TREATISE ON
INVERTEBRATE PALEONTOLOGY

Prepared under the Guidance of the
Joint Committee on Invertebrate Paleontology

Paleontological Society

Society of Economic Paleontologists and Mineralogists

Palaeontographical Society

Directed and Edited by

RAYMOND C. MOORE

Part E
ARCHAEOCYATHA AND PORIFERA

GEOLOGICAL SOCIETY OF AMERICA
and
UNIVERSITY OF KANSAS PRESS

1955

Reprinted 1963

Library of Congress Catalogue Card
Number: 53-12913

Printed in the U.S.A. by
THE UNIVERSITY OF KANSAS PRESS
Lawrence, Kansas

Address All Communications to The Geological Society of America, 419 West 117 Street, New York 27, N. Y.

The *Treatise on Invertebrate Paleontology* has been made possible by (1) a grant of funds from The Geological Society of America through the bequest of Richard Alexander Fullerton Penrose, Jr., for preparation of illustrations and partial defrayment of organizational expense; (2) contribution of the knowledge and labor of specialists throughout the world, working in co-operation under sponsorship of The Palaeontographical Society, The Paleontological Society, and The Society of Economic Paleontologists and Mineralogists; and (3) acceptance by the University of Kansas Press of publication without cost to the Societies concerned and without any financial gain to the Press.

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PARTS

The indicated Parts (excepting the first and last) are to be published at whatever time each is ready. All may be assembled ultimately in bound volumes. The list of contributing authors is subject to change.

A—INTRODUCTION. B—PROTISTA 1 (chrysomonads, silicoflagellates, coccolithophorids, diatoms, xanthomonads, dinoflagellates, euglenids). C—PROTISTA 2 (foraminifers, testaceans). D—PROTISTA 3 (radiolarians, tintinnines). E—PORIFERA (sponges, archaeocyathids). F—COELENTERATA (hydrozoans, scyphozoans, anthozoans). G—BRYOZOA. H—BRACHIOPODA. I—MOLLUSCA 1 (chitons, scaphopods, gastropods). J—MOLLUSCA 2 (gastropods). K—MOLLUSCA 3 (nautiloid cephalopods). L—MOLLUSCA 4 (ammonoid cephalopods). M—MOLLUSCA 5 (dibranchiate cephalopods). N—MOLLUSCA 6 (pelecypods). O—ARTHROPODA 1 (trilobitomorphs). P—ARTHROPODA 2 (chelicerates). Q—ARTHROPODA 3 (ostracodes). R—ARTHROPODA 4 (branchiopods, cirripeds, malacostracans, myriapods, insects). S—ECHINODERMATA 1 (cystoids, blastoids, carpoids, eocrinoids, paracrinoids, edrioasteroids, haplozoans). T—ECHINODERMATA 2 (crinoids). U—ECHINODERMATA 3 (asterozoans, echinozoans). V—GRAPTOLITHINA. W—MISCELLANEA (worms, conodonts, conulariids, problematical fossils). X—ADDENDA (index).

Part G, Bryozoa (p. i-xiii, 1-253, about 2,000 individual figures, cloth-bound) and Part D, Protista 3 (p. i-xii, 1-195, 1,050 figures, cloth-bound) are published. Copies are available on orders sent to the Geological Society of America (419 West 117th Street, New York) with payment of three dollars ($3.00) in U.S. currency for each copy, which price includes cost of wrapping and shipping to any address in the world.

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EDITORIAL PREFACE

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 in seeking to organize what has been learned of this subject up to the mid-point of the present century. Such work has value in providing a most useful summary of the collective results of multitudinous investigations and thus should constitute an indispensable text and reference book for all persons who wish to know about remains of invertebrate organisms preserved in rocks of the earth's crust. This applies to neozoologists as well as paleozoologists and to beginners in study of fossils as well as to thoroughly trained, long-experienced professional workers, including teachers, stratigraphical geologists, and individuals engaged in research on fossil invertebrates. The making of a reasonably complete inventory of present knowledge of invertebrate paleontology may be expected to yield needed foundation for future research and it is hoped that the *Treatise* will serve this end.

The *Treatise* is divided into parts which bear index letters, each except the initial and concluding ones being defined to include designated groups of invertebrates. The chief purpose of this arrangement is to provide for independence of the several parts as regards date of publication, because it is judged desirable to print and distribute each segment as soon as possible after it is ready for press. Pages in each part will bear the assigned index letter joined with numbers beginning with 1 and running consecutively to the end of the part. When the parts ultimately are assembled into volumes, no renumbering of pages and figures is required.

The outline of subjects to be treated in connection with each large group of invertebrates includes (1) description of morphological features, with special reference to hard parts, (2) ontogeny, (3) classification, (4) geological distribution, (5) evolutionary trends and phylogeny, and (6) systematic description of genera, subgenera, and higher taxonomic units. In general, paleoecological aspects of study are omitted or little emphasized because comprehensive treatment of this subject is being undertaken in a separate work, prepared under auspices of a committee of the United States National Research Council. A selected list of references is furnished in each part of the *Treatise.*

Features of style in the taxonomic portions of this work have been fixed by the Editor with aid furnished by advice from the Joint Committee on Invertebrate Paleontology representing the societies which have undertaken to sponsor the *Treatise.* It is the Editor's responsibility to consult with authors and co-ordinate their work, seeing that manuscript properly incorporates features of adopted style. Especially he has been called on to formulate policies in respect to many questions of nomenclature and procedure. The subject of family and subfamily names is reviewed briefly in a following section of this preface, and features of *Treatise* style in generic descriptions are explained.

A generous grant of $25,000 has been made by the Geological Society of America for the purpose of preparing *Treatise* illustrations. Administration of expenditures has been in charge of the Editor and most of the work by photographers and artists has been done under his direction at the University of Kansas, but sizable parts of this program have also been carried forward in Washington and London.

FORM OF ZOOLOGICAL NAMES

Many questions arise in connection with the form of zoological names. These include such matters as adherence to stipulations concerning Latin or Latinized nature of words accepted as zoological names, gender of generic and subgeneric names, nominative or adjectival form of specific names, required endings for some family-group names, and numerous others. Regulation extends to capitalization, treatment of particles belonging to modern patronymics, use of neo-Latin letters, and approved methods for converting diacritical marks. The magnitude and complexities of nomenclature problems surely are enough to warrant the complaint of those who hold that zoology is the study of animals rather than of names applied to them.

CLASSIFICATION OF ZOOLOGICAL NAMES

In accordance with the "Copenhagen Decisions on Zoological Nomenclature" (London, 135 p., 1953), zoological names may be classified usefully in various ways. The subject is summarized here with introduction of designations for some categories which the *Treatise* proposes to distinguish in systematic parts of the text for the purpose of giving readers comprehension of the nature of various names together with authorship and dates attributed to them.

CO-ORDINATE NAMES OF TAXA GROUPS

Five groups of different-rank taxonomic units (termed *taxa,* sing., *taxon*) are discriminated, within each of which names are treated as co-ordinate, being transferrable from one category to another without change of authorship or date. These are: (1) Species Group (subspecies, species); (2) Genus Group (subgenus, genus); (3) Family Group (tribe, subfamily, family, superfamily); (4) Order/Class Group (suborder, order, subclass, class); and (5) Phylum Group (subphylum, phylum). In the first 3 of these groups, but not others, the author of the first-published valid name for any taxon is held to be the author of all other taxa in the group which are based on the same nominate type and the date of publication for purposes of priority is that of the first-published name. Thus, if author A in 1800 introduces the family name X-idae to include 3 genera, one of which is *X-us;* and if author B in 1850 divides the 20 genera then included in X-idae into subfamilies called X-inae and Y-inae; and if author C in 1950 combines X-idae with other later-formed families to make a superfamily X-acea (or X-oidea, X-icae, etc.); the author of X-inae, X-idae and X-acea is A, 1800, under the Rules. Because taxonomic concepts introduced by authors B and C along with appropriate names surely are not attributable to author A, some means of recording responsibility of B and C are needed. This is discussed later in explaining proposed use of *"nom. transl."*

The co-ordinate status of zoological names belonging to the species group is stipulated in Art. 11 of the present Rules; genus group in Art. 6 of the present Rules; family group in paragraph 46 of the Copenhagen Decisions; order/class group and phylum group in paragraphs 65 and 66 of the Copenhagen Decisions.

ORIGINAL AND SUBSEQUENT FORMS OF NAMES

Zoological names may be classified according to form (spelling) given in original publication and employed by subsequent authors. In one group are names which are entirely identical in original and subsequent usage. Another group comprises names which include with the original subsequently published variants of one sort or another. In this second group, it is important to distinguish names which are inadvertent changes from those constituting intentional emendations, for they have quite different status in nomenclature. Also, among intentional emendations, some are acceptable and some quite unacceptable under the Rules.

VALID AND INVALID NAMES

Valid names. A valid zoological name is one that conforms to all mandatory provisions of the Rules (Copenhagen Decisions, p. 43-57) but names of this group are divisible into subgroups as follows: (1) *"inviolate names,"* which as originally published not only meet all mandatory requirements of the Rules but are not subject to any sort of alteration (most generic and subgeneric names); (2) *"perfect names,"* which as they appear in original publication (with or without precise duplication by subsequent authors) meet all mandatory requirements and need no correction of any kind but which nevertheless are legally alterable under present Rules (as in changing the form of ending of a published class/order-group name); (3) *"imperfect names,"* which as originally published and with or without subsequent duplication meet mandatory requirements but contain defects such as incorrect gender of an adjectival specific name (for example, *Spironema recta* instead of *Spironema rectum*) or incorrect stem or form of ending of a family-group name (for example, Spironemidae instead of Spironematidae); (4) *"transferred names,"* which are derived by valid emendation from either of the 2nd or 3rd subgroups or from a pre-existing transferred name (as illustrated by change of a family-group name from -inae to -idae or making of a superfamily name); and (5) *"improved names,"* which include necessary as well as somewhat arbitrarily made emendations allowable under the Rules for taxonomic categories not now covered by regulations as to name form and alterations that are distinct from changes that distinguish the 4th subgroup (including names derived from the 2nd and 3rd subgroups and possibly some alterations of 4th subgroup names).

It is useful for convenience and brevity of distinction in recording these subgroups of valid zoological names to introduce Latin designations, following the pattern of *nomen nudum, nomen novum,* etc. Accordingly, the subgroups are (1) *nomina inviolata* (sing., *nomen inviolatum,* abbr., *nom. inviol.*); (2) *nomina perfecta* (sing., *nomen perfectum,* abbr., *nom. perf.*); (3) *nomina imperfecta* (sing., *nomen imperfectum,* abbr., *nom. imperf.*); (4) *nomina translata* (sing., *nomen translatum,* abbr., *nom. transl.*); (5) *nomina correcta* (sing., *nomen correctum,* abbr., *nom. correct.*).

Invalid names. Invalid zoological names consisting of originally published names that fail to comply with mandatory provisions of the Rules and consisting of inadvertent changes in spelling of names have no status in nomenclature. They are not available as replacement names and they do not preoccupy for purposes of the Law of Homonomy. In addition to *nomen nudum,* invalid names may be distinguished as follows: (1) *"denied names,"* which consist of originally published names (with or without subsequent duplication) that do not meet mandatory requirements of the Rules; (2) *"null names,"* which comprise unintentional alterations of names; and (3) *"vain or void names,"* which consist of invalid emendations of previously published valid or invalid names. Void names do have status in nomenclature, being classified as junior synonyms of valid names.

Proposed Latin designations for the indicated kinds of invalid names are as follows: (1) *nomina negata* (sing., *nomen negatum,* abbr., *nom. neg.*); (2) *nomina nulla* (sing., *nomen nullum,* abbr., *nom. null.*); (3) *nomina vana* (sing., *nomen vanum,* abbr., *nom. van.*). It is desirable in the *Treatise* to identify invalid names, particularly in view of the fact that many of these names (*nom. neg., nom null.*) have been considered incorrectly to be junior objective synonyms (like *nom. van.*), which have status in nomenclature.

SUMMARY OF NAME CLASSES

Partly because only in such publications as the *Treatise* is special attention to classes of zoological names called for and partly because new designations are now introduced as means of recording distinctions explicitly as well as compactly, a summary may be useful. In the following tabulation valid classes of names are indicated in boldface type, whereas invalid ones are printed in italics.

Definitions of Name Classes

nomen **correctum (nom. correct.).** Name with intentionally altered spelling of sort required or allowable under the Rules but not dependent on transfer from one taxonomic category to another ("improved name"). (*See* Copenhagen Decisions, paragraphs 50, 71-2-a-i, 74, 75, 79, 80, 87, 101; in addition, change of endings for categories not now fixed by Rules.)

nomen **imperfectum (nom. imperf.).** Name that as originally published (with or without subsequent identical spelling) meets all mandatory requirements of the Rules but contains defect needing correction ("imperfect name"). (*See* Copenhagen Decisions, paragraphs 50-1-b, 71-1-b-i, 71-1-b-ii, 79, 80, 87, 101.)

nomen **inviolatum (nom. inviol.).** Name that as originally published meets all mandatory requirements of the Rules and also is uncorrectable or alterable in any way ("inviolate name"). (*See* Copenhagen Decisions, paragraphs 152, 153, 155-157).

nomen negatum (nom. neg.). Name that as originally published (with or without subsequent identical spelling) constitutes invalid original spelling and although possibly meeting all other mandatory requirements of the Rules, is not correctable to establish original authorship and date ("denied name"). (*See* Copenhagen Decisions, paragraph 71-1-b-iii.)

nomen nudum (nom. nud.). Name that as originally published (with or without subsequent identical spelling) fails to meet mandatory requirements of the Rules and having no status in nomenclature, is not correctable to establish original authorship and date ("naked name"). (*See* Copenhagen Decisions, paragraph 122.)

nomen nullum (nom. null.). Name consisting of an unintentional alteration in form (spelling) of a previously published name (either valid name, as *nom. inviol., nom. perf., nom. imperf., nom. transl.;* or invalid name, as *nom. neg., nom. nud., nom. van.,* or another *nom. null.*) ("null name"). (*See* Copenhagen Decisions, paragraphs 71-2-b, 73-4.)

nomen perfectum (nom. perf.). Name that as originally published meets all mandatory requirements of the Rules and needs no correction of any kind but which nevertheless is validly alterable ("perfect name").

nomen translatum (nom. transl.). Name that is derived by valid emendation of a previously published name as result of transfer from one taxonomic category to another within the group to which it belongs ("transferred name").

nomen vanum (nom. van.). Name consisting of an invalid intentional change in form (spelling) from a previously published name, such invalid emendations having status in nomenclature as junior objective synonyms ("vain or void name"). (*See* Copenhagen Decisions, paragraphs 71-2-a-ii, 73-3.)

Except as specified otherwise, zoological names accepted in the *Treatise* may be understood to be classifiable either as *nomina inviolata* or *nomina perfecta* (omitting from notice *nomina correcta* among specific names) and these are not discriminated. Names which are not accepted for one reason or another include junior homonyms, a few senior synonyms classifiable as *nomina negata* or *nomina nuda,* and numerous junior synonyms which include both objective *(nomina vana)* and subjective (all classes of valid names) types; effort to classify the invalid names as completely as possible is intended.

NAME CHANGES IN RELATION TO GROUP CATEGORIES

SPECIFIC AND SUBSPECIFIC NAMES

Detailed consideration of valid emendation of specific and subspecific names is unnecessary here because it is well understood and relatively inconsequential. When the form of adjectival specific names is changed to obtain agreement with the gender of a generic name in transferring a species from one genus to another, it is never needful to label the changed name as a *nom. transl.* Likewise, transliteration of a letter accompanied by a diacritical mark in manner now called for by the Rules (as in changing originally published *brőggeri* to *broeggeri*) or elimination of a hyphen (as in changing originally published *cornu-oryx* to *cornuoryx* does not require *"nom. correct."* with it. Revised provisions for emending specific and subspecific names are stated in the report on Copenhagen Decisions (p. 43-46, 51-57).

GENERIC AND SUBGENERIC NAMES

So rare are conditions warranting change of the originally published valid form of generic and subgeneric names that lengthy discussion may be omitted. Only elimination of diacritical marks of some names in this category seems to furnish basis for valid emendation. It is true that many changes of generic and subgeneric names have been published, but virtually all of these are either *nomina vana* or *nomina nulla.* Various names which formerly were classed as homonyms are not now, for two names that differ only by a single letter (or in original publication by presence or absence of a diacritical mark) are construed to be entirely distinct. Revised provisions for emendation of generic and subgeneric names also are given in the report on Copenhagen Decisions (p. 43-47).

Examples in use of classificatory designations for generic names as previously given are the following, which also illustrate designation of type species, as explained later.

Kurnatiophyllum Thomson, 1875 [**K. concentricum;* SD Gregory, 1917] [=*Kumatiophyllum* Thomson, 1876 *(nom. null.); Cymatophyllum* Thomson, 1901 *(nom. van.); Cymatiophyllum* Lang, Smith & Thomas, 1940 *(nom. van.)*].

Stichophyma Pomel, 1872 [**Manon turbinatum* Römer, 1841; SD Rauff, 1893] [=*Stychophyma* Vosmaer, 1885 *(nom. null.); Sticophyma* Moret, 1924 *(nom. null.)*].

Stratophyllum Smyth, 1933 [**S. tenue*] [=*Ethmoplax* Smyth, 1939 (*nom. van. pro Stratophyllum); Stratiphyllum* Lang, Smith & Thomas, 1940 (*nom. van. pro Stratophyllum* Smyth) (*non Stratiphyllum* Scheffen, 1933)].

Placotelia Oppliger, 1907 [**Porostoma marconi* Fromentel, 1859; SD deLaubenfels, herein] [=*Plakotelia* Oppliger, 1907 *(nom. neg.)*].

FAMILY-GROUP NAMES; USE OF *"NOM. TRANSL."*

The Rules now specify the form of endings only for subfamily (-inae) and family (-idae) but decisions of the Copenhagen Congress direct classification of all family-group assemblages (taxa) as co-ordinate, signifying that for purposes of priority a name published for a unit in any category and based on a particular type genus shall date from its original publication for a unit in any category, retaining this priority (and authorship) when the unit is treated as belonging to a lower or higher category. By exclusion of -inae and -idae, respectively reserved for subfamily and family, the endings of names used for tribes and superfamilies must be unspecified different letter combinations. These, if introduced subsequent to designation of a subfamily or family based on the same nominate genus, are *nomina translata,* as is also a subfamily that is elevated to family rank or a family reduced to subfamily rank. In the *Treatise* it is desirable to distinguish the valid emendation comprised in the changed ending of each transferred family group name by the abbreviation *"nom. transl."* and record of the author and date belonging to this emendation. This is particularly important in the case of superfamilies, for it is the author who introduced this taxon that one wishes to know about rather than the author of the superfamily as defined by the Rules, for the latter is merely the individual who first defined some lower-rank family-group taxon that contains the nominate genus of the superfamily. The publication of the author containing introduction of the superfamily *nomen translatum* is likely to furnish the information on taxonomic considerations that support definition of the unit.

Examples of the use of *"nom. transl."* are the following.

Subfamily STYLININAE d'Orbigny, 1851

[*nom. transl.* EDWARDS & HAIME, 1857 (*ex* Stylinidae D'ORBIGNY, 1851]

Superfamily ARCHAEOCTONOIDEA Petrunkevitch, 1949

[*nom. transl.* PETRUNKEVITCH, herein (*ex* Archaeoctonidae PETRUNKEVITCH, 1949)]

Superfamily CRIOCERATITACEAE Hyatt, 1900

[*nom. transl.* WRIGHT, 1952 (*ex* Crioceratitidae HYATT, 1900)]

FAMILY-GROUP NAMES; USE OF "NOM. CORRECT."

Valid emendations classed as *nomina correcta* do not depend on transfer from one category of family-group units to another but most commonly involve correction of the stem of the nominate genus; in addition, they include somewhat arbitrarily chosen modification of ending for names of tribe or superfamily. Examples of the use of *"nom. correct."* are the following.

Family STREPTELASMATIDAE Nicholson, 1889

[*nom. correct.* WEDEKIND, 1927 (*ex* Streptelasmidae NICHOLSON, 1889, *nom. imperf.*)]

Family PALAEOSCORPIIDAE Lehmann, 1944

[*nom. correct.* PETRUNKEVITCH, herein (*ex* Palaeoscorpionidae LEHMANN, 1944, *nom. imperf.*)]

Family AGLASPIDIDAE Miller, 1877

[*nom. correct.* STØRMER, herein (*ex* Aglaspidae MILLER, 1877, *nom. imperf.*)]

Superfamily AGARICIICAE Gray, 1847

[*nom. correct.* WELLS, herein (*ex* Agaricioidae VAUGHAN & WELLS, 1943, *nom. transl. ex* Agariciidae GRAY, 1847)]

FAMILY-GROUP NAMES; REPLACEMENTS

Family-group names are formed by adding letter combinations (prescribed for family and subfamily but not now for others) to the stem of the name belonging to genus (nominate genus) first chosen as type of the assemblage. The type genus need not be the oldest in terms of receiving its name and definition, but it must be the first-published as name-giver to a family-group taxon among all those included. Once fixed, the family-group name remains tied to the nominate genus even if its name is changed by reason of status as a junior homonym or junior synonym, either objective or subjective. According to the Copenhagen Decisions, the family-group name requires replacement only in the event that the nominate genus is found to be a junior homonym, and then a substitute family-group name is accepted if it is formed from the oldest available substitute name for the nominate genus. Authorship and date attributed to the replacement family-group name are determined by first publication of the changed family-group name.

The aim of family-group nomenclature is greatest possible stability and uniformity, just as in case of other zoological names. Experience indicates the wisdom of sustaining family-group names based on junior subjective synonyms if they have priority of publication, for opinions of different workers as to the synonymy of generic names founded on different type species may not agree and opinions of the same worker may alter from time to time. The retention similarly of first-published family-group names which are found to be based on junior objective synonyms is less clearly desirable, especially if a replacement name derived from the senior objective synonym has been recognized very long and widely. To displace a much-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. Conversely, a long-used family-group name founded on a junior objective synonym and having priority of publication is better continued in nomenclature than a replacement name based on the senior objective synonym. The Copenhagen Decisions (paragraph 45) take account of these considerations by providing a relatively simple procedure for fixing the desired choice in stabilizing family-group names. In conformance with this, the *Treatise* assigns to contributing authors responsibility for adopting provisions of the Copenhagen Decisions.

Replacement of a family-group name may be needed if the former nominate genus is transferred to another family-group. Then the first-published name-giver of a family-group assemblage in the remnant taxon is to be recognized in forming a replacement name.

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 for any of these assemblages, 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. Also, every family containing differentiated subfamilies must have a nominate *(sensu stricto)* subfamily, which is based on the same type genus as that for the family, and the author and date set down for the nominate subfamily invariably are identical with those of the family, without reference to whether the author of the family or some subsequent author introduced subdivisions.

Changes in the form of family-group names of the sort constituting *nomina correcta,* as previously discussed, do not affect authorship and date of the taxon concerned, but in publications such as the *Treatise* it is desirable to record the authorship and date of the correction.

ORDER/CLASS-GROUP NAMES; USE OF *"NOM. CORRECT."*

Because no stipulation concerning the form of order/class-group names is given yet by the Rules, emendation of all such names actually consists of arbitrarily devised changes in the form of endings. Nothing precludes substitution of a new name for an old one, but a change of this sort is not considered to be an emendation. Examples of the use of *"nom. correct."* as applied to order/class-group names are the following.

Order DISPARIDA Moore & Laudon, 1943

[*nom. correct.* Moore, 1952 (*ex* Disparata Moore & Laudon, 1943)]

Suborder FAVIINA Vaughan & Wells, 1943

[*nom. correct.* Wells, herein (*ex* Faviida Vaughan & Wells, 1943)]

Suborder FUNGIINA Verrill, 1865

[*nom. correct.* Wells, herein (*ex* Fungiida Duncan, 1884, *ex* Fungacea Verrill, 1865)]

TAXONOMIC EMENDATION

Emendation has two measurably distinct aspects as regards zoological nomenclature. These embrace (1) alteration of a name itself in various ways for various reasons, as has been reviewed, and (2) alteration of taxonomic scope or concept in application of a given zoological name, whatever its hierarchical rank. The latter type of emendation primarily concerns classification and inherently is not associated with change of name, whereas the other type introduces change of name without necessary expansion, restriction, or other modification in applying the name. Little attention generally has been paid to this distinction in spite of its significance.

Most zoologists, including paleozoologists, who have signified emendation of 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 may accompany the name, with statement of the author and date of the emendation. On the other hand, a multitude of workers concerned with systematic zoology think that publication of "*emend.*" with a zoological name is valueless because more or less alteration of taxonomic sort is introduced whenever a subspecies, species, genus, or other assemblage of animals is incorporated under or removed from the coverage of a given zoological name. 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 radical revisions are put forward, generally with published statement of reasons for changing the application of a name. To erect a signpost at such points of most significant change is worth while, both as aid to subsequent workers in taking account of the altered nomenclatural usage and as indication that not-to-be-overlooked discussion may be found at a particular place in the literature. Authors of contributions to the *Treatise* are encouraged to include records of all specially noteworthy emendations of this nature, using the abbreviation "*emend.*" with the name to which it refers and citing the author and date of the emendation.

In Part G (Bryozoa) and Part D (Protista 3) of the *Treatise,* the abbreviation "*emend.*" is employed to record various sorts of name emendations, thus conflicting with usage of "*emend.*" for change in taxonomic application of a name without alteration of the name itself. This is objectionable. In Part E (Archaeocyatha, Porifera) and later-issued divisions of the *Treatise,* use of "*emend.*" is restricted to its customary sense, that is, significant alteration in taxonomic scope of a name such as calls for noteworthy modifications of a diagnosis. Other means of designating emendations that relate to form of a name are introduced.

STYLE IN GENERIC DESCRIPTIONS

DEFINITION OF NAMES

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 2 or more distinct taxonomic units, however, it is necessary to differentiate such homonyms, and 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, *Callopora* HALL, 1851, introduced for Paleozoic trepostome bryozoans, is invalid because GRAY in 1848 published the same name for Cretaceous-to-Recent cheilostome bryozoans, and BASSLER in 1911 introduced the new name *Hallopora* to replace HALL's homonym. The *Treatise* style of entry is:

Hallopora BASSLER, 1911 [*pro Callopora* HALL, 1851 (*non* GRAY, 1848)].

In like manner, a needed replacement generic name may be introduced in the *Treatise* (even though first publication of generic names otherwise in this work is avoided). The requirement that an exact bibliographic reference must be given for the replaced name commonly can be met in the *Treatise* by citing a publication recorded in the list of references, using its assigned index number, as shown in the following example.

Mysterium DELAUBENFELS, *nom. nov.* [*pro Mystrium* SCHRAMMEN, 1936 (ref. 40, p. 60) (*non* ROGER, 1862)] [**Mystrium porosum* SCHRAMMEN, 1936].

For some replaced homonyms, a footnote reference to the literature is necessary. A senior homonym is valid, and in so far as the *Treatise* is concerned, such names are handled according to whether the junior homonym belongs to the same major taxonomic division (class or phylum) as the senior homonym or to some other; in the former instance, the author and date of the junior homonym are cited as:

Diplophyllum HALL, 1851 [*non* SOSHKINA, 1939] [**D. caespitosum*].

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

CITATION OF TYPE SPECIES

The name of the type species of each genus and subgenus is given next following the generic name with its accompanying author and date, or after entries needed for definition of the name if it is involved in homonymy. The originally published combination of generic and trivial names for this species is cited, accompanied by an asterisk (*), with notation of the author and date of original publication. An exception in this procedure is made, however, if the species was first published in the same paper and by the same author as that containing definition of the genus which it serves as type; in such case, the initial letter of the generic name followed by the trivial name is given without repeating the name of the author and date, for this saves needed space. Examples of these 2 sorts of citations are as follows:

Diplotrypa NICHOLSON, 1879 [**Favosites petropolitanus* PANDER, 1830].

Chainodictyon FOERSTE, 1887 [**C. laxum*].

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

Acervularia SCHWEIGGER, 1819 [**A. baltica* (=**Madrepora ananas* LINNÉ, 1758)].

It is judged desirable to record the manner of establishing the type species, whether by original designation or by subsequent designation, but various modes of original designation are not distinguished. According to convention adopted in the *Treatise,* absence of any indication as to manner of fixing the type species is to be understood as signifying original designation. If the type species has been fixed by subsequent designation, this is indicated by the letters "SD" followed by the name of the author and date of such subsequent designation, as follows:

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

SYNONYMS

Citation of synonyms is given next following record of the type species and if 2 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. Examples showing *Treatise* style in listing synonyms follow.

Calapoecia BILLINGS, 1865 [**C. anticostiensis;* SD LINDSTRÖM, 1833] [=*Columnopora* NICHOLSON, 1874; *Houghtonia* ROMINGER, 1876].

Staurocyclia HAECKEL, 1882 [**S. cruciata* HAECKEL, 1887] [=*Coccostaurus* HAECKEL, 1882 (obj.); *Phacostaurus* HAECKEL, 1887 (obj.)].

A synonym which also constitutes a homonym is recorded as follows:

Lyopora NICHOLSON & ETHERIDGE, 1878 [**Palaeopora? favosa* M'COY, 1850] [=*Liopora* LANG, SMITH & THOMAS, 1940 (*non* GIRTY, 1915)].

ABBREVIATIONS

Some authors' names and most stratigraphic and geographic names are abbreviated in order to save space. General principles for guidance in determining what names should be abbreviated are frequency of repetition, length of name, and avoidance of ambiguity. Abbreviations used in this division of the *Treatise* are explained in the following alphabetically arranged list.

Abbreviations of Stratigraphic and Place Names and Words Used in Bibliographic Citations

Abh., Abhundlung, -en
Acad., Académie, Academy
Afr., Africa
Akad., Akademie
Alg., Algeria
Am., America, American
Ann., Annals
Antarct., Antarctica
Arg., Argentina
Atl., Atlantic
Aus., Austria
Austral., Australia
B.C., British Columbia
Bd., Band, Bände
Belg., Belgium
Br., British
Bull., Bulletin, -s
C., Central
Cam., Cambrian
Can., Canada
Carb., Carboniferous
Cenom., Cenomanian
Cenoz., Cenozoic
Coll., Collection, -s; College
Colo., Colorado
Comm., Commission, Committee
Comp., Comparative
Cosmop., Cosmopolitan
Cret., Cretaceous
Czech., Czechoslovakia
Dev., Devonian
E., East
Eng., England
Eoc., Eocene
Eu., Europe
fig., figure, -s
Fla., Florida
Fr., France
Geol., Geological, Geology, Geologie
Ger., Germany
Gesell., Gesellschaft
GulfMexico, Gulf of Mexico
Helv., Helvetian
Hist., History
I., Island, -s
Ill., Illinois
Ind., Indian, Indiana
Inst., Institute
Ire., Ireland

Jour., Journal
Jur., Jurassic
K., Kaiserlich, Königlich
Kans., Kansas
Ky., Kentucky
L., Lower
loc., locality, -ies
long., longitudinal
M., Middle
Mag., Magazine
Manch., Manchuria
Mem., Memoir
Mém., Mémoire
Mesoz., Mesozoic
Minn., Minnesota
Mio., Miocene
Misc., Miscellaneous
Miss., Mississippian
Mitt., Mitteilungen
Mon., Monograph, Monographie
Mus., Musée, Museum
N., North
N.Am., North America
nat., natural
Natl., National
naturf., naturforschende
Nev., Nevada
Newf., Newfoundland
nom., nomen
nov., nova, -us, -um
NW., Northwest
N.Y., New York
N.Z., New Zealand
O., Ocean
obj., objective
Okla., Oklahoma
Ord., Ordovician
p., page, -s
Pa., Pennsylvania
Pac., Pacific
Palaeontogr., Palaeontographica, -l
Paläont., Paläontologie
Paleont., Paleontology, -ical
Penn., Pennsylvanian
Perm., Permian
pl., plate, -s
Pleisto., Pleistocene
Precam., Precambrian
Prof., Professional
Pub., Publication, -s
Quart., Quarterly
Que., Quebec
Rec., Recent
Rept., Report, -s
Rev., Review, Revue
Roy., Royal, Royale
Russ., Russia
S., Sea, South
Santon., Santonian
Sci., Science, -s; Scientific
Scot., Scotland
SD, subsequent designation
sec., -s, section, -s
Sib., Siberia
Sil., Silurian
Sitzungsber., Sitzungsberichte
Soc., Société, Society
Sp., Spain
Suppl., Supplement
SW., Southwest
Tenn., Tennessee
Tert., Tertiary
Tex., Texas
Trans., Transactions
transv., transverse
Trias., Triassic
U., Upper
Univ., University
U.S.A., United States
U.S.S.R., Union of Soviet Socialist Republics
Va., Virginia
Ver., Verein
Verh., Verhandlung, -en
vol., volume, -s
Vt., Vermont
W., West
Wiss., Wissenschaft, -en
Wyo., Wyoming
Zool., Zoology, -ical

Abbreviations of Authors' Names

Bedf.-B., Bedford, R., & Bedford, J.
Bill., Billings, Elkanah
Blainv., Blainville, H. M. D. de
Blum., Blumenbach, D. J. F.
Bolk., Bolkhovitinova, M.
Born., Bornemann, J. G.
Bow., Bowerbank, J. S.
Brongn., Brongniart, A.
Chalmas, Chalmas, M. Munier
Coss., Cossmann, Maurice
Court., Courtiller, A.
Dawson-H., Dawson, J. W., & Hinde, G. J.
Defr., Defrance, M. J. L.
deLaub., Laubenfels, M. W. de
Död., Döderlein, L.
Edw.-H., Edwards, H. Milne, & Haime, Jules
Ehr., Ehrenberg, O. G.
Eichw., Eichwald, C. E. von
Étal., Étallon, A.
Fenton-F., Fenton, C. L., & Fenton, M. A.
Fischer, Fischer von Waldheim, G.
From., Fromentel, E. de
Goldf., Goldfuss, G. A.
Hall-C., Hall, James, & Clarke. J. M.
Hinde-H., Hinde, G. J., & Holmes, W. M.
His., Hisinger, W.
Hkl., Haeckel, Ernst
Lam., Lamarck, J. B. P. A. de M. de
Lamx., Lamouroux, J. V. F.
Lesq., Lesquereux, Leo
Lonsd., Lonsdale, William
Meek-W., Meek, F. B., & Worthen, A. H.
Mich., Michelin, J. L. H.
Miller-D., Miller, S. A., & Dyer,
Murch., Murchison, R. I.
Ok., Okulitch, V. J.
Oppl., Oppliger, F.
Orb., Orbigny, A. D. d'
Phill., Phillips, John
Quenst., Quenstedt, F. A.
Raf., Rafinesque, C. S.
Ray.-O., Raymond, P. E., & Okulitch, V. J.
Rued., Ruedemann, Rudolf
Schloth., Schlotheim, E. F.
Schram., Schrammen, A.
Spriest., Spriestersbach, J.
Steinm., Steinmann, G.
Stuck., Stuckenberg, A.
Term.-T., Termier, Henri, & Termier, Geneviève
Toll, Toll, E. von
Traut., Trautschold, H.
Tschern., Tschernyschew, T.
Ulr., Ulrich, E. O.
Vinassa, Vinassa de Regny, P. E.
Vol., Vologdin, A. G.
Waag.-W., Waagen, William, & Wentzel, Joseph
Walc., Walcott, C. D.
Whitf., Whitfield, R. P.
Y.-Y., Young, John, & Young, John
Zittel-E., Zittel, K. A. von, & Eastman, C. R.

REFERENCES TO LITERATURE

Each part of the *Treatise* is accompanied by a selected list of references to paleontological literature consisting primarily of recent and comprehensive monographs available but also including some older works recognized as outstanding in importance. The purpose of giving these references is to aid users of the *Treatise* in finding detailed descriptions and illustrations of morphological features of fossil groups, discussions of classifications and distribution, and especially citations of more or less voluminous literature. Generally speaking, publications listed in the *Treatise* are not original sources of information concerning taxonomic units of various rank but they tell the student where he may find them; otherwise it is necessary to turn to such aids as the *Zoological Record* or NEAVE'S *Nomenclator Zoologicus*. References given in the *Treatise* are arranged alphabetically by authors and accompanied by index numbers which serve the purpose of permitting citation most concisely in various parts of the text; these citations of listed papers are inclosed invariably in parentheses and are distinguishable from dates because the index numbers comprise no more than 3 digits. Ordinarily, index numbers for literature references are given at the end of generic or family diagnoses.

SOURCES OF ILLUSTRATIONS

At the end of figure captions an index number is given to supply record of the author of illustrations used in the *Treatise*, reference being made to an alphabetically arranged list of authors' names which follows.

RAYMOND C. MOORE

SUPPLEMENTAL NOTE

VALUE OF RECORDING DISTINCTIONS AMONG INVALID ZOOLOGICAL NAMES

Further consideration of the various categories of zoological names as defined and discussed in foregoing pages has suggested the desirability of calling special attention to some aspects of the subject which, although important to the *Treatise*, were passed over. The intention to record information which may most clearly and precisely set forth grounds for rejecting some names and accepting others was stated, but except for illustration by a few examples designed to show *Treatise* style, that is about all. What criteria may be recognized for reliable distinction between valid and invalid names, and if a name is found to be invalid, what good is served by classifying it further? Of course, junior homonyms require notice because they must be renamed; junior objective synonyms cannot be overlooked, because they preoccupy and are available as replacement names for junior homonyms; junior subjective synonyms need to be recorded because they also preoccupy, are available as replacement names, and may be recognized as valid by anyone at any time when they are removed from synonymy. This brings us to invalid names which have no status in nomenclature (*nomina nuda, nomina negata, nomina nulla*). Is there any point in recording such names (taking space also for citation of author, date, and type of name), since for all intents of zoological nomenclature these names do not exist? A reasonable answer seems to be that definition of their status is necessary before correct treatment of them under the Rules is possible; once this is known, the names may be rejected and neglected.

Recognition of the status of some zoological names as *nomina nuda, nomina negata,* or *nomina nulla* may be very simple, but accurate determination of others may be difficult, requiring careful study. In either case, specialists who are thoroughly acquainted with the literature relating to a particular taxonomic unit such as phylum, class, order, or smaller division and who have made themselves familiar with the regulations pertaining to zoological names are best able to furnish needed information, and comprehensive publications like the

Treatise are appropriate for compilation and indexing of such records. Examples of each of the 3 mentioned classes of invalid names may be found in each of the 5 groups of taxa (species group, genus group, etc.), but they are most common and important for notice in the species and genus groups. Convenient over-brief characterization of a *nomen nudum* emphasizes its lack of "indication" associated with the name, whether the name itself is formed correctly or incorrectly (including a so-called family-group taxon not based on a type genus). *Nomina negata* are rare. A *nomen nullum* rightly may be defined as comprising any unexplained deviation from original spelling of a zoological name; this readily serves for distinction of most *nomina nulla* from *nomina vana.*

It is important to distinguish and record all *nomina vana* because automatically they are junior objective synonyms, although all junior objective synonyms are by no means classifiable as *nomina vana.* For example, a subjective junior synonym of a generic name may be converted to a junior objective synonym under circumstances permitting fixation of an identical type species; this does not produce a *nomen vanum.*

Previously published parts of the *Treatise,* as well as Part E and others nearing readiness for press, largely omit information relating to invalid names, many of which are not listed at all. Parts issued in future will include notice of as many such names as authors are able and willing to furnish.

RAYMOND C. MOORE

PART E

ARCHAEOCYATHA AND PORIFERA

ARCHAEOCYATHA

By VLADIMIR J. OKULITCH

CONTENTS

INTRODUCTION

Archaeocyathids are exclusively Cambrian marine organisms with world-wide distribution, which now are recognized as an independent phylum called Archaeocyatha. They lived in large numbers on calcareous sea bottoms forming "gardens" of sessile benthos but not building topographically prominent reefs (bioherms). Apparently they lived in relatively narrow belts parallel to coastlines of the Cambrian shallow seas. Their tolerance to muddy water was low and they seem to have been unable to maintain vigorous growth where subjected to encroachment by algae. In North America and Australia, disappearance of the Archaeocyatha coincides with extinction of the Olenellidae, at the close of the Early Cambrian, but in Eurasia they seem to have persisted throughout most if not all of Middle Cambrian time. No discernible descendants have been recognized, and the phylum, therefore, is a short-lived one. During its life span, the bewildering array of forms produced indicates an almost explosive evolution.

MORPHOLOGY

GENERAL FEATURES

The skeletons of the Archaeocyatha were built of calcium carbonate. They are exceedingly fragile and fragments of some resemble large spicules. The most typical skeletons are cone-, goblet-, or vase-shaped, but irregular crenulate saucer-like and conical forms are found. Simpler types consist of outer and inner conical cups with varied sorts of structural elements between them (Fig. 1). Commonly, as in *Ajacicyathus*, the supports between the cups have the form of vertical radial plates, termed **parieties.** The outer cup is perforated by numerous pores which generally are very fine. This **outer wall** may have almost cylindrical form or flare outward at various angles from the point of initial growth, its cross section ranging from nearly circular to elliptical or irregular shapes. Sections of longitudinally fluted or corrugated walls have a crenulated appearance, and indentations of the wall commonly correspond in position to placement of parieties on the inner side. The **inner wall** generally is concentric with the outer, but it may be incomplete toward the apex of the cone. Pores are numerous and mostly large, so that in some specimens the inner wall is reduced to a mere network of fused rods. Space between the 2 walls, termed the **intervallum**, tends to have constant width everywhere, and it is divided into nearly uniform intercepts by the parieties. The intervallum also may contain horizontal or inclined structures consisting of rods, straight or curved plates **(tabulae)**, irregularly bent plates **(taeniae)**, tubules, and complex vesicular tissue. Adjacent parieties may be connected by horizontal or curved plates **(dissepiments)** or by rods **(synapticulae)**. Most of these structures, like the walls, are porous, size of the pores ranging from very fine to very coarse. The cavity inside the inner wall is entirely open

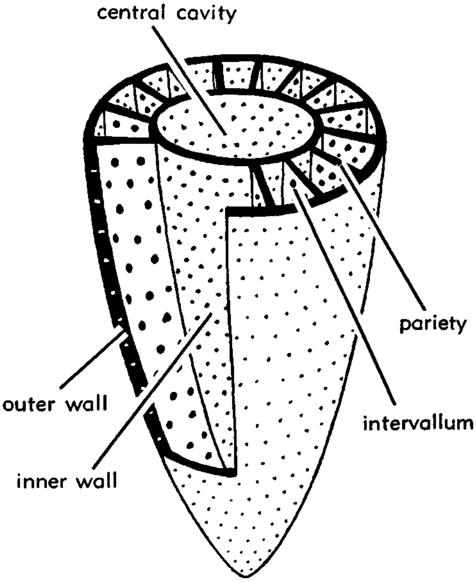

Fig. 1. Diagrammatic sketch of a typical archaeocyathid (*Ajacicyathus*) with porous outer and inner walls joined by radially disposed porous cross walls (parieties) (7).

upward, but in some genera the lower part is occupied by irregular vesicular tissue.

All skeletal elements of the intervallum and probably the side of the inner wall facing the central cavity are judged to have been covered by living tissue while the animals were growing (Okulitch, 1946). Evidence of a coelenteron is lacking and it seems likely that assimilation of food was confined mainly to the region of the intervallum. The anatomy of the Archaeocyatha thus is quite unlike that of the Coelenterata and differs also from structures characteristic of the Porifera, for sponges lack concentrically disposed walls with intervening parieties and have skeletons composed of distinct spicules.

The Archaeocyatha are presumed to have reproduced sexually, giving rise to larvae that for a time floated or swam about freely and then settled to the bottom. At this stage, the animal must have had a hollow saclike form, open at the top, thus closely resembling a gastrula or the olynthus stage of a sponge. The primitive gastral space or spaces communicated with the exterior by means of mural pores and the open central cavity. Secretion of a skeleton began with building the outer wall, then the parieties, and finally the inner wall. Some archaeocyathid species are known to increase by budding or fission.

OUTER WALL

In simplest form, the outer wall is a laminar perforated structure which varies chiefly in the size and distribution of its pores. The aggregate area of pore spaces may be distinctly less than that of solid wall, or, conversely, it may be appreciably larger, and between these extremes all gradations occur. Exceptionally, the wall consists of a fragile framework of slender spicule-like rods joined together so as to inclose large pores. Various minor structures (shelves, rugae, vesicles) occur in some genera, and among archaeocyathids characterized by simple large pores a thin skin **(pellis)** may be present on the outer surface or on both sides of the wall. This skin is perforated by fine pores that lead to the normal large openings in the wall beneath them. Probably the function of the pellis was to strain inward flowing water (Vologdin, 1932).

Types of outer-wall pores observed in archaeocyathids are illustrated in Fig. 2. Those designated by the letters *A* and *B* are moderately large, and their arrangement in a flattened quincunxial pattern is independent of the location of parieties. The number of pores in each intercept ranges from 2 to 10. Type-*C* pores are spaced more closely in horizontal rows than vertically, forming an elongate quincunxial pattern, and transverse sections of walls with such pores resemble a dotted line. A slight change in spacing of *A*-, *B*-, or *C*-type pores gives rise to close-set or isolated quads arranged in single, double, or multilinear series in each intercept. Absolute size of the pores is an important distinguishing

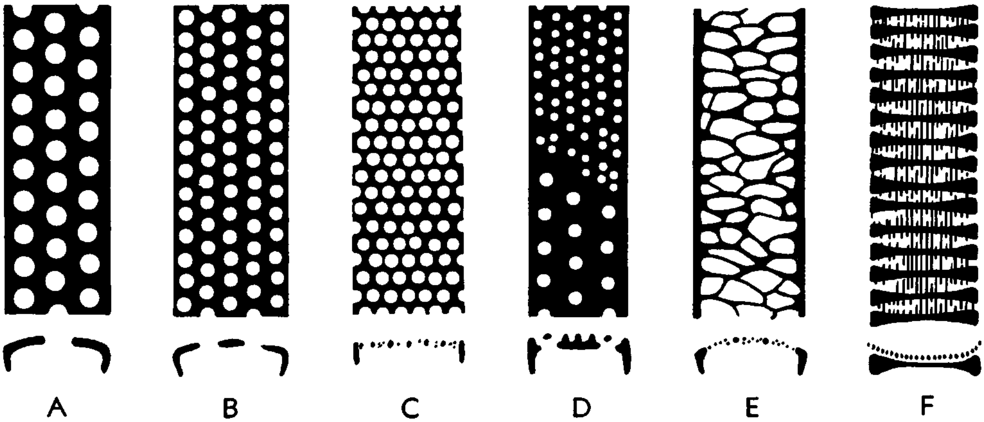

Fig. 2. Types of outer-wall pores in archaeocyathids (12).

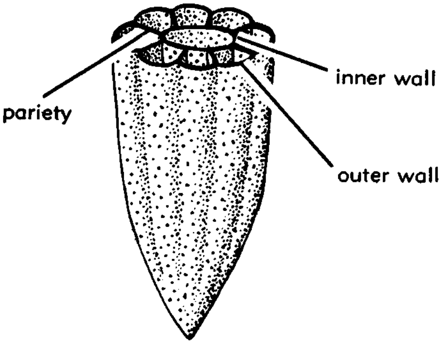

FIG. 3. Vertically fluted cup of *Archaeocyathellus,* showing relation of grooves to parieties (7).

feature. Type-*D* pores are compound canals consisting of a single passageway at the inner side of the wall and several narrow branch canals at the outer side. A combination of simple and complex perforations that produces a somewhat irregularly reticulate outer wall structure is classed as type-*E* pores. Still another type *(F)*, termed clathriform, is described by VOLOGDIN (1932):

> The external wall is formed by a series of horizontal lamellar bandlike skeletal elements (tabellae) of various sections . . . which form rings girdling the cup along the external edges of the parieties. The interspaces (rimae) between these horizontal tabellae are sheltered from the outside by a lattice of minute closely set laminae, forming a thin delicate lattice-work (clathri).

Minor variations of the outer wall structure comprise outgrowths or indentations that interrupt the otherwise smooth surface. The most noteworthy are longitudinal grooves which commonly correspond with placement of the parieties on the inside. *Archaeocyathellus* has well-developed grooves of this sort (Fig. 3).

INTERIOR STRUCTURES

Inner wall.—The inner wall of archaeocyathids is highly variable in nature, but general constancy of structure within the limits of different genera and families makes this part of the skeleton useful for taxonomic distinctions. The recognized main types of inner wall are as follows: (1) simple lamellar wall perforated by small pores which collectively have smaller area than that of solid skeletal tissue; (2) simple lamellar wall with large round or oval pores which together exceed the solid tissue in area, as in *Ajacicyathus nevadensis*; (3) delicate network formed by fusion of slender bars and rods, as in *Acanthinocyathus*; (4) simple perforated wall complicated on the intervallum side by a narrow layer of vesicular tissue which is joined to the parieties, as in *Ethmophyllum;* (5) structurally complex skeletal tissue between 2 concentric lamellae, as in *Tercyathus* (Fig. 4); (6) wall characterized by considerable development of minor skeletal elements such as hooks, flat or curved shelves, and ringlike structures extending into the inner cavity.

Several important families of the Archaeocyatha are distinguished readily by the type of their inner-wall structure. For example, the relatively simple skeletons of Ajacicyathidae, Pycnoidocyathidae, Archaeocyathidae, and some Coscinocyathidae are characterized by inner walls of types 1 and 2; the Acanthinocyathidae have inner walls of type 3; genera of the Ethmophyllidae

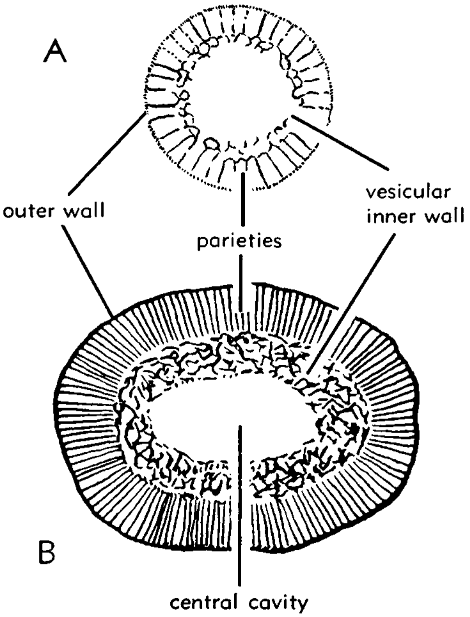

FIG. 4. Transverse sections showing parieties and vesiculose structure in position of the inner wall. *A, Ethmophyllum,* with moderately numerous particles and thin vesicular zone (13). *B, Tercyathus,* with abundant closely spaced parieties and thick vesicular zone (12).

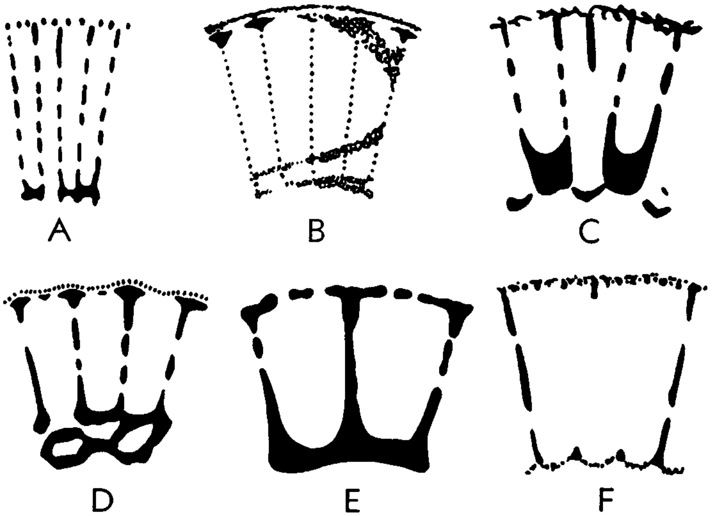

FIG. 5. Types of parieties and inner walls represented in transverse sections (12).

commonly exhibit type 4; and *Tercyathus* is marked by type 5, which is an elaboration of type 4. Type 6 lacks value for taxonomic differentiation.

Intervallum.—During life, the bulk of living tissue of archaeocyathid species probably was lodged in the intervallum, for only a thin layer of such tissue is inferred to have covered the exterior of the outer wall and central-cavity side of the inner wall. Useful for classification of the archaeocyathids is the ratio of intervallum width to central-cavity diameter (intervallum coefficient), and likewise significant is the number of parieties in relation to total diameter of the skeleton (parietal coefficient). Both of these coefficients should be stated in descriptions of species.

Parieties.—Simple radial parieties are best shown by members of the Ajacicyathidae, where they appear as vertical radial plates, generally perforate, extending from outer to inner walls. They may be relatively few in number (Figs. 1, 3) or very numerous (Fig. 4). The pores of parieties, like those of the walls, differ greatly in number, size, and arrangement. Although TAYLOR (1910, p. 89) states that no pores have been detected in *Archaeocyathus tubavallum* and that parieties of *A. stapipora* are imperforate except near their junction with the inner wall, the parieties of most genera exhibit numerous clearly visible pores, their aggregate area being equal to or exceeding that of solid tissue (as in *Archaeocyathus retesepta* and *Nevadocyathus septaporus*). Extreme reduction of solid substance in the parieties may lead to their replacement by radial rods (as in *Dictyocyathus*) or anastomosing bars and rods. Some types of parieties and inner walls are illustrated in Fig. 5. Among genera of the Metacyathida, the parieties are complicated by taeniae, synapticulae, dissepiments, and irregular vesiculose tissue in the intervallum. Also, members of the Syringocnemida have peculiar tubular structures in the intervallum.

Tabulae.—The Coscinocyathidae and Metacoscinidae are characterized by horizontal perforate plates (tabulae) associated with the parieties or supplanting them in some genera. The tabulae are flat or arched and their spacing differs considerably. The vertical distance between tabulae should be stated always in descriptions of species.

Central cavity.—A central cavity occurs in most Archaeocyatha, the only exceptions being some species of *Protopharetra* and among the coral-like Anthocyathea. The shape of this cavity differs greatly, ranging from a narrow tubelike form to a great bowl-shaped space. Conceivably, its function may have corresponded to that of the central cavity (cloaca) of the sponges. Vesicular tissue which occurs in the central cavity of young specimens of Metacyathida is interpreted by Vologdin as a deposit formed late in ontogeny, serving to shut off a no-longer-used part of the cup, whereas Bedford & Bedford think that this tissue was formed at a very early growth stage which was followed by development of the regular 2-walled cup and empty central cavity.

EXOTHECAL LAMELLAE

Some specimens of Archaeocyatha, especially among the Metacyathida, bear exothecal tissue attached to the outer side of the cup, forming concentric layers around it or extending in long plumelike filaments away from it. Okulitch (1946) judges that these exothecal lamellae denote abnormal proliferation of living tissue on the outside of the outer wall which secreted skeletal material essentially like that found in the intervallum. Exothecal lamellae of 4 types have been recognized.

SINGLE-WALLED ARCHAEOCYATHIDS

Not all genera of the Archaeocyatha have double walls, for some, such as *Monocyathus,* possess only a single porous wall. Because all archaeocyathids seemingly pass through a single-walled stage during their early development, forms that retain this structure in adult growth stages, grouped in the class called Monocyathea, are inferred to be the most primitive members of the phylum. Their very delicate wall is perforated by regularly spaced pores which in most species are arranged in a honeycomb or quincunxial pattern.

SPITZES

A subcylindrical to steeply conical initially formed part of the archaeocyathid skeleton is termed the spitz. The Ajacicyathida and Metacyathida, which are the most important orders of Archaeocyathea, developed from *Monocyathus*-like single-walled spitzes. Parieties and an inner wall appeared very early in the Ajacicyathida, whereas imperforate transverse partitions are first-formed structures in the nepionic cup of the Metacyathida, followed by irregular trabeculae. This divergence in early growth stages furnishes basis for main systematic divisions of the class. A restoration of a young archaeocyathid, prepared from serial sections of the spitz of *Ajacicyathus nevadensis,* indicates the single-walled structure of the initially formed part of the skeleton (Fig. 6). Vologdin (1931) has shown that *Ventriculocyathus* develops from a single-walled porous stem (spitz) which increases in diameter as regular parieties and a porous inner wall appear. Bornemann (1891) has demonstrated that other young specimens have spitzes resembling *Protopharetra* in structure.

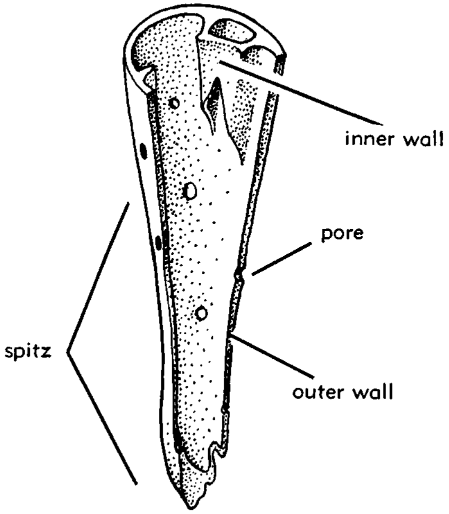

Fig. 6. Restoration of initial part of the skeleton of *Ajacicyathus nevadensis* with wall cut away to show inner cavity and lack of double walls at beginning of growth (7).

MORPHOLOGICAL TERMINOLOGY

For convenience of reference, an alphabetically arranged glossary of morphological terms commonly used in description of the Archaeocyatha is introduced here. Common words such as "wall," "pore," "shelf," and the like which are employed in their usual meaning, without technical significance, are omitted from the list of terms.

Glossary of Morphological Terms

central cavity. Narrow tubelike to broad bowl-shaped interior space enclosed by inner wall (or rarely by outer wall alone); may be partly filled with vesicular tissue (Figs. 1, 2, 3).

clathrus (pl., **clathri**). Delicate lamina closely set with others in the intervallum of some archaeocyathids, forming a lattice work.

dissepiment. Curved or flat subhorizontal plate forming cystlike connection between parieties in the intervallum.

exothecal lamella. Calcareous plate or filament that with others may form concentric layers outside of outer wall or project away from this wall.

inner wall. Lamellar or porous structure, generally rather thin, having approximate form of the outer wall and parallel to it; surrounds central cavity (Figs. 1-3, 5).

intervallum. Space between the outer and inner walls; may contain various structures, chief of which are the parieties (Fig. 1).

outer wall. Laminar perforated calcareous structure forming exterior of skeleton (Fig. 1-4).

pariety (pl., **parieties**). Radial wall in intervallum between outer and inner walls (Fig. 1-3).

pellis. Thin calcareous skin distinguishable on outer side (less commonly on inner side also) of outer wall; bears very fine pores.

rima. Space between horizontal tabellae in intervallum.

spitz. Subcylindrical to steeply conical initially formed part of skeleton, located at proximal extremity (Fig. 6).

synapticula. Rodlike structure extending between parieties.

tabella. Subhorizontal lamella forming part of ring girdling outer edges of parieties in some archaeocyathids.

tabula. Subhorizontal perforate plate in intervallum extending from one pariety to another or in some genera supplanting the parieties.

taenia. Irregularly bent small plate in intervallum.

SYSTEMATIC POSITION

Earlier workers have classed the Archaeocyatha (also called Pleospongea by OKULITCH, 1937) with corals, sponges, protozoans, and calcareous algae. BILLINGS (1859) assigned them to the Protozoa, although he recognized the possibility that they might belong in an intermediate position between sponges and corals. DAWSON (1865) considered them to be Foraminifera, whereas VON TOLL (1899) suggested affinities with calcareous algae. HINDE (1889) refuted arguments for placing the archaeocyathids among protozoans, and TAYLOR (1910) showed conclusively that they lacked relationship with algae. Subsequently for many years, opinions were almost equally divided between paleontologists who would assign these fossils to the Porifera and those who preferred to classify them as a division of the Coelenterata.

Work by VOLOGDIN, BEDFORD & BEDFORD, and OKULITCH supplied information that made it virtually impossible to arrange the Archaeocyatha among coelenterates. TING (1937) observed what he thought were siliceous tetraxon spicules in archaeocyathids from Sardinia, and therefore he assigned the whole group to the Silicispongia, a mistake which was followed blindly by SIMON (1939). Needless to say, no evidence at all supports their view. However, the dissimilarity of archaeocyathid structures to those of corals led OKULITCH (1943) to interpret the fossils characterized by them as a group of calcareous sponges which he designated as the class Pleospongia. Lack of relationship with corals is indicated by the following attributes of archaeocyathids: (1) presence of a porous inner wall; (2) soft parts probably confined to the intervallum and possibly a lining on outer and inner walls, very unlike anthozoan polyps; (3) lack of regularity in plan of the parieties, which may be increased or reduced in haphazard manner; (4) structure of parieties, indicating lack of homology with septa of corals; (5) absence of parieties in all nepionic skeletons (spitzes) and in some adult individuals; (6) nearly constant width of the intervallum; (7) perforate nature of tabulae in contrast to imperforate tabulae of corals; (8) wide dissimilarity in form of many archaeocyathids from corals; and (9) geologic antiquity of archaeocyathids and separation from oldest known corals by a great time span.

Possible relations of the Archaeocyatha with sponges have been reviewed recently by OKULITCH & DE LAUBENFELS (1953), who conclude that essential differences far outweigh superficial resemblances. Significant dissimilarities may be stated briefly as follows: (1) sponges invariably lack parieties and none have laminar outer and inner walls such as are possessed by archaeocyathids; (2) although a few fossil sponges seem to have stiffened cloacal walls, these probably represent post-mortem alteration; (3) although some sponges possess a cortex, this consists of spicules which do not form a wall; (4) the granular-lamellar skeleton of archaeocyathids differs greatly from the spicular skeleton of sponges both in mode of development and general structure; (5) the Archaeocyatha are confined to Cambrian rocks, whereas the oldest known calcareous sponges occur in the Devonian. Other differences appear in mode of growth, for in archaeocyathids an initially imperforate spitz gives rise to perforate walls in which increasing size of pores may leave only slender rods between them, but the sponge skeleton is built up from somewhat widely separated needle-like spicules in early ontogeny to a more or less compact structure composed of crowded spicules in mature growth. Although end products may have similar form, beginnings of individuals belonging to these groups are entirely different. Knowledge of the soft parts of the Archaeocyatha is lacking, and hence no basis exists for the postulate that these animals possessed chambers lined by choanocytes, as in sponges.

The conclusion that archaeocyathids can be classified neither as sponges nor as coelenterates, together with certainty that they are unrelated to protozoans, algae, or other defined major group of organisms, makes proposal of them as an independent phylum necessary. Accordingly, they are so classified and the name Archaeocyatha is adopted for them. The alternative designations Cyathospongia and Pleospongia are unsuitable, because they suggest affinity with the Porifera.

CLASSIFICATION

The classification of archaeocyathids accepted here is modified from that proposed earlier by Okulitch (1943) so as to approach closely the arrangement of divisions advocated by Bedford & Bedford (1939), which is basically similar to the classification adopted by Vologdin (1937, 1940). The classification proposed by Simon (1939) is radically different. An outline of the suprageneric divisions recognized in the systematic descriptions of the phylum Archaeocyatha (placed in the subkingdom Parazoa) follows, with figures indicating the number of recognized genera in each.

Divisions of Archaeocyatha

- Monocyathea (class) (8). *L.Cam-M.Cam.*
  - Monocyathida (order) (6). *L.Cam.-M.Cam.*
    - Monocyathidae (4). *L.Cam.-M.Cam.*
    - Rhizacyathidae (2). *L.Cam.-M.Cam.*
  - Archaeophyllida (order) (2). *L.Cam.*
    - Archaeophyllidae (2). *L.Cam.*
- Archaeocyathea (class) (58). *L.Cam.-M.Cam.*
  - Ajacicyathida (order) (32). *L.Cam.-M.Cam.*
    - Ajacicyathidae (9). *L.Cam.-M.Cam.*
    - Dictyocyathidae (3). *L.Cam.-M.Cam.*
    - Bicyathidae (2). *M.Cam.*
    - Ethmophyllidae (10). *L.Cam.*
    - Coscinocyathidae (8). *L.Cam.-M.Cam.*
  - Metacyathida (order) (20). *L.Cam.-M.Cam.*
    - Archaeocyathidae (6). *L.Cam.-M.Cam.*
    - Pycnoidocyathidae (9). *L.Cam.-M.Cam.*
    - Metacoscinidae (5). *L.Cam.-M.Cam.*
  - Acanthinocyathida (order) (2). *L.Cam.*
    - Acanthinocyathidae (2). *L.Cam.*
  - Hetairacyathida (order) (1). *L.Cam.*
    - Radiocyathidae (1). *L.Cam.*
  - Syringocnemida (order) (3). *L.Cam.*
    - Syringocnemidae (3). *L.Cam.*
- Anthocyathea (class) (2). *L.Cam.*
  - Anthomorphida (order) (1). *L.Cam.*
    - Anthomorphidae (1). *L.Cam.*
  - Somphocyathida (order) (1). *L.Cam.*
    - Somphocyathidae (1). *L.Cam.*
- Classification uncertain (7). *Algonkian-M.Cam.*
- Archaeocyatha total (75). *L.Cam.-M.Cam.*

SYSTEMATIC DESCRIPTIONS

Phylum ARCHAEOCYATHA Vologdin, 1937

[as "subtype" of "type Porifera"; emend. as phylum, Ok. & deLaub., 1953]
[=Cyathospongia Ok., 1935; Pleospongia Ok., 1937]

Organisms characterized by a calcareous skeleton mostly of conical form, generally with concentric outer and inner walls separated by a space (intervallum) of uniform width containing radially disposed longitudinal partitions (parieties), associated in some with cross bars, platforms, vesicles and other accessory structures, but inner wall lacking in some genera and parieties variably developed; all or nearly all of the skeleton perforated by small or large pores, which may be so numerous and closely spaced as to leave little solid substance between them. *L.Cam.-M.Cam.*

Class MONOCYATHEA Okulitch, 1943

[*nom. correct.* OK., herein (*ex* Monocyatha OK., 1943)]

Conical to tubular forms with single laminar wall perforated by regularly or irregularly spaced pores, or with walls more or less spongy. *L.Cam.-M.Cam.*

Order MONOCYATHIDA Okulitch, 1935

[*nom. correct.* OK., herein (*ex* Monocyathina OK., 1935)]

Small Monocyathea (diameter 3 to 6 mm.) with numerous pores piercing the wall. *L.Cam.-M.Cam.*

Family MONOCYATHIDAE Bedford & Bedford, 1934

Conical steep-sided forms with numerous circular or oval pores which in some intersect the wall obliquely and may be canal-like. *L.Cam.-M.Cam.*

Monocyathus BEDF.-B., 1934 [**M. porosus*] [*?=Archaeolynthus* TAYLOR, 1910 (no species)]. Thin-walled cone perforated by large pores, resembling the olynthus stage of calcareous sponges. *L.Cam.*, S.Austral.——FIG. 7,*4*. **M. porosus;* ×4 (6).

Rhabdocnema OK., 1937[*pro Rhabdocyathus* TOLL, 1899 (*non* BROOKS, 1893)] [**Rhabdocyathus sibiricus* TOLL, 1899]. Small elongate conical to cylindrical forms, walls pierced by canal-like pores that may become narrow radially disposed tubes. *L.Cam.-M.Cam.*, Asia-Austral.——FIG. 7,*2*. *R. solidimurus* (VOL.), Asia; *2a,b,* oblique long. and transv. secs., ×5 (12).

Rhabdocyathella VOL., 1937 [**R. beileyi*]. Wall pierced by oblique pores, lower part of cone filled with spongy tissue. *M.Cam.*, Asia.——FIG. 7,*3*. **R. beileyi,* transv. sec., ×6 (12).

?**Tunkia** BEDF.-B., 1936 [**T. incerta*]. Very small, relatively thick-walled, with minute oval pores. *L.Cam.*, S.Austral.——FIG. 7,*1*. **T. incerta;* ×6 (6).

Family RHIZACYATHIDAE Bedford & Bedford, 1939

Cylindrical, without central cavity, interior filled by anastomosing bars or vesicular tissue. *L.Cam.-M.Cam.*

Rhizacyathus BEDF.-B., 1939 [**Protopharetra radix* BEDF.-B., 1937]. Very small, seemingly without

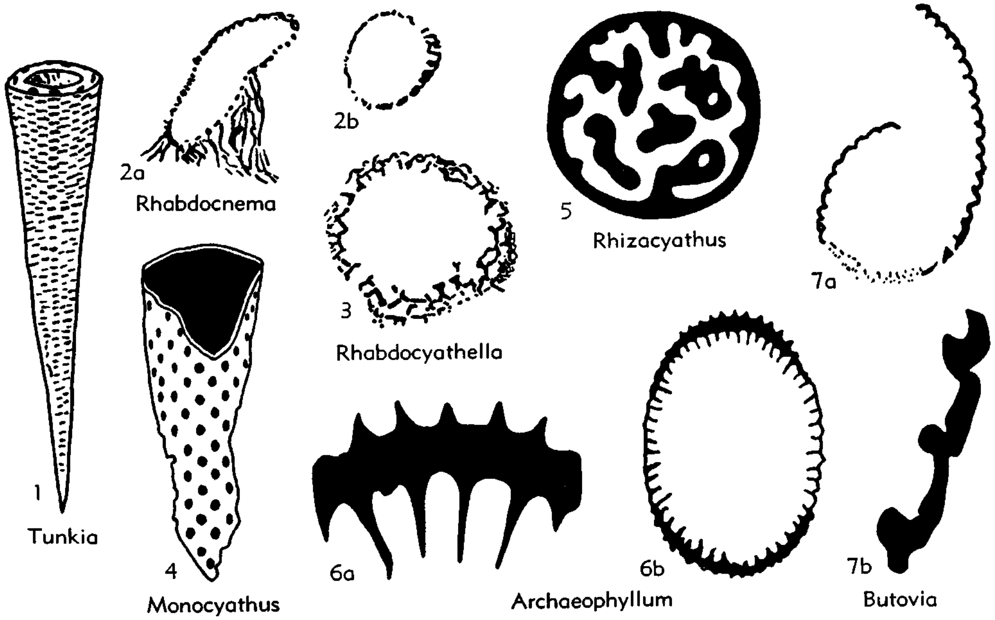

FIG. 7. Monocyathida, Archaeophyllida (p. E9-E10).

pores, filled by anastomosing flattened bars disposed obliquely or longitudinally. *L.Cam.*, S. Austral.——FIG. 7,*5*. **R. radix* (BEDF.-B.); transv. sec., ×8 (6).

Bačatocyathus VOL., 1940 [**B. kazakevici*]. Conical, interior filled by vesicles and supporting rods, wall with large pores (5). *M.Cam.*, Asia.

Order ARCHAEOPHYLLIDA Okulitch, 1943

[*nom. correct.* OK., herein (*ex* Archaeophyllina OK., 1943)]

Single-walled, with tabulae inside cups. *L.Cam.*

This group is included in the Monocyathea with reservations, because some characters indicate affinities with the Anthocyathea.

Family ARCHAEOPHYLLIDAE Vologdin, 1931

Conical or cornute, with external and internal vertical ribs; interior crossed by more or less regular thin tabulae, concave upward; wall may be porous. *L.Cam.*

Archaeophyllum VOL., 1931 [**A. edelsteini*]. Relatively thick-walled, internal ribs extended so as to resemble septa of corals and outer side marked by short vertical ribs. *L.Cam.*, Asia.——FIG. 7,*6*. **A. edelsteini*, Sib.; *6a,b*, transv. secs., ×14, ×2 (12).

Butovia VOL., 1931 [**B. serrata*]. Differs from *Archaeophyllum* in constant thickness of wall which bears gently rounded longitudinal corrugations instead of sharp ridges; wall imperforate. *L.Cam.*, Asia——FIG. 7,*7*. **B. serrata*, Sib.; *7a,b*, transv. secs., ×2, ×14 (12).

Class ARCHAEOCYATHEA Okulitch, 1943

[*nom. correct.* OK., herein (*ex* Archaeocyatha OK., 1943 (*non* VOL., 1937))]

Cup-, beaker-, or saucer-shaped, with 2 walls connected by radial parieties or a varyingly complex system of straight or curved bars and rods; horizontal tabulae present or absent; all structural elements perforated by pores. Spitzes mostly like those of Monocyathea, suggesting a common origin. *L.Cam.-M.Cam.*

This class contains all typical Archaeocyatha. Orders are defined on the basis of wall structure and, to some extent, nature of the spitz.

Order AJACICYATHIDA Bedford & Bedford, 1939

[*nom. correct.* OK., herein (*ex* Ajacicyathina BEDF.-B., 1939)] [=Archaeocyatha regularia VOL., 1931]

Inner and outer walls perforate, complete, joined by simple radial parieties; inner cavity distinct; spitz comprising a simple conical tube joined to outer wall by radial rods or perforate plates. *L.Cam.-M.Cam.*

Family AJACICYATHIDAE Bedford & Bedford, 1939

Cups slender cone- to expanded saucer-shaped; walls and parieties simple, tabulae lacking. The family contains no forms with specialized or complex structures. *L.Cam.-M.Cam.*

Ajacicyathus BEDF.-B., 1939 [**Archaeocyathus ajax* TAYLOR, 1910] [=*Ventriculocyathellus* VOL., 1931; *Archaeocyathellus* SIMON, 1939 (*non* FORD, 1873)]. Pores of both walls arranged in regular quincunx; inner walls with pores at line of each pariety and additional rows in each intercept; outer surface without vertical fluting (4). *L.Cam.*, N.Am.-Eu.-Asia-Austral.——FIG. 8,*9*. *A. nevadensis* (OK.), N.Am.; *9a,b*, transv. sec., restoration with part of outer wall removed, ×10 (7). Also Figs. 1, 6.

Archaeocyathellus FORD, 1873 (*non* SIMON, 1939) [**A. rensselaericus*] [=*Protocyathus* FORD, 1878]. Generally small, regularly conical or turbinate, with sharp distinct spitz of *Ajacicyathus* type; parieties simple, imperforate or rarely perforate; outer wall longitudinally furrowed, both inner and outer walls perforate (2). *L.Cam.*, N.Am.-Eu.-Asia-Austral.——FIG. 8,*1*. *A. floreus* (BEDF.-B.), Austral.; transv. sec., ×4 (6). Also Fig. 3.

Densocyathus VOL., 1937 [**D. sanaschtycolensis*]. Compound, consisting of simple *Ajacicyathus*-type cups joined together. *M.Cam.*, Sib.——FIG. 8,*6*. **D. sanaschtycolensis*; transv. sec., ×5 (12).

Nevadacyathus OK., 1943 [**Archaeocyathus septaporus* OK., 1935]. Differs from other genera of family in having very large pores in parieties, area of pores being equal to that of solid matter or greater. Intermediate between *Ajacicyathus* and Dictyocyathidae (2). *L.Cam.*, Nev.——FIG. 8,*10*. **N. septaporus* (OK.); restoration with part of outer wall removed, ×15 (7).

Orbicyathus VOL., 1937 [**O. mongolicus*]. Both walls strongly crenulate transversely but width of intervallum constant. *M.Cam.*, Asia.——FIG. 8,*3*. **O. mongolicus*, Mongolia; restoration, ×3 (12).

Pluralicyathus OK., 1950 [*pro Polycyathus* VOL., 1928 (*non* DUNCAN, 1876)] [**Polycyathus heterovallum* VOL., 1928]. Colonial, with common outer wall but several distinct central cavities, probably formed by lateral budding; pores of outer wall branch into several passageways; inner wall simple, relatively thick. *M.Cam.*, Asia.——FIG. 8,*2*. *P. heterovallum (VOL.), restoration, ×2 (11).

Septocyathus VOL., 1937 [*S. pedaschenkoi] [?=*Ajacicyathus* BEDF.-B., 1939]. Regular cup differing from other Ajacicyathidae in its much-thickened outer wall and peripheral parts of parieties. *M.Cam.*, Asia.——FIG. 8,*11*. *S. pedaschenkoi, Sib.; transv. sec., ×6 (12).

Tumulocyathus VOL., 1937 [*T. pustulatus]. Outer wall with vesicular protuberances which mask pore openings; parieties simple, radial; inner wall simple, perforate. *M.Cam.*, Sib.——FIG. 8,*8*. *T. admirabilis* VOL., *8a,b*, transv. and long. secs., ×5 (12).

Urcyathus VOL., 1940 [*U. asteroides]. Regular cup with longitudinally crenulate inner wall. *M.Cam.*, Asia.——FIG. 8,*5*. *U. asteroides, transv. sec., ×6 (12).

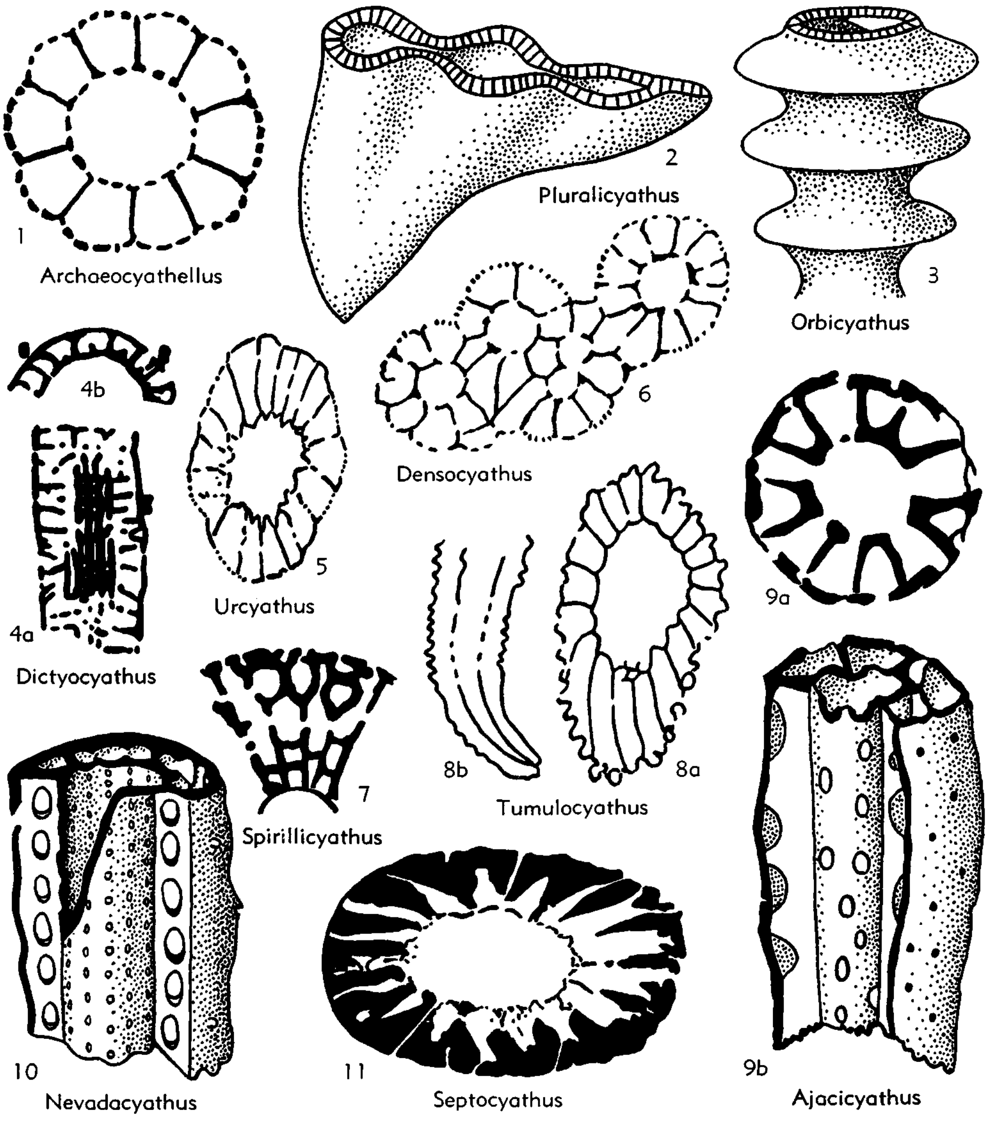

FIG. 8. Ajacicyathida: Ajacicyathidae, Dictyocyathidae (p. E10-E12).

Family DICTYOCYATHIDAE Taylor, 1910

Perforate lamellar parieties replaced by horizontal or inclined bars or rods and with synapticulae in some forms; spitzes like those of Ajacicyathidae. *L.Cam.-M.Cam.*

Dictyocyathus Born., 1891 [**D. tenerimus*] [=*Alphacyathus* Bedf.-B., 1939]. Cup with finely porous outer wall and sievelike coarsely porous inner wall; intervallum without continuous parieties, the walls being connected by a very delicate scaffolding of cylindrical bars. *L.Cam.-M.Cam.*, Eu.-Asia-Austral.——Fig. 8,*4*. *D. simplex* Taylor, *L.Cam.*, Austral.; *4a,b*, long. and transv. secs., ×4 (9).

Dokidocyathus Taylor, 1910 [**D. simplicissimus*]. Differs from *Dictyocyathus* in having flattened connecting bars between walls (4). *L.Cam.*, Austral.

Spirillicyathus Bedf.-B., 1937 [**S. tenuis*] [=*Spiralicyathus* Bedf.-B., 1937]. Differs from other Dictyocyathidae in having parieties constructed of radial and longitudinal bars connected by tangential rods or synapticulae; near outer wall the parieties commonly anastomose. *L.Cam.*, Austral.——Fig. 8,*7*. **S. tenuis;* part of transv. sec., ×8 (6).

Family BICYATHIDAE Vologdin, 1933

Cups consisting essentially of concentric porous walls, without parieties or tabulae but having vesicles in some. *M.Cam.*

Bicyathus Vol., 1933 [**B. ertaschkensis*]. Intervallum containing some very delicate vesicles (5). *M.Cam.*, Asia.——Fig. 9,*6*. **B. ertaschkensis,* Sib.; transv. sec., ×5 (12).

Vacuocyathus Ok., 1950 [*pro Coelocyathus* Vol., 1933 (*non* Sars, 1857)] [**Coelocyathus kidrjassovensis* Vol., 1933]. Outer wall commonly covered by a thin pellis; intervallum empty, without parieties, radial rods, or tabulae (5). *M.Cam.*, S. Ural-N.Caucasus.——Fig. 9,*5*. **V. kidrjassovensis* (Vol.), Urals; transv. sec., ×3 (12).

Family ETHMOPHYLLIDAE Okulitch, 1943

Outer wall and parieties simple, perforate; chiefly distinguished by complex inner wall, which appears in cross section as a single row of vesicles *(Ethmophyllum)* or a vesiculose band thickened to width of intervallum *(Tercyathus)*; spitz like that of *Ajacicyathus*. *L.Cam.*

Ethmophyllum Meek, 1868 [**E. whitney*] [=*Beltanacyathus* Bedf.-B., 1936; *Zonacyathus* Bedf.-B., 1937; *?Leptosocyathus* Vol., 1937]. Inner wall consisting of 1 or 2 rows of vesicles perforated by oblique canals. *L.Cam.*, N.Am.-Eu.-Asia-Austral.——Fig. 9,*2*. **E. whitneyi,* Nev.; part of transv. sec., ×10 (7) Also Fig. 4*A*.

Ethmocyathus Bedf.-B., 1934 [**E. lineatus*] Differs from other Ethmophyllidae in having inner wall in form of regular honeycomb of diagonally arranged small square cells which are produced by fusion of wavy edges of the parieties; inner face of inner wall crossed by fine grating of minute horizontal annular bars. *L.Cam.*, Austral.——Fig. 9,*1*. **E. lineatus; 1a,* side, ×2; *1b,* part of transv. sec., ×8 (6).

Ethmocoscinus Simon, 1939 [**Coscinocyathus papillipora* Bedf.-B., 1934]. Inner wall as in *Ethmophyllum,* outer wall simple or modified sievelike; intervallum with both parieties and tabulae, as in *Coscinocyathus* (3). *L.Cam.*, Austral.——Fig. 9,*3*. **E. papillipora* (Bedf.-B.); transv. sec., ×1 (6).

Thalamocyathus Gordon, 1920 [**Archaeocyathus trachealis* Taylor, 1910; SD Simon, 1939] [=*Cyclocyathus* Vol., 1931; *Bronchocyathus* Bedf.-B., 1936]. Outer wall finely porous, parieties thin and numerous; inner wall characterized by horizontal annular shelves or rings and various minor structures projecting into central cavity. *L.Cam.*, Eu.-Asia-Austral.-Antarct.——Fig. 9,*4a*. **T. yakovlevi* (Vol.), Sib.; transv. sec. of inner wall, ×15 (8).

Cadniacyathus Bedf.-B., 1937 [**C. asperatus*]. Outer surface vertically fluted, furrows corresponding to position of parieties; inner wall with scalelike hooks projecting upward and inward into central cavity. *L.Cam.*, Austral.——Fig. 9,*8*. **C. asperatus;* part of transv. sec., ×4 (6).

Annulocyathus Vol., 1940 [**A. pulcher*]. Differs from *Thalamocyathus* in having outer wall composed of horizontal lamellae (bractae) with slitlike pores, the lamellae being bent uniformly longitudinally so as to resemble superposed inverted V's (5). *M.Cam.*, Sib.——Fig. 9,*7*. **A. pulcher; 7a,b,* transv. and long. secs., ×5 (12).

Clathrocyathus Vol., 1932 [**C. firmus*]. Like *Ethmophyllum* but has outer wall composed of horizontal massive lamellae (tabellae) united by thin vertical lamellae, making a fine grillwork. *M.Cam.*, Sib.

Tercyathus Vol., 1932 [**T. duplex*]. Like *Clathrocyathus* and *Ethmophyllum* but inner wall very complex, consisting of a vesicular zone that may attain width of the intervallum; parieties numerous. *M.Cam.*, Sib.——Fig. 9,*9*. *T. altaicus* Vol.; part of transv. sec., ×10 (7). Also Fig. 4*B*.

Leptosocyathus Vol., 1937 [**L. curviseptum*] [=*Leptocyathus* Vol., 1937]. Regular wall and parieties but inner wall composed of scalelike plates. *M.Cam.*, Asia.

Sajanocyathus Vol., 1937 [**S. ussovi*]. Like *Ethmophyllum* but colonial, with budding by longitudinal invagination of both walls, thus dividing the central cavity. *M.Cam.*, Sib.——Fig. 9,*10*. **S. ussovi,* transv. sec., ×5 (12).

Family COSCINOCYATHIDAE Taylor, 1910

Distinguished from other Ajacicyathida by perforate horizontal or arched tabulae that cross intervallum but not central cavity; spitzes of *Ajacicyathus* type. *L.Cam.-M.Cam.*

Coscinocyathus Born., 1884 [**C. tuba;* SD Ting, 1937] [=*Coscinoptycha* Taylor, 1910; *Tuvacyathus* Vol., 1937]. Turbinate, open saucer-shaped, or subcylindrical, with normal walls and radial parieties; intervallum crossed by horizontal or curved perforate tabulae. *L.Cam.-M.Cam.*, cosmop. ——Fig. 10,*3*. *C. cornucopiae* Born., *M.Cam.*, Sardinia; *3a,b,* long. and transv. secs., ×3 (7).

Coscinocyathellus Vol., 1937 [**C. parvus*] [=*Formosocyathus* Vol., 1937; *Ethmocoscinus* Simon, 1939]. Inner wall like that of *Ethmophyllum* (5). *M.Cam.*, Sib.

Carinacyathus Vol., 1932 [**C. loculatus*] [=*Stillicidocyathus* Ting, 1937; *Salairocyathus* Vol., 1940; *Sigmocyathus* Bedf.-B., 1936]. Inner wall with horizontal annular shelves and rings, as in *Thalamocyathus* (5). *M.Cam.*, Sib.——Fig. 10,*4*. **C. loculatus; 4a,b,* transv. and long. secs. of part of intervallum, ×10 (12).

Dictyocoscinus Bedf.-B., 1936 [**D. beltanum*]. Intervallum with open meshwork like that of *Dic-*

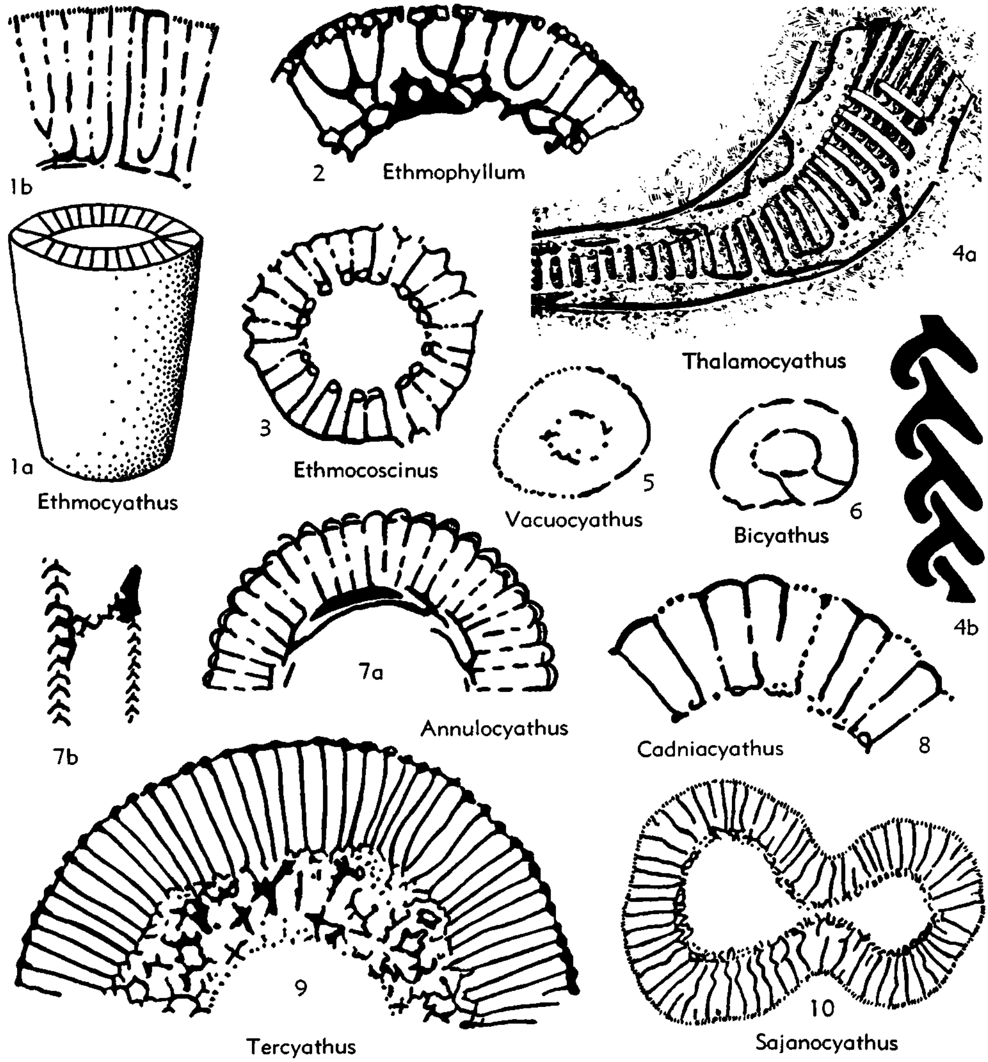

Fig. 9. Ajacicyathida: Bicyathidae, Ethmophyllidae (p. E12).

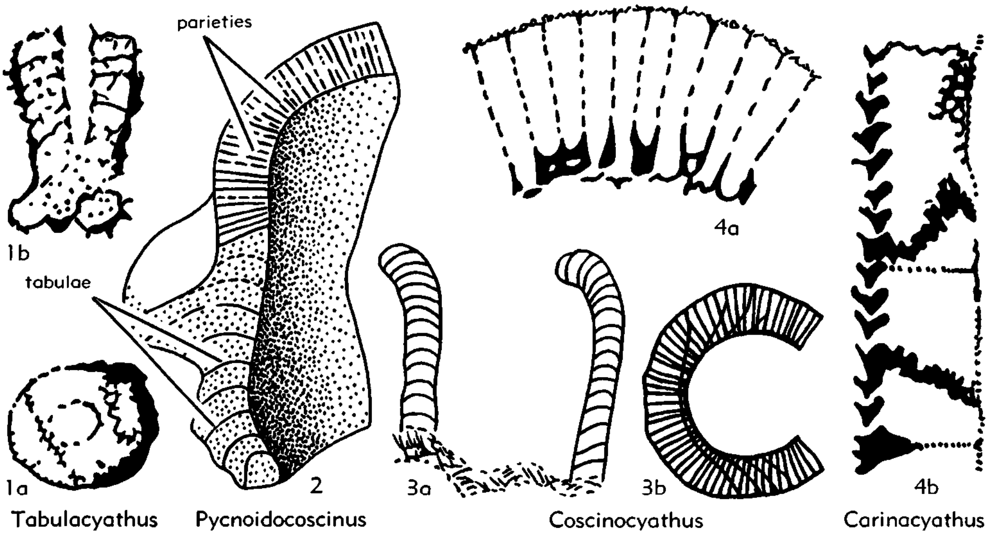

Fig. 10. Ajacicyathida: Coscinocyathidae (p. E13-E14).

tyocyathus, horizontal sieve-plates at intervals forming a tabular structure as in *Coscinocyathus. L.Cam.,* Austral.

Polycoscinus Bedf.-B., 1937 [**P. contortum*] [?= *Coscinocyathus* Born., 1884] Like *Coscinocyathus* but colonial, with branching, meandering walls. *L.Cam.,* Austral.

Pycnoidocoscinus Bedf.-B., 1936 [**P. pycnoideum*]. Outer wall with prominent annulations as in *Pycnoidocyathus;* tabulae numerous, arched, consisting of an irregular fine mesh; inner wall with regular vertical rows of rectangular pores subdivided by vertical rods in middle of intercepts. *L.Cam.,* Austral.——Fig. 10,2. **P. pycnoideum;* part of walls and intervallum, ×1 (6).

Tabulacyathus Vol., 1932 [**T. taylori*] [=*Tabulocyathus* Vol., 1937; *Putapacyathus* Bedf.-B., 1936]. Walls ridged, regularly porous, with perforate tabulae; parieties absent. *L.Cam.-M.Cam.,* Austral.-Sib.——Fig. 10,*1*. **T. taylori, M.Cam.,* Siberia; *1a,b,* transv. and long. secs., ×8 (12).

Asterocyathus Vol., 1940 [**Coscinocyathus dentatus* Vol., 1938] [*?=Coscinocyathus* Born., 1884]. Differs from *Coscinocyathus* in having a longitudinally crenulate inner wall (5). *M.Cam.,* Mongolia-Sib.

Order METACYATHIDA Bedford & Bedford, 1936

[*nom. correct.* Ok., herein (*ex* Metacyathina Bedf.-B., 1936)]

Archaeocyathea with 2 perforate walls and intervallum filled commonly by irregular parieties, taeniae, synapticulae, and dissepiments; inner cavity partly filled by vesicular or trabecular tissue; spitz of *Archaeopharetra* type, beginning as a small conical tube with transverse partitions and additional parts of skeleton developed from these until entire cone is filled by trabecular and dissepimental tissue; upper, adult parts of cup more regular, with distinct inner wall, parieties, central cavity, and outer wall developed in some. *L.Cam.-M.Cam.*

Family ARCHAEOCYATHIDAE Taylor, 1910

[=Spirocyathidae Taylor, 1910; Metacyathidae Bedf.-B., 1934; Flindersicyathidae Bedf.-B., 1937]

Walls connected by porous taeniae, vesicular tissue, or very irregular parieties; lower part of central cavity may be filled by vesicles. *L.Cam.-M.Cam.*

Archaeocyathus Bill., 1861 [**A. atlanticus*] [=*Spirocyathus* Hinde, 1889; *Retecyathus* Vol., 1932; *Flindersicyathus* Bedf.-B., 1937; *?Protopharetra* Born., 1884]. Walls subcylindrical or steeply conical, with intervallum filled by vesicles and curved taeniae. *L.Cam.,* cosmop.——Fig. 11,*10*. **A. atlanticus; 10a,b,* transv. and long. secs., ×1 (7).

Araneocyathus Vol., 1937 [**A. ratschkovskyi;* SD Ok., herein]. Nonporous taeniae and vesicles in intervallum and also in central cavity of some. *L.Cam.,* Sib.

Archaeopharetra Bedf.-B., 1936 [**A. typica*]. Small tubular forms with interior filled by irregular trabecular and dissepimental tissue, without defined inner wall or central cavity. Possibly nepionic Metacyathida. *L.Cam.*, Austral.——Fig. 11, *4*. **A. typica*; *4a,b*, side view with part of outer wall removed, transv. sec., ×8 (6).

Copleicyathus Bedf.-B., 1937 [**C. confertus*]. Differs from other Archaeocyathidae in having thickened inner wall of felted anastomosing rods; outer wall of normal perforate type; parieties numerous, irregular, commonly curved to join neighbors, their many pores producing a netlike structure. *L.Cam.*, N.Am.-Austral.——Fig. 11,*9*. **C. confertus*, Austral.; part of transv. sec., ×8 (6).

Fig. 11. Metacyathida: Archaeocyathidae, Pycnoidocyathidae (p. E14-E16).

Metaldetes Taylor, 1910 [*_M. cylindricus_] [=_Metacyathus_ Bedf.-B., 1934]. Growing from spitz of _Archaeopharetra_ type; intervallum filled by parietal and trabecular tissue complicated by dissepiments in upper part of cup; parieties and taeniae generally porous. Differs from _Archaeocyathus_ in more regular development of parieties (4). _L.Cam.,_ N.Am.-Eu.-Asia-Austral.——Fig. 11,_6_. *_M. cylindricus;_ transv. sec., ×5 (8).

Protopharetra Born., 1884 [*_P. polymorpha;_ SD Simon, 1939]. Cylindrical to irregular forms with intervallum filled by curved bars, taeniae, and flattened fibers that build a mass of vesicular tissue; inner wall indistinct; central cavity very narrow, in some filled by vesicles so that inner wall is undefinable; spitz of _Archaeopharetra_ type. _L.Cam.-M.Cam.,_ cosmop.——Fig. 11,_3_. *_P. polymorpha;_ transv. sec., ×5 (7).

Family PYCNOIDOCYATHIDAE Okulitch, 1950

[=Cambrocyathidae Ok., 1937]

Walls connected by perforate radial parieties with abundant synapticulae; outer wall may be crenulate; irregular spitz of _Archaeophraretra_ type. _L.Cam.-M.Cam._

Pycnoidocyathus Taylor, 1910 [*_P. synapticulosus_] [=_Cambrocyathus_ Ok., 1937]. Subcylindrical or conical, outer wall with deep transverse annulations; parieties partly well defined, radial, and partly wavy, passing into trabecular tissue within the bulges, all more or less synapticulate; dissepiments in some species; inner wall simple, perforated by pores or large canals (2, 4). _L.Cam.,_ cosmop.

P. (Pycnoidocyathus).——Fig. 11,_5_. *_P. (P.) synapticulosus,_ Austral.; _5a,b,_ part of transv. sec., ×0.75; _5b,_ side view, ×0.5 (7).

P. (Archaeofungia) Taylor, 1910 [*_A. ajax_] [=_Metafungia_ Bedf.-B., 1934; _Sibirecyathus_ Vol., 1937]. Small cylindrical or conical forms without annulations, characterized by strong development of synapticulae; central cavity rather narrow (4). _L.Cam.-M.Cam.,_ Austral.-Sib.-B.C.

Ardrossacyathus Bedf.-B., 1937 [*_A. endotheca_]. Outer wall irregular, parieties with dissepiments, inner wall porous; central cavity filled by endothecal tissue in form of curved irregular sheets. _L.Cam.,_ Austral.——Fig. 11,_8_. *_A. endotheca;_ part of transv. sec., ×8 (6).

Dendrocyathus Ok. & Roots, 1947 [*_D. unexpectans (sic)_]. Complex parieties branching dendritically in their course from inner to outer wall and connected by synapticulae or taeniae. _L.Cam.,_ B.C.——Fig. 11,_1_. *_D. unexpectans,_ transv. sec., ×3 (7).

Echinocyathus Term.-T., 1950 [*_E. goundafensis_]. Outer wall with tubercles and spines, parieties with synapticulae. _L.Cam.,_ N.Afr.——Fig. 11, _2_. *_E. goundafensis;_ transv. sec., ×1 (10).

Loculicyathus Vol., 1931 [*_Coscinocyathus irregularis_ Toll., 1899] [=_Loculocyathus_ Vol., 1937]. Delicate vesicular tissue in intervallum and central cavity. _L.Cam.-M.Cam.,_ Sib.——Fig. 11,_7_. *_L. irregularis;_ oblique long. sec., ×3 (11).

Metethmophyllum Ok., 1943 [*_Ethmophyllum meeki_ Walc., 1891]. Complex inner wall of _Ethmophyllum_ type, parieties with dissepiments or synapticulae (2). _L.Cam.,_ N.Am.——Fig. 12, _5_. *_M. meeki_ (Walc.); transv. sec., ×2 (7).

Paranacyathus Bedf.-B., 1937 [_pro Paracyathus_ Bedf.-B., 1936 (_non_ Edw.-H., 1848)] [*_Paracyathus parvus_ Bedf.-B., 1936] [=_Spirocyathella_ Vol., 1940]. Small to medium conical cups, base without inner wall or parieties, filled by irregular trabecular tissue; radial parieties, inner wall, and central cavity become defined shortly above base; dissepiments may occur; pores small and irregular near base but large and regularly arranged higher up. _L.Cam.-M.Cam.,_ Austral.-S. Urals.——Fig. 12, _6_. *_P. parvus_ (Bedf.-B.), _L.Cam.,_ Austral.; _6a,b,_ transv. secs. of upper and lower parts, ×8 (6).

Sigmocyathus Bedf.-B., 1936 [*_Coscinocyathus didymoteichus_ Taylor, 1910] [=_Hemistillicidocyathus_ Ting, 1937]. Large turbinate cups with many straight parieties, without synapticulae or tabulae; inner wall or both walls with continuous annular sigmoidally curved plates; growth from an irregular base of trabeculae and vesicular tissue that fills central cavity and obliterates parieties. _L.Cam.,_ cosmop.——Fig. 12,_4_. *_S. didymoteichus_ (Taylor); _4a,_ part of transv. sec., ×4; _4b,_ surface of pariety, ×8 (9).

Sigmofungia Bedf.-B., 1936 [*_S. flindersi_] Cylindrical, with well-defined radial parieties which may be somewhat irregular, with numerous synapticulae; pores of inner wall in vertical rows, each pore being separated from adjoining ones in row by a sigmoidally curved plate. _L.Cam.,_ Austral.——Fig. 12,_1_. *_S. flindersi; 1a,b,_ transv. sec. and detail of inner wall, ×4 (6).

Family METACOSCINIDAE Bedford & Bedford, 1936

Metacyathida distinguished by horizontal or arched tabulae; spitz of _Archaeopharetra_ type. The family parallels the Coscinocyathidae among Ajacicyathida. _L.Cam.-M.Cam._

Metacoscinus Bedf.-B., 1934 [*_M. reteseptatum_]. Upper part of cup with straight netlike parieties but lower part with irregular parieties and filled with vesicles; tabulae present. _L.Cam.,_ Austral.——Fig. 12,_3_. *_M. reteseptatum; 3a,_ transv. sec. of upper part showing parieties and tabula; _3b,_ transv. sec. of lower part; _3c,_ long. sec. of pariety; all ×4 (6).

Altaicyathus Vol., 1932 [*_A. notabilis_]. Differs from _Claruscyathus_ in having vertical pillars beneath the tabulae. _M.Cam.,_ Sib.-Mongolia.

Archaeosycon Taylor, 1910 [*_Archaeocyathus bil-_

lingsi Walc., 1886] [=?*Altaicyathus* Vol., 1932; *Aptocyathus* Vol., 1937]. Cylindrical, intervallum wide, with rudimentary or irregular parieties and strongly developed arched perforate tabulae. *L.Cam.-M.Cam.*, N.Am.-Sib. (4).——Fig. 12,7. **A. billingsi* (Walc.), *L.Cam.*, N.Am.; long. sec., ×2 (9).

Claruscyathus Vol., 1932 [**C. cumfundus*] [=*Eucyathus* Vol., 1937]. General structure like that of *Archaeocyathus* but has upwardly convex tabulae. *L.Cam.-M.Cam.*, Sib.-Antarct.——Fig. 12, 2. *C. solidus* (Vol.), *M.Cam.*, Sib.; transv. sec. ×5 (12).

Paracoscinus Bedf.-B., 1936 [**P. mirabile*]. Cup developed from an irregular base; parieties clearly defined, with closely set curved tabulae. *L.Cam.*, Austral.

Order ACANTHINOCYATHIDA Okulitch, 1935

[*nom. correct.* Ok., herein (*ex* Acanthocyathina Ok., 1935)]

Walls and parieties formed by a network of curved bars or fused spicular elements. *L.Cam.*

Family ACANTHINOCYATHIDAE Bedford & Bedford, 1934

Outer wall composed of fused spicular elements inclosing large open spaces and inner wall comprising an open simple polygonal net; walls united by a very

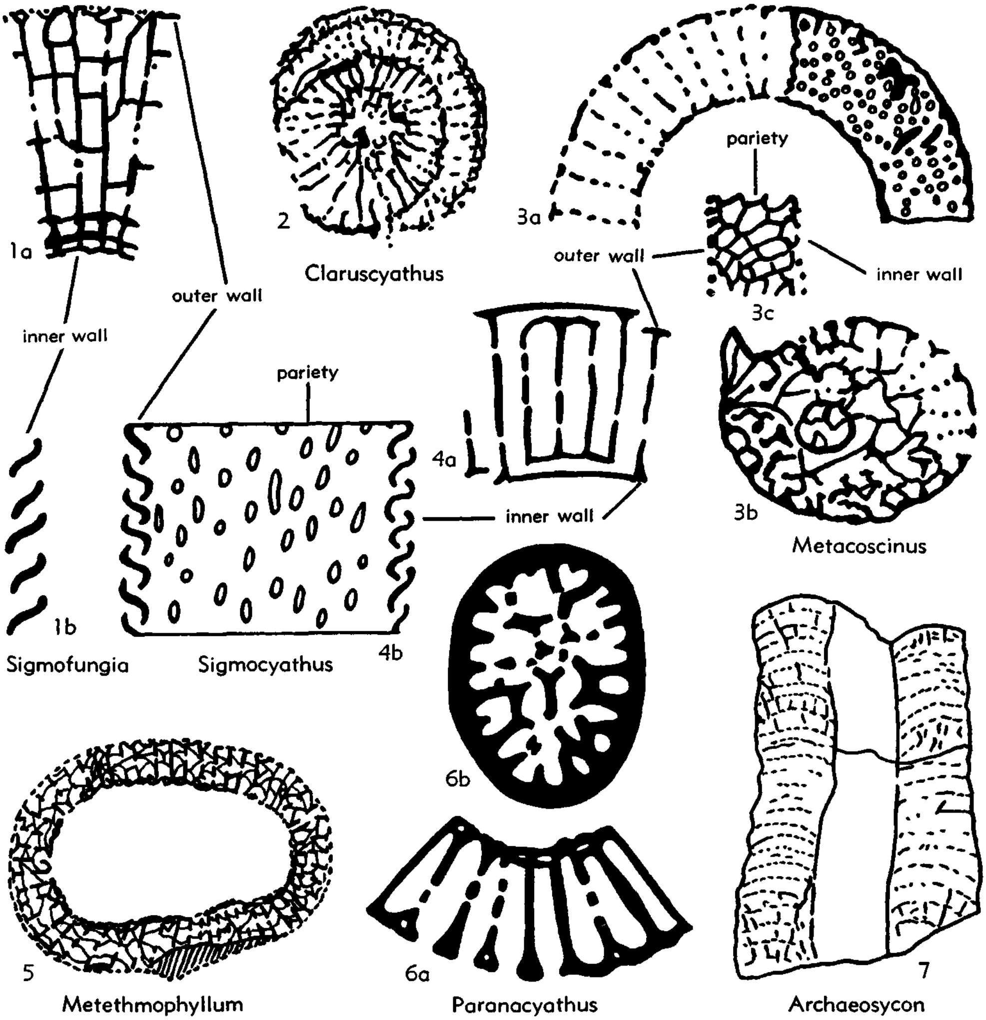

Fig. 12. Metacyathida: Pycnoidocyathidae, Metacoscinidae (p. E16-E17).

scanty framework of delicate radial rods. *L.Cam.*

Acanthinocyathus Bedf.-B., 1936 [*pro Acanthocyathus* Bedf.-B., 1934 (*non* Edw.-H., 1848)] [**Acanthocyathus apertus* Bedf.-B., 1934]. Conical cups with walls of fused spicular elements. *L.Cam.,* Austral.——Fig. 13,*1*. **A. apertus* (Bedf.-B.); *1a,* outer wall; *1b,* long. sec. tangent to inner wall, ×2 (6).

Pinacocyathus Bedf.-B., 1934 [**P. spicularis*]. Differs from *Acanthinocyathus* in the pattern of wall elements. *L.Cam.,* Austral.

Order HETAIRACYATHIDA Okulitch, 1943

[*nom. correct.* Ok., herein (*ex* Hetairacyathina Ok., 1943)]

Walls sheathlike, strengthened by radiating spicule-like structures; probably aberrant Archaeocyathea. *L.Cam.*

Family RADIOCYATHIDAE Okulitch, 1937

[=Hetairacyathidae Bedf.-B., 1934]

Thin perforate outer and inner walls, strengthened on intervallum side by radiating spicules distally joined to adjacent spicules. Some of the radiate skeletal elements resemble the rodlike parieties of the Acanthinocyathidae and Dictyocyathidae. *L.Cam.*

Radiocyathus Ok., 1937 [*pro Heterocyathus* Bedf.-B., 1934 (*non* Edw.-H., 1849)] [**Hetairacyathus minor* Bedf.-B., 1937] [=*Hetairacyathus* Bedf.-B., 1937]. Both walls with series of straight or curved lines of tubercles or spicules radiating from centers several mm. apart; a connecting rod passes inward from each center to the inner wall. *L.Cam.,* Austral.——Fig. 13,*2*. **R. minor* (Bedf.-B.); *2a,* transv. sec. of part of intervallum; *2b,* exterior of outer wall, ×4 (6).

Order SYRINGOCNEMIDA Okulitch, 1935

[*nom. correct.* Ok., herein (*ex* Syringocnemina Ok., 1935)]

Intervallum containing radial or inclined cells or pipes. *L.Cam.*

Family SYRINGOCNEMATIDAE Taylor, 1910

[*nom. correct.* Ok., herein (*ex* Syringocnemidae Taylor, 1910)]

Regular cups with 2 porous walls; intervallum filled by porous lamellae arranged to form a system of radial or oblique prismatic cells, pipes, or tubes. *L.Cam.*

Syringocnema Taylor, 1910 [**S. favus*] [=*Beticocyathus* Simon, 1939]. Walls inclosing central cavity, intervallum occupied by horizontal radial cells with perforate 6-sided walls (4). *L.Cam-M.Cam.,* N.Am.-Asia-Austral.——Fig. 13,*5*. **S. favus, L.Cam.,* Austral.; *5a,* reconstruction, ×0.75; *5c,* transv. and long. secs., ×4 (9).

Syringocyathus Vol., 1937 [**S. aspectabilis* Vol., 1940]. Intervallum occupied by prismatic loculae oriented at acute angles to central axis. *L.Cam.-M.Cam.,* N.Am.-Asia.——Fig. 13,*4*. **S. aspectabilis* Vol., *M.Cam.,* Asia; transv. sec., ×6 (12).

Tubocyathus Vol., 1937 [**T. smolianinovae*]. Intervallum with anastomosing porous laminae which form a system of radial polygonal loculae; vesicular tissue present also (5). *M.Cam.,* Asia. ——Fig. 13,*3*. **T. smolianinovae;* transv. sec., ×5 (12).

Class ANTHOCYATHEA Okulitch, 1943

[*nom. correct.* Ok., herein (*ex* Anthocyatha Ok., 1943)]

Conical cups with perforate or imperforate skeleton superficially resembling anthozoans; inner cavity filled with skeletal tissue which is far more regular and persistent than in Metacyathida; radial parieties distinct. *L.Cam.*

These fossils are interpreted as an aberrant branch of the Archaeocyatha which separated early from the rest and left no descendants. Although some authors regard them as ancestral to corals, it is probable that the group is entirely independent and unrelated to Anthozoa. If this is true, resemblance to the corals merely denotes convergence. Lack of pores and filling of the central cavity with skeletal tissue necessarily demand a considerably different mode of procuring nourishment from that of other Archaeocyatha.

Order ANTHOMORPHIDA Okulitch, 1935

[*nom. correct.* Ok., herein (*ex* Anthomorphina Ok., 1935)]

Outer wall and parieties imperforate; central cavity partly filled with vesicular tissue. *L.Cam.*

Family ANTHOMORPHIDAE Okulitch, 1935

Characters of order. *L.Cam.*

Anthomorpha Born., 1884 [**A. margarita*]. Strong radial parieties united by irregular dissepiments; central cavity vesicular in its lower part and open in upper part. *L.Cam.*, Eu.-Austral.——Fig. 13,*7*. **A. margarita,* Austral.; transv. sec., ×4 (9).

Order SOMPHOCYATHIDA Okulitch, 1943

[*nom. correct.* Ok., herein (*ex* Somphocyathina Ok., 1943)]

Central cavity filled by dense skeletal tissue resembling a spongy columella, skeleton perforate. *L.Cam.*

Family SOMPHOCYATHIDAE Okulitch, 1935

Characters of order. *L.Cam.*

Somphocyathus Taylor, 1910 [**S. coralloides*]. Small conical cups with outer and inner walls pierced by large remote pores and united by remote straight parieties; central cavity occupied by dense skeletal tissue containing numerous tubular canals (4). *L.Cam.*, Austral.——Fig. 13,*6*. **S. coralloides*; transv. sec., ×6 (9).

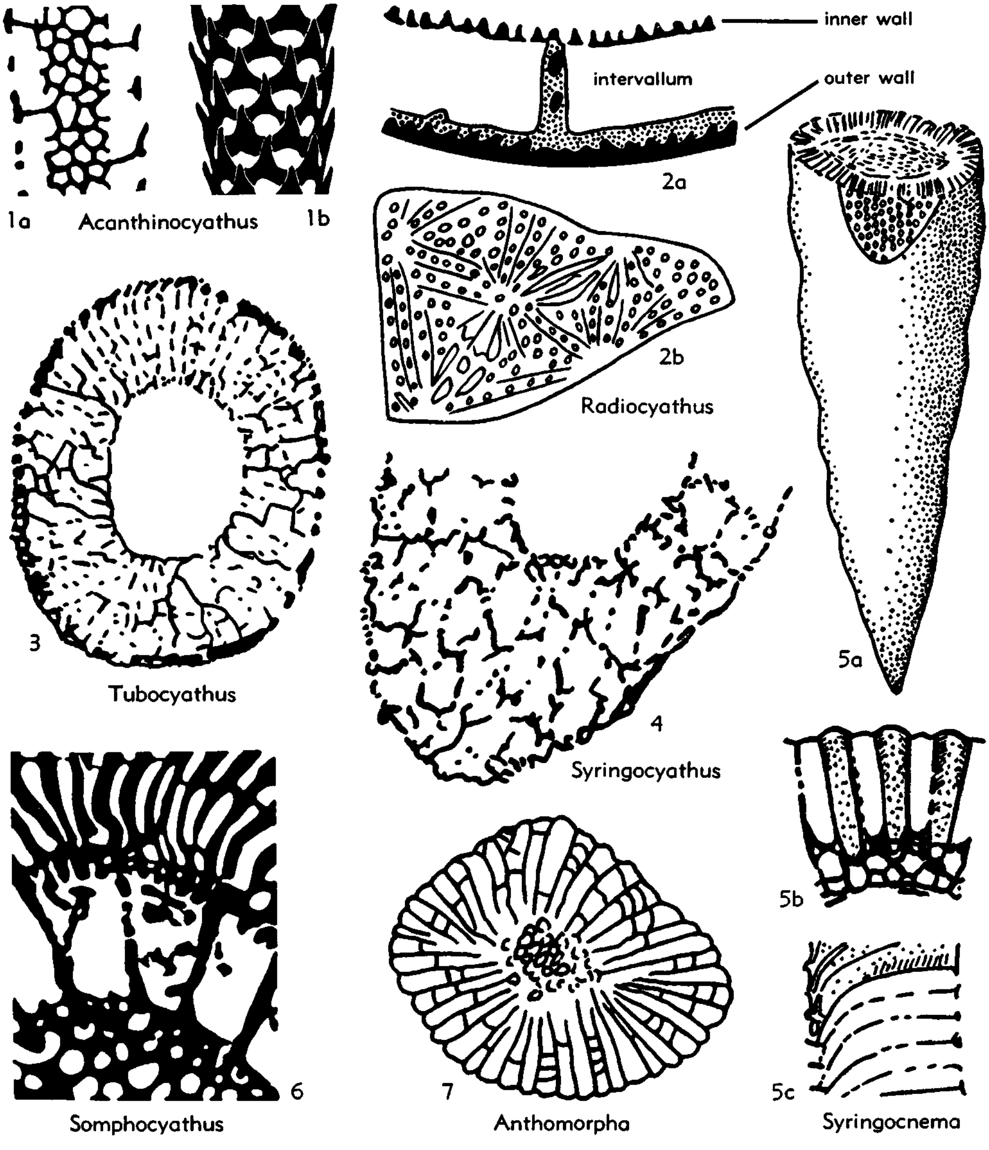

Fig. 13. Acanthocyathida, Hetairacyathida, Syringocnemida, Anthomorphida, Somphocyathida (p. E18-E19).

CLASSIFICATION UNCERTAIN

The following genera have been included by some authors in the Archaeocyatha. Their relationship with this group is very uncertain, either because of poor preservation of the known specimens or because of considerable differences in observed skeletal structure.

Atikokania WALC., 1912, *Archean,* Steeprock Lake Series, Can.
Haguia WALC., 1899. *M.Cam.,* NW.Wyo.
Matthewcyathus OK., *M.Cam.,* N.B., Can.
Trachyum BILL., *Ord.,* Newf.
Uranosphaera BEDF.-B., 1934, *L.Cam.,* Austral.
Wilbernicyathus WILSON, 1950. *U.Cam.,* Tex.
Yakovlevia VOL., 1931, *L.Cam.-M.Cam.,* Sib.

INVALID GENERA

Fossils named *Exocyathus* BEDF.-B., *Metaldetimorpha* BEDF.-B., *Labyrinthomorpha* VOL., and *Tercia* VOL., were originally described as independent genera and OKULITCH (1943) assigned them to a subclass called Exocyatha. After restudy of the group, OKULITCH (1946) concluded that its members were not independent zoologic entities but represented merely exothecal outgrowths of regular Archaeocyatha. Therefore, they are not now regarded as valid genera.

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(7) **Okulitch, V. J.**
(8) **Simon, W.**
(9) **Taylor, T. G.**
(10) **Termier, H., & Termier, G.**
(11) **Toll, E. von**
(12) **Vologdin, A. G.**
(13) **Walcott, C. D.**

PORIFERA

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INTRODUCTION

Sponges are many-celled aquatic animals characterized by bulky internal skeletons and passageways for water currents produced by flagellate cells. The skeletons commonly consist of opaline silica, but calcium carbonate may occur instead, with or without other inert substances.

Sponges constitute the phylum Porifera (or Spongiaria), which is placed in the subkingdom Metazoa, in contrast to Protozoa. They belong to the branch Parazoa in contrast to the Eumetazoa or proper many-celled animals.

PORIFERA COMPARED WITH PROTOZOA

Some kinds of Protozoa aggregate to form colonies rather than remaining as completely isolated cells. The colonies may even show a sort of cell specialization in which so-called somatic cells carry on principal activities of the organism excepting reproduction, whereas others, termed germ cells, do little except carry on reproduction. Sponges may be compared to such protozoan colonies.

No agreement concerning sponge individuality exists. Living sponges may be cut into small pieces that continue to live, each fragment resembling a juvenile individual. When conspecific sponges meet as a result of growth, they fuse into a single mass. In these respects resemblance to colonies of Protozoa prevails.

Sponges may be so finely divided by cutting and grinding that completely isolated cells result. These cells, astonishingly like Protozoa, may survive for 2 to 12 days as independent organisms, thus further resembling one-celled organisms of the Protista.

Unlike Protozoa, isolated sponge cells cannot survive indefinitely. If mutually interconnected by a sort of mucous-like colloid, generally present, they reassemble through it to form co-operating aggregates that are small functioning sponges. If they do not so reassemble, they inevitably perish.

Sponges comprise not only germ cells, but at least 2 kinds of specialized somatic cells: (1) flagellate cells called **choanocytes,** each with a thin collar around the base of the single flagellum, so closely like choanoflagellate Protozoa that evolution from such ancestors is indicated; and (2) amoeboid cells that move about by pseudopods, some being divisible into categories based on appearance and function. Some germ cells are also amoeboid.

Because of lack of complete cellular independence and especially because of having 2 or more kinds of somatic cells, sponges are removed from the Protozoa.

PORIFERA COMPARED WITH EUMETAZOA

Sponges are Metazoa because many-celled, but they differ from proper Metazoa in quasi-independence of the cells and lack of distinct individuality.

Eumetazoa may contain some free-moving amoeboid cells, but (unlike sponges) these occur only in secondary roles. Eumetazoa are distinctively characterized by organs formed from layers of mutually coherent cells, which appear in embryos, there called "germ layers," although not consisting of germ cells. Examples are ectoderm and endoderm; such do not occur in sponges.

Sponge cells commonly move freely with respect to one another, as proved by microscopic observations of living animals. Such cells remain associated only because they adhere to and travel on (or through) their community skeleton. Sponge cells may cohere and co-operate, as, for example, in closing openings; when so doing they form syncytiums. A **syncytium** may be defined as a mass of protoplasm containing more than one nucleus, a sort of single cell. Those found in sponges are better described as a number of cells so intimately conjoined that no sharp boundaries remain between them.

The term "epithelium" is often employed for such membranous sponge structures as linings of canals, and the thin dermis observed in some genera. These membranes may be entirely syncytial, but invariably are at least partially syncytial and generally are replete with inanimate colloidal material. For example, sheets consisting only of horny substance (spongin) may serve as canal linings or dermis. Sponges contain no typical epithelial cells.

ONTOGENY

Sponges arise by syngamy of spermatozoa with ova, or by asexual means. There may be cleavage of a zygote, or a grouping of somatic cells to form or assist in forming the embryo.

Free-swimming sponge larvae are the rule, each comprising an ovoid organism 0.2 to 0.5 mm. in diameter. Each consists of a jelly-like matrix containing amoeboid cells, its surface more or less covered with flagellate cells. These adhere to the jelly rather than to one another and should not be regarded as ectoderm. The flagella beat in unco-ordinated manner, but propulsion is in one direction because of the absence of flagellate cells at one end of the larva.

After a few hours or as much as 3 days, the larva attaches to a comparatively solid basis; otherwise it perishes. Some sponges are specialized to grow on mud, with root-like supports, but most kinds must become fixed to rock, shells, or other rigid material.

In the newly attached sponge, the amoeboid cells move, and shape the jelly so as to form one or more cavities connected to the outside by perforations called pores, hence "Porifera." There is no infolding or invagination of layers. The flagellate cells move as individuals, in a temporarily amoeboid manner, from the outer surface to inner surfaces; a sort of positive cryptotaxis.

The flagellate cells of adult sponges occur only on the concave surfaces of chambers; when abundant they seem to form a layer, but when less abundant (as is common) it is obvious that they are not mutually coherent.

Flagellate chambers may be formed from primordial cells (archaeocytes). One such cell may undergo cleavage, yielding 32 to 64 small cells which come to occupy the same chamber, putting out their collars and flagella.

Fresh-water sponges, just before winter or a dry season, form peculiar reproductive bodies called **gemmules,** which are quiescent larvae about 300 microns in diameter, surrounded by a tough organic case that resembles chitin or spongin. Gemmules survive freezing and desiccation for as much as 6 months and they may be carried in wind-blown dust or adherent to the feet of migrating birds. They "germinate" into ordinary sponge larvae when a favorable environment again exists. Many gemmules are covered with distinctive microscleres (small spicules). It is quite possible that fossil gemmules may some day be found; if so, a fresh-water origin will be indicated. Otherwise, no sponge fossils dependably indicate fresh-water origin.

MORPHOLOGY

GENERAL FEATURES

Probably each species of sponge has its characteristic symmetry, but often this is obscured. When sponges grow near each other, or among other animals or inanimate objects, crowding may cause distortion. Sponges that grow in strong currents (3 km. or more per hour) tend to be more or less globular or incrusting, regardless of their other inherent symmetry. The overall shape may be amorphous, incrusting, globular, or cylindrical, and may have many, few, or no branches. Some are lamellate (wall-shaped) or flabellate (fan-shaped); some are tubular, and others vase-shaped. Some are stalked. Some have root-like processes below.

Some mature sponges are less than 1 cm. in greatest dimension, or may be incrustations less than 1 mm. thick. At the other extreme, cylindrical sponges are known that are more than 1 m. in diameter and nearly the same in height. Many mature sponges have about the size of a human fist or head.

Three levels of sponge architecture exist. (1) **Ascon structure** consists of a single chamber, made of jelly plus mineral skeleton and amoebocytes, with numerous choanocytes on its inner surface (Fig. 14). At one end is generally a single exit, properly called an **apopyle.** Numerous smaller inlet openings **(prosopyles)** invariably occur. Ascon chambers commonly are 50 microns in diameter but may be several mm. long. (2) **Sycon structure** consists of many ascon-type chambers grouped around an axial exhalant canal **(apochete)** (Figs. 14, 15). The numerous apopyles empty into it and its exit is the **apopore.** Sycon chambers generally are 50 microns in diameter and 100 to 500 microns long. (3) **Rhagon structure** consti-

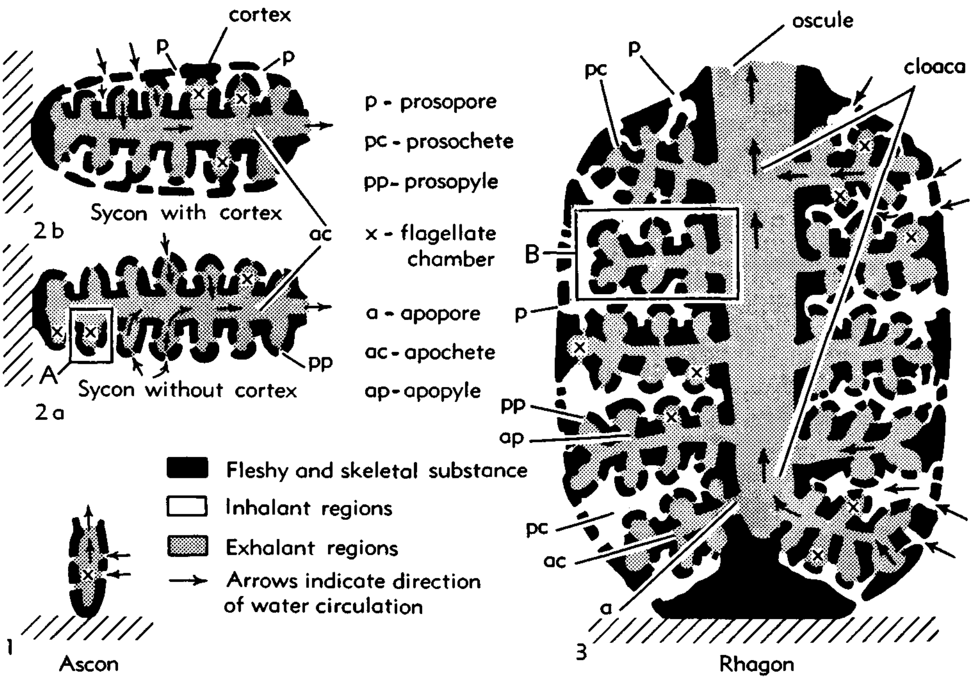

FIG. 14. Diagrammatic sagittal sections showing types of sponge architecture (68n). *1,* Ascon type, comprising a single flagellate chamber, ×2. *2,* Sycon type, composed of several flagellate chambers opening into a single excurrent passageway; *2a,* form without cortex (as in *Scyphia*), area outlined at "A" showing correspondence to ascon structure, ×5; *2b,* form with outer cortex (as in *Grantia*) and inhalant sinuses (prosochetes), ×5. *3,* Rhagon type, consisting of many sycon-like elements, as in area outlined at "B," arranged around a central excurrent passageway (cloaca), ×80.

tutes an aggregation of many sycon-like units. Their apochetes generally lead through apopores to a larger exit passageway, called a **cloaca** (Figs. 14, 15). The outlet of a cloaca may be called **oscule**, but any final exit from a sponge generally is called an oscule. Rhagon chambers are 20 to 50 microns in diameter and 30 to 100 microns long.

About 98 per cent of all sponges, Recent and fossil, considered as individuals or as species, are of rhagon type.

Among some sycons and nearly all rhagons, inhalant canals **(prosochetes)** occur. These begin with **prosopores**, branch repeatedly, and deliver to prosopyles.

Many sponges have a distinct **dermis**, 10 to 50 microns thick, over a comprehensive subdermal cavity in which pillar-like structures support the dermis. Pores (eupores) pierce the dermis, and prosopores lead inward from its floor. The dermis may attain thickness of 1 mm. or more and may be packed with skeletal structures. It is then called a **cortex.**

The interior of a sponge, called **endosome,** is set apart from outer structures **(ectosome),** such as dermis or cortex. Endosomal skeletal structures may be described as confused, reticulate, plumose, or radiate in arrangement. The cavities range from hardly visible to the naked eye (dense) through medium-size (about as large as in bread) to so large (exceeding 10 mm.) that the structure is termed cavernous.

Consistency of (Recent) sponges may be stony hard, or soft as froth, or intermediate in hardness. They vary from brittle to very elastic or "spongy." The surface may be relatively smooth, tuberculate, conulose, or hispid.

Colors of deep-sea sponges are dull, but shallow-water sponges in life are generally brightly colored; scarlet, gold, emerald, azure and royal purple, as well as snowy white to velvety black sponges abound.

SKELETON

One type of sponge skeleton consists of a soft colloid, varying from a mucous-like

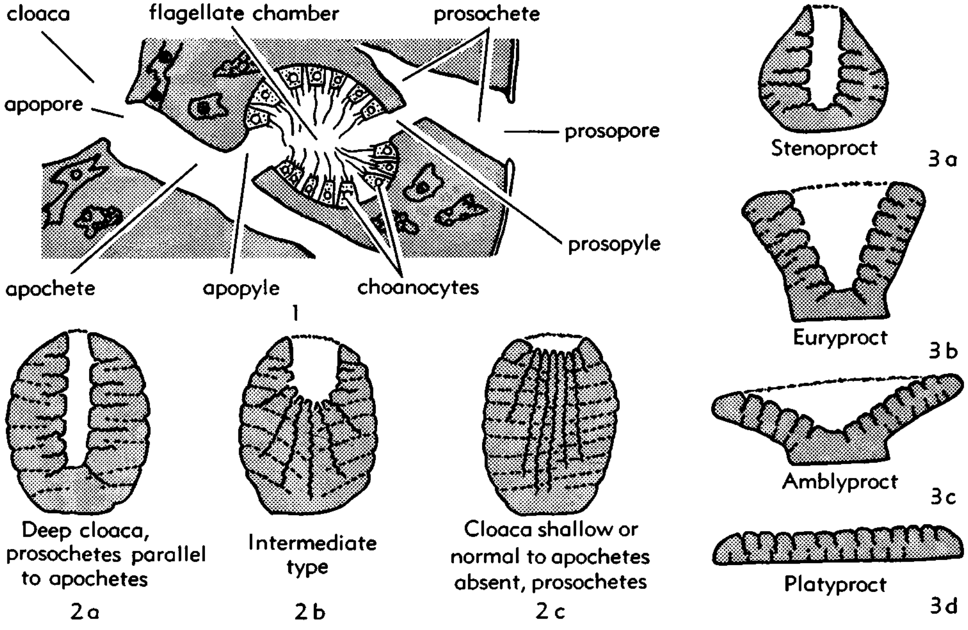

FIG. 15. Diagrammatic sections of sponges showing relationships of canals to cloacas (68n). *1*, Flagellate chamber with choanocytes; amoebocytes in surrounding jelly-like body substance; outer surface of sponge at right, ×1,000. *2*, Sagittal sections showing relations of prosochetes (dotted) to apochetes (wavy lines). *3*, Sagittal sections showing types of sponges *(3a-d)* defined by shape and relative width of the cloaca.

sol to rather stiff gel. In some species its existence is transient and small; and in a few it is the only skeleton ever present.

A second type is composed of separate mineral units called **spicules.** The mineral may be calcium carbonate (calcite) or opaline silica. No sponge ever produces both of these sorts.

A third type of sponge skeleton comprises an organic flexible but tough material called **spongin,** which is chemically related to horn and hair. It may be absent, or merely join spicule to spicule, or consist of fibers which contain spicules, or replace the spicules entirely. Only sponges of this latter sort are suitable for use as commercial sponges. The article of commerce is the completely defleshed reticulate skeleton of spongin fibers.

A considerable minority of sponge genera are sharply characterized by the fact that they can and do secure foreign debris in quantity and use this material as part of their skeleton. They take sand, bits of shell, and even the spicules of other sponge species. Thus a specimen may contain siliceous spicules of its own manufacture, and calcareous spicules from a neighbor. The occurrence of foreign spicules often renders identification extremely difficult.

A few sponges become rigid with age, uncommonly by mere interlocking of complex spicules but generally by the joining of spicules together by cement, which is silica for the siliceous spicules and calcium carbonate for calcareous spicules. Such rigid sponges constitute the vast majority of all fossil sponges. Doubtless in the past, as at present, an even greater number of sponges were of the kind that disintegrate after death.

During fossilization opaline silica may dissolve and be replaced by calcium carbonate, or vice versa, and either may be replaced by iron compounds. The original chemical nature must often be deduced by comparison with known Recent forms.

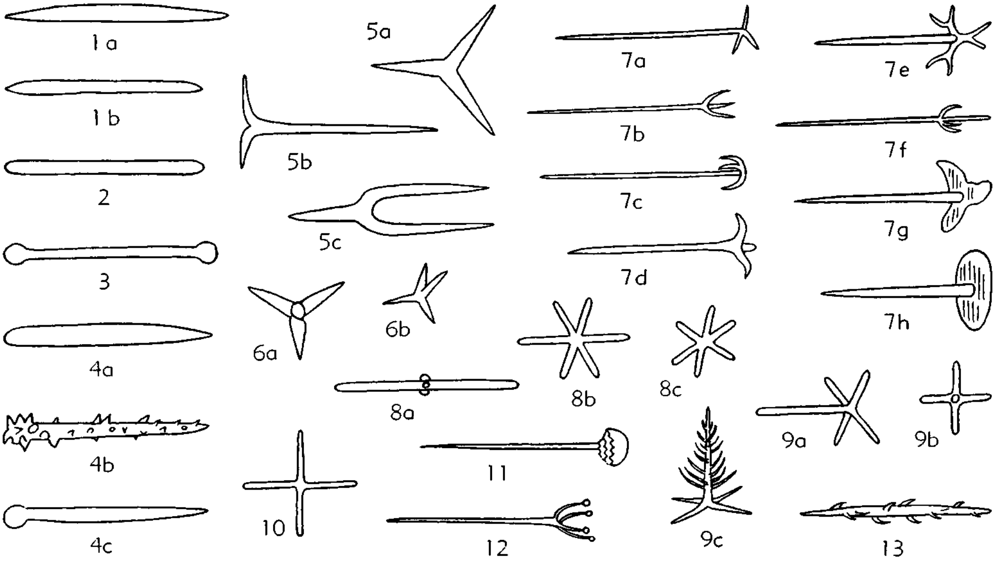

Fig. 16. Megasclere siliceous sponge spicules, approximately ×100 (68n).

1. Oxeas; *1a,* fusiform type; *1b,* hastate type.
2. Strongyle.
3. Tylote.
4. Style; *4a,* smooth type; *4b,* spiny (acanthose) type; *4c,* tylostyle.
5. Triacts; *5a,* regular type (triaxon); *5b,* sagittal type; *5c,* tuning-fork type.
6. Calthrops (tetraxon); *6a,b,* from different viewpoints.
7. Triaenes (tetraxons); *7a,* orthotriaene; *7b,* protriaene; *7c,* anatriaene; *7d,* plagiotriaene; *7e,* dichotriaene; *7f,* mesotriaene; *7g,* phyllotriaene; *7h,* discotriaene.
8. Hexacts (triaxons); *8a,* modified form resembling strongyle; *8b,c,* regular forms.
9. Pentacts (triaxons); *9a,* oblique view; *9b,* end view; *9c,* pinule.
10. Stauract.
11. Clavule.
12. Scopule.
13. Uncinate.

Spicules of sponges are divided into two categories: **megascleres** (Fig. 16) and **microscleres** (Fig. 17). The former make up the framework of the organism, but similar forms (still called megascleres) may be loose in the flesh. Microscleres, sometimes called flesh spicules, never form any part of the skeletal framework and therefore are rare in fossils. Megascleres are usually about 10 times the dimensions of the microscleres, but exceptionally large microscleres may exceed very small megascleres in size. Confusion is rare, because most microscleres are distinguished by their shapes also. Most megascleres exceed 3 microns in diameter, many are 10 microns, and some are more than 30 microns. Microscleres generally are 1 micron or less in (shaft) diameter. Megascleres mostly are more than 100 microns long, but many large forms are more than 300 microns in length, and a few attain greatest length of 1,000 microns. Microscleres typically range from 10 to 100 microns in length, but some are about 30 microns long.

In naming spicules, the roots "actine" (ray) and "axon" (axis) are often used. A triaxon spicule may have 3, 4, 5, or 6 rays, respectively describable as triactine, tetractine, pentactine, or hexactine, depending on how many rays extend from the central point. This does not mean that growth of the rays started at this point, but is purely academic. Thus with regard to monaxon

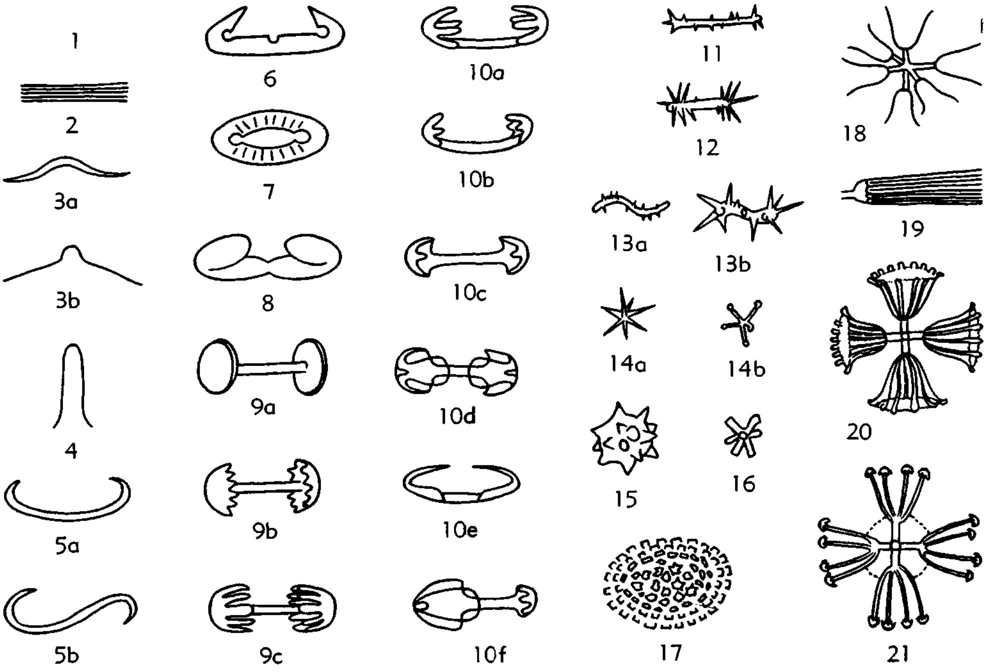

FIG. 17. Microsclere siliceous sponge spicules, approximately ×1,000 (68n).

1. Raphide (microxea).
2. Trichodragma (bundle of parallel raphides).
3. Toxas; *3a,b,* different types.
4. Forceps (may be spinose like other microscleres).
5. Sigmas; *5a,b,* different types.
6. Diancistra (rare).
7. Clavidisc (rare).
8. Placochela (rare), oblique view.
9. Amphidiscs; *9a,b,* birotulate types; *9c,* form approaching chela.
10. Chelas; *10a,* isochela of anchorate type, with shaft displaced laterally; *10b,c,* isochela of arcuate type in 2 views; *10d,e,* isochela of palmate type in 2 views; *10f,* anisochela.
11. Streptaster.
12. Amphiaster (rare).
13. Spirasters; *13a,b,* different types
14. Euasters; *14a,* oxyaster type; *14b,* tylaster type.
15. Sphaeraster.
16. Chiaster.
17. Sterraster.
18. Hexaster, oblique view.
19. Graphiohexaster, showing only one of 6 arms.
20. Floricome, with arms in line of view omitted.
21. Discohexaster, with arms in line of view omitted.

spicules, if the ends are alike, they are called diactine arbitrarily; if the ends are unlike they are called monactine. Almost invariably tetraxon spicules are also tetractine. Many terms applied to sponge spicules are explained in the glossary which follows.

It is rarely possible to identify a sponge genus, family, or order from the evidence of isolated spicules. For example, simple diactines called oxeas occur in several hundred genera of Recent sponges, including the genus *Reniera.* Fossil oxeas have been identified as *Reniera.* It would be equally logical to discover a fossil feather and identify it as belonging to the Tennessee Warbler. On the other hand, just as peacock feathers are indeed distinctive, so a few sorts of remarkable spicules may serve for generic identification.

Axial canals and other features are treated in connection with skeletal physiology.

MORPHOLOGICAL TERMINOLOGY

The literature on sponges contains very many names for soft and hard parts, as well as numerous descriptive morphological terms. A majority of these are unfamiliar to paleontologists who are not specialists in study of the sponges. Accordingly, compilation of an alphabetically arranged list that includes most of these terms or components (chiefly prefixes and suffixes) used in forming various morphological words is judged desirable. The glossary which follows gives brief explanation of the terms, together with classification in categories. The most commonly used terms are differentiated by printing in boldface type. Names referring to types of megasclere spicules and their parts are accompanied by the symbol "(M)," and similarly those referring to microsclere spicules and their parts are marked by "(m)." Names denoting placement of spicule assemblages, regardless of included types, are accompanied by "(S)." Other morphological terms are not thus restricted and these are not distinguished by a special symbol.

Glossary of Morphological Terms

acantho- (M). Prefix indicating spiny, more or less covered by spines.

amoebocyte. Cell moving by means of pseudopods.

amphiaster (m). Microsclere formed by union of 2 euasters (Fig. 17,*12*).

amphiblastula. Larva in which area without flagellate cells equals area with them.

amphidisc. (m). Rod with recurved clads at each end (Fig. 17,*9*).

amphioxea (M). Same as oxea (Fig. 16,*1*).

anatriaene (M). Triaene with clads curving back toward point of rhabd (Fig. 16,*7c*).

anchorate (m). Chela with 4 recurved clads at each end (Fig. 17,*10a*).

aniso- (m). Prefix indicating unlike; refers to ends of spicule.

anomoclad (M). Desma of sphaeroclone type.

apochete. Exhalant canal extending from apopyles to apopore (Fig. 14,*2*).

apopore. Aperture forming exit from apochete, may be equivalent to oscule (Fig. 14,*2*).

apopyle. Exhalant aperture from flagellate chamber (Figs. 14; 15,*1*).

aporrhysum. Same as apochete.

archaeo-. Prefix signifying primordial.

arcuate (m). Chela with clads in 3's, commonly flattened (Fig. 17,*10b,c*).

ascon. Sponge structure consisting of single relatively large chamber (Fig. 14,*1*).

aster (m). Rays diverging from a central focus (Fig. 17,*11-21*).

basalia. (S). Spicules protruding from lower surface of sponge.

birotule (m). Rod with disc or umbel at each end in plane normal to axis (Fig. 17,*9a,b*).

-blast. Suffix denoting "that which produces."

calcareous. Containing calcium, generally $CaCO_3$.

calthrops (M). Tetraxon with equal rays arranged normal to faces of tetrahedron (Fig. 16,*6*).

canalaria. (S). Spicules in lining of canals.

centrum. Middle part of spicule, from which rays irregularly diverge.

chamber. Cavity containing operative flagellate cells (Figs. 14;15,*1*).

chela (m). Like sigma but with terminal elaborations (Fig. 17,*10*).

chiaster (m). Aster with very blunt rays (Fig. 17,*16*).

choanocyte. Flagellate cell provided with collar (Fig. 15,*1*).

clad (M). Any of 3 similar rays of triaene (Fig. 16,*7*).

cladome (M). Aggregate of clads.

clavule (M). monact with terminal toothed umbel (Fig. 16,*11*).

cleme (M). Uncinate spicule (Fig. 16,*13*).

cloaca. Large exhalant cavity adjoined by apopores Figs. 14,*3*; 15,*1*,*2*).

collen-. Prefix referring to jelly.

comitalia (S). Opposed to principalia.

conule. Cone-shaped surface protrusion, generally over a fiber end.

coring. Refers to spicules located well inside of a tract or fiber.

coronal. Located on rim of oscule.

cortex. Relatively thick leathery external cover (Fig. 14,*2b*).

cribriporal. Grouped pores, generally in concavities.

cysten-. Prefix meaning bladder or capsule.

dendritic. Treelike branching.

dermalia (S). Spicules in outer layer.

dermis. Skinlike external covering.

desma. (M). Irregularly shaped spicule bearing lumpy mineral deposits.

desma-. Prefix referring to fiber (ligament).

diact (M). Monaxon of 2-ray type, produced in opposite directions.

diactine (M). Having 2 rays.

diaene (M). Like triaene but having only 2 clads.

diaxon (M). Spicule with 2 axes (*see* stauract).

dicho-. Prefix meaning dividing in 2 parts.

dichotomous. Branching by forking, Y-like.

dichotriaene (M). Triaene with forked clads (Fig. 16,*7e*).

dicranoclone (M). Desma with swollen terminal couplings.

dictyonalia (S). Spicules fused into rigid framework.

diplodal. Chambers with apopore about same size as prosopore.

discohexaster (m). Aster with branching rays that terminate in umbels (Fig. 17,*21*).

discotriaene (M). Triaene with flattened clads forming a disc normal to rhabd (Fig. 16,*7h*).

echinating. Said of spicules partially protruding from a tract or fiber.

ectosome. Outer region such as cortex or dermis.

endosome. Inner portion of sponge body.

ennomoclone (M). Spicule of dicranoclone or sphaeroclone type.

epirrhysum. Prosochete.

euaster (m). Aster lacking a centrum (Fig. 17,*14*).

eulerhabd (M). Like ophirhabd but more sharply curved.

eupore. Aperture through dermis to subdermal cavity.

eurypylorus. Chamber with extremely large apopore.

eutaxiclad (M). Desma of dicranoclone type.

fiber. Column more homogeneous than a tract.

flagellum. Long projection from cell, used as propeller.

floricome (m). Like hexaster but very elaborate (Fig. 17,*20*).

forceps (m). Tongs-shaped (Fig. 17,*4*).

fusiform (M). Spicule thicker centrally than near ends (Fig. 16,*1a*).

gastral cavity. Cloaca, not at all gastric.

gastralia (S). Spicules in lining of cloaca.

gemmule. Sponge embryo in a protective capsule.

gono-. Prefix referring to sex.

graphiohexaster (m). Six-ray aster with long thin parallel branches (Fig. 17,*19*).

hastate (M). Cylindrical spicule with abruptly conical points (Fig. 16,*1b*).

hexact (M). Triaxon with 6 rays nearly normal to one another (Fig. 16,*8*).

hexactine (M). Having 6 rays.

hexaster (m). Six-ray aster with ends generally branched (Fig. 17,*18-21*).

histo-. Prefix referring to tissue.

hypo- (S). Prefix meaning partly in a membrane, partly extending into endosome.

intermedia (S). Spicules between elements of principalia or dictyonalia.

iso- (m). Prefix meaning ends alike.

keratose. Pertaining to spongin (*ḳeras*, horn).

kyphorhabd (M). Strongyle with row of tubercles along one side.

leucon. Same as rhagon.

lipostomous. Without apertures visible to naked eye.

maltha. Mesogloea.

marginalia (S). Spicules protruding upward around an oscule.

megaclad (M). Relatively large smooth desma (syn., megaclone).

megaclone (M). Same as megaclad.

mesenchyme. Aggregate of amoeboid cells.

mesogloea. Layer of jelly.

mesotriaene (M). Triaene with rhabd projecting on both sides of cladome (Fig. 16,*7f*).

microxea (m). Like oxea but very small (Fig. 17,*1*).

monact (M). Monaxon produced in a single direction.

monactine (M). Having one ray only.

monaene (M). Like triaene but having only one clad.

monaxon (M). Spicule with a single axis.

myo-. Prefix referring to muscle.

octact (M). Spicule with 8 rays, generally 6 in one plane with others normal.

olynthus. Newly attached sponge larva.

ophirhabd (M). Oxea curved in several places.

orthotriaene (M). Triaene with clads perpendicular to rhabd (Fig. 16,*7a*).

oscule. Any comparatively large exit aperture (Fig. 14,*3*).

ostium. Eupore or prosopore.

oxea (M). Diactine monaxon with both ends pointed (syn. amphioxea) (Fig. 16,*1*).

oxyaster (m). Aster with sharp rays (Fig. 17,*14a*).

palmate (M). Chela with sheetlike or winglike elaborations (Fig. 17,*10d,e*).

paragastric. Cloacal, not at all gastric.

parenchyma. Endosome, as applied to sponges.

parenchymalia (S). Spicules in endosome, not in any lining.

parenchymula. Larva; area without flagellate cells very small.

phago-. Prefix referring to eating.

phyllotriaene (M). Triaene with clads flattened in plane normal to rhabd (Fig. 16,*7g*).

pinaco-. Prefix referring to epithelium.

pinule (M). Pentact with rhabd bearing long curved spines (Fig. 16,*9c*).

plagiotriaene (M). Like orthotriaene but clads thick, not straight (Fig. 16,*7d*).

pleuralia (S). Spicules protruding from lateral surface.

plumicome (m). Like floricome.

polyact (M). Spicule with many rays diverging from a central focus.

pore. Any small aperture.

posticum. Apopore.

principalia (S). Spicules constituting main skeletal framework.

prosochete. Inhalant canal, leading to chambers (Figs. 14;15,*1,2*).

prosopore. Aperture leading to prosochete (Figs. 14; 15,*1*).

prosopyle. Inhalant aperture of flagellate chamber (Figs. 14; 15,*1*).

prostalia (S). Spicules protruding from any surface.

protetraene (M). Tetraene with clads curving away from point of rhabd.

protriaene (M). Triaene with clads curving away from point of rhabd (Fig. 16,*7b*).

pseudopod. Temporary locomotor projection from cell.

raphide (m). Very thin microxea (Fig. 17,*1*).

regular triact (M). Spicule with 3 equal rays separated by angles of 120 degrees (Fig. 16,*5a*).

rhabd (M). Odd ray of a triaene, generally straight.

rhagon. Complex sponge structure, with many chambers (Fig. 14,*3*).

rhizoclad (M). Desma with rootlike processes (syn., rhizoclone).

rhizoclone (M). Same as rhizoclad.

rhopalostyle (M). Peculiarly lumpy spicule with bifurcate head.

rooting tuft (S). Aggregate of basalia with root function.

sagittal triact (M). Three-rayed spicule having one ray very unlike others, generally T-shaped (Fig. 16,*5b*).

sclero-. Prefix referring to skeleton.

scopule (M). Protetraene with tylote clads (Fig. 16,*12*).

selenaster (m). Like stellaster but based on a spiraster.

sigma (m). Shaped like letter C or S (Fig. 17,*5*).

siliceous. Containing silica, SiO_2 or silicate.

sphaeraster (m). Aster with globular centrum (Fig. 17,*15*).

sphaeroclone (M). Subglobular desma produced by swelling of centrum.

spicule. Unit of sponge mineral skeleton, "little spike" (Fig. 16, *4*).

spiraster (m). Spirally twisted rod-bearing spines or short rays.

spongin. Organic flexible substance, related to hair or horn.

spongocoel. Rhagon cloaca, sycon apochete, or ascon chamber.

stato-. Prefix referring to gemmule.

stauract (M). Tetractine diaxon with 4 rays in one plane (Fig. 16,*10*).

sterraster (m). Ovoid spicule with numerous radiating blunt rays (Fig. 17,*17*).

streptaster (m). Straight rod with long spines or rays (Fig. 17,*11*).

strongylaster (m). Aster with rays bluntly rounded at tips.

strongyle (M). Diactine monaxon with both ends bluntly rounded (Fig. 16,2).

style (M). Monactine monaxon with one end blunt and other pointed (Fig. 16,*4*).

sycon. Sponge structure comprising one layer of chambers (Fig. 14,*2a,b*).

tetraclad (M). Desma with rays bearing terminal couplings or based on a calthrops, generally both (syn., tetraclone).

tetraclone (M). Same as tetraclad.

tetractine (M). Having 4 rays.

tetraene (M). Like triaene but having 4 clads.

tetraxon (M). Spicule with 4 axes (Fig. 16,*6,7*).

theso-. Prefix referring to storage.

toko-. Prefix referring to reproduction.

tornote (M). Diactine monaxon with both ends hastate.

toxa (m). Bow-shaped spicule with 3 bends (Fig. 17,*3*).

tract. Fascicular column of spicules.

triact (M). Spicule with 3 rays (*see* regular triact, sagittal triact) (Fig. 16,*5*).

triactine (M). Having 3 rays.

triaene (M). Tetraxon with one ray differing from others (Fig. 16,*7*).

triaxon (M). Spicule with 3 axes (Fig. 16,*5*,*8*,*9*).

trichodragma (m). Aggregate of parallel raphides (Fig. 17,*2*).

tropho-. Prefix referring to nutrition.

tuning fork (M). Triact shaped like tuning fork (Fig. 16,*5c*).

tylaster (m). Aster with rays swollen at tips (Fig. 17,*14b*).

tylo- (M). Prefix referring to tip with globular swelling (Fig. 16,*4c*).

tylote (M). Diactine monaxon with both ends swollen (Fig. 16,*3*).

umbel (M). Cluster of subequal rays diverging from a common point.

uncinate (M). Fusiform oxea with thornlike spines (Fig. 16,*13*).

verticillate (M). Having spines arranged in nodes or whorls.

PHYSIOLOGY

SKELETAL SECRETION

The skeleton of sponges serves to give support and rigidity to the organism. Also, many spicule sorts are so shaped as to deter predators from eating the sponge. Sponges that lack spicules may possess chemical deterrents and even some spicule-bearing ones contain strong irritants or toxins.

Megascleres are first represented by an axial thread. This is organic, probably protoplasmic, and stains distinctively with nigrosin. Axial threads arise by longitudinal fission of pre-existing similar ones inside living sponge cells. Amoeboid cells deposit mineral material on and around an axial thread in concentric layers that alternately contain more and then less organic material. Where two or more cells collaborate in the formation of a single spicule, as is common, they unite to form a syncytium surrounding it. During growth, the spicule increases principally in diameter, but the axial thread is at once completely enclosed, with mineral layers surrounding its ends, so that the length of the spicule also increases somewhat. The axial canal, where the axial thread had been, is often visible in spicules. Spicules in water, not surrounded by flesh, may undergo slow solution. This may greatly enlarge the axial canal so that it becomes conspicuous.

Generally, no axial thread is evident in microscleres; these spicules arise inside a single cell and remain completely enclosed until fully formed.

Spicules may be anchored in place, especially within or on fibers, but often they are moved about. Many kinds arise deep within the sponge and are moved toward the surface as they mature. They may accumulate on or near the surface, or even be extruded. Accordingly, it has been suggested that to some extent they may represent a sort of physiological excretion.

The incorporation of foreign material seems to begin by adherence of it to the sponge's surface, and then amoeboid cells transport it to specific internal locations. For example, such debris may be placed inside certain vertical fibers and nowhere else.

MOTION

Motion in sponges is of three sorts: flagellate, amoeboid, and muscular.

Flagellate cells (choanocytes) are responsible for locomotion of the larva and for water currents that sweep through the adult. Each flagellum moves in a circular path with a spiral shape, thus serving like a ship's propeller. Under favorable conditions the flagellum may revolve about 10 times per second.

Amoeboid travel, by pseudopods, is characteristic of many or perhaps all cells of a sponge. Thus chambers and canals are formed, spicules are moved, and wounds are promptly repaired. Even choanocytes may be briefly amoeboid, especially in the post-larval fixation stage.

Muscular contraction can be used to close inhalant openings of all, or nearly all, sponges. In a minority of species, the larger exhalant openings can also be thus closed, with force comparable to the grip of a human hand. The sphinctrate muscular rings are syncytial. Since a syncytium is regarded by some authorities as a single cell, the statement has been made that the sponge pore is surrounded by a single cell, but this is misleading.

Reaction in sponges occurs with absolutely no nerve tissue whatsoever. The cells are sensitive, and respond to stimuli, as, for example, in closing pores and in travel to wounds; there exist thigmotaxis and chemotaxis. Transmission, however, occurs only in so far as cytolytic products diffuse or the motion of one cell physically jostles its neighbor. Activity thus spreads from a point of impact, but it extends only a few millimeters outward and disappears rapidly.

NUTRITION

Nutrition in sponges requires more study. Early research revealed pathways for elimination of colored foreign particles, but this is not related to nutrition. Some shallow-water sponges are full of symbiont plants and almost certainly derive nourishment from them. The majority of Porifera, for lack of illumination, cannot thus depend upon photosynthetic collaborators. The inlets to their flagellate chambers are so small (2 microns) that their diet must consist of very small organisms (hekistoplankton), especially bacteria. There are indications that nourishment may be transferred from cell to cell within the sponge, but no mouth, stomach, or alimentary canal exists and no structures of Porifera may properly be termed gastral.

RESPIRATION

Respiration in sponges is cell by cell, as in Protozoa. In species studied carefully, the oxygen consumption has been found to be approximately the same as in other marine invertebrates, for example, 0.15 cc. of consumed oxygen per hour per cc. of sponge, including some nonliving material (spicules). Sponges containing photosynthetic symbionts deliver carbon dioxide to them and secure oxygen in return.

EXCRETION

Excretion in sponges is cell by cell, as in Protozoa, but details are not known. Contractile vacuoles assist osmotic regulation in fresh-water sponges. Doubtless vegetable symbionts, when present, dispose of nitrogenous animal excretions.

CIRCULATION

Circulation in sponges may be represented by water currents which enter the relatively small surficial pores and proceed to the flagellate chambers. Because of the greater diameter of these chambers, the velocity temporarily decreases and action of the flagella on the slower moving water yields hydraulic efficiency. The moderately small exit passageways are progressively larger and larger; other than this, nothing so far published indicates how it happens that the current moves in only one direction. The flagellate cells have no co-ordination with one another, and unless damaged, beat continuously. The gross current becomes considerable. A sponge of 200 g. (dry) weight, in life will pass a metric ton (1,000 kg.) of water through its channels each 24-hour day.

REPRODUCTION

Reproduction in sponges certainly results sometimes from syngamy of spermatozoon with ovum, yielding a normal zygote. It is also certain that small cell aggregates, comparable to buds, may be formed asexually, and after they separate from the parent, they start new sponges. The relative abundance of the 2 methods is not known. There are reports of sperm penetrating sponge flagellate cells as a prelude to transfer into ova for syngamy (fertilization).

ECOLOGY

Sponges are eaten, in spite of spicules and toxins, by many nudibranch gastropods, by a few holothurians, and by a very few fishes. Angel fishes, especially, may take the sponge by accident while seeking worms. Sponges nearly always contain many animal, as well as plant, inhabitants, of which some, such as shrimps, are merely commensal but many others parasites. CASTER has demonstrated the occurrence of ophiuroid echinoderm inhabitants in fossil sponges, and such association is known in modern seas. Recent sponges commonly contain as many as 3 probably parasitic animals (chiefly nematodes) per cc. but almost equally abundant minute amphipod crustaceans are found. The occurrence of beneficial plant symbionts has been discussed.

Sponges frequently kill neighbors by lateral growth and smothering, and in turn they may perish similarly. Sponges of the family Clionidae excavate burrows in calcareous material by unknown means. They thus damage many mollusks, even contributing to killing them. Fossil clionids are known, but fossil excavations may be difficult to identify.

Sponges without mineral skeletons have been used by mankind for at least 4,000 years, especially for cleansing, but also for padding, pigment application, and other uses.

DISTRIBUTION

Sponges are moderately common on the ocean floor, and more abundant along shores, especially near low-tide mark. More than 10,000 Recent species have been described. Probably about half of these are synonyms, but exploration has been so incomplete that surely many undescribed species exist. More than 1,400 genera have been established for Recent sponges. Of these, about 20 occur in fresh water and another 20 are found well up in the intertidal region. All others live only where they are immersed always in sea water. Numerous genera are found in deep water. No depth seems to be too great for sponge tolerance. The entire class Hyalospongea is confined at present to such depths that light does not penetrate, and is rare at depths less than 200 m.

Sponges are largest and most abundant, both in species and in individuals, in equatorial waters, but as compared even to the coldest polar waters, only by a factor between 5 and 10. For example, nearly 400 arctic species are known, and sponges are about as common on arctic shores as along the New England coast.

PRECAMBRIAN

Sponges doubtless evolved in the Precambrian, although indubitable proof is wanting. DUNBAR (*Historical Geology*, 1949) mentions Precambrian sponge spicules in the Grand Canyon region (Arizona); this is on authority of SCHUCHERT, seemingly based on oral reports by WALCOTT. The present location of collected specimens, if they exist, is unknown. In 1951, G. W. BAIN discovered fossils in the Katanga system, presumed to be of Precambrian age, in the Belgian Congo (Africa), and he described (personal letter) them as closely resembling the Recent ascon calcisponge *Leucosolenia;* unfortunately, an accident destroyed his specimens. WALCOTT (1912, Canadian Dept. Mines, vol. 28, p. 17) described a Precambrian fossil from Canada as *Atikokania*. This has been identified variously as an inorganic concretion or a poorly preserved sponge. CAYEUX (1895, Annales Soc. géol. du Nord, p. 52-65) described Precambrian fossils from Brittany which closely resemble the spicules of calcisponges; they are lumpy and crooked, unlike the spicules of most sponges. CAYEUX's conclusion that several classes and orders of sponges are represented is here doubted. G. J. HINDE in a personal letter to CAYEUX (July 10, 1895) accepted the sponge nature of these fossils. It seems advisable to have a zoological name whereby the discovery by CAYEUX may be designated, and this is here proposed as follows: *Eospicula cayeuxi* DELAUB., gen. et sp. nov. Sponge with triact spicules, probably of the class Hyalospongea. Type specimen represented by figure 48 of plate II, Ann. Soc géol. du Nord, 1895, which is a triact with strongylote rays 15 by 20, 15 by 60 and 15 by 80 microns. Precambrian of Brittany.

PALEOZOIC AND YOUNGER

More than 1,000 genera have been established for fossil sponges. Scarcely 20 of these can be regarded with any confidence as identical with Recent sponge genera. Many sponge fossils are so poorly preserved that identification of them is extremely uncertain.

Chert may consist of more or less fused sponge spicules from the abundant kinds that disintegrate upon dying. Flints may likewise be nearly or entirely of sponge origin and in some of them whole fossil sponges appear.

The Cambrian and various succeeding periods yield fossil records which indicate abundance of sponges comparable to that of the present. The first certainly distinguishable calcisponges are Devonian, and huge assemblages of Hyalospongea flourished in Devonian time, especially in New York and Pennsylvania. An even greater sponge abundance is indicated in Lower Carboniferous rocks of Great Britain by thick strata of chert largely composed of isolated sponge spicules; in Yorkshire these chert beds are as much as 105 m. thick. Sponges seem generally to have been somewhat fewer in the Permian and Triassic periods, but in Lower Jurassic deposits of central Europe thick strata are full of isolated sponge spicules. Also, Jurassic beds of southern Germany contain numerous lithistid sponges. Hyalosponge abundance reached a climax in the Cretaceous of Europe, especially in northern Germany and France. Tertiary sponge occurrences are more like those of the Quaternary and Recent.

CLASSIFICATION

The phylum Porifera is divisible into 3 classes: Demospongea (*demos,* common), Hyalospongea (*hyalos,* glass), and Calcispongea (*calx,* lime).

Calcispongea invariably have proper skeletons of calcareous spicules, and none secrete siliceous material or spongin. Some are rhagon, some sycon, and some ascon.

All Hyalospongea have proper skeletons of siliceous spicules without associated calcareous material or spongin. The junctions of their skeletal elements tend to be at right angles. The protoplasmic structures are scanty, with relatively huge open spaces. The structure is technically rhagon, but so simple that it appears almost like sycon.

Demospongea typically have spongin as part or all of their skeleton, but there are exceptions which are referable to this class because of their significant resemblance to spongin-containing relatives. Most demosponges contain siliceous spicules, with or without spongin. A few contain only spongin, and still fewer produce neither spicules nor spongin. Skeletal structures in this class tend to meet at 120-degree angles and the flesh is compact rhagon.

Demospongea other than the Lithistida are extremely unlikely to yield recognizable fossils. Spongin fibers may leave imprints or molds, and in some fossils casts of canal systems persist. Ancient abundance is indicated by many flints, cherts, and beds of spicules.

Recent Demospongea comprise some 90 families. Members of most of these disintegrate so promptly and so completely upon dying that it does not seem advisable to describe them in a paleontologic discussion. A few paleontologists have hazarded identifications of genera from these families on the evidence of isolated spicules, but efforts of this sort are extremely unreliable.

A tabular summary of suprageneric divisions of the Porifera, showing stratigraphic distribution of recognized units, is introduced here for convenience in surveying the whole assemblage. The number of genera in each division (taking account of those mentioned in the *Treatise*) is indicated by numbers enclosed in parentheses, but it is necessary to point out that these numerical data are incomplete because very many Recent genera and not a few whole families that lack importance in paleontology are omitted. Taxonomic units containing more or less numerous unmentioned genera are distinguished by an asterisk (*).

Suprageneric Divisions of Porifera

- Demospongea *(class)* (*374). *Cam.-Rec.*
  - Keratosida *(order)* (*8). *Carb.-Rec.*
    - Spongiidae *(family)* (*4). *Carb.-Rec.*
    - Dysideidae (*3). *Jur.-Rec.*
    - Family uncertain (1)
  - Haplosclerida *(order)* (*18). *Cam.-Rec.*
    - Spongillidae *(family)* (*3). *Jur.-Rec.*
    - Haliclonidae (*5). *L.Ord.-Rec.*

- Desmacidontidae (*2). *Tert.-Rec.*
- Haplistiidae (2). *M.Ord.-L.Carb.*
- Wapkiidae (1). *Cam.*
- Hazeliidae (1). *Cam.*
- Takakkawiidae (1). *Cam.*
- Family uncertain (3). *Jur.-Cret.*
- Poecilosclerida *(order)* (*16). *Cam.-Rec.*
  - Myxillidae *(family)* (*2). *Tert.-Rec.*
  - Tedaniidae (*4). *Tert.-Rec.*
  - Cladorhizidae (*2). *Tert.-Rec.*
  - Amphilectidae (*2). *Tert.-Rec.*
  - Hamptoniidae (1). *Cam.*
  - Acarniidae (*2). *Cret.-Rec.*
  - Family uncertain (3). *Jur.-Tert.*
- Hadromerida *(order)* (*15). *Cam.-Rec.*
  - Spirastrellidae *(family)* (*3). *Tert.-Rec.*
  - Suberitidae (*3). *L.Cret.-Rec.*
  - Piraniidae (1). *Cam.-Sil.*
  - Clionidae (*8). *Sil.- Rec.*
- Epipolasida *(order)* (*10). *Cam.-Rec.*
  - Sollasellidae (*6). *Ord.-Rec.*
  - Corralioidae (1). *Cam.*
  - Choiidae (1). *M.Cam.-Sil.*
  - Tethyidae (*1). ?Tert., *Rec.*
  - Family uncertain (1). *Cam.*
- Choristida *(order)* (*25). *Carb.-Rec.*
  - Ancorinidae *(family)* (*5). *Jur.-Rec.*
  - Geodiidae (*5). *Carb.-Rec.*
  - Craniellidae (4). *Cret.-Tert.*
  - Scolioraphididae (3). *Jur.-U.Cret.*
  - Ophiraphiditidae (*5). *Jur.-Rec.*
  - Family uncertain (3). *Jur.-Cret.*
- Carnosida *(order)* (*11). *Carb.-Rec.*
  - Halinidae *(family)* (*11). *Carb.-Rec.*
- Lithistida *(order)* (*286). *Cam.-Rec.*
  - Rhizomorina *(suborder)* (*73). *Cam.-Rec.*
    - Kaliapsidae *(family)* (*6). *Cret.-Rec.*
    - Scytaliidae (8). *Jur.-U.Cret.*
    - Chonellidae (8). *Jur.-Tert.*
    - Astroboliidae (4). *Jur.-Tert.*
    - Cnemidiastridae (3). *Ord.-Jur.*
    - Jereopsiidae (*4). *U.Jur.-Rec.*
    - Leiodorellidae (*12). *Jur.-Rec.*
    - Plinthodermatiidae (1). *U.Cret.*
    - Neopeltidae (*2). *Cret.-Rec.*
    - Scleritodermatidae (*2). *Cret.-Rec.*
    - Family uncertain (23). *Cam.-Mio.*
  - Megamorina *(suborder)* (*22). *Carb.-Rec.*
    - Pleromidae *(family)* (*11). *Jur.-Rec.*
    - Dorydermatidae (6). *Carb.-U.Cret.*
    - Helobrachiidae (1). *U.Cret.*
    - Isoraphiniidae (3). *Jur.-Cret.*
    - Family uncertain (1). *Cret.*
  - Tetracladina *(suborder)* (*97). *Ord.-Rec.*
    - Aulocopiidae *(family)* (12). *Ord.-Perm.*
    - Archaeoscyphiidae (7). *Ord.*
    - Chenendoporidae (12). *?Perm., Jur.-U.Cret.*
    - Hallirhoidae (11). *Jur.-Tert.*
    - Plinthosellidae (5). *?Perm., Cret.*
    - Astrocladiidae (4). *Cret.-Tert.*
    - Aulaxiniidae (2). *Cret.*
    - Jereidae (10). *?Perm., Cret.*
    - Discodermiidae (*16). *L.Cret.-Rec.*
    - Phymaraphiniidae (7). *Cret.-Tert.*
    - Family uncertain (11). *Carb.-Rec.*
  - Eutaxicladina *(suborder)* (*30). *Ord.-Rec.*
    - Astylospongiidae *(family)* (16). *Ord.-Cret.*
    - Gignouxiidae (*8). *Jur.-Rec.*
    - Chiastoclonellidae (5). *Ord.-Tert.*
    - Pseudoverruculinidae (1). *U.Cret.*
  - Anomocladina *(suborder)* (25). *Cam.-Jur.*
    - Cylindrophymatidae *(family)* (7). *Carb.-Jur.*
    - Eospongiidae (12). *Cam.-Sil.*
    - Mastosiidae (1). *Jur.*
    - Family uncertain (5). *Ord.-Cret.*
  - Suborder uncertain (39). *Dev.-Tert.*
- Hyalospongea *(class)* (*287). *L.Cam.-Rec.*
  - Lyssakida *(order)* (*86). *L.Cam.-Rec.*
    - Hyalonematidae *(family)* (*1). *Eoc.-Rec.*
    - Pheronematidae (*2). *Cret.-Rec.*
    - Euplectellidae (*3). *U.Cret.-Rec.*
    - Sympagellidae (*1). *Eoc.-Rec.*
    - Lanuginellidae (*2). *Eoc.-Rec.*
    - Stauractinellidae (1). *Jur.*
    - Protospongiidae (9). *L.Cam.-U.Sil.*
    - Leptomitidae (3). *L.Cam.-Ord.*
    - Teganiidae (4). *Ord.*
    - Holasterellidae (5). *Sil.-Carb.*
    - Dictyospongiidae (39). *Ord.-Carb.*
      - Dictyospongiinae *(subfamily)* (25). *Sil.-Carb.*
      - Prismodictyinae (14). *Ord.-Carb.*
    - Uphantenidae (2). *U.Dev.-Carb.*
    - Brachiospongiidae (4). *Ord.-Sil.*
    - Multivasculatidae (1). *U.Cam.*
    - Vauxiidae (1). *M.Cam.*
    - Amphispongiidae (1). *U.Sil.*
    - Titusvilliidae (*4). *L.Carb.-Rec.*
    - Family uncertain (3). *Ord.-Carb.*
  - Dictyida *(order)* (*102). *M.Ord.-Rec.*
    - Euryplegmatidae *(family)* (*1). *?Cret., Rec.*
    - Hexactinellidae (*9). *Jur.-Rec.*
    - Eubrochididae (4). *U.Cret.*
    - Staurodermatidae (14). *Jur.-Mio.*
    - Leptophragmatidae (6). *Jur.-Tert.*
    - Emplocidae (1). *M.Jur.*
    - Polythyrididae (4). *M.Ord.-U.Cret.*
    - Polystigmatiidae (1). *U.Cret.*
    - Pleurostomatidae (10). *Jur.-Rec.*
    - Porospongiidae (3). *U.Jur.-U.Cret.*
    - Myliusiidae (*9). *Jur.-Rec.*
    - Botryosellidae (8). *U.Jur.-U.Cret.*
    - Euretidae (5). *Jur.-Tert.*
    - Dactylocalycidae (*10). *Cret.-Rec.*
    - Aphrocallistidae (*1). *Cret.-Rec.*
    - Wapkiosidae (*2). *Cret.-Rec.*
    - Family uncertain (14). *Dev.-Cret.*
  - Lychniskida *(order)* (*68). *?Trias., Jur.-Rec.*
    - Ventriculitidae *(family)* (20). *Jur.-U.Cret.*
    - Coeloscyphiidae (2). *Cret.*
    - Polyblastidiidae (2). *Jur.-Cret.*
    - Coeloptychiidae (2). *U.Cret.*
    - Camerospongiidae (7). *Jur.-Tert., ?Rec.*

    - Cypelliidae (7). *Jur.-Cret.*
    - Oncotoechidae (1). *U.Cret.*
    - Callodictyidae (9). *Cret.*
    - Coscinoporidae (3). *U.Cret.*
    - Becksiidae (7). *Jur.-U.Cret.*
    - Calyptrellidae (5). *Jur.-U.Cret.*
    - Family uncertain (3). *?Trias., U.Cret.*
  - Heteractinida *(order)* (11). *L.Cam.-Carb.*
    - Chancelloriidae *(family)* (1). *M.Cam.-U.Cam.*
    - Astraeospongiidae (6). *M.Cam.-Carb.*
    - Asteractinellidae (4). *L.Cam.-Perm.*
  - Order uncertain (20). *M.Ord.-Cret.*
- Calcispongea *(class)* (*104). *Cam.-Rec.*
  - Solenida *(order)* (*1). *Cam.-Rec.*
    - Camarocladiidae *(family)* (1). *Cam.-Ord.*
  - Lebetida *(order)* (*3). *L.Jur.-Rec.*
    - Grantiidae *(family)* (*1). *U.Jur.-Rec.*
    - Leuconiidae (*2). *L.Jur.-Rec.*
  - Pharetronida *(order)* (*67). *Perm.-Rec.*
    - Chalarina *(suborder)* (*36). *Perm.-Rec.*
      - Sestrostomellidae *(family)* (5). *Trias.-Cret.*
      - Stellispongiidae (11). *Trias.-Cret.*
      - Elasmostomatidae (3). *Jur.-Cret.*
      - Pharetrospongiidae (1). *L.Cret.-U.Cret.*
      - Lelapiidae (11). *Perm.-Eoc.*
      - Discocoeliidae (3). *Trias.-Cret.*
      - Elasmocoeliidae (2). *Jur.-Cret.*
    - Stereina *(suborder)* (*6). *Jur.-Rec.*
      - Porosphaeridae *(family)* (*5). *Cret.-Rec.*
      - Bactronellidae (1). *Jur.-Eoc.*
    - Suborder uncertain (25). *Trias.-Tert.*
  - Thalamida *(order)* (26). *U.Carb.-Cret.*
    - Sebargasiidae *(family)* (5). *U.Carb.-Cret.*
    - Barroisiidae (3). *Trias.-Cret.*
    - Cystothalamiidae (2). *Penn.-Perm.*
    - Celyphiidae (8). *U.Carb.-Trias.*
    - Cryptocoeliidae (5). *Perm.-Cret.*
    - Sphaerocoeliidae (1). *U.Cret.*
    - Family uncertain (2). *Perm.-Trias.*
  - Order uncertain (7). *Sil.-M.Jur.*
- Class uncertain (13). *Precam.-Cret.*
- Porifera total (*778). *Precam.-Rec.*
- Unrecognizable supposed Porifera (269). *Cam.-Rec.*
- Receptaculitidae *(family)* (11). *Ord.-Dev., ?Carb.*

SYSTEMATIC DESCRIPTIONS

Phylum PORIFERA Grant, 1872

Aquatic metazoa without germ layers, whose numerous flagellate cells draw water through many small inlets and expel it through fewer exits. *Cam.-Rec.*

Class DEMOSPONGEA Sollas, 1875

[*nom. correct.* deLaub., herein (*ex* Demospongiae Sollas, 1875)]

Architecture compact rhagon. Siliceous spicules, or spongin, or (commonly) both, or (rarely) neither present. Diverse sorts of foreign inclusions occur in many. *Cam.-Rec.*

Order KERATOSIDA Grant, 1861

[*nom. correct.* deLaub., herein (*ex* Keratosa Grant, 1861)]

Skeleton of spongin only, except as foreign inclusions occur. *Carb.-Rec.*

Family SPONGIIDAE Gray, 1867

[*nom. correct.* deLaub., 1936 (*ex* Spongiadae Gray, 1867)]

Keratose sponges with small spherical flagellate chambers (not shown by fossils). *Carb.-Rec.*

Spongia Linné, 1759 [**S. officinalis*]. Fibers very spongy even when dry; chiefly clear, but a few ascending fibers contain debris. *Rec.*, cosmop.

Verongia Bow., 1845 [**Spongia fistularis* Pallas, 1766]. Fibers peculiarly pithed. *Rec.*, cosmop.——Fig. 18,*3*. **V. fistularis* (Pallas), skeletal fiber, ×100 (68n).

Aplysinofibria Bolk., 1923 [**A. carbonicola*]. Fibroid structures like those of *Verongia.* Such have often been called aplysinoid fibers because many species of *Verongia* have been incorrectly identified as *Aplysina.*

Scyphia Oken, 1814 [**Spongia scyphiformis* Esper, 1794; SD deLaub., 1936]. Hollow, conical. Over 200 poorly described fossil species from many systems have been assigned incorrectly to this genus, merely because they were hollow cones, although in other respects extremely diversified. No certain fossils of this genus exist. *Rec.*

Family DYSIDEIDAE Gray, 1867

Large, sac-shaped (eurypylous) flagellate chambers (not shown by fossils). Fibers usually loaded with foreign debris. *Jur.-Rec.*

Dysidea Johnson, 1842 [**Spongia fragilis* Montagu, 1818; SD deLaub., 1936][=*Spongelia* Nardo, 1844]. All the fibers cored with foreign debris (22). *Eoc.*(Belg.)-*Rec.*(cosmop.).

Spongelites Rothpletz, 1900 [**S. fellenbergi*]. Reticulate sand-filled fibers. *Jur.*, Eu.

Spongeliomorpha de Saporta, 1887 [**S. iberica*] Resembles *Spongelites. Mio.*, Sp.

Family UNCERTAIN

Felixium deLaub. *nom. nov.* [*pro Rhizocorallium* Felix, 1913[1] (*non* Zenker, 1836)][**Rhizocorallium glaseli* Felix, 1913]. Elaborately sculptured, curved cylinder 5×20 cm. *Cret.*, Ger.

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[1] Felix, J., *Ueber ein cretacische Geschiebe mit Rhizocorallium glaseli:* Sitzungsber. Natur Gesell., Leipzig, Bd. 39, p. 19-25.

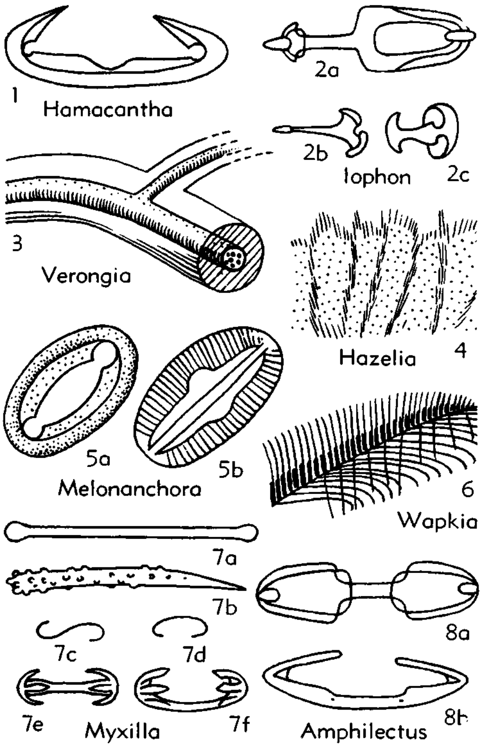

FIG. 18. Keratosida (*3*), Haplosclerida (*4, 6*), Poecilosclerida (*1, 2, 5, 7, 8*) (p. E36-E38).

Order HAPLOSCLERIDA Topsent, 1898

[*nom. correct.* DELAUB., herein (*ex* Haplosclerina TOPSENT, 1898)]

Sponges with almost no dermal specialization whatsoever. Generally reticulate with much spongin. Megasclere spicules generally of just one simple type. *Cam.-Rec.*

Family SPONGILLIDAE Gray, 1867

Fresh-water species (a few in brackish water) with gemmules. Some genera have microscleres like those of many Hyalospongea. *Jur.-Rec.*

Spongilla LAM., 1815 [**Spongia lacustris* LINNÉ, 1759; SD POTTS, 1881]. Megascleres simple oxeas, gemmules contain spiny oxeas (acanthoxeas) (22). *Jur.-Rec.*, cosmop.

Meyenia CARTER, 1881 [**M. fluviatilis;* SD DELAUB., 1936]. Gemmules contain amphidisc microscleres. Commonly reported erroneously as *Ephydatia* (=*Tupha*). *Pleisto.-Rec.*, cosmop.

Heteromeyenia POTTS, 1881 [**H. repens;* SD DELAUB., 1936]. Like *Meyenia* but amphidiscs include 2 distinct types (22). *Pleisto.-Rec.*, cosmop.

Family HALICLONIDAE de Laubenfels, 1932

Extremely simple skeletons, lacking microscleres; most typical of order. *L.Ord.-Rec.*

Haliclona GRANT, 1841 [**Spongia oculata* LINNÉ, 1759][=*Chalina* BOW., 1862]. Incrusting to ramose (14). *?Eoc., Rec.*, cosmop.

Reniera NARDO, 1847 [**R. aquaeductus* SCHMIDT, 1862; SD SCHMIDT, 1862]. Like *Haliclona* but a hollow cylinder. Many Ord.-Eoc. fossils erroneously assigned to this genus, based on presence of oxeas (22). *Rec.*

Petrosia VOSMAER, 1865 [**Reniera dura* SCHMIDT, 1862; SD DELAUB., 1932]. Differs from *Haliclona* in having 4 kinds of monaxons (8). *?Tert., Rec.*, cosmop.

Climacospongia HINDE, 1884 [**C. radiata*]. Vertical tracts of overlapping oxeas connected horizontally by single oxeas forming a reticulate skeleton; canals radiate from point at base. May be a lyssakid hyalosponge (12). *Sil.*, Tenn.

Petrosites HOWELL & LANDES, 1936 [**P. humilis*]. ?Like *Petrosia*. *L.Ord.*, Wis.

Family DESMACIDONTIDAE Gray, 1867

[*nom. correct.* DELAUB., herein (*ex* Desmacidonidae GRAY, 1867)]

Like Haliclonidae but having microscleres; flesh commonly slimy. *Tert.-Rec.*

Desmacidon BOW., 1862 [**Spongia fruticosa* MONTAGU, 1818; SD DELAUB., 1936]. Megascleres all oxeas; microscleres sigmas and arcuate isochelas; flesh very slimy (14,22). *?Tert., Rec.*, Eu.

Guitarra CARTER, 1874 [**G. fimbriata;* SD DELAUB., 1932]. Megascleres monaxons; microscleres include placochelas (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Family HAPLISTIIDAE de Laubenfels, nov.

Skeleton composed chiefly of grouped simple monaxons. *M.Ord.-L.Carb.*

Haplistion Y.-Y., 1877 [**H. armstrongi*]. Rugose oval disk with many holes. *M.Ord.*(Wales)-*L.Carb.*(Scot.).

Lasiocladia HINDE, 1884 [**L. compressa*]. More vague and confused than *Haplistion*. *L.Dev.-L.Carb.*, Belg.

Family WAPKIIDAE de Laubenfels, nov.

Oxeas form close network in elongate

oval patterns or flat fronds with compact walls; spongin indicated by firm surface and crisp outlines. *Cam.*

Wapkia Walc., 1920 [**W. grandis*]. Can. (45). ——Figs. 18,*6*; 19,*4*. **W. grandis,* part of frond showing arrangement of long spicules, ×1, ×3 (88, 88*).

Family HAZELIIDAE de Laubenfels, nov.

Simple elongate cylindrical, ramose or frondose; thin-walled, with dense dermal layer containing special fine spicules and some larger ones of the endosome; all spicules simple monaxons. *Cam.*

Hazelia Walc., 1920 [**H. palmata*]. Can. (45). ——Fig. 18,*4*. **H. palmata,* part of surface showing ascending tracts and hispid upper edge, ×2 (88).

Family TAKAKKAWIIDAE de Laubenfels, nov.

Slender thin-walled tube with longitudinal tracts of delicate oxeas, probably embedded in spongin. *Cam.*

Takakkawia Walc., 1920 [**T. lineata*]. Can. (45). ——Fig. 19,*3*. **T. lineata,* ×1 (88*).

Family UNCERTAIN

Eurydiscites Sollas, 1880 [**E. irregularis*]. Only a few loose spicules. *Cret.,* Eng.

Toriscodermia Wisniowski, 1886 [no species]. Loose spicules. *Jur.,* Eu.

Esperites Carter, 1871 [**E. giganteus*]. Isolated sigma. *L.Cret.,* Eu.

Order POECILOSCLERIDA Topsent, 1898

[*nom. correct.* deLaub., herein (*ex* Poecilosclerina Topsent, 1898)]

Demosponges with dermal specialization or other complexities of spicules but no radiate structure or astrose microscleres; spiny spicules, spongin, or both commonly present. *Cam.-Rec.*

Family MYXILLIDAE Hentschel, 1923

Megascleres diactinal, smooth in ectosome, and monactinal, chiefly spined in endosome. *Tert.-Rec.*

Myxilla Schmidt, 1862 [**Halichondria rosacea* Lieberkühn, 1859]. Microscleres comprise sigmas and anchorate isochelas (22). ?*Tert.*(N.Z.), *Rec.* (cosmop.).——Fig. 18,*7*. **M. rosacea* (Lieberkühn), Rec., cosmop.; *7a,b,* monaxon megascleres, ×100, *7a,* tylote, *7b,* acanthostyle; *7c,f,* microscleres, ×500, *7c,d,* sigmas, *7e,f,* anchorate isochela in 2 views (68n).

Iophon Gray, 1867 [**Halichondria scandens* Bow., 1866; SD Dendy, 1924]. Microscleres include deformed anisochelas (22). *Tert.*(N.Z.)-*Rec.*(cosmop.)——Fig. 18,*2*. **I. scandens* (Bow.), Rec., N.Atl.; *2a-c,* deformed anisochelas, ×500 (58).

Family TEDANIIDAE Ridley & Dendy, 1886

[*nom. correct.* deLaub., herein (*ex* Tedaniina Ridley & Dendy, 1886)]

Differs from Myxillidae in having chiefly smooth monaxons in endosome. *Tert.-Rec.*

Tedania Gray, 1867 [**Halichondria anhelans* Lieberkühn, 1859; SD deLaub., 1936]. Microscleres exclusively faintly spined raphids. *Rec.,* cosmop.

Acarnus Gray, 1867 [**A innominatus*]. Spicules include peculiar anatetraenes (14,22). ?*Tert.* (N.Z.), *Rec.*(cosmop.).

Melonanchora Carter, 1874 [**M. elliptica*]. Microscleres include clavidiscs (14,22). ?*Tert.*(N.Z.), *Rec.*(cosmop.).——Fig. 18,*5*. **M. elliptica,* Rec., N.Atl.; *5a,b,* clavidiscs, ×400 (53).

Forcepia Carter, 1874 [**F. colonensis*]. Microscleres include forceps (14,22). *Tert.*(N.Z.)-*Rec.* (cosmop.).

Family CLADORHIZIDAE de Laubenfels, 1936

Bizarre-shaped deep-sea sponges with peculiar chelas among microscleres. *Tert.-Rec.*

Cladorhiza Sars, 1872 [**C. abyssicola*]. Swollen anisochelas (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Chondrocladia W.Thomp., 1873 [**C. vergata*]. Peculiar anchorate isochelas (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Family AMPHILECTIDAE de Laubenfels, 1936

Monactinal spicules throughout, both in ectosome and endosome, none spiny. *Tert.-Rec.*

Amphilectus Vosmaer, 1880 [**Isodictya gracilis* Bow., 1866; SD Dendy, 1921]. Microscleres are all palmate isochelas (14,22). ?*Tert.*(N.Z.), *Rec.* (cosmop.).——Fig. 18,*8*. **A. gracilis* (Bow.), Rec., N.Atl.; *8a,b,* front and side of palmate isochelas, ×500 (68n).

Hamacantha Gray, 1867 [**Halichondria johnsonii* Bow., 1864]. Microscleres include diancistras (14, 22). *Tert.,*(N.Z.)-*Rec.*(cosmop.).——Fig. 18,*1*. **H. johnsonii* (Bow.), Rec., N.Atl.; diancistra, ×500 (52).

Family HAMPTONIIDAE de Laubenfels, nov.

Bladder-like globose sponges with thin loose walls; spicules consisting of oxeas and styles radially disposed about hollow center, with traces of spongin. Possibly related to Axinellidae, which differ in having solid axial region. *Cam.*

Hamptonia WALC., 1920 [**H. bowerbanki*]. Can. (45).——FIG. 19,*1,2*. **H. bowerbanki*, M.Cam., B.C.; ×0.75, ×4.5 (88*).

Family ACARNIIDAE de Laubenfels, 1936

Spicules all spiny, mostly with confused arrangement. *Cret.-Rec.*

Acarnia GRAY, 1867 [**Hymeniacidon cliftoni* Bow., 1864]. Acanthostrongyles and acanthotylotes present. *Rec.*, SW.Pac.

Acanthoraphis HINDE, 1884 [**A. intertextus*]. All spicules are similar spiny oxeas (12). *Cret.*, Eng.

Family UNCERTAIN

Ophiodesia SCHRAM., 1936 [**O. solivaga*]. Spiny styles and smooth sinuous oxeas (40). *Jur.*, Eng.

Makiyama DELAUB., *nom. nov.* [*pro Sagarites* MAKIYAMA, 1931[1] (*non* ASHMEAD, 1900)] [**Sagarites chitanii* MAKIYAMA, 1931]. Resembles *Halichondria*. *Tert.*, Japan.

Oppligera DELAUB., *nom. nov.* [*pro Subularia* OPPL., 1921[2] (*non* MONTEROSATO, 1884)] [**Subularia clavaeformis* OPPL., 1921]. Small club-shaped sponge with cloaca; spicules 2-mm. long styles. *Jur.*, Eu.

Order HADROMERIDA Topsent, 1898

[*nom. correct.* DELAUB., herein (*ex* Hadromerina TOPSENT, 1898)]

Demosponges with radiate architecture, a cortex, and astrose microscleres, although one of these may be lacking; megascleres are chiefly tylostyles and include no tetraxons, spongin completely lacking. *Cam.-Rec.*

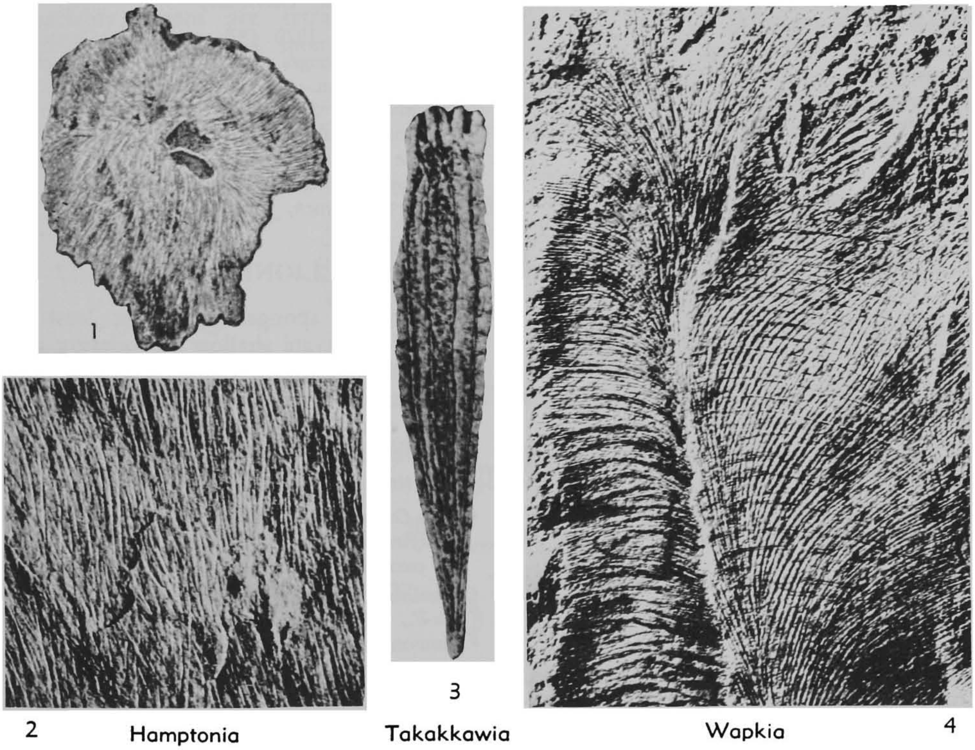

FIG. 19. Haplosclerida (*3, 4*), Poecilosclerida (*1, 2*) (p. E38-E39).

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[1] MAKIYAMA, J. (1931) *Stratigraphy of the Kakewaga Pliocene in Totomi:* Mem. Coll. Sci. Kyoto, vol. 7B, p. 5.

[2] OPPLIGER, F. (1921) *Fossil Sponges from the Jurassic:* Actes Soc. Helvet. Sci. Nat., vol. 101, p. 205.

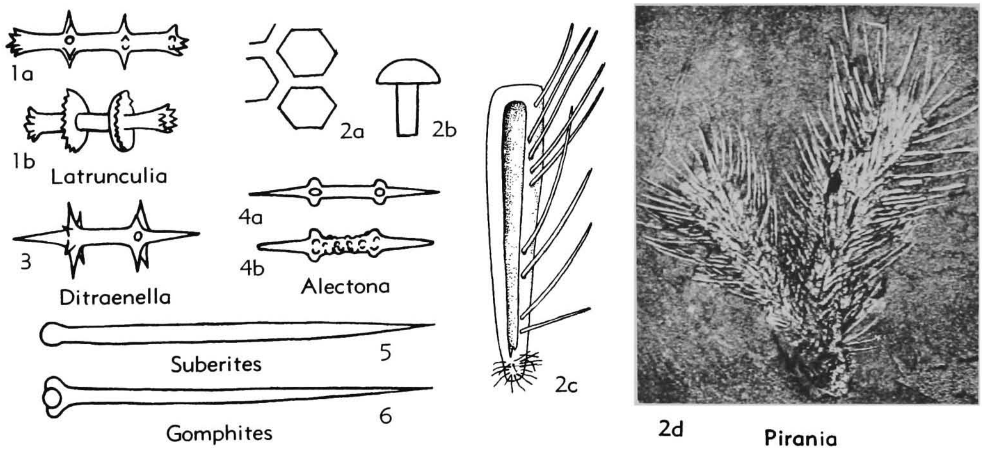

Fig. 20. Hadromerida (p. E40-E41).

Family SPIRASTRELLIDAE Hentschel, 1909

[=Choanitidae deLaub., 1936]

Forms having astrose microscleres, not boring. *Tert.-Rec.*

Spirastrella Schmidt, 1868 [**S. cunctatrix*]. Megascleres comprise tylostyles only and microscleres spirasters only. *Rec.*, cosmop.

Latrunculia de Bocage, 1869 [**L. cratera*]. Peculiar chessman microscleres. *Tert.* (N.Z.)-*Rec.* (14).——Fig. 20,*1*. **L. cratera; 1a,b,* chessman spicules, Rec., N.Atl., ×400 (58).

Ditraenella Hinde-H., 1892 [**D. oamaruensis*]. Verticillate spined microrhabds, like some in *Latrunculia,* which seem to be immature chessman spicules (14). *Tert.,* N.Z.——Fig. 20,*3*. **D. oamaruensis,* Tert., N.Z.; microsclere, ×400 (64).

Family SUBERITIDAE Ridley & Dendy, 1886

Like Spirastrellidae but lacking microscleres, not boring. *L.Cret.-Rec.*

Suberites Nardo, 1833 [**Alcyonium domunculum* Olivi, 1792]. Architecture radiate, with small tylostyles in cortex and large ones in endosome (22). *?Tert., Rec.*——Fig. 20,*5*. *S.* sp.; tylostyle, ×100 (53).

Gomphites Carter, 1871 [**G. parfitti*]. Megascleres with heads bearing several lateral protrusions (generally 4), exactly as in *Terpios* (Rec.), from which fossils may have differed in ways not preserved (22). *L.Cret.,* Eu.——Fig. 20,*6*. **G. parfitti;* megasclere, ×100 (53).

Rhopaloconus Sollas, 1880 [**R. tuberculatus*]. Tylostyles extremely thick, with heads covered by many small lumps. *Cret.,* Eu.

Family PIRANIIDAE de Laubenfels, nov.

Architecture hollow, spicules consisting chiefly of tylostyles with points directed outward, but short boltlike ectosomal spicules with heads outward form a sort of surface pavement. *Cam.-Sil.*

Pirania Walc., 1920 [**P. muricata*]. Characters of family; sponges tubular, may be branched. *Cam.-Sil.,* Can.——Fig. 20,*2*. **P. muricata,* M.Cam., B.C.; *2a,* part of pavement formed by ectosomal spicules, ×2; *2b,* one of these spicules in side view, ×2; *2c,* diagrammatic outline of stem showing walls and spicules, ×3; *2d,* branched specimen, ×1.5 (88).

Family CLIONIDAE Gray, 1867

Burrowing sponges which at least in early life excavate shallow meandering galleries of subuniform diameter (commonly 1 to 6 mm.) in calcareous shells, with numerous exits of gallery-size diameter; if branches occur, they are about as large as main stem. *Sil.-Rec.*

Cliona Grant, 1826 [**C. celata*)]. Spicules chiefly tylostyles but generally spirasters are present and less commonly oxeas (22). *Dev.-Rec.,* cosmop.

Clionolithes Clarke, 1908 [**C. radicans;* SD Fenton-F., 1932]. Galleries about 0.5 mm. diameter, commonly radiating. *Dev.-Carb.,* U.S.A.

Clionoides Fenton-F., 1932 [**C. thomasi*]. Irregularly branched widely spaced galleries. *Dev.,* Iowa.

Filuroda Solle, 1938 [**Clionolithes reptans* Clarke, 1908]. Poorly known. *Dev.,* Eu.

Thoosa Hancock, 1849 [**T. cactoides;* SD deLaub., 1936]. Megascleres typically are conjoined spheres with one or more radiating shafts; microscleres commonly with verticillate spines as in *Ditraenella* (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Alectona Carter, 1879 [**A. millari;* SD deLaub., 1936]. Like *Thoosa* but not certainly burrowing and larva seems to be choristid; some megascleres peculiarly lumpy (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).——Fig. 20,*4*. **A. millari,* Rec., N.Atl.; *4a,b,* microscleres, ×400 (53).

?Topsentopsis deLaub., *nom. nov.* [*pro Topsentia* Clarke, 1921[1] (*non* Berg, 1899)] [**Topsentia devonica* Clarke, 1921]. Large central galleries each with distal enlargement; so unlike any modern form that sponge affinities are doubtful. *Dev.,* U.S.A.

?Palaeosabella Clarke, 1921 [**Vioa prisca* M'Coy, 1862]. Probably a burrowing worm. *Sil.-Carb.,* U.S.A.

Order EPIPOLASIDA Sollas, 1888

[*nom. correct.* deLaub., herein (*ex* Epipolasidae Sollas, 1888)]

Architecture typically radiate, with cortex, and having astrose microscleres, but one of these characters may be lacking; invariably absent are tetraxon spicules, normal tylostyles, and spongin. Principal spicules commonly are strongyles with swollen spindle-like shafts. *Cam.-Rec.*

Family SOLLASELLIDAE Lendenfeld, 1888

Microscleres lacking. *Ord.-Rec.*

Sollasella Lendenfeld, 1888 [**S. digitata*]. Ramose; spicules include oxeas and strongyles in plumose arrangement. *Rec.,* SW.Pac.

Atractosella Hinde, 1887 [**A. siluriensis*]. Known only from smooth fusiform spicules. *M.Ord.-M.Sil.,* Eu.——Fig. 21,*1*. **A. siluriensis, Sil.,* Eng.; strongyle, ×30 (63).

Belemnospongia Miller, 1889 [**B. fascicularis*]. Oxeas radiate upward and outward from pointed base (24). *Carb.,* U.S.A.

Opetionella Zittel, 1878 [**O. radians*]. Globular (49). *Jur.,* Eu.

Trichospongia Bill., 1865 [**T. sericea*]. Hemispherical form with diactinal spicules. *Ord.,* Can.

Rhizopsis Schram., 1910 [**R. horrida*]. Like core of radiate sponge with outer parts decayed away. *U.Cret.,* Eu.

Family CORRALIOIDAE de Laubenfels, nov.

Conical forms expanding from small base in a series of fluted or lobate stages; oxeas in vertical tracts. *Cam.*

Corralio Walc., 1920 (p. 346) [*pro Corralia* Walc., 1920, p. 288 (*non* Roewer, 1913)] [**Corralia undulata* Walc., 1920] (45). Can.

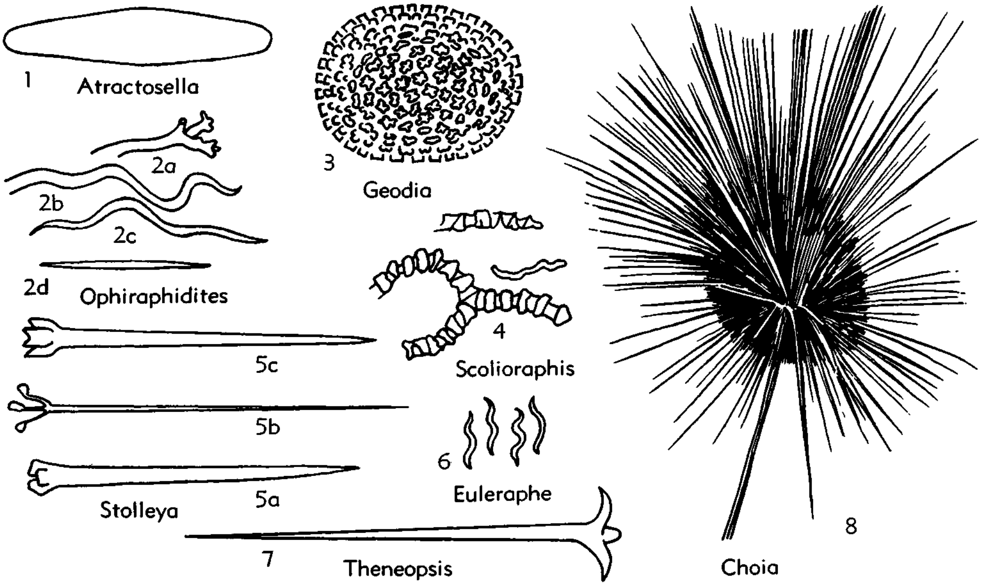

Fig. 21. Epipolasida (*1, 8*), Choristida (*2-7*) (p. E41-E43).

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[1] Clarke, J.M. (1921) *Organic dependence and disease, their origin and significance;* N.Y. State Mus., Bull. 221, p. 88.

Family CHOIIDAE de Laubenfels, nov.

Unattached forms consisting of thin central disc with very long oxeote spicules radiating from rim in same plane. Like *Radiella* (Rec.) of the Suberitidae but lacks tylostyles. *M.Cam.-Sil.*

Choia WALC., 1920 [**C. carteri*] (45). Que.-B.C.-Utah-Wales.——FIG. 21,*8*. **C. carteri,* M.Cam., Can.; ×2 (88).

Family TETHYIDAE Gray, 1867

Spheroidal forms with warty, strongly corticate surface; microscleres include sphaerasters and euasters. *?Tert., Rec.*

Tethya LAM., 1914 [**Alcyonium aurantium* PALLAS, 1766; SD TOPSENT, 1920] (8).

Family UNCERTAIN

Sentinella WALC., 1920 [**S. draco*]. Flat, thin, poorly preserved form with tubercles and some monaxon spicules (45). Possibly close to *Tethya. Cam.,* Can.

Order CHORISTIDA Sollas, 1888

Like Epipolasida but having long-shafted triaenes and commonly other tetraxon spicules. *Carb.-Rec.*

Family ANCORINIDAE Gray, 1867

Coarse thick-shafted triaenes include dichotriaenes; presence of euasters characterizes Recent ancorinids but commonly they are lost from fossils. *Jur.-Rec.*

Ancorina SCHMIDT, 1862 [**A. cerebrum;* SD DELAUB., 1936]. Contains oxeas, anatriaenes, dichotriaenes, and 3 kinds of asters. *Rec.,* cosmop.

Theneopsis SCHRAM., 1910 [*pro Tethyopsis* ZITTEL, 1878 (*non* STEWART, 1870)] [**Tethyopsis steinmanni* ZITTEL, 1878]. Oxeas and plagiotriaeanes (38). *Cret.,* Eu.——FIG. 21,*7*. **T. steinmanni* (ZITTEL), Cret., Eu.; plagiotriaene, ×30 (93).

Stelletta SCHMIDT, 1862 [**S. grubii;* SD BURTON & RAO, 1932]. Microscleres comprise 2 types of euasters (22). *Cret.-Rec.*

Stolleya SCHRAM., 1899 [**S. microtulipa;* SD herein]. Oxeas and peculiar triaenes. *Cret.,* Eu.——FIG. 21,*5*. **S. microtulipa,* Cret., Eu.; *5a-c,* triaenes, ×20 (82).

Discispongia KOLB, 1909 [**D. unica*]. Cup-shaped form with oxeas and dichotriaenes (20). *Jur.,* Eu.

Family GEODIIDAE Gray, 1867

Like ancorinids but with dermal armor of distinctive large microscleres termed sterrasters. *Carb.-Rec.*

Geodia LAM., 1815 [**G. gibberosa*] [=*Cydonium* FLEMING, 1828] (22). *Cret.-Rec.*——FIG. 21,*3*. **G. gibberosa,* Rec.; sterraster, ×400 (68n).

Erylus GRAY, 1867 [**Stelletta mammillaris* SCHMIDT, 1862]. Like *Geodia* but with flattened sterrasters (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Geodiopsis SCHRAM., 1910 [**Geodia cretacea* SCHRAM., 1899]. Like *Geodia* but with large smooth spheres which may represent sterrasters (38). *Cret.,* Eu.

Geodites CARTER, 1871 [**G. haldonensis;* SD DELAUB., herein]. Like *Geodiopsis* but with rays (clads) of triaenes blunted at ends. *Carb.-Tert.,* cosmop.

Rhaxella HINDE, 1890 [**R. perforata*]. Only sterrasters known. *U.Jur.,* Eng.

Family CRANIELLIDAE de Laubenfels, 1936

Sigmoid spiny microscleres characterize Recent forms but they are absent from fossils; otherwise members of the family are distinguished by lack of coarse triaenes. *Cret.-Tert.*

Craniella SCHMIDT, 1870 [**Alcyonium cranium* MÜLLER, 1876] (14). *Tert.-Rec.,* N.Z.

Megaloraphium SCHRAM., 1910 [**M. auriforme*]. Ear-shaped form with thin oxeas and protriaenes and some sinuous spicules (38). *U.Cret.,* Eu.

Polytretia SCHRAM., 1910 [**P. seriatopora*]. Like *Megaloraphium* but with large pores on outer surface and oscular groups on inside (38). *U.Cret.,* Eu.

Tetillopsis SCHRAM., 1910 [**T. dorinzi*]. Only thin oxeas and protriaenes present. Belongs among tetillids if microscleres lacking originally (38). *U.Cret.,* Eu.

Family SCOLIORAPHIDIDAE Zittel, 1879

[*nom. correct.* DELAUB., herein (*ex* Scolioraphidae ZITTEL, 1879)]

Some spicules strikingly annulate, like those found in the lithistid family Thamnospongiidae. *Jur.-U.Cret.*

Scolioraphis ZITTEL, 1878 [**S. cerebriformis;* SD DELAUB., herein]. Meandriform leaves or irregular shapes containing dense masses of lumpy spicules (48). *U.Cret.,* Eu.——FIG. 21,*4*. **S. cerebriformis,* spicules, ×25 (93).

Helminthophyllum SCHRAM., 1936 [**H. feifeli*]. Lumpy spicules with ornament not quite encircling rays are associated with smooth spicules (40). *Jur.,* Ger.

Condylacanthus FISCHER, 1867 [**C. gaudryi*]. Like *Scolioraphis* but less well known. *Cret.*, Fr.

Family OPHIRAPHIDITIDAE Schrammen, 1903

[*nom. correct.* DELAUB., herein (*ex* Ophiraphididae SCHRAM., 1903)]

Lithistid-like sponges characterized by peculiarly sinuous or contorted spicules, some having well-defined triaenes; evident tetraxons lacking in most. *Jur.-Rec.*

Ophiraphidites CARTER, 1876 [**O. tortuosus*]. Contorted spicules only. Type species (Rec.) represented by macerated fragments encrusting deep-sea sponge (22). *Cret.-Tert.*(Eu.)-*Rec.*(cosmop.).——FIGS. 21,*2*; 22. *O. infundibuliformis* SCHRAM., Cret., Fr.; 21,*2a*, triaene, ×16; 21,*2b,c*, ophirhabds, ×16; 21,*2d*, oxea, ×16 (21,*2*, 82); 22, spicular skeleton, ×20 (72*).

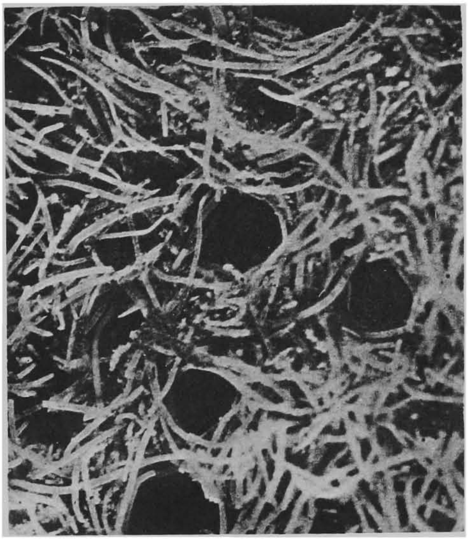

FIG. 22. *Ophiraphidites infundibuliformis* SCHRAM., Cret., Fr. (p. E43).

Heteroraphidites SCHRAM., 1901 [**H. spongiosus*] [=*Alloioraphium* SCHRAM., 1910]. Some spicules have swollen knoblike terminations (tylote) (36). *U.Cret.-Tert.*, cosmop.

Rhabdospongia SOLLAS, 1873 [**R. communis*]. Spicules are sinuous oxeas (42). *L.Cret.*, Eu.

Ophiodesia SCHRAM., 1936 [**O. solivaga*]. Spicules are sinuous ophirhabds and lumpy styles (40). *Jur.*, Eu.

Euleraphe SCHRAM., 1936 [**E. incrustans*]. Thin crust on other sponges; short sinuous spicules called eulerhabds. Strikingly similar spicules of *Megaloraphium* and *Polytreta* (Choristida) probably are convergent (40). *Jur.*, Ger.——FIG. 21,*6*. **E. incrustans;* eulerhabds, ×50 (82).

Family UNCERTAIN

Arthaberia SIEMIRADZKI, 1915 [**A. balinensis*]. Semilithistid. *Jur.*, Eu.

Cephaloraphidites SCHRAM., 1899 [**C. cavernous;* SD DELAUB., herein]. May comprise assembled spicules of diverse sponges. *Cret.*, Eu.

Fusiferella DELAUB., *nom. nov.* [*pro Atractophora* SCHRAM., 1924 (ref. 39, p. 76) (*non* STAL, 1853)] [**Atractophora armata* SCHRAM., 1924] (39). *Cret.*, Ger.

Order CARNOSIDA Carter, 1875

[*nom. correct.* DELAUB., herein (*ex* Carnosa CARTER, 1875)]

Fleshy demosponges lacking radiate structure and long-shafted triaenes and with little or no cortex. Most forms have small tetraxons with all rays nearly equal (calthrops), astrose microscleres, or both, but some lack spicules entirely, being distinguished from keratose sponges by absence of spongin. *Carb.-Rec.*

Family HALINIDAE de Laubenfels, 1936

Calthrops present and generally microscleres also. *Carb.-Rec.*

Halina BOW., 1858 [**H. bucklandi;* SD DELAUB., 1936] [=*Dercitus* GRAY, 1867]. Small calthrops common, associated with 2 types of microscleres (streptasters, toxas) (22). *Cret.-Rec.*——FIG. 23,*1*. **H. bucklandi*, Rec., Eu.; *1a*, calthrops, ×100; *1b*, streptaster, ×300; *1c*, toxa, ×300 (68n).

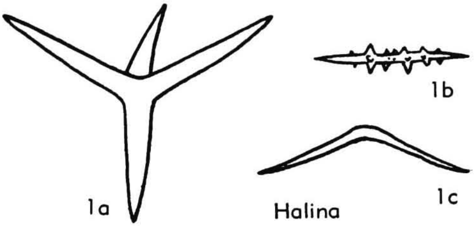

FIG. 23. *Halina bucklandi* BOW., Rec., Eu. (p. E43).

Calthropella SOLLAS, 1888 [**C. simplex;* SD LENDENFELD, 1903]. Calthrops and euasters (22). *Cret.-Rec.*, cosmop.

Triptolemma DELAUB., *nom. nov.* [*pro Triptolemus* SOLLAS, 1888[1] (*non* PECKAM, 1885)] [**Triptolemus cladosus* SOLLAS, 1888]. Calthrops, oxeas, streptasters (14,22). ?*Tert.*(N.Z.), *Rec.*(cosmop.)

Pachastrella SCHMIDT, 1868 [**P. monilifera;* SD

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[1] SOLLAS, W. J. (1888) *Report on the Tetractinellida collected by H.M.S. Challenger during the years 1873-76:* Edinburgh, vol. 25, p. 93.

DELAUB., 1936]. Oxeas, calthrops, smooth microxeas, spirasters (22). *Carb.-Rec.,* cosmop.

Propachastrella SCHRAM., 1910 [**Pachastrella primaeva* ZITTEL, 1878]. Calthrops with deformities, some with extra branching as in dichotriaenes (38). *U.Cret.,* Eu.

Paropsites POČTA, 1884 [**P. hindei*]. Oxeas, small spheres, clathrops with tips of rays finely branched (30). *Cret.,* Eu.

Corticium SCHMIDT, 1862 [**C. candelabrum*]. Calthrops, some lumpy and with ray tips finely branched (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Plakina SCHULZE, 1880 [**P. monolopha;* SD DELAUB., herein]. Oxeas and calthrops, some with one or more rays branched at tips but not lumpy (22). *Cret.-Rec.,* cosmop.

Youngella DELAUB., *nom. nov.* [*pro Chlamys* Y.-Y., 1877[1] (*non* Knoch, 1801)]. Resembles *Corticium* but poorly known. *Carb.,* Scot.

Acanthastrella SCHRAM., 1924 [**A. penniculosa*]. Spiny calthrops (39). *Jur.-Cret.,* Eu.

Acanthophora SOLLAS, 1873 [**A. hartogii*]. Poorly known (42). *L. Cret.,* Eu.

Order LITHISTIDA Schmidt, 1870

[*nom. correct.* ZITTEL, 1877 (*ex* Lithistidae Schmidt, 1870)]

Sponges characterized by lumpy spicules called desmas, and these generally so interlocked or cemented that rigid frameworks result. *Cam.-Rec.*

In nearly all lithistid sponges some spicules are comparatively simple and regular in form; typical microscleres also occur, but these are almost invariably lost from fossils. The desmas seem to be such megascleres as occur in other orders of Demospongea, but with increments of silica (Fig. 24). The microscleres indicate that most Lithistida are related to Choristida, but some are close to other orders. The group is judged to be polyphyletic, therefore, but it must be retained for two reasons. First, the general lack of microscleres preclude other allocation. Second, the sharp characterization and importance of these sponges warrant distinctive appellation.

Lithistids are represented in the Cambrian but are more abundant in the Ordovician and subsequent systems; they are most abundant in Cretaceous rocks. Doubtless in the past, as now, other orders were much more common, but lithistids are most apt to be recognizable fossils. Modern lithistids occur chiefly below the zone of penetration of light, and are world-wide in distribution.

The Lithistida are divisible into 5 suborders on the basis of desma type.

Suborder RHIZOMORINA Zittel, 1878

Desmas typically of rhizoclone type, small (commonly with rays about 0.2 mm. long,

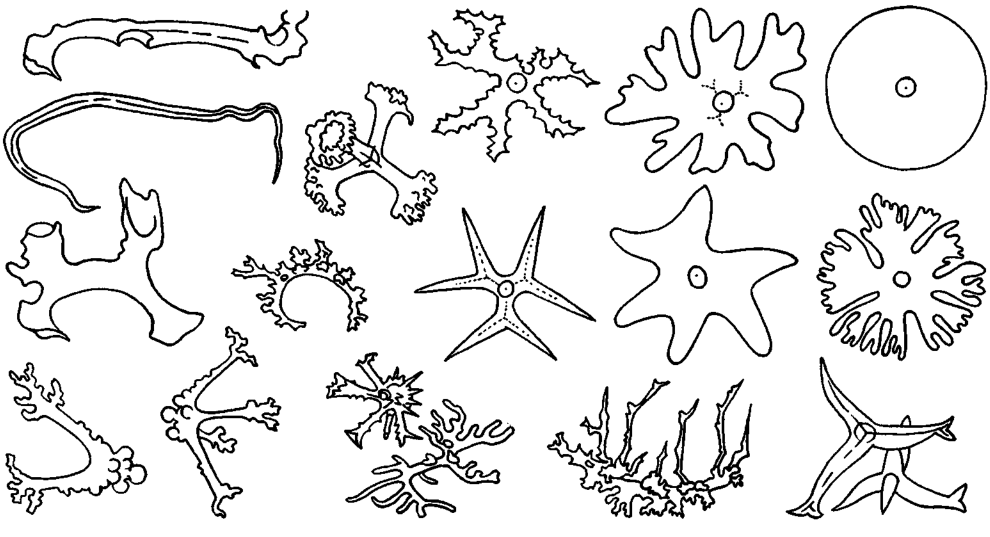

FIG. 24. Types of lithistid desmas, approximately ×25 (68n).

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[1] YOUNG, J., & YOUNG, J. (1877) *On a Carboniferous Hyalonema and other sponges from Ayrshire:* Ann. Mag. Nat. Hist. (4), vol. 20, p. 425.

rarely as much as 0.5 mm.), mostly not joined together at tips of rays. *Cam.-Rec.*

None of the rhizomorine (signifying piece of root) or rhizocladine desmas are clearly based on an original tetraxonid framework, but commonly they show development from a single straight or crooked initial rod (primordium). If 4 main rays are produced, the desma has a superficial tetraclad appearance; such spicules occur in the suborder but are rare. The common sort of desma, consisting of highly irregular rugose rhizoclones, is often termed monocrepid. Skeletons formed by union of these spicules may be classed as (1) confused when the desmas are joined together in quite irregular manner, and as (2) fibroid when the united desmas form elongate columnar tracts which may exhibit coarse reticulation. Because various genera (as *Scytalia, Chonella,* and others) have been interpreted divergently by different authors and because intermediate structures of dubious nature exist, both types of skeletons may be included in a given family.

Many sponges assigned to the Rhizomorina have smooth spicules, as well as rhizoclone desmas. These smooth spicules generally resemble typical choristid types, but they may correspond to sorts characteristic of other orders, indicating possible relationship to them. On the basis of external appearance, each of the 6 families in this suborder may be compared with some family of the Tetracladina.

Representatives of the Rhizomorina are found in nearly every system, beginning with the Cambrian, but Paleozoic fossils are mostly not well preserved. Greatest abundance of forms belonging to the suborder occurs in Cretaceous rocks.

Family KALIAPSIDAE de Laubenfels, 1936

Typical rhizomorine sponges. *Cret.-Rec.*

Kaliapsis Bow., 1869 [**K. cidaris*]. Phyllotriaenes, rhizoclad desmas, and acanthostyles. *Rec.,* Ind.O.-Pac.O.

Corallistes SCHMIDT, 1870 [**C. typus*]. Amorphous or polymorphic lithistids with monocrepid desmas, associated in some individuals with megacladine and dicranocladine types; smooth oxeas and dichotriaenes present. Recent species are characterized by streptaster microscleres. Skeleton divergently defined as fibroid (48) or confused (22,26). *Tert.-Rec.,* cosmop.

Procorallistes SCHRAM., 1901 [**P. polymorphus;* SD herein]. Like *Corallistes* but has few or no smooth spicules (36). *Cret.-Mio.,* Ger.-Fr.

Laosciadia POMEL, 1872 [**L. fungiformis* (?=*Spongia plana* PHILL., 1829)] [=*Trachydictya* POMEL, 1872; *Seliscothon* ZITTEL, 1878 (**Spongia plana* PHILL., 1829; SD DELAUB., herein)]. Vase or funnel shape, skeleton radiate-lamellate (31, 49). *Cret.,* Eu.——FIG. 25,*5*. *L. cylindricum* (MORET), Cret., Fr.; skeleton white, ×25 (72).

Histiodia POMEL, 1872 [**H. undulata;* SD DELAUB., herein]. [=*Histodia* MORET, 1924 *(nom. null.)*]. Vase- or funnel-shaped. Fascicles of confluent and intercrossing canals in cortex (25, 31). *Cret.-Tert.* Fr.-Alg.——FIG. 25,*1*. *H. cylindrica* (MORET), Cret., Fr.; desmas, ×30 (72).

Pseudoseliscothon MORET, 1926 [**P. cazioti*]. Like *Histiodia* but desmas have extremely long roots (26). *U.Cret., Fr.*——FIG. 25,*2*. **P. cazioti;* desmas, ×25 (72).

Family SCYTALIIDAE de Laubenfels, nov.

Like Kaliapsidae but large cloaca gives tubular sponge, as in the tetracladine family Chenendoporidae. *Jur.-U.Cret.*

Scytalia ZITTEL, 1878 [**Jerea turbinata* RÖMER, 1864; SD SCHRAM., 1924]. Tubes commonly branched (49). *Jur.-Cret.,* Eu.

Coelocorypha ZITTEL, 1878 [**Siphonocoelia nidulifera* RÖMER, 1864; SD herein]. Differs from *Scytalia* in narrowness of cloacal tube; skeleton fibroid (49). *Cret.,* Eu.——FIG. 25,*4*. *C. subglobosa* ZITTEL, Ger.; spicules, ×64 (93).

Stachyspongia ZITTEL, 1878 [**Siphonocoelia spica* RÖMER, 1864; SD DELAUB., herein]. Like *Coelocorypha* but with large conical protrusions, especially near distal end; skeleton fibroid-confused (49). *U.Cret.,* Eu.——FIG. 25,*7*. *S. tuberculosa* RÖMER, U.Cret., Fr.; side view of sponge, ×1.2 (72).

Yrrhiza DELAUB., *nom. nov.* [*pro Rhizinia* KOLB, 1910 (ref. 20, p. 242) (*non* HAMMERSCHMIDT, 1838)] [**Rhizinia immunuta* KOLB, 1910]. Resembles *Coelocorypha. Jur.,* Eu.

Chondriophyllum SCHRAM., 1924 [**Verruculina tenuis* RÖMER, 1864]. Thin-walled cup or leaf (39). *U.Cret.,* Eu.

Aulosoma SCHRAM., 1924 [**Spongia radiciformis* PHILL., 1835]. Slender cylinder with surface pattern of narrow canals (39). *U.Cret.,* Ger.

Rhabdotum SCHRAM., 1924 [**R. columna*]. Like *Aulosoma* but with porous surface (39). *Cret.,* Eu.

Polyrhizophora LINCK, 1883 [**P. jurassica*]. Resembles *Coelocorypha* but poorly known. *Jur.,* Eu.

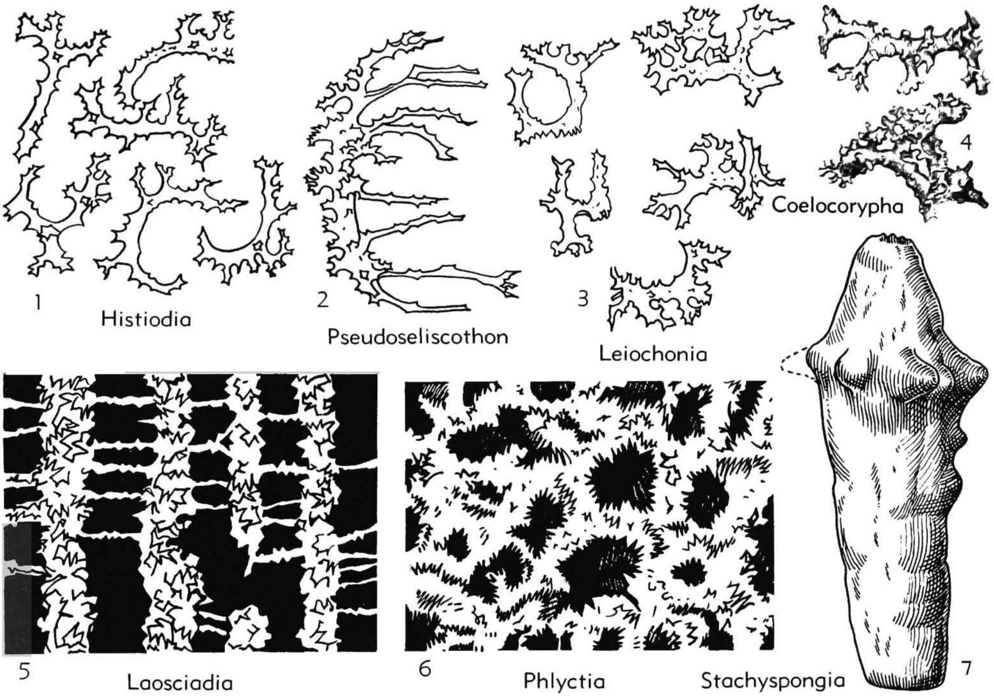

FIG. 25. Lithistida (Rhizomorina): Kaliapsidae, Scytaliidae, Chonellidae, Astroboliidae (p. E45-E47).

Family CHONELLIDAE Schrammen, 1924

Thin-walled, generally vase- or cup-shaped sponges; entire surface marked by pattern of fine pores with jagged outlines owing to lumpy desmas around them; smooth spicules few or lacking. *Jur.-Tert.*

Chonella ZITTEL, 1878 [**Cupulospongia tenuis* RÖMER, 1861]. Ear-shaped; skeleton fibroid-confused (49). *Cret.-Mio.,* Eu.-N.Afr.

Platychonia ZITTEL, 1878 [**Spongites vagans* QUENST., 1858; SD DELAUB., herein]. Like *Chonella* but skeleton extremely confused (49). *U.Jur.-Tert.,* Eu.

Discostroma ZITTEL, 1878 [**Tragos intricatum* QUENST., 1878]. Discoid, with shallow concavity at top; skeleton confused (49). *Jur.,* Eu.

Patanophyma OPPL., 1915 [**P. polyporum*]. Thin-walled vase (28). *Jur.,* Eu.

Leiochonia SCHRAM., 1901 [**L. cryptoporosa;* SD DELAUB., herein]. Moderately thick-walled cup, saucer, or plate; skeleton confused (36). *Cret.,* Eu.——FIG. 25,*3*. **L. cryptoporosa;* spicules, ×25 (72).

Amphichondrium SCHRAM., 1924 [**Verruculina convoluta* QUENST.]. Thin-walled cup (39). *U.Cret.,* Eu.

Pseudoscytalia SCHRAM., 1924 [**Spongia terebrata* PHILL., 1835]. Like *Amphichondrium* but with definite cortex (39). *U.Cret.,* Eu.

Chonellopsis SCHRAM., 1936 [**C. striata;* SD DELAUB., herein]. Small ear- or leaf-shaped form (40). *Jur.,* Eu.

Family ASTROBOLIIDAE de Laubenfels, nov.

Oscules set in shallow depressions sur-

FIG. 26. *Pliobolia fragilis* (SCHRAM.), U. Cret. (Santon.) (p. E47).

rounded by stellate pattern of radiating grooves, which in life probably were covered by dermis and functioned as apochetes; smooth spicules few or absent. Corresponds to tetracladine family Astrocladiidae. *Jur.-Tert.*

Astrobolia Zittel, 1878 [**Cnemidium conglobatum* Reuss, 1846; SD deLaub., herein]. Asymmetrical, with many small pores; skeleton ?fibroid (49). *Cret.*, Eu.

Phlyctia Pomel, 1872 [**P. expansa;* SD deLaub., herein]. Distinctive skeleton, no canals (31). *Tert.*, N.Afr.——Fig. 25,6. *P.* sp.; conjoined desmas (white), ×30 (72).

Pliobolia Pomel, 1872 [**P. vermiculata*] [=*Coscinostoma* Schram., 1910]. Funnel-shaped; skeleton confused (31). *U.Cret.*(Ger.)-*Mio.*(N.Afr.).——Fig. 26. *P. fragilis* (Schram.), U.Cret.(Santon.), Fr.; ×1 (72*).

Cytoracia Pomel, 1872 [**Stellispongia grandis* Römer, 1864; SD deLaub., herein]. Globular lobate; skeleton confused (31). *Jur.-Cret.*, Eu.

Family CNEMIDIASTRIDAE Schrammen, 1936

Massive to cylindrical, lateral surfaces bearing vertical ridges and grooves which commonly form radiate pattern on summit; smooth spicules rare or absent. Corresponds to tetracladine family Aulaxiniidae. *Ord.-Jur.*

Cnemidiastrum Zittel, 1878 [**Cnemidium stellatum* Goldf., 1833; SD deLaub., herein] [=*Lithostrobilus* Schram., 1936]. Cylindrical or top-shaped, with deep central cloaca; prosopores in grooves between ridges; skeleton confused. *Ord.-U.Jur.*, Eu.(49).——Fig. 27,2. **C. stellatum* (Goldf.), *U.Jur.*, Ger.; *2a*, specimen, ×0.5; *2b*, vert. tang. sec., showing radial canals in clefts, ×1; *2c*, desma, ×60 (94).

Proseliscothon Siemiradzki, 1915 [**P. cracoviense*]. Wider than high, cloaca lacking. *Jur.*, Eu.

Cnemispongia Quenst., 1878 [**C. goldfussii;* SD deLaub., herein]. Externally like *Cnemidiastrum* but skeleton unknown (32). *?Mesoz.*, Ger.

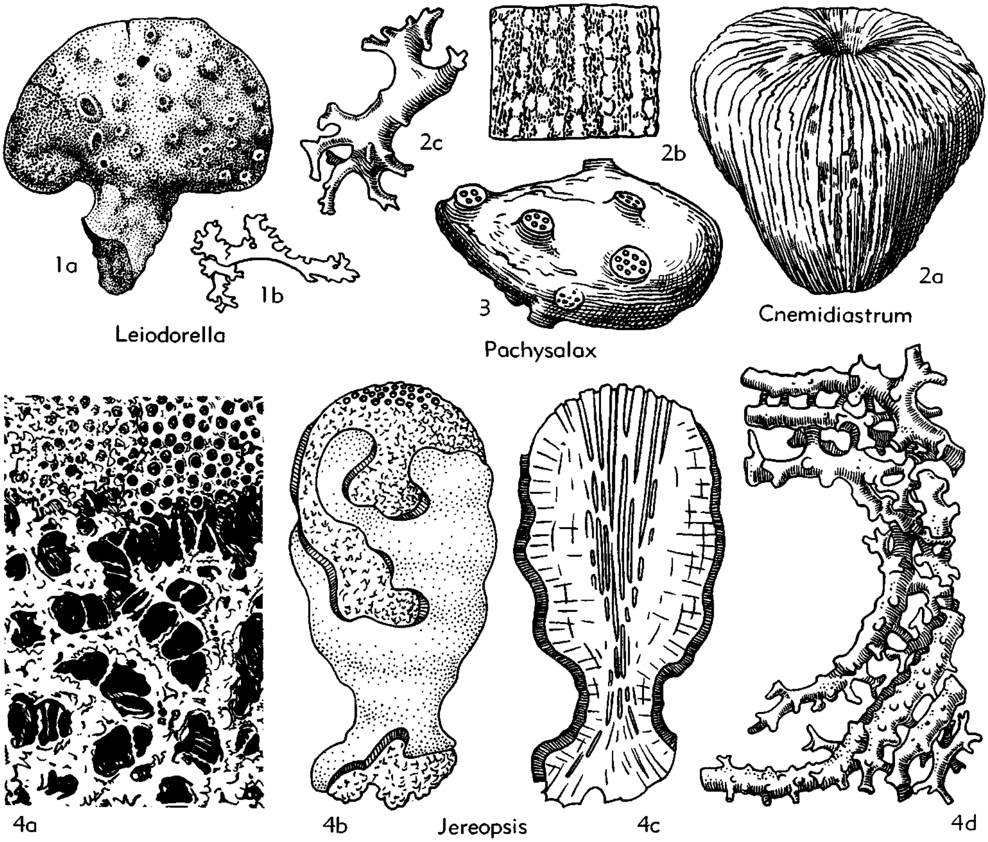

Fig. 27. Lithistida (Rhizomorina): Cnemidiastridae, Jereopsiidae, Leiodorellidae (p. E47-E48).

Family JEREOPSIIDAE de Laubenfels, nov.

Cylindrical to massive, summit rather flat, bearing oscules of several deep narrow vertical cloacas; sides finely porous, with prosochetes intersecting cloacas at right angles; smooth spicules rare. Corresponds to tetraclad family Jereiidae. *U.Jur.-Rec.*

Jereopsis Pomel, 1872 [**J. inaequalis;* SD deLaub., herein] [=*Jereopsidea* Pomel, 1872 (**Jereopsis aberrans* Pomel, 1872; SD deLaub., herein); *Jereica* Zittel, 1878]. Skeleton fibroid (25, 49). *Cret.-Tert.,* Eu.-Alg.——Fig. 27,*4a*. *J. punctata* (Goldf.), Cret., Fr.; part of skeleton, cortex with pores at right, naked endoskeleton at left, ×18 (72).——Fig. 27,*4b-d*. *J. polystoma* (Römer), Cret., Fr.; *4b,c,* side view and vert. sect., ×0.5; *4d,* rhizoclone desmas, ×60 (93).

Hyalotragos Zittel, 1878 [**Tragos patella* Goldf., 1833; SD deLaub., herein]. Commonly wider than high, shallow concavity at top (49). *U.Jur.,* Eu.

Pachysalax Schram., 1910 [**P. processifer*]. Fig- or potato-shaped, with about 10 raised areas, each resembling an individual of *Hyalotragos* or *Jereopsis* (38). *U.Cret.,* Eu.——Fig. 27,*3*. **P. processifer;* side view, ×0.5 (82).

Pomelia Zittel, 1878 [**P. schmidti*]. Resembles *Jereopsis* (49). *?Mio.*(N.Afr.),*Rec.*(Fla.).

Family LEIODORELLIDAE Schrammen, 1924

Form diverse but having smooth corticate surface with abundant small oscules surrounded by circular raised rim which has rounded (not sharp) upper edge. *Jur.-Rec.*

Leiodorella Zittel, 1878 [**L. expansa;* SD herein] [=*Amphisyringium* Schram., 1924]. Ear- or plate-shaped, possibly encrusting, both sides corticate; skeleton confused (49). *Jur.,* Eu.——Fig. 27,*1*. **L. expansa; 1a,* specimen, ×0.5; *1b,* desma, ×50 (93).

Amphistomium Schram., 1924 [**A. aequabile*]. Like *Leiodorella* but cup-shaped (39). *Cret.,* Eu.

Epistomella Zittel, 1878 [**Spongites clivosa* Quenst., 1843]. Like *Leiodorella* but oscules on one side only (49). *Jur.,* Eu.

Pyrgochonia Zittel, 1878 [**Tragos acetabulum* Goldf., 1833]. Like *Leiodorella* but desmas differ (49). *U.Jur.,* Eu.

Verruculina Zittel, 1878 [**Manon micrommata* Römer, 1841; SD deLaub., herein]. Funnel- or leaf-shaped; skeleton fibroid, some smooth spicules (49). *M.Cret.-Tert.,* Eu.——Fig. 28,*1*. *Verruculina,* various species from Cret., Eu.; *1a, V. auriformis* Römer, ×0.7 (94); *1b, V. astraea* Hinde; *1c, V. seriatopora* Römer; *1d, V. cupula* Schram.; *1e, V. miliaris* Reuss; *1b-e,* ×0.7 (72).

Scythophymia Pomel 1872 [**S. crassa;* SD deLaub., herein]. Moret (26) says "most spp. = *Verruculina*" (31). *Tert.,* Alg.

Pleurophymia Pomel 1872 [**P. cotyle;* SD deLaub., herein]. Moret (26) says "most spp. =*Verruculina*" (31). *Tert.,* Alg.

Amphithelion Zittel, 1878 [**Manon macrommata* Römer, 1841; SD Schram., 1924]. Like *Verruculina* but both oscules and pores have round raised rims. *Cret.,* Eu.

Hyalospongia Siemiradzki, 1915 [**Tragos infrajugum* Quenst., 1878]. Plate- or disk-shaped, top like *Leiodorella,* base with radiating rounded ridges. *Jur.,* Eu.

Bothrolemma Schram., 1936 [**Platychonia osculifera* Kolb, 1910]. Encrusting on other sponges (40). *Jur.,* Eu.

Stichophyma Pomel, 1872 [**Manon turbinatum* Römer, 1841; SD Rauff, 1893] [=*Marisca* Pomel, 1872; *Meta* Pomel, 1872 (*non* Laporte, 1849); *Stychophyma* Vosmaer, 1885 *(nom. null.)*; *Sticophyma* Moret, 1924 *(nom. null.)*]. Like *Leiodorella* but with serial annulate swellings; skeleton fibroid (31). *Cret.-Mio.,* Eu.-N.Afr.

Macandrewia Gray, 1859 [**M. azorica*]. Like *Stichophyma* but lacks annulate swellings and oscules confined to nearly level summit. *Cret.-Rec.*

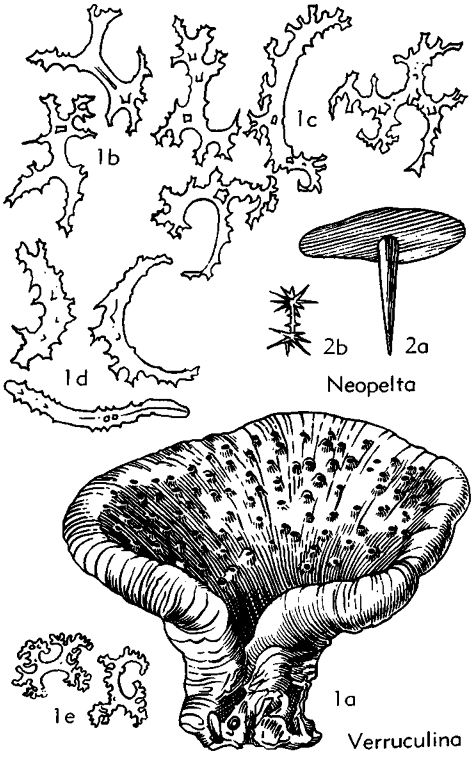

Fig. 28. Lithistida (Rhizomorina): Leiodorellidae, Neopeltidae (p. E48-E49).

Family PLINTHODERMATIIDAE de Laubenfels, nov.

Extremely thin leaflike, probably plate- or vase-shaped when complete, with one side smooth and the other rough like shark skin; without evident pores, oscules, or canals. *U.Cret.*

Plinthodermatium Schram., 1910 [**P. exile*] (38). *U.Cret.,* Ger.

Family NEOPELTIDAE Sollas, 1888

Dermal armor of discotriaenes present. Corresponds to tetracladine family Discodermiidae. *Cret.-Rec.*

Neopelta Schmidt, 1880 [**N. imperfecta*]. Endosome packed with desmas and containing some smooth oxeas and amphiasters. *Cret.-Rec.,* cosmop. ——Fig. 28,*2*. **N. imperfecta,* Rec., N.Atl.; *2a,* discotriaene, ×50; *2b,* amphiaster, ×500 (81).

Trachynoton deLaub., *nom. nov.* [*pro Trachynotus* Schram., 1924 (ref. 39, p. 76) (*non* Bell, 1862)]. [**Coscinostoma auricula* Schram., 1912]. Desmas and dermal siliceous plates (?discotriaenes lacking inward-pointing rhabds). *U.Cret.,* Ger.

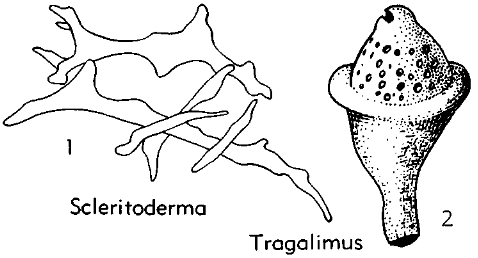

Fig. 29. Lithistida (Rhizomorina): Scleritodermatidae, Uncertain family (p. E49).

Family SCLERITODERMATIDAE Sollas, 1888

[*nom. correct.* deLaub., herein (*ex* Scleritodermidae Sollas, 1888)]

Rhizocladine sponges which seem closely related to the order Epipolasida in lacking tetraxon spicules, whereas other rhizocladine families show relationship to the order Choristida. *Cret.-Rec.*

Scleritoderma Schmidt, 1879 [**S. paccardi*]. Strongyles and monocrepid (monaxonid) desmas. In Recent species, microscleres include sigmas and sigma-like spirasters (22). *Cret.-Rec.,* cosmop.—— Fig. 29,*1*. *S. paccardi,* Rec., Gulf Mexico; spicules, ×100 (81).

Azorica Carter, 1873 [**A. pfeifferae*]. Smooth oxeas and monocrepid desmas; skeleton fibroid (8). *Cret.-Rec.,* cosmop.

Family UNCERTAIN

Pemmatites Dunikowski, 1885 [**P. verrucosa;* SD deLaub., herein]. Mass of rhizoclones with some strands of monaxons. *Carb.-Perm.,* Eu.

Nipterella Hinde, 1889 [**Calathium paradoxicum* Bill., 1865]. Subcylindrical, top convex. *Cam.-Ord.,* E.Can.

Bolidium Zittel, 1878 [**Amorphispongia palmata* Römer, 1864]. Many small pores but no evident oscules or canals; desmas with peculiarly rounded lumps (49). *Cret.,* Eu.

Tragalimus Pomel, 1872 [**Dimorpha balanus* Court., 1861; SD deLaub., herein]. Distinctive annulated pear shape, spicules poorly known. *Cret.,* Fr.——Fig. 29,*2*. **T. balanus* (Court.); side view, ×0.2 (56).

Elasmalimus Pomel, 1872 [**Dimorpha prolifera* Court., 1861; SD deLaub., herein]. Contorted; possibly same as *Tragalimus. Cret.,* Fr.

Dimorpha Court., 1872 [**D. cornuta;* SD deLaub., herein]. Like *Tragalimus* but with incomplete belt and 2 conspicuous oscules at top. *Cret.,* Fr.

Urnacristata deLaub., *nom. nov.* [*pro Lophiophora* Schram., 1924 (ref. 39, p. 110) (*non* Zryk, 1915)] [**Lophiophora sulcata* Schram., 1924] (39). *Cret.,* Ger.

Orecyta deLaub., *nom. nov.* [*pro Cytorea* Pomel, 1872 (ref. 31, p. 225) (*non* Laporte, 1849)] [**Limnorea nobilis* Römer, 1864] (31). *Cret.,* Eu.

Oncodona deLaub., *nom. nov.* [*pro Oncophora* Schram., 1924 (ref. 39, p. 112) (*non* Diesing, 1851)] [**Oncophora maeandrina* Schram., 1924] (39). *U.Cret.,* Ger.

Multipocula deLaub., *nom. nov.* [*pro Polypora* Schram., 1901 (ref. 36, p. 16) (*non* M'Coy, 1842)] [**Polypora reticulata* Schram., 1901] (38). *Cret.,* Ger.

Verrucospongia Orb., 1849 [**Manon sparsum* Reuss, 1829; SD deLaub., herein] (29). *U.Cret.,* Eu.

Microrhizophora Kolb, 1910 [**M. pentagona*]. Very small (20). *Jur.,* Eu.

Oncocladia Kolb., 1910 [**O. sulcata*] (20). *Jur.,* Eu.

Allomera Pomel, 1872 [**A. obovata;* SD deLaub., herein] (31). *Mio.,* N.Afr.

Perimera Pomel, 1872 [**Polystoma boletiformis* Court., 1861] (31). *Cret.,* Eu.

Pleuromera Pomel, 1872 [**P. inaequalis*] (31). *Mio.,* N.Afr.

Plococonia Pomel, 1872 [**Spongia contortolobata* Mich., 1847] (31). *Cret.,* Eu.

Pocillospongia Court., 1861 [**P. pyriformis;* SD deLaub., herein] [=*Poecilospongia* Pomel, 1872] (6). *Cret.,* Eu.

Heterothelion Schram., 1924 [**Verruculina cupula*] (39). *Cret.,* Ger.

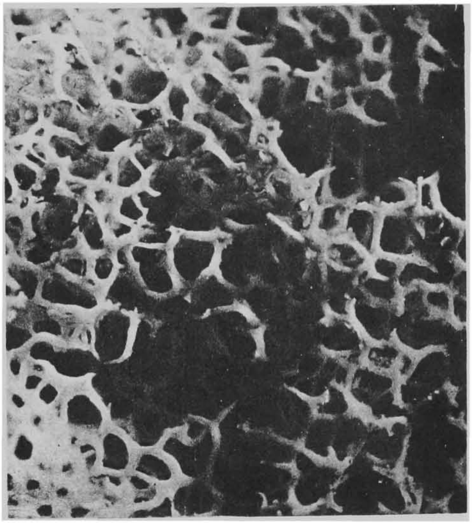

FIG. 30. *Propleroma regnardi* MORET, U.Cret., Fr. (p. E50).

Cryptothelion SCHRAM., 1924 [**C. geminum*] (39). *Cret.,* Ger.

Sporadothelion SCHRAM., 1924 [**S. dissipatum*] (39). *Cret.,* Ger.

Coelosphaeroma SCHRAM., 1910 [**C. appendiculata*] (38). *U.Cret.,* Ger.

Macrobrochus SCHRAM., 1910 [**M. emscheris;* SD DELAUB., herein] (38). *U.Cret.,* Ger.

Suborder MEGAMORINA Zittel, 1878

Desmas of megaclone type, relatively large (length commonly more than 1 mm.), with rays mostly smooth except for rounded lumps. Vertical canals representing large apochetes or narrow cloacas lead to several oscules on upper surface, and numerous small prosopores on sides are inhalant openings of subhorizontal or curved narrow prosochetes. Architecture resembles that of the rhizocladine Jereopsiidae and tetracladine Jereidae. *Carb.-Rec.*

Family PLEROMIDAE Sollas, 1888

Mostly subcylindrical sponges, unbranched, symmetrical. *Jur.-Rec.*

Pleroma SOLLAS, 1888 [**P. turbinatum*]. Desmas smooth except at ends of clads; microscleres raphids and spirasters. *Rec.,* E.Ind.——FIG. 31,*3*. **P. turbinatum; 3a,b,* megascleres, ×45 (72).

Nematinion HINDE, 1884 [**N. calyculum*]. Elongate cylindrical (commonly more than 25 cm. high), with somewhat concave summit (12). *Cret.,* Eu.——FIG. 31,2. **N. calyculum;* side, ×0.3 (63).

Carterella ZITTEL, 1878 [**Jerea cylindrica* GÜMBEL, 1861; SD DELAUB., herein]. Like *Nematinion* but with convex summit (49). *Cret.,* Eu.

Propleroma MORET, 1926 [**P. regnardi*]. Resembles *Carterella* (27). *U.Cret.,* Fr.——FIGS. 30,31,*1*. **P. regnardi;* 30, skeleton, ×20 (72*); 31,*1a-e,* desmas, ×40 (72).

Inodia MORET, 1926 [**I. elizabethae*]. Like *Carterella* but spicules very long (26). *U.Cret.,* Fr. ——FIG. 31,*5*. **I. elizabethae;* desmas, ×20 (72).

Pachypoterion HINDE, 1884 [**P. robustum;* SD DELAUB., herein]. Like *Nematinion* but expanded upward in goblet form (12). *U.Cret.,* Eu.

Holodictyon HINDE, 1884 [**H. capitatum*]. Like *Pachypoterion* but canal system obscure. *Cret.,* Eu.——FIG. 31,*6*. **H. capitatum; 6a,* side view of specimen, ×0.3; *6b,* conjoined spicules, ×25 (63).

Heterostinia ZITTEL, 1878 [**H. cyathiformis*]. Polymorphic, commonly like *Holodictyon* or *Pachypoterion* (49). *Cret.,* Eu.——FIG. 31,*7*. *H. obliqua* BENNETT; spicules, ×10 (63).

Anomorphites KOLB, 1910 [**A. plicatus;* SD DELAUB., herein] [=*Anomorphistes* FERRER HERNANDEZ *(nom. null.)*]. Cup- or saucer-shaped (20). *Jur.,* Eu.

Lyidium SCHMIDT, 1870 [**L. torquilla*]. *Eoc.-Rec.,* Eu.

Megalithista ZITTEL, 1878 [**M. foraminosa*]. Summit so concave as to produce cup shape (49). *U.Jur.,* Ger.

Family DORYDERMATIDAE Moret, 1926

[*nom. correct.* DELAUB., herein (*ex* Dorydermidae MORET, 1926)]

Like Pleromidae but cylinders branched, or growth massive with many distinct oscular areas, each resembling the summit of *Pleroma. Carb.-U.Cret.*

Doryderma ZITTEL, 1878 [**D. roemeri* HINDE, 1883 (*pro Polyjerea dichotoma* RÖMER, 1861)]. Branches shorter than wide (49). *Carb.-U.Cret.,* Eu.——FIG. 31,*8*. **D. roemeri* HINDE, U.Cret., Eng.; *8a,* side view of specimen, ×1; *8b,* dermal layer, ×2; *8c,* spicules, ×10; *8d,* spicules, showing some triaenes, ×30; *8e,* transverse section, showing prosochetes containing smooth spicules, ×20 (*8a-d*,92; *8e*,72).

Brochodora SCHRAM., 1910 [**B. ramusculus;* SD DELAUB., herein]. Resembles *Doryderma* (38). *Cret.,* Eu.

Homalodora SCHRAM., 1910 [**Spongia ramosa* MANTELL, 1822; SD DELAUB., herein]. Like *Doryderma* but has longer branches (38). *U.Cret.,* Eu.

Valhalla DELAUB., *nom. nov.* [*pro Asteroderma* SCHRAM., 1901 (ref. 36, p. 13) (*non* PERRIER, 1888)] [**Asteroderma expansa* SCHRAM., 1901] (36). *Cret.,* Eu.

Placonella HINDE, 1883 [**P. perforata;* SD DELAUB., herein]. Mass with several concave round oscular areas. *Jur.,* Eu.

Amphilectella SCHRAM., 1901 [**A. piriformis;* SD DELAUB., herein]. Pear-shaped (36). *U.Cret.,* Ger.

Family HELOBRACHIIDAE Schrammen, 1910

Besides typical megaclone desmas, contains peculiar spicules having an axial sphere from which strongly curved rays (commonly 3) diverge, the rays as much as 1 mm. long. *U.Cret.*

Helobrachium SCHRAM., 1910 [**H. consecatum*]. Incrusting, with or without lobes; oxeas present (38). *U.Cret.,* Ger.——FIG. 31,*4*. **H. consecatum;* peculiar threadlike spicules, ×12 (82).

Family ISORAPHINIIDAE Schrammen, 1924

Unusually large megaclone desmas nearly or quite unbranched; may be grouped in bundles and generally are joined at their extremities to form a network. *Jur.-Cret.*

Isoraphinia ZITTEL, 1878 [**Siphonocoelia texta*

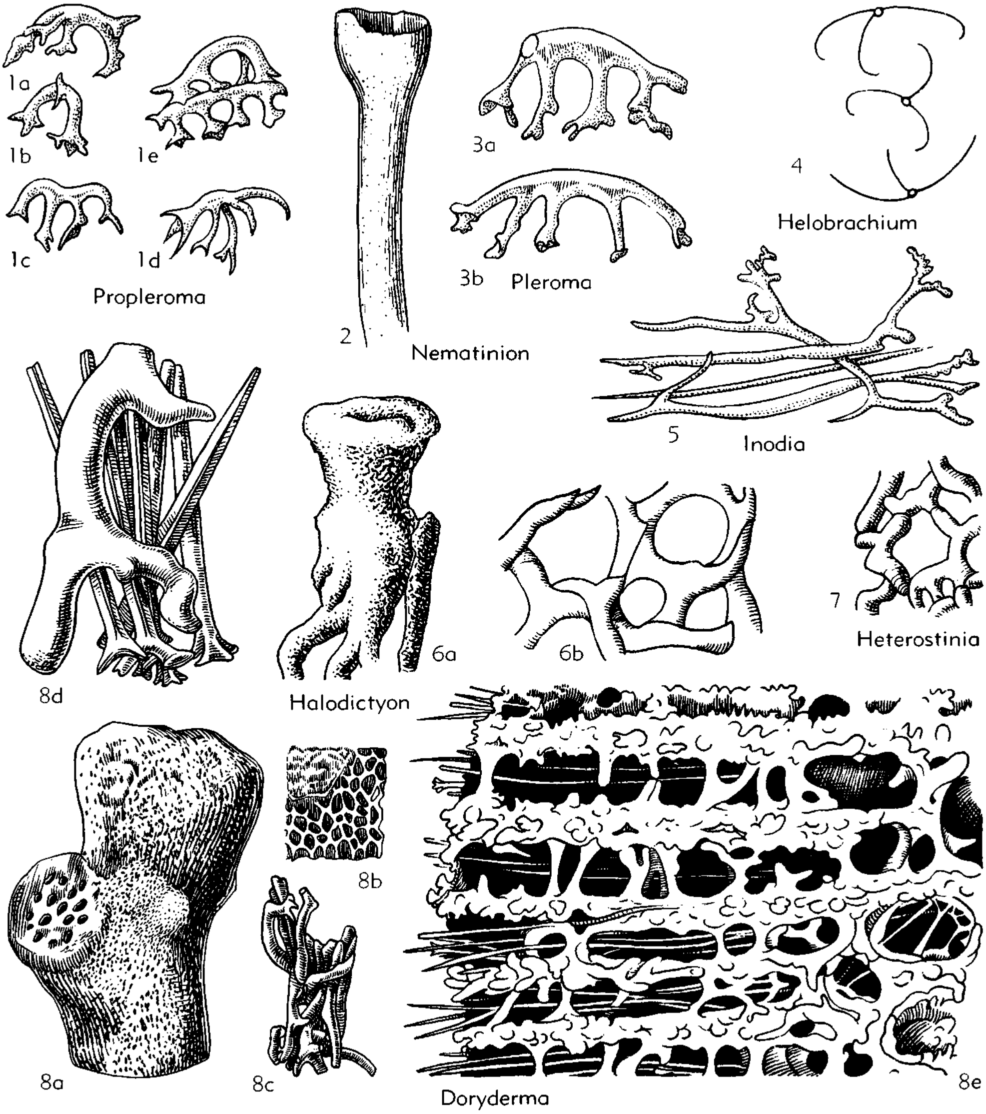

FIG. 31. Lithistida (Megamorina): Pleromidae, Dorydermatidae, Helobrachiidae (p. E50-E51).

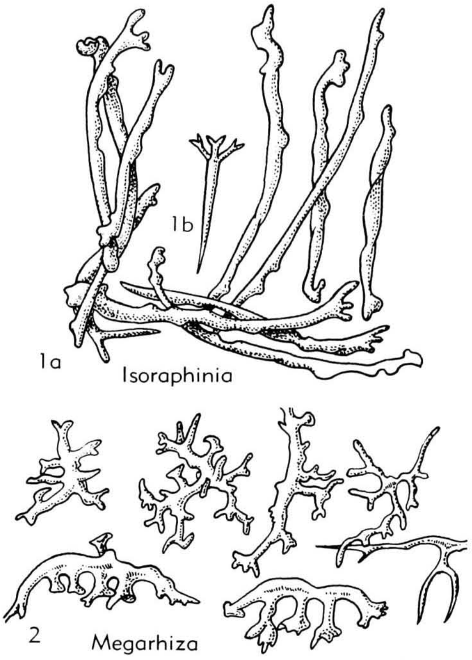

FIG. 32. Lithistida (Megamorina): Isoraphiniidae, Uncertain family (p. E52).

RÖMER, 1864]. Cylindrical, with wide, deep cloaca; contains choristid-type spicules (49). *Cret.*, Eu. ——FIG. 32,*1*. **I. texta* (RÖMER); *1a*, spicules of principal skeleton, ×30; *1b*, dermal dichotriaene, ×15 (72).

Heloraphinia SCHRAM., 1936 [**H. arborescens*]. Like *Isoraphinia* but with warty branches (40). *Jur.*, Ger.

Pachycothon SCHRAM., 1901 [**P. giganteum;* SD DELAUB., herein]. Skeleton as in *Isoraphinia* but canal system unknown (36). *Jur.-Cret.*, Eu.

Family UNCERTAIN

Megarhiza SCHRAM., 1901 [**M. dubia;* SD DELAUB., herein]. Desmas intermediate between rhizocladine and megacladine types (36). *Cret.*, Eu.——FIG. 32,*2*. *M. colungensis* MORET, Cret., Fr.; spicules, ×30 (72).

Suborder TETRACLADINA Zittel, 1878

Desmas of tetraclone type, mostly with rays smooth except at tips but some covered with lumps or spines; union of desmas commonly at contacts of elaborately sculptured ray extremities, forming a rigid fine-meshed reticulation. *Ord.-Rec.*

The desmas of this suborder, based on a tetraxonid framework, generally are intermediate in size between those of the Rhizocladina and Megacladina, but many are as small as the former and a few as large as the latter. If the tetraxonid nature of the spicules is evident, sponges containing them ordinarily are assignable to the Tetracladina whether tip-to-tip reticulation exists or not. The term tetracrepid frequently is applied to these desmas.

Tetracladine sponges predominate over other types in known fossils of Ordovician age and they are common in many younger formations. Greatest abundance is observed in Cretaceous deposits. Only a few are recorded from Tertiary rocks and the group is nearly lacking in modern faunas.

Family AULOCOPIIDAE de Laubenfels, nov.

Rounded to amorphous sponges having typically a set of prosochetes parallel to the surface and apochetes approximately normal to the surface, but this pattern may be vague; most ancient and generalized family of the suborder. *Ord.-Perm.*

Aulocopium OSWALD, 1847 [**A. aurantium* OSWALD, 1850; SD RAUFF, 1893]. Subglobular short-stalked form, underside with wrinkled dense dermis; canal system typical of family. *Ord.-Sil.*, Eu.-Ill.——FIG. 34,*1*. **A. aurantium*, Sil., Ger.; *1a*, side view of sponge, partly dissected, ×0.5; *1b*, network of spicules, ×60 (94).

Dendroclonella RAUFF, 1895 [**D. rugosa*]. Like upper part of *Aulocopium*. *U.Sil.*, Tenn.

Allosaccus RAY.-O., 1940 [**A. prolixus*]. Resembles *Dendroclonella* (34). *Ord.*, Tenn.-Va.

Exochopora RAY.-O., 1940 [**Calathium canadense* BILL., 1865] (34). *Ord.*, Can.-Ill.

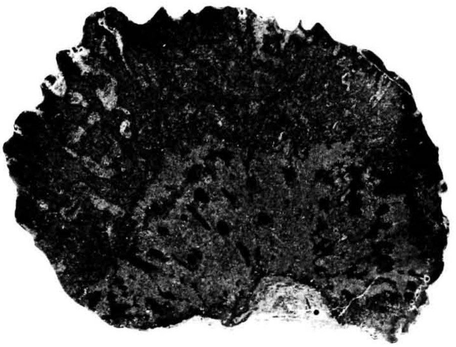

FIG. 33. *Defordia defuncta* R. H. KING, L.Perm., Tex. (p. E53).

Hudsonospongia Ray.-O., 1940 [**H. cyclostoma*]. Pear-shaped, top gently concave (34). *M.Ord.,* Tenn.-N.Y.-Vt.-Can.

Psarodictyon Ray.-O., 1940 [**P. magnificum*]. Discoid (34). *Ord.,* N.Y.

Rhopalocoelia Ray.-O., 1940 [**R. clarkii*]. Cylindrical (34). *Ord.,* N.Y.-Tenn.

Aulocopina Bill., 1874 [**A. granti*]. Resembles *Aulocopium. Sil.,* Can.

Aulocopella Rauff, 1895 [**A. winnipegensis*]. Much like *Aulocopium. Ord.,* Can.

Protachilleum Zittel, 1877 [**P. kayseri*] (40). *Sil.,* Arg.

?**Defordia** King, 1943 [**D. defuncta*]. Hemispherical, rough-surfaced like bath sponge, with large canals normal to the surface and branching near it and with slender canals parallel to surface (22), *Perm.,* Tex.——Fig. 33. **D. defuncta;* long. sec., ×1 (66).

?**Pseudovirgula** Girty, 1908 [**P. tenuis*]. Cylindrical, with oscules on side (8). *Perm.,* Tex.

Family ARCHAEOSCYPHIIDAE Rauff, 1894

Highly organized vase-shaped sponges, moderately large (10 to 20 cm. high and nearly as wide), with rather smooth walls 1 to 2 cm. thick marked by vertical rows of apopores betwen dense radiate ridges; outer side profusely porous, commonly with rounded elevations 1 or 2 cm. high or with annular rings of similar height. *Ord.*

Archaeoscyphia Hinde, 1889 [**Archaeocyathus minganensis* Bill., 1859]. Curved horn-shaped,

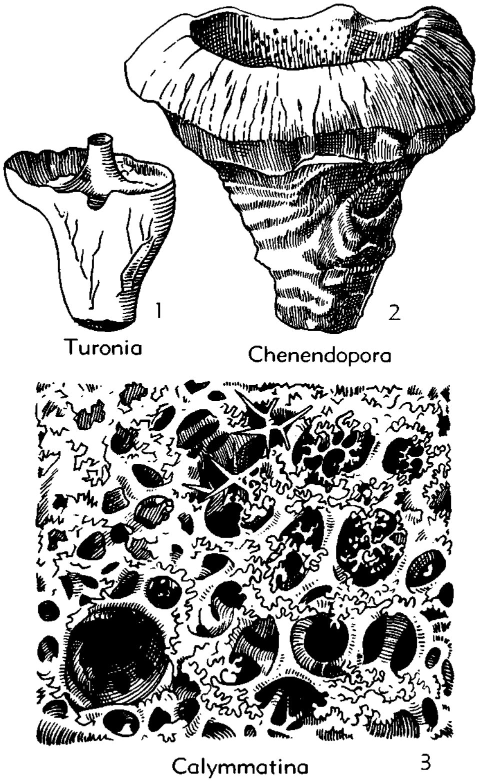

Fig. 35. Lithistida (Tetracladina): Chenendoporidae (p. E54-E55).

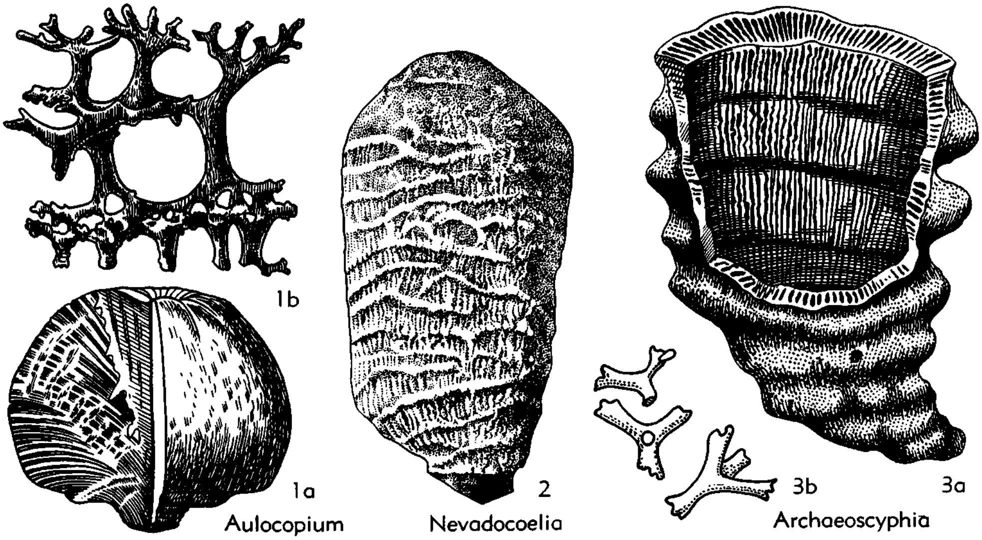

Fig. 34. Lithistida (Tetracladina): Aulocopiidae, Archaeoscyphiidae (p. E52-E54).

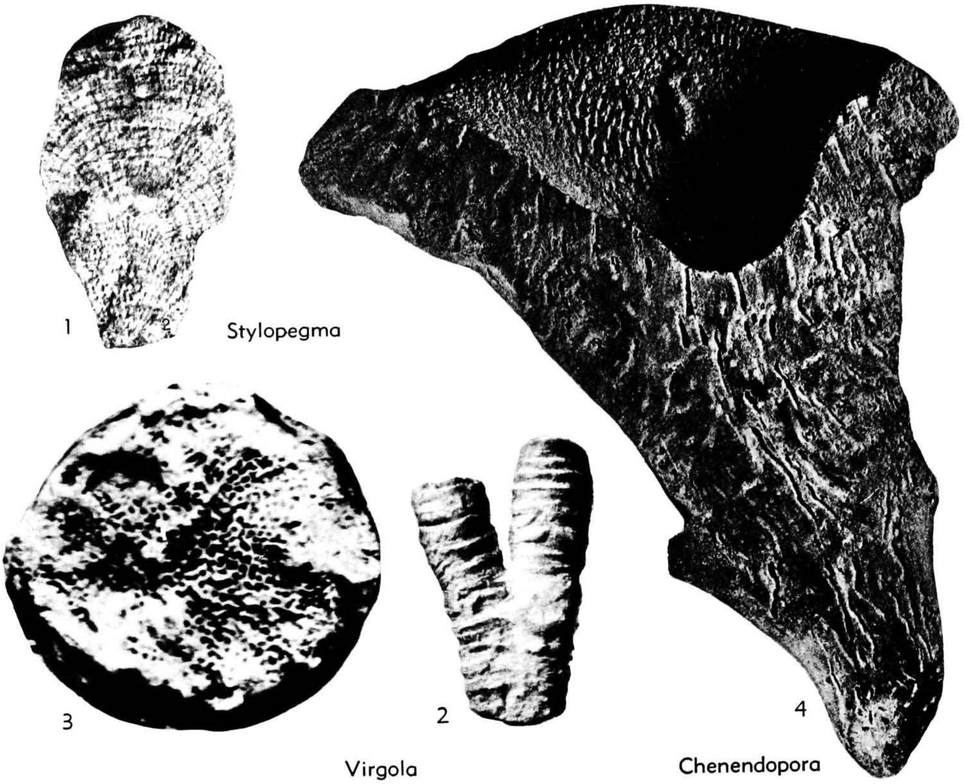

FIG. 36. Lithistida (Tetracladina): Chenendoporidae (p. E54-E55).

central cavity very deep and wide. *Ord.,* Can. (13).——FIG. 34,*3*. **A. minganensis* (BILL.); *3a,* side view of specimen, part of wall removed, ×0.3; *3b,* spicules, ×35 (63).

Nevadocoelia BASSLER, 1927 [**N. wistae*]. Simple, erect, stalked, with cloaca extending full length; outer surface ridged transversely (1). *M.Ord.,* Nev.——FIG. 34,*2*. **N. wistae,* side view of specimen, ×6 (84).

Patellispongia BASSLER, 1927 [**P. oculata*]. Lamellate, possibly comprising fragments of vase; convex side smooth, with cortex containing canals; concave side with large ?apopore openings (1). *M.Ord.,* Nev.

Hesperocoelia BASSLER, 1927 [**H. typicalis*]. Like *Patellispongia* but flat (1). *M.Ord.,* Nev.

Lissocoelia BASSLER, 1927 [**L. ramosa*]. Hollow cylinders (1). *M.Ord.,* Nev.

Calycocoelia BASSLER, 1927 [**C. typicalis*]. Cup-shaped (1). *M.Ord.,* Nev.

Ozarkocoelia CULLISON, 1944 [**O. irregularis*]. *Ord.,* U.S.A.

Family CHENENDOPORIDAE Schrammen, 1910

Like Archaeoscyphiidae but structure much simpler. Corresponds to the rhizocladine family Scytaliidae. *?Perm., Jur.-U.Cret.*

Chenendopora LAMX., 1821 [**C. fungiformis*] [=*Chenendropora* FROM., 1860]. Many slender apochetes open into cloaca (21). *U.Cret.,* Eu.——FIG. 35,*2*. **C. fungiformis,* side view of specimen, ×0.3 (94).——FIG. 36,*4*. *C. gratiosa* COURT., Fr.; ×1 (72*).

Trachysycon ZITTEL, 1878 [**Plocoscyphia muricata.* RÖMER, 1864]. Fig- or egg-shaped, cloaca very large (49). *Cret.,* Eu.

Protetraclis STEINM., 1881 [**P. linki*]. Elongate vase-shaped. *Jur.,* Ger.

Rhizotetraclis KOLB., 1910 [**R. plana*] (28). *Jur.,* Ger.

Tretoechus OPPL., 1915 [**T. coniformis*]. Like *Protetraclis;* thick-walled (29). *Jur.,* Ger.

Turonia MICH., 1849 [**T. variabilis*] [=*Turonifungia* FROM., 1860]. Expanding upward to sharp-rimmed crater containing central cone with oscule (but interpreted by author with reverse orientation). *U.Cret.,* Eu.——FIG. 35,*1*. **T. variabilis;* side view, ×0.5 (59).

Calymmatina ZITTEL, 1878 [**C. rimosa;* SD DE-LAUB., herein]. Long tubes, some branched; dense cortex (49). *U.Cret.,* Eu.——Fig. 35,*3. C. niciensis* Moret; surface showing main skeletal framework and scattered dermal spicules, with large opening of a prosopore, ×25 (72).

Pachycalymma Schram., 1901 [**P. subglobosa;* SD deLaub., herein]. Like *Calymmatina* but thicker (36). *Cret.,* Eu.

Kalpinella Hinde, 1884 [**K. pateraeformis;* SD deLaub., herein]. Stalked cup with large pores on outside and similar exhalant openings on inside. Resembles *Marginospongia* but approaches the Hallirhoidae. *U.Cret.,* Eng.

Marginospongia Orb., 1849 [**Alcyonium infundibulum* Lamx., 1821] [=*Marginoierea* From., 1860]. Like *Kalpinella* but pores minute (29). *Cret.,* Eu.

?**Virgola** deLaub., *nom. nov.* [*pro Virgula* Girty, 1908 (ref. 8, p. 73) (*non* Simpson, 1900)] [**Virgula neptunia* Girty, 1908]. Cylindrical, commonly branched, some with deep cloaca, all with conspicuous rectangular-mesh reticulation (8). *Perm.,* Tex.——Fig., 36,*3.* **V. neptunia* (Girty), Capitan; transv. sec., ×5 (60).——Fig. 36,*2. V. rigida* (Girty), Capitan, ×1 (60*).

?**Stylopegma** King, 1943 [**S. dulce*]. Like *Virgola* (19). *Perm.,* Tex.——Fig. 36,*1. S. conica* King, L.Perm., W.Tex.; nat. oblique long. sec., ×1 (66*).

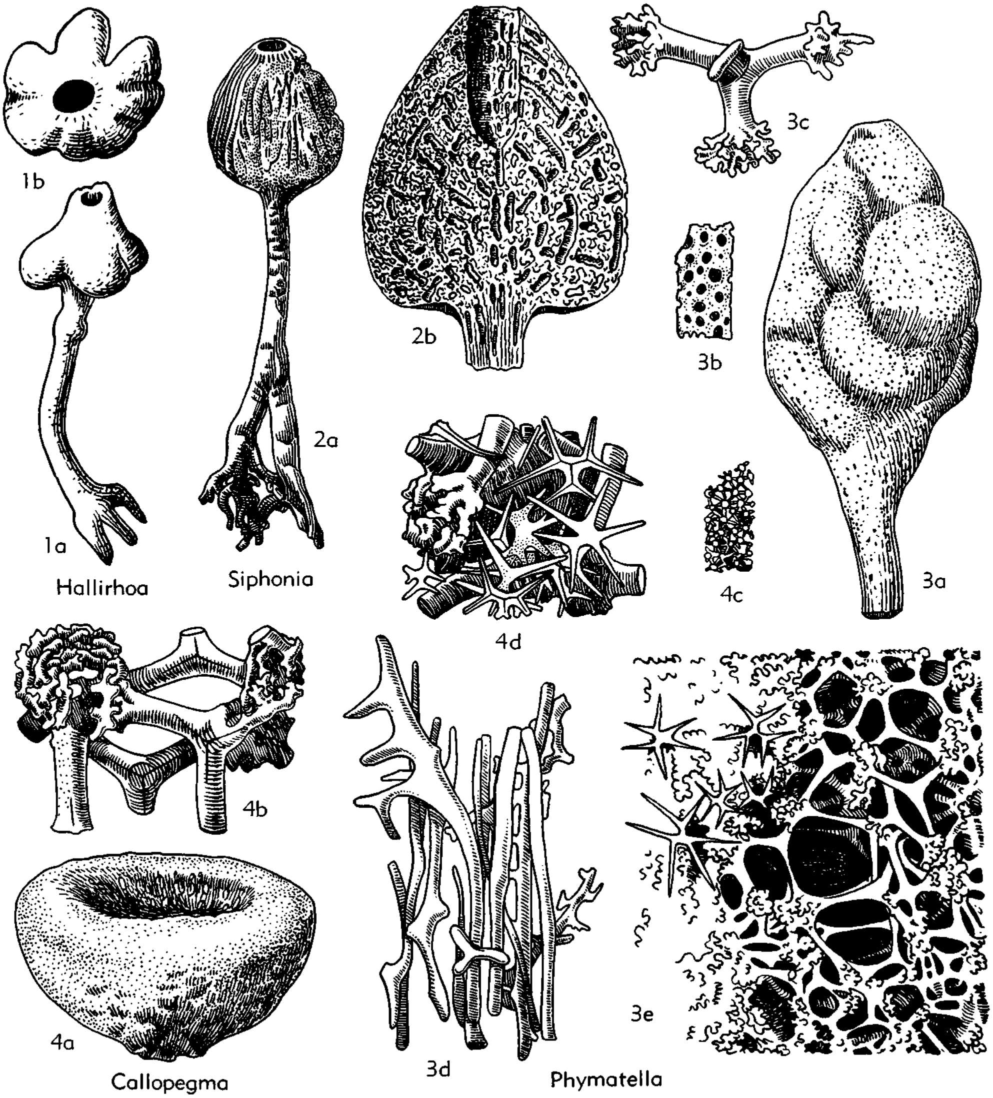

Fig. 37. Lithistida (Tetracladina): Hallirhoidae (p. E56).

Family HALLIRHOIDAE de Laubenfels, nov.

Mostly stalked (some with very long stalks), commonly with lobate lateral protrusions; surface rather smooth, with only minute pores; apochetes generally parallel to surface, with apopores in rows within cloaca; prosochetes invariably slender, subnormal to surface. *Jur.-Tert.*

Hallirhoa Lamx., 1821 [**H. costata*]. Lobate body shorter than root-bearing stalk (21). *U.Cret.*, Eu.——Fig. 37,*1*. **H. costata*; *1a*, side view; *1b*, top view of another specimen; both ×0.4 (72).

Siphonia Parkinson, 1822 [**Choanites konigii* Mantell, 1822; SD Hinde, 1887] [=*Siphoneudea* From., 1860]. Nonlobate body on long stem with large roots; well-developed canal system typical of family. *M.Cret.-Tert.*, Eu.——Fig. 37,*2*. *S. tulipa* Zittel, U.Cret., Eng.; *2a*, side view, ×0.5; *2a*, side view, ×0.5; *2b*, sagittal sec., ×1 (94).

Phymatella Zittel, 1878 [**Eudea intumescens* Römer, 1864; SD deLaub., herein]. Body irregularly lobate, longer than stem; cloaca very small (49). *U.Cret.*, Eu.——Fig. 37,*3*. *P. tuberosa* Quenst.; *3a*, side view, ×0.5; *3b*, portion of surface showing prosopores, ×1; *3c*, desma of articulated main skeleton, ×5; *3d*, spicules from stalk, ×50 (94).——Fig. 37,*3e*. *P. nodosa* Hinde; part of reticulate main skeleton (below) and cortex with dichotriaenes (above), ×30 (72).

Bathotheca Oppl., 1915 [**Batotheca ovata* Oppl., 1915 (pl. 9, fig. 4); SD deLaub., herein] [=*Batotheca* Oppl., 1915, p. 59 (*non* Enderlein, 1905)]. Like *Siphonia* but pores coarser and lacks cloaca (28). *Jur.*, Eu.

Carterella Schram., 1901 [**C. tuberosa;* SD deLaub., herein]. Funnel-shaped (36). *U.Cret.*, Eu.

Callopegma Zittel, 1878 [**C. acaule;* SD deLaub., herein]. Funnel-shaped, with very short stem (49). *U.Cret.*, Ger.-Belg.——Fig. 37,*4*. **C. acaule*, Ger.; *4a*, side view, ×0.75; *4b*, united desmas, ×40; *4c,d*, part of lateral surface, ×2, ×40 (94).

Sontheimia Kolb., 1910 [**S. parasitica;* SD deLaub., herein]. Globular, very short-stemmed, with or without cloaca (20). *Jur.*, Ger.

Asterocalyx Moret, 1926 [**A. beaussetensis*]. Horn-shaped, stemmed; apopores in cloaca grouped, with radiating ridges (26). *U.Cret.*, Fr.

Bolospongia Hinde, 1884 [**B. globata;* SD deLaub., herein]. Globular, commonly lobate as in *Phymatella* (12). *Jur.-Cret.*, Eu.

Thecosiphonia Zittel, 1878 [**Lymnorea nobilis* Römer; SD herein]. Top-shaped, dense cortex, with cloaca (49). *U.Cret.-Tert.*, Eu.

Pseudoplocoscyphia Schram., 1901 [**P. moeandrina*] (36). *U.Cret.*, Ger.

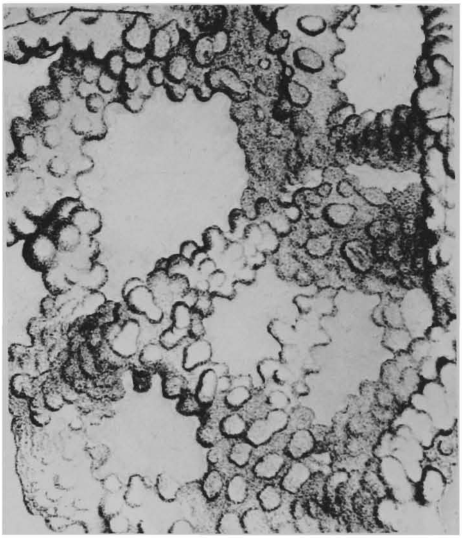

Fig. 38. *Plinthosella squamosa* Zittel, Cret., Ger. (p. E56).

Family PLINTHOSELLIDAE Schrammen, 1910

Shape various, commonly small (diameter 1 cm. or less), with surface openings (pores, ?oscules) consisting of jagged interstices between rough skeletal elements. Somewhat resemble Chonellidae. *?Perm., Cret.*

Plinthosella Zittel, 1878 [**P. squamosa;* SD Hinde, 1884] [=*Phintosella* Počta, 1883]. Globular, free or short-stemmed, with large oscules; at least some desmas very lumpy (49). *Cret.*, Eu.——Fig. 38. **P. squamosa*, Ger.; skeletal structure, ×64 (93*).

Pycnodesma Schram., 1910 [**P. globosum*]. Minute, stalked, without cloaca (38). *U.Cret.*, Eu.——Fig. 39,*1*. **P. globosum;* part of surface, ×15 (72).

Phymaplectia Hinde, 1884 [**P. irregularis;* SD deLaub., herein]. Platelike, dermal desmas triradiate, very lumpy (12). *U.Cret.*, Eng.

Zitteleus deLaub., *nom. nov.* [*pro Spongodiscus* Zittel, 1878 (ref. 49, p. 153) (*non* Ehr., 1854)]. [**Turonia radiata* Court., 1861]. Like *Phymaplectia* (49). *Cret.*, Fr.

?Monarchopemmatites deLaub., 1947 [*pro Pseudopemmatites* King, 1943 (*non* Fraipount, 1911)] [**Pseudopemmatites skinneri* King, 1943]. Surface with many pores but no dermis, large canals, or oscules (19). *Perm.*, Tex.

Family ASTROCLADIIDAE Schrammen, 1910

Scattered oscules numerous, each surrounded by stellate pattern of radiating grooves. Corresponds to rhizocladine family Astroboliidae. *Cret.-Tert.*

Astrocladia ZITTEL, 1878 [**Asterospongia laevis* RÖMER, 1861; SD DELAUB., herein]. Ramose; cortex contains desmas resembling rhizoclones (49). *U.Cret.-Tert.,* Eu.——FIG. 39,*2. A. ramosa* (MICH.), *Cret.,* Fr.; side view of specimen, ×0.5 (72).

Microdendron SCHRAM., 1901 [**M. ramulosum*]. Cylindrical or ramose, with incomplete dermis. Similar gross structure is seen in *Cystispongia* (Camerospongiidae) (36). *U.Cret.,* Ger.

Ingentilotus DELAUB., *nom. nov.* [*pro Dactylotus* SCHRAM., 1910 (ref. 38, p. 115) (*non* SCHOENHERR, 1884)] [**Dactylotus micropelta* SCHRAM., 1910]. Bushy, with flat branches; desmas resemble rhizoclones (38). *U.Cret.,* Ger.

Myrmeciophytum SCHRAM., 1910 [**Stellispongia verrucosa* RÖMER, 1864]. Oscules on wartlike elevations (38). *U.Cret.,* Ger.

Family AULAXINIIDAE de Laubenfels, nov.

Mostly subcylindrical, invariably marked by parallel longitudinal furrows on surface, which probably represent large subdermal canals in the living sponge. Corresponds to rhizocladine family Cnemidiastridae. *Cret.*

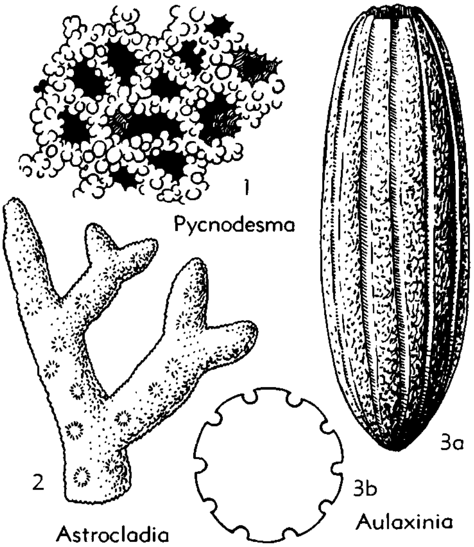

FIG. 39. Lithistida (Tetracladina): Hallirhoidae, Astrocladiidae, Aulaxiniidae (p. E56-E57).

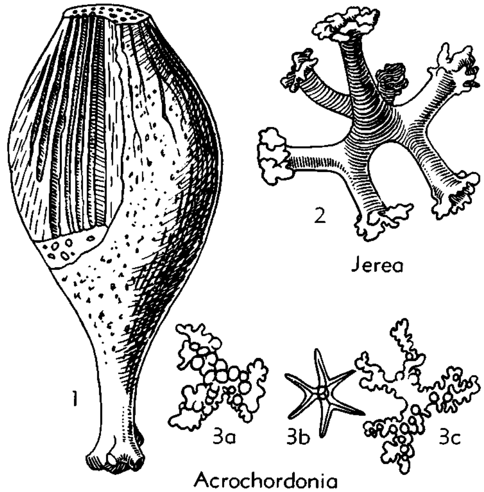

FIG. 40. Lithistida (Tetracladina): Jereidae (p. E57-E58).

Aulaxinia ZITTEL, 1878 [**Siphonocoelia sulcifera* RÖMER, 1864]. Cylindrical, with deep to shallow cloaca; desmas very large (49). *U.Cret.,* Ger.-Eng. ——FIG. 39,*3.* **A. sulcifera* RÖMER; *3a,b,* side view and transv. sec. ×0.3 (63).

Rhopalospongia HINDE, 1884 [*Polypothecia gregaris* BENNETT, 1831; SD DELAUB., herein]. Elongate club-shaped, with roots; many conspicuous pores (12). *L.Cret.,* Eng.

Family JEREIDAE de Laubenfels, nov.

Relatively large vertical apochetes open into a round, flat or gently concave area at summit of sponge; slender prosochetes, which may be obscure, are nearly normal to lateral surface and to ascending canals. Corresponds to rhizocladine family Jereicidae. *?Perm., Cret.*

Jerea LAMX., 1821 [**J. pyriformis*] [=*Ierea* FROM., 1860]. Ovoid, stalked (24). *Cret.,* Eu.——FIG. 40,*1.* **J. pyriformis,* Ger.; side partly dissected, ×0.5 (50).——FIG. 40,*2. J. quenstedti* ZITTEL, Ger.; desma, ×40 (94).

Polyierea FROM., 1860 [**Jerea gregaria* MICH., 1847] [=*Polyjerea* POMEL, 1872]. Like compound *Jerea* and may be merely a growth form of this genus (7). *Cret.,* Eu.

Dichojerea POMEL, 1872 [**Polyjerea dichotoma* RÖMER, 1864; SD RAUFF, 1893]. Like *Polyierea* (31). *Cret.,* Eu.

Bolojerea RAUFF, 1933 [**B. glebula*]. Resembles *Jerea. U.Cret.,* Eu.

Jereomorpha MORET, 1925 [**J. cenomanensis*]. Like *Jerea. U.Cret.,* Fr.

Placoscytus SCHRAM., 1910 [*pro Sollasella* SCHRAM., 1901 (*non* LENDENFELD, 1887)] [**Sollasella jer-*

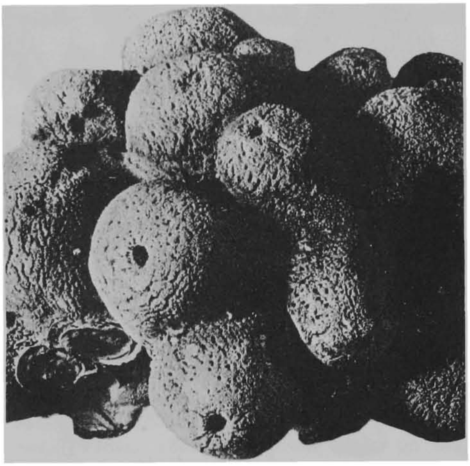

Fig. 41. *Discodermia galloprovincialis* Moret, U. Cret. (Santon.), Fr. (p. E58).

eaeformis Schram., 1910]. Like *Polyierea* on stalk, possibly a growth form of *Jerea* (38). *U.Cret.*, Ger.

Nelumbia Pomel, 1872 [**Polystoma cupula* Court., 1861; SD deLaub., herein]. Like *Jerea* with roots (31). *U.Cret.*, Eu.

?**Anthracosycon** Girty, 1908 [**A. fiscus*]. Much like *Jerea. Perm.*, Tex.

?**Laubenfelsia** King, 1943 [**L. regularis*]. Like *Jerea* but spicules much as in *Stromatidium* (22). *Perm.*, Tex.

Acrochordonia Schram., 1901 [**A. ramosa*]. Like *Jerea* but stalkless and with very lumpy tetraclones (36). *U.Cret.*, Ger.——Fig. 40,*3*. **A. ramosa; 3a,c*, lumpy tetraclones, ×30; *3b*, dermal smooth dichotriaene, ×30 (72).

Family DISCODERMIIDAE Schrammen, 1910

Dermal armor of discotriaenes or phyllotriaenes. Corresponds to rhizocladine family Neopeltidae. *L.Cret.-Rec.*

Discodermia Bocage, 1869 [**D. polydiscus*]. Polymorphic; discotriaenes grading toward phyllotriaenes (8). *Cret.-Rec.*, cosmop.——Fig. 41. *D. galloprovincialis* Moret, U.Cret.(Santon.), Fr.; ×0.8 (72*).

Racodiscula Zittel, 1878 [**Corallistes asteroides* Carter, 1873; SD deLaub., herein]. Phyllotriaenes common (49). *Cret.-Rec.*, cosmop.——Fig. 42,*2*. **R. asteroides*, Cret., Eu.; phyllotriaene from side facing sponge interior, ×50 (93).

Theonella Gray, 1868 [**T. swinhoei*]. Somewhat radiate architecture (22). *Tert.-Rec.*, cosmop.

Ragadinia Zittel, 1878 [**Cupulospongia rimosa* Römer, 1864]. Saucer-shaped, with canals opening on conspicuous branched furrows on both surfaces (49). *U.Cret.*, Ger.——Fig. 42,*4*. **R. rimosa* (Römer); *4a*, specimen, ×0.7; *4b*, desmas; *4c*, dermal phyllotriaene; *4d*, other dermal spicules; *4b-d*, ×40 (94).

Phyllodermia Schram., 1924 [**P. spinosa;* SD deLaub., herein]. Expanding upward from one or more short stalklike parts; top concave (38). *U.Cret.*, Ger.——Fig. 42,*7*. **P. spinosa; 7a*, top views of 3 specimens; *7b*, sagittal sec. of same ×0.2 (38).

Pseudojerea Moret, 1926 [**P. massiliensis;* SD deLaub., herein]. Shape like *Jerea*, with cortex as in *Discodermia* (26). *U.Cret.*, Fr.——Fig. 43,*2*. **P. massiliensis*, Santon.; ×15 (72*).

Lerouxia Moret, 1926 [**L. galloprovincialis*]. Ramose (26). *U.Cret.*, Fr.——Fig. 43,*1*. **L. galloprovincialis*, Santon.; ×15 (72*).

Dactylocalycites Carter, 1871 [**D. callodiscus;* SD deLaub., herein]. Loose thin discoid spicules, which seem to be distinctively modified phyllotriaenes or discotriaenes. *L.Cret.*(Eng.)-*Tert.* (N.Z.).——Fig. 42,*1a*. **D. callodiscus*, Tert., Austral.; spicules, ×150; 42,*1b*, same from L.Cret., Eng., ×150 (53).

Stellettites Carter, 1871 [**S. haldonensis*]. Resembles *Dactylocalycites. L.Cret.*, Eu.

Eustrobilus Schram., 1910 [**E. callosus*]. Cylindrical, cloaca large; some peculiar fusiform spicules (38). *U.Cret.*, Ger.——Fig. 42,*6*. **E. callosus; 6a*, tetraclones of main skeleton, with associated smooth spicules, ×30; *6b*, dermal phyllotriaenes, ×30 (72).

Cladodermia Schram., 1924 [**Discodermia colossia* Schram., 1912]. Rooted, cloaca deep (38). *U.Cret.*, Eu.

Leiophyllum Schram., 1924 [**L. panniculosum*]. Large, like man's arm, with network of subdermal canals; has cortex and roots (39). *U.Cret.*, Eu.

Polyrhipidium Schram., 1924 [**P. cristagalli*]. Stalked (30). *U.Cret.*, Ger.

Colossolacis Schram., 1910 [**C. plicata*]. Plates and cylinders radiating from central mass; dermal spicules very large (38). *U.Cret.*, Ger.

Rhoptrum Schram., 1910 [**R. scytaliforme*]. Short wide cylinder, cloaca deep (38). *U.Cret.*, Ger.

?**Pachycorynea** Počta, 1907 [**P. erecta*]. Cylindrical, cloaca opening at side; large monaxons in cortex. *U.Cret.*, Eu.

Family PHYMARAPHINIIDAE Schrammen, 1910

[*nom. transl. et correct.* deLaub., herein (*ex* Phymaraphininae Schram., 1910)]

Distinguished from Discodermiidae by peculiar spicules, desmas of main skeleton with annular enlargements of rays. Corresponds to the choristid family Scolioraphididae. *Cret.-Tert.*

Thamnospongia Hinde, 1884 [**T. glabra;* SD deLaub., herein]. Cylindrical, ramose, with longitudinal canals ?apochetes; spicules of main skeleton small and oddly swollen, those of dermis phyllotriaene-like (12). *U.Cret.-Tert.,* Eu.——Fig. 42,*5*. **T. glabra,* U.Cret., Eng.; *5a,* specimen, ×0.3; *5b,* endosomal spicules, ×50; *5c,* dermal spicules, ×50; (63).

Pholidocladia Hinde, 1884 [**P. dichotoma;* SD deLaub., herein]. Horn-shaped, may be branched; desmas distinct from those of *Thamnospongia* (12). *Cret.,* Eu.——Fig. 42,*3*. **P. dichotoma,* network or tetraclone spicules, ×20 (63).

Phymaraphinia Schram., 1901 [**P. infundibuliformis;* SD deLaub., herein]. Resembles *Pholidocladia* (36). *U.Cret.,* Ger.

Prokaliapsis Schram., 1901 [**P. cylindrica;* SD deLaub., herein]. Like *Pholidocladia* (36). *Cret.,* Ger.

Cycloclema Schram., 1910 [**Rhagadinia compressa* Hinde, 1883]. Like *Pholidocladia* (38). *U.Cret.,* Eu.

Lopadophorus Schram., 1910 [**Oculispongia janus* Römer, 1864; SD deLaub., herein] (38). *U.Cret.,* Ger.

Phymaplectia Hinde, 1884 [**P. irregularis;* SD deLaub., herein]. Saucer- to funnel-shaped, with dermal triaenes but no phyllotriaenes (12). *Cret.,* Eng.

Family UNCERTAIN

Vermiculissimum deLaub., *nom. nov.* [*pro Stelidium* Schram., 1924 (ref. 39, p. 55) (*non* Robertson, 1903)] [**Stelidium vermiculare* Schram., 1924]. Wormlike, very small pores. *Cret.,* Ger.

Compsaspis Sollas, 1880 [**C. cretacea*]. Spicules. *Cret.,* Eu.

Sulcastrella Schmidt, 1879 [**S. clausa*]. *Cret.-Rec.,* Eu.

Stuckenbergia Tschern., 1898 [**Kazania ufensis*]. *?Carb.-?Perm.,* Eu.

Pseudoguettardia Moret, 1926 [**Guettardia thiolati* d'Archiac, 1842] (26). *Cret.,* Eu.

Moretia Hérenger, 1944 [**M. elegans*]. *Cret.,* Sp.

Mortieria Kon., 1842 [**M. vertebralis*]. *Carb.-Perm.,* Eu.

Chalaropegma Schram., 1910 [**C. cerebriforme*] (38). *U.Cret.,* Ger.

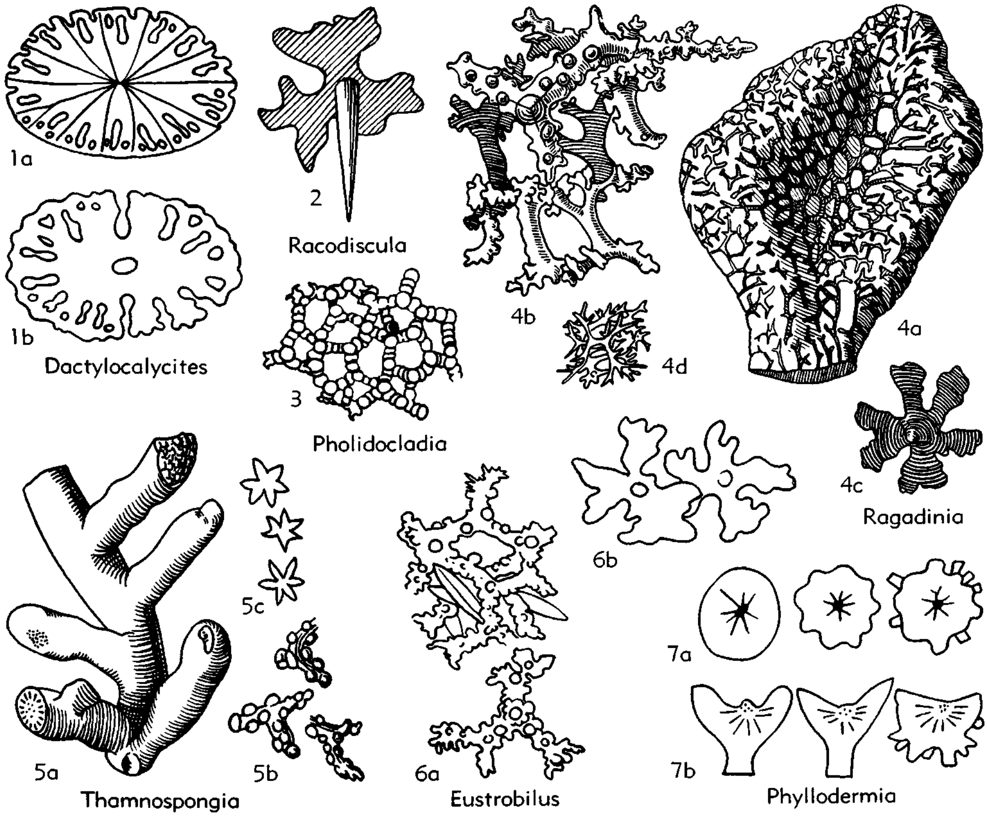

Fig. 42. Lithistida (Tetracladina): Discodermiidae, Phymaraphiniidae (p. E58-E59).

Astrolemma Schram., 1924 [**A. semiglobosum*] (39). *U.Cret.,* Ger.

Mastophorus Schram., 1924 [**M. arboreus*] (39). *U.Cret.,* Ger.

Paraspelaeum Schram., 1924 [**P. obductum;* SD herein] (39). *U.Cret.,* Ger.

Suborder EUTAXICLADINA Rauff, 1893

Rigid skeleton composed of desmas termed dicranoclones, characterized by 3 or 4 (rarely 5 or more) rays diverging from a point; union of desmas mostly between ray tip of one spicule and center or apex of another, rather than by junction of terminal parts of rays (clads) belonging to different spicules; lumpy swelling commonly present at the desma junctions. *Ord.-Rec.*

The term ennomoclone, employed by some workers, is applicable to the type of desmas found in the Eutaxicladina and Anomocladina, but it seems preferable to distinguish the dominantly tripod or tetrapod forms classed as dicranoclones from those having a strongly swollen, subglobular centrum, which are called sphaeroclones; the latter characterize anomocladine sponges. Except in the family Chiastoclonellidae, the clads of these desmas are all on one side of the globular centrum. The Eutaxicladina superficially resemble tetracladine sponges, but structure of the skeleton, as defined by nature and union of the desmas, is essentially different. Differentiation of the Eutaxicladina and Anomocladina, especially in case preservation of fossils is poor, may be difficult, because enlargement of junctions of spicular elements is noteworthy in both.

Family ASTYLOSPONGIIDAE Rauff, 1893

Subglobular or hemispherical sponges traversed by large apochetes which converge from all sides to a small or large apical cloaca. *Ord.-Cret.*

Astylospongia Römer, 1860 [**Siphonia praemorsa* Goldf., 1826; SD Pomel, 1872]. Spheroidal unattached bodies with external ridges and grooves running longitudinally as in the Cnemidiastridae and Aulaxiniidae, desmas commonly with 5 or 6 rays. *Ord.-Sil.,* cosmop.——Fig. 44,*1*. **A. praemorsa* (Goldf.), Sil., Ger.; *1a,* partly dissected specimen from side, ×1; *1b,c,* united desmas, ×12, ×100 (94).

Astylomanon Rauff, 1894 [*Palaeomanon cratera* Römer, 1860; SD deLaub., herein]. Like *Astylospongia* but lacks external sculpture (33). *Sil.,* Tenn.——Fig. 44,*4*. **A. cratera* (Römer), sagittal sections of 3 specimens, ×0.3 (78).

Palaeomanon Römer, 1860 [**Siphonia cratera* C. F. Römer, 1848]. Like *Astylomanon* but decidedly more bowl-shaped. *Sil.,* Tenn.

Microspongia Miller-D., 1878 [**M. gregaria*] [=*Hindia* Duncan, 1879]. Globular, all evident canals radially disposed around a central point; desmas symmetrical, distinctive. *Ord.-Perm.,* cosmop.——Fig. 44,*2*. **M. gregaria,* Sil., U.S., dicranoclone, ×200 (94).——Fig. 45. *M. fibrosa* Römer, M.Sil., Tenn.; *1,* mold, infilled channels appearing as tuberculate rods, ×8; *2,* section showing radial spicules, ×1; *3,* spicular skeleton, ×50 (63*).

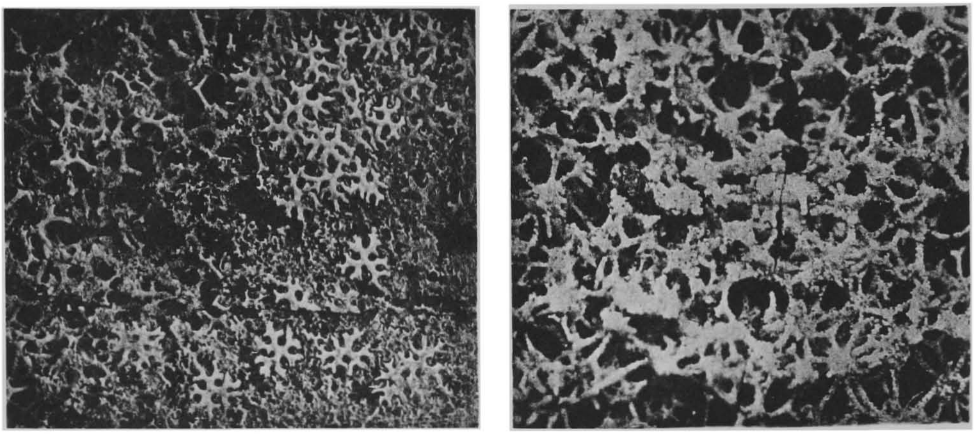
1 Lerouxia 2 Pseudojerea

Fig. 43. Lithistida (Tetracladina): Discodermiidae (p. E58).

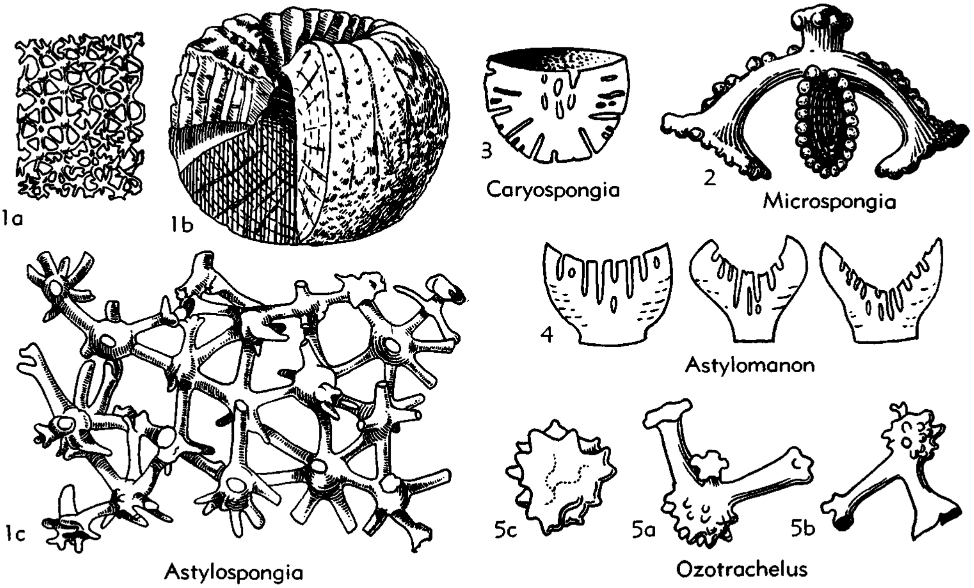

FIG. 44. Lithistida (Eutaxicladina): Astylospongiidae (p. E60-E61).

Neohindia SCHRAM., 1901 [**N. cylindrica*]. Like *Microspongia* but stalked and with distinct cloaca (36). *U.Cret.,* Ger.

Ozotrachelus DELAUB., *nom. nov.* [*pro Pachytrachelus* SCHRAM., 1910 (ref. 38, p. 170) (*non* CHAUDOIR, 1852)] [**Pachytrachelus expectatus* SCHRAM., 1910]. Resembles *Microspongia* but desmas have serpentine axial canal and sphaeroclones present (38). *U.Cret.,* Ger.——FIG. 44,*5*. **O. expectatus* (SCHRAM.); *5a,b,* dicranoclones, ×35; *5c,* sphaeroclone, ×35 (82).

Caryomanon RAUFF, 1894 [**C. glandulosum;* SD DELAUB., herein] [=*Carpomanon* HOWELL, 1937]. Like *Astylomanon* but exterior more lumpy (33). *Sil.,* Tenn.

Caryospongia RAUFF, 1894 [**Siphonia juglans* QUENST., 1878; SD DELAUB., herein] [=*Carpospongia* RAUFF, 1894]. Like *Astylomanon* but with canals normal to all parts of surface (33). *Ord.-Sil.,* cosmop.——FIG. 44,*3*. **C. juglans* (QUENST.), Sil. Eu.; sagittal section, ×0.3 (33).

Steliella HINDE, 1889 [**S. billingsi;* SD DELAUB., herein]. Subcylindrical, resembles *Astylospongia* (16). *M.Ord.,* Can.

Cyathospongia HALL, 1882 [**C. excrescens;* SD MILLER, 1889]. Somewhat like *Palaeomanon. Sil.,* N.Y.

Rhytidoderma SCHRAM., 1936 [**R. berckhemeri*]. Lumpy, with dermal net (40). *Jur.,* Ger.

?Mastophyma GERTH, 1927 [**M. jonkeri*]. *Perm.,* E.Ind.

?Palaeojerea GERTH, 1927 [**P. molengraaffi*]. *Perm.,* E.Ind.

?Palaeophyma GERTH, 1927 [**P. cucumeriformis*]. *Perm.,* E.Ind.

?Phacellopegma GERTH, 1927 [**P. campanum*]. *Perm.,* E.Ind.

?Pycnospongia GERTH, 1927 [**P. timorensis*]. *Perm.,* E.Ind.

Family GIGNOUXIIDAE de Laubenfels, nov.

Skeleton as in Astylospongiidae but shape more vaselike or hornlike. *Jur.-Rec.*

Gignouxia MORET, 1926 [**G. niciensis,* SD DELAUB., herein]. Skeleton an extremely symmetrical reticulation formed of triclad desmas; dichotriaenes also present (26). *U.Cret.,* Fr.——FIG. 46,*5*. **G. niciensis;* part of skeleton, perspective view, ×25 (72).

Iouea DELAUB., *nom. nov.* [*pro Phalangium* SCHRAM., 1910 (ref. 38, p. 170) (*non* LINNÉ, 1758)] [**Phalangium cylindratum* SCHRAM., 1910]. Cylindrical, skeletal network less regular than in *Gignouxia. Cret.,* Ger.——FIG. 46,*1*. *I. cylindratum* (SCHRAM.); section normal to surface, showing dicranoclones of main skeleton and arrangement of different kinds of dermal spicules, the latter commonly lost during fossilization, ×20 (72).

Phrissospongia MORET, 1926 [**P. glandiformis*]. Differs from *Gignouxia* in peculiarly shaped dermal spicules (26). *U.Cret.,* Fr.——FIG. 46,*2*. **P. glandiformis; 2a,b,* dermal spicules, ×40 (72).

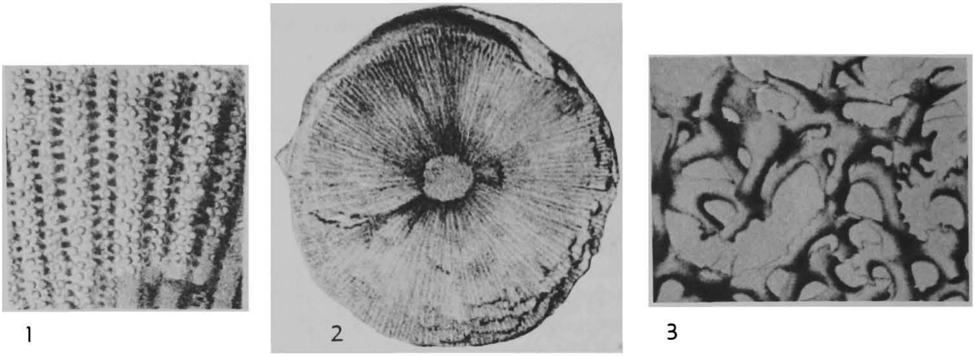

FIG. 45. *Microspongia fibrosa* RÖMER, M.Sil., Tenn.; *1*, mold, canals appearing as tuberculate rods, ×8; *2*, section showing radially arranged spicules, ×1; *3*, skeleton, ×50 (63*) (p. E60).

Dicranoclonella SCHRAM., 1936 [**D. praecursor;* SD DELAUB., herein]. Like *Gignouxia* but ear-shaped; pores resemble oscules (40). *Jur.*, Ger.

Leiocarenus SCHRAM., 1936 [**L. papillosus;* SD DELAUB., herein]. Differs from *Dicranoclonella* in having some dermal siliceous plates (40). *Jur.*, Ger.

Kyphoclonella KOLB, 1910 [**K. multiformis*] [=*Cyphoclonella* OPPL., 1925]. Polymorphic, somewhat like *Gignouxia* (20). *Jur.*, Eu.

Pachynion ZITTEL, 1878 [**Jerea scripta* RÖMER, 1864; SD DELAUB., herein]. Elongate vase-shaped (49). *Cret.*, Ger.

Coscinospongia BOW., 1869 [**C. heteroformis*]. Skeletal network vague; dichotriaenes with crooked rhabd occur in Recent species. *Cret.-Rec.*, cosmop.

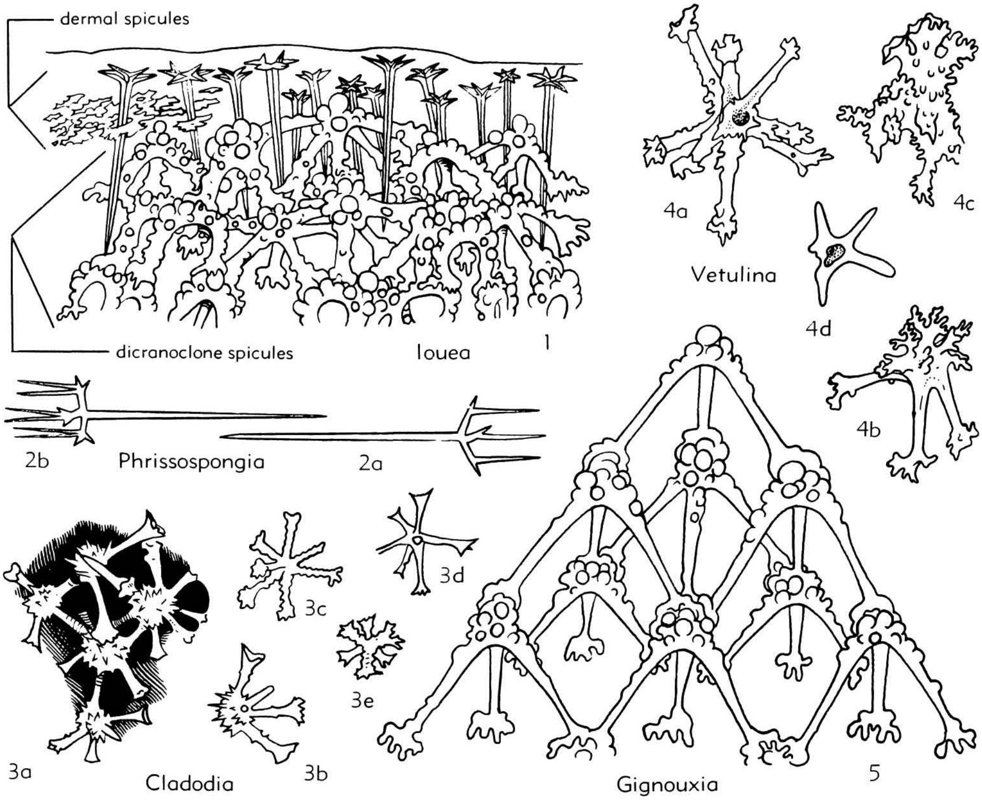

FIG. 46. Lithistida (Eutaxicladina): Gignouxiidae, Chiastoclonellidae (p. E61-E63).

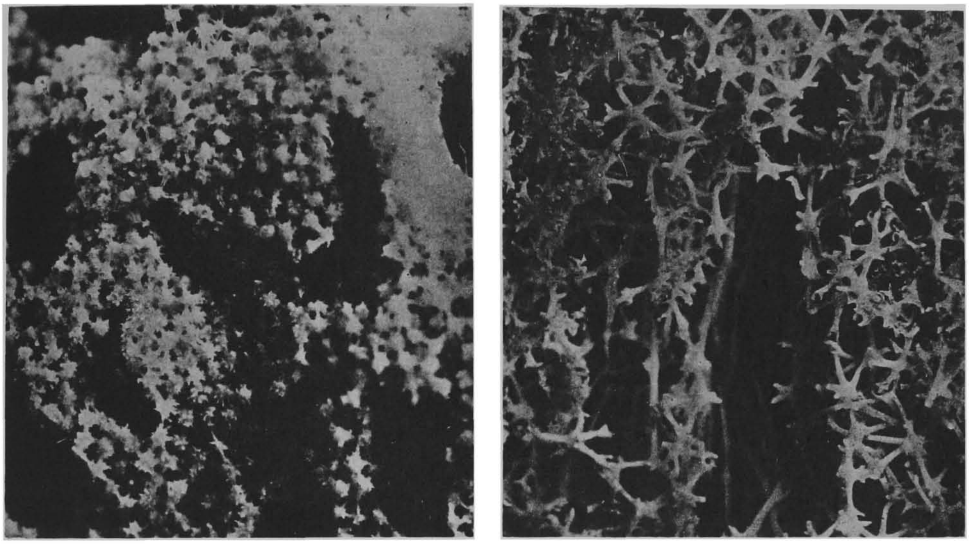

FIG. 47. Lithistida (Eutaxicladina): Chiastoclonellidae (p. E63).

Family CHIASTOCLONELLIDAE de Laubenfels, nov.

Some desmas typical of Eutaxicladina, but others have clads on more than one side of the globular centrum, thus resembling the sphaeroclones of the Anomocladina. *Ord.-Tert.*

Chiastoclonella RAUFF, 1894 [**C. headi*]. Spheroidal, composed of concentric shells of interlocked desmas separated by relatively open zones (33). *Ord.-Sil.*, Eu.

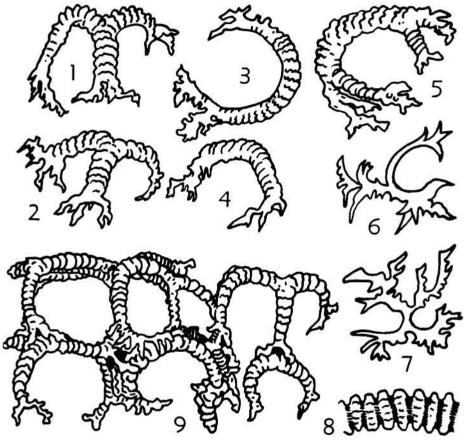

FIG. 48. *Pseudoverruculina niciensis* MORET, U.Cret. Fr. (p. E63).

Cladodia MORET, 1925 [**C. kiliani*]. Cylindrical (26). *Cret.*, Fr.——FIG. 46,*3*. **C. kiliani; 3a,* skeletal network; *3b,* normal sphaeroclone; *3c-e,* distinctive sphaeroclones from surface region; *3a-c,* ×50 (72).

Exodictydia MORET, 1926 [**E. canalifera;* SD DE-LAUB., herein]. Like *Cladodia* but massive or cup-shaped (26). *Cret.*, Fr.——FIG. 47,*1*. *E. cyathiformis* MORET, Santon.; ×35 (72*).

Regnardia MORET, 1926 [**R. lapparenti*]. Like *Cladodia* but ramose (26). *U.Cret.*, Fr.——FIG. 47,*2*. **R. lapparenti,* Cenom.; ×20 (72*).

Vetulina SCHMIDT, 1879 [**V. stalactites*]. Chiefly known from spicules only. *Tert.-Rec.*, Eu.——FIG. 46,*4*. *V. stalactites,* Rec., W.Ind. *4a,b,* typical sphaeroclones; *4c,* abnormal desma; *4d,* juvenile desma showing granular core around which spherical swelling develops; *a-c,* ×30 (85).

Family PSEUDOVERRUCULINIDAE de Laubenfels, nov.

Spicules chiefly dicranoclads with rays bearing distinctive subannulate elevations on one side; some smooth desmas (megarhizoclones) present. *U.Cret.*

Pseudoverruculina MORET, 1926 [**P. niciensis*]. Lamellate (26). *U.Cret.*, Fr.——FIG. 48. **P. niciensis; 1,2,* tripod desmas; *3-5,* dicranoclones; *6,7,* megarhizoid desmas; *8,* part of desma, ×30; *9,* articulated desmas; *1-7, 9,* ×20 (72).

Suborder ANOMOCLADINA Zittel, 1878

Lithistid sponges of tetracladine type, with reticulate skeleton formed by coalescence of desmas at points where extremities of their rays meet one another, but distinguished by the strongly swollen centrum of the desmas which gives rise to the subglobular spicules termed sphaeroclones. The rays (clads) of these spicules, ranging from 3 to mostly 5 or more in number, are disposed in radially subequal manner, instead of directionally grouped as in typical dicranoclones which characterize eutaxicladine lithistids; superficially the latter may resemble Anomocladina, but their swellings are at junctions of the spicules (tips of the clads), not at centrums. *Cam.-Jur.*

Family CYLINDROPHYMATIDAE Schrammen, 1936

[*nom. correct.* deLaub., herein (*ex* Cylindrophymidae Schram., 1936)]

Skeleton typically anomocladine, shape of sponge generally tubular. *Carb.-Jur.*

Cylindrophyma Zittel, 1878 [**Scyphia milleporata* Goldf., 1833, SD deLaub., herein]. Cylindrical, thick-walled (49). *Jur.*, Eu.——Fig. 49,*1*. **C. milleporata* (Goldf.), U.Jur., Ger.; *1a*, part of skeleton, ×30; *1b*, specimen from side, ×0.5 (94).

Melonella Zittel, 1878 [**Siphonia radiata* Quenst., 1858]. Like *Cylindrophyma* but globular, with deep cloaca; may be stalked (49). *M.Jur.-U.Jur.*, Ger.-Eng.

Didymosphaera Linck, 1883 [**D. steinmanni*]. Like *Cylindrophyma* but some desmas resemble rhizoclones. *Jur.*, Ger.

Heliospongia Girty, 1908 [**H. ramosa;* SD King, 1943]. Like much-enlarged *Cylindrophyma* (diameter 12 cm.) (8). *Carb.-Perm.*, Kan.

Coelocladia Girty, 1908 [**C. spinosa*]. Resembles *Cylindrophyma* (8). *Carb.*, Kan.

Linochone Schram., 1936 [**L. rimosa*]. Thick-walled cup (40). *Jur.*, Ger.

Coscinodiscus Schram., 1936 [**C. suevicus*]. Like *Linochone* (40). *Jur.*, Ger.

Family EOSPONGIIDAE de Laubenfels, nov.

Lithistids with very unsymmetrical desmas, generally resembling anomocladine forms but difficult to classify; mostly preserved poorly. *Cam.-Sil.*

Eospongia Bill., 1861 [**E. roemeri;* SD Miller, 1889]. Flat-topped cone with conspicuous vertical canals, cloaca at summit. *M.Ord.*, Can.——Fig. 49,*2*. **E. roemeri*, specimen from side ×1 (84).

Calathium Bill., 1865 [**C. formosum;* SD Miller, 1889]. Like *Eospongia*, with special cortex lining conical cloaca (24). *Cam.-Ord.*, Can.-E.Asia.

Trachyum Bill., 1865 [**T. cyathiforme;* SD Miller, 1889]. Structure denser, finer-grained than *Eospongia* (24). *Cam.-Sil.*, Can.

Edriospongia Miller, 1889 [**E. basalis* Ulr., 1889]. Massive, sides indented (24). *Ord.*, Ill.

Anthaspidella Miller, 1889 [**A. mammulata*]. Saucer- to funnel-shaped (24). *Cam.Ord.*, Ill.-E.Asia.

Zittelella Miller, 1889 [**Z. typicalis* Ulr., 1889]. Funnel-shaped, with horizontal canals relatively prominent (24). *M.Ord.*, Can.——Fig. 49,*3*. **Z. typicalis;* specimen from side, ×1 (84).

Dystactospongia Miller, 1883 [**D. insolens;* SD Miller, 1889]. Subcylindrical, with shallow cloaca (24). *Ord.-Sil.*, Ohio.

Strotospongia Miller, 1889 [**S. masculosa* Ulr., 1890]. Funnel-shaped, with intertwined vertical leaves radially arranged around cloaca (24). *Ord.*, U.S.A.

Heterospongia Ulr., 1889 [**H. subramosa*]. Like *Dystactospongia*, sublobate. *L.Sil.*, Ohio-Ky.

Saccospongia Ulr., 1889 [**S. rudis*]. Subcylindrical, deep cloaca. *Ord.-Sil.*, Ky.

Pycnopegma Rauff, 1895 [**P. pileum;* SD deLaub., herein]. Globose, stalked, without cloaca. *Ord.-Sil.*, U.S.A.

Anomoclonella Rauff, 1895 [**A. zitteli;* SD deLaub., herein]. *Ord.-Sil.*, U.S.A.

Family MASTOSIIDAE de Laubenfels, nov.

Subhemispherical lithistids with somewhat elongate rounded processes, resembling an inverted udder with teats; surface smooth, without oscules; no canals evident. Skeleton composed of sphaeroclones, oxeas, triaenes, and globular spicules resembling sterrasters of *Geodia*. *Jur.*

Mastosia Zittel, 1878 [**M. wetzleri*] (49). *Jur.*, Ger.

Family UNCERTAIN

Corallidium Zittel, 1878 [**Cnemidium diceratinum* Quenst., 1852] (49). *U.Jur.*, Ger.

Lecanella Zittel, 1878 [**L. pateraeformis;* SD deLaub., herein] (49). *Jur.*, Ger.

Streptospongia Ulr., 1889 [**S. labyrinthica*]. *Ord.*, U.S.A.

Streptosolen Miller, 1889 [**S. obconicus* Ulr., 1889] (24). *Ord.*, U.S.A.

Poterionella Počta, 1903 [**P. trunciformis*]. Like *Lecanella*. *Cret.*, Eu.

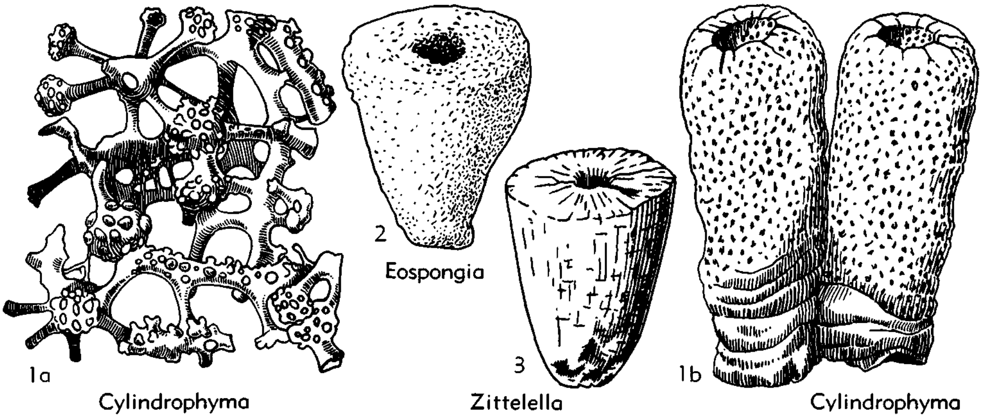

Fig. 49. Lithistida (Anomocladina): Cylindrophymatidae, Eospongiidae (p. E64).

Suborder UNCERTAIN

Hippalimus Lamx., 1821 [**H. fungoides*] [=*Hippalimeudia* From., 1860]. Mushroom-shaped, with apical oscule (21). *U.Cret.,* Eu.

Polysiphoneudea From., 1860 [**Siphonia arbuscula* Mich., 1847] [=*Polysiphonia* Pomel, 1872 (obj.)] (7). *U.Cret.,* Eu.

Siphonocoelia From., 1860 [**Scyphia elegans* Goldf., 1833] (7). *U.Jur.,* Eu.

Cupulina Court., 1861 [**C. pocillum;* SD deLaub., herein] (5). *U.Cret.,* Fr.

Platispongia Court., 1861 [**P. speculum;* SD deLaub., herein] (5). *U.Cret.,* Fr.

Polystoma Court., 1861 [**P. irregulare;* SD deLaub., herein] (5). *U.Cret.,* Fr.

Asterospongia Römer, 1864 [**A. laevis;* SD deLaub., herein] (35). *Cret.,* Ger.

Discodermites Sollas, 1880 [**D. cretaceus*]. *Cret.,* Eu.

Macandrewites Sollas, 1880 [**Dactylocalycites vicaryi* Carter, 1871]. *Cret.,* Eng.

Podapsis Sollas 1880 [**P. cretacea;* SD deLaub., herein]. *Cret.,* Eu.

Hyaloderma Oppl., 1921 [**H. porata*]. *Jur.,* Eu.

Ocellaria de Carbonnière, 1801 [**O. nuda;* SD Pomel, 1872]. *U.Cret.,* Eu.

Olkenbachia Solle, 1938 [**O. hirsuta*]. *Dev.,* Eu.

Ortmannispongia Schram., 1936 [*pro Ortmannia* Schram., 1924 (*non* Rathbun, 1902)] [**Ortmannia colligens* Schram., 1924; SD deLaub., herein]. *Cret.,* Eu.

Sphaeropegma Schram., 1936 [**S. nuda*] (40). *Cret.,* Eu.

Stromatidium Girty, 1908 [**S. typicale*] (8). *Perm.,* Tex.

Timidella deLaub., *nom. nov.* [*pro Timorella* Gerth, 1909[1] (*non* Bergh, 1905)] [**Timorella permica* Gerth, 1909]. *Perm.,* E.Ind.

Adrianella Parona, 1933 [**A. distefanoi*]. *Perm.,* Eu.

Arbuscula Parona, 1933 [**A. contortiplicata*]. *Perm.,* Eu.

Bothrochlaenia Pomel, 1872 [**B. pavonia*] (31). *U.Jur.,* ?Eu.

Cladolithosia Pomel, 1872 [no species] (31). *Cret.,* Eu.

Cymbochlaenia Pomel, 1872 [**Chenendopora complanata* Orb., 1850; SD deLaub., herein (31). *Cret.,* Eu.

Diacyparia Pomel, 1872 [**Chenendopora rugosa* Orb., 1849; SD deLaub., herein] (31). *Cret.,* Eu.

Elasmolimus Pomel, 1872 [**Dimorpha prolifera* Court., 1861; SD deLaub., herein] (31). *Cret.,* Eu.

Hypothyra Pomel, 1872 [**Scyphia trilobata* Mich., 1847] (31). *Cret.,* Eu.

Ischadia Pomel, 1872 [**I. typica*] (31). *Tert.,* N.Afr.

Orosphecion Pomel, 1872 [**Manon pulvinarium* Goldf., 1833] (31). *Cret.,* Eu.

Pachypsechia Pomel, 1872 [**P. subannulata*] (31). *Jur.,* N.Afr.

Physocalpia Pomel, 1872 [**Scyphia mamillata* Court., 1861] (31). *Cret.,* Fr.

Placojerea Pomel, 1872 [**Jerea desnoyersii* Mich., 1847] (31). *Cret.,* Fr.

Plethosiphonia Pomel, 1872 [**P. oroides*]. [=*Pliobunia* Pomel, 1872] (31). *Tert.,* N.Afr.

Polythyra Pomel, 1872 [**Scyphia perforata* Court., 1861] (31). *Cret.,* Eu.

Pterocalpia Pomel, 1872 [**Scyphia alata* Court., 1861] [=*Petrocalpia* Rauff, 1893 (*nom. null.*)]. *Cret.,* Eu.

Rhagosphecion Pomel, 1872 [**Cnemidium conglobatum* Reuss, 1841] (31). *Cret.,* Eu.

Rhizostele Pomel, 1872 [**Rhizospongia clavata* Court., 1861] (31). *Cret.,* Eu.

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[1] Gerth, H. (1909) *Timorella permica, n.g., n. sp., eine neue Lithistide aus dem Perm von Timor:* Centralbl. Mineral., vol. 22, p. 695.

Scythophyma Pomel, 1872 [**C. crassa;* SD deLaub., herein] (31). *Tert.,* N.Afr.

Trachycinclis Pomel, 1872 [**Spongia ramosa* Mantell, 1822] (31). ?Age, ?loc.

Tragalimus Pomel, 1872 [**Dimorpha balanus* Court., 1861] [=*Glyphalimus* Pomel, 1872] (31). *Cret.,* Eu.

Class HYALOSPONGEA Vosmaer, 1886

[*nom. correct.* deLaub., herein (*ex* Hyalospongiae Vosmaer, 1886)] [=Hexactinellida Sollas, 1887]

Skeletal structure siliceous, very open, generally with large central cloaca as in sycons; flesh of simple rhagon type but much less compact than in Demospongea. Some Paleozoic forms may have been ascon. *?Precam., L.Cam.-Rec.*

The rays of hyalosponge spicules typically form a right angle where they diverge from one another, whereas spicules of demosponges tend to have rays separated by angles of 60 or 120 degrees. A very common type of spicule in the Hyalospongea is a tetraxon with all 4 rays in the same plane; these are termed stauracts. Spicules with 5 rays (pentacts) or 6 rays (hexacts) are like stauracts with extra rays meeting the others perpendicularly. Octactinal and so-called polyactinal spicules (with more than 8 rays) also occur. The name Hexactinellida, which has been used for the class, is inappropriate because spicules other than hexacts are prevalent in some genera and because Hexactinellida is almost identical with the family name Hexactinellidae.

Living Hyalospongea invariably contain, among other spicules, microscleres which are either a rod with disclike expansions at each end (amphidisc) or a spicule with many rays diverging from a center (aster). None has both amphidiscs and asters. Accordingly, the class has been divided in two orders: Amphidiscophora (with amphi-

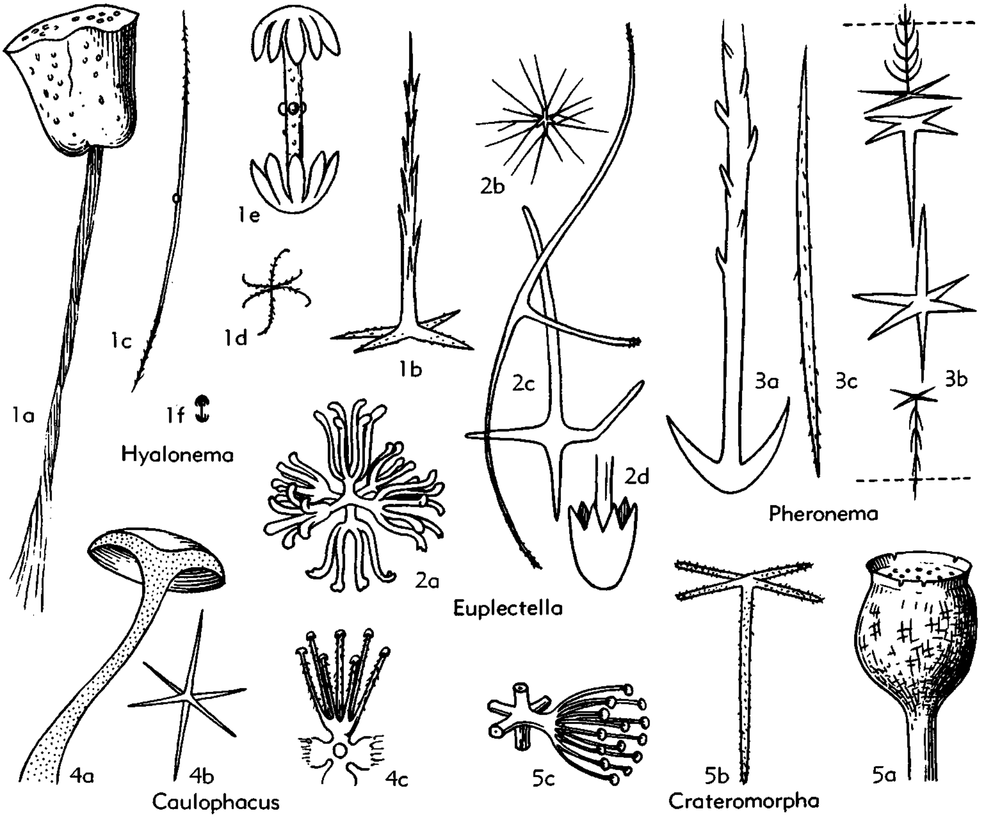

Fig. 50. Lyssakida: Hyalonematidae, Pheronematidae, Euplectellidae, Sympagellidae, Lanuginellidae (p. E67-E68).

discs) and Hexasterophora (with asters). The latter is divisible into 3 suborders called Lyssakinosa, characterized by lack of firm union of the megasclere spicules during part or all of the life of the sponge; Hexactinosa, with tips of spicules fused very early in ontogeny to form a netlike (dictyine) rigid skeleton; and Lychniskosa, distinguished from Hexactinosa by spicules with peculiar hollow axial nodes. The Amphidiscophora resemble the Lyssakinosa in lacking a firmly knit skeleton.

Fossil hyalosponges cannot be classified like living forms on the basis of microsclere characters, for these spicules rarely are preserved in association with individuals to which they belong. Consequently, in paleontological study 4 orders are recognized: Lyssakida, which comprises the lyssacine Hexasterophora combined with all Amphidiscophora; Dictyida, which is essentially equivalent to the hexasterophoran suborder Hexactinosa; Lychniskida, similarly corresponding to the hexasterophoran suborder Lychiniskosa; and Heteractinida, which contains sponges characterized by polyactinal or heteractinal spicules, all of Paleozoic age.

Order LYSSAKIDA Zittel, 1877

[*nom. correct.* DELAUB., herein (*ex* Lyssakina ZITTEL, 1877)]

Mostly vase-shaped or globular sponges, walls with stauractine spicules and commonly diactine and more complex types also; anchorage generally effected by large tuft of long hairlike spicules. *L.Cam.-Rec.*

Members of this group attain maximum variety and abundance in Devonian strata. They are less important in the Carboniferous, unknown in Permian and Triassic deposits, represented by a single Jurassic example, fairly common in Cretaceous and Tertiary rocks, and abundant at the present time.

Family HYALONEMATIDAE Gray, 1857

[*nom. correct.* DELAUB., herein (*ex* Hyalonemadae GRAY, 1857)]

Principal skeleton composed of diacts; basal tuft of spicules extending as axial part of massive main skeletal structure. Living forms included in Amphidiscophora. *Eoc.-Rec.*

Hyalonema GRAY, 1832 [**H. sieboldi* GRAY, 1835]. Basal tuft of spirally twisted hairlike spicules very long (30 cm. or more) and narrow (about 1 cm.), their proximal ends bearing recurved clads (22). *Eoc.-Rec.*, cosmop.——FIG. 50,*1*. **H. sieboldi* GRAY, Rec., Japan; *1a*, side view, ×0.15; *1b*, pinule, ×160; *1c*, diact, ×80; *1d*, hexact, ×160; *1e*, amphidisc, ×80; *1f*, small amphidisc, ×160 (83).

Family PHERONEMATIDAE Gray, 1872

[*nom. correct.* DELAUB., herein (*ex* Pheronemadae GRAY, 1872)]

Principal skeleton composed of hexacts; attachment by several separate basal tufts. Living forms included in Amphidiscophora. *Cret.-Rec.*

Pheronema LEIDY, 1868 [**P. annae*]. Thick-walled cup (22). *Tert.-Rec.*, cosmop.——FIG. 50,*3*. **P. annae*, Rec., W.Indies; *3a*, proximal end of root tuft spicule, ×120; *3b*, spicules of body wall placed as in living sponge, outer surface above and cloacal surface below, ×50; *3c*, uncinate spicule known as a cleme, ×120 (83).

Semperella GRAY, 1868 [**Hyalonema schultzei* SEMPER, 1868]. Like *Pheronema* but club-shaped, not hollow, with oscules in longitudinal grooves on sides (22). *Cret.-Rec.*, cosmop.

Family EUPLECTELLIDAE Gray, 1867

Skeleton composed almost wholly of hexacts that form rigid framework but not by tip-to-toe union of the spicules; body tubular. Living forms included in Amphidiscophora. *U.Cret.-Rec.*

Euplectella OWEN, 1841 [**E. aspergillum*]. Oscule closed by sieve; attached by root tuft. Modern forms known as "Venus's flower basket" (22). *Mio.-Rec.*, cosmop.——FIG. 50,*2*. **E. aspergillum*, Rec., Philippines; *2a*, floricome, ×235; *2b*, oxyhexaster, ×150; *2c*, spicules of main skeleton associated with hexacts (not shown), ×50; *2d*, proximal tip of root tuft spicule, ×150 (83).

Regadrella SCHMIDT, 1880 [**R. phoenix*]. Like *Euplectella* but firmly attached and skeletal latticework diagonally disposed (22). *U.Cret.-Rec.*, cosmop.

Proeuplectella MORET, 1936 [**P. fragilis*] (26). *U.Cret.*, Fr.——FIG. 51,*2*. *P. cenomaniensis* MORET, Cenom.; ×10 (72*).

Family SYMPAGELLIDAE Schulze, 1887

[*nom. transl.* DELAUB., herein (*ex* Sympagellinae SCHULZE, 1887)]

Goblet- or mushroom-shaped sponges attached by a stalk. Living forms included in Hexasterophora. *Eoc.-Rec.*

Caulophacus SCHULZE, 1886 [**C. elegans*]. Umbrella-like (22). *Eoc.-Rec.*——FIG. 50,*4*. **C. latus*

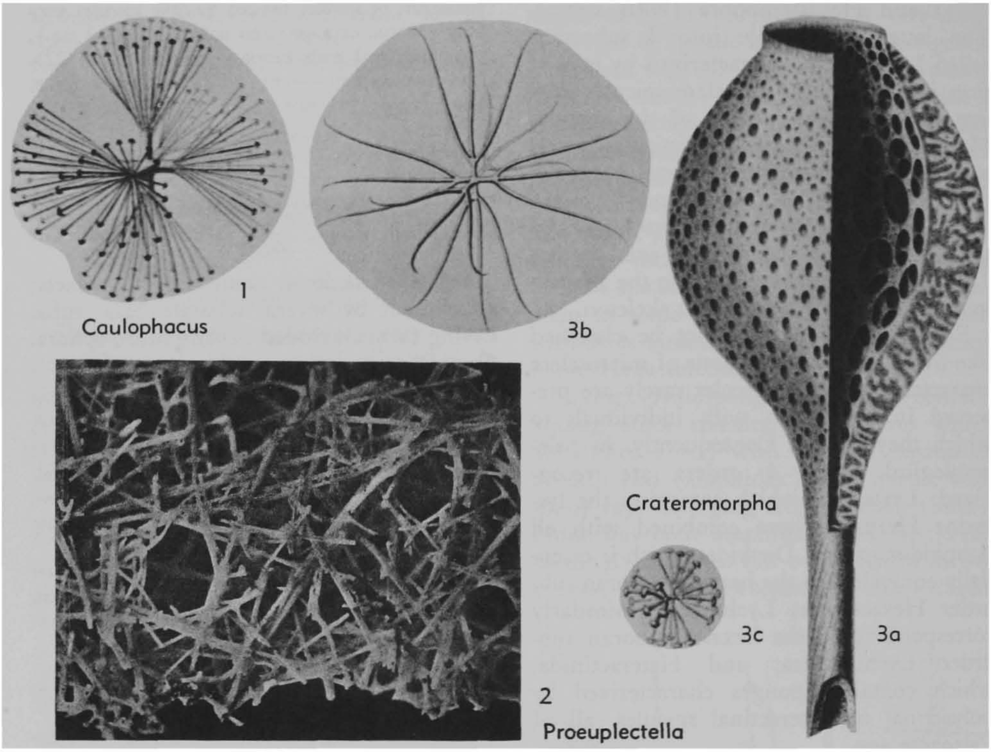

FIG. 51. Lyssakida: Euplectellidae, Sympagellidae, Lanuginellidae (p. E67-E68).

Schulze, Rec., Ind.O.; *4a,* part of sponge sectioned longitudinally, cut surface stippled, ×1; *4b,* hexact of main skeleton, ×12; *4c,* discohexaster, ×150 (83).——Fig. 51,*1*. *C. elegans* Schulze, Rec., cosmop.; discohexaster, ×100 (83*).

Family LANUGINELLIDAE Schulze, 1887

[*nom transl.* deLaub., herein (*ex* Lanuginellinae Schulze, 1887)]

Cup- or sac-shaped, with or without root tufts, surface covered by pentacts and hexacts, each with 4 or 5 projecting exposed rays and a long one extending into the body. Living forms included in Hexasterophora. *Eoc.-Rec.*

Crateromorpha Carter, 1872 [**C. meyeri*]. Stalked, with large cloaca; besides hexacts and pentacts, spicules include stauracts, diacts, hexasters, and discohexasters (22). *Eoc.-Rec.,* cosmop. ——Fig. 50,*5*. **C. meyeri,* Rec., Philippines; *5a,* side view, ×0.25; *5b,* pentact, ×80; *5c,* discohexaster (other 5 rays like that drawn unbroken), ×500 (83).——Fig. 51,*3*. *C. thierfelderi* Schulze, Rec., E.Indies; *3a,* side showing surface and section, ×1; *3b,* oxyhexaster, ×300; *3c,* discohexaster, ×250 (83*).

Rosella Carter, 1872 [**R. antarctica*]. Like *Crateromorpha* but unstalked, with root tuft, rim of cloaca without collar (22). *Tert.-Rec.,* cosmop.

Family STAURACTINELLIDAE de Laubenfels, nov.

Globular sponges, spicules a mass of hexacts, other types unknown (hence misnamed, for stauracts are lacking). *Jur.*

Stauractinella Zittel, 1877 [**S. jurassica*]. Rays of hexacts unequal in length (49). *Jur.,* Eu.

Family PROTOSPONGIIDAE Hinde, 1887

Very thin-walled hollow spheroidal or inverted cone-shaped sponges, commonly with root tufts; spicules chiefly tetraxons, stauracts in body, diacts in some root tufts and around oscule. *L.Cam.-U.Sil.*

The occurrence of only a single layer of spicules in the wall of various members of this family suggests that soft parts were of ascon type. Seemingly, pentact and hexact spicules had not yet evolved. The protospongiids are closely similar to contemporary forms having only monacts and diacts, classed as belonging to the Demospongea, which points to lack of wide divergence between classes of sponges in early Paleozoic time.

Protospongia SALTER, 1864 [**P. fenestrata*]. Hollow sphere of walnut size or smaller, with root tuft of diacts; semirigid wall formed of stauracts more or less joined at ray tips, smaller stauracts in meshes and commonly a coronal fringe of erect oxeas around oscule. Some whole forms have only 23 stauracts and 3 root spicules. *L.Cam.-Ord.*, NW.Eu.-N.Am.-China.——FIG. 52,*1*. *P. mononema* DAWSON-H., Ord., Can.; *1a*, side view, ×0.5; *1b*, spicules of wall, ×3 (57).

Cyathophycus WALC., 1879 [**C. reticulatus*] [=*Cyathospongia* DAWSON, 1888 (*non* HALL, 1882)]. Like *Protospongia* but funnel-shaped, probably without root tuft. *Ord.*, N.Y.-Can.——FIG. 52,*2*. *C. quebecensis* DAWSON-H., Can.; diagrammatic sketch, ×0.8 (57).

Phormosella HINDE, 1887 [**P. ovata*]. Globular, small without root tuft (13). *Ord.*, Eng.——FIG. 52,*5*. **P. ovata;* part of thin wall, ×3 (13).

Megastylia RUED., 1934 [**M. calyciformis*]. Vase-shaped, spicules larger than in *Protospongia*, probably attached to floating seaweed. *L.Ord.*, N.Y.

Diagoniella RAUFF, 1894 [**Protospongia coronata* DAWSON-H., 1889; SD WALC., 1920]. Differs from *Protospongia* in having diagonal pattern formed by stauract rays (33). *Ord.*, Can.——FIG. 52,*4*. **D. coronata* (DAWSON-H.); side view, ×1 (57).

Plectoderma HINDE, 1884 [**P. scitulum*]. Larger and coarser than *Protospongia*, with stauracts locally in bundles, so that more than one spicule may occur in thickness of wall. *U.Sil.*, Scot.

Palaeosaccus HINDE, 1893 [**P. dawsoni*]. Skeleton more symmetrical than that of *Protospongia*. *Ord.*, Que.

Stephanella HINDE, 1891 [**S. sancta*]. Radially arranged fine lines in patches 18 to 24 mm. dia., presumed to be imprints of *Protospongia*-type sponge bases. *Cam.-Ord.*, Can.

Kiwetinokia WALC., 1920 [**K. utahensis*]. Probably sac-shaped sponges anchored by long spicules, preserved as tangled masses of spicules, including stauracts, triacts, prodiaenes, and spirally intertwined diacts (45). *Cam.-Ord.*, Can.-Idaho-Utah.——FIG. 52,*3*. **K. utahensis*, Cam., Utah; *3a*, stauracts; *3b,c*, triacts; *3d*, diact; all ×3 (88).

Family LEPTOMITIDAE de Laubenfels, nov.

Like Protospongiidae but only diactinal spicules certainly present. *L.Cam.-Ord.*

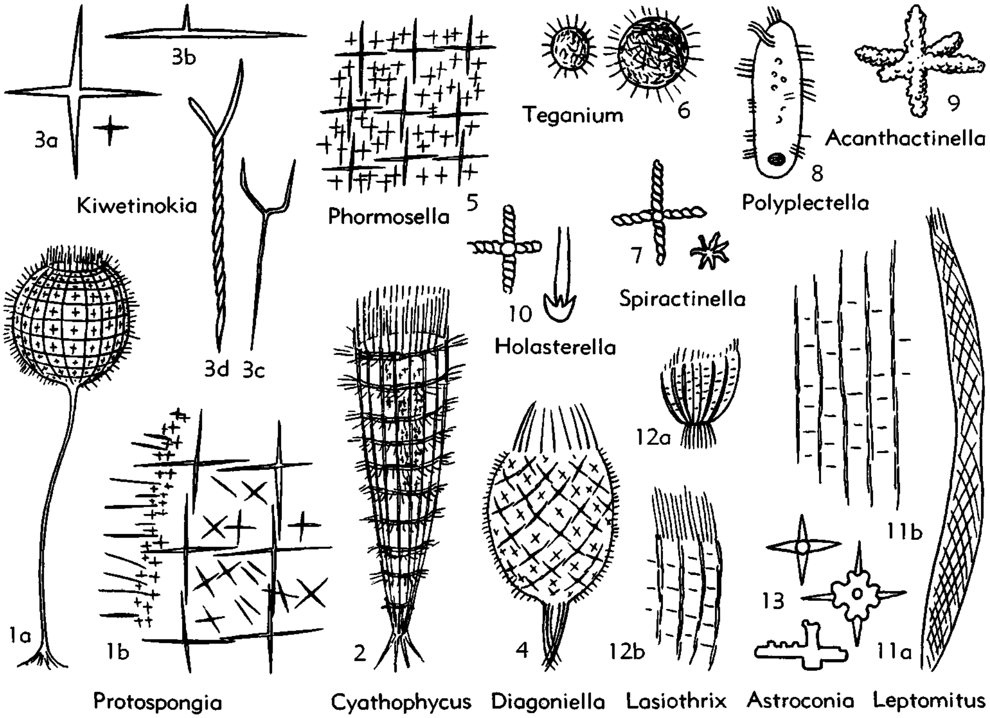

FIG. 52. Lyssakida: Protospongiidae, Leptomitidae, Teganiidae, Holasterellidae (p. E69-E70)

This assemblage appropriately could be classified among haplosclerine demosponges on some characters but they also resemble closely lyssakid Hyalospongea of *Protospongia* type. In early Paleozoic time the classes of sponges seem not to have been sharply differentiated.

Leptomitus WALC., 1886 [**L. zitteli*] [=*Tuponia* WALC., 1920]. Thin-walled vaselike, attaining height of 80 cm. and diameter of 4 cm., with root fringe; spicules comprise crisscrossed long diacts locally joined ladder-wise with short diacts (45). *L.Cam.-M.Cam.*, Vt.-B.C.——FIG. 52,*11*; 53,*1*. *L. lineata* (WALC.), type of *Tuponia*, M. Cam., B.C.; 52,*11a*, sketch of sponge, ×1; 52,*11b*, long and short diacts, ×5 (41); 53,*1*, part of specimen, ×3 (88,88*).

Halichondrites DAWSON-H., 1889 [**H. confusus*]. Resembles *Leptomitus;* remains fragmentary. *Cam.-Ord.*, Can.——53,*2*. *H. elissa* WALC., M. Cam., B.C.; ×0.75 (88*).

Lasiothrix DAWSON-H., 1889 [**L. curvicostata*]. Small hollow spheroids with root tufts and coronal erect fringe at rim of apical aperture (osculc); spicules much as in *Leptomitus. Ord.*, Can.——FIG. 52,*12*. **L. curvicostata; 12a*, side view of sponge, ×1; *12b*, part of skeleton, ×5 (57).

Family TEGANIIDAE de Laubenfels, nov.

Hollow spheroidal or sac-shaped forms with protruding long thin diacts. *Ord.*

Teganium RAUFF, 1894 [**T. subsphaericum*]. Pea-size globular forms with fringe or complete cover of radiating spicules, skeleton of body wall composed of stauracts (33). N.Y.——FIG. 52,*6*. **T. subsphaericum;* two specimens, ×1 (62).

Polyplectella RUED., 1925 [**P. mira*]. Differs from *Teganium* in elongate form and grouping of projecting spicules in tufts. N.Y.——FIG. 52,*8*. **P. mira;* ×1 (80).

Foerstella RUED., 1925 [**F. rotunda*]. Like *Polyplectella* but protruding spicules very long (to 70 mm.) and without root tufts. N.Y.

Sycodictya RUED., 1925 [**S. rara*]. Thicker walled than *Polyplectella* and with small, apical oscule leading to central cloaca. N.Y.

Family HOLASTERELLIDAE de Laubenfels, nov.

Spicules of skeleton not coherent, some smooth but most of them rough and lumpy, as in lithistids. *Sil.-Carb.*

These sponges of strongly lyssakid type are a small, probably polyphyletic group which seem to represent a development in the Hyalospongea corresponding to that of the Lithistida in the Demospongea. Also, they show some resemblances to the division of hyalosponges called Heteractinida. The holasterellids are found chiefly in Carboniferous formations.

Holasterella CARTER, 1879 [**H. wrightii*]. Spicules commonly have annular markings. *L.Carb.*, Eire.——FIG. 52,*10*. **H. wrightii;* spicules, ×12 (63).

Astroconia SOLLAS, 1881 [**A. granti*]. Exceptionally large spicules. *Sil.*, Eng.-Can.——FIG. 52,*13*. **A. granti;* spicules, ×6 (78).

Rhakistella WELLER, 1931 [**R. alba*]. Spicules lumpy and spinose, somewhat as in *Astroconia. Penn.*, Ill.

Spiractinella HINDE, 1887 [**Holasterella wrighti* CARTER, 1880]. Like *Holasterella* but spicules with spiral ridges and some stelliform (13). *Carb.*, Eng.——FIG. 52,*7*. **S. wrighti* (CARTER); spicules, ×4 (94).

Acanthactinella HINDE, 1887 [**Holasterella benniei* HINDE, 1884]. Differs from *Holasterella* in granular surface of spicules (13). *Carb.*, Eng.——FIG. 52,*9*. **A. benniei* (HINDE); spicule, ×6 (63).

Family DICTYOSPONGIIDAE Hall, 1882

[*nom. correct.* DELAUB., herein (*ex* Dictyospongidae ZITTEL-E., 1913, *ex* Dictyospongiae HALL, 1882)]

Like Protospongiidae but mostly larger, generally vase-shaped, with more rigid skeleton that is almost of dictyid type, consisting typically of a single layer of longitudinal and transverse spicule strands which form a quadrate-meshed network; almost invariably a primary reticulation of coarser, more widely spaced strands is distinguishable from secondary meshwork composed of fine, closely spaced strands, and projecting spicules may occur along lines of the primary network. *Ord.-Carb.*

This is one of the most important families of Paleozoic sponges, represented by many large and beautiful fossils, especially from Devonian rocks of New York. The Dictyospongiidae clearly are derived from protospongiid stocks, characterized by their rectangular, stauract-based wall pattern of extreme thinness which indicates a probably ascon architecture. As demonstrated by living species, the relatively inefficient hydraulic system of ascon sponges is not adapted for bodies much larger than those of the Protospongiidae, with height attaining 3 cm. and diameter 1 cm., and thus the more strongly built, considerably larger Dictyospongiidae, with bodies commonly ranging in diameter from 10 to 30 cm., almost surely possessed semi-rhagon architecture such as prevails in modern hyalosponges. Indeed, the family of Dictyospongiidae contains genera like *Phragmodictya* which have all essential attributes of ancestors of the living lyssakid sponges belonging to the order Amphidiscophorida, and the dictyospongiids *Mastodictya* and *Lyrodictya* contain recognizable uncinates and clavules corresponding to spicule types that occur together in modern Farreidae of the Hexasterophorida. The farreid sponges have relatively thin reticulate walls, closely resembling Paleozoic genera in appearance. Comparative studies support judgment that several sorts of Recent sponges, widely scattered in accepted classifications, are products of evolution from dictyospongiid ancestors.

The family is divided here into somewhat artificial subfamilies on the basis of body shape, genera characterized by prismatic form being assigned to the Prismodictyinae and others which lack this form being included in the Dictyospongiinae. Among the Prismodictyinae is *Acanthodictya,* from Ordovician rocks of Canada, which is the oldest known member of the family; this subfamily is chiefly developed in the Devonian of North America, 2 genera only (*Hydnoceras, Rhabdosispongia*) being known from Europe. With exception of a species of *Griphodictya,* all described Dictyospongiinae come from North America, about one half of the genera occurring in Devonian formations and one half in the Carboniferous.

Subfamily DICTYOSPONGIINAE Hall, 1882

[*nom. transl.* DELAUB., herein (*ex* Dictyospongiidae *nom. correct. ex* Dictyospongiae HALL, 1882)]

Shape not prismatic. *Sil.-Carb.*

Dictyospongia HALL-C., 1898 [**Dictyophyton sceptrum* HALL, 1890]. Elongate vaselike, with root tuft of long hairlike spicules; reticulate skeleton formed by longitudinal strands about 5 mm. apart crossed by transverse spicules 10 to 15 mm. apart, with secondary much smaller reticulation. Well-preserved specimens may show loose spicules resembling those of living hyalosponges (10).

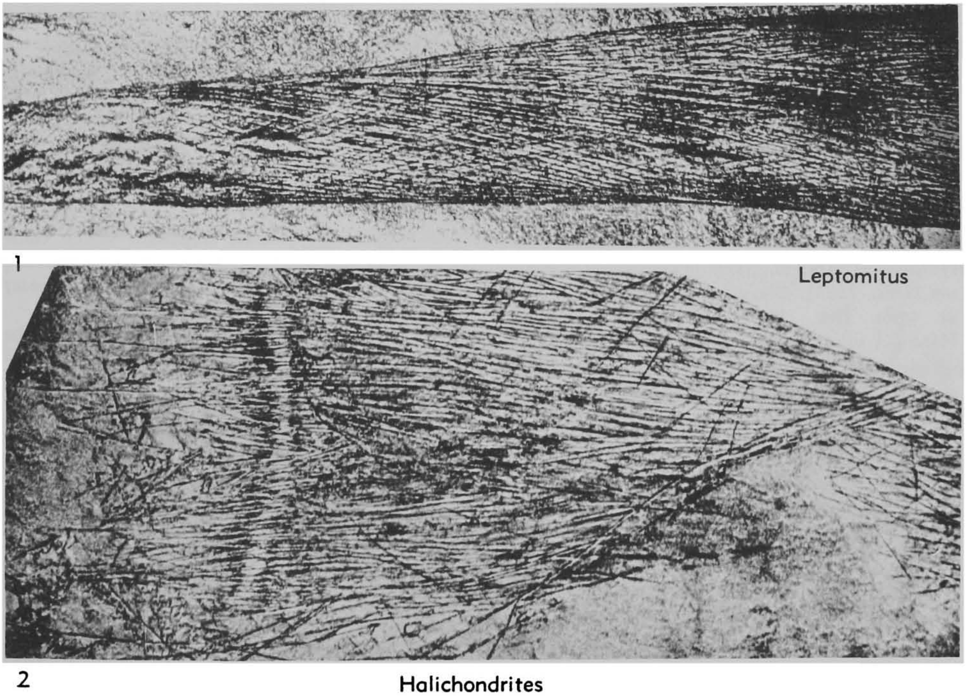

FIG. 53. Lyssakida: Leptomitidae (p. E70).

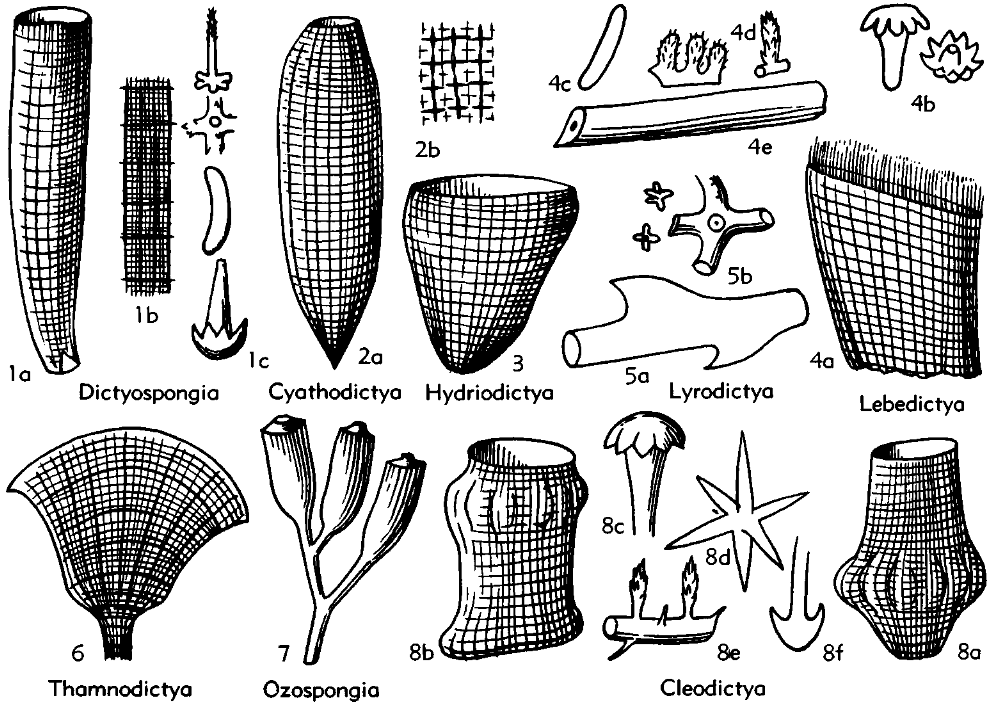

FIG. 54. Lyssakida: Dictyospongiidae (p. E72).

Dev., N.Y. (other records probably erroneous).——FIG. 54,*1*. **D. sceptrum* (HALL); *1a,* side view, ×0.2; *1b,* reticulate skeleton, ×1; *1c,* spicules, ×250 (62).

Cyathodictya HALL-C., 1900 [**Cyathophycus reticulatus* WALC., 1879]. Symmetrical rounded vase-like forms (10). *Sil.-Dev.,* Iowa-N.Y.——FIG. 54,*2*. **C. reticulata* (WALC.), Dev., N.Y.; *2a,* side view, ×0.1; *2b,* reticulate skeleton, ×3 (62).

Hydriodictya HALL-C., 1900 [**Dictyophyton patulum* HALL, 1884]. Obconical or straight-sided cups or vases. Dev., N.Y.——FIG. 54,*3*. *H. cylix* HALL-C.; side view, ×0.3 (62).

Lebedictya HALL-C., 1900 [**L. crinita*]. Like *Hydriodictya* but with coronal fringe (10). Carb., Ind.——FIG. 54,*4*. **L. crinita; 4a,* part of sponge from side ×0.2; *4b,* clavules; *4c,* strongyle; *4d,* pinule; *4e,* part of principal skeleton; *4b-e,* ×250 (62).

Thamnodictya HALL, 1884 [**Dictyophyton newberryi* HALL, 1864]. Funnel- or lotus-shaped (10). *Carb.,* Ohio.——FIG. 54,*6*. **T. newberryi* (HALL); side view, ×0.4 (62).

Ozospongia CLARKE, 1918 [**O. johnstoni*]. Several individuals on branching stalk; longitudinal strands of reticulate skeleton prominent; truncate summit with moderately large oscule. *Dev.,* N.Y.——FIG. 54,*7*. **O. johnstoni;* side view, ×0.2 (55).

Lyrodictya HALL, 1884 [**L. romingeri*]. Probably like *Hydriodictya* in shape; longitudinal strands of skeleton each formed by several rows of large spicules, transverse elements suppressed, some loose spicules (10). *Carb.,* N.Y.-Iowa.——FIG. 54,*5*. **L. romingeri; 5a,* part of large uncinate spicule; *5b,* other spicules, ×100 (62).

Actinodictya HALL, 1890 [**A. placenta*]. Known only from large leaflike fragments which combine dictyospongiid and protospongiid characters (10). *Dev.,* N.Y.-Pa.——FIG. 55,*5*. **A. placenta;* part of skeleton, ×0.5 (62).

Arystidictyon HALL-C., 1900 [**A. elegans*]. Like *Hydriodictya* in shape but skeleton as in *Actinodictya* (10). *Dev.,* N.Y.

Cleodictya HALL, 1884 [**C. gloriosa*]. [=*Tylodictya* HALL-C., 1900]. Vase- or tubelike, with girdle of bulges (10). *Carb.,* Ind.-Pa.——FIG. 54,*8a*. **C. gloriosa;* side view, ×0.1 (62).——FIG. 54,*8c-f*. *C. mohri* HALL; loose spicules, ×40 (62).——FIG. 54,*8b*. *C. warranensis* (HALL-C.) (type of *Tylodictya*); side view, ×0.4 (62).

Hallodictya HALL-C., 1900 [**H. aciensis*]. Fragments (to 9 by 19 mm.) like a wad of paper, probably from wall of very large vase-shaped sponges with irregular primary skeleton (10). *Dev.,* N.Y.

Iowaspongia THOMAS, 1923 [**I. annulata*]. Vase-like with annular sharp ridges. *U.Dev.,* Iowa.——FIG. 55,*1*. **I. annulata;* side view, ×0.2 (87).

Aglithodictya Hall-C., 1900 [*_A. nummulina_]. Like _Iowaspongia_ but much smaller (10). _U.Dev._, Pa.——Fig. 55,_6_. *_A. nummulina;_ side view, ×1 (62).

Griphodictya Hall-C., 1900 [*_G. epiphanes_]. Vase-like, constricted at midheight; distinctive loose spicules (10). _Dev.-Carb._, Fr.-Ind.——Fig. 55,_3_. *_G. epiphanes,_ Carb., Ind.; _3a,_ hexaster; _3b,_ streptaster; _3c-g,_ tips of clavules (?amphidiscs); _3h,i,_ ends of long diacts, ×175 (62).

Ectenodictya Hall, 1884 [*_E. implexa_] [=_Calathospongia_ Hall-C., 1898]. Somewhat like _Griphodictya;_ types fragmentary (10). _Carb._, Pa.

Ceratodictya Hall-C., 1898 [*_Dictyophyton annulatum_ Hall, 1863]. Large tubular body with several rounded annular swellings (10). _Dev.-Carb._, N.Y.-Pa.-Ohio.——Fig. 55,_7a_. *_C. annulata_ (Hall), Dev., N.Y.; side, ×0.4 (62).——Fig. 55,_7b_. _C. carpenteriana_ Hall-C., Dev., N.Y.; side, ×0.2 (62).

Mastodictya Hall-C., 1900 [*_Dictyospongia osculata_ Hall-C., 1898]. Compound, narrowing apically (10). _Carb._, Ind.——Fig. 55,_9_. *_M. osculata_ (Hall-C.); side, ×0.6 (62).

Cryptodictya Hall, 1890 [*_C. alleni_]. Inverted saucer-shaped with low mammiform prominences (10). Dev., Pa.

Rhombodictyon Whitf., 1886 [*_R. reniforme_]. Subglobular, with rhomb-shaped meshes in primary skeleton (10). _Dev._, N.Y.

Sphaerodictya Hall-C., 1900 [*_S. subsphaerica_]. Small, globular or discoid (10). _Dev._, N.Y.

Acloeodictya Hall-C., 1900 [*_A. marsipus_]. Sac-shaped with deeply sculptured surface, possibly with root tuft (10). _Carb._, Ind.——Fig. 55,_4_. *_A. marsipus; 4a,_ side, ×0.2; _4b,_ spicules, ×100 (62).

Phragmodictya Hall, 1882 [*_Dictyophyton cattiliforme_ Whitf., 1881]. Truncate inverted cone probably with _Hyalonema_-type root tuft (10). Carb., Ind.——Fig. 55,_2_. *_P. cattiliformis_ (Whitf.); _2a,_ side (restoration), ×0.2 (91); _2b,_ spicules, ×200 (62).

Pseudohydnoceras Reimann, 1934 [*_P. erraticum_]. Small stalked sponge with bulbous prominences on upper side. _Dev._, N.Y.——Fig. 55,_8_. *_P. erraticum;_ side, ×0.3 (79).

Dictyorhabdus Walc., 1892 [*_D. priscus_]. Fragments of tube with bulbous swellings along one

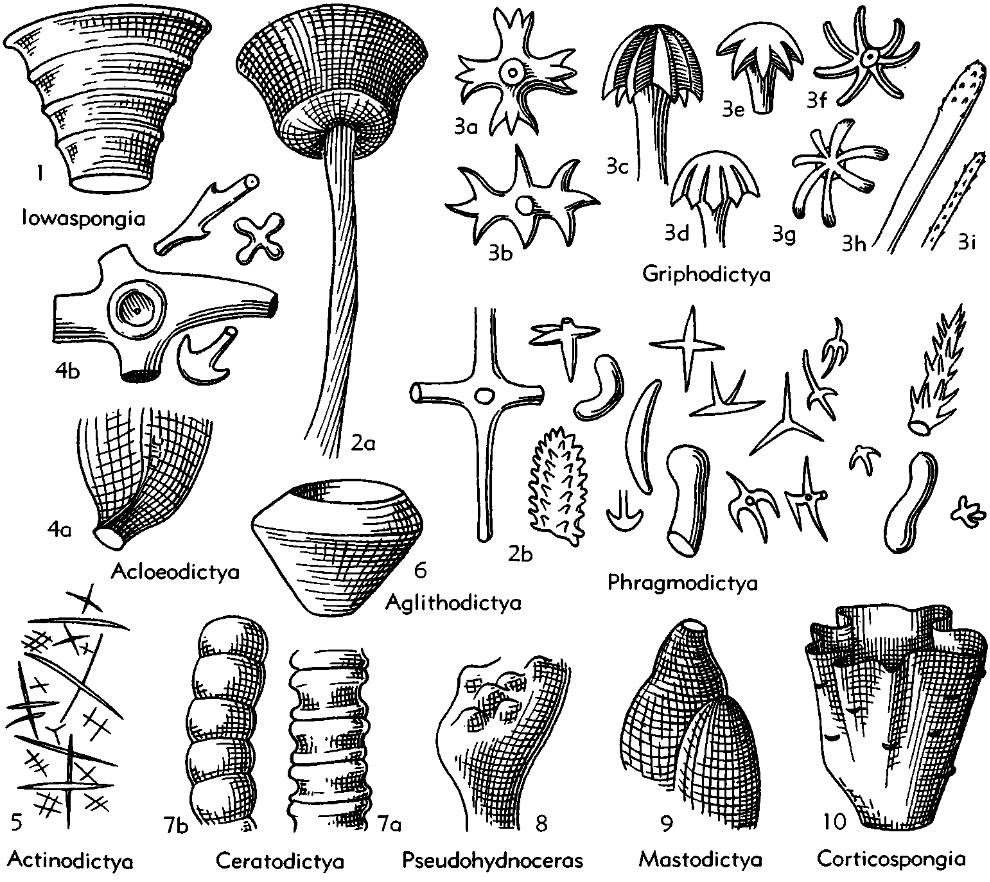

Fig. 55. Lyssakida: Dictyospongiidae (p. E72-E74).

side only. Thick wall as in Brachiospongiidae but lattice-work skeleton as in Dictyospongiidae. *Dev.*, Colo.

Corticospongia CASTER, 1939 [**C. bradfordensis*]. Vaselike, with folded walls and transverse lenticular swellings (3). *U.Dev.*, Pa.——FIG. 55,*10*. **C. bradfordensis;* side, ×0.3 (54).

Subfamily PRISMODICTYINAE de Laubenfels, nov.

Prismatic forms with polygonal transverse section, generally 8-sided. *Ord.-Carb.*

Prismodictya HALL-C., 1898 [**Dictyophyton telum* HALL, 1884]. Regular form without peculiarities (10). *U.Dev.-L.Carb.*, N.Y.-Ind.——FIG. 56,*1*. **P. telum* (HALL), U.Dev., N.Y.; side, ×0.7 (62).

Helicodictya HALL-C., 1898 [**H. trypania*]. Like *Prismodictya* but spirally twisted (10). *U.Dev.*, N.Y.-Pa.——FIG. 56,*4*. **H. trypania;* side, ×0.7 (62).

Ithacadictya CASTER, 1939 [**I. cornelli*]. Small *Prismodictya*-like forms with conspicuous spicule tufts at intersections of longitudinal and transverse ridges; corona of oscular spicules present (3). *Dev.*, N.Y.——FIG. 56,*3*. **I. cornelli;* side, ×1 (54).

Acanthodictya DAWSON-H., 1889 [**A. hispida*]. Longitudinal ridges with continuous row of bristle-like projecting spicules. *Ord.*, Can.——FIG. 56,*12*. **A. hispida;* side, ×0.5 (57).

Clathrospongia HALL-C., 1900 [**Dictyophyton abacus* HALL, 1884]. Vaselike, expanding from very small base; deep boxlike meshes between elevated strands of primary skeleton (10). *U.Dev.*, N.Y.——FIG. 56,*2*. **C. abacus* (HALL); side, ×0.4 (62).

Thysanodictya HALL-C., 1900 [**Dictyophyton halli* HALL, 1890]. Like *Clathrospongia* but has broad flat base (10). *Dev.*, N.Y.

Dictyophyton HALL, 1863 [**D. filitextile;* SD MILLER, 1889] [=*Dictyophytra* RAUFF, 1894]. Differs from *Prismodictya* in having regular rings

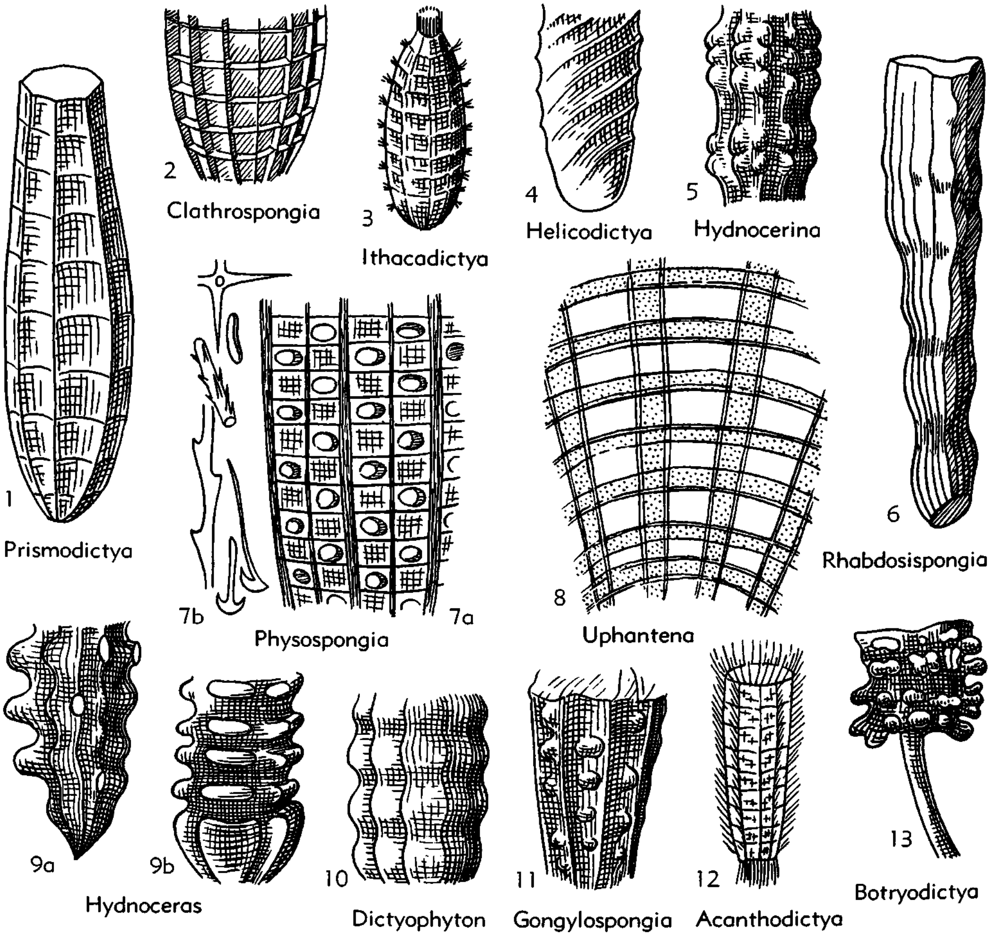

FIG. 56. Lyssakida: Dictyospongiidae, Uphantenidae (p. E74-E76).

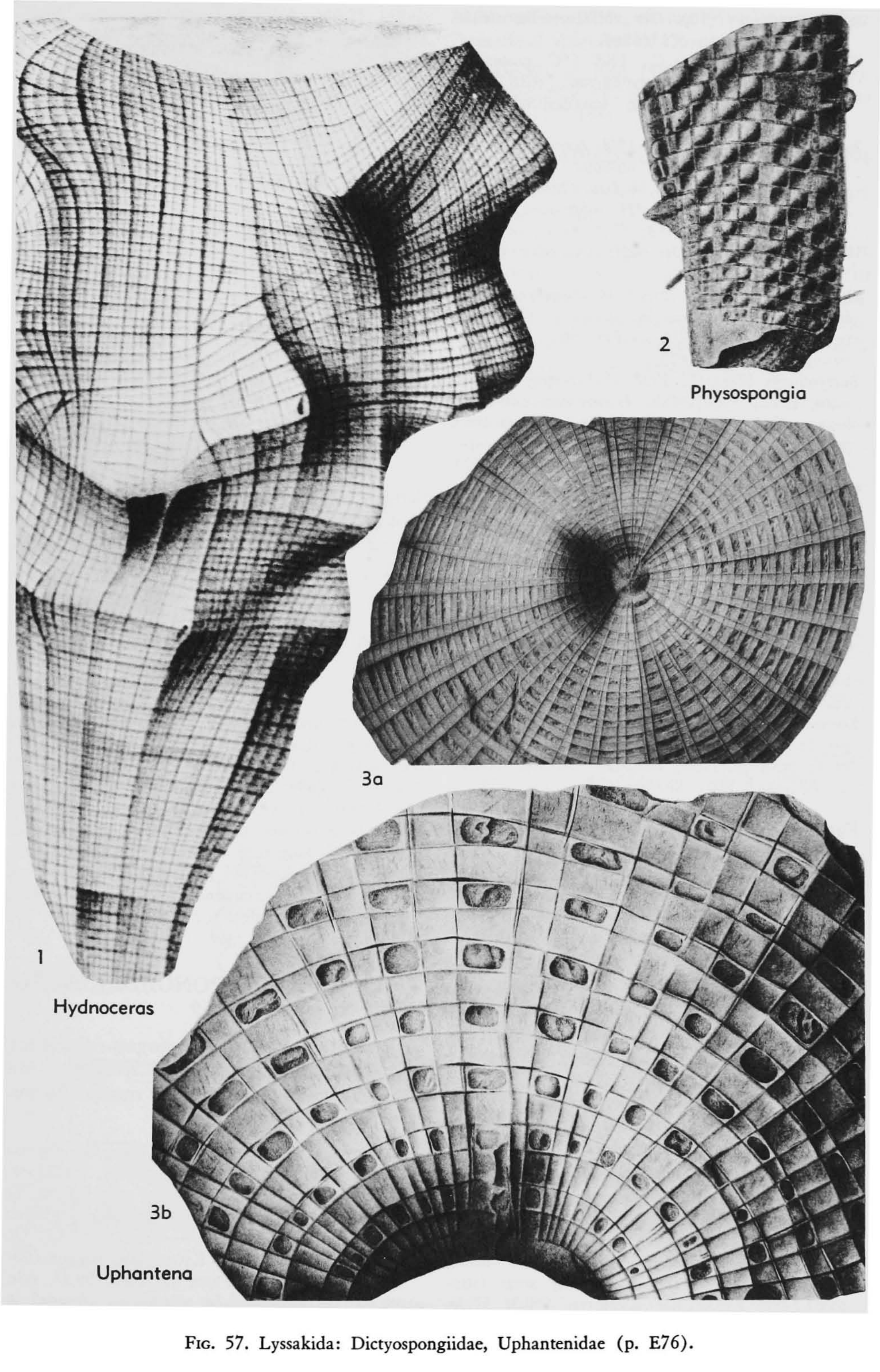

Fig. 57. Lyssakida: Dictyospongiidae, Uphantenidae (p. E76).

of prominences (10). *Dev.,* N.Y.——Fig. 56,*10.* **D. filitextile;* side, ×1 (68n).

Clepsydrospongia Hall-C., 1900 [**C. matutina*]. Less regular than *Dictyophyton,* with small rounded projections along longitudinal ridges (10). *Dev.,* N.Y.

Hydnoceras Conrad, 1842 [**H. tuberosum*]. Distinguished by annular bulbous swellings on longitudinal ridges (10). *U.Dev.-Carb.,* N.Y.-Pa.-Fr.——Fig. 56,*9a; 57,1.* **H. tuberosum,* U.Dev., N.Y.; 56,*9a,* side, ×0.3; 57,*1,* same, ×1 (62, 62*).——Fig. 56,*9b. H. walcotti* Clarke, U.Dev., N.Y.; ×0.3 (55).

Hydnocerina Clarke, 1918 [**H. armstrongi*]. Differs from *Hydnoceras* in grouping of annular prominences. Dev., Pa.——Fig. 56,*5.* **H. armstrongi;* side, ×0.4 (55).

Botryodictya Hall-C., 1900 [**Dictyophyton ramosum* Lesq., 1884]. Like *Hydnoceras* but seemingly stalked and with annular prominences much produced; coronal fringe (10). *U.Dev.,* Pa.——Fig. 56,*13.* **B. ramosa* (Lesq.); side, ×0.3 (62).

Gongylospongia Hall-C., 1898 [**G. marshi* Hall-C., 1900]. Like *Prismodictya* but with bulbous prominences on nearly flat sides (10). *U.Dev.,* N.Y.——Fig. 56,*11.* **G. marshi;* side, ×0.25 (62).

Rhabdosispongia Hall-C., 1900 [**Dictyophyton amalthaea* Hall, 1890]. Subcylindrical form with several longitudinal ridges with annular swellings as in *Ceratodictya;* transverse skeletal strands hardly perceptible (10). *U.Dev.,* Pa.-Fr.——Fig. 56,*6.* **R. amalthaea* (Hall), Pa.; side, ×0.2 (62).

Roemerispongia Hall-C., 1900 [**Dictyophyton gerolsteinense* Römer, 1883]. Obconical cup with many prismatic faces; secondary skeleton reduced or obliterated (10). *M.Dev.,* Ger.

Family UPHANTENIDAE de Laubenfels, nov.

Large bowl-shaped hyalosponges characterized by relatively wide-shaped straplike bands of spicules arranged longitudinally and transversely, with double thickness at their nearly right-angle intersections; no trace of secondary reticulation but meshes of primary skeleton evidently occupied by fleshy tissue except for openings to the interior. *U.Dev.-Carb.*

Uphantena Vanuxem, 1842 [**U. chemungensis*] [=*Hyphantaenia* Hall-C., 1900]. Discoid (probably by flattening), some with diameter more than 35 cm.; radially disposed skeletal straps narrow, concentric ones 5 mm. or more wide; apertures rectangular (indicated by impression of fleshy film) (10). *U.Dev.,* N.Y.——Figs. 56,*8;* 57,*3.* **U. chemungensis;* 56,*8,* part of surface showing skeletal strands and fleshy areas (stippled) with rectangular apertures, ×0.3; 57,*3a,* mold of surface, ×0.25; 57,*3b,* part of surface showing "windows," ×0.3 (62,62*).

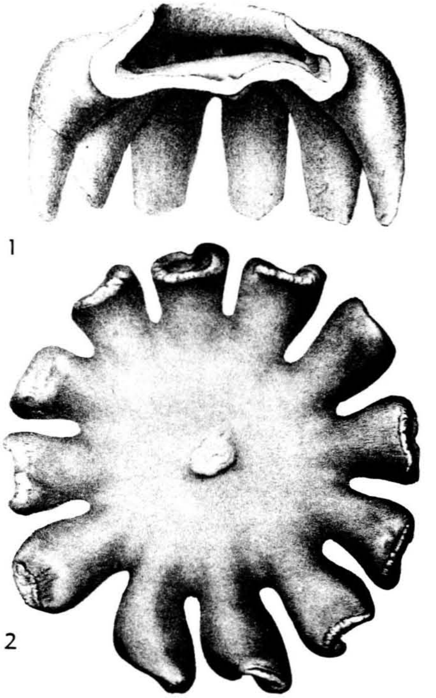

Fig. 58. *Brachiospongia digitata* (Owen), Ord., Ky. (p. E76).

Physospongia Hall, 1882 [**P. dawsoni;* SD Miller, 1889]. Smaller and finer structure than in *Uphantena,* with rounded apertures that may have been covered by blister-like domes; skeletal nodes with long tufts of projecting spicules; some loose spicules preserved (10). *Carb.,* Ind.——Figs. 56,*7;* 57,*2.* **P. dawsoni;* 56,*7a,* part of wall, ×0.4; 56,*7b,* spicules, ×20; 57,*2,* side view, ×1 (62,62*).

Family BRACHIOSPONGIIDAE Beecher, 1889

Radially lobate hyalosponges resembling dictyospongiids, especially *Cleodictya,* but thicker-walled and more like modern forms. *Ord.-Sil.*

Brachiospongia Marsh, 1867 [**Scyphia digitata* Owen, 1858; SD Beecher, 1889] [=*Rhaeaspongia* Lamont, 1935]. Body with 8 to 12 (generally 10) hollow radial projections, without root tuft. *Ord.,* Ky.-Scot.——Figs. 58; 59,*1.* **B. digitata* (Owen), Ord., Ky.; 59,*1a,* ?upper (distal) surface, with one arm cut open; 59,*1b,* side, oriented as in *1a;* 59,*1c,* spicules as arranged in wall, exterior toward left; *1a,b,* ×0.25 (68n); 58,*1,2,* side in section and ?upper surface, ×0.5, ×0.25 (51*).

Colpospongia Lamont, 1935 [**C. lineata*]. Bowl-shaped, with circular attachment disk, thin walls longitudinally folded. Comparison with *Brachiospongia* indicates correctness of orientation shown in fig. 59,*1*. *Ord.,* Scot.

Pattersonia Miller, 1882 [**P. difficilis*] [=*Strobilospongia* Beecher, 1889]. Walls produced in successive rings of lobate prominences, with basal tuft of long hairlike root spicules. *Ord.,* Ky.-?N.Y.-?Ohio.——Fig. 59,*2*. *P. tuberosa* (Beecher) (type of *Strobilospongia*), Ord., Ky.; side, ×0.3 (79).

Oncosella Rauff, 1894 [**O. catinus*]. Broad-based cylindrical sponge with root tuft; skeleton includes ectosomal spiny hexacts and endosomal smooth hexacts (33). *Sil.,* Eng.

Family MULTIVASCULATIDAE de Laubenfels, nov.

Incrusting lyssakids with many tubular proliferations, a growth form which is common in Demospongea but nearly unknown in Hyalospongea. *U.Cam.*

Multivasculatus Howell & Van Houten, 1940 [**M. ovatus*]. Skeleton formed by common types of hexacts, straight diacts, and deformed spicules (16). *U.Cam.,* Wyo.——Fig. 59,*5*. **M. ovatus; 5a,* part of surface, ×0.5; *5b,* vertical section, ×0.7 (84).

Family VAUXIIDAE de Laubenfels, nov.

Thin-walled tubular lyssakids with or without branches, characterized by peculiar triactinal spicules. *M.Cam.*

Vauxia Walc., 1920 [**V. gracilenta*]. Can. (45).——Fig. 59,*4*. **V. gracilenta;* spicules arranged as in wall, ×7 (88).

Family AMPHISPONGIIDAE Rauff, 1894

Proximal (lower) part radiate, distal part tubular. *U.Sil.*

The radiate structure of the lower part of these sponges, although common in demosponges, is very rare in the Hyalospongea. It is possible that some early Paleozoic presumed demosponges are actually basal portions of amphispongiids.

Amphispongia Salter, 1861 [**A. oblonga*]. A mass of very thick styles radiating from a central point forms skeleton of lower part, whereas stauracts, pentacts, and thin diacts comprise the reticulate skeleton of the upper part. *U.Sil.,* Scot.——Fig. 59,*3*. **A. oblonga; 3a,* side, ×0.8; *3b,c,* spicules of upper and lower parts, ×5 (63).

Family TITUSVILLIIDAE Caster, 1939

Skeletal framework lyssakid to later distinctly dictyid, cup-shaped individuals budded in linear succession to form branching colonies. Central cloaca continuous, walls 3 layers thick, otherwise resembling *Ceratodictya*. *L.Carb.-Rec.*

Titusvillia Caster, 1939 [**T. drakei*]. Individuals complex in structure, each fairly distinct, the

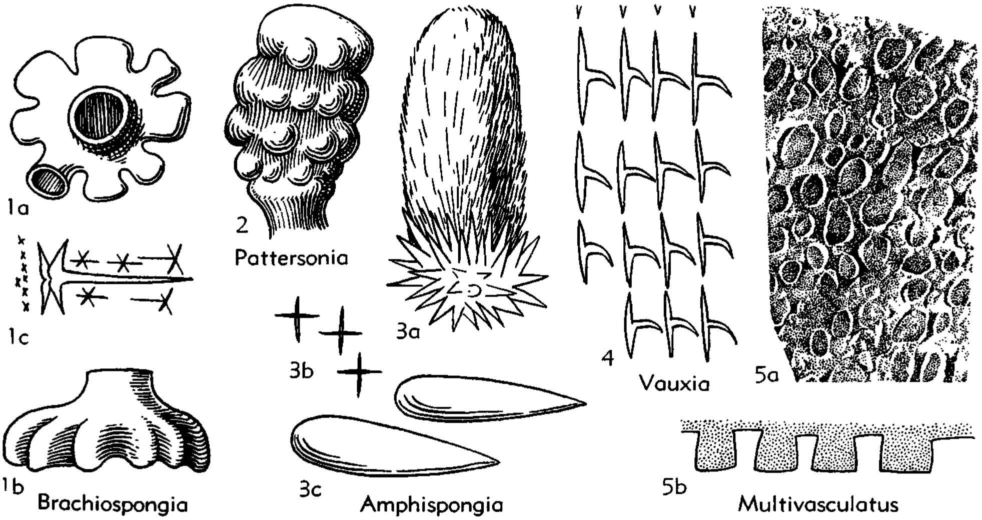

Fig. 59. Lyssakida: Brachiospongiidae, Multivasculatidae, Vauxiidae, Amphispongiidae (p. E76-E77).

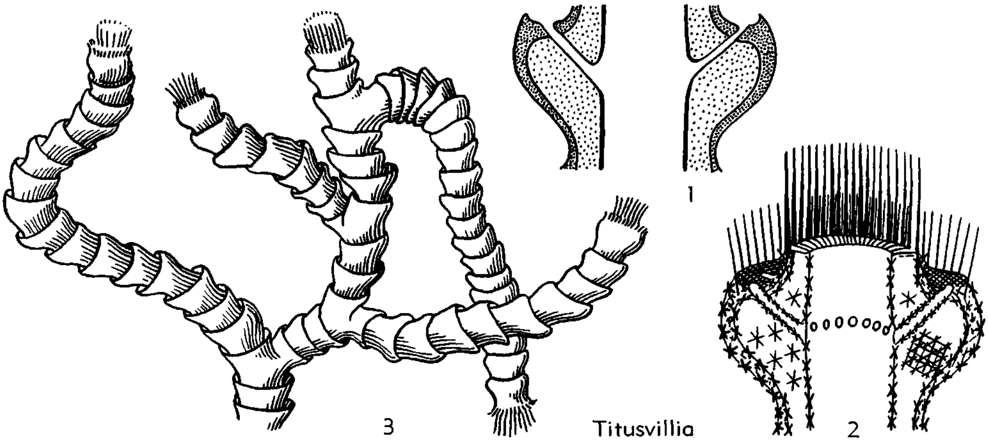

FIG. 60. *Titusvillia drakei* Caster, Miss., Pa. (p. E78).

terminal one on a branch having a conspicuous coronal fringe of long straight spicules; some branches of colony seem to have grown backward (3). *L.Carb.*, Pa.——Fig. 60. **T. drakei; 1,* diagrammatic longitudinal section; *2,* similar section of terminal individual; *3,* part of colony showing growth habit; *1, 2,* ×2; *3,* ×0.4 (54).

Armstrongia Clarke, 1920 [**Ceratodictya oryx* Clarke, 1918]. Simpler and evidently more primitive than *Titusvillia;* diagnosis mainly based on form later named *A.? clarkei* Caster (1941), which may not be congeneric with the poorly preserved type. *U.Dev.*, Pa.

Protoarmstrongia Caster, 1941 [**P. ithacensis*]. Branching strands with simple annular swellings but no cuplike individuals. *U.Dev.*, N.Y.

Sclerothamnus Marshall, 1875 [**S. clausi*]. Shape and size much like *Titusvillia* but branching simpler; dictyonine strands spined. Microscleres (tylohexasters) known. *Rec.*, E.Ind.

Family UNCERTAIN

Pyritonema M'Coy, 1850 [**P. fasciculatus;* SD deLaub., herein]. Name applied to masses of parallel hairlike spicules which seemingly comprise root tufts of lyssakid sponges; possibly useful but not valid as a distinct genus. *Sil.*, Eng.

Acanthospongia Römer, 1861 [**A. siluriensis;* SD deLaub., herein] [=*Acanthaspongia* Griffith, 1862]. *Sil.*, Eire.

Opeamorphus deLaub., *nom. nov.* [*pro Acestra* C. F. Römer, 1861[1] (*non* Dallas, 1852)] [**Acestra subularis* C.F. Römer, 1861]. Awl-shaped spicules. *Ord.-Carb.*, Eu.

Order DICTYIDA Zittel, 1877

[*nom. correct.* deLaub., herein (*pro* Dictyonina Zittel, 1877)]

Skeleton rigid, formed of symmetrically arranged hexacts, all joined tip to tip except in exterior ranks so as to make rectangular cribwork; no diact spicules. *M.Ord.-Rec.*

The dictyid hyalosponges closely resemble members of the Lychniskida in some respects; they form a readily distinguished group which, although rare in Paleozoic rocks, attained abundance in Mesozoic time and is flourishing today.

Family EURYPLEGMATIDAE
de Laubenfels, nov.

Hexacts of main skeleton less well fused together than in most of the order; classed among dictyids because of absence of diactinal spicules, which characterize the Lyssakida. *?Cret., Rec.*

Euryplegma Schulze, 1886 [**E. auriculare*]. Ear-shaped, thin-walled, with pores on both sides (22). cosmop.

Family HEXACTINELLIDAE
Schmidt, 1870

Mostly vase-shaped, relatively thick-walled dictyids distinguished by predominance of the strong ectosomal reticulate skeleton as compared with corresponding structure of the endosomal region; wall thickness may exceed diameter of the cloaca. *Jur.-Rec.*

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[1] Römer, C. F. (1861) *Die fossile Fauna der silurischen diluvial-Geschiebe von Sadewitz*: Breslau, p. 55.

Hexactinella Carter, 1885 [**H. ventilabrum*]. Bowl-shaped to crumpled, irregular; spicules granulose or minutely spined (22). *U.Cret.-Rec.*, cosmop.——Fig. 61,*1*. **H. ventilabrum*, Rec., part of skeletal network and loose spicules, outer surface at top, ×35 (83).

Tretodictyum Schulze, 1886 [**T. tubulosum;* SD Ijima, 1927]. Generally elongate tubular; living forms distinguished by microscleres (22). *U.Cret.-Rec.*, cosmop.

Prohexactinella Moret, 1927 [**P. cenomanensis*]. Globular, with walls thicker than diameter of cloaca (26). *U.Cret.*, Fr.

Andreaea Schram., 1902 [**A. hexagonalis*]. Like *Hexactinella* but walls thinner, with prosopores and apopores symmetrically arranged (37). *Cret.*, Ger.

Pycnocalyptra Schram., 1936 [**P. calyx*]. Thick-walled cup (40). *Jur.*, Ger.

Pachyascus Schram., 1936 [**P. formosus*]. Thick-walled cylinder (40). *Jur.*, Ger.

Polyopesia Schram., 1902 [**P. angustata*]. (37). *U.Cret.*, Ger.

Poteridium Rauff, 1933 [**P. cretaceum*]. Globular (33). *Cret.*, Eu.

Xenoschrammenum deLaub., *nom. nov.* [*pro Amphiblestrum* Schram., 1936 (ref. 40, p. 57) (*non* Gray, 1848)] [**Amphiblestrum venosum* Schram., 1936]. Thick-walled cup (40). *Jur.*, Ger.

Family EUBROCHIDIDAE de Laubenfels, nov.

[=Callibrochididae Schram., 1912]

Vase-shaped, with very compact ectosomal skeleton but exceptionally large-meshed endosomal network seen in wall of cloaca; many spicular rays with small branched appendages. *U.Cret.*

Eubrochis Schram., 1902 [**E. senonica*] [=*Callibrochis* Schram., 1912] (37). Ger.

Oxyrhizium Schram., 1912 [**O. eximium*] (38). Ger.

Habrosium Schram., 1912 [**H. convolutum*]. Walls folded (38). Ger.

Wollemannia Schram., 1912 [**W. araneosa*] (38). Ger.——Fig. 61,*4*. **W. araneosa; 4a,* side, ×0.7; *4b,* part of skeleton, ×22 (82).

Family STAURODERMATIDAE Zittel, 1877

[*nom. correct.* deLaub., herein (*pro* Staurodermidae Zittel, 1877)]

Commonly vaselike, invariably with external skeletal layer composed typically of stauracts but in some including stauract-like hexacts, with principal skeleton beneath. *Jur.-Mio.*

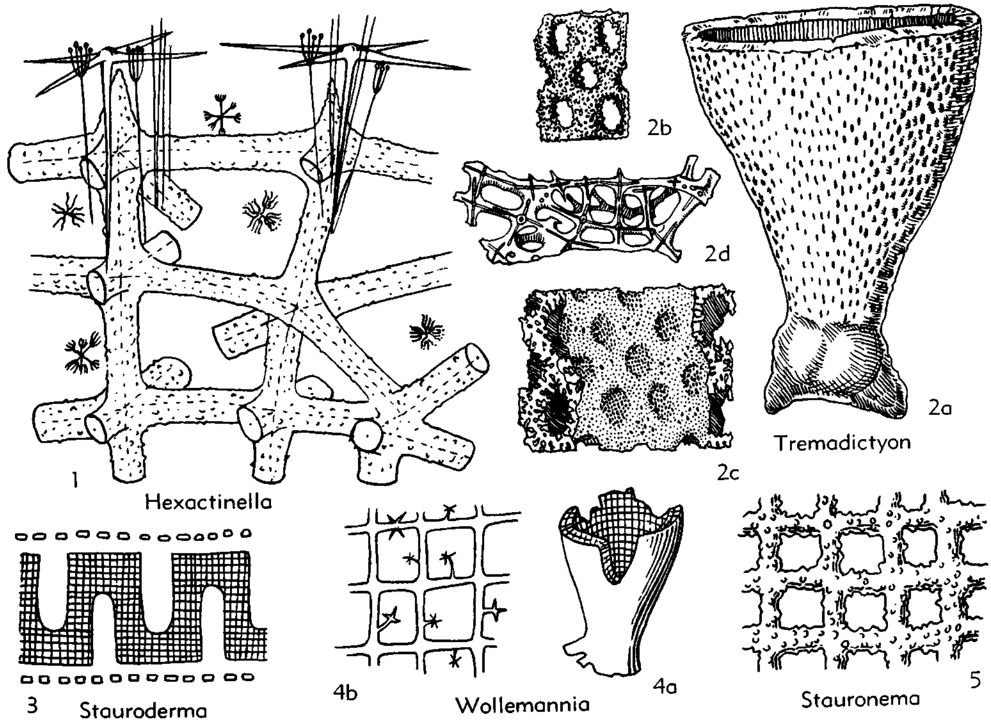

Fig. 61. Dictyida: Hexactinellidae, Eubrochididae, Staurodermatidae (p. E79-E80).

Stauroderma Zittel, 1877 [**Scyphia buchi* Goldf., 1833; SD deLaub., herein]. Funnel-shaped or platelike, with broad shallow cloaca; special dermal skeleton on both sides (49). *Jur.*, Eu.——Fig. 61,*3*. **S. buchi* (Goldf.), diagrammatic section of wall showing regular arrangement of prosochetes and apochetes, ×1 (93).

Tremadictyon Zittel, 1877 [**Scyphia reticulatum* Goldf., 1833; SD deLaub., herein]. Like *Stauroderma* but special skeleton not so evident on cloacal surface (49). *U.Jur.*, Eu.——Fig. 61,*2*. **T. reticulatum* (Goldf.); *2a*, side, ×0.3; *2b*, part of outer skeleton, ×2; *2c*, part of dermis, ×1; *2d*, skeletal network, ×8 (94).

Stauronema Sollas, 1877 [**S. carteri;* SD deLaub., herein]. Like *Tremadictyon* but discoid to saucer-shaped and with more regular skeleton of spinose spicules. *L.Cret.*, Eng.——Fig. 61,*5*. **S. carteri*, part of skeleton, ×1 (63).

Saynospongia Moret, 1927 [**Elasmoierea palmicea* Dumortier, 1871]. Shape like dagger sheath, with skeleton of fine cubical cribwork (26). *Jur.*, Fr.

Paracraticularia Schram., 1936 [**Scyphia procumbens* Goldf., 1833; SD deLaub., herein]. Like *Tremadictyo*n but consisting of branched tubes (40). *Jur.*, Ger.

Placotrema Hinde, 1884 [**P. cretaceum*]. Thick flat-topped discoid form without perceptible cloaca (12). *Cret.*, Eng.

Cincliderma Hinde, 1884 [**C. quadratum*]. Differs from *Tremadictyon* in more delicate skeletal structure (12). *Cret.*, Eng.

Eubrochus Sollas, 1876 [**E. clausus*]. Resembles *Tremadictyon* but siliceous network covers oscule. *Cret.*, Eng.

Polyschema Oppl., 1915 [**P. hersbergense;* SD deLaub., herein]. Like *Eubrochus*, with roots (28). *Jur.*, Switz.

Feifelia Schram., 1936 [**F. gigas*]. Like *Tremadictyon* but prosopores smaller and apopores larger (40). *Jur.*, Ger.

Zittelospongia Malfatti, 1901 [**Z. meandriformis*] [=*Malfattispongia* Gregorio, 1908]. Like *Paracraticularia* but more lumpy and crumpled. *Tert.*, Eu.

Psephosyllogus Schram., 1936 [**P. diligens*]. Thicker-walled than *Tremodictyon*, with oval prosopores in rows; apopores round (40). *Jur.*, Ger.

Placochlaenia Pomel, 1872 [**P. protuberans*] (31). *Mio.*, N.Afr.

Purisiphonia Bow., 1869 [**P. colarkei*]. *?U.Jur.*, *?L.Cret.*, Austral.

Family LEPTOPHRAGMATIDAE Schrammen, 1912

[*nom. correct.* deLaub., herein (*pro* Leptophragmidae Schram., 1912)]

Generally vase-shaped, with body wall at least 3-layered, consisting of a dense outer dermis perforated by many small pores, a subdermal layer commonly distinguished by delicate unsymmetrical skeletal reticulation, and an inner thick main skeleton formed of rectangular cribwork. Prosochetes and apochetes tend to be arranged in longitudinal and transverse rows, which is a character useful for family identification because outer skeletal layers tend to be lost in fossilization. *Jur.-Tert.*

Leptophragma Zittel, 1878 [**Scyphia murchisoni* Goldf., 1833; SD deLaub., herein]. May be *Laocaetis* with outer layers lost (49). *Jur.-Cret.*, Eu.

Laocaetis Pomel, 1872 [**L. crassipes*] [=*Craticularia* Zittel, 1878] (26). *Jur.-Tert.*, Eu.-Afr. ——Fig. 62,*5c*. **L. crassipes*, Mio., Alg., diagrammatic section of wall showing outer dense perforated layer *(x)*, subdermal layer with flimsy reticulate skeleton *(y)*, and main inner skeleton with prosochetes *(z)*, ×1 (72).——Fig. 62,*5*. *L. paradoxa* (Münster), U.Jur., Ger. (here designated as type of *Craticularia*); *5a*, oblique view of main skeleton, outer layers lacking, ×0.3; *5b*, part of reticulate skeleton, ×12 (94).

Strephinia Hinde, 1884 [**S. convoluta;* SD deLaub., herein]. Like *Leptophragma* but wall folded or even doubled (12). *Cret.*, Eng.

Sphenaulax Zittel, 1878 [**Scyphia costata* Goldf., 1833]. Like *Leptophragma* but with oval prosopores (?and apopores) vertically elongate (49). *Jur.*, Eu.——Fig. 62,*4*. **S. costata* (Goldf.), side; ×0.3 (77).

Sestrodictyon Hinde, 1884 [**S. convolutum*]. Like *Leptophragma* with inverted conical form but may resemble rolled sheet of thick paper with overlapped edges; meshes of thick-fibered reticulate endosomal skeleton round rather than square (12). *L.Cret.*, Switz.——Fig. 62,*8*. **S. convolutum;* part of skeleton, ×40 (63).

Thyroidium deLaub., *nom. nov.* [*pro Thyridium* Schram., 1936 (ref. 40, p. 31) (*non* Dejean, 1833)] [**Scyphia schweiggeri* Goldf., 1833] (40). *Jur.*, Ger.

Family EMPLOCIDAE de Laubenfels, nov.

Dictyids with multilayered skeleton in which radially disposed longitudinal subdermal canals occur in successive zones separated by layers composed of rectangular cribwork, so that cross sections resemble growth rings. *M.Jur.*

Emploca Sollas, 1883 [**E. ovata*] [=*Taxoploca* Sollas, 1888]. Globular. Eng.——Fig. 62,*3*. **E. ovata;* diagrammatic sagittal sec., ×2 (85).

Family POLYTHYRIDIDAE Schrammen, 1912

[*nom. correct.* DELAUB., herein (*pro* Polythyridae SCHRAM., 1912)]

Exterior relatively smooth, cloaca with deep longitudinal furrows containing apopores in their floors. *M.Ord.-U.Cret.*

Polythyris SCHRAM., 1912 [**P. cuneata*]. Small, stalked, with spiny fibers (38). *U.Cret.*, Ger.——FIG. 62,*7*. **P. cuneata;* oblique view, top removed to show stellate outline of cloaca in section, ×1 (82).

Ubiquiradius DELAUB., *nom. nov.* [*pro Actinocyclus* SCHRAM., 1912 (ref. 38, p. 277) (*non* EHR., 1831)] [**Actinocyclus mirus* SCHRAM., 1912] (38). *Cret.*, Ger.——FIG. 62,*2*. **U. mirus* (SCHRAM.); *2a,* oblique view of base showing attachment area and longitudinal rows of prosopores; *2b,* cloacal surface, both ×1 (82).

Ecblastesia RAUFF, 1933 [**E. intrinsecuscostata*]. Conjoined cone-shaped branches. *Cret.*, Eu.——FIG. 62,*1*. **E. intrinsecuscostata;* oblique view, ×1 (78).

Okulitchina WILSON, 1948 [**O. magna;* SD DELAUB., herein]. Skeleton a 3-dimensional network of hexacts with lumpy enlargements of the fused ray tips; cloaca as in *Polythyris.* One of the extremely few Paleozoic sponges having dictyid characters (47). *M.Ord.*, Can.——FIG. 62,*6*. **O. magna;* oblique view, sectioned to show form of cloaca, ×0.6 (92).

Family POLYSTIGMATIIDAE Schrammen, 1912

Thin lamellate dictyonids with prosopores and oval oscules or apopores on both sides. *U.Cret.*

Polystigmatium SCHRAM., 1912 [**P. striatopunctatum*] (38). Ger.

Family PLEUROSTOMATIDAE de Laubenfels, nov.

Moderately thick-walled vaselike dictyids with many inconspicuous long narrow canals (prosochetes, apochetes) which undulate and branch, differing greatly from the prominent short, wide, straight canals in the Leptophragmatidae, Myliusiidae, and others. *Jur.-Eoc.*

Pleurostoma RÖMER, 1840 [**P. radiatum;* SD DELAUB., herein]. Cup-shaped, with 1 or 2 vertical rows of round openings that reach from exterior to cloaca. *U.Cret.*, Eu.

Guettardiscyphia FROM., 1860 [*pro Guettardia* MICH., 1847 (*non* NARDO, 1833)] [**Guettardia stellata* MICH., 1847]. Walls strongly folded, cloaca with correspondingly deep longitudinal furrows (26). *U.Cret.-Eoc.*, Eu.——FIG. 63,*2a*. **G. stellata* (MICH.), Cret., Fr.; oblique view, top removed, ×0.6 (7).——FIG. 63,*2b*. *G. radians* HINDE, Cret., Fr.; side, ×0.5 (63).

Koleostoma MORET, 1927 [**K. godeti*]. Like *Guettardiscyphia* in shape but with crescentic openings

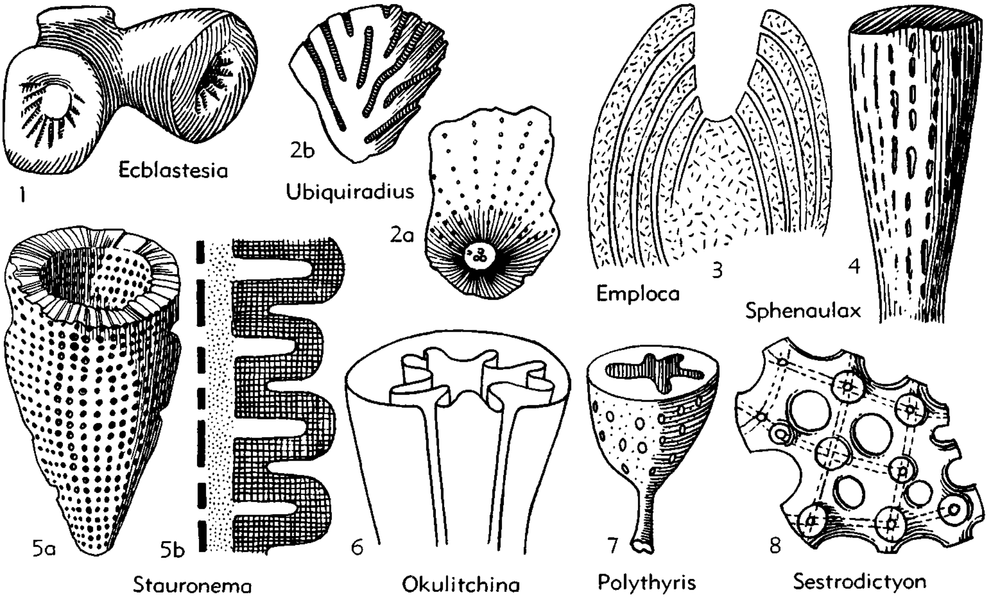

FIG. 62. Dictyida: Staurodermatidae, Leptophragmatidae, Emplocidae, Polythyrididae (p. E80-E81).

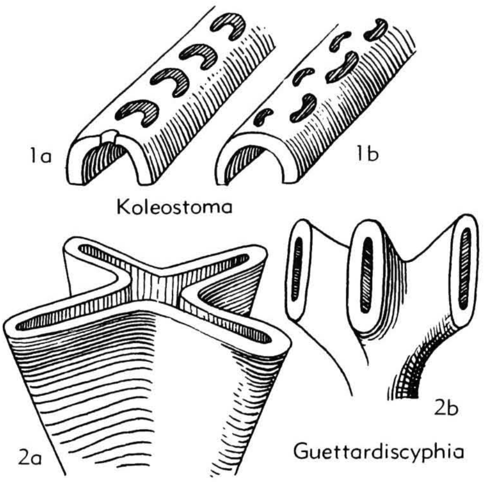

Fig. 63. Dictyida: Pleurostomatidae (p. E81-E82).

into cloaca in rows along ridges (26). _U.Cret.,_ Fr.——Fig. 63,_1;_ 64. *_K. godeti,_ Cenom.; 63,_1a,b,_ oblique views of ridges with common and somewhat unusual types of wall openings, ×2 (72); 64, skeleton, ×10 (72*).

Lopanella Počta, 1883 [*_L. depressa_]. Less symmetrical than _Pleurostoma_ and lacking window-like openings into cloaca (30). _U.Cret.,_ Czech.

Petalope Počta, 1883 [*_P. auriformis;_ SD deLaub., herein]. Resembles _Pleurostoma_ (30). _U.Cret.,_ Czech.

Erineum Schram., 1936 [*_E. minutum_]. Like _Lopanella_ (40). _U.Cret.,_ Ger.

Caesaria Quenst., 1857 [*_Scyphia articulata_ Goldf., 1833; SD deLaub., herein]. Like _Lopanella_ but cylindrical, with several annular constrictions (32). _U.Jur.,_ Ger.

Rhodanospongia Moret, 1927 [*_R. robusta_]. Goblet-shaped, with large pentacts having 4 recurved clads at sponge surface and straight rhabd directed inward. _Jur.,_ Fr.

Gevreya Moret, 1927 [*_G. synthetica_]. Long tube flaring distally in winglike folds as in _Guettardiscyphia,_ with large openings (?oscules) along sides. _Jur.,_ Fr.

Walcottella deLaub., _nom. nov._ [_pro Rhopalicus_ Schram., 1936 (ref. 40, p. 36) (_non_ Foerster, 1856)] [*_Scyphia pertusa_ Goldf., 1833]. Like _Lopanella_ (40). _U.Cret.,_ Ger.

Family POROSPONGIIDAE
Schrammen, 1936

[_nom. correct._ deLaub., herein (_pro_ Porospongiadae Schram., 1936)]

Massive or cylindrical dictyids having several conspicuous oscules, skeleton with many stauracts and hexacts in surface meshes forming a sort of cortex. _U.Jur.-U.Cret._

Porospongia Orb., 1849 [*_Manon marginatum_ Goldf., 1833; SD Rauff, 1893] [=_Porostoma_ From., 1860]. Lamellate, upper surface with many large oscules leading from short cloacas; dense dermis with stauracts and hexacts. Type species has rim around oscules but others do not (29). _U.Jur.,_ Eu.——Fig. 65,_1. P. impressa_ (Goldf.); _1a,_ side, ×1; _1b,_ part of dermal layer, ×6; _1c,_ part of endosomal skeleton ×12 (94).

Mimeticosia Rauff, 1933 [*_M. alata_]. Saucer-shaped, apochetes conspicuous, oscules prominent. _U.Cret.,_ Eu.

Multiloqua deLaub., _nom. nov._ [_pro Polyphemus_ Schram., 1936 (ref. 40, p. 47) (_non_ Bernhauer, 1914)] [*_Polyphemus strombiformis_ Schram., 1936]. Resembles _Porospongia_ (40). _Jur.,_ Ger.

Family MYLIUSIIDAE
de Laubenfels, nov.

Moderately thick-walled dictyids which lack ectosomal skeleton above a subdermal space, as in the Laocaetididae; walls commonly crumpled and in many forms having spiny tracts in the reticulate framework of the skeleton. Laocaetidids which have lost their dermis may closely resemble members of this family but with varying certainty are distinguishable by structure of the endosomal skeleton. _Jur.-Rec._

Myliusia Gray, 1859 [*_M. callocyathus_]. Somewhat vaselike but with very contorted walls which show large apopores on inner side; skeletal fibers spiny and meshes between them not square. Many sponges belonging in the Dactylocalycidae are

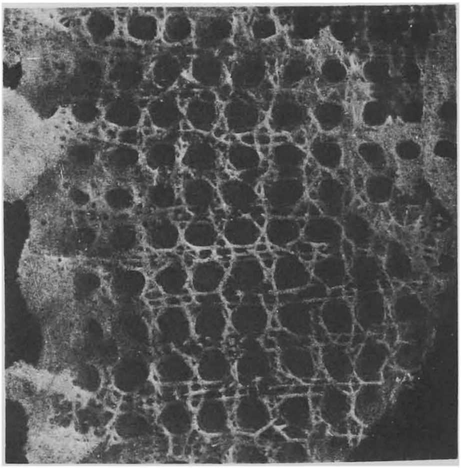

Fig. 64. _Koleostoma godeti_ Moret, U.Cret., Fr. (p. E82).

assigned erroneously to this genus (22). *Cret.-Rec.,* cosmop.——Fig. 65,*2*. **M. callocyathus,* Rec.; *2a,* side view, sectioned to show cloaca, ×1; *2b,* part of skeleton with some loose spicules in place, ×40 (83).

Linonema deLaub., *nom. nov.* [*pro Linosoma* Schram., 1936 (ref. 40, p. 55) (*non* Eichelbaum, 1909)] [**Linosoma calyx* Schram., 1936; SD deLaub., herein]. Differs from *Myliusia* in having oval or slitlike prosopores (40). *Jur.,* Ger.

Chonelasma Schulze, 1886 [**C. lamella;* SD Ijima, 1927]. Much like *Laocaetis* without dermis. Recent species recognized by nature of loose spicules not preserved in fossils (22). *?U.Cret., ?Tert., Rec.,* cosmop.

Mastodictyum Sollas, 1883 [**M. whidborni*]. Resembles *Chonelasma* but upper side has nipple-like processes. *M.Jur.,* Eng.

Cyrtobolia Počta, 1883 [**Achilleum formosum* Reuss, 1846; SD deLaub., herein]. Vase-shaped like *Chonelasma* but exterior has cushion-like projections. *U.Cret.,* Eu.

Etheridgia Tate, 1864 [**E. mirabilis;* SD deLaub., herein]. Root-bearing inverted cone with oscule on flat summit; some dermis as in *Stauroderma. Cret.,* Eng.

Ordinatus deLaub., *nom. nov.* [*pro Eutactus* Schram., 1936 (ref. 40, p. 38) (*non* Gemminger & Harold, 1873)] [**Scyphia texturata* Goldf., 1833]. Cylindrical to narrow vaselike with sides full of pores (40). *Jur.,* Ger.

Stereochlamis Schram., 1912 [**S. praecissa;* SD deLaub., herein]. Tubular (38). *U.Cret.,* Ger.

Ramispongia Quenst., 1878 [**R. ramosa;* SD deLaub., herein] (32). *Jur.,* Ger.

Family BOTRYOSELLIDAE Schrammen, 1912

Branched tubular dictyids with walls

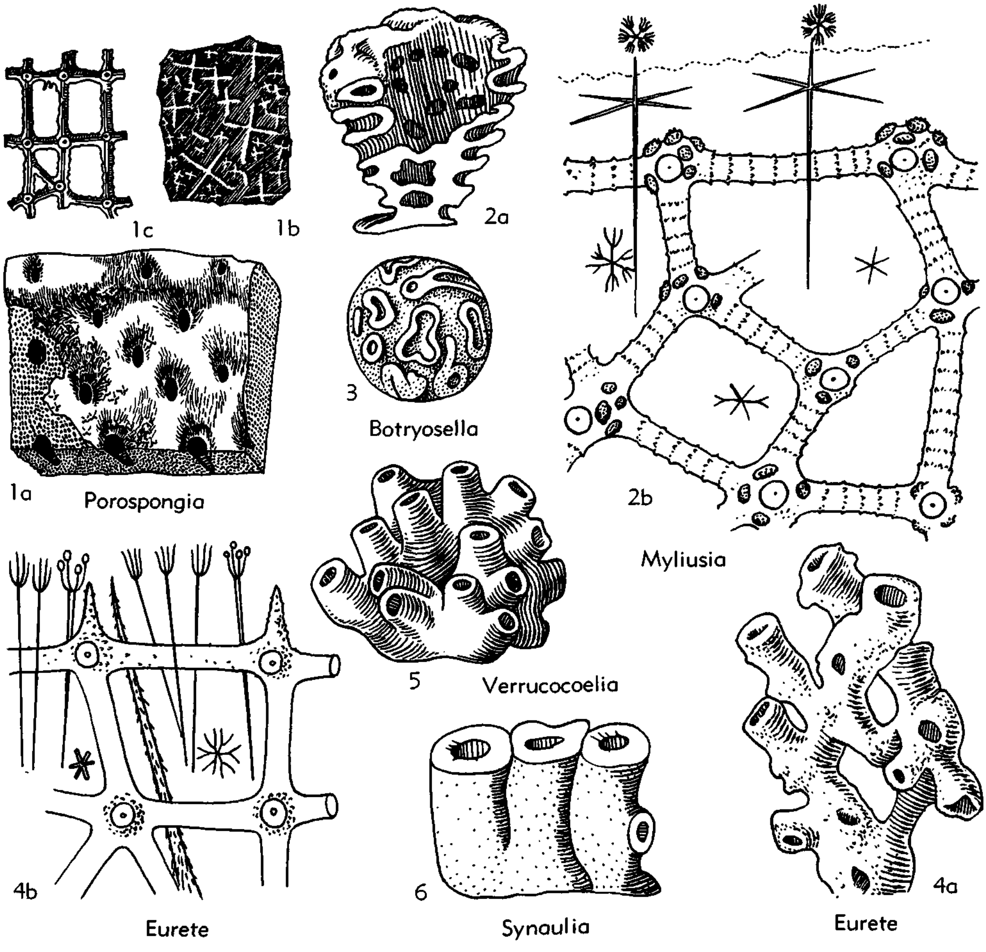

Fig. 65. Dictyida: Porospongiidae, Myliusiidae, Botryosellidae, Euretidae (p. E82-E84).

nearly as thick as in the Myliusiidae, with few or no canals. *U.Jur.-U.Cret.*

Botryosella Schram., 1912 [**B. labyrinthica*]. Globular mass with irregularly folded walls, interpreted as base from which tubular outgrowths are separated and lost (38). *U.Cret.*, Ger.——Fig. 65,*3*. **B. labyrinthica;* sketch, ×1 (82).

Verrucocoelia Étal., 1859 [**Scyphia verrucosa* Goldf., 1833; SD Hinde, 1893]. Has many short branches. *L.Cret.*, Eu.——Fig. 65,*5*. **V. verrucosa* (Goldf.); oblique view, X0.5 (61).

Typhlopleura Schram., 1902 [**T. dichotoma*] (37). *Cret.*, Ger.

Stichmaptyx Schram., 1912 [**S. alatus*]. Walls folded, contorted (38). *U.Cret.*, Ger.

Intextum deLaub., *nom. nov.* [*pro Syringium* Schram., 1912 (ref. 38, p. 256) (*non* Principi, 1909)] [**Syringium textum* Schram., 1912]. Prosopores stellate, apopores round (38). *U.Cret.*, Ger.

Sporadopyle Zittel, 1878 [**Scyphia obliqua* Goldf., 1833; SD deLaub., herein]. Cuplike or tubular, commonly with branches, apopores in rows (49). *U.Jur.-U.Cret.*, Eu.

Synaulia Počta, 1883 [**S. germinata;* SD deLaub., herein]. Some tubular branches coalesce (30). *U.Cret.*, Czech.——Fig. 65,*6*. **S. germinala;* side, ×1 (75).

Botroclonium Počta, 1883 [**B. arborescens;* SD deLaub., herein]. Large lateral oscules (30). *U.Cret.*, Czech.

Family EURETIDAE Schulze, 1886

Thin-walled tubes, generally about 1 cm. in diameter, that commonly branch and anastomose, with oscules at branch tips. Nature of loose spicules is useful in differentiating living forms but these are rarely preserved in association with firm skeletons of fossils. *Jur.-Tert.*

Eurete Semper, 1868 [**E. simplicissimum*]. Two or more dictyine layers in tube walls (22). *U.Cret.-Rec.*, cosmop.——Fig. 65,*4a*. *E. marshalli* Schulze, Rec., E. Ind.; side view ×1 (83).——Fig. 65,*4b*. *E. schmidtii* Schulze, Rec., W.Pac.; part of skeleton showing some loose spicules in place, ×40 (83). ——Fig. 66,*1*. *E. semperi* Schulze, Rec., E. Indies; ×1 (83*).

Proeurete Schram., 1902 [**P. plicatum*]. Like *Eurete* but lacks loose spicules (37). *U.Cret.*, Ger.

Farrea Bow., 1862 [**F. occa*]. Differs from *Eurete* in having only a single reticulate skeletal layer (22). *U.Cret.-Rec.*, cosmop.

Plectospyris Sollas, 1883 [**P. elegans;* SD deLaub., herein]. Resembles *Eurete*. *Jur.*, Eng.

Ptychodesia Schram., 1912 [**P. papillata*]. Deep grooves serve as apochetes (38). *U.Cret.*, Ger.

Family DACTYLOCALYCIDAE Gray, 1867

[=Hapalopegmidae Schram., 1912]

Vase- or sheetlike dictyids composed of interlaced fine tubes, mostly less than 2 mm. in diameter, with very thin walls showing irregular reticulation that may have triangular meshes; no canals. *Cret.-Rec.*

Dactylocalyx Stutchbury, 1841 [**D. pumiceus;* SD deLaub., 1936]. Contorted sheet; meshes of reticulate skeleton commonly triangular (22). *Tert.-Rec.*, Atl.(tropical).——Fig. 66,*4*. *D. subglobosus* Gray, Rec., E.Indies; ×10 (83*).

Periphragella Marshall, 1875 [**P. elisae*]. Cup- or vaselike (8). *U.Cret.-Rec.*, cosmop.——Fig. 66,*2*. *P. elongata* Moret, U.Cret.(Cenom.), Fr.; ×15 (72).

Lefroyella Thomson, 1877 [**L. decora*]. Like *Periphragella* but cloacal wall longitudinally folded (22). *U.Cret.-Rec.*, cosmop.

Auloplax Schulze, 1904 [**A. auricularis*]. Platelike; in living forms distinguished from *Dactylocalyx* by characters of loose spicules (22). *U.Cret.-Rec.*, cosmop.

Meandrospongia Orb., 1849 [**M. foliacea*] [=*Maeandrospongia* Römer, 1864] (29). Cret., Eu.

Zittelispongia Sintzov, 1879 [**Z. alcyonoides*]. *U.Cret.*, Russia.

Scleroplegma Schmidt, 1889 [**S. lanterna;* SD deLaub., herein]. *U.Cret.-Rec.*, Ger.-Atl.

Pyrospongia Zahalka ,1900 [**P. vrbaei;* SD deLaub., herein]. *Cret.*, Eu.

Hapalopegma Schram., 1912 [**H. fragile*]. Skeletal meshes oblong (38). *U.Cret.*, Eu.——Fig. 66,*3*. *H. tubuliferum* Moret, Cenom., Fr.; ×10 (72*).

Jima deLaub., *nom. nov.* [*pro Pleurotoma* Schram., 1912 (ref. 38, p. 257) (*non* Ehr., 1839)] [**Pleurotoma ijimai* Schram., 1912]. Tubular (38). *U.Cret.*, Ger.

Family APHROCALLISTIDAE Gray, 1867

Generally tubular dictyids with honeycomb-type of wall formed by tubules disposed perpendicularly to wall surface. *Cret.-Rec.*

Aphrocallistes Gray, 1858 [**A. beatrix*]. Branching tubes (22). *Rec.*, cosmop.——Fig. 66,*5*. *A. vastus* Schulze, Rec., Japan, ×1 (83*).

Family WAPKIOSIDAE de Laubenfels, nov.

[=Pleurothyrisidae Schram., 1912]

Dictyids consisting of an axial tube

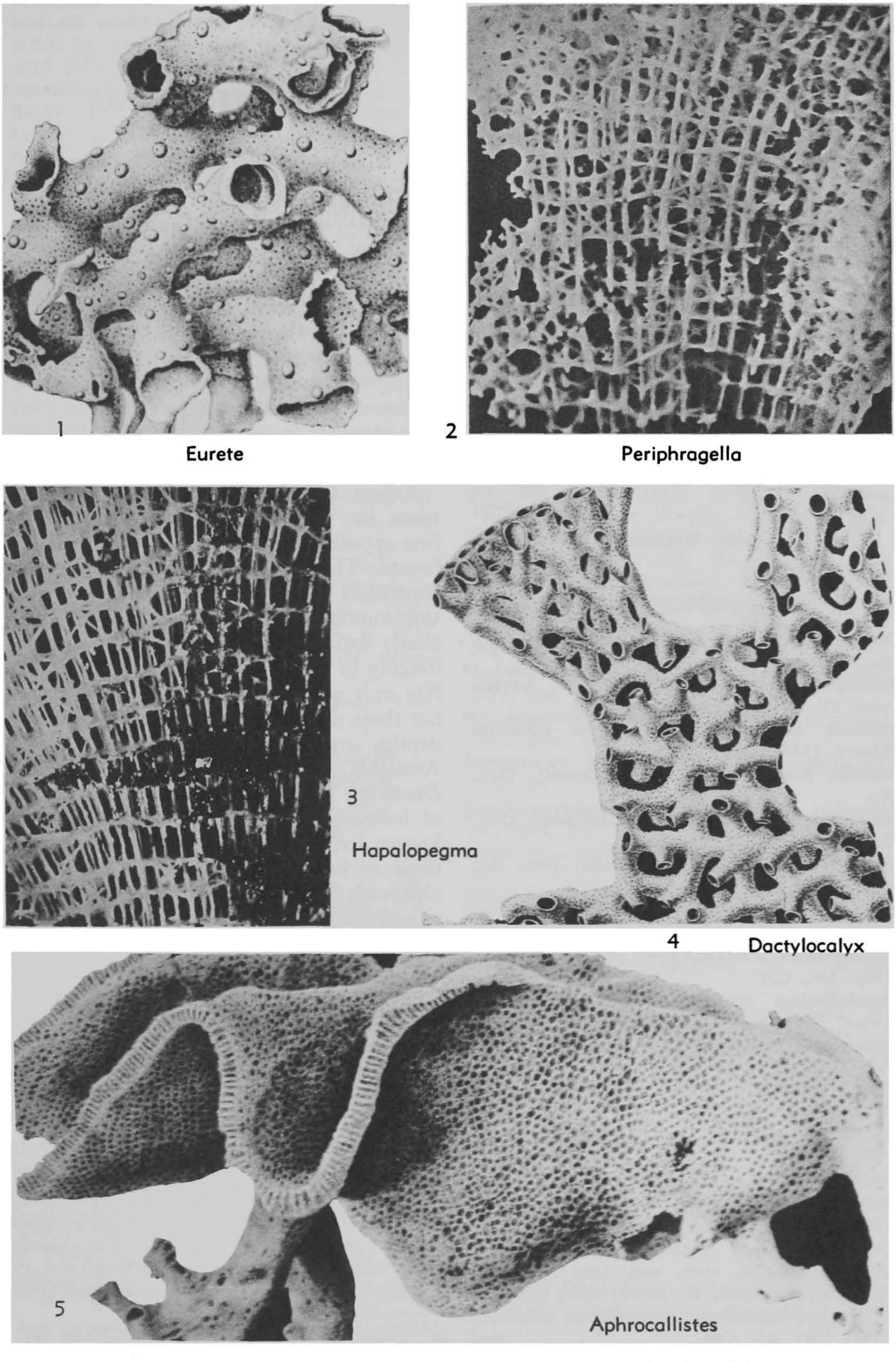

FIG. 66. Dictyida: Euretidae, Dactylocalycidae, Aphrocallistidae (p. E84).

that bears a succession of leaf- or flangelike shelves. *Cret.-Rec.*

Pleurochorium SCHRAM., 1912 [**P. feschulzei*]. Tubes branching, with many large leaflike lateral projections. *Cret.-Rec.,* Eu.-E.Indies-Ind.O. ——FIG. 67,*1*. **P. feschulzei,* Cret., Ger.; side view, ×1 (82).——FIG. 67,*2*. *P. annandalei* (KIRKPATRICK), Rec., Ind.O.; ×0.8 (67).

Wapkiosa DELAUB., *nom. nov.* [*pro Pleurothyris* SCHRAM., 1912 (ref. 38, p. 251) (*non* LOWE, 1843)] [**Pleurothyris tortuosa* SCHRAM., 1912] (38). *U.Cret.,* Ger.

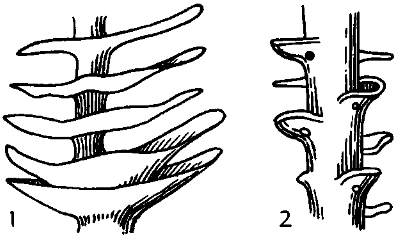

FIG. 67. Dictyida: Wapkiosidae (p. E86).

Family UNCERTAIN

Caseispongia QUENST., 1878 [**C. articulata*] (33). *Jur.,* Ger.

Pseudopemmatites FRAIPÖUT, 1911 [**P. fourmarieri;* SD DELAUB., herein]. *Dev.,* Eu.

Aulacosia RAUFF, 1933 [**Ocellaria cancellata* RÖMER, 1864]. *Cret.,* Eu.

Belonisia RAUFF, 1933 [**B. necopinata*]. *Cret.,* Eu.

Periplectum RAUFF, 1933 [**P. constrictum*]. *Cret.,* Eu.

Leptolacis SCHRAM., 1936 [**L. striata*] (40). *Jur.,* Ger.

Polysyge SCHRAM., 1936 [**P. pusilla*] (40). *Jur.,* Ger.

Rhogostomium SCHRAM., 1936 [**R. corrugatum*] (40). *Jur.,* Ger.

Rhombedonium SCHRAM., 1936 [**R. cypelliaeforme*] (40). *Jur.,* Ger.

Tremaphorus SCHRAM., 1936 [**T. punctatus*] (40). *Jur.,* Ger.

Nitidus DELAUB., *nom. nov.* [*pro Epaphroditus* SCHRAM., 1936 (ref. 40, p. 62) (*non* HERMAN, 1912)] [**Epaphroditus nitidus* SCHRAM., 1936] (40). *Jur.,* Ger.

Mysterium DELAUB., *nom. nov.* [*pro Mystrium* SCHRAM., 1936, (ref. 40, p. 60) (*non* ROGER, 1862)] [**Mystrium porosum* SCHRAM., 1936] (40). *Jur.,* Ger.

Octobrum DELAUB., *nom. nov.* [*pro Rhabdium* SCHRAM., 1936 (ref. 40, p. 63) (*non* SCHAUM, 1859)] [**Rhabdium angustatum* SCHRAM., 1936] (40). *Jur.,* Ger.

Lonsda DELAUB., *nom. nov.* [*pro Gonis* LONSD., 1849[1] (*non* BRANDT, 1835)] [**Gonis contortuplicata* LONSD., 1849]. *Cret.,* Eng.

Order LYCHNISKIDA Schrammen, 1902

[*nom. correct.* DELAUB., herein (*pro* Lychniskophora SCHRAM., 1902)]

Shape and rigid skeleton having general pattern of Dictyida but the central part of each hexact has short diagonal buttresses that connect adjacent pairs of rays so as to form an octohedral pattern resembling an open-sided lantern (*lychnos,* lamp); these so-called lantern nodes have 12 ribs consisting of the diagonal buttresses along angles of the octohedron and 8 triangular tiny openings in position of the faces of the octohedron (Fig. 69). *?Trias., Jur.-Rec.*

Except for a doubtful record of occurrence in Triassic rocks, the Lychniskida first appear as rare forms in Jurassic sponge faunas. They are extremely abundant and diversified in Cretaceous deposits, relatively uncommon in Tertiary formations, and nearly extinct today, for only 3 species belonging to 2 genera are known to be living. Not only are modern lychniskids very rare but those discovered, all from great oceanic depths, are in poor condition for study. Available examples of the Recent genus *Diapleura* are macerated specimens devoid of loose spicules; in *Aulocystis,* the other known living lychniskid, loose spicules like those of hexact-bearing dictyids have been observed. It is a curious fact that all described fossils referable to the Lychniskida come from localities in Europe.

Family VENTRICULITIDAE Smith, 1847

[=Pachyteichismatidae SCHRAM., 1936 (*nom correct.* DELAUB., herein, *pro* Pachyteichismidae SCHRAM., 1936)]

Vase-shaped lychniskids with walls traversed by definite prosochetes and apochetes. *Jur.-U.Cret.*

Ventriculites MANTELL, 1822 [**V. radiatus;* SD POMEL, 1867] [=*Retispongia* ORB., 1849; *Retiscyphia* FROM., 1860]. Shape ranging from nearly cylindrical to saucer-like; moderately thin wall with conspicuous canals parallel to longitudinal axis of sponge; small base with

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[1] LONSDALE, W. (1849) *Notes on fossil zoophytes:* Geol. Soc. London, Quart. Jour., vol. 5, p. 63.

radiating roots. *M.Cret.-U.Cret.*, Eu.——Fig. 68,*1*. **V. striatus* Smith, U.Cret., Ger.; *1a*, side, ×0.5; *1b*, transv. sec., ×1; *1c*, part of skeleton, ×12 (94).

Cephalites Smith, 1849 [**C. perforatus;* SD Rauff, 1893]. Differs from *Ventriculites* in having sharply truncate upper margin with fine skeletal network. *Cret.*, Eng.

Calathiscus Sollas, 1883 [**C. variolatus;* SD deLaub., herein]. Like *Ventriculites* but having some nodes without lantern structure. *Jur.*, Eng.

Rhizopterion Zittel, 1878 [**Scyphia cervicornis* Goldf., 1833; SD deLaub., herein]. Like *Ventriculites* but with elongate-oval prosopores in floors of longitudinal furrows (49). *Cret.*, Eu.

Leiostracosia Schram., 1902 [**L. punctata*]. Resembles *Rhizopoterion* (38). *U.Cret.*, Ger.

Lychniscaulus Schram., 1936 [**L. vannus*]. Like *Rhizopoterion* but smaller and less furrowed (40). *Jur.*, Ger.

Étalloniella Oppl., 1926 [*pro Étallonia* Oppl., 1915 (*non* Oppel, 1861)] [**Étallonia idanensis* Oppl., 1915]. Thin-walled cup consisting of regularly reticulating minute hexacts (28). *Jur.*, Eu.

Napaeana deLaub., *nom. nov.* [*pro Eudictyon* Schram., 1902 (ref. 37, p. 15) (*non* Marshall, 1875)] [**Eudictyon striatum* Schram., 1902] [=*Napaea* Schram., 1912 (ref. 38, p. 273) (*non* Robineau-Desvoidy, 1830)]. Like *Rhizopoterion* (38). *U.Cret.*, Ger.

Pleuropyge Schram., 1912 [**P. plana*]. Like *Ventriculites* but with cortex (38). *U.Cret.*, Ger.

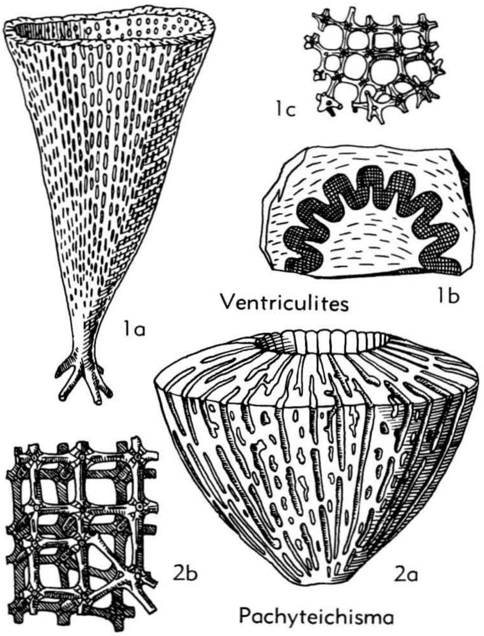


Fig. 68. Lychniskida: Ventriculitidae (p. E87).

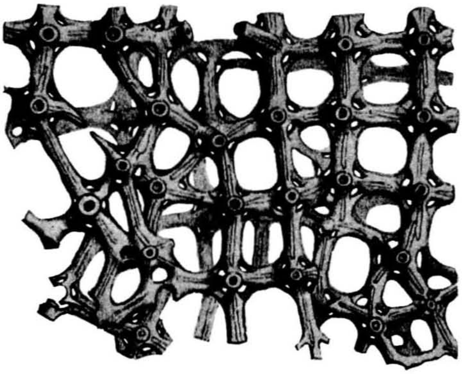


Fig. 69. *Trochobolus crassicosta* Zittel, U.Jur., Ger. (p. E87).

Lepidospongia F. A. Römer, 1862 [**L. denticulata;* SD Rauff, 1893] [=*Chlaenia* Pomel, 1872]. Some pores on sides of tubercles (35). *Cret.*, Ger.

Licmosinion Pomel, 1872 [**L. cymoria*]. Like *Ventriculites* but leaf-shaped (31). *L.Cret.*, Alg.

Astropegma Pomel, 1872 [**Ventriculites stellata* Römer, 1864; SD deLaub., herein] (31). *L.Cret.*, Alg.

Plectodermatium Schram., 1902 [**P. fragilis*] (37). *Cret.*, Ger.

Microblastidium Schram., 1902 [**M. decurrens*] (37). *Cret.*, Ger.

Desmoderma Schram., 1936 [**D. evestigata*]. *Cret.*, Fr.

Rhizopoteronopsis Lachasse, 1943 [**R. caillauensis*]. *Cret.*, Fr.

Rhizocheton Lachasse, 1943 [**R. jacobi*]. *Cret.*, Fr.

Pachyteichisma Zittel, 1878 [**P. carteri;* SD deLaub., herein]. [=*Lancispongia* Quenst., 1878]. Bowl- or top-shaped (49). *U.Jur.*, Eu. ——Fig. 68,*2*. **P. carteri; 2a*, side, ×0.5; *2b*, part of skeleton, ×12 (94).

Trochobolus Zittel, 1878 [**T. crassicosta;* SD deLaub., herein]. Resembles *Pachyteichisma* but skeletal meshes smaller and apopores more round (49). *U.Jur.*, Ger.——Fig. 69. **T. crassicosta*, U.Jur., Ger.; skeletal structure, enlarged (93*).

Pachyrachis Schram., 1936 [**P. labyrinthica*] (40). *Jur.*, Ger.

Family COELOSCYPHIIDAE
de Laubenfels, nov.

Differs from Ventriculitidae in growing invariably as rather narrow branching tubes. *Cret.*

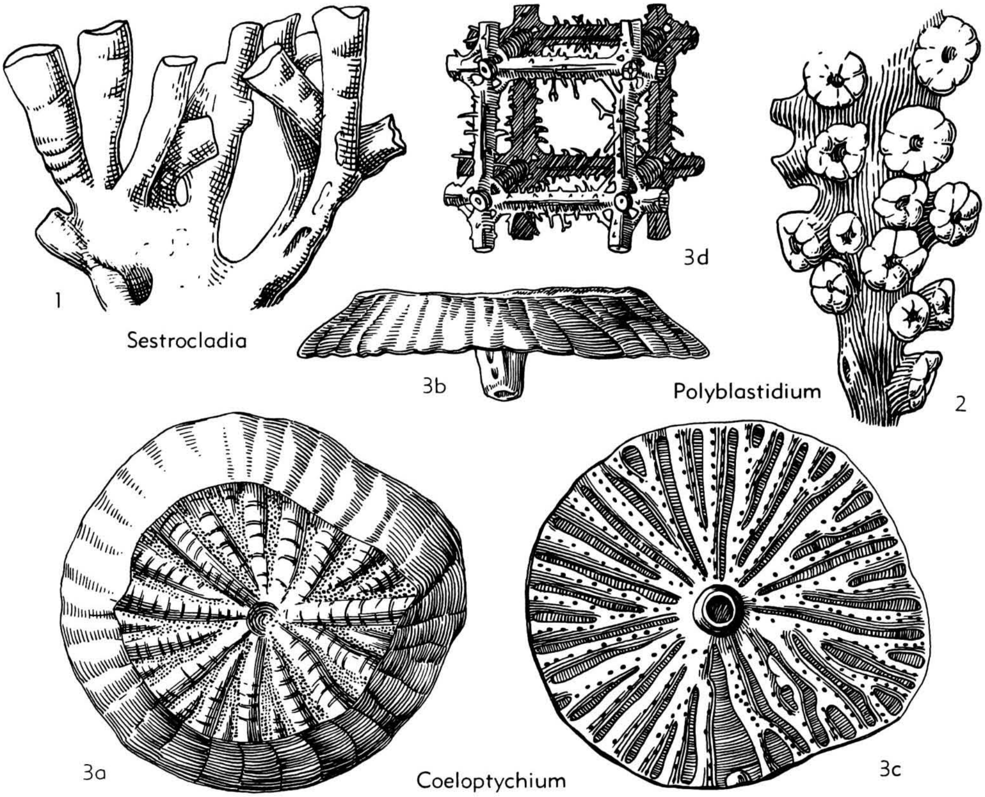


FIG. 70. Dictyida: Coeloscyphiidae, Polyblastidiidae, Coeloptychiidae (p. E89).

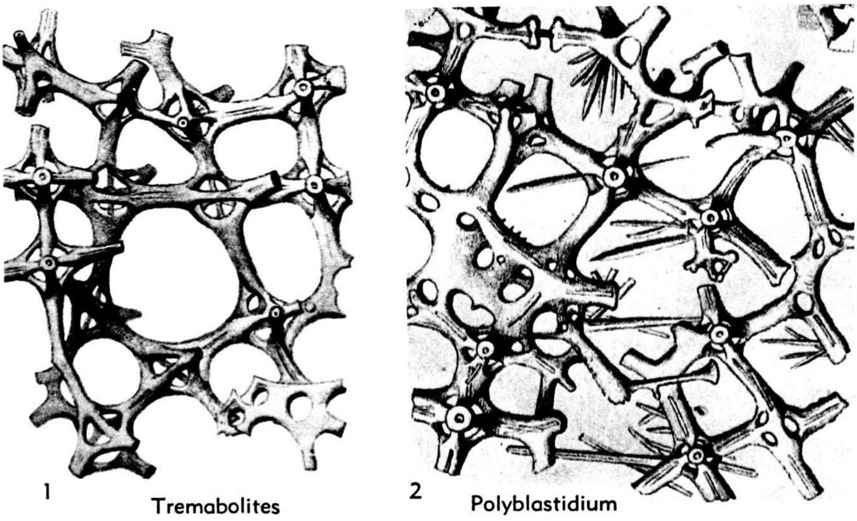


FIG. 71. Dictyida: Polyblastidiidae, Camerospongiidae (p. E89).

Coeloscyphia Tate, 1865 [**C. sulcata;* SD deLaub., herein]. Several thin-walled tubes branching from a center. *Cret.,* Ire.

Sestrocladia Hinde, 1884 [**S. furcata*]. Tubes irregularly bifurcating (12). *Cret.,* Eng.——Fig. 70,*1*. **S. furcata;* side, ×0.25 (63).

Family POLYBLASTIDIIDAE Schrammen, 1912

Central vertical axis bearing numerous radially directed short cylindrical branches each containing a rather large cloaca. *Jur.-Cret.*

Polyblastidium Zittel, 1878 [**P. luxurians*]. Branches tending to arrangement in whorls, in some species with cloaca of stellate cross section (49). *Cret.,* Eu.——Fig. 70,*2;* 71,*2*. **P. luxurians,* Ger.; 70,*2,* part of sponge, ×1; 71,*2,* skeletal structure, enlarged (93, 93*).

Phlyctaenium Zittel, 1878 [**Mastospongia cylindrata* Quenst., 1878; SD deLaub., herein]. Central axis tubular (49). *Jur.,* Ger.

Family COELOPTYCHIIDAE Zittel, 1877

Growth form umbrella- or mushroom-like. *U.Cret.*

Coeloptychium Goldf., 1833 [**C. agaricoides*] [=*Coelochonia* From., 1860; *Lophoptychium, Schizoptychium* Pomel, 1872]. Underside with radial branching ridges that bear relatively large prosopores; upper surface with very numerous small apopores in radial furrows (48). *U.Cret.,* Eu.——Fig. 70,*3*. **C. agaricoides; 3a-c,* top, side, and bottom, ×0.7; *3d,* part of skeleton, ×60 (94).

Myrmecioptychium Schram., 1912 [**M. bodei*]. Resembles *Coeloptychium* (38). *U.Cret.,* Ger.

Family CAMEROSPONGIIDAE Schrammen, 1912

Subglobular stalked lychniskids with rather large cloaca, endosomal skeleton having the form of many intertwined tubular canals, upper part covered by fine-meshed dermal reticulation. *Jur.-Tert., ?Rec.*

The difference between lower and upper parts of these sponges may reflect living conditions in which all but an area surrounding the oscule was buried in sediment. Thus, differences interpreted to have generic significance may be merely an expression of ecological variations. Similar gross features are seen in the Plocoscyphiidae (Lychniskida).

Camerospongia Orb., 1849 [**Scyphia fungiformis* Goldf., 1833] [=*Cameroscyphia* From., 1860]. Upper and lower parts very dissimilar (29). *Cret.-Tert.,* Eu.——Fig. 72,*1*. **C. fungiformis* (Goldf.); side, ×1 (94).

?**Polygonatium** Schram., 1936 [**P. sphaeroides*]. Resembles *Camerospongia* in form but lower and upper parts similar; irregularly placed prosopores diverse in size, skeleton formed of unequal-ray hexacts of varying size with stauracts in dermal layer (40). *Jur.,* Ger.

Tremabolites Zittel, 1878 [**Manon megastoma* Römer, 1841; SD deLaub., herein]. Differs from *Camerospongia* in having several oscules on summit (49). *U.Cret.,* Eu.——Fig. 71,*1*. *T. confluens* Fischer, Ger.; skeletal structure enlarged (93*).

Toulminia Zittel, 1878 [**Cephalites catenifer*

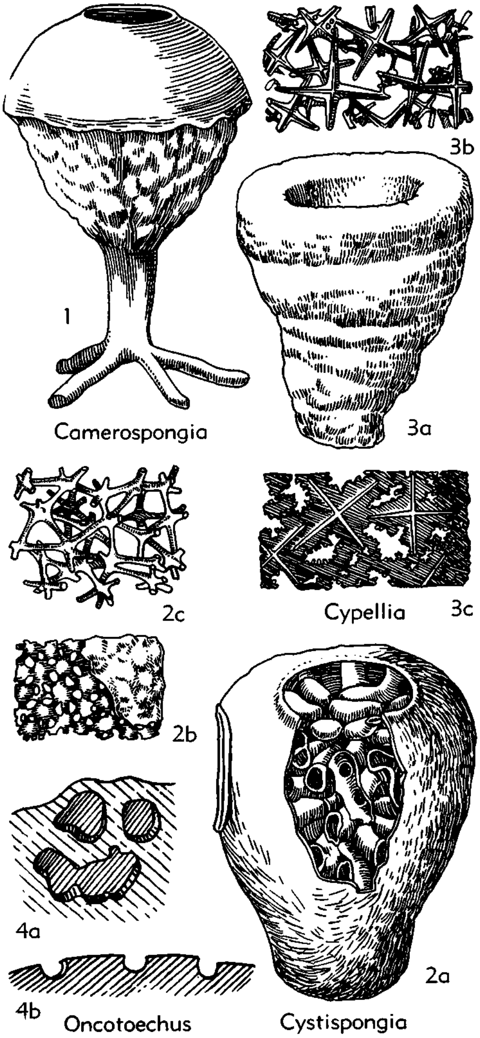
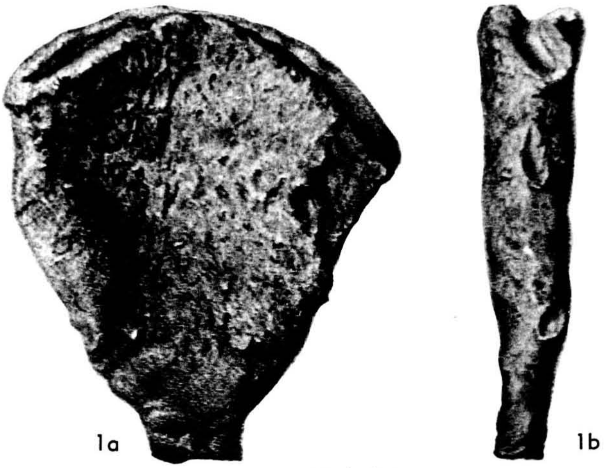
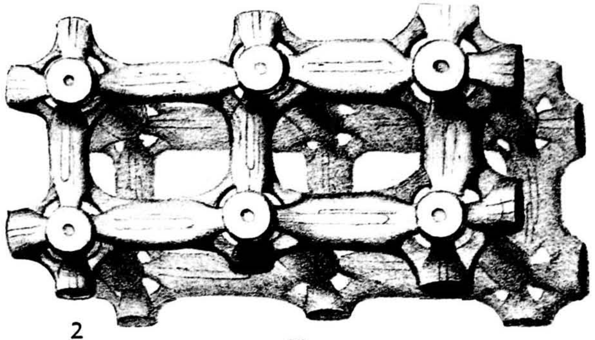


Fig. 72. Dictyida: Camerospongiidae, Cypelliidae, Oncotoechidae (p. E89-E91).



Diplodictyon



Plerope

FIG. 73. Dictyida: Callodictyidae (p. E91-E92).

SMITH, 1848; SD DELAUB., herein]. Resembles *Camerospongia* (49). *Jur.-Cret.*, Eu.

Cameroptychium LEONHARD, 1897 [**C. patella;* SD DELAUB., herein]. Like *Camerospongia. U.Cret.*, Eu.

Ornatus DELAUB., *nom. nov.* [*pro Phalacrus* SCHRAM., 1912 (ref. 38, p. 321) (*non* PAYKULL, 1800)] [**Phalacrus expectatus* SCHRAM., 1912]. Like *Camerospongia* but oscule covered by network (38). *U.Cret.*, Ger.

Cystispongia F. A. RÖMER, 1864 [**Cephalites bursa* QUENST., 1852; SD RAUFF, 1893]. Like *Tremabolites* but fine-meshed dermal reticulation extends far down sides (35). *U.Cret.-Tert., ?Rec.*, Eu.——FIG. 72,*2*. **C. bursa* (QUENST.), U.Cret., Ger.; *2a*, side, with part of dermal layer removed, ×1; *2b*, dermal layer and skeleton, ×12; *2c*, endosomal skeleton, ×12 (94).

Family CYPELLIIDAE
Schrammen, 1936

Like Camerospongiidae in having a fine-meshed dermal reticulation, commonly formed by stauracts, but endosomal skeleton is a regular framework corresponding to that of the Ventriculitidae, lacking a convoluted tubular structure. *Jur.-Cret.*

Cypellia POMEL, 1872 [**Scyphia rugosa* GOLDF., 1833; SD DELAUB., herein] [=*Phanerochiderma, Cryptochiderma, Paracypellia* SCHRAM., 1936]. Subcylindrical, expanding upward, with single deep cloaca (31). *U.Jur.*, Eu.——FIG. 72,*3*. **C. rugosa* (GOLDF.), Ger.; *3a*, side, ×0.5; *3b,c*, dermal layer, ×12 (94).

Porocypellia POMEL, 1872 [**Scyphia pyriformis* GOLDF., 1833]. Like *Cypellia* but bean-sized, with several oscules (31). *Jur.*, Eu.

Ophrystoma ZITTEL, 1878 [**Porospongia micrommata* RÖMER, 1864]. Like *Porocypellia* but oscules on flat top (49). *Cret.*, Eu.

Cavispongia QUENST., 1878 [**Spongites cylindrata* QUENST., 1843; SD DELAUB., herein]. Fossils chiefly casts (20, 32). *Jur.*, Ger.

Discophyma OPPL., 1915 [**Stauroderma étalloni* OPPL., 1907; SD DELAUB., herein]. Cup-shaped, with thick walls full of coarse pores (28). *Jur.*, Eu.

Placotelia Oppl., 1907 [**Porostoma marconi* From., 1859; SD deLaub., herein] [=*Plakotelia* Oppl., 1907 *(nom. neg.)*] (27). *Jur.*, Eu.

Sporadopyge Schram., 1936 [**S. speciosa*]. Thick-walled cup with dermal stauracts, oval oscules larger than numerous prosopores (40). *Jur.*, Ger.

Family ONCOTOECHIDAE
Schrammen, 1912

Cylindrical or rounded lychniskids with narrow cloaca, exterior marked by subdermal branched and anastomosed canals which probably were covered by protoplasmic tissue in life. *U.Cret.*

Oncotoechus Schram., 1912 [**O. cavernosus;* SD deLaub., herein] (38). *U.Cret.*, Ger.——Fig. 72,*4*. **O. cavernosus; 4a,* part of surface, ×1; *4b,* section normal to surface, ×1 (82).

Family CALLODICTYIDAE
Zittel, 1877

[*nom. correct.* deLaub., herein (*pro* Callodictyonidae Zittel, 1877)]

Skeletal reticulation very coarse, meshes serving as prosopores, apopores, or both. *Cret.*

Callodictyon Zittel, 1878 [**C. infundibulum*] [=*Callodictyonella* Strand, 1928]. Thin-walled cup, skeletal beams spiny (49). *U.Cret.*, Ger.

Marshallia Zittel, 1878 [**Pleurostoma tortuosum* Römer, 1864; SD deLaub., herein]. Like *Callodictyon* but exterior with radial or longitudinal folds bearing oscules in irregular rows, resembling *Coeloptychium* (49). *Cret.*, Eu.

Pleurope Zittel, 1878 [**Pleurostoma lacunosum* Römer, 1864]. Flattened vase-like, resembling a dagger sheath; skeletal beams smooth (49). *Cret.*, Eu.——Fig. 73,*2;* 74,*2*. **P. lacunosa* (Römer), Ger.; 73,*2,* skeletal structure, enlarged (93); 74,*2,* side, ×0.3 (93*).

Porochonia Hinde, 1884 [**Ventriculites simplex* Smith, 1848]. Thin-walled funnel with successively an outer delicate membrane, round-meshed network, rectangular network, and delicate cloacal membrane (12). *Cret.*, Eng.——Fig. 74,*1*. **P. simplex* (Smith); impression of outer skeletal framework, ×20 (63*).

?**Sclerokalia** Hinde, 1884 [**S. cunningtoni*]. Thick-walled cup, exterior without dermis but cloacal dermis perforated by vertical rows of apopores (12). *Cret.*, Eng.

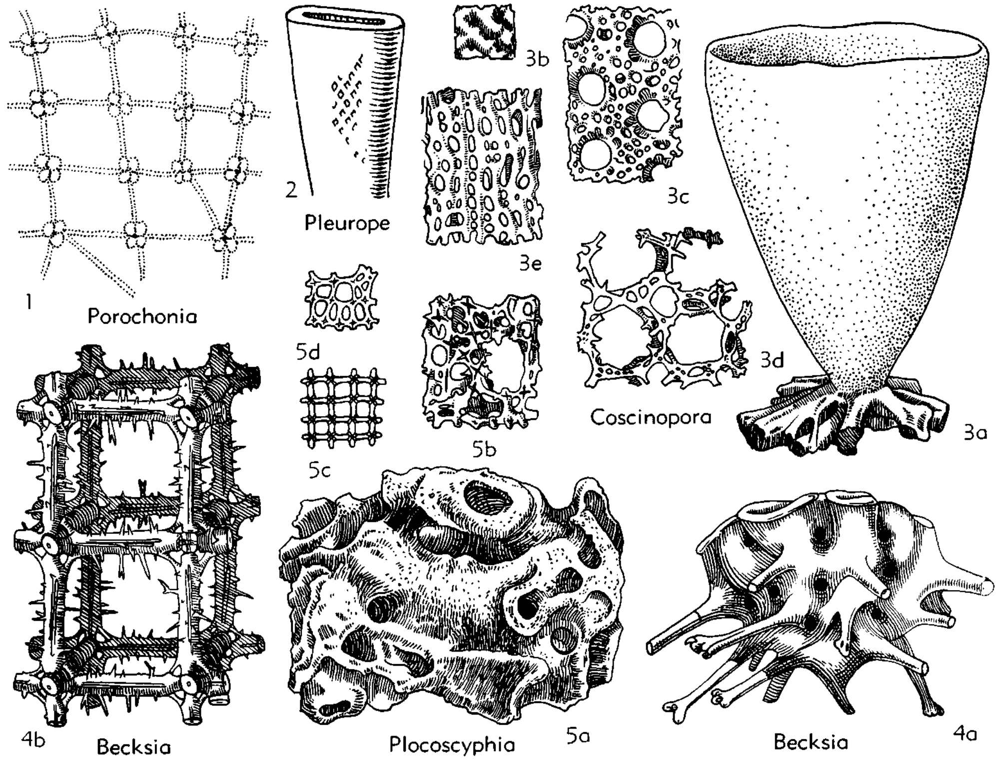


Fig. 74. Dictyida: Callodictyidae, Coscinoporidae, Becksiidae (p. E91-E92).

Diplodictyon Zittel, 1878 [**Scyphia heteromorpha* Reuss, 1845]. Like *Pleurope* but stalked, with rather large prosopores on one or both narrow edges, without large apopores; resembles *Guettardiscyphia* (49). *U.Cret.*, Ger.——Fig. 73,*1*. *D. bayfieldi* Hinde, Eng.; *1a,b*, side and edge, ×1 (63*).

Elasma Moret, 1926 [**E. moreti*]. Wavy sheets of uniform thickness with pores on one side only; skeleton reticulate (28). *Cret.*, Fr.

Beaussetia Moret, 1926 [**B. membraniformis*]. Like *Elasma* but without evident pores on either side (26). *U.Cret.*, Fr.

Sporadoscinia Pomel, 1872 [**Scyphia retiformis* Römer, 1864; SD Rauff, 1893]. Cup-shaped, with conspicuous lacelike patterns on outer and inner sides; skeletal network with spiny beams (31). *Cret.*, Eu.

Family COSCINOPORIDAE Zittel, 1877

Thin-walled vase-shaped lychinskids. *U.Cret.*

Coscinopora Goldf., 1833 [**C. infundibuliformis*] [=*Coscinoscyphia* From., 1860; *Coccinopora* Schlüter, 1870]. With roots (9). *U.Cret.*, Eu. ——Fig. 74,*3*. **C. infundibuliformis; 3a*, side, ×0.5; *3b,c*, outer surface, ×1, ×3; *3d*, main skeletal structure, ×12; *3e*, part of root, ×12 (94).

Cinclidella Schram., 1912 [**C. solitaria*]. Like *Coscinopora* but form nearly tubular (38). *U.Cret.*, Ger.

Balantionella Schram., 1902 [**B. elegans*]. Small fine-textured leaves (37). *U.Cret.*, Ger.

Family BECKSIIDAE Schrammen, 1912

Lychniskids with cortex and endosomal skeleton containing convoluted tubes, some of which branch and anastomose. *Jur.-U.Cret.*

Plocoscyphia Reuss, 1846 [**Spongus labyrinthicus* Mantell, 1822; SD Pomel, 1872] [=*Brachiolites* Smith, 1848; *Plocosmilia* From., 1860; *Plocospongia* Quenst., 1878]. Shape irregular, moderately thick-walled. *Jur.-Cret.*, Eu.——Fig. 74,*5*. *P. pertusa* Geinitz, Cret., Hungary; *5a*, part of specimen, ×1; *5b*, cortex, ×5; *5c,d*, endosomal skeleton, ×12 (*5a-d*, 94).——Fig. 75. *P. communis* Moret, U.Cret.(Cenom.), Fr.; ×1 (72*).

Gyrispongia Quenst., 1878 [**G. subruta;* SD deLaub., herein]. ?Weathered *Plocoscyphia* (32). *Cret.*, Ger.

Cyclostigma Schram., 1912 [**Plocoscyphia acinosa* Schram., 1902; SD deLaub., herein]. Differs from *Plocoscyphia* in having small hexacts in lining of tubes (38). *U.Cret.*, Ger.

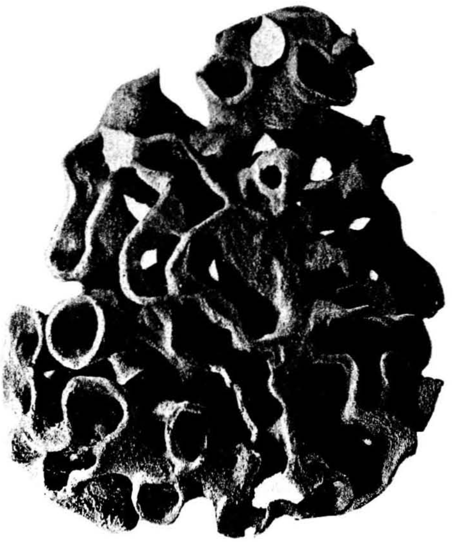


Fig. 75. *Plocoscyphia communis* Moret, U.Cret. (Cenom.), Fr. (p. E92).

Exanthesis Moret, 1926 [**Plocoscyphia reticulata* Hinde, 1883]. Tubes with somewhat indistinct radial arrangement (26). *U.Cret.*, Eng.-Fr.

Ceriodictyon Oppl., 1907 [**C. coniformis*]. Large cloaca (27). *Jur.*, Switz.

Becksia Schlüter, 1868 [**B. soekelandi*]. Cup-shaped with hollow roots at base, walls formed by laterally joined vertical tubes (26). *U.Cret.*, Ger.-Fr.——Fig. 74,*4*. **B. soekelandi; 4a*, side, ×0.5; *4b*, part of skeleton, ×50 (72).

Callicylix Schram., 1912 [**C. farreides*]. Large cloaca (38). *U.Cret.*, Ger.

Family CALYPTRELLIDAE Schrammen, 1912

Like Becksiidae but lacking a cortex; also resemble the dictyid family Euretidae. *Jur.-U.Cret.*

Calyptrella Schram., 1912 [**C. bertae*]. Very regular meshes (38). *U.Cret.*, Ger.

Kentrosia Schram., 1902 [**K. incrustans;* SD deLaub., herein] [=*Centrosia* Moret, 1926]. Peculiar lantern nodes bear sharp spike on external ray; may be a becksiid that has lost its cortex (37). *Cret.*, Ger.

Sarophora Schram., 1912 [**S. armata*]. Like *Kentrosia* but projecting ray of lantern ends in broomlike tuft (38). *Cret.*, Ger.

Coscinaulus Schram., 1936 [**C. micropora*]. Small thin-walled porous tube (40). *Jur.*, Ger.

Plectascus Schram., 1912 [**Dendrospongia clathrata* Römer, 1864]. Saclike form with anastomosing srtongly folded tubes (38). *U.Cret.*, Ger.

Family UNCERTAIN

Scolecosia Rauff, 1933 [**S. scrobiculata*]. *U.Cret.*, Eu.

Bolitesia Schram., 1912 [**B. mirabilis*]. Very coarsely reticulate (38). *U.Cret.*, Ger.

Triadocoelia Vinassa, 1911 [**T. magyara*]. Ill known but surely a lychniskid. *?Trias.*, Hung.

Order HETERACTINIDA Hinde, 1888

Main skeletal framework composed of polyactinal spicules. *L.Cam.-Carb.*

No other sponges have many-rayed (astrose) siliceous spicules classifiable as megascleres, that is, composing the main body skeleton, although many demosponges and most families of Recent hyalosponges contain polyactinal microscleres. The Heteractinida are an exclusively Paleozoic group, from which later sponges characterized by spicules with fewer rays conceivably may have developed with accompanying suppression of rays to yield more simple patterns.

Family CHANCELLORIIDAE de Laubenfels, nov.

Heteractinids with a tough ectosome and dense endosome but lacking fusion of spicules into a rigid dictyonid framework. The spicules resemble long-shafted triaenes of the demosponge order Choristida, which have 3 clads at the outer end of a long rhabd, but 2 to 9 clads occur in spicules of this family; they are recurved like the clads of tetracts called anatriaenes. *M.Cam.-U.Cam.*

Chancelloria Walc., 1920 [**C. eros*]. Main skeleton composed chiefly of anahexaenes but clads range from 4 to 9; marginal skeleton mainly formed of anadiaenes (45). Can.(B.C.)-Mo.——Figs. 76; 77,*1*. **C. eros;* 76, specimen showing spicules, ×2.3; *77,1a,* anahexaene, ×15; *77,1b,* anadiaenes, ×7.5 (88, 88*).

Family ASTRAEOSPONGIIDAE de Laubenfels, nov.

Characterized by relatively large spicules having 6 evenly spaced rays approximately in the same plane and 2 generally short rays normal to this plane, the latter reduced to a mere lump in some spicules. *M.Cam.-Carb.*

Astraeospongium Römer, 1854 [**Blumenbachium meniscus* Römer, 1848] [=*Astraeospongia* Römer, 1860; *Octasium* Schlüter, 1885]. Saucer- or low bowl-shaped, with rather thick walls, no trace of attachment; skeleton a felted mass of 8-rayed spicules. *Sil.-Dev.*, Eu.-N.Am.——Fig. 77,*6*. **A. meniscus* (Römer), Sil., U.S.A.; *6a,b,* top and side, ×0.7 (94); *6c,d,* spicules, ×6 (68).

Eiffelia Walc., 1920 [**E. globosa*]. Spheroidal, probably hollow, for surface consists of a single layer of spicules having 6 straight clads with rhabd reduced to mere button (45). *M.Cam.*, B.C.——Fig. 77,*5*. **E. globosa;* spicule, ×7 (88).

Hyalostelia Zittel, 1879 [**Hyalonema smithi* Y.-Y., 1877]. Skeleton with many hexacts, spicules of astraeospongiid type comprising a minority; root tufts present (49). *Carb.*, Ill.-Eng.——Fig. 77,*2a*. **H. smithi* (Y.-Y.), spicules, ×15 (63). ——Fig. 77,*2b*. *H. diabola* Weller, L.Penn., Ill.; spicule, ×15 (89).

Protohyalostelia Chapman, 1940 [**P. mawsoni*]. Similar to *Hyalostelia*, cup-shaped. *Cam.*, Austral.

Leptopoterion Ulr., 1889 [**L. mammiferum*] [=*Leptopterion* Miller, 1889]. Obconical, unattached. *Ord.*, Ohio.

Tholiasterella Hinde, 1887 [**T. gracilis;* SD de-Laub., herein]. Thin-walled, spicules commonly spiny or lumpy on side toward sponge surface, some with recurved clads as in *Chancelloria* (13). *Carb.*, Eng.-Scot.-Ger.——Fig. 77,*4*. **T. gracilis; 4a,* fused spicules of dermal layer, ×5; *4c-d,* loose spicules, ×5 (94, 63).

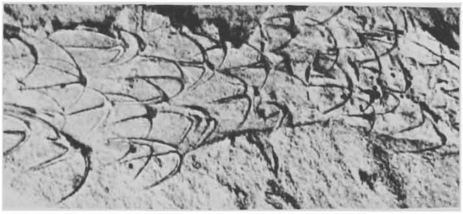


Fig. 76. *Chancelloria eros* Walc., M.Cam., B.C. (p. E93).

Family ASTERACTINELLIDAE de Laubenfels, nov.

Principal spicules profusely polyactinal. *L.Cam.-Perm.*

Asteractinella Hinde, 1887 [**A. expansa*]. Form unknown; spicules star- or flower-like (13). *Carb.*, Eng.——Fig. 77,*3*. **A. expansa; 3a,* stellate spicule, ×7; *3b,* floriform spicule, ×12 (63).

Wewokella Girty, 1912 [**W. solida*]. Cylindrical, with deep cloaca; spicules are sphaerasters, with many rays protruding from central sphere. *U.Penn.*, Okla.-Tex.

Talpaspongia R. H. King, 1943 [**T. clavata*]. Endosomal skeleton finer-textured than in *Wewok-*

ella (19). *L.Perm.*, Tex.——Fig. 78. **T. clavata;* transv. sec., ×1 (66*).

Uranosphaera Bedf.-B., 1943 [**U. polyaster*]. Segment of bowl or hollow sphere; some rays of asters bifurcate. *L.Cam.*, Austral.

Order UNCERTAIN

Spongus Mantell, 1822 [**S. townsendi;* SD deLaub., herein]. Cup-shaped. *Cret.*, Eng.

Lonsda deLaub., *nom. nov.* [*pro Conis* Lonsd., 1849 (Quart. Jour. Geol. Soc. London, vol. 5, p. 63) (*non* Brandt, 1835)] [**Conis contortuplicata* Lonsd., 1835]. Many-ridged mass. *Cret.*, Eng.

Bothroconis King, 1850 [**B. plana*]. Vaselike with flaring rim. *Perm.*, Eng.

Acanothyra Pomel, 1872 [**Camerospongia polydactyla* Römer, 1864; SD deLaub., herein] (31). *Cret.*, Eu.

Antrispongia Quenst., 1878 [**A. dilabyrinthica;* SD deLaub., herein]. ?Euretidae, ?Calyptrellidae (32). *L.Cret.*, ?Eng.

Baccispongia Quenst., 1878 [**B. baccata;* SD deLaub., herein]. Cup-shaped, lumpy (32). *Jur.*, Ger.

Crucispongia Quenst., 1878 [**C. annulata;* SD deLaub., herein] Annulate cup (32). *Jur.*, Ger.

Textispongia Quenst., 1878 [**T. coarctata;* SD deLaub., herein] [=*Leptophyllus* Quenst., 1878] (32). *Jur.*, Ger.

Chirospongia Miller, 1889 [**C. wenti*] (25). *M.Ord.*, U.S.A.

Lysactinella Girty, 1896 [**L. gebhardi;* SD deLaub., herein]. *L.Dev.*, U.S.A.

Nepheliospongia Clarke, 1900 [**N. typica*]. Vaselike, with polygonal surface net. *U.Dev.*, ?N.Y.

Pachylepisma Schram., 1902 [**P. robusta*] (37). *Cret.*, Ger.

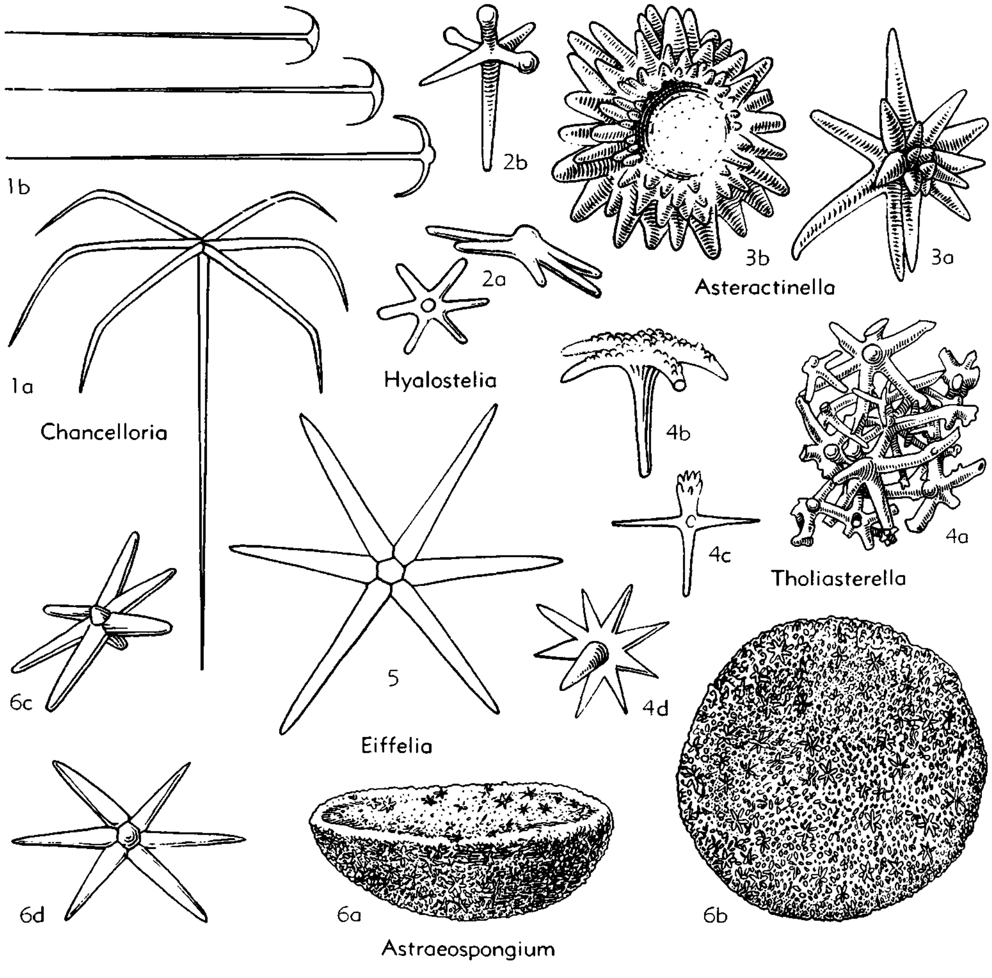


Fig. 77. Heteractinida: Chancelloriidae, Astraeospongiidae, Asteractinellidae (p. E93-E94).

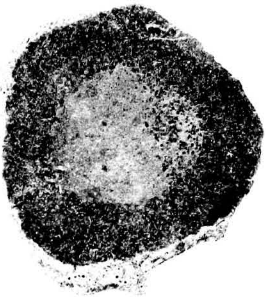


Fig. 78. *Talpaspongia clavata* R. H. King, L.Perm., Tex. (p. E94).

Idiodictyon deLaub., *nom. nov.* [*pro Eudictyon* Bistram, 1903[1] (*non* Marshall, 1875)] [**Eudictyon steinmanni* Bistram, 1903]. *L.Jur.*, Ger.

Ammonella Walther, 1904 [**A. quadrata*]. ?Age, Italy.

Oxospongia Clarke, 1920 [**O. johnstoni;* SD deLaub., herein]. ?Age, ?loc.

Farreopsis Schram., 1924 [**F. diffusa*] (39). *Cret.*, Ger.

Diplopleura Regnard, 1927 [**D. hatoni*]. *Cret.*, Fr.

Uralonema Librovich, 1929 [**U. karpinskii*]. *Carb.*, Sib.

Hodsia Moissev, 1939 [**H. caucasia*]. *Trias.*, Russ.

Sahraja Moissev, 1939 [**S. triassica*]. *Trias.*, Russ.

Class CALCISPONGEA de Blaineville, 1834

[*nom. correct.* deLaub., herein (*pro* Calcispongiae Blainv., 1834)] [=Calcarea Bow., 1864]

Skeleton composed of calcareous spicules. *Cam.-Rec.*

This class includes not only sponges of rhagon architecture but (unlike other classes) also sponges of sycon and ascon architecture. The skeletons invariably contain spicules of calcium carbonate, which is not proper to other sponges, and no calcisponge secretes silica or spongin. Almost universally, if not entirely so, the spicules belong to the 3 types described as simple diacts, triacts of various shapes, and tetracts. The triacts may be Y- or T-shaped, and some (termed pharetrones) have a distinctive tuning-fork appearance.

Calcispongea with tuning-fork spicules, both those living today and kinds known as fossils, commonly show an interlocking or cementing together of these spicules that produces a rigid structure. Such skeletons, which may be compared to the dictyonine Hyalospongea and lithistid Demospongea, are more likely to be preserved in manner showing the shape of the sponge than loosely knit skeletons.

Haeckel (1870) divided the calcareous sponges into three assemblages that he named Ascones (characterized by ascon type of structure), Sycones (having sycon type of architecture), and Leucones (with rhagon architecture). Dendy & Row (1913) rejected Haeckel's classification on the ground of its seeming artificiality and inadequacy as expression of phylogenetic relationships. Likewise, students of living calcisponges have made little or no use of Haeckel's system, generally recognizing instead the 2 orders Homocoela and Heterocoela defined by Poléjaeff (1883). The Homocoela includes only a single genus *(Leucosolenia)* of ascon type, whereas the Heterocoela contains all other calcareous sponges. In 1898, Bidder divided the calcisponges into orders called Calcaronea and Calcinea, based on the location of nuclei of the choanocytes in apical or basal position; since this has been found to vary within the same species, Bidder's classification has not been accepted.

Dendy & Row (1913) concluded that all of the calcisponges should be assigned to a single order which they named Calcarea, although they pointed out evidence of diphyletic nature of the group, one stem arising from *Dendya* and another from *Sycetta.* De Laubenfels (1936) concluded that the division suggested by Dendy & Row was significant and therefore undertook to recognize it by establishing 2 orders named Asconosa and Syconosa. The first includes all of Haeckel's Ascones and about half of his Leucones; also, it comprises Poléjaeff's Homocoela and about half of his Heterocoela. The order Syconosa contains all of Haeckel's Sycones and the remainder of his Leucones; it includes much of Poléjaeff's Heterocoela but as now modified, excludes pharetrone sponges that Poléjaeff probably would have included. Little attention to fossil sponges was given by most of these authors.

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[1] Bistram, V., (1903) *Beiträge zur Kenntnis der Fauna des unteren Lias in der Val Solda*: Ber. Ges. Freiburg, vol. 13, pp. 84, 199.

ZITTEL (1878) mentioned Ascones, Sycones, and Leucones, treating them as families, but assigned all fossil calcisponges (except one in Sycones) to his new family Pharetrones. STEINMANN (1882) ranked the Pharetrones as an order and divided it into suborders named Inozoa and Sphinctozoa. DE LAUBENFELS (herein) concludes that the Sphinctozoa differ sufficiently from typical Pharetrones to deserve separation as an independent order, leaving the virtually unused name Inozoa as a junior synonym of Pharetrones. On the other hand, use of the name introduced by STEINMANN seems inadvisable because (1) it conflicts with the generic name *Sphinctozoa* and (2) the ending -zoa (as in Protozoa, Metazoa) seems inappropriate for an ordinal division of the Calcispongea. The new name Thalamida is used instead.

The names Asconosa and Syconosa have been criticized properly on the ground of their resemblance to HAECKEL's assemblages called Ascones and Sycones. In order to avoid confusion, the new names Solenida (for Asconosa) and Lebetida (for Syconosa) are here introduced, with taxonomic emendation consisting in the removal of pharetrone genera which earlier were included in Asconosa and Syconosa. Thus, the Calcispongea are divided into 4 orders: Solenida, having most simple structure, *Cam.-Rec.* (mostly Rec.); Lebetida, somewhat less simple, *L.Jur.-Rec.* (mostly Rec.); Pharetronida, more elaborate in structure, *Perm.-Rec.* (mostly fossil); and Thalamida, most elaborate, *Carb.-Cret.* (known only as fossil).

Order SOLENIDA de Laubenfels, nov.

[=Asconosa DELAUB., 1936]

Calcisponges either permanently of ascon architecture or (generally) progressing to rhagon architecture by enclosure of ascon structure within an ectosomal envelope. (A single genus of fossil sponges is placed here quite provisionally.) *Cam.-Rec.*

Family CAMAROCLADIIDAE de Laubenfels, nov.

Small branching tubes somewhat resembling modern Leucosoleniidae. *Cam.-Ord.*

Camarocladia MILLER, 1889 [**C. dichotoma*]. Diameter of tubes about 2 mm. (in agreement with ascon-type sponges); walls containing doubtfully identified triactinal spicules associated with puzzling globular bodies (24). Pa.-Ky.-Ill.-Minn.——FIG. 79,*1*. **C. dichotoma;* outline, ×1 (71).

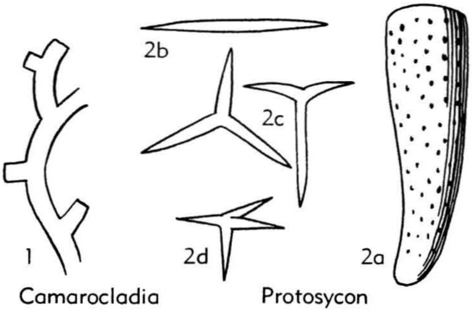

FIG. 79. Solenida, Lebetida (p. E96).

Order LEBETIDA de Laubenfels, nov.

[=Syconosa DELAUB., 1936]

Calcisponges either permanently of sycon architecture or progressing in some to rhagon architecture by compounding sycon units; ascon structure consistently lacking. *L.Jur.-Rec.*

Family GRANTIIDAE Dendy, 1892

Sycon architecture persistent within an inclosing dermis or cortex, not exposed. *U.Jur.-Rec.*

Protosycon ZITTEL, 1878 [*Scyphia punctata* GOLDF., 1833]. Resembles modern *Grantia* (49). *U.Jur.*, Ger.——FIG. 79,*2*. **P. punctatum* (GOLDF.); *2a*, side, ×1; *2b-d,* diact, triacts, tetract (93).

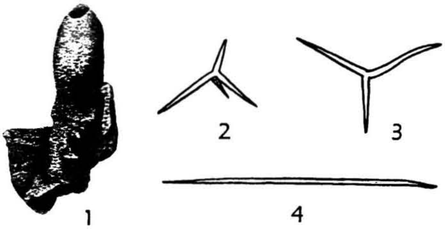

FIG. 80. *Leuconia walfordi* (HINDE), L.Jur., Eng. (p. E97).

Family LEUCONIIDAE Vosmaer, 1886

[*nom. correct.* DELAUB., herein (*pro* Leuconidae VOSMAER, 1886)]

Initially like Grantiidae but developing a simple rhagon architecture, generally with single cloaca of simple type. *L.Jur.-Rec.*

Leuconia GRANT, 1834 [**Spongia nivea* GRANT, 1826; SD BOW., 1862] [=*Leucandra* HKL., 1872]. Simple rhagon sponges with dermal triacts over endosomal diacts, triacts, and tetracts (22). *L.Jur.*(Eng.)-*Rec.*(cosmop.).——FIG. 80,*1-4*. *L. walfordi* (Hinde), M.Lias, Northampt.; *1*, side, ×10; *2-4*, spicules, ×100 (63*).

Protoleucon BOLK., 1923 [**P. pavlovi*]. *Cret.-Tert.*, U.S.S.R.

Order PHARETRONIDA Zittel, 1878

[*nom. correct.* DELAUB., herein (*pro* Pharetrones ZITTEL, 1878)]

Characterized by triacts of tuning-fork type, many spicules interlocked so as to form strands which often are called fibers, or the spicules may be cemented together. Much of the cement may have been added during fossilization. *Perm.-Rec.*

Suborder CHALARINA de Laubenfels, nov.

Pharetronids having skeletal strands formed of spicules that are merely interlocked, entangled, or joined side to side, not connected tip to tip (named from *chalaros*, slack, loose). *Perm.-Rec.*

Family SESTROSTOMELLIDAE de Laubenfels, nov.

Somewhat massive sponges with numerous oscules, possibly representing several individuals, as in the bath sponge and many others. *Trias.-Cret.*

Sestrostomella ZITTEL, 1878 [**S. robusta;* SD DELAUB., herein]. Oscules may be covered by a net (49). *Trias.-Cret.*, Eu.——FIG. 81,*4*. *S. rugosa* HINDE, Cret., Eng., pharetrone spicules, ×150 (63).

Trachysinia HINDE, 1884 [**T. aspera;* SD DELAUB., herein]. Surface lumpy. *M.Jur.*, Fr.——FIG. 81,*5*. **T. aspera,* specimen, ×0.5 (63).

Trachytila WELTER, 1910 [**T. tuberosa*]. Prosopores conspicuous except on summit (46). *L.Cret.*, Ger.——FIG. 81,*1*. **T. tuberosa,* specimen, ×0.7 (90).

Winwoodia RICHARDSON & THACKER, 1920 [**W. porula;* SD DELAUB., herein]. Massive. *M.Jur.*, Eng.

Thamnonema SOLLAS, 1883 [**T. pisiforme*]. Globular, without cloaca; skeletal strands radiating from center of base, commonly branched. *M.Jur.*, Eng.

Family STELLISPONGIIDAE de Laubenfels, nov.

Shape rounded, with fine-textured commonly wrinkled dermis around sides but not on summit; radiating grooves around oscules probably denote apochetes which originally were covered by soft tissue with or without loose spicules; in life, the dermis may have been flexible. *Trias.-Cret.*

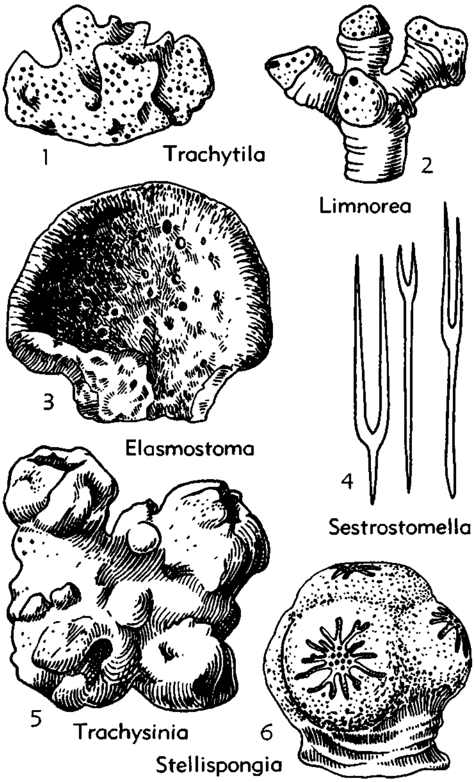

FIG. 81. Pharetronida (Chalarina): Sestromellidae, Stellispongiidae, Elasmostomatidae (p. E97-E98).

Stellispongia ORB., 1849 [**Cnemidium variabile* MÜNSTER, 1841; SD HINDE, 1893] [=*Seriospongia* ÉTALLON, 1860; *Dvoracia* POMEL, 1872]. *Trias.-Jur.*, *?Cret.*, Eu.-Peru.——FIG. 81,*6*. *S. glomerata* (QUENST.), U.Jur., Ger.; side ×1 (94).

Endostoma RÖMER, 1864 [**Scyphia foraminosum* GOLDF., 1833; SD DELAUB., herein]. Resembles *Stellispongia*. *?Cret.*, Eu.

Enaulofungia FROM., 1861 [**E. corallina*] [=*Holcospongia* HINDE, 1893]. Pores in vertical rows on sides (7). *Jur.-Cret.*, Eu.

Inobolia HINDE, 1884 [**I. inclusa*]. Like *Stellispongia* but oscules not evident (12). *M.Jur.*, Eng.

Synopella ZITTEL, 1878 [**Lymnorea sphaerica* MICH., 1847; SD DELAUB., herein]. Rounded, may be compound, warty, with coarse spicular strands (49). *Cret.*, Eu.

FIG. 82. *Pharetrospongia strahani* SOLLAS, Cret., Eng. (p. E98).

Blastinia ZITTEL, 1878 [**Achilleum costatum* GOLDF., 1833; SD DELAUB., herein]. Budlike, cloaca elaborate, stalked; skeletal strands very crooked (49). *Jur.,* Eu.

Euzittelia ZEISE, 1897 [**E. magnifica*]. Like *Blastinia* but cloaca more simple. *Jur.-Cret.,* Eu.

Limnorea GOLDF., 1833 [*pro Lymnorea* LAMX., 1821 (*non* PERON & LESUEUR, 1810)] [**Lymnorea mammillosa* LAMX., 1821] [=*Lymnoreotheles* FROM., 1860; *Lymnorella* RICHARDSON & THACKER, 1920]. Cylindrical branching sponges with naked porous tops (9). *M.Jur.,* Eu.——FIG. 81,*2*. **L. michelini* (ORB.); side, ×1 (59).

Epitheles FROM., 1860 [**Myrmecium hemisphaericum* GOLDF., 1833]. Probably congeneric with *Limnorea* but not branched (7). *U.Jur.,* Fr.

Diasterofungia FROM., 1861 [**D. insignis*]. Like *Limnorea. M.Jur.,* Fr.

Blastinoidea RICHARDSON & THACKER, 1920 [**B. frithica*]. Like *Blastinia* but without surface furrows. *M.Jur.,* Eng.

Family ELASMOSTOMATIDAE de Laubenfels, nov.

Primarily lamellate or leaf-shaped but may form somewhat pronounced concavo-convex growths distinguishable from typical bowl-shaped sponges in occurrence of oscules on the convex side about as commonly as on the concave surface. *Jur.-Cret.*

Elasmostoma FROM., 1860 [**Tragos acutimargo* RÖMER, 1839]. Irregular shallow saucer or fan with abundant prosopores on one side and groups of 3 to 6 oscules on the other (7). *Jur.-Cret.,* Eu.——FIG. 81,*3*. **E. acutimargo* RÖMER, L.Cret., Ger.; concave side, ×1 (94).

Steinmanella WELTER, 1910 [**S. latidorsa*]. Like *Elasmostoma;* layered walls suggest growth sequence (46). *Cret.,* Ger.

Diaplectia HINDE, 1884 [**D. auricula;* SD DELAUB., herein]. Cup-, fan-, or platter-shaped (12). *M.Jur.,* Eng.-Fr.

Family PHARETROSPONGIIDAE de Laubenfels, nov.

Pharetronids characterized by hard skeletal strands composed of linearly arranged, laterally joined diacts (oxeas), resembling the spongin-cemented fibers of modern demosponges such as *Haliclona. L.Cret.-U.Cret.*

Pharetrospongia SOLLAS, 1877 [**P. strahani*]. Variously convoluted plates. Eng.——FIG. 82. **P. strahani,* U.Cret., Kent; ×0.5 (63*).

Family LELAPIIDAE Dendy & Row, 1913

Erect cylinders or inverted cones with one or more deep cloacas opening on the rather flat top. *Perm.-Rec.*

Lelapia GRAY, 1867 [**L. australis*]. Stemlike, with cloacal layer of tetracts. *Rec.,* Austral.

Corynella ZITTEL, 1878 [**Scyphia foraminosa* GOLDF., 1833; SD HINDE, 1884]. Variably cylindrical, knobby, or top-shaped, with one or more oscules; canals evident or not; normal rhagon

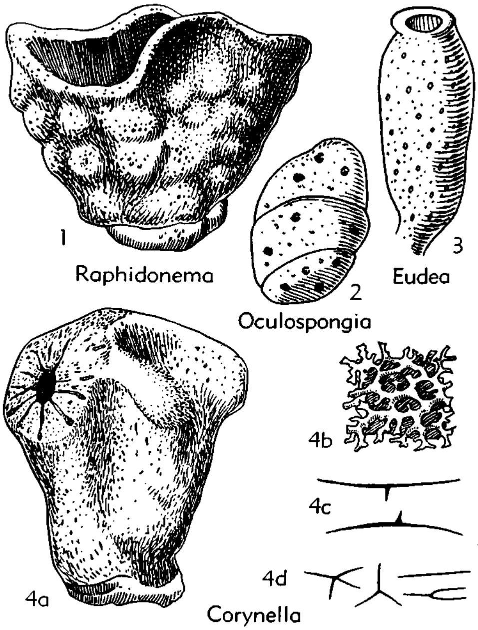

FIG. 83. Pharetronida (Chalarina): Lelapiidae (p. E99).

architecture with prosochetes and apochetes (49). *Trias.-Cret.,* Eu., ?E.Indies.——Fig. 83,*4*. *C. quenstedti* Zittel, U.Jur., Ger.; *4a,* side ×1; *4b,* part of skeleton, ×4; *4c,* spicules of strand, ×75; *4d,* near-surface spicules, ×25 (*4a,b,* 94; *4c,d,* 63).

Conocoelia From., 1860 [**Siphonocoelia crassa* From., 1861; SD deLaub., herein]. Like *Corynella* but very coarse meshes of skeletal network serve as canals (49). *L.Cret.,* Fr.-Ger.

Oculospongia From., 1860 [**O. neocomiensis*]. Cushion-shaped (7). *L.Cret.,* Fr., ?Ger.——Fig. 83,*2*. **O. neocomiensis,* side, ×1 (59).

Virmula Gregorio, 1930 [**V. notans*]. Resembles *Corynella* and *Conocoelia. Perm.,* Sicily.

Eudea Lamx., 1821 [**E. clavata;* SD deLaub., herein]. Tube- or club-shaped, with smooth porous surface and single large oscule at summit (21). *Trias.-Jur.,* Eu.——Fig. 83,*3*. *E. gracilis* (Münster), Trias., Ger.; ×1 (59).

Raphidonema Hinde, 1884 [**R. contortum;* SD deLaub., herein]. Vase- or funnel-shaped, exterior rough and lumpy, cloacal surface smooth, with small apopores (12). *Trias.-Cret.,* Eu.——Fig. 83,*1*. *R. farringdonense* (Sharpe), L.Cret., Eng.; side, ×0.7 (94).

?Tretocalia Hinde, 1900 [**T. pezica*]. Small, possibly juvenile. *Eoc.,* Austral.

Pachytilodia Zittel, 1878 [**Scyphia infundibuliformis* Goldf., 1833] [=*Pachytylodia* Zittel-E., 1900]. Thick-walled funnel with coarse skeletal network, prosopores very numerous, separated by thin walls (49). *L.Cret.-U.Cret.,* Eu.

Pachymura Welter, 1910 [**P. goldfussi*]. Like *Pachytilodia* in nature of pores but with skeleton as in *Raphidonema* (46). *L.Cret.,* Ger.

Himatella Zittel, 1878 [**Tragos milleporata* Münster, 1841]. Inverted cone with large oscule, dermis smooth, pores minute (49). *Trias.,* Switz.

Family DISCOCOELIIDAE de Laubenfels, nov.

Bushlike pharetronids with oscules at or near tips of branches. *Trias.-Cret.*

Discocoelia From., 1861 [**Scyphia cymosa* Mich., 1847; SD Rauff, 1893] [*pro Polycoelia* From., 1860 (*non* King, 1849)] [=*Discoelia* From., 1861; *Pliocoelia* Pomel, 1872 (**Scyphia cymosa* Mich., 1847; SD deLaub., herein); *Dendrocoelia* Lambe, 1864]. Digitate extensions from a common base, each with moderately large oscule at its rounded extremity (7). *M.Jur.,* Eu.

Peronidella Hinde, 1893 [*pro Peronella* Zittel, 1878 (*non* Gray, 1855)] [**Spongia pistilliformis* Lamx., 1821; SD deLaub., herein]. Like *Dendrocoelia* but with several small oscules on each column. *Trias.-Cret.,* Eu., ?E.Indies.——Fig. 84,*1*. *P. dumosa* (From.), U.Jur., Ger.; side, ×1 (94).

Eusiphonella Zittel, 1878 [**Scyphia bronni* Goldf., 1833; SD deLaub., herein]. Like *Peronidella* but with conspicuous grooves (mainly longitudinal) in cloacal wall, apopores large (49). *Jur.,* Eu.——Fig. 84,*3*. **E. bronni* (Goldf.), Ger.; side, ×1 (94).

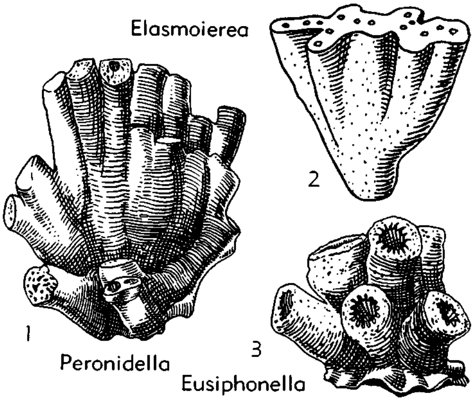

Fig. 84. Pharetronida (Chalarina): Discocoeliidae, Elasmocoeliidae (p. E99).

Family ELASMOCOELIIDAE de Laubenfels, nov.

Vaselike or tubular, with walls formed by laterally joined erect small tubes. *Jur.-Cret.*

Elasmocoelia Römer, 1864 [**E. orbiculata;* SD deLaub., herein] (35). *Cret.,* Ger.

Elasmoierea From., 1860 [**E. sequana*] [=*Elasmojerea* Zittel, 1878]. Not certainly vase-shaped (7). *Jur.-L.Cret.,* Ger.-Fr.——Fig. 84,*2*. **E. sequana,* L.Cret., Fr.; side, ×0.7 (59).

Suborder STEREINA de Laubenfels, nov.

Pharetronids with rigid skeleton formed by union of spicules at ray tips as in tetraclad lithistids (Demospongea) and dictyids (Hyalospongea) (*sterea,* firm). *Jur.-Rec.*

Family POROSPHAERIDAE de Laubenfels, nov.

Globular, with pores and oscules distributed over all or nearly all of the spiny surface. *Cret.-Rec.*

Porosphaera Steinm., 1878 [**Millepora globularis* Phill., 1829]. Spiny globes less than 1 cm. in diameter. *Cret.,* Czech.——Fig. 85,*1*. **P. globularis* (Phill.); ×35 (63).

Porosphaerella Welter, 1910 [**P. subglobosa*]. Like *Porosphaera* but skeletal network more regular (46). *L.Cret.*, Ger.——FIG. 85,*3*. **P. subglobosa;* part of skeleton, ×50 (90).

Sagittularia WELTER, 1910 [**S. adfixa*]. Like *Porosphaera* but less regular in form and structure and less firmly cemented (46). *L.Cret.*, Ger.

Petrostroma DÖD., 1892 [**P. schulzei*]. Massive, with digitate processes or coarse spines. *Cret.-Rec.*, Ger.-Japan.

Plectroninia HINDE, 1900 [**P. halli*]. Top-shaped, with relatively smooth surface; skeleton formed of cemented spiny tetracts. *L.Cret.-Rec.*, Ger.-Austral.-S.Pac.

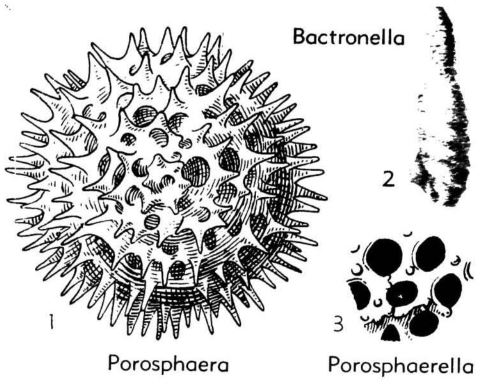

FIG. 85. Pharetronida (Stereina): Porosphaeridae, Bactronellidae (p. E99-E100).

Family BACTRONELLIDAE de Laubenfels, nov.

Subcylindrical to massive. *Jur.-Eoc.*

Bactronella HINDE, 1884 [**B. pusillum*]. Rod- or club-shaped, small; lower half smooth with transverse wrinkles or annular swellings, upper half porous; without evident oscule (12). *Jur.-Eoc.*, Ger.-Austral.——FIG. 85,*2*. **B. pusillum*, U.Jur., Ger.; ×1.3 (63*).

Suborder UNCERTAIN

Leiospongia ORB., 1849 [**Achilleum milleporatum* MÜNSTER, 1841; SD DELAUB., herein] [=*Leiofungia* FROM., 1860] (29). *Trias.*, Eu.

Tremospongia ORB., 1849 [**Lymnorea sphaerica* MICH., 1847; SD RAUFF, 1893] (29). *U.Cret.*, Fr.

Colospongia LAUBE, 1865 [**Manon dubium* MÜNSTER, 1841]. *Trias.*, Eu.

Conispongia ÉTAL., 1859 [**C. thurmanni;* SD RAUFF, 1893]. *U.Jur.*, Fr.

Diplostoma FROM., 1860 [**D. neocomiense*] (7). *Cret.*, Fr.

Polycnemiseudea FROM., 1860 [**Cnemidium gregarium* ORB., 1849] (7). *U.Cret.*, Fr.

Polyendostoma F. A. RÖMER, 1864 [**P. sociale;* SD DELAUB., herein] (35). *?Cret.*, ?Ger.

Aplosphecion POMEL, 1872 [**A. radiciforme*] (31). *Tert.*, Alg.

Cnemicopanon POMEL, 1872 [**Monotheles punctata* RÖMER, 1864; SD DELAUB., herein] (31). *Cret.*, Ger.

Coeloconia POMEL, 1872 [**Scyphia cylindrica* GOLDF., 1833] (31). *Tert.*, Alg.

Dyoconia POMEL, 1872 [**D. pomeli* DELAUB., *nov.* (=*Scyphia cylindrica* GOLDF., 1833, *pars*)] (31). *Tert.*, Alg.

Coniatopenia POMEL, 1872 [**Elasmostoma peziza* RÖMER, 1864] (31). *Cret.*, Ger.

Diestosphecion POMEL, 1872 [**Tremospongia grandis* RÖMER, 1864] (31). *Cret.*, Ger.

Dycopanon POMEL, 1872 [**Scyphia monilifera* RÖMER, 1864] (31). *Cret.*, Ger.

Trachyphlyctia POMEL, 1872 [**Spongia helvelloides* LAMX., 1821; SD RAUFF, 1893] (31). *Cret.*, Ger.

Trachysphecion POMEL, 1872 [**Spongia stellata* LAMX., 1821; SD RAUFF, 1893] (31). *Cret.*, Ger.

Crispispongia QUENST., 1878 [**C. expansa;* SD DELAUB., herein] (32). *Jur.*, Ger.

Astrofungia GREGORIO, 1883 [**A. cidariformis;* SD DELAUB., herein]. ?Age, Italy.

Rauffia ZEISE, 1897 [**R. clavata*]. *Mesoz.*, Eu.

Strambergia ZEISE, 1897 [no species]. *Mesoz.*, Eu.

Plectinia POČTA, 1903 [**P. minuta;* SD DELAUB., herein]. *Cret.*, Czech.

Myrmecidium VINASSA, 1920 [*pro Myrmecium* GOLDF., 1833 (*non* LATREILLE, 1825)] [**Myrmecium hemisphaericum* GOLDF., 1833; SD DELAUB., herein]. *Jur.*, Ger.

Molengraafia VINASSA, 1920 [**M. regularis*]. *?Trias.*, E.Indies.

Alasonia SIRKOVA, 1938 [**A. remesi*]. *Jur.*, Czech.

Aphlebospongia SIRKOVA, 1938 [**A. remesi*]. *Jur.*, Czech.

Order THALAMIDA de Laubenfels, nov.

[=Sphinctozoa STEINM., 1882 *(partim)*]

Calcisponges with skeleton consisting of straight, curved, or branched series of hollow spheroidal bodies, commonly about 1 cm. in diameter, some with a tubular cloaca or inhalant siphon in axial position (*thalamos,* chamber). *U.Carb.-Cret.*

The hollow chambers of fossils belonging to the Thalamida do not prove that corresponding open cavities existed in these sponges when living. Many modern species of the Porifera are characterized by ectosome that is notably denser than the endosome, and some, like *Geodia,* possess an armored exterior associated with flimsy endosome full of small cavities. Accordingly, it is reasonable to suggest that in living Thalamida the spheroidal rooms may have

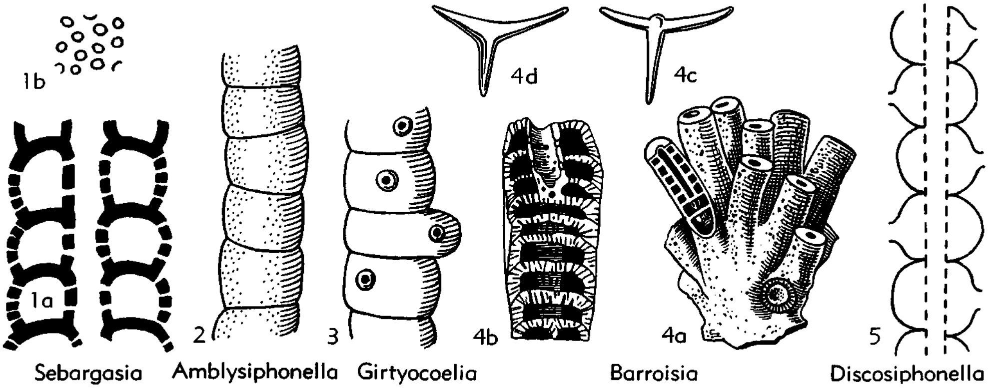

FIG. 86. Thalamida: Sebargasiidae, Barroisiidae (p. E101).

been filled with endosomal tissue containing numerous canals and minute flagellate chambers. Such tissue probably would contain loose spicules which almost invariably would be scattered and lost in fossilization. Sponges belonging to the Thalamida generally have been classed in the group here termed Lebetida, despite evidence that they have a distinctly more elaborate chamber system than that of the lebetids.

MORET (1952) in the *Traité de Paléontologie* (Masson) designates as sphinctozoarians ("sphinctozoaires") some sponges of the type here termed Thalamida. STEINMANN's (1882) "Sphinctozoa," defined as a suborder of calcisponges, comprises only part of the division named Thalamida.

Family SEBARGASIIDAE Girty, 1908

Linear series of hollow subglobular bodies pierced by an axial tube which may be a cloaca but more probably served an inhalant function. *U.Carb.-Cret.*

Sebargasia STEINM., 1882 [**S. carbonaria*]. *Carb.,* Spain.——FIG. 86,*1*. **S. carbonaria; 1a,* long. sec., ×1; *1b,* surface pores, ×7 (86).

Amblysiphonella STEINM., 1882 [**A. barroisi*] [=*Tetraproctosia* RAUFF, 1938]. Differs slightly from *Sebargasia* in pore structure (43). *U.Carb.-Perm.,* Eu.-N.Am.-Japan-Peru-E.Ind.——FIG. 86,*2*. **A. barroisi,* Carb., Sp.; side, ×1 (86).

Girtyocoelia Coss., 1909 [*pro Heterocoelia* GIRTY, 1908 (*non* DAHLBOM, 1854)] [**Heterocoelia beedei* GIRTY, 1908]. Like *Sebargasia* but with some pores in outer wall much larger than others and surrounded by a raised rim, resembling oscules; if these openings were exhalant, the axial tube probably was an inhalant passageway. *Penn.,* Kan.-Okla.-Tex.——FIG. 86,*3*. **G. beedei* (GIRTY); side, ×2 (84).

Discosiphonella INAE, 1936 [**D. manchuriensis*]. Like *Girtyocoelia* but oscule-like openings on alternate sides. *Carb.,* Manch.——FIG. 86,*5*. **D. manchuriensis;* diagrammatic long. sec., ×1.5 (65).

Thalamopora F. A. RÖMER, 1840 [**T. cribosa;* SD DELAUB., herein]. *Cret.,* Ger.-Fr.

Family BARROISIIDAE de Laubenfels, nov.

Like Sebargasiidae but colonial in growth, composed of a number of chamber-series joined together. *Trias.-Cret.*

Barroisia CHALMAS, 1882 [**Tubipora anastomosans* MANTELL, 1822]. Axial tubes may not reach to base of colony. *Cret.,* Eng.——FIG. 86,*4*. **B. anastomosans* (MANTELL), L.Cret.(Apt.), Berksh.; *4a,* colony with a branch cut longitudinally, ×1; *4b,* column of chambers cut obliquely, ×2.5; *4c,* tetract, ×36; *4d,* triact, ×72 (94).

Tremacystia HINDE, 1884 [**Verticillites d'orbignyi;* SD DELAUB., herein]. Resembles *Barroisia* (12). *Jur.-Cret.,* Eng.-Fr.-Ger.

Welteria VINASSA, 1920 [**W. repleta*]. Like *Barroisia. Trias.,* E.Indies.

Family CYSTOTHALAMIIDAE Girty, 1908

Differs from Sebargasiidae in that axial tube is surrounded by adherent hollow spheroidal chambers instead of piercing a linear series of such chambers. *Penn.-Perm.*

Cystothalamia GIRTY, 1908 [**C. nodulifera*]. Globular chambers irregularly disposed, each bearing one or more oscule-like openings (8). *Perm.,* Tex.

Cystauletes R. H. KING, 1943 [**C. mammilosus*]. Hollow globes spirally arranged around axial tube, each with many coarse pores (?apopores) (19). *M.Penn.*, Okla.——FIG. 87,*1*. **C. mammilosus;* side, ×1 (19).

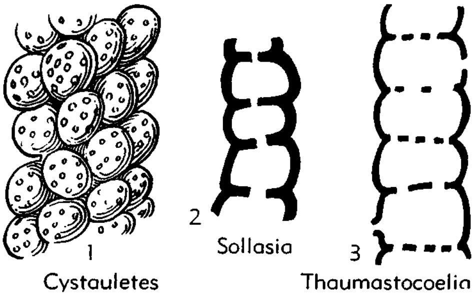

FIG. 87. Thalamida: Cystothalamiidae, Celyphiidae (p. E102).

Family CELYPHIIDAE
de Laubenfels, nov.

Thalamid calcisponges consisting of a row of rounded appressed chambers not pierced by an axial tube but with openings in side walls which seem to be true oscules. *U.Carb.-Trias.*

Celyphia POMEL, 1872 [**Manon submarginata* MÜNSTER, 1841] (31). *Trias.*, Eu.

Thaumastocoelia STEINM., 1882 [**T. cassiana*]. Like *Celyphia* but walls between adjacent chambers perforated (43). *Perm.-Trias.*, Eu.——FIG. 87,*3*. **T. cassiana,* Trias., Italy; long. sec., ×1 (86).

Enoplocoelia STEINM., 1882 [**Scyphia armata* KLIPSTEIN, 1845]. Each globe with several apertures that seem to be oscules (43). *Perm.-Trias.*, Eu.

Henricellum WILCKENS, 1937 [**H. insigne*]. *Trias.*, E.Indies.

Girtycoelia R. H. KING, 1933 [**G. typica*]. Like *Celyphia* but rows of globes may branch (18). *Penn.*, Kan.-Tex.

?Imperatoria GREGORIO, 1930 [**I. marconi*]. Individuals shaped like inverted cone. *Perm.*, Eu.

Sollasia STEINM., 1882 [**S. ostiolata*]. Like *Celyphia* but with a single large aperture in wall betwen chambers (43). *Penn.-Perm.*, Eu.——FIG. 87,*2*. **S. ostiolata,* Carb., Sp.; diagrammatic long. sec., ×3 (86).

Family CRYPTOCOELIIDAE
Steinmann, 1882

Resembling Celyphiidae in growth form but the successive rounded chambers contain internal structures such as longitudinal pillars or vesicles. *Perm.-Cret.*

Cryptocoelia STEINM., 1882 [**C. zitteli*]. Chambers containing longitudinal pillars (43). *Trias.-Cret.*, Eu.——FIG. 88,*1*. **C. zitteli,* Trias., Aus.; *1a*, side, ×1; *1b*, long. sec., ×1 (86).

Waagenella DELAUB., *nom. nov.* [*pro Steinmannia* WAAG.-W., 1888[1] (*non* FISCHER, 1886)] [**Steinmannia salinaria* WAAG.-W., 1888]. Chambers filled with vesicles which are larger than normal flagellate chambers. *Perm.-Trias.*, India-E.Indies.

Seranella WILCKENS, 1937 [**S. tenuissima*]. Like *Waagenella* but some chambers penetrated halfway by a cloaca. *Trias.*, E.Indies.

Cryptocoeliopsis WILCKENS, 1937 [**C. gracilis*]. Like *Waagenella* but chamber walls paper-thin. *Trias.*, E.Indies.

Deningeria WILCKENS, 1937 [**D. camerata*]. Chamber walls thicker (1 mm.) than in *Waagenella,* with dense vesicular tissue just inside walls becoming attenuated and open toward interior open space that simulates a cloaca. *Trias.*, E.Indies.

Family SPHAEROCOELIIDAE
Steinmann, 1882

Like Celyphiidae but with walls formed by rigid skeletal strands composed of many overlapping rows of monactinal spicules, as in the common spongin-cemented fibers of Demospongea. *U.Cret.*

Sphaerocoelia STEINM., 1882 [**Thalamopora michelini* SIMONOWITSCH, 1871] (43). Eu.——FIG. 88,*2*. **S. michelini* (SIMONOWITSCH); side, ×2.5 (86).

Family UNCERTAIN

Polyphymaspongia R. H. KING, 1943 [**P. explanata*] (22). *Perm.*, Tex.——FIG. 88,*6*. **P. explanata;* section of peripheral part of sponge, ×1 (66).

Polytholosia RAUFF, 1938 [**P. complicata*]. Complex aggregation of chambers varying in size, shape, and position. *Trias.*, Peru.

Order UNCERTAIN

Ascosymplegma RAUFF, 1938 [**A. torosum*]. Rounded fossils attaining height of 15 cm. composed of tubes 4 to 7 mm. diameter piled one on another, with pharetronid-type walls but no spicules known. *Trias.*, Peru.

Epeudea FROM., 1860 [**Eudea cribraria* MICH., 1847] (7). *M.Jur.*, Fr.

Polysiphon GIRTY, 1908 [**P. mirabilis*] (11). *Perm.*, Tex.

Holocoelia STEINM., 1913 [**H. toulai;* SD DELAUB., herein]. ?Age, ?loc.

Gaspespongia PARKS, 1933 [**G. basalis*]. *Sil.*, Can.

Scribroporella SPRIEST., 1935 [**S. socialis*]. *M.Dev.*, Ger.

Oligoplagia HERAK, 1944 [**O. carnica*]. *Trias.*, Aus.

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[1] WAAGEN, W., & WENTZEL, J. (1888) *Salt Range fossils:* India Geol. Survey, Mem., ser. 13, pt. 6, p. 979.

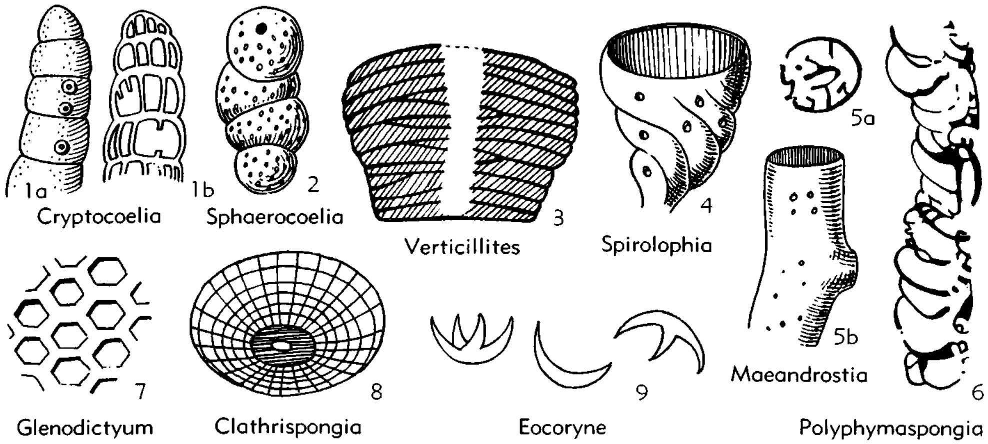

FIG. 88. Thalamida: Cryptocoeliidae, Sphaerocoeliidae, Incertae Sedis (p. E102-E103).

Class UNCERTAIN

Atikokania WALC., 1912 [**A. lawsoni*]. Cylindrical or elongate conical, with cloaca-like central cavity surrounded by radiating and concentric skeletal strands. *Precam.*, Can.

Eocoryne MATTHEW, 1886 [**E. geminum*]. Relatively large peculiarly shaped spicules (1.5-2 mm.). *M.Cam.*, Can.——FIG. 88,*9*. **E. geminum; 9a-c,* spicules enlarged (70).

Cyathophycus WALC., 1879 [**C. subsphaericus*]. Lacking spicules or reticulate structure. *Ord.*, N.Y.

Caliculospongia FOERSTE, 1916 [**C. pauper*]. Cylindrical, with deep cloaca, walls with many round canals but no spicules or fibers. *Ord.*, Ky.

Cotyliscus R. H. KING, 1943 [**C. ewersi*]. Cuplike, with canals penetrating walls (19). *Miss.*, Tex.

Maeandrostia GIRTY, 1908 [**M. kansasensis*]. Cylindrical, with scattered small oscules, walls penetrated by irregular canals (19). *Penn.*, Kan.-Tex. ——FIG. 88,*5*. **M. kansasensis; 5a,* transv. sec., ×1; *5b,* side, ×1 (66).

Guadalupia GIRTY, 1908 [**G. zitteliana*]. Stalked fronds and branches (8). *Perm.*, Tex.

Fissispongia R. H. KING, 1938 [**F. jacksboroensis*]. Resembles *Maeandrostia*. *Penn.*, Tex.

Verticillites DEFR., 1829 [**V. cretaceus*] [=*Verticillipora* BLAINV., 1834; *Verticillocoelia* FROM., 1860]. Tubes surrounded by chambers, somewhat resembling Thalamida. *Trias.-Cret.*, Eu.——FIG. 88,*3*. **V. cretaceus,* Cret.; long. sec., ×1 (86).

Preverticillites PARONA, 1933 [**P. columella*]. Like *Verticillites* but lacking cloaca. *Perm.*, Italy.

Clathrispongia QUENST., 1878 [**C. orbica*]. Shallow saucer-shaped, with rectangular skeletal network next to surface (32). *Jur.*, Ger.——FIG. 88,*8*. **C. orbica;* side, ×0.5 (77).

Spirolophia POMEL, 1872 [**Pleurostoma tortuosa* RÖMER, 1864]. Cup-shaped, spirally convoluted (31). *Cret.*, Ger.——FIG. 88,*4*. **S. tortuosa* (RÖMER); side, ×0.3 (76).

Glenodictyum VON DER MARCK, 1873 [**G. hexagonum*]. Skeleton with conspicuous hexagonal network. *Cret.*, Eu.——FIG. 88,*7*. **G. hexagonum;* part of skeleton, ×0.2, (69).

Megalelasma POČTA, 1903 [**M. dispansum*]. Inverted cone-shaped, 17 cm. high and 41 cm. in diameter, with walls 1 cm. thick. *Cret.*, Czech.

UNRECOGNIZABLE SUPPOSED SPONGES

Many authors writing before 1889 had inadequate methods for ascertaining the fine structure of sponge fossils, and for this or other reasons they gave unrecognizable descriptions even though their specimens might today prove to be recognizable. Exploration in museums may eventually permit transferring some of their generic names from the uncertain group to a definite place in the taxonomic arrangement of sponges.

It is embarrassingly true that numerous fossils, especially of sponges, have been so altered during fossilization that little information can be gleaned from them, regardless of method or zeal. In the following tabulation, many names refer to fossils that are not known certainly to be sponges. The names are arranged alphabetically because too little is known to warrant effort in grouping them.

Achilleum Oken, 1814 [**A. manus;* SD deLaub., herein]. *Cret.-Rec.,* Eu.

Adelphocoelia Étal., 1860 [**Scyphia propinqua* Goldf., 1833]. *Jur.,* Eu.

Alcyonolithes Blum., 1815 [**A. stadensis*]. *?Age,* ?loc.

Amorphocoelia Étal., 1860 [**A. incrustans*]. *Jur.,* Eu.

Amorphospongia Orb., 1848 (*non* From., 1860) [**Achilleum tuberosum* Goldf., 1833; SD deLaub., herein]. *Jur.,* Eu.

Angidia Pomel, 1872 [**A. cribrosa;* SD deLaub., herein]. *Cenoz.,* Alg.

Aplorytis Pomel, 1872 [**Lymnorea bajocensis* Orb., 1849]. *Jur.,* Eu.

Araeoplocia Pomel, 1872 [**Maeandrospongia annulata* Römer, 1864; SD deLaub., herein]. *Cret.,* Eu.

Arthrocypellia Pomel, 1872 [**Scyphia articulata* Goldf., 1833]. *Cret.,* Eu.

Asteriscosella Christ, 1925 [**A. nassovica*]. *Dev.,* Ger.

Asteropagia Pomel, 1872 [**Asterospongia globosa* Römer, 1864; SD deLaub., herein]. *Cret.,* Eu.

Astrolmia Pomel, 1872 [**Cnemidium astrophorum* Goldf., 1833]. *Cret.,* Eu.

Astrospongia Étal., 1859 [**A. subcostata*]. *Jur.,* Fr.

Ateloracia Pomel, 1872 [**Cnemidium manon* Münster, 1841]. *Cret.,* Eu.

Atelosphecion Pomel, 1872 [**A. commutatum*]. *Cenoz.,* Alg.

Aulocopagia Pomel, 1872 [**Leiospongia meandrina* Orb., 1849]. *Cret.,* Eu.

Aulacospongia Gerth, 1927 [**A. hanieli*]. *Perm.,* Timor.

Badinskia Pomel, 1872 [**B. lobata*]. *Cenoz.,* Alg.

Batalleria Hérenger, 1946 [**B. cylindrata*]. *Cret.,* Sp.

Batospongia Miller, 1889 [**B. spicata*]. *Carb.,* U.S.A.

Bicupula Court., 1861 [**B. gratiosa;* SD deLaub., herein]. *U.Cret.,* Fr.

Biopalla Wallace, 1878 [**B. keokuki*]. *Carb.,* Iowa.

Blumenbachium Koenig, 1825 [**B. globosum*]. *?Age,* ?loc.

Bonneyia Sollas, 1873 [no species]. *L.Cret.,* Eu.

Bothriopeltia Pomel, 1872 [**Cribrispongia baugieri* Orb.; SD Rauff, 1893]. *Cret.,* Eu.

Broseocnemis Pomel, 1872 [**B. asperata* Pomel]. *Jur.,* Alg.

Bursispongia Quenst. 1877 [**B. bursata*]. *Jur.,* Ger.

Calpia Pomel, 1872 [**Cribrospongia cariosa* Römer, 1864]. *Cret.,* Eu.

Calymmospongia Strand, 1928 [**Cystispongia subglobosa* Römer, 1864; SD Rauff, 1893] [=*Calymma* Pomel, 1872 (*non* Huebner, 1823)]. *Cret.,* Eu.

Camerocoelia Étal., 1858 [* ?type]. *?Age,* ?loc.

Catalopia Pomel, 1872 [**C. gemmans*]. *Cret.,* Alg.

Cephalocoelia Étal., 1859 [**C. gresslyi*]. *?Age,* ?loc.

Ceriopelta Pomel, 1872 [no species]. *?Age,* ?loc.

Chenendroscyphia From., 1860 [**Chenendopora marginata* Mich., 1847]. *?Age,* ?loc.

Chitoracia Pomel, 1872 [**C. roemeri;* SD Rauff, 1893]. *Cret.,* Eu.

Cladocalpia Pomel, 1872 [**Tubulospongia dendroides* Court., 1861; SD deLaub., herein]. *U.Cret.,* Eu.

Cladocinclis Pomel, 1872 [**Tubulospongia dendumosa* Orb., 1849]. *Cret.,* Eu.

Cladopagia Pomel, 1872 [no species]. *?Age,* ?loc.

Cladosmila Pomel, 1872 [**Ceriopora(?) prolifera* Goldf., 1833]. *?Age,* ?loc.

Clionothes Lee & Thomas, 1919 [**C. lizardensis*]. *?Age,* ?loc.

Cnemaulax Pomel, 1872 [**C. verrucosus*]. *Cenoz.,* Alg.

Cnemicoelia Étal., 1858 [*?Type]. *?Age,* ?loc.

Cnemidium Goldf., 1853 [**C. lamellosum* Goldf., 1833; SD Miller, 1889]. *U.Cret.,* Eu.

Cnemipsechia Pomel, 1872 [**C. fungiaeformis*]. *Cenoz.,* Alg.

Cnemiracia Pomel, 1872 [**Stellispongia aperta;* SD deLaub., herein]. *Cret.,* Eu.

Cnemiseudea From., 1860 [**Scyphia costata* Goldf., 1833]. *U.Jur.,* Ger.

Cnemopeltia Pomel, 1872 [**Cnemidium rimulosum* Goldf., 1833]. *Cret.,* Eu.

Coelosphaeridium C. F. Römer, 1885 [**C. cyclocrinophilum*]. *?Age,* ?loc.

Coelosmila Pomel, 1872 [**Ceriopora favosa* Goldf., 1833; SD deLaub., herein]. *Cret.,* Eu.

Collojerea Pomel, 1872 [**Siphonia ramosa* Mich., 1847]. *Cret.,* Eu.

Colpoplocia Pomel, 1872 [**Plocoscyphia michelini* Orb., 1849; SD Rauff, 1893]. *U.Jur.,* Eu.

Confervites Brongn., 1828 [**C. fasciculata;* SD deLaub., herein]. *Jur.,* Eu.

Corthya Pomel, 1872 [no species]. *?Age,* ?loc.

Cribrocoelia Étal., 1859 [**C. striata;* SD deLaub., herein]. *Jur.,* Eu.

Cribroscyphia From., 1860 [**Scyphia polyommata* Goldf., 1833]. *U.Jur.,* Eu.

Cribrospongia Orb., 1849 [**Scyphia reticulata* Goldf., 1833]. *U.Jur.,* Eu.

Cryptodesma Schram., 1924 [**Asterospongia globosa* Römer, 1864; SD deLaub., herein]. *Cret.,* Eu.

Cupulospongia Orb., 1849 [**Tragos patella* Goldf., 1833; SD deLaub., herein]. [=*Cupulochonia* From., 1861]. *U.Jur.,* Fr.

Cyathoplocia Pomel, 1872 [**Scyphia texata* Goldf., 1833]. *?Age,* ?loc.

Cyclospongia Miller, 1892 [**C. discus*]. *Dev.,* U.S.A.

Cylindrocoelia Ulr., 1889 [**C. endoceroidea* Ulr.; SD Miller, 1889]. *Ord.,* U.S.A.

Cylindrospongia F. A. Römer, 1864 [**C. abbreviata;* SD deLaub., herein]. *Cret.,* Eu.

Cyronella Beede, 1899 [*?Type]. *?Age,* ?loc.

Cystoloena Pomel, 1872 [**Cystospongia undulata* Römer, 1848; SD Rauff, 1893]. *Cret.,* Eu.

Cystopora Pomel, 1872 [**Verticillites truncatus* Orb., 1848; SD deLaub., herein]. *Cret.,* Eu.

Dendrospongia F. A. Römer, 1864 [**D. clathrata;* SD deLaub., herein]. *Cret.,* Eu.

Dercites Carter, 1871 [**D. haldonensis*] [=*Dercitites* Sollas, 1880]. *L.Cret.,* Eu.

Desmoscinia Pomel, 1872 [**Scyphia procumbens* Goldf., 1833]. *?Age,* ?loc.

Desmospongia Étal., 1863 [**Spongites semicinctus* Quenst., 1878]. *Jur.,* Fr.

Dichoplectella Matthew, 1891 [**D. irregularis*]. *?Age,* ?loc.

Dichorea Pomel, 1872 [**Lymnorea michelini* Orb., 1849]. *Cret.,* Eu.

Dictyocladia Pomel, 1872 [**D. ramosa*]. *U.Jur.,* Alg.

Dictyonocoelia Étal., 1855 [**D. schveiggeri*]. *Jur.,* Eu.

Dictyosmila Pomel, 1872 [**D. reteporiformis*]. *Cret.,* Eu.

Didesmospongia Étal., 1864 [no species]. *Jur.,* Eu.

Diseudea From., 1860 [**Siphonia lagenaria* Mich., 1847] [=*Copanon* Pomel, 1872]. *M.Jur.,* Eu.

Distheles From., 1860 [**D. depressa*]. *Jur.,* Eu.

Dolispongia Quenst., 1877 [**Scyphia meandrina* Goldf., 1833; SD deLaub., herein]. *Jur.,* Ger.

Donatispongia Malfatti, 1901 [**D. patellaris*]. *Cenoz.,* Eu.

Dulmius Gregorio, 1930 [**D. innovatus*]. *Perm.,* Sicily.

Elasmeudea Pomel, 1872 [**Eudea cribraria* Mich., 1847; SD Rauff, 1893]. *Cret.,* Eu.

Elasmopagia Pomel, 1872 [**E. anomala;* SD Rauff, 1893]. *Cret.,* Alg.

Eligma Regnard, 1927 [**E. douvilli*]. *Cret.,* Fr.

Emplocia Pomel, 1872 [**Brachiolites foliaceus* T. Smith]. *Cret.,* Eu.

Enteropycnus deLaub., *nom. nov.* [*pro Pycnogaster* Schram., 1924 (ref. 39, p. 30) (*non* Graell, 1851)] [**Pycnogaster texturatus* Schram., 1924]. *Cret.,* Ger.

Erythrospongia Hudson, 1929 [**E. lithodes*]. *Carb.,* Eng.

Eucoscinia Pomel, 1872 [**Scyphia cancellata* Goldf., 1833; SD deLaub., herein]. *Cret.,* Eu.

Eulespongia Quenst., 1878 [**Siphonocoelia texta* Römer, 1864]. *Cret.,* Eu.

Evinospongia Stoppani, 1860 [**E. cerea;* SD deLaub., herein]. *Trias.,* Italy.

Exosinion Pomel, 1872 [**Ventriculites gracilis* Römer, 1864]. *Cret.,* Eu.

Favispongia Quenst., 1878 [**Scyphia obliqua* Goldf., 1833]. *Jur.,* Eu.

Favospongia Hinde, 1888 [**F. ruthveni*]. *U.Sil.,* Eu.

Floria Gregorio, 1930 [**F. permiana*]. *Perm.,* Sicily.

Forospongia Orb., 1849 [**Tragos acetabulum* Goldf., 1833]. *Jur.,* Eu.

Fungispongia Ringueberg, 1884 [**F. irregularis*]. *Sil.,* U.S.A.

Gelasinophorus Schram., 1924 [**G. reitmeyeri* Schram.; SD deLaub., herein]. *Cret.,* Eu.

Gemmellarella Parona, 1933 [**G. permica*]. *Perm.,* Eu.

Gigantodesma Schram., 1924 [**Pachypoterion auritum* Schram.; SD deLaub., herein]. *Cret.,* Ger.

Goniocoelia Étal., 1858 [?Type]. *?Age,* ?loc.

Gonioscyphia From., 1860 [**Scyphia striata* Goldf., 1833]. *U.Jur.,* Fr.

Goniospongia Orb., 1849 [**G. schlotheimii;* SD Rauff, 1893]. *U.Jur.,* Fr.

Gymnomyrmecium Pomel, 1872 [**Myrmecium gracile* Münster, 1841]. *Cret.,* Eu.

Gymnorea Pomel, 1872 [**Polycoelia gemmans* From., 1864; SD Rauff, 1893]. *Cret.,* Eu.

Hallisida Pomel, 1872 [**Hallirhoa lycoperdites* Lam., 1821]. *Cret.,* Eu.

Hemicoetis Pomel, 1872 [**Scyphia tenue* Römer, 1841]. *Cret.,* Eu.

Hemipenia Pomel, 1872 [**Oculispongia polymorpha* Römer, 1864; SD deLaub., herein]. *Cret.,* Eu.

Hemispongia Orb., 1849 [**H. rouyana* Orb.; SD deLaub., herein]. [=*Strobocoelia* Pomel, 1872]. *Cret.,* Eu.

Herpophlyctia Pomel, 1872 [**H. subregularis*]. *Cenoz.,* Alg.

Herpothis Pomel, 1872 [**H. saheliensis*]. *Cenoz.,* Alg.

Heteropenia Pomel, 1872 [**Manon peziza* Goldf., 1833] [=*Trachypenia* Pomel, 1872; *Catagma* Sollas, 1878 (**Manon peziza* Goldf., 1833; SD deLaub., herein)]. *Cret.,* Eu.

Heterosmila Pomel, 1872 [**H. diastoporiformis*]. *Cenoz.,* Alg.

Holcosinion Pomel, 1872 [**Ocellaria laticostata* Römer, 1864; SD deLaub., herein]. *Cret.,* Eu.

Holoracia Pomel, 1872 [**Cnemidium turbinatum* Münster, 1841; SD Rauff, 1891]. *Cret.,* Eu.

Holosphecion Pomel, 1872 [**H. tuberosum*]. *Cenoz.?,* Alg.

Homalorea Pomel, 1872 [**Tremospongia dilatata* Römer, 1864]. *Cret.,* Eu.

Homolpia Pomel, 1872 [**Spongus townsendi* Mantell, 1822]. *Cret.,* Eu.

Homoptychium Pomel, 1872 [**Coeloptychium deciminum* Römer, 1864]. *Cret.,* Eu.

Hylospongia Sollas, 1872 [no species]. *?Age,* ?loc.

Hystrispongia Miller, 1889 [=*Hystriospongia* Ulr., 1890]. *Carb.,* U.S.A.

Isophyllum deLaub., *nom. nov.* [*pro Coelophyllum* Schram., 1924 (ref. 39, p. 150) (*non Coelophyllum* Scudder, 1875)] [**Coelophyllum marginatum* Schram., 1924]. *Cret.,* Ger.

Kazania Stuck., 1895 [**K. elegantissima* Stuck.; SD deLaub., herein]. *Carb.,* Eu.

Labyrintholites Sintzov, 1879 [*_L. varians;_ SD deLaub., herein]. _Cret.,_ U.S.S.R.

Leiohyphe Schram., 1924 [*_L. solitaria;_ SD deLaub., herein]. _Cret.,_ Eu.

Leptomitosia Böhm, 1928 [*_L. dubia_]. _Cret.,_ Eu.

Lithosia Pomel, 1872 [*_Turonia radiata_ Court., 1861; SD deLaub., herein]. _Cret.,_ Eu.

Lithospongites Carter, 1873 [*_L. kittoni;_ SD deLaub., herein]. _Carb.,_ Eu.

Loboptychium Schram., 1924 [*_L. convarrum;_ SD deLaub., herein]. _Cret.,_ Eu.

Loczia Vinassa, 1901 [*_L. cryptocoelioides_ Vinassa; SD deLaub., herein]. _?Age,_ loc.

Lodanella Kayser, 1885 [*_L. mira_]. _L.Dev.,_ Eu.

Loenocoelia Pomel, 1872 [*_L. ramosa;_ SD Rauff, 1893]. _Cret.,_ Alg.

Loenopagia Pomel, 1872 [*_Tragos ramosum_ Klipstein, 1845]. _Cret.,_ Eu.

Madrespongia Quenst., 1878 [*_M. trichotomoides_ Quenst.; SD deLaub., herein]. _U.Jur.,_ Ger.

Maeandroptychium Sintzov, 1879 [*_M. polymorfum;_ SD deLaub., herein]. _Cret.,_ U.S.S.R.

Mammillopora Brown, 1825 [*_M. paucissimae;_ SD deLaub., herein]. _?Cret., Rec.,_ Eu.

Manon Oken, 1814 [*_Spongia dichotoma_ Linné, 1767; SD deLaub., herein]. _?Cret., Rec.,_ Eu.

Mantellia Parkinson, 1822 [no species]. _?Age,_ ?loc.

Mastoscinia Pomel, 1872 [*_Scyphia verrucosa_ Goldf., 1833; SD deLaub., herein]. _Cret.,_ Eu.

Mastospongia Quenst., 1878 [*_M. coniformis;_ SD deLaub., herein]. _Jur.,_ Ger.

Megalodictyon Oppl., 1926 [*_M. fretreulensis_]. _Jur.,_ Eu.

Megaspongia Quenst., 1878 [*_M. tessellata;_ SD deLaub., herein]. _Jur.,_ Ger.

Megastroma Dawson, 1883 [*_M. laminosum_]. _?Age,_ ?loc.

Monamona deLaub., _nom nov._ [_pro Mona_ Smith, 1911[1] (_non_ Hulst, 1888)]. [*_Mona monensis_ Smith, 1911]. _Carb.,_ Isle of Man.

Monilites Carter, 1871 [*_M. haldonensis;_ SD deLaub., herein]. _Cret.,_ Eu.

Monotheles From., 1860 [*_M. neocomiensis_]. _L.Cret.,_ Eu.

Nanodiscites Sollas, 1880 [*_N. parvus_]. _Cret.,_ Eu.

Nelumbosium Gregorio, 1930 [*_N. primum_]. _Perm.,_ Sicily.

Nexispongia Quenst., 1878 [*_N. libera_]. _Jur.,_ Ger.

Nudispongia Quenst., 1878 [*_N. cribrata;_ SD deLaub., herein]. _Jur.,_ Ger.

Ocellarioscyphia From., 1860 [*_Ventriculites radiatus_ Mantell, 1822; SD deLaub., herein]. _Cret.,_ Eng.

Oegophymia Pomel, 1872 [?type species]. _?Age,_ ?loc.

Oligocoelia Vinassa, 1901 [*_O. zitteli;_ SD deLaub., herein]. _?Age,_ ?loc.

Olynthia Pomel, 1872 [*_Manon marginatum_ Münster, 1841; SD Rauff, 1893]. _Cret.,_ Eu.

Oncolpia Pomel, 1872 [*_Brachiolites elegans_ T. Smith, 1848]. _Cret.,_ Eu.

Orthodiscus Schram., 1924 [*_O. fragilis_ Schram.; SD deLaub., herein]. _Cret.,_ Ger.

Operytis Pomel, 1872 [*_Tragos stellatum_ Goldf., 1833] [=_Actinopagia_ Pomel, 1872]. _Cret.,_ Eu.

Orispongia Quenst., 1878 [*_Spongites perforatus_ Quenst.; SD deLaub., herein]. _Jur.,_ Ger.

Pachaena Sollas, 1880 [*_P. hindi_]. _Cret.,_ Eu.

Pachastrellites Sollas, 1880 [*_P. fusifer_]. _Cret.,_ Eu.

Pachychlaenia Pomel, 1872 [*_Manon megastoma_ Reuss]. _Cret.,_ Eu.

Pachycinclis Pomel, 1872 [*_Amorphospongia carantonensis_ Orb., 1849]. _Cret.,_ Eu.

Pachypegma Schram., 1924 [*_P. macrostoma_]. _Cret.,_ Eu.

Pachyselis Schram., 1924 [*_Chonella auriformis_]. _Cret.,_ Eu.

Pachytoechia Pomel, 1872 [*_Cnemidium parva_ Étal., 1859]. _Cret.,_ Eu.

Palaeoderma Gerth, 1927 [*_P. tubulosa_]. _Perm.,_ U.S.A.

Palaeoierea Laube, 1864 [*_Manon(?) gracilis_ Münster, 1841]. _?Age,_ Eu.

Palaeospongia Orb., 1849 [*_Porites cyathiformis_ Hall, 1847; SD Miller, 1889] [=_Palaeochonia_ From., 1860]. _Sil.,_ N.Y.

Paracinclis Pomel, 1872 [*_Amorphospongia digitata_ Orb., 1849]. _Cret.,_ Eu.

Paramoudra Buckland, 1817 [no species]. _?Age,_ ?loc.

Paraplocia Pomel, 1872 [*_Spongia labyrinthica_ Mantell, 1822; SD deLaub., herein]. _Cret.,_ Eu.

Parenia Počta, 1885 [?type]. _?Age,_ ?loc.

Pareudea Étal., 1859 [*_P. bronni;_ SD deLaub., herein] [=_Parendea_ Étal., 1863]. _Jur.,_ Fr.

Peregrinus Krasmopeeva, 1940 [*?type]. _?Age,_ ?loc.

Periphora Regnard, 1927 [*_P. robusta_]. _Cret.,_ Eu.

Perispongia Orb., 1849 [*_P. reflexa_]. _?Age,_ ?loc.

Phragmoscinia Pomel, 1872 [*_Scyphia decorata_ Goldf., 1833]. _Cret.,_ Eu.

Phymatocoelia Pomel, 1872 [*_Scyphia uvaeformis_ Giebel]. _Cret.,_ Eu.

Phymatolpia Pomel, 1872 [*_Brachiolites tuberosus_ T. Smith, 1848]. _Cret.,_ Eu.

Phymocoetis Pomel, 1872 [*_Ocellaria interrupta_ Römer, 1864]. _Cret.,_ Eu.

Phymoracia Pomel, 1872 [*_Stellispongia verrucosa_ Römer, 1864]. _Cret.,_ Eu.

Phymosinion Pomel, 1872 [*_Coeloptychium muricatum_ Römer, 1841]. _Cret.,_ Eu.

Pilosphecion Pomel, 1872 [*_Tragos acutemarginatum_ Klipstein, 1845; SD Rauff, 1893]. _Cret.,_ Eu.

Placorea Pomel, 1872 [*_Limnorea mammillaris_ Römer, 1864]. _Cret.,_ Eu.

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[1] Smith, J., (1911) _Carboniferous limestone rocks of the Isle of Man:_ Geol. Soc. Glasgow, Trans., v. 14, p. 149.

Planispongia Quenst., 1877 [*_P. auriformis_ Quenst.; SD deLaub., herein]. _Jur.,_ Eu.

Plectodocis Pomel, 1872 [*_Brachiolites fenestratus_ T. Smith, 1848]. _Cret.,_ Eu.

Plesiocnemis Pomel, 1872 [*_P. siphonioides;_ SD Rauff, 1893]. _U.Jur.,_ Alg.

Plethocoetis Pomel, 1872 [*_Laocoetis irregularis;_ SD deLaub., herein]. _Cenoz.,_ Alg.

Plococoelia Étal., 1864 [*_P. obscura_]. _Jur.,_ Fr.

Polycantha Sollas, 1873 [*_P. etheridgii_]. _L.Cret.,_ Eu.

Polyozia Pomel, 1872 [*_P. ropalina_]. _Cenoz.,_ Alg.

Polyproctus Schram., 1924 [*_P. tuberosus;_ SD deLaub., herein]. _Cret.,_ Eu.

Polyscyphia Sintzov, 1879 [*_P. pseudocoeloptychium_]. _Cret.,_ U.S.S.R.

Porosmila From., 1860 [*_P. martini_]. _L.Jur.,_ Eu.

Pseudosiphonia Court., 1861 [*_P. tuberculata_]. _Cret.,_ Eu.

Psilobolia Pomel, 1872 [*_P. metaeformis_]. _Cenoz.,_ Alg.

Pterosmila Pomel, 1872 [*_Ceriopora alata_ Goldf., 1833; SD deLaub., herein]. _Cret.,_ Eu.

Ptychocoetis Pomel, 1872 [*_Pleurostoma trilobatum_ Römer, 1864]. _Cret.,_ Eu.

Pulvillus Carter, 1878 [*_P. thomsoni;_ SD deLaub., herein]. _Carb.,_ Eu.

Puppispongia Gregorio, 1930 [*_P. prostrema_]. _Perm.,_ Sicily.

Quenstedtella deLaub., _nom. nov._ [*_Vermispongia hamiltonensis_ Whitf., 1905] [_pro Vermispongia_ Whitf., 1905[1] (_non_ Quenst., 1878)]. _Dev.,_ Ind.

Radicispongia Quenst., 1878 [*_R. radiciformis_]. _Jur.,_ Eu.

Rauffella Ulr., 1889 [*_R. filosa_ Ulr.; SD Miller, 1889]. _Ord.,_ U.S.A.

Reteporiten Walch, 1776? [*?type]. _?Age,_ ?loc.

Retia Sollas, 1872 [no species]. _L.Cret.,_ Eu.

Retispinopora Brydone, 1912 [*_R. arbusculum;_ SD deLaub., herein]. _?Age,_ ?loc.

Rhabdaria Bill., 1865 [*_R. fragilis_ Bill.; SD Miller, 1889]. _Cam.-Ord.,_ U.S.A.

Rhabdocnemis Pomel, 1872 [*_Scyphia costata_ Goldf., 1833; SD Rauff, 1893]. _Cret.,_ Ger.

Rhabdocoetis Pomel, 1872 [*_Ocellaria cancellata_ Römer, 1864]. _Cret.,_ Ger.

Rhiposinion Pomel, 1872 [*_Ventriculites decurrens_ T. Smith, 1848]. _Cret.,_ Eu.

Rhizogonima Pomel, 1872 [*_Rhizospongia digitata_ Court., 1861]. _Cret.,_ Eu.

Rhytidolpia Pomel, 1872 [*_Ventriculites striatus_ T. Smith, 1848]. _Cret.,_ Eu.

Rhyzospongia Orb., 1849 [*_Polypotecia pictonica_ Mich., 1847] [=_Rhysospongia_ Orb., 1850; _Rhizospongia_ Orb., 1852 (_non_ Charlesworth, 1848); _Risospongia_ From., 1860; _Rizoscyphia_ From., 1860]. _U.Cret.,_ Fr.

Saccotragos Oppl., 1926 [*_S. acuminata_]. _Jur.,_ Eu.

Satratus Seeley, 1902 [*_S. brainerdi;_ SD deLaub., herein]. _M.Ord.,_ Vt.

Scheia Tschernychew & Stepanov, 1926 [*_S. tuberosa_]. _?Age,_ U.S.S.R.

Schizorhabdus Zittel, 1878 [*_S. libycus, nom. nud._] (49). _Cret.,_ ?Afr.

Sciadosinion Pomel, 1872 [*_Coeloptychium plicatellum_ Römer, 1841]. _Cret.,_ Eu.

Scythia Orb., 1850 [*?type]. _?Age,_ ?loc.

Sestrimia Pomel, 1872 [*_Manon impressum_ Goldf., 1833]. _Cret.,_ Eu.

Siderospongia Traut., 1870 [*_S. sirenis_]. _?Age,_ ?loc.

Silurispongia Martin, 1878 [*_S. conus_]. _Sil.,_ Eu.

Solenolmia Pomel, 1872 [*_Scyphia manon_ Münster, 1841] [=_Solenopsechia_ Pomel, 1872]. _Cret.,_ Eu.

Solenothyia Pomel, 1872 [*_Camerospongia schlönbachii_ Römer, 1864]. _Cret.,_ Eu.

Sparsispongia Orb., 1850 [*_Stromatopora polymorpha_ Goldf., 1833]. _Jur.,_ Eu.

Sphecidion Pomel, 1872 [*_Manon tubuliferum_ Goldf., 1833]. _Cret.,_ Eu.

Spheciopsis Pomel, 1872 [*_Achilleum poraceum_ Klipstein, 1845]. _Cret.,_ Eu.

Sphenodictya Herzer, 1901 [*_S. cornigera;_ SD deLaub., herein]. _?Age,_ ?loc.

Sphenopterium Meek-W., 1860 [*_Palaeacis compressus;_ SD deLaub., herein]. _Carb.,_ U.S.A.

Spongarium Murch., 1839 [*_S. edwardsii_] [=_Spongiarum_ Brown, 1848 (obj.)]. _Sil.,_ Eu.

Spongillopsis Geinitz, 1864 [*_S. dyadica;_ SD deLaub., herein]. _?Age,_ ?loc.

Spongoconia Pomel, 1872 [*_S. angulosa;_ SD deLaub., herein]. _Cenoz.,_ Alg.

Spongopagia Pomel, 1872 [*_Spongia informis_ Mich., 1847]. _Cret.,_ Eu.

Spongospira Stoehr, 1880 [*_S. florealis_]. _?Age,_ ?loc.

Sporocalpia Pomel, 1872 [*_Plocoscyphia morchella;_ SD deLaub., herein]. _Cret.,_ Eu.

Sporosinion Pomel, 1872 [*_Ventriculites impressus_ T. Smith, 1848; SD Rauff, 1893]. _Cret.,_ Eu.

Spumispongia Quenst., 1877 [*_S. punctata_ Quenst.; SD deLaub., herein]. _Jur.,_ Eu.

Stamnia Pomel, 1872 [*_Cephalites alternana_ T. Smith, 1848; SD deLaub., herein] [=_Phymostamnia, Oncostamnia, Sestrostamnia, Rhytistamnia, Tretostamnia, Xystrostamnia_ Pomel, 1872]. _Cret.,_ Eu.

Stamnocnemis Pomel, 1872 [*_Cnemidium rouyana_ Orb., 1850]. _Cret.,_ Eu.

Stegendea From., 1864 [=_Stegeudea_ From., 1864]. _Mesoz.,_ Eu.

Stelgis Pomel, 1872 [*_Ventriculites radiatus_ Mantell, 1822] [=_Cladostelgis_ Pomel, _Pleurostelgis_ Pomel, 1872]. _Cret.,_ Eu.

Stenocoelia From., 1864 [*?Type]. _?Age,_ ?loc.

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Synolynthia Pomel, 1872 [**Choanites subrotunda* Mantell, 1822]. *Cret.,* Eu.

Taseoconia Pomel, 1872 [**T. obovata*]. *Cenoz.,* Alg.

Taothis Pomel, 1872 [**Polytrema pavonia* Orb., 1849]. *Mesoz.,* Eu.

Testaspongia Quenst., 1878 [**T. craniolaris* Quenst.; SD deLaub., herein]. *Mesoz.,* Eu.

Tethylites Sollas, 1880 [**T. cretaceus*]. *Cret.,* Eu.

Tetrasmila From., 1860 [**T. corallina*]. *U.Jur.,* Eu.

Thalamospongia Orb., 1849 [**T. cottaldina*] [=*Thalamosmila* From., 1860]. *Mesoz.,* Eu.

Thecospongia Étal., 1859 [**T. gresslyi*]. *Jur.,* Fr.

Tholothis Pomel, 1872 [**Polytrema convexa* Orb., 1849; SD deLaub., herein]. *Mesoz.,* Eu.

Thryonia Pomel, 1872 [**Cephalites seriatoporus* Römer, 1864]. *Mesoz.,* Eu.

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Tretolmia Pomel, 1872 [**Scyphia psilopora* Goldf., 1833]. *Cret.,* Eu.

Tretolopia Pomel, 1872 [**T. sparsa* Pomel, SD deLaub., herein]. *?Cenoz.,* ?Alg.

Trinacriella Parona, 1833 [**T. retusa*]. *Perm.,* Italy.

Trioxites Raf., 1839 [**Achilleum dubium* Goldf., 1833]. *?Age,* ?loc.

Triphyllactis Sollas, 1880 [**T. elegans* Sollas]. *?Age,* ?loc.

Triposphaerilla Wisniowski, 1889 [**T. poctae*]. *Jur.,* Eu.

Trochospongia C. F. Römer, 1887 [**T. cyathophylloides*]. *Sil.,* Eu.

Ttachycnemus Pomel, 1872 [**T. rugosa* Pomel] [=*Trachycnemus* Rauff, 1893]. *Cret.,* Eu.

Tubispongia Quenst., 1878 [**T. caeca* Quenst.; SD deLaub., herein]. *Jur.,* Ger.

Tubulospongia Court., 1861 [**T. insignis* Court.; SD deLaub., herein]. *Cret.,* Fr.

Vermispongia Quenst., 1878 [**V. wittingensis*]. *Mesoz.,* Ger.

Vomacispongites deLaub., *nom. nov.* [*pro Spongites* Schloth., 1820[1] (*non* Oken, 1814)] [**Spongites pertusus* Schloth., 1820]. *Cret.,* Eu.

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GENERIC NAMES INCORRECTLY APPLIED TO PORIFERA BUT BELONGING TO OTHER ORGANISMS

Alcyonium Linné, 1758 (ascidian).
Alveolites Lam., 1801 (coelenterate).
Anthelia Lam., 1816 (coelenterate).
Anthophyllum Schweigger, 1820 (coelenterate).
Bebryce Philippi, 1842 (coelenterate).
Cellepora Gmelin, 1789 (bryozoan).
Ceriopora Goldf., 1833 (bryozoan).
Chaetetes Fischer, 1810 (coelenterate).
Choanites Mantell, 1822 (ascidian).
Cylindrites Goeppert, 1842 (alga).
Eschara Lam., 1801 (bryozoan).
Fibularia Lam., 1816 (echinoderm).
Fungites Martini, 1762 (coelenterate).
Heliolites Dana, 1846 (coelenterate).
Hydnopora Phill., 1836 (bryozoan).
Isis Linné, 1758 (coelenterate).
Lichenopora Defr., 1823 (coelenterate).
Millepora Linné, 1758 (coelenterate).
Palaeacis Meek-W., 1860 (coelenterate).
Retepora Lam., 1801 (bryozoan).
Somphospongia Beede, 1899 (alga).
Theonoa Lamx., 1821 (bryozoan).

Kingdom, Phylum, Class, Order UNCERTAIN

Family RECEPTACULITIDAE Eichwald, 1860

The name of this family is based on retention of *Receptaculites* Blainv., 1830, established by nearly universal long usage, instead of its senior synonym *Receptacules* Defr., 1827.

Ovoid, globose, or discoid fossils with calcareous hard parts consisting of closely joined ossicles with smooth or excavate, rhomboid or hexagonal outer faces from which generally a pillar-like process (rhabd) bearing 4 laterally directed branches (clads) extend inward. Bowl-shaped fossils may be derived from collapse of originally globular forms. The ossicles commonly are arranged very regularly, forming wall that incloses a central cavity, but the existence of pores, canals, or openings comparable to oscules is debatable. *Ord.-Dev., ?Carb.*

This important assemblage of early and middle Paleozoic fossils, here treated as a family of unknown affinities, has been interpreted by various authors as belonging with calcareous algae, foraminifers, sponges, corals, or echinoderms, or as representing an independent extinct phylum. They lack any marks of attachment, but most of them seem to be much too ponderous to warrant interpretation of them as floating organisms. Presumably, they lived on the sea bottom, and, judged by the nature of associated invertebrates and physical characters of formations containing them, they were able to thrive in moderately shallow waters.

Well-preserved specimens show that the components of the skeleton consist of microgranular nearly clear calcite; the ossicles are not crystalline and possess no fine honeycomb structure, as in echinoderms. Many receptaculitid fossils, especially those collected from dolomitic rocks, are molds and thus constitute only impressions of the original hard parts; some paleontologists have misconstrued them as actual remains of the organisms, interpreting the impressions of spicules as canals, like those of sponges.

Distinctive features of the skeletal elements are their form, arrangement, and gradation in size. Each ossicle or spicule typically comprises an expanded platelike "head" that forms part of the exterior of the fossil, a shaft perpendicular to the head extending inward, and raylike lateral prominences (generally 4) joined to the shaft. The generally hexagonal heads fit together as a pavement, and are arranged in a quincunxial pattern of intersecting double spirals that extend outward from a center; the heads increase regularly in size so that the largest are those farthest from the center. Such an arrangement of skeletal elements is never found in undoubted sponges. Although characters of the ossicles bear some resemblance to sponge spicules, most features of these fossils are not spongelike. The fact that nearly all receptaculitids in which the hard parts are preserved are calcareous strongly indicates that the original skeleton consisted of calcium carbonate, but this is not conclusive evidence, since it is well known that siliceous spicules may be altered to calcite in the course of fossilization. GÜMBEL has reported evidence of organic layers both on the outer and inner sides of the skeleton.

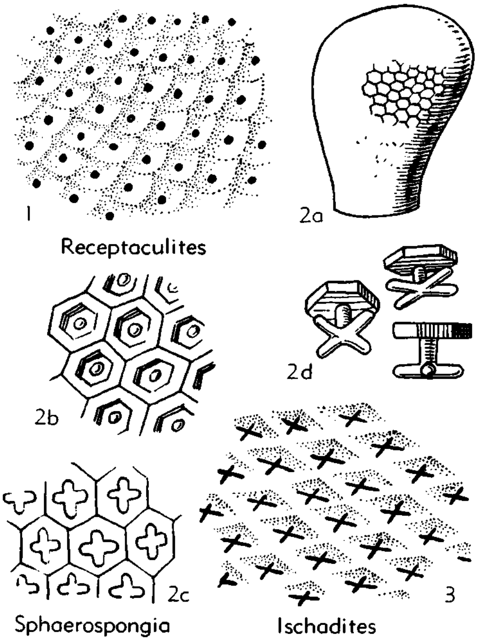

FIG. 89. Receptaculitidae (p. E110).

Many fossils of this family, such as specimens of *Ischadites,* reveal an apical opening that may have been an oscule. No unquestioned pores are reported. On the other hand, the present close juxtaposition of the dermal discs may be post-mortem. Many sponges shrink after dying. Some Recent sponges have pores in surface grooves between skeletal elements. Therefore, the possibility exists that the Receptaculitidae may have been aberrant Porifera.

Receptaculites BLAINV., 1830 [ICZN pend.] [**Receptacules* DEFR., 1827]. Cup- or saucer-shaped, expanded exterior parts of spicules hexagonal or rhombic to somewhat rounded, closely adjoined so as to form an even pavement, rhabds relatively stout, with 4 laterally directed clads just below expanded platelike head and seemingly with platelike expansion at inner extremity that forms part of a continuous inner well. In fossils preserved as molds, the skeletal parts are represented by cavities. *M.Ord.-Dev., ?Carb.,* cosmop.——Fig. 89,*1*. **R. neptuni* (Defr.), Ord., Wis.; part of outer surface of a mold, showing form of expanded exterior portions of spicules and position of rhabds, ×2.

Acanthochonia Hinde, 1884 [**A. barrandei*]. Like *Receptaculites* in form but with surface as in *Ischadites* (14). *Sil.*, Czech.

Ischadites Murch., 1839 [**I. koenigii*] [=*Tettragonis* Eichw., 1842; *Tetragonis* Lonsd., 1845]. Globular, ovoid, hollow, with apical aperture (?oscule); rhomboidal dermal plates of spicules arranged concentrically, inner rhabds so reduced that clads are appressed on inner face, resembling stauracts (14). *Ord.-Dev.*, Eu.-N.Am.——Fig. 89,*3*. **I. koenigii*, Sil., Br.I.; part of surface, ×2 (73).

Sphaerospongia Pengelly, 1861 [*pro Sphaeronites* Phill., 1841 (*non* His., 1828)] [=*Polygonosphaerites* F. A. Römer, 1880]. External parts of spicules hexagonal, rhabds very short (11, 13). *Ord.-Dev.*, Eu.——Fig. 89,*2*. **S. tesselata* (Phill.), Dev., Eng.; *2a*, side, ×0.5; *2b,c*, outer and inner views of spicules, ×2; *2d*, reconstructions of ossicles, ×1 (68n based on 63).

Cerionites Meek-W., 1868 [**C. dactylioides*]. Like *Sphaerospongia*. *U.Sil.*, Ill.

Cyclocrinites Eichw., 1842 [**C. sparkii*]. *Ord.*, Eu.

Dictyocrinus Hall, 1859 [**D. squamifer*] [=*Dictuocrinites* Hall, 1859]. Like *Sphaerospongia* in shape but surface resembling that of *Receptaculites*. *?Ord.*, U.S.A.

Lepidolites Ulr., 1889 [**L. dickhanti;* SD Miller, 1889]. Like *Dictyocrinus*. *Ord.*, U.S.A.

Nidulites Salter, 1851 [**N. favus*]. Pear-shaped, with outer faces of ossicles deeply concave, forming honeycomb pattern. *Ord.*, N.Am.-Eng.

Anomaloides Ulr., 1878 [**A. reticulatus*]. Conical, with spines perpendicular to surface. *Ord.*, N.Am.

Pasceolus Bill., 1857 [**P. halli;* SD Hinde, 1884]. *Ord.*, N.Am.

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Some 500 articles containing significant data in regard to fossil sponges have been published and about 300 of these have been studied in the preparation of this portion of the *Treatise;* those not consulted being almost entirely of such nature that study of them was not required.

Of 50 selected papers here cited, numbers 17, 22, and 44 contain general information about the Porifera, Recent as well as fossil. Numbers 41 and 50 cover the whole range of invertebrate fossils appropriately, but discuss few genera of sponges. Numbers 5, 7, 9, 21, 31, 32, and 35 are antiquated, but have historical interest and initiate many new names. The following numbers contain main sources of generic names and therefore have descriptions of greatest value: 12, 13, 25, 26, 28, 30, 36-40, 43, 45, 49.

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INDEX

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