flower, 1955, p. 352 [**Goniatites proteus* Brown, 1841, p. 217; OD]. Conch form discoidal, evolute on early stages, later with narrow umbilicus. Sculpture consisting of delicate spiral ornamentation and transverse striae; crossing of both produces reticulate pattern. Ventrolateral grooves may be present. Ventral lobe wide, with relatively low median saddle; first lateral saddle rounded. Adventitious lobe deep and acute. Two or three species. [The phylogenetic relationship of this genus is uncertain. Some authors (e.g., Bogoslovskaia, Kuzina, & Leonova, 1999) assign *Hudsonoceras* to the family Nomismoceratidae.] *Pennsylvanian (lower Bashkirian):* Great Britain, Wales, Ireland, Belgium, France, Russia (South Urals), USA (Arkansas).——Fig. 27,*4a–c*. **H. proteus* (Brown); *a,* side view, Clare Shale near Roadford, Clare County, Ireland, Kinderscoutian, SUI 320005, ×3 (Quinn & Saunders, 1968); *b,* suture of lectotype, Lob Mill, Todmorden, Yorkshire, England, MM L11797b, diameter at 8 mm, ×8.3; *c,* cross section of original syntype, Lob Mill, Todmorden, Yorkshire, England, MM L11797a, ×3.7 (Moore, 1946).

Peytonoceras Saunders, 1966, p. 43 [**P. ornatum* Saunders, 1966, p. 45; OD]. Conch with extremely narrow umbilicus. Lateral ribs delicate and closely spaced, sinuous; spiral lirae crossed by growth lines forming reticulate pattern. One ventrolateral groove well pronounced. One species. [The adult suture is not known for this genus.] *Mississippian (lower Serpukhovian [Arnsbergian]):* USA (Arkansas).——Fig. 27,*5a–b*. **P. ornatum,* holotype, Peyton Creek beds, upper Chesterian, UA L114-10; *a,* side view, ×3 (Saunders, 1973); *b,* cross section, ×6.8 (Saunders, 1966).

?Pseudogirtyoceras Wagner-Gentis in Higgins & Wagner-Gentis, 1982, p. 346 [**P. villabellacoi* Wagner-Gentis in Higgins & Wagner-Gentis, 1982, p. 347; OD]. Conch involute, with moderately narrow umbilicus and oxycone ventral side at adult stage; early whorls evolute. Surface of test almost smooth, on ventral side with faint undulations of growth lines; two to four constrictions on last whorl. Median saddle of ventral lobe slightly higher than half the entire lobe. Ventrolateral saddle narrowly rounded and asymmetric. One species. [Type species is insufficiently known. Similar suture line and conch form suggest a close relationship with *Zhifangoceras* Sheng, 1984 (Pericyclidae) and *Calygirtyoceras* Korn, Klug, & Mapes, 1999; the latter genus may be a junior synonym provided a calyx stage of the inner whorls can be proven.] *Mississippian (lowermost Visean):* Spain.——Fig. 28,*4*. **P. villabellacoi,* suture of holotype, Villabellaco, Palencia, Villabellaco Formation, BMNH C.82323, ×5 (Higgins & Wagner-Gentis, 1982).

Sulcogirtyoceras Ruzhentsev, 1960d, p. 204 [**Eumorphoceras burhennei* Brüning, 1923a, p. 265; OD]. Conch form and suture line similar to *Girtyoceras*. Acute venter only at last whorl. Shell surface in young stage smooth, rarely with ribs, later temporarily ribs or umbilical nodes. Constrictions typical, and numerous forming biconvex transversal sulci. Ventrolateral grooves always present. Four species. [For discussion, see Kullmann, Korn, & Pitz, 1983, p. 545.] *Mississippian (upper Visean):* Germany, Czech Republic, Portugal, Kazakhstan (South Urals), USA (Arkansas, Kentucky, Texas).——Fig. 28,*3a–b*. **S. burhennei* (Brüning), Herdringen, Rhenish Massif, *Goniatites striatus* Zone, Germany; *a,* lectotype, GPIM 3478, side view, ×2; *b*, suture of lectotype, diameter at 24 mm, ×2.7 (Kullmann, Korn, & Pitz, 1983).

Sundernites Korn, 1993b, p. 49 [**S. horni;* OD]. Conch form small, early whorls thickly discoidal, later stages discoidal; umbilicus moderately wide. Umbilical ribs, irregularly spaced, forming ventrolateral salient. Growth lines biconvex, no ventrolateral grooves. Two species. *Mississippian (lower Serpukhovian [Pendleian]):* Great Britain, Germany.——Fig. 28,*1a–b*. **S. horni,* holotype, Sundern-Hellefeld, Hangende Alaunschiefer, Rhenish Massif, Germany, lowermost Serpukhovian, WMN P18247, ×5 (Korn, 1993b).

Torulites Kuzina & Yatskov, 1987, p. 106 [**T. septentrionalis;* OD]. Conch form involute, in young stages with wide umbilicus, later with small umbilicus; ventral side relatively broadly rounded. Ornamentation consisting of biconvex growth lines and irregularly bifurcated ribbing; three or four constrictions present. Ventral lobe relatively narrow, with low median saddle and widely divergent sides. Adventitious lobe symmetric and with slightly sinuous sides. One species. *Mississippian*

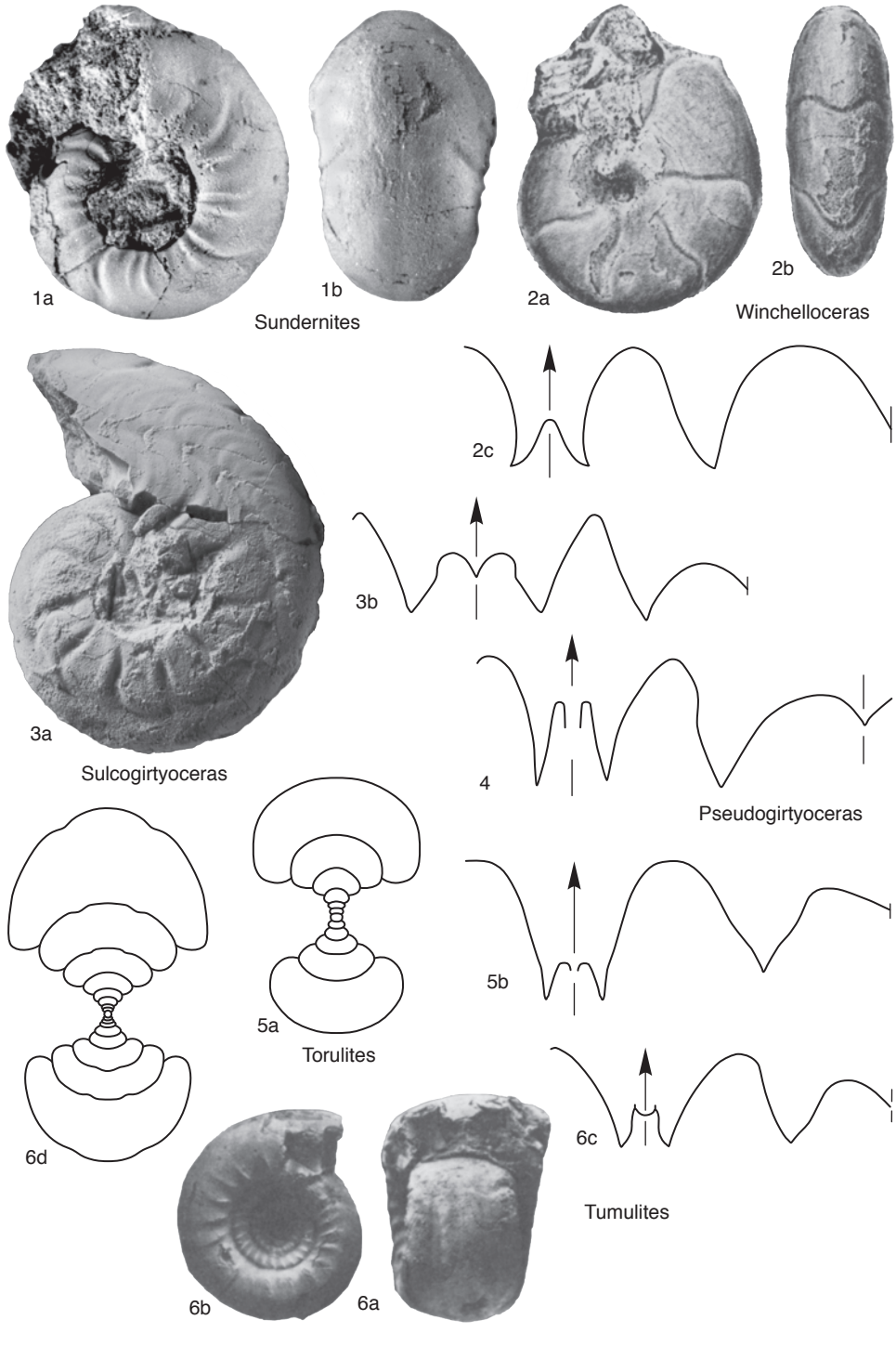

FIG. 28. Girtyoceratidae (p. 46–48).

(lower Visean): Russia (Novaia Zemlia).——Fig. 28,*5a–b. *T. septentrionalis,* Milin Formation, Olenii rivulet, Severnaia Tainaia basin; *a*, cross section, PIN 4006/476, ×4.3; *b*, holotype, suture, PIN 4006/478, ×8 (Kuzina & Yatskov, 1987).

Tumulites McCaleb, Quinn, & Furnish, 1964, p. 28 [**T. varians* McCaleb, Quinn, & Furnish, 1964, p. 30; OD]. Conch thickly discoidal to subglobose, moderately involute, usually with narrow umbilicus. Umbilical ribs forming ventrolateral salient and rounded sinus on venter. Ventrolateral grooves always present. First lateral saddle broadly rounded. Five species. *Mississippian (Serpukhovian):* Belgium, Great Britain, Germany, Ireland, Poland, Russia (South Urals), China (Gansu, Ningxia), USA (Arkansas, Texas).——Fig. 28,*6a–d. *T. varians; a–b,* paratype, Batesville, Fayetteville Shale, Arkansas, USA, upper Chesterian, SUI 11531, ×3.75; *c*, suture of holotype, Fayetteville Formation, Town Branch bed, Arkansas, UA L-119-TB-5, diameter at 15 mm, ×3.4; *d*, cross section of paratype, SUI 11536, ×2 (McCaleb, Quinn, & Furnish, 1964).

Winchelloceras Ruzhentsev, 1965, p. 9 [**Goniatites allei* Winchell, 1862, p. 363; OD]. Conch discoidal, involute, with very narrow umbilicus; venter broadly rounded, rarely oxycone. Growth lines fine or coarse, with deep hyponomic sinus. Constrictions may be present; no spiral ornamentation. Ventral lobe with relatively low median saddle. Adventitious lobe deep and acute, symmetrical, sometimes bell shaped, usually smaller than ventral lobe. Seven species. *Mississippian (upper Tournaisian–lower Visean [Osagean]):* ?Spain, Algeria, Russia (North Urals), Kyrgyzstan (Tian Shan), USA (Michigan).——Fig. 28,*2a–c. *W. allei* (Winchell), hypotype, Coldwater Shale, 2 km southwest of Coldwater, Michigan, USA, Osagean, UM 30703c; *a–b,* ×2; *c,* suture, UM 30704, ×2.6 (Miller & Garner, 1955).

?Zhongningoceras Yang, 1986, p. 262 [**Z. bellum;* OD]. Conch form small, involute, with moderately wide umbilicus. Sculpture consisting of fine concave-convex growth lines that form long salient and deep hyponomic sinus, and fine simple ribs on flanks; umbilical tubercles present. Several strong constrictions present; on venter one shallow groove partly exposed. Ventral lobe rather wide, with moderately low median saddle; adventitious lobe V-shaped and much less deep than ventral lobe. Two species. [Type specimens are very small and possibly immature.] *Mississippian (lower Serpukhovian [Arnsbergian]):* China (Ningxia).——Fig. 26,*4. *Z. bellum,* suture of paratype, reversed, Zhongning, diameter at 11.2 mm, ×8.8 (Yang, 1986).

Family BERKHOCERATIDAE Librovich, 1957

[Berkhoceratidae Librovich, 1957, p. 265]

Conch completely involute. Ventral lobe quadripartite, with simple, cuneate branches. Adventitious lobe simple, deep, and acute. Sutural formula: $(E_1E_2E_mE_2E_1)$ AL:UI [German], $(V_{1.1}V_{1.2}V_{1.2}V_{1.1})$LU:ID [Russian]. *Mississippian (upper Visean–Serpukhovian).*

Kazakhoceras Ruzhentsev, 1947a, p. 521 [**K. yanshini* Ruzhentsev, 1947a, p. 522; OD; =?*Neodimorphoceras hawkinsi* Moore, 1930, p. 168; Ruzhentsev & Bogoslovskaia, 1971, p. 197, subj.] [=*Berkhoceras* Librovich, 1938, p. 48, *nom. nud.; =Berkhoceras* Librovich, 1957, p. 259 (type, *B. boreale* Librovich, 1957, p. 260, OD)]. Conch form lenticular and almost oxycone. Growth lines crossed sometimes by fine spiral lirae. Five species. *Mississippian (upper Visean–Serpukhovian):* Great Britain, Belgium, Ireland, Germany, Spain, Poland, Russia (Novaia Zemlia, South Urals), Kazakhstan (Karaganda), China (Guangxi, Gansu, Ningxia), Kyrgyzstan, Tajikistan, Uzbekistan.——Fig. 29,*4a–c. *K. yanshini,* Nocedo, Cantabrian Mountains, Spain, Arnsbergian; *a–b,* GPIT 1494/1226, ×1 (Kullmann, new); *c,* suture, Perlora, Cantabrian Mountains, Spain, lower Serpukhovian, GPIT 1268/68, whorl height at 22 mm, whorl width at 15 mm, ×1.5 (Kullmann, 1962).

Family EOGONIOLOBOCERATIDAE Ruzhentsev & Bogoslovskaia, 1978

[Eogoniloboceratidae Ruzhentsev & Bogoslovskaia, 1978, p. 83]

Conch form subdiscoidal, evolute on early whorls; umbilicus of adult forms very narrow. No prominent sculpture; spiral ornamentation and constrictions may be present. Ventral lobe wide, with strongly divergent sides; median saddle broad and half as high as entire ventral lobe, also with strongly divergent sides. First lateral saddle narrowly rounded, subacute or acute, adventitious lobe pointed. [This family is similar to Goniolobocerati dae, but the phylogenetic relationship is uncertain.] *Mississippian (upper Visean–Serpukhovian), Pennsylvanian (?lower Bashkirian [?Yeadonian]).*

Eogonioloboceras Librovich, 1957, p. 249 [**Goniolobocera*s *asiaticum* Librovich, 1940, p. 117; OD] [=*Atratoceras* Librovich, 1957, p. 249 (type, *Goniolobocera*s *(Milleroceras) atratum* Librovich, 1940, p. 183, OD); for discussion, see Ruzhentsev & Bogoslovskaia, 1971, p. 201]. Ventral lobe angular, median saddle about half as high as entire lobe. First lateral saddle subacute or narrowly rounded. Adventitious lobe acute and deep. Five species. [*Atratoceras* was erected for forms with constrictions and less angularity of the lobes.] *Mississippian (upper Visean–Serpukhovian), Pennsylvanian*

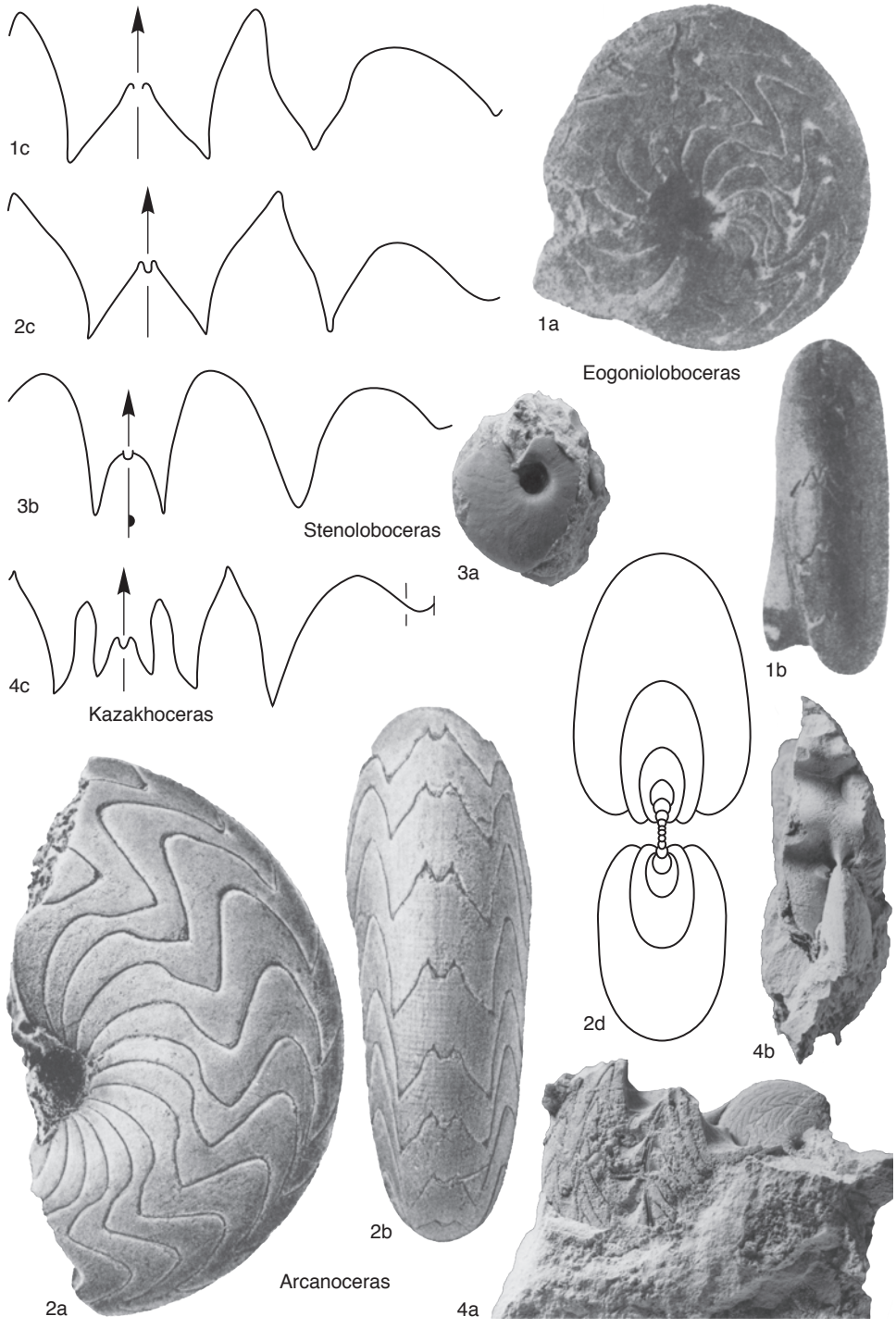

FIG. 29. Berkhoceratidae and Eogonioloboceratidae (p. 48–50).

(?lower Bashkirian [?Yeadonian]): Russia (South Urals), Kazakhstan (Karaganda), China (Guangxi), *upper Visean–Serpukhovian;* China (Guangxi), *?lower Bashkirian [?Yeadonian].*——Fig. 29,*1a–c.* **E. asiaticum* (Librovich), holotype, Verkhnii Sokur basin, Kazakhstan, upper Visean, CNIGR 168/5450; *a–b,* ×1.5 (Librovich, 1940); *c,* suture, enlarged, magnification not stated (Bogoslovskii, Librovich, & Ruzhentsev, 1962).

Arcanoceras Ruzhentsev, 1965, p. 10 [**Girtyoceras burmai* Miller & Downs, 1950b, p. 576; OD]. Conch form as in *Eogonioloboceras,* but with extremely evolute early whorls; at fifth whorl rapid increase of involution. Adult whorl with very narrow umbilicus. Biconvex growth lines crossed by fine spiral ornamentation. Suture line as in *Eogonioloboceras,* but even more angular; first lateral saddle pointed. Adventitious lobe almost triangular, with concave sides. Six species, two questionable. *Mississippian (upper Visean–Serpukhovian [Pendleian, ?Arnsbergian]):* Spain, Russia (Novaia Zemlia, South Urals), Kazakhstan (South Urals), China (Guangxi, Ningxia), USA (Texas).——Fig. 29,*2a–d.* **A. burmai* (Miller & Downs); *a–b,* holotype, San Saba, Texas, Barnett Formation, upper Chesterian, SUI 2642, ×6 (Miller & Downs, 1950b); *c*, suture, Dombar Hills, South Urals, Kazakhstan, uppermost Visean, PIN 455/6998, ×1.3; *d*, cross section, Zhaksy Kargaly River, South Urals, Kazakhstan, lower Serpukhovian, PIN 455/6962, ×3 (Ruzhentsev & Bogoslovskaia, 1971).

Stenoloboceras Ruan, 1981b, p. 213[227] [**S. stenolobatum;* OD]. Conch form discoidal, with narrowly rounded venter on early whorls, becoming slightly acute later. Growth lines biconvex. Ventral lobe moderately wide, with roundly diverging sides. Median saddle broad and less than half as high as entire lobe; prongs of ventral lobe rather narrow. First lateral saddle high and rounded, adventitious lobe asymmetric and V-shaped. One species. *Mississippian (Serpukhovian):* China (Guangxi).——Fig. 29,*3a–b.* **S. stenolobatum,* holotype, Qixu, upper Locheng Formation, NIGP 48933; *a*, side view, ×1; *b*, suture, reversed, ×3.9 (Ruan, 1981b).

Family ANTHRACOCERATIDAE Plummer & Scott, 1937

[Anthracoceratidae Plummer & Scott, 1937, p. 321]

Conch form discoidal, involute. Growth lines delicate, with ventrolateral salient and ventral sinus. Suture relatively primitive; ventral lobe commonly wide, with divergent sides. [The phylogenetic relationship of this family is uncertain and may be an artificial grouping.] *Mississippian (upper Visean [upper Namurian])–Pennsylvanian (Moscovian).*

Anthracoceras Frech, 1899, p. 285 [**Nomismoceras (Anthracoceras) discus* Frech, 1899, p. 337; M]. Conch form subdiscoidal, with narrow, almost closed umbilicus. Growth lines with ventral sinus and strong salients forming a lingua on ventrolateral shoulder; second salient weak on flanks. Faint longitudinal ornamentation in some species. Ventral lobe wide, with strongly divergent sides. First lateral saddle broadly rounded. Adventitious lobe rounded during ontogeny, pointed at maturity. Many species, several questionable species. [The type species material is insufficiently preserved]. *Mississippian (Serpukhovian)–Pennsylvanian (Moscovian):* Belgium, Great Britain, France, Germany, Ireland, Netherlands, Czech Republic, Poland, Spain, Algeria, Morocco, China (Guangxi, Gansu, Xinjiang, Ningxia), USA (Arkansas, Missouri, Oklahoma).——Fig. 30,*4a. A. glabrum* Bisat, side view, Throstle Nest, Silsden, Airedale, Sabden Shales, Arnsbergian, ×3.4 (Currie, 1954).——Fig. 30,*4b. A. paucilobum* (Phillips), suture, Thornliebank, Renfrewshire, Scotland, Orchard Limestone, Arnsbergian, RSM 1911.62.493a, ×3 (Currie, 1954).

?Anthracoceratoides Ramsbottom, 1970, p. 54 [**A. cornubiensis;* OD]. Early whorls widely umbilicate, later with narrow umbilicus. Growth lines on young stages more or less linear, later with slight ventrolateral salient and ventral sinus. First lateral saddle almost subacute, adventitious lobe pointed. One species. [The type species for this genus is poorly known; Ruzhentsev and Bogoslovskaia (1978, p. 166) regarded it as a synonym of *Schartymites.*] *Pennsylvanian (Moscovian [Langsettian]):* Great Britain.——Fig. 30,*3.* **A. cornubiensis,* paratype, suture, nodule in Bude Sandstone, Sandimouth, Cornwall, IGSL HR2156, diameter at 8 mm, magnification not stated (Ramsbottom, 1970).

Cathranoceras Nikolaeva, 1990, p. 109 [**C. badavense;* OD]. Conch form similar to *Anthracoceras;* ornamentation with transversal riblets. Ventral lobe with subparallel sides and relatively low median saddle. Ventrolateral saddle broadly rounded, adventitious lobe half as long as ventral lobe, acute. One species from one locality. [The type material for this genus is poorly known.] *Pennsylvanian (lower Bashkirian [Homoceras Zone]):* Uzbekistan.——Fig. 30,*1a–c.* **C. badavense,* Aksu-Vakhshivardara, Surkhantau Range; *a–b,* paratype, PIN 4372/2, ×4; *c,* suture of holotype, PIN 4372/1, whorl height at 4.4 mm, whorl width 4.1 mm, ×12 (Nikolaeva, 1990).

?Ningxiaceras Yang, 1987, p. 158[171] [**N. brevilobatum*; OD]. Conch thinly lenticular with narrowly rounded or acute venter; umbilicus narrow. Ventral lobe with rounded prongs, median saddle reaching a third of entire lobe. Adventitious lobe at diameter of 10 mm deep and broadly rounded. [The holotype for this genus is insufficiently known, and its systematic position is uncertain.] *Pennsylvanian (Bashkirian):* China (Ningxia).——Fig. 30,*2a–b.* **N. brevilobatum,* holotype, Xiaoyuchuan, Zhongwei, no. 855; *a,* ×2; *b,* suture, diameter at 10 mm, ×6.3 (Yang, 1987).

Sudeticeras Patteisky, 1929, p. 274 [**Homoceratoides hoeferi* Patteisky in Patteisky & Fohlbrecht,

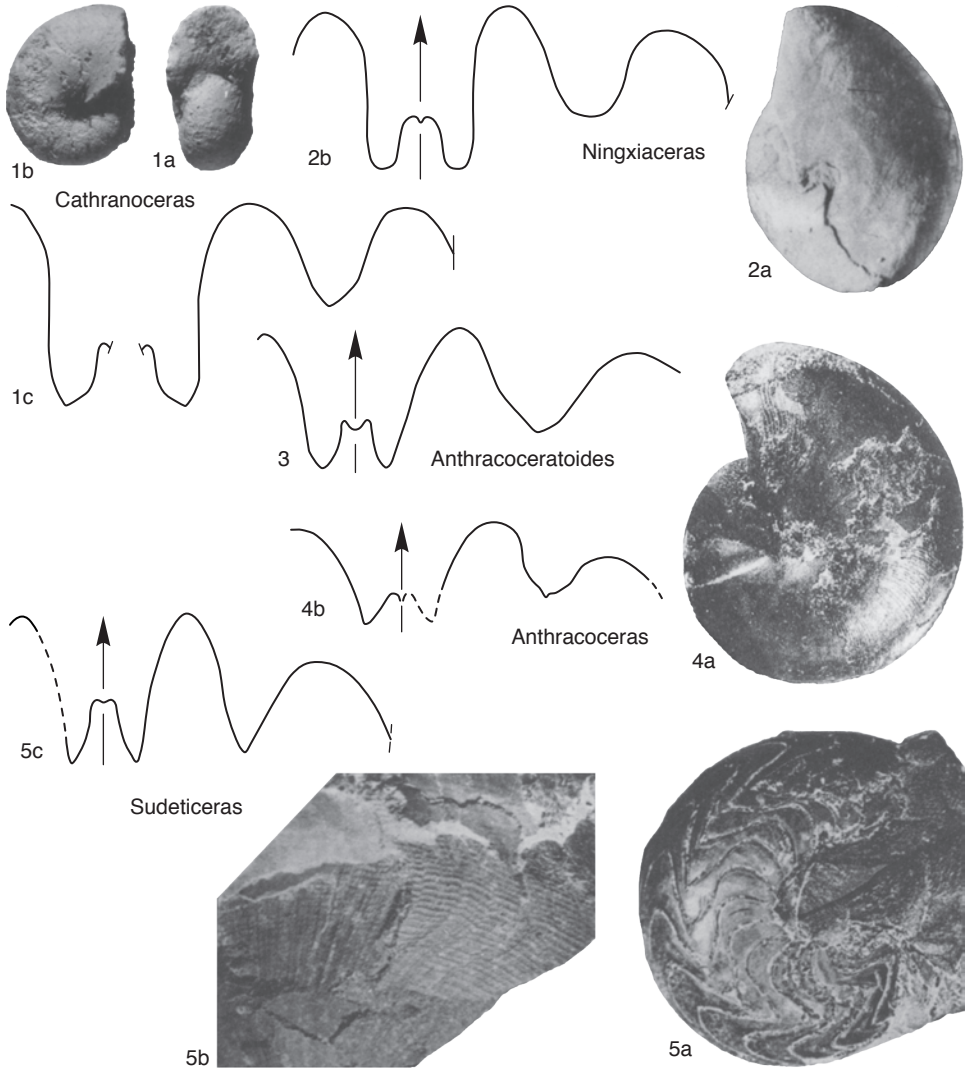

FIG. 30. Anthracoceratidae (p. 50–51).

1928, p. 63; OD] [=*Glyphioceratoides* KNOPP, 1931, p. 15, M, obj., *nom. van.;* =*Cravenites* BISAT, 1950, p. 16 (type, *C. varians* BISAT, 1950, p. 18, OD)]. Conch with very narrow umbilicus; venter rounded. Growth lines fine, nearly linear on flanks, biconvex, with shallow salient on ventrolateral shoulder and with marked ventral sinus. Ornamentation weak, crenistriate, in some forms with spiral pattern. Constrictions present in many species. Ventral lobe relatively narrow at base, with median saddle about or little less than half as high as entire lobe. First lateral saddle asymmetrically rounded; adventitious lobe relatively large, with almost straight sides. Many species. [The type species material is insufficiently preserved.] *Mississippian (upper Visean–Serpukhovian):* Great Britain, Ireland, Belgium, Germany, Czech Republic, Poland, Portugal, Spain, Algeria, Morocco, Poland, Russia and Kazakhstan (South Urals), Russia (Novaia Zemlia), Kazakhstan (Karaganda), China (Guangxi, Ningxia), USA (Arkansas, Alaska).——FIG. 30,*5a–c. S. splendens* (BISAT); *a,* side view, Hilly Clough Farm, Barnoldswick, Yorkshire, Bollandian, upper Visean, GSM GSL83593, ×1.3; *b,* ornamentation of test, River Ribber, Dinkley, Lancashire, GSM GSL83587, ×2.5; *c,* suture, Hilly Clough Farm, GSM GSL83593, diameter at 33 mm, ×1.8 (Moore, 1950).

GONIATITOIDEA

JÜRGEN KULLMANN

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Superfamily GONIATITOIDEA de Haan, 1825

[*nom. correct.* MILLER & FURNISH, 1954, p. 687, *pro* Goniatitidea PLUMMER & SCOTT, 1937, p. 103, *nom. transl. ex* Goniatitea DE HAAN, 1825, p. 156]

Conch form discoidal to globular, rarely oxycone; moderately involute, usually with narrow umbilicus. Spiral ornamentation, if present, conspicuous and in some forms stronger than growth lines or striae. Course of growth lines and constrictions variable, with ventral sinus. Basic sutural formula (family Goniatitidae): ($E_1E_mE_1$) ALUI [German], (V_1V_1)LU:ID [Russian]; increase of sutural elements by trifurcation of branches of ventral lobe as well as of adventitious lobe (Delepinoceratidae), but no trifurcation of the adventitious lobe alone (Agathiceratoidea). *Mississippian (upper Tournaisian)–Pennsylvanian (Bashkirian, ?Moscovian).*

Family GONIATITIDAE de Haan, 1825

[*nom. transl.* SCHINDEWOLF, 1934, p. 160, *ex* Goniatitea DE HAAN, 1825, p. 156] [=Glyphioceratidae HYATT, 1884 in 1883–1884, p. 322, obj.]

Ventral lobe relatively narrow, with median saddle usually less than half as high as entire lobe, rarely higher; branches diverging strongly, apicad mostly pointed. Ventrolateral saddle acute or subacute. Adventitious lobe in lateral position, broad, pointed. No increase of additional suture elements. *Mississippian (upper Tournaisian–lower Serpukhovian [Chesterian]).*

Goniatites DE HAAN, 1825, p. 39 [**Conchiliolithus Nautilites sphaericus* MARTIN, 1809, p. 15 (*nomen nudum* because of nonbinominal derivation), =*Ammonites sphaericus* SOWERBY, 1814, p. 116, *nom. subst.,* SD Opinion 420, ICZN, 1956, p. 135] [=*Glyphioceras* HYATT, 1884 in 1883–1884, p. 328, obj.; SD HOLZAPFEL, 1889, p. 26, for discussion, see BISAT, 1924, p. 82; =*Sphenoceras* FOORD, 1903, p. 218, obj., SD LIBROVICH, 1938, p. 51, for discussion, see BISAT, 1924, p. 82; SCHMIDT, 1925, p. 563; =?*Progoniatites* KORN & others, 2003, p. 89 (type, *P. maghribensis,* OD); closely related or even synonymous; close similarity of *Goniatites* and *Progoniatites* in suture and conch form suggests synonymy despite considerable age difference; for discussion, see CONRAD & PAREYN, 1968, p. 572, and see genus entry for *Progoniatites*, p. 55 herein.] Conch form subglobose to globose; umbilicus open but narrow. Commonly numerous longitudinal lirae, crossing transverse striae, thereby producing reticulate or crenistriate pattern. Ventral lobe with more or less straight sides; height of median saddle about or a little less than half height of entire ventral lobe. Adventitious lobe with almost straight sides. Many species. *Mississippian (upper Tournaisian, upper Visean [Goniatites Zone, Chesterian]):* Great Britain, Ireland, Belgium, Germany, Czech Republic, Bosnia, Poland, Russia and Kazakhstan (South Urals), Russia (Verkhoian), Portugal, Spain, Algeria, Morocco, ?Turkey, China (Xinjiang), Australia (Queensland), Canada (Yukon Territories), USA (Arkansas, Alaska, Indiana, Oklahoma, Utah).——FIG. 31,*3a–c.* **G. sphaericus* (MARTIN); *a–b,* Bolland, England, Gilbertson Collection, BMNH C290a, ×1 (Nikolaeva, 2008); *c,* holotype, suture, BMNH C43871, Derbyshire, diameter at 25 mm, whorl width 22 mm, whorl height 11.7 mm, ×2.3 (Korn, 1988b).——FIG. 31,*3d–f.* *G. crenistria* (PHILLIPS); *d–e,* lectotype, Bolland, Gilbertson Collection, BMNH C282a, ×2; *f,* enlargement of flank, showing growth striae (Nikolaeva, 2008).

Arnsbergites KORN, 1988b, p. 95 [**Goniatites falcatus* ROEMER, 1850, p. 50; OD]. Conch form globular; evolute on inner whorls, later conch with moderately wide umbilicus. Ornamentation consisting of numerous delicate longitudinal lirae that cross transverse striae with strong ventrolateral and dorsolateral salients. Constrictions on internal molds common. Ventral lobe relatively wide, median saddle half as high as entire lobe. Ventrolateral saddle subacute. Adventitious lobe deep with somewhat sinuously curved sides. Seven species. *Mississippian (upper Visean [middle Goniatites Zone]):* Great Britain, Ireland, Germany, Czech Republic, Poland, Morocco.——FIG. 33,*2a–d.* **A. falcatus* (ROEMER); *a–b,* Dough Mountain, Leitrim County, Ireland, GSM ZI 3881, ×1 (Hodson & Moore, 1959); *c,* suture, diameter at 33.2 mm, whorl height 16.2 mm, whorl width 23.8 mm, Oelinghausen, Rhenish Massif, SMN Stuttgart 25057, ×2; *d,* cross section, Oelinghausen, ×2.4 (Korn, new).

Goniatitella KORN, 1988b, p. 134 [**G. agricola* KORN, 1988b, p. 135; OD]. Conch small, globular, with very narrow umbilicus. Growth lines delicate, almost linear. Ventral lobe relatively wide, with almost parallel flanks, median saddle moderately low, ventrolateral saddle subacute; adventitious lobe with sinuous flanks. One species. [This genus may

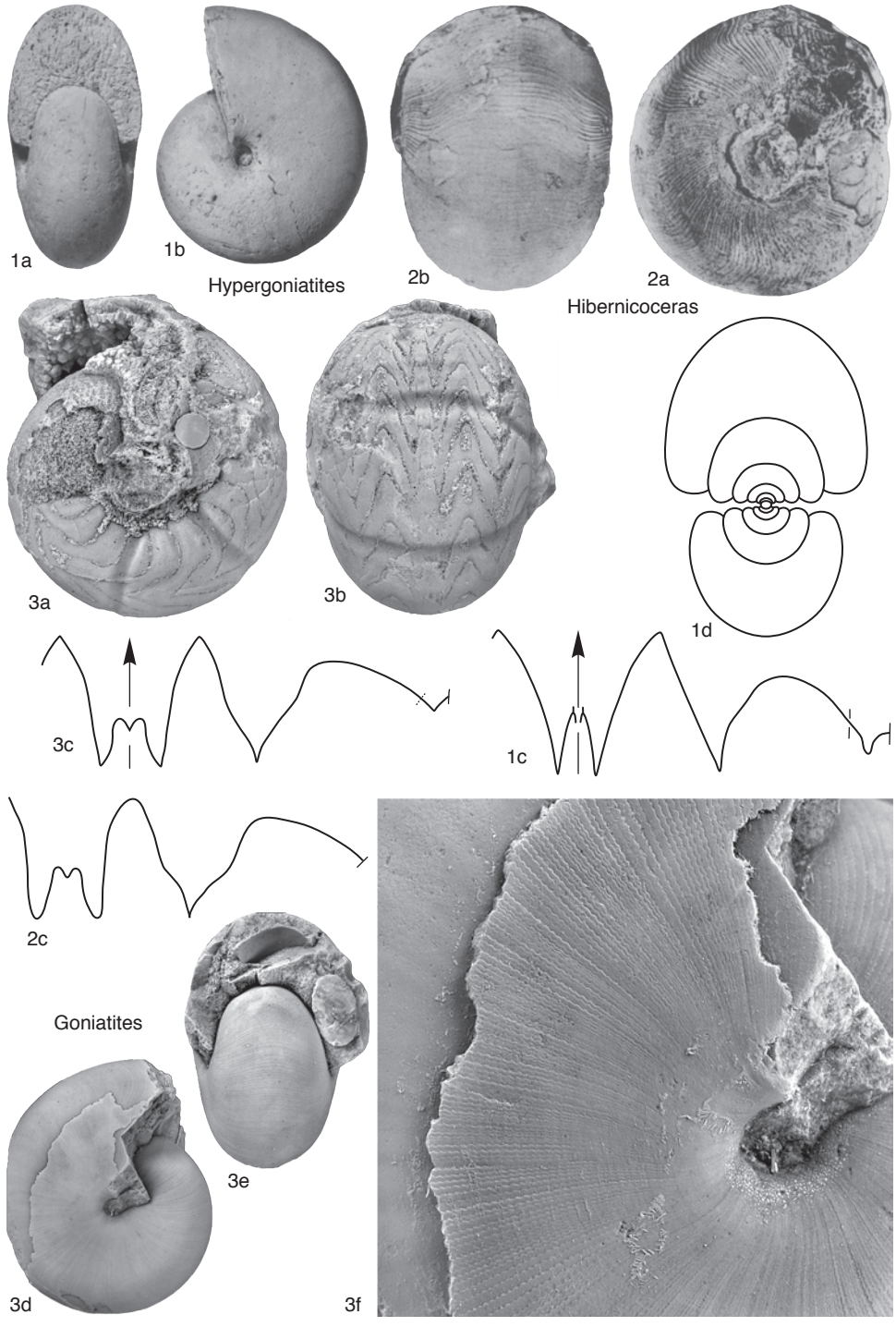

FIG. 31. Goniatitidae (p. 52–55).

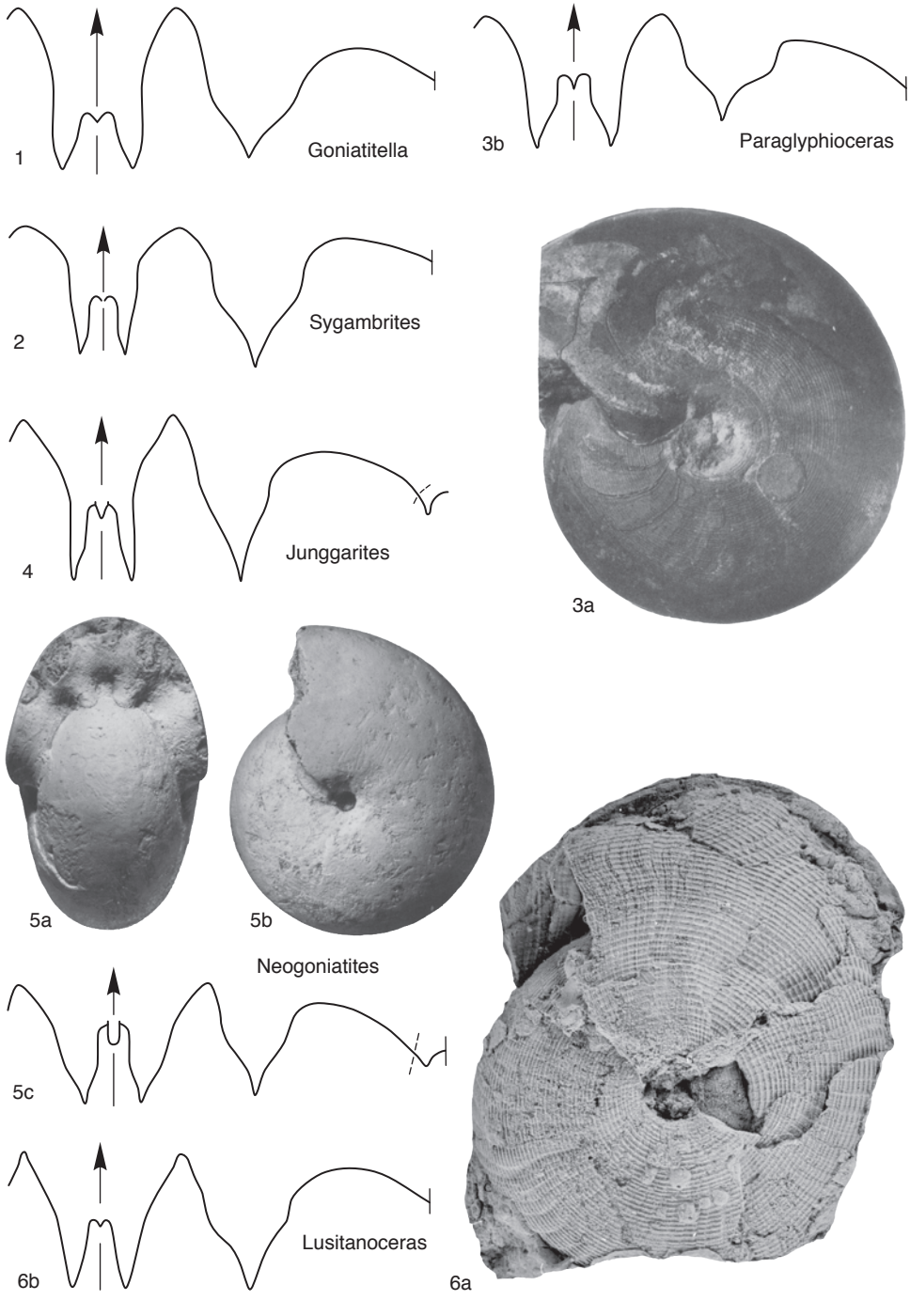

FIG. 32. Goniatitidae (p. 52–57).

be a junior synonym of *Goniatites* or related genera; juvenile specimens have a maximum diameter of 12.5 mm.] *Mississippian (upper Visean [middle Goniatites Zone]):* Germany.——Fig. 32,*1. *G. agricola,* holotype, suture, diameter at 11.6 mm, whorl height 6.8 mm, whorl width 10 mm, Landhausen, Rhenish Massif, WMN 10187, ×5 (Korn, 1988b).

Hibernicoceras Moore & Hodson, 1958, p. 87 [**H. hibernicum;* OD]. Conch form in young stages globular with wide umbilicus, later thickly discoidal with narrow umbilicus. Transverse striae rursiradiate to almost linear on flanks; slight salient on ventrolateral shoulder, forming shallow ventral sinus. Longitudinal lirae very faint, mainly around umbilicus. Ventral lobe moderately wide, with almost parallel sides in apical half, slightly diverging orad. First lateral saddle asymmetrical, subacute in adult forms. Adventitious lobe fairly wide, with sides more or less sigmoidal. Many species. *Mississippian (upper Visean):* Poland, Czech Republic, Germany, Ireland, Portugal, China (Xinjiang).——Fig. 31,*2a–c. *H. hibernicum,* holotype, Kiltyclogher, County Leitrim, Ireland, middle *Goniatites* Zone, GSM Zl 3025; *a–b,* ×2; *c,* suture, diameter at 15 mm, ×4.5 (Moore & Hodson, 1958).

Hypergoniatites Ruzhentsev & Bogoslovskaia, 1970, p. 58 [**H. exiguus;* OD]. Conch form as in *Goniatites,* usually with very narrow umbilicus. Growth lines faint, crenistriate, more or less linear, rarely with constrictions. Ventral lobe narrow at its base, orad very wide, with slightly continuously curved sides; median saddle reaching less than half entire height, prongs of ventral lobe narrow. Adventitious lobe with curved apical process. Many species. *Mississippian (upper Visean–lower Serpukhovian):* Russia (Novaia Zemlia), Spain, Morocco, China (Xinjiang), Kazakhstan (South Urals), Tajikistan, Uzbekistan.——Fig. 31,*1a–d. *H. exiguus; a–b,* holotype, Dombar Hills, South Urals, Kazakhstan, uppermost Visean, PIN 455/7494, ×1; *c,* holotype, suture, whorl height at 12.2 mm, whorl width 13.0 mm, ×3; *d,* cross section, PIN 455/7498, ×2 (Ruzhentsev & Bogoslovskaia, 1970).

Junggarites Liang & Wang, 1991, p. 105 [**J. pinguis* Liang & Wang, 1991, p. 106; OD]. Conch form as in *Goniatites,* with extremely narrow umbilicus. Growth lines crenistriate, spiral ornamentation faint. Ventral lobe with relatively narrow prongs, almost parallel sided; upper part of flanks widely divergent. Ventrolateral saddle subacute, adventitious lobe asymmetrical, deep, and bell shaped. One species. *Mississippian (upper Visean):* China (Xinjiang).——Fig. 32,*4. *J. pinguis,* suture, Kalajila, Altai, NIGP 91469, whorl height at 28 mm, whorl width 36 mm, ×2 (Liang & Wang, 1991).

Lusitanoceras Pereira de Sousa, 1923, p. 304 [**L. algarviense;* M]. Conch form of early whorls almost globular, with wide umbilicus; later stages subdiscoidal, with narrow umbilicus. Ornamentation consisting of faint biconvex growth striae, on young stages crenistriate, later with predominant spirals. Constrictions common. Ventral lobe moderately wide, with median saddle half as high as entire ventral lobe, prongs being almost parallel; flanks of ventral lobe in their orad half widely diverging. Ventrolateral saddle acute or subacute. Adventitious lobe deep, slightly bell shaped. More than ten species. [This genus is transitional to *Dombarites.*] *Mississippian (upper Visean [upper Goniatites Zone]):* cosmopolitan.——Fig. 32,*6a. *L. algarviense,* side view, Vaqueiros, Mértola Formation, Portugal, IGML 235, ×1 (Korn, 1997).——Fig. 32,*6b. L. poststriatum* (Brüning), suture, partly restored ventral part, Murraçao, Faro, Portugal, Mértola Formation, IGML 376, whorl height at 22.8 mm, ×1.7 (Korn, 1997).

Neogoniatites Ruzhentsev & Bogoslovskaia, 1970, p. 56 [**N. milleri;* OD] [=*?Xainzalites* Sheng, 1983, p. 58 (type, *X. xainzaensis,* OD)]. Conch form and ornamentation as in *Goniatites.* Ventral lobe wide, sides curved outside in upper half; median saddle higher than half height of entire lobe. Adventitious lobe with slightly pouched flanks. More than ten species. [This genus is closely related to *Paraglyphioceras. Xainzalites* is based on poorly preserved specimens apparently showing characteristics of *Neogoniatites.*] *Mississippian (upper Visean–lower Serpukhovian [upper Goniatites Zone, Pendleian]):* Spain, Morocco, Iran, China (Xinjiang, Xizang), Kazakhstan (South Urals), Tajikistan, USA (Kentucky, Nevada, Oklahoma, Texas).——Fig. 32,*5a–b. *N. milleri milleri,* holotype, Dombar Hills, South Urals, Kazakhstan, uppermost Visean, PIN 455/7093, ×1 (Ruzhentsev & Bogoslovskaia, 1971).——Fig. 32,*5c. N. milleri latus* Ruzhentsev & Bogoslovskaia, holotype, suture, Dombar Hills, South Urals, Kazakhstan, uppermost Visean, PIN 455/7107, whorl height at 22.7 mm, whorl width 29.5 mm, ×2.2 (Ruzhentsev & Bogoslovskaia, 1971).

Paraglyphioceras Brüning, 1923b, p. 22 [**P. rotundum* Brüning, 1923b, p. 27; SD Korn, 1988b, p. 117]. Conch thickly discoidal, on early whorls with wide umbilicus, adult stages with very narrow umbilicus. Growth lines crenistriate, on all stages biconvex and prorsiradiate; spiral ornamentation closely spaced. Ventral lobe V-shaped, moderately wide, median saddle about half as high as entire lobe. Ventrolateral lobe narrowly rounded to subacute, adventitious lobe symmetrical and bell shaped. Many species. [A suitable figure of the holotype is not available; the figured species is closely related.] *Mississippian (upper Visean [lower Goniatites Zone–middle Goniatites Zone]):* Great Britain, Ireland, Belgium, Germany, Czech Republic, Poland.——Fig. 32,*3a–b. P. striatum* (Sowerby), holotype, Derbyshire, England, upper Visean, BMNH 43870; *a,* side view, ×1.5 (Bisat, 1934); *b,* suture, diameter at 34.6 mm, whorl height 19.2 mm, whorl width 23.0 mm, ×2 (Korn, 1988b).

?Progoniatites Korn & others, 2003, p. 89 [**P. maghribensis;* OD] [=*Pericycloides* Follot, 1953, p. 14, *nom. nud.,* no type designated, subj.]. Similar to *Goniatites,* with V-shaped ventral lobe and moderately high median saddle, but ventrolateral saddle

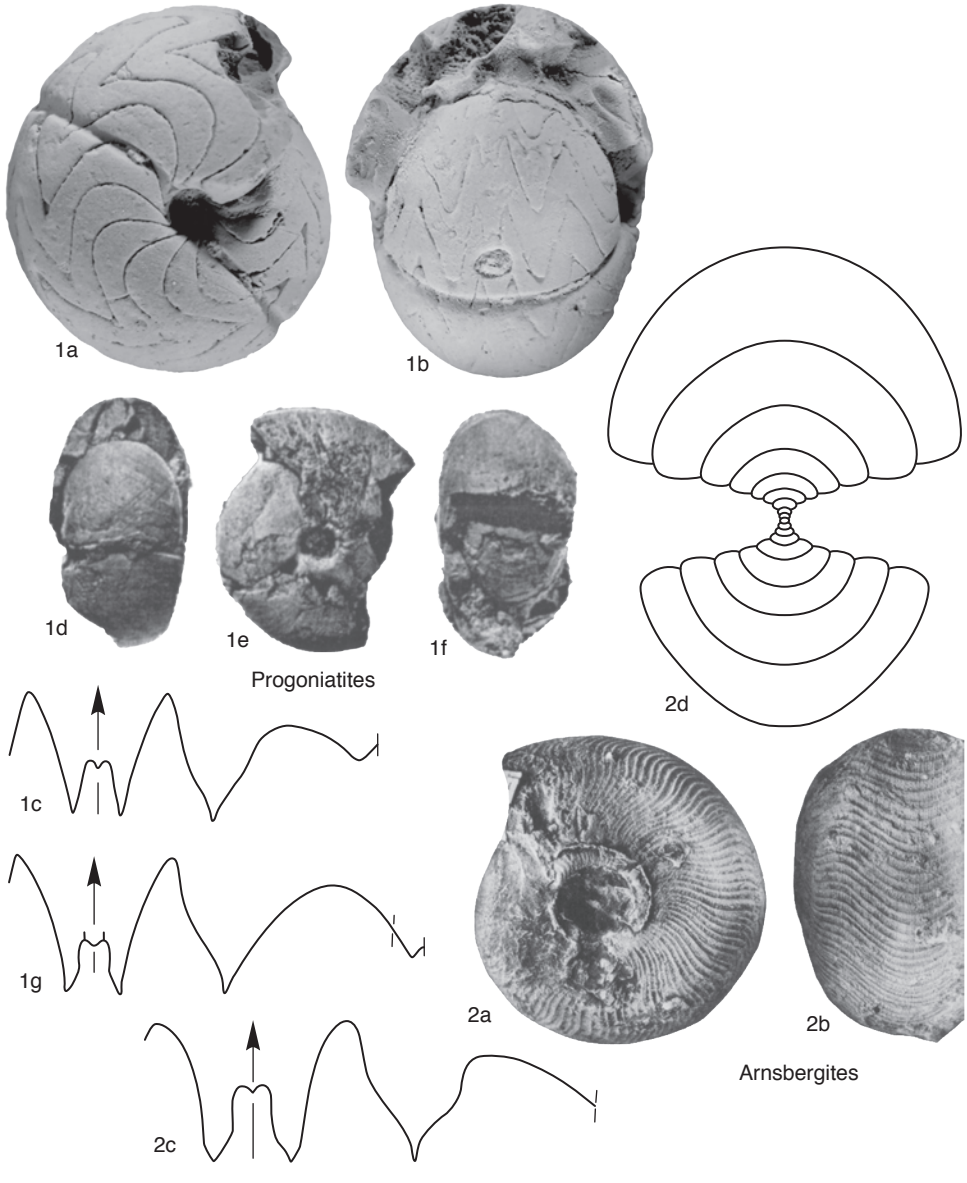

FIG. 33. Goniatitidae (p. 52–56).

slightly subacute. Three species. [The similarity of *Goniatites* and *Progoniatites* (=*Pericycloides* FOLLOT, 1953) in suture and conch form suggests synonymy despite considerable age difference; for discussion, see CONRAD & PAREYN, 1968, p. 572, and see genus entry for *Goniatites*, p. 52 herein.] *Mississippian (lower upper Tournaisian):* Morocco.——FIG. 33,*1a–c.* **P. maghribensis,* holotype, Taouz, Jebel Ouaoufilal, east of Ksar Bouhamed, Tafilalt, Oued Znaïgui Formation, MB C.3978; *a–b,* ×3; *c,* suture, diameter at 14.7 mm, whorl height 6.7 mm, whorl width 12.4 mm, ×3.4 (Korn & others, 2003).——FIG. 33,*1d–g. P. karensis* (KUZINA), Peiakha River, Pai-Khoi, Komi, Tournaisian-Visean boundary beds, PIN 2775/508; *d–f,* apertural, lateral, and ventral views, ×1.5; *g,* suture of holotype, whorl height at 10 mm, whorl width 14 mm, ×6.7 (Kuzina, 2000).

Sygambrites KORN, 1988b, p. 138 [**S. wollbriggensis;* OD] [?=*Kalajilagites* LIANG & WANG, 1991, p. 96 (type, *K. stenolobus,* OD)]. Conch form subglobular, relatively wide, with very narrow umbilicus.

Ventral lobe narrow, median saddle half as high as entire lobe, ventrolateral saddle relatively broad. Only holotype known. [*Kalajilagites* displays a more subacute ventrolateral saddle. This character is regarded herein as being of specific significance.] *Mississippian (upper Visean):* Germany.——Fig. 32,*2. *S. wollbriggensis,* holotype, suture, Wicheln, Möhnesee, Rhenish Massif, Kulmplattenkalk, WMN 10191, diameter at 18.7 mm, whorl height 8.1 mm, whorl width 18.9 mm, ×4.2 (Korn, 1988b).

Family DELEPINOCERATIDAE Ruzhentsev, 1957

[Delepinoceratidae Ruzhentsev, 1957, p. 58]

Conch form and ornamentation as in Goniatitidae; suture with tendency toward trifurcation of external lobes. Triangular whorls on immature stages in some genera common. Sutural formula of advanced forms: $(E_{1d}E_{1m}E_{1v}E_mE_{1v}E_{1m}E_{1d})(A_vA_mA_d)$LUI [German], $(V_2V_1V_2)(V_2V_1V_2)(L_2L_1L_2)$U:ID [Russian]. [Some authors (e.g., Ruzhentsev & Bogoslovskaia, 1971) restrict this family to genera with trifid prongs of the ventral lobe and trifid adventitious lobe; they assign genera with undivided ventral lobe to the family Agathiceratidae. This view disregards the peculiar characteristics of the Pennsylvanian and Permian genus *Agathiceras* and dissects the close relationship of delepinoceratid genera. This group is probably derived from *Lusitanoceras.*] *Mississippian (upper Visean)–Pennsylvanian (Bashkirian, ?Moscovian).*

Subfamily DELEPINOCERATINAE Ruzhentsev, 1957

[*nom. transl.* Kullmann, herein, *ex* Delepinoceratidae Ruzhentsev, 1957, p. 58]

Tendency of trifurcation of branches of ventral lobe as well as of adventitious lobe. *Mississippian (upper Visean–Serpukhovian).*

Delepinoceras Miller & Furnish, 1954, p. 690 [**Dimorphoceras thalassoides* Delépine & Menchikoff, 1937, p. 83; OD]. Branches of ventral lobe and adventitious lobe tridentate; median saddle very high. Five species. [The type species is poorly known and poorly preserved, and no suitable figure is available. The chosen species is closely related.] *Mississippian (Serpukhovian):* France, Spain, Algeria, Russia (Novaia Zemlia), Russia and Kazakhstan (South Urals), China (Guangxi), Uzbekistan, Tajikistan (Darvaz, Hissar Mountains), USA (Arkansas, Oklahoma, Utah, Nevada, California).——Fig. 34,*1a–c. D. bressoni* Ruzhentsev; *a–b,* Ada, Pontotoc County, Oklahoma, Springer Formation, upper Chesterian, SUI Iowa City 10986, ×2 (Furnish, Quinn, & McCaleb, 1964); *c,* holotype, suture, Kzyl-Shin, South Urals, Kazakhstan, upper Serpukhovian, PIN 455/330, whorl height at 32.0 mm, whorl width 27.5 mm, ×1 (Ruzhentsev & Bogoslovskaia, 1971).

Platygoniatites Ruzhentsev, 1956a, p. 158 [**P. molaris;* OD] [=*Altayceras* Wang, 1983, p. 527 (type, *A. chinensis* Wang, 1983, p. 528, OD)]. Sides of ventral and adventitious lobes with tendency toward processes, but not yet tridentate. Some forms with triangular coiling on immature stages. Ventral lobe wide, median saddle higher than half the height of entire ventral lobe. Prongs of ventral lobe and adventitious lobe pouched and bell shaped. [The synonym *Altayceras* is based on a single compressed and poorly preserved specimen that may belong in *Platygoniatites.*] Many species. *Mississippian (uppermost Visean–Serpukhovian):* Spain, Portugal, Russia (Novaia Zemlia), Russia and Kazakhstan (South Urals), China (Guangxi, Ningxia, Xinjiang), Tajikistan (Darvaz), USA (Nevada).——Fig. 34,*2a–f. *P. molaris,* Dombar Hills, South Urals, Kazakhstan, lower Serpukhovian; *a–b,* PIN 455/210, ×1; *c–d,* PIN 455/212, ×1; *e,* holotype, suture, PIN 455/209, whorl height at 31.5, whorl width 25 mm, ×1 (Ruzhentsev & Bogoslovskaia, 1971); *f,* cross section, Dombar Hills, PIN 455/214, ×2 (Ruzhentsev, 1956a).

Subfamily DOMBARITINAE Kullmann, 2007

[Dombaritinae Kullmann in Kullmann, Wagner, & Winkler Prins, 2007, p. 138] [type genus, *Dombarites* Librovich, 1957, p. 257]

Delepinoceratidae with tendency toward trifurcation of adventitious lobe only. *Mississippian (upper Visean)–Pennsylvanian (Bashkirian, ?Moscovian).*

Dombarites Librovich, 1957, p. 257 [**D. tectus* Librovich, 1957, p. 258; OD] [=*Revilloceras* Wagner-Gentis, 1980, p. 13 (type, *Mesoglyphioceras granosum barruelense* Wagner-Gentis, 1963, p. 11, OD)]. Conch form in general similar to *Lusitanoceras,* but adventitious lobe with short processes on both sides with tendency to become tridentate. Several species with triangular whorls on immature stages; some species with oxycone venter on adult stages. Ornamentation usually with closely spaced lirae, some species lacking spiral ornamentation. Ventral lobe relatively wide, median saddle about half as high or higher, in some species reaching two-thirds height of entire ventral lobe. Sides of ventral lobe diverging, less in apicad part, strongly in orad part; inflexion point coinciding usually with height of median saddle. First lateral saddle acute or subacute; adventitious

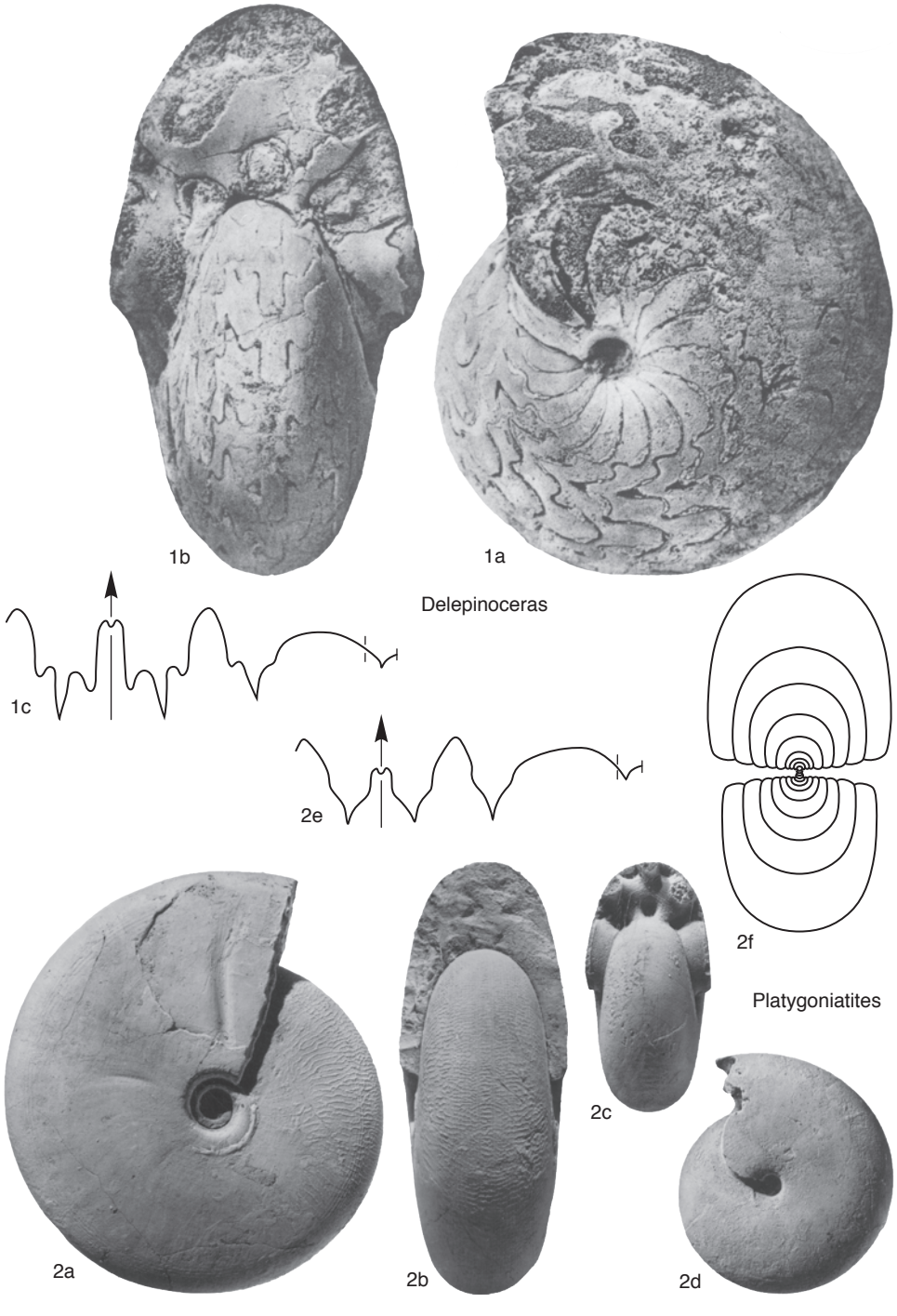

FIG. 34. Delepinoceratidae (p. 57).

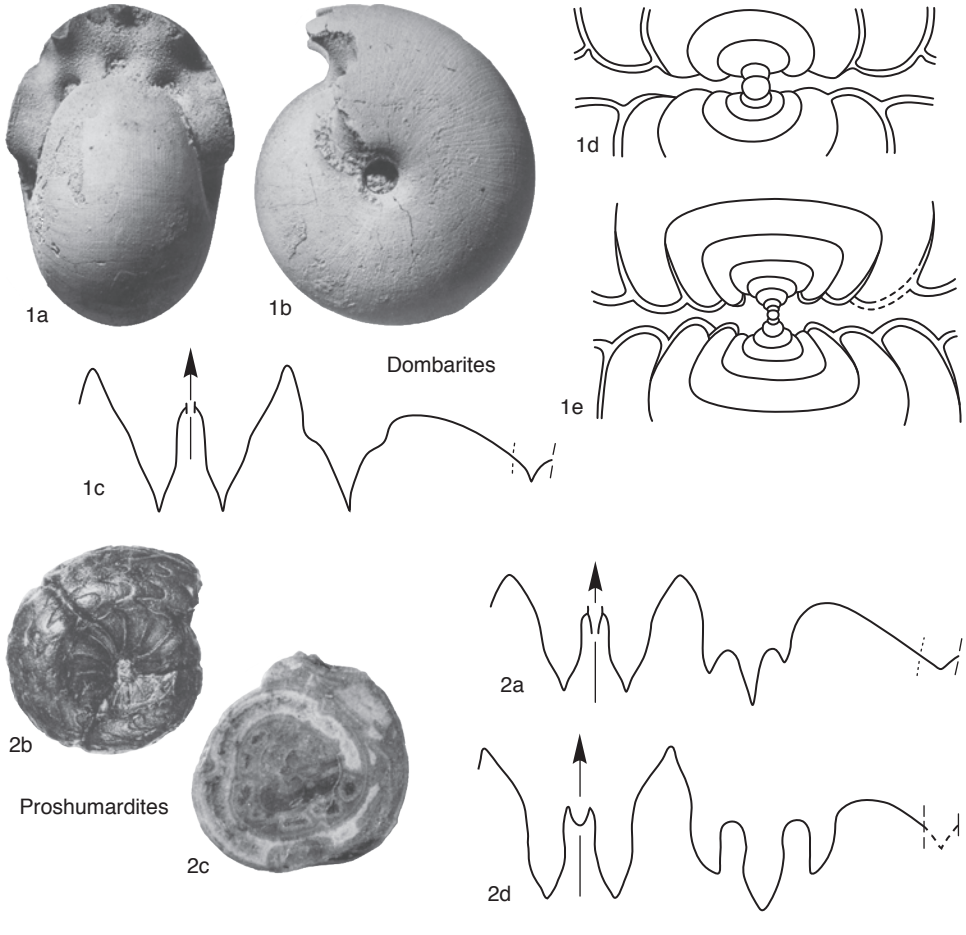

FIG. 35. Delepinoceratidae (p. 57–60).

lobe wide. Many species. [*Revilloceras* was established for forms with blunted tips of ventrolateral saddle, a general character in small forms.] *Mississippian (upper Visean–lower Serpukhovian):* France, Portugal, Spain, Algeria, Russia (Novaia Zemlia), Russia and Kazakhstan (South Urals), China (Guangxi, Ningxia, Xinjiang, Xizang), Tajikistan (Darvaz), Uzbekistan, USA (Arkansas, Oklahoma, Texas, Utah).——FIG. 35,*1a–c. *D. tectus; a–b,* Dombar Hills, South Urals, Kazakhstan, lower Serpukhovian, PIN 455/19456, ×1; *c,* suture, whorl height at 31 mm, whorl width 41.5 mm, PIN 455/19455, ×1.1 (Ruzhentsev & Bogoslovskaia, 1970).——FIG. 35,*1d–e. D. choctawensis* (SHUMARD), Johnston County, Oklahoma, Caney Shale, upper Chesterian; *d,* cross section showing subspherical early whorls, USNM 119502, ×5; *e,* cross section showing subquadrate early whorls, USNM 119504, ×5 (Gordon, 1965).

Proshumardites RAUZER-CHERNOUSOVA, 1928, p. 165 [**P. karpinskii;* OD] [=*Trigonoshumardites* KULLMANN, 1962, p. 333 (type, *P. (T.) wocklumerioides,* OD)]. Conch form thickly discoidal, umbilicus very narrow. Several species with triangular whorls on immature stages. Ornamentation consisting of fine growth lines and usually of prominent, closely spaced lirae; spiral ornamentation lacking in some species. Ventral lobe relatively wide; median saddle higher than half height of entire ventral lobe. Ventrolateral saddle rather broad, subacute, or narrowly rounded. Adventitious lobe wide and tridentate. More than ten species. [*Trigonoshumardites* had been erected for species with triangular inner whorls, a character regarded herein

as being of specific significance. Several authors have assigned some species of Serpukhovian age to *Pericleites;* its type, *Pericleites atticus* RENZ, had been secured from lower Permian (?Asselian) strata (see RENZ, 1955, p. 413, 416), however; for discussion, see family Agathiceratidae herein (below).] *Mississippian (Serpukhovian)–Pennsylvanian (Bashkirian, ?Moscovian):* France, Spain, Serbia, Slovakia, Ukraine (Donets), Algeria, Iran, China (Gansu, Guangxi, Guizhou, Xinjiang), Japan, Russia (Novaia Zemlia, South Urals), Kazakhstan (South Urals, Tian Shan), Kyrgyzstan, Tajikistan (Darvaz, Hissar Mountains, Pamirs), Uzbekistan, Canada (Northwest Territories), USA (Arkansas, Oklahoma, Texas, Utah, Nevada.——FIG. 35,*2a.* **P. karpinskii,* Chumaza River, South Urals, Bashkortostan, lower Bashkirian, Russia, whorl height at 8 mm, whorl width 10.5 mm, PIN 455/28786, ×4.3 (Ruzhentsev & Bogoslovskaia, 1978). ——FIG. 35,*2b–d. P. delepinei* (SCHINDEWOLF); *b,* Ben-Zireg, Algeria, Tagnana Formation, upper Serpukhovian, ×2 (Pareyn, 1961); *c,* median cut showing triangularity of inner whorls, Druzetic-Milivojevici, upper Serpukhovian, Serbia, Collection Stevanovics Beograd, S 23, ×3; *d,* suture, Cantabrian Mountains, Perlora, Asturias, Spain, upper Serpukhovian, diameter at about 18 mm, GPIT 1206/258, ×2.4 (Kullmann, 1962).

AGATHICERATOIDEA

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Superfamily AGATHICERATOIDEA Arthaber, 1911

[*nom. correct.* MILLER & FURNISH, 1954, p. 687, *pro* Agathiceratida BÖHMERS, 1936, p. 65, *nom. transl. ex* Agathiceratidae ARTHABER, 1911, p. 178] [=suborder Agathiceratina LEONOVA, 2002, p. 36]

Conch form thickly discoidal to globular; whorl section involute, umbilicus very small to closed. Siphuncle retrochoanitic, with long septal necks. Siphuncle of inner whorls in central position, and migrating ventrad becoming marginal on later volutions. *Pennsylvanian (Kasimovian)–Guadalupian (Wordian).*

Family AGATHICERATIDAE Arthaber, 1911

[Agathiceratidae ARTHABER, 1911, p. 178] [=Aristoceratinae LEONOVA, 2002, p. 41]

Suture line with trifurcation of adventitious lobe resulting in three discrete, subequal lateral lobes. Sutural formula: $(E_1E_mE_1)A_vA_mA_dLUI$ [German], $(V_1V_1)L_2L_1L_2U{:}ID$ [Russian]. [The presumed root group Dombaritinae (e.g., *Proshumardites*) is questionable.] *Pennsylvanian (Kasimovian)–Guadalupian (Wordian).*

Agathiceras GEMMELLARO, 1887, p. 75 [**A. suessi* GEMMELLARO, 1887, p. 79; OD] [=*Paragathiceras* RUZHENTSEV, 1950, p. 92 (type, *Agathiceras ? tornatum* GEMMELLARO, 1887, p. 82, OD)]. Conch form subdiscoidal, involute. Sculpture with prominent longitudinal lirae. Apertural constrictions common. Ventral lobe broad, with pouched, apicad pointed branches; median saddle in some forms reaching almost total height of ventral lobe. In adult, adventitious lobe of early whorls developing three discrete and subequal spatulate lobes. Many species. [*Paragathiceras* was erected for a form with a parabolic outline; for discussion, see GLENISTER & FURNISH, 1961, p. 695.] *Pennsylvanian (Kasimovian)–Guadalupian (Wordian):* Italy (Carnic Alps, Sicily), Slovenia, Tunisia, Ukraine (Crimea), Russia (South Urals, Siberia), Kazakhstan (South Urals), Afghanistan, China (Guizhou, Guangxi, Jilin, Nei Monggol, Xinjiang, Xizang), Iraq, Oman, Indonesia (Timor), Japan (Akiyoshi, Kitakami), Tajikistan (Darvaz, Pamirs), Thailand, Canada (British Columbia, Northwest Territories), Mexico

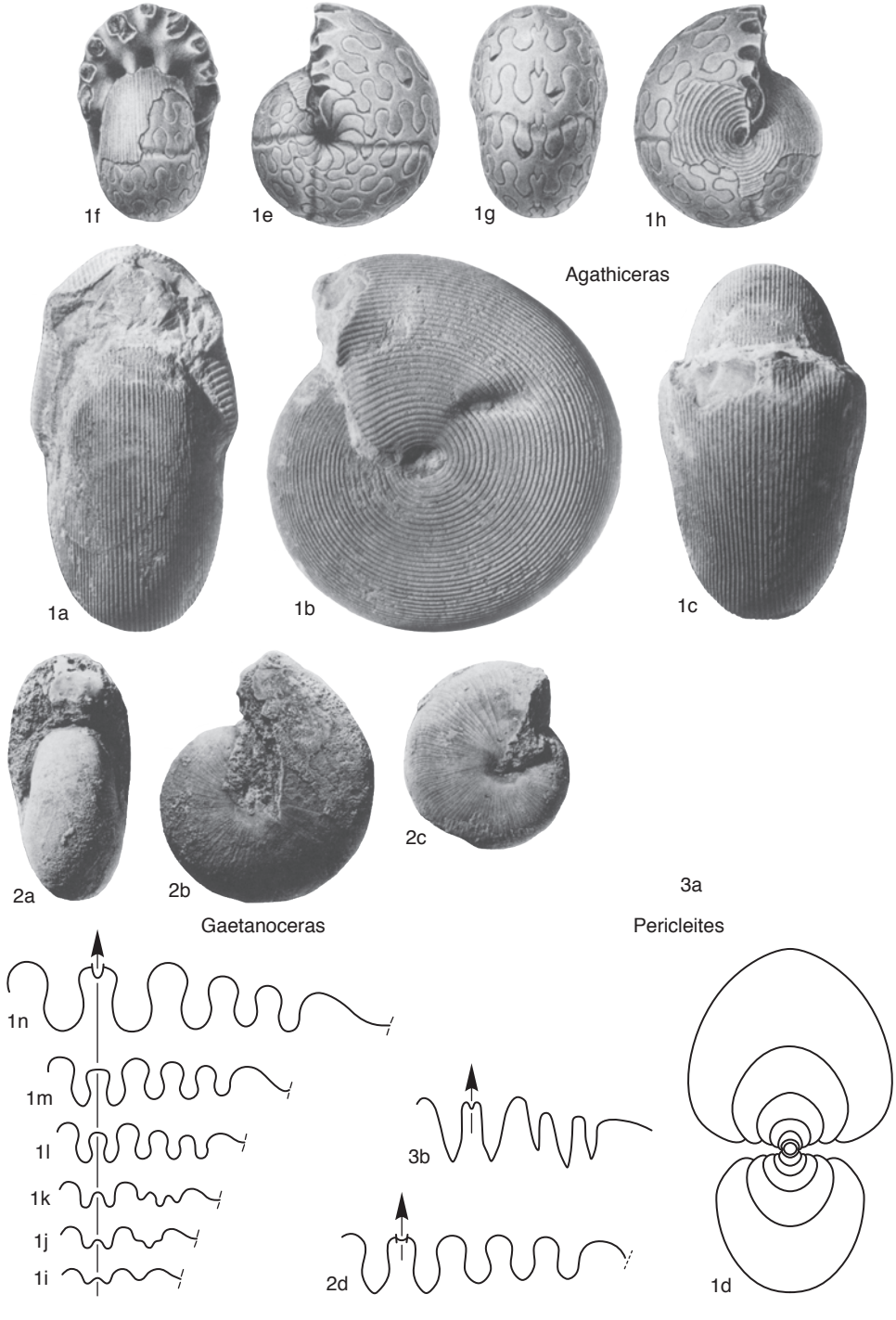

FIG. 36. Agathiceratidae (p. 60–62).

(Coahuila), USA (Texas, California), Australia (Western Australia).——FIG. 36,*1a–d. *A. suessi; a–c,* lectotype, Palazzo Adriano, Sicily, Italy, Sosio Limestone, Wordian, MGUP 86, approximately ×1.5 (Davis, Furnish, & Glenister, 1969); *d,* cross section, SUI 13613A, ×3 (Dixon, 1960).——FIG. 36,*1e–h. A. frechi* BÖSE, Wolf Camp, Glass Mountains, Brewster County, Texas, USA, Gaptank Formation, Virgilian, YPM 16762, ×2 (Miller & Furnish, 1940a).——FIG. 36,*1i–n. A. uralicum* (KARPINSKII), ontogenetic development of suture line; *i,* whorl width at 0.8 mm, PIN 317/2437, ×25; *j,* whorl width at 1 mm, ×25; *k,* whorl width at 1.3 mm, ×25; *l,* whorl width at 3.3 mm, ×10; *m,* whorl height at 3.5 mm, whorl width 4.3 mm, ×10; *n,* left bank of Aktasty River, eastern limestones, Aktastinskii subformation, Artinskian, PIN 317/2435, whorl height at 12 mm, whorl width 11 mm, ×5 (Ruzhentsev, 1956b).

Gaetanoceras RUZHENTSEV, 1938, p. 262 [**Agathiceras martini* HANIEL, 1915, p. 72; OD]. Similar to *Agathiceras,* but ornamentation consisting of delicate growth lines only. Five species. *Cisuralian (Kungurian)–Guadalupian (Wordian):* Tajikistan (Pamirs), Indonesia (Timor), China (Hunan).——FIG. 36,*2a–d. *G. martini* (HANIEL); *a–b,* lectotype (GLENISTER, FURNISH, & ZHOU, herein), Bitauni beds, Artinskian, Timor, GIUA no.THD 12735 (same as HANIEL, 1915, pl. 49,*18*), ×1; *c,* side view, GIUA, no. THD 874, ×1; *d,* holotype, suture, ×5.5 (Glenister, Furnish, & Zhou, new).

?Pericleites RENZ, 1910, p. 464 [**Paralegoceras (Pericleites) atticum;* M]. Conch form as in *Agathiceras,* thickly discoidal, with extremely narrow or even closed umbilicus. Ornamentation consisting of coarse, widely spaced growth lines forming a shallow sinus on flanks and on venter. No ribs and no spiral ornamentation. Ventral lobe relatively wide, Y-shaped, and adorad widely diverging, with lanceolate prongs, median saddle much higher than half height of entire lobe. Ventrolateral saddle subacute. On flanks, three spatulate lobes separated by rounded saddles, middle lobe being longer than ventrad and dorsad ones. One species. [The holotype (the only specimen) is poorly preserved, and the inner part of the suture and its ontogeny is unknown. Some authors regard the genus as closely related to *Proshumardites* (e.g., SCHMIDT, 1925, p. 599; RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 236), others as incompletely and insufficiently known (MILLER & CLINE, 1934a, p. 183; SCHINDEWOLF, 1939a, p. 431). For the revised stratigraphic assignment of the lower Permian, see RENZ, 1955, p. 413, 416.] *Cisuralian (?Asselian):* Greece.——FIG. 36,*3a–b. *P. atticus,* Hagia Triada, Attica, black Permian limestones, collection Renz; *a,* side view, approximately ×0.5; *b,* suture line, ×0.7 (Miller & Cline, 1934a, adapted from Renz, 1910).

NEOGLYPHIOCERATOIDEA

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Superfamily NEOGLYPHIOCERATOIDEA Plummer & Scott, 1937

[*nom. transl.* RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 242, *ex* Neoglyphioceratidae PLUMMER & SCOTT, 1937, p. 185]

Conch form very variable, from vermicular and evolute to globular and involute. Growth lines usually biconvex, with ventral sinus or salient. Spiral ornamentation common, consisting frequently of more or less widely spaced strong lirae. Ventrolateral grooves present in some genera. Strong constrictions widespread and often typical. Ventral lobe relatively narrow, with subparallel or divergent sides; median saddle low to about half as high as entire ventral lobe. First lateral saddle broadly rounded, adventitious lobe usually relatively narrow and pointed, lateral lobe on or close to umbilical wall. Sutural formula: $(E_1E_mE_1)$ ALUI [German], (V_1V_1)LU:ID [Russian]. *Mississippian (upper Visean)–Pennsylvanian (lower Bashkirian).*

Family NEOGLYPHIOCERATIDAE Plummer & Scott, 1937

[Neoglyphioceratidae PLUMMER & SCOTT, 1937, p. 185]

Conch subdiscoidal or pachycone, whorl section moderately involute or involute, mostly with narrow umbilicus. Spiral ornamentation frequent, but faint, or missing in some forms; no ventrolateral grooves. Ventral lobe with subparallel or divergent sides. *Mississippian (upper Visean–Serpukhovian).*

Subfamily NEOGLYPHIOCERATINAE Plummer & Scott, 1937

[*nom. transl.* KULLMANN, herein, *ex* Neoglyphioceratidae PLUMMER & SCOTT, 1937, p. 185]

Conch rather small, usually lenticular in adult whorls, sometimes with flattened flanks. Spiral ornamentation usually densely spaced, faint, and frequently crenulate. *Mississippian (upper Visean–Serpukhovian).*

Neoglyphioceras BRÜNING, 1923b, p. 30 [**Goniatites spiralis* PHILLIPS, 1841, p. 121; SD PLUMMER & SCOTT, 1937, p. 185] [=*Paragoniatites* LIBROVICH, 1938, p. 81, 103 (type, *Gastrioceras caneyanum* GIRTY, 1909, p. 57, OD)]. Conch form discoidal to subglobose, moderately involute. Sculpture consisting of fine transverse striae crossed by prominent longitudinal lirae; strong constrictions form lateral sinus, shallow salient on ventrolateral shoulder and shallow ventral sinus. Some species exhibit riblets. Ventral lobe relatively narrow, with roundly diverging sides; first lateral saddle broadly rounded. Adventitious lobe wide, bell shaped, pointed. Many species. *Mississippian (upper Visean–Serpukhovian):* Belgium, Great Britain, Ireland, Germany, Czech Republic, Poland, Portugal, Spain, Algeria, Morocco, Russia (Novaia Zemlia, South Urals, Siberia), China (Ningxia), Kazakhstan (South Urals, Karaganda), USA (Arkansas, Illinois, Oklahoma, Utah).——FIG. 37,*4a–b.* **N. spirale* (PHILLIPS); *a,* side view, Dough Mountains, County Leitrim, Ireland, upper Visean, ×2 (Moore & Hodson, 1958); *b,* suture, Sauerland, Germany, upper Visean, magnification not indicated (Brüning, 1923b).

Lusitanites RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 321 [**Goniatites subcircularis* MILLER, 1889, p. 440; OD]. Similar to *Neoglyphioceras,* but constrictions with ventral salient and spiral ornamentation consisting of 28 to 42 lirae; growth lines linear on ventral side, no riblets. Ventral lobe rather narrow, median saddle low, reaching one-third of entire lobe. Six species. *Mississippian (upper Visean):* Belgium, Great Britain, Ireland, Germany, Czech Republic, Poland, France, Portugal, Spain, Algeria, Russia (Novaia Zemlia, South Urals), Kazakhstan (South Urals, Mugodzhary), Tajikistan, Uzbekistan, USA (Arkansas, Kentucky, Utah, Texas).——FIG. 37,*1a–c.* **L. subcircularis* (MILLER), Crab Orchard, Rockcastle County, Kentucky, USA, Meramec series, PUC; *a–b,* ×2; *c,* suture, diameter at 12 mm, ×5.6 (Miller & Furnish, 1940b).

Lytheoceras RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 320 [**L. nitidum*; OD]. Similar to *Neoglyphioceras*, but no spiral ornamentation. Deep constrictions, one or two per whorl, almost linear. Two species. *Mississippian (lower Serpukhovian):* Russia and Kazakhstan (South Urals).——FIG. 37,*2a–c.* **L. nitidum; a–b,* holotype, River Zhaksy-Kargali, left bank, Aktiubinsk oblast', Aqtöbe, PIN 455/35639, ×2; *c,* suture, PIN 455/35641, whorl height at 4.4 mm, whorl width 5.3 mm, ×6.2 (Ruzhentsev & Bogoslovskaia, 1971).

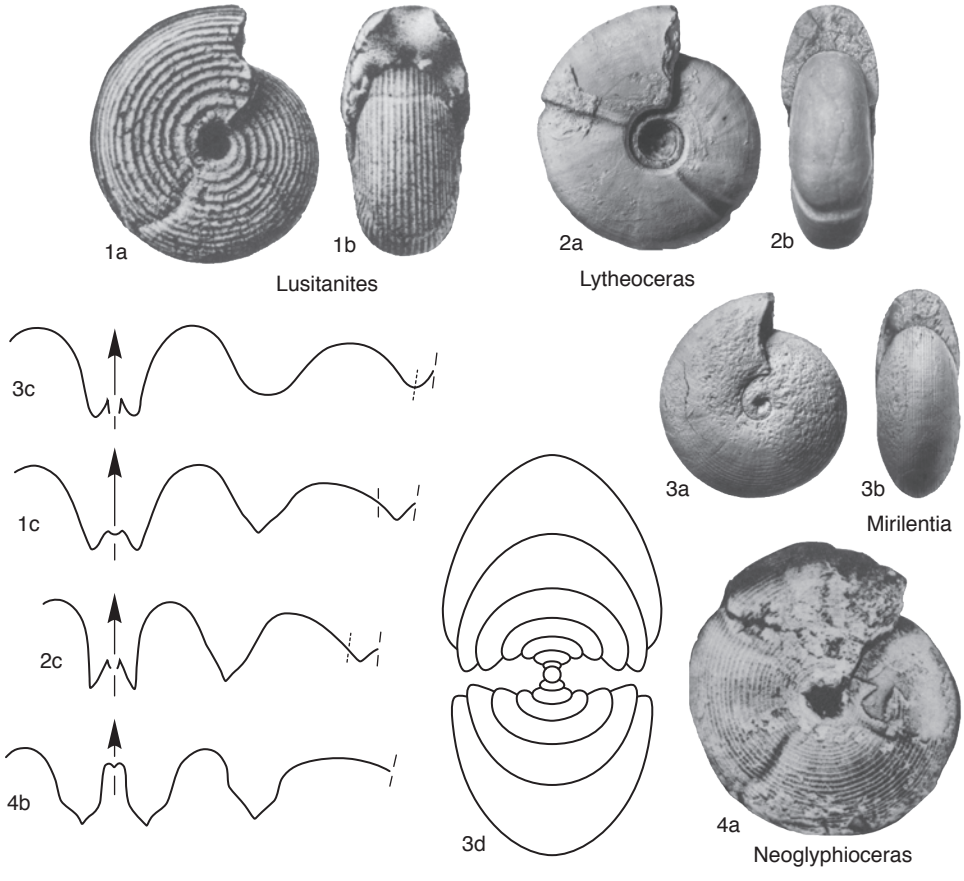

FIG. 37. Neoglyphioceratidae (p. 63–64).

Mirilentia RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 328 [**M. uberta*; OD]. Conch form small, thickly discoidal, with narrowly rounded, almost oxycone ventral side; umbilicus narrow, last half whorl with wide umbilicus. Faint longitudinal lirae may disappear on later stages; 3 to 4 constrictions, only on young stages, with lateral sinus and ventral salient. Ventral lobe narrow, rounded, with very low median saddle. Adventitious and lateral lobes broadly rounded. Three species. *Mississippian (Serpukhovian):* Russia and Kazakhstan (South Urals), Algeria.——FIG. 37,*3a–d. *M. uberta; a–b,* holotype, side view, apertural view, Dombar Hills, South Urals, Kazakhstan, lower Serpukhovian, PIN 455/35655, ×2; *c,* suture, PIN 455/35659, whorl height at 4.2 mm, whorl width 5.2 mm, ×8; *d,* cross section, PIN 455/35658, ×5 (Ruzhentsev & Bogoslovskaia, 1971).

Subfamily LYROGONIATITINAE Ruzhentsev & Bogoslovskaia, 1971

[Lyrogoniatitinae RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 272]

Shell form rather large, subdiscoidal or pachycone, moderately evolute to moderately involute. Umbilicus moderately wide. Some forms with umbilical seam covered by test material. Sculpture variable, some forms with umbilical notches. Lirae usually stronger than growth lines, sometimes 20 to 50 on outer surface; constrictions usually wide and deep, especially on steinkern. [Lyrogoniatitinae was established (RUZHENTSEV & BOGOSLOVSKAIA, 1971) as a

subfamily of Cravenoceratidae, sorting out *Lyrogoniatites* and other neoglyphioceratids from Neoglyphioceratidae. The arguments in regard to assumed different phylogenetic lineages in Neoglyphioceratidae, Cravenoceratinae, and Lyrogoniatitinae are not followed herein. The assignment of the closely related genera *Neoglyphioceras, Lyrogoniatites,* and *Pachylyroceras* to different families is regarded herein as questionable.] *Mississippian (upper Visean–lower Serpukhovian).*

Lyrogoniatites Miller & Furnish, 1940b, p. 368 [**L. newsomi georgiensis;* OD]. Similar to *Neoglyphioceras*, but with broader conch and lower number (30–60) of longitudinal lirae. Constrictions usually deep and narrow, with ventrolateral salient and ventral sinus on all growth stages. Ventral lobe rather narrow. Seven species and three questionable species. *Mississippian (upper Visean–lower Serpukhovian):* Great Britain, Germany, Portugal, Algeria, Czech Republic, Russia (Novaia Zemlia, South Urals), Kazakhstan (South Urals), Tajikistan (Darvaz), Uzbekistan, China (Ningxia), USA (Alaska, Georgia).——Fig. 38,*1a–d. *L. georgiensis*, holotype, Land's well, Lot 286, about 9 km north of Rome, Floyd County, Georgia, Chesterian, USNM 60600; *a–c,* ×1.5; *d,* suture, diameter at 15 mm, ×4.3 (Miller & Furnish, 1940b).

Alaoceras Ruzhentsev & Bogoslovskaia, 1971, p. 250 [**A. bajtalense* Ruzhentsev & Bogoslovskaia, 1971, p. 251; OD]. Conch subdiscoidal to pachycone, umbilicus wide or moderately wide. Umbilical seam as in *Pachylyroceras,* closed by test material with a thin groove alongside. Sculpture displays umbilical notches; spiral ornamentation weak, sometimes disappearing. One or two constrictions per whorl. Ventral lobe narrow at base; sides of ventral lobe considerably diverging. Two species. *Mississippian (upper Visean–lower Serpukhovian):* Kazakhstan (South Urals).——Fig. 38,*4a–c. *A. bajtalense,* holotype, Dombar Hills, South Urals, lower Serpukhovian, PIN 455/29782; *a–b,* apertural view, ×1; *c,* suture, whorl height at 7 mm, whorl width 18 mm, ×4 (Ruzhentsev & Bogoslovskaia, 1971).

Caenolyroceras Ruzhentsev & Bogoslovskaia, 1971, p. 277 [**C. subgloboide* Ruzhentsev & Bogoslovskaia, 1971, p. 278; OD]. Similar to *Lyrogoniatites,* but on early whorls with wide umbilicus, later moderately wide umbilicus. Ornamentation consisting of 35–55 strong spiral lirae and faint, weakly biconvex growth lines. Constrictions may be present. Two or three species. [The figures for *C. chalicum* are better than those for *C. subgloboide*.] *Mississippian (upper Visean–lower Serpukhovian):* ?Great Britain, Germany, Poland, Kazakhstan (South Urals), ?China (?Ningxia).——Fig. 38,*3a–c. C. chalicum* Korn, holotype, Estinghausen, Sauerland, Rhenish Massif, Germany, upper Visean, WMN 10210; *a–b,* ×2.5; *c,* paratype, suture, WMN 10216, whorl height at 4.1 mm, whorl width 9.6 mm, ×7.5 (Korn, 1988b).

Dombarigloria Ruzhentsev & Bogoslovskaia, 1971, p. 248 [**D. miranda* Ruzhentsev & Bogoslovskaia, 1971, p. 249; OD]. Conch form as in *Pachylyroceras.* Sculpture consisting of only 14–18 longitudinal lirae; no or inconspicuous constrictions. Ventral lobe narrow, with parallel sides. Two species. [This genus is closely related to *Pachylyroceras* and may be its junior synonym.] *Mississippian (upper Visean):* Kazakhstan (South Urals).——Fig. 38,*2. *D. miranda,* holotype, suture, Dombar Hills, PIN 455/29450, whorl height at 7.3 mm, whorl width 22.0 mm, ×2.6 (Ruzhentsev & Bogoslovskaia, 1971).

Pachylyroceras Ruzhentsev & Bogoslovskaia, 1971, p. 243 [**Lyrogoniatites cloudi* Miller & Youngquist, 1948, p. 660; OD] [=*Entogonoceras* Plummer & Scott, 1937, text-fig. 88, *nom. nud.,* no type designated; for discussion, see Gordon, 1965, p. 197]. Conch form large, thickly discoidal to subglobular, moderately evolute to moderately involute. Umbilicus rather wide, seam covered by test material. Sculpture consisting of about 20–30 coarse, widely spaced longitudinal lirae; constrictions in most forms variable, wide, and deep. Ventral lobe narrow, with slightly divergent sides. Seven species. *Mississippian (upper Visean [Meramecian–Chesterian]):* Spain, Portugal, Kazakhstan (South Urals), Tajikistan (Darvaz), USA (Arkansas, Oklahoma, Texas).——Fig. 38,*5a–d. *P. cloudi* (Miller & Youngquist); *a–c,* holotype, San Saba County, 4 km SE of San Saba, Texas, Chesterian, USNM, ×1.5 (Miller & Youngquist, 1948); *d,* suture, Dombar Hills, South Urals, Kazakhstan, PIN 455/29171, whorl height at 5.4 mm, whorl width 12.0 mm, ×5 (Ruzhentsev & Bogoslovskaia, 1971).

Family CRAVENOCERATIDAE Ruzhentsev, 1957

[Cravenoceratidae Ruzhentsev, 1957, p. 58]

Conch form broad or thickly discoidal, moderately evolute to involute; in general evolute on inner whorls. Surface in general smooth, weak spirals may be present in some species; coarse, widely spaced longitudinal lirae rare. Ventral lobe relatively narrow, median saddle comparatively low. *Mississippian (Serpukhovian)–Pennsylvanian (lower Bashkirian).*

Subfamily CRAVENOCERATINAE Ruzhentsev, 1957

[*nom. transl.* Ruzhentsev, 1960d, p. 212, *ex* Cravenoceratidae Ruzhentsev, 1957, p. 58]

Umbilicus moderately narrow. Growth striae dominant, frequently lamellar,

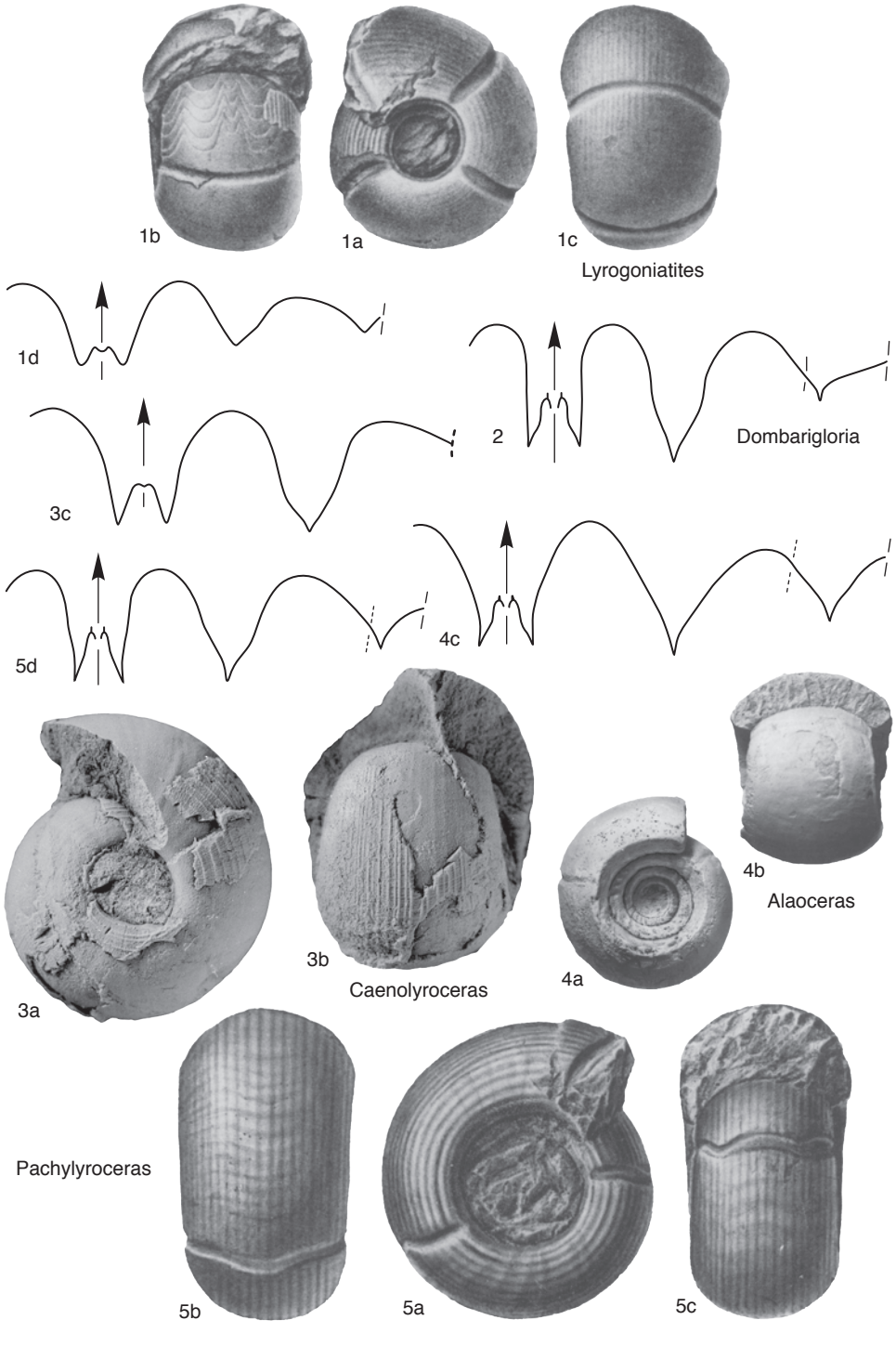

FIG. 38. Neoglyphioceratidae (p. 65).

sometimes dichotomizing. Spiral ornamentation may be present, but no reticulate ornament. *Mississippian (Serpukhovian [Chesterian])–Pennsylvanian (lower Bashkirian).*

Cravenoceras Bisat, 1928, p. 132 [**Homoceras malhamense* Bisat, 1924, p. 106; OD] [?=*Emstites* Korn, 1988b, p. 140 (type, *Paraglyphioceras schaelkense* Brüning, 1923b, p. 29, OD)]. Conch form thickly discoidal to globose, widely to moderately umbilicate, in young stages extremely evolute. Sculpture consisting of transverse lamellae, which are more or less straight on flanks, but forming a shallow ventral sinus. Spiral ornament may be present. Constrictions weak or absent. Ventral lobe narrow, with relatively low median saddle. Many species. [*Cravenoceras* is probably a senior synonym of *Emstites*; for discussion, see below. It is closely related and seems to be transitional to glaphyritid genera, e.g., *Syngastrioceras*; for discussion, see Saunders & Work, 1999.] *Mississippian (Serpukhovian [Chesterian]):* Great Britain, Ireland, Belgium, ?Germany, Spain, Portugal, Algeria, Czech Republic, Poland, Serbia, Russia (Moscow basin, Novaia Zemlia, South Urals), Ukraine, Kazakhstan (Karaganda, South Urals), Uzbekistan, Tajikistan (Darvaz), China (Xizang, Ningxia, Gansu), Australia (New South Wales), USA (California, Nevada, Oklahoma).——Fig. 39,*1a–d.* **C. malhamense* (Bisat), holotype, Bordley Shales, Moore Close Gill, Malham, Yorkshire, England, lower Serpukhovian; *a,* side view, ×3; *b,* side view of young specimen, ×5; *c,* suture, diameter at 13 mm, ×5.6; *d,* outline of holotype, ×5.6 (Bisat, 1924).

?Aenigmatoceras Ruzhentsev & Bogoslovskaia, 1978, p. 144 [**A. rhipaeum;* OD]. Conch subdiscoidal, involute, umbilicus moderately narrow. Two or three deep constrictions per whorl, deepest with sinus on flanks, shallow and almost linear on venter. Ventral lobe wide, with divergent sides. Median saddle exceeding slightly half height of entire ventral lobe, prongs not pouched. First lateral saddle rather wide, rounded. Two species. [Deep constrictions in this genus suggest a resemblance to *Tympanoceras,* but the phylogenetic relationship is uncertain and assignment to Cravenoceratidae is tentative.] *Pennsylvanian (lower Bashkirian [Kinderscoutian]):* Russia (South Urals, Bashkortostan), Uzbekistan (Kyzylkumy).——Fig. 39,*2a–d.* **A. rhipaeum; a–b,* holotype, Akberda River, Bashkortostan, upper *Reticuloceras* Zone, PIN 455/36120, ×1.5; *c,* suture of holotype, whorl height at 7.5 mm, whorl width 11.0 mm, ×4.1; *d,* cross section, Malaia Suren' river, PIN 455/38943, ×3.3 (Ruzhentsev & Bogoslovskaia, 1978).

Cravenoceratoides Hudson, 1941, p. 282 [**Goniatites nitidus* Phillips, 1836, p. 235; OD]. Conch form subglobular to subdiscoidal, moderately evolute to moderately involute. Sculpture consisting of almost radial transverse striae dichotomizing somewhat irregularly at or close to umbilical shoulder. Ventral lobe relatively wide, with diverging sides. Nine species. *Mississippian (Serpukhovian [Chesterian]):* Belgium, Great Britain, Ireland, Germany, Czech Republic, Poland, Portugal, Algeria, Morocco, Kazakhstan (South Urals), Uzbekistan (Fergana, Kyzylkumy), USA (California).——Fig. 40,*5a–b.* **C. nitidus* (Phillips), lectotype, Dinckley, River Ribble, England, Arnsbergian, BMNH C279, ×5 (Hudson, 1946).

?Emstites Korn, 1988b, p. 140 [**Paraglyphioceras schaelkense* Brüning, 1923b, p. 29; OD]. Conch form thickly discoidal to globular. Umbilicus of early whorls very wide, later narrow or moderately wide. Umbilical edge well developed. Ornamentation consisting of fine biconvex or convex growth lines; some species with faint spiral lirae. Ventral lobe rather narrow and V-shaped, median saddle moderately low, first lateral saddle broadly rounded. Ventrolateral saddle asymmetrical and very narrow in juvenile specimens. Ten species, several questionable. [This genus is closely related to *Cravenoceras* and is probably its junior synonym; some authors regard minor differences in the ontogenetic development of the ventral lobe and ventrolateral saddle as being sufficient to warrant generic separation (for discussion, see Korn & Tilsley, 2002, p. 116).] *Mississippian (Serpukhovian [basal Pendleian, Chesterian]):* Germany, ?Great Britain, ?Ireland, Russia (Novaia Zemlia, South Urals), Kazakhstan (South Urals), USA (Arkansas).——Fig. 39,*3a–c.* **E. schaelkensis* (Brüning), Schälk near Letmathe, Rhenish Massif, Germany, basal Serpukhovian, WMN 10195 (collection Korn); *a–b,* ×2; *c,* suture, WMN 10199, whorl height at 10.1 mm, whorl width 14.3 mm, ×4.1 (Korn, 1988b).

Gorboviceras Kuzina & Yatskov, 1999, p. 96 [**G. biconvexum;* OD]. Conch form small, thickly discoidal, widely umbilicate on early whorls, later moderately wide. Ornamentation of juvenile forms consisting of biconvex lamellae, later linear lamellae with ventral sinus. Ventral lobe with subparallel sides, slightly constricted close to first lateral saddle. Adventitious lobe deep, with sinuous sides. Two species. *Mississippian (lower Serpukhovian):* Russia (Novaia Zemlia).——Fig. 39,*4a–c.* **G. biconvexum,* holotype, Berkha island, southern shore, PIN 4279/2500; *a–b,* ×1.5; *c,* suture, whorl height at 5.2 mm, whorl width 12.0 mm, ×4 (Kuzina in Kuzina & Yatskov, 1999).

Lechroceras Ruan & Zhou, 1987, p. 117 [**L. latilobatum* Ruan & Zhou, 1987, p. 118; OD]. Conch form pachycone, with moderately wide umbilicus. Growth lines lamellar, spiral ornamentation and constrictions present. Ventral lobe very wide, with widely divergent sides and rather low median saddle. Adventitious lobe subacute, comparatively short. One species. *Mississippian (lower Serpukhovian):* China (Ningxia).——Fig. 40,*4a–c.* **L. latilobatum; a–b,* holotype, lower member of Tsingyuan Formation, Shangxiaoyuchuan section, Zhongwei County, NGPI 95800, ×2 (new, courtesy of Zhou Zuren); *c*, suture, NIGP 95799, whorl height at 7.4 mm, ×4 (Ruan & Zhou, 1987).

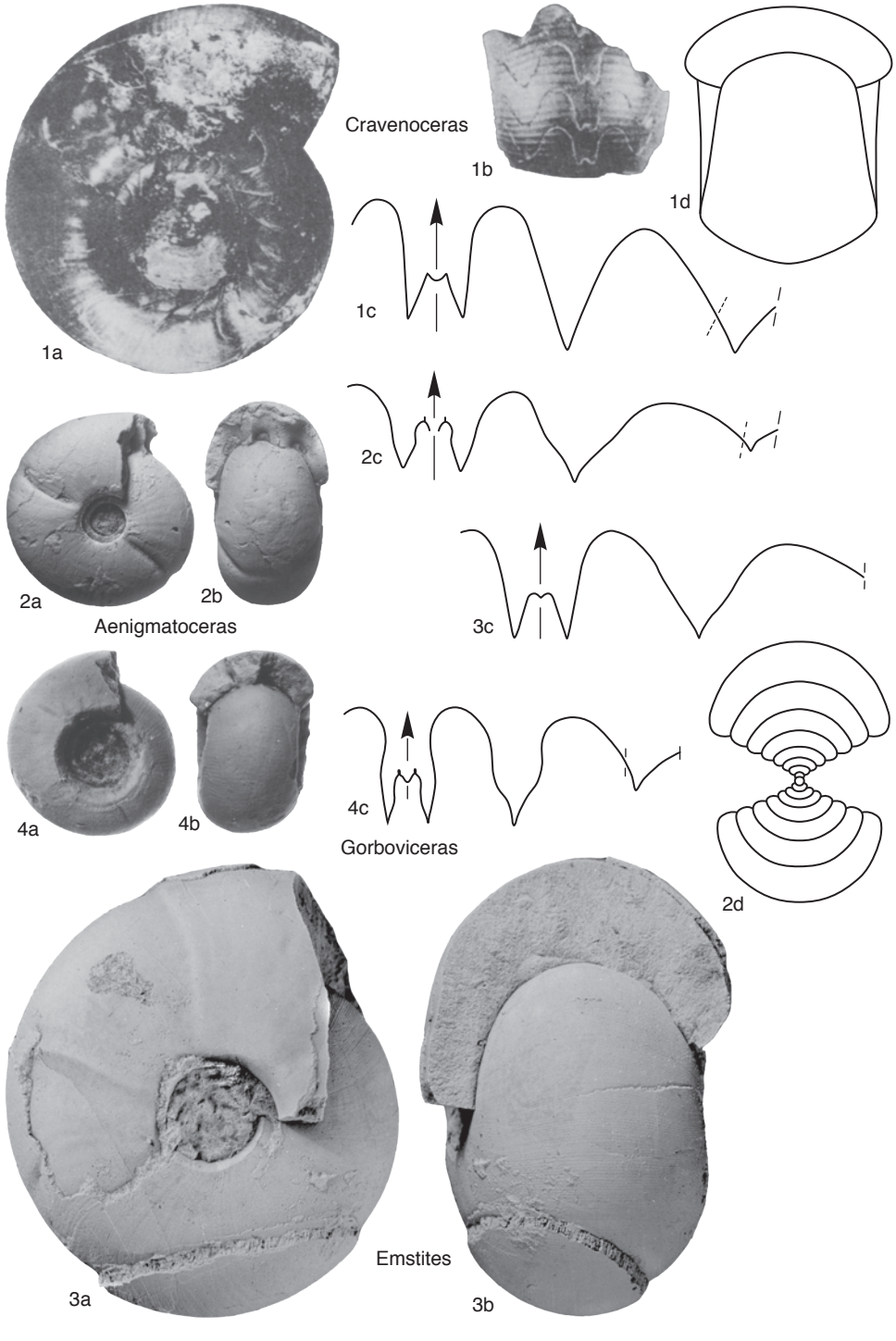

FIG. 39. Cravenoceratidae (p. 67).

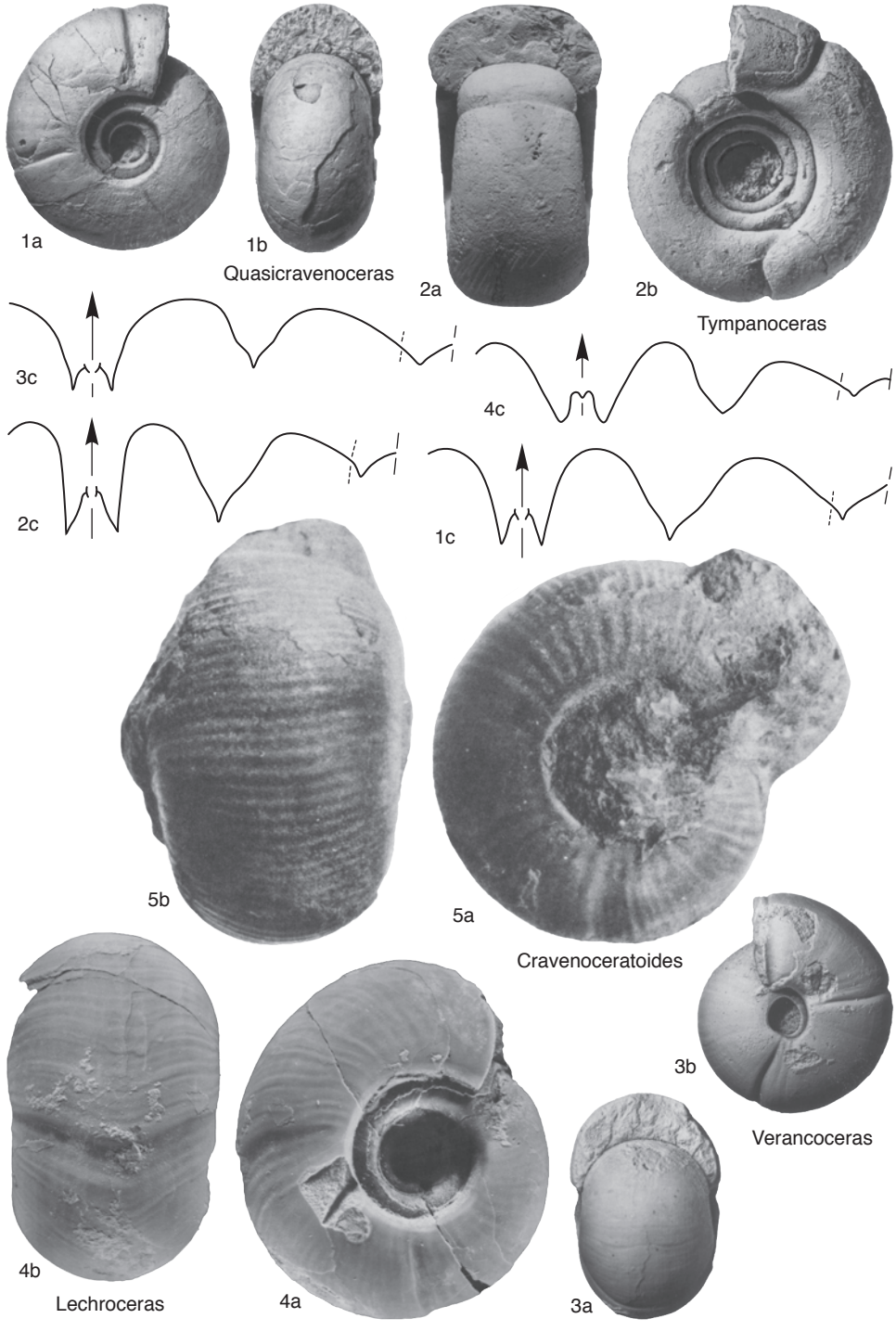

FIG. 40. Cravenoceratidae (p. 67–70).

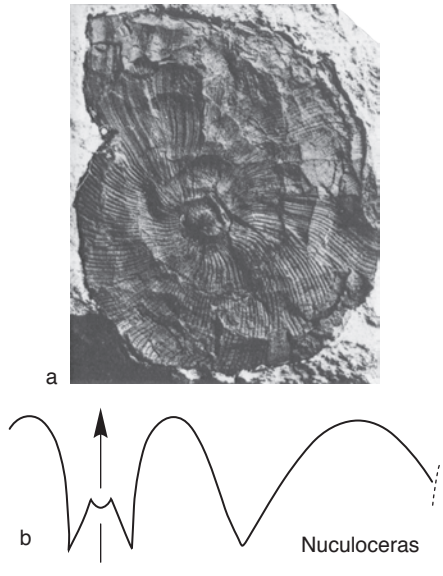

FIG. 41. Cravenoceratidae (p. 70).

Quasicravenoceras RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 279 [**Q. consuetum;* OD]. Conch form subdiscoidal, relatively involute, umbilicus moderately narrow or narrow. Sculpture consisting of distinct lamellae, sometimes thickened to little riblets; some longitudinal lirae may be present at umbilical ridge. Constrictions weak on shell surface, but strong and deep on steinkern. Ventral lobe with widely divergent sides, first lateral saddle very broad, rounded. Four species. *Mississippian (lower Serpukhovian):* Russia (Novaia Zemlia, South Urals), Kazakhstan (South Urals).——FIG. 40,*1a–c. *Q. consuetum*; *a–b,* holotype, Dombar Hills, South Urals, Kazakhstan, PIN 455/32707, ×1; *c,* suture, PIN 455/32710, whorl height at 7.7 mm, whorl width 13.0 mm, ×4 (Ruzhentsev & Bogoslovskaia, 1971).

Tympanoceras RUZHENTSEV, 1958, p. 295 [**T. trisulcum;* OD; =*T. trisulcatum* RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 270, *nom. van.*] [=*Collectoceras* RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 266 (type, *C. dombarense,* OD); =*Aravanites* ZAKHAROV, 1971, p. 93 (type, *A. kirgizstanicus,* OD)]. Conch form discoidal to subglobular, moderately involute, with wide umbilicus; height of aperture small. One to four constrictions per whorl, orad concave on flanks, crossing venter straight. Ventral lobe rather narrow, with relatively low median saddle; first lateral saddle broadly rounded. Adventitious lobe relatively narrow, pointed, with straight sides. Five species and two or three questionable species. [*Collectoceras* is distinguished by the presence of only one single deep constriction, regarded herein as being a specific rather than generic character. *Aravanites* is based on two poorly preserved specimens with somewhat more involute conch shape and slightly flattened flanks.] *Mississippian (lower Serpukhovian–upper Serpukhovian):* Russia (Novaia Zemlia, South Urals), Spain, Kazakhstan (South Urals), Kyrgyzstan, Uzbekistan; Spain, *upper Serpukhovian.*——FIG. 40,*2a–c. *T. trisulcum; a–b,* holotype, Dombar Hills, South Urals, Kazakhstan, lower Serpukhovian, PIN 455/458, ×2; *c,* suture, PIN 455/30363, whorl height at 6.0 mm, whorl width 12.0 mm, ×4 (Ruzhentsev & Bogoslovskaia, 1971).

?Verancoceras RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 282 [**V. admirabile* RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 283; OD]. Conch form as in *Quasicravenoceras*, but broader and with irregular umbilicus. Growth lines displayed as weak lamellae, no spiral ornamentation. Ventral lobe very narrow, with low median saddle. Three species. [This genus is closely related to *Quasicravenoceras*; its generic independence is uncertain.] *Mississippian (upper Serpukhovian):* Russia and Kazakhstan (South Urals), China (Xizang).——FIG. 40,*3a–c. *V. admirabile; a–b,* holotype, side view, Zhaksy-Kargali River, left bank, Aqtöbe (=Aktiubinsk oblast'), South Urals, Kazakhstan, Arnsbergian, PIN 455/33390, ×1.5; *c,* suture, PIN 455/33393, whorl height at 6.0 mm, whorl width 8.8 mm, ×6 (Ruzhentsev & Bogoslovskaia, 1971).

Subfamily NUCULOCERATINAE Ruzhentsev, 1957

[*nom. transl.* RUZHENTSEV, 1960d, p. 213, *ex* Nuculoceratidae RUZHENTSEV, 1957, p. 58]

Conch form pachycone. Umbilicus very narrow or closed. Faint dichotomizing riblets and weak lirae present. [The root group and phylogenetic relationship of this subfamily are uncertain.] *Mississippian (Serpukhovian).*

Nuculoceras BISAT, 1924, p. 100 [**N. nuculum;* OD]. Conch form subglobose to globose, narrowly umbilicate. Sculpture consisting of strong transverse striae crossed by closely spaced longitudinal lirae, sometimes producing crenistriate pattern. Transverse striae with ventrolateral salient and shallow ventral sinus. Ventral lobe narrow, with relatively low median saddle; first lateral saddle narrowly rounded. Adventitious lobe relatively narrow, pointed, with straight sides. Five species and four questionable species. [The type material for this genus is poorly known; for discussion, see RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 310.] *Mississippian (Serpukhovian):* Great Britain, Ireland, Belgium, Germany, Netherlands, Serbia, Ukraine, Morocco, China (Xizang), Kazakhstan (South Urals).——FIG. 41*a. *N. nuculum,* Couthuyin, Liège, Belgium, upper Serpukhovian, ×1.4 (Demanet, 1941).——FIG. 41*b. N. crenistriatoides* KULLMANN, holotype, suture, Družetić-Milivojević, Serbia, upper Serpukhovian, SLM 4063/22, whorl height at 5 mm, whorl width 6.5 mm, ×3.5 (Kullmann, 1962).

Family FERGANOCERATIDAE Ruzhentsev, 1960

[*nom. transl.* Ruzhentsev & Bogoslovskaia, 1971, p. 330, *ex* Ferganoceratinae Ruzhentsev, 1960d, p. 203]

Conch form discoidal or subdiscoidal, with rather narrow umbilicus. Ventrolateral furrows present. Sculpture consisting of strong longitudinal lirae crossed by growth lines forming ventral and lateral sinus. Ventral lobe rather wide, with divergent sides; median saddle moderately high or higher than half the height of entire ventral lobe. First lateral saddle broadly rounded, adventitious lobe in some forms asymmetric. *Mississippian (upper Visean).*

Ferganoceras Librovich, 1957, p. 253 [**F. elegans* Librovich, 1957, p. 254; OD] [=*Ruddelites* Malinky & Mapes, 1982, p. 309 (type, *R. drahovzali* Malinky & Mapes, 1982, p. 312, OD)]. Conch form discoidal, moderately involute; umbilicus rather narrow. Sculpture consisting of faint growth lines with ventral and lateral sinus, crossing longitudinal lirae and ventrolateral grooves. Suture as in *Neoglyphioceras.* Four species. [*Ruddelites* is based on small specimens showing minor differences at the ventral lobe, and the measurements and characters are regarded herein as being of specific significance.] *Mississippian (upper Visean):* France, Algeria, China (Guangxi), Kazakhstan (South Urals), Uzbekistan (Fergana, Kyzylkumi, Tian Shan), USA (Arkansas).——Fig. 42,*1a–c. *F. elegans,* Dombar Hills, South Urals, Kazakhstan; *a–b,* side view, PIN 455/6231, ×1.5; *c,* suture, PIN 455/6158, whorl height at 8.2 mm, whorl width 8.4 mm, ×3 (Ruzhentsev & Bogoslovskaia, 1971).

Nummoceras Ruzhentsev & Bogoslovskaia, 1971, p. 333 [**N. limbatum;* OD]. Similar to *Ferganoceras,* but conch form thin-discoidal, involute on last whorls, with almost flattened ventral side. Ventral lobe very wide, with median saddle half as high as entire lobe. Adventitious lobe about as deep as ventral lobe. One species. *Mississippian (upper Visean):* Kazakhstan (South Urals).——Fig. 42,*2a–d. *N. limbatum; a–b,* holotype, Dombar Hills, PIN 455/5802, ×1.5; *c,* suture, PIN 455/5807, ×5; *d,* cross section, PIN 455/5804, ×5 (Ruzhentsev & Bogoslovskaia, 1971).

Family RHYMMOCERATIDAE Ruzhentsev & Bogoslovskaia, 1971

[Rhymmoceratidae Ruzhentsev & Bogoslovskaia, 1971, p. 334] [=Rhymmoceratinae Ruzhentsev & Bogoslovskaia, 1971, p. 335]

Conch form discoidal, vermicular, evolute, with wide umbilicus. Conspicuous ornamentation varies considerably. Ventral lobe rather narrow, with low median saddle; advanced forms reach gastrioceran type of suture, but median lobe does not exceed half length of entire ventral lobe. [The root group and phylogenetic relationship of this family are uncertain.] *Mississippian (upper Visean)–Pennsylvanian (lower Bashkirian).*

Rhymmoceras Ruzhentsev, 1958, p. 293 [**R. vermiculatum;* OD]. Conch form small, discoidal, or vermicular, with wide umbilicus; ventral side well rounded. Sculpture consisting of prominent transversal striae, with ventrolateral salient and shallow ventral sinus, crossing longitudinal lirae and thereby producing a reticulate ornamentation. Faint riblets may be present. Several constrictions common on each whorl. Ventral lobe relatively narrow, with roundly divergent sides; first lateral saddle well rounded. Adventitious lobe larger than ventral lobe, pointed. Five species. *Mississippian (lower Serpukhovian):* Serbia, Spain, China (Ningxia), Kazakhstan (South Urals), Uzbekistan.——Fig. 42,*3a–c. *R. vermiculatum; a–b,* holotype, Dombar Hills, South Urals, Kazakhstan, PIN 455/425, ×3; *c,* suture, PIN 455/429, whorl height at 2.5 mm, whorl width 6.0 mm, ×5 (Ruzhentsev & Bogoslovskaia, 1971).

?Chumazites Ruzhentsev & Bogoslovskaia, 1978, p. 146 [**C. primus* Ruzhentsev & Bogoslovskaia, 1978, p. 147; OD]. Conch form small, subdiscoidal; inner whorls evolute, later whorls involute, with moderately narrow umbilicus. Ornamentation consisting of lamellae exhibiting shallow ventral sinus; no spiral sculpture. Inner mold with distinct riblets; no constrictions. First lateral saddle narrowly rounded. Two species. [The phylogenetic relationship of this genus is uncertain, and assignment to the Rhymmoceratidae is tentative.] *Pennsylvanian (lower Bashkirian):* Russia (South Urals).——Fig. 42,*5a–c. *C. primus; a–b,* holotype, Chumaza river, Bashkortostan, PIN 455/36444, ×3; *c,* suture, whorl height at 2.5 mm, whorl width 4 mm, ×10 (Ruzhentsev & Bogoslovskaia, 1978).

Ophilyroceras Ruzhentsev & Bogoslovskaia, 1971, p. 335 [**O. tersum* Ruzhentsev & Bogoslovskaia, 1971, p. 336; OD]. Sculpture consisting of 15 to 18 prominent longitudinal lirae. Strong constrictions with ventral salient always present. Suture primitive; ventral lobe narrow, median saddle low. Adventitious lobe smaller than ventral lobe, pointed. One species. [This genus is closely related and transitional to *Rhymmoceras.*] *Mississippian (upper Visean):* Kazakhstan (South Urals).——Fig. 42,*4a–c. *O. tersum; a–b,* holotype, Dombar Hills, PIN 455/33404, ×1.5; *c,* suture, PIN 455/33405, whorl height at 2.4 mm, whorl width 4.5 mm, ×6 (Ruzhentsev & Bogoslovskaia, 1971).

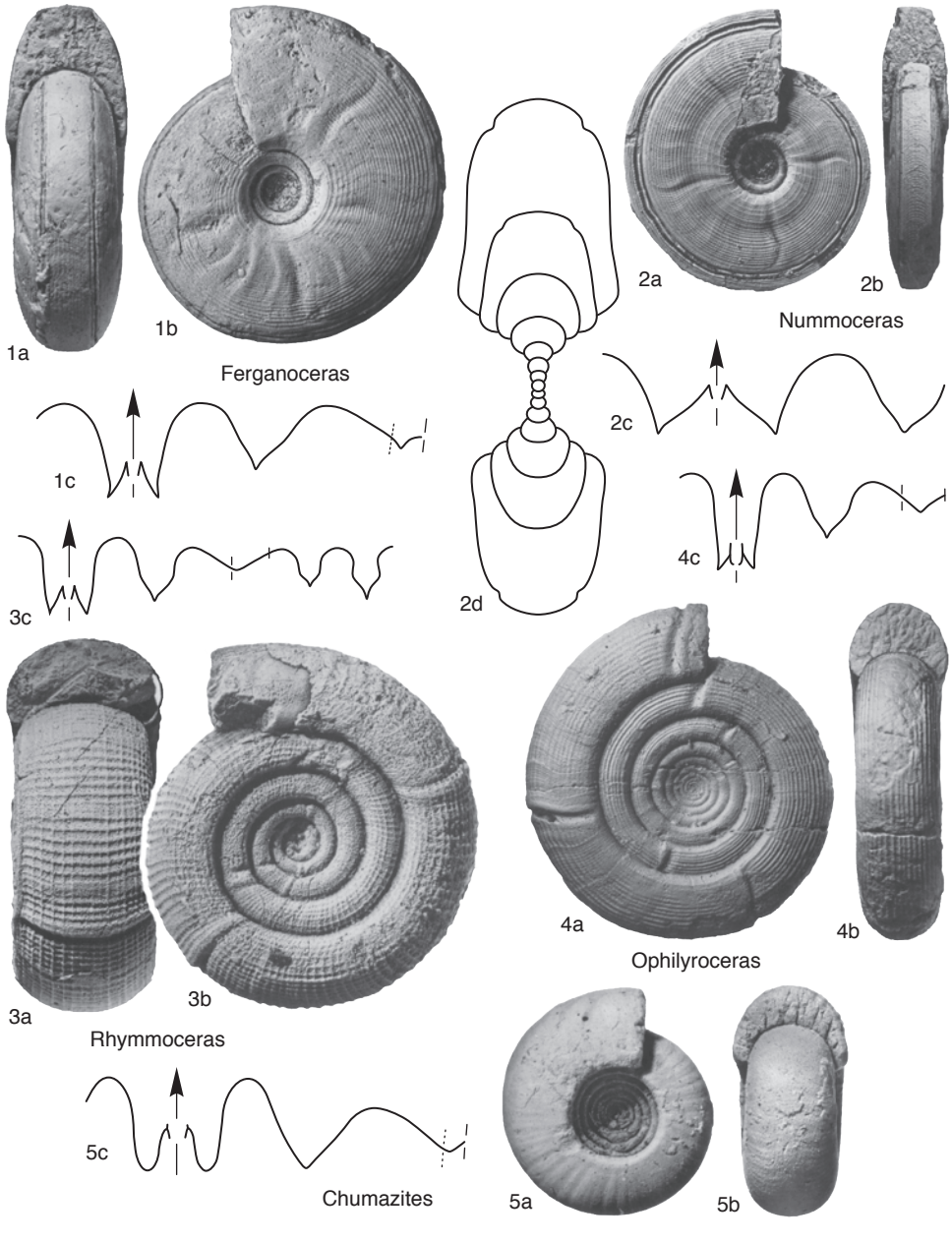

FIG. 42. Ferganoceratidae and Rhymmoceratidae (p. 71).

NEODIMORPHOCERATOIDEA

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Superfamily NEODIMORPHOCERATOIDEA Furnish & Knapp, 1966

[*nom. transl.* RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 61, *ex* Neodimorphoceratinae FURNISH & KNAPP, 1966, p. 304]

Conch form thickly discoidal to discoidal, with tendency to oxyconic ventral side. Sculpture consisting of dichotomizing costellae. In the course of phylogeny ventral lobe widening and becoming bipartite. Sutural formula: $(E_1E_mE_1)$ALUI --> $(E_1E_2E_mE_2E_1)$ALUI [Germany], (V_1V_1) LU:ID --> $(V_{1.1}V_{1.2}V_{1.2}V_{1.1})$LU:ID [Russian]. *Pennsylvanian (Bashkirian)–Cisuralian (Asselian).*

Family RAMOSITIDAE Ruzhentsev & Bogoslovskaia, 1969

[Ramositidae RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 62]

Conch form thickly discoidal to subdiscoidal, very involute. Umbilicus varying from moderately to extremely narrow. Ventral lobe wide, its branches being simple; first lateral saddle rounded. [The root group and phylogenetic relationship of this family are uncertain.] *Pennsylvanian (Bashkirian).*

Ramosites RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 62 [**R. ramosus* RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 64; OD]. Conch form discoidal to subglobular, involute. Umbilicus moderately narrow to extremely narrow. Sculpture radial; flat costellae regularly dichotomizing on flanks, on later stages with ventral sinus. No umbilical tubercles. Ventral lobe wide, median saddle reaching two-thirds height of entire ventral lobe. Adventitious lobe broad, ampullaceous. Many species. *Pennsylvanian (Bashkirian):* Belgium, Great Britain, Ireland, Netherlands, Germany, France, Spain, Portugal, Poland, Russia (South Urals), China (Guangxi, Ningxia, Xinjiang), Kazakhstan (South Urals), Kyrgyzstan, Uzbekistan (Fergana, Kyzylkumy).——FIG. 43,*1a–d. *R. ramosus; a–b,* Sholak-Say Canyon, South Urals, Kazakhstan, PIN 455/38151, ×1; *c,* side view, PIN 455/38152, ×1.5; *d,* suture of holotype, PIN 455/85150, whorl height at 13.3 mm, whorl width 16.0 mm, ×2.3 (Ruzhentsev & Bogoslovskaia, 1978).

Hodsonites RAMSBOTTOM, 1977, p. 288 [**Homoceras magistrorum* HODSON, 1957, p. 21; OD]. Conch as in *Homoceras*. Ornamentation with forwardly projecting small plications at umbilical edge from which fine striae arise by bi- or trifurcation, and intercalation crossing flanks and venter. Constrictions numerous. Ventral lobe wide, with low median saddle. One species. *Pennsylvanian (lower Bashkirian):* Great Britain, Ireland, Belgium, Germany, Poland.——FIG. 43,*2. *H. magistrorum* (HODSON), holotype, River Aille, near Lisdoonvarna, County Clare, Ireland, lower *Homoceras* Zone, GSM 86909, ×4 (Hodson, 1957).

Homoceratoides BISAT, 1924, p. 112 [**H. prereticulatus;* OD]. Conch form as in *Homoceras.* Sculpture of early whorls consisting of forwardly projecting small plications at umbilical edge, from which fine striae arise by bi- or trifurcation; growth striae may be intercalated. Later growth stages without plications; with increasing growth dichotomizing point receding from umbilical shoulder up to lateral area. Transverse striations noncrenulate. Constrictions usually present. Suture line with very broad ventral lobe and broadly rounded first lateral saddle. Many species. [The phylogenetic relationship of this genus is uncertain; it may be related to Bisatoceratidae (RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 303).] *Pennsylvanian (Bashkirian [Kinderscoutian–Yeadonian]):* Great Britain, Ireland, Belgium, Netherlands, Germany, Poland, Russia (South Urals), Ukraine (Donets), Portugal, Morocco, China (Guizhou, Xinjiang), Uzbekistan (Fergana).——FIG. 43,*3a. *H. prereticulatus,* Holden Gill, Silsden, Airedale, Yorkshire, England, Kinderscoutian, ×4 (Bisat, 1924).——FIG. 43,*3b–e. H. varicatus* (SCHMIDT), juvenile forms, Neheim, Emde brickworks, Rhenish Massif, Germany, Kinderscoutian; *b–c,* GPIT 1492/1833, ×8; *d–e,* GPIT 1492/1834, ×5 (Kullmann, new).——FIG. 43,*3f. H. librovitchi* RUZHENTSEV & BOGOSLOVSKAIA, holotype, suture, Schartym River, South Urals, Russia, Kinderscoutian, lower Bashkirian, PIN 455/40472, whorl height at 12.8 mm, whorl width 12.6 mm, ×2.5 (Ruzhentsev & Bogoslovskaia, 1978).

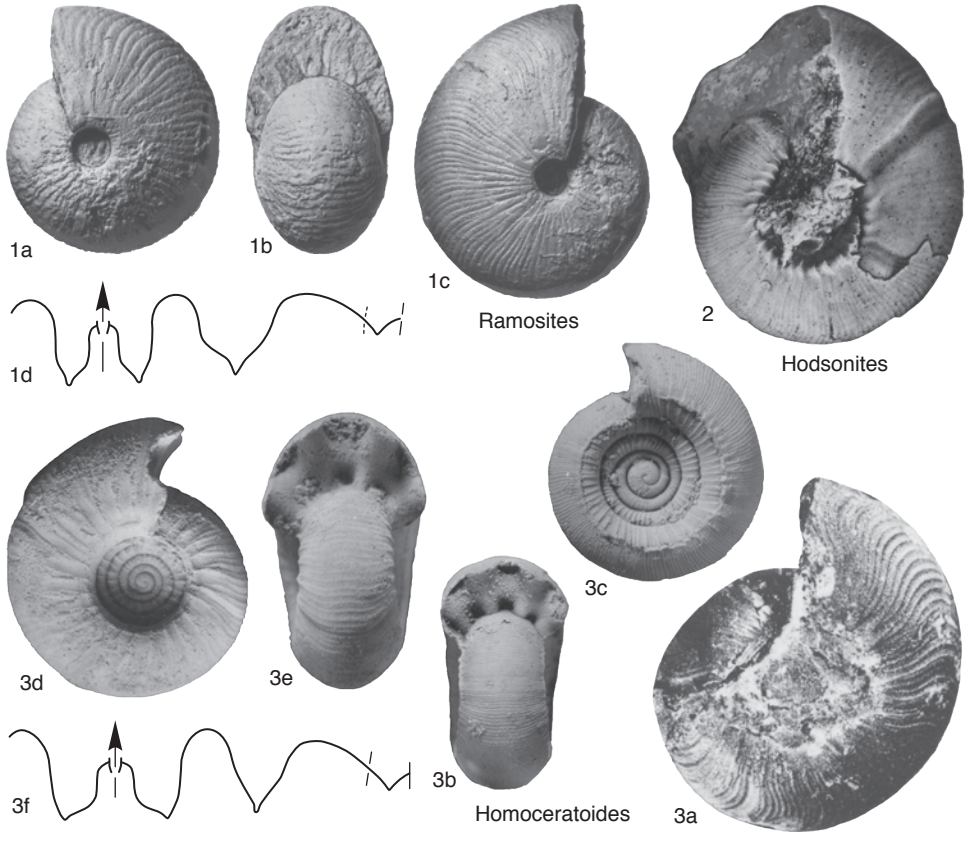

FIG. 43. Ramositidae (p. 73).

Family NEODIMORPHOCERATIDAE Furnish & Knapp, 1966

[*nom. transl.* RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 65, *ex* Neodimorphoceratinae FURNISH & KNAPP, 1966, p. 304]

Conch form subdiscoidal to lenticular, involute. Umbilicus very narrow. Sculpture consisting of dichotomizing costellae, at least on early whorls. Spiral ornamentation common. Ventral lobe very wide, quadripartite, with simple lanceolate branches. First lateral saddle rounded to subacute. Sutural formula: $(E_1E_2E_mE_2E_1)$ALUI [German], $(V_{1.1}V_{1.2}V_{1.2}V_{1.1})$LU:ID [Russian]. *Pennsylvanian (upper Bashkirian)–Cisuralian (Asselian).*

Neodimorphoceras SCHMIDT, 1925, p. 512, 600 [**Dimorphoceras texanum* SMITH, 1903, p. 126; M] [=*Texites* SMITH, 1927b, p. 73, obj.]. Conch form lenticular or discoidal; umbilicus almost closed. Venter rounded, rarely concave. Ribs confined to early whorls; shell surface at maturity usually rather smooth, biconvex growth lines being very faint. Prongs of ventral lobe prominently bifid; first lateral saddle subangular. *Pennsylvanian (Moscovian)–Cisuralian (Asselian).*

N. (**Neodimorphoceras**). Ventral side with pronounced groove appearing at a diameter of about 20 mm. Five species. *Pennsylvanian (Moscovian–Gzhelian [Virgilian]):* USA (Illinois, Oklahoma, Texas), Canada (Northwest Territories).——FIG. 44,*2a–i. *N. (N.) texanum* (SMITH); *a–b,* Jacksboro, 5.6 km east of town, Texas, Finis shale, Graham Formation, Virgilian, SUI 13829, ×1; *c–e,* Jacksboro, 8 km north of town, Texas, Wayland shale, Graham Formation, Virgilian, SUI 13828, ×5; *f–h,* ontogenetic development of suture, SUI 13828, ×11.6; *i,* adult suture, James P. Conlin collection, Ft. Worth 3549, ×3.7 (Miller & Downs, 1950a).

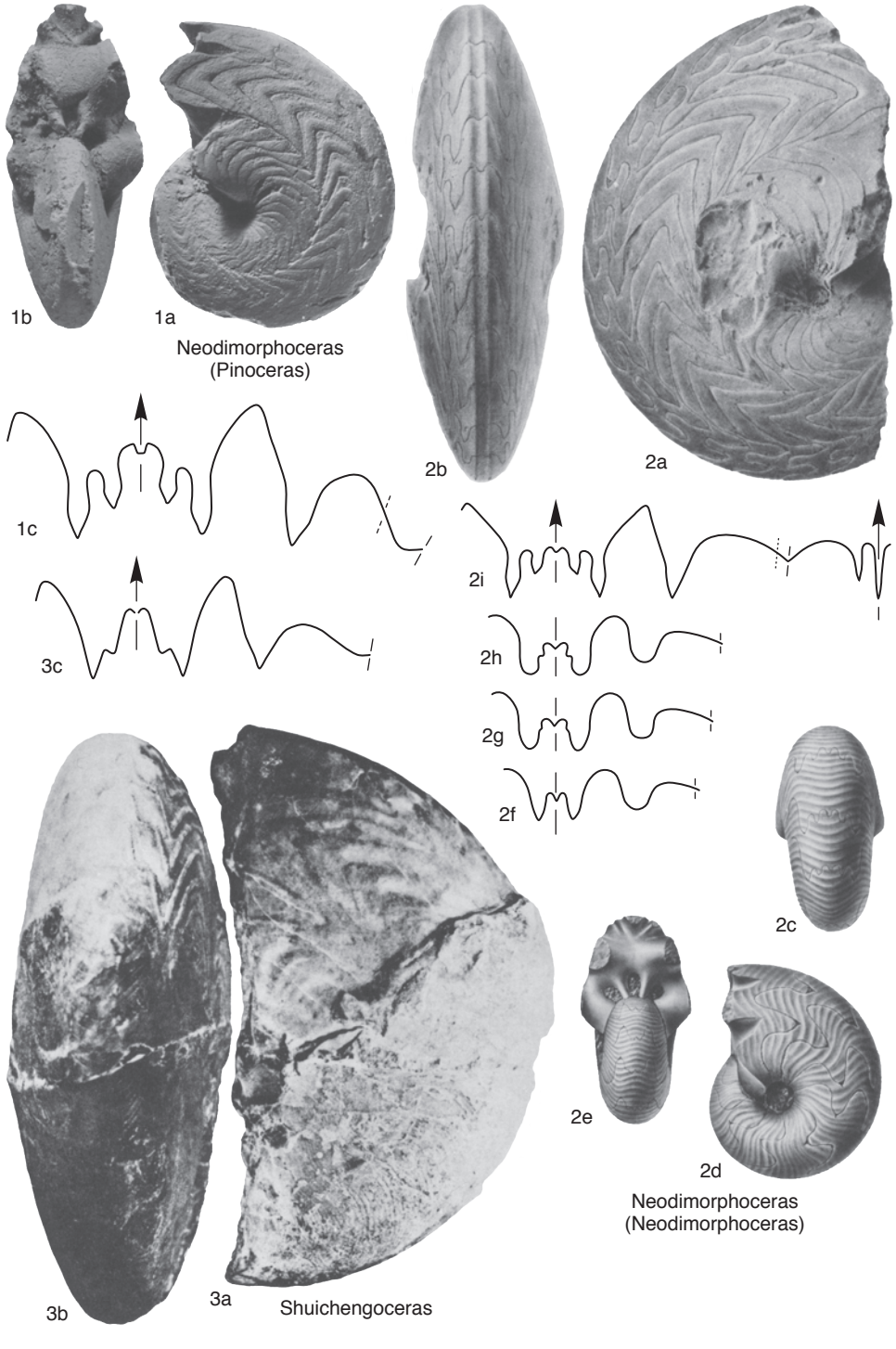

FIG. 44. Neodimorphoceratidae (p. 74–76).

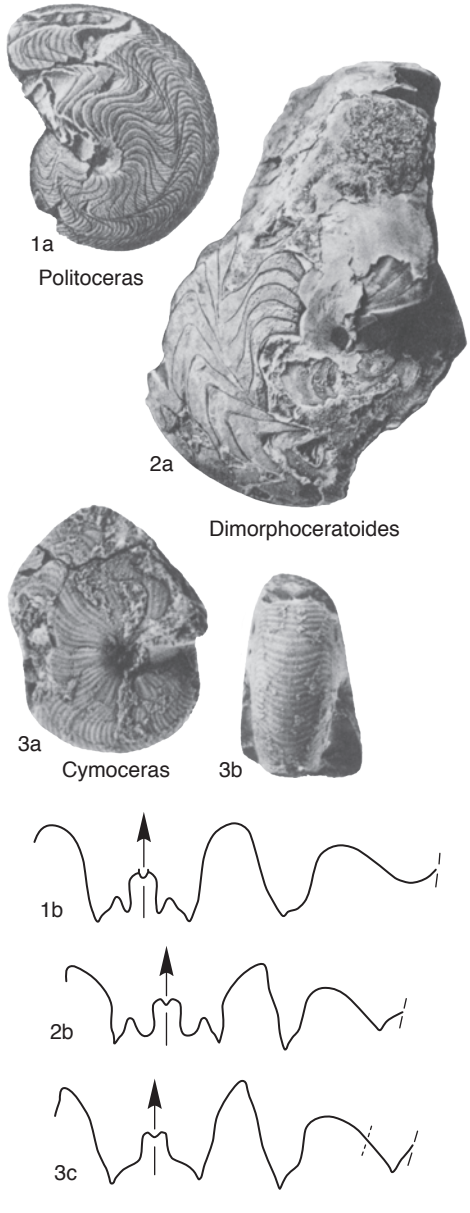

FIG. 45. Neodimorphoceratidae (p. 76).

N. (Pinoceras) RUZHENTSEV, 1947a, p. 523 [**N. (P.) daixense;* OD]. Ventral side broadly or narrowly rounded, without groove, even at large whorls. [This genus contains one species.] *Pennsylvanian (Gzhelian)–Cisuralian (Asselian):* Russia and Kazakhstan (South Urals).——FIG. 44,*1a–c. *N. (P.) daixense,* holotype, Ilinska, Chkalovskaia Oblast', South Urals, Russia, Gzhelian, PIN 320/1600; *a–b,* ×1.5; *c,* suture, whorl height at 18.0 mm, ×2 (Ruzhentsev, 1950).

Cymoceras MCCALEB, 1964, p. 236 [**C. miseri;* OD]. Conch form subdiscoidal. Biconvex transverse striae, with ventral sinus. Ventral lobe very wide, with asymmetrical branches; flanks of median saddle curved. Two species. *Pennsylvanian (upper Bashkirian):* ?Kyrgyzstan, Japan, USA (Arkansas, Texas).——FIG. 45,*3a–c. *C. miseri,* holotype, Woolsey, 2.5 km northeast, Washington County, Brentwood Member, Bloyd Formation, Arkansas, SUI 11633; *a–b,* ×1.7; *c,* suture, diameter at 17 mm, ×3.8 (adapted from McCaleb, 1968).

Dimorphoceratoides FURNISH & KNAPP, 1966, p. 305 [**D. campbellae;* OD]. Similar to *Cymoceras,* but with separate parts in branches of ventral lobe, its ventral part being rounded, the dorsal one acuminate. One species. *Pennsylvanian (upper Bashkirian–Moscovian):* USA (?Arkansas, Kentucky, Ohio).——FIG. 45,*2a–b. *D. campbellae,* holotype, Kendrick homestead, about 5.5 km east, Kendrick Shale, Floyd County, Kentucky, USA, upper Morrowan, SUI 11854; *a,* ×1.25; *b,* suture, diameter at 34 mm, ×1.2 (Furnish & Knapp, 1966).

Politoceras LIBROVICH, 1946, p. 80 [**Goniatites politus* SHUMARD in SHUMARD & SWALLOW, 1858, p. 199; OD]. Similar to *Cymoceras* and *Dimorphoceratoides,* but both ventral and dorsal parts of bipartite prongs of the ventral lobe acuminate (E_1, E_2 [German], $V_{1.1}$, $V_{1.2}$ [Russian]). Two or three species. *Pennsylvanian (Moscovian):* Great Britain, Belgium, Germany, Spain, ?Algeria, Ukraine (Donets), USA (?Illinois, Missouri, Oklahoma).——FIG. 45,*1a–b. *P. politum* (SHUMARD), neoholotype, George Howell strip pit, Henry County, Missouri, Cherokee Formation above Mulky Coal Member, Desmoinesian, SUI, Owen collection 672; *a,* ×2; *b,* suture, diameter at 18 mm, ×2.6 (Miller & Owen, 1939).

Shuichengoceras YIN, 1935, p. 31 [**Goniloboceras (S.) yohi* YIN, 1935, p. 31; OD]. Conch form discoidal, involute. Ventral side narrowly rounded. Branches of ventral lobe subdivided into two pointed parts; height of median saddle reaching about two-thirds entire ventral lobe. One species. *Pennsylvanian (upper Bashkirian):* China (Guizhou).——FIG. 44,*3a–c. *S. yohi,* northwestern Wangchapa, Wangjiapa Limestone; *a–b,* ×1 (Yin, 1935); *c,* suture, ×0.5 (Yin, 1935, adapted by Ruzhentsev & Bogoslovskaia, 1969a, fig. 4a).

GASTRIOCERATOIDEA

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Superfamily GASTRIOCERATOIDEA Hyatt, 1884

[*nom. correct.* RUZHENTSEV, 1957, p. 58, *pro* Gastrioceratidea PLUMMER & SCOTT, 1937, p. 169, *nom. transl. ex* Gastrioceratidae WEDEKIND, 1914, p. 12, *nom. correct. pro* Gastriocerae HYATT, 1884 in 1883–1884, p. 325] [*non* Gastrioceratidae MA & LI, 1998, p. 81, ?Guadalupian (Maokoa) of Jiangxi, China, subj.; insufficiently known, probably immature conchs belonging to Paragastrioceratidae]

Conch form variable, in general with broad whorl section and umbilicus. Early whorls commonly evolute. Shell smooth or sculptured. Prongs of ventral lobe relatively wide and pouched, its sides being curved or straight, but usually not divergent; median saddle usually half as high or higher than entire ventral lobe. First lateral saddle rounded, rarely subacute. Sutural formulae: $(E_1E_mE_1)$ALUI [German], (V_1V_1)LU:ID [Russian]. *Mississippian (?upper Visean [Chesterian], Serpukhovian)–Cisuralian (Asselian).*

Family GLAPHYRITIDAE Ruzhentsev & Bogoslovskaia, 1971

[*nom. transl.* RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 149, *ex* Glaphyritinae RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 285] [=Clistoceratidae RUZHENTSEV, 1975, p. 41; =Somoholitoidea RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 148, *partim*]

Conch form discoidal to globular, moderately involute to moderately evolute. Shell surface in general smooth, or with faint transverse or longitudinal ornamentation. [Clistoceratidae have been erected for subglobular forms with involute whorls and a narrow umbilicus. Some authors (e.g., RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 148) assign Glaphyritidae to superfamily Somoholitoidea RUZHENTSEV, 1938 (not recognized herein), on the basis that glaphyritids may represent the root group of the late Pennsylvanian and early Permian somoholitids because of the presence of pouched lateral lobes among glaphyritids; that character is regarded herein as being of minor general significance and inapplicable for systematic discrimination of superfamilies.] *Mississippian (?upper Visean [Chesterian], Serpukhovian)–Cisuralian (Asselian).*

Subfamily FAYETTEVILLEINAE Ruzhentsev & Bogoslovskaia, 1971

[Fayettevilleinae RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 340]

First four whorls planorbis-like serpenticone, third and fourth whorls as high or higher than wide, ventral side rounded; conchs smaller than 10 mm with very low median saddle and very short prongs. Adult conchs discoidal to subglobular with narrow or moderately wide umbilicus. Ventral lobe parallel sided or slightly divergent, with broadly rounded ventrolateral saddle and deep and acute or subacute adventitious lobe, frequently with slightly sinuous sides. [Fayettevilleinae was established as a subfamily of Rhymmoceratidae; for discussion, see MEEKS & MANGER, 1999.] *Mississippian (?upper Visean, Serpukhovian [Chesterian]).*

Fayettevillea GORDON, 1960, p. 146 [**F. planorbis* GORDON, 1960, p. 147; OD] [=?*Fayettevillea (Parafayettevillea)* YANG, 1986, p. 267 (type, *F. (P.) serpentina* YANG, 1986, p. 268, OD)]. Conchs of less than 20 mm diameter discoidal with moderately wide umbilicus. Growth lines with slight ventral salient, noncrenulate and widely spaced; a single crenulate ridge located on umbilical shoulder. On later stages wide umbilicus and weak constrictions. Ventral lobe almost parallel sided, adventitious lobe attenuate, medially expanded. Many species, some questionable. [For discussion, see MEEKS & MANGER, 1999, p. 146. *Parafayettevillea* is based on immature material, suggesting a relationship to *Fayettevillea*.] *Mississippian (?upper Visean, Serpukhovian):* Great Britain, ?Spain, Russia (Novaia Zemlia, South Urals), Kazakhstan (South Urals), Tajikistan (Hissar Mountains), USA (Arkansas, Oklahoma, California, Nevada, Utah).——FIG. 46,*1a–h.* **F. planorbis; a–c,* holotype, Fayetteville, 3.2 km east, Arkansas, USA, lower part of Fayetteville Shale, Chesterian, USNM 119552, ×2; *d,* suture, diameter at 6.7 mm, whorl height 1.7 mm, whorl width 2.8 mm, ×9 (Gordon, 1965); *e–h,* West Fork, Arkansas, upper part of Fayetteville Shale, Chesterian; *e–f,* SUI 93163, ×1.8; *g,* suture, diameter at 35 mm, reversed, SUI 93167, ×2.3; *h,* cross section, ammonitella crushed, SUI 93968,

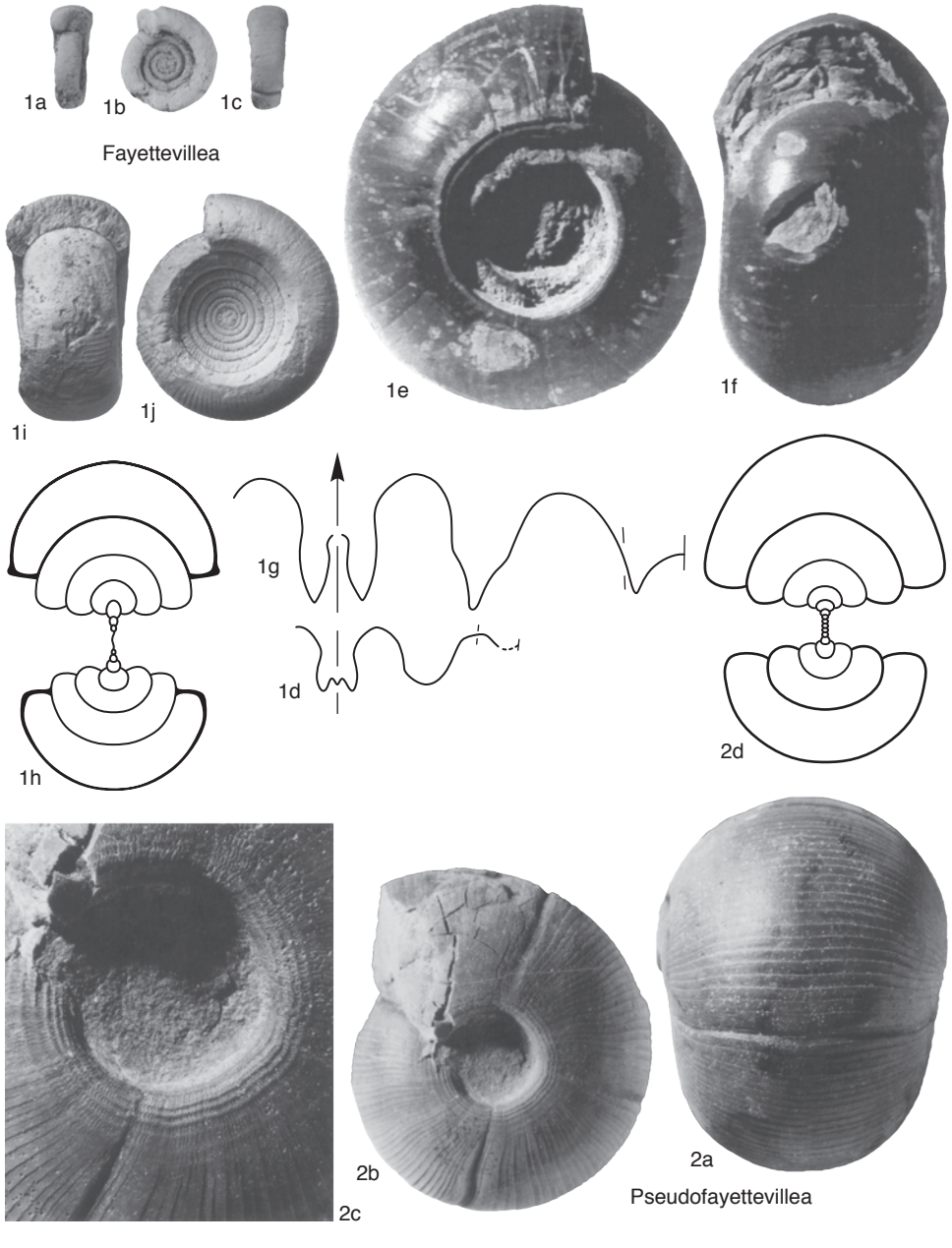

FIG. 46. Glaphyritidae (p. 77–79).

diameter at 23.2 mm, ×2.4 (Meeks & Manger, 1999).——FIG. 46,*1i–j. F. orientalis* RUZHENTSEV & BOGOSLOVSKAIA, Verkhniaia Kardailovka, Orenburg oblast', South Urals, upper Serpukhovian, PIN 455/33842, ×2 (Ruzhentsev & Bogoslovskaia, 1971).

Pseudofayettevillea MEEKS & MANGER, 1999, p. 140 [**P. gordoni* MEEKS & MANGER, 1999, p. 147; OD]. Conch form as *Fayettevillea*, but earlier pachycone with narrow umbilicus on all growth stages. Umbilical shoulder and adjacent conch flank ornamented by revolving ridges formed by liral crenulations, constrictions common. Ventral lobe with sinuous sides, ventrolateral saddle broadly rounded, adventitious lobe slightly constricted at its base. One species. *Mississippian (lower Serpuk-*

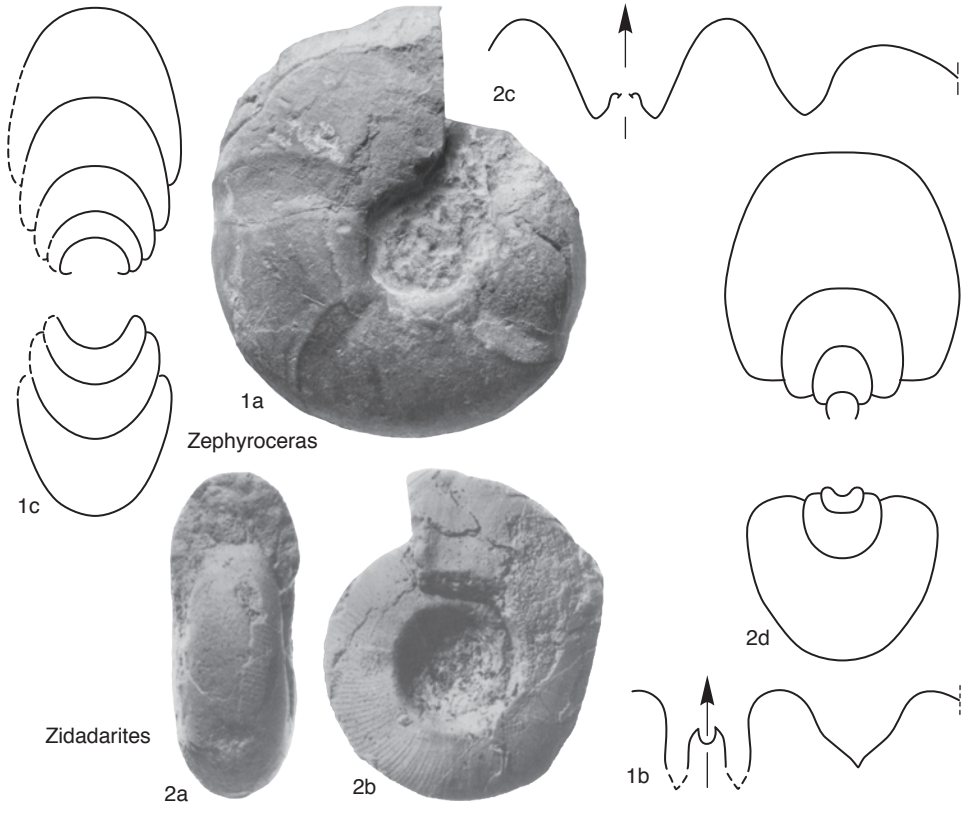

FIG. 47. Glaphyritidae (p. 79).

hovian [Chesterian]): USA (Arkansas).——FIG. 46,*2a–d. *P. gordoni,* holotype, West Fork, upper part of Fayetteville Shale, SUI 93064; *a–b,* ×1.9; *c,* side view of umbilical area, ×4.4; *d,* cross section at 23.5 mm, SUI 93986, ×2.4 (Meeks & Manger, 1999).

Zephyroceras KULLMANN, 1962, p. 314 [**Eoasianites (Zephyroceras) asturicus* KULLMANN, 1962, p. 316; OD]. Conch form subdiscoidal, involute, with moderately wide or narrow umbilicus. Several constrictions on internal mold well developed, with pronounced ventral sinus. Ventral lobe moderately wide, with lanceolate prongs; median saddle reaching about two-thirds height of entire lobe. Adventitious lobe wide and rather low, acute with slightly restricted tip. Five or six species. *Mississippian (upper Serpukhovian):* Spain, Russia and Kazakhstan (South Urals), Uzbekistan, Kyrgyzstan (Tian Shan), USA (Nevada).——FIG. 47,*1a–c. *Z. asturicum,* Perlora, Asturias, Cantabrian Mountains, Spain; *a,* paratype, GPIM L 4024, side view, ×1; *b,* suture, GPIM L 4022, diameter at 16 mm, ×3.7 (Kullmann, 1962); *c,* cross section, enlarged (Kullmann, new).

Zidadarites NIKOLAEVA, 1997, p. 232 [**Z. leveni;* OD]. Conch thickly discoidal, with moderately wide or narrow umbilicus and subangular umbilical shoulder. Ornamentation consisting of coarse lamellae, no spirals. Ventral lobe moderately wide, with low median saddle. One or two species. *Mississippian (upper Serpukhovian):* Tajikistan (Darvaz), USA (Arkansas, Oklahoma).——FIG. 47,*2a–d. *Z. leveni; a–b,* holotype, Khyrsdara River, left bank, southwestern Darvaz, Pamirs, PIN 4407/177, ×2.5; *c,* suture, PIN 4407/185, whorl height at 2.1 mm, whorl width 4.5 mm, ×9.7; *d,* cross section, PIN 4407/186, ×6.2 (Nikolaeva, 1997).

Subfamily GLAPHYRITINAE Ruzhentsev & Bogoslovskaia, 1971

[Glaphyritinae RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 285]

Conch form subdiscoidal to globular, moderately or completely involute; first whorls commonly evolute. Umbilicus moderately wide to moderately narrow. Ventral lobe commonly half height of entire lobe, ventrolateral saddle broad and rounded or narrow and acute. *Mississippian (Serpukhovian)–Cisuralian (Asselian).*

Glaphyrites Ruzhentsev, 1936a, p. 484 [**Gastrioceras modestum* Böse, 1919, p. 83; OD] [=*Ambiguites* Smith, 1938, p. 29 (type, *A. gargantuus,* OD)]. Conch form globular to thickly discoidal, more or less involute, ventral side broadly rounded. Moderately evolute on inner whorls, later with moderately wide or narrow umbilicus. Growth lines on young stages usually with ventral salient, at maturity with broad sinus. Umbilical shoulder of immature whorls commonly slightly nodose. Ventral lobe fairly wide, height of median saddle exceeding half height of entire ventral lobe. First lateral saddle broadly rounded, adventitious lobe deep, relatively wide, and bell shaped. Many species. [*Ambiguites* was based on one rather large specimen with narrowly rounded, almost acute venter, which does not show form and sculpture of inner whorls; the type species is probably conspecific with *G. subdiscus* (Unklesbay, 1962). The suture is only partly known.] *Mississippian (lower Serpukhovian)–Cisuralian (Asselian):* Belgium, Czech Republic, Serbia, Russia (Polar Urals, Novaia Zemlia, South Urals, Verkhoian), Kazakhstan (South Urals), Kyrgyzstan (Kyzylkumi, Fergana, Tian Shan), Tajikistan (Hissar Mountains, Pamirs), Uzbekistan, Iran, China (Gansu, Guizhou, Ningxia, Xinjiang, Xizang), Spain, Algeria, Morocco, Namibia, Mexico, Argentina, Peru, Uruguay, USA (Arkansas, Iowa, Illinois, Kansas, Kentucky, Missouri, New Mexico, Nevada, Utah, Oklahoma, Pennsylvania, Ohio, California, Texas), Canada (Northwest Territories).——Fig. 48,*3a–c. *G. modestus* (Böse); *a–b,* Jacksboro, about 5.6 km east of town, Finis Shale, Graham Formation, northcentral Texas, USA, Virgilian, JPC 3699, ×1.5 (Miller & Downs, 1950a); *c,* suture, Wolf Camp, 8 km northeast, Glass Mountains, Brewster County, Texas, upper part of Gaptank Formation, YPM 16789, diameter at 12 mm, ×4.7 (Miller & Furnish, 1940a).——Fig. 48,*3d. G. rhymnus* Ruzhentsev, cross section, left bank of River Sakmara, at km 165, South Urals, Gzhelian, PIN 320/3330, ×3 (Ruzhentsev, 1950).

Cryptotyloceras Titus, 2000, p. 31 [**C. gordoni* Titus, 2000, p. 32; OD]. Conch form, growth lines, and suture similar to *Glaphyrites.* Temporarily nodose stage with distinct umbilical nodes beginning with cadicone stage, disappearing at maturity. One species. *Mississippian (lower Serpukhovian [Arnsbergian]):* USA (Utah, Nevada).——Fig. 48,*2a–c. *C. gordoni,* holotype, eastern Foot Range, Bishop Spring Anticline, Millard County, Utah, USA, Chainman Shale, USNM 414930; *a–b,* ×2; *c,* suture, diameter at 12 mm, reversed, SUI 93615, ×7 (Titus, 2000).

Eosyngastrioceras Titus, 2000, p. 38 [**E. quadratum* Titus, 2000, p. 39; OD]. Conch form pachycone to globular or cadicone, with narrow umbilicus. Growth lines rectiradiate; single prominent spiral cord on umbilical shoulder. Ventral lobe with moderately high median saddle, almost parallel sides, asymmetric ventrolateral saddle; rather wide adventitious lobe, slightly constricted at base. Three species. [*Eosyngastrioceras* and *Syngastrioceras* are regarded by Titus, 2000, as root groups of neoiococeratids.] *Mississippian (Serpukhovian):* USA (California, Utah, Nevada, Arkansas, Texas).——Fig. 48,*4a–b. *E. quadratum,* Cave Valley Well, Lincoln County, Nevada, USA, lower part of Scotty Wash Formation, SUI 93554, ×2 (Titus, 2000).——Fig. 48,*4c–d. E. inexpectans* Titus, Lincoln County, Nevada, lower part of Scotty Wash Formation; *c,* suture, SUI 93579, diameter at 26 mm, ×2; *d,* cross section, SUI 93556, ×2 (Titus, 2000).

Oxiglaphyrites Kuzina & Yatskov, 1999, p. 109 [**O. insolitus;* OD]. Ventral lobe wide, diverging orad considerably at an inflexion point half the height of entire lobe, median saddle low. Ventrolateral saddle narrowly rounded or subacute, adventitious lobe wide and almost rectangular, about as deep as ventral lobe. One or two species. *Mississippian (lower Serpukhovian [Arnsbergian]):* Russia (Novaia Zemlia).——Fig. 49,*1a–d. *O. insolitus,* holotype, Rogacheva River, PIN 4279/2360; *a–b,* ×1.5; *c,* suture, whorl height at 8.0 mm, whorl width 14.5 mm, ×4; *d,* cross section, ×9 (Kuzina & Yatskov, 1999).

Paracravenoceras Gordon, 1960, p. 141 [**P. ozarkense* Gordon, 1960, p. 143; OD]. Conch form thickly discoidal to subglobose. Immature stages showing sinuous striae, with ventrolateral salients, ventral and lateral sinuses; straight growth striae at maturity. First lateral saddle rounded to slightly subacute at maturity. Two or three species. [This genus is transitional to *Syngastrioceras* and may be its junior synonym; for discussion, see Nassichuk, 1975, p. 85.] *Mississippian (Serpukhovian):* Kyrgyzstan (?Tian Shan), China (Guangxi), USA (Arkansas, Nevada, Texas).——Fig. 48,*1a–e. *P. ozarkense,* holotype, Fayetteville, east of Sequoyah Mountain, Arkansas, USA, Fayetteville Shale, Chesterian, USNM 119539; *a–b,* ×2; *c,* suture, USNM 119542, diameter at 16.0 mm, whorl height 6.9 mm, whorl width 13.8 mm, ×2.5; *d,* cross section, ×1; *e,* cross section, USNM 119544, ×4 (Gordon, 1965).

Richardsonites Elias, 1956, p. 128 [**Gastrioceras richardsonianum* Girty, 1909, p. 54; OD]. Conch large, subdiscoidal to pachycone, moderately evolute, umbilicus wide to moderately narrow; on early whorls subdiscoidal and planorbiform. Usually up to five broad convex constrictions; ventral groove may be present. Median saddle higher than half height of entire ventral lobe. Eight species (two questionable). [This type species lacks constrictions but possesses a ventral groove.] *Mississippian (Serpukhovian):* Great Britain, Spain, Ukraine (Donets), Russia (Novaia Zemlia), USA (Arkansas, Oklahoma, Texas, Utah, Nevada, California).——Fig. 49,*2a–e. *R. richardsonianus* (Girty), Frisco, Pontatoc County, Oklahoma, Caney Shale, Chesterian; *a–b,* ×1 (Youngquist, 1949); *c,* suture, PIN 2965/7, whorl height at 17.3 mm, whorl width 24 mm, ×1.6 (Ruzhentsev & Bogoslovskaia, 1971); *d,* cross section, USNM 119532, ×1; *e,* topotype, cross section, USNM 119533, ×3.6 (Gordon, 1965).

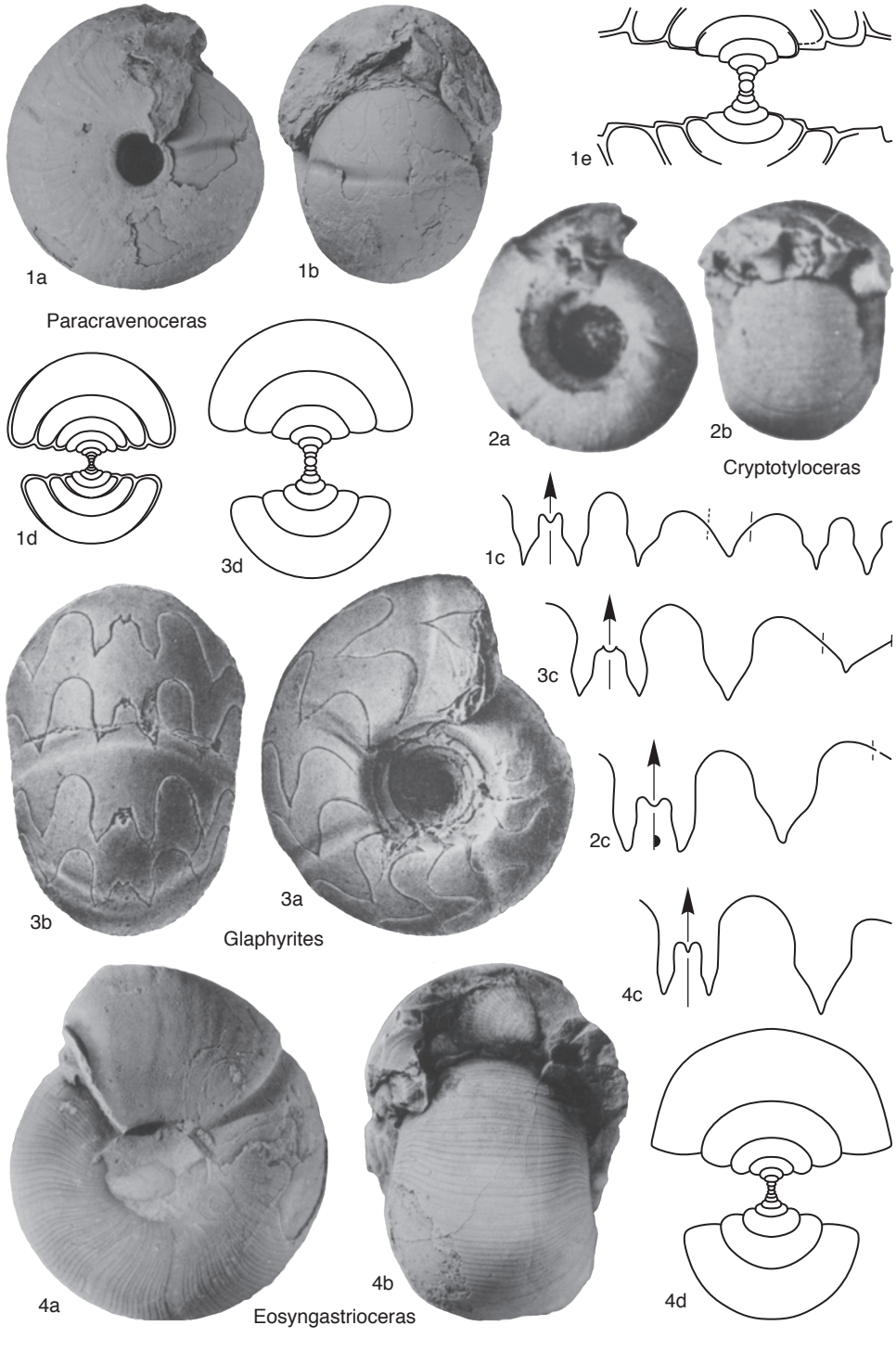

FIG. 48. Glaphyritidae (p. 80).

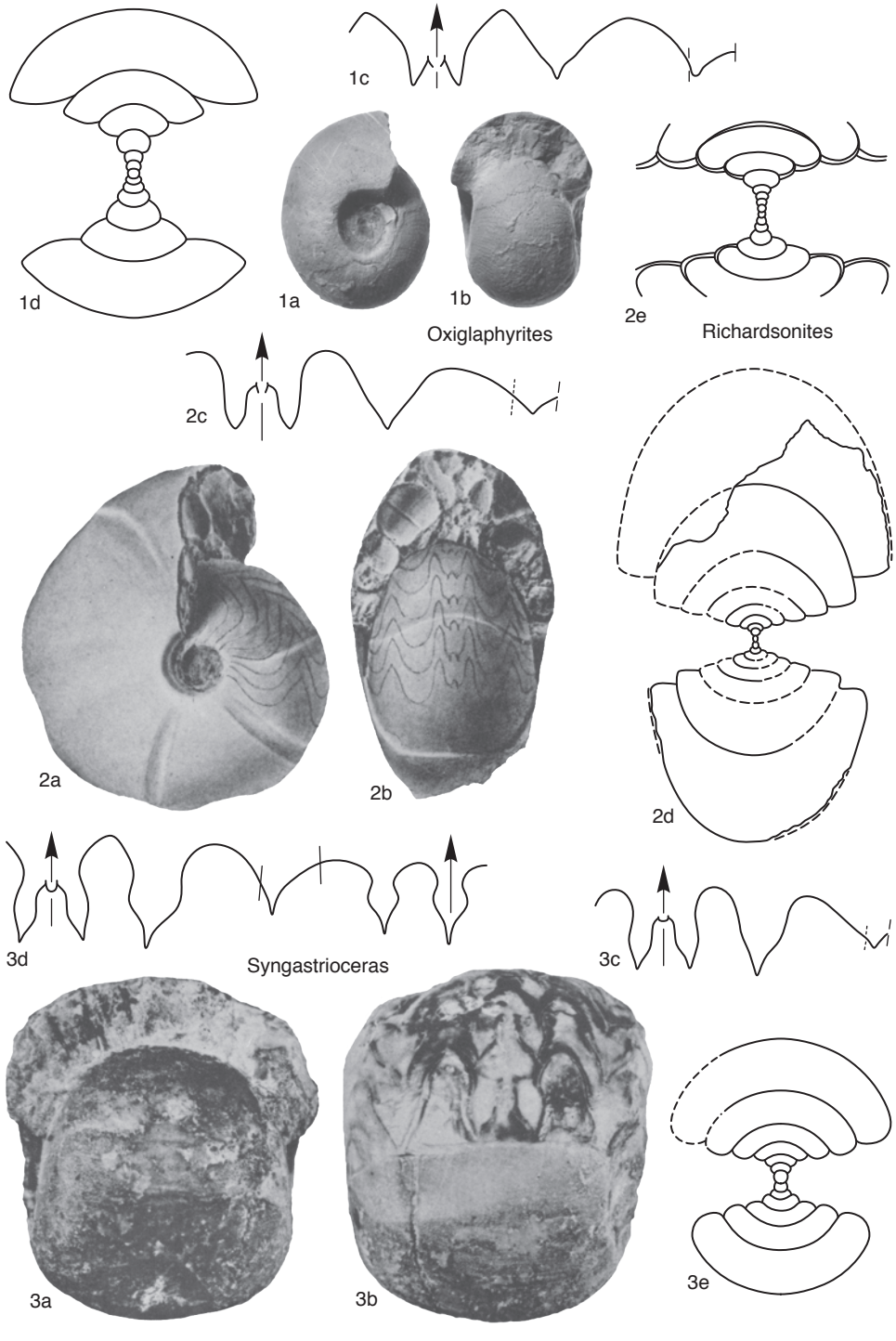

FIG. 49. Glaphyritidae (p. 80–83).

Syngastrioceras Librovich, 1938, p. 81 [**Gastrioceras orientale* Yin, 1935, p. 19; OD] [=*Pseudoglaphyrites* Ruzhentsev & Bogoslovskaia, 1971, p. 292 (type, *P. shokalensis* Ruzhentsev & Bogoslovskaia, 1971, p. 293, OD), for discussion, see Nassichuk, 1975, p. 95; =*Neogastrioceras* Nassichuk, 1975, p. 95 (type, *N. arcticum* Nassichuk, 1975, p. 96, OD)]. Conch form pachycone to globular, umbilicus moderately wide to narrow. Constrictions may be present on internal mold. Suture line similar to *Glaphyrites*, but first lateral saddle subacute to acute on adult stages. Many species. [This genus is transitional to *Glaphyrites.* At the adult stage, *Pseudoglaphyrites* exhibits a comparatively high median saddle and acute ventrolateral saddle, similar to *S. oblatum* (Fig. 49,*3e*). *Neogastrioceras* differs slightly in the proportions of the suture: their ventral prongs are wider and the first lateral saddle is narrower, characters regarded herein as being of specific significance.] *Mississippian (Serpukhovian)–Pennsylvanian (Moscovian):* Belgium, Great Britain, France, Spain, Algeria, Russia (Novaia Zemlia, South Urals), Ukraine (Donets), Kazakhstan (South Urals), Kyrgyzstan (Fergana), Tajikistan (Hissar Mountains, Pamirs), Uzbekistan (Kyzylkumi, Tian Shan), China (Guangxi, Guizhou, Xinjiang), Japan, Canada (Northwest Territories), USA (Arkansas, Illinois, Nevada, Utah, Oklahoma, Texas).——Fig. 49,*3a–c. *S. orientale* (Yin), holotype, northwest of Wangjiapa, Guizhou, China, Moscovian; *a–b,* ×1 (Yin, 1935); *c,* suture, enlarged, magnification not stated (Yin, 1935; adapted by Bogoslovskii, Librovich, & Ruzhentsev, 1962).——Fig. 49,*3d. S. globosum* (Easton), suture, Fayetteville, Washington County, Arkansas, Cane Hill Member, Hale Formation, basal Morrowan, SUI 34143, diameter at 25 mm, ×2.4 (Saunders, 1971).——Fig. 49,*3e. S.* sp., cross section, Confusion Range, Utah, Chainman Shale, Chesterian, GPIT 1418/1104, ×2.8 (Kullmann & Scheuch, 1972).

Subfamily STENOGLAPHYRITINAE Ruzhentsev & Bogoslovskaia, 1971

[Stenoglaphyritinae Ruzhentsev & Bogoslovskaia, 1971, p. 300]
[=Clistoceratidae Ruzhentsev, 1975, p. 33]

Conch form subdiscoidal to globular, moderately to completely involute; width of umbilicus ranging from moderately narrow to closed. Some genera with evolute early whorls. [This genus is transitional to Glaphyritinae.] *Mississippian (Serpukhovian)–Pennsylvanian (Moscovian).*

Stenoglaphyrites Ruzhentsev & Bogoslovskaia, 1971, p. 301 [**Cravenoceras involutum* Gordon, 1965, p. 210; OD]. Conch form similar to glaphyritids, first whorls usually evolute, but adult stages with narrow or closed umbilicus. Growth lines linear. Constrictions may be present on internal mold. Suture similar to *Glaphyrites,* ventral lobe wide, with almost parallel sides; adventitious lobe deep and acute, lanceolate or bell shaped, but never pouched. Many species. *Mississippian (Serpukhovian)–Pennsylvanian (lower Bashkirian [Yeadonian]):* Ireland, Portugal, Russia (South Urals), Kazakhstan (South Urals, Tian Shan), Uzbekistan (Kyzylkumy), China (Xinjiang), USA (Arkansas, California, Nevada, Texas).——Fig. 50,*5a–e. *S. involutus* (Gordon); *a–c,* holotype, Batesville, Stone County, Pitkin limestone, upper shale member, Chesterian, Arkansas, USA, USNM 119523, ×1; *d,* suture, USNM 119524, diameter at 6.0 mm, whorl height 3.1 mm, whorl width 4.4 mm, ×7.8; *e,* paratype, cross section, USNM 119524, ×3.8 (Gordon, 1965).

Aclistoceras Ruzhentsev, 1975, p. 41 [**A. felix* Ruzhentsev, 1975, p. 42; OD]. Conch form pachycone to subglobular, involute, with narrow but open umbilicus. Prongs of ventral lobe moderately pouched, median saddle exceeding slightly half height of entire ventral lobe. Ventrolateral saddle broadly rounded, first lateral lobe lanceolate or bell shaped. Six species. *Pennsylvanian (Bashkirian–Moscovian):* Russia (Siberia), China (Xinjiang, Guangxi), USA (Arkansas, Texas), Canada (Northwest Territories).——Fig. 50,*1a–b. *A. felix; a,* holotype, suture, Sette-Daban, Udachnyi rivulet, lower Ekachan Formation, North Verkhoian, East Siberia, PIN 3088/48, whorl height at 12.0 mm, whorl width 24.5 mm, ×2.3; *b,* cross section, PIN 3088/51, Zyrian River Basin, Druzhok rivulet, North Verkhoian, East Siberia, Agidzhin Formation, ×2.8 (Ruzhentsev, 1975).

Clistoceras Nassichuk, 1967, p. 240 [**C. globosum* Nassichuk, 1967, p. 241; OD]. Conch and suture similar to *Aclistoceras,* but umbilicus closed on late growth stages by thickening of primary shell at umbilical shoulder and helicolateral deposits. One or more constrictions per whorl. Faint growth lines, on young stages sinuous, at maturity slightly biconvex, with shallow ventral sinus. First lateral saddle subacute. Umbilical portion of lateral lobe exhibiting incipient flexure, caused by helicolateral deposits. One species. *Pennsylvanian (Moscovian [Duckmantian]):* China (Xinjiang), Canada (Northwest Territories).——Fig. 50,*4a–d. *C. globosum,* Hare Fiord, Ellesmere Island, Hare Fiord Formation, Atokan, Northwest Territories; *a,* apertural view, GSC 19968, ×4; *b,* side view, GSC 19966, ×4.3; *c,* suture, conch diameter at 11.5 mm, ×6.5; *d,* cross section, GSC 19965, ×2.5 (Nassichuk, 1967).

Euroceras Ruzhentsev & Bogoslovskaia, 1971, p. 306 [**E. ellipsoidale* Ruzhentsev & Bogoslovskaia, 1971, p. 307; OD]. Conch form subdiscoidal, with very narrow umbilicus. Constrictions on internal mold, with pronounced ventral sinus. Ventral lobe wide, with wide branches; median saddle reaching three-quarters height of entire ventral lobe, sides almost parallel. Five species. [Inner whorls are unknown for this genus. *Euroceras* may belong

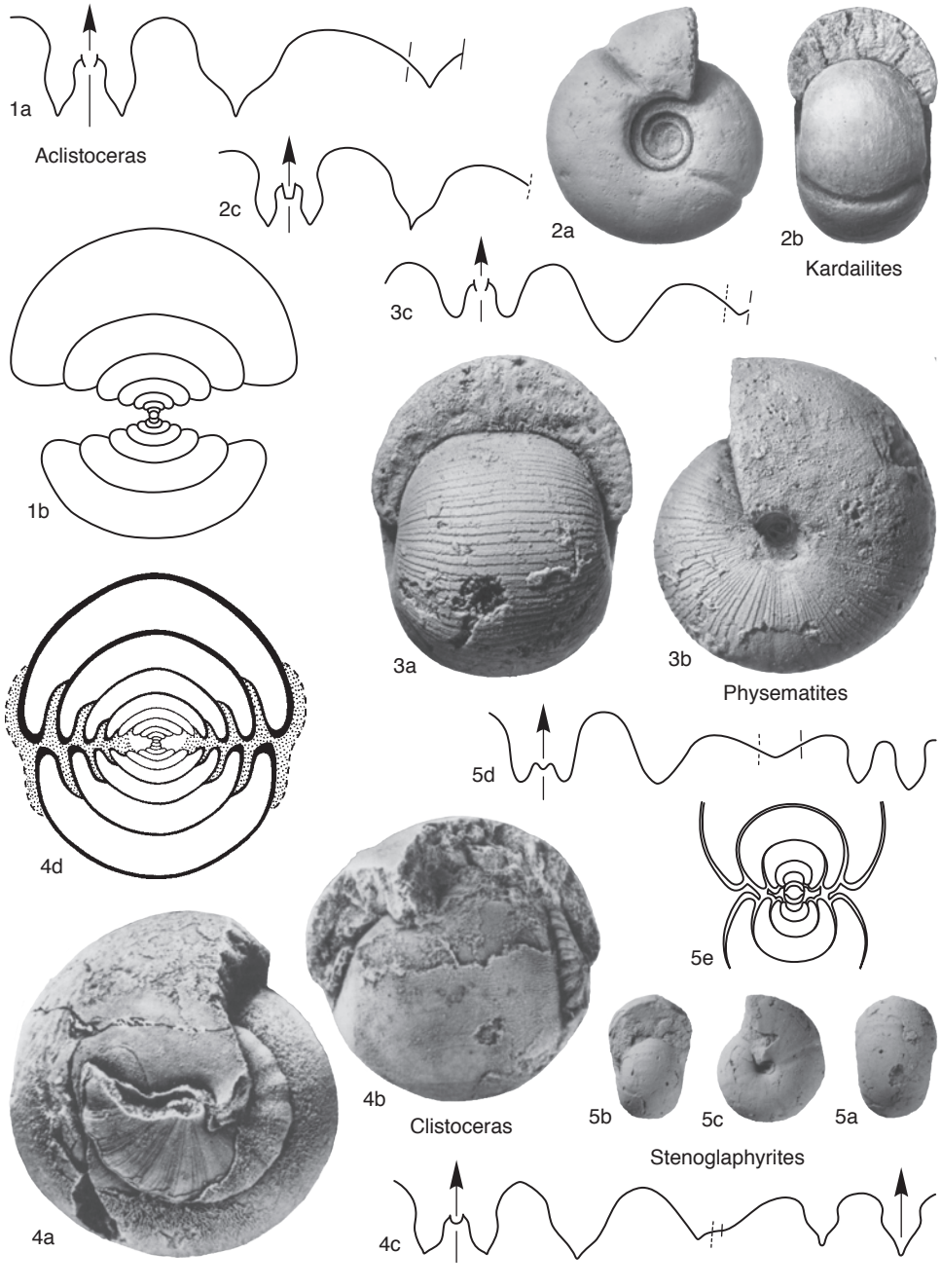

FIG. 50. Glaphyritidae (p. 83–85).

to Bisatoceratidae and may be a junior synonym of *Neoglaphyrites;* for discussion, see NASSICHUK, 1975, p. 106.] *Mississippian (Serpukhovian):* Spain, Ukraine (Donets), Kazakhstan (South Urals), China (Guangxi), USA (Nevada).——FIG. 51,*5a–c.*

**E. ellipsoidale,* holotype, Sholak-Sai Canyon, South Urals, Kazakhstan, Arnsbergian, PIN 455/38136; *a–b,* ×1; *c,* suture, whorl height at 13.4 mm, whorl width 15.8 mm, ×2.4 (Ruzhentsev & Bogoslovskaia, 1971).

Kardailites Ruzhentsev & Bogoslovskaia, 1971, p. 271 [**K. primus* Ruzhentsev & Bogoslovskaia, 1971, p. 272; OD]. Conch relatively small, pachycone, rather involute, with moderately narrow umbilicus. Two strong constrictions exhibiting slight ventral salient. Ventral lobe wide, with pouched prongs; median saddle higher than half height of entire ventral lobe, ventrolateral saddle very broad, adventitious lobe bell shaped. One species. [The holotype of the type species may be immature. The phylogenetic relationship is uncertain for this genus; deep constrictions suggest a relationship to cravenoceratids, and suture is of gastrioceran type.] *Mississippian (lower Serpukhovian [Arnsbergian]):* Russia (South Urals).——Fig. 50,*2a–c. *K. primus,* holotype, Verkhnaia Kardailovka, Ural river, Orenburgskaia oblast', PIN 455/36131; *a–b,* ×1.5; *c,* suture, whorl height at 6.2 mm, whorl width 10.9 mm, ×4.1 (Ruzhentsev & Bogoslovskaia, 1971).

Paraschartymites Ruzhentsev & Bogoslovskaia, 1978, p. 172 [**P. repens;* OD] [=?*Pseudoschartymites* Yang, 1987, p. 159, 171 (type, *P. ningxiaensis* Yang, 1987, p. 160, OD)]. Conch form small, discoidal or lenticular, completely involute; last whorls surround completely the previous ones. Early whorls evolute, widely umbilicate; adult stages with relatively narrow umbilicus. Growth lines consisting of weak rectilinear lamellae; weak constrictions may be present on internal mold. Ventral lobe with rather wide prongs and divergent sides. Height of median saddle reaching three-quarters height of all lobes. Four species. [This genus is similar to *Schartymites* in the interpretation of Ruzhentsev, 1975, p. 42, fig. 5v; if Ruzhentsev's view is correct, *Paraschartymites* is to be regarded as a junior synonym of *Schartymites. Pseudoschartymites* appears to be based on specimens with immature sutures; its relationship remains questionable.] *Pennsylvanian (lower Bashkirian [Reticuloceras Zone]):* Russia (Novaia Zemlia, South Urals), Kyrgyzstan (Fergana), Uzbekistan (Kyzylkumi), China (?Ningxia).——Fig. 51,*4a–d. *P. repens,* holotype, Malaia Suren river, left bank, Bashkortostan, Russia, PIN 455/38632; *a–b,* ×1.5; *c,* suture, whorl height at 8.2 mm, whorl width 9.5 mm, ×4.7; *d,* cross section, ×2.2 (Ruzhentsev & Bogoslovskaia, 1978).

Physematites Ruzhentsev & Bogoslovskaia, 1978, p. 162 [**P. charis;* OD]. Conch very small, subglobular, completely involute; umbilicus narrow. Growth lamellae almost rectilinear. Constrictions may be present on internal mold. Ventral lobe wide, with divergent sides. Median saddle exceeding half height of ventral lobe; basal portion of ventral prongs rounded. Adventitious lobe deeper than ventral lobe, also rounded. One species. [The type material for this genus may be immature.] *Pennsylvanian (lower Bashkirian [Homoceras Zone]):* Russia and Kazakhstan (South Urals), Tajikistan (Hissar Mountains), China (Xinjiang, Ningxia).——Fig. 50,*3a–c. *P. charis,* holotype, Sholak-Sai Canyon, Aktiubinskaia oblast', Aqtöbe, South Urals, Kazakhstan, PIN 455/36712; *a–b,* ×3; *c,* suture, whorl height at 5.5 mm, whorl width 10.0 mm, ×3.9 (Ruzhentsev & Bogoslovskaia, 1978).

Rhadinites Saunders, 1973, p. 40 [**Cravenoceras miseri* Gordon, 1965, p. 211; OD]. Early whorls lenticular with wide umbilicus, at maturity pachycone, with narrow umbilicus. Growth lines straight on young stages, later sinuous. Ventral lobe almost parallel sided, median saddle reaching two-thirds height of entire ventral lobe; ventrolateral saddle asymmetric and almost subacute in adult specimens. One or two species. [This genus is transitional to *Glaphyrites* or *Syngastrioceras.*] *Mississippian (?lower Serpukhovian, upper Serpukhovian):* Russia and Kazakhstan (South Urals), Russia (?Novaia Zemlia), USA (Arkansas, Oklahoma).——Fig. 51,*1a–d. *R. miseri* (Gordon); *a–b,* Boggy Creek, Pontotoc County, Oklahoma, Rhoda Creek Formation, Chesterian, SUI 34708e, ×1.3; *c,* suture, Peyton Creek, 8 km southeast of Leslie, Van Buren County, Arkansas, SUI 34743g, diameter at about 20 mm, whorl height 10 mm, ×2.4; *d,* cross section, SUI 34742b, ×3 (Saunders, 1973).

?Schartymites Librovich, 1939b, p. 16, 40 [**Goniatites barbotanus* de Verneuil, 1845, p. 369; OD]. Conch subdiscoidal to globular, involute; in adult stages umbilicus very narrow. Growth lamellae weak, with ventral sinus at maturity. Height of median saddle reaching three-quarters height of entire ventral lobe. Many species. [This genus was erected without clear diagnosis; type species is poorly known, its early whorls are unknown, and the holotype is uncertain. According to Ruzhentsev (1975, p. 42), *Schartymites* is evolute on inner whorls, but his figure is not based on the type material. *Schartymites* seems to be closely related to *Stenoglaphyrites.*] *Pennsylvanian (lower Bashkirian [Kinderscoutian–Yeadonian]):* Russia (Novaia Zemlia, South Urals), Kazakhstan (Tian Shan), Uzbekistan (Fergana, Kyzylkumy), Kyrgyzstan (South Fergana), Iran, China (?Guizhou).——Fig. 51,*2a–d. *S. barbotanus* (de Verneuil), Shartym river, Cheliabinskaia oblast', South Urals, PIN 455/38095; *a–b,* ×1; *c,* suture, whorl height at 14.5 mm, whorl width 23 mm, ×2 (Ruzhentsev & Bogoslovskaia, 1978); *d,* cross section, PIN 455/38098, ×2.2 (Ruzhentsev & Bogoslovskaia, 1978).

Subitoceras Ruzhentsev & Bogoslovskaia, 1978, p. 163 [**S. sholakense* Ruzhentsev & Bogoslovskaia, 1978, p. 164; OD]. Conch form large, discoidal, very involute; umbilicus narrow. Prominent growth lamellae forming a ventral salient in young stages, adult stages exhibit ventral sinus; no constrictions. Ventral lobe wide, with almost parallel sides; height of median saddle reaching about three-quarters of entire ventral lobe. Adventitious lobe wide, shorter than ventral lobe. One species from one locality. *Pennsylvanian (lower Bashkirian [Homoceras Zone]):* Kazakhstan (South Urals), Kyrgyzstan.——Fig. 51,*3a–c. *S. sholakense,* holotype, Sholak-Say Canyon, South Urals, Kazakhstan, PIN 455/38490;

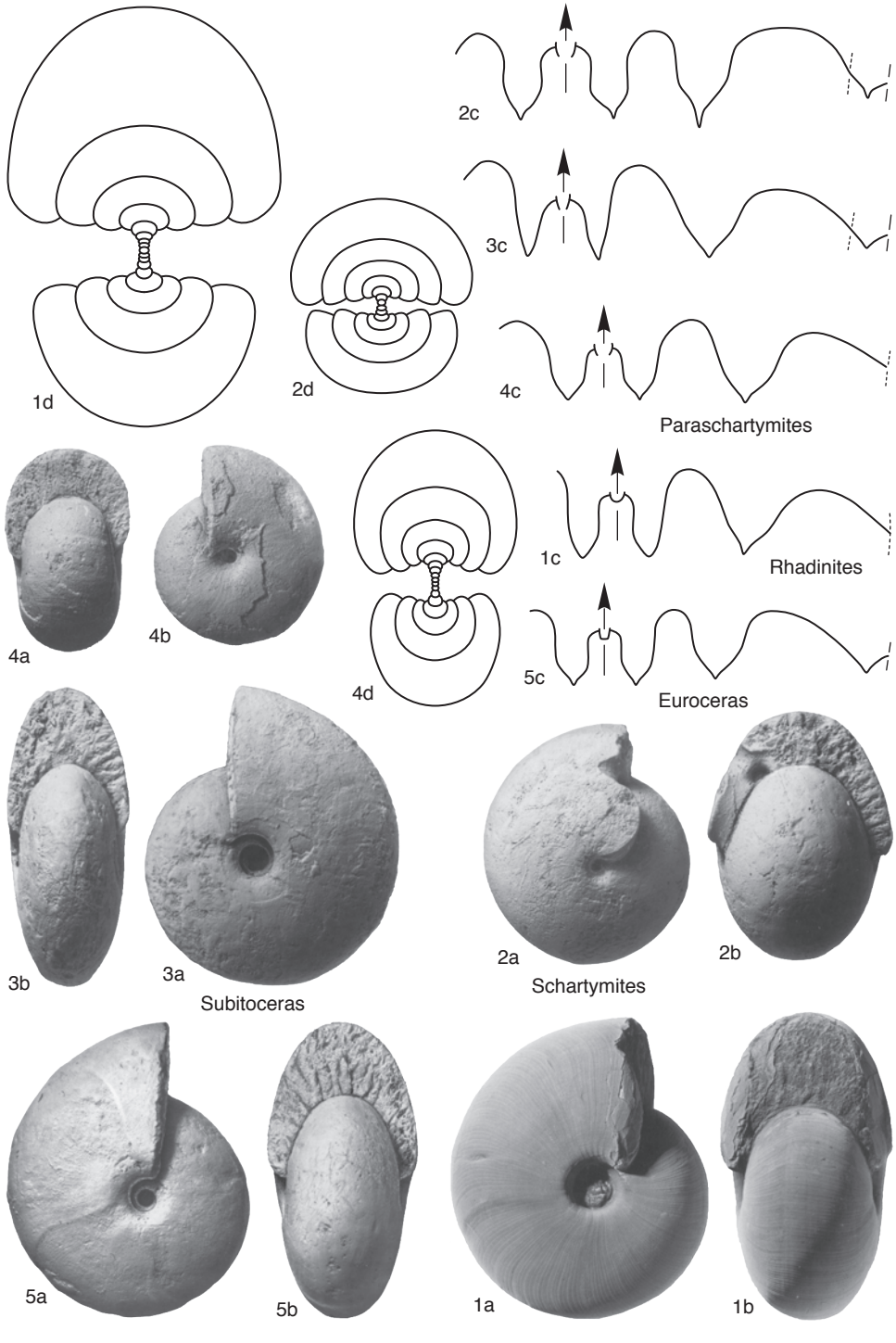

FIG. 51. Glaphyritidae (p. 83–87).

a–b, ×1; *c,* suture, whorl height at 12.4 mm, whorl width 13.0 mm, ×2.7 (Ruzhentsev & Bogoslovskaia, 1978).

Family HOMOCERATIDAE Spath, 1934

[*nom. transl.* Ruzhentsev, 1960d, p. 211, *ex* Homoceratinae Spath, 1934, p. 15]

Early whorls evolute, adult conch form discoidal to globose and involute. Umbilicus moderately wide to narrow. More or less prominent transversal ornamentation frequently present; course of growth striae or lamellae variable, but always forming ventral sinus. Spiral ornamentation rare and if present, mostly restricted to umbilical shoulder. Umbilical tubercles in advanced forms. Ventral lobe relatively wide, with sigmoidal or roundly diverging sides; median saddle fairly high. First lateral saddle broadly rounded. Adventitious lobe pointed, mostly with straight sides, rarely bell shaped or rounded. *Pennsylvanian (lower Bashkirian [Chokierian–Yeadonian, Halian]).*

Subfamily HOMOCERATINAE Spath, 1934

[Homoceratinae Spath, 1934, p. 15]

Commonly early whorls evolute, frequently with wide and low aperture and sharp umbilical shoulder (calyx stage). Adult whorls often strongly oxyconic. Transversal ornamentation rarely coarse, usually lamellate, and sometimes dichotomizing. Umbilical tubercles in advanced forms. No reticulate ornamentation. *Pennsylvanian (lower Bashkirian [Chokierian–Yeadonian]).*

Homoceras Hyatt, 1884 in 1883–1884, p. 330 [**Goniatites smithii* Brown, 1841, p. 218; SD ICZN, 1976, opinion 1061; original type, *Goniatites calyx* Phillips, 1836, p. 236, by monotypy, was based on a very young and uncharacteristic shell; for discussion, see Ramsbottom, 1972, p. 161] [=*Pseudohomoceras* Librovich, 1947, p. 61, obj., *nom. nud.*]. Conch subdiscoidal, widely to moderately umbilicate; early whorls evolute, wide, and with low aperture, with sharp umbilical shoulder and wide umbilicus (calyx stage). Adult stages of some forms oxycone. Transverse ornamentation coarse, lamellate, on immature stages almost linear, later with weakly pronounced ventrolateral salient and shallow ventral sinus. Ventral lobe relatively wide, with sigmoidal sides; median lobe fairly low to half height of entire ventral lobe. First lateral saddle well rounded, adventitious lobe wide and pointed. Many species. [For discussion, see Moore, 1946, p. 395; Ruzhentsev & Bogoslovskaia, 1971, p. 19–22. *Pseudohomoceras* was erected without any description; its type species was chosen as new type of *Homoceras.*] *Pennsylvanian (lower Bashkirian [Homoceras Zone]):* Belgium, Great Britain, France, Germany, Ireland, Netherlands, Portugal, Algeria, Morocco, Poland, Russia and Kazakhstan (South Urals), Tajikistan (Hissar Mountains, Pamirs), Uzbekistan (Fergana, Kyzylkumy), China (Guangxi, Guizhou), USA (Nevada).——Fig. 52,*2a–b. *H. smithii* (Brown), Roadford, river Aille, Clare County, Ireland, *Homoceras* Zone, ×2.5 (Hodson & Leckwijck, 1958).——Fig. 52,*2c–d. H. coronatum* Haug, Sholak-Sai Canyon, Aqtöbe (=Aktiubinskaia oblast'), South Urals, Kazakhstan, *Homoceras* Zone; *c,* PIN 455/39217, suture at 24.5 mm, whorl height 25.0 mm, whorl width 25.0 mm, ×1.4; *d,* cross section, PIN 455/39222, ×2.9 (Ruzhentsev & Bogoslovskaia, 1978).

?Aljezurites Korn, 1997, p. 67 [**A. katharinae* Korn, 1997, p. 68; OD]. Conch small, pachyconic, with moderately wide umbilicus. Early growth stage up to 12 mm diameter with ventral groove. Ornamentation with concave-convex riblets dichotomizing near umbilicus. Ventral lobe wide with almost parallel sides and more than twice as wide as lanceolate adventitious lobe; median saddle reaching about three-quarters height. One species. [Early whorls and morphogeny for this genus are unknown, and the systematic assignment is uncertain.] *Pennsylvanian (lower Bashkirian [Kinderscoutian]):* Portugal.——Fig. 52,*4a–c. *A. katharinae,* holotype, Carrapateira, Praia das Quebradas, Portugal, *Reticuloceras* Zone, IGML 1; *a–b,* ×2; *c,* suture, IGML 36, whorl height at 7.4 mm, ×4 (Korn, 1997).

Bashkortoceras Ruzhentsev & Bogoslovskaia, 1971, p. 24 [**B. salavati;* OD]. Only few whorls evolute, calyx stage indistinct; later stages involute, umbilicus narrow, adult whorls mostly oxycone. Fine growth lamellae form ventral sinus. Double and triple intraventral ridges commonly developed on intermediate ontogenetic stages. Ventral lobe with cuneiform branches; adventitious lobe very short. Three species. *Pennsylvanian (lower Bashkirian [Kinderscoutian]):* Russia (South Urals), Uzbekistan (Kyzylkumy).——Fig. 53,*2a–d. *B. salavati,* holotype, Malaia Suren' river, left bank, Bashkortostan, South Urals, *Reticuloceras* Zone, PIN 455/40134; *a–b,* ×1.5; *c,* suture, whorl height at 8.3 mm, whorl width 13.4 mm, ×3; *d,* cross section, PIN 455/40135, ×3 (Ruzhentsev & Bogoslovskaia, 1971).

Bogdanoceras Ruzhentsev & Bogoslovskaia, 1971, p. 30 [**B. bifurcum;* OD]. Conch form subdiscoidal, calyx stage distinct. Later whorls involute, umbilicus moderately narrow. Sculpture consisting of coarse ribs dichotomizing on middle of flanks, forming ventral sinus. Two intraventral ridges developed in intermediate ontogenetic stages. Longitudinal elongate tubercles on umbilical shoulder.

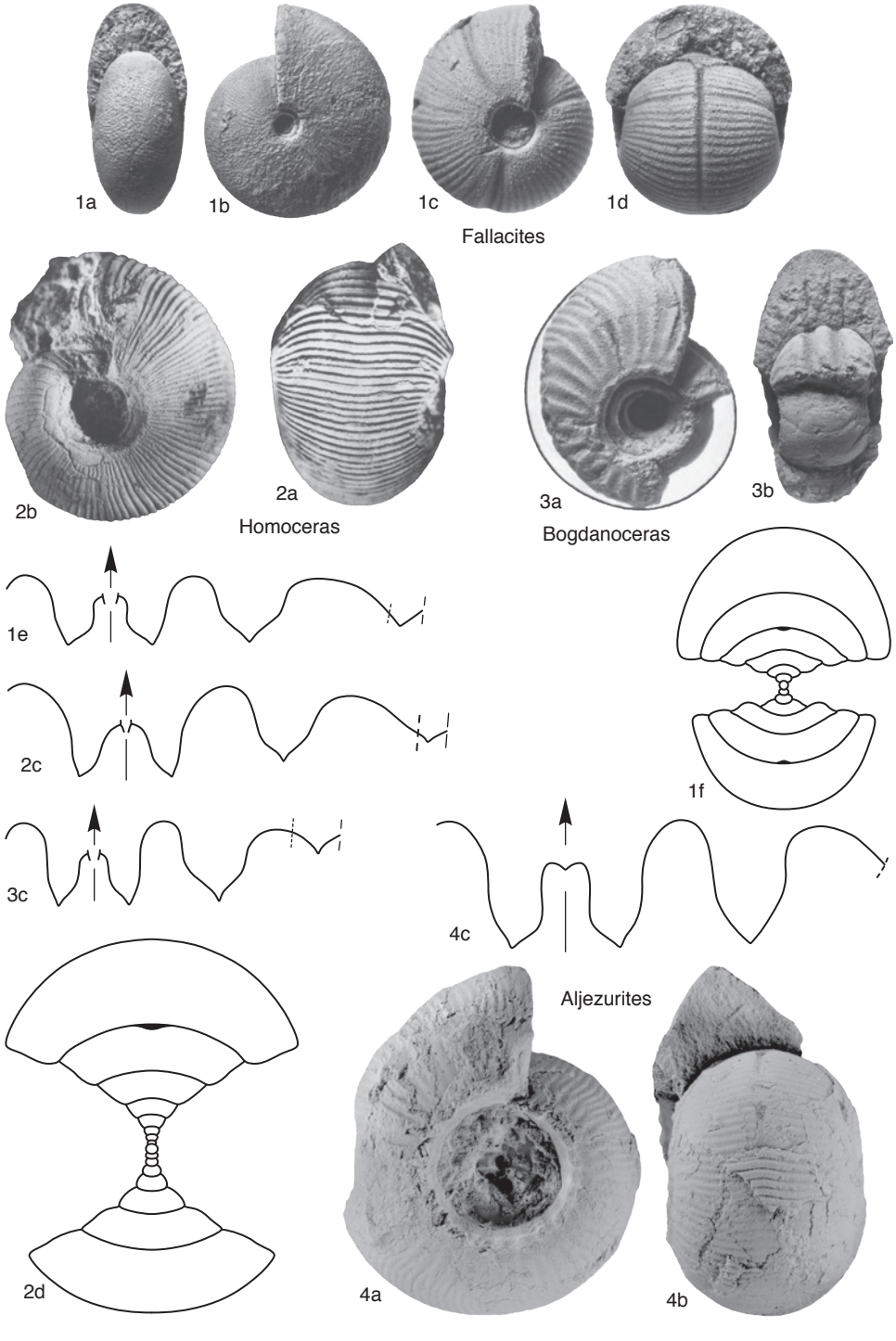

FIG. 52. Homoceratidae (p. 87–89).

One species. [The type material consists of two poorly preserved specimens.] *Pennsylvanian (lower Bashkirian [Reticuloceras Zone]):* Russia (South Urals).——Fig. 52,*3a–c. *B. bifurcum,* holotype, Bol'shaia Suren' river, left bank, Bashkortostan, PIN 455/40437; *a–b,* ×1; *c,* suture, whorl width at 10 mm, ×3.7 (Ruzhentsev & Bogoslovskaia, 1971).

Fallacites Ruzhentsev & Bogoslovskaia, 1971, p. 29 [**F. portentosus;* OD]. Conch form subdiscoidal; calyx stage of early whorls extremely broad; later stages completely involute, umbilicus moderately narrow. Ornamentation consisting of fine dichotomizing lamellae; on intermediate stages one intraventral ridge. Ventral lobe with rather wide median saddle reaching about two-thirds entire height of ventral lobe. Adventitious lobe very wide. One species. *Pennsylvanian (lower Bashkirian [lower Reticuloceras Zone]):* Russia (South Urals).——Fig. 52,*1a–f. *F. portentosus,* Chumaza river, Bashkortostan; *a–b,* holotype, PIN 455/40408, ×1; *c–d,* paratype, PIN 455/40413, ×3; *e,* suture, PIN 455/40410, whorl height at 7.4 mm, whorl width 11 mm, ×3.7; *f,* cross section, PIN 455/40412, ×3 (Ruzhentsev & Bogoslovskaia, 1971).

Isohomoceras Ruzhentsev & Bogoslovskaia, 1971, p. 19 [**Glyphioceras inostranzewi* Karpinskii, 1889, p. 60; OD]. Conch form and suture line similar to *Homoceras.* Early whorls evolute, but lacking sharp umbilical shoulder (no calyx stage). Seven species. *Pennsylvanian (lower Bashkirian [Homoceras Zone]):* Belgium, Great Britain, Ireland, Germany, Portugal, Algeria, Russia and Kazakhstan (South Urals), Kyrgyzstan (South Fergana), Uzbekistan (Fergana, Gissar Mountains), USA (Nevada).——Fig. 53,*4a–b. *I. inostranzewi* (Karpinskii), Shartym river, Cheliabinskaia oblast', South Urals, Russia, *Homoceras* Zone; *a,* suture, PIN 455/39720, whorl height at 24 mm, whorl width 21 mm, ×1.8; *b,* cross section, PIN 455/39723, ×3 (Ruzhentsev & Bogoslovskaia, 1971).

Parahomoceras Ruzhentsev & Bogoslovskaia, 1971, p. 31 [**P. asperum* Ruzhentsev & Bogoslovskaia, 1971, p. 32; OD]. Early whorls evolute, but without calyx stage, umbilical shoulder narrowly rounded, no keel. No furrows on internal mold. Later stages do not possess lamellar growth striae. Tubercles along umbilical shoulder as in *Umbetoceras,* but small and slightly prolongated. Two species. *Pennsylvanian (lower Bashkirian [Homoceras Zone]):* Russia and Kazakhstan (South Urals), Morocco.——Fig. 53,*1a–b. *P. asperum,* Sholak-Sai Canyon, Aqtöbe (=Aktiubinskaia oblast'), South Urals, Kazakhstan; *a,* suture, PIN 455/40439, whorl height at 5.4 mm, whorl width 14.5 mm, ×4.2; *b,* cross section, PIN 455/40440, ×3 (Ruzhentsev & Bogoslovskaia, 1971).

Umbetoceras Ruzhentsev & Bogoslovskaia, 1971, p. 28 [**U. uskalykense;* OD] [=?*Machangoceras* Yang, 1978, p. 168 (type, *M. subglobosum* Yang, 1978, p. 169, OD)]. Early whorls evolute, with distinct calyx stage; conch form of adult stage involute, pachycone, and with moderately wide umbilicus. Sculpture consisting of strong riblets on intermediate stages; tubercles present on umbilical shoulder. Deep ventral furrow on internal mold. Suture resembling gastrioceran type: ventral lobe wide, median saddle exceeding two-thirds height of entire ventral lobe, adventitious lobe wide. Five species. [?*Machangoceras* is based on one poorly preserved specimen with a subglobular conch form; its ontogeny is insufficiently known.] *Pennsylvanian (lower Bashkirian [Kinderscoutian–Yeadonian]):* Russia (South Urals), Uzbekistan (Fergana, Tian Shan).——Fig. 53,*3a–c. *U. uskalykense,* holotype, Uskalyk river, west of Umbetov, Bashkortostan, South Urals, Russia, Kinderscoutian, PIN 455/40390; *a–b,* ×2; *c,* suture, whorl height at 6.0 mm, whorl width 13.5 mm, ×3 (Ruzhentsev & Bogoslovskaia, 1971).

Vallites Ruzhentsev & Bogoslovskaia, 1971, p. 20 [**Homoceras henkei* Schmidt, 1934, p. 453; OD]. Adult whorls with conspicuous umbilical wall ornamented with spiral lirae. Early whorls evolute, with rounded umbilical shoulder, no calyx stage; adult whorls pachyconic, completely involute and with very narrow umbilicus. Transverse striae simple or dichotomizing. Ventral lobe rather wide, with cuneiform branches; median saddle fairly high. Adventitious lobe shorter than ventral lobe. Seven species. *Pennsylvanian (lower Bashkirian [Homoceras Zone–Reticuloceras Zone]):* Belgium, Great Britain, Ireland, Germany, Czech Republic, Poland, Portugal, Algeria, Morocco, Russia (South Urals), Uzbekistan (Fergana).——Fig. 53,*5a–d. *V. henkei* (Schmidt); *a,* side view, Roadford, River Aille, County Clare, Ireland, lower *Reticuloceras* Zone, GSM 86931, ×2; *b–c,* Emde-Neheim brickworks, Sauerland, Rhenish Massif, Germany, lower *Reticuloceras* Zone, collection Pitz, GÖT, ×2 (Kullmann, new); *d,* cross section, Ireland, lower *Reticuloceras* Zone, PIN 2966/16, ×3 (Ruzhentsev & Bogoslovskaia, 1971).——Fig. 53,*5e. V. schmidti* Ruzhentsev & Bogoslovskaia, holotype, suture, Bol'shaia Suren' river, east of Suleiman, South Urals, Bashkortostan, Russia, PIN 455/40113, whorl height at 9.3 mm, whorl width 10.5 mm, ×3 (Ruzhentsev & Bogoslovskaia, 1971).

Subfamily DECORITINAE Ruzhentsev & Bogoslovskaia, 1975

[*nom. transl.* Kullmann, herein, *ex* Decoritidae Ruzhentsev & Bogoslovskaia, 1975, p. 48]

Conch form small, in general similar to Homoceratinae, but no calyx stage, with sharp umbilical shoulder on early whorls. Sculpture consisting of dichotomous or polyschizotomous ribs forming shallow ventrolateral salient and ventral sinus. Reticulate ornamentation in advanced forms. Ventral lobe relatively narrow, median saddle usually lower than half height of entire ventral lobe.

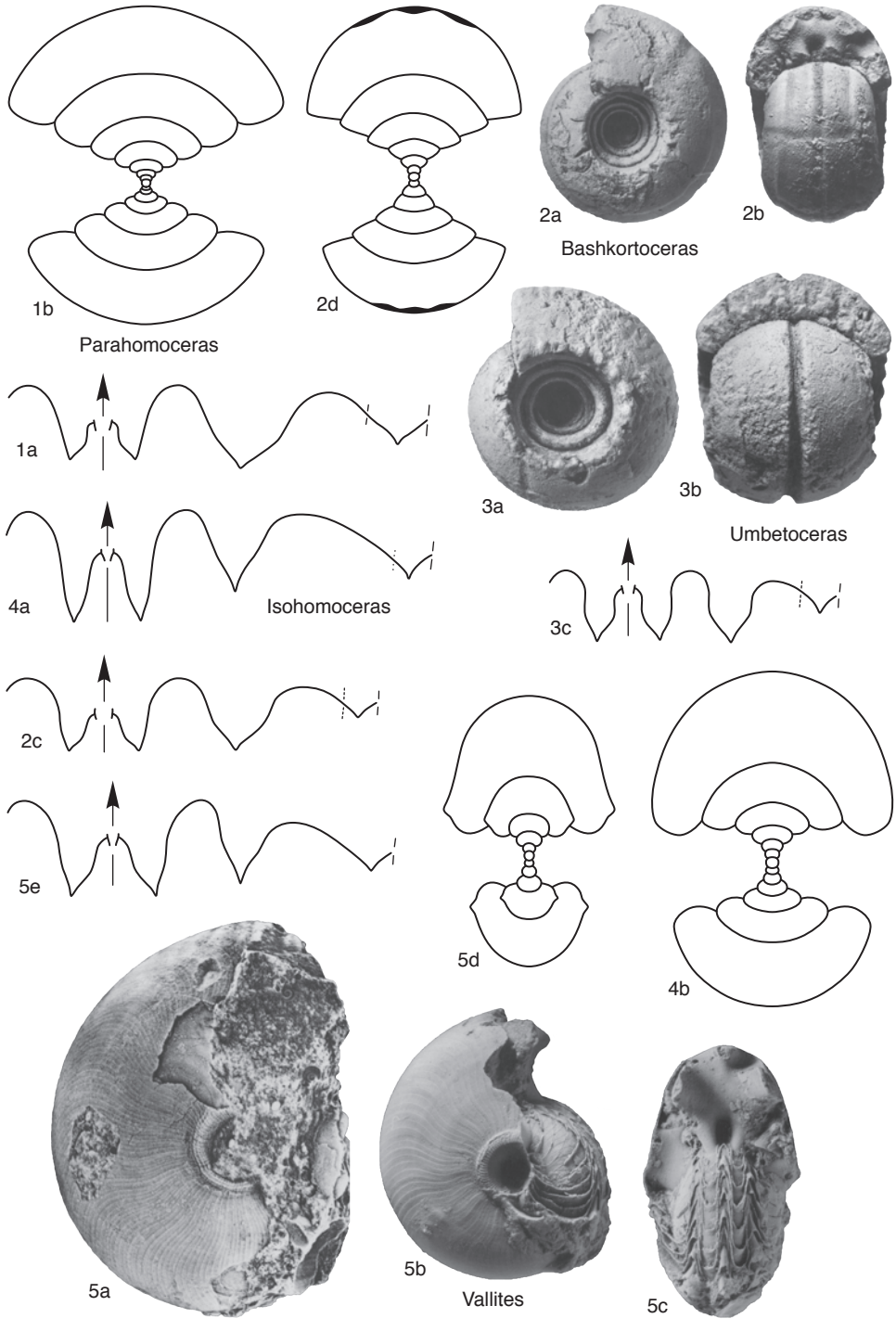

FIG. 53. Homoceratidae (p. 87–89).

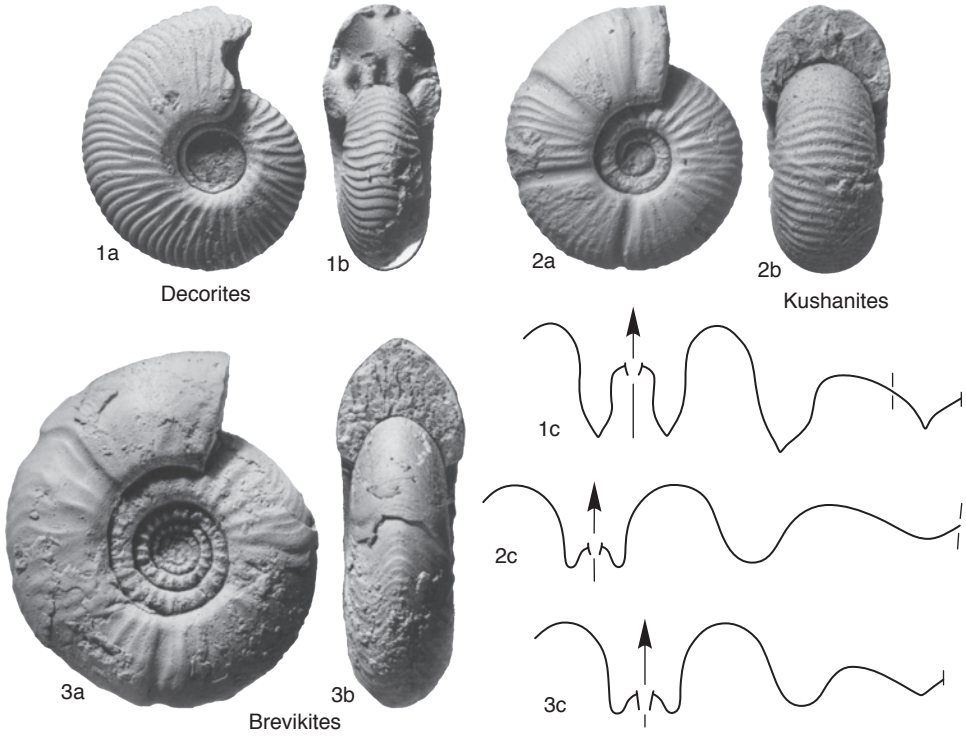

FIG. 54. Homoceratidae (p. 91–92).

Prongs of ventral lobe and adventitious lobe may be small and rounded. [Decoritidae was established as an independent family, but RUZHENTSEV and BOGOSLOVSKAIA (1978, p. 222) confirmed the close relationship to the Homoceratidae.] *Pennsylvanian (lower Bashkirian [Kinderscoutian–Yeadonian]).*

Decorites RUZHENTSEV & BOGOSLOVSKAIA, 1975, p. 48 [**D. crassicostatus;* OD]. Conch form lenticular, involute, with moderately wide to narrow umbilicus. Umbilical tubercles present on immature stages. Strong dichotomous ribs, starting at elongated tubercles crossing flanks and venter with shallow ventrolateral salient and ventral sinus. No longitudinal ornament. Median saddle about half as high as entire ventral lobe. Three or four species. *Pennsylvanian (lower Bashkirian [Reticuloceras Zone]):* Russia (South Urals), ?Algeria, Uzbekistan (Fergana, Kyzylkumy, Tian Shan).——FIG. 54,*1a–c. *D. crassicostatus,* holotype, Bol'shaia Suren' river, eastern Suleiman, South Urals, Bashkortostan, Russia, PIN 455/42252; *a–b,* ×2; *c,* suture, whorl height at 7.6 mm, whorl width 7.6 mm, ×4 (Ruzhentsev & Bogoslovskaia, 1975).

Brevikites RUZHENTSEV & BOGOSLOVSKAIA, 1975, p. 51 [**B. inops;* OD]. Conch form lenticular, with tendency to oxycone venter; umbilicus moderately wide. Early whorls with umbilical tubercles, later wrinkles, giving rise to dichotomous riblets; intercalated ribs present. Riblets form narrow ventral sinus. Weak longitudinal lirae present. Several constrictions per whorl. Ventral lobe relatively narrow, almost parallel sided, with very low median saddle. Adventitious lobe subacute or rounded. Two species. *Pennsylvanian (lower Bashkirian [Kinderscoutian, Reticuloceras Zone]):* Russia (South Urals).——FIG. 54,*3a–c. *B. inops; a–b,* holotype, Bol'shaia Karsakla, Malaia Suren', Bashkortostan, PIN 455/47877, ×2; *c,* suture, whorl height at 6 mm, whorl width 7.7 mm, ×4.8 (Ruzhentsev & Bogoslovskaia, 1975).

Kushanites RUZHENTSEV & BOGOSLOVSKAIA, 1975, p. 50 [**K. kirgizorum;* OD]. Conch form lenticular, rarely pachycone; umbilicus moderately wide. Sculpture with prominent dichotomous ribs, crossing venter with a very shallow sinus, ending in wrinkles near umbilical wall. No spiral ornamentation. Several narrow and deep constrictions per whorl. Suture line primitive, with rounded lobes and saddles, ventral lobe narrow, with very low median saddle. One species, from one locality. *Pennsylvanian (lower Bashkirian [Marsdenian–Yeadonian]):* Uzbekistan (Fergana), China (Ningxia).——FIG. 54,*2a–c. *K. kirgizorum,* holotype, Aravan river, southwest of Yangi-Kurgan, Fergana, Uzbekistan, Yeadonian,

PIN 2195/3014; *a–b,* ×2; *c,* suture, whorl height at 6 mm, whorl width 7.7 mm, ×7.2 (Ruzhentsev & Bogoslovskaia, 1975).

Family RETICULOCERATIDAE Librovich, 1957

[Reticuloceratidae Librovich, 1957, p. 252]

Conch form subdiscoidal, moderately to completely involute; umbilicus wide to narrow. Linear or biconvex growth lines, commonly crossed by longitudinal lirae, thus forming reticulate ornamentation. Nodelike riblets and lateral plications in some forms. Ventrolateral furrows may be present. Suture line relatively simple, in some forms with rounded elements. Prongs of ventral lobe well developed, but rarely pouched, frequently at its base narrowly rounded; median saddle usually about half as high as entire ventral lobe, or slightly higher. Advanced genera with higher median saddle, wider lateral lobe, and generally attenuate lobes. [The root group of Decoritinae and Surenitinae may be *Homoceras.*] *Pennsylvanian (Bashkirian [Alportian–Langsettian]).*

Subfamily SURENITINAE Ruzhentsev & Bogoslovskaia, 1975

[*nom. transl.* Kullmann, herein, *ex* Surenitidae Ruzhentsev & Bogoslovskaia, 1975, p. 52] [=Melvilloceratidae Nassichuk, 1975, p. 133]

Umbilical tubercles on early growth stages, frequently disappearing in adult forms. Reticulate ornamentation restricted to later growth stages. Growth striae with ventral and lateral sinus; early stages display irregularly ramified riblets. Ventral lobe wide, median saddle relatively high. [Surenitinae was established as an independent family; Ruzhentsev and Bogoslovskaia (1975, p. 47) confirmed the close relationship of both Decoritinae and Surenitinae to *Homoceras,* the joint ancester. The spiral ornamentation, the common character, is predominant in the family Reticuloceratidae. Melvilloceratidae comprise genera with advanced sutures displaying a comparatively high median saddle, regarded herein as being of generic or specific significance.] *Pennsylvanian (lower Bashkirian [Alportian–Langsettian]).*

Surenites Ruzhentsev & Bogoslovskaia, 1975, p. 52 [**S. krestovnikovi;* OD]. Conch form rather involute, umbilicus moderately wide. At immature stages only transverse striae and umbilical tubercles present, giving rise to riblets forming ventral sinus; adult shell surface bearing reticulate ornamentation. Some species with crenulate growth striae, but no lirae. Intraventral furrow and constrictions on internal mold may be present. Six species. *Pennsylvanian (lower Bashkirian [Alportian–Marsdenian]):* Russia (South Urals), Ukraine (Donets), China (Xinjiang), Uzbekistan (Fergana, Kyzylkumy).——Fig. 55,*4a–c.* **S. krestovnikovi,* Bol'shaia Suren', eastern tributary Suleiman, South Urals, Bashkortostan, Russia, Kinderscoutian; *a–b,* holotype, PIN 455/40748, ×1.5; *c,* suture, PIN 455/40747, whorl height at 9.6 mm, whorl width 11.3 mm, ×3.1 (Ruzhentsev & Bogoslovskaia, 1975).

Aphantites Ruzhentsev & Bogoslovskaia, 1978, p. 243 [**A. aenigmaticus;* OD]. Conch form small, lenticular, almost completely involute, umbilicus narrow. Faint umbilical tubercles restricted to early whorls; weak riblets on young shells are predominant over fine and frequent spirals. Suture primitive: ventral lobe with rounded prongs, diverging orad, with very broad first lateral saddle, adventitious lobe deep and broadly rounded. One species. *Pennsylvanian (lower Bashkirian [Yeadonian]):* Uzbekistan (Fergana).——Fig. 55,*5a–c.* **A. aenigmaticus,* Yangi-Kurgan, left bank of Aravan river, Fergana, Uzbekistan, Yeadonian, PIN 2195/1205; *a–b,* ×1.5; *c,* suture, whorl height at 6.0 mm, whorl width 9.8 mm, ×5.3 (Ruzhentsev & Bogoslovskaia, 1978).

Gaitherites Quinn, 1965, p. 234 [**Pygmaeoceras solidum* Gordon, 1965, p. 262; M]. Conch form pachycone, with narrow umbilicus. Ornamentation consisting of linear growth lines, no spiral elements. Umbilical ribs present on young stages. Median saddle reaching two-thirds height of entire ventral lobe; first lateral saddle narrowly rounded. Two or three species. [No suitable illustrations of the type species are available.] *Pennsylvanian (upper Bashkirian [Bloydian]):* China (Guangxi), USA (Arkansas, Oklahoma).——Fig. 55,*1a–c. G. morrowensis* (Miller & Moore), Gaither Mountain, 11.3 km southwest of Harrison, Boone County, Arkansas, USA, Bloydian; *a–b,* ×3 (Saunders, Manger, & Gordon, 1977); *c,* suture, same locality, upper Morrowan, ×1.2 (Miller & Moore, 1938).

?Marianoceras Librovich in Bogoslovskii, Librovich, & Ruzhentsev, 1962, p. 381 [**Goniatites marianus* de Verneuil, 1845, p. 369; OD]. Whorl width wide, conch form pachycone or subglobular; umbilicus moderately wide. Sculpture consisting of nodes, originating at umbilical ridge, prolonging to ribs; growth lines and spiral ornamentation weak. Two species. [Originally only small and perhaps immature specimens were known for this genus. Librovich in Bogoslovskii, Librovich, & Ruzhentsev, 1962, p. 381) regarded *Marianoceras* as a subgenus of *Branneroceras* because of its

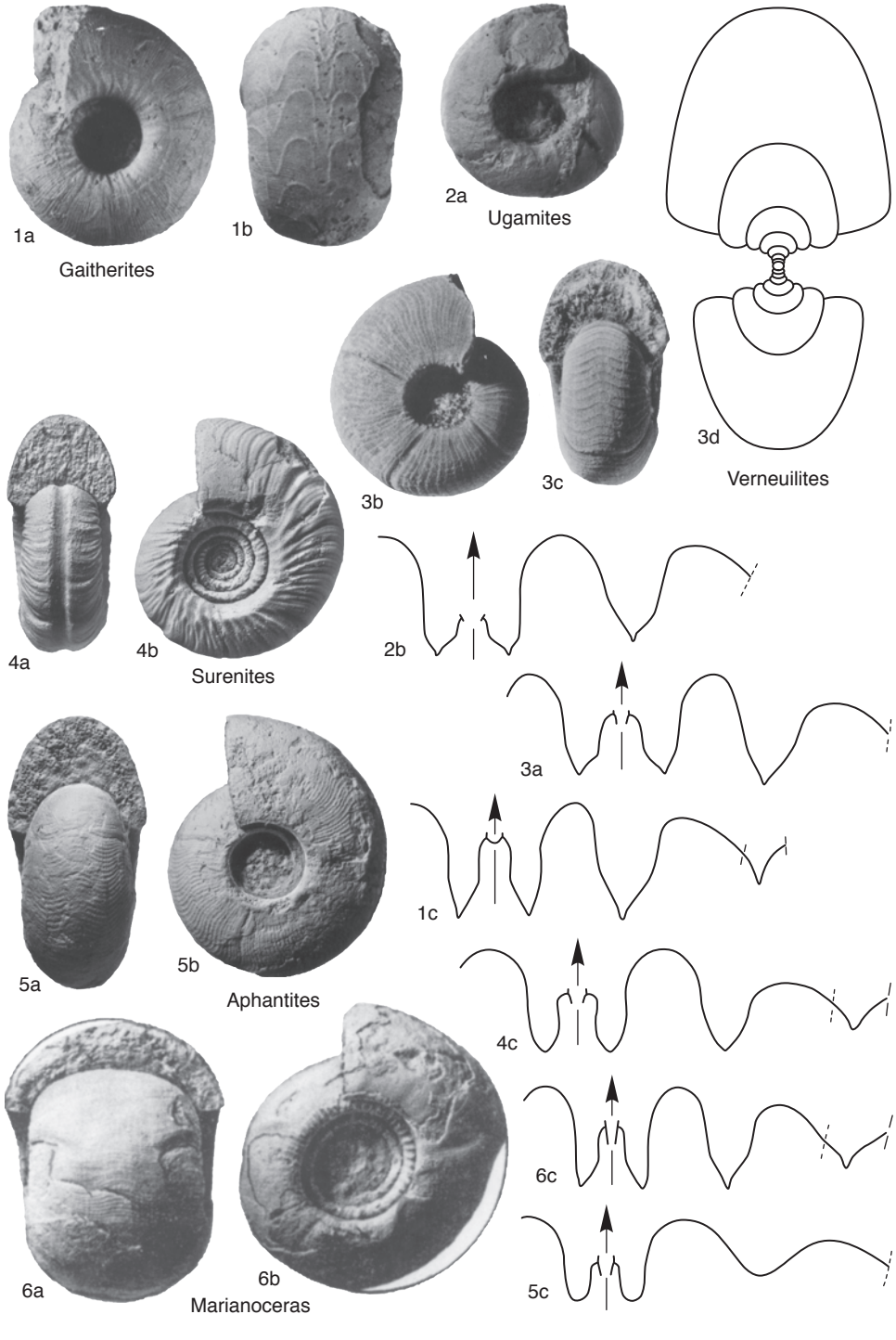

FIG. 55. Reticuloceratidae (p. 92–94).

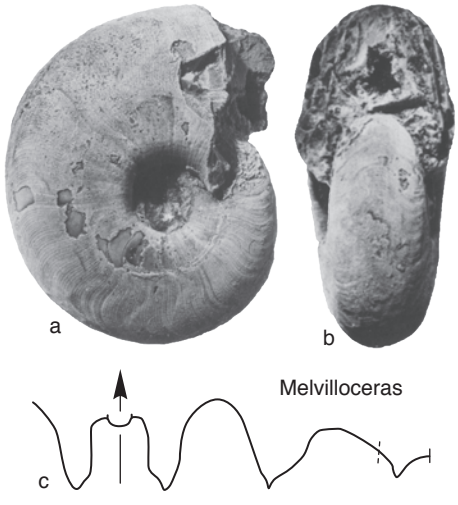

FIG. 56. Reticuloceratidae (p. 94).

relatively wide umbilicus; however, it seems to be closely related to *Verneuilites* and may be its junior synonym.] *Pennsylvanian (lower Bashkirian):* Portugal, Russia (South Urals), Ukraine (Donets), Kazakhstan, Kyrgyzstan (Tian Shan).——FIG. 55,*6a–c. *M. marianum* (DE VERNEUIL), Shartym River, South Urals, Russia, PIN 455/428855; *a–b,* ×2; *c,* suture, PIN 455/42884, whorl height at 8.5 mm, whorl width 18.0 mm, ×2.4 (Ruzhentsev & Bogoslovskaia, 1978).

Melvilloceras NASSICHUK, 1975, p. 134 [**M. sabinense* NASSICHUK, 1975, p. 135; OD] [=?*Lutuginoceras* POPOV, 1979, p. 86 (type, *L. rotaii,* OD)]. Conch form lenticular and moderately involute, with narrow umbilicus. Umbilical nodes present during early growth stages. Ornamentation delicately reticulate; sinuous growth striae more conspicuous than longitudinal lirae. Four to six constrictions per whorl. Broad ventral lobe, with median saddle exceeding three-quarters height of entire ventral lobe. One or two species. [*Lutuginoceras* is based on the holotype of the type species only, which is possibly an immature specimen, the suture of which is unknown; assignment to *Melvilloceras* or related genus is probable.] *Pennsylvanian (upper Bashkirian [Langsettian]):* Ukraine (Donets), Canada (Northwest Territories).——FIG. 56*a–c. *M. sabinense; a–b,* holotype, Barrow Dome, Melville Island, Northwest Territories, Otto Fiord Formation, Bloydian, GSC 33804, ×2; *c,* suture, diameter at 22 mm, GSC 33807, magnification not stated (Nassichuk, 1975).

Ugamites NIKOLAEVA, 1994, p. 104 [**U. rumjanzevae;* OD]. Conch form lenticular to subdiscoidal, with moderately wide umbilicus. Transverse ornamentation consisting of inconspicuous and feeble umbilical placations giving rise to bunches of fine and closely spaced crenulated striae; longitudinal ornamentation also very delicate. Ventral lobe with subparallel sides and comparatively low median saddle. One species. *Pennsylvanian (lower Bashkirian [Bilinguites-Cancelloceras Zone]):* Kazakhstan (Tian Shan).——FIG. 55,*2a–b. *U. rumjanzevae*, holotype, Koishaly-Sai, Ugam Mountains, PIN 4324/24; *a,* side view, ×2; *b,* suture, whorl height at 5.7 mm, whorl width 9.0 mm, ×6.2 (Nikolaeva, 1995).

Verneuilites LIBROVICH, 1939b, p. 16 [**Glyphioceras diadema verneuili* YANISHEVSKII, 1900, p. 322; OD] [=*Pygmaeoceras* GORDON, 1960, p. 147 (type, *Gastrioceras pygmaeum* MATHER, 1915, p. 243, OD); =?*Paraverneuilites* POPOV, 1979, p. 76 (type, *P. linter,* OD)]. Conch at early growth stage widely umbilicate, adult conch form lenticular to subdiscoidal, involute, with narrow, in some forms very narrow, umbilicus. Growth lines almost linear, without sharp ventrolateral salient. Early stages display finely crenulate lirae, which may became delicately reticulate later. Umbilical plications or nodelike riblets present. Some forms with constrictions. Ventral lobe considerably wide, median saddle reaching two-thirds height of entire ventral lobe. Seven or eight species. [*Pygmaeoceras* is based on immature specimens that seem to be congeneric with *Verneuilites;* for discussion, see MANGER & SAUNDERS, 1980, p. 46. *Paraverneuilites* is based on immature specimens that are similar in conch shape to *Verneuilites* but do not show umbilical nodes and reticulate ornamentation; suture unknown.] *Pennsylvanian (Bashkirian [Yeadonian, ?Langsettian]):* Great Britain, Russia (South Urals, Siberia), ?Ukraine (Donets), China (Ningxia, Xinjiang), USA (Arkansas, Oklahoma).——FIG. 55,*3a. *V. verneuili* (YANISHEVSKII), suture, Shartym river, Cheliabinskaia oblast', South Urals, Russia, lower Bashkirian, Yeadonian, PIN 455/42624, whorl height at 10 mm, whorl width 11 mm, ×3.2 (Ruzhentsev & Bogoslovskaia, 1978).——FIG. 55,*3b–d. V. pygmaeus* (MATHER), Kessler Mountain, east side, Washington County, Arkansas, Bloyd Formation, UA 77-205-6; *b–c,* ×2.7; *d,* cross section, UA 77-218-213, ×2.7 (Manger & Saunders, 1980).

Subfamily RETICULOCERATINAE Librovich, 1957

[*nom. transl.* KULLMANN, herein, *ex* Reticuloceratidae LIBROVICH, 1957, p. 252] [=Arkanitinae MCCALEB, QUINN, & FURNISH, 1964, p. 26]

Ornamentation reticulate. Umbilical tubercles, nodelike riblets, and lateral plications common, frequently restricted to early whorls. Conch form lentiform to pachycone, with tendency to develop oxycone ventral side. Width of umbilicus varies from wide

to narrow. Suture variable, in some genera relatively simple, displaying rounded lobes; median saddle comparatively low. [The root group may be *Surenites* (for discussion, see RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 59), which is possibly the predecessor of *Phillipsoceras*.] *Pennsylvanian (Bashkirian [Kinderscoutian–Langsettian]).*

Reticuloceras BISAT, 1924, p. 114 [**Goniatites reticulatus* PHILLIPS, 1836, p. 235; OD]. Conch form involute, with wide or narrow umbilicus. Ornamentation in general weakly developed; sculpture consisting of transverse growth striae, sometimes crenulate, with ventrolateral salient and ventral sinus, usually crossed by fine spiral lirae, thus producing reticulate ornamentation. Small riblets near umbilicus and faint umbilical nodes common at early whorls. Constrictions may be present, but no ventrolateral furrows. Median saddle reaching half height of entire ventral lobe; adventitious lobe as wide and deep as ventral lobe. Two subgenera: *Reticuloceras (Reticuloceras)* BISAT, 1924 and *Reticuloceras (Swintoceras)* SAUNDERS & RAMSBOTTOM, 1993 (for discussion, see SAUNDERS & RAMSBOTTOM, 1993, p. 995). [This genus is closely related and transitional to *Phillipsoceras:* the relation of width of umbilicus:diameter in *Reticuloceras* is 0.25–0.15 (average value = 0.18) and in *Phillipsoceras* is 0.5–0.3 (average value = 0.39); for discussion, see RUZHENTSEV and BOGOSLOVSKAIA, 1978, p. 275.] *Pennsylvanian (lower Bashkirian).*

R. (**Reticuloceras**). Conch form with narrow, in some forms very narrow, umbilicus. Sculpture in general weakly developed and mainly restricted to early stages, consisting of strongly reticulate ornamentation and small weak ribs near umbilicus as well as faint umbilical nodes. Ventral lobe always narrow and deep, with almost parallel sides. Many species. *Pennsylvanian (lower Bashkirian [Kinderscoutian–Marsdenian]):* Belgium, Great Britain, Ireland, France, Germany, Netherlands, Poland, Portugal, Algeria, Morocco, Russia (South Urals), Ukraine (Donets), Uzbekistan (Fergana, Kyzylkumy), China (Ningxia).——FIG. 57,*2a–b. *R. (R.) reticulatum* (PHILLIPS); *a,* Hagen, Westfalen, Rhenish Massif, Germany, upper *Reticuloceras* Zone, Kinderscoutian, ×2 (Schmidt, 1925); *b,* suture, Donets, Ukraine, collection Librovich, magnification not stated, approximately ×4 (Bogoslovskii, Librovich, & Ruzhentsev, 1962).

R. (**Swintoceras**) SAUNDERS & RAMSBOTTOM, 1993, p. 995 [**Homoceras spiraloides* BISAT & HUDSON, 1943, p. 407; OD]. Reticulate ornamentation weakly developed. Noncrenulate to crenulate transverse striae linked by faint spiral lirae. Umbilical nodes at early whorls and constrictions on later stages may be present. Ventral lobe with narrow prongs that tend to be swollen. Three species. *Pennsylvanian (lower Bashkirian [Reticuloceras Zone]):* Great Britain, USA (Arkansas).——FIG. 57,*5. *R. (S.) spiraloides* (BISAT & HUDSON), suture of paratype, Swint Clough, Alport Valley, Derbyshire, England, *Reticuloceras* Zone, Kinderscoutian, Keyworth GSM 63089, diameter at 15 mm, whorl height 8 mm, ×4.8 (Saunders & Ramsbottom, 1993).

Agastrioceras SCHMIDT, 1938, p. 120 [**Glyphioceras subcrenatum* var. *carinata* FRECH, 1899, pl. 46,*3;* OD]. Inner whorls evolute; whorl height strongly increasing on later stages, with tendency to develop narrowly rounded or oxycone venter. Conch form lenticular or subdiscoidal, no angular flanks. Umbilicus moderately wide to narrow. Sculpture of inner whorls only with small nodes at umbilical wall, some species with very fine spiral ornamentation. Nine or ten species. [For discussion, see PATTEISKY, 1965. The suture line of the type species is unknown for this genus.] *Pennsylvanian (Bashkirian [Marsdenian–Langsettian]):* Belgium, Great Britain, Germany, Netherlands, Poland, Kyrgyzstan and Uzbekistan (Tian Shan).——FIG. 57,*1a–c. *A. carinatum* (FRECH); *a,* side view, Albringhausen, Rhenish Massif, Germany, Yeadonian, GMB Foto 41, ×2 (Kullmann, new, same specimen as Patteisky, 1959, pl.10,*1*); *b,* Herbede, Rhenish Massif, Germany, GMB Foto 419, ×1 (Kullmann, new, same specimen as Patteisky, 1959, pl. 10,*9*); *c,* cross section, Silschede, Rhenish Massif, Yeadonian, GMB Foto 2114, ×2.7 (Kullmann, new, same specimen as Patteisky, 1965, pl. 3,*11c*).

Alurites RUZHENTSEV & BOGOSLOVSKAIA, 1975, p. 57 [**A. costatus;* OD]. Conch form small, ophiocone to lenticular, rather involute, umbilicus wide. Sculpture reticulate, spiral ornamentation weak. Umbilical tubercles or riblets sickle shaped, giving rise to fasciculate ribbing and forming ventral sinus. Prongs of ventral lobe narrow and rounded or subacute, median saddle comparatively low. Five or six species. *Pennsylvanian (lower Bashkirian [Kinderscoutian–Marsdenian]):* Russia (South Urals), Uzbekistan (Kyzylkumy), China (?Ningxia).——FIG. 58,*1a–c. *A. costatus,* holotype, Chumaza river, Bashkortostan, South Urals, lower Bashkirian, Kinderscoutian, PIN 455/47898; *a–b,* ×2.5; *c,* suture, PIN 455/47897, whorl height at 2.7 mm, whorl width 5.2 mm, ×10 (Ruzhentsev & Bogoslovskaia, 1975).

Arkanites MCCALEB, QUINN, & FURNISH, 1964, p. 26 [**Eumorphoceras relictum* QUINN, MCCALEB, & WEBB, 1962, p. 112; OD]. Conch form subglobose, rather evolute, with moderately wide umbilicus and broadly rounded ventral side. Sculpture consisting of well-developed umbilical ribbing, sometimes with nodelike bases. Ventrolateral grooves broad and deep. Suture line almost of gastrioceran type: ventral lobe large, median saddle exceeding half height of entire ventral lobe; first lateral saddle broadly rounded. Adventitious lobe large, with sigmoidal sides, and pointed. Three species. *Pennsylvanian (lower Bashkirian [Marsdenian–Yeadonian]):* China (Ningxia), USA (Arkansas, Oklahoma).

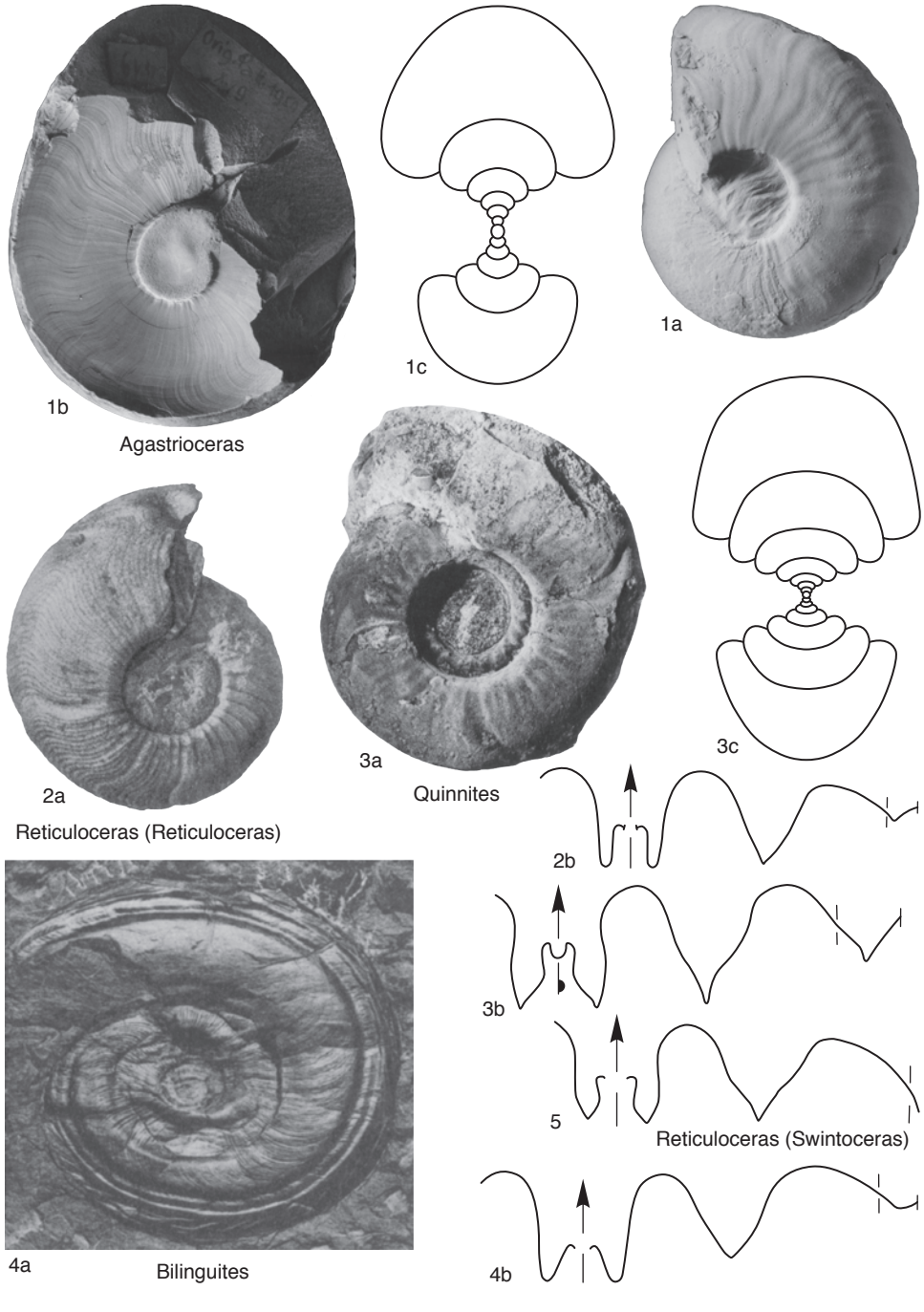

FIG. 57. Reticuloceratidae (p. 95–99).

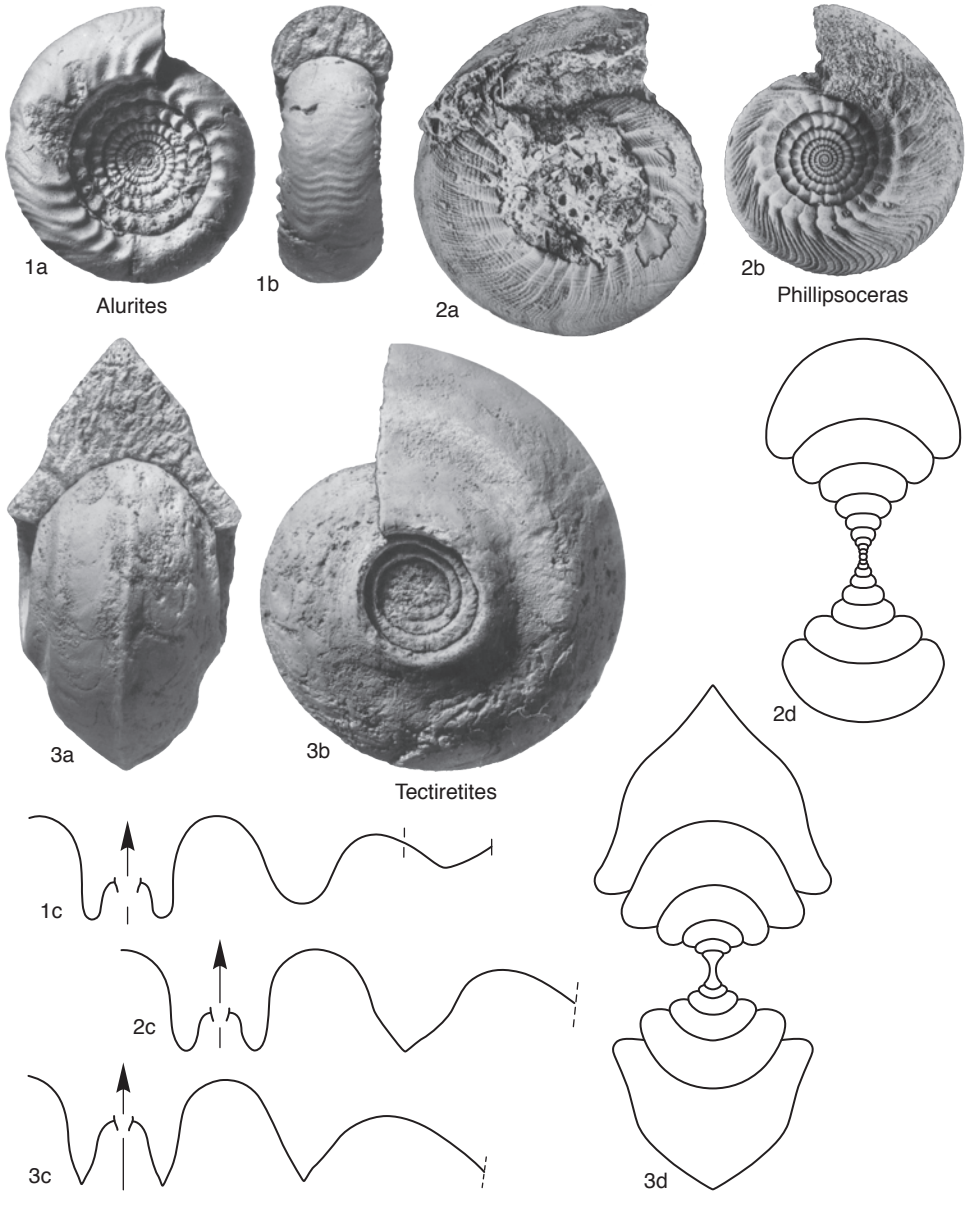

FIG. 58. Reticuloceratidae (p. 95–99).

——FIG. 59,*1a–d. *A. relictus* (QUINN, MCCALEB, & WEBB); *a–b,* Bradshaw Mountain, Carroll County, Arkansas, USA, Prairie Grove Member, Hale Formation, UA L-63-BM-13, ×1.75; *c,* UA L-63-BM-13, suture at 40 mm diameter, ×2; *d,* cross section, SUI 11535, ×2.4 (McCaleb, Quinn, & Furnish, 1964).

Bilinguites LIBROVICH, 1946, p. 79 [**Reticuloceras superbilingue* BISAT, 1924, p. 51; OD]. Conch form similar to *Reticuloceras*, with moderately wide to narrow umbilicus, but ornamentation with strong ventrolateral salient and two ventrolateral furrows on each side; longitudinal lirae weak, if present. Many species. *Pennsylvanian (lower Bashkirian [?Kinderscoutian, Marsdenian–Yeadonian]):* Belgium, Great Britain, Germany, Ireland, Netherlands, Poland, Portugal, Algeria, Morocco, Russia (South Urals), Ukraine (Donets), China (Gansu, Guizhou,

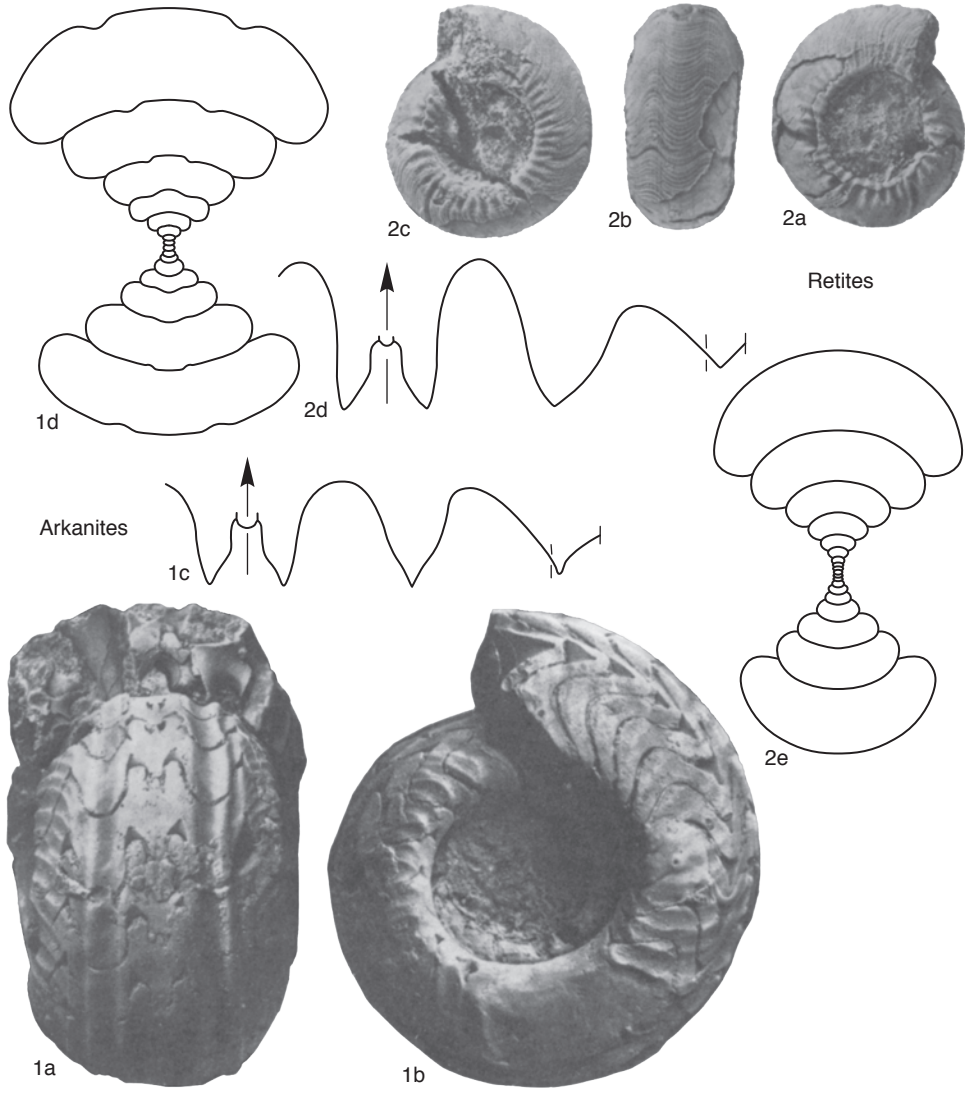

FIG. 59. Reticuloceratidae (p. 95–99).

Ningxia), Uzbekistan (Fergana, Tian Shan), Canada (Northwest Territories), USA (Oklahoma).—— FIG. 57,*4a–b. *B. superbilinguis* (BISAT); *a,* side view, Aiseau-Presles, Hainaut, Belgium, upper Marsdenian, depository not stated, ×3 (Demanet, 1941); *b,* suture, Donets, Ukraine, Marsdenian, magnification not stated (Bogoslovskii, Librovich, & Ruzhentsev, 1962).

Phillipsoceras RUZHENTSEV & BOGOSLOVSKAIA, 1975, p. 55 [**Goniatites (Beyrichoceras) circumplicatile* FOORD, 1903, p. 200; OD]. Conch form on early whorls with wide, later with moderately wide umbilicus, frequently narrowly umbilicate in adult forms. Some species with tendency to form oxycone venter. Sculpture consisting of transverse growth striae crossed by fine spiral lirae, thus producing strong reticulate ornamentation. At early whorls rather strong riblets or nodes near umbilicus. Adventitious lobe wider than ventral lobe. Many species. [This genus is closely related and transitional to *Reticuloceras* and may be its junior synonym: the relation of width of umbilicus:diameter in *Reticuloceras* is 0.25–0.15 (average value = 0.18) and in *Phillipsoceras* is 0.5–0.3 (average value = 0.39); for discussion, see RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 275.] *Pennsylvanian (lower Bashkirian [Kinderscoutian–Marsdenian]):* Belgium, England, Wales, Ireland, France, Germany, Spain, Portugal,

Morocco, Russia (South Urals), Kazakhstan (Tian Shan), Kyrgyzstan (Fergana), Uzbekistan (Fergana, Tian Shan, Kyzylkumi), China (Gansu).——Fig. 58,*2a–b. *P. circumplicatile* (Foord); *a,* lectotype, side view, Lisdoonvarna district, County Clare, Ireland, Kinderscoutian, GSEI 4803 K, ×2; *b,* side view, Neheim, Rhenish Massif, Germany, Kinderscoutian, GS London 86917, ×2.5 (Hodson, 1957).——Fig. 58,*2c–d. P. alpharhipaeum* Ruzhentsev & Bogoslovskaia; *c,* suture, left bank of Malaia Suren' river, Bashkortostan, South Urals, Kinderscoutian, PIN 455/43212, whorl height at 5.6 mm, whorl width 9.7 mm, ×6; *d,* cross section, Chumaza river, Bashkortostan, South Urals, Kinderscoutian, PIN 455/43151, ×2.7 (Ruzhentsev & Bogoslovskaia, 1978).

Quinnites Manger & Saunders, 1980, p. 31 [**Gastrioceras (Branneroceras) henbesti* Gordon, 1965, p. 255; OD]. Conch form lenticular to subdiscoidal, with moderately wide or wide umbilicus. Umbilical riblets common; weak spiral ornamentation, strong constrictions, and ventral groove may be present. Suture gastrioceratoid, with elongate, attenuate ventral prongs, adventitious lobe elongate. Three or four species. *Pennsylvanian (lower Bashkirian [Marsdenian–Yeadonian]):* Russia (?Novaia Zemlia), Kazakhstan (Tian Shan), USA (Arkansas).——Fig. 57,*3a–c. *Q. henbesti* (Gordon), House of Hess, 3.2 km south of West Fork, Washington County, Arkansas; *a,* holotype, side view, USNM 119660, ×1.4; *b,* suture, diameter at 23.9 mm, reversed, ×3.3; *c,* topotype, cross section, UA 77-218-224, ×1.9 (Manger & Saunders, 1980).

Retites McCaleb, 1964, p. 233 [**R. semiretia* McCaleb, 1964, p. 234; OD]. Similar to *Phillipsoceras,* conch lenticular, evolute, with wide or moderately wide umbilicus. Strong ribs present in all stages, more or less confined to umbilical shoulder diverging into weak ribbing on ventrolateral side and venter. Reticulate sculpture formed by coarse, noncrenulate transverse striae, longitudinal ornamentation weak. Type of suture line reticuloceratid; prongs of ventral lobe attenuate, not pouched, median saddle not reaching half height of entire ventral lobe. Eight species. [This genus is transitional to *Phillipsoceras* and may be its junior synonym.] *Pennsylvanian (lower Bashkirian [Kinderscoutian–Yeadonian]):* Portugal, Russia (South Urals), Kazakhstan (Tian Shan), Kyrgyzstan (Fergana), Uzbekistan (Kyzylkumi), China (Guangxi, Ningxia), USA (Arkansas).——Fig. 59,*2a–e. *R. semiretia; a–c,* holotype, Fayetteville, Washington County, Arkansas, Cane Hill Member, Hale Formation, lower Morrowan, SUI 11683, ×1.75; *d,* suture, diameter at 25 mm, magnification not indicated (McCaleb, 1964); *e,* cross section, Fayetteville Railroad cut, Cane Hill Member, Hale Formation, lower Morrowan, UA 77-218-107, ×2.7 (Manger & Saunders, 1980).

Tectiretites Ruzhentsev & Bogoslovskaia, 1975, p. 59 [**T. hodsoni;* OD] [=*Reticuloceras (Panxianoceras)* Yang, 1978, p. 171 (type, *R. (P.) microreticulatum,* OD)]. Inner whorls evolute, later stages involute, with moderately wide umbilicus. At maturity, conch form oxycone and tectiform, with angular flanks and ventral keel. Ornamentation consisting of small nodes at umbilical wall, in some species elongated to riblets that cross venter with small sinus. Most species with spiral ornamentation. Suture reticuloceratid. Many species. [For discussion, see Manger & Saunders, 1980, p. 13. *Panxianoceras* was erected for forms with a relatively wide umbilicus, regarded herein as being of specific significance.] *Pennsylvanian (lower Bashkirian [Kinderscoutian–Marsdenian]):* Great Britain, Ireland, Portugal, Russia (South Urals), Kazakhstan (Tian Shan), Uzbekistan (Tian Shan), Kyrgyzstan (Tian Shan, Fergana), China (Guizhou, Xinjiang).——Fig. 58,*3a–c. *T. hodsoni,* holotype, Abuliaisov, 3.5 km east, Bashkortostan, South Urals, Russia, PIN 455/46136; *a–b,* ×1; *c,* suture, whorl height at 18.5 mm, whorl width 28 mm, ×2.1 (Ruzhentsev & Bogoslovskaia, 1975).——Fig. 58,*3d. A. confinis* (Ruzhentsev & Bogoslovskaia), holotype, cross section, Chumaza river, Bashkortostan, South Urals, Kinderscoutian, PIN 455/46305, ×1.3 (Ruzhentsev & Bogoslovskaia, 1978).

Family GASTRIOCERATIDAE Hyatt, 1884

[*nom. correct.* Wedekind, 1914, p. 12, *pro* Gastriocerae Hyatt, 1884 in 1883–1884, p. 325]

Conch form subdiscoidal to globular. Early whorls usually evolute, adult stages with wide or moderately narrow umbilicus. Umbilical shoulder with nodes, generally elongate transversely, sometimes combined with rather strong ribs. Growth striae sinuous or rather straight, mostly with ventral sinus. Longitudinal lirae present in some forms. Suture similar to Glaphyritidae; ventral lobe wide, deeply subdivided, moderately pouched, with asymmetrical prongs; height of median saddle exceeding half height of entire ventral lobe. Origin of family possibly in unsculptured glaphyritids. [Some authors (e.g., Ruzhentsev & Bogoslovskaia, 1978, p. 60) regard *Surenites* or related forms as predecessors of *Cancelloceras* and *Gastrioceras.*] *Pennsylvanian (lower Bashkirian [Marsdenian]–Moscovian).*

Gastrioceras Hyatt, 1884 in 1883–1884, p. 327 [**Ammonites listeri* Sowerby, 1814, p. 97; SD Foord & Crick, 1897, p. 226; *non* Martin, 1809, pl. 35,*3;* see Opinion 231, ICZN, 1954, p. 239)] [=*Gastrioceras (Lissogastrioceras)* Gordon, 1965, p. 257 (type, *Gastrioceras fittsi* Miller & Owen, 1944, p. 424, OD)]. Conch form typically broad. Umbilical shoulder ornamented with nodes that are

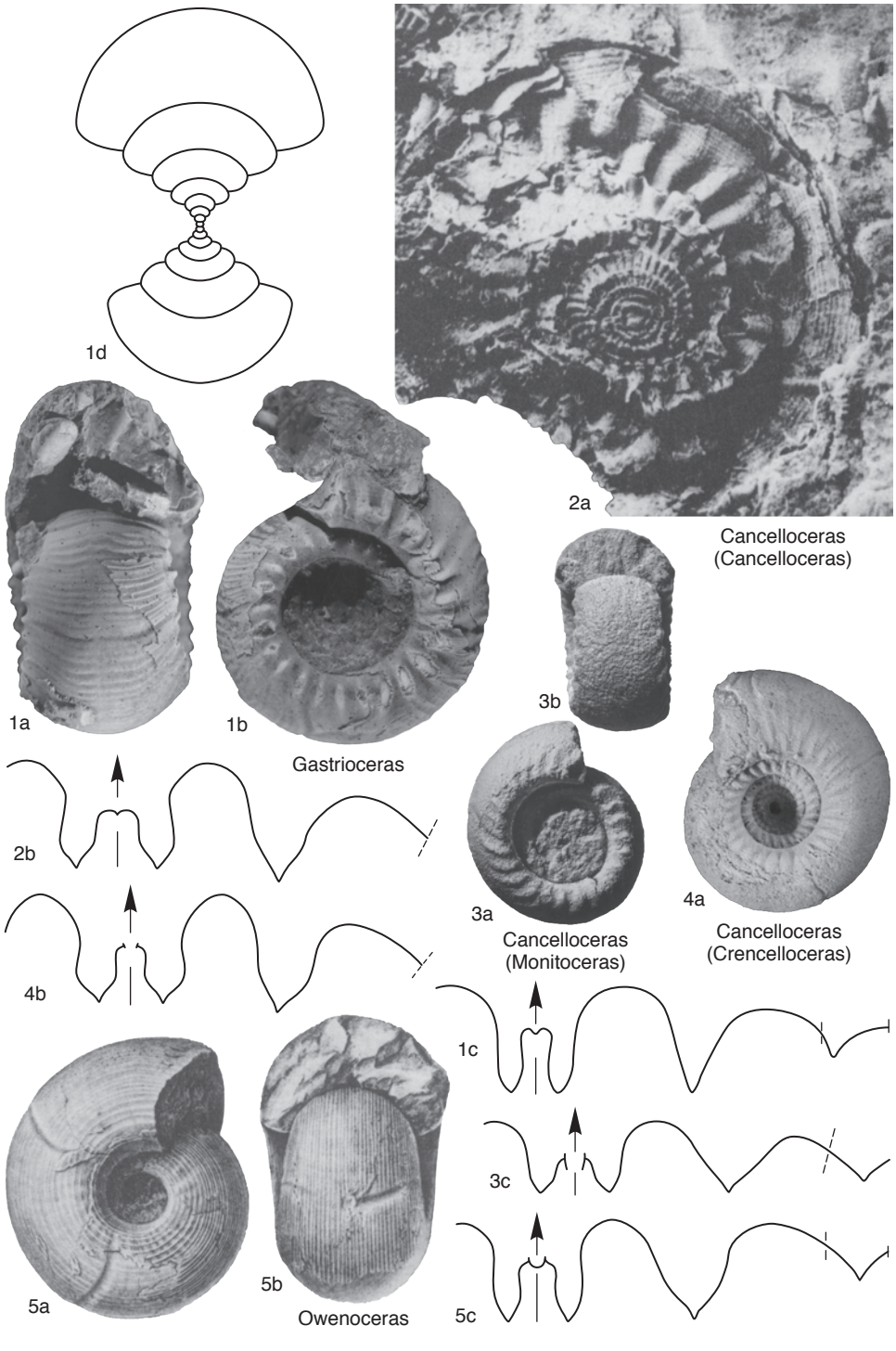

FIG. 60. Gastrioceratidae (p. 99–101).

elongated transversely; in some species rather strong ribs. Longitudinal lirae usually very faint or absent, sometimes confined to umbilical shoulders. Suture similar to *Glaphyrites,* ventral lobe wide, height of median saddle exceeding half height of entire ventral lobe, its prongs being slightly pouched or attenuate; first lateral saddle broadly rounded, adventitious lobe deep, relatively wide and bell shaped, in some forms attenuate. Many species. [*Lissogastrioceras* exhibits smooth unornamented ventral regions, regarded herein as being of specific significance.] *Pennsylvanian (upper Bashkirian [Langsettian]–Moscovian):* Belgium, Netherlands, Great Britain, Ireland, Germany, Portugal, Algeria, Morocco, Poland, Ukraine (Donets), Uzbekistan (Fergana), China (Gansu, Guizhou, Xinjiang, Ningxia), Japan, Canada (Northwest Territories), USA (Arkansas, Illinois, Ohio, Kentucky, Oklahoma, Texas, Alabama).——Fig. 60,*1a–c.* **G. listeri* (Sowerby), Shore, Lancashire, Bullion Mine, England, Langsettian, GSM 56454; *a–b,* ×2 (new, courtesy of W. Ramsbottom; same specimen as Ramsbottom & Calver, 1962, pl.15,*9*); *c,* suture, BMNH C. 4953, provenance not stated, diameter at 58.5 mm, magnification not stated (Foord & Crick, 1897).——Fig. 60,*1d. G. carbonarium carbonarium* (von Buch), cross section, Essen-Rellinghausen, Mine Langenbrahm II, Rhenish Massif, Germany, Langsettian, GMB P220, Foto 2130, ×2.6 (Kullmann, new, same specimen as Patteisky, 1965, pl. 7,*4b*).

Cancelloceras Ruzhentsev & Bogoslovskaia, 1969b, p. 1333 [**Gastrioceras cancellatum* Bisat, 1923, p. 47; OD] [=*Leiogastrioceras* Yang, 1978, p. 184 (type, *L. discoideum,* OD)]. Conch moderately involute. Well-developed tubercles on umbilical shoulder similar to *Gastrioceras,* but with reticulate ornamentation at maturity. Suture resembles *Gastrioceras.* Many species. Three subgenera: *Cancelloceras (Cancelloceras)* Ruzhentsev & Bogoslovskaia, 1969b; *Cancelloceras (Monitoceras)* Ruzhentsev & Bogoslovskaia, 1978; and *Cancelloceras (Crencelloceras)* Nikolaeva & Kullmann, 1995. [*Leiogastrioceras* was established for species with relatively high median saddle and narrow adventitious lobe. For discussion, see Nikolaeva & Kullmann, 1995.] *Pennsylvanian (lower Bashkirian [Marsdenian–Yeadonian]):* Belgium, England, Wales, France, Germany, Netherlands, Poland, Portugal, Russia (South Urals), Ukraine (Donets), Algeria, Morocco, Kazakhstan (Tian Shan), Kyrgyzstan (Tian Shan), Uzbekistan (Fergana, Tian Shan), China (Ningxia, Guizhou), USA (Arkansas, Oklahoma, Nevada).

C. (Cancelloceras). Spirals more pronounced than transverse ornamentation; relatively low number of plications. Seven species. *Pennsylvanian (lower Bashkirian [Marsdenian–Yeadonian]):* Great Britain, Belgium, Netherlands, ?France, Germany, Portugal, Algeria, ?Poland, Ukraine (Donets), Uzbekistan (Fergana), China (Ningxia).——Fig. 60,*2a–b.* **C. (C.) cancellatum* (Bisat); *a,* lectotype, side view, Meanwood, Leeds, Yorkshire, Rough Rock, Yeadonian, BMNH C.25767, ×3.5 (new, courtesy of W. Ramsbottom, same specimen as Ramsbottom & Calver, 1962, pl. 14,*5*); *b,* suture, Eira Velha, Portugal, upper part of Quebradas Formation, Yeadonian, IGML 379, whorl height at 11.8 mm, whorl width 11.8 mm, ×3.2 (Korn, 1997).

C. (Crencelloceras) Nikolaeva & Kullmann, 1995, p. 369 [**Cancelloceras elegans* Ruzhentsev & Bogoslovskaia, 1978, p. 296; OD]. Transverse ornamentation more pronounced than spirals, in general higher number of plications. Conch form and suture similar to *Cancelloceras.* Many species. [No suitable illustration displaying characteristics of the ornament of the type species is available.] *Pennsylvanian (lower Bashkirian [Marsdenian–Yeadonian]):* England, Wales, Germany, Belgium, Netherlands, Portugal, Algeria, Russia (South Urals), Ukraine (Donets), Kazakhstan (Tian Shan), Uzbekistan (Fergana, Tian Shan), China (Ningxia), USA (Arkansas, Oklahoma).——Fig. 60,*4a–b. C. (C.) crencellatum* Bisat, =*C. (Cr.) soliari* Nikolaeva & Kullmann, paratype, Choça, near São Marcos da Serra, southwestern Portugal, Quebradas Formation, Yeadonian, IGML 24/1; *a,* side view, ×2; *b,* suture, ×3.1 (Nikolaeva & Kullmann, 1995).

C. (Monitoceras) Ruzhentsev & Bogoslovskaia, 1978, p. 288 [**Gastrioceras marianum karpinskii* Yanishevskii, 1900, p. 319; OD]. Strong transverse ornamentation, weak spirals; umbilical riblets disappearing on early stages. Ventral lobe with wide prongs and divergent sides. One species. *Pennsylvanian (lower Bashkirian [Marsdenian]):* Russia (South Urals).——Fig. 60,*3a–c.* **C. (M.) karpinskii* (Yanishevskii), Shartym river, Cheliabinsk oblast', Marsdenian; *a–b,* PIN 455/48002, ×2; *c,* suture, PIN 455/48000, whorl height at 6.3 mm, whorl width 12.3 mm, ×4.2 (Ruzhentsev & Bogoslovskaia, 1978).

?Owenoceras Miller & Furnish, 1940b, p. 359 [**Neoglyphioceras bellilineatum* Miller & Owen, 1939, p. 154; OD]. Conch form involute, with moderately wide or rather narrow umbilicus. Shell surface with prominent longitudinal lirae; growth lines weak. Umbilical nodes may be present. Suture similar to *Gastrioceras.* Three or four species. [The root group and phylogenetic reationship of the genus is uncertain.] *Pennsylvanian (upper Moscovian):* China (Xinjiang, ?Guizhou), Russia (Siberia), USA (Missouri, Oklahoma).——Fig. 60,*5a–c.* **O. bellilineatum* (Miller & Owen), Ewing strip pit, Henry County, Missouri, Cherokee Formation above Mulky coal, Desmoinesian, Owen collection no. 627; *a–b,* ×2; *c,* suture, diameter at 17 mm, whorl height 5 mm, whorl width 12 mm, ×4.5 (Miller & Owen, 1939).

THALASSOCERATOIDEA

JÜRGEN KULLMANN

[University of Tübingen, Germany]

Superfamily THALASSOCERATOIDEA Hyatt, 1900

[*nom. transl.* KULLMANN, 1962, p. 67, *ex* Thalassoceratidae HYATT, 1900, p. 553]

Conch form thick-discoidal to globular, involute. Umbilicus narrow or closed. Growth striae biconvex, with ventral sinus. Ventral lobe wide; height of median saddle usually extending considerably to half height of entire ventral lobe. Lobes simple (Bisatoceratidae) or serrate and digitate (Thalassoceratidae). [The close relationship of families in this superfamily is uncertain.] *Pennsylvanian (upper Bashkirian)–Guadalupian (Wordian).*

Family BISATOCERATIDAE Miller & Furnish, 1957

[*nom. transl.* RUZHENTSEV, 1975, p. 33, *ex* Bisatoceratinae MILLER & FURNISH in MILLER, FURNISH, & SCHINDEWOLF, 1957, p. 60]

Conch subdiscoidal, with narrow or closed umbilicus. Lobes comparatively simple; median saddle high, sometimes reaching almost height of ventral lobe. Spiral ornamentation in some forms. [The relationship to the superfamily is uncertain.] *Pennsylvanian (upper Bashkirian)–Cisuralian (Asselian, ?Artinskian).*

Bisatoceras MILLER & OWEN, 1937, p. 417 [**B. primum;* OD]. Conch subdiscoidal, umbilicus very narrow or closed; immature growth stages globular. Growth lines usually biconvex, forming ventral and lateral sinuses; constrictions may be present. Median saddle of ventral lobe exceeding two-thirds height of entire ventral lobe. Adventitious lobe simple, with convex sides. Many species. *Pennsylvanian (upper Bashkirian–Moscovian [Missourian]):* China (Guangxi), Japan, Russia (Novaia Zemlia, Siberia), Canada (Northwest Territories), USA (Arkansas, California, Kansas, Missouri, Nevada, Oklahoma).——FIG. 61,*1a–b. *B. primum,* syntype, 1 km south of Collinsville, Oklahoma, USA, Coffeyville Formation, concretions just above Dawson coal, Missourian, Owen collection; *a,* side view, ×2; *b,* suture, ×2.3 (Miller & Owen, 1937).

Neoglaphyrites RUZHENTSEV, 1938, p. 272 [**Glaphyrites (Neoglaphyrites) bashkiricus* RUZHENTSEV, 1938, p. 272; OD]. Conch involute, with open but very narrow umbilicus. Umbilical wall steep. Suture line similar to *Bisatoceras*, but with V-shaped lobe on umbilical wall. Five species. [For discussion, see NASSICHUK, 1975, p. 105. No suitable illustrations of the type species are available.] *Pennsylvanian (?upper Bashkirian, Gzhelian)–Cisuralian (Asselian, ?Artinskian):* Russia (Bashkortostan, South Urals), China (Gansu), Japan, Canada (Northwest Territories), USA (Oklahoma).——FIG. 61,*3a–b. N. bisulcatus* NASSICHUK, Ellesmere Island, Northwest Territories, Canada; *a,* GSC 33749, ×1; *b*, holotype, GSC 33748, ×2 (Nassichuk, 1975).——FIG. 61,*3c. N. satrus* (MAKSIMOVA), holotype, suture, north of Akhunovo, Yuresan River, Bashkortostan, Russia, Asselian, PIN 323/441, whorl height at 13.2 mm, whorl width 14.8 mm, ×1.8 (Ruzhentsev, 1951).

Pseudobisatoceras MAKSIMOVA, 1940a, p. 859 [**Bisatoceras secundum* MILLER & MOORE, 1938, p. 353; OD]. Similar to *Bisatoceras* but with spiral ornamentation. Two species. [This genus may be a junior synonym of *Bisatoceras*.] *Pennsylvanian (upper Bashkirian–Moscovian):* Russia (Novaia Zemlia), USA (Arkansas, Oklahoma).——FIG. 61,*2. *B. secundum* (MILLER & MOORE), syntype, suture, east side of Gaither Mountain, 11 km southwest of Harrison, Arkansas, Brentwood Limestone, Bloydian, ×2.1 (Miller & Moore, 1938).

Family THALASSOCERATIDAE Hyatt, 1900

[Thalassoceratidae HYATT, 1900, p. 553]

Lobes partly asymmetrical, serrate to digitate, with progressive increase in degree of digitation; saddles rounded. Some forms with ventrolateral grooves; no longitudinal ornamentation. Umbilical callus may be present. Ventral lobe with moderately high median saddle and diverging sides (Gleboceratinae new subfamily) or with high median saddle and digitate prongs of ventral lobe (Thalassoceratinae). Strong sculpture rare. *Pennsylvanian (Kasimovian)–Guadalupian (Wordian).*

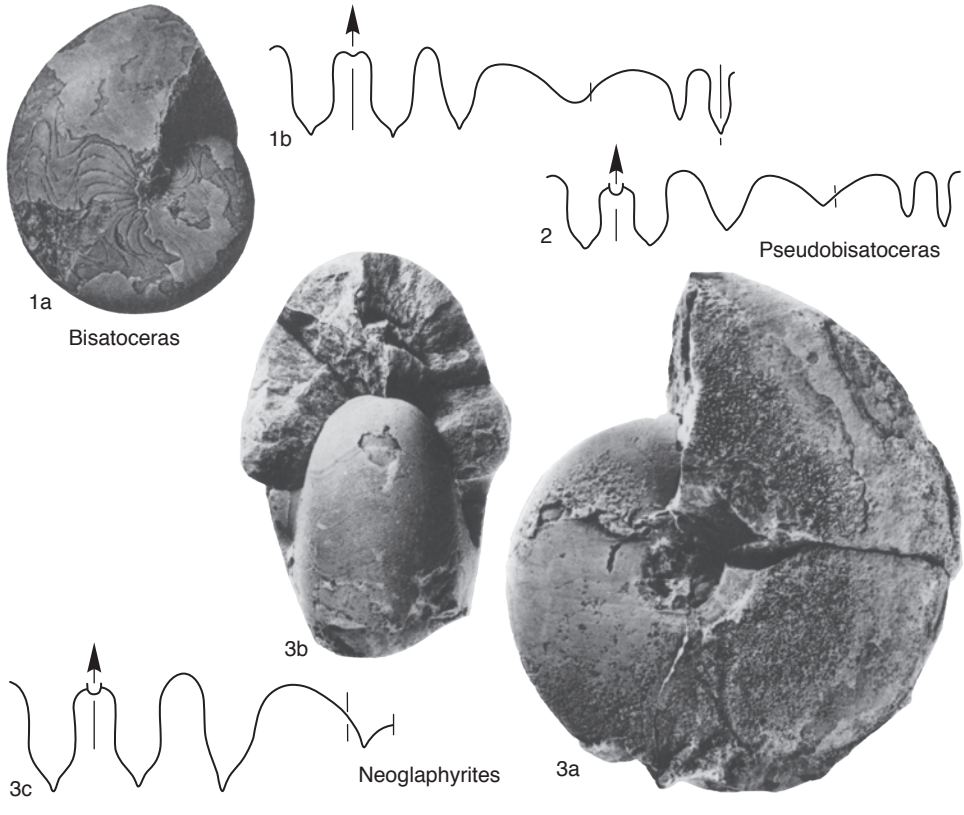

FIG. 61. Bisatoceratidae (p. 102).

Subfamily GLEBOCERATINAE new subfamily

[Gleboceratinae KULLMANN, herein] [=Yinoceratinae RUZHENTSEV, 1960d, p. 207, *partim*] [type genus, *Gleboceras* RUZHENTSEV, 1950, p. 108]

Small-sized thalassoceratoideans with globular conch and very narrow umbilicus. Shell surface may be smooth or with strong ribbing and tubercles. Ventral lobe simply subdivided, with slightly diverging sides and broadly rounded ventrolateral saddle. Adventitious and lateral lobes digitate or serrate. [The systematic affinities of this subfamily are unknown, and assignment to Thalassoceratidae is tentative.] *Pennsylvanian (Kasimovian [Virgilian]).*

Gleboceras RUZHENTSEV, 1950, p. 108 [**G. mirandum;* OD]. Conch globular, umbilicus very narrow. Ventral lobe moderately wide, with gently bended sides and simple, lanceolate prongs. First lateral lobe serrate, umbilical lobe with irregular incisions. One or two species. *Pennsylvanian (Kasimovian [Virgilian]):* Russia (South Urals), USA (Oklahoma).——FIG. 62,*1a–c.***G. mirandum,* holotype, Sakmara River at km 167, Chkalovskaia Oblast', South Urals, Russia, lower Zhigulian, PIN 320/1876; *a–b,* ×3 (Bogoslovskii, Librovich, & Ruzhentsev, 1962); *c,* suture, whorl width at 7 mm, ×6.4 (Ruzhentsev, 1950).

Mapesites WORK & BOARDMAN, 2003, p. 1195 [**M. chautauquaensis;* OD]. Conch subglobose, with depressed whorls and narrow umbilicus. Sculpture exhibiting tuberculate ventrolateral ridge and strong ribs that intersect with ventral sulci producing three longitudinal rows of barlike tubercles. Ventral lobe with median saddle half as high as entire lobe, and diverging sides. First lateral lobe irregularly digitate. One species. *Pennsylvanian (Kasimovian [basal Virgilian]):* USA (Kansas).——FIG. 62,*2a–d.* **M. chautauquaensis,* holotype, 1.4 km west of Peru, Chautauqua County, SUI 62428; *a–c,* ×5.5; *d,* suture, diameter at 7 mm, enlarged, magnification not stated (Work & Boardman, 2003).

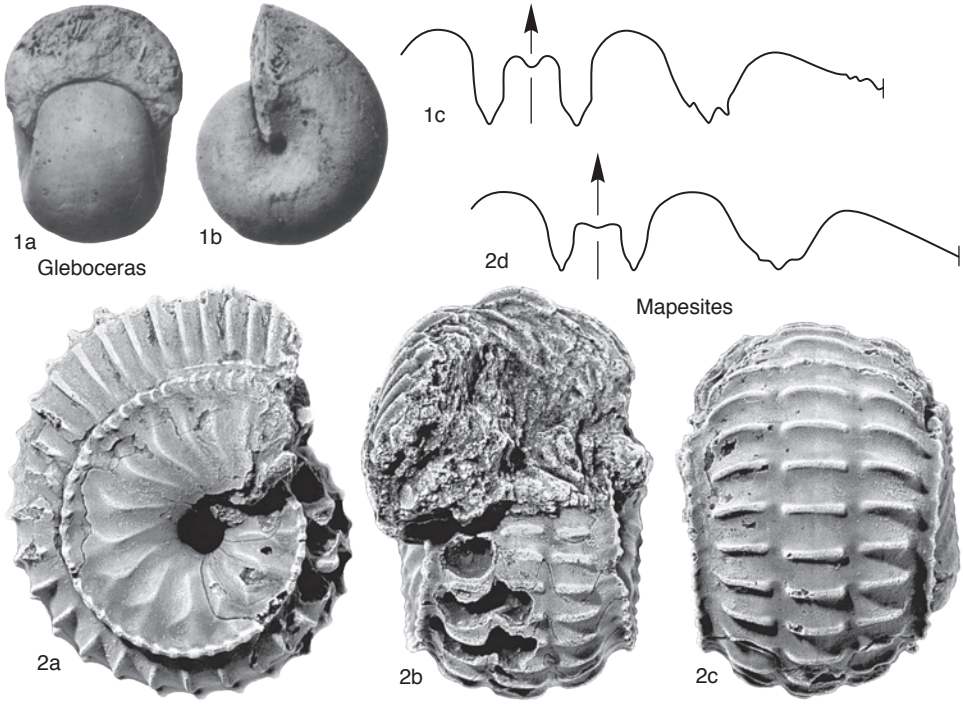

FIG. 62. Thalassoceratidae (p. 103).

Subfamily THALASSOCERATINAE Hyatt, 1900

[*nom. transl.* KULLMANN, herein, *ex* Thalassoceratidae HYATT, 1900, p. 553] [=Aristoceratinae LEONOVA, 2002, p. 41]

Lobes including ventral lobe partly asymmetrical serrate to digitate, with tendency toward increased degree of digitation; saddles rounded. Some forms with ventrolateral grooves; no spiral ornamentation. Conch surface smooth. Umbilical callus may be present. *Pennsylvanian (Kasimovian [Missourian])–Guadalupian (Wordian).*

Thalassoceras GEMMELLARO, 1887, p. 69 [**T. phillipsi* GEMMELLARO, 1887, p. 71; SD PLUMMER & SCOTT, 1937, p. 357]. Conch form subdiscoidal, with very narrow or closed umbilicus. Digitation of suture line reaching saddles. External lateral lobe wider than prongs of ventral lobe; saddles narrowly rounded. Seven species. *Cisuralian (Sakmarian)–Guadalupian (Wordian):* Italy (Sicily), Slovenia (?Karawanken Mountains), Russia (North and South Urals), Ukraine (Crimea), Kazakhstan (South Urals), Tajikistan (Pamirs), China (Guizhou), Indonesia (Timor), Australia (Western Australia), USA (?Texas).——FIG. 63,*3a–d. *T. phillipsi*, lectotype, (Beinert, Furnish, & Glenister, herein), Rocca de San Benedetto, Sicily, MGUP 109, Wordian; *a–c,* same as GEMMELLARO, 1887, pl. 10,*13–14,* ×2.5 (Furnish & Glenister, new); *d,* suture, diameter at 16 mm, ×2.3 (Miller, Furnish, & Schindewolf, 1957).——FIG. 63,*3e. T. gemmellaroi* (KARPINSKII), cross section, left shore of Aktasta River, South Urals, Aktastinian subformation, PIN 317/2634, ×5.1 (Ruzhentsev, 1956b).

Aristoceras RUZHENTSEV, 1940b, p. 524 [**A. chkalovi* RUZHENTSEV, 1940b, p. 526; OD] [=*Uralites* VOINOVA, 1934, p. 3 (type, *U. orenburgensis,* M, *nom. nud., non* CHERNOV, 1907, p. 292, *nom. nud., teste* RUZHENTSEV, 1950, p. 98)]. Conch form discoidal, with narrow or closed umbilicus, venter flat, with ventrolateral grooves. Coarse sinuous growth lamellae forming deep ventral sinus and narrow ventrolateral salient. Constrictions may be present. Suture similar to *Eothalassoceras.* Five species, two species questionable. [For discussion, see RUZHENTSEV, 1950, p. 98.] *Pennsylvanian (Kasimovian)–Cisuralian (Asselian):* Russia and Kazakhstan (South Urals), ?Spain, USA (Oklahoma, Texas).——FIG. 63,*1a–d. *A. chkalovi; a–b,* South Urals, Russia, Gzhelian, ×1.25 (Bogoslovskii, Librovich, & Ruzhentsev, 1962); *c–d,* west of Nikols'kii, South Urals, lower part of Orenburg stage; *c,* holotype, suture, PIN 320/786, whorl height at 10.4 mm, whorl width 8.2 mm,

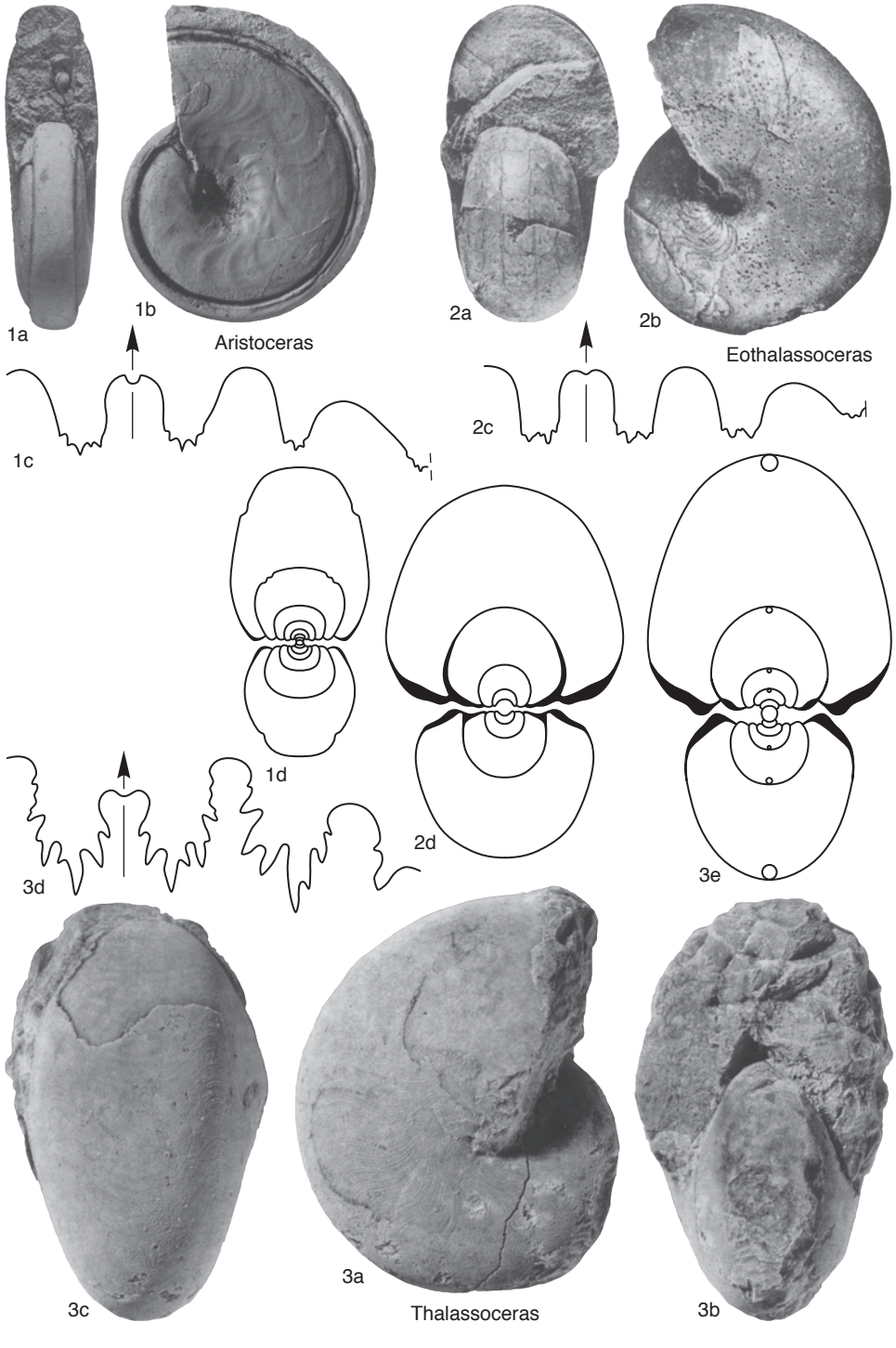

Fig. 63. Thalassoceratidae (p. 104–107).

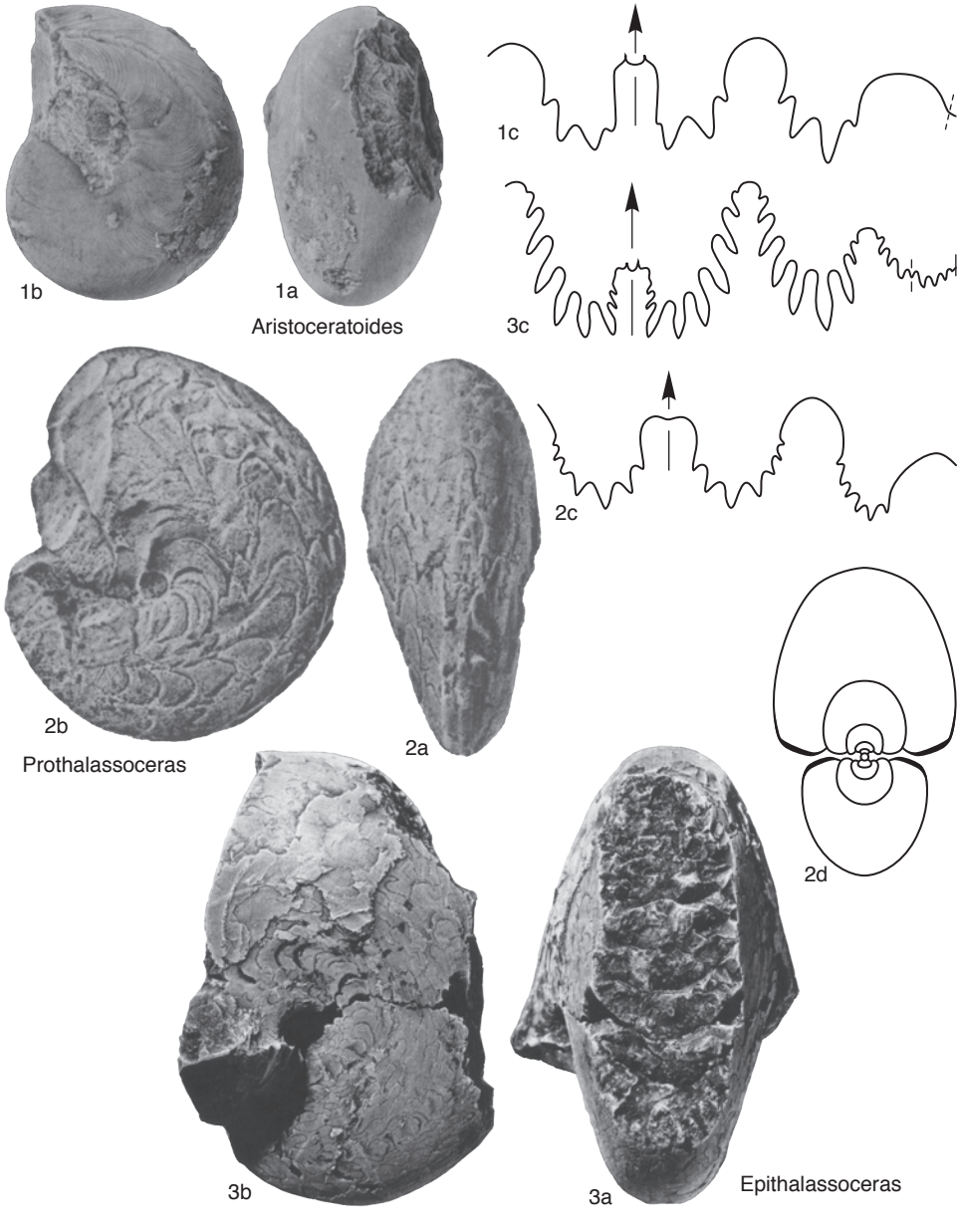

FIG. 64. Thalassoceratidae (p. 107).

×3.4 (Ruzhentsev, 1950); *d,* cross section, PIN 320/787, ×2.7 (Ruzhentsev, 1950).

Aristoceratoides Ruzhentsev, 1960d, p. 206 [**Thalassoceras varicosum* Gemmellaro, 1887, p. 74; OD]. Conch wide, with rounded venter and ventrolateral grooves. Growth lamellae with strong ventrolateral salient. Suture with almost regular digits restricted to lower halves of lobes. Two species and one questionable species. [For discussion, see Beinert, 1971.] *Guadalupian (?Roadian, Wordian):* Italy (Sicily), Mexico (?Coahuila).——Fig. 64,*1a–c.* **A. varicosus* (Gemmellaro), lectotype, Railroad station at Roccapalumba, near Torto River, about 27 km southeast of Palermo, Sicily, compact erratic limestone block, Wordian, IGUP 110, Beinert, Furnish & Glenister, herein, same as Gemmellaro, 1887, pl. 5,*20,22; a–b,* ×3 (new); *c,* suture, diameter at 8 mm, ×8.4 (Beinert, 1971).

Eothalassoceras Miller & Furnish, 1940a, p. 105 [**Prothalassoceras inexpectans* Miller & Owen, 1937, p. 418; OD]. Sutural serration irregular, asymmetrical, shallow, and restricted to bases of prongs of ventral lobe and adjacent lobes. Ventral lobe very wide, almost parallel sided, median saddle as high as first lateral saddle. Two species. *Pennsylvanian (Kasimovian–Gzhelian):* USA (Alaska, Oklahoma, Texas, New Mexico).——Fig. 63,*2a–d.* **E. inexpectans* (Miller & Owen), 1.2 km south of Collinsville, Tulsa County, Oklahoma, Coffeyville Formation, just above Dawson coal, Missourian; *a–c,* lectotype (Beinert, 1971), SUI 1996; *a–b,* ×1.5; *c,* suture, Coffeyville Formation, about 1 mile south of Collinsville, Oklahoma, diameter at 21 mm, ×2.3 (Miller & Owen, 1937); *d,* cross section, topotype, SUI 34668, ×2.5 (Beinert, 1971).

Epithalassoceras Miller & Furnish, 1940a, p. 105 [**E. ruzencevi;* OD]. Conch thickly discoidal, with small umbilicus. Suture similar to *Thalassoceras,* but external lobes even more strongly denticulate: external suture dissected nearly to tops of saddles by deep digits. Median saddle about half height of entire ventral lobe. First lateral lobe as wide as each prong of ventral lobe. Internal lateral lobe bifid. Two species. *Guadalupian (Roadian–Wordian):* USA (Texas), Mexico (Coahuila).——Fig. 64,*3a–c.* **E. ruzencevi*, holotype, West of Noria de Malascachas, Valle de Las Delicias, Coahuila, Mexico, Malascachas section, Wordian, YPM 16303; *a–b,* ×2 (Beinert, Furnish, & Glenister, new); *c,* suture, diameter at approximately 9 mm, ×3 (Miller & Furnish, 1940a).

Prothalassoceras Böse, 1919, p. 102 [**P. welleri* Böse, 1919, p. 104; SD Plummer & Scott, 1937, p. 353] [=*Allothalassoceras* Leonova, 2002, p. 41 (type, *Prothalassoceras bogoslovskayae* Leonova in Leonova & Dmitriev, 1989, p. 115, OD)]. Conch subdiscoidal to subglobular, with very narrow or closed umbilicus. Suture line almost completely digitate, but denticulation of lobes not reaching saddles. Adventitious lobe narrower than prongs of ventral lobe. Many species. [*Allothalassoceras* has a slightly wider umbilicus and wider conch close to the umbilicus, which is regarded herein as being of specific significance.] *Pennsylvanian (Kasimovian)–Cisuralian (Kungurian):* Russia and Kazakhstan (South Urals), Tajikistan (Darvaz, Pamirs), Canada (Yukon), USA (New Mexico, Texas).——Fig. 64,*2a–c.* **P. welleri; a–b,* McGregor Ranch, Otero County, New Mexico, Hueco Formation, Artinskian, USNM, ×1.5 (Miller & Parizek, 1948); *c,* suture, upper part of Wolfcamp Formation, Texas, ×2.6 (Miller & Furnish, 1940a).——Fig. 64,*2d. P. jaikense* Ruzhentsev, cross section, Chkalovskaia oblast', South Urals, Russia, Gzhelian, ×2.8 (Bogoslovskii, Librovich, & Ruzhentsev, 1962).

SCHISTOCERATOIDEA

JÜRGEN KULLMANN

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Superfamily SCHISTOCERATOIDEA Schmidt, 1929

[*nom. transl.* KULLMANN, herein, *ex* Schistoceratidae SCHMIDT, 1929, p. 75]

Conch form discoidal to thickly discoidal; evolute and usually with wide umbilicus to moderately involute with narrow umbilicus. Triangular coiling of early whorls common in some groups. Shell surface smooth or reticulate; growth lines sinuous, with ventral sinus. Early whorls may exhibit riblike nodes on umbilical shoulder, extending to biconvex growth striae. Suture similar to Gastrioceratoidea, but with the following tendencies during the course of phylogeny: (1) median saddle becoming as high as entire ventral lobe; (2) ventral lobe becoming wide and in some forms giving rise to additional sutural elements or subelements (Welleritidae); (3) umbilical portion of suture expanded between L and U [German], U and I [Russian], in some genera giving rise to new sutural elements: $(E_1E_mE_1)$AL:UI --> $(E_1E_mE_1)ALU_2$:U_1I --> $E_1E_mE_1ALU_{2v}U_{2m}U_{2d}U_1$I [German], (V_1V_1)LU:ID --> $(V_1V_1)LU_1$:U_2ID --> $(V_1V_1)LU_1U_{2.2}U_{2.1}$:$U_{2.2}$ID [Russian] (Schistoceratidae, Welleritidae, Christioceratidae); (4) trifurcation of lobes (Schistoceratidae, Christioceratidae). *Pennsylvanian (upper Bashkirian)–Cisuralian (Sakmarian).*

Family SCHISTOCERATIDAE Schmidt, 1929

[Schistoceratidae SCHMIDT, 1929, p. 75] [=Bendoceratidae PLUMMER & SCOTT, 1937, p. 208, subj.]

Triangular or irregular coiling of early whorls common. Ornamentation of shell surface reticulate; at young stage with riblike nodes on umbilical shoulder. During the course of phylogeny, umbilical portion of suture expanding and giving rise to additional sutural elements by addition of a second umbilical lobe (U_2) and finally its trifurcation ($U_{2v}U_{2m}U_{2d}$) [German], $U_{2.2}U_{2.1}$:$U_{2.2}$ [Russian]. Sutural development $(E_1E_mE_1)$AL:UI --> $E_1E_mE_1ALU_{2v}U_{2m}$:$U_{2d}U_1$I [German], (V_1V_1)LU:ID --> $(V_1V_1)LU_1U_{2.2}U_{2.1}$:$U_{2.2}$ID [Russian]. *Pennsylvanian (upper Bashkirian)–Cisuralian (Sakmarian).*

Schistoceras HYATT, 1884 in 1883–1884, p. 336 [**S. hyatti* SMITH, 1903, p. 108; SD SMITH, 1903, p. 104; =*Goniatites missouriensis* MILLER & FABER, 1892, p. 164, subj., *fide* MILLER & FURNISH, 1940c, p. 538] [=*Metaschistoceras* PLUMMER & SCOTT, 1937, p. 255 (type, *M. heilprini* PLUMMER & SCOTT, 1937, p. 256, OD); for discussion, see MILLER & FURNISH, 1940c, p. 538]. Conch form moderately evolute to involute, with narrow umbilicus at maturity. Growth striae biconvex; longitudinal lirae present, but reticulate ornamentation inconspicuous. Shell surface smooth, without nodes. Median saddle almost as high as first lateral saddle; second umbilical lobe trifurcate, its portions being completely separate. Sutural formula $E_1E_mE_1ALU_{2v}U_{2m}$:$U_{2d}U_1$I [German], $(V_1V_1)LU_1U_{2.2}U_{2.1}$:$U_{2.2}$ID [Russian]. Seven species. *Pennsylvanian (Kasimovian)–Cisuralian (Sakmarian):* Russia and Kazakhstan (South Urals), Slovenia (?Karawanken Mountains), Russia (Siberia), China (Ningxia), USA (Illinois, Iowa, Missouri, Ohio, Oklahoma, Pennsylvania, Texas). ——FIG. 65,*1a–c.* **S. missouriense* (MILLER & FABER); *a–b,* Kansas City, Missouri, USA, Winterset Limestone, middle part of Missourian, ×1; *c,* suture, Jack County, Texas, USA, Graham Formation, Virgilian, SUI 14000, ×1 (Miller & Furnish, 1940c).——FIG. 65,*1d. S. diversecostatum* BÖSE, cross section, upper part of Gaptank Formation, Virgilian, Texas, ×4 (Ruzhentsev, 1950).

Branneroceras PLUMMER & SCOTT, 1937, p. 218 [**Gastrioceras branneri* SMITH, 1896, p. 257; OD] [=*Tschungkuoceras* GERTH, 1950, p. 264 (type, *Gastrioceras perornatum* YIN, 1935, p. 25, OD), for discussion, see MCCALEB, 1968, p. 64]. Conch form evolute, with wide or moderately wide umbilicus. Coiling of inner whorls in some forms irregular to tetragonal. Ribs transversely elongate, fasciculating into several weak ribs, or dichotomizing on flanks or ventrolateral shoulder, with ventrolateral salient and deep ventral sinus. Growth striae biconvex, crossed by fine longitudinal lirae, producing crenulate appearance. Branches of ventral lobe narrow; height of median saddle about three-quarters entire ventral lobe. Eight species. [For more information about the irregularity of the inner whorls, see MCCALEB, 1968, pl. 9,*9, 12, 16*. For general discussion about the genus, see NASSICHUK, 1975, p. 139.]

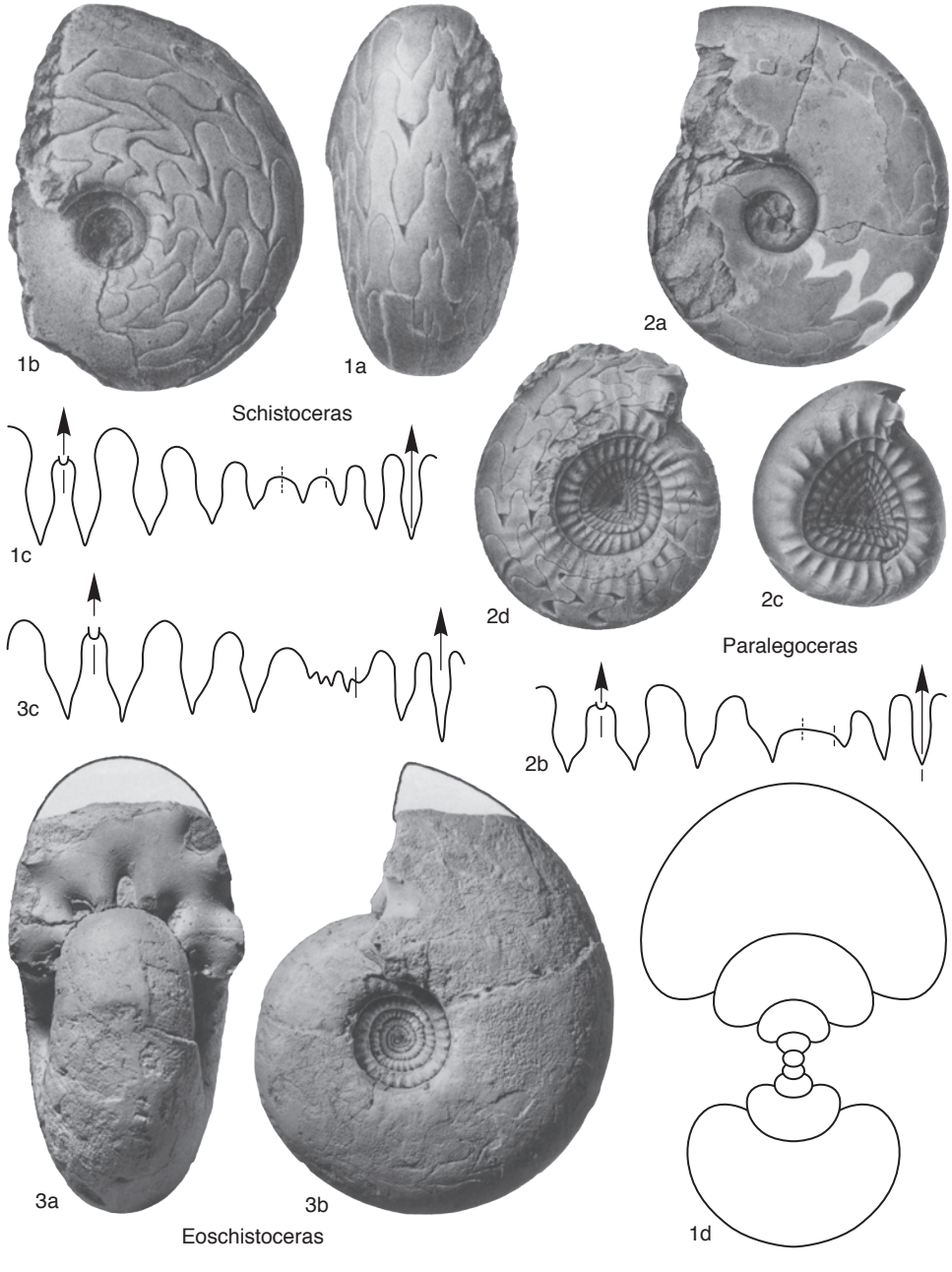

FIG. 65. Schistoceratidae (p. 108–111).

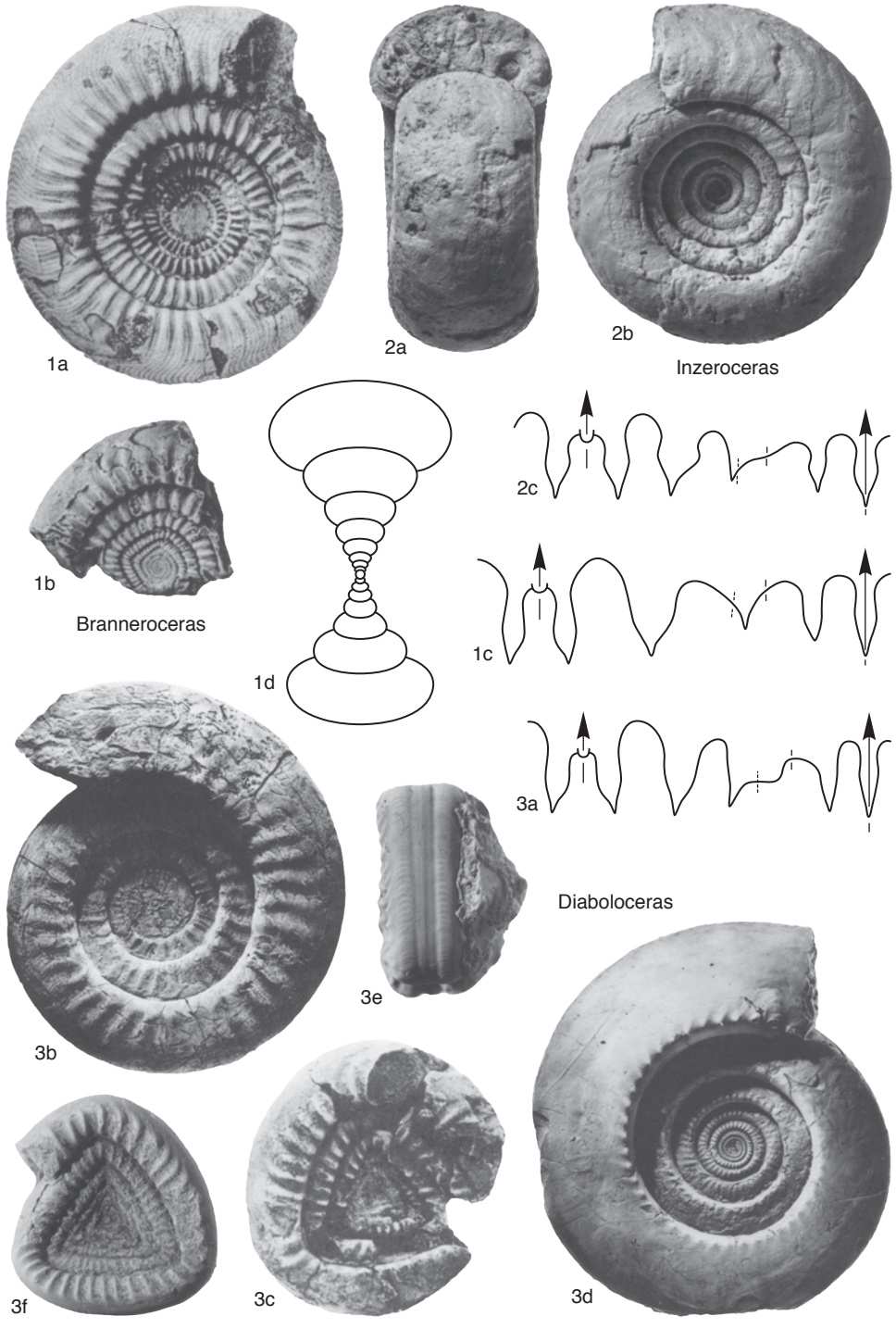

FIG. 66. Schistoceratidae (p. 108–111).

Pennsylvanian (upper Bashkirian–Moscovian): Spain, Ukraine (Donets), Algeria, China (Gansu, Guangxi, Guizhou, Xinjiang), Japan, Iran, Kyrgyzstan, Uzbekistan, Canada (Northwest Territories), USA (Arkansas, Oklahoma, Texas, Nevada).——Fig. 66,*1a–d. *B. branneri* (Smith); *a,* side view, Brentwood Limestone Member, Bloyd Formation, 11 km southwest of Harrison, Boone County, Arkansas, SUI 11694, ×0.8; *b,* side view of fragment, limestone conglomerate of Brentwood Member, Devil's Den State Park on Lee Creek, about 12 km southwest of Winslow, Washington County, SUI 11693, ×1.9 (McCaleb, 1968); *c,* suture, SUI 1975, east side of Gaither Mountains, about 11 km southwest of Harrison, Boone County, Arkansas, ×1.5 (Miller & Moore, 1938); *d,* cross section, Morrowan, Arkansas, ×4.1 (Ruzhentsev, 1950).

Diaboloceras Miller & Furnish, 1940c, p. 527 [**D. varicostatum;* OD] [=*Trigonogastrioceras* Librovich, 1957, p. 255 (type, *T. uralicum* Librovich, 1957, p. 256, OD); =?*Rodiezmoceras* Wagner-Gentis in Moore & others, 1971, p. 349 (type, *R. bisati,* OD)]. Conch very large, umbilicus always wide; inner whorls exhibit triangular coiling and may develop keel and two ventral grooves. Ribs on flanks weak, ornamentation reticulate. Second umbilical lobe on dorsal side of lateral lobe, not yet separate; sutural formula: $(E_1E_mE_1)AL(U_2)U_1I$ [German], $(V_1V_1)L(U_1U_2)$:ID [Russian]. Eight species. [*Trigonogastrioceras* was based on an immature specimen; for discussion, see Gordon, 1965, p. 267. *Rodiezmoceras,* based on three poorly preserved specimens, also has coarse ribs, but the axis of the umbilical lobe lies on the lateral flank; it may be a representative of *Diaboloceras* or *Paralegoceras.* For discussion of genus, see Nassichuk, 1975, p. 147; Saunders, Manger, & Gordon, 1977, p. 124; and Ruzhentsev & Bogoslovskaia, 1978, p. 63.] *Pennsylvanian (upper Bashkirian–Moscovian):* Spain, Russia (Novaia Zemlia, South Urals, Siberia), Ukraine (Donets), China (Xinjiang), Japan, Canada (Northwest Territories), USA (Alabama, Arkansas, Kentucky, Oklahoma, Texas).——Fig. 66,*3a. *D. varicostatum,* suture, Braggs Mountain, southeastern Muskogee, Oklahoma, USA, lower Atoka Formation, SUI 1418, diameter at approximately 50 mm, ×1.3 (Miller & Furnish, 1958a).——Fig. 66,*3b–c. D. neumeieri* Quinn & Carr, conglomeratic limestone in Trace Creek Shale Member, Bloyd Formation, 3.2 km west of Woolsey, Washington County, Arkansas, USA; *b,* holotype, UA L11WO1, ×0.3; *c,* paratype, UA L11WO2, side view of fragment, ×1.7 (McCaleb, 1968).——Fig. 66,*3d. D. ruzhencevi* Andrianov, upper Bashkirian, Siberia, ×0.17 (Ruzhentsev & Ganelin, 1971).——Fig. 66,*3e–f. D. uralicum* (Librovich), Sibai Canyon, Urtazym area, Orenburgskaia oblast', South Urals, Kordailov Formation, upper Bashkirian, ×3 (Librovich, 1957).

Eoschistoceras Ruzhentsev, 1952a, p. 914 [**E. turkestanicum;* OD]. Triangular coiling of early whorls less pronounced than in *Paralegoceras.* Width of umbilicus decreasing during ontogeny. Ornamentation reticulate, with umbilical ribs. Suture line similar to *Paralegoceras,* but second umbilical lobe becoming trifurcate. Two species. *Pennsylvanian (Kasimovian–Gzhelian):* Kazakhstan, USA (Oklahoma).——Fig. 65,*3a–c. *E. turkestanicum; a–b,* holotype, south of Karatau, promontories of Turkestan Range, Kazakhstan, lower Gzhelian, PIN 700/2, ×1; *c,* suture, PIN 700/3, whorl height at about 19.5 mm, whorl width 24.5 mm, ×1.5 (Ruhentsev, 1952a).

Inzeroceras Ruzhentsev, 1974b, p. 35 [**I. bellum* Ruzhentsev, 1974b, p. 36; OD]. Conch discoidal, evolute, with wide umbilicus. No triangular coiling of early whorls. Sculpture consisting of weak umbilical plications and well-developed lirae. Ventral lobe fairly broad, divided by high median saddle into two lanceolate branches. Adventitious lobe pouched; primary umbilical lobe has rudimentary crenulations centered on umbilical seam. One species from one locality. [Ruzhentsev and Bogoslovskaia (1978, p. 64) included *Inzeroceras* in the family Christioceratidae, regarding it as a forerunner of *Christioceras* with its trifid mode of lateral lobes.] *Pennsylvanian (Moscovian):* Russia (South Urals).——Fig. 66,*2a–c. *I. bellum,* holotype, Askyn River, Solontsy, Bashkortostan, PIN3470/1; *a–b,* ×3; *c,* suture, whorl height at 4.3 mm, whorl width 7.8 mm, ×3.4 (Ruzhentsev, 1974b).

Paralegoceras Hyatt, 1884 in 1883–1884, p. 327 [**Goniatites iowensis* Meek & Worthen, 1860, p. 471; M] [=*Bendoceras* Plummer & Scott, 1937, p. 208 (type, *Goniatites texanus* Shumard, 1863, p. 109, OD), for discussion, see Miller & Furnish, 1940c, p. 522]. Conch large, subdiscoidal; early whorls evolute, with triangular coiling. Adult stages moderately involute. Ornamentation reticulate, transverse umbilical nodes present, disappearing at maturity. Ventral lobe wide, with high median saddle. Second umbilical lobe independent in adult stage, sutural formula: $E_1E_mE_1ALU_2U_1I$ [German], $(V_1V_1)LU_1$:U_2:ID [Russian]. Five species, two questionable. [For discussion, see Gordon, 1965, p. 267.] *Pennsylvanian (Moscovian):* ?Slovakia, China (Xinjiang), Japan, USA (Arkansas, Iowa, California, Ohio, Oklahoma, Texas), Peru. ——Fig. 65,*2a–b. *P. iowense* (Meek & Worthen), holotype, Cherokee Formation, Wapello County, Iowa, USA, Desmoinesian, UI 11098; *a,* side view, ×0.5; *b,* suture, diameter at approximately 60 mm, ×0.8 (Miller & Furnish, 1940c).——Fig. 65,*2c–d. P. texanum* (Shumard), Clarita, Coal County Oklahoma, USA, lower Atoka Formation; *c,* side view, SUI 13996, ×1.3; *d,* side view, SUI 13998, ×0.7 (Miller & Furnish, 1940c).

Paraschistoceras Plummer & Scott, 1937, p. 248 [**Ammonites hildrethi* Morton, 1836, p. 149; OD] [=*Pintoceras* Plummer & Scott, 1937, p. 245 (type, *P. postvenatum,* OD), *nom. nud.,* legally established by first revising authors, Miller & Furnish, 1958a, p. 257, subjective synonym of *Paraschistoceras strawnense* Plummer & Scott, 1937, p. 248)]. Conch evolute, with wide umbilicus on young stages, but moderately wide at maturity;

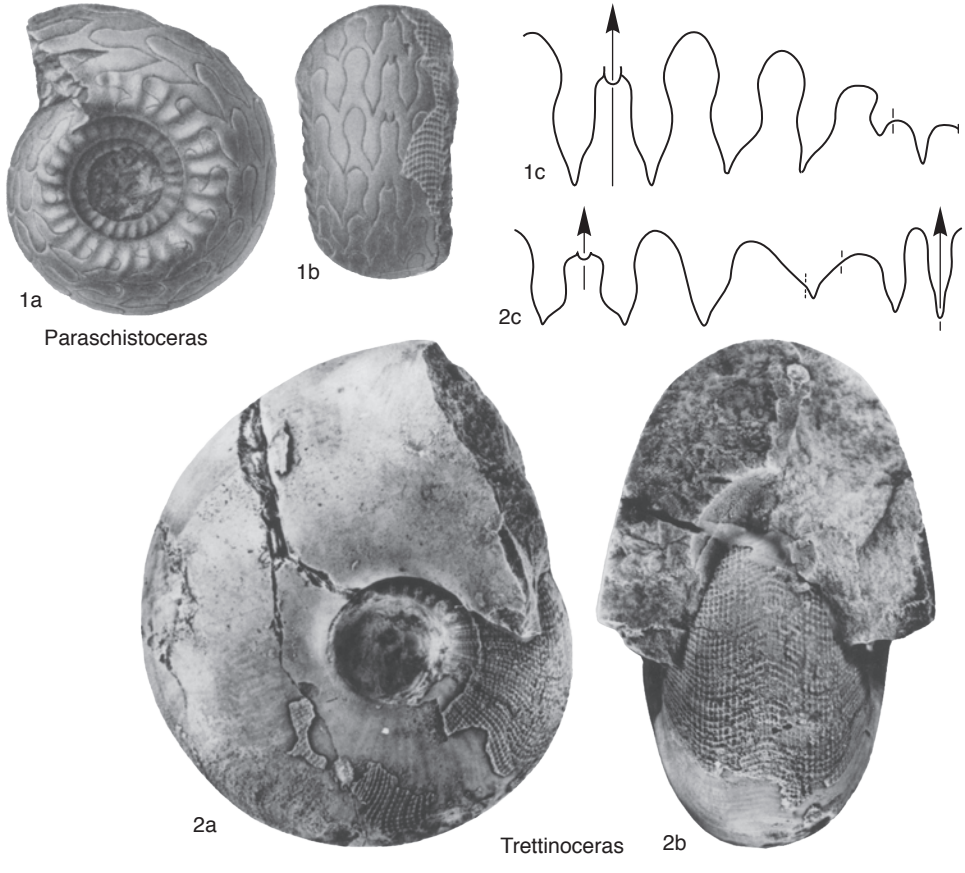

FIG. 67. Schistoceratidae (p. 111–112).

no triangular coiling of inner whorls. Growth striae biconvex; longitudinal lirae present, but reticulate ornamentation inconspicuous. Umbilical shoulder nodose during early growth stages, shell surface smooth at maturity. Median saddle almost as high as first lateral saddle; second umbilical lobe weakly trifurcate. Sutural formula $E_1E_mE_1ALU_{2v}U_{2m}$:$U_{2d}U_1I$ [German], (V_1V_1) $LU_1U_{2.2}U_{2.1}$:$U_{2.2}ID$ [Russian]. Four species. [This genus is similar to *Eoschistoceras* and may be its senior synonym.] *Pennsylvanian (Kasimovian–Gzhelian):* Russia and Kazakhstan (South Urals), Russia (Siberia), Uzbekistan (Fergana), USA (Illinois, Kansas, Missouri, Ohio, Oklahoma, Pennsylvania, Texas).——FIG. 67,*1a–b. *P. hildrethi* (MORTON), Kansas City, Missouri, USA, Muncie Creek shale, Missourian, ×1.5 (Miller & Furnish, 1940c).——FIG. 67,*1c. P. postvenatum* (PLUMMER & SCOTT), suture, 24 km south of Holdenville, Hughes County, Oklahoma, USA, Wewoka Formation, Desmoinesian, SUI 1962, diameter at approximately 75 mm, ×0.7 (Miller & Furnish, 1958a).

Trettinoceras NASSICHUK, 1975, p. 136 [**T. ellesmerensis* NASSICHUK, 1975, p. 137; OD]. Conch moderately involute, with relatively narrow umbilicus; early whorls triangularly coiled. Umbilical nodes conspicuous in immature stages, absent at maturity. Ornamentation reticulate, consisting of longitudinal lirae and more pronounced sinuous growth lamellae. Height of median saddle exceeding slightly half height of entire ventral lobe. One species from one locality, of uncertain affinity. *Pennsylvanian (Moscovian [Atokan]):* Canada (Northwest Territories).——FIG. 67,*2a–c.* **T. ellesmerensis,* holotype, north side of Hare Fiord, northern Ellesmere Island, GSC 33810; *a–b,* ×2.2; *c,* suture, diameter at 42 mm, magnification not stated (Nassichuk, 1975).

Family PSEUDOPARALEGOCERATIDAE Librovich, 1957

[Pseudoparalegoceratidae LIBROVICH, 1957, p. 255]

Conch form with wide to moderately wide umbilicus. No triangular inner whorls. Shell surface smooth. Suture line without addi-

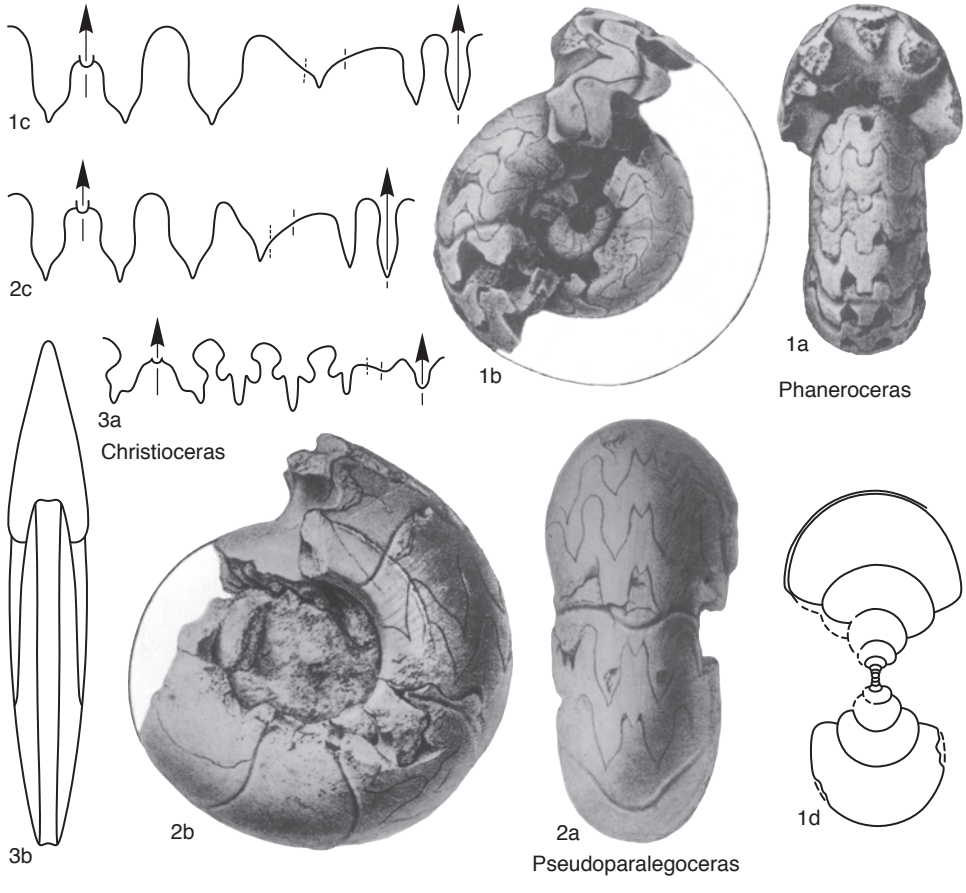

FIG. 68. Pseudoparalegoceratidae and Christioceratidae (p. 113–119).

tional elements. Median saddle exceeding three-quarters height of entire ventral lobe. Primary umbilical lobe centered on umbilical shoulder or adjacent flank. *Pennsylvanian (upper Bashkirian–Kasimovian).*

Pseudoparalegoceras MILLER, 1934a, p. 18 [**Gastrioceras russiense* TSVETAEVA, 1888, p. 42; OD] [=*Strawnoceras* PLUMMER & SCOTT in PLUMMER & HORNBERGER, 1935, p. 20 (type, *S. brazoense,* M, *nom. nud.*)]. Width of umbilicus one-third to about one-half conch diameter. Growth lines sinuous, reticulate. Axis of umbilical lobe shifted to flank, lying slightly outside umbilical shoulder. Six species. [This genus is transitional to *Phaneroceras*; for discussion, see GORDON, 1965, p. 263.] *Pennsylvanian (upper Bashkirian–Kasimovian):* Russia (Moscow Basin, North Urals), Kazakhstan (South Urals), Spain, China (Guizhou), Japan, USA (Alaska, Arkansas, New Mexico, Oklahoma, Texas).——FIG. 68,*2a–c.* **P. russiense* (TSVETAEVA), Russian platform, Moscow Basin, Moscovian; *a–b,* ×0.75 (Tsvetaeva, 1888, adapted from Bogoslovskii, Librovich, & Ruzhentsev, 1962); *c,* suture, ×0.8 (Miller & Furnish, 1940c, adapted from Karpinskii, 1889, fig. 22a).

Phaneroceras PLUMMER & SCOTT, 1937, p. 189 [**Gastrioceras compressum* HYATT, 1891, p. 355; OD] [=*Eoparalegoceras* DELÉPINE, 1939, p. 34 (type, *E. clariondi,* M); for discussion, see GORDON, 1965, p. 263]. Axis of umbilical lobe centered on umbilical shoulder or wall. Ten species. [This genus is transitional to *Pseudoparalegoceras.* For discussion, see MCCALEB, 1968, p. 55, and NASSICHUK, 1975, p. 110. View of conch of type species is not available; type species of poorly defined genus is doubtful.] *Pennsylvanian (upper Bashkirian–Moscovian):* Spain, Morocco, Algeria, Ukraine (Donets), Russia (Siberia), China (Guizhou), Japan,

Canada (Northwest Territories), USA (Arkansas, Ohio, Oklahoma, Texas), Mexico, Peru.——FIG. 68,*1a–d. P. kesslerense* (MATHER), holotype, Fayetteville, western slope of East Mountain, Kessler limestone member of Bloyd Formation, Washington County, Arkansas, USA, WMUC 16123; *a–b,* ×2; *c,* suture, based on holotype, ×2.5 (Miller & Moore, 1938); *d,* cross section, USNM 119677, ×1.4 (Gordon, 1965).

Family ORULGANITIDAE Ruzhentsev, 1965

[Orulganitidae RUZHENTSEV, 1965, p. 13] [=Yakutoceratidae LIBROVICH, 1968, p. 159]

Conch form discoidal to globular, moderately to completely involute; umbilicus moderately narrow to narrow. Early whorls generally with triangular coiling; adult whorls normally coiled. Sculpture consisting of longitudinal lirae; biconvex growth lines faint. No tubercles or nodes. Prongs of ventral lobe relatively narrow, median saddle usually half as high or considerably higher than entire ventral lobe. *Pennsylvanian (lower Moscovian).*

Orulganites RUZHENTSEV, 1960c, p. 143 [**Owenoceras trianguliumbilicatum* Y. POPOV, 1960, p. 87; OD]. Conch form subdiscoidal, with moderately wide umbilicus. Longitudinal lirae faint. One species. *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*1a–d. *O. trianguliumbilicatus* (POPOV); *a–b,* holotype, western slope of Orulgan Range, north of Dzhardzhan, River Syncha Basin, Syncha-Soguru creek, Tiksa Formation, ×1 (Popov, 1960); *c–d,* Sette-Daban Range, River Tompo Basin, Sukhoi creek, Natalin Formation, PIN 3088/16, ×1.5 (Ruzhentsev & Ganelin, 1971).

Aldanites Y. POPOV, 1970, p. 124 [**A. rotundus* Y. POPOV, 1970, p. 125; OD]. Similar to *Orulganites,* but no triangular whorls. One species. *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*4a–b. *A. rotundus,* holotype, Sukhoi Creek, Tompo River Basin, Sette-Daban region, South Yakutia, Natalin Formation, TsGM 28/8717, ×1 (Y. Popov, 1970).

Kayutoceras RUZHENTSEV & GANELIN, 1971, p. 59 [**K. triangulare* RUZHENTSEV & GANELIN, 1971, p. 60; OD]. Early whorls triangular-subglobular, with very strong constrictions, involute; umbilicus moderately wide. Later stages with narrow umbilicus and normal coiling. Sculpture consisting of irregularly located lirae; two tracks of thicker lirae on ventral side. Height of median saddle reaching two-thirds entire ventral lobe. One species. *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*7a–e. *K. triangulare; a–b,* side view, apertural view of immature specimen, right bank of Paren' River, Omolon Massif, PIN 3088/8, ×2; *c–d,* left bank of Gornoi River, Omolon Massif, PIN 3088/9, ×1; *e,* holotype, suture, right bank of Paren' River, Omolon Massif, PIN 3088/3, whorl height at 12.6 mm, whorl width 22 mm, ×1.5 (Ruzhentsev & Ganelin, 1971).

Parayakutoceras Y. POPOV, 1970, p. 123 [**P. secretum;* OD]. Conch form thickly discoidal, involute; umbilicus narrow. Longitudinal lirae faint. Growth lines with ventral salient at maturity. Ventral lobe relatively wide, median saddle reaching two-thirds height of entire ventral lobe. Four species. *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*6a. *P. secretum;* side view, middle Kolyma Massif, Zyrianka River, Agidzhin Formation, ×1 (Y. Popov, 1970).——FIG. 69,*6b. P. discoidale* (RUZHENTSEV), holotype, suture, Omulev uplift, Taryn-Yuriakh River, Agidzhin Formation, PIN 3088/67, whorl height at 17.7 mm, whorl width 19.0 mm, ×1 (Ruzhentsev, 1975).

Yakutoceras Y. POPOV, 1965, p. 70 [**Y. aldanicum* Y. POPOV, 1965, p. 71; OD] [=*Mezorulganites* ANDRIANOV, 1985, p. 27 (type, *M. borealis,* OD)]. Conch form subdiscoidal to subglobular, moderately evolute, with moderately wide umbilicus. Longitudinal ornamentation present; constrictions on immature stages may be present. Three species. [This genus is transitional to *Orulganites* and may be its junior synonym. The name was proposed by LIBROVICH, 1947, p. 64, without sufficient description and indication of type species; formal description and type species by Y. POPOV, 1965, p. 70. For discussion, see RUZHENTSEV & GANELIN, 1971, p. 57. *Mezorulganites* differs slightly in its suture.] *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*2a–c. *Y. aldanicum; a–b,* Sobopol River, Orulgan Range, Yakutia, Yupenchin Formation, TsGM 19/8717, ×1; *c,* suture, Popovka River, Kolyma Massif, Siberia, Burgalii Formation, TsGM 15/8717, whorl height at 14 mm, ×1.3 (Y. Popov, 1970).

?Yakutoglaphyrites RUZHENTSEV, 1960c, p. 143 [**Owenoceras involutum* Y. POPOV, 1960, p. 88; OD]. Conch form thickly discoidal, involute, with narrow umbilicus. Ornamentation reticulate. Prongs of ventral lobe lanceolate; height of median saddle exceeding three-quarters height of entire ventral lobe. One species from one locality. [This genus is insufficiently known, and its generic independence is uncertain.] *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*5a–c. *Y. involutum* (POPOV), holotype, Yuel-Siktiakh River, Orulgan Range, Suorgan Formation, TsGM 32/8717; *a–b,* ×1 (Popov, 1960); *c,* suture, whorl height at 30 mm, magnification not indicated (Popov, 1970).

Yanshinoceras ANDRIANOV, 1985, p. 24 [**Y. alexandri;* OD]. Conch form large, with triangular coiling on all stages except last whorl. Umbilicus moderately wide and triangular on early and middle stages.

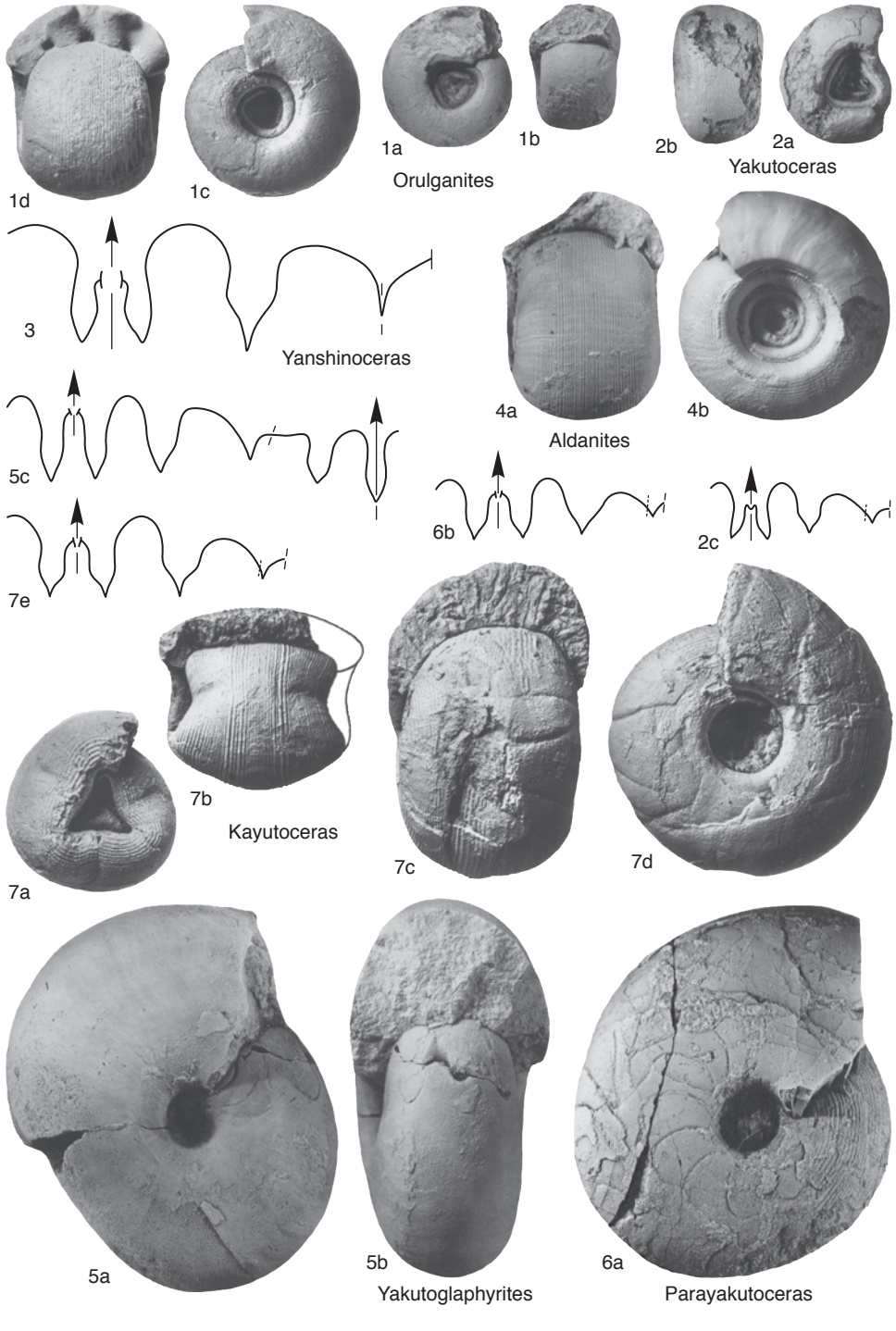

Fig. 69. Orulganitidae (p. 114–116).

Sculpture consisting of irregularly spaced longitudinal lirae and fine transverse striae. Constrictions on early and middle stages. Ventral and adventitious lobes comparatively narrow; lateral lobe situated at umbilical edge. One species. *Pennsylvanian (lower Moscovian):* Russia (Siberia).——Fig. 69,*3. *Y. alexandri,* Iudomy River Basin, Setan'in Formation, TsGM 4/10137, whorl height at 11 mm, whorl width 30 mm, ×6.3 (Andrianov, 1985).

Family WELLERITIDAE Plummer & Scott, 1937

[Welleritidae Plummer & Scott, 1937, p. 375] [=Aqishanoceratataceae Wang, 1981, p. 472; =Aqishanoceratidae Wang, 1981, p. 472]

Conch form discoidal, moderately evolute to involute, with moderately narrow umbilicus. Triangular coiling of inner whorls in some forms. Ornamentation consisting of biconvex striae or densely spaced riblets forming ventral sinus, commonly reticulate. In the course of phylogeny, additional suture elements in ventrolateral and umbilical areas. *Pennsylvanian (upper Bashkirian–Moscovian).*

Subfamily WELLERITINAE Plummer & Scott, 1937

[*nom. transl.* Miller & Furnish in Miller, Furnish, & Schindewolf, 1957, p. 66, *ex* Welleritidae Plummer & Scott, 1937, p. 375]

Ventral side flattened, in some forms with ventral groove. In the course of phylogeny, development of second adventitious lobe and several additional suture elements in umbilical area. *Pennsylvanian (Moscovian).*

Wellerites Plummer & Scott, 1937, p. 376 [**W. mohri* Plummer & Scott, 1937, p. 377; OD] [=*Walkerites* Smith, 1938, p. 31 (type, *W. vulgaris,* OD)]. Conch form discoidal, with moderately narrow umbilicus; ventral side flattened. Growth lamellae rather prominent, with deep ventral and lateral sinus. Transverse ribs on inner whorls, submedian sulcus on later stages. Median saddle of ventral lobe as high as entire ventral lobe. Second adventitious lobe relatively large. Several umbilical lobes on flanks and umbilical shoulder. Sutural formula: $(E_1E_mE_1)A_2A_1LU$ ... [German], (V_1V_1) L^1LU ... [Russian]. Three species. [For discussion, see Miller & Furnish, 1958a, p. 264.] *Pennsylvanian (Moscovian):* Russia (South Urals), Japan, USA (Ohio, Oklahoma, Texas).——Fig. 70,*1a–c. *W. mohri,* 1.6 km east of Millsap, Pinto County, Texas, Millsap Lake Formation, Desmoinesian; *a–b,* SUI 13844, ×1; *c,* SUI 13843, ×0.8 (Miller & Furnish, 1958a).

Aqishanoceras Wang, 1981, p. 473 [**A. bellum;* OD]. Conch form similar to *Winslowoceras,* with groove on concave ventral side. Ornamentation consisting of biconvex, densely spaced riblets. Ventral lobe wide, median saddle about half as high as entire lobe. Lateral lobes relatively narrow, lanceolate; outer umbilical lobe acute, on umbilical wall. Sutural formula: $(E_1E_mE_1)ALU_2U_1I$ [German], $(V_1V_1)LU_1U_2$:ID [Russian]. One species. *Pennsylvanian (Moscovian):* China (Xinjiang).——Fig. 70,*2a–c. *A. bellum,* holotype, southeast of Aqishan, eastern Xinjiang, upper part of Yamansu Formation, ?Moscovian; *a,* side view, ×4; *b,* cross section, ×4; *c,* suture, whorl height at 5.5 mm, ×6 (Wang, 1981).

Eowellerites Ruzhentsev, 1957, p. 59 [**Bendoceras moorei* Plummer & Scott, 1937, p. 216; OD] [=*Bendites* Miller & Furnish, 1958a, p. 267, obj.]. Conch form thin-discoidal, evolute; umbilicus wide, ventral side flattened or concave. Biconvex growth striae crossed by longitudinal lirae producing reticulate ornamentation. Suture line with small second adventitious lobe. Sutural formula: $(E_1E_mE_1)A_2A_1LU_2U_1I$ [German], (V_1V_1) $L^1LU_2U_1ID$ [Russian]. Three species. [For discussion, see Gordon, 1965, p. 273.] *Pennsylvanian (Moscovian):* Japan, USA (Arkansas, Texas).——Fig. 70,*4a. *E. moorei* (Plummer & Scott), holotype, suture, 5.6 km east of Rochelle, McCulloch County, Texas, Smithwick Shale, Desmoinesian, UT P4847, whorl height at 7.0 mm, whorl width 4.8 mm, ×2.5 (Plummer & Scott).——Fig. 70,*4b. E. discoidalis* Gordon, holotype, outline, Van Buren, Crawford County, Arkansas, upper Atokan Formation, Atokan, USNM 119682, ×0.8 (Gordon, 1965).

?Faqingoceras Yang, 1978, p. 189 [**F. discoideum* Yang, 1978, p. 190; OD]. Conch form lenticular to thickly discoidal, relatively involute; umbilicus moderately wide. Flanks parallel, ventral side slightly flattened. Ornamentation with sigmoidal, biconvex growth striae, forming ventral sinus; one or several deep constrictions may be present. Ventral lobe moderately wide, median saddle half height of entire lobe, ventrolateral saddle broadly rounded. Adventitious lobe V-shaped. No additional suture elements. Four species. [The phylogenetic relationship of this genus is uncertain; the similarity of the sculpture suggests a relationship to Welleritidae.] *Pennsylvanian (Moscovian):* China (Guizhou), Japan.——Fig. 71*a–b. *F. discoideum,* holotype, Riupansui City, northwestern slope of Faqing, Suicheng district, Guizhou, upper part of Dala Formation, CAGS Beijing 0213, ×1 (Yang, 1978).——Fig. 71*c–d. F. ruzhencevi* Nishida, Kyuma, & Egashira, Mine City, Isa Quarry, Akiyoshi, Yamaguchi Prefecture, Akiyoshi Limestone, upper Moscovian, ASM 51780; *c,* immature specimen, side view with constriction, ×2; *d,* suture, enlarged (Nishida, Kyuma, & Egashira, 1996).

Winslowoceras Miller & Downs, 1948, p. 678 [**W. henbesti* Miller & Downs, 1948, p. 679; OD].

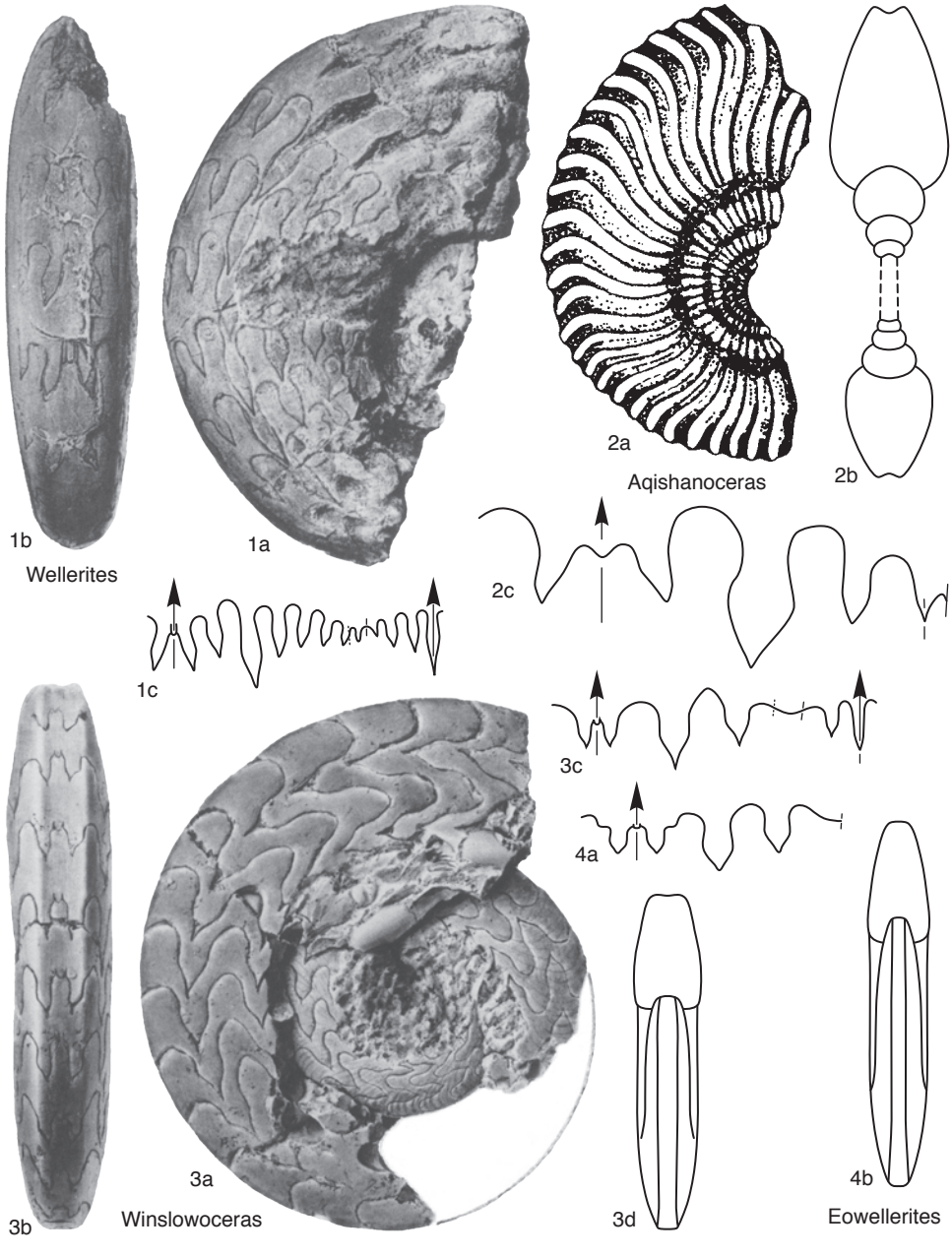

FIG. 70. Welleritidae (p. 116–118).

Conch form discoidal, moderately evolute, with rather wide umbilicus; early whorls triangularly coiled. Ventrolateral shoulders subangular, ventral side flattened or concave. Growth lines biconvex and crossed by faint longitudinal lirae. Ventral lobe short, relatively small. Second umbilical lobe on umbilical wall. Sutural formula $(E_1E_mE_1)ALU_2{:}U_1I$ [German], $(V_1V_1)LU_1U_2{:}ID$ [Russian]. Two or three species. *Pennsylvanian (Moscovian):* China (Guizhou), Japan, Canada (Northwest Territories), USA (Arkansas, Oklahoma).——FIG. 70,*3a–d. *W. henbesti,* holotype, Railroad tunnel at Winslow,

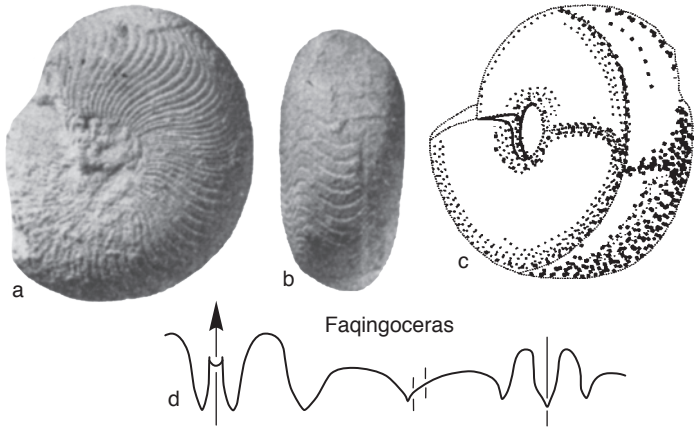

FIG. 71. Welleritidae (p. 116).

Washington County, Arkansas, USA, Winslow Formation, Atokan, USNM 118929; *a–b,* ×1; *c,* suture, ×1.1 (Miller, Furnish, & Schindewolf, 1957); *d,* outline, ×0.6 (Gordon, 1965).

Subfamily AXINOLOBINAE Bogoslovskii, Librovich, & Ruzhentsev, 1962

[Axinolobinae BOGOSLOVSKII, LIBROVICH, & RUZHENTSEV, 1962, p. 388]

Ventral lobe wide, with subdivided prongs. Sutural formula ($E_{1d}E_{1v}E_mE_{1v}E_{1d}$)$ALU_2U_1D$ [German], ($V_{1.1}V_{1.2}V_{1.2}V_{1.1}$)$LU_1U_2$:ID [Russian]. [The subfamily evolved from early schistoceratids, possibly from *Paraphaneroceras* (for discussion, see RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 63).] *Pennsylvanian (upper Bashkirian).*

Axinolobus GORDON, 1960, p. 149 [**A. modulus;* OD]. Ventral side narrowly rounded; umbilicus moderately wide. Sculpture consisting of relatively prominent transverse striae, strongest on umbilical shoulder. Three species. *Pennsylvanian (upper Bashkirian):* Russia (South Urals), Spain, Algeria, USA (Arkansas, Oklahoma).——FIG. 72,*2a–b. *A. modulus,* holotype, 5 km northwest of Gore, Muskogee County, Oklahoma, Witts Springs Formation, upper Morrowan, USNM 119684; *a,* suture, diameter at 71 mm, whorl height 25.1 mm, whorl width 18 mm, ×0.9; *b,* outline, ×0.6 (Gordon, 1965).——FIG. 72,*2c. A. quinni* MCCALEB & FURNISH, east of Gene Autry, Johnston County, Oklahoma, Gene Autry Shale, Golf Course Formation, Bloydian, SUI 11700, ×1 (McCaleb, 1968).——FIG. 72,*2d. A. percostatus* (Schmidt, 1955), La Camocha coal mine, Gijón, Spain, upper Bashkirian, Collection Jongmans, Heerlen, ×1 (new, courtesy of H. W. J. van Amerom).

Paraphaneroceras RUZHENTSEV in RUZHENTSEV & GANELIN, 1971, p. 56 [**Diaboloceras peroccidens* GORDON, 1969, p. 8; OD]. Conch form similar to *Diaboloceras,* early whorls irregular, but not triangularly coiled. Ornamentation reticulate; transverse ribs forming ventral and lateral sinuses. Numerous radial-elongate tubercles developed along umbilical shoulder. Ventral lobe extremely wide with very high median saddle, its prongs being as wide as adventitious lobe. Saddle between lateral and umbilical lobe wide, as in *Diaboloceras.* One species. [The systematic position of this genus is questionable. RUZHENTSEV & BOGOSLOVSKAIA (1978, p. 63) included *Paraphaneroceras* in the family Axinolobidae, regarding it as forerunner of *Axinolobus* with its bifid prongs of the ventral lobe. For discussion, see TITUS, 1997, p. 158.] *Pennsylvanian (upper Bashkirian):* USA (Nevada).——FIG. 72,*1a–b. *P. peroccidens* (GORDON), Las Vegas, Indian Springs area, Bird Spring Formation, Bloydian; *a,* holotype, USNM 161550, ×1; *b,* paratype, suture, USNM 161552, whorl height at approximately 24 mm, ×1.2 (Gordon, 1969).

Family CHRISTIOCERATIDAE Nassichuk & Furnish, 1965

[*nom. transl.* RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 63, *ex* Christioceratinae NASSICHUK & FURNISH, 1965, p. 725]

Conch form discoidal, evolute; at maturity moderately evolute, with ventral groove. Sculpture on early whorls consisting of prominent ribs extending from umbilicus

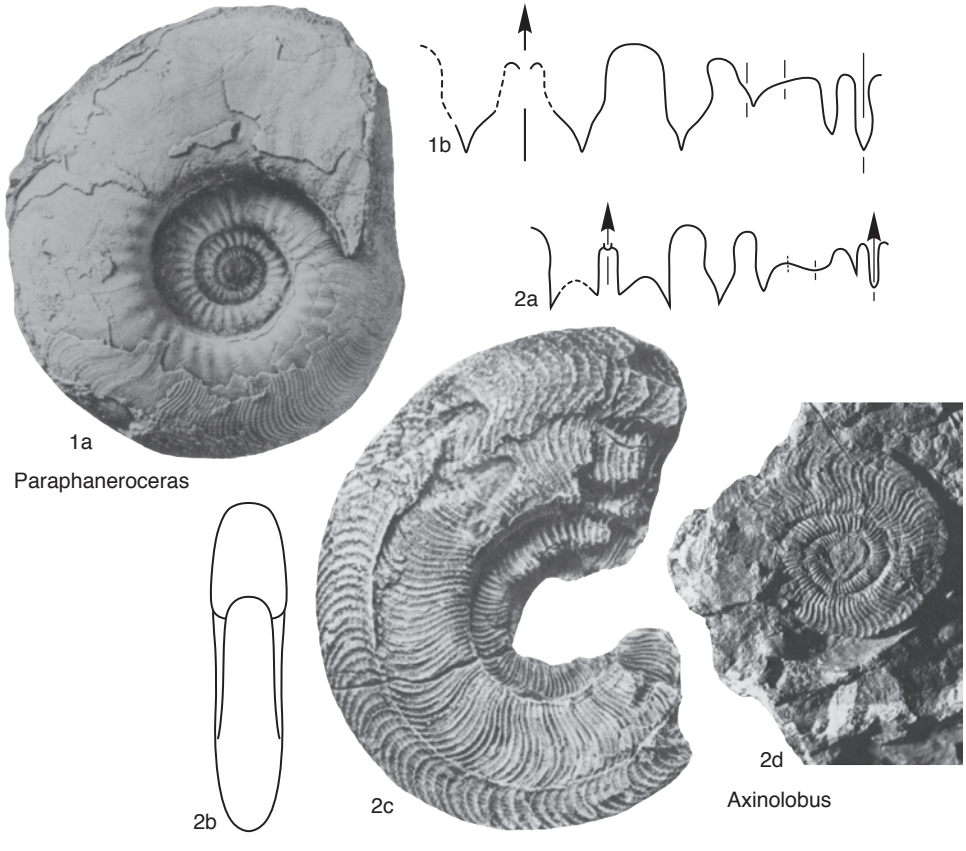

FIG. 72. Welleritidae (p. 118).

to ventral side. Trifurcation of lateral and umbilical lobes as well as of prongs of ventral lobe. [The family evolved from early schistoceratids, maybe *Inzeroceras* (for discussion, see RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 64).] *Pennsylvanian (Moscovian).*

Christioceras NASSICHUK & FURNISH, 1965, p. 725 [**C. trifurcatum* NASSICHUK & FURNISH, 1965, p. 726; M] [=*Parawinslowoceras* ABRAMOV, 1970, p. 375 (type, *P. domokhtovi* Y. POPOV, 1970, p. 136, M), *nom. nud.*]. Ventral groove and umbilical or ventrolateral nodes at maturity. Sutural formula: $(E_1E_mE_l)(A_vA_mA_d)(L_vL_mL_d)(U_{1v}U_{1d}{:}U_{1d})I$ [German], $(V_1V_l)(L_2L_1L_2)(U_2U_1U_2)(I_2I_1{:}I_2)D$ [Russian]. Two species. [*Parawinslowoceras* was established without a diagnosis.] *Pennsylvanian (Moscovian):* Russia (Siberia), Canada (Northwest Territories), USA (Texas).——FIG. 68,*3a–b. *C. trifurcatum,* holotype, Hare Fiord reef, Ellesmere Island, Northwest Territories, Canada, GSC 19879; *a,* suture, diameter at 19 mm, ×3; *b,* outline, ×3.7 (Nassichuk & Furnish, 1965).

GONIOLOBOCERATOIDEA

JÜRGEN KULLMANN

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Superfamily GONIOLOBOCERATOIDEA Spath, 1934

[*nom. transl.* RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 66, *ex* Goniolobocerati dae SPATH, 1934, p. 15]

Conch form discoidal to globular, in general involute; umbilicus narrow. Ventral lobe wide, with diverging sides; sides straight or slightly curved. Median saddle usually exceeding half height of ventral lobe. Sutural formula: $(E_1E_mE_1)$AL:UI [German], (V_1V_1)LU:ID [Russian]. *Pennsylvanian (Bashkirian)–Cisuralian (Asselian).*

Family WIEDEYOCERATIDAE Ruzhentsev & Bogoslovskaia, 1978

[Wiedeyoceratidae RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 85]

Conch form subdiscoidal to globular. Some forms with umbilical nodes or plications on young stages. Suture relatively simple; ventral lobe with steep sides. First lateral saddle rounded, lobes may be also rounded. Adventitious lobe usually shorter than ventral lobe. *Pennsylvanian (Bashkirian–Gzhelian).*

Wiedeyoceras MILLER, 1932, p. 79 [**Eumorphoceras sanctijohanis* WIEDEY, 1929, p. 321; OD] [=*Gordonites* MILLER & FURNISH, 1958b, p. 685 (type, *Anthracoceras missouriense* MILLER & OWEN, 1939, p. 147, OD), for discussion, see FURNISH & SPINOSA, 1966, p. 254.] Conch form subdiscoidal to thickly discoidal; involute, with narrow umbilicus. Ornamentation consisting of fine transverse striae, slightly sinuous, with shallow sinus and salients; sometimes faint spiral lirae present. Faint nodes along umbilical margin may be present on inner whorls. Ventral lobe with steep sides; adventitious lobe pointed. Eight species. *Pennsylvanian (Bashkirian–Moscovian):* Ukraine (Donets), China (Ningxia, Xinjiang), USA (Arkansas, Illinois, Iowa, Oklahoma).——FIG. 73,*2a–c. *W. sanctijohanis* (WIEDEY), Squirrel Hollow, Greene County, Iowa, Cherokee Shale, Desmoinesian; *a–b,* SUI 12386, ×2; *c,* suture, SUI 12387, ×6 (Furnish & Spinosa, 1966).

Donetzoceras LIBROVICH, 1946, p. 79 [**Gastrioceras donetzense* LIBROVICH, 1939a, p. 136; OD]. Conch relatively small, thickly discoidal. Inner whorls evolute, later stages involute. Sculpture consisting of nodelike riblets and umbilical plications that disappear at maturity. Growth lines forming shallow ventral sinus and ventrolateral salient. Shallow lateral sulci may be developed. Ventral lobe pointed; median saddle about half as high as entire ventral lobe. Adventitious lobe rounded and shorter than ventral lobe. Five species. [For discussion, see SAUNDERS, MANGER, & RAMSBOTTOM, 1979, p. 1136.] *Pennsylvanian (upper Bashkirian–Moscovian):* Great Britain, Belgium, Netherlands, Germany, Ukraine (Donets), Algeria, Morocco.——FIG. 73,*5a–c. *D. donetzense* (LIBROVICH), Khartsiskoe, Donets Basin, I-Formation, Ukraine, upper Bashkirian; *a–b,* holotype, VSEGEI 70A, ×4; *c,* suture, diameter at 12.1 mm, VSEGEI 70 B, ×6.3 (Saunders, Manger, & Ramsbottom, 1979).

Luganoceras A. POPOV, 1979, p. 54 [**L. originale;* OD]. Conch form similar to *Wiedeyoceras,* but umbilicus very narrow. Ventral lobe extremely wide, with divergent, almost straight sides; first lateral saddle broadly rounded. Adventitious lobe wide and shallow but pointed. One species from one locality. *Pennsylvanian (Moscovian):* Ukraine (Donets).——FIG. 73,*4. *L. originale,* suture of holotype, Golubevo, Luganka River, Donets Basin, K Formation, Member K7, VSEGEI 123, magnification not stated (A. Popov, 1979).

Mangeroceras STURGEON & others, 1982, p. 1474 [**M. canfieldense* STURGEON & others, 1982, p. 1475; M]. Conch form and sculpture similar to *Donetzoceras.* Ventral lobe with sigmoidal sides; adventitious lobe large. Prongs of ventral lobe and adventitious lobe pointed at base. One species. [This genus is closely related to *Donetzoceras* and *Wiedeyoceras* and may be a junior synonym of either one.] *Pennsylvanian (Moscovian):* USA (Ohio).——FIG. 73,*1. *M. canfieldense,* suture, Canfield, Mahoning County, Putnam Hill Shale, Allegheny Group, OSU 30713, diameter at approximately 35 mm, ×1.4 (Sturgeon & others, 1982).

Pennoceras MILLER & UNKLESBAY, 1942, p. 147 [**P. seamani;* OD]. Conch subglobular, umbilicus closed. Sculpture consisting of prominent straight ribs. Suture line primitive in general, with rounded elements. Median saddle low, not reaching half height of entire ventral lobe. Three species, two questionable. [The relationship of this genus is uncertain, and assignment to the Wiedeyoceratidae is tentative.] *Pennsylvanian (Kasimovian–Gzhelian):* USA (Ohio, Oklahoma, Kansas, Pennsylvania).——FIG. 73,*3a–d. *P. seamani,* lectotype (by MAPES & others, 1997, p. 219), Creighton, Allegheny County, Pennsylvania, Brush Creek Limestone,

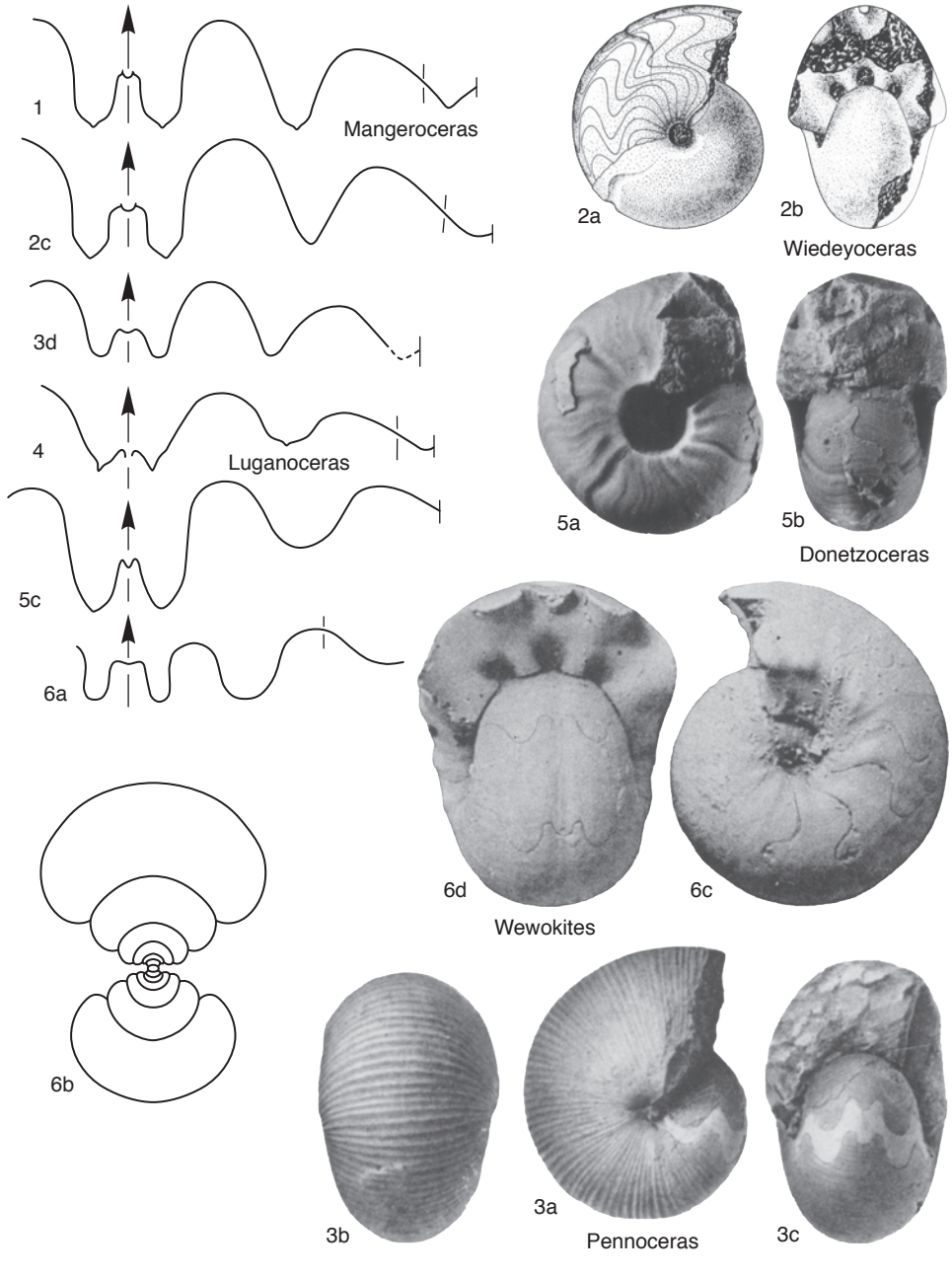

FIG. 73. Wiedeyoceratidae (p. 120–122).

Conemaugh, Missourian, CM 22292; *a–c,* ×1; *d,* suture, diameter at approximately 8 mm, enlarged (adapted from Miller & Unklesbay, 1942).

?Wewokites FURNISH & BEGHTEL, 1961, p. 290 [**Gastrioceras venatum* GIRTY, 1911, p. 149; OD]. Conch very small, subdiscoidal to subglobular, involute throughout; umbilicus relatively wide. Growth lines biconvex. Umbilical shoulder nodose, sometimes extending as low ridges toward ventral side. Ventral furrow may be present. Suture line primitive: lobes and saddles rounded, even at their basis; median saddle relatively high. Two species. [The holotype

does not show ventral furrow. The relationship of this genus is uncertain; its assignment is questionable because it may represent immature forms of a larger genus. For discussion, see UNKLESBAY, 1962, p. 64.] *Pennsylvanian (upper Moscovian):* USA (Oklahoma).——FIG. 73,*6a–b. *W. venatus* (GIRTY), west of Okmulgee, Okmulgee County, Wewoka Formation; *a,* suture, magnification not stated; *b,* cross section, approximately ×3.5 (Furnish & Beghtel, 1961).——FIG. 73,*6c–d. W. newelli* UNKLESBAY, holotype, 3.9 km west of Okmulgee, Highway 56, Okmulgee County, Wewoka Formation, upper Desmoinesian, OU 3830-34, 4206, ×6 (Unklesbay, 1962).

Family GONIOLOBOCERATIDAE Spath, 1934

[Goniloboceratidae SPATH, 1934, p. 15] [=Gonioglyphioceratidae RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 86]

Conch form in general discoidal, involute, with narrowly rounded or oxyconic ventral side, sometimes with external or ventrolateral grooves. Ventral lobe extremely wide, with strongly diverging sides; median saddle broad, with diverging sides, higher than half height of entire ventral lobe. First lateral saddle narrowly rounded, subacute, or acute. Adventitious lobe broad and pointed, seldom rounded. [Family Gonioglyphioceratidae was erected for genera with rounded adventitious lobe.] *Pennsylvanian (upper Bashkirian)–Cisuralian (Asselian).*

Gonioloboceras HYATT, 1900, p. 551 [**Goniatites goniolobus* MEEK, 1877, p. 98; OD] [=*Milleroceras* HYATT, 1900, p. 550 (type, *Goniatites parrishi* MILLER & GURLEY, 1896, p. 36, OD, =*Goniatites goniolobus* MEEK, 1877, p. 98); =*Gurleyoceras* MILLER, 1932, p. 76 (type, *Goniolloboceras welleri* SMITH, 1903, p. 125, OD, =*Goniatites goniolobus* MEEK, 1877, p. 98); for discussion, see MILLER & DOWNS, 1950a, p. 194, 196]. Conch form subdiscoidal, involute, with extremely narrow umbilicus. Ventral lobe with high and broad median saddle and extremely divergent sides. First lateral saddle narrow and acute; adventitious lobe triangular, ventral side convex, dorsal side concave. Six species. [For discussion, see FURNISH & GLENISTER, 1971, p. 303. The inner whorls are not known for this genus.] *Pennsylvanian (upper Bashkirian–Gzhelian):* Ukraine (Donets), Morocco, China (Xinjiang), USA (Kansas, Ohio, Missouri, New Mexico, Oklahoma, Texas).——FIG. 74,*2a–c. *G. goniolobum* (MEEK), holotype, New Mexico, USA, upper Pennsylvanian, USNM 156437; *a–b,* ×1; *c,* suture, diameter at 65 mm, ×1.5 (Furnish & Glenister, 1971).

Gonioglyphioceras PLUMMER & SCOTT, 1937, p. 336 [**Goniolloboceras welleri gracile* GIRTY, 1911, p. 153; OD] [=*Eudissoceras* MILLER & OWEN, 1937, p. 408 (type, *E. collinsvillense* MILLER & OWEN, 1937, p. 409, OD)]. Ventral side narrow, bicarinate. Suture line similar to *Goniolloboceras,* but adventitious lobe rounded. Four species. [For discussion, see FURNISH & GLENISTER, 1971, p. 303. *Eudissoceras* is based on immature specimens of *Gonioglyphioceras gracile* (GIRTY) and is therefore regarded as a junior synonym of *Gonioglyphioceras;* for discussion, see UNKLESBAY, 1962, p. 69.] *Pennsylvanian (Moscovian–Kasimovian):* Ukraine (Donets), USA (Oklahoma).——FIG. 75,*2a–c. *G. gracile* (GIRTY), about 3.2 km west of Lovelady school, east of Ada, Pontotoc County, Oklahoma, USA, lower Wewoka Formation, Desmoinesian, SUI 8811; *a–b,* ×1.5 (Furnish & Glenister, 1971); *c,* suture, ×2.6 (Plummer & Scott, 1937, adapted from Girty, 1915).

Goniolloboceratoides NASSICHUK, 1975, p. 74 [**G. curvatus* NASSICHUK, 1975, p. 75; OD]. Conch form discoidal and highly involute; umbilicus narrow. Umbilical shoulder narrowly rounded, umbilical walls flat. Venter rounded, at maturity slightly flattened. Fine growth striae with ventral and lateral sinus. Prongs of ventral lobe broad and rounded during ontogeny, bluntly pointed at maturity. First lateral saddle asymmetric, rounded and twice as broad as adventitious lobe. Two species. *Pennsylvanian (Moscovian):* Canada (Northwest Territories), USA (Missouri).——FIG. 75,*3a–c. *G. curvatus,* holotype, Ellesmere Island, Hare Fiord, Hare Fiord Formation, Atokan, Northwest Territories, GSC 33688; *a–b,* ×2; *c,* suture, diameter at 43 mm, enlarged (Nassichuk, 1975).

?Megatrochoceras YANG, 1978, p. 158 [**M. striatum;* OD]. Conch very large, subdiscoidal and involute, with very narrow umbilicus. Ventral side broadly rounded, becoming oxycone at maturity. Ornamentation consisting of biconvex growth lines forming ventral sinus. Ventral lobe wide, with sinuous sides, median saddle higher than half height of entire lobe; ventrolateral saddle rounded. Adventitious lobe acute, with sinuous dorsal side. One species. [The relationship and generic assignment is questionable for this genus.] *Pennsylvanian (upper Bashkirian):* China (Guizhou).——FIG. 74,*1a–b. *M. striatum,* holotype, West Guizhou, ?upper Bashkirian; *a,* side view, ×0.5; *b,* suture, reversed, ×0.6 (Yang, 1978).

Mescalites FURNISH & GLENISTER, 1971, p. 304 [**G. discoidale* BÖSE, 1920, p. 52; OD]. Conch form similar to *Goniolloboceras*, but with weak furrow on ventral side; umbilicus covered by a callus at maturity. Suture similar to *Goniolloboceras*, but at maturity with small additional ventral element close to siphuncle. Sutural formula: $(E_1E_2E_m.E_2E_1)$ ALUI [German], $(V_1V_2V_2V_1)$LU:ID [Russian]. Two species. [Some species placed in this genus are questionable.] *Pennsylvanian (upper Gzhelian)–Cisuralian (Asselian):* Slovenia, *upper Gzhelian;* USA (New Mexico, Oklahoma, Texas), *Asselian.*——FIG. 74,*3a–d. *M. discoidale* (BÖSE); *a–c,* Tularosa, Otero County, New Mexico, USA, middle Bursum

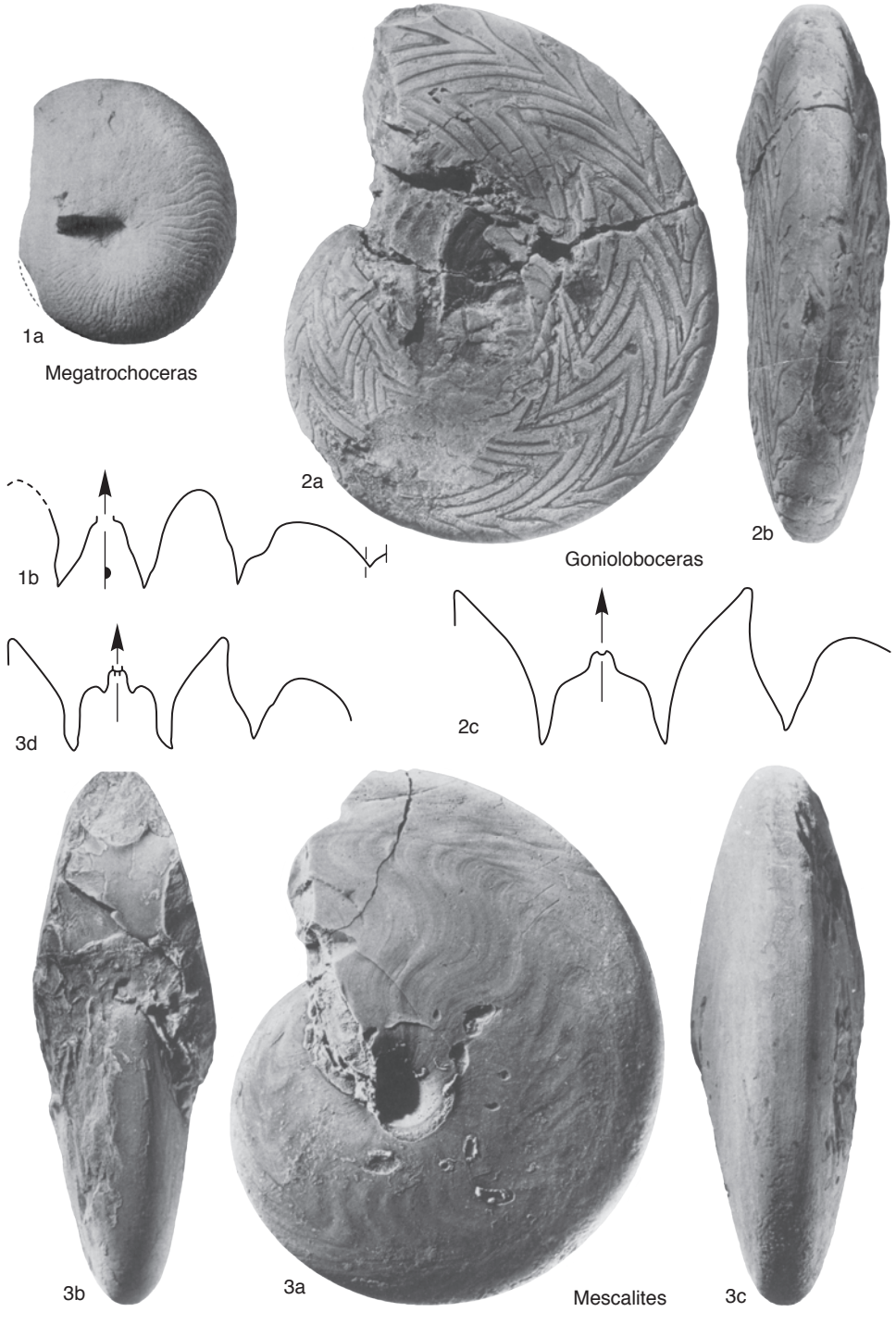

FIG. 74. Goniloboceratidae (p. 122–125).

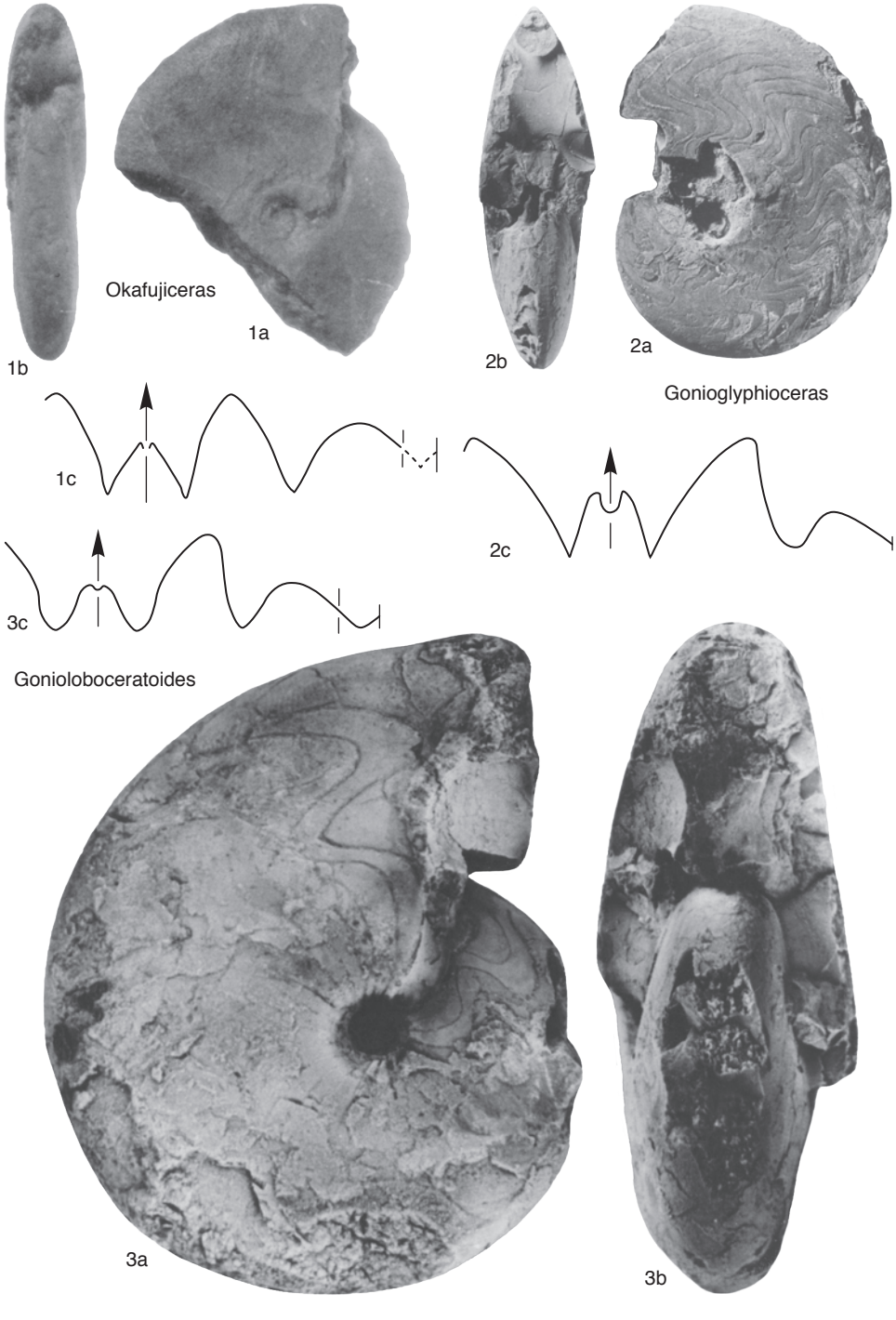

FIG. 75. Gonioloboceratidae (p. 122–125).

Formation, Asselian, SUI 33020, ×1.5; *d,* suture, SUI 8876B, diameter at 50 mm, ×1.5 (Furnish & Glenister, 1971).

Okafujiceras Nishida & Kyuma, 1982, p. 40 [**O. isaense;* OD]. Conch small, discoidal, with very narrow umbilicus and rapid increase in whorl height. Suture of adult whorls with wide ventral lobe, V-shaped prongs, and widely diverging sides; median saddle not exceeding half height of entire lobe. First lateral saddle subacute, adventitious lobe V-shaped. One species. *Pennsylvanian (upper Bashkirian):* Japan.——Fig. 75,*1a–c. *O. isaense,* holotype, Mine City, Isa Quarry, Akiyoshi, Yamaguchi Prefecture, ASM 5552; *a–b,* ×1; *c,* suture, diameter at approximately 24 mm (Nishida & Kyuma, 1982).

ADRIANITOIDEA

Brian F. Glenister,[1] William M. Furnish,[2] and Zhou Zuren[3]

[[1]retired, formerly of the University of Iowa; [2]deceased, formerly of the University of Iowa; [3]Nanjing Institute of Geology and Palaeontology]

Superfamily ADRIANITOIDEA Schindewolf, 1931

[*nom. correct.* Ruzhentsev, 1957, p. 58, *pro* Adrianitida nov. superfam. Böhmers, 1936, p. 29, *nom. transl. ex* Adrianitidae Schindewolf, 1931, p. 199]

Conch small (diameter at maturity commonly 2.5–5 cm, range 1–7 cm), highly variable: widely evolute to involute, globular to (rarely) fusiform or discoidal. Dimorphism probably common, but documentation inadequate. Mature modifications ordinarily comprise slight geniculation, marked subterminal constrictions and terminal flare, and modification of peristome to form pair of conspicuous ventrolateral lappets. Constrictions common, frequently reflected on both internal mold and shell surface. Sculpture variable, but commonly comprises fine longitudinal and transverse elements that form pronounced reticulate pattern; ribs rare. Characterized by sutures with ventral prongs narrower than adjacent lateral lobe, low secondary ventral saddle, and numerous (8–34) subequal, undivided, narrow, pointed, medially constricted (lingulate) external and internal so-called lateral lobes. Basic sutural formula: (V_1V_1)LU:U^1ID [Russian], $(E_1E_mE_1)LU_2U_1I$ [German].

Elements of lateral lobe (L) and internal lobe (I) remained entire. Lobes were added in umbilical saddle, those first formed migrating to internal suture. Subsequent additions to both internal and external suture, thus: $(V_1V_1)LUU^3U^4U^5U^5$:$U^4U^2U^1$ID. Sutural trace conspicuously arched in some advanced forms. [Superfamily members are normally rare, abundance and diversity being greatest in the middle Guadalupian (Wordian). There are superficial homeomorphs of some associated taxa, especially Agathiceratoidea, but they represent a distinctive and separate lineage.] *Pennsylvanian (upper Moscovian [Desmoinesian])–Lopingian (Wuchiapingian).*

Family ADRIANITIDAE Schindewolf, 1931

[Adrianitidae Schindewolf, 1931, p. 199] [=Dunbaritidae Miller, Furnish, & Schindewolf, 1957, p. 67, *nom. transl.* Ruzhentsev, 1960d, p. 229, *ex* Dunbaritinae Miller, Furnish, & Schindewolf, 1957, p. 67]

Description as for superfamily. Twelve of 19 recognized adrianitin genera occur in the Wordian Stage, and 7 of them are completely restricted to that interval. [Gradation in conch form, sculpture, and sutural complexity exists between virtually all adrianitids, and this major complex constitutes the Adrianitinae. Rare monotypic extremes are recognized as the simple 10-lobed sutures of the Dunbaritinae, rounded lobes with parallel sides characterize the Texoceratinae, and extremes in conch form are recognized as the advanced Hoffmanniinae.] *Pennsylvanian (upper Moscovian [Desmoinesian])–Lopingian (Wuchiapingian).*

Subfamily ADRIANITINAE Schindewolf, 1931

[*nom. transl.* Miller, Furnish, & Schindewolf, 1957, p. 66, *ex* Adrianitidae Schindewolf, 1931, p. 199] [=Pamiritellinae Ruzhentsev & Bogoslovskaia, 1978, p. 87; =Emilitinae Leonova & Bogoslovskaia, 1990, p. 88]

Evolutionary complex comprising all adrianitids with exception of advanced evolute Hoffmanniinae and suturally distinctive Dunbaritinae and Texoceratinae. [The generic taxobases are, in order of perceived significance: lobe count, path of sutural trace (straight to strongly arched), conch form (especially umbilical ratio U/D), sculpture (smooth, transverse, longitudinal, reticulate, unusual such as scalloped), and mature modifications (probably warrant greater importance, but are preserved and reported relatively rarely; Davis, 1972).] *Pennsylvanian (upper Moscovian [Desmoinesian])–Lopingian (Wuchiapingian).*

Adrianites Gemmellaro, 1887, p. 41 [**A. elegans* Gemmellaro, 1887, p. 43; SD Diener, 1921, p. 20]. Conch relatively narrow (W/D, 0.6) with wide umbilicus (U/D, 0.2) and evenly reticulate sculpture. Sutural trace moderately arched, with six pairs of external lateral lobes to umbilical shoulders. Six named species. *Guadalupian (Wordian):* Italy (Sicily), Oman, China (Xinjiang, Jilin, ?Xizang), ?Malaya, Canada (British Columbia), Croatia, Indonesia (Timor), Afghanistan, Tajikistan (?Pamir), USA (?Texas), Russia (?Southern Urals).——Fig. 76,*3a–d.* **A. elegans,* Sosio limestone; *a–c*, lectotype (herein), MGUP 85A of Gemmellaro (1887, pl. 6,*14–15*), ×2; *d*, topotype, GPIT 24409-13, diameter at 14 mm (new).

Aricoceras Ruzhentsev, 1950, p. 203 [**Adrianites ensifer* Gemmellaro, 1887, p. 46; OD] [=*Metaricoceras* Ruzhentsev, 1950, p. 203 (type, *Agathiceras cancellatum* form. *discoidalis* Haniel, 1915, p. 75, OD)]. Conch globular, with narrow umbilicus; sculpture evenly reticulate, outlining shallow sinus on flanks; mature peristome with long ventrolateral lappets. Sutural trace forming low arch, with four or five pairs of external lateral lobes to umbilical shoulders. Four named species. [This genus is similar to *Neocrimites*, but with evenly reticulate sculpture, lappets, and arched sutural trace.] *Cisuralian (Artinskian [probably Baigendzhinian])–Guadalupian (Wordian):* Canada (British Columbia), Italy (Sicily), Iraq (Kurdistan), Oman, Indonesia (Timor), Australia (New South Wales, Queensland).——Fig. 77,*1a–e.* **A. ensifer* (Gemmellaro), Sosio limestone, Wordian, Sicily; *a–b*, lectotype (herein), MGUP 82A of Gemmellaro (1887, pl. 6,*11–12*), ×2 (new); *c–d*, paralectotype, MGUP 82B of Gemmellaro (unfigured), ×2 (new); *e*, paralectotype, MGUP 82C of Gemmellaro (1887, pl. 6,*13*), diameter ranging 10–19 mm (modified after Gemmellaro, 1887).

Crimites Tumanskaia, 1937a, p. 146 [**Agathericeras Krotowi* Karpinskii, 1889, p. 66; SD Glenister & Furnish, 1961, p. 726] [?=*Istycoceras* Pavlov, 1967, p. 74 (type, *I. bodylevskyi,* OD)]. Similar to *Emilites* (globular, involute), from which it was derived, but suture characterized by three pairs of external lateral lobes, three pairs of internal laterals, and three or four smaller lobes on each umbilical wall. Fourteen named species. *Cisuralian (Asselian)–Guadalupian (Wordian):* Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Ukraine (Crimea), Indonesia (Timor), USA (Nevada).——Fig. 76,*1a–c.* **C. krotowi* (Karpinskii), Artinskian, Urals; *a–b,* Aktastinian, Southern Urals, ×1.5 (Ruzhentsev, 1956b); *c*, Baigendzhinian, Central Urals, diameter at 10 mm (Bogoslovskaia, 1962).

Doryceras Gemmellaro, 1887, p. 82 [**D. fimbriatum;* OD]. Conch small (1 cm at maturity; USNM 499156, probable dimorph 25% smaller) with deep subterminal constriction and strong terminal flare of mature peristome lacking lappets and any other significant modification of premature apertural contours. Fine ribs form high salient across umbilical wall, and broad shallow sinus across flat venter. Suture comprises three pairs of external lateral lobes, two pairs of internal laterals, and additional lobe centered on umbilical seam. One named species (assignment of *D. stouckenbergi* Gemmellaro, 1888 is questionable). [This genus is interpreted herein as an adrianitin paedomorph.] *Guadalupian (Wordian):* Italy (Sicily).——Fig. 76,*2a–g.* **D. fimbriatum*, Sosio limestone; *a–b*, lectotype (herein), MGUP 126A of Gemmellaro (1887, pl. 10,*26*), ×4; *c–d*, paralectotype, MGUP 126B of Gemmellaro (1887, pl. 10,*28*), ×4; *e–f*, topotype, USNM 499154, ×4; *g*, composite, diameter approximately 5 mm, based on paralectotype, MGUP 126C of Gemmellaro (1887, pl. 10,*27*) and topotypes GPIT 24409-19 and USNM 499154 (new).

Emilites Ruzhentsev, 1938, p. 265 [**Paralegoceras incertum* Böse, 1919, p. 100; OD] [=*Plummerites* Miller & Furnish, 1940a, p. 103, obj.]. Conch globular with small umbilicus (U/D, commonly 0.1), and scalloped transverse sculpture. Suture comprises two pairs of external lateral lobes and two pairs of internal laterals. External suture characterized by irregularly denticulate third lateral saddle across umbilical wall. Sutural formula: (V_1V_1)LU:U^1ID [Russian]. Seven species, representing primitive forms of subfamily. *Pennsylvanian (upper Moscovian)–Cisuralian (Sakmarian)*: USA (Texas, Oklahoma), Canada (Arctic Archipelago, Ellesmere Island), Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Uzbekistan (Fergana), southern China (Guangxi).——Fig. 78,*4a–c.* **E. incertus* (Böse), Virgilian, western Texas; *a–b*, ×2; *c*, diameter at 10 mm (Miller & Furnish, 1940a).

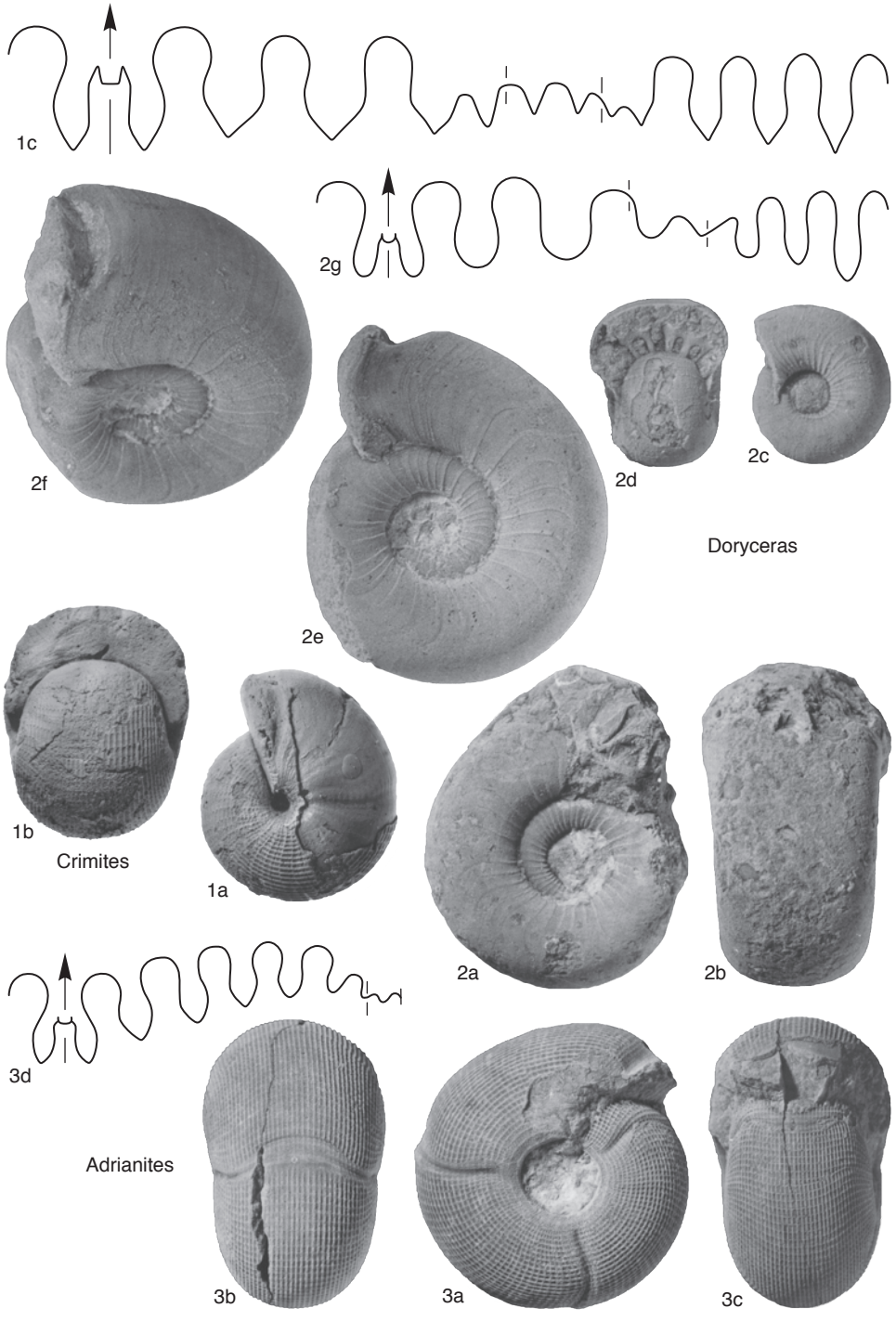

FIG. 76. Adrianitidae (p. 126).

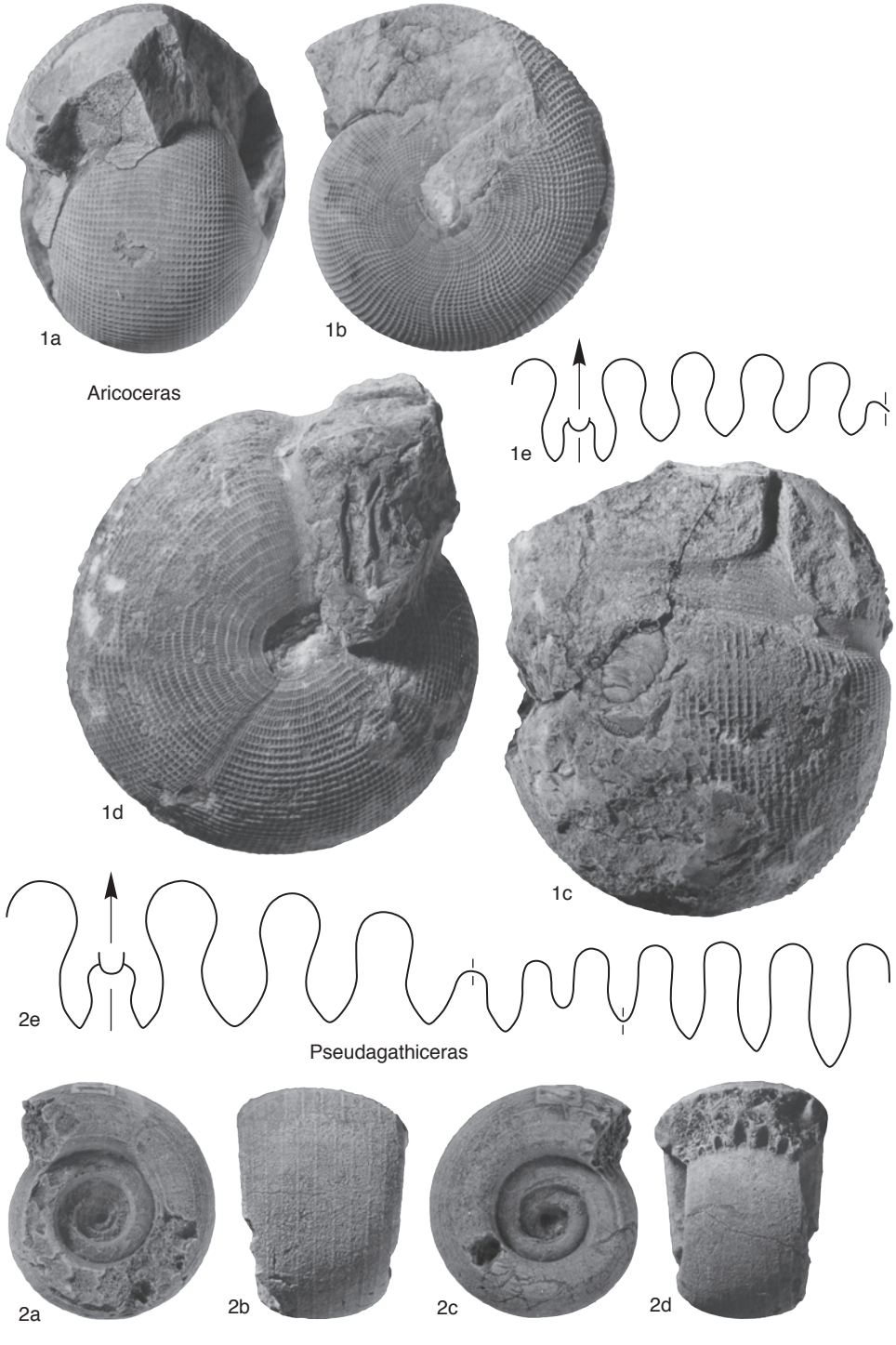

FIG. 77. Adrianitidae (p. 126–132).

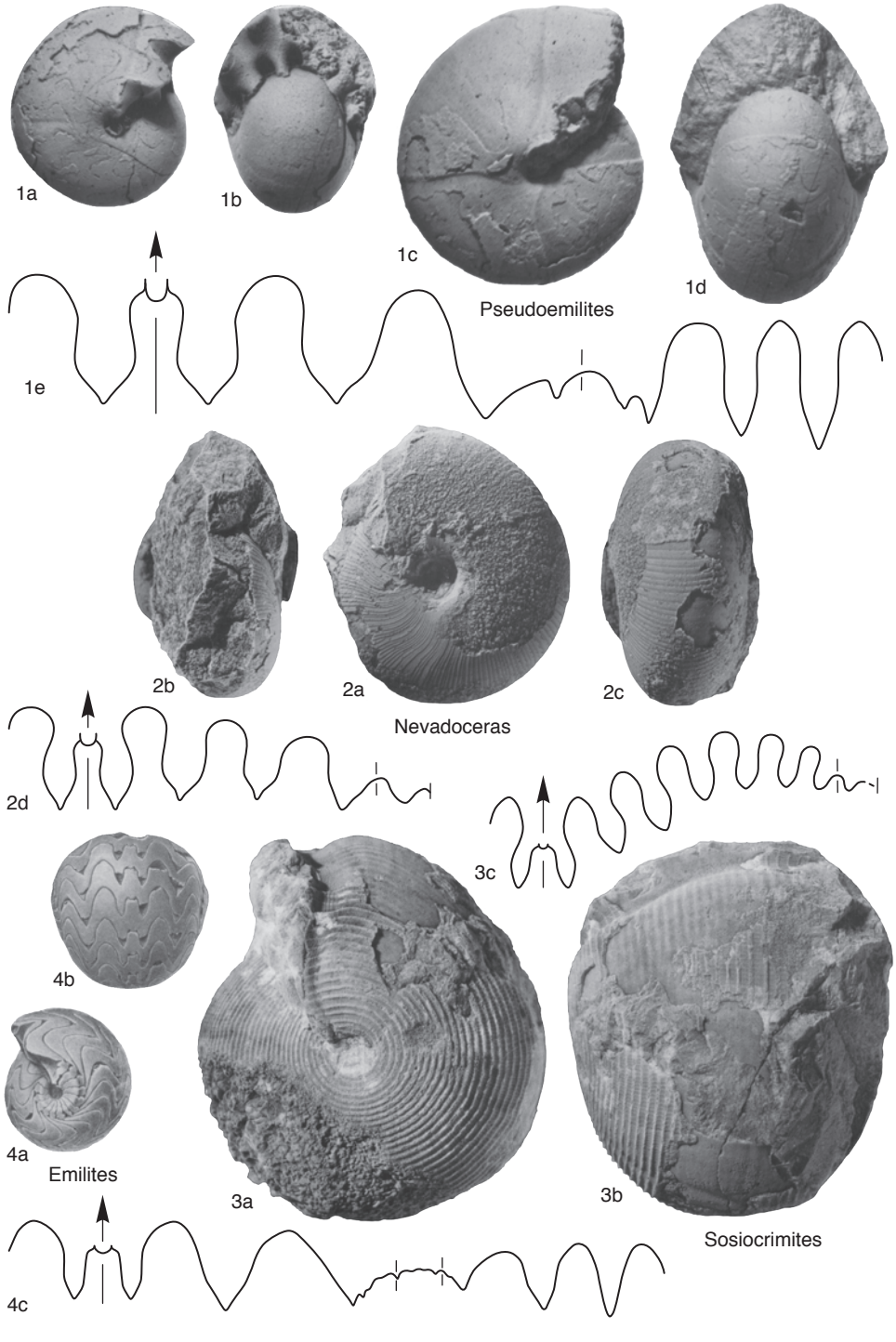

FIG. 78. Adrianitidae (p. 126–133).

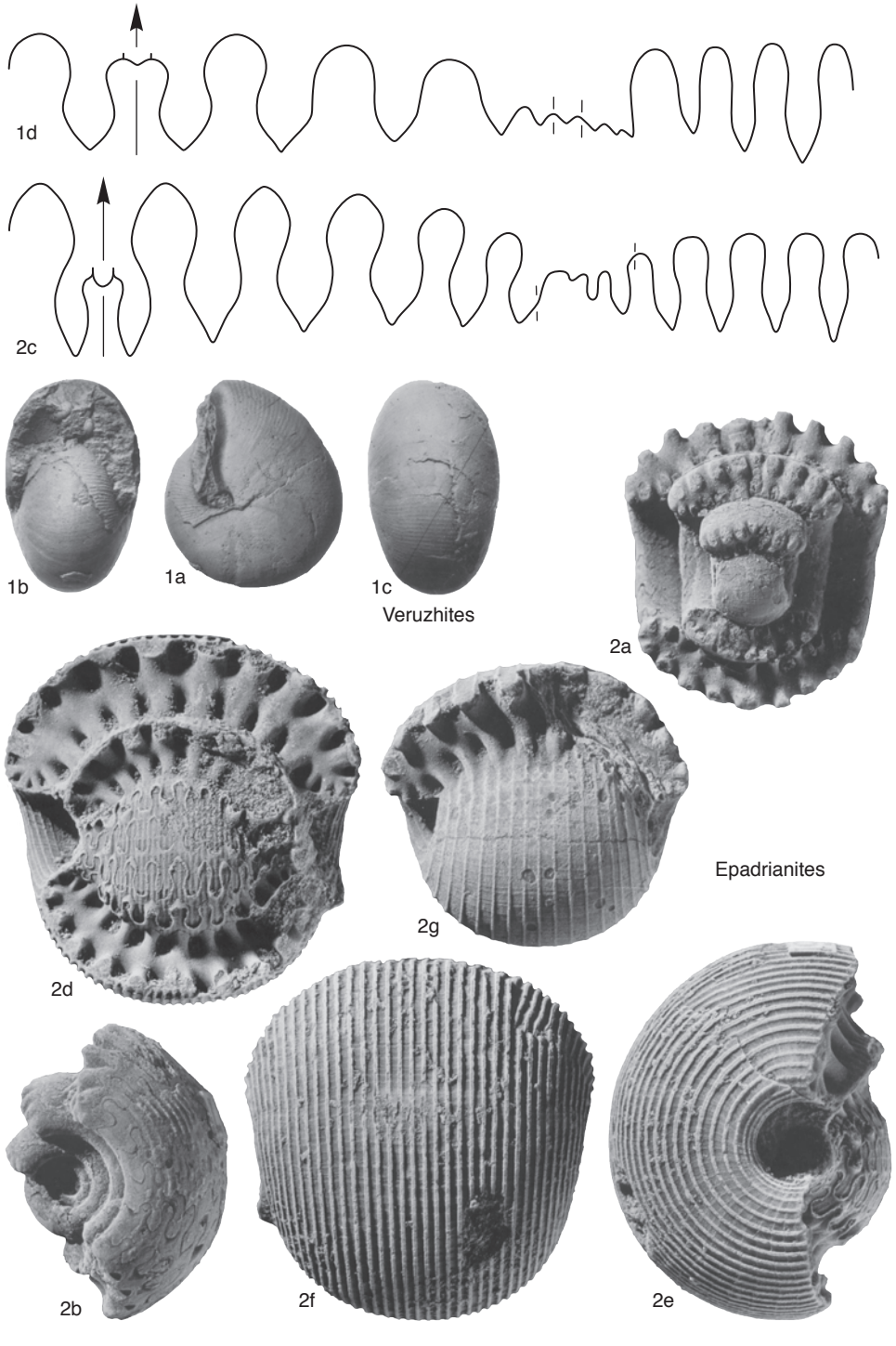

FIG. 79. Adrianitidae (p. 131–134).

Epadrianites Schindewolf, 1931, p. 200 [**Agathiceras timorense* Boehm, 1908, p. 321; OD] [=*Basleoceras* Ruzhentsev, 1950, p. 203 (type, *Agathiceras Beyrichi* Haniel, 1915, p. 83, OD)]. Conch large (diameter at maturity up to 7 cm), globular, with moderately large umbilicus and longitudinal lirae much stronger than transverse sculpture. Mature modifications incompletely known, but comprise slight geniculation, reduction of umbilical diameter, subterminal constriction, and terminal flare that probably extended into ventrolateral lappets. Sutural trace transverse; suture comprises four or five pairs of external lateral lobes, three or four pairs of internal lateral lobes, and two or three additional lobes on each umbilical wall. Seven named species. *Guadalupian (Wordian)–Lopingian (Wuchiapingian):* Indonesia (Timor), China (Jilin, Guizhou), Italy (Sicily), Oman, Croatia, Mexico (Coahuila), Azerbaijan (Dzhulfa).——Fig. 79,*2a–c.* **E. timorensis* (Boehm), Amarassi beds, Wuchiapingian, Amarassi, Timor; *a–b*, holotype, MTHD (same as Boehm, 1908, pl. 11,*3a–c,* fig. 1a–b), ×2; *c*, topotype, SUI 12685A, diameter at 40 mm (new).——Fig. 79,*2d–f. E. involutus* Haniel, lectotype, Amarassi beds, Bihati, Timor, MTHD 12751 (same as Haniel, 1915, pl. 5,*8a,b*), ×2 (new).——Fig. 79,*2g. E. beyrichi*, paralectotype (herein), MTHD 12745, Wordian, Basleo beds, Basleo, Timor (probable source of suture, Haniel, 1915, fig. 23), ×2 (new).

Neoaricoceras Ruzhentsev, 1950, p. 203 [**Adrianites Kingi* Gemmellaro, 1887, p. 47; OD]. Similar to *Sosiocrimites* in general conch form and mature modifications, but characterized by closed mature umbilicus and virtual absence of longitudinal sculpture. Sutural trace moderately and uniformly arched, with seven pairs of external lateral lobes to umbilical shoulders. One species. *Guadalupian (Wordian):* Italy (Sicily).——Fig. 80,*3a–c.* **N. kingi* (Gemmellaro), Sosio limestone; *a–b,* lectotype (herein), MGUP 81A of Gemmellaro (1887, pl. 9,*31–32*), ×2; *c*, paralectotype, composite, MGUP 81B of Gemmellaro (1887, pl. 9,*35*) and USNM 509805, diameter at 13 mm (new).

Neocrimites Ruzhentsev, 1940a, p. 838 [**Adrianites fredericksi* Emel'iantsev, 1929, p. 150; OD] [=*Metacrimites* Ruzhentsev, 1950, p. 202, *partim* (type, *Adrianites newelli* Miller & Furnish, 1940a, p. 117, OD); =*Millerites* Cantú Chapa, 1997, p. 66 (type, *Adrianites newelli* Miller & Furnish, 1940a, p. 117, OD)]. Similar to *Crimites* (globular, involute), from which it was derived, but longitudinal sculpture may be much stronger than transverse. Sutural trace directly transverse with four or five pairs of external lateral lobes, three or four pairs of internal laterals, and two or three smaller lobes on umbilical wall. Fifteen named species. *Cisuralian (Artinskian [Baigendzhinian])–Guadalupian (Capitanian):* southern Kazakhstan (Southern Urals), Tajikistan (Pamir), Russia (Urals, northern Caucasus), USA (Texas), Mexico (Coahuila), Indonesia (Timor), China (Xizang, Guangxi, Guizhou, Gansu), ?Western Australia.——Fig. 80,*1a–c.* **N. fredericksi* (Emel'iantsev), Baigendzhinian, Southern Urals; *a–b*, ×1.5; *c*, diameter at 18 mm (Ruzhentsev, 1956b).

Nevadoceras Schiappa, Spinosa, & Snyder, 1995, p. 1075 [**N. steeli;* OD]. Similar to *Crimites* in simple sutural characteristics, but with narrower conch and wider umbilicus. Distinctive scaliform striae form shallow sinus across venter and a rounded salient across dorsolateral flank. One species. *Cisuralian (Artinskian):* USA (Nevada).——Fig. 78,*2a–d.* **N. steeli; a–c*, ×1.5; *d*, diameter at 18 mm (Schiappa, Spinosa, & Snyder, 1995).

Palermites Tumanskaia, 1937b, p. 377 [**Adrianites Distefanoi* Gemmellaro, 1887, p. 48; OD]. Conch large (diameter 3–5 cm at maturity; bimodal size distribution in topotypes of type species suggests dimorphism), compressed (W/D, 0.6), characterized by retention of evolute form to maturity (U/D, 0.5). Juvenile shell smooth; transverse sculpture with low dorsolateral and ventral salients becoming progressively more prominent in ultimate volution. Mature modifications comprise slight geniculation in coiling, penultimate constriction, and terminal flare of aperture that includes formation of narrow, divergent ventrolateral lappets. Sutural trace gently arched. Suture comprises five pairs of external lateral lobes, five pairs of internal laterals, and two additional lobes on umbilical wall. Two species. *Guadalupian (Wordian)*: Italy (Sicily), Ukraine (?Crimea), Iraq (Kurdistan), northern China (?Jilin).——Fig. 81*a–e.* **P. distefanoi* (Gemmellaro), Sosio limestone, Sicily; *a–b,* lectotype (herein), MGUP 76A of Gemmellaro (1887, pl. 9,*36–37*), ×2; *c–d*, topotype, SUI 32456, ×2; *e*, paralectotype, composite, MGUP 76B of Gemmellaro (1887, pl. 9,*40*), external suture, and paralectotype, MGUP 76C (unfigured), internal, diameter approximately 18 mm (new).

Pamiritella Tumanskaia, 1963, p. 75 [**Adrianites vinogradovi* Tumanskaia, 1949, p. 76; OD] [?=*Pamirioceras* Pavlov, 1967, p. 71 (type, *P. markovskii,* OD)]. Incompletely known, but probably distinguishable by combination of weak sculpture, narrow conch (W/D, 0.4–0.5), involute form (U/D, of 0.25 decreased to 0.05 as mature modification), and possession of slightly arched sutural trace with five or six pairs of external lateral lobes. One named species. *Cisuralian (Kungurian [Bolorian]):* Tajikistan (Pamir).

Pseudagathiceras Schindewolf, 1931, p. 200 [**Agathiceras (Doryceras?) Wichmanni* Haniel, 1915, p. 85; OD]. Conch evolute, similar to *Doryceras* in general form but larger and commonly with strong but variable sculpture. Suture comprises total of 16–18 lobes; depending on whorl section, 3 or 4 pairs of lobes on external lateral flanks, 1 or 2 pairs on umbilical wall, and 2 or 3 pairs internally. Three named species (questionable grouping). *Guadalupian (?Wordian):* Indonesia (Timor), Japan (Kitakami), Mexico (Coahuila).——Fig. 77,*2a–e.* **P. wichmanni* (Haniel), Basleo beds, Basleo,

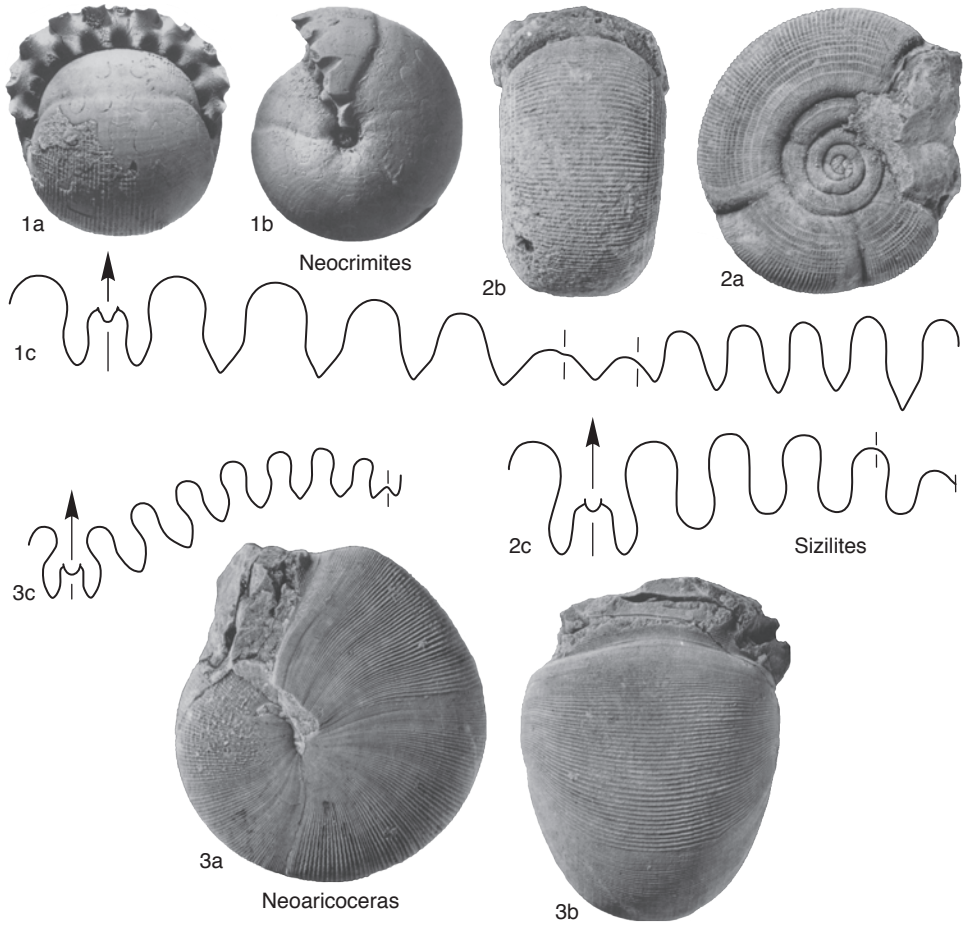

FIG. 80. Adrianitidae (p. 131–132).

Timor, lectotype (herein), MTHD 12752 (same as HANIEL, 1915, pl. 5,*15a–c,* ?text-fig. 24); *a–d,* ×2; *e,* diameter at 16 mm (new).

Pseudoemilites LEONOVA, 1988, p. 32 [**P. asianus;* OD]. Smooth, involute, globular adrianitins characterized by anomalously primitive suture: ten lobes, prongs of ventral lobe only slightly narrower than corresponding first lateral, secondary ventral saddle almost aligned with lateral saddles. Second external and second internal lateral lobes both prominently bidentate. One species. [Suture resembles those of Pennsylvanian adrianitins in some respects, but phyletic relationships are unclear.] *Cisuralian (Kungurian [Bolorian]):* Tajikistan (Pamir).——FIG. 78,*1a–e. *P. asianus; a–d,* ×2; *e*, diameter about 15–17 mm (adapted from Leonova & Dmitriev, 1989).

Sizilites TUMANSKAIA, 1937b, p. 377 [**Adrianites affinis* GEMMELLARO, 1888, p. 16; OD]. Conch small (15 mm at maturity), compressed (W/D, 0.6), evolute (Umin /D, 0.40). Sculpture reticulate; forwardly arched transverse elements predominate on venter, whereas longitudinal lirae are dominant on dorsolateral flanks. Mature aperture constricted strongly, ultimate peristome flared (expanded), probably forming dorsolateral lappets. Sutural trace slightly arched; suture comprises four pairs of linked external lateral and internal lateral lobes. Three species (Sicilian species possibly dimorphs). *Guadalupian (Wordian)*: Italy (Sicily), Iraq (Kurdistan).——FIG. 80,*2a–c. *S. affinis* (GEMMELLARO), Sosio limestone, Sicily; *a–b,* lectotype (herein), MGUP 88 of GEMMELLARO (1888, pl. D,*6–7*), ×2.67; *c*, topotype, SUI 62700, Rocca di Salomone, diameter at 12 mm (new).

Sosiocrimites RUZHENTSEV, 1950, p. 202 [**Adrianites insignis* GEMMELLARO, 1887, p. 44; OD] [?=*Subcrimites* LIANG, 1982, p. 652 (type, *Neocrimites (Subcrimites) compressus,* OD)]. Conch form and sculpture generally similar to ancestor, *Neocrimites*, but with mature modifications comprising slight geniculation, deep subterminal constriction, and terminal

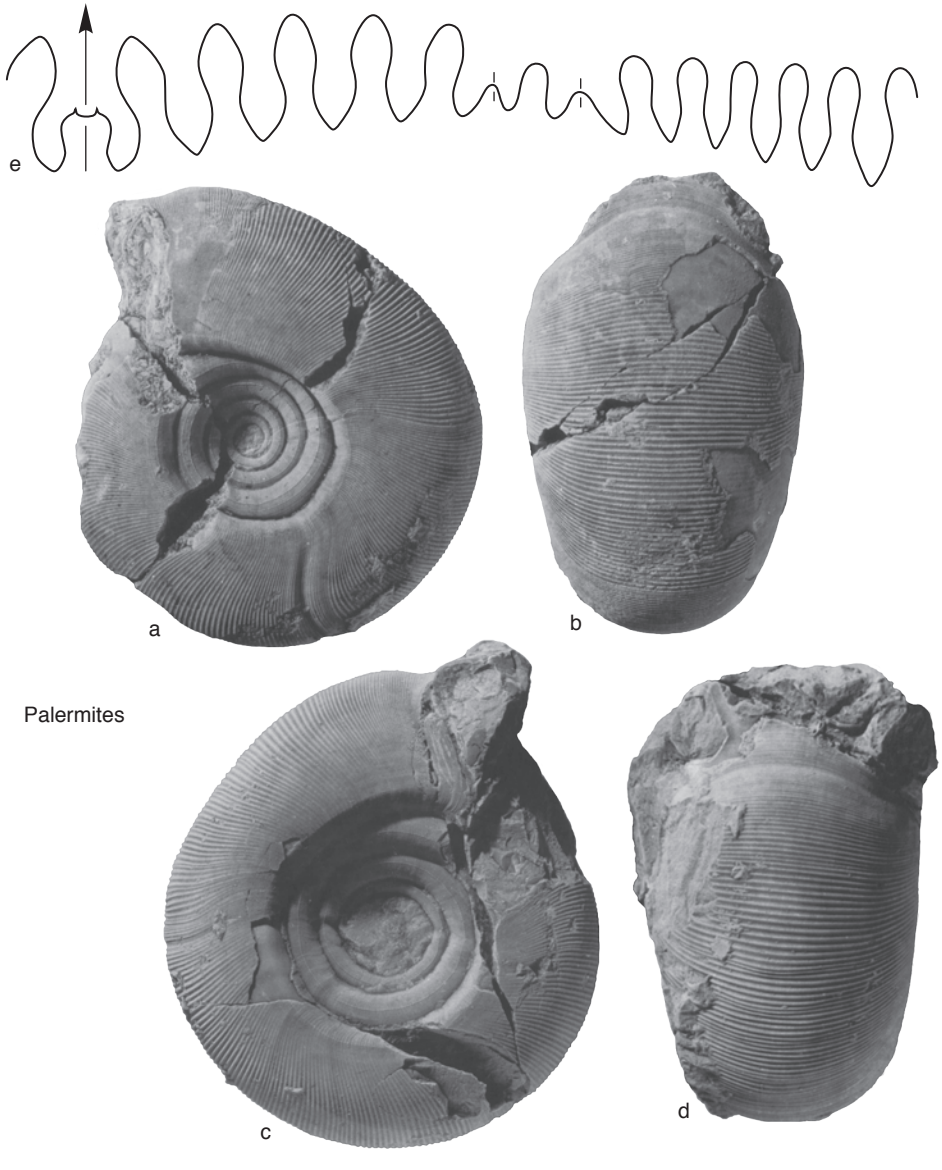

FIG. 81. Adrianitidae (p. 131).

flare (expansion) that extends ultimate peristome as ventrolateral lappets. Characterized by moderate and uniformly arched sutural trace with six or seven pairs of external lateral lobes to umbilical shoulder. Four species. *Cisuralian (Artinskian [Yakhtashian])–Guadalupian (Wordian):* Italy (Sicily), Tunisia (?Djebel Tebaga), Ukraine (Crimea), Tajikistan (Pamir), Iraq (Kurdistan), Oman, ?Malaysia, China (?Jilin, ?Xizang), USA (?Texas).——FIG. 78,*3a–c*. **S. insignis* (GEMMELLARO), Sosio limestone, Sicily; *a–b,* lectotype (herein), MGUP 84 of GEMMELLARO (1887, pl. 6,*8–9*), ×2; *c*, topotype, MGPU I2866, Canavari Collection (GRECO, 1935, pl. 14,*12a,b*), Rocca di Salomone, diameter at 16 mm (new).

Veruzhites LEONOVA, 1988, p. 33 [**V. pamiricus;* OD]. Similar to *Crimites* in globular conch form and number of lobes, but narrower (W/D, 0.6 at maturity) and differing in possession of anomalously high secondary ventral saddle and ventral prongs of width subequal to adjacent first lateral lobe.

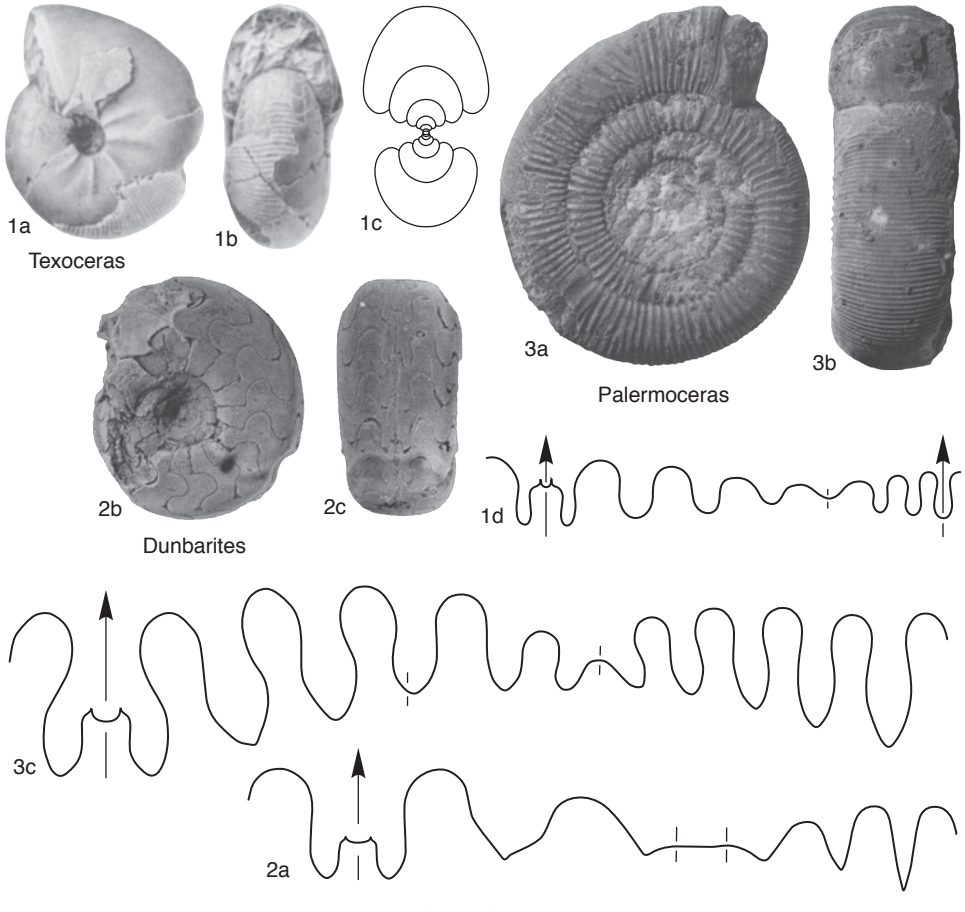

FIG. 82. Adrianitidae (p. 134–135).

One species. *Cisuralian (Artinskian [Yakhtashian]–Kungurian [Bolorian]):* Tajikistan (Pamir).——FIG. 79,*1a–d. *V. pamiricus*, Bolorian, southeastern Pamir; *a–c*, ×1.5 (Leonova, 1988); *d*, diameter at 14 mm (modified by C. Spinosa, adapted from Leonova, 1988).

Subfamily DUNBARITINAE Miller, Furnish, & Schindewolf, 1957

[Dunbaritinae MILLER, FURNISH, & SCHINDEWOLF, 1957, p. 67]
[=Dunbaritidae RUZHENTSEV, 1960d, p. 229]

Rare, aberrant, discoidal adrianitids characterized by combination of evolute conch form and few (10) lobes. Sutural formula: (V_1V_1)LU:U^{1}ID [Russian]. [Adrianitoidean affinites are indicated by basic sutural formula and incipient denticulation (unrecorded previously) of secondary umbilical saddle (U/U^1). The conch form and the nature of the constrictions are unique.] *Pennsylvanian (Moscovian–Gzhelian).*

Dunbarites MILLER & FURNISH, 1940c, p. 532 [**Paralegoceras rectilaterale* MILLER, 1930, p. 402; OD]. Whorl section quadrate with rounded ventrolateral shoulders and relatively flat flanks and venter. Constrictions on internal mold radial from umbilicus to midflank, where they deepen into conspicuous conical pit and steeply arched forward on ventrolateral flank, and transverse or with shallow backward sag across venter. Secondary umbilical saddle faintly crenulate, commonly with discernible secondary lobe at crest. Two named species. *Pennsylvanian (Moscovian–Gzhelian):* USA (western Texas, Oklahoma).——FIG. 82,*2a. *D. rectilateralis*

(MILLER), Gaptank Formation, Virgilian, western Texas, lectotype (herein), YPM 12934A, diameter at 10 mm (Miller & Furnish, 1940c).——FIG. 82,*2b–c. D.* n. sp., Desmoinesian, Wewoka Formation, SUI 48683, ×3 (new).

Subfamily PALERMOCERATINAE new subfamily

[Palermoceratinae ZHOU & GLENISTER, herein] [=Hoffmanniinae MOJSISOVICS, 1888, p. 20; =Hoffmanninae (*sic*) SPATH, 1934, p. 16, first formal usage; =Hoffmanniidae PLUMMER & SCOTT, 1937, p. 359; RUZHENTSEV, 1960d, p. 229] [type genus, *Palermoceras* ZHOU & GLENISTER, herein, p. 135]

Narrow, widely evolute adrianitids with strong ribs. *Guadalupian (Wordian).*

Palermoceras ZHOU & GLENISTER, *nom. nov.* herein, p. 218, *pro Hoffmannia* GEMMELLARO, 1887, p. 49; LEONOVA, 2002, p. 65, junior homonym, ICZN *Code* Article 52; *non* HEINEMANN & WOCK, 1877, modern moth insect; *nec* FORCART, 1953, modern Gastropoda, Mollusca [**Adrianites (Hoffmannia) Hoffmanni* GEMMELLARO, 1887, p. 49; OD]. Conch small (2–3 cm at maturity), thinly discoidal (W/D, 0.4), umbilicus wide (U/D, 0.5), whorls with uniformly rounded umbilical walls. Numerous strong ribs are directly transverse across umbilical wall, doubling in number on venter through both bifurcation and intercalation near umbilical shoulder, and forming low ventral salient. Sutural trace arched with five pairs of external lateral lobes and four pairs of internal laterals. Two named species. [The assignment of *Hoffmannia burgensis* GEMMELLARO, 1888, to the genus is doubtful.] *Guadalupian (Wordian):* Italy (Sicily), USA (?Texas).——FIG. 82,*3a–c. *P. hoffmanni* (GEMMELLARO), Sosio limestone; *a–b,* lectotype (herein), MGUP 78A of GEMMELLARO (1887, pl. 7,*1,3*), ×2; *c,* topotype, MGUP 79 of GEMMELLARO (1888, pl. C,*18;* presence of two additional pairs of lobes illustrated by GEMMELLARO in internal suture close to umbilical seam has not been verified), diameter approximately 20 mm (new).

Subfamily TEXOCERATINAE Ruzhentsev & Bogoslovskaia, 1978

[Texoceratinae RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 87]

Distinctive, compressed, involute adrianitids, lacking lappets, and characterized by lobes that are parallel-sided and rounded at base. [The scalloped sculpture of *Texoceras* has been interpreted (RUZHENTSEV & BOGOSLOVSKAIA, 1978) to justify inclusion of *Doryceras* within the subfamily and to indicate ancestry in *Emilites*. Although sutures are generally similar, neither genus is considered more closely related than implied by common familial assignment (the crenulate growth lines of type *Doryceras* are unlike the scallops of *Texoceras*), and the single unique feature of *Texoceras* is the shape of the lobes.] *Guadalupian (Roadian).*

Texoceras MILLER & FURNISH, 1940a, p. 110 [**Agathoceras (sic) texanum* GIRTY, 1908, p. 501; OD]. Conch 2–3 cm at maturity, compressed (W/D, 0.5) with small umbilicus (U/D, 0.2). Growth lines and coarse dorsolateral plications are directly transverse. Growth lines characterized by prominent scallops whose cusps extend forward and coalesce with those that precede them to form fine longitudinal lirae. Mature modifications comprise deep subterminal constriction and flared ultimate peristome, without lappets. All lobes rounded at base, most are parallel sided; sutural trace directly transverse, formula: $(V_1V_1)LUU^3{:}U^2U^1ID$ [Russian]. One species. *Guadalupian (Roadian):* USA (western Texas), China (?Xizang).——FIG. 82,*1a–d. *T. texanum* (GIRTY), Bone Spring Limestone, western Texas; *a–b,* ×1.33; *c,* diameter at 15 mm; *d,* diameter at 16 mm (Miller, Furnish, & Schindewolf, 1957).

SHUMARDITOIDEA

BRIAN F. GLENISTER,[1] WILLIAM M. FURNISH,[2] and ZHOU ZUREN[3]

[[1]retired, formerly of the University of Iowa; [2]deceased, formerly of the University of Iowa;
[3]Nanjing Institute of Geology and Palaeontology]

Superfamily SHUMARDITOIDEA Plummer & Scott, 1937

[*nom. transl.* BASSE, 1952, p. 581, *ex* Shumarditidae PLUMMER & SCOTT, 1937, p. 287]

Conch relatively narrow, evolute to involute, and without strong ornament. Basic sutural formula: $(V_1V_1)(L_2L_1L_2)U{:}(I_2I_1I_2)D$ [Russian], $(E_1E_mE_1)ALUI$ [German]. Dorsal lobe (D) deeply trifid in all but ancestral forms and rare terminal paedomorphs. Sutural phylembryogenesis involved tripartition of the umbilical lobe (U) in advanced Parashumarditidae and all of the descendant Perrinitidae, and development of strongly denticulate lobes that diverge to narrow crests of intervening saddles in advanced Perrinitidae. *Pennsylvanian (Moscovian)–Guadalupian (Roadian)*.

Family SOMOHOLITIDAE Ruzhentsev, 1938

[Somoholitidae RUZHENTSEV, 1938, p. 280]

Probable ancestral Shumarditoidea, with evolute conch, and with longitudinal lirae dominant in all but terminal representative (*Neoshumardites*). Narrow ventral prongs and all remaining sutural elements except the umbilical lobe (U) are medially inflated to prominently pouched. Sutural formula: $(V_1V_1)LU{:}ID$ [Russian], $(E_1E_mE_1)ALUI$ [German]. Evolutionary succession probably: *Somoholites* (Moscovian–Artinskian) > *Andrianovia* (?Asselian, Sakmarian) > *Neoshumardites* (Artinskian). *Pennsylvanian (Moscovian [Desmoinesian])–Guadalupian (Roadian).*

Somoholites RUZHENTSEV, 1938, p. 280 [**Gastrioceras beluense* HANIEL, 1915, p. 54; OD]. Somoholitids characterized by combination of strong longitudinal lirae and lobes (except U) that are inflated medially, but not to the extent of developing paired pouches. Thirteen named species. *Pennsylvanian (Moscovian [Desmoinesian])–Cisuralian (Artinskian [Aktastinian Substage]):* Indonesia (Timor), USA (Texas, Oklahoma, Kansas, Missouri, Ohio, Pennsylvania, Nevada, Oregon), Canada (Arctic Archipelago: Ellesmere Island, Yukon), Kazakhstan (Southern Urals), Russia (Urals, Verkhoian, Okhotskii Massif), Tajikistan (Pamir), China (Xinjiang, Guizhou).——FIG. 83,*3a–c. *S. beluensis* (HANIEL), Somohole beds, Asselian–Sakmarian, Timor; *a–b,* ×1; *c,* diameter at 30 mm (Saunders, 1971).

Andrianovia BOARDMAN, WORK, & MAPES, 1994, p. 49 [**Preshumardites sakmarae* RUZHENTSEV, 1938, p. 283; OD]. Somoholitids characterized by combination of strong longitudinal lirae and external lateral lobe, internal lateral lobe and dorsal lobe (L, I, D) are strongly pouched medially. Three named species. *Cisuralian (?Asselian, Sakmarian):* Russia (Southern Urals, Verkhoian), Kazakhstan (Southern Urals), Indonesia (?Timor).——FIG. 83,*2a–c. *A. sakmarae* (RUZHENTSEV), Sakmarian; *a–b,* ×0.67; *c,* diameter approximately 13 mm (Ruzhentsev, 1951).

Neoshumardites RUZHENTSEV, 1936b, p. 1084 [**N. triceps;* OD]. Somoholitids that lack longitudinal sculpture. Suture generally similar to *Andrianovia*, but pouching of external lateral, internal lateral, and dorsal lobes (L, I, D) less strongly developed (degree to which this is a function of ontogeny is uncertain), and internal lobes much narrower. Three named species. *Cisuralian (Sakmarian)–Guadalupian (Roadian):* Russia (Southern Urals, Verkhoian), Canada (Northwest Territories).——FIG. 83,*1a–c. *N. triceps; a–b,* ×0.67; *c,* diameter approximately 40 mm (Ruzhentsev, 1956b).

Family PARASHUMARDITIDAE Boardman, Work, & Mapes, 1994

[Parashumarditidae BOARDMAN, WORK, & MAPES, 1994, p. 55]

Evolute shumarditoideans characterized by symmetry of subdivisions as primary internal lateral lobe (I) evolved from tridentate to incipiently trifid ($I_{2(v)}I_1I_{2(d)}$): inner (dorsal) subdivision of I, i.e., ($I_{2(d)}$), is larger than outer two subdivisions ($I_{2(v)}$ and I_1), and secondary saddle of that dorsal subdivision ($I_1/I_{2(d)}$) is slightly to much higher than saddle that bounds the ventral subdivision ($I_{2(v)}/I_1$). Primary external lateral and umbilical lobes (L and U) also changed from tridentate (L) or undivided (U) to trifid in the course of evolution. Prongs of ventral lobe (V_1V_1) generally

simple (undivided), but may be bidentate. *Pennsylvanian (Moscovian–Gzhelian [Desmoinesian–Virgilian]).*

Parashumardites Ruzhentsev, October 19, 1939b, p. 851 [**Shumardites senex* Miller & Cline, 1934a, p. 184; OD] [=*Subshumardites* Schindewolf, post November 7, 1939a, p. 440 (type, *Shumardites fornicatus* Plummer & Scott, 1937, p. 300, OD)]. Parashumarditids distinguished by undivided prongs (V_1) in the ventral lobe, and by tripartition ($U_2U_1U_2$) of the umbilical lobe. Sutural formula: $(V_1V_1)(L_2L_1L_2)U_2U_1{:}U_2(I_2I_1I_2)D$ [Russian]. Five named species. *Upper Pennsylvanian*: USA (Texas, Oklahoma), Canada (Arctic Archipelago: Ellesmere Island), *Missourian–Virgilian;* Russia (Southern Urals, Moscow Basin), *Kasimovian*.——Fig. 84,*1a–d. *P. senex* (Miller & Cline), Missourian, Oklahoma; *a–c,* lectotype, Nellie Bly Formation, SUI 641B (Nassichuk, 1969, p. 126), ×1 (new); *d*, hypotype, Quivira Shale, SUI 62490, diameter at 37 mm (new, courtesy of D. M. Work & W. B. Saunders).——Fig. 84,*1e. P. eurinus* Ruzhentsev, Zhigulian, Pennsylvanian, Southern Urals, height at 11 mm, diameter ranging from 30 to 35 mm (Ruzhentsev, 1950).

Aktubites Ruzhentsev, 1955b, p. 1108 [**A. trifidus;* OD]. Ancestral parashumarditids characterized by combination of undivided prongs of ventral lobe (V_1), undivided primary umbilical lobe (U), and only incipient tripartition of the primary external lateral and internal lateral lobes (L and I). Sutural formula: $(V_1V_1)(L_2L_1L_2)U{:}(I_2I_1I_2)D$ [Russian]. One species. *Pennsylvanian (Moscovian):* Kazakhstan (Southern Urals), Russia (Verkhoian), Spain; USA (Oklahoma, Ohio, Texas), *Middle Pennsylvanian (Desmoinesian)*.——Fig. 85,*2a–c. *A. trifidus*, Moscovian, Southern Urals; *a–b,* ×1.33; *c,* diameter approximately 25 mm (Ruzhentsev, 1955b).

Eoshumardites Y. Popov, 1960, p. 84 [**Shumardites (E.) lenensis* Popov, 1960, p. 85; OD]. Conch proportions as in *Parashumardites;* paths of fine ribs and constrictions almost directly transverse, but display slight variation. General form of suture also closely similar to *Parashumardites,* especially in degree of tripartition and asymmetry of subdivisions in primary external and internal lateral lobes (L and I). However, primary umbilical lobe (U) remained undivided; diagnostically, prongs of ventral lobe are bidentate, the dorsal denticle being deeper than corresponding ventral denticle. Sutural formula: $(V_1V_1)(L_2L_1L_2)U{:}(I_2I_1I_2)D$ [Russian]. One or two species. [The latter relationship is duplicated only rarely in Goniatitina. *Eoshumardites* is interpreted as an aberrant terminal endemic. Two of the named species are from the same sample, and sutures in the 1960 and 1970 papers are slightly different interpretations of the same specimens. Y. Popov (1960) suggested possible dimorphism, expressed as slightly different conch form and slight differences in growth lines across venter.] *Pennsylvanian (?Moscovian):* Russia (northern Verkhoian).——Fig. 84,*2a–c. *E. lenensis; a–b,* plastoholotype, Tiksin Formation, SUI 35153 (holotype, 52/8717 of Popov, 1970), ×0.67; *c*, composite based on plastoholotype, reinterpretation of published sutures (Popov, 1970, fig. 25–26), and topotypes PIN 4473/18 and 4473/19, diameter ranging 25–45 mm (new).

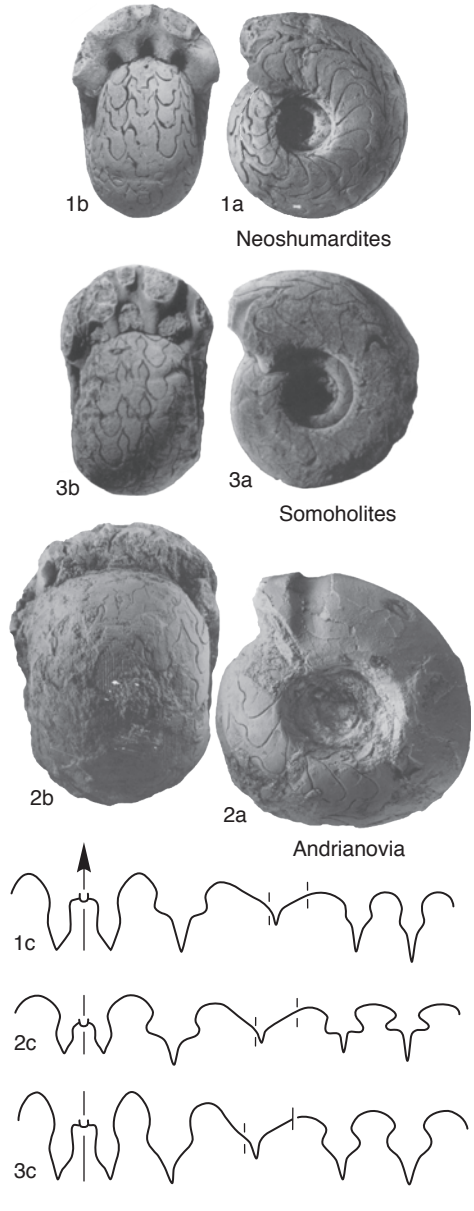

Fig. 83. Somoholitidae (p. 136).

Eovidrioceras Boardman, Work, & Mapes, 1994, p. 55 [**E. inexpectans;* OD]. Parashumarditids of

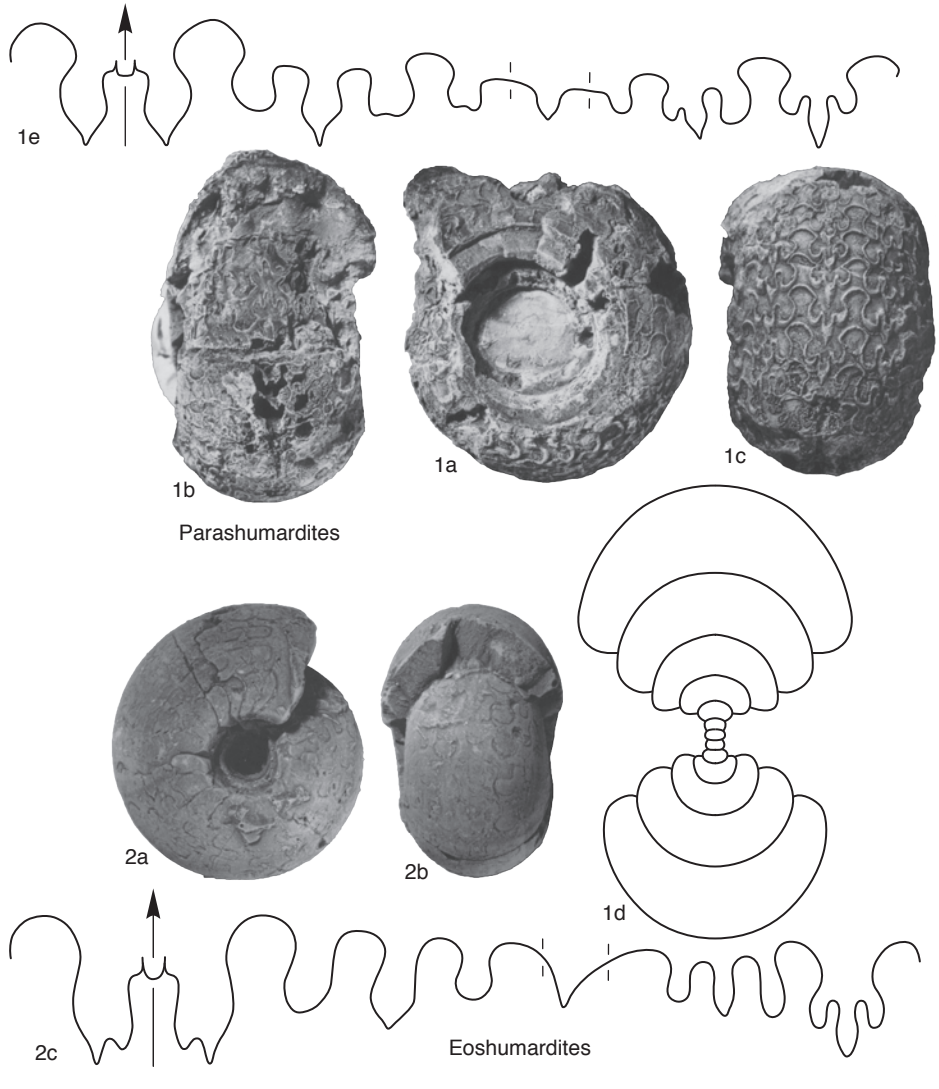

FIG. 84. Parashumarditidae (p. 137).

intermediate sutural advancement, characterized by combination of undivided prongs of ventral lobe (V_1), nearly complete isolation of the three subdivisions of both the primary external and internal lateral lobes (L and I), and undivided primary umbilical lobe (U). Sutural formula: $(V_1V_1)(L_2L_1L_2)$ U:$(I_2I_1I_2)$D [Russian]. Inner (dorsal) subdivision of the internal lateral lobe ($I_{2(d)}$) is significantly larger than the two remaining subdivisions of I, and secondary saddle $I_1/I_{2(d)}$ is much higher than saddle $I_{2(v)}/I_1$. Two species. [The juvenile sutures of the ancestral (Virgilian) vidrioceratid *Vidrioceras conlini* (MILLER & DOWNS, 1950a) are virtually identical to those of mature (Missourian) *Eovidrioceras inexpectans* (BOARDMAN, WORK, & MAPES, 1994), affording strong evidence that this parashumarditid genus represents the direct ancestor of the Vidrioceratidae and ultimately the entire Cycloloboidea.] *Upper Pennsylvanian:* USA (Oklahoma), *Missourian*; Uzbekistan (southern Fergana: Karachatyr Range), *Pennsylvanian (Gzhelian)* [Gzhelian *fide* A. V. POPOV, 1992, but BOARDMAN, WORK, & MAPES (1994) suggest Kasimovian on overall faunal analysis].——FIG. 85,*1a–c.* **E. inexpectans*, Dewey Formation, Oklahoma; *a–b,* ×2; *c,* diameter at 14 mm (Boardman, Work, & Mapes, 1994).

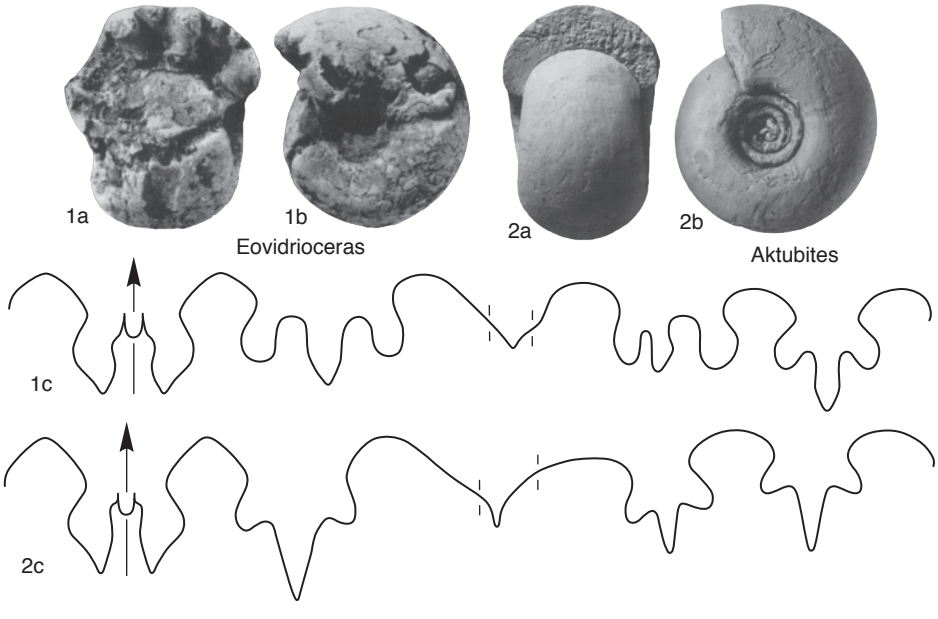

FIG. 85. Parashumarditidae (p. 137–139).

Family SHUMARDITIDAE Plummer & Scott, 1937

[Shumarditidae PLUMMER & SCOTT, 1937, p. 287]

Evolute shumarditoideans (Umin/D, 0.25–0.5), possibly derived from the ancestral somoholitid *Somoholites* but differing in absence of longitudinal sculpture (lirae) and in possession of broader ventral lobe with higher secondary ventral saddle. External lateral lobe evolved from pouched to fully trifid ($L > L_2L_1L_2$). Internal lateral lobe simple (but with median inflation) to incipiently trifid, the latter with diagnostic asymmetry: i.e., where lobe is divided, outer (ventral) subdivision ($I_{2(v)}$) is larger than dorsal ($I_{2(d)}$), and secondary saddle of the ventral subdivision ($I_{2(v)}/I_1$) is higher than secondary saddle that bounds the dorsal subdivision ($I_1/I_{2(d)}$). Primary umbilical lobe (U) remained undivided, or (rarely) notched dorsally. Dorsal lobe (D) simple, with median inflation, to conspicuously tridentate. External lobes may be bidentate in advanced representatives. Evolutionary succession: *Preshumardites* (Missourian) >*Pseudaktubites* (Missourian–Virgilian) > *Shumardites* (Virgilian). *Pennsylvanian (Kasimovian–Gzhelian [Missourian–Virgilian]).*

Shumardites SMITH, 1903, p. 134 [**S. simondsi;* OD] [=*Postaktubites* RUZHENTSEV, 1955b, p. 1108 (type, *Shumardites cuyleri* PLUMMER & SCOTT, 1937, p. 297, OD)]. Advanced shumarditids characterized by incipient bipartition of prongs of the ventral lobe (V_1), near or complete isolation of the three subdivisions of the lateral lobe ($L_2L_1L_2$), and by umbilical lobe that is either entire or notched by shallow crenulation near umbilical seam. Sutural formula: $(V_1V_1)L_2L_1L_2U{:}(I_2I_1I_2)D$ [Russian]. Five named species. *Upper Pennsylvanian:* USA (Texas), *Virgilian;* Kazakhstan (Southern Urals), Russia (Southern Urals, Moscow Basin), *Gzhelian.*——FIG. 86*a–b*. **S. simondsi*, Wayland Shale, Virgilian, northcentral Texas; *a,* diameter at 25 mm (Miller & Downs, 1950a); *b,* diameter at 56 mm (estimated) (Boardman, Work, & Mapes, 1994).——FIG. 86*c–f. S. cuyleri* (PLUMMER & SCOTT), Virgilian, northcentral Texas; *c–d,* Finis Shale, ×1 (Miller & Downs, 1950a); *e,* height at 25 mm (estimated) (Boardman, Work, & Mapes, 1994); *f,* hypotype, Bluff Creek Shale, SUI 55646, diameter at 50 mm (new, courtesy of D. M. Work & W. B. Saunders).

Preshumardites PLUMMER & SCOTT, 1937, p. 288 [**Gastrioceras gaptankense* MILLER, 1930, p. 401; OD]. Ancestral shumarditids characterized by

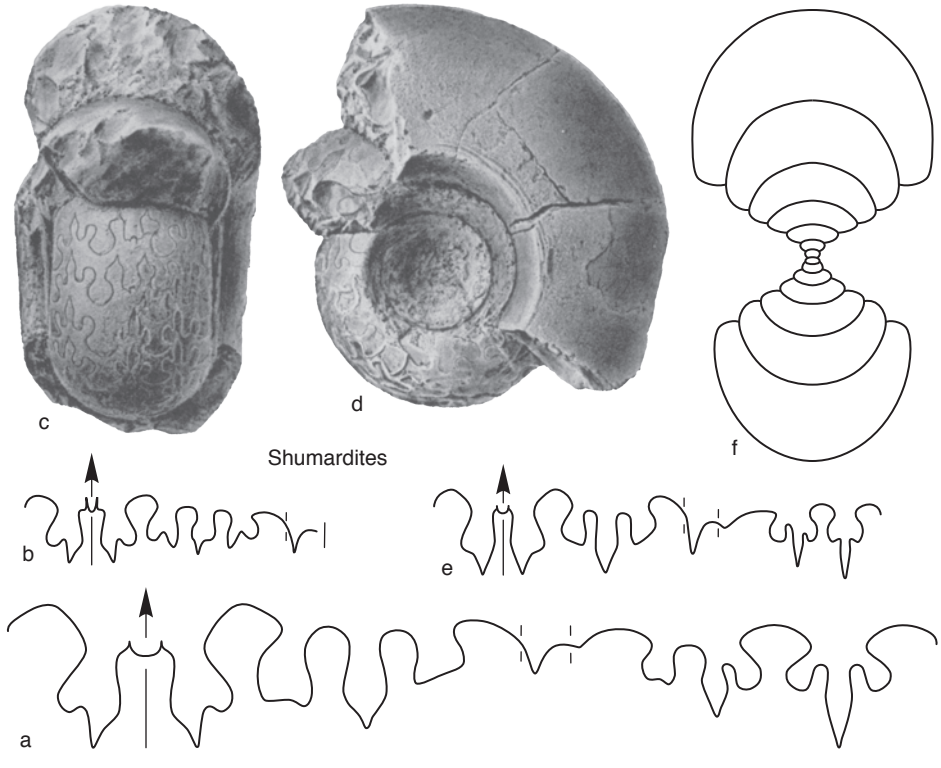

FIG. 86. Shumarditidae (p. 139–140).

external lateral lobe, internal lateral lobe, and prongs of ventral lobe (L, I, and V_1) that are conspicuously inflated medially but do not form lateral pouches. Sculpture restricted to growth lamellae that trace broad ventral salient (i.e., longitudinal lirae not developed). Three species. *Upper Pennsylvanian (Kasimovian):* USA (western and northcentral Texas, Kansas, Missouri, Illinois, Pennsylvania).——FIG. 87,*2a–e. *P. gaptankensis* (MILLER); *a–d,* Wolf Mountain Shale, Graford Formation, northcentral Texas; *a,* ×3; *b–c,* ×1.5 (Boardman, Work, & Mapes, 1994); *d*, hypotype, SUI 55600, diameter at 56 mm (new, courtesy of D. M. Work & W. B. Saunders); *e*, Gaptank Formation, western Texas, height at 15 mm, diameter about 35–40 mm (Saunders, 1971).

Pseudaktubites BOARDMAN, WORK, & MAPES, 1994, p. 50 [**Preshumardites stainbrooki* PLUMMER & SCOTT, 1937, p. 292; OD]. Shumaridtids of intermediate sutural complexity in which both external and internal lateral lobes (L and I) have prominent lateral pouches but do not achieve incipient trifurcation. Two species. *Upper Pennsylvanian:* USA (Texas, Oklahoma, Kansas).——FIG. 87,*1a–d. *P. stainbrooki* (PLUMMER & SCOTT), Colony Creek Shale, Caddo Creek Formation, Virgilian, northcentral Texas; *a–c,* ×2; *d,* diameter approximately 48 mm (Boardman, Work, & Mapes, 1994).

Family PERRINITIDAE Miller & Furnish, 1940

[Perrinitidae MILLER & FURNISH, 1940a, p. 137] [=Shumarditidae PLUMMER & SCOTT, 1937, p. 287, *partim*; RUZHENTSEV in BOGOSLOVSKII, LIBROVICH, & RUZHENTSEV, 1962, p. 388; =Paraperrinitinae THARALSON, 1984, p. 822, *non* TOUMANSKAIA, 1939]

Relatively involute shumarditoideans in which the primary external, umbilical, and internal lobes (L, U, I) are fully tripartite. Lobes characteristically diverge to narrow crests of adjacent saddles and are strongly subdivided in the most advanced forms. Evolutionary succession: *Properrinites* (Asselian–Artinskian) > *Metaperrinites* (Artinskian–Kungurian) > *Perrinites* (Artinskian–Roadian). [THARALSON (1984) proposed the subfamily Paraperrinitinae as differing from

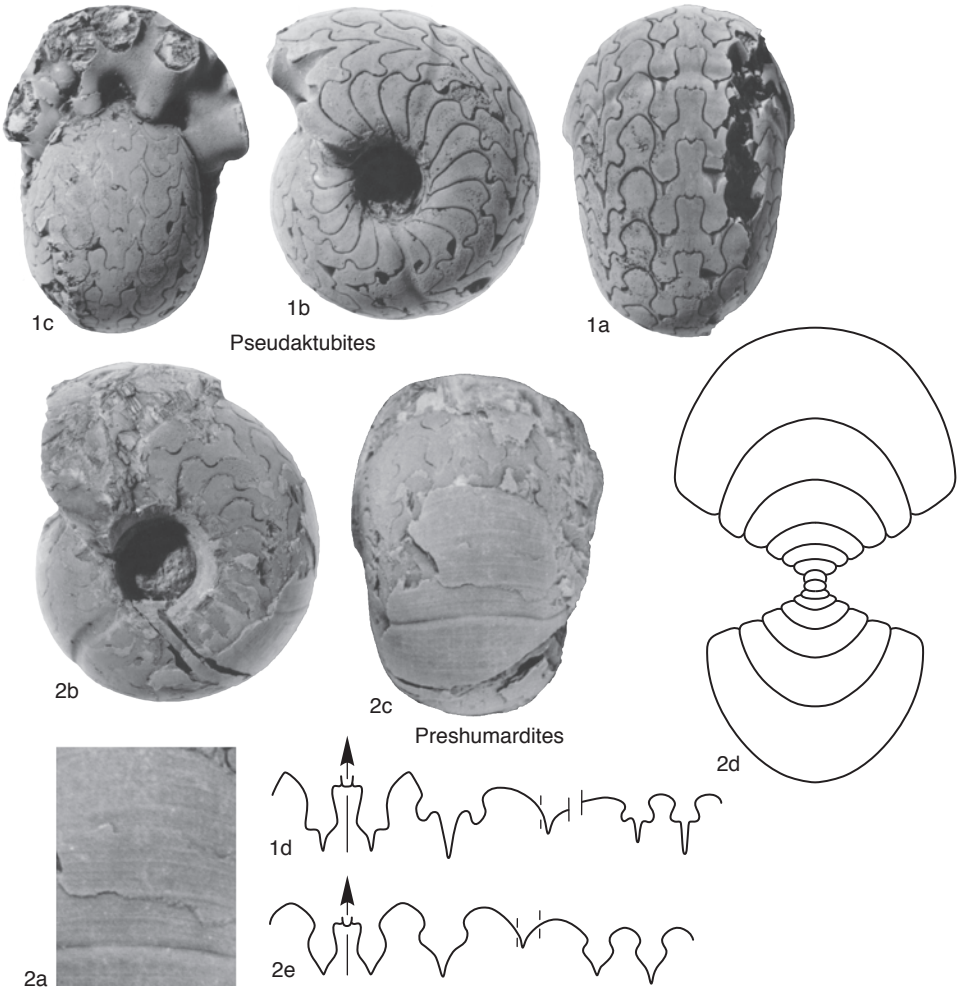

FIG. 87. Shumarditidae (p. 140).

the Perrinitinae in complete subdivision of the third internal lateral lobe. However, as the author acknowledged (THARALSON, 1984, p. 809), large specimens of the most advanced perrinitin species (e.g., *Perrinites vidriensis* BÖSE, 1919) may display incipient subdivision of the third internal lateral lobe into two lobes. Consequently, any possible differentiation of the two subfamilies would involve difficult and complex analysis of interaction of ontogenetic and evolutionary development. The classification scheme proposed by THARALSON therefore appears unrealistic and is rejected herein. Derived from advanced Pennsylvanian parashumarditids (BOARDMAN, WORK, & MAPES, 1994; compare Fig. 89*d* and Fig. 84,*1e* herein).] *Cisuralian (Asselian)–Guadalupian (Roadian).*

Perrinites BÖSE, 1919, p. 155 [**P. vidriensis;* OD] [=*Perrimetanites* LEONOVA, 1983, p. 51 (type, *P. progressus*, OD)]. Advanced perrinitids that achieved conch diameters as great as 30 cm; at moderate size, whorls are equidimensional (H/W, 0.7–1.25), umbilicus small (Umin/D, 0.05–0.2), and hyponomic sinus deep. Mature sutures display

3 or 4 discrete first-order subdivisions on ventral flank of each prong of ventral lobe (V_1), and 3 or 4 prominent subdivisions on each flank of dorsal lobe (D); second-order subdivisions are common in external sutures of large specimens. Umbilical lobe complex is somewhat variable, but formula commonly $(V_1V_1)L_2L_1L_{2.1}L_{2.2}U_2(U_{1.2}U_{1.1}):(U_{2.2}U_{2.1})(I_{2.2}I_{2.1})I_1I_2D$ [Russian]. Six named species. [Ventral bifurcation ($I_{2.2}$) of the third dorsolateral lobe (I_2) is almost completely suppressed in advanced species.] *Cisuralian (Artinskian)–Guadalupian (Roadian):* Americas (widespread from Venezuela and Colombia to Idaho), Tajikistan (Pamir), Ukraine (?Crimea), Afghanistan (Bamyan Mountains), China (Xinjiang, Qinghai), Thailand (Saraburi Area, including Muak Lek), Indonesia (Timor).——Fig. 88,*2a. *P. vidriensis*, Cathedral Mountain Formation, western Texas, diameter at 23 mm (Tharalson, 1984).——Fig. 88,*2b–d. P. hilli*, Kungurian–Roadian, Texas; *b–c,* Leonard Formation, western Texas, ×1.33; *d*, Blaine Formation, northcentral Texas, diameter at 65 mm (Miller & Furnish, 1940a).

Metaperrinites Ruzhentsev, 1950, p. 166 [**Properrinites cumminsi vicinus* Miller & Furnish, 1940a, p. 143; OD] [=*Paraperrinites* Tumanskaia, 1939, p. 17 (type, *Perrinites Brouweri* Smith, 1927a, p. 55; OD: the type designated by Smith, 1927a, p. 55, pl. 14,*1–2*, i.e., holotype *fide* ICZN *Code* Article 73(a)(i) is a marathonitid), *sensu* Tharalson, 1984, p. 827, *partim*; =*Shuangyangites* Liang, 1982, p. 650 (type, *S. involutus,* OD); =*Mapirites* Leonova, 1983, p. 44 (type, *M. latumbilicatus,* OD); =*Shyndoceras* Leonova, 1983, p. 47 (type, *S. obsoletum,* OD); =*Nepirrites* Leonova, 1983, p. 48 (type, *N. medius,* OD); =*Ripernites* Leonova, 1983, p. 50 (type, *R. pressulus,* OD)]. Perrinitids intermediate and gradational between *Properrinites* and *Perrinites* in size, conch form, depth of hyponomic sinus, and overall complexity of suture. Whorls generally depressed (H/W, 0.7–1.2), and umbilicus variable (Umin/D, 0.1–0.4). Mature sutures display 1–3 first-order subdivisions on ventral flank of each prong of ventral lobe (V_1), dorsal lobe (D) has either one or two prominent notches on each flank; second-order subdivisions generally weakly developed but may occur in all external saddles in advanced species. Both fourth external lateral saddle and fourth internal lateral saddle generally lie beneath but close to alignment of adjacent saddles. Nine named species. *Cisuralian (Artinskian–Kungurian)*: USA (Texas, New Mexico, California, Nevada), Tajikistan (Pamir), Ukraine (?Crimea), China (Guizhou, Guangxi, Jilin, Xinjiang), Thailand (Loei), Indonesia (Timor).——Fig. 88,*1a–c. *M. vicinus* (Miller & Furnish), Clyde Formation, Kungurian, northcentral Texas; *a–b,* ×1.5; *c*, diameter at 55 mm (Miller & Furnish, 1940a).

Properrinites Elias, 1938, p. 102 [**Perrinites Bösei* Plummer & Scott, 1937, p. 307; OD; *non P. plummeri* Elias, 1938, p. 104, by action of Miller & Furnish, 1940a, p. 139; *fide* ICZN *Code* Article 24] [=*Subperrinites* Tharalson, 1984, p. 809 (type, *Perrinites bakeri* Plummer & Scott, 1937, p. 390, OD)]. Ancestral perrinitids of medium size (maximum conch diameter 15 cm) with depressed whorls (H/W, 0.6–0.9), moderate umbilicus (Umin/D, 0.2–0.5), and shallow hyponomic sinus. Mature sutures have a single discrete first-order subdivision on ventral flank of each prong of ventral lobe (V_1) and a dorsal lobe (D) that is prominently trifid; second-order subdivisions are either absent or incipient and confined to first lateral saddle. Crest of fourth external lateral saddle and fourth internal lateral saddle lie beneath general sutural alignment. Sutural formula: $(V_1V_1)L_2L_1(L_{2.1}L_{2.2})U_2U_1:U_2(I_{2.2}I_{2.1})I_1I_2D$ [Russian]. Six named species. *Cisuralian (Asselian–Sakmarian):* USA (Texas, New Mexico, Kansas, Nebraska, Nevada), Canada (Yukon), Tajikistan (Pamir), southern China (Guangxi), Indonesia (Timor).——Fig. 89*a–c. *P. boesei* (Plummer & Scott), Admiral Formation, northcentral Texas; *a–b,* ×2; *c,* diameter at 53 mm (adapted from Tharalson, 1984).——Fig. 89*d–f. P. bakeri*, Lenox Hills Formation, western Texas; *d,* diameter at 8.3 mm; *e,* diameter at 17 mm; *f,* diameter at 50 mm (adapted from Tharalson, 1984).

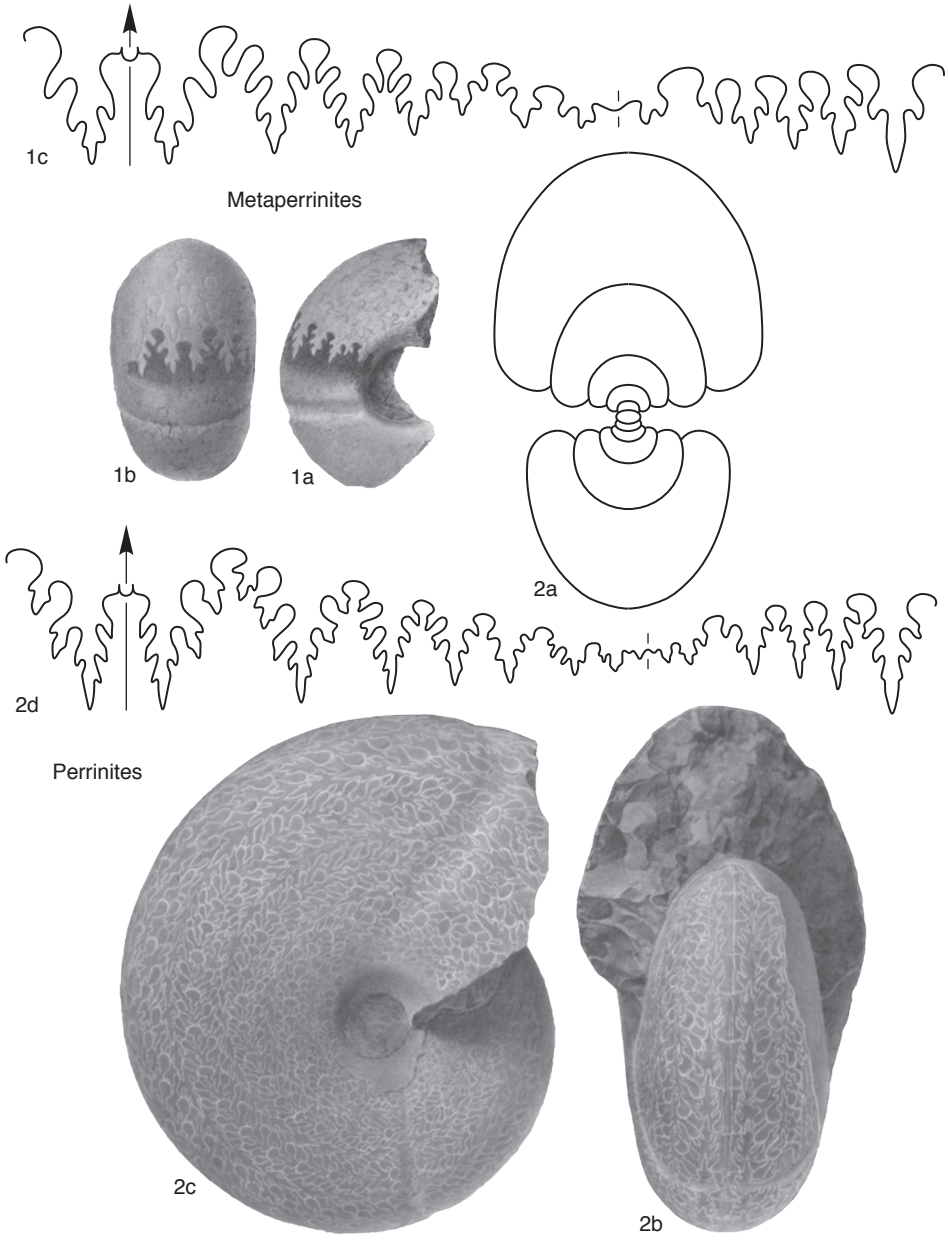

FIG. 88. Perrinitidae (p. 141–142).

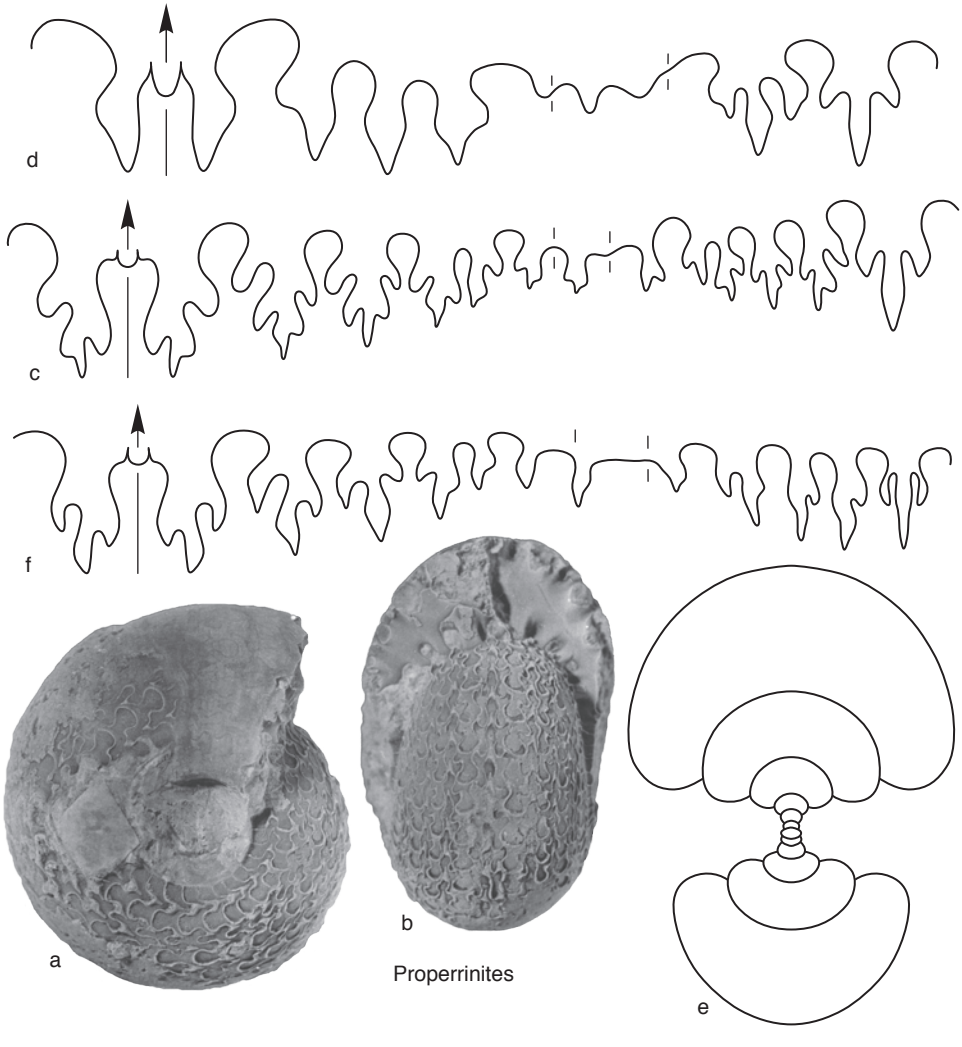

FIG. 89. Perrinitidae (p. 142).

CYCLOLOBOIDEA

BRIAN F. GLENISTER,[1] WILLIAM M. FURNISH,[2] and ZHOU ZUREN[3]

[[1]retired, formerly of the University of Iowa; [2]deceased, formerly of the University of Iowa; [3]Nanjing Institute of Geology and Palaeontology]

Superfamily CYCLOLOBOIDEA Zittel, 1895

[*nom. transl.* MILLER & FURNISH, 1954, p. 687, *ex* Cyclolobidae ZITTEL, 1895, p. 408]

Conch variable, from spherical to lenticular, but commonly broad and large (many greater than 20 cm), with small to closed umbilicus. Ribs and constrictions, when present, are approximately transverse, but commonly trace a lateral salient with median backward sag, and rounded ventral sinus. The basic sutural formula comprises 20 lobes: $(V_1V_1)L_2L_1L_2U_2U_1U_2{:}I_2I_1I_2(D_2D_1D_2)$ [Russian], $(E_1E_mE_1)A_vA_mA_dL_vL_mL_dU_vU_mU_d(I_1I_mI_1)$ [German]. Subdivisions of dorsally situated U_2 usually lie on the umbilical wall, but in rare cases they migrated into internal suture. Total number of lobes may reach 60, due mainly to repeated bifurcation and subsequent full isolation of external lateral lobe and internal lateral lobe lying successively closest to umbilicus. Dorsal lobe broadly tripartite, in most forms, to extent that designation of incipient trifurcation is warranted. Sutural elements are characteristically parallel-sided. Most lobes are bidentate or tridentate in ancestral family, the Vidrioceratidae. However, both lobes and saddles became complexly denticulate during phylogenesis of the descendant Cyclolobidae. [The superfamily evolved from the shumarditoidean family Parashumarditidae, in the late Pennsylvanian, and diversified in the Permian to range throughout that system.] *Pennsylvanian (Gzhelian [Virgilian])–Lopingian (Changhsingian).*

Family VIDRIOCERATIDAE Plummer & Scott, 1937

[Vidrioceratidae PLUMMER & SCOTT, 1937, p. 129] [=Neostacheoceratinae TUMANSKAIA, 1939, p. 18; =Pamiritinae TUMANSKAIA, 1939, p. 18; =Glassoceratinae RUZHENTSEV, 1960d, p. 231; =Peritrochiinae RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 86]

Ancestral cycloloboideans with thickly subdiscoidal to globular conch (W/D, 0.5–1.0). Shell smooth, growth lines approximately transverse; mature peristome commonly modified by constriction and formation of ventrolateral lappets. Total number of lobes increased during phylogenesis from 16 to more than 50. However, note that in the 8-lobed parashumarditid ancestor, *Eovidrioceras*, both the primary external lateral lobe (L) and the primary internal lateral lobe (I) are incipiently trifid, thus: $(V_1V_1)(L_2L_1L_2){:}U(I_2I_1I_2)D$ [Russian]. Denticulation is confined to lobe bases; except for simple lobes near umbilicus, most external lobes are tridentate and internals are bidentate. Dorsal lobe (D) almost invariably broad and deeply trifid. *Pennsylvanian (Gzhelian [Virgilian])–Lopingian (Changhsingian).*

Vidrioceras BÖSE, 1919, p. 146 [**V. Uddeni;* OD] [=*Hypershumardites* A. POPOV, 1992, p. 54 (type, *H. zacharovi*, OD)]. Vidrioceratids in which constrictions form a high, rounded ventral salient. Suture characterized by shallowly to deeply bidentate form of third external lateral lobe. Sutural formula: $(V_1V_1)L_2L_1L_2(U_2U_1U_2){:}I_2I_1I_2D$ [Russian]. Seven named species. *Pennsylvanian (Gzhelian)–Cisuralian (Artinskian):* Russia and Kazakhstan (Southern Urals), Uzbekistan (Fergana: Karachatyr Range), Indonesia (Timor: Artinskian Bitauni beds); USA (Texas, Oklahoma), *Virgilian.*——FIG. 90,*2a–d.* **V. uddeni*, upper Gaptank Formation, western Texas; *a–c,* ×1.33; *d*, diameter at 17 mm (Miller & Furnish, 1940a).——FIG. 90,*2e.*

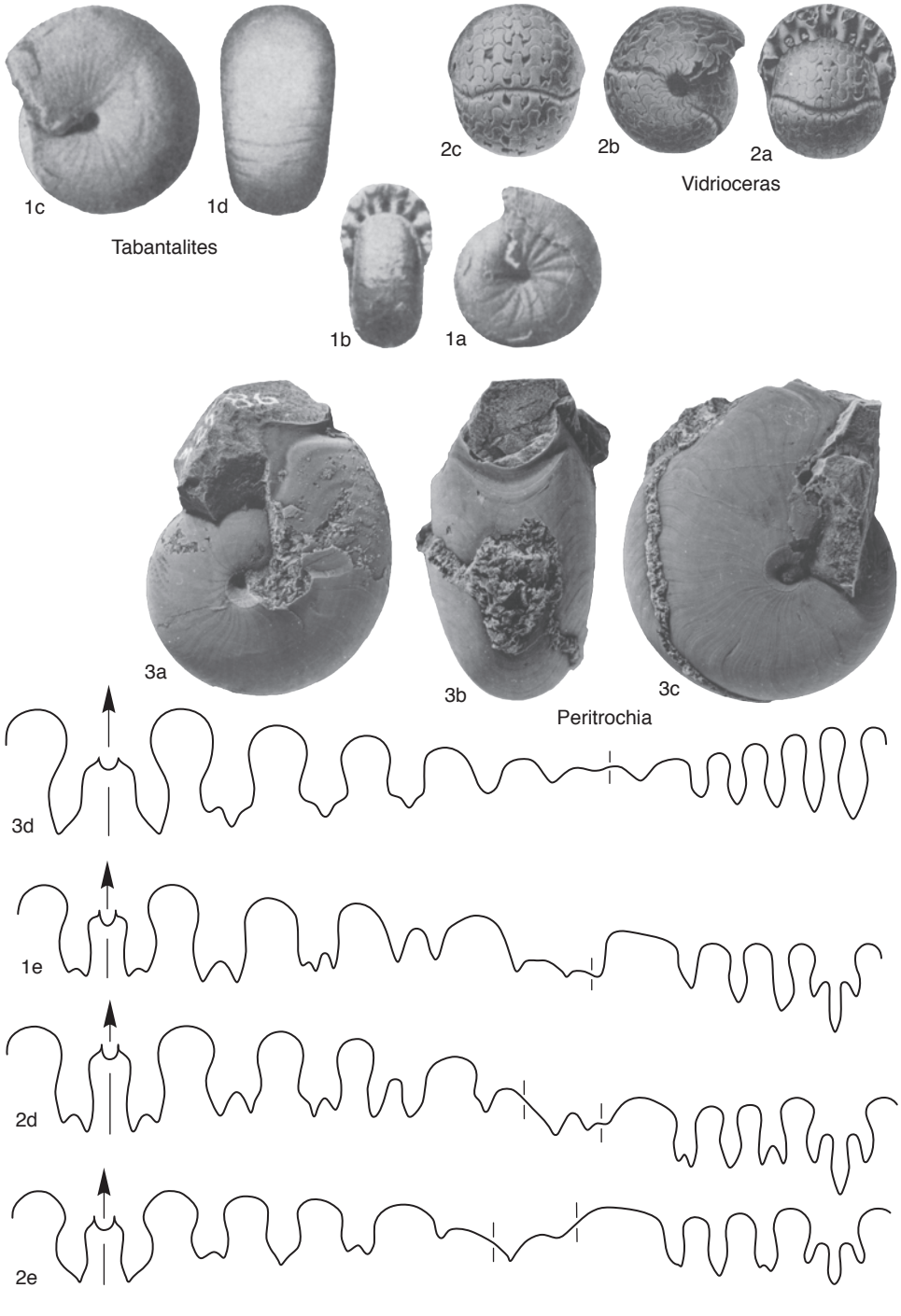

FIG. 90. Vidrioceratidae (p. 145–150).

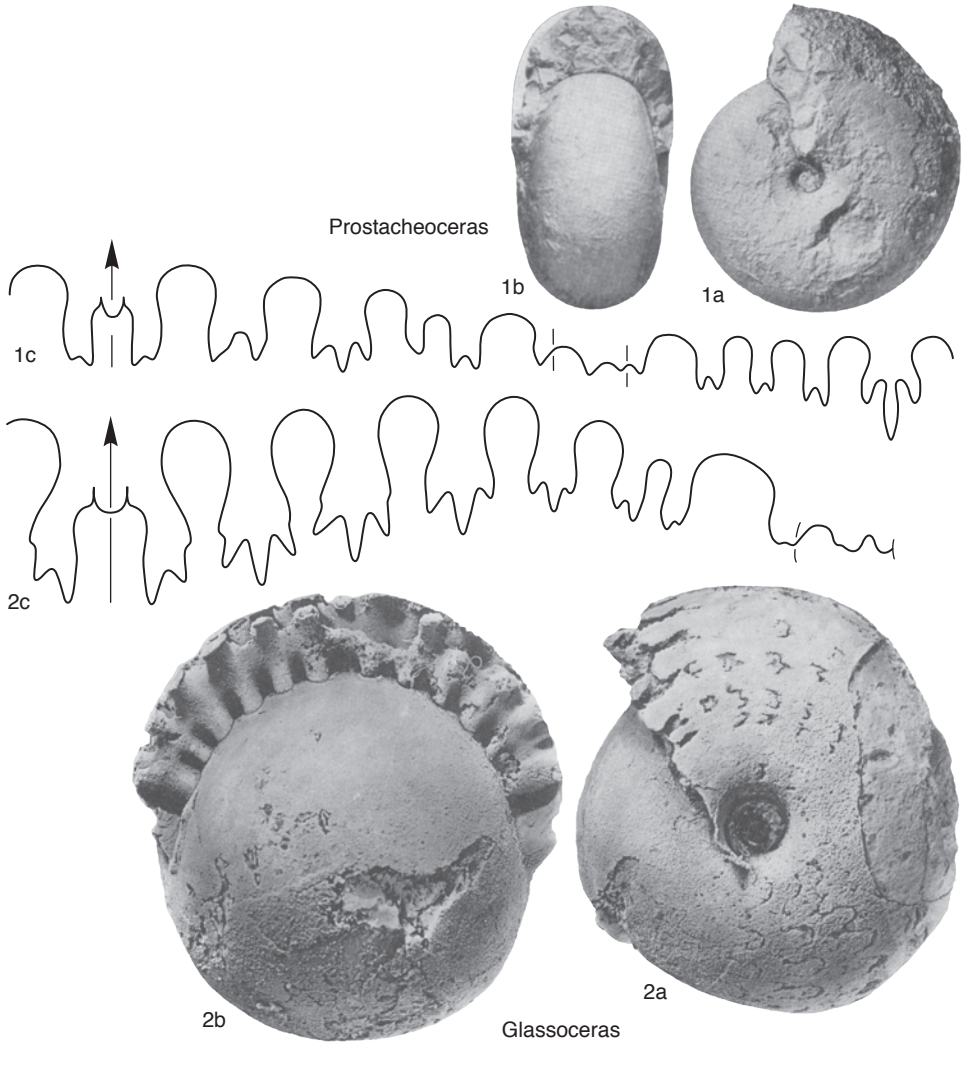

FIG. 91. Vidrioceratidae (p. 147–149).

V. borissiaki RUZHENTSEV, Gzhelian, Southern Urals, height at 8.3 mm, diameter approximately 17 mm (Ruzhentsev, 1950).

Glassoceras RUZHENTSEV, 1960d, p. 231 [**Stacheoceras normani* MILLER & FURNISH, 1957b, p. 1055; OD] [=*Subglassoceras* RUZHENTSEV, 1960d, p. 232 (type, *Stacheoceras bransonorum* MILLER & CLINE, 1934b, p. 293, OD)]. Spherical, smooth-shelled vidrioceratids in which mature suture comprises five or six pairs of external lateral lobes and one less pair of internal laterals. Prongs of ventral lobe and several adjacent external lateral lobes exhibit minor denticulation above bidentate or tridentate lobe base. Sutural trace arched slightly. Sutural formula: $(V_1V_{1'})L_2L_1L_{2.1}L_{2.1.1}(L_{2.1.1.1}L_{2.1.1.1})U_2U_1(U_{2.1}{:}U_{2.1})I_{2.1.1}I_{2.1.1.1}I_{2.1.1}I_1I_2D$ [Russian]. Two species. [This genus could be interpreted as an ancestral cycloloboidean but is better regarded as a separate lineage of Vidrioceratidae (GLENISTER & FURNISH, 1987, p. 994).] *Guadalupian (Roadian):* USA (western Texas, Wyoming).——FIG. 91,*2a–c*. **G. normani* (MILLER & FURNISH), Road Canyon Formation, western Texas; *a–b*, ×1.5; *c*, diameter at 34 mm (Miller & Furnish, 1957b).

Martoceras TUMANSKAIA, 1938a, p. 107 [**Marathonites Dieneri* SMITH, 1927a, p. 46; OD] [=*Pamirites* TUMANSKAIA, 1938a, p. 107 (type, *P. clinei,* OD); ?=*Grioceras* TUMANSKAIA, 1939, p. 18 (type,

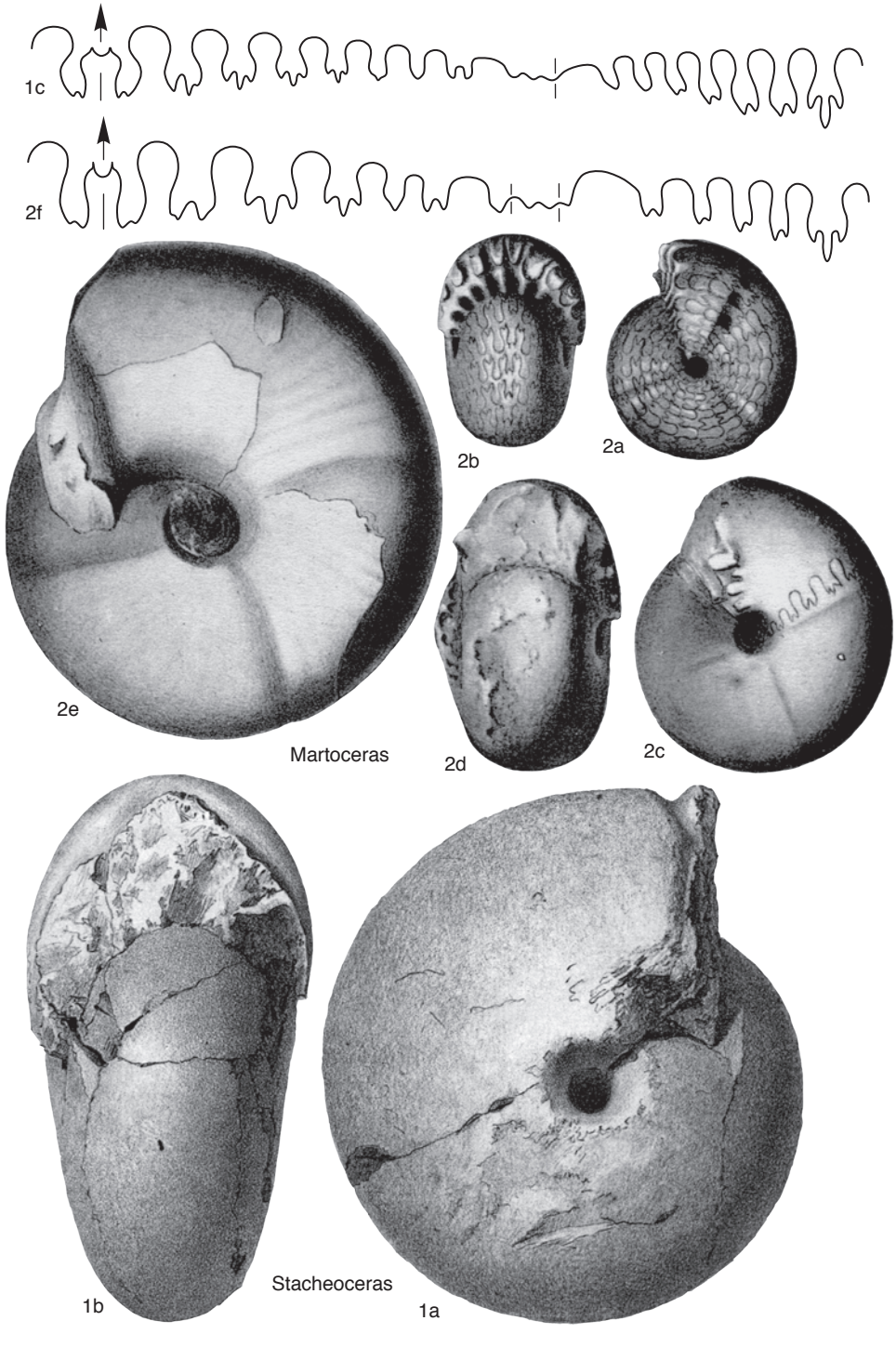

FIG. 92. Vidrioceratidae (p. 147–149).

Stacheoceras burnense var. *kermensis* Tumanskaia, 1931, p. 92, OD); ?=*Chengxianites* Xu in Xu & Wei, 1977, p. 572 (type, *C. hunanensis*, OD); =*Waagenina sensu* Ruzhentsev, 1940e, p. 118; Ruzhentsev *in* Bogoslovskii, Librovich, & Ruzhentsev, 1962, p. 396; Zhou, 1979, p. 392 (type interpreted as *Waagenia subinterrupta* Krotov, 1885, p. 205; SD, see notation herein under vidrioceratid genus *Stacheoceras,* below).] Conch subdiscoidal, diameter up to 7 cm. Mature modifications comprise subterminal constriction and terminal flare (expansion), with broad ventrolateral lappets. External lateral lobes number four or five pairs, and internal laterals one less (three or four); the last in each series commonly is bipartite. Sutural formula of advanced species: $(V_1V_1)L_2L_1L_{2.1}L_{2.1.1}(L_{2.1.1.1}L_{2.1.1.1})U_2U_1U_{2.1}$:$U_{2.1}I_{2.1}I_{2.1}I_1I_2D$ [Russian]. Eight named species. *Cisuralian (Asselian)–Guadalupian (Wordian)*: Indonesia (Timor), Venezuela, Mexico, Italy (Sicily), Russia (Urals), Ukraine (Crimea), Kazakhstan (Southern Urals), Tajikistan (Pamir), southern China (Hunan, Guizhou).——Fig. 92,*2a–e*. **M. dieneri* (Smith), Somohole beds, Asselian–Sakmarian, Timor, Indonesia, ×1 (Haniel, 1915, pl. 6,*12a–b, 6a–b*; pl. 7,*1*; adapted from Smith, 1927a, p. 46).——Fig. 92,*2f. M. subinterruptum* (Krotov), Southern Urals, diameter approximately 24 mm (Ruzhentsev, 1956b).

?Neoglassoceras Zakharov, 2004, p. 522 [**N. caucasicum*; OD]. Inadequately known, from single specimen, similar to vidrioceratids in general suture pattern, especially dorsad paired lateral lobes and digitations at all lobe bases, but differing in possession of popanoceratid-like compressed conch. One species. *Lopingian (Changhsingian):* Russia (northwestern Caucasus).

Peritrochia Girty, 1908, p. 498 [**P. erebus;* M]. Conch small (mature diameter 2 cm), with biconvex growth lines. Mature modifications comprise subterminal constriction and subsequent flare (expansion) of peristome, and formation of a pair of broad ventrolateral lappets bounding an accentuated hyponomic sinus. Suture is characterized by undivided prongs of ventral lobe (V_1) and a dorsal lobe (D) that lacks division in all growth stages. Sutural formula: $(V_1V_1)L_2L_1L_{2.1}L_{2.1}U_2U_1$:$U_2I_{2.1}I_{2.1}I_1I_2D$ [Russian]. One species. [The origin of the fourth external lobe and fourth internal lobe ($L_{2.1}$ and $I_{2.1}$) through subequal bifurcation of the third laterals (L_2 and I_2) relates *Peritrochia* to the Vidrioceratidae rather than to the Marathonitidae.] *Guadalupian (Roadian):* USA (western Texas).——Fig. 90,*3a–d*. **P. erebus*, upper Cutoff Formation, topotypes; *a*, SUI 32586, ×2; *b–c,* SUI 32585, ×2 (new); *d*, diameter at 11 mm (Miller & Furnish, 1940a).

Prostacheoceras Ruzhentsev, 1937, p. 410 [**Marathonites juresanensis* Maksimova, 1935, p. 283; OD]. Conch relatively narrow, with rounded ventrolateral flanks. Two subdivisions of the third external lateral lobe ($L_{2.1}L_{2.1}$) are almost fully isolated at 2 cm conch diameter. Sutural formula: $(V_1V_1)L_2L_1(L_{2.1}L_{2.1})U_2U_1U_{2.1}$:$U_{2.1}I_2I_1I_2D$ [Russian]. Fourteen named species. [This genus is regarded as a plausible ancestor to the cyclolobid subfamily Kufengoceratinae.] *Cisuralian (Asselian)–Guadalupian (Wordian):* Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Ukraine (Crimea), Italy (Sicily), Afghanistan, Malaysia, Thailand (Muak Lek, Loei), China (Jilin, Hunan, Xinjiang), Canada (British Columbia), USA (Texas).——Fig. 91,*1a–c.* **P. juresanense* (Maksimova), Asselian, Southern Urals; *a–b,* ×0.67; *c*, diameter approximately 20 mm (Ruzhentsev, 1951).

Stacheoceras Gemmellaro, 1887, p. 26 [**S. mediterraneum* Gemmellaro, 1887, p. 29; SD Diener, 1921, p. 22] [=*Waagenia* Krotov, 1885, p. 204, *non* Neumayr, 1878, *nec* Kriechbaumer, 1874; =*Waagenina* Krotov, 1888, p. 474 (type, *Arcestes antiquus* Waagen, 1879, p. 28, SD Miller & Furnish, March 15, 1940a, p. 131; *non* Ruzhentsev, post Nov. 4, 1940e, p. 118; *fide* Nassichuk, 1977, p. 574 and Bogoslovskaia, 1978, p. 65); =*Neostacheoceras* Schindewolf, 1931, p. 201 (type, *N. hanieli,* OD); =*Furnishites* Cantú Chapa, 1997, p. 73 (type, *Stacheoceras rothi* Miller & Furnish, 1940a, p. 132, OD); =*Parastacheoceras* Ehiro & Misaki, 2005, p. 9 (type, *P. bidentatum*, OD)]. Advanced vidrioceratids that may exceed 10 cm in mature conch diameter. Mature modifications comprise deep subterminal constriction and associated flare (expansion) of the peristome and long narrow ventrolateral lappets. External suture consists of 6–12 pairs of lateral lobes; prongs of ventral lobe (V_1) are bidentate or tridentate, and first external lateral lobe (L_2) is bidentate to quadridentate. Internal suture generally has one less pair of lobes than external; most internal lobes exhibit conspicuous dorsal flexure adapically. Sutural formula for moderately complex forms: $(V_1V_1)L_2L_1L_{2.1}L_{2.1.1}L_{2.1.1.1}L_{2.1.1.1.1}(L_{2.1.1.1.1.1}L_{2.1.1.1.1.1})U_2U_1U_2$:$I_{2.1.1.1}L_{2.1.1.1}I_{2.1.1}I_{2.1}I_1I_2D$ [Russian]. Forty-three species. *Cisuralian (Artinskian [Aktastinian])–Lopingian (Changhsingian):* Italy (Sicily), Slovenia, Ukraine (Crimea), Azerbaijan (Caucasus), Tajikistan (Pamir), Afghanistan, Iraq (Kurdistan), Oman, Tunisia (Djebel Tebaga), Pakistan (Salt Range), India (Himalayas), China (Gansu, Xinjiang, Yunnan, Guizhou, Xizang, ?Hunan, ?Guangxi, Zhejiang, Sichuan), Indonesia (Timor), Malaysia, Madagascar, Japan (Kitakami), Mexico (Coahuila, ?Guerrero), USA (Texas, California, Wyoming), Canada (Ellesmere Island, British Columbia), East Greenland.——Fig. 92,*1a–b*. **S. mediterraneum*, Sosio Limestone, Wordian, Sicily; lectotype (herein), MGUP 68 of Gemmellaro (1887, pl. 4,*2–3*), ×1 (Gemmellaro, 1887).——Fig. 92,*1c. S. toumanskyae* Miller & Furnish, La Difunta beds, Capitanian, Guadalupian, Coahuila, Mexico, diameter at 30 mm (Miller & Furnish, 1940a).

Tabantalites Ruzhentsev, 1952b, p. 76 [**T. bifurcatus;* OD]. Conch thinly discoidal and evolute in earliest growth stages, but involute with depressed whorls at maturity (U/D, 0.05; W/D, 0.6). Suture is similar to those of advanced *Vidrioceras*, with

bifid third external lateral lobe; perhaps distinguishable by undivided (lanceolate) form of internal lateral lobes. Sutural formula: $(V_1V_1)L_2L_1(L_{2.1}L_{2.1})U_2U_1$:$U_2I_2I_1I_2D$ [Russian]. Three species. [Shell thickening on the umbilical shoulder forms a spiral ridge around the umbilicus similar to those common in Marathonitidae. This has been interpreted to suggest affinities, but sutural ontogeny of the third external lateral lobe ($L_{2.1}L_{2.1}$) necessitates assignment to the Vidrioceratidae.] *Cisuralian (Asselian–lower Sakmarian [Tastubian Substage]):* Kazakhstan (Southern Urals), Tajikistan (Pamir), Russia (?Verkhoian), Canada (Yukon).——Fig. 90,*1a–e*. **T. bifurcatus*, Asselian, Southern Urals; *a–b*, ×2; *c–d*, ×1.5; *e*, width at 18 mm, diameter approximately 30 mm (Ruzhentsev, 1952b).

Family CYCLOLOBIDAE Zittel, 1895

[Cyclolobidae Zittel, 1895, p. 408]
[=Timoritidae Böhmers, 1936, p. 61]

Advanced cycloloboideans characterized by numerous, extensively denticulate lobes. During phylogenesis, prongs of ventral lobe became strongly expanded, number of external lobes across flanks to umbilical shoulder increased from 3 pairs to 12 pairs, denticulation of lobes extended almost to crest of saddles, and sutural trace became strongly arched. *Guadalupian (Roadian)–Lopingian (Changhsingian)*.

Subfamily KUFENGOCERATINAE Zhao, 1980

[Kufengoceratinae Zhao, 1980, p. 79]

Small ancestral cyclolobids with phragmocone diameters 2–10 cm, but mature conchs generally less than 10 cm. Sutures have 3 to 5 pairs of denticulate external lateral lobes across flanks to umbilical shoulders, and several small lobes on each umbilical shoulder and wall. Denticulation of lateral lobes is generally confined to adapical two-thirds of suture. Prongs of ventral lobe are approximately one-half width of corresponding first lateral lobe, and their ventral flank is either smooth or weakly denticulate. Sutural trace almost directly transverse. [*Kufengoceras* Ruzhentsev, 1956a, was suppressed as a synonym of *Shengoceras* Chao, 1955; however, the subfamilial name remains valid, ICZN *Code* Article 40a (Zhou, Glenister, & Furnish, 2000, p. 78). Subfamily derived from the Cisuralian Vidrioceratidae, plausibly from *Prostacheoceras* Ruzhentsev (1937) through *Guiyangoceras* Zhou (1985).] *Guadalupian (Roadian)–Lopingian.*

Shengoceras Chao, 1955, p. 141 [**Waagenoceras simplex* Chao, 1955, p. 138; OD; subjective senior synonym of *Shengoceras lenticulare* Chao, 1955, p. 141, by page priority] [=*Kufengoceras* Ruzhentsev, 1956a, p. 160 (type, *Waagenoceras simplex* Chao, 1955, p. 138, OD); =*Parakufengoceras* Leonova, 2002, p. 91 (type, *P. primitivum,* OD)]. Subglobular kufengoceratins, with uniformly rounded venter and flanks and moderately wide umbilicus. Internal mold smooth, except for faint ribs and constrictions, both tracing uniformly rounded low ventral salient. External suture characterized by narrow secondary ventral saddle, ventral prongs with extensive ventral and dorsal denticulations in mature stages, three pairs of moderately denticulate lobes across flanks, and several simpler lobes on umbilical shoulder and wall. Two or three species. [The holotype of *Shengoceras lenticulare* was collected in direct association with most of the type material of *Waagenoceras simplex* Chao, the type species of *Kufengoceras*. The single feature that distinguishes the two forms is the irregular ventral angularity of the ultimate whorl of *S. lenticulare*, which we attribute to preservational deformation.] *Guadalupian (Roadian–Capitanian), Lopingian (?Wuchiapingian)*: southern China (Guangxi, southern Jiangxi, northeastern Guangdong), Mexico (Coahuila).——Fig. 93,*3a–f*. **S. simplex* (Chao), Kuhfeng Shale, Wordian, Guangxi; *a–c,* ×0.67; *d–e*, ×1 (Chao, 1955); *f,* topotype, NIGP 128936A, diameter approximately 30 mm (new).

Guiyangoceras Zhou, 1985, p. 196 [**G. guiyangense*; OD]. Similar in conch form and number of lobes to *Shengoceras.* Slightly more primitive sutural features, partly a function of small size, comprise broadly quadrate secondary ventral saddle, smooth ventral flank of ventral prongs (V_1), and less extensive denticulation of all lobes. Sutural formula: $(V_1V_1)L_2L_1(L_{2.1}L_{2.1})(U_2U_1U_2)I_{2.1}$:$I_{2.1}I_1I_2(D_2D_1D_2)$ [Russian]. Two species. [*Guiyangoceras* was probably derived from the vidrioceratin genus *Prostacheoceras* Ruzhentsev (1937); the two genera are comparable in conch form and sutural formula and differ mainly in extensive denticulation of most external lobes in the former. *Guiyangoceras* is the probable ancestor of the Kufengoceratinae, which in turn gave rise to the Cyclolobinae.] *Guadalupian (Roadian):* southern China (upper Dangchong Formation, Hunan).——Fig. 93,*4a–d*. **G. guiyangense; a–c,* ×2; *d,* diameter approximately 15 mm (Zhou, 1985).

Liuzhouceras Zhao, 1980, p. 79 [**Waagenoceras shengi* Chao, 1955, p. 140; OD]. Inadequately known genus, probably similar to *Shengoceras* in conch form and suture, but strongly ribbed. Two species.

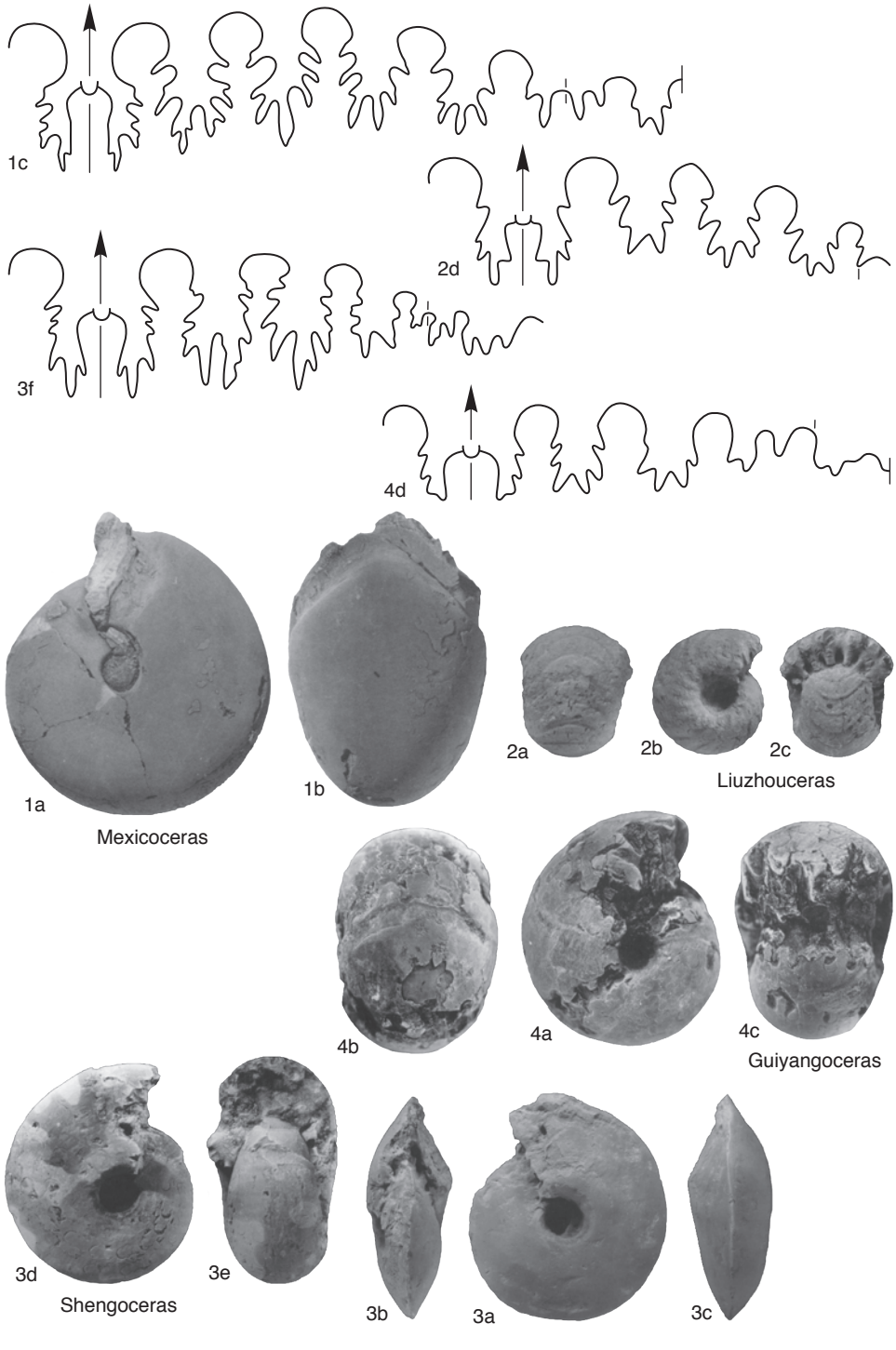

FIG. 93. Cyclolobidae (p. 150–153).

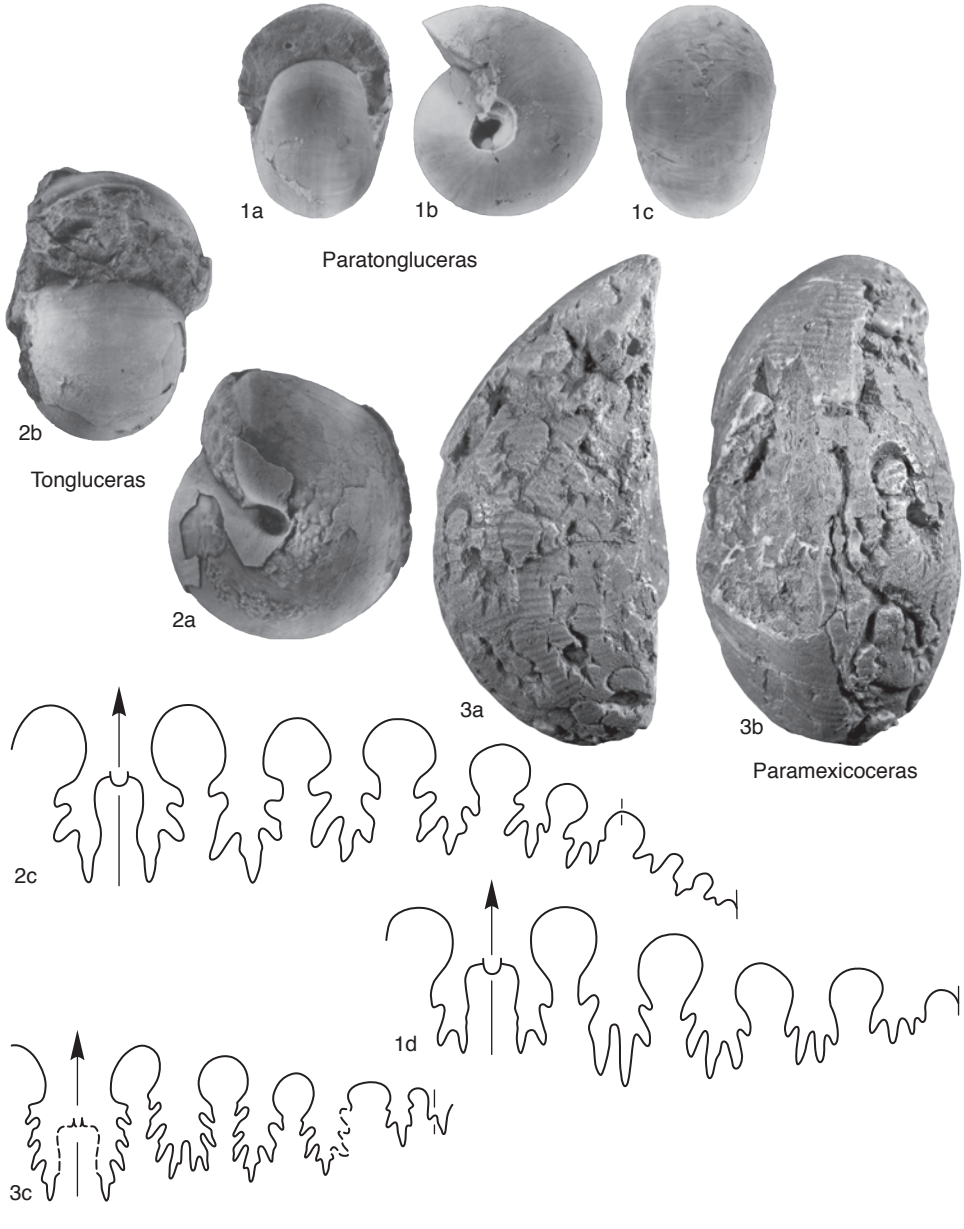

FIG. 94. Cyclolobidae (p. 153).

Guadalupian (Roadian–Capitanian): southern China (Guangxi, Hunan).——FIG. 93,*2a–d.* **L. shengi* (CHAO), Kuhfeng Shale, Guangxi; *a–c,* ×1 (Chao, 1955); *d*, holotype, diameter approximately 18 mm, NIGP 7465 (new).

Mexicoceras RUZHENTSEV, 1955a, p. 701 [**Waagenoceras cumminsi* var. *guadalupense* GIRTY, 1908, p. 502; OD]. Smooth, globular to subglobular conchs that commonly reach maturity at less than 10 cm conch diameter. Mature modifications comprise slight geniculation and formation of deep, wide, subterminal constriction with accentuated ventral salient. Mature external suture is characterized by narrow ventral lobe and five pairs of moderately denticulate lobes to umbilical shoulders. Sutural formula: $(V_1V_1)L_2L_1L_{2.1}L_{2.1.1}(L_{2.1.1.1}L_{2.1.1.1})$ $U{:}I_{2.1.1}I_{2.1.1}I_{2.1}I_1I_2(D_2D_1D_2)$ [Russian]. Four named species. *Guadalupian (Wordian–Capitanian)*: USA

(western Texas), Mexico (Coahuila), southern China (Jiangxi, Hunan, Jilin).——Fig. 93,*1a–c.* **M. guadalupense* (Girty), Wordian, Texas; *a–b*, topotype, USNM 144423 (same as Miller & Furnish, 1940a, pl. 41,*3–4,* pl. 42,*6*), ×1 (new); *c,* diameter at 40 mm (Miller & Furnish, 1940a).

Paramexicoceras Y. Popov, 1970, p. 139 [**P. aldanense;* OD]. Kufengoceratins with small umbilicus (U/D, approximately 0.1) and slightly depressed whorls; characterized by conspicuous ribs in all growth stages that form a broadly rounded ventral sinus in ultimate volution. External sutures consist of four pairs of strongly denticulate lateral lobes across flanks to umbilical shoulders, plus several simpler elements on each umbilical wall. Two species. *?Guadalupian, Lopingian:* Russia (southern Verkhoian), Central East Greenland (Jameson Land).——Fig. 94,*3a–c.* **P. aldanense*, holotype, age uncertain, alluvial source, southern Verkhoian, plastoholotype, SUI 35151, NIIGA 56/8717; *a–b*, ×1 (Popov, 1970); *c*, diameter approximately 60 mm, sketched in part (new).

Paratongluceras Zhao & Zheng, September 1977, p. 247 [**P. subglobosum*; OD] [?=*Shimenites* Xu in Xu & Wei, April 1977, p. 571 (type, *S. hunanensis,* OD); if the synonym relationship is confirmed, *Shimenites* would be the subjective senior synonym and would replace *Paratongluceras* as the valid name for the genus]. Similar to *Shengoceras* in conch form and gross features of suture. External suture comprises four pairs of lateral lobes to umbilical shoulders, each with long digits in lobe base but comparatively little other serration. One species. *Guadalupian (Roadian–Wordian):* southern China (Jiangxi, Hunan).——Fig. 94,*1a–d.* **P. subglobosum*, Hutang Formation, Jiangxi; *a–c,* ×0.67 (Zhao & Zheng, 1977); *d*, holotype, NIGP 44611 (same as Zhao & Zheng, 1977, fig. 19b), diameter at 43 mm (new).

Tongluceras Zhao & Zheng, 1977, p. 245 [**T. lengwuense*; OD]. Conch globose, and similar in most features to *Mexicoceras*, including slight geniculation and formation of deep, wide, subterminal constriction at mature aperture. All elements of external suture closely similar to those of *Shengoceras*, but sutural trace slightly arched, five pairs of denticulate lateral lobes to umbilical shoulders. Two species. [Numerous external lobes and a slight arch of sutural trace suggest this genus is an ancestor of Cyclolobinae.] *Guadalupian* (probably *Roadian):* lower Dingjiashan Formation, southern China (Zhejiang).——Fig. 94,*2a–c.* **T. lengwuense*; *a–b*, ×0.67 (Zhao & Zheng, 1977); *c*, paratype, NIGP 44606 (same as Zhao & Zheng, 1977, fig. 17b), diameter at 31 mm (new).

Subfamily CYCLOLOBINAE Zittel, 1895

[*nom. transl.* Zhao, 1980, p. 79, *ex* Cyclolobidae Zittel, 1895, p. 408]

Large cyclolobids, commonly 20–30 cm diameter at maturity. Suture advanced, characterized by 7 to 12 pairs of external lateral lobes across flanks to umbilical shoulders, each with extreme denticulation that extends almost to crest of saddle. Prongs of ventral lobe subequal in width or wider than corresponding first lateral lobe, and, like dorsal flank, ventral side is extensively denticulate. Sutural trace becoming progressively more strongly arched forward during phylogenesis. [This subfamily is derived indirectly from the Vidrioceratidae, probably through the kufengoceratin genus *Tongluceras* Zhao & Zheng (1977) and the ancestral cyclolobin *Demarezites* Ruzhentsev (1955a).] *Guadalupian (Roadian)–Lopingian (Changhsingian).*

Cyclolobus Waagen, 1879, p. 21 [**Phylloceras Oldhami* Waagen, 1872, p. 353; OD] [=*Krafftoceras* Diener, 1903, p. 162 (type, *Cyclolobus (Krafftoceras) Haydeni* Diener, 1903, p. 167, SD Diener, 1921, p. 27); =*Godthaabites* Frebold, 1932, p. 17 (type, *G. kullingi,* OD); =*Procycloceras* Tumanskaia, 1939, p. 19, *nom. nud.*]. Conch commonly 10–20 cm diameter at maturity, compressed, with narrow umbilicus (U/D, 0.1–0.2). Growth lines biconvex; ribs and constrictions conspicuous in juveniles, generally absent in large specimens. Mature modifications comprise slight geniculation and formation of deep subterminal constriction with accentuated ocular and hyponomic sinuses. All sutural elements strongly denticulate; genus characterized by tertiary subdivision near crest of first external lateral saddle. Prongs of ventral lobe wide; 9 to 12 pairs of subequal external lateral lobes diminish in size to umbilical shoulders; sutural trace is strongly arched. Seven species. *Lopingian (Wuchiapingian–Changhsingian):* Pakistan (Salt Range), India (Kashmir, Himalaya), China (southern Xizang), Japan (Kitakami), Russia (Maritime Territory), Armenia (?Vedi River), Indonesia (Timor), Western Australia, Madagascar, USA (California), Greenland.——Fig. 95*a.* **C. oldhami* (Waagen), Chhidru Formation, Lopingian, Salt Range, Pakistan, diameter at 125 mm (Furnish, 1966).——Fig. 95*b–g. C. walkeri* Diener; *b–f*, Ambilobé beds, Ankitohazo, northern Madagascar, ×0.75; *g*, Chhidru Formation, Lopingian, Salt Range, Pakistan, diameter approximately 50 mm (Furnish & Glenister, 1970).

Changhsingoceras Zhao, Liang, & Zheng, 1978, p. 78 (Chao & Liang in Chao, 1965, p. 1820, *nom. nud.*) [**C. meishanense;* OD]. Inadequately known genus, resembling some *Cyclolobus* in possession of strongly ribbed, globular juvenile stage that became proportionally narrower with growth. Suture is generally similar to that of *Cyclolobus*, especially in presence of distinctive tertiary subdivision near crest of first lateral saddle, but differs in

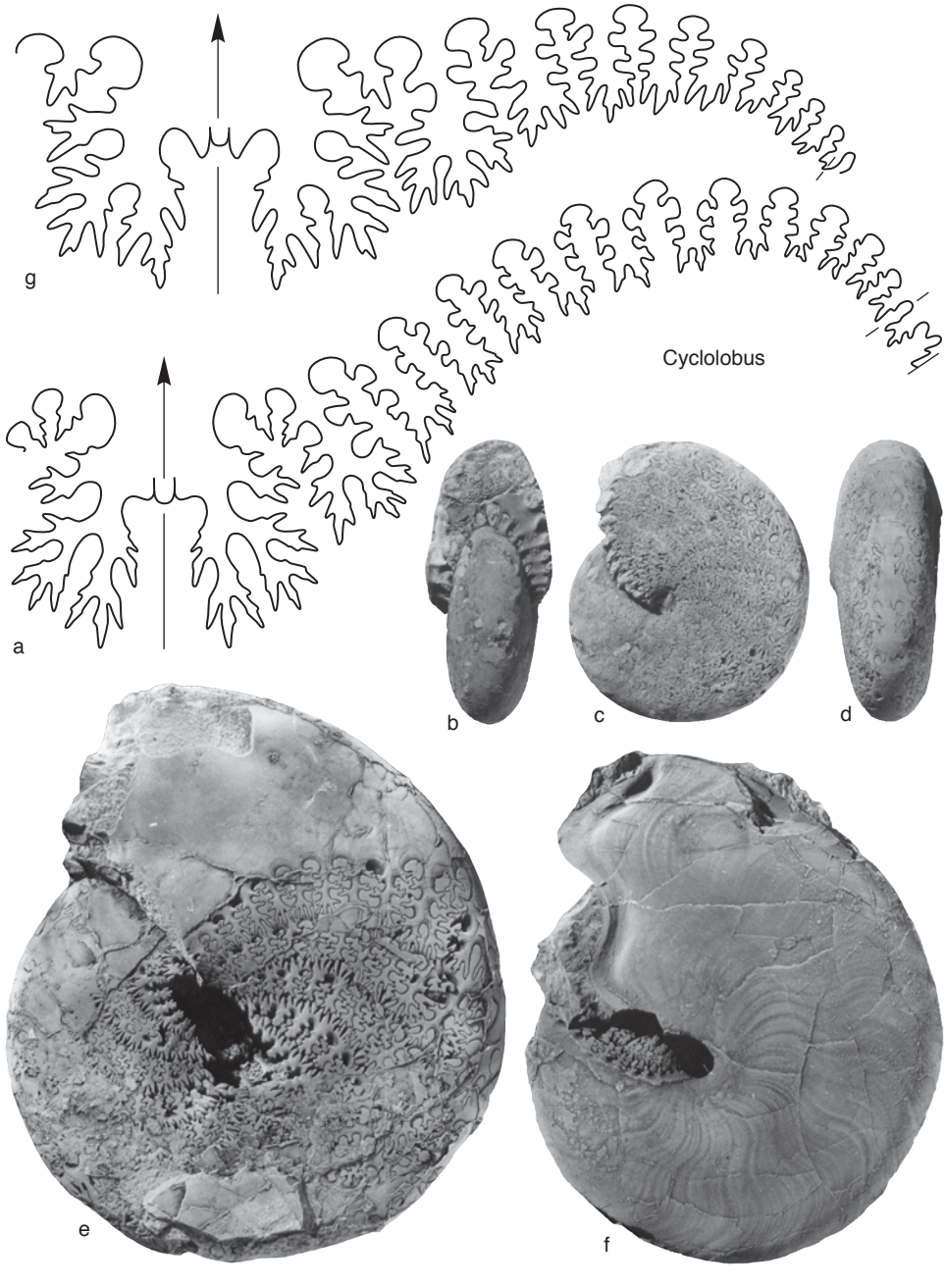

FIG. 95. Cyclolobidae (p. 153).

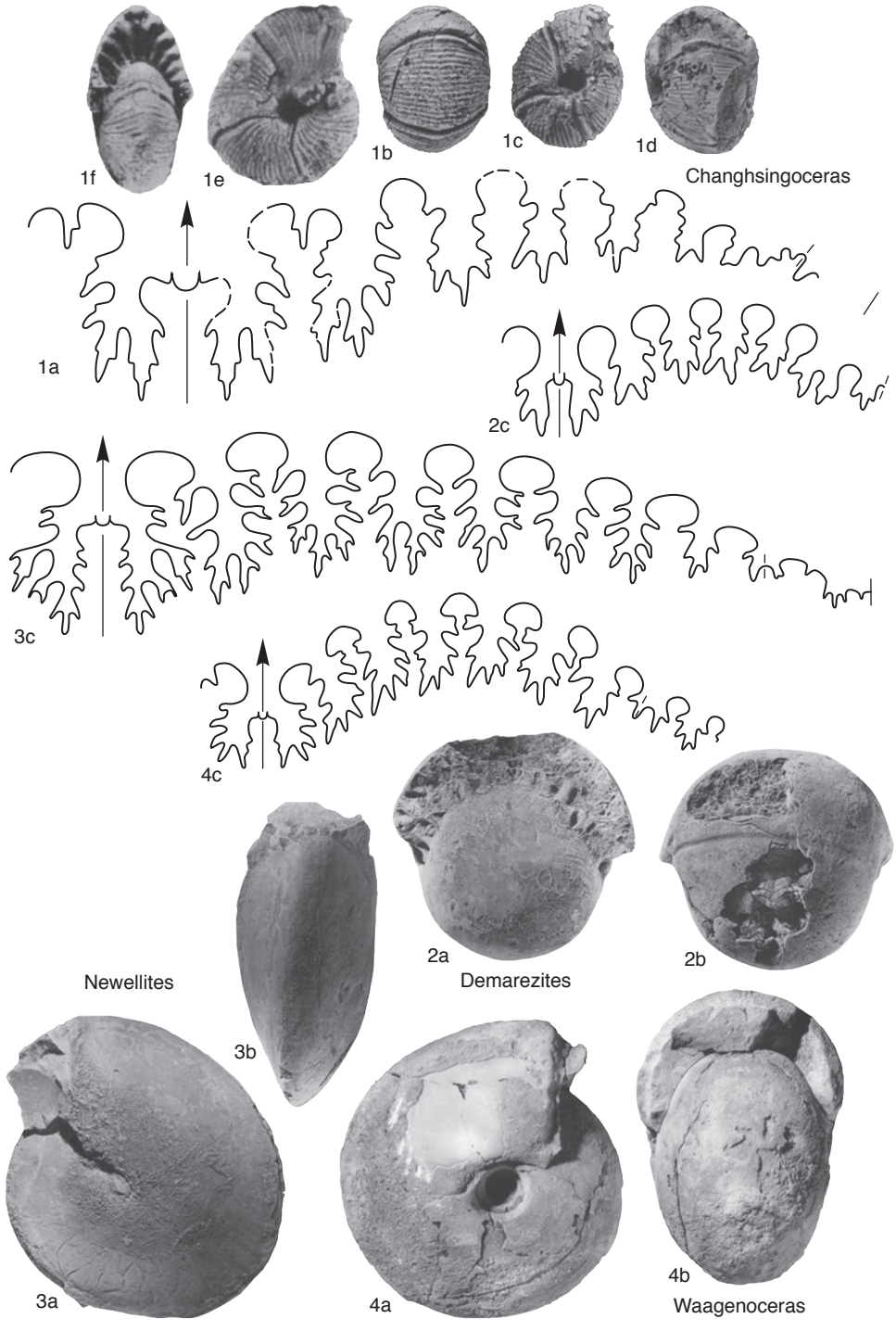

FIG. 96. Cyclolobidae (p. 153–156).

possession of seven pairs of external lateral lobes to umbilical shoulder. Three species. *Lopingian (Changhsingian):* China (Zhejiang, Sichuan, Anhui, Shanxi, Hunan), Russia (Maritime Territory). ——Fig. 96,*1a. *C. meishanense*, holotype, Meishan Member, Changhsing Limestone, Zhejiang, NIGP 34266, diameter approximately 75 mm (new). ——Fig. 96,*1b–f. C. sichuanense* Zhao, Liang, & Zheng, Mingyuexia Member, Dalong Formation, Sichuan; *b–d*, ×1; *e–f*, ×0.67 (Zhao, Liang, & Zheng, 1978).

Demarezites Ruzhentsev, 1955a, p. 703 [**Waagenoceras oyensi* Gerth, 1950, p. 250; OD]. Smooth, globose (W/D, 0.9–1.0) ancestral cyclolobins. Characterized by 7 pairs of moderately denticulate external lobes to umbilical shoulders, the 5–6 lobe pairs being incompletely isolated, even at 50 mm phragmocone diameter. Prongs of ventral lobe (V_1) have ventral flanks that are weakly sinuous rather than denticulate. Six or seven species (only three described). [This genus is probably derived from the kufengoceratin genus *Tongluceras* Zhao & Zheng, from which it differs by its larger size, more strongly arched sutural trace, and possession of seven rather than five pairs of denticulate external lobes.] *Guadalupian (Roadian–Wordian):* Indonesia (Timor), Mexico (Coahuila), USA (western Texas, Idaho), Canada (?British Columbia).——Fig. 96,*2a–c. *D. oyensi* (Gerth), lectotype, GIUA-E229, Tae Wei beds, ?Roadian, Timor; *a–b,* ×0.5; *c*, diameter ranging 50–55 mm (Glenister & Furnish, 1987).

Kurdiceras Vašíček & Kullmann, 1988, p. 104 [**K. latum*; OD]. Familial assignment uncertain, based on rare juveniles. Incipient trifurcation of primary lateral lobe undiagnostic. Widely evolute form, path of growth lines (high salient across flanks and venter, with minor backward sags on ventrolateral shoulder and venter) and ventrolateral constrictions suggest affinity with cyclolobids. One species. *Guadalupian (Wordian):* Iraq (Kurdistan).

Newellites Furnish & Glenister in Davis, Furnish, & Glenister, 1969, p. 105 [**Waagenoceras richardsoni* Plummer & Scott, 1937, p. 158; OD]. Cyclolobids of intermediate sutural complexity that reach mature conch diameter of 15–20 cm. Juveniles similar to *Waagenoceras*, with globular form, open umbilicus, transverse ribs, and strong forward arch of sutural trace. In contrast, mature body whorl smooth, with umbilicus closed by geniculate coiling; whorl section lenticular, and venter acutely angular. Mature external suture comprises eight pairs of lobes to umbilical shoulders and forms weakly arched sutural trace. One species. *Guadalupian (Wordian):* USA (western Texas).——Fig. 96,*3a–c. *N. richardsoni* (Plummer & Scott), Manzanita Member, Cherry Canyon Formation; *a–b*, ×0.37 (Davis, Furnish, & Glenister, 1969); *c*, diameter at 60 mm (Miller & Furnish, 1940a).

Timorites Haniel, 1915, p. 108 [**T. curvicostatus* Haniel, 1915, p. 109; SD Diener, 1921, p. 25] [=*Hanieloceras* Miller, 1933, p. 413 (type, *Waagenoceras intermedium* Wanner, 1932, p. 272, OD); =*Wanneroceras* Tumanskaia, 1937c, p. 93 (type, *Waagenoceras Gemmellaroi* Haniel, 1915, p. 120, M); ?=*Subeothinites* Zakharov, 1984, p. 151 (type, *E. pamiriensis,* OD); =*Coahuiloceras* Cantú Chapa, 1997, p. 82 (type, *Timorites schucherti* Miller & Furnish, 1940a, p. 175, OD)]. Similar to *Cyclolobus,* but conch broader and commonly retaining ribs to maturity. External suture with 8 to 11 pairs of lobes to umbilical shoulders, and lacking a tertiary subdivision near crest of first lateral saddle. Seventeen named species. *Guadalupian (Capitanian)–Lopingian (Wuchiapingian):* Indonesia (Timor), USA (western Texas), Mexico (Coahuila), Russia (Maritime Territory, Amur), Azerbaijan, Iran (north, central), Tajikistan (?Pamir), China (Yunnan, Xizang), Japan (Kitakami).——Fig. 97*a–b. *T. curvicostatus*, Amarassi beds, Wuchiapingian, Soefa, Timor, lectotype (herein), PIUB 29b of Haniel (1915, pl. 52,*9a–c*), ×2 (new).——Fig. 97*c–i. T. schucherti* Miller & Furnish, La Difunta beds, Capitanian, Coahuila, Mexico; *c–f*, ×2; *g–h,* ×1.2 (Miller, 1944); *i,* diameter at approximately 70 mm (Miller & Furnish, 1940a).

Waagenoceras Gemmellaro, 1887, p. 11 [**W. Mojsisovicsi*; SD Diener, 1921, p. 25]. Intermediate in size, conch form, and sutural complexity between *Demarezites* and *Timorites*. External suture has seven or eight pairs of lobes to umbilical shoulders, each more complexly denticulate than in *Demarezites;* seven to eight lobe pair incompletely isolated. Sutural formula for advanced forms: $(V_1V_1)L_2L_1L_{2.1}L_{2.1.1}L_{2.1.1.1}L_{2.1.1.1.1}(L_{2.1.1.1.1.1}L_{2.1.1.1.1.1})U_2U_1U_2{:}(I_{2.1.1.1.1.1}I_{2.1.1.1.1.1})I_{2.1.1.1}I_{2.1.1}I_{2.1}I_1I_2(D_2D_1D_2)$ [Russian]. Ten named species. *Guadalupian (Wordian–Capitanian):* Italy (Sicily), Iraq (Kurdistan), Oman, Indonesia (Timor), Russia (Amur), China (Guizhou, Fujian, Gansu), Mexico (Coahuila, Sonora, ?Guerrero), USA (western Texas), Canada (British Columbia).——Fig. 96,*4a–c. *W. mojsisovicsi*, Sosio limestone, Wordian, Sicily; *a–b*, lectotype, MGUP 34 of Gemmellaro (1887, pl. 2,*1–2*), ×0.5 (Davis, Furnish, & Glenister, 1969); *c*, composite, diameter ranging 50–100 mm (Miller & Furnish, 1940a).

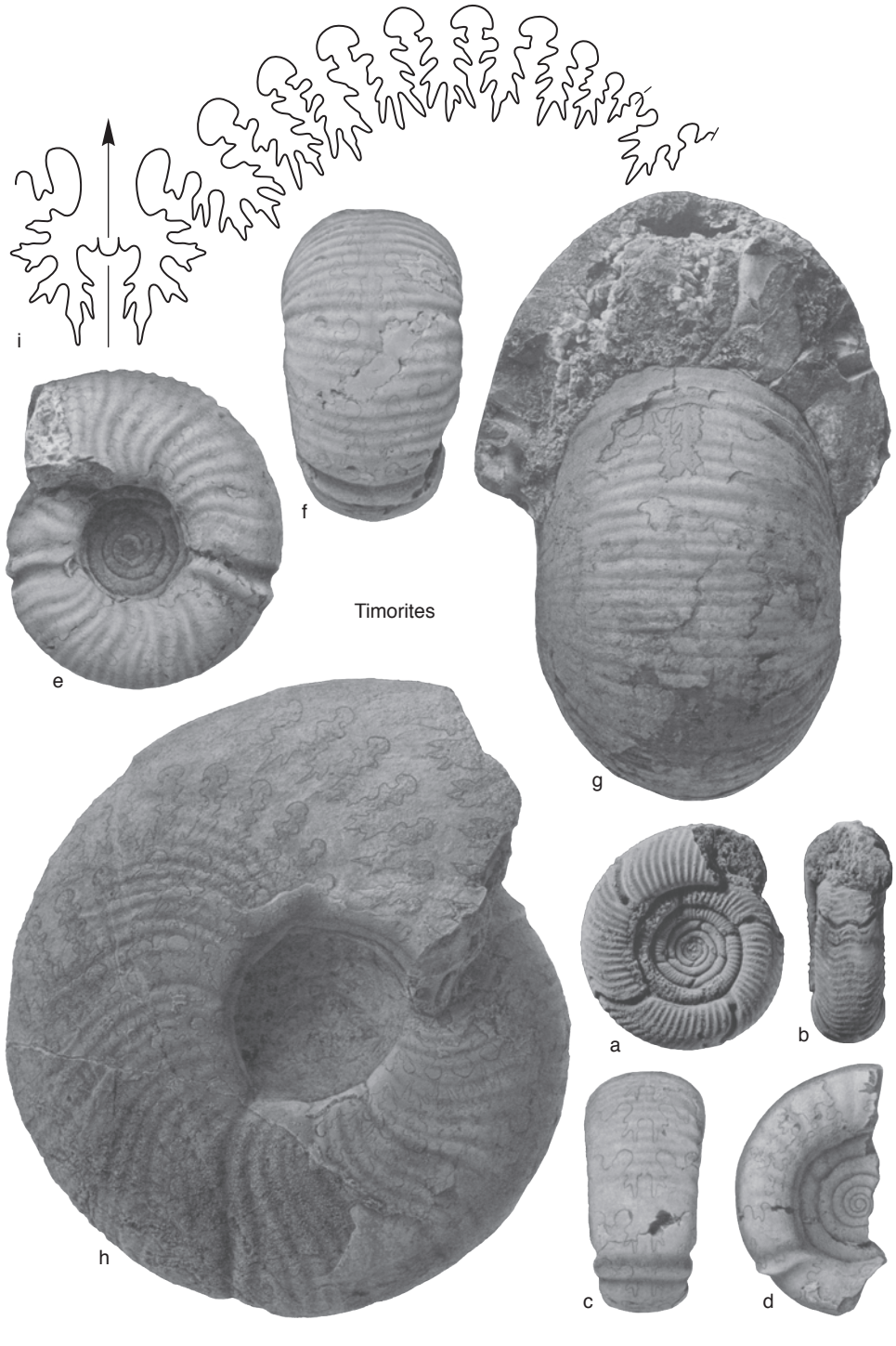

FIG. 97. Cyclolobidae (p. 156).

MARATHONITOIDEA

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[[1]retired, formerly of the University of Iowa; [2]deceased, formerly of the University of Iowa; [3]Nanjing Institute of Geology and Palaeontology]

Superfamily MARATHONITOIDEA Ruzhentsev, 1938

[*nom. transl.* Ruzhentsev, 1957, p. 58, *ex* Marathonitinae Ruzhentsev, 1938, p. 258]

Conch usually thickly discoidal (rarely thinly lenticular as mature modification), with umbilicus ranging from narrow to closed. Shell surfaces lack conspicuous sculpture, but growth lines may be accentuated into subtle asymmetric ridges with shallow backward sag at midflank and shallowly rounded hyponomic sinus. Mature modifications commonly comprise slight to extreme geniculation of mature body chamber, accompanied by changes in whorl section and by constriction at terminal peristome. Basic suture comprises 20 lobes, 18 of which originated by tripartition and subsequent full isolation of subdivisions of primary external lateral, umbilical, and internal lateral lobes (L, U, and I [Russian]). Up to four additional lobes were produced by subsequent bifurcation of dorsal subdivision of L and of some elements in umbilical complex. External and internal lateral lobes initially tridentate or bidentate, but external laterals became complexly and irregularly digitate in course of evolution. *Pennsylvanian (Moscovian* [rare in *Atokan, Desmoinesian])–Lopingian (Wuchiapingian).*

Family MARATHONITIDAE Ruzhentsev, 1938

[*nom. transl.* Ruzhentsev, 1940e, p. 124, *ex* Marathonitinae Ruzhentsev, 1938, p. 258] [=Kargalitinae Ruzhentsev, 1960d, p. 226; ?=Jilingitinae Liang, 1982, p. 651]

Ancestral marathonitoids characterized by simple, bidentate, or tridentate external and internal lateral lobes. Conch involute, subquadrate in section. Mature modifications commonly comprise slight to extreme geniculation and terminal constriction, but lappets are unknown. Sutures maintain basic tripartition of external lateral lobe ($L > L_2L_1L_2$), umbilical lobe ($U > U_2U_1U_2$), and internal lateral lobe ($I > I_2I_1I_2$). Dorsal subdivision of primary umbilical lobe lies internally near umbilical seam, so that basic sutural formula is: $(V_1V_1)L_2L_1L_2U_2U_1{:}U_2I_2I_1I_2D$ [Russian]. [Intraspecific sutural variation is extreme, and third-order subdivisions of lobes may appear sporadically (e.g., Ruzhentsev, 1956b, fig. 88), especially in first external lateral lobe. In light of this variation, recognition of two subfamilies based primarily upon bidentate versus tridentate form of the first external lateral lobe (e.g., Bogoslovskaia, 1990) is untenable. Detailed biostratigraphic studies of Pennsylvanian ancestors (Boardman, Work, & Mapes, 1994) add support to the contention that subfamilies defined on details of lobe subdivision are polyphyletic. Dorsal lobe is trifid in ancestral forms but became only tridentate and eventually entire in some descendants (Ruzhentsev & Bogoslovskaia, 1978). Terminal progenesis resulted in sutural simplification (Glenister & Furnish, 1988a). Marathonitids are characteristic elements of Cisuralian ammonoid faunas (e.g., Ruzhentsev, 1956b) but appeared in the Middle Pennsylvanian (rare in Atokan, Desmoinesian; Chatelain, 1984) and ranged to rarity and extinction in the Guadalupian (Glenister & Furnish, 1988a).] *Pennsylvanian (Moscovian* [rare in *Atokan, Desmoinesian])–Guadalupian (Capitanian).*

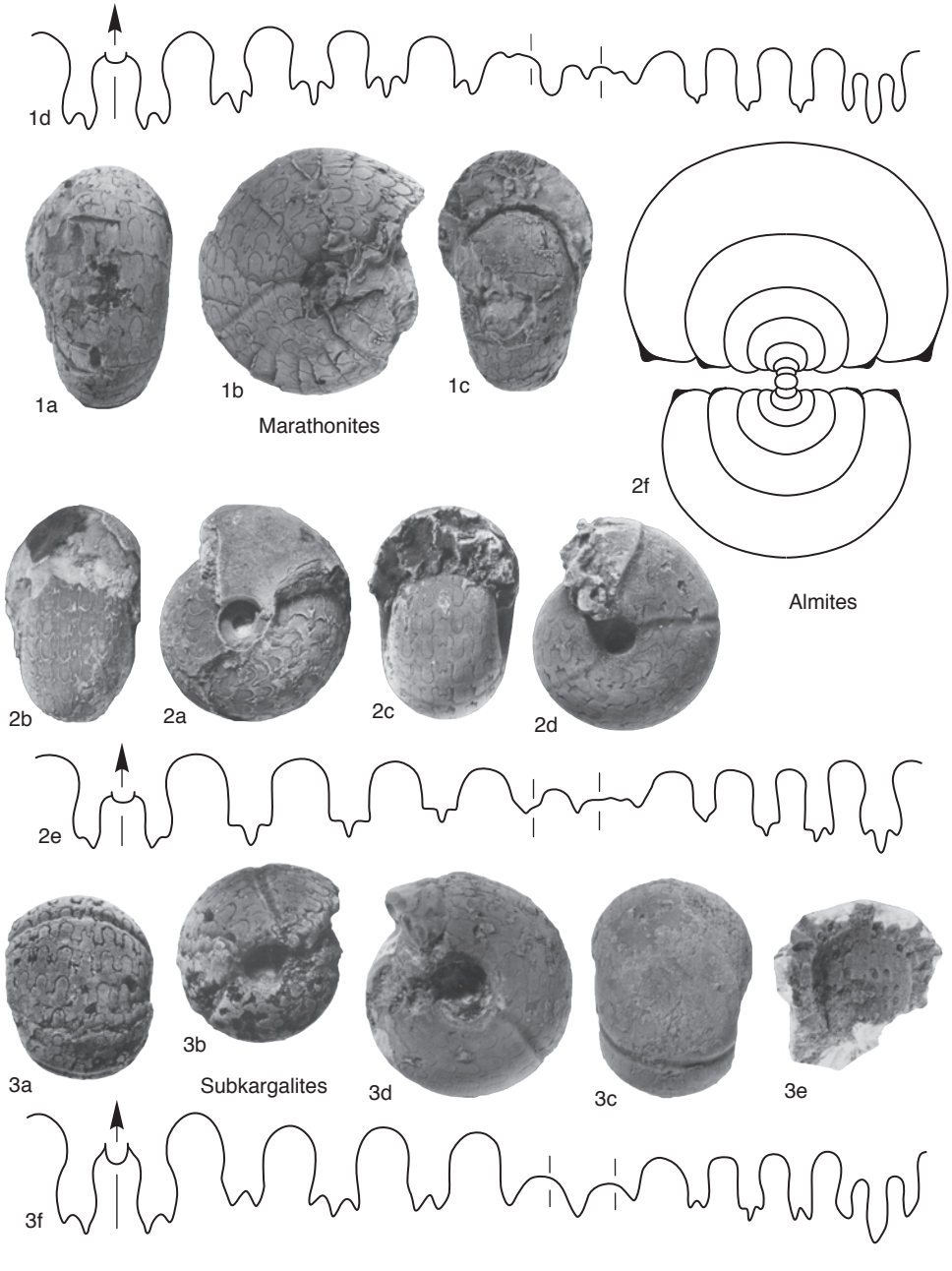

FIG. 98. Marathonitidae (p. 160–163).

Marathonites Böse, 1919, p. 133 [**M. J. P. Smithi;* OD] [=*Policeras* Tumanskaia, 1939, p. 18 (type, *Marathonites vidriensis* Böse, 1919, p. 141, OD); =*Martites* Tumanskaia, 1949, p. 68 (type, *Marathonites sulcatus* Böse, 1919, p. 139, OD)]. Marathonitids in which the first external lateral lobe resembles the other two external lateral elements in being symmetrically tridentate. Dorsal lobe broad and deeply tripartite ($D_2D_1D_2$) to conch diameters in excess of 2 cm. Mature specimens may exhibit weak geniculate coiling, but umbilicus remains open. Three named species. *Pennsylvanian (upper Moscovian–Gzhelian)*: USA (Texas, Oklahoma, Ohio), *Desmoinesian–Virgilian;* Russia and Kazakhstan (Southern Urals), *Gzhelian.*——Fig. 98,*1a–d*. **M. jpsmithi*, upper Gaptank Formation, Virgilian, Wolfcamp Hills, western Texas; *a–c*, lectotype (herein), TMM-B34364 (Böse, 1919, pl. 6,*78,81–83*), ×1.67 (new); *d*, topotype, diameter at 23 mm (Miller & Furnish, 1940a).

Almites Tumanskaia, 1941, p. 261 [**Marathonites sellardsi* Plummer & Scott, 1937, p. 146; OD] [?=*Paraperrinites* Tumanskaia, 1939, p. 17 (type, *Perrinites Brouweri* Smith, 1927a, p. 55, OD). The type of *P. brouweri* (MTHD 12791; Smith, 1927a, pl. 14,*1–2*) is a marathonitid, probably *Almites gracilis* (Smith, 1927a); it must be considered the holotype (ICZN *Code*, Article 73, a, i) despite the fact that a cotype (MTHD 12792; Smith, 1927a, pl. 14,*3–4*) is a well-preserved perrinitid, referable to *Perrinites subcumminsi* (Haniel, 1915); =*Neomarathonites* Ruzhentsev, 1950, p. 190 (type, *Marathonites invariabilis* Ruzhentsev, 1933, p. 173, OD)]. Similar to *Marathonites*, but dorsal lobe narrow and weakly tridentate. Twelve species. *Upper Pennsylvanian (Gzhelian)–Cisuralian (Artinskian):* USA (Texas), *Virgilian;* USA (Texas, New Mexico, California, Nevada), Guatemala, Ukraine (Crimea), Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Austria (Karawanken Mountains), southern China (Guangxi, Guizhou), Indonesia (Timor), *Asselian–Artinskian [Baigendzhinian].*——Fig. 98,*2a–e*. **A. sellardsi* (Plummer & Scott), Admiral Formation, Sakmarian, Coleman County, central Texas; *a–b*, lectotype (herein), TMM-P849 (Plummer & Scott, 1937, pl. 32,*6*), ×2; *c–d*, paralectotype, TMM-P848 (Plummer & Scott, 1937, pl. 32,*3–5*), ×2.67 (new); *e*, diameter at 16 mm (Miller & Furnish, 1940a).——Fig. 98,*2f. A. invariabilis* (Ruzhentsev), Artinskian, Southern Urals, diameter at 9.5 mm (Ruzhentsev, 1940e).

Cardiella Pavlov, 1967, p.76 [**C. gracia*; OD] [=*Aksuites* Pavlov, 1967, p. 77 (type, *A. permicus,* OD)]. Small to medium size marathonitids (1.5–4.0 cm mature diameter), similar to *Almites* in suture and juvenile conch but characterized by moderate to extreme geniculate coiling and modification of cross section in ultimate volution. Terminal restriction reduced apertural area to one-half, accompanied by shell thickening that closed umbilicus and produced deep furrow on internal mold. Ten named species. [*Cardiella* is gradational with *Almites*, representatives of which (e.g., *A. ganti* Smith, 1903) may display umbilical closure and slight geniculation.] *Upper Pennsylvanian (Kasimovian)–Cisuralian (Artinskian):* USA (Texas, Oklahoma, Kansas), *Missourian–Virgilian*; Tajikistan (Pamir), Ukraine (Crimea), Russia and Kazakhstan (Southern Urals), southern China (Guangxi), Indonesia (Timor), USA (Nevada), *Asselian–Artinskian [Baigendzhinian].*——Fig. 99,*1a–e*. **C. gracia*, Kochusu Formation, Bolorian-Kungurian, Pamir; *a–c*, ×1; *d*, diameter at 23 mm; *e*, diameter approximately 15 mm (Leonova, 1981).——Fig. 99,*1f–g*. *C. martodjojoi* Glenister & Furnish, Bitauni beds, Baigendzhinian, Bitauni, Timor, ×1 (Glenister & Furnish, 1987).——Fig. 99,*1h*. *C. shyndensis* Leonova, Bolorian, Pamir, diameter approximately 15 mm (Leonova, 1981).

Jilingites Liang, 1982, p. 651 [**J. bidentus*; OD]. Incompletely understood taxon, resembling *Kargalites*, but differing in bidentate form of external lateral lobes. Two species. *Guadalupian (?Wordian, Capitanian):* China (Jilin), Japan (Kitakami).

Kargalites Ruzhentsev, 1938, p. 259 [**Marathonites timorensis typica* Ruzhentsev, 1933, p. 175; OD]. Marathonitids in which dorsal lobe is narrow and undivided to weakly tridentate. Eleven named species. [Intraspecific variation is extreme in this genus, even for marathonitids. Populations of the type species display ventral prongs that range from undivided to bidentate; irregularly bidentate first external lateral lobes that may possess third-order subdivision of the denticles; and a dorsal lobe that ranges from undivided through asymmetrically bidentate to narrowly tridentate (Ruzhentsev, 1956b).] *Upper Pennsylvanian (Gzhelian)–Cisuralian (Kungurian):* USA (Texas, Ohio), *Virgilian;* Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), China (Guangxi), Indonesia (Timor), Mexico (Chiapas), Canada (Ellesmere Island), Japan (Kitakami), *Asselian–Kungurian.*——Fig. 100,*1a–f*. **K. typicus* (Ruzhentsev), Aktastinian, Artinskian, Southern Urals; *a–d,* ×1; *e*, diameter at 20 mm; *f,* diameter at 10 mm (Ruzhentsev, 1956b).

Promarathonites A. Popov, 1992, p. 58 [**P. maclai* = *P. maklayi* (sic); OD]. Inadequately known group, apparently intermediates morphologically and stratigraphically between *Subkargalites* and *Marathonites*. Characterized by combination of bidentate first external lateral lobe with tridentate second and third external laterals. Three species. *Upper Pennsylvanian:* Uzbekistan (Fergana: Karachatyr Ridge), *Gzhelian;* USA (Texas, Kansas), *Missourian–Virgilian*.

Pseudovidrioceras Ruzhentsev, 1936b, p. 1087 [**Vidrioceras girtyi* Miller & Cline, 1934b, p. 290; OD]. Terminal paedomorphs (smallest, youngest, and rarest genus of Marathonitidae) characterized by small conch (diameter 1.5 cm or less at maturity), compressed whorls (W/D, approximately 0.5), undivided prongs of ventral lobe, three tridentate external lateral lobes, and primary umbilical lobe that is undivided or incipiently trifid. Mature modifications comprise complete

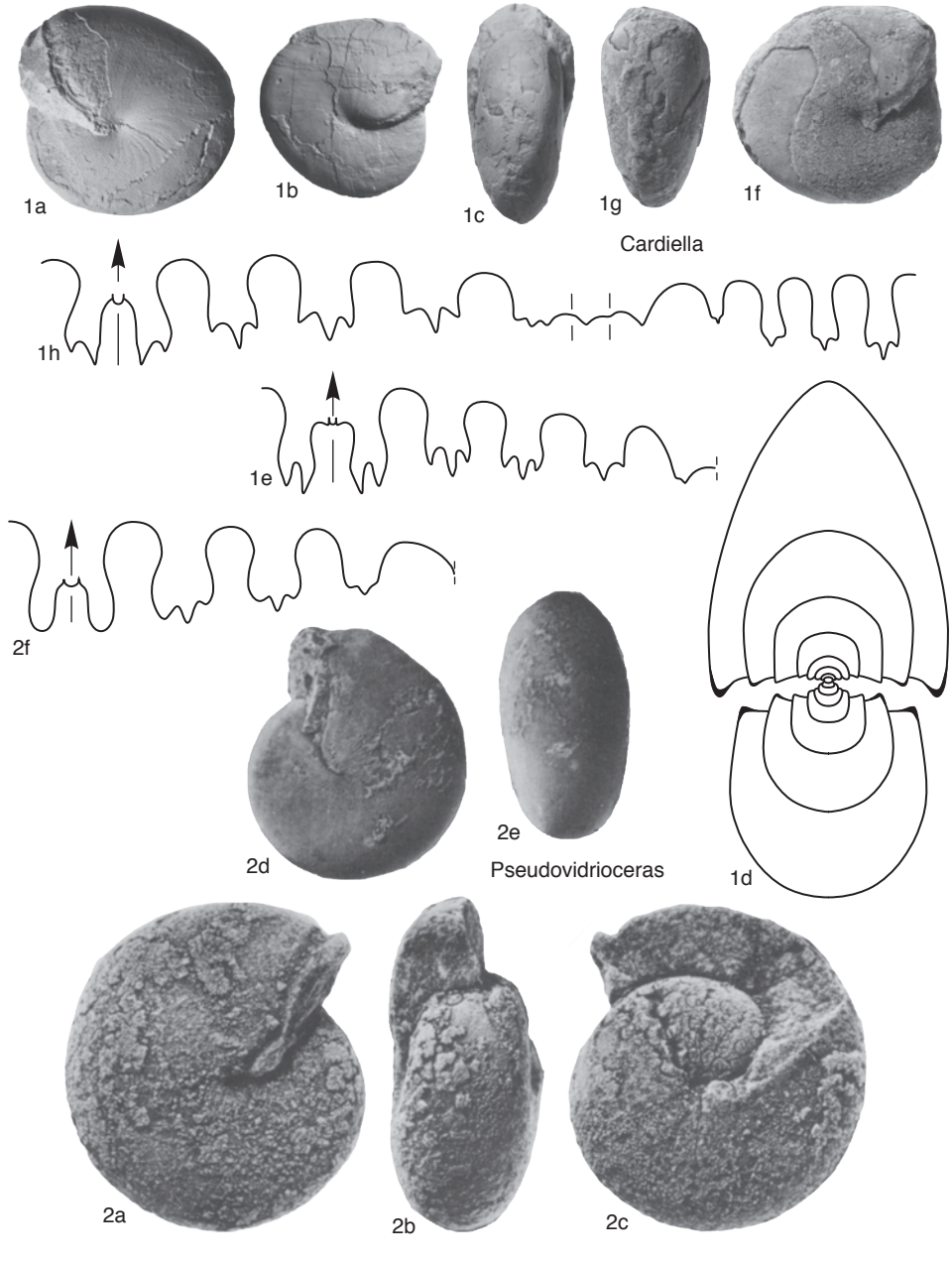

FIG. 99. Marathonitidae (p. 160–161).

closure of umbilicus, subterminal constriction, and formation of narrow U-shaped hyponomic sinus. Four species. *Guadalupian (Roadian–Wordian):* USA (Wyoming, Texas, New Mexico), Italy (Sicily), Ukraine (Crimea), Tajikistan (Pamir).——FIG. 99,*2a–c.* **P. girtyi* (MILLER & CLINE), ×3 (Glenister & Furnish, 1988a).——FIG. 99,*2d–f. P. pygmaeum* (GEMMELLARO); *d–e*, ×3; *f*, diameter at 6.5 mm (Glenister & Furnish, 1988a).

Suakites LEONOVA, 1982, p. 31 [**S. compositus*; OD]. Relatively poorly known but similar generally to other marathonitids and perhaps differing in advanced form of external lateral lobes, all three of which are deeply and asymmetrically tridentate

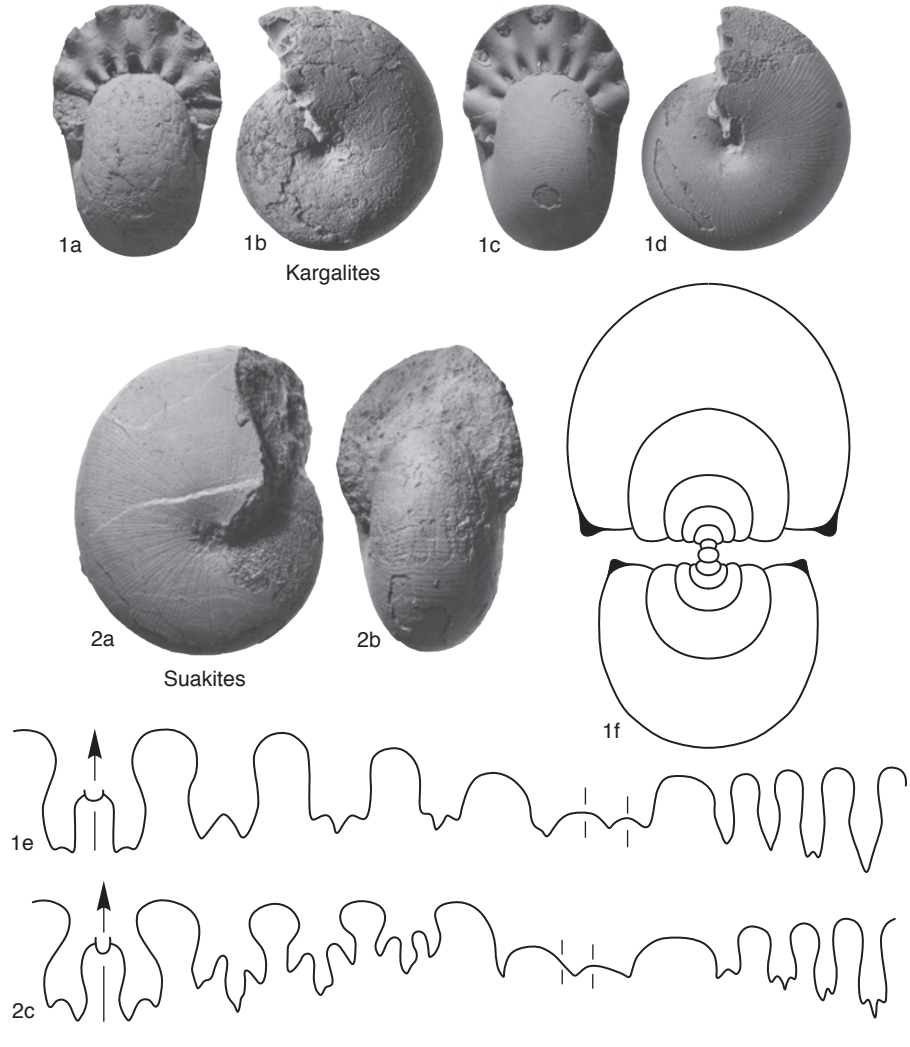

FIG. 100. Marathonitidae (p. 160–162).

and may display secondary crenulation of denticles. One species. [As the marathonitid with the most advanced suture, *Sua kites* resembles *Eohyattoceras*, the ancestral representative of the descendant marathonitoid Hyattoceratidae. *Eohyattoceras* differs primarily (GLENISTER & FURNISH, 1987) in the incipient isolation of a fourth external lateral lobe $L_2 > (L_{2.1}L_{2.2})$]. *Cisuralian (Artinskian):* Pamir.——FIG. 100,*2a–c. *S. compositus*, Kochusu Formation, Bolorian-Kungurian; *a–b*, ×2; *c*, diameter approximately 35 mm (Leonova & Dmitriev, 1989).

Subkargalites RUZHENTSEV, 1950, p. 191 [*?*Marathonites Hargisi sic* BÖSE, 1919, p. 144; OD]. Ancestral marathonitids, similar to *Kargalites*, but dorsal lobe broad and deeply tripartite ($D_2D_1D_2$) to conch diameters exceeding 2 cm. Four named

species. *Middle Pennsylvanian–Cisuralian (Asselian):* USA (Texas, Oklahoma, Kansas), rare in *Atokan, Desmoinesian–Missourian;* Canada (Ellesmere Island), probably *Asselian*; Russia (Southern Urals), Uzbekistan (Fergana: Karachatyr Range), *Kasimovian.*——Fig. 98,*3a–f. *S. hargisi* (Böse), lower Gaptank Formation, Missourian, western Texas; *a–b*, holotype, TMM-B36183 (Böse, 1919, pl. 7,*33–39*), ×2; *c–e*, hypotype, YPM 12938B (external) and YPM 12938C (internal) (Miller, 1930, pl. 39,*1–5*), ×1; *f,* diameter approximately 20 mm (new, suture courtesy of D. M. Work).

Family HYATTOCERATIDAE Miller, Furnish, & Schindewolf, 1957

[*nom. transl.* Glenister & Furnish, 1987, p. 987, *ex* Hyattoceratinae Miller, Furnish, & Schindewolf, 1957, p. 53]

Distinctive advanced marathonitoids characterized by 20–24 sutural elements and complex irregular phylloid serration of external lateral lobes. Conch discoidal, with small to closed umbilicus. Mature modifications occur in advanced forms and include geniculate coiling, modification in whorl section, and penultimate constriction followed by terminal flare of ventral peristome. Spectacular dimorphism is suggested (Davis, Furnish, & Glenister, 1969). [Derivation from the Marathonitidae occurred in the early Permian, plausibly from the marathonitid *Almites*, through the rare ancestral hyattoceratid *Eohyattoceras.* However, abundance is limited to the Guadalupian and Lopingian, where representatives are sporadically common from the Wordian through the Wuchiapingian (Glenister & Furnish, 1987).] *Cisuralian (*probably *upper Sakmarian or lower Artinskian)–Lopingian (Wuchiapingian).*

Hyattoceras Gemmellaro, 1887, p. 14 [**H. Geinitzi* Gemmellaro, 1887, p. 16; SD Diener, 1921, p. 25] [=*Abichia* Gemmellaro, 1887, p. 18 (type, *Hyattoceras (Abichia) Abichi*, M]. Advanced hyattoceratids with fourth external lateral lobe ($L_{2.2}$) fully isolated by 2.5 cm conch diameter. Sutural formula: $(V_1V_1)L_2L_1L_{2.1}L_{2.2}U_2U_{1.1}$:$U_{1.1}U_2I_2I_1I_2D$ [Russian]. Mature modifications are characteristic. Spectacular dimorphism is probable, but has not been confirmed fully. Eight named species, several of which may be dimorphs. *Cisuralian (?upper Artinskian [?Baigendzhinian]), Guadalupian (Wordian)–Lopingian (Wuchiapingian):* Italy (Sicily), Indonesia (Timor), China (Jiangxi, Gansu, Xizang), Canada (British Columbia).——Fig. 101*a–e. *H. geinitzi*, Sosio limestone, Wordian, Sicily; *a–d,* ×1.33 (Davis, Furnish, & Glenister, 1969); *e*, diameter at 22 mm (Glenister & Furnish, 1987).——Fig. 101*f–g. H. abichi* (Gemmellaro), Sosio limestone, plausible dimorph of associated *H. geinitzi*, ×2 (Davis, Furnish, & Glenister, 1969).——Fig. 101*h. H. guembeli* (Gemmellaro), Sosio limestone, diameter at 20 mm (Glenister & Furnish, 1987).——Fig. 101*i–j. H. subgeinitzi* (Haniel), Amarassi beds, Wuchiapingian, Amarassi, Timor, terminal paedomorph of Hyattoceratidae (youngest, smallest, rarest, lobe digitation reduced), diameter ranging 12–14 mm (Glenister & Furnish, 1987).

Eohyattoceras Glenister & Furnish, 1987, p. 988 [**E. gerthi*; OD] [=*Prohyattoceras* Oyens, 1938, p. 1123, *nom. nud.*; =*Demarezites* Ruzhentsev, 1955a, p. 703, *partim* (type, *Waagenoceras oyensi* Gerth, 1950, p. 250, OD); =*Leeites* Bogoslovskaia, 1990, p. 72 (type, *Eohyattoceras leei* Glenister & Furnish, 1987, OD)]. Ancestral hyattoceratids with fourth external lateral lobe ($L_{2.2}$) incompletely isolated, and denticulation relatively simple and confined to bottom one-half of lobes. Sutural formula for type species (U_1 is undivided in ancestors): $(V_1V_1)L_2L_1(L_{2.1}L_{2.2})U_2U_{1.1}$:$U_{1.2}U_2I_2I_1I_2D$ [Russian]. Two species. *Cisuralian (upper Sakmarian or lower Artinskian)–Guadalupian (Roadian):* Indonesia (Timor), USA (Nevada).——Fig. 102*a–g. *E. gerthi*, Tae Wei beds, ?Roadian, Timor; *a–f*, ×2; *g*, diameter approximately 26 mm (Glenister & Furnish, 1987).——Fig. 102*h. E. leei* (Glenister & Furnish), Riepetown Formation, ?Sakmarian, Nevada , diameter at 30 mm (Glenister & Furnish, 1987).

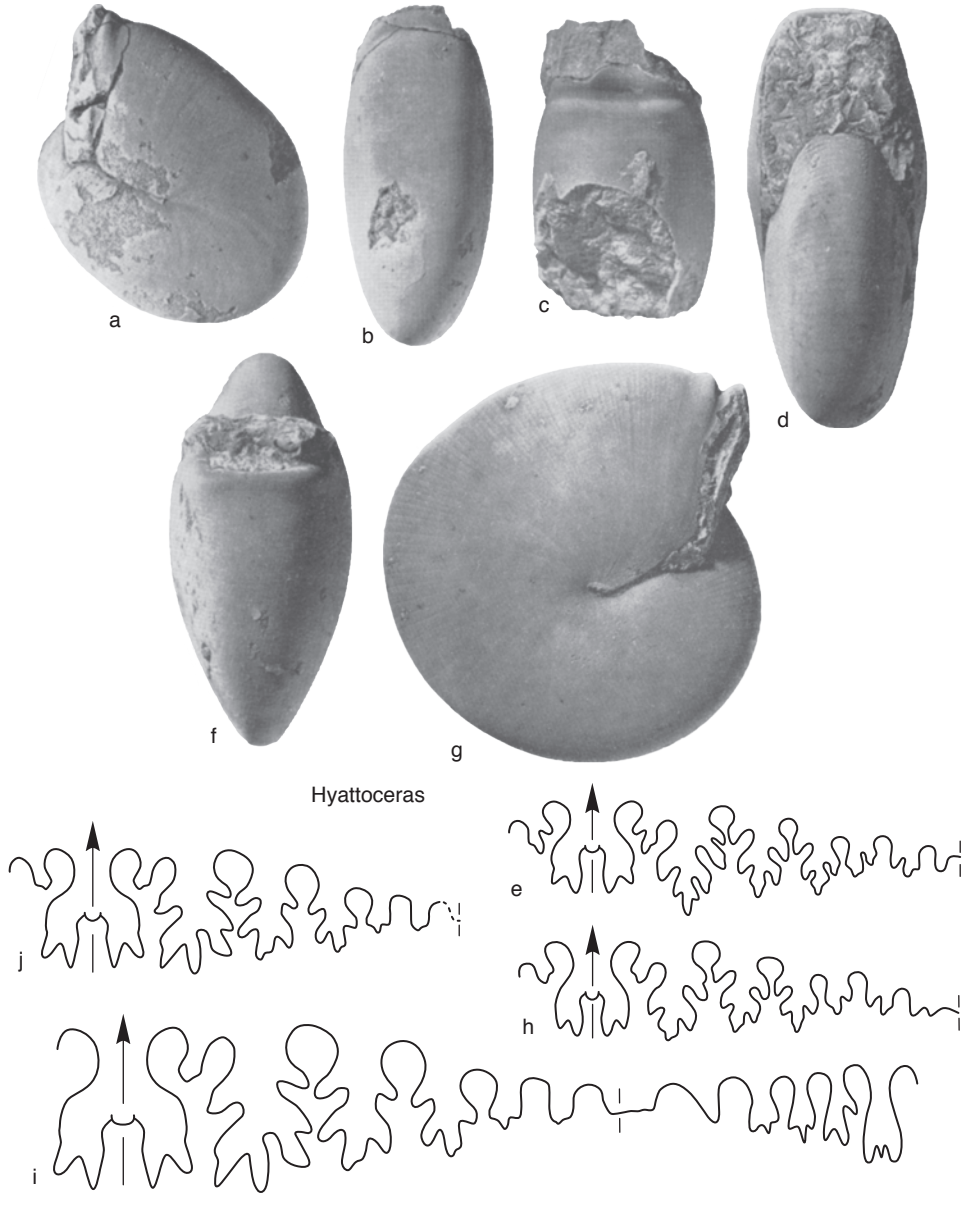

FIG. 101. Hyattoceratidae (p. 163).

FIG. 102. Hyattoceratidae (p. 163).

NEOICOCERATOIDEA

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JÜRGEN KULLMANN,[3] and ZHOU ZUREN[4]

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[3]University of Tübingen, Germany; [4]Nanjing Institute of Geology and Palaeontology]

Superfamily NEOICOCERATOIDEA Hyatt, 1900

[*nom. transl.* RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 68, *ex* Neoicoceratidae HYATT, 1900, p. 550]

Conch form, sculpture, and apertural outline highly variable. Large specimens of ancestral stock (Neoicoceratidae, mainly *Eoasianites*) are commonly globular, lacking in conspicuous ornament, and characterized by a ventral salient and simple 8-lobed suture. Basic sutural formula: (V_1V_1)LU:ID [Russian], $(E_1E_mE_1)$ALUI [German]. [Major early Permian radiation comprises Paragastrioceratidae, which retained the basic suture but transformed the ventral salient into a deep hyponomic sinus, and Metalegoceratidae, which transformed the suture from a total of 8 to 16 lobes by repeated tripartition of the primary umbilical lobe (U).] *Pennsylvanian (Bashkirian)–Lopingian (Changhsingian).*

Family NEOICOCERATIDAE Hyatt, 1900

[Neoicoceratidae HYATT, 1900, p. 550]

[Materials for this family prepared by Jürgen Kullmann]

Conch form discoidal to subdiscoidal, evolute. Umbilical nodes or lateral ribs may be present on immature or adult stages. Sutural formula: $(E_1E_mE_1)$ALUI [German], (V_1V_1)LU:ID [Russian]; no additional elements. [For discussion, see RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 68.] *Pennsylvanian (Bashkirian)–Cisuralian (Asselian).*

Neoicoceras HYATT, 1900, p. 550 [**Goniatites elkhornensis* MILLER & GURLEY, 1896, p. 37; OD]. Conch cross section low trapezoidal, umbilicus extremely wide. Suture similar to *Eoasianites*, but median saddle about half as high as entire ventral lobe. Three or four species. [The holotype of the type species (the only specimen) is fragmental and does not show shell ornamentation. Genus may be related to *Somoholites* or early schistoceratids. For discussion, see FURNISH & KNAPP, 1966, p. 300.] *Pennsylvanian (Bashkirian–Moscovian):* Russia (Novaia Zemlia), Canada (Northwest Territories), USA (Kentucky, Texas).——FIG. 103,*3. *N. elkhornense* (MILLER & GURLEY), suture of holotype, fragment, Big Sandy River, Elkhorn Creek, Kendrick Shale, Breathitt Formation, eastern Kentucky, USA, upper Morrowan, WMUC 6210, ×1.7 (Furnish & Knapp, 1966).

?Akiyoshiceras KYUMA & NISHIDA, 1987, p. 26 [**A. subridens* KYUMA & NISHIDA, 1987, p. 28; OD]. No conspicuous ornamentation at early and later whorls. Depressions and transverse swellings of adult conch developed regularly. Median saddle of suture considerably higher than half height of entire ventral lobe. Two species. [The generic assignment is questionable for this genus. The conch form and suture suggest a close relationship to *Eoasianites.*] *Pennsylvanian (lower Moscovian):* Japan.——FIG. 103,*1a–c. *A. subridens,* holotype, Mine City, Quarry Isa machi, Akiyoshi, Yamaguchi prefecture, lower part of Akiyoshi Limestone, ASM50439; *a–b,* ×0.75; *c,* suture, diameter at 37 mm, ×1.9 (Kyuma & Nishida, 1987).

Eoasianites RUZHENTSEV, 1933, p. 165 [**E. subhanieli* RUZHENTSEV, 1933, p. 166; OD] [=*Prometalegoceras* RUZHENTSEV, 1936a, p. 505, obj.; =*Trochilioceras* PLUMMER & SCOTT, 1937, p. 181 (type, *T. tenuosum* PLUMMER & SCOTT, 1937, p. 183, OD); =*Pronoceras* PLUMMER, 1950, pl. 19 (type, *Gastrioceras prone* MILLER & OWEN, 1937, p. 415, M, *nom. nud.*]. Conch form subdiscoidal, evolute, with low height of aperture. Transverse striae usually with orad salient. Umbilical tubercles confined to immature stages; constrictions may be present. Ventral lobe with slightly pouched prongs, median saddle exceeding two-thirds height of entire ventral lobe. First lateral saddle subacute. More than ten species. [The type species of *Trochilioceras* and *Pronoceras* are regarded as congeneric with *Eoasianites.* For discussion, see RUZHENTSEV, 1950, p. 129.] *Pennsylvanian (Kasimovian)–Cisuralian (Asselian):* Russia and Kazakhstan (South Urals), China (Guangxi, Xinjiang), Tajikistan (Pamirs), Canada (Yukon), USA (Alaska, Kansas, Oklahoma, Texas).——FIG. 103,*2a–b. *E. subhanieli,* holotype, Sholak-sai river, South Urals, uppermost Asselian, PIN 318/1207,

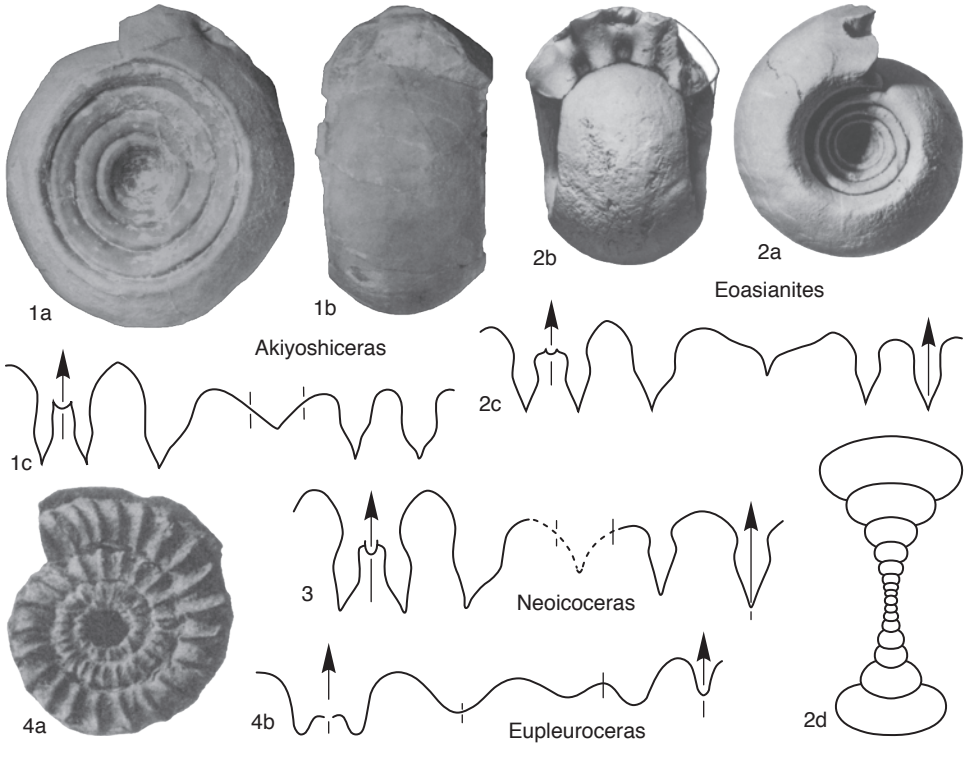

FIG. 103. Neoicoceratidae and Eupleuroceratidae (p. 166–167).

×1 (Ruzhentsev, 1951).——FIG. 103,*2c. E. hartmannae* RUZHENTSEV, suture, Zhaksy-Kargala river, South Urals, uppermost Asselian, PIN 318/312, whorl height at 9.8 mm, whorl width 19.6 mm, ×1.8 (Ruzhentsev, 1951).——FIG. 103,*2d. E. concinnus* RUZHENTSEV, cross section, west of Nikolskii, right bank of Ural river, Chkalovskaia Oblast', South Urals, lower part of Orenburg formation, Gzhelian, PIN 320/1740, ×4 (Ruzhentsev, 1950).

Family EUPLEUROCERATIDAE Ruzhentsev, 1957

[Eupleuroceratidae RUZHENTSEV, 1957, p. 59]

[Materials for this family prepared by Jürgen Kullmann]

Conch form snakelike, with keel. Sculpture with lateral ribs. [The relationship of this family to Neoicoceratidae is uncertain.] *Pennsylvanian (Kasimovian).*

Eupleuroceras MILLER & CLINE, 1934a, p. 179 [**E. bellulum* MILLER & CLINE, 1934a, p. 180; OD]. Conch snakelike, coiled, evolute, with a small and sharp ventral keel. Sculpture with conspicuous prorsiradiate ribs on flanks, reaching ventrolateral margin. Lobes of adults acute at their base, median saddle relatively low. One species (holotype, immature). [Conch form, ornamentation, and suture configuration suggests a relationship to Neoicoceratidae.] *Pennsylvanian (Kasimovian):* USA (Kansas, Oklahoma, Texas).——FIG. 103,*4a–b. *E. bellulum,* 4.8 km west and 1 km north of Cherryvale, Montgomery County, Kansas, Drum limestone, Nelly Bly Formation, Missourian, probably immature cotype, SUI; *a,* ×4; *b,* suture, approximately ×25 (Miller & Cline, 1934a).

Family PARAGASTRIOCERATIDAE Ruzhentsev, 1951

[Paragastrioceratidae RUZHENTSEV, 1951, p. 138]
[=Aulacogastrioceratidae ZHAO & ZHENG, 1977, p. 240]

[Materials for this family prepared by Brian F. Glenister, William M. Furnish, and Zhou Zuren]

Eight-lobed neoicoceratoideans characterized initially by widely evolute narrow conch, strongly depressed whorls, and by transverse

ribs that form a high ventral salient. Sutural formula: (V_1V_1)LU:ID [Russian], ($E_1E_mE_1$) ALUI [German]. Primary evolutionary trends comprised reduction in relative umbilical diameter, restriction of strong transverse ornament to inner volutions, and development of a deep hyponomic sinus. Accompanying modifications involved compressed whorls, angular venter, dorsolateral ribs and nodes, and coarse strigae. *Cisuralian (Asselian)–Lopingian (Changhsingian).*

Subfamily PARAGASTRIOCERATINAE Ruzhentsev, 1951

[*nom. transl.* Furnish, 1966, p. 278, *ex* Paragastrioceratidae Ruzhentsev, 1951, p. 138]

Paragastrioceratids in which growth lines form a ventral salient. *Cisuralian (Asselian–Kungurian).*

Paragastrioceras Chernov, 1907, p. 288 [**Goniatites Jossae* de Verneuil, 1845, p. 371; SD Ruzhentsev, 1936b, p. 1079] [=*Girtyites* Wedekind, 1918, p. 160, obj.; ?=*Eotumaroceras* Andrianov, 1985, p. 143 (type, *E. endybalense,* OD); ?=*Baraioceras* Andrianov, 1985, p. 155 (type, *A. stepanovi,* OD)]. Conch large, thickly subdiscoidal (W/D, commonly 0.4–0.6) with wide umbilicus (U/D, greater than one-third) and depressed whorls (H/W, commonly two-thirds). Pronounced nodes or laterally attenuate ribs generally retained on umbilical shoulders to maturity. Strong longitudinal strigae and weaker convex growth lines produce reticulate sculpture. Prongs of ventral lobe characteristically much narrower than lateral lobe; both prongs and lateral lobe (V_1 and L) are attenuated adapically and constricted adorally. Thirty named species. [A fully mature aperture has been observed in this genus, rarely, to comprise long paired ventral salients bisected by a deep hyponomic sinus.] *Cisuralian (Asselian–Kungurian):* Kazakhstan (Southern Urals), Russia (Urals, Verkhoian, Ochtsko-Kolymskiy Massif), Tajikistan (?Darvas), Italy (Carnic Alps), Slovenia, Canada (Arctic Archipelago, Yukon), Western Australia, China (Nei Mongol).——Fig. 104,*1a–c.* **P. jossae jossae* (de Verneuil), Baigendzhinian, Southern Urals; *a–b*, ×0.67; *c*, diameter at 70 mm (Ruzhentsev, 1956b).

Epijuresanites Y. Popov, 1970, p. 134 [**E. musalitini;* OD]. Poorly understood group of species, possibly distinguishable by combination of broadly expanded prongs of ventral lobe, medially expanded lateral lobe (L), and incipiently trifid umbilical lobe. Conch discoidal (W/D, 0.3–0.6), umbilicus narrow (Umin/D, 0.2–0.4). Longitudinal and transverse ornament usually fine; growth lines form low ventral salient or shallow sinus. Seven species. *Cisuralian (Kungurian):* Russia (Verkhoian), China (Gansu, ?Nei Mongol), Australia (New South Wales, Queensland).——Fig. 105*a–b.* **E. musalitini*, holotype, Tumara Suite, western Verkhoian, NIIGA 48/8717, plastoholotype, SUI 35144; *a*, ×0.67; *b*, diameter at approximately 55 mm (new).

Svetlanoceras Ruzhentsev, 1974a, p. 23 [**Uraloceras serpentinum* Maksimova, 1948, p. 7; OD]. Small (commonly less than 2.5 cm mature diameter), thinly discoidal paragastrioceratins (W/D, less than 0.4) with depressed whorls (H/W, less than 0.8) and wide umbilicus (Umin/D, 0.4–0.7). Numerous ribs across umbilical wall and shoulder multiply by intercalation and bifurcation to produce finer ornament across flanks and venter; ribs and constrictions form high ventral salient; longitudinal lirae less pronounced than transverse ornament. Suture primitive: prongs of ventral lobe narrower and deeper than lateral lobe; lateral lobe approximately symmetrical, with flanks diverging adorally. Seven species. [Primitive features of this ancestral paragastrioceratid are consistent with its small mature size. *Svetlanoceras* is the rootstock of both the Paragastrioceratinae and the Pseudogastrioceratinae. It is the dominant paragastrioceratid in the Asselian, but transitions to descendant *Uraloceras* extend as high as the upper Sakmarian (Sterlitamakian).] *Cisuralian (Asselian–Sakmarian [Tastubian]):* Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), India (?Eastern Himalaya), southern China (Guangxi), Western Australia, USA (western Texas), Canada (Yukon).——Fig. 104,*3a–c.* **S. serpentinum* (Maksimova), Asselian, Southern Urals; *a–b*, ×1.5; *c*, diameter at 15 mm (Ruzhentsev, 1951).

Synuraloceras Ruzhentsev, 1952b. p. 73 [**S. carinatum*; OD]. Similar to *Svetlanoceras*, from which it was probably derived, but with smaller umbilicus (Umin/D, 0.3–0.4) and angular mature venter. One species. [*Synuraloceras* resembles the pseudogastrioceratin genus *Strigogoniatites* in both suture and whorl section. However, *Strigogoniatites* differs fundamentally in possession of the deep hyponomic sinus that characterizes all Lopingian Paragastrioceratidae.] *Cisuralian (lower Sakmarian [Tastubian]):* Kazakhstan (Southern Urals).——Fig. 104,*5a–d.* **S. carinatum*; *a–c*, ×1; *d*, diameter at 25 mm (Ruzhentsev, 1952b).

Tumaroceras Ruzhentsev, 1961, p. 57 [**T. yakutorum*; OD] [?=*Strigotumaroceras* Y. Popov, 1970, p. 133 (type, *S. zavodowskii,* OD), genus is reputed to be distinguishable by its angular venter, but types are crushed and unsatisfactory for reference; ?=*Bulunites* Andrianov, 1985, p. 131 (type, *B. mezhvilki,* OD), the suture drawings are suspect for taxonomic assignment and may be *Epijuresanites*]. Similar to *Paragastrioceras*, but with wider whorls (W/D, 0.7), smaller umbilicus (Umin/D, 0.3), and lacking ventrolateral nodes or other conspicuous

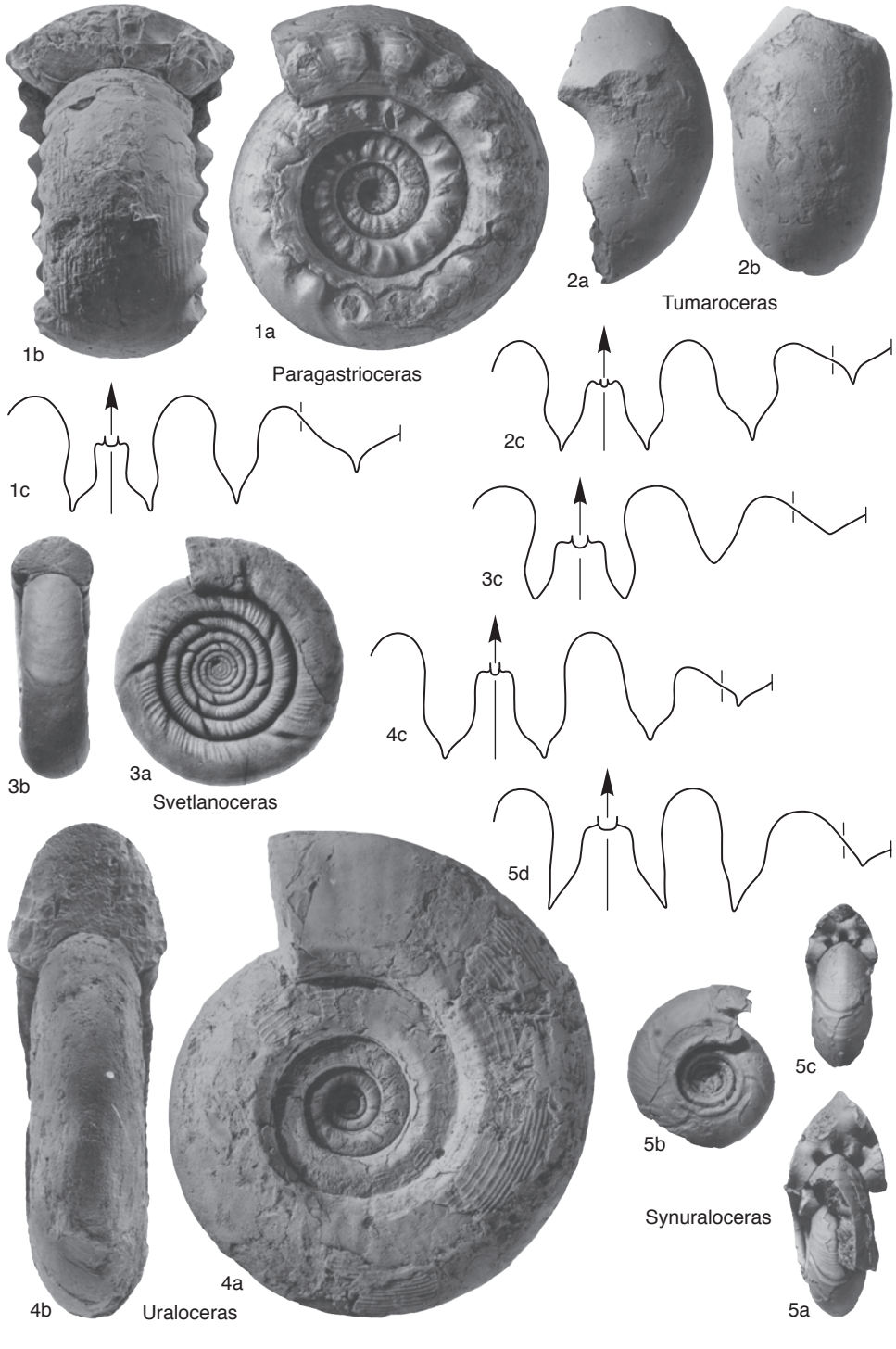

FIG. 104. Paragastrioceratidae (p. 168–170).

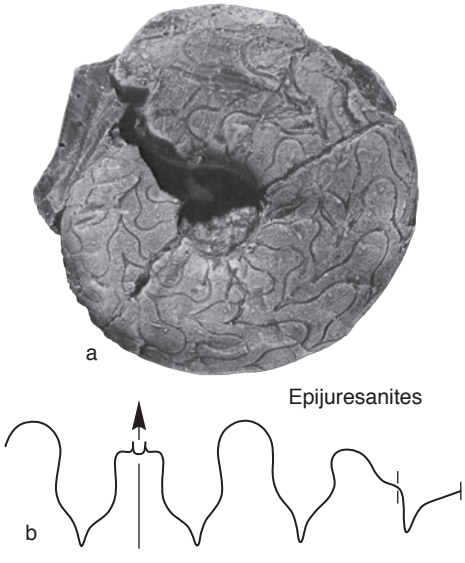

FIG. 105. Paragastrioceratidae (p. 168).

ornament. Six named species. *Cisuralian (Kunguri-an):* Russia (North Urals: Pay-Khoy and Vaigach, Verkhoian, Omolon Massif).——FIG. 104,*2a–c*. **T. yakutorum*, Member B, Endybal' Formation, Siberia, western Verkhoian; *a–b*, ×0.9; *c*, whorl height 25 mm (Ruzhentsev, 1961).

Uraloceras RUZHENTSEV, 1936b, p. 1080 [**Gastrioceras Suessi* KARPINSKII, 1889, p. 52; OD]. Similar to *Paragastrioceras*, but thinner (W/D, generally less than 0.4), usually more involute (Umin/D, 0.3–0.5), and with equidimensional whorl section (H/W, 0.8–1.1). Umbilical ribs characterize juveniles but are not retained in larger whorls. Prongs of ventral lobe equal to or wider than lateral lobe. Twenty-four named species. [Fully mature aperture comprises constriction and terminal flare (expansion), both forming a ventral salient without a hyponomic sinus.] *Cisuralian (Sakmarian–Artinskian)*: Kazakhstan (Southern Urals), Russia (Southern and Central Urals, Verkhoian, Omolon Massif, North Urals: Pechora Basin, Pai-Khoi, Vaigach Island), Canada (Arctic, Yukon, British Columbia), USA (Nevada, Alaska), Australia (New South Wales, Queensland), China (Xizang, Nei Mongol, Gansu, Guangxi).——FIG. 104,*4a–c*. **U. suessi* (KARPINSKII), Baigendzhinian, Southern Urals; *a–b*, ×0.5; *c*, diameter at 100 mm (Ruzhentsev, 1956b).

Subfamily PSEUDOGASTRIOCERATINAE Furnish, 1966

[Pseudogastrioceratinae FURNISH, 1966, p. 278]

Paragastrioceratids in which growth lines form shallow to deep hyponomic sinus. *Cisuralian (lower Sakmarian [Tastubian])–Lopingian (Changhsingian).*

Pseudogastrioceras SPATH, 1930, p. 8 [**Goniatites Abichianus* MÖLLER, 1879, p. 230; M] [=*Grabauites* SUN, 1939, p. 41 (type, *Gastrioceras (Girtyites) liui* GRABAU, 1924, p. 478, OD)]. Conch large, involute (Umin/D, 0.1–0.2) with strongly compressed whorls and narrowly rounded, mature venter. Coarse longitudinal strigae are confined to venter and ventrolateral flanks; conspicuous dorsolateral ornament absent in all growth stages. Sutures characterized by strongly divergent flanks of ventral lobe, wide asymmetric ventral prongs (width V_1/L approximates 1.0), and relatively unconstricted flaring flanks of lateral lobe. Six species. [*Pseudogastrioceras* resembles and intergrades with the weakly ornamented involute species of both *Roadoceras* and *Altudoceras*, e.g., *R. roadense* (BÖSE, 1919) and *A. altudense* (BÖSE, 1919); but it is separable primarily on conch form and sutural contours.] *Lopingian:* Armenia, Azerbaijan (Nakhichevan), Iran (north, central), southern China (widespread), Japan (Kitakami).——FIG. 106,*5a–c*. **P. abichianum* (MÖLLER), Wuchiapingian, vicinity of Dzhulfa, Nakhichevan; *a–b,* ×0.67; *c,* diameter at 60 mm (Ruzhentsev, 1974a).

Altudoceras RUZHENTSEV, 1940c, p. 286 [**Gastrioceras altudense* BÖSE, 1919, p. 88; OD] [=*Hengshanites* ZHOU, 1985, p. 196 (type, *Altudoceras hunanense* XU in XU & WEI, 1977, p. 568, OD)]. Similar to *Pseudogastrioceras* in general conch form, but with wider umbilicus (Umin/D, 0.25–0.5) and conspicuous dorsolateral ribs or nodes in at least juvenile stages. Hyponomic sinus deep and rounded. Ventral lobe characterized by subparallel flanks and narrow asymmetric prongs (width V_1/L 0.6–1.0). Fourteen named species. *Guadalupian (Wordian–Capitanian):* USA (western Texas, Alaska), Mexico (Coahuila), Italy (Sicily), Tunisia, Oman, Iraq (Kurdistan), Pakistan, China (widespread), Russia (Novaia Zemlia), Indonesia (Timor).——FIG. 106,*4a–d*. **A. altudense* (BÖSE), Wordian, western Texas; *a–c*, ×1.33; *d*, diameter at 20 mm (Miller & Furnish, 1940a).

Aulacogastrioceras ZHAO & ZHENG, 1977, p. 240 [**A. spinosum*; OD]. Conch evolute (U/D, 0.5),

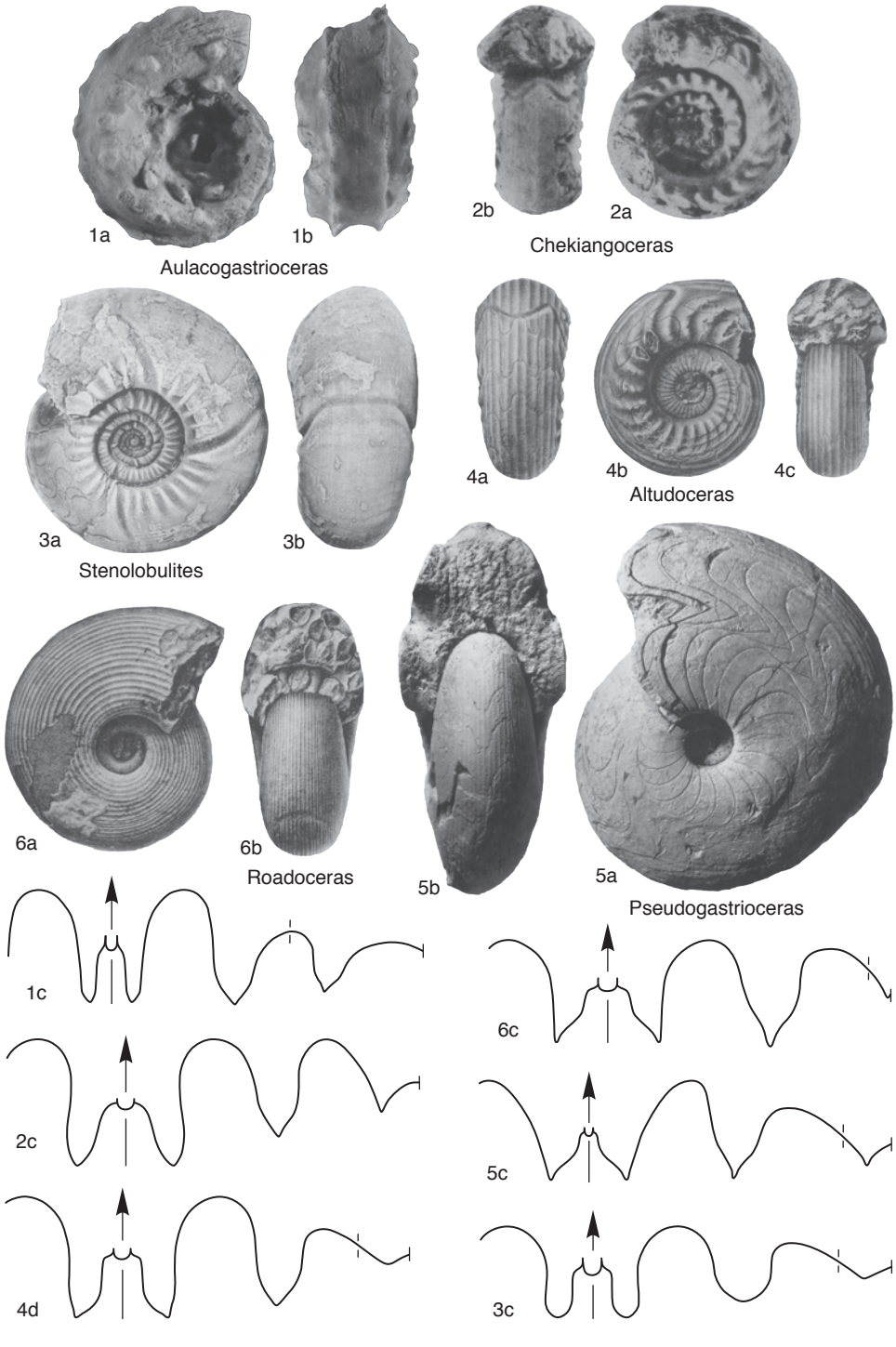

FIG. 106. Paragastrioceratidae (p. 170–172).

characterized by subtrapezoidal whorl section and conspicuous ornament. Venter shallowly concave with width one-half that of corresponding maximum whorl width, bounded by pair of narrow ventrolateral keels comprising longitudinally elongate bladelike nodes. Each whorl flank displays a row of coarse equidimensional nodes that are progressively more prominent apically. Suture has narrow ventral prongs (width V_1/L less than 0.5) and primary umbilical lobe similar in shape to corresponding lateral lobe (unlike flaring, divergent, V-shaped flanks of U in other pseudogastrioceratins). One species, rare and aberrant in South China. *Guadalupian (?Roadian–?Wordian)*: southern China (Jiangxi), Hutang Formation.——Fig. 106,*1a–c. *A. spinosum*; *a–b*, ×1; *c*, diameter at 28 mm (Zhao & Zheng, 1977).

Chekiangoceras Ruzhentsev, 1974a, p. 24 [**C. carinatum;* OD; *nom. nov. pro Paragastrioceras carinatum* Chao, 1965, p. 1817, *nom. nud.*, Zhao & Zheng, 1977, p. 236]. Similar to *Altudoceras*, but mature whorls depressed, trapezoidal in section, and bluntly angular ventrally. One species. [Although accompanied by adequate illustrations, the original attempt to name the type species (Chao, 1965) did not fulfill the requirements of ICZN *Code* Article 13(a). Ruzhentsev (1974a) validated the specific name; he must be considered to be the author, as he alone meets the requirements of Article 50.] *Guadalupian (?Roadian–?Wordian):* southern China (Zhejiang), Shimei Member, Dingjiashan Formation.——Fig. 106,*2a–c. *C. carinatum*; *a–b*, ×0.67; *c*, diameter at 45 mm (Chao, 1965).

Daubichites Y. Popov, 1963, p. 149 [**D. orientalis;* OD]. Similar to paragastrioceratin *Tumaroceras* in general conch form, but narrower (W/D, commonly 0.5) and with smaller umbilicus (Umin/D, 0.2–0.3). Ribs invariably present on umbilical shoulders of juveniles and may persist to maturity; growth lines and constrictions form shallow to deep hyponomic sinus. Prongs of ventral lobe and lateral lobe both approximately bilaterally symmetrical, subequal in size (width V_1/L 0.7–1.0). Eleven species. *Guadalupian (Roadian, ?Wordian):* Russia (Maritime Territory, Verkhoian, Novaia Zemlia), China (Zhejiang, Nei Mongol, ?Xizang), Canada (Arctic, ?British Columbia), USA (Wyoming, Idaho, Texas, ?Arizona), Western Australia, Indonesia (Timor).——Fig. 107,*2a–c. *D. orientalis*, holotype, ?Wordian, Maritime Territory, TsGM 1/8236, plastoholotype, SUI 32740; *a–b*, ×1; *c*, diameter at 55 mm (new).

Roadoceras Zhou, 1985, p. 195 [**Gastrioceras roadense* Böse, 1919, p. 85; OD]. Suture and general conch form similar to *Altudoceras*, including asymmetry of ventral prongs, but differing in generally smaller umbilicus (Umin/D, approximately one-quarter) and early suppression of coarse dorsolateral ribs so that longitudinal strigae are the only conspicuous ornament at diameters greater than 25 mm. Six species. *Guadalupian (Wordian)–Lopingian (Wuchiapingian):* USA (western Texas), Mexico (Coahuila), Russia (Amur), southern China (Hunan).——Fig. 106,*6a–c. *R. roadense* (Böse), Wordian, western Texas; *a–b*, ×1 (Miller & Furnish, 1940a); *c*, topotype, SUI 13589, diameter at 22 mm (new).

Stenolobulites Mikesh, Glenister, & Furnish, 1988, p. 2 [**S. stenolobulus*; OD]. Similar to *Altudoceras*, but with prongs of the ventral lobe that are symmetrical and less than 0.6 the width of lateral lobe. Seven species. [Ancestral pseudogastrioceratin, derived from paragastrioceratin genus *Svetlanoceras* and gradational with it and with diverse pseudogastrioceratins of the Roadian and Guadalupian. As with *Svetlanoceras*, many features of the conch and suture are largely a function of its small mature size.] *Cisuralian (lower Sakmarian [Tastubian])–Guadalupian (Roadian):* USA (Texas, New Mexico, Utah, Idaho), Guatemala.——Fig. 106,*3a–c. *S. stenolobulus*, Roadian, western Texas; *a–b*, ×3; *c*, diameter at 12 mm (Mikesh, Glenister, & Furnish, 1988).

Strigogoniatites Spath, 1934, p. 15 [**Glyphioceras angulatum* Haniel, 1915, p. 51; OD] [=*Retiogastrioceras* Zhao, Liang, & Zheng, 1978, p. 76 (type, *R. pulchrium,* OD); ?=*Metagastrioceras* Zhao, Liang, & Zheng, 1978, p. 75 (type, *M. fengchengense,* OD); ?=*Sabaliceras* Yang & Yang, 1992, p. 597 (type, *S. wangrenense,* OD)]. Similar to *Altudoceras*, from which it evolved, but with smaller umbilicus (Umin/D, commonly 0.2–0.25). Ornament comprises strong strigae that are restricted progressively to ventrolateral flanks as maturity is approached. Transverse section of mature whorls characterized by shallowly concave dorsolateral flanks separated by broad ridge from flat ventrolateral flanks that converge to an angular to narrowly rounded venter. Ventral lobe constricted medially in advanced forms, with wedge-shaped anteriorly divergent prongs. Fourteen species. [Both *Retiogastrioceras* and *Metagastrioceras* were proposed for specimens from the Laoshan Shale of Jiangxi; the precise zonation is uncertain, but the age is probably Wuchiapingian. All features of shell and suture of *Retiogastrioceras* are consistent with reference to *Strigogoniatites*, but the rare juvenile types of *Metagastrioceras* cannot be assigned confidently.] *Guadalupian (Wordian)–Lopingian (Wuchiapingian, ?Changhsingian):* Indonesia (Timor), USA (western Texas), Mexico (Coahuila), southern China (widespread), Tunisia, Iran (northern).——Fig. 107,*1a–c. *S. angulatum* (Haniel), holotype, Amarassi beds, Wuchiapingian, Amarassi, Timor, MTHD 12703; *a–b*, ×0.67; *c*, diameter at 72 mm (new).

Subfamily ATSABITINAE Furnish, 1966

[Atsabitinae Furnish, 1966, p. 278]

Thinly discoidal paragastrioceratids with wide umbilicus and prosiradiate ribs on the flanks. Suture characterized by exceptionally broad ventral lobe. [Affinities between the two included genera are dubious, as is the

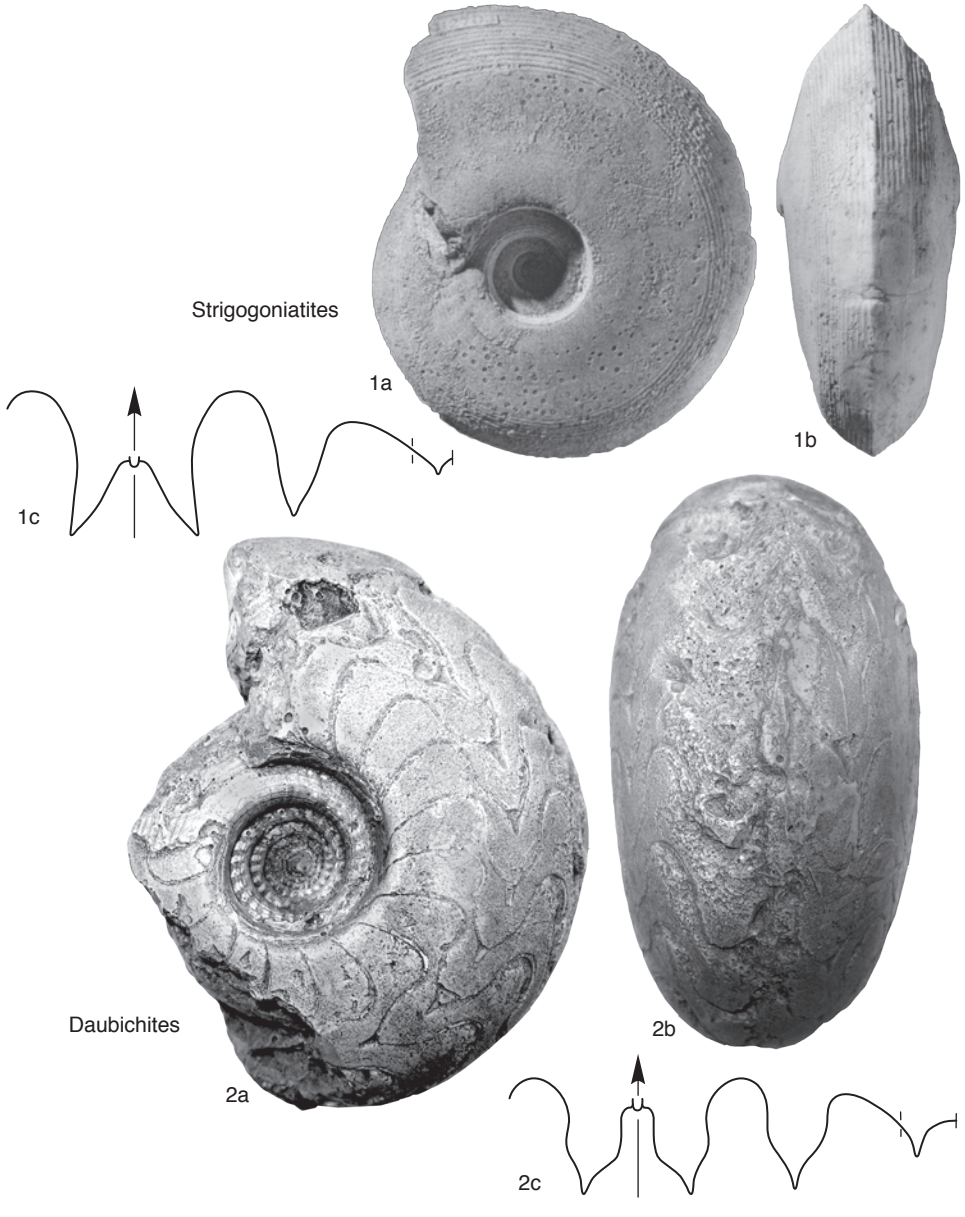

FIG. 107. Paragastrioceratidae (p. 172).

relationship to the apparent homeomorph *Eupleuroceras* MILLER & CLINE, 1934b, a genus referred herein with question to the neoicoceratoidean family Neoicoceratidae.] *Cisuralian (Artinskian)–Guadalupian (Wordian).*

Atsabites HANIEL, 1915, p. 50 [**A. Weberi*; M]. Atsabitin characterized by ventral lobe with parallel sides and width four times that of deep lateral lobe. One species. *Cisuralian (Artinskian)*: Indonesia (Timor).——FIG. 108,*2a–c*. **A. weberi*; *a*, hypotype of WANNER (1932, pl. 10,*3*), between Nilulet and Namaban, Bitauni, Timor, ×1; *b*, lectotype (herein), PIUB 11 of HANIEL (1915, pl. 4,*1a–c*), Hatu Dame, Timor, ×1 (Haniel, 1915); *c*, lectotype, diameter at 75 mm (new).

Anatsabites RUZHENTSEV, 1957, p. 59 [**Paraceltites multiliratus* PLUMMER & SCOTT, 1937, p. 369;

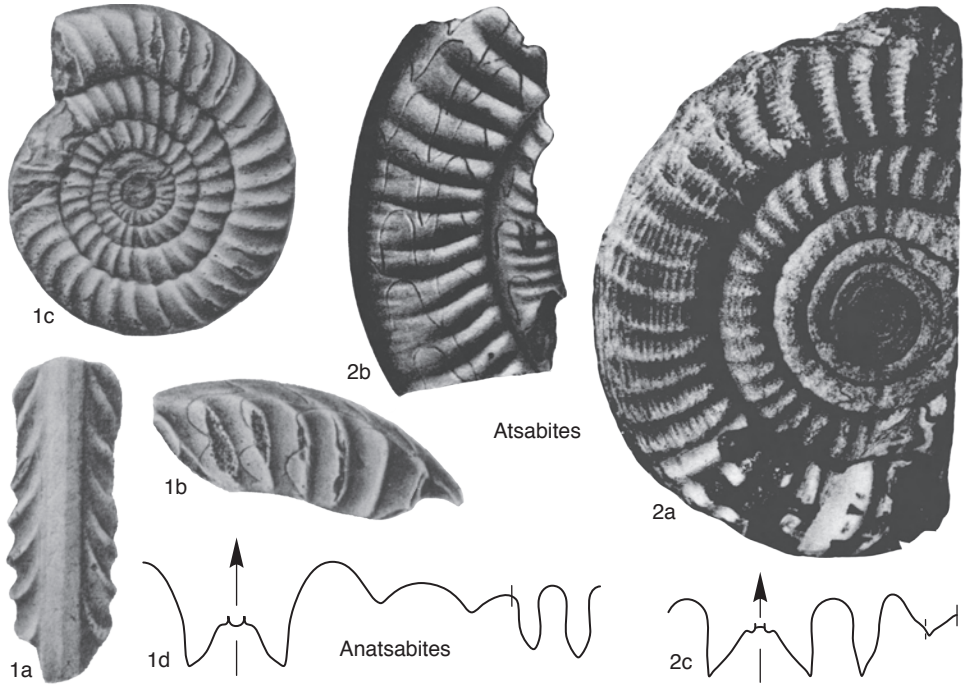

FIG. 108. Paragastrioceratidae (p. 173–174).

OD]. Similar to *Atsabites* in conch form, but with coarser ventral strigae; distinguished by divergent flanks of ventral lobe and by anomalously shallow lateral lobe. Two species. *Guadalupian (Wordian):* USA (western Texas).——FIG. 108,*1a–d. *A. multiradiatus* (PLUMMER & SCOTT); *a–b*, ×2; *c*, ×1.5; *d*, diameter at 34 mm (Miller & Furnish, 1940a).

Family METALEGOCERATIDAE Plummer & Scott, 1937

[Metalegoceratidae PLUMMER & SCOTT, 1937, p. 258] [=Pericycloceratidae ZHAO & ZHENG, 1977, p. 243; LEONOVA in LEONOVA & DMITRIEV, 1989, p. 123]

[Materials for this family prepared by Brian F. Glenister, William M. Furnish, and Zhou Zuren]

Neoicoceratoideans exhibiting a wide range in conch form, from subglobular and narrowly umbilicate to thinly lenticular and evolute. Evolution proceeded from smooth shelled to strongly ribbed, with progressive development of a deep hyponomic sinus. Family is characterized by tripartition of primary umbilical lobe ($U > U_2U_1U_3$), then repeated to transform total number of lobes from 12 to 16 ($U_1 > U_{1.2}U_{1.1}U_{1.2}$). [Subfamilies are distinguishable on conch form and relative width of prongs in the ventral lobe (V_1).] *Cisuralian (Asselian)–Guadalupian (Wordian).*

Subfamily METALEGOCERATINAE Plummer & Scott, 1937

[*nom. transl.* NASSICHUK, 1970, p. 86, *ex* Metalegoceratidae PLUMMER & SCOTT, 1937, p. 258] [=Pericyclolobidae ZHAO & ZHENG, 1977, p. 243; LEONOVA in LEONOVA & DMITRIEV, 1989, p. 123]

Conch large (up to 60 cm diameter), subdiscoidal to globular, and narrowly umbilicate to openly evolute. Growth lines and constrictions are transverse (rectiradiate) or with shallow ventral sinus; generally smooth at maturity. Characterized by 12 or 16 lobes, with prongs of ventral lobe no more than two-thirds as wide as corresponding lateral lobe. *Cisuralian (Asselian–Artinskian), Guadalupian (?Roadian–?Wordian).*

Metalegoceras SCHINDEWOLF, 1931, p. 199 [**Paralegoceras sundaicum* form. *evoluta* HANIEL, 1915, p. 60; OD] [=*Epilegoceras* CHERNOV, 1907, p. 292, *nom. nud.; =Asianites* RUZHENTSEV, 1933, p. 166 (type, *A. sogurensis,* OD); =*Dodecalegoceras* VOINOVA,

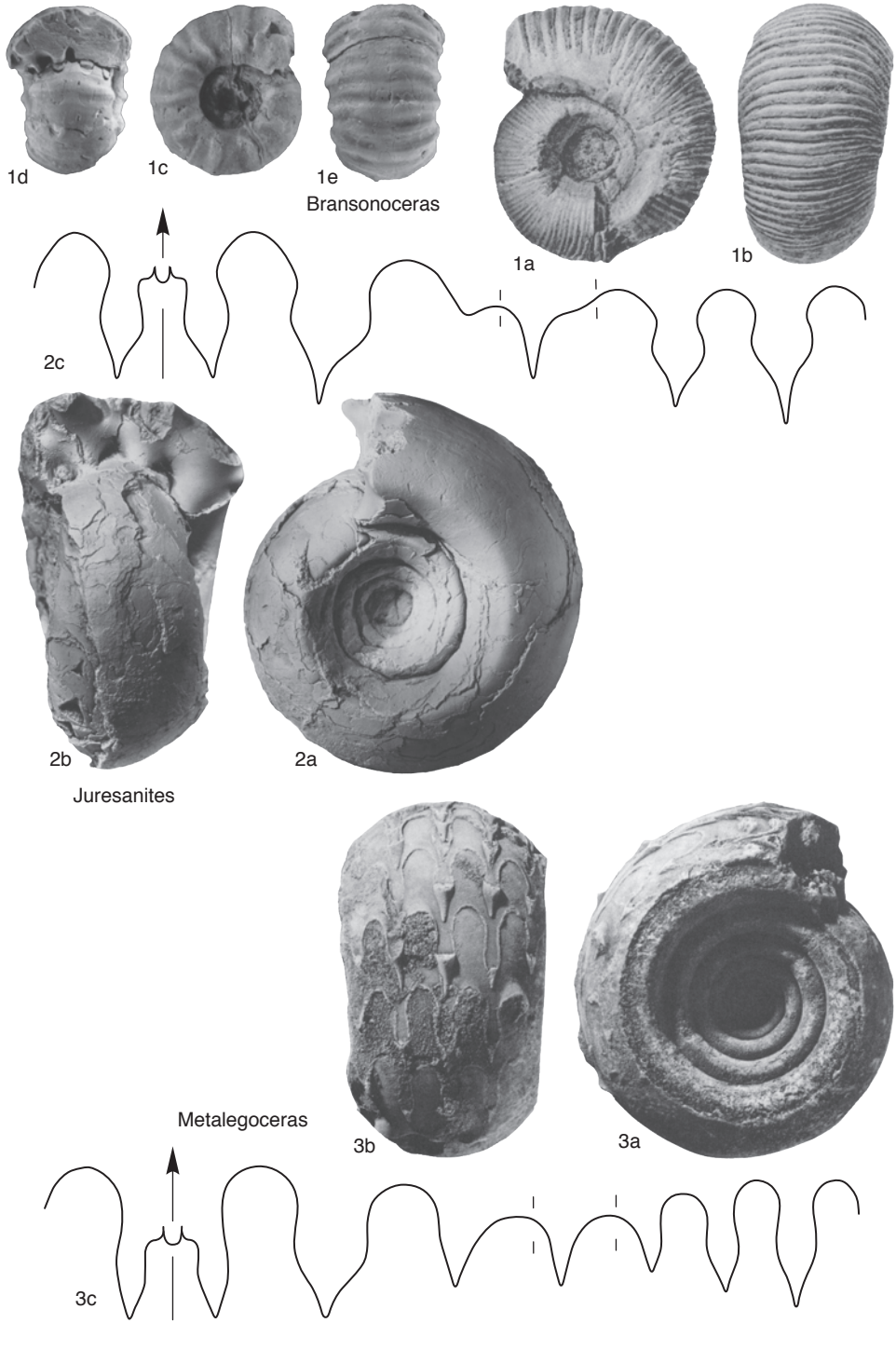

FIG. 109. Metalegoceratidae (p. 174–177).

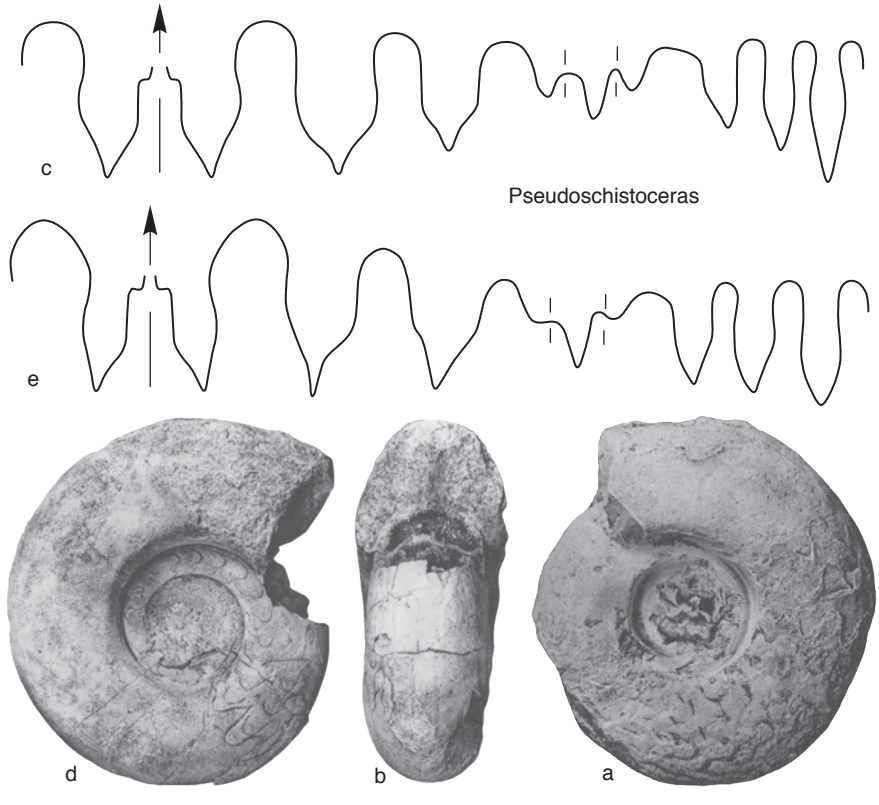

FIG. 110. Metalegoceratidae (p. 177).

1934, p. 14 (type, *D. razumowskajae* VOINOVA, 1934, p. 18); =*Parametalegoceras* BOGOSLOVSKAIA in BOGOSLOVSKAIA, USTRITSKII, & CHERNIAK, 1982, p. 62 (type, *P. arcticum,* OD); =*Pseudometalegoceras* BOGOSLOVSKAIA, 1985, p. 62 (type, *Metalegoceras liratum* ZHAO & ZHENG, 1977, p. 242, OD); ?=*Lingzhouceras* SHENG, 1988a, p. 131 (type, *L. ornatum,* OD)]. Conch variable in relative width (W/D, 0.5–0.9) and umbilical diameter (Umax/D, 0.3–0.8). Suture has 12 lobes, 7 external; 3 umbilical elements ($U_2U_1U_3$) are fully isolated; U_2 subequal to or larger in area than U_1, both external; U_3 internal and subequal to U_1. Sutural formula: $(V_1V_1)LU_2U_1$:U_3ID [Russian], $(E_1E_mE_1)AL_vL_mL_dUI$ [German]. Thirty-seven named species. [Several new species of metalegoceratid have been described (ZHAO & ZHENG, 1977) from the Hutang Formation (Roadian–Wordian) of southern China (Jiangxi) and referred to *Metalegoceras*. They represent the basis for extending the range of the subfamily above the Baigendzhinian, although some aspects of both morphology and occurrence remain unclear.] *Cisuralian (Sakmarian–Artinskian), Guadalupian (?Roadian–?Wordian):* Kazakhstan (Southern Urals), Russia (Urals, Novaia Zemlia, Okhotskii Massif, Kulu-Tasskiy region), Tajikistan (Pamir), Indonesia (Timor), Australia (Canning Basin), China (Jilin, Xizang, Guizhou, Jiangxi), USA (Texas, New Mexico), Canada (Yukon, Northwest Territories), Oman.——FIG. 109,*3a–c*. **M. evolutum* (HANIEL); *a–b*, Bitauni beds, Baigendzhinian, Timor, Indonesia, ×0.67 (Glenister, Windle, & Furnish, 1973); *c*, Baigendzhinian, Southern Urals, diameter at 30 mm (Ruzhentsev, 1956b).

Bransonoceras MILLER & PARIZEK, 1948, p. 354 [**B. bakeri;* OD] [=*Pericycloceras* ZHAO & ZHENG, 1977, p. 243 (type, *P. costatum,* OD); =*Eolegoceras* LEONOVA in LEONOVA & DMITRIEV, 1989, p. 123 (type, *E. murgabense,* OD)]. Similar to *Metalegoceras*, but with strong transverse ribs retained to maturity. Three or four species. [The single specimen referred to *Pericycloceras costatum* exhibits a shallow crenulation on the fourth external saddle, close to the umbilical seam. Such features are developed sporadically in other metalegoceratids and are regarded as pathologic or capricious (GLENISTER, WINDLE, & FURNISH, 1973).] *Cisuralian (Artinskian), Guadalupian (?Roadian–?Wordian):* USA (New Mexico, Nevada, California), China (Guizhou, Zhejiang), Tajikistan (Pamir).——FIG. 109,*1a–b*. **B. bakeri*, holotype, USNM 112961, middle Hueco Formation, Artinskian, New Mexico, ×1.5 (Miller & Parizek, 1948).——FIG. 109,*1c–e*. *B. costatum*, type species of *Pericycloceras,* Dingji-

ashan Formation, ?Roadian, Zhejiang, ×1.5 (Zhao & Zheng, 1977).

Juresanites MAKSIMOVA, 1940b, p. 862 [**J. primitivus*; OD] [?=*Mennneroceras* ANDRIANOV, 1985, p. 127 (type, *M. menneri*, OD); described from a single specimen, on which subdivision details of the umbilical lobe are unclear]. Conch variable in relative width (W/D, 0.6–0.9) and umbilical diameter (Umin/D, 0.25–0.6). Characterized by incomplete isolation of three subdivisions of umbilical lobe: outer subdivision (U_2) is close to umbilical shoulder, with an area less than one half that of U_1; dorsal subdivision (U_3) is a shallow crenulation centered on umbilical seam or wall. Sutural formula: (V_1V_1) $L(U_2U_1U_3)$:ID [Russian]. Ten named species. *Cisuralian (Asselian–lower Sakmarian [Tastubian]):* Kazakhstan (Southern Urals), Russia (Southern Urals, Verkhoian), Western Australia (Perth Basin), Indonesia (Timor).——FIG. 109,*2a–c. *J. primitivus*, Asselian, Southern Urals; *a–b*, ×0.67; *c*, diameter at 45 mm (Ruzhentsev, 1952b).

Pseudoschistoceras TEICHERT, 1944, p. 87 [**P. simile*; OD] [?=*Gaoyaonites* XU, 1979, p. 42 (type, *G. guangdongensis,* OD]. Conch relatively narrow (W/D, 0.45–0.6) with small umbilicus (Umin/D, 0.25–0.35). Suture characterized by second tripartition of umbilical lobe to form a total of 16 lobes, 9 external. Sutural formula: (V_1V_1)$LU_2(U_{1.2}U_{1.1}$:$U_{1.2}$) U_3ID [Russian]. Three or four species. *Cisuralian (Artinskian [Baigendzhinian,* and possibly *Aktastinian]):* Western Australia (Carnarvon Basin), Indonesia (Timor, Western Irian Jaya), ?southern China (Guizhou, Guangdong).——FIG. 110*a–c. *P. simile*, Cordalia Sandstone, Carnarvon Basin, Western Australia; *a–b*, ×0.67; *c*, diameter at 80 mm (Glenister & Furnish, 1961).——FIG. 110*d–e. *P. gigas* (SMITH), Bitauni beds, Baigendzhinian, Timor; *d*, ×0.33; *e*, diameter at 115 mm (Glenister & Furnish, 1961).

Subfamily SPIROLEGOCERATINAE Nassichuk, 1970

[Spirolegoceratinae NASSICHUK, 1970, p. 86; RUZHENTSEV, 1974a, p. 28; BOGOSLOVSKAIA & PAVLOVA, 1988, p. 112, *partim*] [=Anuitidae ANDRIANOV, 1985, p. 154, *partim*]

Conch intermediate in size (up to 20 cm diameter), subdiscoidal and narrowly umbilicate (U/D, less than 0.4). Growth lines and constrictions prosiradiate; ornament reticulate, with prominent longitudinal lirae retained to maturity. Sutures twelve lobed, characterized by broad ventral prongs. Sutural formula: (V_1V_1)LU_2U_1:U_3ID [Russian]. [A rare unnamed metalegoceratid species from the Cisuralian (Sakmarian) of Western Australia (GLENISTER, WINDLE, & FURNISH, 1973, p. 1040) has sutural and conch characteristics of ancestral *Sverdrupites* and perhaps also of *Spirolegoceras.*] *Cisuralian (?upper Sakmarian [?Sterlitamakian]), Guadalupian (Roadian).*

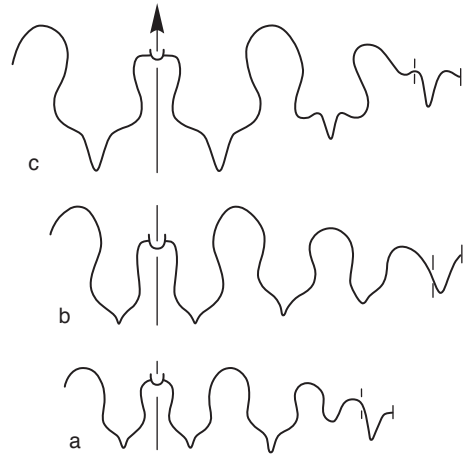

FIG. 111. Variations in width of ventral lobe prongs and in shape of lobes in Spirolegoceratinae (p. 177–178).

Spirolegoceras MILLER, FURNISH, & CLARK, 1957, p. 1064 [**S. fischeri;* OD][=*Gobioceras* BOGOSLOVSKAIA in BOGOSLOVSKAIA & PAVLOVA, 1988, p. 112 (type, *G. elenae*, OD)]. Suture characterized by prongs of ventral lobe that are wider than lateral lobe; ventral prongs and lateral lobe are strongly expanded medially, incipiently trifid at maturity; ventral subdivision of umbilical lobe (U_2) retains curved divergent flanks through ontogeny. Two species. [*Gobioceras* was named for a Roadian species from the Kirgizian Tien-Shan. It may serve as a primitive subgenus of *Spirolegoceras*, in which the ventral trifurcation (U_2) of the primary umbilical lobe remained smaller than the original element (U_1).] *Guadalupian (Roadian):* USA (Idaho), Mongolia (Gobi Tien-Shan).——FIG. 112,*1a–c. *S. fischeri*, Meade Peak Member, Phosphoria Formation; *a–b,* topotype, SUI 33053, ×1.33; *c*, diameter at 21 mm (Nassichuk, 1970).——FIG. 112,*1d–e. *S. elenae*, Roadian, Gobi Tien-Shan, ×0.67 (Bogoslovskaia & Pavlova, 1988).——FIG. 111*c. *S. elenae*, Roadian, Gobi Tien-Shan; diameter approximately 60 mm (Bogoslovskaia & Pavlova, 1988).

Sverdrupites NASSICHUK, 1970, p. 89 [**Spirolegoceras harkeri* RUZHENTSEV, 1961, p. 61; OD] [=*Anuites* ANDRIANOV, 1985, p. 156 (type, *A. Kosynskyi*, OD); =*Pseudosverdrupites* KUTYGIN, 1996, p. 18 (type, *P. Bidnikovi*, OD)]. Similar to *Spirolegoceras*, but lateral lobe and prongs of ventral lobe did not become incipiently trifid; width of ventral prongs 0.85–1.2 mm (V_1/L) that of corresponding lateral lobe. Ventral subdivision of umbilical lobe (U_2) is expanded medially in all but the questionable Australian representative. Three or four species. [Figures 112,*1d,* 112,*2d,* and 112,*2e* herein portray stages in development of the two external subdivisions

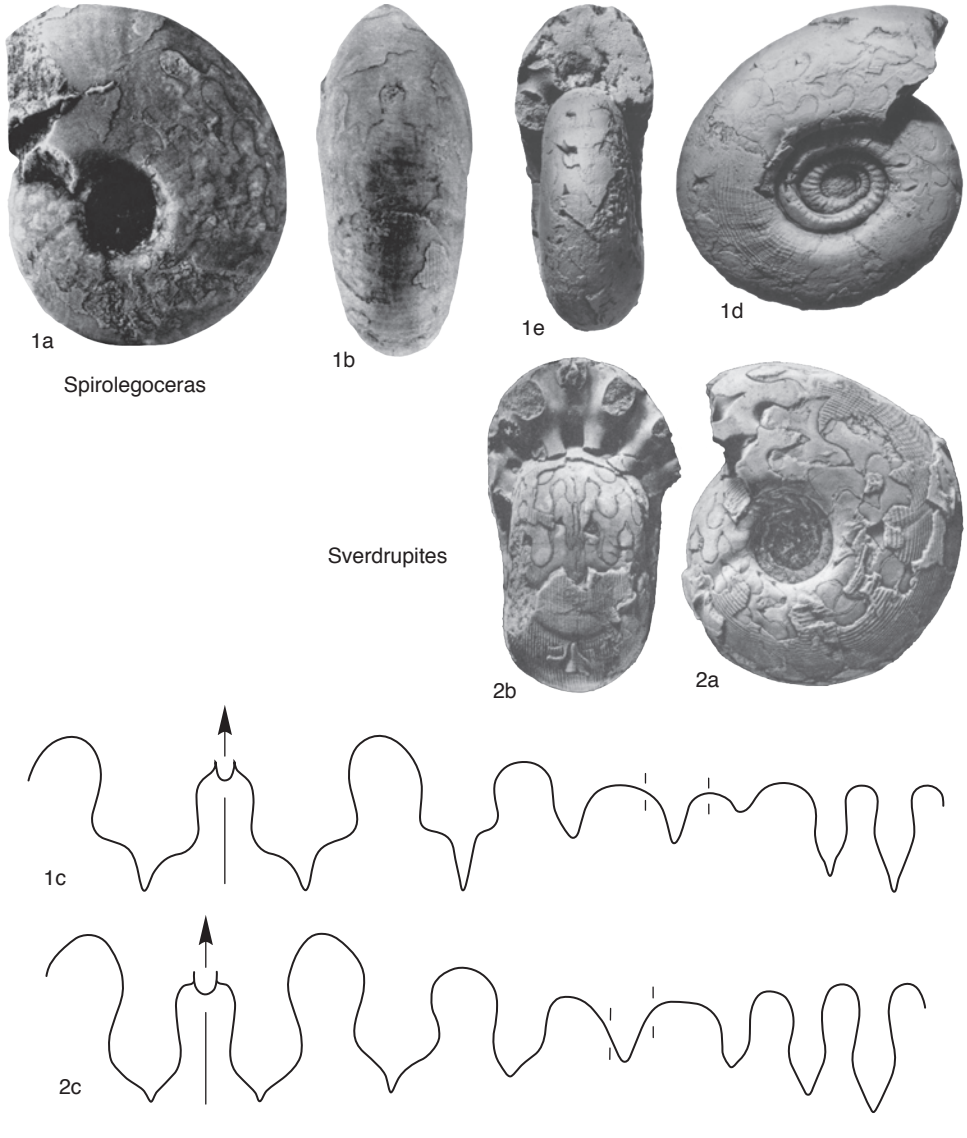

FIG. 112. Metalegoceratidae (p. 177–178).

of the primary umbilical lobe, confirming metalegoceratid affinities.] *Cisuralian (?upper Sakmarian [?Sterlitamakian]), Guadalupian (Roadian):* Canada (Arctic Archipelago: Devon Island, Melville), Russia (Novaia Zemlia,Volga-Urals, Omolon Massif, Okhotskii Massif, Verkhoian), Western Australia (?Carnarvon Basin).——FIG. 112,*2a–c.* **S. harkeri* (RUZHENTSEV), Assistance Formation, Roadian, Devon Island, Canada; *a–b*, ×1.3 (Nassichuk, Furnish, & Glenister, 1966); *c*, diameter at 60 mm (Nassichuk, 1970).——FIG. 111*b.* **S. harkeri* (RUZHENTSEV), Assistance Formation, Roadian, Devon Island, Canada; external part of Figure 112,*2c* (Nassichuk, 1970).——FIG. 111*a. S.* sp., Assistance Formation, Devon Island, diameter at 30.5 mm (Nassichuk, 1970).

Subfamily EOTHINITINAE Ruzhentsev, 1956

[*nom. transl.* FURNISH, 1973, p. 526, *ex* Eothinitidae RUZHENTSEV, 1956b, p. 193] [=Epiglyphioceratinae ZAKHAROV, 1984, p. 152]

Discoidal metalegoceratids with wide umbilicus; strong ribs form deep ventral sinus. Twelve lobes, seven external. Sutural

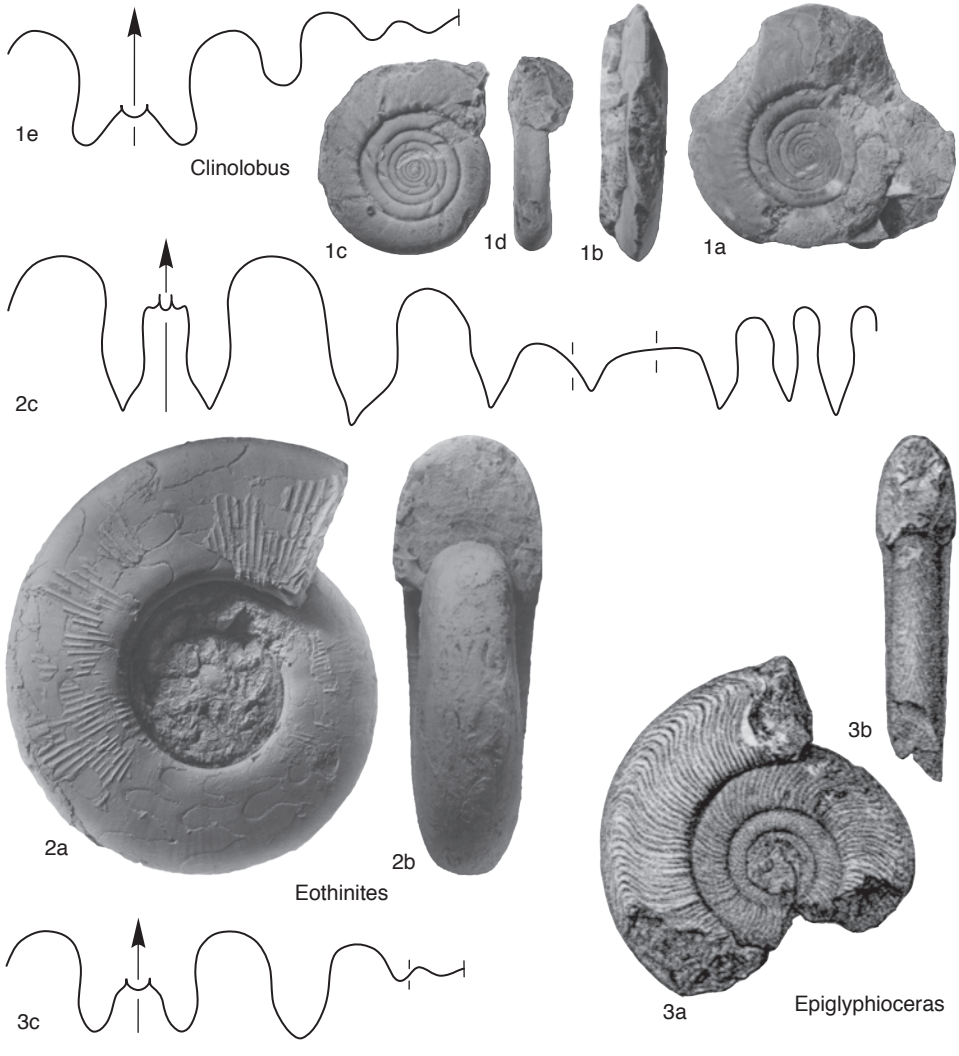

FIG. 113. Metalegoceratidae (p. 179–180).

formula: $(V_1V_1)LU_2U_1{:}U_3ID$ [Russian]. [Full familial status may be justifiable, but is not recognized herein due to uncertainty of some aspects of phylogenesis. Wordian eothinitins represent the terminal paedomorphs of the Metalegoceratidae.] *Cisuralian (lower Artinskian)–Guadalupian (Wordian).*

Eothinites RUZHENTSEV, 1933, p. 169 [**E. kargalensis*; OD] [=*Uralites* CHERNOV, 1907, p. 292, *nom. nud.*, *non* VOINOVA, 1934, p. 3, *nom. nud.*; =*Rhiphaeites* RUZHENTSEV, 1933, p. 171 (type, *Paralegoceras pseudo-meneghinii* HANIEL, 1915, p. 64, OD)]. Conch subdiscoidal (W/D, 0.2–0.4) with moderately wide umbilicus (Umin/D, 0.35–0.7). Ribs commonly bifurcate on umbilical shoulder and may be associated with weaker longitudinal lirae; shallow sinus across flanks is separated from deeper ventral sinus by prominent ventrolateral salient. Prongs of ventral lobe are generally much narrower than corresponding lateral lobe, but may be up to 1.5 times that width. Thirteen species. [Extreme variation in the relative width of prongs of the ventral lobe may indicate polyphyletic derivation; narrow prongs resemble those of *Paragastrioceras*, wider ones *Uraloceras*, and each may warrant full generic status.] *Cisuralian (lower Artinskian [Aktastinian]–Kungurian):* Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Ukraine (Crimea), Indonesia (Timor), USA (Texas), China (Guizhou, Guangxi, Xinjiang).——FIG. 113,*2a–c.*

Epiglyphioceras* Spath, 1930, p. 13 [Glyphioceras meneghinii* Gemmellaro, 1887, p. 92; OD]. Similar to *Eothinites* in general conch form, but smaller and with ribs outlining deeper sinus across venter (depth of sinus one-half corresponding whorl width). Prongs of ventral lobe less than two-thirds width of lateral lobe. Two species. [Tripartition of primary umbilical lobe, at about 10 mm phragmocone diameter, has not been reported previously. As the diminutive terminal paedomorph of the Eothinitinae, *Epiglyphioceras* closely resembles similar-sized juvenile stages of the large Cisuralian ancestor *Eothinites*.] *Guadalupian (?Roadian, Wordian):* Italy (Sicily), Tajikistan (Pamir), Afghanistan. ——Fig. 113,*3a–c*. **E. meneghinii* (Gemmellaro), lectotype (herein), MGUP 134 (Gemmellaro, 1887, pl. 10,*39–40*), Sosio limestone, Sicily; *a–b*, ×2 (Gemmellaro, 1887); *c*, diameter at 15 mm (new).

Subfamily CLINOLOBINAE Miller, Furnish, & Schindewolf, 1957

[Clinolobinae Miller, Furnish, & Schindewolf, 1957, p. 67]

Similar to Eothinitinae in sutural ontogeny and general conch form, but narrowly lenticular with acutely angular venter at maturity. *Cisuralian (upper Artinskian [Baigendzhinian])–Guadalupian (Wordian).*

Clinolobus* Gemmellaro, 1887, p. 84 [C. Telleri;* OD]. Small metalegoceratids (2 cm maximum diameter), with umbilical ratio (Umin/D) approximating 0.5. Conch narrowly discoidal with rounded venter to 10 mm diameter, thereafter lenticular with acutely angular venter. Low nodes closely spaced on dorsolateral shoulder; fine ribs became strongly biconvex coincident with development of angular venter. All lobe bases rounded to maximum observed conch diameter; primary umbilical lobe strongly tripartite by 8 mm phragmocone diameter. Two species. [Juveniles closely resemble *Epiglyphioceras* in conch form, ornament, and suture. Distinguishing generic characters developed coincident with formation of angular venter.] *Cisuralian (upper Artinskian [Baigendzhinian])–Guadalupian (Wordian):* Italy (Sicily), USA (western Texas).——Fig. 113,*1a–e*. **C. telleri*, Sosio limestone, Wordian, Sicily; *a–b*, lectotype (herein), MGUP 127A of Gemmellaro (1887, pl. 10,*29–30*), ×2; *c–d*, paralectotype, MGUP 127B of Gemmellaro (1887, pl. 10,*31–33*), mature and juvenile conchs, respectively, ×2; *e*, diameter at 8 mm (all new).

POPANOCERATOIDEA

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Superfamily POPANOCERATOIDEA Hyatt, 1900

[*nom. transl.* Ruzhentsev, 1957, p. 59, *ex* Popanoceratidae Hyatt, 1900, p. 564]

Conch small (diameter less than 10 cm), narrowly discoidal (W/D, 0.1–0.35), and usually involute beyond third or fourth volution. Ribs and constrictions form high dorsolateral salient and slope backward through shallow ventrolateral sinus to narrow U- or V-shaped sinus across rounded to flat venter. Distinctive hemispherical pits occur on shell surface and internal mold and across midflanks in many juveniles. Mature modifications comprise subterminal constriction, terminal flare, and formation of pair of narrow ventrolateral keels bounding accentuated hyponomic sinus. Basic sutural formula: $(V_1V_1)L_2L_1(L_{2.1}L_{2.1})U^1U_1{:}U^2U_2(I_{2.1}I_{2.1})I_{1.1}I_{1.2}(D_2D_1D_2)$ [Russian], $(E_1E_mE_1)A_{1v}A_{1m}A_{1dv}A_{1d2v}A_{1d3}A_2LU_2U_3U_{1v2}U_{1vd}U_{1m}U_{1d}(I_1I_mI_1)$ [German].

All saddles rounded, dorsal lobe (D) incipiently trifid, most lateral lobes strongly denticulate at base, especially in advanced forms. Total number of lobes 22 to 38. Umbilical complex stabilized at 4 lobes, 2 of them derived from saddles ($U > U^1U_1{:}U^2U_2$). External lateral lobes added by repeated bifurcation and subsequent isolation of lateral lobe nearest umbilicus: $L_2 > L_{2.1}L_{2.1} > L_{2.1}(L_{2.1.1}L_{2.1.1})$. Mode of addition of internal lateral lobes distinctive, according to formula: $I > I_2I_1 > (I_{2.1}I_{2.1})I_{1.1}I_{1.2} > (I_{2.1.1}I_{2.1.1})$

$I_{2.1}I_{1.1}I_{1.2}$. *Cisuralian (Asselian)–Lopingian (Wuchiapingian).*

Family POPANOCERATIDAE Hyatt, 1900

[Popanoceratidae Hyatt, 1900, p. 564] [=Tauroceratinae Tumanskaia, 1939, p. 18; =Pamiropopanoceratinae Leonova, 2002, p. 96]

Involute popanoceratoideans (U/D, 0.1–0.2) that during phylembryogenesis developed prongs of ventral lobe that are substantially broader than adjacent lateral lobes, and strong denticulation of most external lateral lobes. Sutural trace straight and directly transverse. [This ancestral family originated in the earliest Permian Asselian age with one rare, diminutive species. Size, abundance, and specific diversity increased to maxima in the Guadalupian (Artinskian through Wordian). Thereafter, the group declined to eventual extinction, ending with a rare paedomorphic relic in the basal Wuchiapingian Stage, substantially before the end of the Permian (Glenister & Furnish, 1988b).] *Cisuralian (Asselian)–Lopingian (Wuchiapingian).*

Popanoceras Hyatt, 1884 in 1883–1884, p. 337 [**Goniatites sobolewskyanus* de Verneuil, 1845, p. 372; SD Gemmellaro, 1887, p. 19, as *Popanoceras Sobolewskianum* (*sic*)] [=*Pamiropopanoceras* Leonova in Leonova & Dmitriev, 1989, p. 174 (type, *P. meridionale,* OD)]. Prongs of ventral lobe (V_1) equal to or wider than adjacent lateral lobe, bidentate to quadridentate; four or five external lateral lobes moderately dentate. Twelve named species. *Cisuralian (lower Artinskian [Aktastinian])–Guadalupian (Roadian):* Kazakhstan (Southern Urals), Russia (Southern Urals), China (Xizang, Jilin, Guizhou), Japan (Fukushima), Madagascar, Tajikistan (Pamir), Ukraine (Crimea), Indonesia (Timor), Western Australia (Carnarvon Basin), USA (Texas).——Fig. 114,*1a–e.* **P. sobolewskyanum* (de Verneuil), upper Artinskian, Baigendzhinian, Southern Urals; *a–c,* ×0.67; *d,* diameter approximately 25 mm (Ruzhentsev, 1956b); *e*, diameter at 35 mm (Miller & Furnish, 1940a).

Epitauroceras Glenister & Furnish, 1988b, p. 57 [**E. soewarnoi*; OD]. Terminal relics of Popanoceratidae, characterized by small size (diameter less than 25 mm), and first lateral lobe with denticulation extending more than one-half distance to crest of first lateral saddle. One species. [*Epitauroceras* conforms to pattern now recognized for a significant number of Late Paleozoic ammonoid family-group taxa (Glenister & Furnish, 1988b) in which the last survivors for each group are rare, diminutive paedomorphs.] *Lopingian (Wuchiapingian):* Indonesia (Timor).——Fig. 114,*2a–e.* **E. soewarnoi*, Amarassi beds; *a–c*, ×0.67; *d–e*, diameter about 10–12 mm (Glenister & Furnish, 1988b).

Neopopanoceras Schindewolf, 1939a, p. 447, *nom. nov.* Zhou & Glenister, herein, p. 218, *pro Tauroceras* Tumanskaia, 1938b, p. 145 (type, *Tauroceras scrobiculatum* Tumanskaia, 1938b, p. 145, OD), *non* Hope, 1840, modern insect, Coleoptera, *fide* ICZN *Code* Articles 23.3.5, 52.2 [**Popanoceras scrobiculatum* Gemmellaro, 1887, p. 25; OD; *fide* ICZN *Code* 67.8–67.8.1] [=*Gemmellaroceras* Tumanskaia, 1937d, p. 470, *nom. nud.*, *non* Hyatt, 1900, p. 574, Jurassic ammonoid]. Prongs of ventral lobe much wider than adjacent lateral lobe. Six or seven external lateral lobes at maturity, most strongly denticulate like ventral prongs. Eleven named species. *Guadalupian (Wordian):* Italy (Sicily), Tunisia, Oman, Iraq (Kurdistan), Afghanistan, Ukraine (Crimea), Tajikistan (Pamir), Malaya, China (Jilin, Xizang, Xinjiang), USA (western Texas), Mexico (Coahuila).——Fig. 115,*1a–f.* **N. scrobiculatum* (Gemmellaro), Sosio limestone, Sicily; *a–c,* topotype, MGUP 45 of Gemmellaro (1888, pl. B,*2–4*), ×0.67; *d–f,* ×1.33 (Glenister & Furnish, 1988b).——Fig. 115,*1g. N. bowmani* (Böse), Word Limestone, western Texas, diameter at 40 mm (Miller & Furnish, 1940a).

Propopanoceras Tumanskaia, 1938a, p. 108 [**Popanoceras Lahuseni* Karpinskii, 1889, p. 67; OD)]. Prongs of ventral lobe bidentate and narrower than corresponding first lateral lobe. Four or five external lateral lobes, at least one of which is tridentate or quadridentate, fourth or fifth incipiently bifid. Seven named species. [There are no suitable illustrations of the holotype available.] *Cisuralian (Sakmarian):* Russia and Kazakhstan (Southern Urals), Indonesia (Timor), Western Australia (Canning Basin), USA (western Texas).——Fig. 115,*2a–c. P. simense*, Tastubian, Urals; *a–b*, ×1.5; *c*, diameter at 23 mm (Ruzhentsev, 1951).

Protopopanoceras Ruzhentsev, 1938, p. 260 [**Popanoceras sublahuseni* Gerasimov, 1937, p. 18; OD]. Rare ancestral popanoceratids characterized by combination of ventral prongs narrower than adjacent lateral lobe, bidentate first and second lateral lobes, and bifid third lateral ($L_{2.1}L_{2.1}$). One species. *Cisuralian (Asselian):* Russia (Southern Urals).——Fig. 115,*3a–c.* **P. sublahuseni* (Gerassimov); *a–b,* ×1; *c,* diameter at 25 mm (Ruzhentsev, 1951).

Family MONGOLOCERATIDAE Ruzhentsev & Bogoslovskaia, 1978

[*nom. transl.* Glenister & Furnish, 1981, p. 64, *ex* Mongoloceratinae Ruzhentsev & Bogoslovskaia, 1978, p. 87]

Involute to comparatively evolute popanoceratoideans (U/D, 0.01–0.35) that maintained narrow prongs of ventral lobe during phylogenesis but developed numerous strongly denticulate lobes and also an arched

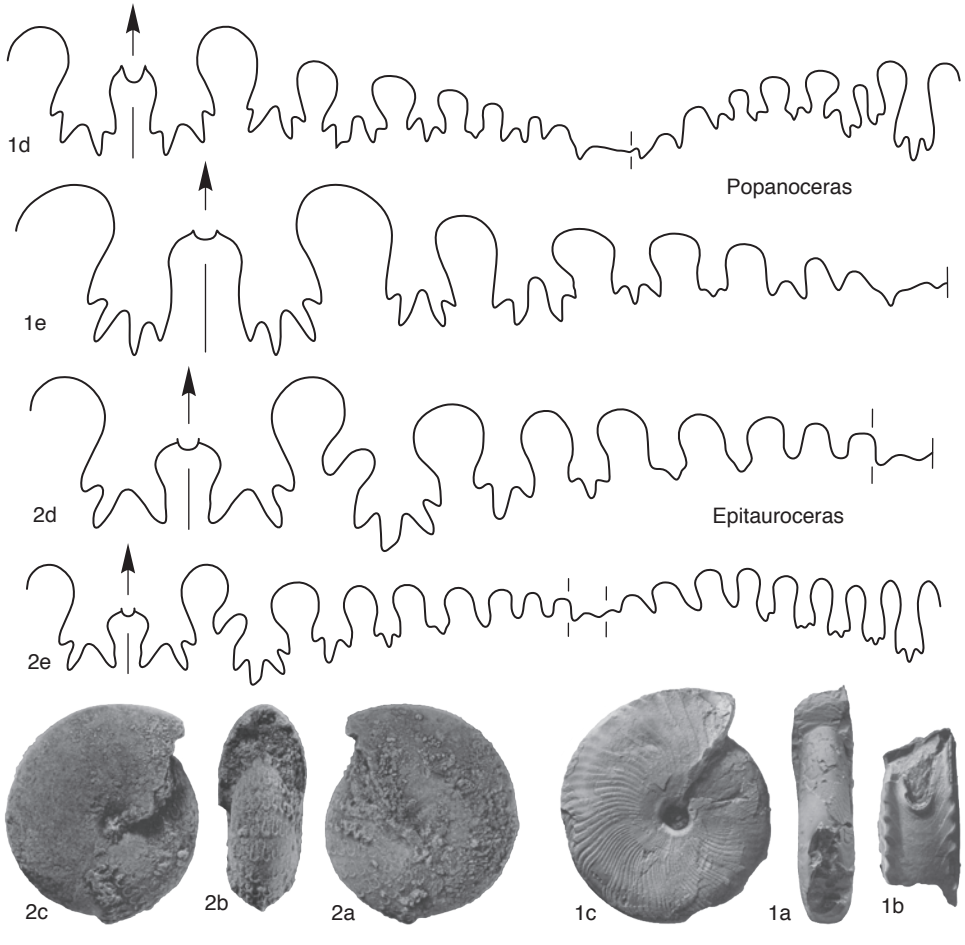

FIG. 114. Popanoceratidae (p. 181).

trace of external suture across dorsolateral flanks. [The early Permian history of the family, after presumed divergence from primitive popanoceratids, is unknown.] *Cisuralian (Kungurian)–Guadalupian (*probably *Capitanian).*

Mongoloceras RUZHENTSEV, 1960a, p. 110 [**M. gobiense;* OD]. Prongs of ventral lobe and most of six or seven external lateral lobes strongly denticulate. Mature sutures resemble popanoceratid *Tauroceras*, but juveniles have ventral prongs narrower than adjacent first lateral lobe, and arched trace of external suture dorsad of third lateral saddle. Two named species. *Guadalupian:* Mongolia (Usu-Hongor), Oman, China (?Jilin).——FIG. 116, *1a–c.* **M. gobiense*, Honguer-Ula Limestone, probable Capitanian, southern Mongolia; *a–b,* ×1.33; *c*, diameter at 22 mm (Ruzhentsev, 1960a).——FIG. 116,*1d–i. M. omanicum* GLENISTER & FURNISH, Wordian, near Ba'id, Oman; *d–h,* ×1; *i*, diameter at 40 mm (Glenister & Furnish, 1988b).

Angrenoceras SHENG, 1988b, p. 153 [**A. langcuoense*; OD]. Poorly known mongoloceratids, probably distinguishable generically by exceptionally broad secondary ventral saddle (width one-half that of entire ventral lobe). Two named species. *Guadalupian (*probably *Capitanian):* China (Xizang).

Biarmiceras LEONOVA, KUTYGIN, & SHILOVSKY, 2005, p. 479 [**Popanoceras tumarense* RUZHENTSEV, 1961, p. 60; OD]. Resembles *Mongoloceras* in narrow

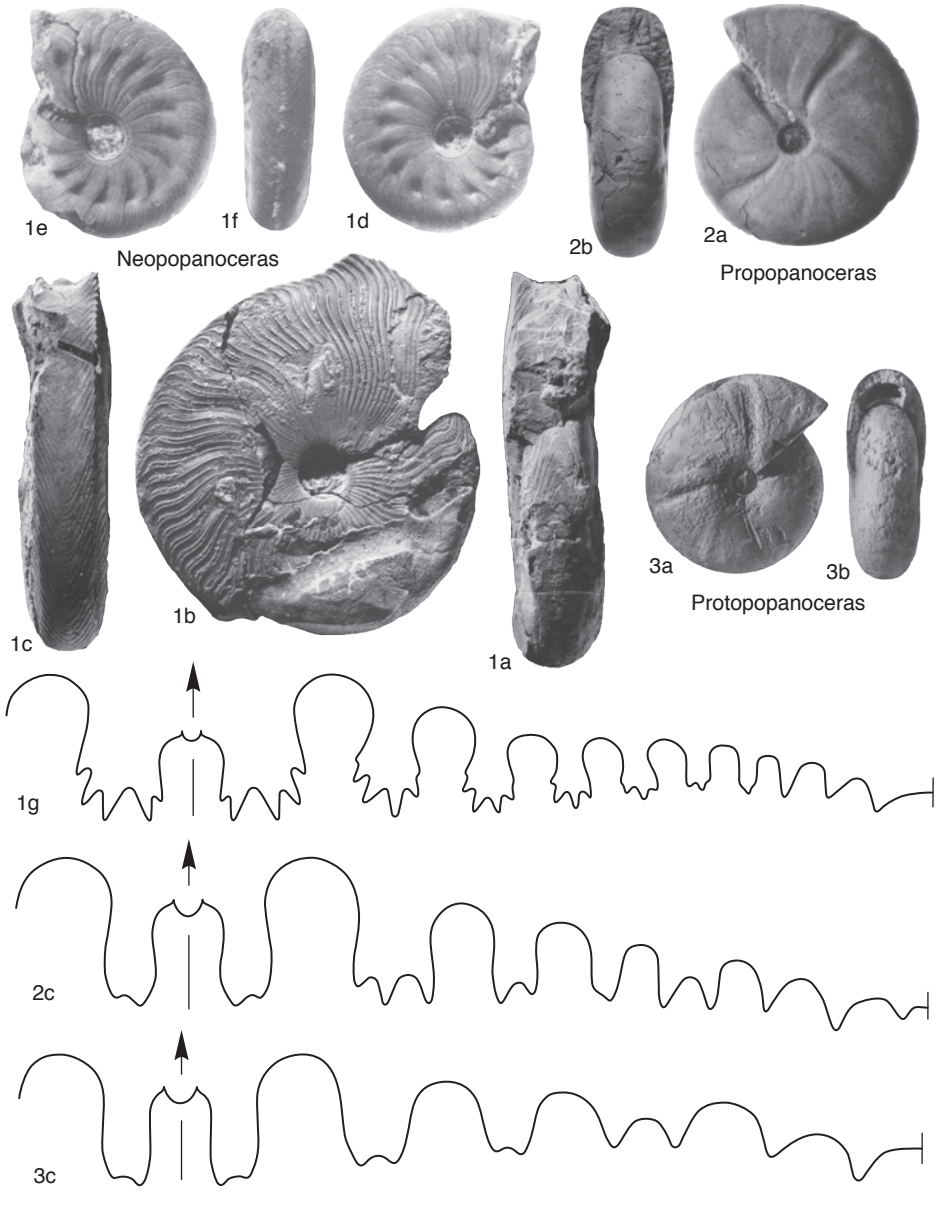

FIG. 115. Popanoceratidae (p. 181).

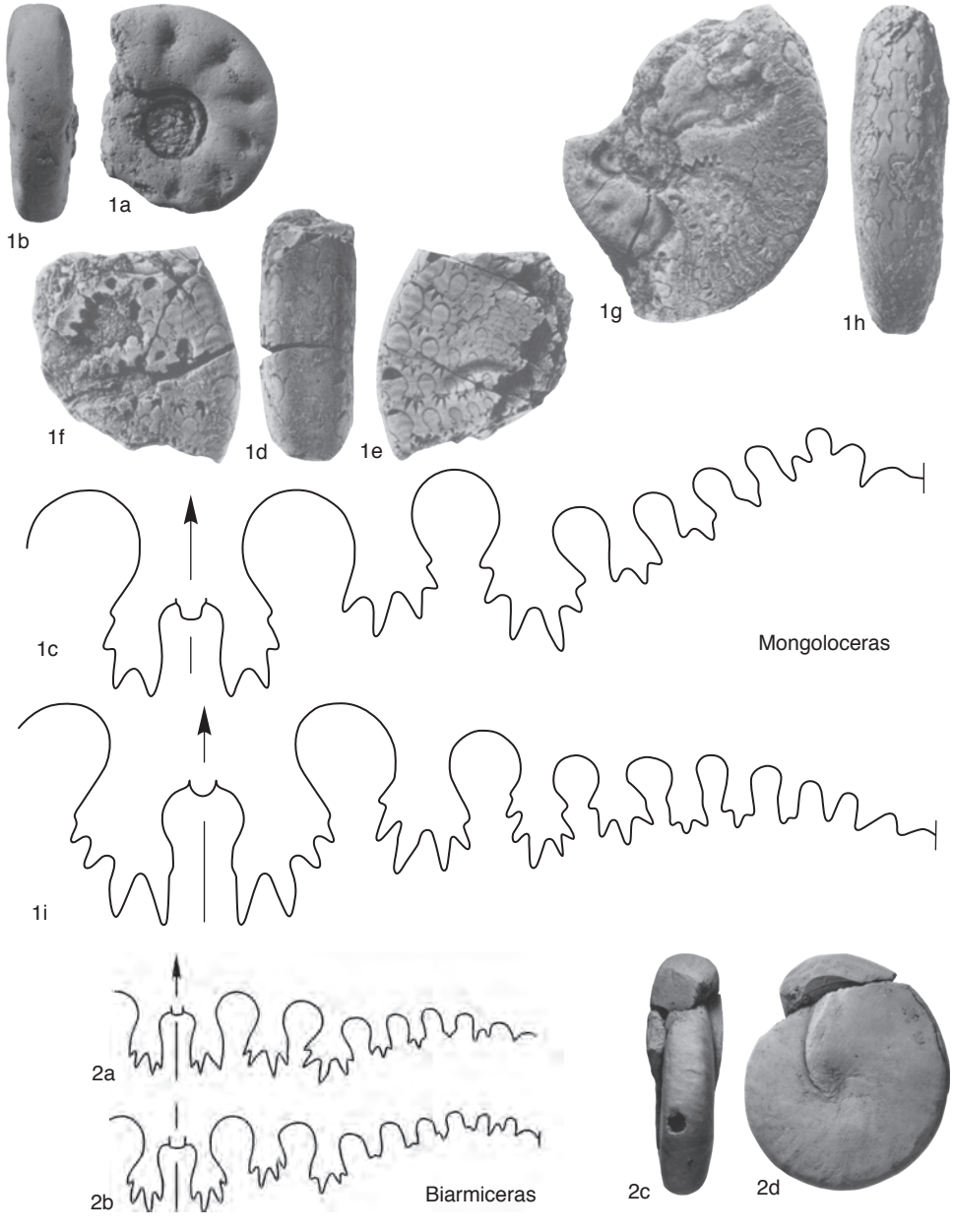

FIG. 116. Mongoloceratidae (p. 182–184).

ventral prongs, arched trace of external suture, and dorsad subdivision of third lateral saddle, but distinguishable by nearly closed or very small umbilicus (U/D 0.01–0.13). Five species. *Cisuralian (Kungurian)–Guadalupian (Roadian):* Russia (western Verkhoian, Volga-Urals), Canada (Northwest Territories).——FIG. 116,*2a. *B. tumarense* (RUZHENTSEV), holotype, Kungurian, Tumara basin, western Verkhoian, PIN 1802/31, diameter at 21.5 mm (new, courtesy of T. B. Leonova).——FIG. 116,*2b–d. B. kremeshkense* LEONOVA, KUTYGIN, & SHILOVSKY, Kazanian Stage, Volga-Urals; *b*, diameter at 31 mm; *c–d*, ×1.5 (Leonova, Kutygin, & Shilovsky, 2005).

PROLECANITIDA

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Order PROLECANITIDA Miller & Furnish, 1954

[*nom. transl.* Teichert, 1967, p. 206, *ex* Prolecanitina Miller & Furnish, 1954, p. 687] [=Medlicottiida Zakharov, 1983, p. 29]

Conch thinly discoidal to lenticular, initially widely evolute. Umbilicus narrow or closed at maturity in most representatives in the Pennsylvanian, Permian, and Triassic. Shell generally smooth or with fine growth lines that form low lateral and ventral salients; ventrolateral ribs and nodes on ventrolateral shoulder appear rarely in Carboniferous but are common in Permian. Full body chamber preserved rarely, approximately one-half volution in length, generally lacking conspicuous mature modifications. Siphuncle simple, retrochoanitic, and ventral-marginal in position. Basic formula: EALUI [German], VLU:ID [Russian]. Ventral lobe initially narrow and undivided, later tridentate to trifid, rarely broad; dorsal lobe narrow, undivided, or bidentate. Sutures characteristically comprise series of subequal lobes, lateral in position, most successively derived from saddles of umbilical lobe complex; number ranges from 8 to more than 30. Ventrolateral saddle generally lower than adjacent second lateral saddle in ancestral forms, characteristically highest element in Permian and Triassic. First lateral lobe almost invariably widest sutural element, subdivided (usually bifid) in all but ancestral representatives; in later forms ventral prong commonly transformed into complexly subdivided first lateral saddle. *Mississippian (lower Tournaisian)–Lower Triassic (Induan).*

Some uncertainty remains concerning derivation and affinities of the Prolecanitida. Several Paleozoic ammonoid specialists (Karpinskii, 1896; Schindewolf, 1933, 1951c, 1954, 1959; Ruzhentsev, 1949b, 1951, 1960d) maintained that the first lateral lobe represents the primary umbilical element, and that the basic formula therefore is: ELU_2U_1I [German], VUU[1]:ID [Russian]. However, conclusions of more recent studies (Hodgkinson, 1965; Knapp, 1965; for discussion, see Nassichuk, 1975) have confirmed the assumption that, with the possible exception of *Protocanites* and perhaps rare other relatives of ancestral forms (Knapp, 1965), all other genera usually referred to the Prolecanitida have a first so-called lateral lobe that was derived adventitiously. Consequently, the formula is EALUI [German], VLU:ID [Russian]. Affinities with the Goniatitida are therefore closer than visualized previously.

Despite recognition of basic similarity between the sutural ontogeny of Prolecanitida and Goniatitida, the former represents an evolutionary complex that can be distinguished consistently on other features of the suture as well as conch form. It may be interpreted to be ancestral to the Permian representatives of the ceratitid suborder Paraceltitina and their descendant Mesozoic lineages (Spinosa, Furnish, & Glenister, 1975). However, ontogenetic acceleration of earliest sutural development precludes unambiguous determination of the ontogenetic origin of the first so-called lateral lobe in Mesozoic ammonoids. Such determination may be afforded only by Paleozoic ancestors.

Superfamily PROLECANITOIDEA Hyatt, 1884

[*nom. transl.* Miller & Furnish, 1954, p. 687, *ex* Prolecanitidae Hyatt, 1884 in 1883–1884, p. 331]

Conch widely evolute to moderately involute, discoidal, with wide or moderately narrow umbilicus. Shell surface in general smooth except for rare ribbed species. Ventral lobe simple or trifid. Lateral and umbilical lobes simple, acute, or rounded, in some forms denticulate. Total number of lobes 10 to 22. Basic sutural formula: $EALUU_nI$ [German], $VLUU^n$:ID [Russian]. Primary lateral and umbilical lobes (L and U) maintain their identity throughout ontogeny; new elements (U_{1+n}, U^{1+n}) were added by successive derivation in saddles of umbilical lobe complex. Succession of subequal umbilical lobes decreases in size toward umbilicus. *Mississippian (lower Tournaisian)–Guadalupian (Wordian).*

Family PROLECANITIDAE Hyatt, 1884

[Prolecanitidae Hyatt, 1884 in 1883–1884, p. 331] [=Ibergiceratidae Haug, 1898, table 1]

[Materials for this family prepared by Jürgen Kullmann]

Ventral lobe simple, undivided; suture line on flanks with at least two pointed or bifid lobes. Conch shape widely umbilicate. Shell surface smooth, except for rare ribbed species; growth lines linear or sinuous. *Mississippian (lower Tournaisian–lower Serpukhovian), Pennsylvanian (?lower Bashkirian).*

Subfamily PROLECANITINAE Hyatt, 1884

[*nom. transl.* Schindewolf, 1922, p. 14, *ex* Prolecanitidae Hyatt, 1884 in 1883–1884, p. 331] [=Eocanitinae Weyer, 1972a, p. 322]

Ventral lobe pouched, orad wide or slightly narrowed, at its base pointed or pipelike elongated; suture line on flanks with at least three or more simple pointed lobes. Phylogenetic lineage: *Eocanites–Becanites–Michiganites–Prolecanites–Metacanites-Dombarocanites. Mississippian (lower Tournaisian–lower Serpukhovian), Pennsylvanian (?lower Bashkirian).*

Prolecanites Mojsisovics, 1882, p. 199 [**Goniatites mixolobus* G. Sandberger & F. Sandberger, 1850, p. 67, *pars, non* Phillips, 1836, p. 236; SD Hyatt, 1884 in 1883–1884, p. 335; =*Prolecanites mojsisovicsi* Miller, 1938, p. 181, obj.; =?*Goniatites serpentinus* Phillips, 1836, p. 237, subj.] [=*Rhipaeocanites* Ruzhentsev, 1949c, p. 737 (type, *R. librovitchi,* OD)]. Suture line with twelve lobes. Ventral lobe parallel sided or pouched, four lobes on flanks. Sutural formula: $EALU_2U_1U_3I$ [German], $VLUU^1U^2$:ID [Russian]. Many species. [The ontogenetic development of the suture is insufficiently known, and the type species is insufficiently known.] *Mississippian (upper Visean–lower Serpukhovian), Pennsylvanian (?lower Bashkirian):* Belgium, Great Britain, Germany, Bosnia-Herzegovina, Spain, Algeria, Morocco, Poland, Russia and Kazakhstan (South Urals), China (Xinjiang, Xizang), USA (Illinois, Indiana, California); China (Xinjiang), *?lower Bashkirian.*——Fig. 117,*1a–c. P. discoides* Foord & Crick, holotype, Carboniferous Limestone, Yorkshire, England, upper Visean, BMNH C.231; *a–b,* ×1; *c,* suture, diameter at 45 mm, enlarged (Foord & Crick, 1897).

Becanites Korn, 1997, p. 34 [**Prolecanites algarbiensis* Pruvost, 1914, p. 17; OD]. Similar to eight lobes of *Protocanites.* Two lobes on flanks, first lateral lobe slightly pouched, second lateral lobe next to umbilicus lanceolate and long. Six species. [The ontogenetic development of the suture for this genus is insufficiently known.] *Mississippian (middle Tournaisian, ?lower upper Tournaisian):* Germany, Portugal, Morocco, Russia and Kazakhstan (South Urals), USA (Kentucky, Missouri).——Fig. 117,*3a–b. *B. algarbiensis* (Pruvost), neotype, 0.6 km southwest of Bordeira, Portugal, from Bordalete Formation, middle Tournaisian, IGML 253; *a,* ×2; *b,* incomplete suture, diameter at 16 mm, ×5.5 (Korn, 1997).

Dombarocanites Ruzhentsev, 1949c, p. 738 [**D. chancharensis* Ruzhentsev, 1949c, p. 739; OD]. Conch cross section oval. Suture line in general similar to *Prolecanites* and *Metacanites.* Upper part of ventral lobe wide, parallel sided or divergent; basic part very narrow, pipelike. Dorsal lobe bifid. Four species. [This genus is transitional to *Prolecanites* and *Metacanites* and may be a junior synonym of either one; for discussion, see Weyer, 1972a, p. 329.] *Mississippian (upper Visean–lower Serpukhovian):* Serbia, Russia and Kazakhstan (South Urals), Uzbekistan (Fergana), USA (Utah, California).——Fig. 118,*2a–c. *D. chancharensis*, Dombar Hills, South Urals, Kazakhstan; *a–b,* uppermost Visean, PIN 455/1109, ×1; *c,* suture of holotype, lower Serpukhovian, PIN 455/12, whorl height at 8.5 mm, whorl width 5 mm, ×4.8 (Ruzhentsev & Bogoslovskaia, 1971).

Eocanites Librovich, 1957, p. 263 [**Protocanites supradevonicus* Schindewolf, 1926a, p. 104; OD]. Only eight lobes; two lobes on flanks, first lateral lobe considerately longer than second. Sutural formula: EALUI [German], VLU:ID [Russian] Many species. [The ontogenetic development

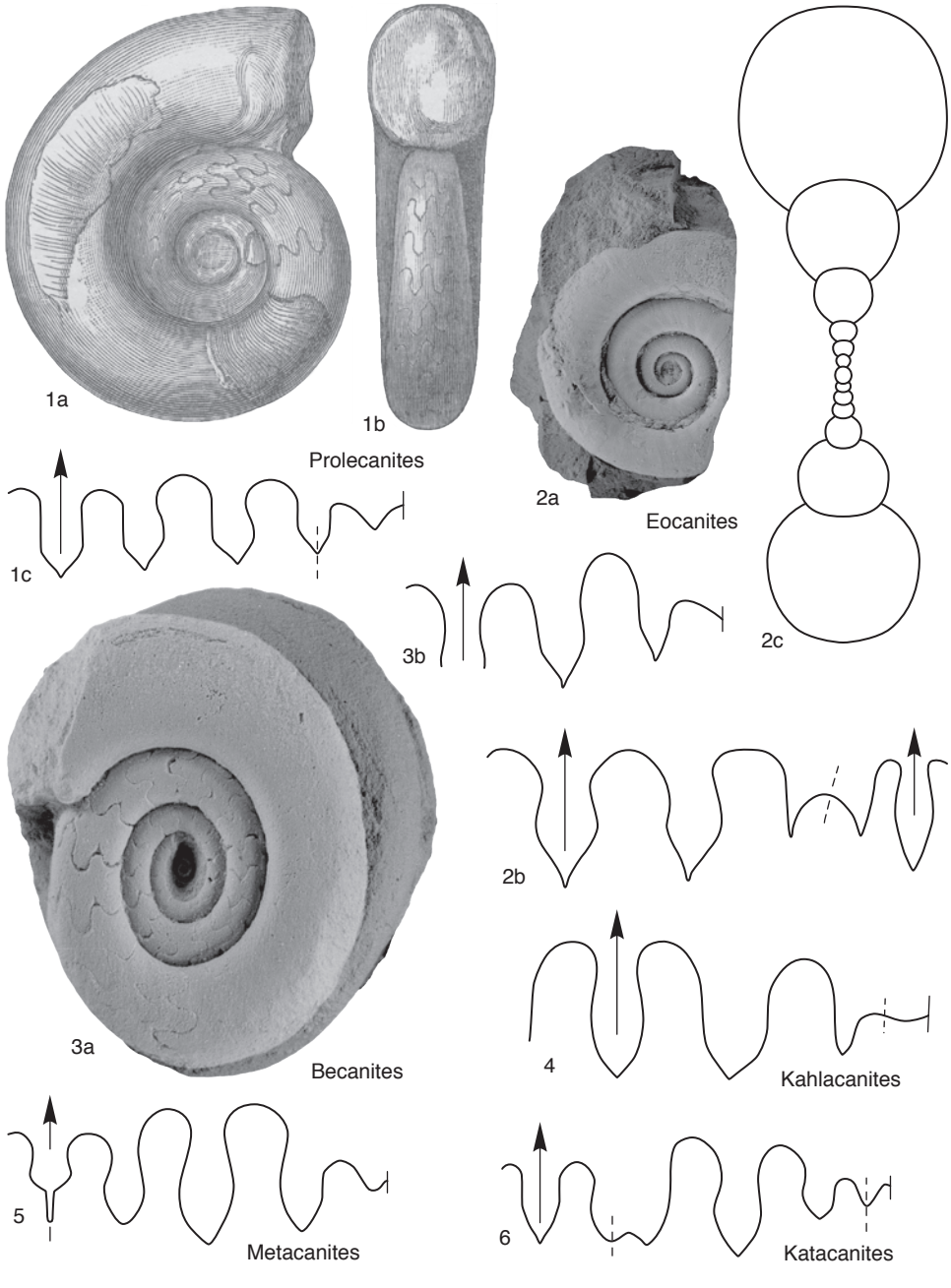

FIG. 117. Prolecanitidae (p. 186–188).

of the suture is insufficiently known.] *Mississippian (lower Tournaisian, ?middle Tournaisian):* Germany, Austria, France, Portugal, ?Morocco, Poland, ?Kazakhstan, China (Guizhou), ?Canada (Alberta).——FIG. 117,*2a–c. *E. supradevonicus* (SCHINDEWOLF); *a,* Ober-Rödinghausen, railway cut, Sauerland, Rhenish Massif, Germany, lowermost layer of Hangenberg limestone, lowermost Tournaisian, GPIT 1130/161, ×1.25; *b,* suture, whorl height at 6.5 mm, whorl width 6.8 mm, GPIT

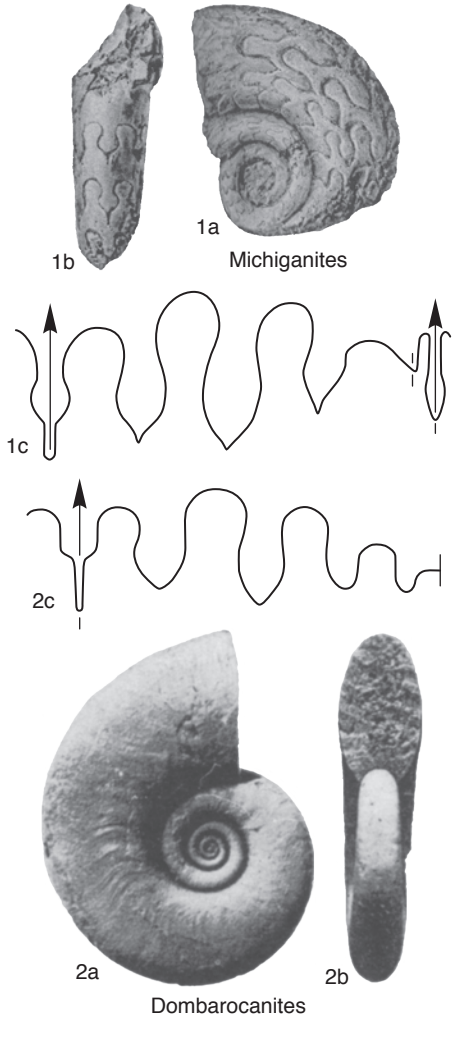

FIG. 118. Prolecanitidae (p. 186–188).

1130/181, ×4.8 (Korn, 1994); *c,* cross section, GPIT 1130/133-134, ×2.5 (Vöhringer, 1960).

Kahlacanites EBBIGHAUSEN & others, 2004, p. 144 [**K. mariae* EBBIGHAUSEN & others, 2004, p. 147; OD]. Ten lobes, three lobes on flanks; second lateral lobe small and hooklike, third rounded and shallow. Sutural formula: EAL_1L_2UI [German], VLU^1U^2:ID [Russian]. Three species. [The ontogenetic development of the suture for this genus is insufficiently known.] *Mississippian (lower Tournaisian):* Algeria.——FIG. 117,*4. *K. mariae,* Gara el Kahla, 35 km southwest of Timimoun, Gourara, Algeria, Grès Supérieur de Kahla, MB.C.5471.1, diameter at 13.9 mm, whorl height 5.0 mm, whorl width 5 mm, ×6.6 (Ebbighausen & others, 2004).

?Katacanites KULLMANN, 1963, p. 283 [**K. quadratoides* KULLMANN, 1963, p. 284; OD]. First lateral lobe bifid, three simple umbilical lobes on flank. One species. [The relationship of the genus is questionable, because the ontogenetic development of the suture is unknown.] *Mississippian (upper Visean):* Spain.——FIG. 117,*6. *K. quadratoides,* holotype, suture, Peña Roscas, Crémenes, León Province, red limestones, Alba Formation, GPIT 1237/363, whorl height at 13.5 mm, whorl width 9.5 mm, ×2.7 (Kullmann, 1963).

?Metacanites SCHINDEWOLF, 1922, p. 15 [**M. serpentinus;* OD; =*Prolecanites serpentinus* DOLLÉ, 1912, p. 251, *non Goniatites serpentinus* PHILLIPS, 1836, p. 237; in accordance with ICZN *Code* Art. 7b]. Conch cross section oval. Suture line in general similar to *Prolecanites.* Upper part of ventral lobe wide, pouched, and orad narrowed; basic part very narrow, pipelike. Two or three species. [This genus is transitional to *Prolecanites* and may be its junior synonym; it is also transitional to *Dombarocanites* and may be its senior synonym; for discussion, see WEYER, 1972a, p. 330. The type species is insufficiently known.] *Mississippian (upper Visean):* Spain, Algeria.——FIG. 117,*5. M. primitivus* KULLMANN, holotype, suture, Peña Roscas, Crémenes, León Province, Spain, red limestones, Alba Formation, GPI T 1237/518, whorl height at approximately 9 mm, whorl width 5 mm, ×4.4 (Kullmann, 1963).

Michiganites RUZHENTSEV in BOGOSLOVSKII, LIBROVICH, & RUZHENTSEV, 1962, p. 348 [**Goniatites marshallensis* WINCHELL, 1862, p. 362; OD]. Suture line with ten lobes. Ventral lobe pouched, three lobes on flanks. Sutural formula: $EALU_2U_1I$ [German], $VLUU^1$: ID [Russian]. Eight or nine species. [The ontogenetic development of the suture is insufficiently known.] *Mississippian (upper Tournaisian–lower Visean):* Great Britain, Ireland, Germany, Russia (North Urals), Spain, Algeria, China (Xizang, Yunnan), Kazakhstan, Kyrgyzstan (Tian Shan), Mongolia, Argentina, USA (Indiana, Michigan, Ohio).——FIG. 118,*1a–c. *M. marshallensis* (WINCHELL), Marshall, Calhoun County, Michigan, Marshall Sandstone, Osagean; *a,* adoral half of specimen, UM 30713b, ×1; *b,* syntype, side view, UM 26685a, ×1; *c,* suture, whorl height at 13 mm, ×2.6 (Miller & Garner, 1955).

Subfamily PROTOCANITINAE Weyer, 1972

[Protocanitinae WEYER, 1972a, p. 325]

Ventral lobe funnel shaped; suture line on flanks with at least two or more simple pointed lobes. Phylogenetic lineage: *Protocanites–Merocanites–Cantabricanites. Mississippian (middle Tournaisian–upper Visean).*

Protocanites SCHMIDT in PAECKELMANN, 1922, p. 283 [**Goniatites lyoni* MEEK & WORTHEN, 1860, p. 471; SD LIBROVICH, 1940, p. 75]. Only eight lobes; two lobes on flanks. Sutural formula: EALUI [German], VLU:ID [Russian]. Seven species. [The ontogenetic development of the suture is insufficiently known]. *Mississippian (middle Tournaisian–upper*

Tournaisian): Belgium, Great Britain, Germany, France, Algeria, Morocco, China (Xinjiang), Japan, Australia (New South Wales, Queensland), USA (?Alaska, Arkansas, Idaho, Indiana, Michigan, Missouri, Kentucky, Nevada, Utah, Virginia).——Fig. 119,*1a–c.* **P. lyoni* (Meek & Worthen), Missouri, USA, Chouteau limestone, Kinderhookian; *a–b,* SUI 9545, ×1 (Miller, Furnish, & Schindewolf, 1957); *c,* suture, topotype, Rockford, Jackson County, Indiana, Rockford limestone, Osagean, ×2 (Miller & Garner, 1955).

Cantabricanites Weyer, 1965, p. 456 [**Prolecanites postapplanatus* Kullmann, 1963, p. 281; OD]. Conch form and suture in general similar to *Merocanites* but with twelve pointed lobes. Ventral lobe V-shaped, four lobes on flanks. Sutural formula: $EALU_2U_1U_3I$ [German], $VLUU^1U^2$:ID [Russian]. Three species. [The ontogenetic development of the suture is insufficiently known.] *Mississippian (upper Visean):* Spain, Canada (British Columbia), Australia (New South Wales).——Fig. 119,*2a–b.* **C. postapplanatus* (Kullmann), Crémenes, Pico Aguasalio, León, Spain, upper part of Alba Formation, BSM A IV/147; *a,* side view, ×0.7; *b,* suture, whorl height at approximately 40 mm, ×1.7 (Kullmann, 1963).

Merocanites Schindewolf, 1922, p. 15 [**Ellipsolites compressus* Sowerby, 1814, p. 84; OD] [=*Erdbachites* Weyer, 1965, p. 455 (type, *Prolecanites applanatus* Frech, 1899, pl. 46a,*9,* OD)]. Conch form oval or with flattened flanks. Ten pointed lobes; ventral lobe rather short lanceolate or V-shaped, three lobes on flanks. Sutural formula: $EALU_2U_1I$ [German], VLU^1:ID [Russian]. Conchs may be very large (diameter more than 25 cm). Many species. [The ontogenetic development of the suture is insufficiently known; Karpinskii, 1896, p. 184, fig. 2-14 described the suppression of A, indicating the formula ELU_2U_1I (German), VU^2U^1:ID (Russian). The type species is insufficiently known.] *Mississippian (upper Tournaisian [Pericyclus Zone]–lower Visean):* Great Britain, Ireland, Germany, France, Italy, Spain, Poland, Algeria, Morocco, Iran, Kazakhstan (Karaganda, South Urals), China (Xinjiang, Xizang), Kyrgyzstan (Tian Shan), Australia (New South Wales), Canada (British Columbia), USA (Kentucky, Michigan, Missouri).——Fig. 119,*3a–c. M. applanatus* (Frech), Crémenes, Pico Aguasalio, León, Spain, lower part of Alba Formation, upper part of lower Visean; *a–b,* side view, GPIT 1236/3, ×0.7; *c,* suture, GPIT 1236/2, whorl height at 31 mm, whorl width 17 mm, ×1 (Kullmann, 1963).

Family DARAELITIDAE Chernov, 1907

[*nom. transl.* Plummer & Scott, 1937, p. 98, *ex* Daraelitinae Chernov, 1907, p. 371] [=Epicanitinae Weyer, 1972a, p. 340]

[Materials for this family prepared by Brian F. Glenister, William M. Furnish, and Zhou Zuren]

Conch smooth, small (generally less than 5 cm), widely evolute, thinly discoidal, usually with elliptical whorl section. Suture characterized by broad trifid ventral lobe, prominent rounded lateral, and succession of subequal umbilically derived lobes that decrease in size toward umbilicus. Total number of lobes 10 to 22, may include as many as two pairs of umbilically derived internal laterals, in addition to internal lateral lobe I. Dorsal lobe bidentate. Prongs of ventral lobe and one to several adjacent external lateral lobes finely serrate at base, except in rare ancestral forms. Basic sutural formula: $(V_2V_1V_2)LUU^1.....U^n$:$I(D_1D_1)$ [Russian].

[Primary lateral and umbilical lobes (L and U) maintained their identity throughout phylembryogenesis, and new elements (U^{1+n}, where n ranges from 0–6) were added by successive derivation in saddles of umbilical lobe complex; up to two of these additions may occur in internal suture. During phylogeny, ventral lobe became progressively wider with corresponding decrease in width of adjacent lateral, serration increased in intensity and number of external lobes affected, and both external and internal umbilical lobes increased in number. Despite display of these several evolutionary trends, Daraelitidae constitute a long-ranging stable lineage that does not provide the basis for fine zonation. Genera are gradational, and definitions are arbitrary. After appearance in the Visean, daraelitids survived as ubiquitous but minor elements of open-marine faunas from Serpukhovian time to extinction in the Wordian.] *Mississippian (Visean)–Guadalupian (Wordian).*

Daraelites Gemmellaro, 1887, p. 65 [**D. Meeki;* OD] [=*Prodaraelites* Chernov, 1907, p. 390, *nom. nud.*]. Conch small (less than 5 cm diameter), discoidal (W/D, 0.35), evolute (Umin/D, 0.25 at 20 mm diameter). Suture characterized by ventral lobe twice width of lateral, serrate lobe bases from venter to midflank, up to nine pairs of umbilically derived lobes (two pairs of which may be internal) separated by asymmetrical saddles. Sutural formula: $(V_2V_1V_2)$ $LUU^1U^2U^3U^5U^7$:$U^6U^4I(D_1D_1)$ [Russian]. Five named species. *Cisuralian (Asselian)–Guadalupian (Wordian):* Italy (Sicily), Iraq (Kurdistan), Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Afghanistan, southern China (Guizhou, Guangxi), Indonesia (Timor), USA (western Texas, Nevada), Canada (British Columbia).——Fig.

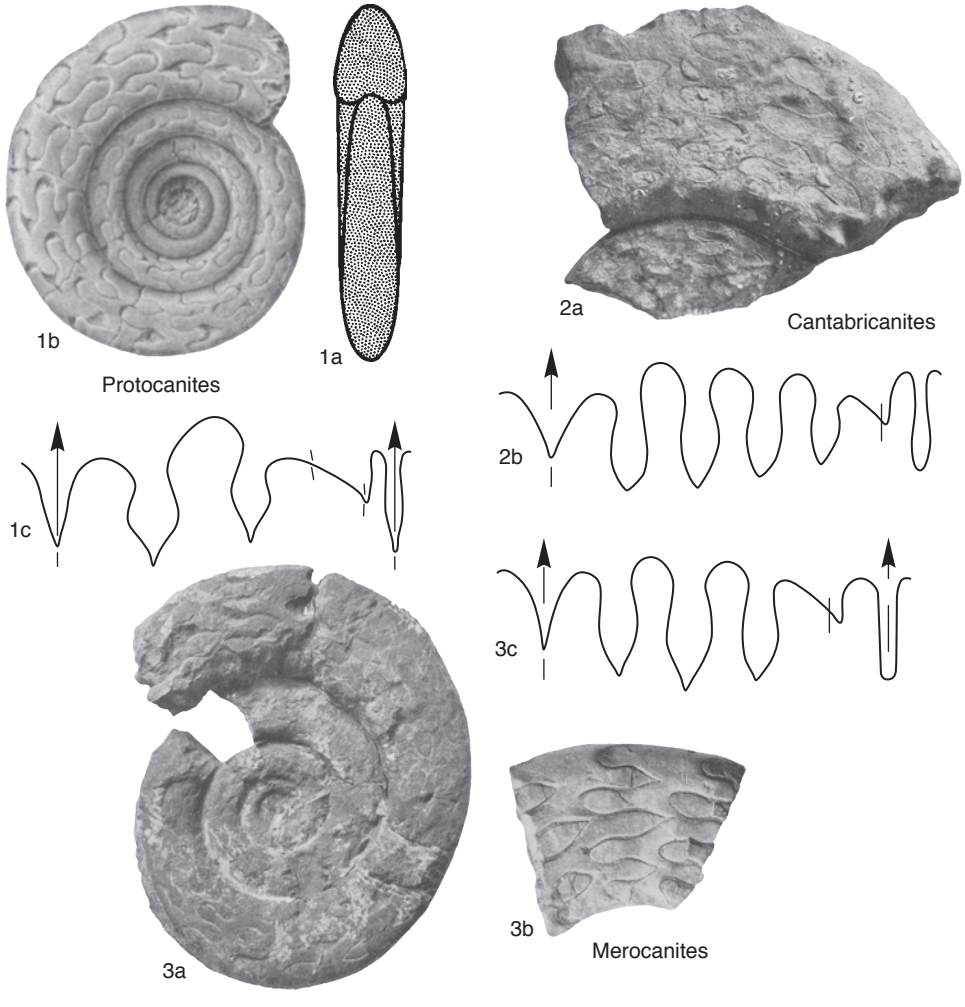

FIG. 119. Prolecanitidae (p. 188–189).

120,*1a–f.* **D. meeki,* Sosio limestone, Wordian, Sicily; *a–b,* lectotype (herein), MGUP 107 of GEMMELLARO (1887, pl. 10,*16–17*), ×1.5; *c–e,* ×1.33; *f,* diameter at 25 mm (Miller & Furnish, 1940a).——FIG. 120,*1g–h. D. elegans* CHERNOV; *g,* Leonard Group, Artinskian, western Texas, USA, diameter at 14 mm (Miller & Furnish, 1940a); *h,* hypotype, SUI 84897, Artinskian (?Aktastinian), Southern Urals, River Aktasty, diameter at 20 mm (new; courtesy of D. M. Work & W. B. Saunders).——FIG. 120,*1i. D. kingi* PLUMMER & SCOTT, Neal Ranch Formation, Asselian, western Texas, diameter at 30 mm (Hodgkinson, 1965).

Boesites MILLER & FURNISH, July 1, 1940b, p. 371 [**Daraelites texanus* BÖSE, 1919, p. 52; OD] [=*Metadaraelites* RUZHENTSEV in MAKSIMOVA & RUZHENTSEV, July 28, 1940, p. 161, obj.; =*Eoboesites* RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 125 (type, *Boesites (Eoboesites) asianus,* OD)]. Similar to *Daraelites,* but ventral and lateral lobes subequal, and with fewer umbilical lobes (5 or 6 pairs, one of which may be internal). Sutural formula: $(V_2V_1V_2)LUU^1U^2U^3U^5{:}U^4I(D_1D_1)$ [Russian]. Fourteen named species. *Pennsylvanian (Bashkirian)–Cisuralian (Sakmarian):* USA (Texas, Oklahoma, Arkansas), Canada (Arctic Archipelago: Ellesmere Island), Spain (Cantabrian Mountains), Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Uzbekistan (Fergana, Kyzylkumy), Kyrgyzstan (southern Fergana, Tian Shan), southern China

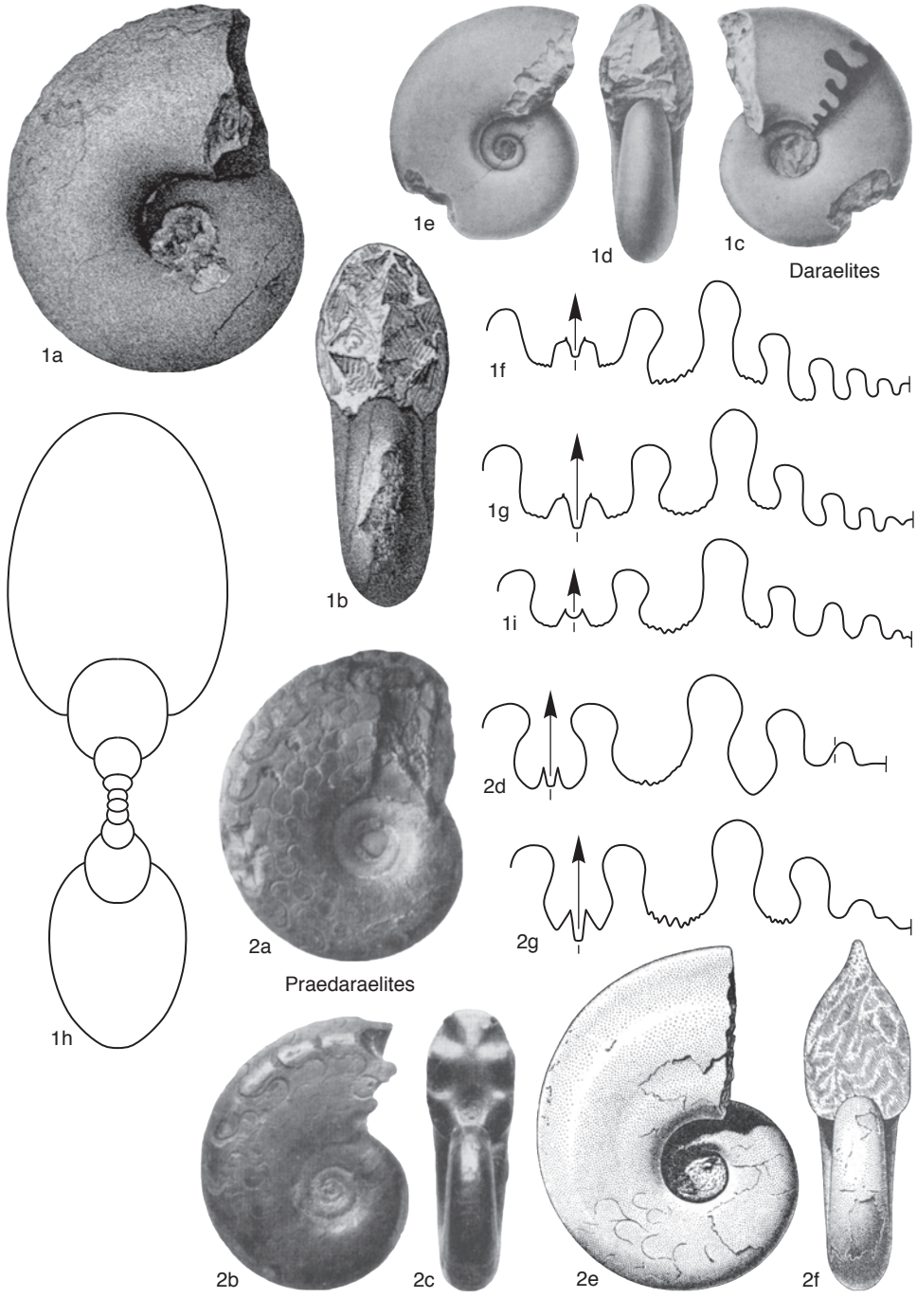

FIG. 120. Daraelitidae (p. 189–192).

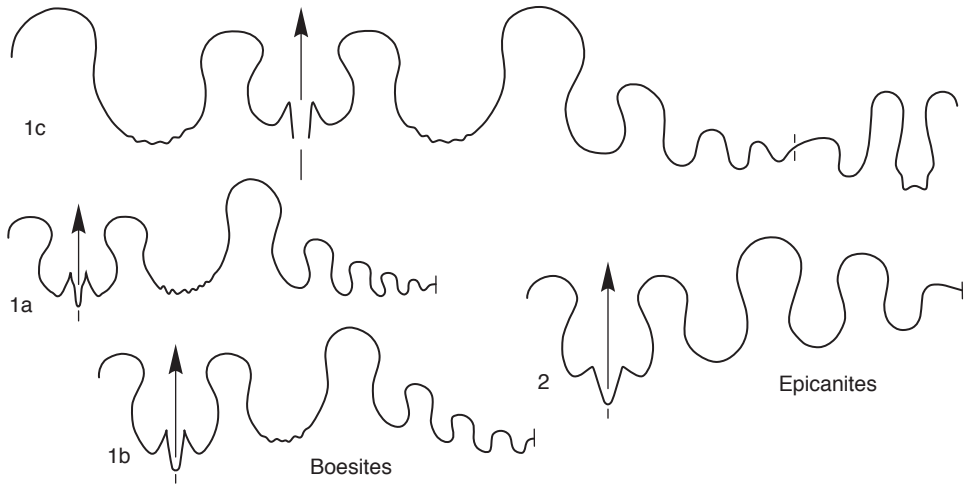

FIG. 121. Daraelitidae (p. 190–192).

(Guangxi), Japan (southwestern Honshu).——FIG. 121,*1a. *B. texanus* (BÖSE), Gaptank Formation, Virgilian–Stephanian, western Texas, diameter at 14 mm (Miller & Furnish, 1940a).——FIG. 121,*1b. B. scotti* (MILLER & FURNISH), Smithwick Shale, Atokan–Westphalian, central Texas, diameter at 16 mm (Miller & Furnish, 1940a).——FIG. 121,*1c. B. gracilis* NASSICHUK, Hare Fiord Formation, Atokan–Moscovian, Ellesmere Island, height of whorl at 13 mm, diameter at approximately 30 mm (Nassichuk, 1975).

Epicanites SCHINDEWOLF, 1926b, p. 75 [**Paraprolecanites Sandbergeri* SCHMIDT, 1925, p. 544; OD] [=*Paraprolecanites* KARPINSKII, 1889, p. 8, *partim* (type, *Prolecanites mojsisovicsi* MILLER, 1938, p. 181); =*Librovitchites* ANDRIANOV, 1985, p. 15 (type, *L. librovitchi,* OD)]. Incompletely known taxon, similar to *Boesites* but lateral lobe smaller than ventral and only slightly larger than two adjacent umbilical lobes (both external). Lobe serration absent or faint. Sutural formula: $(V_2V_1V_2)$ LUU^1U^2:$I(D_1D_1)$ [Russian]. Eight named species. [Primitive features, such as smooth to faintly serrate lobes and approximation to bilateral symmetry of umbilical saddles (latter, type species only) are at least partially a function of small size.] *Mississippian (upper Visean–Serpukhovian):* Ireland, England, France, Spain, Germany, Morocco, Algeria, Russia (Urals, Verkhoian), Kazakhstan (Southern Urals), Mongolia (Gobi Tian Shan), China (Xizang, Xinjiang, Ningxia, Guangxi), USA (Oklahoma).——FIG. 121,*2. *E. sandbergeri* (SCHMIDT), upper Visean, Algeria, diameter approximately 10 mm (Miller & Furnish, 1940b, adapted from Dollé, 1912).

Praedaraelites SCHINDEWOLF, 1934, p. 179 [**Daraelites culmiensis* KOBOLD, 1933, p. 506; OD] [=*Rotocanites* WEYER, 1972a, p. 341 (type, *Praedaraelites simulans* KULLMANN, 1962, p. 349, OD)]. Mature venter angular in one species. Suture as in *Boesites,* but lateral lobe conspicuously larger (in area) than ventral, and with three to five pairs of umbilical lobes (all external). Sutural formula: $(V_2V_1V_2)$ $LUU^1U^2U^3$:$I(D_1D_1)$ [Russian]. Nineteen named species. [The specimen portrayed by Fig. 120,*2e–f* displays a strongly modified whorl section in the ultimate one-third volution. Diameter of the specimen is close to 10 cm, whereas few other daraelitids exceed 5 cm. Subsequent collections from the same general locality show ventral angularity beginning at a diameter of 45 mm. Taxonomic assignment is certain, yet comparable modification is unknown elsewhere within the Prolecanitida.] *Mississippian (Visean–Serpukhovian):* Ireland, England, Germany, Portugal, Spain, France, Algeria, Tajikistan (Pamir), Uzbekistan (Fergana), Kazakhstan (Southern Urals), Russia (Urals, Novaia Zemlia, Verkhoian), China (Xizang, Guangxi), Malaysia.——FIG. 120,*2a–d. *P. culmiensis* (KOBOLD), upper Visean; *a–c*, Spain, ×2 (Kullmann, 1963); *d*, Ireland, diameter at 20 mm (Miller, Furnish, & Clark, 1957).——FIG. 120,*2e–g. P. aktubensis* RUZHENTSEV; *e–f*, ×0.9 (Ruzhentsev in Bogoslovskii, Librovich, & Ruzhentsev, 1962); *g*, diameter at 16 mm (Ruzhentsev, 1949c).

MEDLICOTTIOIDEA

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Superfamily MEDLICOTTIOIDEA Karpinskii, 1889

[*nom. transl.* MILLER & FURNISH, 1954, p. 687, *ex* Medlicottinae (*sic*) KARPINSKII, 1889, p. 45] [=Pronoritidae HYATT & SMITH, 1905, p. 108, *partim*]

Advanced Prolecanitida characterized by complex sutures. Ventral lobe narrow, shallowly tridentate. Lateral lobe broadest sutural element, bifid, generally with ventral prong (L_1) transformed during phylembryogenesis into progressively more strongly adventitiously subdivided ventrolateral saddle. [Family-level groupings based primarily on sutural phylogeny, especially phylembryogenesis of lateral lobe and simple or bidentate form of dorsal lobe.] *Mississippian (Visean)–Lower Triassic (Induan).*

Family PRONORITIDAE Frech, 1901

[*nom. transl.* SMITH, 1903, p. 41, *ex* Pronoritinae FRECH, 1901, p. 481] [=Shikhanitidae RUZHENTSEV, 1951, p. 98]

Ancestral medlicottioideans characterized by moderately evolute conch and relatively simple sutures. Shell smooth, flanks flat, venter rounded (convex to slightly concave). Suture comprises 14–32 lobes. Lateral lobe broad, invariably bifid, commonly approaching twice width of corresponding ventral lobe. Up to 10 pairs of external umbilically derived lobes form subequal series decreasing in size to umbilicus. Prongs of lateral and adjacent umbilical lobes may be bidentate or serrate. Two lineages are characterized by simple (Pronoritinae) or bidentate (Neopronoritinae) dorsal lobe. [Pronoritidae form one of the longer lineages of Paleozoic ammonoids, with few changes occurring from the Mississippian to Lopingian. Throughout this interval, differences are so slight that they are of limited value in biostratigraphy; generic categories are gradational and definitions arbitrary.] *Mississippian (Visean)–Lopingian (Wuchiapingian).*

Subfamily PRONORITINAE Frech, 1901

[Pronoritinae FRECH, 1901, p. 481]

Pronoritids with undivided dorsal lobe. *Mississippian (Visean)–Cisuralian (Artinskian).*

Pronorites MOJSISOVICS, 1882, p. 201 [**Goniatites cyclolobus* PHILLIPS, 1836, p. 237; SD FOORD & CRICK, 1897, p. 260] [=*Ibergiceras* KARPINSKII, 1889, p. 42, *nom. nud.*; =*Subpronorites* CHERNOV, 1907, p. 390, *nom. nud.*] Rare, ancestral pronoritins, characterized by small size (generally less than 5 cm diameter), evolute conch (Umin/D, commonly one-third), and simple 14-lobed suture with formula $(V_2V_1V_2)(L_1L_1)UU^1U^2U^3$:ID [Russian], $(E_1E_mE_1)(L_{v2}L_{vd}L_d)U_2U_3U_4$..... [German]. Eight named species. [*Katacanites* KULLMANN, 1963, p. 283 (type, *K. quadratoides,* OD) resembles *Pronorites* and all other pronoritids in possessing a broad, divided lateral lobe. However, the ventral lobe is reported as undivided and narrowly pointed, as in the Prolecanitidae.] *Mississippian (upper Visean):* England, Belgium, Spain, Poland, Germany, Portugal, Bosnia-Herzegovina, Algeria, Russia and Kazakhstan (Southern Urals), ?Middle Asia, USA (Utah, Arkansas, ?Nevada), Thailand (Patalung).——FIG. 122,*4a–c.* **P. cyclolobus* (PHILLIPS), England; *a–b*, ×1; *c*, diameter approximately 30 mm (Foord & Crick, 1897).

Megapronorites RUZHENTSEV, 1949a, p. 60 [**M. sakmarensis;* OD]. Conch large (diameter to 9 cm), relatively evolute (U/D, 0.4 to 0.2 with increasing size), and with flat venter. Suture comprises 18 lobes, including 5 pairs of external umbilically derived lateral lobes and one pair of internal umbilical lobes; similar to *Stenopronorites* but with primary internal lateral lobe linked to fourth external lateral (U^2) instead of third (U^1) in *Stenopronorites.* Sutural formula: $(V_2V_1V_2)(L_1L_1)UU^1U^2U^3U^5$:$U^4$ID [Russian]. Saddle dividing primary external lateral lobe in *Megapronorites,* also lower and more asymmetric than in *Stenopronorites*. Four named species. *Mississippian (Serpukhovian):* Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Uzbekistan (Fergana, Tian Shan), Spain, southern China (Guangxi).——FIG. 122,*3a–c.* **M. sakmarensis*; *a–b*, ×0.7; *c*, diameter ranging 60–65 mm (Ruzhentsev, 1949a).

Metapronorites LIBROVICH, 1938, p. 82 [**Pronorites uralensis* var. *timorensis* HANIEL, 1915, p. 25; OD]. Conch discoidal, moderately evolute (U/D, commonly 0.1), with flat flanks and rounded to flat venter. Characterized by suture with 26–32

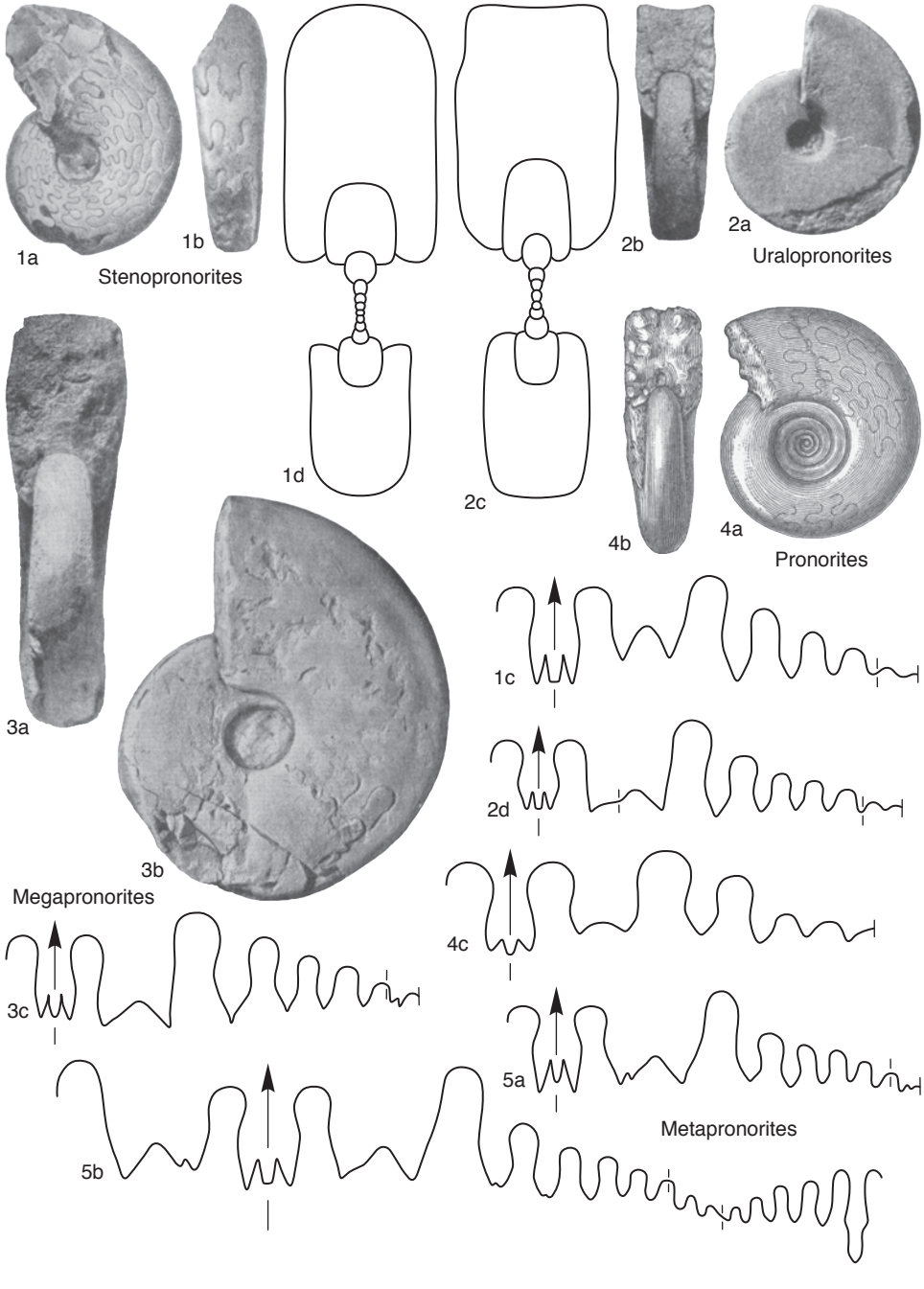

FIG. 122. Pronoritidae (p. 193–196).

lobes, including 7–9 pairs of external umbilically derived lobes and 3–5 pairs of internal umbilicals. Formula: $(V_2V_1V_2)(L_1L_1)UU^1U^2U^4U^6U^8U^{10}.....U^9U^7U^5U^3ID$ [Russian]. Saddle that separates two prongs of external lateral lobe unconstricted, low, with strongly divergent flanks. Either prong of lateral lobe may be denticulate, as may adjacent primary umbilical lobe. Eight named species. [No

suitable illustrations of the type species are available.] *Pennsylvanian (lower Moscovian [Atokan])–Cisuralian (Artinskian):* Indonesia (Timor), USA (western Texas, ?Arkansas), Canada (Yukon, Arctic Archipelago: Ellesmere, Axel Heiberg Island), Kazakhstan (Southern Urals), Russia (Southern Urals, northern Verkhoian), Tajikistan (Pamir), southern China (Guangxi).——Fig. 122,*5a*. *M. pseudotimorensis* (Miller), diameter at 47 mm (Nassichuk, 1975).——Fig. 122,*5b*. *M. cuneilobatus* Ruzhentsev, upper Zhigulian, Southern Urals, diameter approximately 40 mm (Ruzhentsev, 1949a).

Pseudopronorites Nassichuk, 1975, p. 57 [**Pronorites cyclolobus* var. *arkansiensis* Smith, 1896, p. 267; OD)]. Large pronoritins (maximum phragmocone diameter exceeding 9 cm, probably approaching 13 cm and constituting largest representative of family), characterized by primary external lateral lobe subdivided into two more or less equal simple prongs by high (at least two-thirds height of ventrolateral saddle), constricted secondary saddle. Suture comprises 22–26 lobes, 7 or 8 pairs situated externally, and 3 or 4 pairs internally. Juvenile conch smooth, mature shell with broad ventral ribs that become progressively fainter laterally to disappearance dorsad of midflank. Five named species. *Pennsylvanian (Bashkirian–Kasimovian):* Spain, USA (Arkansas, Oklahoma, Kansas, Texas), Canada (Arctic Archipelago: Ellesmere Island), Russia (Novaia Zemlia), China (Guizhou, Guangxi), Japan (southwestern Honshu).——Fig. 123*a–c*. **P. arkansiensis* (Smith); *a–b*, Morrowan, Oklahoma, ×0.75 (Miller, Furnish, & Schindewolf, 1957); *c*, Atokan, Arctic Canada, diameter at 35 mm (Nassichuk, 1975).

Stenopronorites Schindewolf, 1934, p. 169 [**Pronorites cyclolobus* var. *uralensis* Karpinskii, 1889, p. 8; OD; see also *Stenopronorites* Nassichuk, 1975, p. 54] [=*Sinopronorites* Ruan, 1981b, p. 174 (type, *S. nanus,* OD); =*Minepronorites* Nishida, Kyuma, & Egashira, 1998, p. 16 (type, *M. takahasii,* OD)]. Suture similar to *Pseudopronorites,* but saddle dividing prongs of primary external lateral lobe less than one-half height of ventrolateral saddle, and with divergent flanks. Suture comprises 18–24 lobes, including 5 or 6 pairs of external umbilically derived lobes and 1–3 pairs of internal umbilicals. Sutural formula: $(V_2V_1V_2)(L_1L_1)UU^1U^2U^4.....U^3ID$ [Russian]. Fifteen named species. *Upper Mississippian (Serpukhovian)–Middle Pennsylvanian (Moscovian):* Kazakhstan (Southern Urals), Russia (Urals, Novaia Zemlia, Verkhoian, Kolyma, Omolon), Uzbekistan (Fergana, Tian Shan, Kyzylkumy), Kyrgyzstan (southern Fergana, Tian Shan), Morocco, Algeria, Tajikistan (Pamir, Gissar), China (Guizhou, Guangxi, Xinjiang, Ningxia), Japan (southwestern Honshu), USA (Oklahoma, Nevada, California), Canada (Arctic Archipelago: Ellesmere Island), France, Spain, Ukraine (Donets Basin).——Fig. 122,*1a–c*. **S. uralensis* (Karpinskii), Serpukhovian–Bashkirian, Urals; *a–b,* ×1; *c,* diameter approximately 25 mm (Ruzhentsev, 1949a), ×1 (Karpinskii, 1889).——Fig. 122,1*d*. *S. sersoni* Nassichuk, topotype, GSC 103250, Atokan, Ellesmere Island, diameter at 37.5 mm (new, courtesy of D. M. Work & W. B. Saunders).

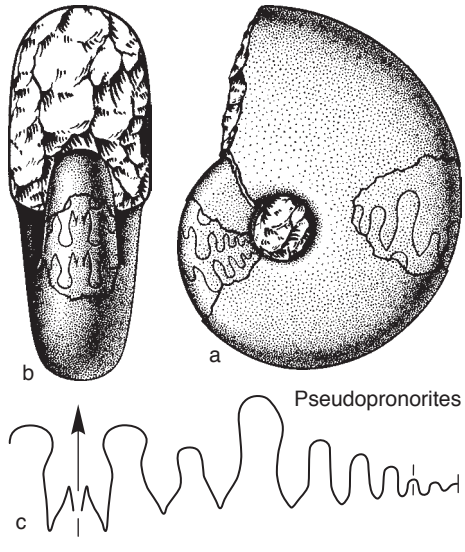

Fig. 123. Pronoritidae (p. 195).

Tridentites Schindewolf, 1934, p. 170 [**Pronorites tridens* Schmidt, 1925, p. 545; OD; =*Goniatites mixolobus* de Koninck, 1880, p. 122, *non* Phillips, 1936, p. 236]. Inadequately known taxon; suture similar to *Pronorites,* but primary external lateral lobe tridentate. One species. *Mississippian (Visean):* Belgium.

Uralopronorites Librovich in Ruzhentsev, 1949a, p. 63 [**U. mirus;* OD; =*Uralopronorites mirus* Librovich in Ruzhentsev, 1947d, p. 45, *nom. nud.*]. Pronoritins with shallowly concave venter, characterized by incipient bifurcation of anomalously broad ventral prong of primary external lateral lobe. Sutural formula: $(V_2V_1V_2)(L_1L_1)UU^1U^2U^4U^6U^7:U^5U^3ID$ [Russian]. Two named species. [Lateral lobe of *U. mirus* is twice width of ventral lobe and more than three times width of adjacent primary umbilical lobe, both relationships representing extremes for Pronoritidae. Additionally, ventral subdivision of the lateral lobe is three-halves as broad as dorsal subdivision and displays an incipient subdivision on its dorsal flank. In all these respects, suture resembles those of ancestral medlicottiid *Prouddenites* (Uddenitinae), a genus characteristic of the Virgilian but represented by more primitive forms in the Desmoinesian (Chatelain, 1984). On these bases, *Uralopronorites* may be interpreted as a medlicottiid precursor. Were it not for its undivided dorsal lobe, *Uralopronorites* could be referred with equal propriety to

the Uddenitinae.] *Mississippian (?Serpukhovian), Pennsylvanian (Bashkirian):* Russia and Kazakhstan (Southern Urals), Tajikistan (Darvas), Serbia.——Fig. 122,*2a–d*. **U. mirus*; *a–b*, ×1; *c*, hypotype, SUI 8490, Urals, diameter at 37 mm (new, courtesy of D. M. Work & W. B. Saunders); *d*, diameter ranging 25–30 mm (Ruzhentsev, 1949a).

Subfamily NEOPRONORITINAE Weyer, 1972

[Neopronoritinae Weyer, 1972a, p. 342]

Pronoritids with bidentate dorsal lobe. *Pennsylvanian (Gzhelian)–Lopingian (Wuchiapingian).*

Neopronorites Ruzhentsev, 1936b, p. 1076 [**Paranopronorites permicus* Chernov, 1907, p. 344; OD] [=*Epipronorites* Maksimova, 1938, p. 25 (type, *E. rotundus,* OD)]. Neopronoritins characterized by irregular serration in prongs of mature external lateral lobe and one to three adjacent umbilical lobes. Dorsal and adjacent internal lobe bidentate. Seven or eight pairs of umbilically derived lobes in external suture, one-half as many internally. Sutural formula: $(V_2V_1V_2)(L_1L_1)UU^1U^2U^4U^6U^8$..... $U^7U^5U^3I(D_1D_1)$ [Russian]. Fourteen named species. [No suitable illustrations of the type species are available.] *Pennsylvanian (Gzhelian)–Cisuralian (Kungurian):* Kazakhstan (Southern Urals), Russia (Urals, Verkhoian), Tajikistan (Pamir), China (Guangxi, Guizhou, Xinjiang, Xizang, Gansu), Indonesia (Timor), Thailand (Loei), USA (Texas), Canada (Ellesmere Island).——Fig. 124,*1a–d. N. carboniferus* Ruzhentsev, Gzhelian, Urals; *a–b*, ×1; *c*, hypotype, SUI 62485, northern Kazakhstan, Aidaralash, diameter at 31 mm (new, courtesy of D. M. Work & W. B. Saunders); *d*, diameter at 42 mm (Ruzhentsev, 1949a).——Fig. 124,*1e. N. tenuis* (Karpinskii), hypotype, SUI 84901, Asselian or Sakmarian, Sholak-Say, Southern Urals, diameter at 34 mm (new, courtesy of D. M. Work & W. B. Saunders).

Paedopronorites Glenister, Furnish, & Zhou, 2004, p. 1014 [**P. leonovae;* OD]. Conch small (maximum phragmocone diameter less than 20 mm), narrowly discoidal (W/D, 0.35–0.40), relatively widely umbilicate (Umin/D, 0.25–0.35, decreasing slightly in ultimate one-half volution), with one-half volution of body chamber. [Dimensions D, H, and W represent conch diameter, corresponding whorl height, and width, and Umin indicates umbilical diameter measured from umbilical seam to seam; all are measured in millimeters, and abbreviations are used in the remainder of the text.] Suture typically comprises 36 lobes, including 8 pairs of umbilically derived external lateral lobes, and 7 pairs of internal umbilicals. Primary lateral lobe broad, constricted adorally, deeply divided into 2 simple round prongs. Ventrad 3 pairs of external umbilical lobes and primary internal lobe asymmetrically bidentate. Both external and internal sutural traces arch forward from venter to umbilical seam. One species. [*Paedopronorites* is interpreted as the terminal paedomorph of the Neopronoritinae. It conforms to the pattern displayed by many late Paleozoic family-level taxa (Glenister & Furnish, 1988a, 1988b), being the geologically youngest representative and characterized by small size, sutural simplification, and low abundance. Eighteen specimens are known from the type Amarassi beds (Amarassi Province, Timor). The consistently small phragmocone diameter (15–17 mm) suggests maturity. Superficial similarity to *Sakmarites* may relate to small size; *Paedopronorites* differs in possession of narrower, more evolute conch and more numerous umbilical subdivisions. The type species is named to honor T. B. Leonova, Paleontological Institute, Moscow.] *Lopingian (Wuchiapingian):* Indonesia (Timor).——Fig. 124,*2a–g*. **P. leonovae; a–c*, holotype, SUI 64445, ×1; *d–e,* paratype, SUI 64446, ×1; *f,* composite holotype, SUI 64445, and paratypes, SUI 64446-64448, diameter at 17 mm (Glenister, Furnish, & Zhou, 2004); *g,* paratype, SUI 12337, diameter at 16 mm (new, courtesy of D. M. Work & W. B. Saunders).

Parapronorites Gemmellaro, 1887, p. 61 [**P. Koninckii;* OD]. Advanced neopronoritins characterized by subequal bidentition of both prongs of external lateral lobe; ventral four to virtually all eight adjacent umbilically derived lobe pairs also bidentate. Internal suture inadequately known (except for *P. rectus* Leonova in Leonova & Dmitriev, 1989), but mature D and I probably bidentate throughout, and umbilical elements simple and number one or two less than in external suture. Five named species (all similar, perhaps conspecific). *Cisuralian (Artinskian)–Guadalupian (Wordian):* Italy (Sicily), Russia (Southern Urals), Ukraine (Crimea), Tajikistan (Pamir), Oman, China (Guizhou, Guangxi, Xizang, Xinjiang), Thailand (Muak Lek), Indonesia (Timor).——Fig. 125,*1a–d*. **P. konincki,* Sosio limestone, Wordian, Sicily; lectotype (herein, *a*), MGUP 101A of Gemmellaro (1887, pl. 5,*16*), and paralectotype (*b–d*), MGUP 101B of Gemmellaro (1887, pl. 5,*17–18*), ×1 (new).——Fig. 125,*1e–f. P. rectus* Leonova in Leonova & Dmitriev, 1989, Bolorian, Pamir; *e*, diameter at 35 mm; *f,* diameter at 40 mm (Leonova & Dmitriev, 1989).

Sakmarites Ruzhentsev, 1936b, p. 1075 [**Pronorites postcarbonarious* var. *vulgaris* Karpinskii, 1889, p. 14; OD]. Diminutive neopronoritins (mature diameter less than 30 mm), with broadly discoidal conch (flanks flat, ventrolateral shoulder narrowly rounded, venter weakly convex, W/D, 0.4–0.6 mm) and relatively large umbilicus (Umin/D, decreases from 0.25–0.15 mm with growth). Body chamber two-thirds volution. Mature peristome outlines shallowly rounded hyponomic sinus, and shallower reentrant across flanks. Suture comprises 18–22 lobes, including 5 or 6 pairs of external umbilically derived lateral lobes and 1 or 2 pairs of internal umbilicals. One or both prongs of primary external lateral lobe, one adjacent umbilical lobe, and primary internal lateral lobe may be

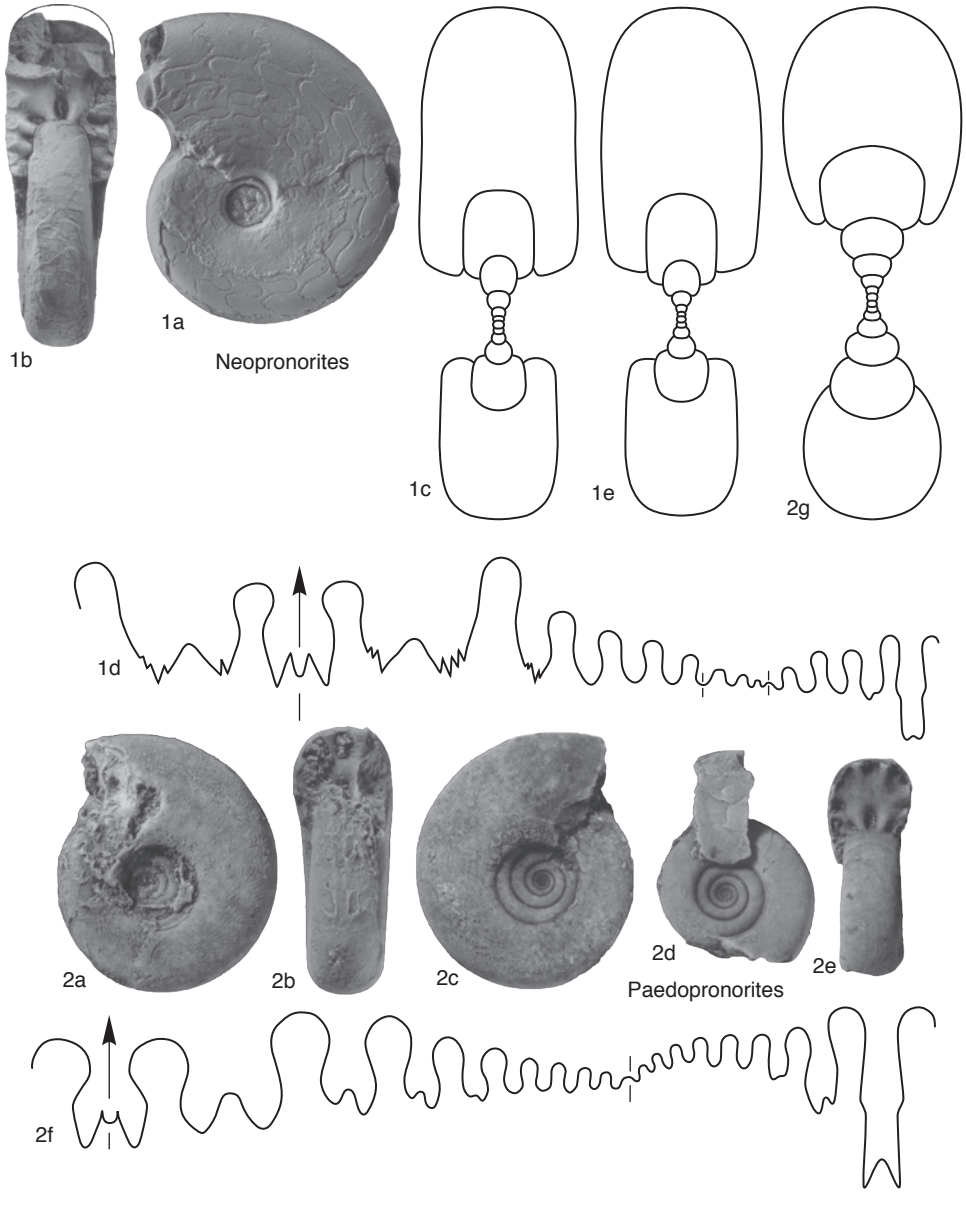

FIG. 124. Pronoritidae (p. 196).

bidentate; dorsal lobe relatively broad. Sutural formula: $(V_2V_1V_2)(L_1L_1)UU^1U^3U^5U^6{:}U^4U^2I(D_1D_1)$ [Russian]. Eight named species. [General sutural similarity suggests a relationship to *Shikhanites.*] *Cisuralian (Asselian–Artinskian [Baigendzhinian])*: Russia (Urals), Kazakhstan (Southern Urals).——FIG. 125,*2a–d*. **S. vulgaris* (KARPINSKII), Artinskian; *a*, hypotype, SUI 84903, diameter at 22 mm (new, courtesy of D. M. Work & W. B. Saunders); *b*, diameter approximately 15 mm (Ruzhentsev, 1950); *c–d,* ×1 (Ruzhentsev, 1956b).——FIG. 125,*2e*. *S. inflatus* RUZHENTSEV, hypotype, Sakmarian, Ultugan-Say, Southern Urals, SUI 97533, diameter at 27 mm (new, courtesy of D. M. Work & W. B. Saunders).

Shikhanites RUZHENTSEV, 1938, p. 245 [**S. singularis;* OD]. Based on single, poorly preserved, septate one-quarter volution, diameter approximately

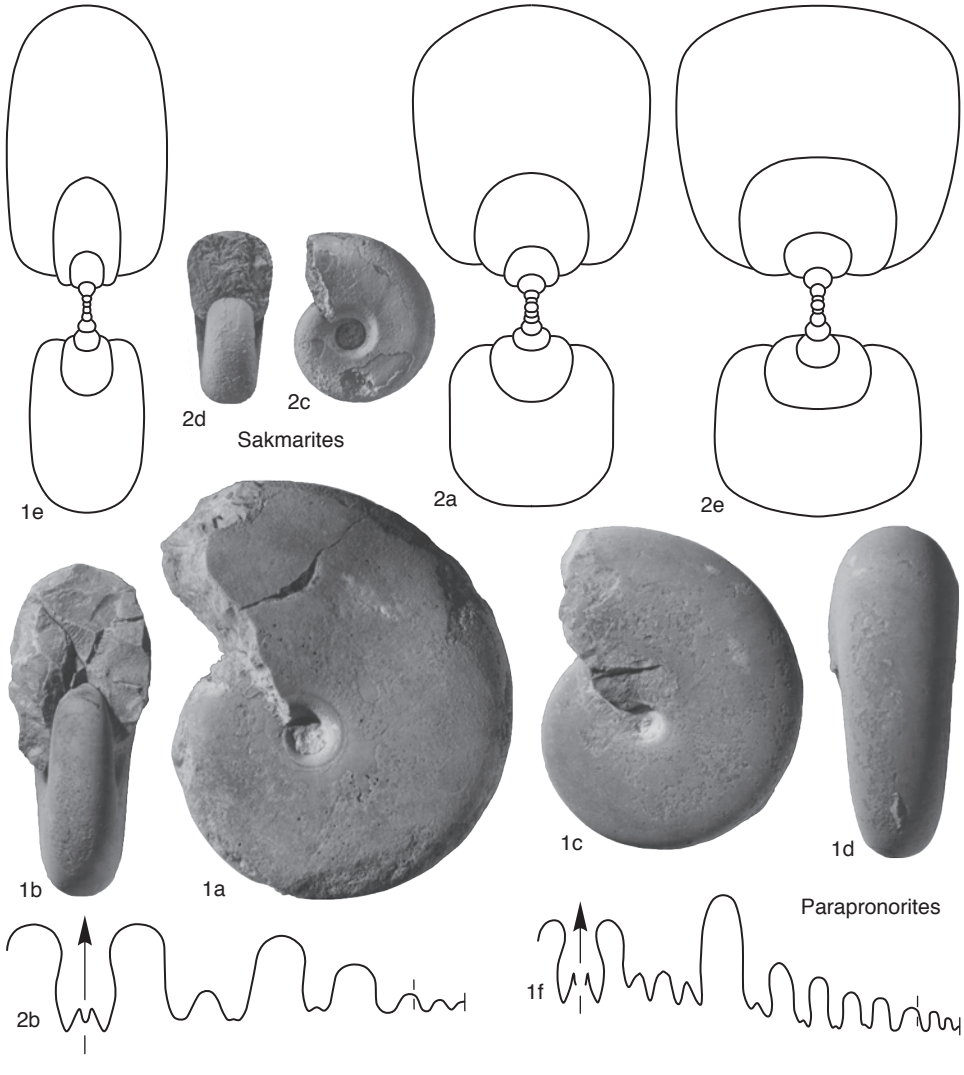

FIG. 125. Pronoritidae (p. 196–197).

25 mm. Conch thinly discoidal, probably involute, with broadly rounded flanks and parabolic ventrolateral shoulders and venter. Ventral lobe interpreted as less than one-half depth of adjacent primary lateral lobe, with middle prong twice depth of shallow flanking pair of prongs. Rounded prongs of lateral lobe may lie significantly below general sutural trace. Succeeding six or more pairs of umbilically derived external lobes simple, with rounded bases. Primary internal lobe (I) linked to third external umbilical (U^2). One species. [Interpreted proportions of ventrolateral sutural elements are atypical for Pronoritidae and may reflect poor preservation of single known representative.] *Cisuralian (Asselian):* Russia (Southern Urals).

Family MEDLICOTTIIDAE Karpinskii, 1889

[*nom. correct.* MILLER & FURNISH, 1954, p. 687, *pro* Medlicottidae HYATT, 1900, p. 563, *nom. transl. ex* Medlicottinae KARPINSKII, 1889, p. 45] [=Darvasiceratidae LEONOVA, 1990, p. 106]

Advanced medlicottioideans characterized by involute conch and complex sutures.

Conch variable in size but commonly large (mature phragmocone diameters as low as 2 cm but may exceed 15 cm, latter representing conch diameter of approximately 25 cm), discoidal to thinly lenticular. Shell lacks conspicuous sculpture except for common presence of row of nodes or ribs near each ventrolateral shoulder. Suture comprises total of 13 to approximately 30 lobes. Ventral prong of broad, primary, external lateral lobe transformed during phylembryogenesis into progressively more highly subdivided ventrolateral saddle, thus: $L_1L_1 > (L_{1.1}L_{1.2}L_1) > v^n s^n l^n L_1$ [Russian]. [In the above formula (Fig. 133*a–b*), v^n (number of subdivisions on ventral flank of ventrolateral saddle) ranges from 0–8, s^n (number of subdivisions on crest of ventrolateral saddle) ranges 0–3, and l^n (number of subdivisions on dorsal flank of ventrolateral saddle) ranges 0–8.] Dorsal lobe bidentate. Umbilically derived external and internal lateral lobes generally form subequal series diminishing uniformly in size to umbilicus. More than one-half of external umbilicals and smaller proportion of internals became bidentate during course of phylembryogenesis. *Pennsylvanian (upper Moscovian)–Lower Triassic (Induan).*

Subfamily UDDENITINAE Miller & Furnish, 1940

[Uddenitinae Miller & Furnish, 1940a, p. 34]

Ancestral medlicottiids characterized by relatively minor modification of primary external lateral lobe. Conch discoidal with flat flanks and shallowly concave to flat venter, lacking conspicuous sculpture, and of moderate size (generally less than 5 cm conch diameter, but reaching 18 cm in extreme case). Ventral prong of primary external lateral lobe transformed during phylembryogenesis into simple broad saddle, thus: $(L_{1.1(v)} L_{1.1(v)}) > s^{1.1}s^{1.1}s^1$ [Russian]. Eight to 13 pairs of umbilically derived external lateral lobes decrease uniformly in size to umbilicus; all normally undivided, although ventral two may be shallowly bidentate. *Pennsylvanian (upper Moscovian [Desmoinesian])–Cisuralian (Kungurian).*

Uddenites Böse, 1919, p. 55 [**U. Schucherti;* OD]. Venter deeply grooved. Ventral prong of primary external lateral lobe bidentate or rarely tridentate, with base aligned at or slightly orad of midheight of adjacent ventral lobe. Sutural formula: $(V_2V_1V_2)$ $(L_{1.1(v)}L_{1.1(v)}L_{1(d)})UU^1U^2$.... [Russian]. Seven named species. *Pennsylvanian (Kasimovian–Gzhelian):* USA (western Texas, northern-southern Midcontinent), Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Uzbekistan (Fergana).——Fig. 126,*1a–d.* **U. schucherti,* Virgilian, Gaptank Formation, western Texas; *a–c*, lectotype (herein), BEG 34282 (same as Böse, 1919, pl. 1,*12–14, 18–20*), ×2; *d*, diameter at 20 mm (Miller & Furnish, 1940a) (new).

Daixites Ruzhentsev, 1941, p. 880 [**D. meglitzkyi;* OD]. Similar in conch form to *Uddenites,* but with uniformly rounded venter and ventrolateral shoulders. Ventral prong of primary external lateral lobe bidentate and aligned approximately with base of adjacent ventral lobe. Four named species. *Pennsylvanian (Gzhelian)–Cisuralian (lower Sakmarian [Tastubian]):* Russia (Southern Urals, Yugorskii Peninsula), Kazakhstan (Southern Urals), Tajikistan (Pamir); USA (western Texas), *Virgilian.*——Fig. 126,*2a–d.* **D. meglitzkyi,* Gzhelian, Southern Urals; *a–c,* ×1; *d*, diameter at 28 mm (Ruzhentsev, 1941).——Fig. 126,*2e. D. attenuatus* Ruzhentsev, SUI 62488, Tabantal, Southern Urals, diameter at 21.6 mm (new, courtesy of D. M. Work).

Neouddenites Ruzhentsev, 1961, p. 53 [**N. andrianovi;* OD]. Conch large (to 18 cm conch diameter), with flat venter and conspicuous ventrolateral groove. Ventral prong of primary external lateral lobe tridentate and aligned at or orad of midheight of adjacent ventral lobe; dorsal prong lies significantly below general lineation of flank lobes. Umbilically derived external lateral lobes more numerous (12 or 13) than in other members of subfamily. Two species. Sutural formula: $(V_2V_1V_2)$ $s^{1.1}s^{1.1}s^1L_{1(d)}UU^1U^2$..... [Russian]. [In the above formula, the ventral prong of the primary external lateral lobe ($L_{1(v)}$) is judged to have been modified during phylembryogenesis to the extent that it is better considered to be a tridentate ventrolateral saddle ($s^{1.1}s^{1.1}s^1$).] *Cisuralian (Artinskian–Kungurian):* Russia (Siberia: Tumara Basin, ?Volga-Urals, western Verkhoian, Omolon Massif), Canada (Yukon).——Fig. 126,*3a–c.* **N. andrianovi,* ?Member C of Echii Formation and Member B of Endybal' Formation, Siberia, western Verkhoian; *a–b,* ×0.5; *c*, diameter at 36 mm (Ruzhentsev, 1961).——Fig. 126,*3d–e. N. caurus* Nassichuk, Furnish, & Glenister, northern Yukon Territory, ×1.33 (Nassichuk, Furnish, & Glenister, 1966).

Prouddenites Miller, 1930, p. 395 [**P. primus;* OD]. Ancestral uddenitins; conch similar to *Uddenites,* but venter flat. Suture characterized by tridentate

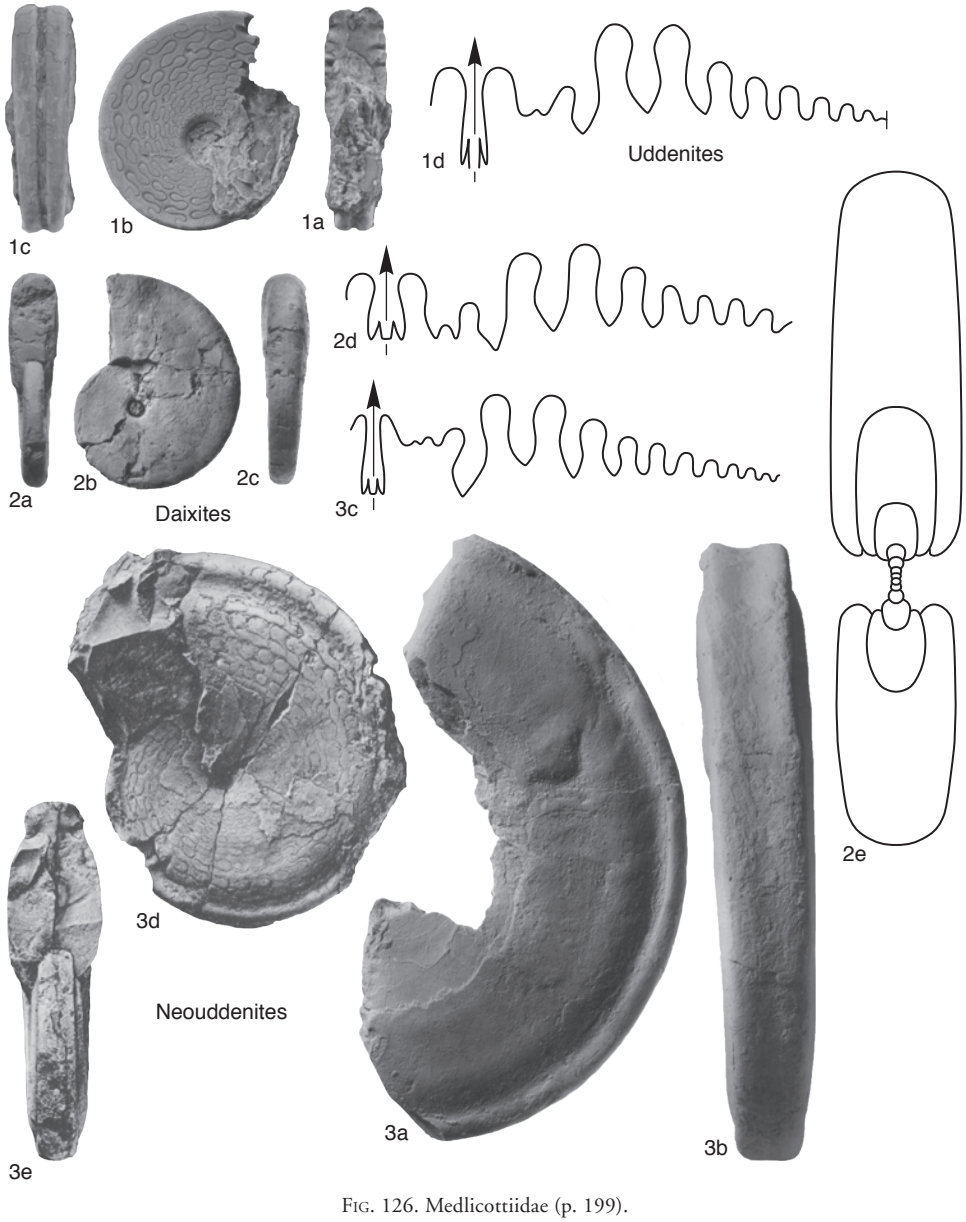

FIG. 126. Medlicottiidae (p. 199).

primary external lateral lobe with all three subdivisions aligned with or slightly orad of base of adjacent ventral lobe. Ventral prong of external lateral lobe ($L_{1.1(v)}L_{1.1(v)}$) broad; both subdivisions and primary umbilical lobe (U) may be bidentate. Three named species. [Overall geometry of the external lateral lobe of *Prouddenites* closely resembles that of presumed ancestor, the Serpukhovian pronoritid *Uralopronorites.* However, the dorsal lobe of *Prouddenites* is bidentate, similar to those of all other medlicottiids, whereas the dorsal lobe of *Uralopronorites* is undivided.] *Pennsylvanian (upper Moscovian [Desmoinesian])–Gzhelian [Virgilian]):* USA (western Texas, north-central Texas, Oklahoma, Kansas, Missouri), Kazakhstan (Southern Urals), China (Xinjiang).——FIG. 127,*1a–f.* **P. primus,* Virgilian; *a–b*, Coffeeville Formation, Oklahoma, ×1 (Miller, Furnish, & Schindewolf, 1957, fig. 119); *c*, Gaptank Formation, western Texas, diameter at 25 mm (Miller & Furnish, 1940a);

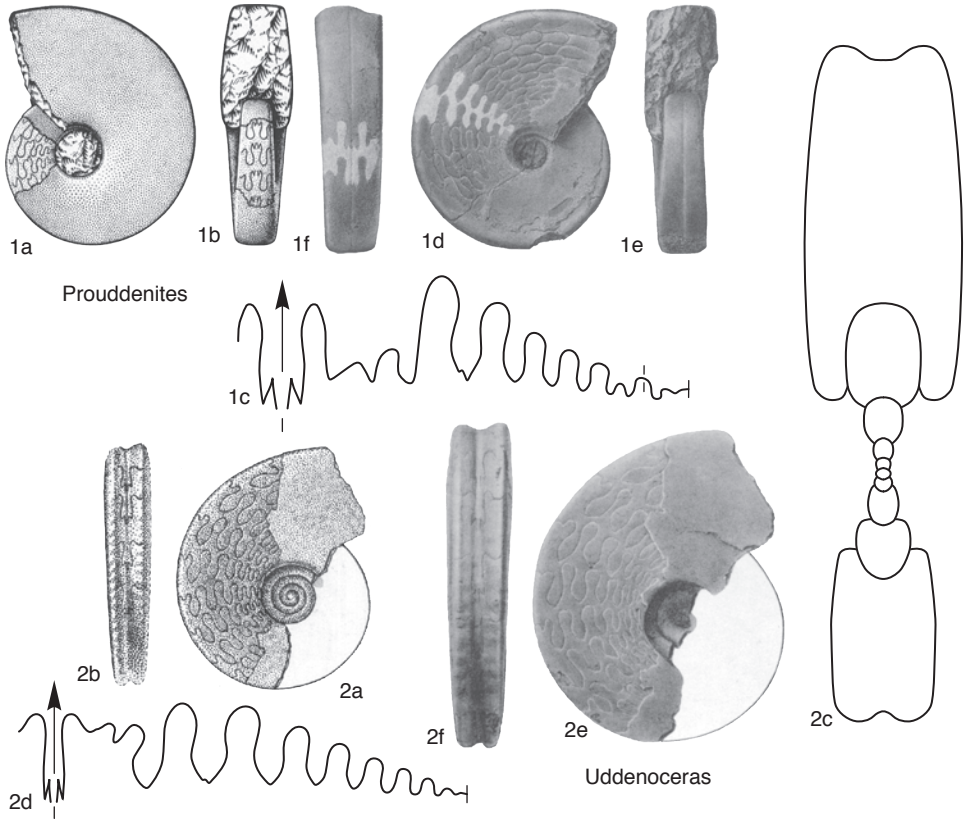

FIG. 127. Medlicottiidae (p. 199–201).

d–f, Winterset Limestone, Missouri, ×1 (Miller & Furnish, 1940c).

Uddenoceras MILLER & FURNISH, 1954, p. 691 [**Uddenites oweni* MILLER & FURNISH, 1940a, p. 36; OD]. Conch similar to *Uddenites,* but commonly narrower and may possess faint ventrolateral nodes. Suture characterized by alignment of all but ventrolateral flank of ventrolateral saddle only slightly apicad of line joining crests of first and second external saddles. Additionally, ventral subdivision of ventrolateral saddle ($s^{1.1}$) is bidentate or faintly crenulate. Three species. *Pennsylvanian (Kasimovian [Missourian]–Gzhelian [Virgilian]):* USA (Texas, northern-southern Midcontinent), Russia (Southern Urals).——FIG. 127,*2a–f.* **U. oweni* (MILLER & FURNISH), Finis Shale, Virgilian, North Texas and Graham Formation, north-central Texas; *a–b,* ×1.5 (Miller, Furnish, & Schindewolf, 1957, fig. 120A,B); *c,* SUI 54555, diameter at 21.5 mm (new, courtesy of D. M. Work); *d,* John Britts Owen Collection 688, diameter at 27 mm; *e–f,* YPM 16800, ×2 (Miller & Furnish, 1940a).

Subfamily MEDLICOTTIINAE Karpinskii, 1889

[*nom. correct.* RUZHENTSEV, 1960d, p. 189, *pro* Medlicottinae KARPINSKII, 1889, p. 45]

Conch intermediate to large, thinly lenticular or discoidal, venter with pair of ventrolateral keels or two rows of nodes. Suture complex, characterized by two or more subdivisions on ventral side of high ventrolateral saddle; more than one-half of umbilically derived external lateral lobes usually bidentate. *Pennsylvanian (Gzhelian)–Lopingian (Wuchiapingian).*

Medlicottia WAAGEN, 1880, p. 83 [**Goniatites orbignyanus* DE VERNEUIL, 1845, p. 378; OD] [?=*Paramedlicottia* LEONOVA, 1992, p. 138 (type, *P. sauksayensis,* OD)]. Conch thinly lenticular, narrow furrowed venter bounded by pair of sharp

ventrolateral keels (generally without nodes). Ventrolateral saddle has 8 to 12 subdivisions, remaining saddles rounded or slightly indented near midheight. External lateral lobe and adjacent umbilical lobes in arched alignment, subequal but decreasing in size to umbilicus. Sutural formula: $(V_2V_1V_2)v^1v^2v^{3\text{-}6}s^1l^1l^{7\text{-}5}l^4l^3l^2l^1L_{1(d)})UU^1U^2$..... [Russian]. Twenty-two named species (most are geographic designations that are too obscurely defined for recognition). *Cisuralian (Sakmarian)–Guadalupian (Wordian):* Russia (Urals, Volga-Urals), Kazakhstan (Southern Urals), Tajikistan (Pamir), Ukraine (Crimea), China (Guizhou, Gansu, ?Xizang, Xinjiang), Japan (southern Kitakami Massif), Indonesia (Timor), Italy (Sicily), Columbia, Mexico (Coahuila), USA (Texas, New Mexico, Nevada), Canada (British Columbia, Yukon, Arctic Archipelago: Devon Island).——Fig. 128*a–q.* **M. orbignyana* (de Verneuil), Artinskian; *a–c*, hypotype, PIUB 9 of Haniel (1915, pl. 2,*8a–c*), Timor, Bitauni, ×1 (new); *d–p,* ontogenetic succession of sutures, showing ventral prong of lateral lobe ($L_{1(v)}$) commonly transformed into complexly subdivided first later saddle, Aktubinsk, Kazakhstan [*d–h,* based on first individual; *i–m,* based on second; *n–o,* third; *p,* fourth]; *d,* whorl height at 0.25 mm; *e,* 0.4 mm; *f,* 0.5 mm; *g,* 0.8 mm; *h,* 1 mm; *i,* 1.2 mm; *j,* 1.8 mm; *k,* 2.5 mm; *l,* 3.6 mm; *m,* 5.3 mm; *n,* 6.7 mm; *o,* 12 mm, and *p,* 33.8 mm (Ruzhentsev, 1949a); *q,* external suture, Aktubinsk, Kazakhstan, SUI 2048, diameter at 35 mm (whorl height estimated about 25 mm or so [probably equal to the stage between *o* and *p* in Ruzhentsev's sequence] (adapted from Miller & Furnish, 1940a).

Artinskia Karpinskii, 1926, p. 8 [**Goniatites Artiensis* Grünewaldt, 1860, p. 138; OD] [=*Promedlicottia* Karpinskii, 1889, p. 23, *nom. nud.; =Prosicanites* Chernov, 1907, p. 359, *nom. nud., non* Tumanskaia in Tumanskaia & Borneman, 1937, p. 113]. Ancestral medlicottiins with subdivision of ventrolateral saddle intermediate in degree between characteristic Medlicottiinae and Propinacoceratinae, and conch resembling Sicanitinae. Conch thinly discoidal, with grooved venter between two rows of prominent ventrolateral nodes bounded by less-conspicuous ribs on ventrolateral flanks. Suture resembles *Medlicottia*, but ventrolateral saddle broader and lower, with 6–8 subdivisions (commonly 2 ventrad, 2 or 3 in crest, 3 dorsad). Sutural formula: $(V_2V_1V_2)v^1v^2s^1s^1l^3l^2l^1L_{1(d)})$ $UU^1U^2U^3U^5$..... [Russian]. Thirteen named species (most indeterminate). [Complex subdivision of the ventrolateral saddle in rare Gzhelian representatives from the Urals initiated lineages that diversified in the early Permian (Asselian), were rare in the succeeding Sakmarian, but then diversified again in the Artinskian to extend through the late Permian and eventual extinction of the order in the Early Triassic (Induan).] *Pennsylvanian (Gzhelian [Virgilian])–Cisuralian (Artinskian*): Kazakhstan (Southern Urals), Tajikistan (Pamir), Russia (Urals, northern Verkhoian), ?southern China (Guangxi), Thailand (Loei), Japan (Kitakami Massif), Indonesia (Timor), USA (Texas, New Mexico), Austria (Carnic Alps).——Fig. 129,*2a–f.* **A. artiensis* (Grünewaldt), Artinskian, Southern Urals; *a–b*, ×1 (Miller, Furnish, & Schindewolf, 1957, as *A. falx*); *c–e*, ×0.67 (Ruzhentsev, 1956b); *f,* diameter at 40 mm (Miller & Furnish, 1940a, as *A. falx*).——Fig. 129,*2g. A. nalivkini* Ruzhentsev, hypotype, SUI 84905, Asselian, Southern Urals, Sholak-Say, diameter at 45 mm (new, courtesy of D. M. Work & W. B. Saunders).

Eumedlicottia Spath, 1934, p. 49 [**Medlicottia bifrons* Gemmellaro, 1887, p. 53; OD]. Conch and suture generally similar to *Medlicottia,* but includes larger specimens (phragmocone may exceed 15 cm diameter), and most saddles in external suture are characterized by distinct paired notches above midheight. Prongs of primary external lateral lobe lie off (above) general lobe alignment. Five named species. *Cisuralian (Artinskian)–Lopingian (Wuchiapingian):* Italy (Sicily), Greece (Chios Island), Oman, Pakistan (Salt Range), southern China (Guizhou), Japan (Kitakami Massif), Russia (Maritime Territory), Indonesia (Timor), Mexico (Coahuila), USA (western and central Texas, Wyoming), Canada (British Columbia), East Greenland.——Fig. 130*a–d.* **E. bifrons* (Gemmellaro), Sosio limestone, Wordian, Sicily; *a,* lectotype (herein), MGUP 93A of Gemmellaro (1887, pl. 9,*18–19*), ×1.33 (new); *b–c,* paralectotype, MGUP 93B of Gemmellaro (1887, pl. 9,*16–17*), ×1.33 (new); *d,* lectotype, diameter approximately 35 mm (Miller & Furnish, 1940a; adapted from Gemmellaro, 1887, pl. 9,*19*).——Fig. 130*e. E. whitneyi* (Böse), Blaine Formation, Roadian, northcentral Texas, diameter at 75 mm (adapted from Miller & Furnish, 1940a).——Fig. 130*f. E. subprimas* Haniel, hypotype, GIUA-T554, Guadalupian, Toenioen Eno, Basleo area, Timor, ×0.67 (new).

Neogeoceras Ruzhentsev, 1947b, p. 641 [**Medlicottia girtyi* Miller & Furnish, 1940a, p. 59; OD]. Sublenticular medlicottiins with relatively broad, shallowly concave venter (width 0.3 to 0.5 maximum conch width). Angular ventrolateral shoulders bordered by shallowly concave ventrolateral flanks, commonly ribbed. Suture characterized by narrow, complexly subdivided ventrolateral saddle ($v^{3\text{-}5}$, $l^{4\text{-}7}$) in which first adventitious element l^1 is only slightly larger than element l^2 and adjacent subdivisions. Additionally, strongly asymmetrical bidentate dorsal subdivision of primary lateral lobe ($L_{1(d)}$) lies beneath general lobe alignment, with ventral prong deeper than dorsal. Ten named species. [Taxonomic position of *Neogeoceras* within the Medlicottiidae is uncertain. Sutures resemble *Medlicottia* in general aspect, but small size of l^1 and extreme depth and asymmetry of $L_{1(d)}$ are unknown in other Medlicottiinae. *Neogeoceras* resembles *Episageceras* in all these respects, and assignment to the Episageceratinae could be justified. However,

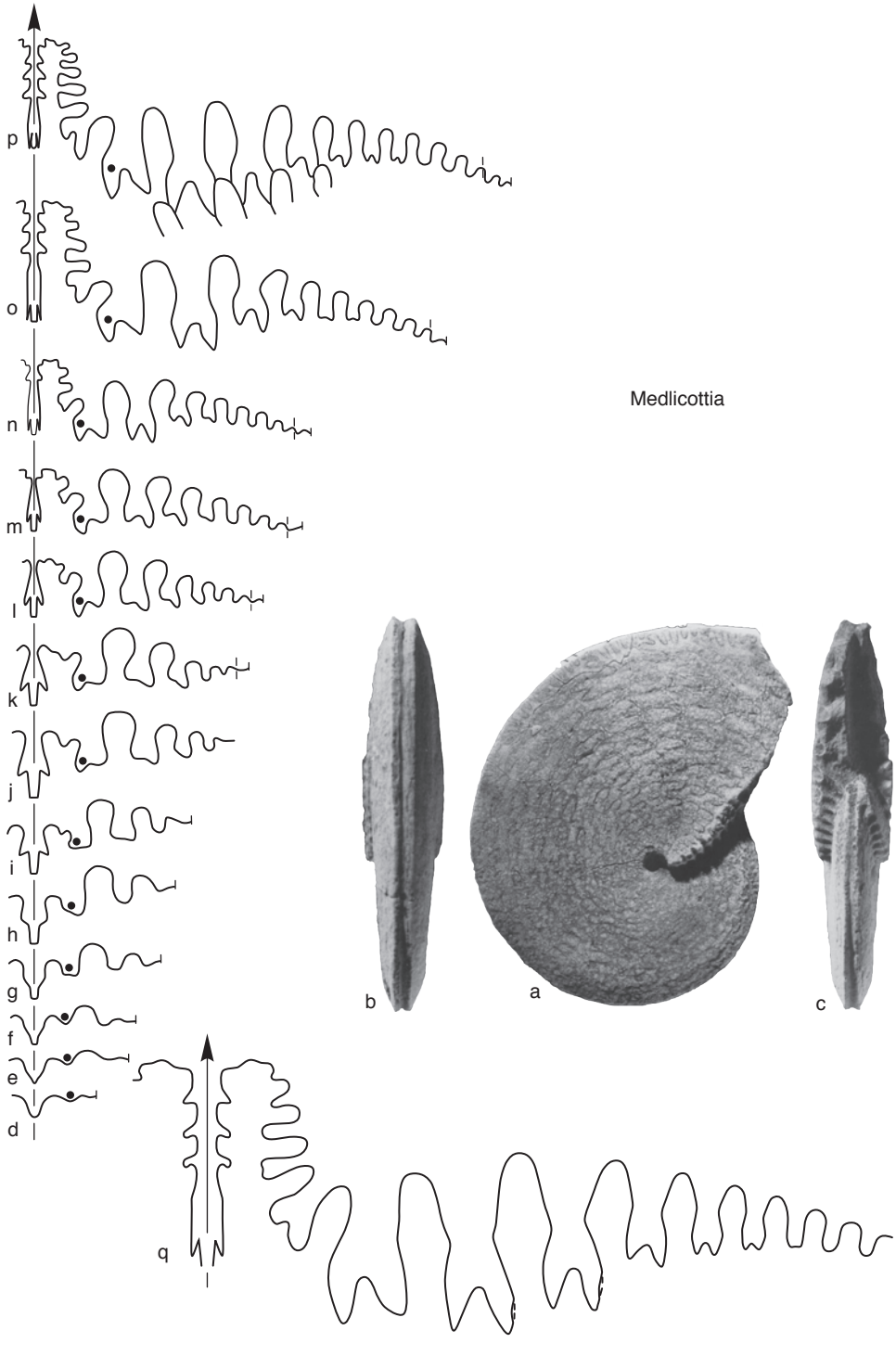

FIG. 128. Medlicottiidae (p. 201–202).

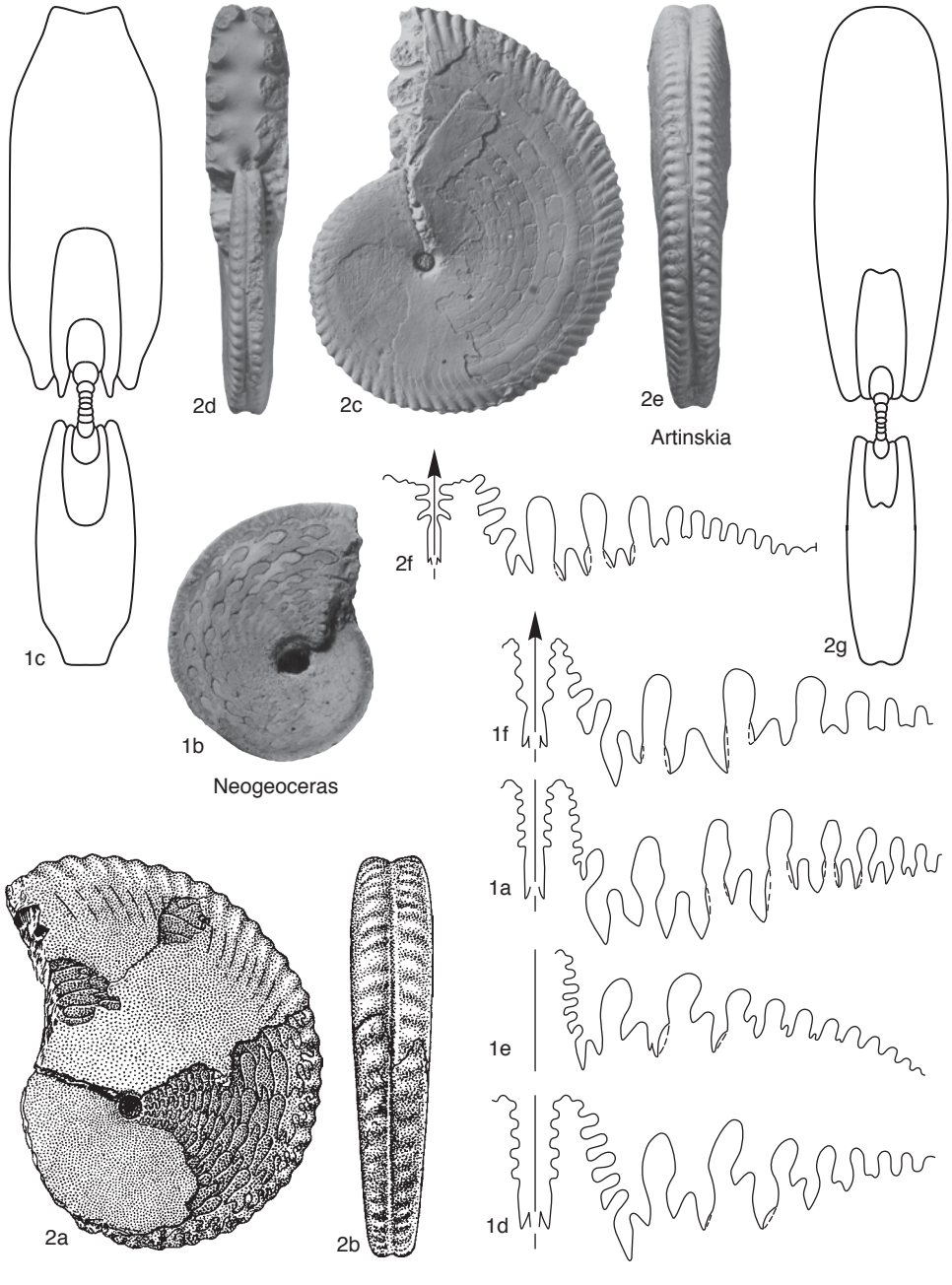

FIG. 129. Medlicottiidae (p. 202–205).

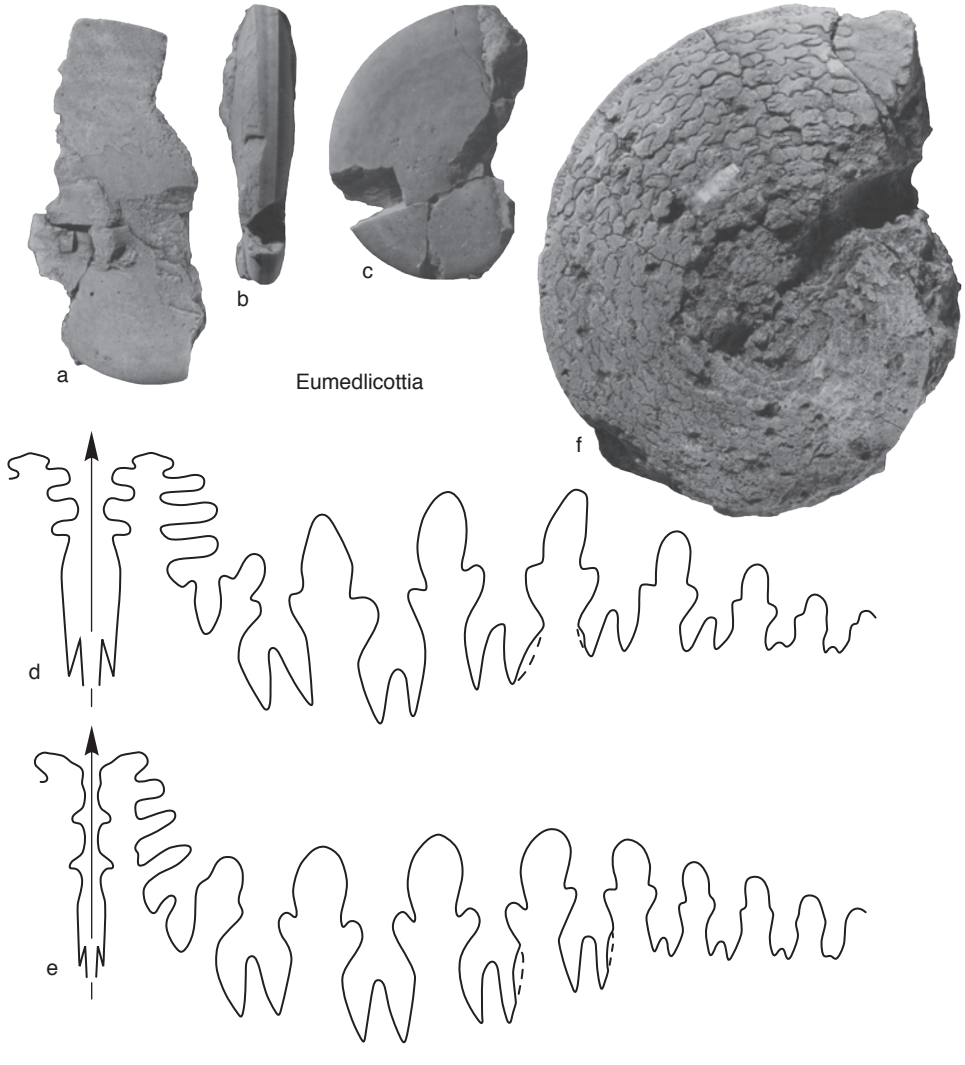

FIG. 130. Medlicottiidae (p. 202).

we prefer to define that subfamily primarily on the basis of the anomalously short primary umbilical lobe (U) and consider *Neogeoceras* as the plausible medlicottiin ancestor of the Episageceratinae.] *Guadalupian (Wordian)–Lopingian (Wuchiapingian):* Mexico (Coahuila), USA (western Texas), Canada (Arctic Archipelago: Cameron Island), Italy (Sicily), Iraq (Kurdistan), Afghanistan, Oman, Russia (Novaia Zemlia, Maritime Territory), China (Xizang), Japan (Honshu), Indonesia (Timor).——FIG. 129,*1a. *N. girtyi* (MILLER & FURNISH), topotype, SUI 61500, Capitanian, Coahuila, diameter at 70 mm (new).——FIG. 129,*1b–d. N. smithi* MILLER & FURNISH; *b*, hypotype, GIUA-B171, Wordian, Basleo, Timor, ×1 (new); *c*, hypotype, SUI 12707, diameter at 29 mm (new, courtesy of D. M. Work & W. B. Saunders); *d*, hypotype, SUI 12657, Amarassi beds, Wuchiapingian, Amarassi, Timor, diameter at 35 mm (new).——FIG. 129,*1e. N. thaumastum* RUZHENTSEV, Wuchiapingian (*fide* ZAKHAROV & PAVLOV, 1986), Maritime Territory, diameter approximately 35 mm (adapted from Ruzhentsev, 1976).——FIG. 129,*1f. N. boreale* (CHERNYSHEV in KARPINSKII, 1926), Wuchiapingian, Novaia Zemlia, diameter approximately 40 mm (Karpinskii, 1926).

Syrdenites NASSICHUK, FURNISH, & GLENISTER, 1966, p. 46 [**S. stoyanowi;* OD]. Conch as in *Medlicottia,* large; phragmocone diameter to 15 cm. Suture generally similar to *Eumedlicottia,* but paired notching in lateral saddles continues further orad along dorsal flank of ventrolateral saddle.

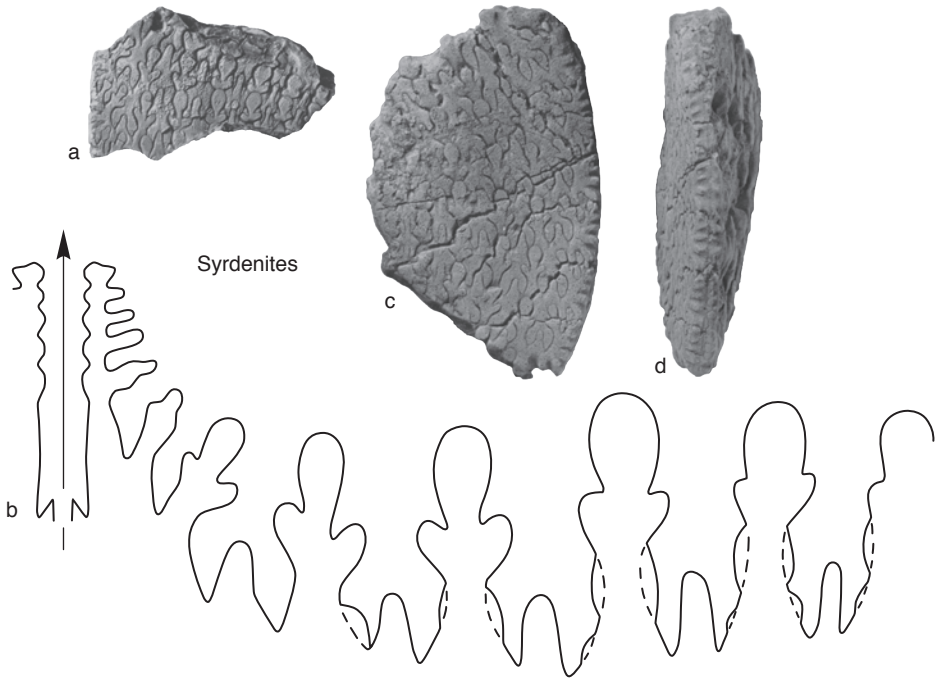

FIG. 131. Medlicottiidae (p. 205–206).

Sutural formula $(V_2V_1V_2)v^1v^2v^3v^4s^1s^{1}[^5]l^{4}[^3]l^{2}[^{1.2}]l^{1.2}[^{1.1}]L_{1(d)}UU^1U^2$..... [Russian]. [Formula indicates that the apical notch on the dorsal flank of the ventrolateral saddle (l^1) subdivided into two discrete elements ($l^{1.2}[^{1.1}]$)]. Sutural elements l^5 through U^2 form a graded sequence, increasing dorsad in size and extent of notching and forming an unbroken arcuate trace. One named species. *Guadalupian (Capitanian)–Lopingian (Wuchiapingian):* Azerbaijan (Caucasus), Russia (Maritime Territory), Japan (Kitakami Massif), Indonesia (Timor), Mexico (Coahuila).——FIG. 131*a–b. *S. stoyanowi,* Wuchiapingian, Azerbaijan; *a*, ×0.5 (Ruzhentsev in Bogoslovskii, Librovich, & Ruzhentsev, 1962, pl. 12,*2*); *b*, diameter approximately 15 cm (Ruzhentsev, 1960d, p. 305, fig. 128b).——FIG. 131*c–d. S.* sp. cf. *S. stoyanowi,* hypotype, SUI 62240, Capitanian, Timor, Toenioen Eno, Basleo area, ×0.67 (new).

Subfamily PROPINACOCERATINAE Plummer & Scott, 1937

[Propinacoceratinae PLUMMER & SCOTT, 1937, p. 89]
[=Miklukhoceratinae LEONOVA in LEONOVA & DMITRIEV, 1989, p. 95; =Darvasiceratidae LEONOVA, 1990, p. 106]

Conch discoidal, with strongly ribbed or nodose venter, ranging in mature diameter from 3.5 cm to 20 cm. Suture characterized by low, broad, ventrolateral saddle with few (2 to 8) subdivisions. More than one-half of umbilically derived external lateral lobes usually bidentate. *Cisuralian (Asselian)–Lopingian (Wuchiapingian).*

Propinacoceras GEMMELLARO, 1887, p. 55 [**P. Beyrichi* GEMMELLARO, 1887, p. 56; SD DIENER, 1921, p. 12]. Conch large (diameter to 20 cm) with strong ventral ribs or nodes separated by median furrow. Suture characterized by undivided ventral flank of ventrolateral saddle and by dorsal subdivision of primary external lateral lobe ($L_{1(d)}$) that is less than one-half size of adjacent primary umbilical lobe. Sutural formula: $(V_2V_1V_2)s^1s^1L_{1(d)}UU^1U^2$..... [Russian]. Type species has mondial distribution; remaining 19 named species poorly characterized and questionably valid. *Cisuralian (Sakmarian)–Guadalupian (Wordian):* Italy (Sicily), Croatia, Iraq (Kurdistan), Oman, Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Afghanistan, Ukraine (Crimea), China (Xizang, Xinjiang, Guizhou, Guangxi, Jilin, Gansu), Mexico (Coahuila), Indonesia (Timor), USA (Texas), Japan (Kitakami Massif), Canada (British Columbia). ——FIG. 132,*1a–c. *P. beyrichi,* Sosio limestone Wordian, Sicily; *a–b*, lectotype (herein), MGUP 96A of GEMMELLARO (1887, pl. 5,*12–13*), ×1.2 (Gemmellaro, 1887); *c*, unfigured paralectotype, MGUP 98A of GEMMELLARO (1887), diameter at 26 mm (new).——FIG. 132,*1d. P. ajense* MAKSIMOVA, hypotype, SUI 84906, Artinskian, Baigendzhinian, central Urals, River Kos'va,

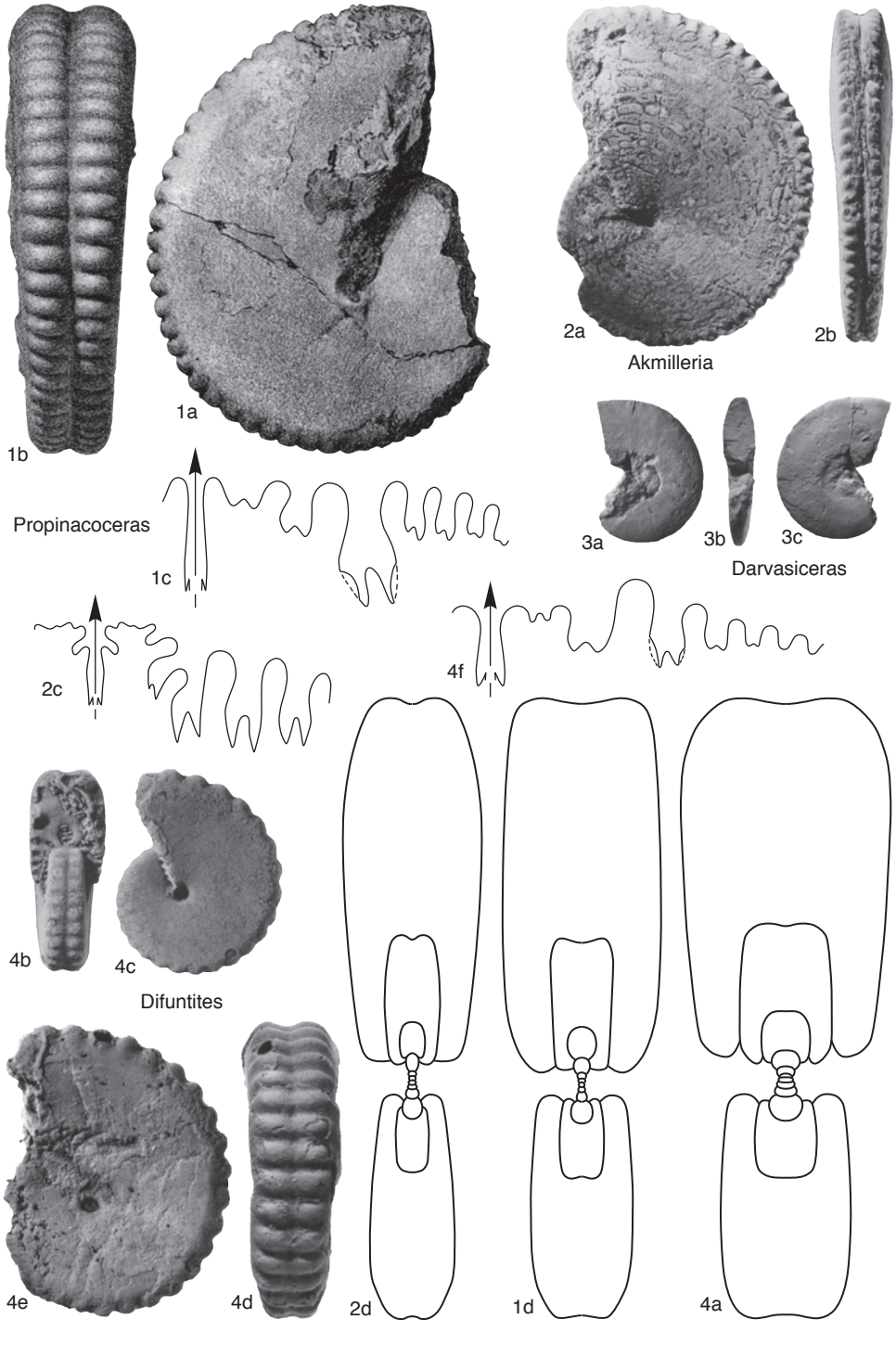

FIG. 132. Medlicottiidae (p. 206–210).

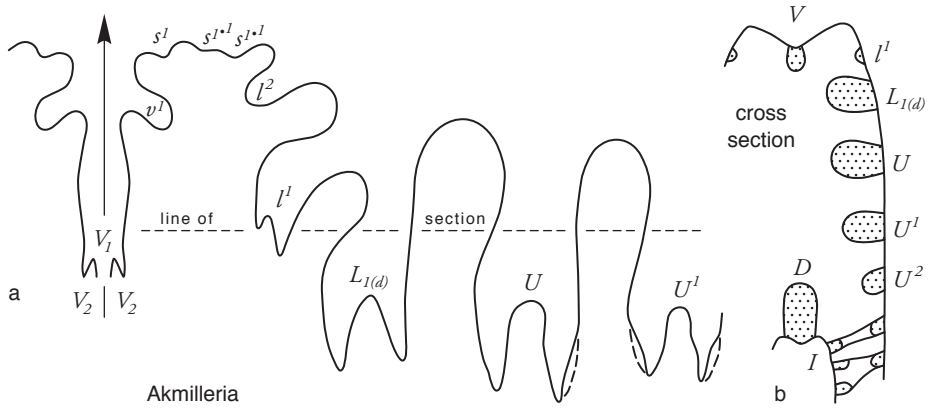

FIG. 133. Medlicottiidae (p. 208).

diameter at 31 mm (new, courtesy of D. M. Work & W. B. Saunders).

Akmilleria RUZHENTSEV, 1940d, p. 474 [**Propinacoceras transitorium* HANIEL, 1915, p. 39; OD]. Conch narrowly discoidal, with two rows of ventral tubercles. Suture characterized by ventrolateral saddle with 5 to 8 subdivisions, 1 on ventral flank, 2 to 5 on crest, 2 dorsad, the first of which is bidentate. Sutural formula: $(V_2V_1V_2)v^1s^1s^1l^2l^1L_{1(d)}UU^1U^2$..... [Russian]. Five named species. *Cisuralian (Asselian–Kungurian):* Kazakhstan (Southern Urals), Indonesia (Timor), USA (commonly Texas, Kansas, Nevada), southern China (Guizhou, Guangxi), Thailand (Loei).——FIG. 132,*2a–c. *A. transitoria* (HANIEL), Bitauni beds, Artinskian, Bitauni, Timor; *a–b*, lectotype (herein), PIUB 7A of HANIEL (1915, pl. 2,*5a–b*), ×0.89 (Haniel, 1915); *c*, previously unfigured paralectotype, PIUB 7B, diameter approximately 70 mm (new).——FIG. 133*a–b. *A. transitoria* (HANIEL); partial suture and septal face to depict sutural symbolism of V. E. RUZHENTSEV utilized herein in modified form (new).——FIG. 132,*2d. A. electraensis* (PLUMMER & SCOTT), hypotype, SUI 51609, Rib Hill-Arcturus Formation, Buck Mountain, Nevada, Artinskian, Aktastinian, diameter at 34 mm (new, courtesy of D. M. Work & W. B. Saunders).

Bamyaniceras TERMIER & TERMIER, 1970, p. 94 [**B. bouyxi;* OD]. Conch similar to *Propinacoceras*, suture with undivided ventral flank and 2 to 4 subdivisions in crest of ventrolateral saddle. Differs in possession of relatively large simple or bifid dorsal subdivision of ventrolateral saddle and retention to maturity of large dorsal subdivision of primary external lateral lobe ($L_{1(d)}$) greater than one-half size of adjacent primary umbilical lobe U, or two elements subequal in extreme cases. Sutural formula $(V_2V_1V_2)s^1s^1l^1L_{1(d)}UU^1$..... [Russian]. Twelve named species. [Ventrolateral sutures of *Bamyaniceras* and *Propinacoceras* may be homeomorphic, the dorsal subdivision of the ventrolateral saddle (l^1) in the former resembling in size and location the dorsal prong of the primary lateral lobe ($L_{1(d)}$) in the latter; however, study of the ontogeny appears to reveal the fundamental difference. *Bamyaniceras* is a dominant medlicottiid of the North American southwest and of Central Asia.] *Cisuralian (Artinskian)–Guadalupian (Wordian):* Tajikistan (Pamir), Afghanistan, Ukraine (Crimea), Italy (Sicily), USA (Texas, Nevada, California), Indonesia (Timor), Thailand (Loei), Western Australia, China (Guizhou, Xinjiang).——FIG. 134,1*a. *B. bouyxi,* Artinskian, Bamyan Mountains, Afghanistan, IGAL, Paris (TERMIER & TERMIER, 1970, pl. 9,*1-2,1-1*), diameter approximately 50 mm (Termier & Termier, 1970).——FIG. 134,1*b–g. B. galilaei* (GEMMELLARO), Sosio limestone, Wordian, Sosio, Sicily; *b,* YPM 15221, diameter approximately 40 mm; *c–d,* lectotype (herein), MGUP 99A of GEMMELLARO (1887, pl. 9,*1–2*), ×1.33; *e–g*, hypotype, USNM 487617, "Pietra Cavorata" (probably Pietra di Salomone), ×1.33 (new).——FIG. 134,1*h–q. B. similis* (HANIEL), Skinner Ranch Formation, Artinskian, near Dugout Mountain, USNM Loc. 700n', Brewster County, western Texas; ontogenetic series of ventrolateral sutures based on one side of single hypotype, USNM 487618, representing alternate sutures for one full whorl, diameter ranging from 5 to 10 mm, and portraying diagnostic developmental features for genus (new).

Darvasiceras LEONOVA, 1990, p. 107 [**D. mirim;* OD] Inadequately known, from rare juveniles; perhaps similar to *Propinacoceras,* but apparently lacking ventrolateral nodes and with anomalously low ventrolateral saddle. Absence of ventrolateral nodes may be a function of small size. One species. *Cisuralian (Artinskian [Yakhtashian]):* Tajikistan (Darvas).——FIG. 132,*3a–c. *D. mirim*, ×1 (Leonova, 1990).

Difuntites GLENISTER & FURNISH, 1988a, p. 57 [**Propinacoceras hidium* RUZHENTSEV, 1976, p. 39;

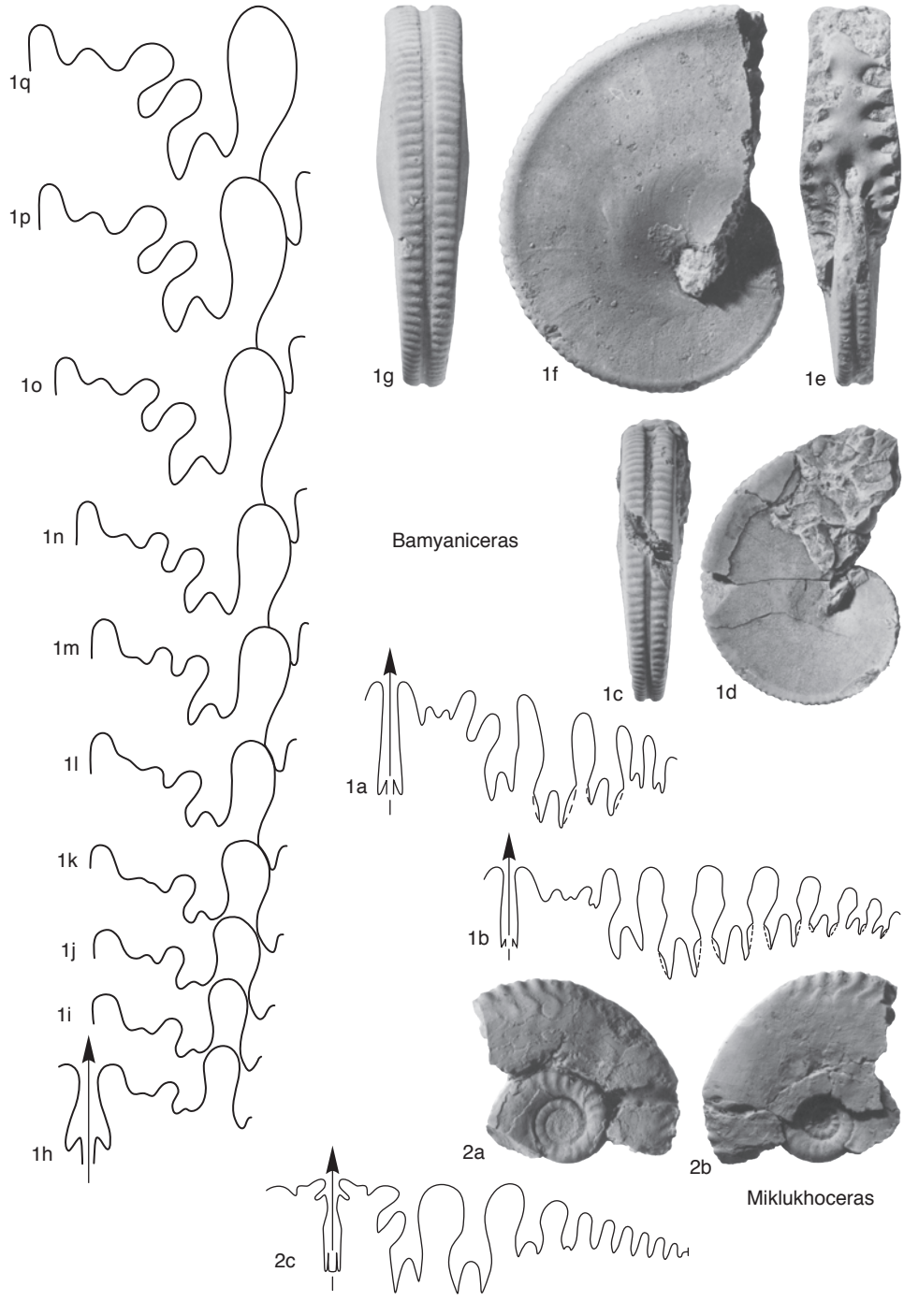

FIG. 134. Medlicottiidae (p. 208–210).

OD]. Conch small, probably less than 35 mm at maturity, broadly discoidal (W/D, 0.3–0.4), with two rows of relatively large ventral nodes. Suture generally similar to *Propinacoceras,* but characterized by dorsal prong of primary lateral lobe ($L_{1(d)}$), whose breadth exceeds that of adjacent primary umbilical lobe (U) in all growth stages. One species. [*Difuntites* is the smallest, broadest, rarest, and youngest propinacoceratin and is interpreted as the terminal paedomorph of the subfamily.] *Lopingian (Wuchiapingian):* Russia (Maritime Territory), Indonesia (Timor), Madagascar, Mexico (Coahuila), China (Guizhou).——Fig. 132,*4a–f.* **D. hidius* (Ruzhentsev); *a*, hypotype, SUI 12653, diameter at 16 mm (new, courtesy of D. M. Work & W. B. Saunders); *b–c*, single mature specimen, Amarassi beds, Wuchiapingian, Timor, ×2.66 (Glenister & Furnish, 1988a); *d–e*, Upper Liudianzin Suite, Shkotovo district, Russian Maritime Territory, ×1; *f,* diameter at 12 mm (Ruzhentsev, 1976).

Kunlunoceras Wang, 1983, p. 516 [**K. kunlunense;* OD]. Inadequately known, from single specimen, apparently similar to *Darvasiceras* in distinctive low ventrolateral saddle, but differing in possession of two rows of prominent ventrolateral nodes. One species. *Cisuralian (?Artinskian):* northwestern China (Xinjiang).

Miklukhoceras Pavlov, 1967, p. 69 [**M. pamiricum;* OD]. Narrowly discoidal propinacoceratins with two rows of ventral nodes. Juveniles characterized by evolute form and conspicuous ribs that extend across entire flank. At larger size, umbilicus remains open (U/D, 0.2–0.3 at 30 mm diameter), and conspicuous ribs are confined to sigmoidal extensions across ventrolateral flanks from ventral nodes. Suture as in *Akmilleria,* with single subdivision on ventral flank of ventrolateral saddle. Four named species. [The relationship of *Miklukhoceras* to other Medlicottiidae remains unclear. The evolute juvenile form characterizes the entire family but generally there is an absence of conspicuous sculpture.] *Cisuralian (Sakmarian–Kungurian):* Tajikistan (Pamir), northwestern China (Xinjiang), Thailand (Muak Lek).——Fig. 134,*2a–c.* **M. pamiricum,* Bolorian, Pamir; *a–b*, ×1; *c*, diameter approximately 40 mm (Leonova & Dmitriev, 1989).

Subfamily SICANITINAE Noetling, 1904

[Sicanitinae Noetling, 1904, p. 343] [=Artioceratinae Leonova in Leonova & Dmitriev, 1989, p. 108]

Conch intermediate in size, lenticular to discoidal, with strong ventral nodes that may be elongate to simulate pair of ventrolateral keels. Ventrolateral saddle low to intermediate height, with few (3 to 10) subdivisions, l^1 commonly large and bidentate to tridentate. Suture characterized by position of primary external lateral lobe ($L_{1(d)}$) significantly below alignment of subequal, adjacent, umbilically derived lateral lobes; more than one-half of umbilically derived external lobes bidentate. *Cisuralian (Asselian)–Guadalupian (Wordian).*

Sicanites Gemmellaro, 1887, p. 62 [**Medlicottia Schopeni* Gemmellaro, 1887, p. 51; SD Miller & Furnish, 1940a, p. 39, =*Sicanites Mojsisovicsi* Gemmellaro, 1887, p. 64, based on page priority] [=?*Prosicanites* Tumanskaia in Tumanskaia & Borneman, 1937, p. 113 (type, *P. edelsteini,* SD Ruzhentsev, 1949a, p. 41); =*Aktubinskia* Ruzhentsev, 1947b, p. 641 (type, *Artinskia notabilis* Ruzhentsev, 1940d, p. 475, OD); =*Vanartinskia* Ruzhentsev, 1978, p. 41 (type, *V. asiana,* OD)]. Conch lenticular, with ventral nodes varyingly bladelike in most species to simulate paired ventrolateral keels. Ventrolateral saddle intermediate in height, with 7 to 10 subdivisions. Sutural formula: $(V_2V_1V_2)v^1v^{2\text{-}3}s^1s^1l^{5\text{-}3}l^2l^1L_{1(d)}UU^1U^2$..... [Russian]. Nine named species. [Gemmellaro's misinterpretation of the ventrolateral saddle resulted in one of the few instances in which he failed to recognize details important in relationships. Polygonal coiling in *S. schopeni* (Fig. 135*d,g,h*) up to a diameter of 15 mm may serve eventually for separate generic recognition, but there is insufficient current information on other assigned species; diagrammatic cross sections herein (e.g., Fig. 132,*1d, 2d, 4a* herein) indicate that all medlicottiids were evolute as juveniles but then became involute abruptly on reaching adulthood.] *Cisuralian (Asselian)–Guadalupian (Wordian):* Italy (Sicily), Croatia, Iraq (Kurdistan), Oman, Ukraine (Crimea), Kazakhstan (Southern Urals), Tajikistan (Pamir), southern China (Guizhou, Guangxi), Thailand (Loei), Indonesia (Timor), USA (western Texas, Nevada), Mexico (Coahuila).——Fig. 135*a–i.* **S. schopeni* (Gemmellaro), Sosio limestone, Wordian, Sicily; *a–b,* lectotype (herein), MGUP 91A of Gemmellaro (1887, pl. 9,*20–22*), ×1.33; *c–d,* paralectotype, MGUP 91B of Gemmellaro (1887, pl. 9,*23–24*), ×3; *e–g,* topotype, USNM 159902, Pietra di Salomone, Sosio Valley, ×3.33; *h*, paralectotype, MGUP 91C of Gemmellaro (1887, pl. 9,*25*), ×3; *i,* lectotype (herein), MGUP 91A of Gemmellaro (1887, pl. 9,*20–22*), diameter at 30 mm (new).——Fig. 135*j. S asiana* (Ruzhentsev; type species of *Vanartinskia*), Asselian, Pamir, diameter at 40–45 mm (Ruzhentsev, 1978).——Fig. 135*k. S. insulcatus* (Haniel), Bitauni beds, Artinskian: Baigendzhinian, Bitauni, Timor, lectotype (herein), PIUB 6A of Haniel (1915, pl. 2,*3a–b*; fig. 6), diameter at 40 mm (new).——Fig. 135*l–n. S. notabilis* (Ruzhentsev; type species of *Aktubinskia*); *l,* Artinskian, Aktastinian, Aktasty River, Southern Urals, diameter at 17 mm (Ruzhentsev, 1956b), *m,* topotype, Artinskian, Aktastinian, Aktasty River, Southern Urals, SUI 10565A, diameter at 30 mm; *n,* hypotype, SUI 62264, Rib Hill-Arcturus Formation, Artinskian, Aktastinian, Buck Mountain, White Pine County, Nevada, diameter at 70 mm (new).——Fig. 135*o. S. costelliferus* (Miller

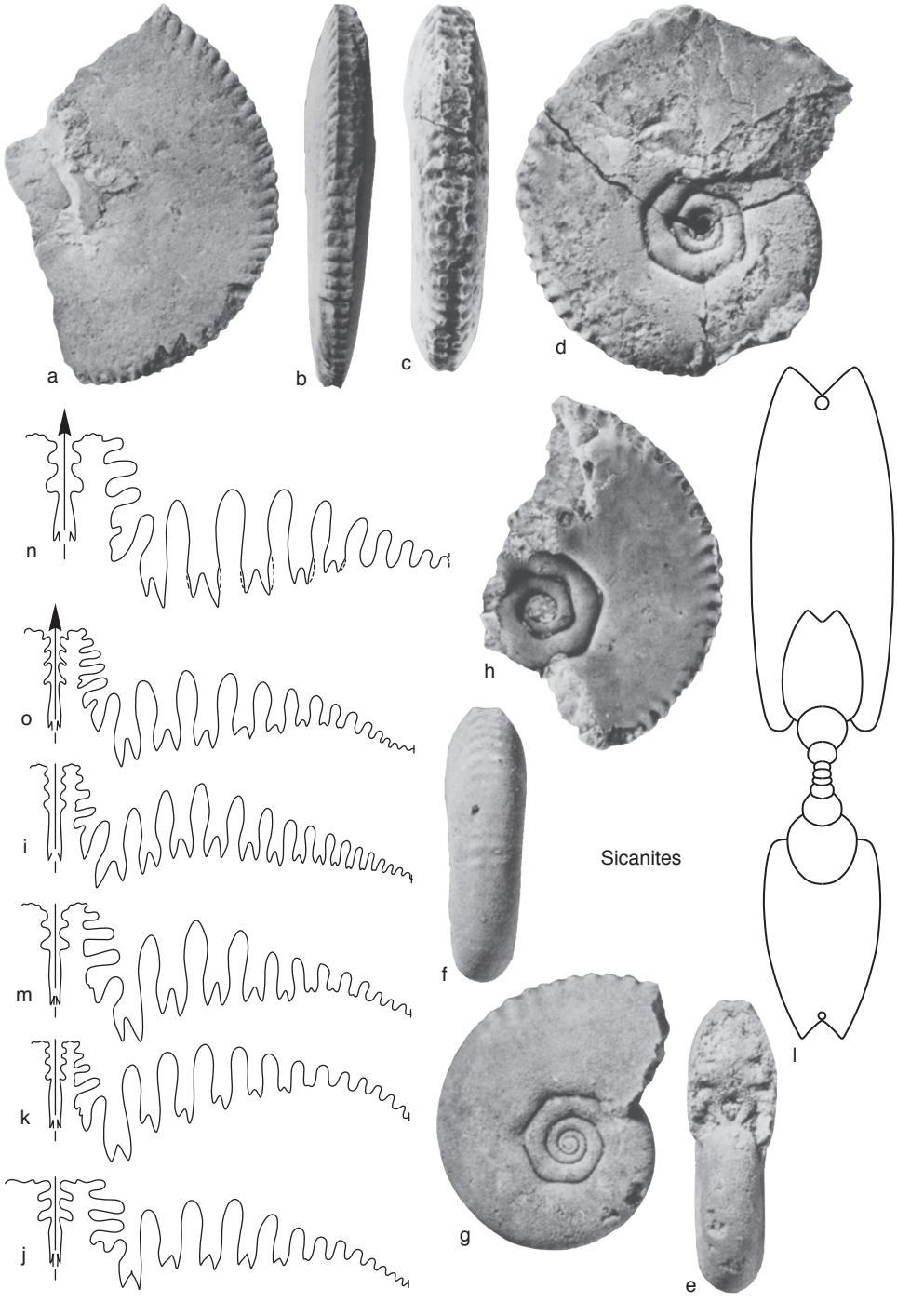

FIG. 135. Medlicottiidae (p. 210–213).

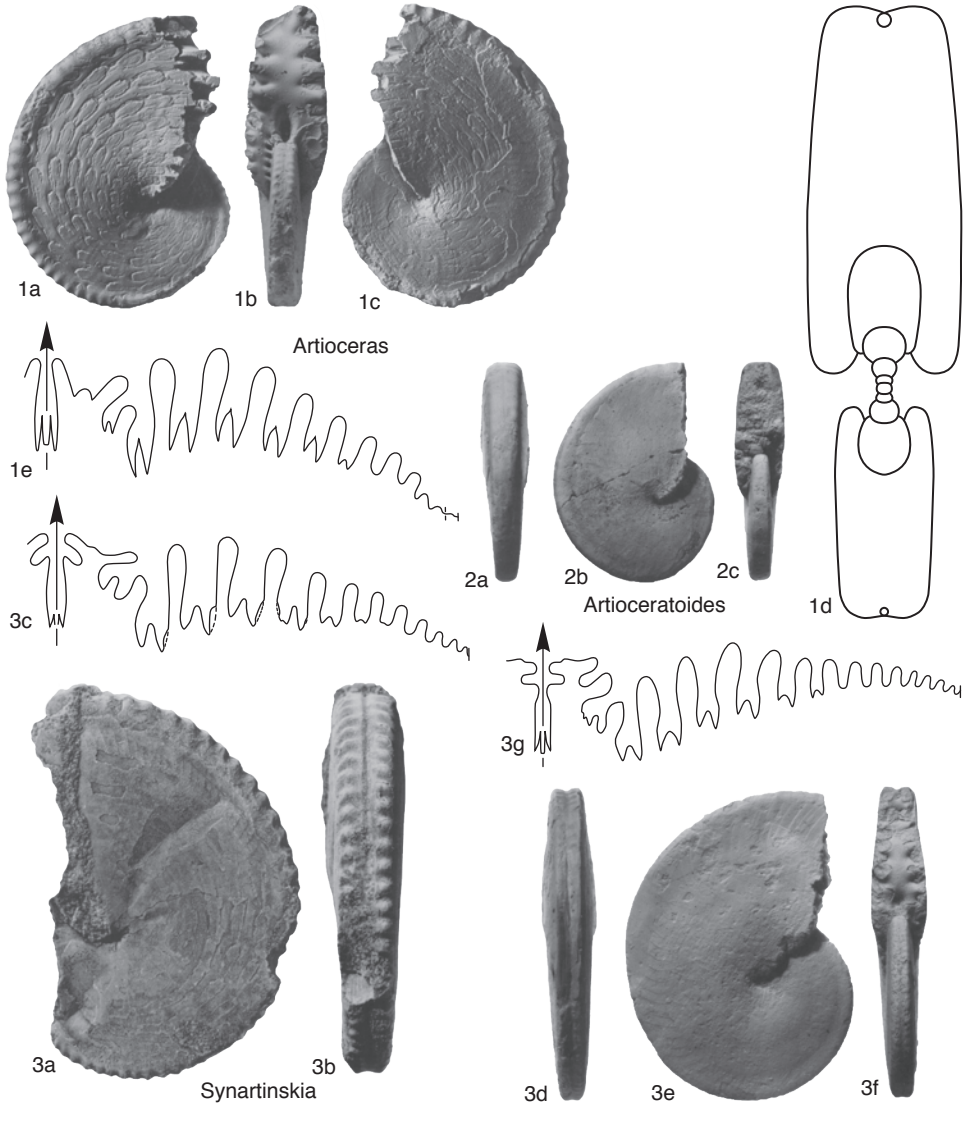

FIG. 136. Medlicottiidae (p. 213).

& Furnish), Leonard Group, Artinskian, western Texas, diameter at 70 mm (Miller & Furnish, 1940a).

Artioceras Ruzhentsev, 1947b, p. 641 [**Propinaceras rhipaeum* Ruzhentsev, 1939c, p. 837; OD]. Conch discoidal with strong equidimensional ventral nodes. Suture characterized by combination of only three subdivisions of ventrolateral saddle with deep dorsal prong of primary external lateral lobe. Sutural formula: $(V_1V_2V_1)s^1s^1l^1L_{1(d)}UU^1U^2$..... [Russian]. One named species. *Cisuralian (Artinskian [Aktastinian])*: Kazakhstan (Southern Urals), southern China (Guizhou, Guangxi), Belgium (Namur).——Fig. 136,*1a–e.* **A. rhipaeum* (Ruzhentsev), Aktasty River area, Southern Urals; *a–c,* ×0.67; *d*, diameter at 14 mm; *e*, diameter at 57 mm (Ruzhentsev, 1956b).

Artioceratoides Leonova, 1985, p. 81 [**A. victori;* OD]. Similar to *Artioceras* in both conch form and suture, but lacking ventral nodes and with only two subdivisions (one bidentate) of ventrolateral saddle. Sutural formula: $(V_1V_2V_1)s^1s^1L_{1(d)}UU^1U^2$..... [Russian]. Two species. [This genus is questionably valid, as differences from *Artioceras* comprise only retention of juvenile characters to slightly larger size.] *Cisuralian (Artinskian–Kungurian):* Tajikistan (Pamir).——Fig. 136,*2a–c.* **A. victori*, ×1 (Leonova, 1985).

Synartinskia Ruzhentsev, 1939d, p. 461 [**S. principalis;* OD] [=*Parasicanites* Leonova, 1985, p. 77 (type, *P. meridionalis,* OD)]. Conch form and ventral sculpture as in *Artioceras.* Suture characterized by deep dorsal prong of primary external lateral lobe in combination with ventrolateral saddle with 4 or 5 subdivisions, one of which is ventrad; first dorsal subdivision (l^1) large and variously dentate. Sutural formula: $(V_2V_1V_2)v^1s^1s^1l^{1-2}L_{1(d)}UU^1U^2$..... [Russian]. Five named species. *Cisuralian (Sakmarian)–Guadalupian (Roadian):* Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Canada (Arctic Archipelago: Devon Island).——Fig. 136,*3a–c.* **S. principalis,* topotype, Sakmarian, Aktyubinsk District, Southern Urals, SUI 10561; *a–b*, ×1.33; *c*, diameter at 40 mm (new).——Fig. 135,*3d–g. S. meridionalis* (Leonova; type species of *Parasicanites*), Bolorian-Kungurian, Pamir; *d–f*, ×1; *g*, diameter at 42 mm (Leonova, 1985).

Subfamily EPISAGECERATINAE Ruzhentsev, 1956

[*nom. transl.* Glenister, Furnish, & Zhou, herein, *ex* Episageceratidae Ruzhentsev, 1956a, p. 160]

Medlicottiids with thickly discoidal conch, broad, flat venter (width 0.4 to 0.5 maximum conch width), and angular ventrolateral shoulders. Characterized by complex suture with primary umbilical lobe (U) much shorter than adjacent elements (L_1 and U^1). More than one-half of umbilically derived external lateral lobes usually bidentate. Ventrolateral saddle narrow, high, subdivided by perhaps as few as 8 and by up to 16 subequal subdivisions paired on either side of angular ventrolateral shoulder. [Episageceratins are rare, and details of sutural ontogeny are poorly known.] *Lopingian (Wuchiapingian)–Lower Triassic (Induan).*

Episageceras Noetling, 1904, p. 363 [**Sageceras (Medlicottia) wynnei* Waagen, 1880, p. 81; SD Diener, 1915, p. 165] [=*Protosageceras* Y. Popov, 1961, p. 10 (type, *P. antiquus,* OD)]. Suture characterized by 10 to 16 subdivisions in ventrolateral saddle and by primary umbilical lobe much shorter and appreciably narrower than adjacent lobes. Sutural formula: $(V_2V_1V_2)v^1v^2v^{3-7}s^1s^1l^{7-3}l^2l^1L_{1(d)}UU^1U^2$..... [Russian]. Five named species. *Lopingian (Wuchiapingian)–Lower Triassic (Induan)*: Madagascar, Pakistan (Salt Range), India (Himalaya), Russia (Verkhoian, Okhotskii), Indonesia (Timor), New Zealand (D'Urville Island, South Island), East Greenland, Mexico (Coahuila).——Fig. 137*a.* **E. wynnei* (Waagen); plastoholotype, Chhidru Formation, Wuchiapingian, Salt Range, SUI 12378, diameter at 70 mm (Waagen, 1880).——Fig. 137*b. E.* sp., Greville Formation, Induan, D'Urville Island, New Zealand, SUI 39603, diameter at 90 mm (new).——Fig. 137*c–f. E. dalailamae* (Diener), *Otoceras* beds, Induan, Spiti, Himalaya; *c–e*, ×0.67; *f*, diameter at 80 mm (Noetling, 1904).——Fig. 137*g–j. E. boulei* Treat, holotype, MNHN 1924-2, Wuchiapingian, Ankitohazo, Madagascar; *g–i*, ×0.67; *j*, diameter at 60 mm (new).——Fig. 137*k–n. E. noetlingi* Haniel; *k–l*, holotype, PIUB 10 of Haniel (1915, pl. 2,*10a–b*), Timor, Kuefeu, ×1.33; *m,* topotype, SUI 62308, diameter at 29 mm (courtesy of D. M. Work & W. B. Sauders); *n*, hypotype, SUI 12023, Lopingian, Timor, Basleo, diameter at 25 mm (new).——Fig. 137*o. E.* aff. *E. noetlingi* [based on general similarity of sutures, but whorl section and ventrolateral nodes suggest affinity with *Nodosageceras*], SUI 32869, La Colorada beds, Wuchiapingian, Coahuila, Mexico, diameter at 18 mm (new).

Latisageceras Ruzhentsev, 1956a, p. 160 [**Episageceras latidorsatum* Noetling, 1904, p. 372; OD]. Conch similar to *Episageceras,* but venter possibly proportionally broader. Suture relatively simple:

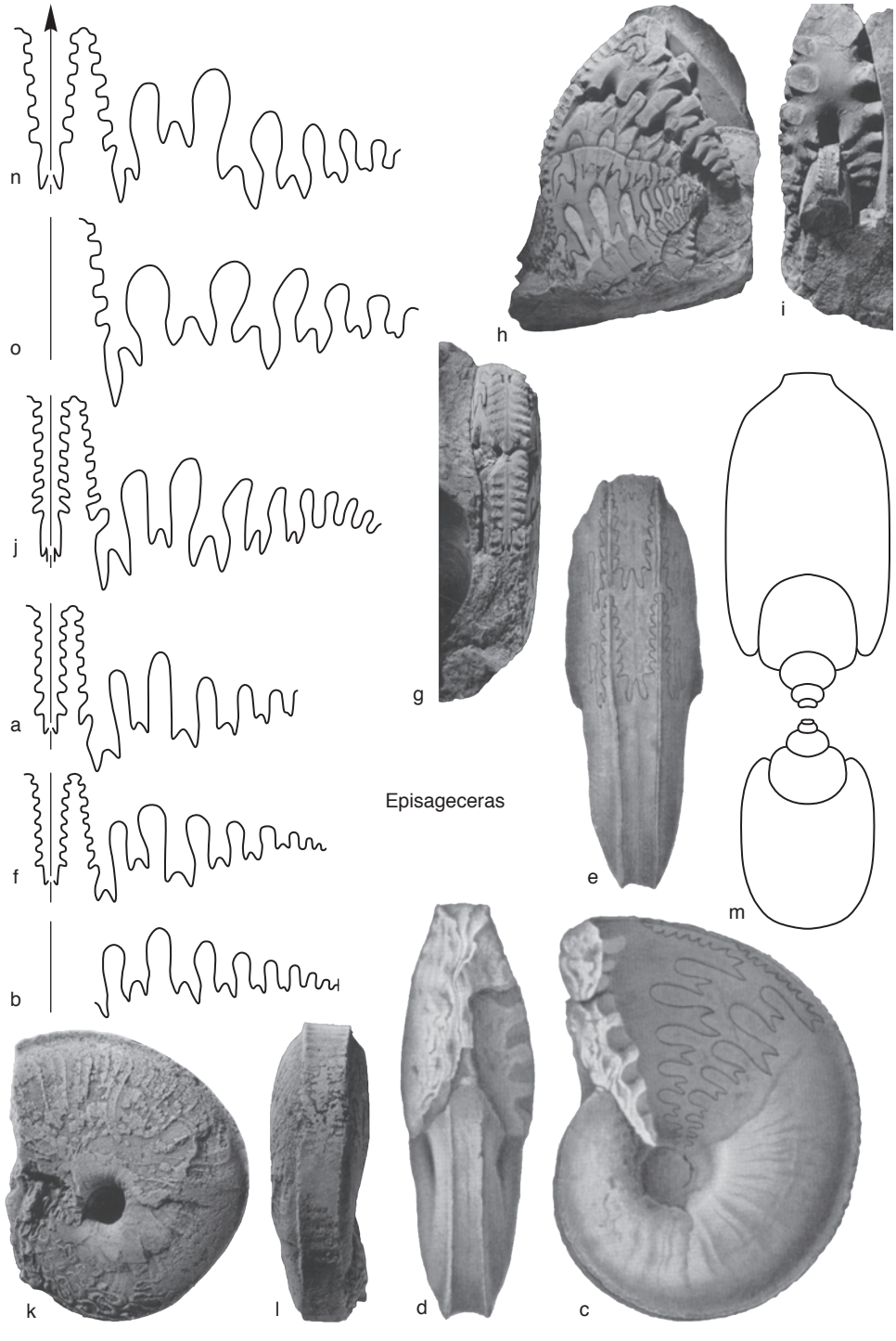

FIG. 137. Medlicottiidae (p. 213).

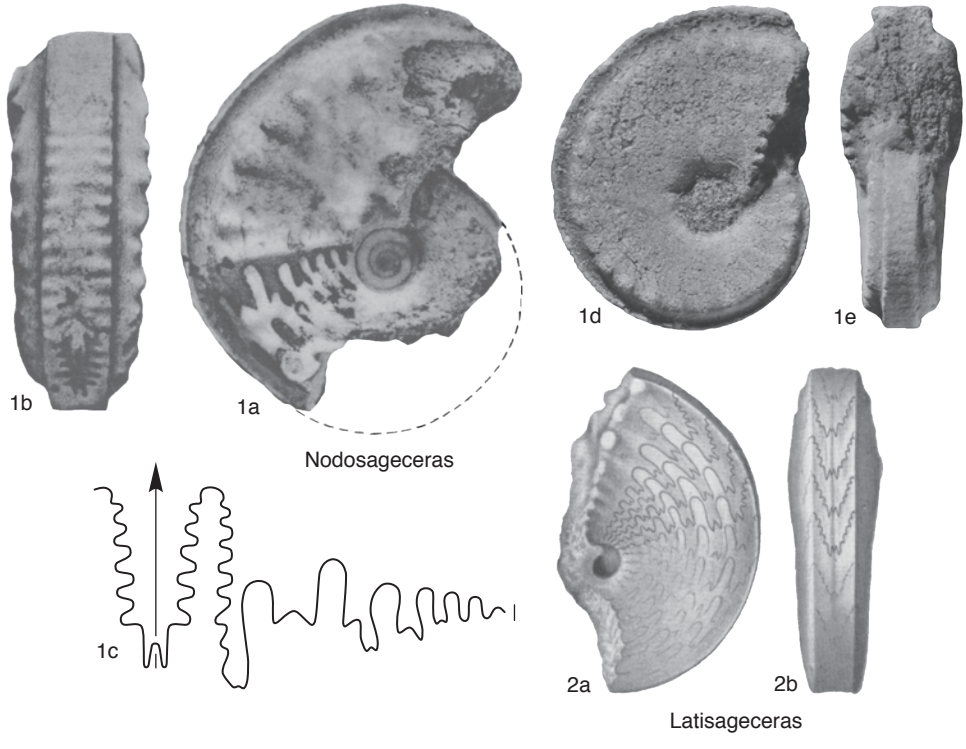

FIG. 138. Medlicottiidae (p. 213–215).

ventrolateral saddle has 8 to 10 subdivisions, and base of primary umbilical lobe may align approximately with adjacent elements. One species. [Genus is rare and inadequately known. The single representative of type species has not been restudied, and published drawings may not accurately portray sutural details.] *Lower Triassic (Induan):* Pakistan (Salt Range), Indonesia (?Timor).——FIG. 138,*2a–b. *L. latidorsatum* (NOETLING), Mianwali Formation, Salt Range, ×0.67 (Noetling, 1904).

Nodosageceras RUZHENTSEV, 1956a, p. 161 [**Episageceras nodosum* WANNER, 1932, p. 257; OD]. Conch similar to *Episageceras,* but groove on ventrolateral flank deeper, and with coarse ribs dorsad of groove to midflank. Primary umbilical lobe much broader than adjacent elements and even shorter than in *Episageceras,* otherwise similar. One species (known from two or three specimens). [See the notation under *Episageceras* (above) for the affinities of *E.* aff *E. noetlingi.*] *Lopingian (Wuchiapingian):* Indonesia (Timor), Mexico (?La Colorada beds, ?Coahuila).——FIG. 138,*1a–c. *N. nodosum* (WANNER); *a–b,* ×2; *c,* diameter approximately 20 mm (Wanner, 1932).——FIG. 138,*1d–e. N.* cf. *N. nodosum,* BMNH C33612, labeled Sosio limestone, Sicily, but preservation and morphology are incongruous: dimensions, shell proportions, sculpture, and preservation strikingly similar to those of Timor types, and common origin is probable, ×2 (new).

UNRECOGNIZED GENERIC NAMES APPLIED TO PALEOZOIC AMMONOIDEA

[Materials for this section prepared by Jürgen Kullmann]

Aganides DE MONTFORT, 1808, p. 30. Type was not named specifically and is of uncertain derivation and affinities. [For discussion, see SCHINDEWOLF, 1923, p. 325.]

Akeshakeceras LIANG & WANG, 1991, p. 80 [**Dzhaprakoceras (A.) longilobatum* LIANG & WANG, 1991, p. 81; OD]. The type species was proposed as a subgenus of *Dzhaprakoceras* but does not belong to

the superfamily Pericycloidea; the holotype shows spiral ornamentation, an acute lateral saddle, and belongs to a goniatitid group (*teste* Riley, 1996, p. 51).

Osmanoceras Kittl, 1904a, p. 674 [**O. undulatum;* M]. Only holotype of type species known, a small, imperfect shell rest that does not display shell form and suture line. *Mississippian (upper Visean):* Bosnia.

Prehoffmannia Plummer & Scott, 1937, p. 360 [*P. milleri; M]. Only holotype of type species known, a small ornamented shell with diameter of 6.3 mm, which does not show shell form and suture. *Pennsylvanian (?Gzhelian):* USA (Texas, Graham Formation, Stephens County).

Family SUNDAITIDAE Ruzhentsev, 1957

[Sundaitidae Ruzhentsev, 1957, p. 56]

[Materials for this section prepared by Brian F. Glenister, William M. Furnish, and Zhou Zuren]

Smooth, thinly discoidal, involute medlicottioideans (Umin/D, 0.15) with parabolic whorl section. Suture characterized by subequal size of external lateral and adjacent primary umbilical lobe, total of approximately 50 lobes, most asymmetrically bidentate, adventitious lobe (s^1) on ventrolateral saddle, and bidentate dorsal lobe. Single genus. *Lopingian (Wuchiapingian).*

Sundaites Haniel, 1915, p. 31 [**S. levis;* OD]. Conch intermediate in size (phragmocone exceeds 4 cm, diameter at mature peristome probably greater than 6 cm), involute (Umin/D, 0.15–0.12 at 3–4 cm diameter), discoidal (W/D, 0.35–0.25), with parabolic whorl section and acutely angular umbilical midwall. Suture comprises 50 lobes, including 12 pairs of umbilically derived external lateral lobes and 10 pairs of internal umbilicals. Virtually all flank lobes (both external and internal) are bidentate. Characterized by shallow adventitious lobe dorsad of crest in ventrolateral saddle and by primary umbilical lobe subequal in size and shape to adjacent primary lateral. One species. *Lopingian (Wuchiapingian):* Indonesia (Timor).——Fig. 139*a–d.* **S. levis*, Amarassi beds; *a–b,* topotype, SUI 64449, ×1; *c,* topotype, SUI 12655, diameter at 41 mm; *d,* composite, topotype, SUI 64449, Haniel, 1915, fig. 5, diameter at 42 mm (new).

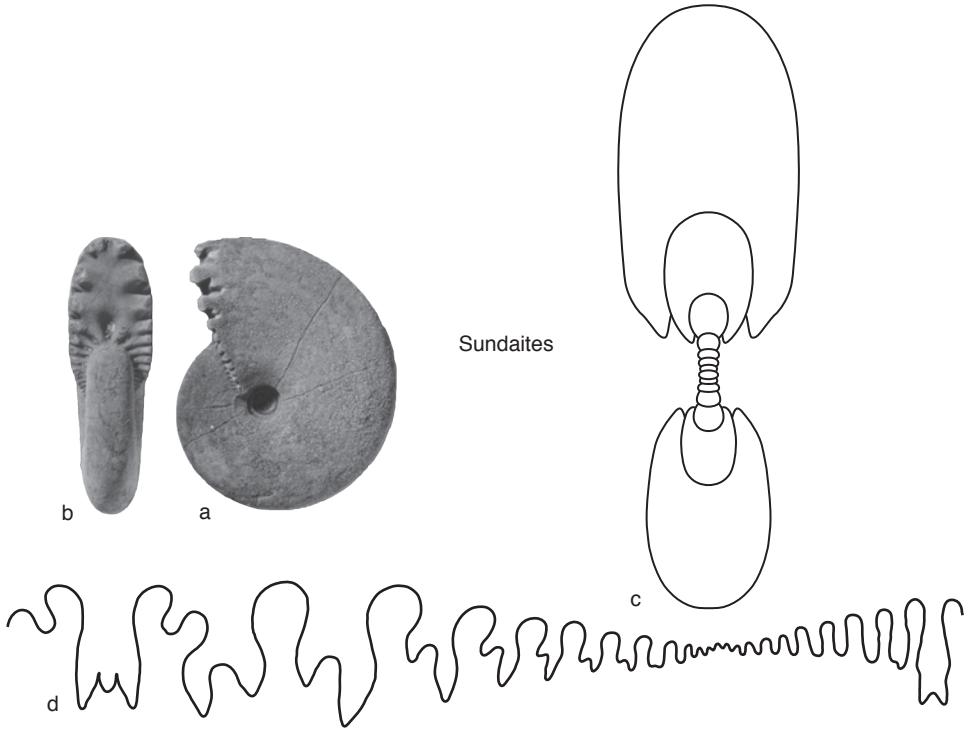

Fig. 139. Sundaitidae (p. 216).

SUPPLEMENTAL GENERA LIST

The following genera have been published or found in the literature since December 2006, the cut-off date for inclusion of full generic descriptions for the present volume. This list represents a late-stage attempt at a complete generic record of the Carboniferous and Permian Ammonoidea.

Suborder TORNOCERATINA
Superfamily PERICYCLOIDEA
Family PERICYCLIDAE
Subfamily PERICYCLINAE

Kornia Ebbighausen & Bockwinkel, 2007, p. 143 [**K. citrus;* OD]. *Mississippian (lower Tournaisian):* Anti-Atlas, Morocco.

Ebbighausen, Volker, & Jürgen Bockwinkel. 2007. Tournaisian (Early Carboniferous/Mississippian) ammonoids from the Ma'der Basin (Anti-Atlas, Morocco). Fossil Record 10(2):125–163, 49 fig.

Superfamily PRIONOCERATOIDEA

Family ACROCANITIDAE
Korn, Bockwinkel, & Ebbighausen, 2007, p. 138

Jdaidites Korn, Bockwinkel, & Ebbighausen, 2007, p. 139 [**J. serpentinus;* OD].

Korn, Dieter, J. Bockwinkel, and V. Ebbighausen. 2007. Tournaisian and Viséan ammonoid stratigraphy in North Africa. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 243(2):127–148, 16 fig.

Suborder GONIATITINA
Superfamily GONIATITOIDEA
Family DELEPINOCERATIDAE
Subfamily DOMBARITINAE

Deleshumardites Kullmann in Kullmann, Wagner & Winkler Prins, 2007, p. 139 [**Proshumardites delepinei* Schindewolf, 1939, p. 429; OD]. *Mississippian (upper Visean), Pennsylvanian (Bashkirian):* Cantabrian Mountains, northern Spain.

Kullmann, Jürgen, Robert H. Wagner, & Cornelis F. Winkler Prins. 2007. Significance for international correlation of the Perapertú Formation in northern Palencia, Cantabrian Mountains. Tectonic/stratigraphic context and description of Mississippian and upper Bashkirian goniatites. Revista Española de Paleontología 22(2):127–145, 8 fig.

Delépine, G., & N. Menchikoff. 1937. La faune des schistes carbonifères à *Proshumardites* de Haci-Diab (Confins Algéro-marocains du Sud). Bulletin de la Société géologique de France 5(7):77–89.

Schindewolf, Otto H. 1939. Zur Kenntnis von *Pericleites* Renz und verwandter paläozoischer Ammoineen. Jahrbuch der Preußischen Geologischen Landesanstalt für 1938, 59:423–455.

Superfamily PERICYCLOIDEA
Family PERICYCLIDAE
Subfamily PERICYCLINAE

Nigrocyclus Korn & Feist, 2007, p. 112 [**Pericyclus niger* Delépine, 1935, p. 69; OD]. *Mississippian (middle Tournaisian):* Cabrières (Montagne Noire), phosphoritic nodules, Puech de la Suque Formation.

Delépine,G. 1935. Contribution à l'étude de la faune du Dinantien des Pyrénées. Première partie. Goniatites et Crustacés des nodules phosphatés de l'Ariège. Bulletin de la Société géologique de France 5(5):65–75, pl. 1.

Korn, Dieter, & Raimund Feist. 2007. Early Carboniferous ammonoid faunas and stratigraphy of the Montagne Noire (France). Fossil Record 10(2):99–124, 20 fig.

Superfamily NEOICOCERATOIDEA
Family PARAGASTRIOCERATIDAE
Subfamily AULACOGASTRIOCERATINAE

Nodogastrioceras Ma & Li, 1998, p. 83 [**N. discum;* OD]. Lower Hutang Formation, and Shangrao Formation, Anzhou, Yongping, Qianshan, Jiangxi.

Ma Junwen, & Li Fuyu. 1998. A new family of Gastrioceratoceae. Jiangxi Geology 12(2):82–88. In Chinese.

Zhou Zuren. 2007. Bizarre Permian ammonoid subfamily Aulacogastrioceratinae from South China. Journal of Paleontology 31(4):797–799, 3 fig.

Family METALEGOCERATIDAE
Subfamily SPIROLEGOCERATINAE

Archboldiceras Leonova & Shilovsky, 2007, p. 32 [**Uraloceras lobulatum* Armstrong, Dear, & Runnegar, 1967, p. 91; OD]. *Permian (Kungurian):* Tiverton Formation, Queensland, Australia.

Armstrong, J. D., J. F. Dear, & B. Runnegar. 1967. Permian ammonoids from Eastern Australia. Journal of the Geological Society of Australia 14(10):87–97, 2 fig., pl. 5–6.

Leonova, T. B., & O. P. Shilovsky. 2007. Evolution of the Permian family Spirolegoceratidae (Goniatitida, Ammonoidea). Paleontological Journal 41(1):28–38, 3 fig., 1 pl.

NOMENCLATORIAL NOTE

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REPLACEMENT NAMES FOR TWO PERMIAN AMMONOID JUNIOR HOMONYMS: *HOFFMANNIA* GEMMELLARO, 1887, AND *TAUROCERAS* TUMANSKAIA, 1938

During preparation of the manuscript for *Treatise on Invertebrate Paleontology,* Part L, vol. 2, Carboniferous and Permian Ammonoidea, two junior homonyms were exposed during the editing process.

Hoffmannia GEMMELLARO, 1887, is the senior homonym of *Hoffmannia* FORCART, 1953 (modern gastropod), but also the junior homonym of *Hoffmannia* HEINEMANN & WOCK, 1877 (moth, modern insect) (see p. 135 herein). This case was documented in a review of these modern biological homonyms and the replacement of the gastropod genus by FORCART (1954, p. 21). Therefore, a replacement for ammonoid genus *Hoffmannia* GEMMELLARO, 1887, must be nominated (Article 52 of the International Code of Zoological Nomenclature [ICZN, 1999]).

We here propose the name *Palermoceras*, based upon the province where the Wordian ammonoid was found in Sicily. The type species for *Palermoceras* is *Adrianites (Hoffmannia) hoffmanni* GEMMELLARO, 1887, p. 49 (ICZN *Code* Article 67.8.1).

The related subfamily Hoffmanniinae MOJSISOVICS, 1888, containing the type genus *Hoffmannia,* is consequently replaced by Palermoceratinae ZHOU & GLENISTER herein (see p. 135 herein; ICZN *Code* Article 39).

Tauroceras TUMANSKAIA, 1938 (type species, *Popanoceras scrobiculatum* GEMMELLARO, 1887, OD) is newly recognized to be the junior homonym of a modern Coleoptera insect (HOPE, 1840), and must be replaced by a new name (see p. 181 herein; ICZN *Code* Article 52.2). According to the *Code*, the principle of priority requires that if a name in use for a taxon is found to be invalid, it must be replaced by the next oldest available name from among its synonyms (ICZN *Code* Article 23.3.5).

Tauroceras has two synonyms:

1) *Gemmellaroceras* TUMANSKAIA, 1937, p. 470, *nom. nud.,* senior synonym but also the junior homonym of *Gemmellaroceras* HYATT, 1900, p. 574.

2) *Neopopanoceras* SCHINDEWOLF, 1939, p. 447 (type, *Popanoceras multistriatum* GEMMELLARO, 1887, p. 21, OD), the only available name for replacing the junior homonym *Tauroceras* TUMANSKAIA.

Neopopanoceras SCHINDEWOLF, 1939, is named herein as the replacement for *Tauroceras* TUMANSKAIA, 1938, type species, *Popanoceras scrobiculatum* GEMMELLARO (ICZN *Code* Article 67.8–8.1).

Finally, we thank Jill Hardesty, editor of the volume, for her careful review of the manuscript and for alerting us about junior homonyms *Hoffmannia* FORCART, 1953, and *Tauroceras* HOPE, 1840, during the editing process.

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Tumanskaia, Ol'ga G. 1937. Gorizonty permi Kryma [Permian deposits of the Crimea]. Problemy Sovetskoi Geologii 1937(5–6):470–472.
Tumanskaia, Ol'ga G. 1938. O novom rode *Tauroceras* iz permskikh otlozhenii Kryma i Sitsilii [On the new genus *Tauroceras* from deposits of Crimea and Sicily]. Sovetskaia Geologiia 1938(12):145–146, 4 fig.

RANGES OF TAXA

The stratigraphic distribution of the Carboniferous and Permian Ammonoidea recognized in Part L, Revised, volume 2, is shown graphically in the range chart (Table 1).

For more detailed stratigraphic information, refer to the systematic sections herein, p. 1–219.

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 parts of the volumes. No taxonomic conclusions should be drawn from the position of taxa in this chart.

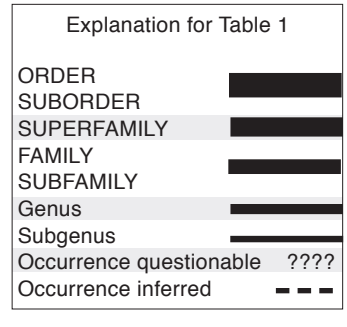
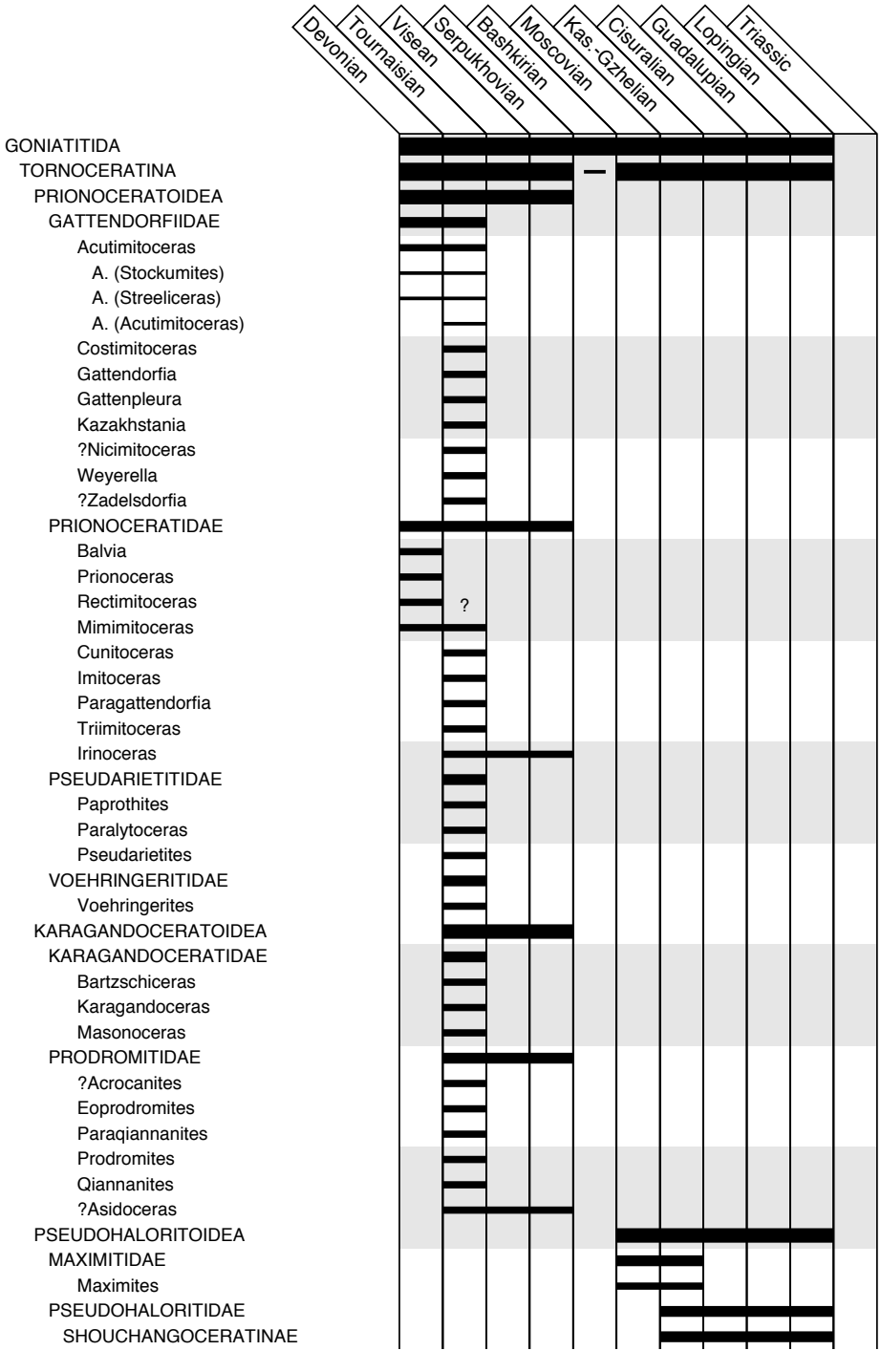


TABLE 1. Stratigraphic distribution of the Carboniferous and Permian Ammonoidea.



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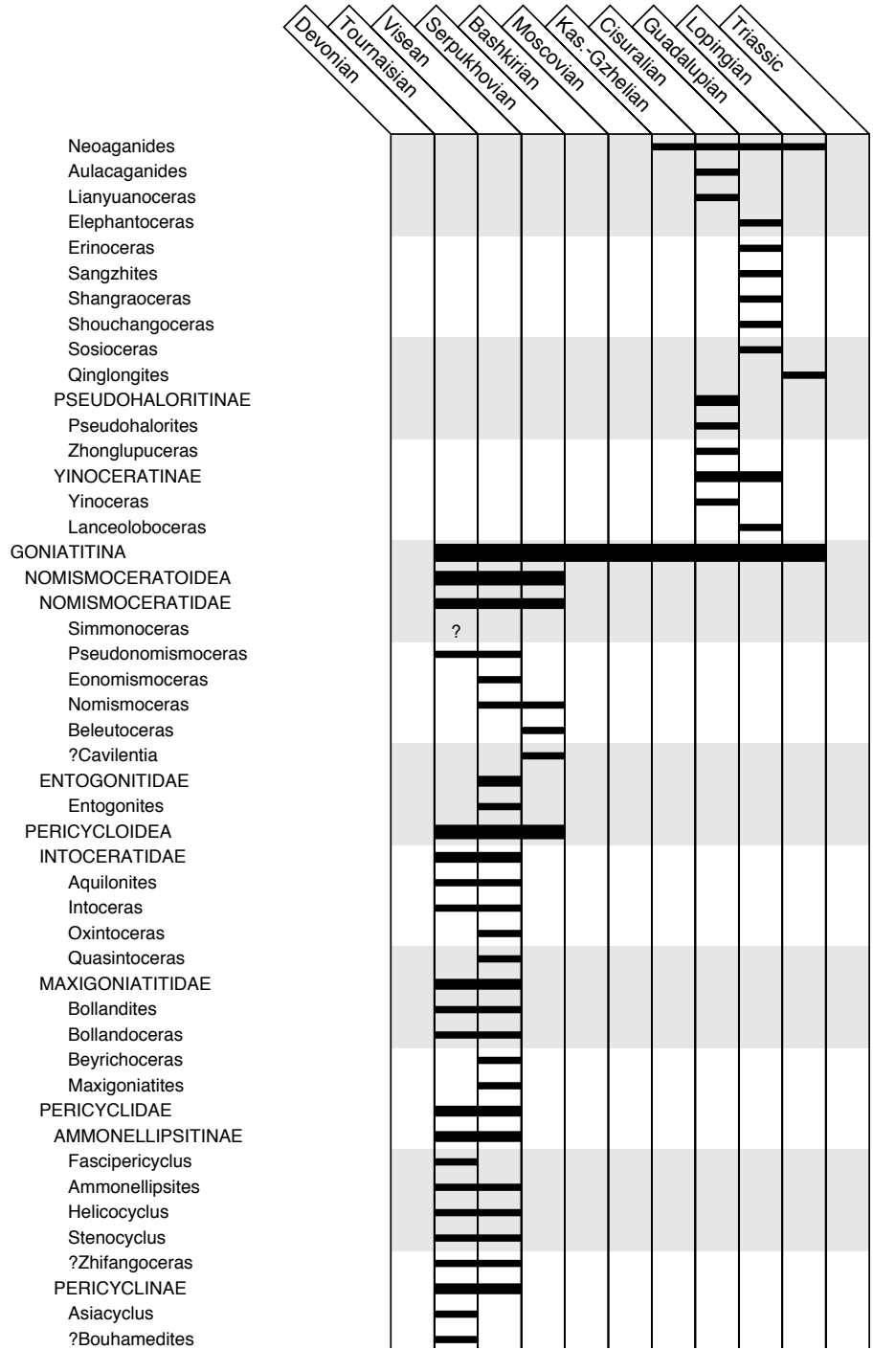

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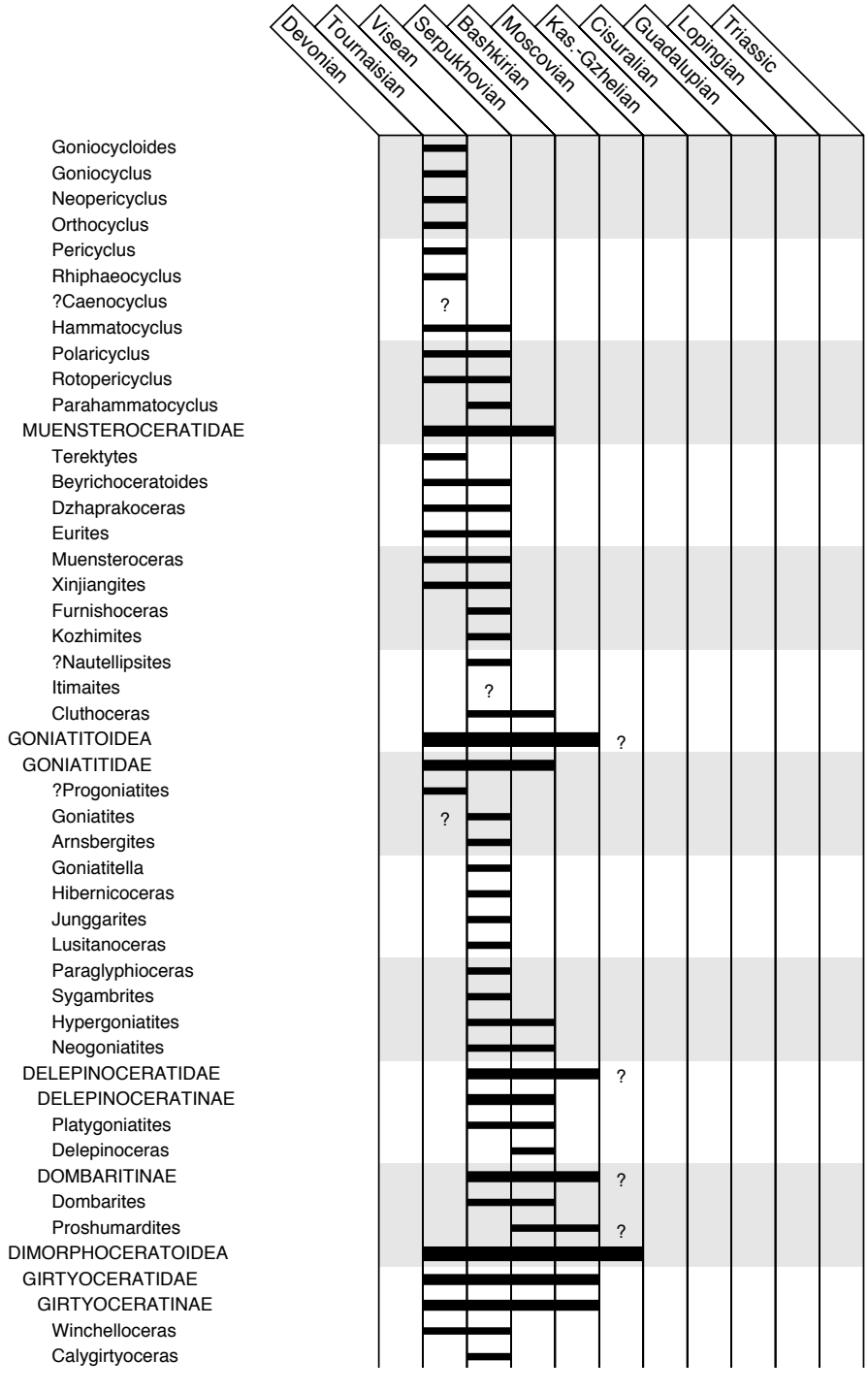

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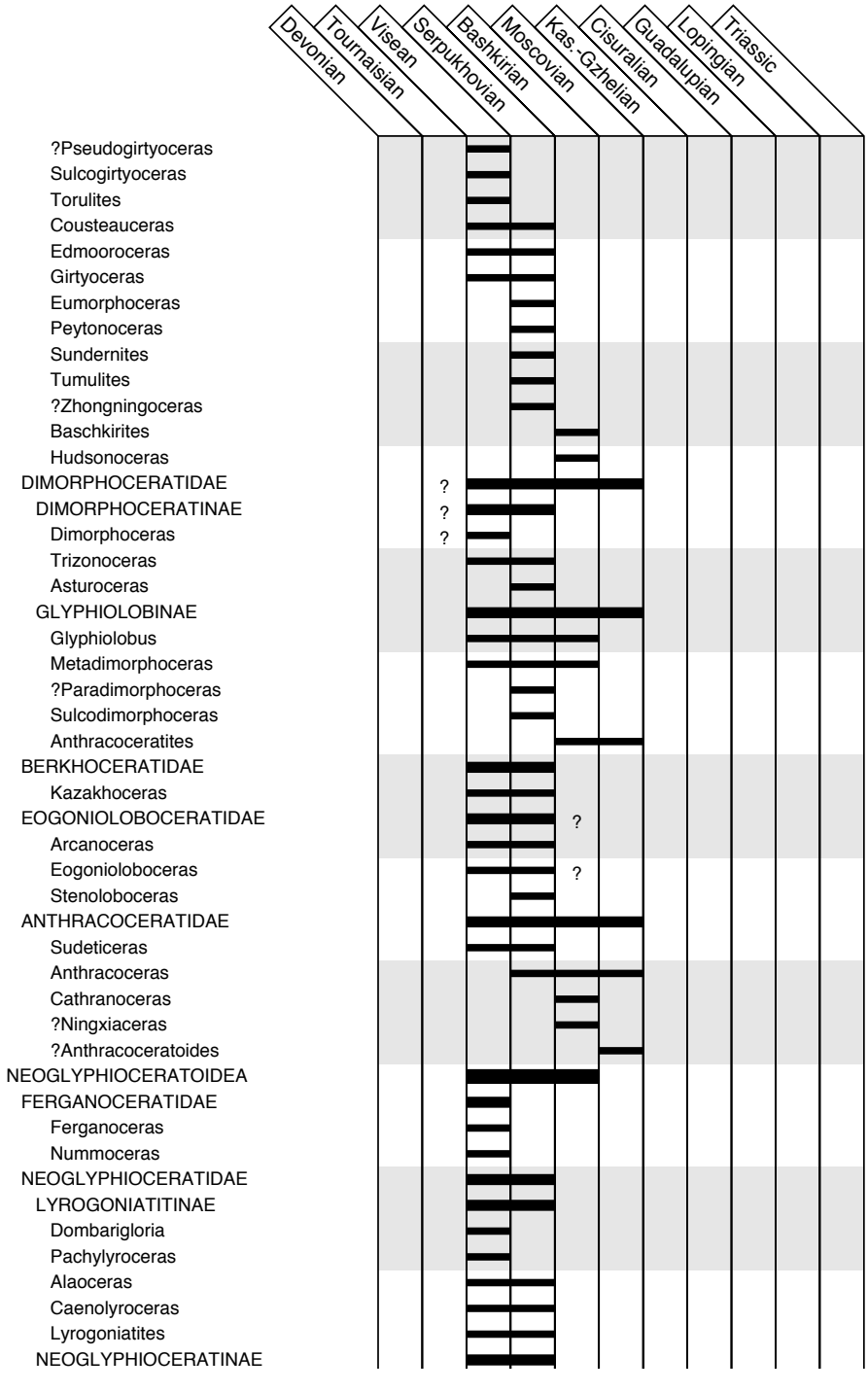

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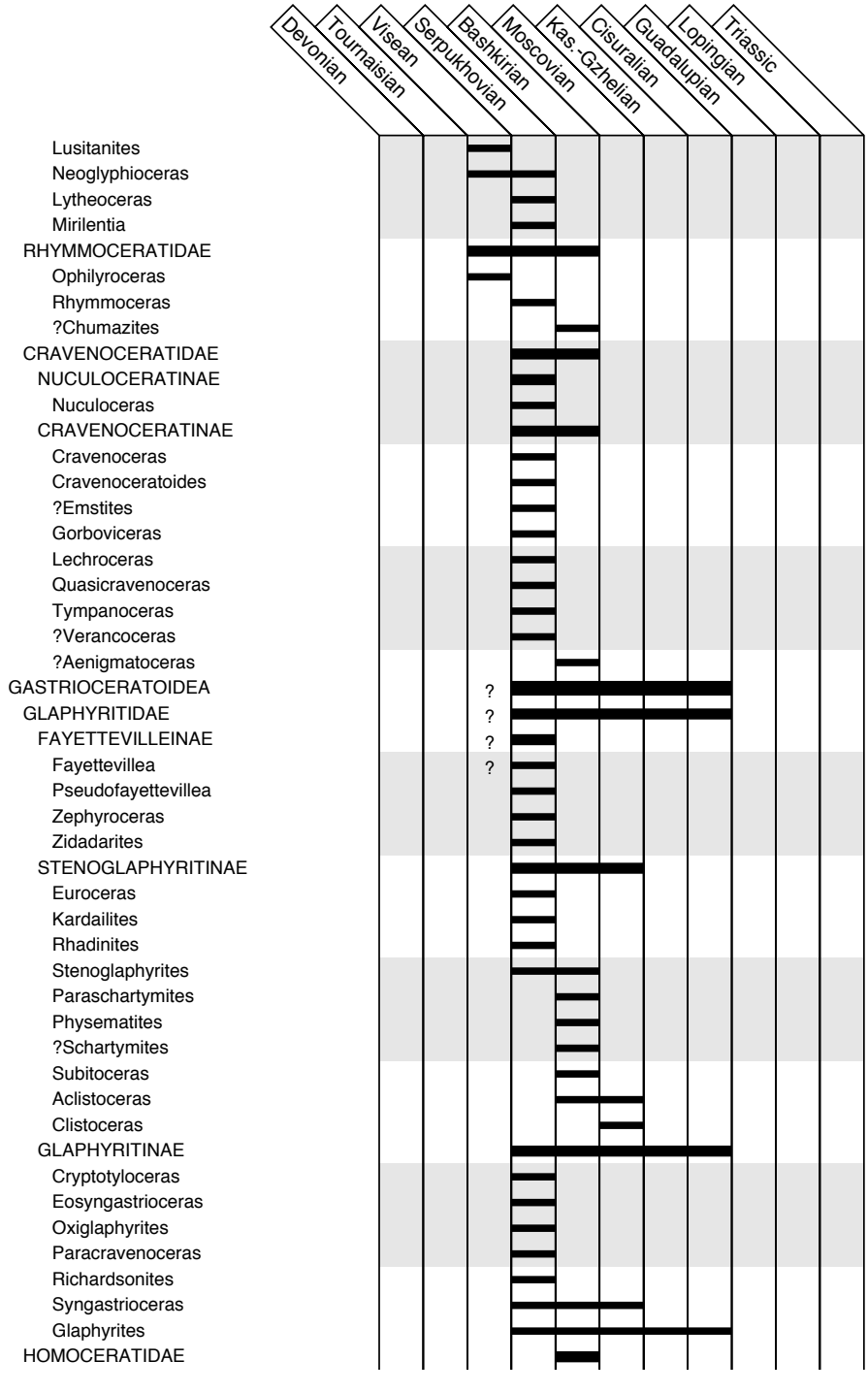

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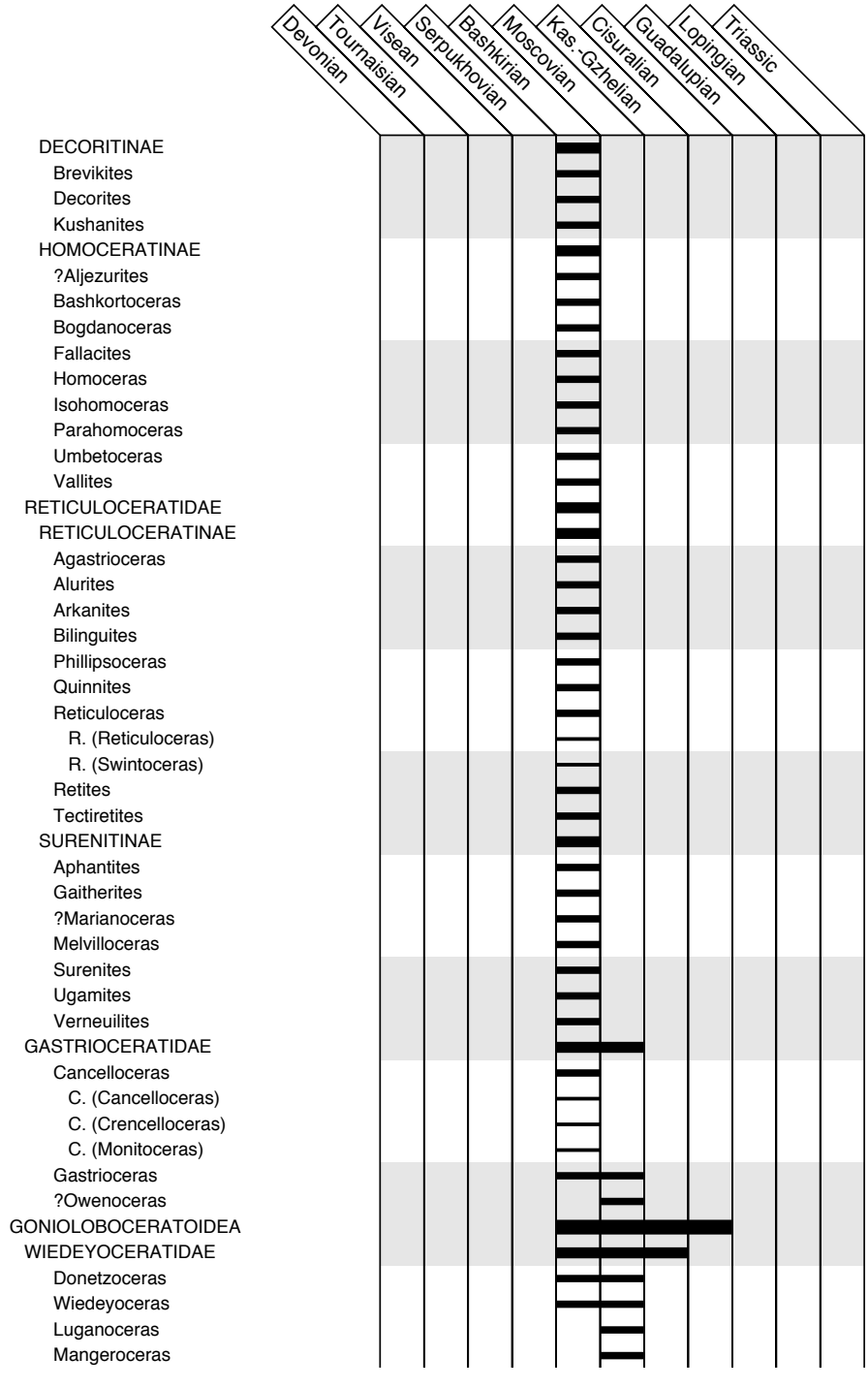

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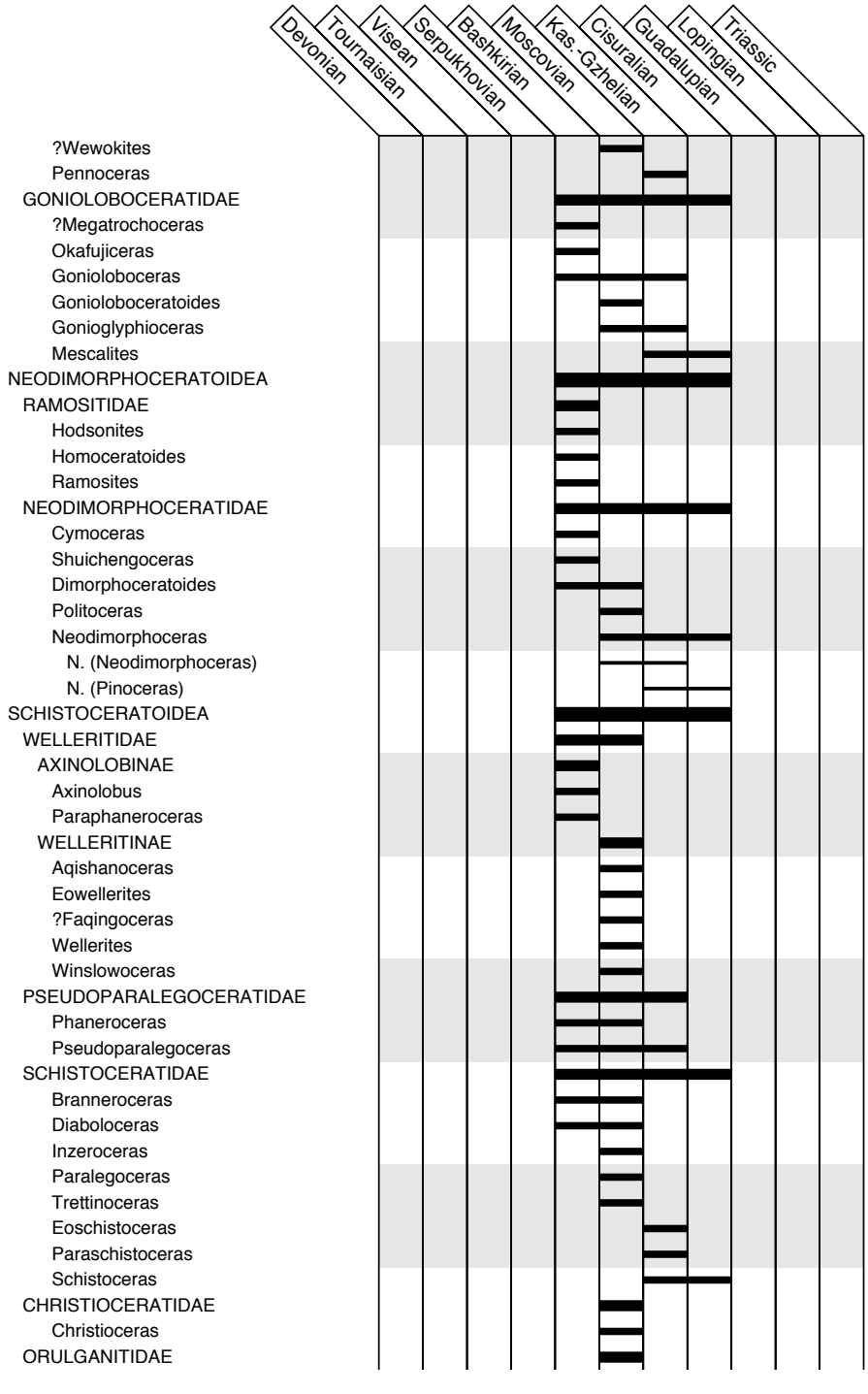

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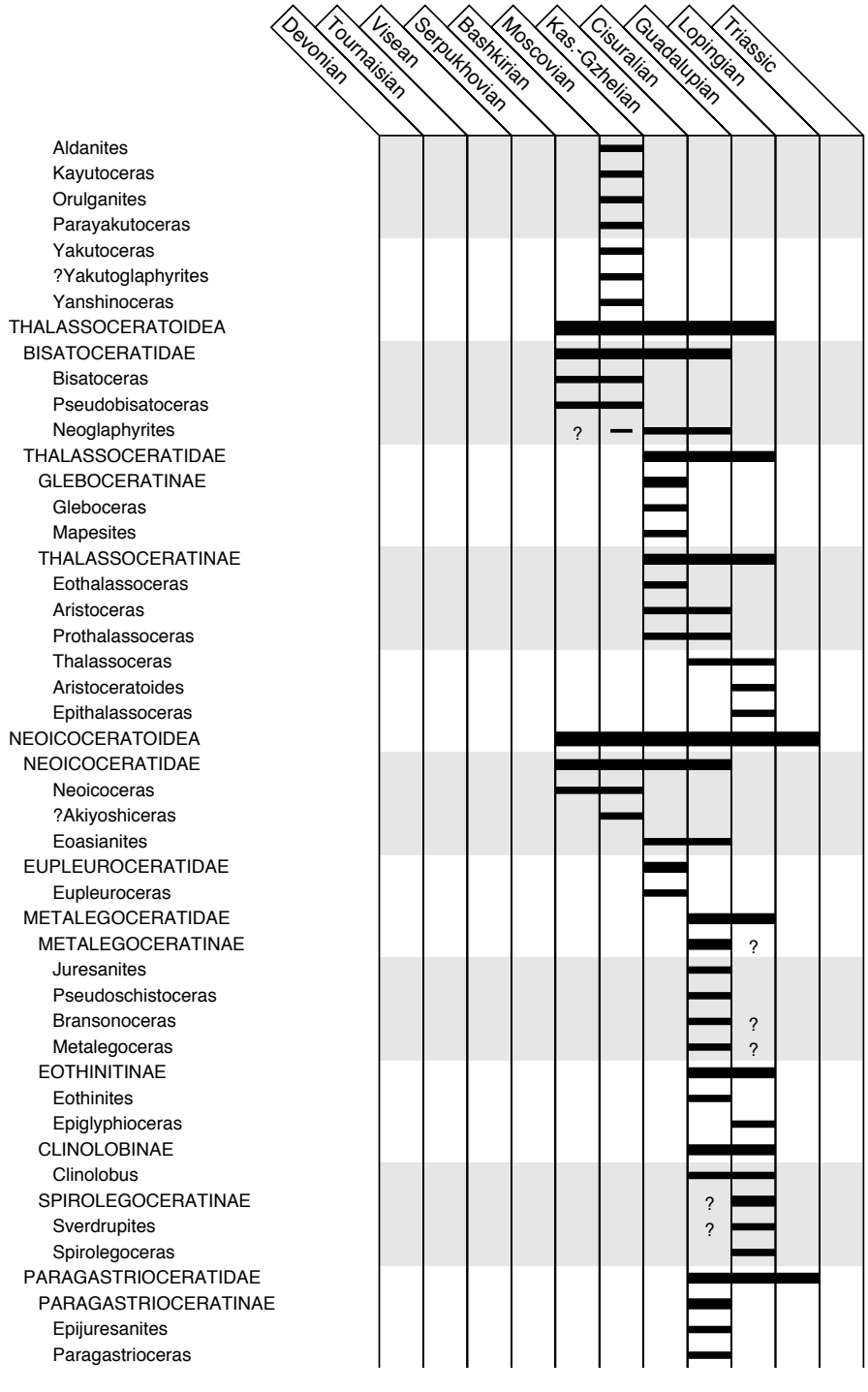

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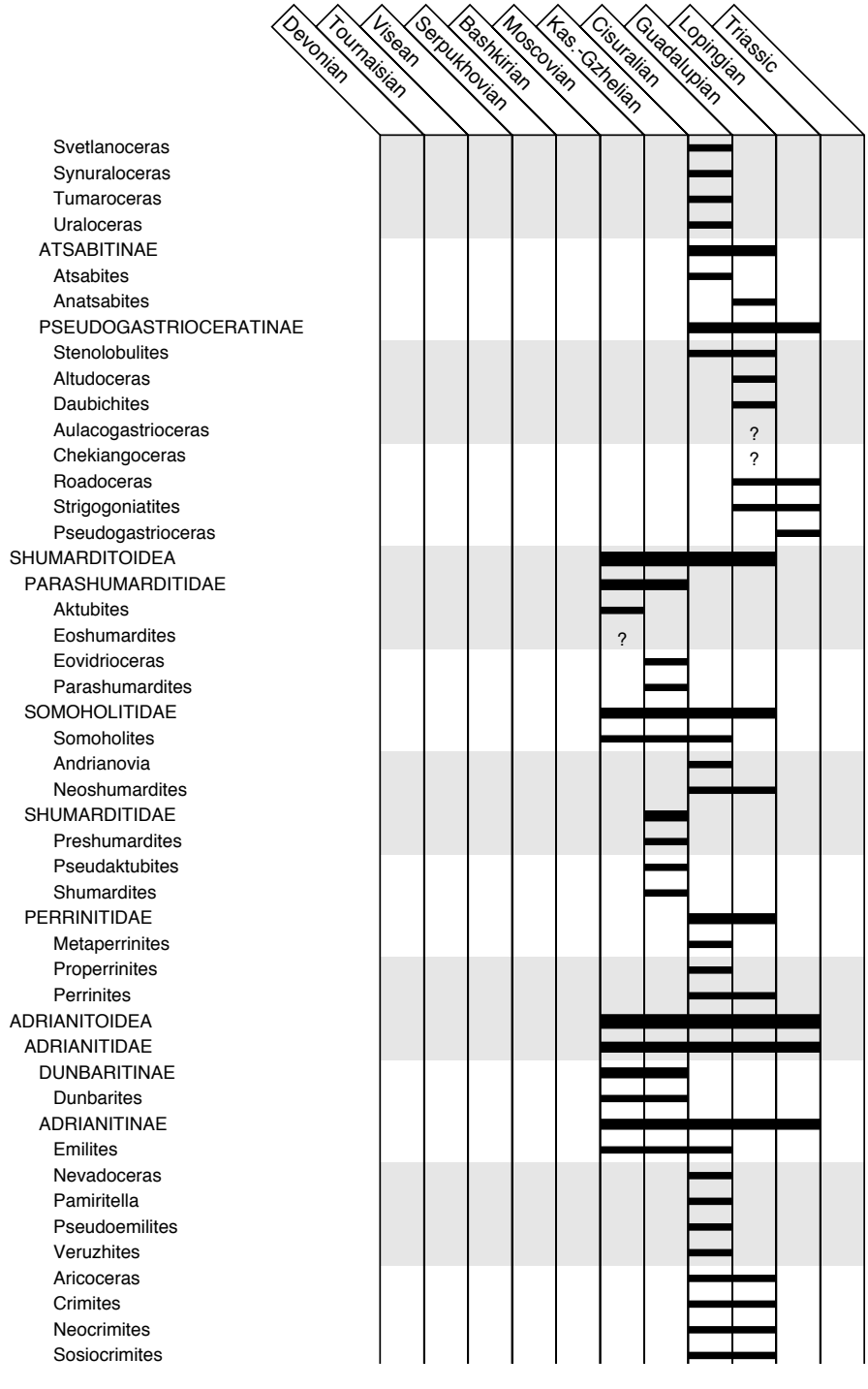

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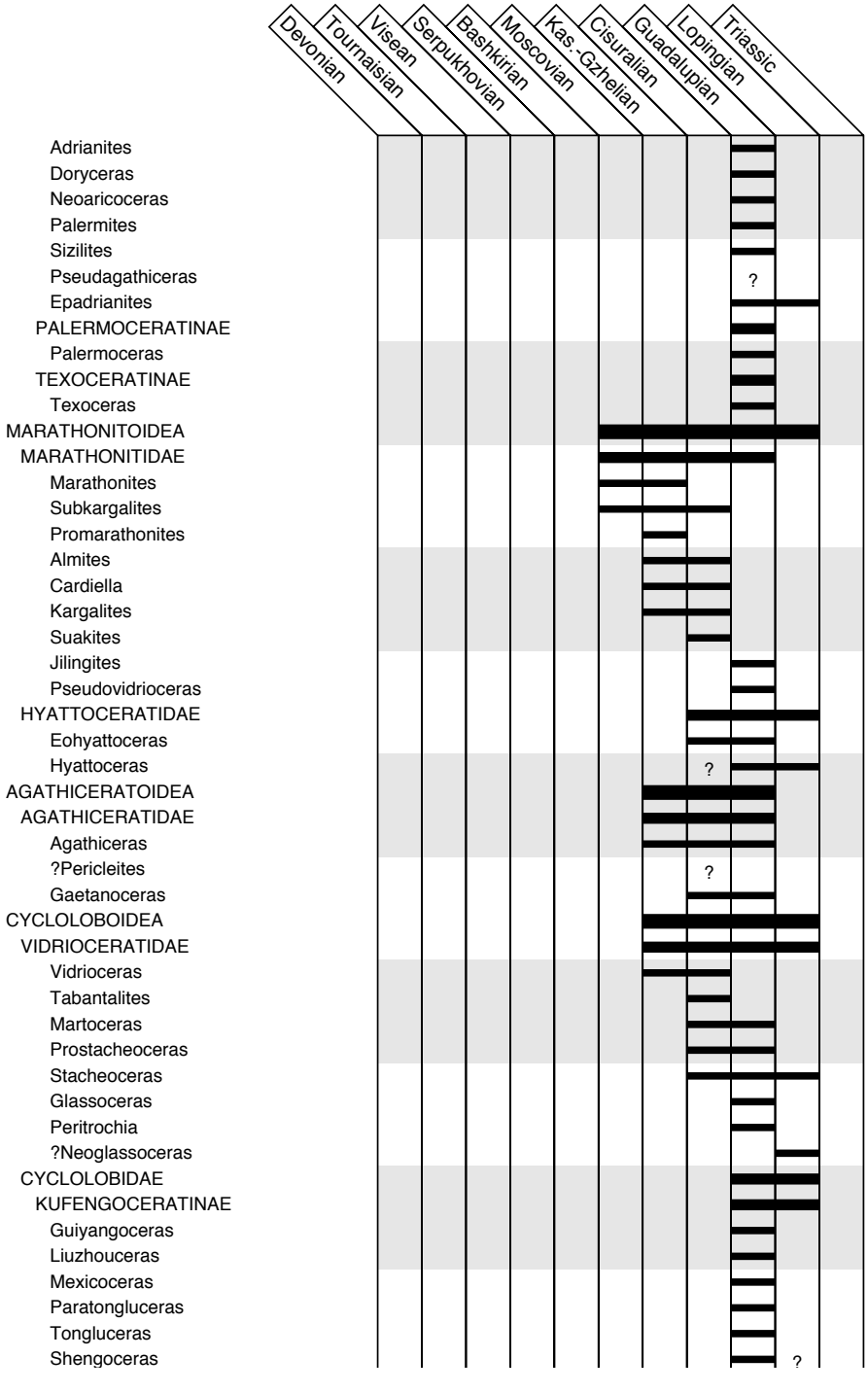


TABLE 1. *(Continued).*

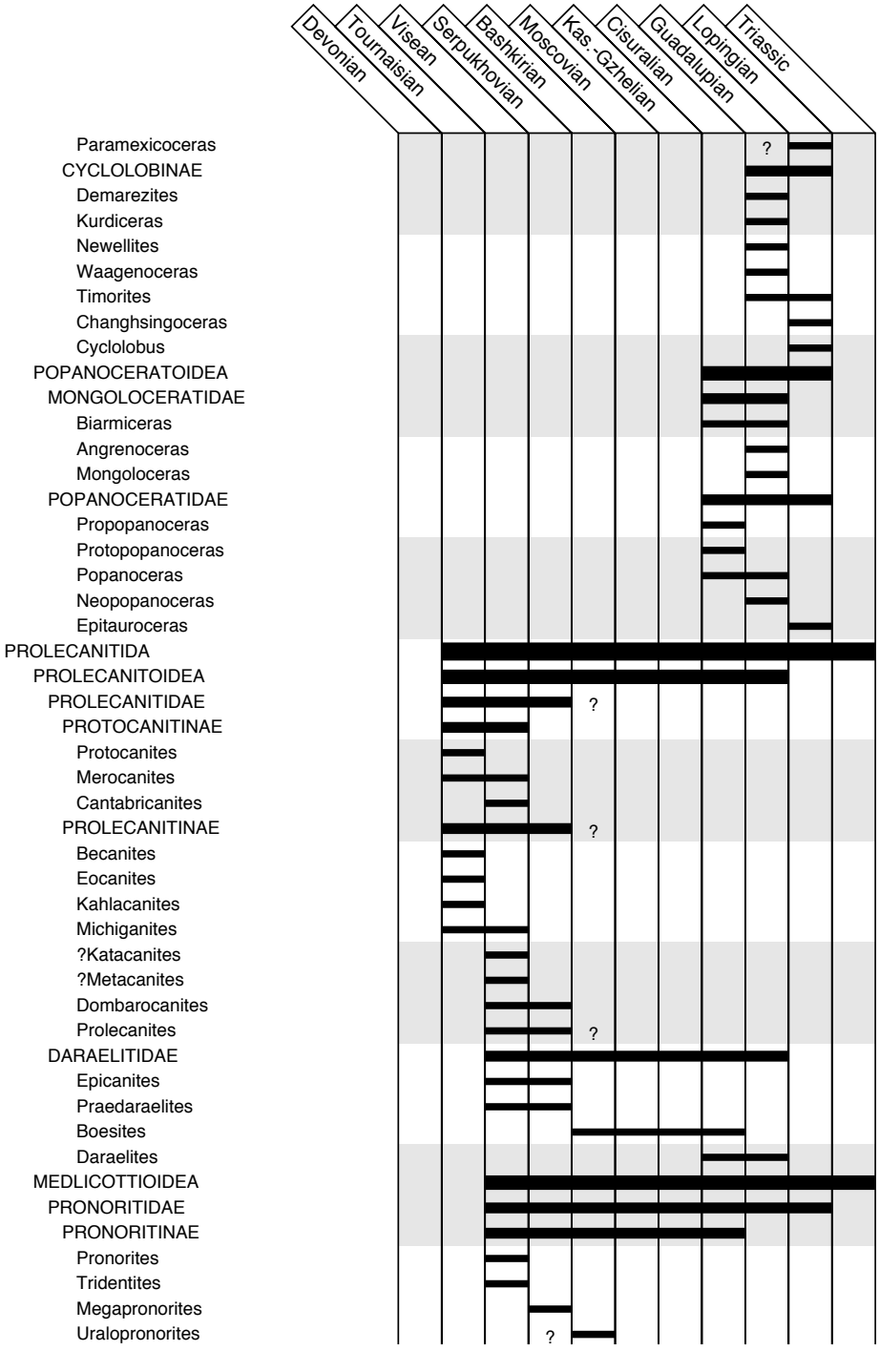
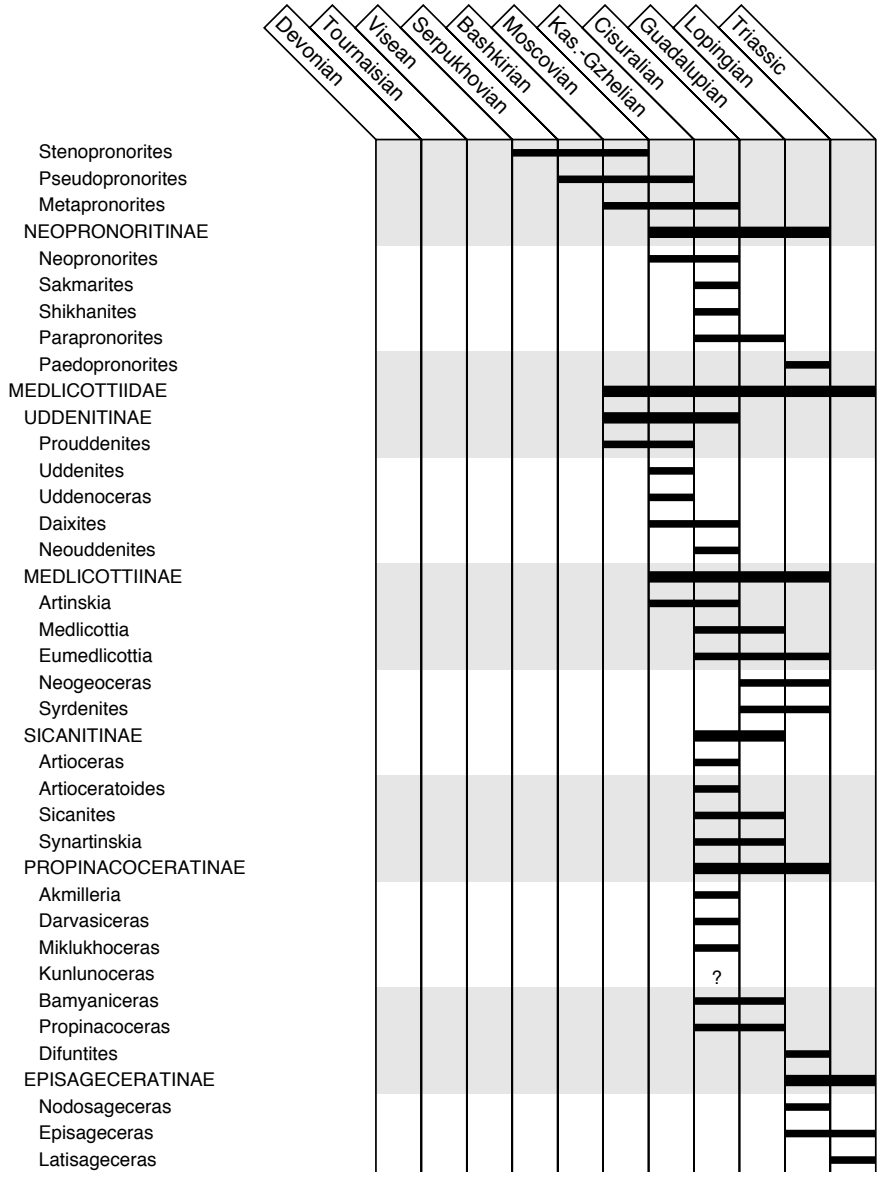


TABLE 1. *(Continued).*



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