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

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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.

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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 investi-

gations 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 zoological 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.

FAMILY AND SUBFAMILY NAMES

Rules adopted as guides in preparing taxonomic parts of *Treatise* text include the following provisions with respect to family and subfamily names.

(1) Family and subfamily names are formed by adding the prescribed endings -idae and -inae, respectively, to the stem of the generic name chosen as nomenclatorial type of the assemblage. This accords with stipulations given in Article 4 of the International Rules of Zoological Nomenclature. No restriction is imposed on an author in choosing the type genus of a new family or subfamily, but a subfamily that includes the type genus of the family to which it belongs (nominotypical subfamily) must be named after such genus. The type genus of a family or subfamily need not be the first-published among those included, but once fixed by publication, it cannot be replaced by another genus in the assemblage unless the type genus in question is transferred to a family or subfamily having an earlier chosen different type genus.

(2) Family and subfamily names are coordinate, which signifies that a name published with the ending -idae may be changed to -inae or vice versa without change in citation of author and date from those of the original publication.

(3) The first-published name of a family or subfamily assemblage shall be accepted unless it is unavailable, as in case of names based on junior homonyms or synonyms or on invalid emendations of generic names, and unless the name conflicts with requirements stated in paragraph 4.

(4) If a family is divided into subfamilies, the name of no such subfamily can antedate the family name. Every family divided into subfamilies must have a nominotypical *(sensu stricto)* subfamily, which has as its type genus the same one which serves as type of the family, and because the name of the family is based on the generic name which (among all included in the assemblage) was first published as type of a familial category, this applies also to the nominotypical subfamily. The author and date of the nominotypical subfamily invariably are identical with those of the family, without reference to whether the author of the family or some subsequent author introduced subfamily divisions. Thus, the family Astrocoeniidae KOBY, 1890, contains the subfamilies Astrocoeniinae KOBY, 1890 (not Astrocoeniinae FELIX, 1898), and Pinacophyllinae VAUGHAN & WELLS, 1943; KOBY did not subdivide the family. Just as the nominotypical subgenus of a genus must be ascribed to the author who erected the genus and must bear the same date, so a nominotypical subfamily cannot be attributed to an author other than the one who first selected the genus that serves the family and nominotypical subfamily as type and it cannot bear a date subsequent to that of erecting the family.

(5) Change from the originally published form of family and subfamily names is required (a) if the taxonomic rank assigned to the assemblage is altered, (b) if the stem of the nominotypical generic name is incorrectly distinguished, or (c) if the name of the type genus is changed.

(6) Changes of the sort specified in 5a and 5b do not call for change in citing author and date of family or subfamily assemblages, for these remain as in the original publication. Style of such citations employed in the *Treatise* is illustrated by the examples "Family Exochellidae BASSLER, 1935 [as Exochellinae]" and "Family Rhabdomesidae VINE, 1883 [as Rhabdomesontidae]." The name enclosed in parentheses indicates the originally published form.

(7) If the name of the type genus of a family or subfamily is changed, the familial name must be altered accordingly and not replaced by a name based on a different genus. For example, the family name Electrinidae D'ORBIGNY, 1851, based on *Electrina* D'ORBIGNY, 1851 (*non* BAIRD, 1850) is altered to Electridae LAGAAIJ, 1952, based on *Electra* LAMOUROUX, 1816 (senior synonym of *Electrina*) and the *Treatise* style of citation is "Family Electridae LAGAAIJ, 1952 [=emend. Electrinidae D'ORB., 1851]."

(8) Names not available for family or subfamily assemblages include (a) vernacular designations, such as membranipores (English), Pisokrinoiden (German), and Aulacocératidés or Syringoporiens (French); (b) terms not founded on generic names, as for example "Hastatidae STOLLEY, 1919," for which no corresponding generic name exists (derivation presumably based on the "section" of the broad genus *Belemnites* called Hastati, after the species *Hibolites hastatus*); (c) names not originally of suprageneric rank, as terms derived from trivial names of species; (d) names formed from the stem of generic or subgeneric names which are junior homonyms or synonyms; (e) names based on a type other than that having priority of designation among all genera and subgenera included in the assemblage; and (f) names based on invalid emendations of generic or subgeneric names, as for example "Family Zitteloceratidae," based on invalid emendation of *Zittelloceras* HYATT to *Zitteloceras* (even though this genus patently was named for ZITTEL). Present International Rules do not contain some of these stipulations.

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)]." 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]", but in the latter 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]" and "*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 "*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; for example, "*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 be subjective. An example showing *Treatise* style in listing of synonyms is offered by the following entry: "*Calapoecia* BILLINGS, 1865 [**C. anticostiensis;* SD LINDSTRÖM, 1883] [=*Columnopora* NICHOLSON, 1874; *Houghtonia* ROMINGER, 1876]." A synonym which is also a homonym is recorded in the following: "*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 lists.

Abbreviations of Stratigraphic and Place Names, Morphological Terms, and Words Used in Bibliographic Citations

Abh., Abhandlung
Acad., Academia, Académie, Academy
Accad., Accademia

Adv., Advancement
afd., afdeeling, afdeling
Afr., Africa
Akad., Akademie
Ala., Alabama
Alb., Albian
Alba., Alberta
Am., America, American
Ann., Annual
antarct., Antarctic
Antarct., Antarctica
Appalach., Appalachian
Apt., Aptian
Aquit., Aquitanian
Arc., Arctic
Arenig., Arenigian
Arg., Argentina
Ariz., Arizona
Ark., Arkansas
Årssk., Årsskrift
art., article, -s
Assoc. Association
Atl., Atlantic
Aus., Austria
Austral., Australia
Auver., Auversian
Baj., Bajocian
Balt., Baltic
Barton., Bartonian
Bath., Bathonian
B.C., British Columbia
Bd., Band, Bände
Belg., Belgium, Belgique
Blk., Black
Blkriv., Blackriveran
Bol., Bolivia
Boll., Bollettino
Br., British
Braz., Brazil
Brux., Bruxellian
Bull., Bulletin, -s
Bur., Bureau
Burdig., Burdigalian
C., Central
Calif., California
Cam., Cambrian
Camp., Campanian
Can., Canada
CanaryI., Canary Islands
Caradoc., Caradocian
Carb., Carboniferous
Cenom., Cenomanian
Chaz., Chazyan
cheil., cheilostome
Chemung., Chemungian
Chest., Chesteran
Claib., Claibornian
Clift., Cliftonian
Clint., Clintonian
Colo., Colorado
Colom., Colombia
Coni., Coniacian
Contr., Contribution, -s
Cret., Cretaceous
crypt., cryptostome
cten., ctenostome
cycl., cyclostome
C.Z., Canal Zone
Czech., Czechoslovakia
Dan., Danian
Deerpark., Deerparkian
Denkschr., Denkschriften
Denm., Denmark
Dept., Department
Desmoin., Desmoinesian
Dev., Devonian
E., East
econ., economische
Eden., Edenian
Ellesm., Ellesmereland
Eng., England
Eoc., Eocene
Est., Estonia
Eur., Europe
Exped., Expedition
fig., figure, -s
Fla., Florida
Fr., France
Ga., Georgia
G.Brit., Great Britain
geol., geologischen
Geol., Geological, Geology
géol., géologique
Ger., Germany
Gesell., Gesellschaft
Gior., Giornale
Gotl., Gotland
Greenl., Greenland
Held., Helderbergian
Helv., Helvetian
hist., histoire
Hist., Historia, History
Holl., Holland
Hung., Hungary
hydrol., hydrologie
I., Island, -s
Ill., Illinois
Ind., Indiana
Inst., Institut, Institute, Institution, Instituto, Institució, Instituut
Ire., Ireland
ital., italiana
Jackson., Jacksonian
Jahrg., Jahrgang
Jour., Journal
Jur., Jurassic
K., Kaiserlich
Kans., Kansas
Keys., Keyseran
Kind., Kinderhookian
Kl., Klasse
Ky., Kentucky
La., Louisiana
Lab., Laboratories, Laboratory
Latt., Lattorfian
Led., Ledian
Lias., Liassic
Lief., Lieferung, -en
Lockport., Lockportian
long., longitudinal
Lut., Lutetian
Maastr., Maastrichtian
Madag., Madagascar
Mal., Malaya
Man., Manitoba
math., mathematische
Maysv., Maysvillian
Md., Maryland
Medin., Medinan
Medit., Mediterranean
Mem., Memoir
Mém., Mémoire
Meramec., Meramecian
Mex., Mexico
Mich., Michigan
Micros., Microscopical
Midway., Midwayan
mineralog., mineralogisch
Mineralog., Mineralogical
Minn., Minnesota
Mio., Miocene
Misc., Miscellaneous
Miss., Mississippi, -an
Missour., Missourian
Mitt., Mitteilungen
Mo., Missouri
Mon., Monograph
Mongol., Mongolia
Mont., Montana
Morrow., Morrowan
mtg., meeting
Mus., Musée, Museo, Museum
N., North
nac., nacional
N.Am., North America
nat., natural, naturali, naturelle, -s
Natl., National
Naturgesch., Naturgeschichte
N.Car., North Carolina
NE. Northeast
Nebr., Nebraska
Neocom., Neocomian
Niag., Niagaran
N.J., New Jersey
N.Mex., New Mexico
no., number, -s, numéro, -s número, -s
n.s., new series
N.Scot., Nova Scotia
N.S.W., New South Wales
NW. Northwest
N.Y., New York
N.Z., New Zealand
N.Zem., Nova Zembla
obj., objective
océanogr., océanographique
Okla., Oklahoma
Oligo., Oligocene
Onesqueth., Onesquethawan
Onond., Onondagan
Ont., Ontario
Ord., Ordovician
Osag., Osagian
Oxf., Oxfordian
p., page, -s
Pac., Pacific
Palaeontogr., Palaeontographica, Palaeontographical
paläont., paläontologische
Paläont., Paläontologia, Paläontologie
Paleoc., Paleocene

Paleont., Paleontologic, -al, Paleontology
paléont., paléontologie
Patag., Patagonian
Penn., Pennsylvanian
Perm., Permian
pl., plate, -s
Pleisto., Pleistocene
Plio., Pliocene
Pol., Poland
Portl., Portlandian
Priabon., Priabonian
Proc., Proceedings
pt., part, -s
Pub., Publication
Quart., Quarterly
Quat., Quaternary
Que., Quebec
Queensl., Queensland
Rec., Recent
Rept., Report, -s
Richmond., Richmondian
Roy., Royal, Royale
Rupel., Rupelian
Russ., Russia, Russisch
S., Sea, South
SaltR., Salt Range
S.Am., South America
Santon., Santonian
S.Car., South Carolina
sci., science, -s, scientific, scientifique, -s, scienza, scienze
Scot., Scotland
SE., Southeast
sec., -s section, -s
Selsk., Selskabs
Senon., Senonian
ser., serial, series
Shrops., Shropshire
Sib., Siberia
Sil., Silurian
Skr., Skrifter
Soc., Société, Society
Sp., Spain
Spitz., Spitzbergen
Sta., Station
Staatsinst., Staatsinstitut
suppl., supplement
SW., Southwest
Swed., Sweden, Swedish
Switz., Switzerland
t., tome, tomo, tomus
tang., tangential
Tasm., Tasmania
Tenn., Tennessee
Tert., Tertiary
Tex., Texas
Tongr., Tongrian
Tonol., Tonolowayan
Tort., Tortonian
Trans., Transactions
transv., transverse
Trav., Travaux
Tremad., Tremadocian
Trenton., Trentonian
trep., trepostome
Trias., Triassic
Turk., Turkey
Turon., Turonian
Undiff., Undifferentiated
Univ., Universidad, Université, Universitets, University
U.S., United States
V., Valley
Va., Virginia
Valang., Valanginian
Verh., Verhandlung, -en
Vicksb., Vicksburgian
Videnskk., Videnskabernes
vol., volume, -s
Vt., Vermont
W., West
Wenlock., Wenlockian
Wilcox., Wilcoxian
Wis., Wisconsin
Wiss., Wissenschaften
Yorks., Yorkshire
Ypres., Ypresian
Yugo., Yugoslavia
Zeitschr., Zeitschrift
zool., zoologisch, -e, -er, -es
Zool., Zoologi, -a, Zoological, Zoologiska, Zoology

Abbreviations of Authors' Names

Bill., Billings, Elkanah
Blainv., Blainville, H. M. D. de
Canu-B., Canu, Ferdinand, & Bassler, R. S.
Canu-L., ——— & Lecointre, Georges
Condra-E., Condra, G. E., & Elias, M. K.
Cumings-G., Cumings, E. R., & Galloway, J. J.
DeKon., DeKoninck, L. G.
Duv., Duvergier, J.
Ehr., Ehrenberg, C. G.
Eichw., Eichwald, Edouard von
Ellis-S., Ellis, John, & Solander, Daniel
Eth., Etheridge, Robert, Jr.
Eth.-F., ——— & Foord, A. H.
Fenton-F., Fenton, C. L., & Fenton, M. A.
Gabb-H., Gabb, W. M., & Horn, G. H.
Goldf., Goldfuss, August
Hag., Hagenow, Friederich von
Hall-S., Hall, James, & Simpson, G. B.
Hall-W., ——— & Whitfield, R. P.
ICZN, International Commission on Zoological Nomenclature
Lamx., Lamouroux, J. V. F.
Lev., Levinsen, G. M. R.
Lonsd., Lonsdale, William
MacGill, MacGillivray, P. H.
Maple., Maplestone, C. M.
Meek-W., Meek, F. B., & Worthen, A. H.
Mich., Michelin, J. L. H.
M.Edw., Milne-Edwards, Henri
M.Edw.-H., ——— & Haime, Jules
Moore-D., Moore, R. C., & Dudley, R. M.
Nekh., Nekhoroshev, A.
Nich., Nicholson, H. A.
Nich.-E., ——— & Etheridge, Robert, Jr.
Nich.-F., ——— & Foord, A. H.
Nickles-B., Nickles, J. M., & Bassler, R. S.
Nikif., Nikiforova, A. J.
Ok., Okulitch, V. J.
d'Orb., d'Orbigny, A. D.
Quenst., Quenstedt, F. A.
Raf., Rafinesque, C. S.
Schloth., Schlotheim, E. F.
Rom., Rominger, Carl
Shulga, Shulga Nesterenko, M. J.
Stuck., Stuckenburg, A.
T.Woods., Tenison Woods, J. E.
Ulr., Ulrich, E. O.
Ulr.-B. ——— & Bassler, R. S.
Vig., Vigneaux, M.
Vinassa, Vinassa de Regny, P. E.
Waag.-W., Waagen, William, & Wentzel, Joseph
Whitf., Whitfield, R. P.
Y.-Y., Young, John, & Young, John
Yabe-H., Yabe, H., & Hayasaka, I.
Yabe-S.,———& Sugiyama, T.

REFERENCES TO LITERATURE

Each part of the *Treatise* is accompanied by a selected list of references to paleontological literature consisting primarily of most 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 classification 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 enclosed invariably in parentheses and are distinguishable from dates because the index numbers comprise no more than 3 digits. Ordinarily, the index numbers for literature references are given at the end of generic or family diagnoses.

The selected references pertaining to Bryozoa and index numbers used in this part of the *Treatise* are given at the end of the text (p. G236).

SOURCES OF ILLUSTRATIONS

At the end of figure captions an index number commonly 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 the list of References to Literature. Index numbers printed in lightface roman type denote reproduction of original illustrations in modified form, as in redrawing (in the manner commonly recorded by the example "after SCHUCHERT"), whereas facsimile copies without any change other than alteration of scale are indicated by numbers in italic type (for example, signifying "from SCHUCHERT").

AID FROM THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

In the course of formulating policies for guidance of *Treatise* authors in dealing with many sorts of problems in zoological nomenclature, the Editor conducted a rather extensive correspondence with American and European specialists, including the Secretary of the International Commission on Zoological Nomenclature, MR. FRANCIS HEMMING, as well as other present and former members of this Commission. In addition, a number of personal conferences were held in London, Paris, Frankfurt-a.-M., Washington, and elsewhere. It is appropriate to express great appreciation on behalf of the *Treatise* project to individuals who thus contributed to the shaping of decisions. MR. HEMMING has aided especially by expediting as much as possible action by the International Commission on questions referred to it for decision, several of these calling for use of the Commission's plenary powers. Without prejudice to any decisions ultimately made, MR. HEMMING has acquiesced to a proposal that recommended nomenclatural dispositions submitted to the Commission but not yet decided when *Treatise* manuscript is ready for the press may be published with the accompanying notation "ICZN pend.", which signifies that action of the International Commission on Zoological Nomenclature is pending.

RAYMOND C. MOORE

PART G

BRYOZOA

By Ray S. Bassler

CONTENTS

INTRODUCTION

The phylum Bryozoa comprises a puzzling group of minute invertebrates, some of which grow into colonies of considerable size. They are widely distributed at all depths and latitudes in the modern seas and are equally well represented as fossils in the stratified rocks.

The Bryozoa, popularly known by the paradoxical term "moss animals," long have been noticed by many strollers along some seashores where their delicate plantlike colonies are washed ashore after every storm. A common sort consists of broad incrustations upon seaweeds. Such specimens attracted early European students, who found that they were composed of a multitude of separate individuals generally less than 1 mm. long. These observers at first interpreted the organisms as plants, but later placed them in a halfway group, "zoophytes," presumed to be part animal and part plant. Then the coral-like appearance of some calcareous Bryozoa gave origin to another term, "corallines," but when it was discovered that each unit of the colony consists of an animal with complete alimentary canal, totally unlike the corals or any other group, there was more general agreement as to their nature. Still, for some time their exact systematic position among the animals remained in doubt, and they were shifted from class to class.

POLYZOA VERSUS BRYOZOA

In 1830 J. V. Thompson published in Ireland his observations "On Polyzoa, a New Animal Discovered as an Inhabitant of some Zoophites" (Zool. Researches, no. 5, p. 89-102, pl. 1-111). A few months later, 1831, C. G. Ehrenberg published in Germany a paper *(Symbolae Physicae, seu Icones et Descriptiones Animalium Evertebratorum, 1828-1831)* in which this group of animals, termed Phytozoa Polypi, was separated under the name Bryozoa, from Greek signifying "moss animals."

Although Polyzoa are judged by many zoologists to have been defined inadequately by Thompson, most English naturalists have preferred this term, which has priority of publication. Continental and American students, on the other hand, with few exceptions have adopted the designation Bryozoa.

As early as 1880, Waters pointed out that Thompson's use of Polyzoa referred to the associated animals (zooids) without differentiating them clearly as a major assemblage within the animal kingdom, whereas

EHRENRERG definitely separated the Bryozoa as a group. Discussions by STEBBING, HERDMAN, HARMER, WATERS, and others, favoring one or other of these terms, are contrasted in the Proceedings of the Linnean Society of London for 1910-1911. A review of the Polyzoa-versus-Bryozoa question, prepared about 1947 by S. F. HARMER at request of the Zoological Society of London, was entirely inconclusive.

Since priority is not recognized as a controlling factor in nomenclature of divisions of the organic world higher than genera, the proper name of this phylum must be agreed to depend on use by a majority of students or by ruling of some authoritative body of zoologists. Preponderance of usage among zoologists, reinforced by nearly unanimous recommendation of American and several European paleontologists consulted, has led to adoption of Bryozoa in the *Treatise*.

DEVELOPMENT OF BRYOZOAN STUDIES

Such familiar bryozoan terms of today as *Retepora* and *Frondipora* appear for the first time in the Historia Naturale "Classification" of Imperato, 1599. In 1755, JOHN ELLIS, English businessman interested in natural history, published his "Essay on Corallines" with plates illustrating bryozoans; in this work he resolved the controversial subject of relationships of the zoophytes by establishing their animal nature. PALLAS, in 1766, described *Eschare spongites,* which is the widespread bryozoan, *Stylopoma spongites,* of modern seas. LINNÉ in the Tenth Edition (1758) of his "Systema Naturae" gave binominal status to the ELLIS species and taxonomic studies of succeeding years.

Notwithstanding great development of studies on the Bryozoa in past and present, investigation of these animals always has been limited to a comparatively few specialists who have been unable to overcome popular belief that the bryozoans present too difficult problems for any but persons willing to spend a lifetime of research upon them. This belief has been strengthened by the fact that most published works are highly technical in nature and usually deal with special aspects of the subject.

For a considerable time the Bryozoa were grouped with Brachiopoda and Ascidia, in the phylum called Molluscoidea, but the Ascidia long have been removed from this assemblage and the Brachiopoda are now classed definitely in a phylum of their own. Finally, of the 2 very unequal main divisions of Bryozoa recognized today, Entoprocta and Ectoprocta, the former is now judged by some zoologists to be classifiable as an independent phylum, and by others to belong with the Bryozoa. If the Entoprocta are removed from the phylum Bryozoa, no need remains to employ the term Ectoprocta.

In the early days of bryozoology in Europe both fossil and Recent species were most often collected and studied as an avocation by people in various walks of life. Outstanding in England were the Rev. THOMAS HINCKS and Canon ALFRED M. NORMAN among the clergy; JOHN ELLIS, just mentioned, and A. W. WATERS in the business world; and in France, there was FERDINAND CANU, who taught physics and meteorology in the Paris schools. Distinguished among the specialists who followed the subject as a part of their profession was the British Museum group comprising GEORGE BUSK in the earlier days, and later J. W. GREGORY, Sir SIDNEY HARMER, W. D. LANG, ANNA HASTINGS, and others who consistently maintained a high level of careful, well-illustrated work. Through the efforts of GREGORY, LANG, and BRYDONE in England, EHRHARD VOIGT in Germany, and G. M. R. LEVINSEN in Denmark, careful surface zonal collecting in the Chalk and other Mesozoic deposits has shown the Bryozoa to be so restricted in stratigraphic range and so widespread in geographic distribution that they form excellent guide fossils. In North America their value is recognized by many oil companies with research staffs engaged in determining their subsurface distribution.

Since the 60-year span of the writer's interest in bryozoans embraces the period during which chief advances in knowledge of the North American fossil species occurred, it seems appropriate to explain how he came to spend so much time in their taxonomic study. Early boyhood experiences in collecting and wondering about the twig-like delicately marked stones found so

abundantly around his home region of Cincinnati excited his curiosity. At this time various amateur and professional geologists, members of the Cincinnati Society of Natural History, were active in studies of the Upper Ordovician fossils of that region. Among these, some of whom became internationally known, were S. A. MILLER, U. P. JAMES and son J. F. JAMES, EDWARD ORTON, the Rev. HENRY HERZER, G. W. HARPER, E. W. CLAYPOLE, A. F. FOERSTE, C. B. DYER, C. L. FABER, J. M. NICKLES, CARL ROMINGER, CHARLES SCHUCHERT, and E. O. ULRICH. Gaining acquaintance with these enthusiasts brought invitations to field excursions and at length permission to browse in the Society's library, where a volume "Synonymic Catalogue of Recent Marine Bryozoa" by the English student Miss E. C. JELLY (1889) aroused the ambition to prepare a similar compilation of American fossil bryozoans. While in high school, he was invited to serve as part-time assistant to E. O. ULRICH, who lived on a somewhat precarious income derived largely from sale of fossil collections and bryozoan thin sections prepared for various universities and museums. In this fortunate opportunity he succeeded CHARLES SCHUCHERT, who had just completed the lithographic illustrations for ULRICH's bryozoan and other reports published in Illinois (1890) and Minnesota (1893) and who had now left for work on his own specialty, the brachiopods, with JAMES HALL at Albany. Learning that J. M. NICKLES was undertaking to catalog the American fossil Bryozoa, agreement to combine efforts led to completion of the NICKLES & BASSLER "Synopsis of American Fossil Bryozoa" (U.S. Geol. Survey Bull. 173, 1900).

In 1901, the writer became assistant to CHARLES SCHUCHERT, then curator of invertebrate fossils at the U.S. National Museum, and almost coincidently, ULRICH and NICKLES moved to Washington as members of the U.S. Geological Survey. Then followed some years in processing for the Museum considerable Paleozoic collections which included many bryozoans. A study of the beautifully preserved Ordovician bryozoans of the European Baltic provinces, based on collections obtained by SCHUCHERT, appeared in 1911 (3). Unusually ample collections of Recent bryozoans from Philippine and southwestern Pacific localities representing more than 300 dredging stations resulted from the U.S. Bureau of Fisheries "Albatross" expedition in 1908-1909 through the activities of PAUL BARTSCH of the Museum staff. Similarly, "Albatross" material from some hundreds of Atlantic Coast and Gulf of Mexico dredgings provided still more Recent bryozoans for investigation. From field work in the Atlantic and Gulf Coastal Plains directed by T. WAYLAND VAUGHAN for the U.S. Geological Survey came a multitude of Tertiary bryozoans. The collection of these faunas, begun in 1907, had reached such proportions in 1913 that the Smithsonian Institution and U.S. Geological Survey commissioned FERDINAND CANU to join the writer in investigating them. CANU, recognized as an outstanding specialist on post-Paleozoic Bryozoa, was assigned senior status in this joint labor, which had to be carried on by shipment of specimens and manuscript to and fro across the Atlantic in perilous war times. The collaboration resulted in reports on North American Early Tertiary Bryozoa in 1920 (24) and North American Later Tertiary and Quaternary Bryozoa in 1923 (26), volumes which included the description and illustration of many other genera and their type species beside those represented in the fossil collections. A personal meeting with CANU was deferred until 1926; this and a later very pleasurable meeting in 1931 gave opportunity for planning continuation of joint researches, but CANU's lamented death in 1932 intervened. Work on a world catalog of bryozoan genera and families for the "Fossilium Catalogus" (Part 67, Bryozoa) was then concluded and published in 1935. Now this contribution to the *Treatise* is an endeavor to lighten the taxonomic studies of present and future students. In its preparation the author realizes his great indebtedness to all the persons mentioned, all of whom, save naturally a few of earliest date, he had the honor and pleasure of knowing personally. He is also very grateful for the support of the several institutions which authorized the various projects.

ACKNOWLEDGMENTS

For secretarial assistance in preparing this manuscript, I am especially indebted to JESSIE G. BEACH, working in Washington, and RUTH BREAZEAL, working in Lawrence. The illustrations were drawn mostly by JOHN W. KOENIG, but many were prepared by JANE S. WHITMORE and a few by NANCY-LOU PATTERSON; assemblage of the figures for reproduction is the work of Mrs. PATTERSON. Not to be overlooked is a large amount of photographic work done by ROBERT O. FAY at the University of Kansas. These artists and photographer were directed by the Editor, RAYMOND C. MOORE, in Lawrence. In addition to much work in revising and checking taxonomic portions of the text and identifying sources of illustrations, Dr. MOORE aided in organizing the glossary of morphological terms and outline of classification; he suggested numerous revisions of nomenclature and was responsible for condensing greatly the data on distribution of bryozoans. For the assistance furnished by these persons I am much indebted and I express to them my deep thanks.

MORPHOLOGICAL CHARACTERS

The Bryozoa are small, composite, almost exclusively marine invertebrates, which develop from a free-swimming larva that becomes sedentary, attaching itself to some foreign object; initial fixation is established by a small chitinous disk **(protoecium)**, from which the primary individual **(ancestrula)** develops. By repeated budding from the ancestrula, a colony **(zoarium)** of varied shape and size is produced according to the nature of the species. Budding occurs in various ways (terminal, lateral, dorsal, frontal, stolonate) but it is an interesting fact that, excepting the ancestrula, all individual bryozoan animals **(zooids)** of the same colony, possibly amounting to thousands, are derived directly or indirectly from the single initial zooid that started the colony.

INDIVIDUAL ANIMAL

Each individual zooid is composed of a double-walled membranous or calcareous sac **(zooecium)** and its contained soft parts **(polypide)** consisting of the visceral mass and food-gathering tentacles. The freely suspended alimentary canal is U-shaped, and, accordingly, the mouth and anus open close to each other. The canal is divisible into 3 distinct regions—esophagus, stomach, and intestine. A heart and vascular system are wanting, but numerous leucocytes float in the body cavity. A nervous ganglion between the mouth and anus sends delicate nerve filaments to the tentacles and esophagus. The upper part of the polypide is generally flexible and can be invaginated through the action of numerous longitudinal and transverse muscles traversing the fluid-filled visceral cavity. Both sexes generally are combined in the same zooid, and, furthermore, the same zooecium may be inhabited at various times by different polypides, which successively degenerate. The reproductive organs are developed in various parts of the body cavity, although spermatozoa commonly occur in the lower region and ova in the upper. The ova may be developed in a special receptacle **(marsupium)**, in an inflation of the zoarial surface **(gonocyst)**, or in a modified zooecium **(gonoecium)** set aside for reproductive purposes. The general term **ovicell** (ooecium) is applicable to all of these structures.

The mouth is surrounded by the lophophore, which bears a crown of slender hollow, ciliated tentacles arranged in a circle or horseshoe shape. Microscopic organisms, such as diatoms and radiolarians, are gathered for food. The 2 large divisions under which the Bryozoa are usually classed (Entoprocta, Ectoprocta) are based upon position of the anal opening, which in most is situated outside the row of tentacles (Ectoprocta); rarely it is placed within this row (Entoprocta).

This description of bryozoan anatomy applies, with certain exceptions, to all divisions of the phylum, and, in general, within each division the individual zooids conform to a single definite type of structure. Modifications in structure are more evident in the protective covering or skeleton of the animal, the zooecium, than in its soft parts,

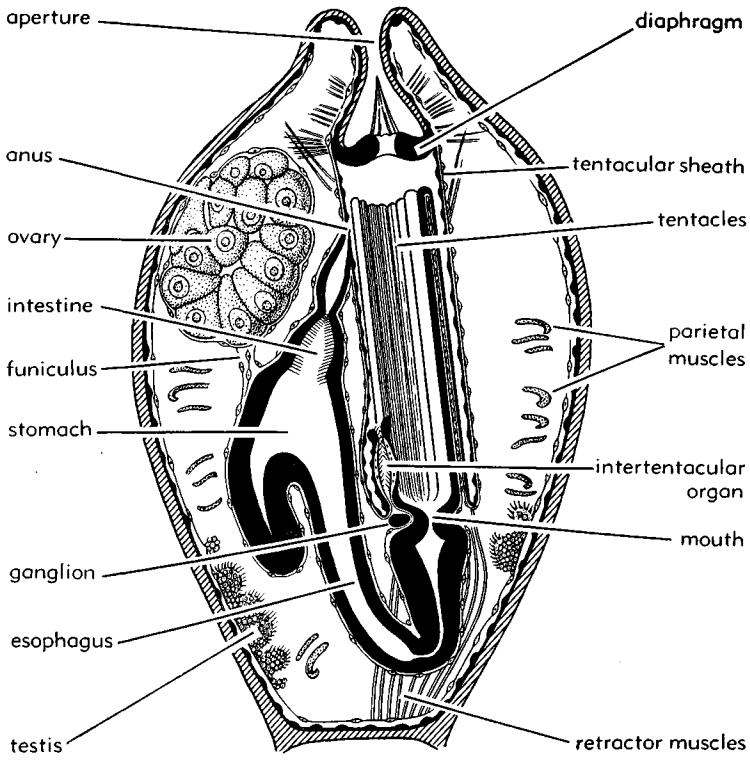


FIG. 1. Anatomy of a single bryozoan zooid (*Alcyonidium albidum* AIDER, of the order Ctenostomata) with polypide retracted; much enlarged *(after Prouho)*.

the polypide. The accompanying diagram of the anatomy of a single zooid (Fig. 1) with retracted polypide illustrates this general structure. The mouth leads into the ciliated pharynx, and this into the esophagus, followed by the stomach, which in turn passes into the intestine, and this through the rectum communicates with the exterior by the anus. When retracted, the tentacles lie in a cavity (tentacular sheath), which opens to the exterior by the **orifice.** The extended polypide is withdrawn into the zooecium by the contraction of retractor muscles attached to the tentacular crown. Among Bryozoa with flexible zooecia, contraction of the body walls by parietal muscles produces protrusion of the polypide, but the means for protrusion are more complicated in forms having rigid calcareous zooecial walls.

A considerable amount of polymorphism occurs in this phylum, and different names have been applied to the various types of individual skeletal structures—**autozooecia** to ordinary zooecia, **gonozooecia** to modified reproductive ones, **kenozooecia** to accessory individuals, and **heterozooecia** to those modified for other functions of the colony. The heterozooecia are reduced members of the colony attached to a zooecium; they include **avicularia** and **vibracula.** The avicularia of some bryozoans have a bird's-head form; the vibracula are bristle-like. The jaws of the avicularia open and close with a snapping motion, which has given rise to the probably erroneous idea that they are organs of defense. The structure of these 2 types of heterozooecia is described in more detail in the consideration of cheilostomatous Bryozoa. Both the avicularia and vibracula are

chitinous and thus incapable of preservation in the fossil state, but their former presence is indicated by the porelike excavations in which they lodged.

COLONIES

The colonies **(zoaria)** which the combined zooids form, present a great variety of shape and structure, although the form is mostly constant in individual species. Commonly the zoaria grow over shells, stones, or other bodies, forming delicate incrustations of exquisite pattern. By the superposition of many such incrustations, lamellate, hemispherical, globular, nodular, or irregular masses may result, and some of these are conspicuously large. Again, the zoaria may arise in broad fronds, branching stems, or bifoliate leaves; some of them form open-meshed lacework of the most regular and beautiful patterns. Although often described as free, only the upper branches actually are free, for most bryozoans are attached basally or by other parts of their surface to extraneous objects; they may be moored to the bottom by rootlike appendages. Thin discoid, apparently free zoaria result from growth about a sand grain, shell fragment, or some destructible object which has disappeared. In many species belonging to quite different families, the zoarium is regularly jointed so as to provide mobility.

The Bryozoa resemble certain corals (Tabulata) and hydrozoans in their external configuration but differ from them radically in the presence of a distinct body cavity, closed alimentary canal, nervous system, and delicate respiratory tentacles surrounding the mouth. A true coenenchyma, such as found in the coelenterates, is not seen in any bryozoan; accordingly, coenenchymal gemmation is unknown, but somewhat similar vesicular tissue may occupy the interzooecial spaces. Such tissue occurs commonly in Paleozoic bryozoans such as the Fistuliporidae and in the expanded base of the Fenestellidae; as elsewhere, the main purpose of such vesicles seems to be that of furnishing support for the zoarium.

MORPHOLOGICAL TERMS APPLIED TO BRYOZOANS

Descriptive literature on Recent and fossil Bryozoa is encumbered by a multiplicity of morphological terms to such extent that understanding of these animals by nonspecialists is impeded greatly and unnecessarily. Morphological nomenclature is even burdensome to the specialist; he must become acquainted with the meaning of diverse terms in order to use the literature, but in his own writing he can well afford to dispense with a majority of them.

The following alphabetically arranged glossary of bryozoan terms has been prepared with the double purpose of (1) aiding students to find readily a definition of terms unfamiliar to them and (2) indicating judgment as to importance of the terms. For the latter purpose, classification of terms in 3 categories is indicated typographically: (a) boldface capitalized words (as **ACANTHOPORE**) are assigned rank as most generally accepted and useful; (b) boldface uncapitalized words (as **anter**) are terms considered secondary, either because they are rather commonly used synonyms of preferred terms, or because their application is restricted to a minor fraction of the bryozoans; and (c) italicized words in the list (as *oecium*) are terms judged to have a minimum usefulness, most of them being suited for discard. An asterisk (*) indicates that the term with which it is associated, although used in the literature, has historical interest only.

GLOSSARY OF MORPHOLOGICAL TERMS

A-zooecium. Skeleton of normal egg-producing zooid in zoarium with dimorphic zooecia, as in *Steginoporella* (syn., zooecium) (*see* B-zooecium).

aborted zooecium. Skeleton of zooid arrested in development; with others forms "packing material" between normal zooecia in some zoaria.

ACANTHOPORE. Cylindrical tube adjoining zooecial walls and parallel to them in growth, formed of cone-in-cone layers with narrow central tubule which may be crossed by minute diaphragms; position commonly marked surficially by projecting spines, mostly at angles between zooecia in Paleozoic species (syn., spiniform tubule) (*see* megacanthopore, micracanthopore).

acanthostegous. Type of ovicell in some cheilostomes (Anasca) consisting of marsupial space between cover membrane (ectocyst) of zooecium and 2 overlying series of concurrent spines.

accessory cell (or tube). Small chamber or tubular space; inclusive term for firmatopores, nematopores, tergopores, dactylethrae, and cancelli (syn., kenozooecium, interstitial cell).

acropetalous. Term applied to spines developed upward from base of zoarium.

adeoniform. Shaped like the lobate bilamellar zoaria in the cheilostome family Adeonidae.

adnate. Growing with one side adherent to a foreign object.

adventitious. Developed sporadically, not in the usual place (as in some avicularia).

alveolus (pl., *alveoli*). Small cavity or pit between zooecia; chiefly in the cyclostome family Lichenoporidae.

anastomosing. Uniting irregularly to form a network; applied to branches that diverge and rejoin (syn., inosculating).

ancestroecium. Skeletal cover (zooecium) of the ancestrula.

ANCESTRULA. First-formed zooid of a colony, derived by metamorphosis of a free-swimming larva.

antenniform. Shaped like insect antenna; jointed, with each segment widening distally.

anter. Part of operculum on distal side of cardelles in cheilostomes, serving for closure of the portion of the orifice called porta, through which the polypide is protruded and withdrawn.

anterior. Direction or side toward which growth proceeds (syn., distal, forward). Ambiguously and objectionably, this term has been used by some authors to denote the side of a zoarium bearing apertures (*see* posterior).

apertural bar. Fused pair of costae next proximal to aperture of cribrimorph cheilostomes.

APERTURE. Outermost opening of zooecium; in cryptostomes, mouth of the vestibule, and in cheilostomes, the opening occupied by an uncalcified frontal membrane. Among cheilostomes having a calcified frontal wall and peristomie, the aperture is synonymous with the terms peristomice and secondary orifice, employed by some authors; but among cheilostomes having a mostly uncalcified frontal membrane, the area occupied by this membrane has been termed aperture. Loosely used in literature, the term aperture is best defined as here indicated and thus may not be confused with orifice.

appendicular organs. Collective term for avicularia and vibracula (syn., heterozooecia).

area. Flat or concave frontal membrane bordered by gymnocyst, in cheilostomes (syn., frontal area).

areola. Same as areole.

areolar pore. One of a series of openings arranged around the frontal margin of cheilostomes (syn., areola, areole, lateral punctation).

AREOLE. Marginal pore on frontal wall in some cheilostomes (Ascophora) connecting endocyst with ectocyst (syn., areola, areolar pore, lateral punctation).

ASCOPORE. Median small opening in the frontal wall of some cheilostomes (Ascophora) leading to the compensatrix, located proximally with reference to the aperture (syn., fenestrula, micropore).

ascus. Hydrostatic organ in some cheilostomes (Ascophora) (syn., compensatrix).

astogeny. Life history (ontogeny) of a colony (asty).

asty. Colony; zoarium.

**autocystid.* Cyclostomatous zooecium of normal size.

autopore. Tube or chamber forming skeleton of one of the main zooids in a colony (syn., zooecium, autozooecium, orthoecium).

autozooecium. Skeleton of normal zooid (syn., zooecium, autopore, orthoecium).

autozooid. One of the normal individuals composing a colony (syn., zooid).

AVICULARIUM (pl., **AVICULARIA**). Specialized cheilostome zooid with reduced polypide but strong muscles which operate a mandible-like operculum; it comprises one type of heterozooid and may be vicarious (in series with normal zooids) or adventitious (attached to some part of the frontal wall of a zooecium). In describing the composite skeletons of cheilostomes, avicularium is used commonly in sense exactly equivalent to the rarely used term aviculoecium.

aviculoecium. Skeletal parts of an avicularium.

axis. Solid calcareous support of a colony, as in *Archimedes*, formed of laminated tissue.

B-zooecium. Enlarged aviculoecium with acute mandible comprising one of the dimorphic zooecial types in some cheilostomes, as *Steginoporella* (*see* A-zooecium).

back. Side of zoarium opposite that bearing zooecial apertures (syn., dorsal, reverse, noncelluliferous) (*see* front).

basal mark. Curved line on underside of hyperstomial ovicell.

basal plate. Expanded calcareous structure serving for attachment of a colony.

basal surface. Underside of an incrusting or freely growing colony.

beak. Pointed operculum of an avicularium (syn., mandible).

bifoliate. Consisting of 2 layers of zooecia growing back to back with a double-walled median lamina (mesotheca) between them (syn., bilamellar).

bilamellar. Same as bifoliate.

blastozooid. Individual produced as a bud.

blind zooecium. Chamber of a zooid closed by a deposit of calcite (syn., kenozooecium).

brood chamber. Enlarged ovicell covering several zooecia, as in some cyclostomes.

brown body. Colored organic tissue in zooecium resulting from disintegration of polypide.

bryozooid. Individual animal of a bryozoan colony, including its skeleton (zooecium) and soft parts (polypide) (syn., zooid, polyzooid).

cadre. Raised frontal edge of side walls in some cheilostomes (Anasca) (syn., mural rim).

calcified zooecium. Chamber of zooid thickened by calcite deposits after death of individual, generally with opening reduced to a small central pore (syn., blind zooecium).

cancellus (pl. **cancelli**). Cylindrical interzooecial tube lacking polypide, closed by finely perforate calcareous lamella with many spines on interior; typically developed in some cyclostomes (Lichenoporidae).

capitulum. Large rounded cluster of zooecial apertures in some cyclostomes.

cardelle. Denticle for hingement of the operculum in cheilostomes (syn., condyle).

carina. Median ridge on front side of branches, chiefly in cryptostomes (syn., keel).

cell. Zooecial chamber or tube (syn., zooecium, autozooecium, autopore, etc.); loosely used term without special signification.

cellariiform. Like the cheilostome *Cellaria,* with zoarium composed of slender jointed cylindrical segments bearing apertures on all sides.

celleporiform. Like the cheilostome *Cellepora,* with zoarium formed of zooecia heaped irregularly in multilamellar masses of variable shape.

celluliferous. Side of zoarium bearing zooecial apertures (syn., front, obverse) (*see* noncelluliferous).

cistern cell. Avicularium-like structure observed in some cyclostomes, as *Entalophora.*

clithridiate. Keyhole-shaped, like apertures of some cheilostomes, as Celleporidae.

coenelasma. Basal lamina of zoarium from which zooecia arise (syn., epitheca, epizoarium).

coenenchyme. Generally vesicular calcareous tissue between zooecia in some cyclostomes and cryptostomes (syn., coenosteum); this term is commonly employed in description of corals but not for bryozoans.

coenoecium. Composite skeleton of a bryozoan colony (syn., zooarium).

coenosteum. Vesicular or dense calcareous tissue between zooecia of some cyclostomes and cryptostomes, especially in the mature region (syn., coenenchyme).

common bud. In Cyclostomata, the protoecium grows into a cylindrical tube with mouth closed by an uncalcified terminal membrane which by the growth of an oblique calcareous septum is divided into 2 parts. The smaller part becomes the common bud, and the larger the first zooecium. Further growth repeats the process with development of a new septum and so on until a zoarium is formed with the common bud portion composed of chitinous fibrous substance extending throughout. First recognized only in Cyclostomata, occurrence of the common bud now is reported by some students in Cryptostomata and Trepostomata.

communication pore. Opening in zooecial wall that serves as passageway for soft tissue connecting adjacent polypides in some zoaria (*see* dietella, septule).

compensation sac. Same as compensatrix.

COMPENSATRIX. Membranous sac beneath the frontal wall of many cheilostomes (Ascophora) for regulating hydrostatic pressure within the zooecium and thus providing for movement of the polypide outward and inward; a water passageway for this organ is located at or near the proximal edge of the aperture in a sinus or tubular opening (ascopore) (syn., compensation sac, zooecial hypostege).

condyle. Rounded protuberance or denticle for hingement of the operculum; a pair of these oppositely placed in the orifice is common in cheilostomes (syn., cardelle).

costa. Radially disposed rib or ridge forming part of frontal shield that arches over frontal membrane in cribrimorph cheilostomes; between them are areolar pores (syn., costula, costule).

costula. Same as costule.

costule. Same as costa but somewhat smaller and commonly spiniform (syn., costula).

cribrimorph. Characterized by radiating costae or costules on the frontal wall, as in Cribrilinidae.

cryptocyst. Shelflike calcareous lamina beneath frontal membrane extending inward from the proximal mural rim in some cheilostomes (Anasca); the space between cryptocyst and frontal membrane serves as hydrostatic chamber (hypostege) in these bryozoans.

cyphonautes. Pelagic larval form in some cheilostomes, as *Membranipora, Electra,* etc.

cystid. Zooecium in cyclostomes, or space between polypide and frontal wall.

CYSIIPHRAGM. Convexly curved calcareous lamina extending from zooecial wall part way across tube, commonly arranged in vertical series forming subhemispherical vesicles; they occur chiefly in trepostomes.

dactylethra (pl., **dactylethrae**). Short kenozooecium consisting of club-shaped tubule without polypide, closed at outer extremity by a finely perforate calcareous lamella.

decussating. Intersecting at acute angle in form of the letter X.

descending lamina. Part of ovicell frontal wall turned downward into the peristome.

DIAPHRAGM. Transverse calcareous platform extending across zooecial tube or mesopore; common in most trepostomes, many cyclostomes, and some cryptostomes (syn., tabula, tabulium; *see* cystiphragm, hemiphragm, heterophragm).

dichotomous. Dividing in 2 branches.

dietella (pl. **dietellae**). Small enclosed space near base of distal parts of zooecial wall containing communication pores traversed by mesenchymatous fibers (syn., pore chamber).

dissepiment. Generally noncelluliferous crossbar connecting branches of fenestrate zoaria.

DISTAL. Direction of growth away from the ancestrula (syn., anterior, forward) (*see* proximal).

dorsal. Side of zooecium opposite that having the frontal wall and aperture, or side of zoarium opposite that bearing apertures (syn., back, reverse).

double-valved ooecium. Ovicell consisting of 2 arched vessels.

ECTOCYST. Thin chitinous outermost layer covering zooecium or entire zoarium (syn., frontal membrane, outer membrane, epitheca of some authors).

ectooecium. External wall of ovicell, commonly calcareous.

eleocellarium. Avicularium-like heterozooecium with long paddle-shaped openings, as in some cyclostomes (Eleidae).

embryonary. Chamber containing embryos during their development (syn., embryophore).

embryonic fission. Division of primary embryo in ovicell giving rise to many larvae, as in cyclostomes.

embryophore. Same as embryonary.

endocyst. Thin membrane lining interior of zooecium and enclosing polypide; it gives rise to the ectocyst and mesenchyme with its derivatives.

endooecium. Inner calcareous wall of ovicell (syn., entooecium).

endotoichal. Type of ovicell in some cheilostomes consisting of hollow formed by resorption of thick calcareous frontal wall and provided with independent opening outward (syn., entotoichal).

endozooecial. Type of ovicell in some cheilostomes consisting of endooecium formed by the distal wall of the zooecium and on the opposite side of ectooecium formed by covering membrane, which impinges deeply on the interior of the next distal zooecium (syn., entozooecial).

**entooecium.* Same as endooecium.

**entotoichal.* Same as endotoichal.

**entozooecial.* Same as endozooecial.

epheboecium. Mature zooecium.

epistome. Protective lip overhanging mouth.

epitheca. Basal lamina of zoarium from which zooecia arise (syn., coenelasma, epizoarium); also used by some authors for outer chitinous membrane (syn., ectocyst, frontal membrane, outer membrane).

epizoarium. Same as coenelasma.

eschariform. Like *Eschara,* with free bilamellar zoarium.

exsert. Thrust out, protruded.

facet. Calcareous lamella serving for closure of zooecial aperture in some cyclostomes; may be centrally perforate.

fenestra. Uncalcified area of ectooecium or frontal wall of zooecium in some cheilostomes. Also used for open spaces (meshes) in reticulate zoaria of cheilostomes such as Reteporidae, Petraliidae, etc.

fenestrula. Same as ascopore.

FENESTRULE. Open space in reticulate zoarium enclosed by branches and connecting crossbars or by anastomosing branches; characteristic of some cryptostomes (Fenestellidae) and trepostomes (Phylloporinidae).

firmatopore. Type of kenozooecium consisting of slender proximally directed tubule on dorsal side of zoarium in some cyclostomes.

fissiparity. Reproduction by division, as among cyclostomes in which the primary embryo by fission gives rise to many larvae.

flagellum (pl., **flagella**). Modified operculum (mandible) of a vibraculum, generally provided with a terminal hairlike bristle (seta).

floatoblast. Floating statoblast of a fresh-water bryozoan.

forward. Direction toward growing edge of zooecium or zoarium, away from ancestrula (syn., anterior, distal).

front. Side of unilamellar or reticulate zoarium that bears zooecial apertures (syn., obverse, celluliferous) (*see* back, dorsal, reverse).

FRONTAL. Pertaining to the exposed side of zooecial chambers which bears the aperture, used chiefly for cheilostomes (syn., ventral; in terminology of some authors, front).

frontal area. Space covered by frontal membrane.

frontal membrane. Uncalcified part of body wall in some cheilostomes (Anasca) on side of zooecium bearing the aperture; may be exposed or covered over by a frontal shield.

frontal shield. Calcareous cover of fused spines above the frontal membrane, the space between (hypostege) functioning as a hydrostatic organ; characteristic of cribrimorph types of anascan cheilostomes (syn., pericyst).

frontal wall. Calcareous cover on external side of the compensatrix in some cheilostomes (Ascophora).

funiculus. Double strand of cells connecting alimentary canal with zooecial wall.

gemmation. Reproduction of zooids by division (budding) or junction of previously formed individuals. Several types of gemmation are recognized: (1) axial, zooids produced along zoarial axis; (2) biparietal, tubes of new zooids adjoined to 2 others as seen in longitudinal section; (3) dorsal, zooids produced from dorsal side of zoarium; (4) intrazooecial, zooids introduced from zooecia without order or definite plan; (5) juxtaposed, zooids with tubes parallel, open at their extremities; (6) oriented, zooids uniformly directed from one or both sides of a lamella; (7) peripheral, zooids produced by bifurcation in all directions; (8) triparietal, new zooids adjoin 3 others.

**génése.* Cell containing female reproductive elements only (syn., gonoecium, gonozooecium).

**gerontoecium.* Very old (senile) zooecium.

gonocyst. Compound ovicell appearing as inflated part of zoarial surface.

gonoecium. Same as gonozooecium.

gonozooecium. Zooecium modified to serve as ovicell (syn., gonoecium).

gonozooid. Individual bryozooid modified for reproduction.

GYMNOCYST. Peripheral calcified portion of frontal membrane in some cheilostomes, developed especially in proximal region, not covered by membranous ectocyst; marginal spines, if present, invariably are produced from the inner border of the gymnocyst.

hemescharan. Like *Hemeschara,* with erect unilamellar zoarium having apertures confined to one side.

hemiphragm. Shelflike platform in zooecial tube joined to walls on one side, extending only part way across tube; it may occur in any part of the tube (syn., semidiaphragm).

hemiseptum (pl., **hemisepta**). Like hemiphragm but confined to near-apertural parts of zooecial tube and only 1 or 2 in a single tube; these are designated as superior hemiseptum (on proximal wall of tube) and inferior hemiseptum (on distal wall of tube); characteristic of many cryptostomes.

heteromorphic. Aberrant forms of zooecia.

heterophragm. Similar to hemiphragm but composed of laminated tissue continuous with zooecial walls and forming strongly arched inward projection; not superposed in series like cystiphragms.

HETEROZOOECIUM (pl., **HETEROZOOECIA**). Modified zooecium lacking polypide or with only a vestige of one but provided with muscles for movement of modified operculum (mandible); aviculoecium and vibraculoecium are different types of heterozooecia.

heterozooid. Individual animal which secretes a heterozooecium; avicularium and vibraculum are different types of heterozooids.

hippoporine. Like the cheilostome *Hippoporina,* characterized by horseshoe-shaped operculum.

hyperstomial. Type of external ovicell in cheilostomes, resting on or indenting distal wall of associated zooecium.

HYPOSTEGE. Space between frontal membrane (ectocyst) and overlying frontal shield (pericyst) in some cheilostomes (Anasca), functioning as hydrostatic organ.

idmoneiform. Signifying erect arborescent zoarial form; descriptive term commonly applied to cyclostomes (actually not like *Idmonea,* which is adnate).

IMMATURE REGION. Basal or internal part of zoarium characterized by thinness of zooecial walls and relative sparseness or absence of transverse structures (diaphragms, cystiphragms, hemiphragms) in them, as well as by absence of kenozooecial structures (mesopores, acanthopores); typically developed in trepostomes, cryptostomes, and some cyclostomes.

immersed avicularium. Small kenozooid on frontal wall of zooecium in some cheilostomes.

incrusting. Attached along one side to a foreign body.

inferior hemiseptum. Shelf projecting part way into zooecial tube from distal side not far from aperture; typical of some cryptostomes.

inosculating. Same as anastomosing.

internode. Segment of jointed zoarium between surfaces of articulation.

interspace. Part of zoarium between adjacent zooecia or their apertures.

interstitial cell. Kenozooecium (syn., accessory cell).

intertentacular organ. Flask-shaped tubular structure between 2 tentacles providing passageway for extrusion of ova.

introvert. Drawn in or turned in, as tentacles and thin distal cuticle of polypide when retracted into zooecial interior.

keel. Median ridge on front side of branches, chiefly in cryptostomes (syn., carina).

KENOZOOECIUM (pl., **KENOZOOECIA**). Modified zooecium without polypide or operculum and generally no aperture or muscles; types of kenozooecia common in some cyclostomes include firmatopores, nematopores, tergopores, dactylethrae, and cancelli (syn., accessory cell, interstitial cell).

kenozooid. Individual animal which secretes a kenozooecium.

labellum. Free tongue of descending lamina of ovicell (syn., labrum).

labial pore. Median or submedian small opening in proximal wall of peristome in some cheilostomes (Reteporidae), formed by coalescence of labial sinus denticles.

labial sinus. Median or submedian slit in proximal wall of peristome in some cheilostomes (Reteporidae).

labium. Descending liplike fold of upper margin of ovicell aperture.

labrum. Same as labellum.

lacuna. Gap or pore commonly consisting of simple slit between adjacent costae or costules in some cheilostomes (cribrimorph Anasca); distinct from areoles, which are pores serving for transfer of food.

lageniform. Like *Lagena* (foraminifer), bottle- or flask-shaped.

lanceolate. Spear-shaped, tapering to point at apex and commonly also at base.

lateral punctation. Same as areole and areolar pore.

lateral sinus. Indentation on side of median carina of ovicell in some cheilostomes, as *Iodictyum.*

lateral slit. Linear indentation on side of labellum or in base of lateral sinus.

lepralioid. Like *Lepralia,* incrusting; referring to cheilostomes.

locella. Small free space into which ovicell may open.

LONGITUDINAL. Parallel to zooecial tube, as longitudinal thin section (syn., vertical).

LOPHOPHORE. Circular or horseshoe-shaped ridge around mouth of polypide bearing ciliated tentacles (syn., tentacular crown).

lucida. Clear area in chitinous membrane such as operculum or mandible.

lumen. Clear line or pore on midline of costule, as in cribrimorph Anasca.

LUNARIUM (pl., **LUNARIA**). Hoodlike overarching projection of peristome on proximal side of zooecial tube, somewhat thickened and more strongly curved than other parts of tube, and in some perforated by 1 to 6 minute longitudinal tubules with diaphragms; common in cyclostomes and some cryptostomes.

lunulitiform. Like *Lunulites,* with free turbinate conical zoarium.

lyrula. Same as lyrule.

lyrule. Median, commonly anvil-shaped tooth on proximal edge of orifice, located below the mucro; common in some cheilostomes (syn., lyrula).

MACULA (pl., **MACULAE**). Cluster of kenozooecia (commonly mesopores) or smaller-than-average zooecia, surficially marked by flat or slightly depressed areas and generally bordered by zooecia somewhat larger than average in size; regularly spaced with others on zoarial surface (*see* monticule). This term was formerly used also for irregular cavities in walls of post-Paleozoic cyclostomes.

MANDIBLE. Small triangular or rounded articulated part of an avicularium, mostly chitinous but calcified in some; an incessantly moving structure homologous with zooecial operculum (syn., beak).

marginal denticle. One of the minute teeth projecting into the peristomie of some cheilostomes (Reteporidae).

marginal spine. Sharp-pointed projection, other than oral spine, in a series surrounding the aperture; characterizes some cheilostomes.

marginal tooth. Prolongation of orifice edge, one of several, in some cheilostomes (Reteporidae).

marginate. Bordered, as in the secondary fold around base of ovicell.

marsupium (pl., *marsupia*). Receptacle joined to zooecium for containment of ova during development to embryos.

MATURE REGION. External part of zoarium characterized by thick zooecial walls, relative abundance of diaphragms, and common occurrence of kenozooecial structures (mesopores, acanthopores), vesicular coenosteum between zooecia, or dense interzooecial stereome; characteristic of trepostomes, cryptostomes, and some cyclostomes.

median lamina. Same as mesotheca.

median process. Flanged structure formed by prolongation of parts of zooecial tube in some cheilostomes.

median tubule. Small pore in mesotheca of some bifoliate zoaria.

megacanthopore. Conspicuously large acanthopore, commonly located at distal border of zooecium in some cryptostomes (*see* acanthopore, micracanthopore).

membranaceous. Same as membranous.

membranimorph. Like simple incrusting cheilostomes such as the anascan Membraniporidae (syn., membranipore, membraniporiform).

membranipore. Same as membranimorph.

membraniporiform. Same as membranimorph.

membranous. Covered with membrane, not preservable (syn., membranaceous).

mesenchymatous. Referring to endocyst-derived tissue such as that traversing tremopores.

mesenchyme. Tissue derived from endocyst.

MESOPORE. Kenozooecium of generally polygonal tubular form, smaller than zooecia adjoining it and containing more numerous diaphragms (syn., accessory cell, interstitial cell).

MESOTHECA. Double laminae of bifoliate zoarium produced by back-to-back growth of 2 unilamellar series of zooecia.

micracanthopore. Small (normal) acanthopore associated with much enlarged ones (megacanthopores); common in cryptostomes and some trepostomes (*see* acanthopore).

micropore. Same as ascopore.

monila. Beadlike expansion in wall of some trepostomes (Stenoporidae).

moniliform. Beaded, alternately expanded and constricted so as to resemble string of beads.

MONTICULE. Clusters of kenozooecia and associated enlarged zooecia regularly spaced as in maculae but projecting as prominences on zoarial surface (syn., tubercle); common in some trepostomes.

monticuliporoid. Like *Monticulipora,* a typical massive stony trepostome.

mucro. Rounded or spinelike projection at proximal edge of peristome in some cheilostomes (Ascophora), located on proximal side of lyrule (syn., mucron).

**mucron.* Same as mucro.

multilamellar. Type of growth in which successive zooecial layers grow over and cover older ones (syn., multilaminar).

multilaminar. Same as multilamellar.

multiporous. Type of communication openings in zooecial walls for passage of mesenchymatous fibers (*see* rosette plate, septule).

munitiform. Signifying large rounded avicularium with wide aperture, typically developed on distal side of fenestrule in some reticulate cheilostomes (Reteporidae).

mural rim. Raised edge of zooecial side walls on frontal side in some anascan cheilostomes, commonly spine-bearing (syn., cadre).

**nanoid.* Same as nanozooid.

nanozooid. Dwarfed zooecium containing reduced polypide with only a single tentacle, occurring in some cyclostomes; ?type of kenozooecium (syn., nanoid).

**neanoecium.* Partly developed (adolescent) zooecium).

nematopore. Very slender tubular kenozooecium opening on dorsal side of zoarium with axis of

tube directed obliquely upward (distally) (syn., accessory cell, interstitial cell).

nervus. Longitudinal threadlike structure on front or back side of zoarium in some cyclostomes (Horneridae).

node. Place of articulation in jointed zoarium, as in some cryptostomes, cyclostomes, and cheilostomes; or junction of stolons in ctenostomes.

noncelluliferous. Side of unilamellar or reticulate zoarium lacking zooecial apertures (syn., back, reverse) (*see* nonporiferous).

nonporiferous. Without pores, covered by epitheca; also in unilamellar and most reticulate zoaria, refers to back (reverse) side which lacks apertures (syn., noncelluliferous).

obverse. Side of unilamellar or reticulate zoarium bearing zooecial apertures (syn., front, celluliferous) (*see* reverse).

occlusor lamina. One of pair of calcareous plates which with side wall of zooecium forms cavity for attachment of muscle that closes operculum, in some cheilostomes.

oeciopore. Aperture of ovicell, serving for escape of larvae.

oeciostome. Peristome surrounding oeciopore in cyclostomes.

**oecium.* Same as zooecium.

ogival. Gothic-arched form of distal-lateral walls of zooecium in some cheilostomes.

OLOCYST. Innermost smooth layer of 3 thin calcified layers forming frontal wall of zooecia and ovicells in some cheilostomes (Ascophora) (*see* pleurocyst, tremocyst).

onychocellarium. Modified generally asymmetrical avicularium in which mandible has lateral membranous winglike expansions; occurs in some cheilostomes (Onychocellidae).

ooecium. Same as ovicell.

OPERCULUM (pl., **OPERCULA**). Small chitinous or calcareous lamina articulating on condyles (cardelles) projecting from edge of orifice; in closed position its distal part (anter) covers the zooecial orifice and its proximal part (poster) closes the opening (vanna) to the compensatrix; typically developed in cheilostomes.

opesiula. Same as opesiule.

opesiular indentation. Same as opesiule.

opesiule. One of the small grooves in cryptocyst for passage of depressor muscles attached to ectocyst (frontal membrane) in some anascan cheilostomes.

OPESIUM (pl., **OPESIA**). Large opening generally equal to entire frontal area of zooecium, bordered by cryptocyst and covered by frontal membrane; characterizes many anascan cheilostomes.

oral avicularium. One definitely associated with the zooecial aperture in some cheilostomes, located on its proximal edge (suboral) or at the side (lateral-oral).

oral shelf. Flattened rim at lateral and distal borders of orifice on which the operculum or mandible rests.

oral spine. Calcareous projection at distal margin or sides of orifice, generally jointed at base.

ORIFICE. Primary opening of the zooecium for extrusion of polypide, in cheilostomes covered by operculum.

orthoecium. Normal zooecium (syn., autozooecium, autopore).

outer membrane. Same as ectocyst.

OVICELL. General term for any structure serving to contain bryozoan larvae during their development (syn., ooecium) (*see* gonocyst, gonoecium, gonozooecium, hyperstomial, endotoichal, endozooecial, vestibular).

parietal pore. Perforation in distal wall of zooecium of some cheilostomes serving as passageway for mesenchymatous fibers connecting polypides (syn., communication pore) (*see* dietella).

pedicellate. Elevated on stalk or pedicel, generally referring to avicularia (syn., pedunculate).

pedunculate. Same as pedicellate.

pelma (pl., **pelmata**). Opening in costa or costula of some cheilostomes (cribrimorph Anasca); primary pelma located nearest to edge of frontal shield and secondary pelma next to primary on inward side.

pelmatidium (pl., **pelmatidia**). Small opening in costa or costula of some cheilostomes (cribrimorph Anasca).

pericyst. Calcified frontal wall above ectocyst in some cheilostomes (Anasca), generally formed of fused marginal spines (syn., frontal shield).

perigastric cavity. Space between polypide and inner wall (endocyst) of zooecium.

peripore. Salient collar surrounding large pores in pericyst.

PERISTOME. Rim surrounding orifice in cheilostomes, many cyclostomes, and some trepostomes, or surrounding aperture in many cryptostomes (*see* peristomie, peristomice).

peristomial ooecium. Single-layered ovicell comprising expansion of peristomie in some cheilostomes (syn., vestibular ovicell).

peristomiale. Upper swollen part of zooecial tube in some ascophoran cheilostomes (Tubucellariidae), corresponding to peristomie.

peristomice. Opening at outer extremity of the peristomie in some cheilostomes (syn., aperture, secondary orifice).

PERISTOMIE. Tubelike extension of the peristome outward from the operculum-bearing orifice in some cheilostomes; homologous, if not synonymous, with the vestibule of cryptostomes.

pinnate. Feather-like, with lateral (generally oblique) branches on each side of a midrib.

petraliiform. Like *Petralia,* consisting of unilamellar zooecial colony attached by rootlets.

pleurocyst. Calcareous frontal layer covering olocyst in some cheilostomes, generally granulated and forming costules between areoles.

polyembryony. Production of many larvae from a single ovum or embryo.

polymorphic. Having several distinct forms of cells, tubes, or chambers consisting of zooecia, kenozooecia, heterozooecia, and ovicells.

POLYPIDE. Collective term for soft parts of zooid, freely movable within zooecium.

polypidian convexity. Incomplete tube protecting tentacular sheath of polypide in some cheilostomes (Onychocellidae).

polypidian tube. Distal prolongation of median opening in descending lamina of cryptocyst in some cheilostomes (Steginoporellidae) for passage of tentacles.

polyzoarium. Same as zoarium (syn., polyzoary).

polyzoary. Same as polyzoarium.

polyzooid. Individual animal of bryozoan colony, comprising polypide and zooecium (syn., zooid, bryozooid).

pore chamber. Small enclosed space near base of distal parts of zooecial walls containing communication pores traversed by mesenchymatous fibers (syn., dietella).

poriferous. Bearing apertures; in unilamellar and most reticulate zoaria refers to front (obverse) side (syn., celluliferous) (*see* nonporiferous).

porta. Part of orifice in cheilostomes on distal side of cardelles, serving as passageway for polypide during its extrusion and retraction; it is closed by part of the operculum termed anter.

poster. Part of operculum in cheilostomes on proximal side of cardelles, serving for closure of the vanna (part of orifice opening into compensatrix).

posterior. Direction or side toward beginning of growth in the ancestrula (syn., proximal); also used by some authors to denote the side of a zoarium lacking apertures (syn., proximal) (*see* anterior).

post-oral shelf. Thickened proximal and lateral margins of cryptocyst in some cheilostomes (Steginoporellidae).

primary aperture. Original opening of zooecium closed by operculum (syn., orifice).

primary peristome. Fold of olocyst around orifice in some cheilostomes.

primary zooid. Same as ancestrula.

primoserial. Zooecium at proximal end of a new series.

proancestrula. Primary zooid of colony at initial stage of attachment.

protoecium. Minute chitino-calcareous discoid embryonic shell at base of ancestrula in cyclostomes (*see* proancestrula).

PROXIMAL. Direction toward origin of growth (syn., posterior) (*see* distal).

pseudopore. Perforation in zooecial walls of some cyclostomes.

pseudorimule. Peristomial canal in some cheilostomes, regulating flow of water from peristomie into compensatrix (*see* rimule).

pseudoseptum. Longitudinal ridge on proximal side of interior of lunarium-bearing zooecial tube, formed by inward projection of either lateral extremity of the lunarium.

pseudospiramen. Asymmetrically placed notch at edge of poster in some cheilostomes (Celleporidae).

pseudostolon. Short slender extension of zooecial tube in some fresh-water bryozoans.

quincuncial. Characterized by arrangement consisting of 4 objects symmetrically placed around a fifth.

rachis. Axial structure of some sort.

radicle. Rootlike structure formed by kenozooecia serving for zoarial attachment.

radicular fiber. Equivalent to minute radicle.

recumbent. Type of ovicell in some cheilostomes (Phylactelliporidae) which reclines against the distal zooecial wall.

repent. Same as reptant.

reptant. Creeping, prostrate.

reteporidan pore. Opening (spiramen) into compensatrix in Reteporidae.

reteporiform. Referring to reticulate zoaria as in the cheilostome Reteporidae.

reticulocellarium. An onychocellarium or avicularium with perforations beneath the opesium.

reverse. Back of unilamellar or reticulate zoarium, lacking zooecial apertures (syn., back, dorsal, noncelluliferous, nonporiferous).

rhamna. Linear median crest on gymnocyst in some cheilostomes.

rimule. Fissure or small cleft at proximal edge of orifice in some cheilostomes, serving as opening to the compensatrix (syn., rimule spiramen, sinus) (*see* vanna).

rimule spiramen. Same as rimule.

rosette plate. Subcircular porous area in distal part of zooecial wall for passage of mesenchymatous fibers between adjacent zooids (*see* multiporous, septule).

rostrate. Beaked, mounted on a beak, as an avicularium.

rostrum. Suboral protuberance on frontal wall of some cheilostomes (Celleporidae); also distal part of avicularium occupied by a mandible.

schizoporellid. Characterized by a median sinus at proximal margin of the orifice, as in Schizoporellidae.

sclerenchyme. Generally dense calcareous tissue (syn., stereom).

sclerite. Thickened line of chitin or calcite on operculum or mandible.

scutum. Commonly large flabellate spine overhanging aperture.

secondary aperture. Opening at outer extremity of peristomie in some cheilostomes or vestibule in cryptostomes (syn., secondary orifice, aperture).

secondary orifice. Same as secondary aperture (syn., aperture).

semidiaphragm. Transverse calcareous platform ex-

tending part way across zooecial tube (syn., hemiphragm) (*see* hemiphragm, hemiseptum, heterophragm).

septal ridge. Linear elevation outlining young zooecium in Reteporidae.

SEPTULE. Single (uniporous) or grouped (multiporous) perforations in distal part of zooecial wall for passage of mesenchymatous fibers connecting adjacent zooids (syn., septulum) (*see* rosette plate).

septulum. Same as septule.

septum. Membranous cross wall between zooids in stolon or elsewhere.

sessoblast. Sessile reproductive body formed by fresh-water bryozoans.

seta (pl., **setae**). Chitinous terminal bristle on flagellum of a vibraculum; also, one of the hairlike processes surrounding delicate structures of some zooids.

shield. Broad elevated area surrounding some zooecial apertures.

sinus. Slit at proximal edge of orifice in some ascophoran cheilostomes (syn., rimule).

spicule. Small spine without internal canal.

spine. Small hollow elongate projection, distally closed or open (*see* marginal spine, oral spine).

**spiniform tubule.* Same as acanthopore.

spiracle. Same as spiramen.

SPIRAMEN. Median pore in frontal wall on proximal side of orifice in some ascophoran cheilostomes, serving as passage to the compensatrix (syn., spiracle).

statoblast. Hard-shelled reproductive body formed by fresh-water bryozoans.

STEREOM. Generally dense calcareous tissue (syn., sclerenchyme).

stigma. Linear or trifoliate fissure in frontal wall of ovicell in some cheilostomes (Reteporidae).

STOLON. Slender creeping tube consisting of kenozooecia, from which zooids with zooecia may develop; characterize ctenostomes.

sulcus (pl., **sulci**). Longitudinal groove between nervi on front or back of some cyclostomes *(Hornera),* with elongate pores (vacuoles) at base.

tabula. Same as diaphragm (syn., tabulium).

tabulate. Bearing tabulae (diaphragms).

tabulium. Rarely used equivalent of tabula.

TANGENTIAL. Referring to sections cut parallel to surface of zoarium.

TENTACLE. Ciliate flexible appendage of lophophore used in gathering food.

tentacle sheath. Delicate introverted membrane enclosing tentacles when polypide is retracted.

tentacular crown. Same as lophophore.

tergopore. Type of accessory tube (kenozooecium) on dorsal side of zoarium, as wide as polypide tubes but with polygonal aperture; characterize some cyclostomes.

termen. Marginal rim of frontal wall surrounding opesium in some cheilostomes (Membraniporidae).

thyrostome. Opening of zooecium through which tentacles and mouth of polypide may be extended (syn., orifice).

tower zooecium. Abnormal erect short tube (kenozooecium) rising from opesium in some cheilostomes (Membraniporidae).

trabecula. Branch separating fenestrules in reticulate cheilostomes (Reteporidae).

TRANSVERSE. Generally refers to sections of zoaria cut at right angles to the direction of colony growth.

TREMOCYST. Perforate calcareous layer of frontal wall overlying pleurocyst or olocyst in some ascophoran cheilostomes.

tremogastre. Zooecium with tremopores.

tremopore. Large perforation in tremocyst; may be continuous with tubule in olocyst.

trochosphere. Form of larva with bilaterally symmetrical ovoid body and round mouth, characteristic of Entoprocta.

trypa. Central pore in frontal wall of some cheilostomes (Microporellidae) corresponding to sinus (syn., ascopore).

tubula. Slender tremopore tube arising from small pore, piercing subjacent olocyst.

umbo. Prominence on frontal wall on proximal side of aperture in some cheilostomes.

unguiculate. Claw-shaped, talon-like.

uniporous. Type of septule having relatively large communication pore (*see* multiporous, rosette plate).

vacuole. Slender tube (kenozooecium) approximately normal to front or back zoarial surface, separated from neighboring similar tubes by stereom; characteristic of some cyclostomes (Horneridae) where commonly they occur at base of sulci.

vanna. Part of zooecial orifice on proximal side of cardelles, functioning as opening to compensatrix; it is closed by part of the operculum termed poster.

vertical section. Same as longitudinal section.

vesicular tissue. Superposed irregular arched small lamellae forming cystose filling of interzooecial spaces, commonly filled partly or entirely near zoarial surface by stereom; characterizes many cryptostomes and some cyclostomes (syn., coenosteum).

vestibular arch. Calcareous lamella on superior part of tentacular sheath.

vestibular ovicell. Same as peristomial ooecium.

VESTIBULE. Circular or oval shaft extending inward from zooecial aperture of cryptostomes, limited at base by hemisepta or by passage from mature to immature part of zooecial tube, this inner limit being interpreted as equivalent to the orifice of cheilostomes.

vibex (pl., **vibices**). Salient line on front and back of trabeculae in reticulate cheilostomes (Reteporidae).

vibracularium. Small kenozooecium without poly-

pide but provided with muscles for movement of vibraculum.

vibraculoecium. Skeletal structure of vibraculum.

VIBRACULUM (pl., **VIBRACULA**). Highly modified chitinous or calcareous avicularian heterozooid with mandible replaced by bristle-like seta movable in various directions for purposes of stabilization.

vicarious. Referring to avicularia that occupy places of zooecia and thus occur between zooecia.

vincularian. Referring to unjointed rodlike zoaria with zooecial apertures on all sides.

ZOARIUM (pl., **ZOARIA**). Assemblage of many zooids comprising an entire bryozoan colony, formed by repeated gemmation from a single initial zooid (ancestrula); form generally fairly constant for each species (syn., asty, polyzoarium, polyzoary, coenoecium). The term zoarium is used also for the collective skeletal parts of a colony.

zooecial hypostege. Same as compensatrix.

zooeciule. Immature zooecium or kenozooecium occurring sporadically among normal zooecia, generally in cyclostomes.

ZOOECIUM (pl., **ZOOECIA**). Chitinous double-walled sac, chamber, or tube containing the soft parts (polypide) of the bryozooid (syn., autopore, autozooecium, oecium, cell).

ZOOID. Single bryozoan animal, consisting of soft parts (polypide) and skeleton (zooecium) (syn., autozooid).

zoophyte. Early name for bryozoan, considered half plant, half animal.

TECHNIQUES

The relationship between the polypide and its protecting zooecial cover is such that the study of Recent Bryozoa embraces 2 distinct processes. The first, dealing with the anatomy of the fleshy polypide, is interpreted by well-known histological methods, while the second usually involves determination by thin sections or otherwise of the calcareous or chitinous zooecial structures. Although much important work on bryozoan anatomy has been accomplished, this is still a favorable field for research. The second process must be discussed more at length because the identifications of many fossil forms are based so largely on the nature of minute wall structure. Thin sections are a prime necessity, particularly for study of the Paleozoic stony Bryozoa—Trepostomata, Cryptostomata, and the Ceramoporoidea division of the Cyclostomata. In the more delicate Cyclostomata and even in the Cheilostomata, where zooecial surface characters are important, such sections are needed frequently.

PREPARATION FOR STUDY

Bryozoa are uncommon in most sandstone strata, but beginning with the Lower Ordovician there is scarcely a limestone formation, especially if it has shale alternations, in which they are not more or less abundant. Generally the specimens are calcareous, but some are silicified, with the internal structure obliterated, which prevents successful sectioning. In certain strata their substance has been dissolved away, leaving a perfect mold in the matrix from which gutta-percha or rubber impressions will usually give a satisfactory idea of the surface characters.

The best specimens usually occur in the shales between or just above or below limestone layers. The smaller forms may be obtained free by carefully washing the shales and separating the specimens from the debris. Some kinds of shales or clay will wash away better if first allowed to become thoroughly dry or even baked. Others do better after thorough soaking or boiling in water.

The surface characters may be obscured by an indurated clayey matrix which can be removed by the use of caustic potash (KOH) in stick form. The deliquescence of small pieces of this substance, which needs to be handled gingerly with unprotected hands, laid upon the fossil softens and loosens the clay, which is then readily washed off. Some workers accomplish the same result by placing specimens in a saturated solution of Glauber's salts, which, in crystallizing, likewise softens the clay. To prevent further action of the small amount of caustic potash still remaining, the specimen must be carefully neutralized by washing and soaking in water containing very dilute hydrochloric acid.

Today the increased use of a 3-percent hydrochloric acid solution in etching solid fossiliferous limestones has resulted in the recovery of many specimens otherwise buried in solid rock. This process was carried on over half a century ago on a large scale particularly in releasing the many

beautiful corals as well as most fragile Bryozoa from the massive Middle Devonian limestones at the Falls of the Ohio. Now it has again become a quite common practice, and many specimens of delicately formed fossils have been revealed. The process requires that the chunk of rock be painted with a plastic such as ambroid to hold the fossils together as solution progresses, leaving an uncoated space for the escape of bubbles. To spray sandstone the use of the Duco-spraying machine and acetone as a solvent if necessary, is recommended. All fossiliferous limestones will not yield silicified specimens by etching, but some release their treasures even in nature in a few years under ordinary surface weathering, especially if a light cover of ordinary clay soil be spread over the rock outcrops occasionally. The Mississippian limestones of Tennessee and nearby states with their classic crinoid localities are noteworthy examples. Horny fossils, including phosphatic and chitinous varieties, will yield to etching when a 10-percent acetic acid solution is employed as the solvent.

Bryozoa in the Recent seas are collected in quantity by dredging, particularly in areas with a shelly bottom, although a thorough search of seaweeds and shells cast upon the beach or of piling and other structures exposed at low tide often will reveal them in considerable numbers. A prolific source of Bryozoa for the student is the common oyster and clam of eastern markets. Most of the specimens secured in these ways are dead, that is, they contain no living polypides, but their study follows the methods indicated for fossil forms. Specimens retaining the polypide may be preserved in alcohol or formaldehyde for some time before the animal matter is destroyed. After decalcifying and embedding in paraffin, thin sections of such specimens may be cut with the microtome, as usual for tissues. If removal of the animal matter is desired in order to study the zooecia unobscured, boiling in Javelle water, as described under "Work on Post-Paleozoic Bryozoans," is necessary.

Thin Sections

The preparation of satisfactory thin sections is not difficult, but care and experience are required to produce uniformly good results. Lacking a diamond saw or other machine for cutting rock sections, one may obtain excellent results by the following old-fashioned method. The materials required are a piece of fine-grained solid sandstone, 8 or 10 inches wide, several inches thick, and 18 or 20 inches long; a water hone an inch thick and 4 or 5 inches long; and a block of wood about 2 inches wide, 4 or 5 inches long, and an inch thick to hold the glass slide. In place of the sandstone, a carborundum slab about an inch thick, 8 inches wide, and 18 inches long, obtainable from the Carborundum Company at Niagara Falls, is very durable and more efficient. Such slabs come in coarse, medium, and fine grades, so that it is advantageous to have a set of all 3 at hand. The wooden block should have its upper edges rounded to fit the hand, and the lower side should be excavated in a manner suited to hold an ordinary glass slip. A carborundum hone of considerable fineness is quite useful, but the best results in final thinning come from a hone of carefully selected lithographic limestone.

The following procedure for sectioning specimens large enough to be handled without difficulty was followed by most students in early days. With a pair of wire nippers, a fragment illustrating the desired structure is cut from the specimen and rubbed upon the sandstone until the surface is perfectly flat. This surface is then smoothed upon the hone and the preparation cemented upon a glass slip with Canada balsam. Proper heating of the glass slip to harden the balsam is an important part of the process, for if allowed to boil too long on a hot plate or over a lamp it will be brittle when cold and the fragment tends to spring off the slide; if heating is too short, the section when thinned will granulate. After heating and subsequent cooling, the balsam should be tested for hardness, the correct degree being intermediate between brittleness and the point where the fingernail can make an impression upon it. If too soft, the slip must be sufficiently reheated; but if too hard it is better to remove the fragment, clean it by smoothing it off again on the hone, and then remount. When proper hardness of the

balsam is obtained, the glass slip is placed in the excavation of the wooden block dipped into water to secure adhesion. Then, after rubbing away all superfluous material on the sandstone or carborundum slab until the section is quite thin, one removes the slide from the block and completes further thinning upon the hone by hand.

In this process, the glass slip becomes scratched and unsightly; for a permanent mount, the entire slip may be rubbed to give a ground-glass appearance, or the thin section may be transferred to a clean slip and covered in the usual way for permanent preservation. The transfer is accomplished by first cleaning off all old balsam with alcohol, then adding a drop of fresh balsam, heating, and when the thin section has become loosened, sliding it onto a clean glass slip with a sharp-pointed instrument. Bubbles may be eliminated by pressure upon the cover glass while the balsam is liquid. Unlike petrologists, most bryozoologists use 1x3-inch slides because they provide greater label space. Canada balsam sticks of the required hardness are useful timesavers. They are prepared by filling with properly hardened balsam tinfoil cylinders made with the help of a lead pencil.

Today most students employ 3 pieces of plate glass about 1x3 feet in dimension, 1 for each of the 3 grades of carborundum employed; No. 320 is generally used for the coarsest, No. 600 for medium, and No. 1000 for final finishing. Fingers placed on top of the slide give sufficient pressure to direct the thinning. Specimens too small to be cut with the wire nippers may be prepared for sectioning held by the fingers, or they may be mounted on a slide in balsam only partially hardened by heating. Remelting the balsam and turning over the specimens with a sharp-pointed instrument, one may complete the sections in the manner described above. In place of Canada balsam, a thermoplastic compound such as Lakeside cement, prepared by the Lakeside Chemical Company of Chicago, is one of several equally good preparations for the purpose.

The above methods apply particularly to solid, ramose, or massive Bryozoa, furnishing the best method to show certain peculiar structural features, particularly those of the inner immature zone and the outer peripheral mature area, where the zooecia develop accessory features, such as acanthopores, mesopores, and diaphragms. Two sections are needed always, a longitudinal one parallel to direction of growth, and a tangential one parallel to the surface and close enough to it to show the mature structure. Two tangential sections generally are required for bifoliate zoaria, one near the surface and the other just above the median lamina. A third section, called transverse, cut at right angles to the longitudinal, is very useful in studying stemlike forms, especially in order to show median pores in the mesotheca. Serial sections have been prepared separately to show structural changes as growth proceeds, but this arduous task is unnecessary, since a single slightly oblique tangential section can be prepared to intersect higher and lower levels of the zooecial tubes, instead of crossing them in the same zone. Thus, extreme youthful to old-age conditions may appear in the same slide. A longer life is insured for the completed section if the cover glass is ringed with asphaltum or some similar cement. Slides in the U.S. National Museum collection so treated more than 75 years ago are still as good as new.

Use of X-rays

The Bryozoa lend themselves to study under the application of X-rays as shown by J. J. Trillat & Roger (1947) and Roger & Buge (1947). Extensions of their work, eliminating the need of so much thin sectioning, will undoubtedly result in much saved time.

WORK ON POST-PALEOZOIC BRYOZOANS

Specimens of Bryozoa of Mesozoic and Cenozoic (particularly Recent) age are generally so fragile that preparation of thin sections may require hardening of zoarial fragments by preliminary boiling in Canada balsam. Thin sections of the walls, particularly the outward-facing frontal, are needed to reveal the nature of the 3 layers (olocyst, tremocyst, pleurocyst) and similar features. Then, so-called opaque sections

may be needed to reveal characters of the zoarial and zooecial interior. The frontal must be abraded away to show the occurrence of various internal structures (dietellae, septules, and others). This abrasion is effected by mounting the fossil, frontal side up, on a slide in hardened balsam and rubbing the surface gently on a hone until the internal structures become visible. Similar opaque sections designed to reveal structures on the inner side of the frontal may be made by mounting the fragment with outer face down and rubbing away the exposed side until outlines of the primitive aperture, ovicell, and other features are revealed clearly. Opaque sections passing lengthwise through the zoarium may be necessary to determine the nature of the ovicell. Such preparations require much care, because the fragments must be mounted on edge and abrasion must follow definite rows of zooecia. A specimen can be trimmed with small wire nippers to exactly the right form, whereupon by mounting in hardened balsam between 2 small bits of wood (fragments of a match serve excellently) to hold it on edge, one can make the necessary abrasion. Lastly, actual dissection of both fossil and Recent specimens with a fine needle under the microscope often is necessary.

Careful washing of the specimens with a camel's-hair brush and (after thoroughly drying) tinting them pink with a light solution of red ink or some stain will bring out characters more clearly than can be observed on the original material. This not only aids in ready separation of species but is a help in preparing illustrations, for the tint forms a background well adapted to photography, even if the specimen subsequently is coated with a light blue film of ammonium chloride. Brushing or soaking with water will remove the tint readily when desired. The modern bryozoans lend themselves to this method, for their glassy surfaces make it difficult to observe characters which appear plainly on the tinted surface. Delicate Paleozoic forms, too, especially fragile silicified specimens of white or yellow color, can be studied better after staining.

Use of Javelle water.—The chitinous covering membrane and other obscuring surface tissues of Recent species may be removed by boiling in Javelle water, whereupon the specimen assumes the aspect of fossils from which, naturally, all the chitinous and fleshy parts have disappeared. Javelle water, usually obtainable from any druggist, can be prepared readily by dissolving one pound of washing soda in a quart of cold water and adding to this ¼ pound of bleaching soda (calcium hypochlorite). After filtering, the solution should be kept in a tightly closed bottle. Preparation of bryozoans by boiling in this solution is a slow process which has the advantage that specimens are not destroyed.

Calcination.—Mary D. Rogick (1945) has published instructions for students of Recent Bryozoa on calcining calcareous specimens by burning away the organic material which obscures the surface. Chitinous structure also is destroyed by calcination with a simple blowpipe, Bunsen burner, or alcohol lamp; a spoon to hold small specimens in place is the only additional equipment necessary for this process. Calcining must stop while the structural zooecial pattern is still evident without showing any crumbling. Then, in form closely similar to fossils, the specimens can be moved with a suitable instrument or brush and mounted on a slide in balsam or glue. For comparison, an uncalcined fragment of the same species or specimen should be mounted next to the preparation.

Mounting chitinous appendages. — The preparation of opercula, mandibles of avicularia, and other chitinous appendages of modern Cheilostomata, so important in taxonomic study of this group under the microscope, is not only in order but is recommended as a pleasant diversion. Methods for the separation of these appendages from the zoarial surface and mounting them properly have been described by various authors, but most of them are complicated and time-consuming. Today, such preparations are made simply by scraping the surface of a few zooecia from the zoarium with a scalpel and gently crushing the material thus obtained in a drop of water on a slide. The appendages, being flexible, seldom are damaged in the process; so after

spreading the material in the water and allowing it to dry, one adds Canada balsam and a cover glass as usual to complete the mount.

PHOTOGRAPHS AND DRAWINGS

The illustration of bryozoans has importance both as a technique in study and for use in publications. Because of the microscopic dimensions of zooecia, their structural features and arrangement in a zoarium cannot be compared readily with corresponding characters of numerous specimens by the unaided eye, nor can specimens generally be examined simultaneously with a microscope. Enlargements made by photography or by drawings are almost indispensable; these furnish materials for study, and selected illustrations may be used in publication. Commonly, 2 types of illustrations are needed: some showing surface characters of the zoarium, and others recording features revealed by thin sections. Both may be prepared with a suitable setup for low-power photomicrography or manually with aid of a camera lucida or use of a micrometer eyepiece. Thin sections may be projected directly on bromide paper by placing the section in a photographic enlarger such as is widely used in making prints from 35-mm. negatives. The slide takes the place of the negative, and very useful record at selected standard magnification (controlled by setting of the enlarger) can be obtained easily and rapidly.

With various highly developed, expensive cameras for photography of microscopic objects, illustrations are not difficult to prepare. If need be, a simple boxlike camera with a bellows length of less than a foot attached to an upright stand, allowing movement of both camera and bellows, may be used, like the one which has served the writer for the past half century in preparing negatives with magnifications up to 100 diameters; use of suitable microscopic objectives and close stopping down of the diaphragm are aids.

Whitening.—The zoaria of many Recent Bryozoa are semitransparent or so glasslike that only with difficulty can their various zooecial features be studied and photographed. Fortunately, their structures may be brought out in great perfection and clearness by gently whitening the surface with the fumes of ammonium chloride through sublimation. A simple apparatus for this purpose is illustrated in figure 2. By

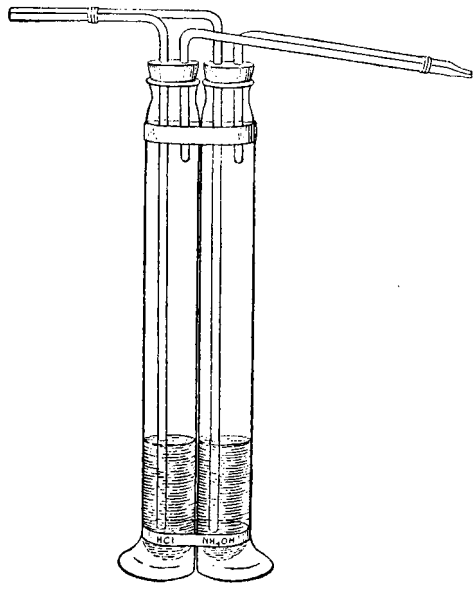


FIG. 2. Apparatus for whitening fossils with ammonium chloride sublimate (131).

blowing through the mouthpiece, one may bring the fumes of hydrochloric acid (HCl) and ammonia (NH_4OH) to unite at the outlets of the tubes, and the white sublimate of ammonium chloride will be deposited upon any object held near the outlets. The density of this sublimate can be controlled so that the object may be coated with a uniform, thin film, varying in color according to its thickness, from a light blue to an ivory white, whereby all the details of structure are reproduced perfectly for study under the microscope without exhibiting any crystalline structure of the ammonium chloride. By this process, the minute sculpturing of structures scarcely visible on the corneous or transparent calcareous colony is brought out in clear relief. This whitening process is a great aid in preliminary study, but it is almost indispensable for illustration of Recent bryozoans by photography. Fossils lend themselves equally well to this method of study and

illustration. The sublimate may be removed by simply blowing the breath upon the object so coated. Small quantities only of acid and ammonia should be used, so that the bottles can be emptied and cleaned frequently, as the reagents not only absorb moisture but lose their strength in several days of use. It is a pity that several important research works of recent years have lost value by furnishing poor photographs made without use of the sublimation process.

The bottles need not be long, and density of the sublimate can be modified by narrowing the ammonium outlet, which reduces the strong ammonium fumes, objectionable to some. Poor results occur from blowing too hard or too long or in a damp atmosphere, in which case the ammonium chloride piles up in curdy masses, evident in illustrations found even in some modern treatises. Good strong solutions (95 percent) of both acid and ammonia are required, but cotton plugs strapped to the ends of the tubes after use will preserve their strength for several days and give relief from continual bottle cleaning. The use of these strong chemicals can be avoided by heating a plug of ammonium chloride powder in a piece of glass tubing to supply the fumes, but this is inconvenient for several obvious reasons. Puffing, instead of continuous blowing, gives the best results. Warming the specimen before whitening aids in case of damp weather.

In recent years, whitening by use of magnesium ribbon has given fair results; when the ribbon is burned, an ivory white sublimate is formed, not quite so suitable for photography. A small strip held firmly with forceps is lighted and the specimen carefully manipulated in the resulting fumes.

CLASSIFICATION

A tabular summary of main divisions of the Bryozoa showing distribution of recognized subordinal, familial, generic, and subgeneric units, is introduced here for convenience in surveying the whole assemblage. This is followed by an outline of classification giving names of suprageneric units, with abbreviated characterizations of higher-than-family categories. The names and taxonomic relationships of main parts of the phylum have been established for periods ranging from 70 to 100 years, but designations of taxonomic rank adopted in the *Treatise,* particularly in omitting such categories as "group" and "tribe," variously used by many authors, include some departures from older classifications. The number of genera and subgenera in each unit are given in parentheses; for example, "(8)" signifies 8 genera, and "(1219;46)" indicates 1219 genera and 46 subgenera.

Suprageneric Divisions of Bryozoans

Entoprocta *(subphylum),* without skeleton, mouth and anus enclosed within circle of tentacles (8). *Rec.*
- Loxosomatidae *(family)* (3). *Rec.*
- Pedicellinidae (5). *Rec.*

Ectoprocta *(subphylum),* mostly with calcareous skeleton but some chitinous, anus not enclosed by tentacles (1219;46). *?U.Cam., Ord.-Rec.*
- Gymnolaemata *(class),* circular row of tentacles around mouth (1210;46). *?U.Cam., Ord.-Rec.*
  - Ctenostomata *(order),* comblike processes at mouth (43). *Ord.-Rec.*
    - Carnosa *(suborder),* zooids in direct line, laterally budded from ancestrula (7). *Rec.*
      - Alcyonidiidae *(family)* (4). *Rec.*
      - Flustrellidridae (3). *Rec.*
    - Paludicellea, zooids stolon-like proximally (8). *Rec.*
      - Victorellidae (3). *Rec.*
      - Arachnidiidae (3). *Rec.*
      - Nolellidae (2). *Rec.*
    - Vesicularina, zooids produced from thick free stolon (8). *Rec.*
      - Vesiculariidae (8). *Rec.*
    - Stolonifera, zooids generally paired along thin creeping stolon (20). *Ord.-Rec.*
      - Walkeriidae (2). *Rec.*
      - Mimosellidae (3). *Rec.*
      - Buskiidae (1). *Rec.*
      - Triticellidae (1). *Rec.*
      - Ropalonariidae (1). *Ord.-Perm.*
      - Vinellidae (5). *Ord.-Cret.*
      - Ascodictyidae (3). *Sil.-Perm.*
      - Terebriporidae (2). *Tert.-Rec.*
      - Penetrantiidae (1). *Rec.*
      - Immergentiidae (1). *Rec.*
  - Cyclostomata *(order),* calcareous tubular zooecia with circular apertures, no operculum (303; 29). *?U.Cam., Ord.-Rec.*
    - Articulata *(suborder),* zoaria mostly jointed (9). *Sil.-Rec.*
      - Crisiidae (8). *Cret.-Rec.*
      - Phaceloporidae (1). *Sil.-Dev.*
    - Tuburiporina, zoaria very rarely jointed, zooecial walls not cancellate (122;7). *Ord.-Rec.*

Cyclostomata, Tubuliporina *(continued)*
Diastoporidae (29). *Ord-Rec.*
Tubuliporidae (25). *Dev.-Rec.*
Multisparsidae (2). *Jur.*
Oncousoeciidae (6). *Jur.-Rec.*
Terviidae (4). *Tert.-Rec.*
Entalophoridae (17). *Jur.-Rec.*
Diaperoeciidae (9). *Jur.-Rec.*
Plagioeciidae (12). *Jur.-Rec.*
Hastingsiidae (1). *Rec.*
Frondiporidae (7). *Jur.-Rec.*
Theonoidae (10;7). *Jur.-Rec.*
Cancellata, zoaria not jointed, zooecial walls cancellate (44). *Jur.-Rec.*
Horneridae (2). *Eoc.-Rec.*
Cytididae (21). *Jur.-Rec.*
Petaloporidae (18). *Cret., ?Rec.*
Pseudidmoneidae (1). *Rec.*
Calvetiidae (1). *Rec.*
Stegohorneridae (1). *Rec.*
Cerioporina, zoaria unjointed somewhat resembling trepostomes, zooecial walls minutely porous (43). *Trias.-Rec.*
Heteroporidae (23). *Trias.-Rec.*
Corymboporidae (3). *Cret.-Rec.*
Tretocycloeciidae (7). *Cret.-Rec.*
Cavidae (6). *Jur.-Cret.*
Leiosoeciidae (4). *Jur.-Eoc.*
Rectangulata, zoarium unjointed, with coelomic spaces (alveoli) between zooids (13;12). *Cret.-Rec.*
Lichenoporidae (13;12). *Cret.-Rec.*
Dactylethrata, zoarium unjointed, zooecia separated by dactylethrae (4). *Cret.*
Clausiidae (4). *Cret.*
Salpingina, zoarium unjointed, avicularia present (13). *Jur.-Cret.*
Eleidae (9). *Jur.-Cret.*
Semiceidae (3). *Cret.*
Lobosoeciidae (1). *Cret.*
Hederelloidea, zooecia laterally budded from preceding one (6;5). *Sil.-Penn.*
Reptariidae (6;5). *Sil.-Penn.*
Ceramoporoidea, zooecial walls laminated granulose, with mural pores (49;5). *?U.Cam., Ord.-Perm.*
Ceramoporidae (14). *?U.Cam., Ord.-Dev.*
Fistuliporidae (22). *Ord.-Perm.*
Hexagonellidae (10). *Dev.-Perm.*
Goniocladiidae (3;5). *Miss.-Perm.*
Trepostomata *(order)*, zooecial tubes with distinct immature and mature regions, aperture terminal (105). *Ord.-Perm., ?Trias.*
Amalgamata *(suborder)*, zooecial walls coalesced (70). *Ord.-Perm.*
Monticuliporidae (13). *Ord.-Dev.*
Heterotrypidae (11). *Ord.-Dev.*
Atactotoechidae (2). *Dev.*
Batostomellidae (10). *Ord.-Dev.*
Stenoporidae (27). *Sil.-Perm.*
Constellariidae (7). *Ord.-Sil.*
Integrata *(suborder)*, zooecial walls not coalesced (35). *Ord.-Perm., ?Trias.*
Amplexoporidae (5). *Ord.-Dev.*
Halloporidae (5). *Ord.-Dev.*
Trematoporidae (14). *Ord.-Dev.*
Phylloporinidae (11). *Ord.-Perm.*
Cryptostomata *(order)*, like Trepostomata but immature region short, aperture at bottom of vestibule (127). *Ord.-Perm.*
Fenestellidae (30). *Ord.-Perm.*
Acanthocladiidae (14). *Sil.-Perm.*
Arthrostylidae (11). *Ord.-Dev.*
Rhabdomesidae (29). *Sil.-Perm.*
Ptilodictyidae (7). *Ord.-Dev.*
Stictoporidae (7). *Ord.-Miss.*
Rhinidictyidae (11). *Ord.-Carb.*
Sulcoreteporidae (8). *Sil.-Perm.*
Rhinoporidae (4). *Sil.*
Cycloporidae (3). *Miss.*
Actinotrypidae (1). *Miss.-Perm.*
Worthenoporidae (1).*Miss.*
Palescharidae (1). *Ord.-Dev.*
Cheilostomata *(order)*, zooecial orifice closed by movable operculum (632;17). *?M.Jur., Cret.-Rec.*
Anasca *(suborder)*, no zooecial hydrostatic system (327;2). *?M.Jur., Cret.-Rec.*
Inovicellata *(division)* (1). *Eoc.-Rec.*
Aeteidae (1). *Eoc.-Rec.*
Scrupariina (6). *Cret.-Rec.*
Scrupariidae (5). *Cret.-Rec.*
Labiostomellidae (1). *Rec.*
Malacostega (90;2). *Cret.-Rec.*
Membraniporidae (18). *Cret.-Rec.*
Electridae (9). *Cret.-Rec.*
Flustridae (7). *Rec.*
Hincksinidae (12). *Cret.-Rec.*
Calloporidae (35;2). *Cret.-Rec.*
Chaperiidae (2). *Oligo.-Rec.*
Hiantoporidae (3). *Cret.-Rec.*
Arachnopusiidae (4). *Eoc.-Rec.*
Coilostega *(division)* (63). *?M.Jur., Cret.-Rec.*
Onychocellidae (11). *?M.Jur., Cret.-Rec.*
Microporidae (17). *Cret.-Rec.*
Lunulitidae (2). *Cret.-Rec.*
Calpensiidae (7). *Cret.-Rec.*
Steginoporellidae (4). *Eoc.-Rec.*
Thalamoporellidae (6). *Cret.-Rec.*
Aspidostomatidae (8).*Cret.-Rec.*
Setosellidae (3). *Cret.-Rec.*
Cothurnicellidae (2). *Rec.*
Alysidiidae (3). *Tert.-Rec.*
Pseudostega *(division)* (19). *Cret.-Rec.*
Cellariidae (13). *Cret.-Rec.*
Membranicellariidae (4). *Cret.-Rec.*
Coscinopleuridae (2). *Cret.-Eoc.*
Cellularina *(division)* (53). *Eoc.-Rec.*
Farciminariidae (7). *Eoc.-Rec.*
Bugulidae (14). *Rec.*
Bicellariellidae (10). *Rec.*
Beaniidae (4). *Rec.*
Scrupocellariidae (16). *Eoc.-Rec.*
Epistomiidae (2). *Rec.*
Cribrimorpha *(division)* (95). *Cret.-Rec.*
Cribrilinidae (21). *Cret.-Rec.*
Myagroporidae (1). *Cret.*
Otoporidae (3). *Cret.*
Ctenoporidae (1). *Cret.*
Thoracoporidae (1). *Cret.*
Taractoporidae (1). *Cret.*
Lagynoporidae (5). *Cret.*
Calpidoporidae (3). *Cret.*
Disheloporidae (2). *Cret.*

Rhacheoporidae (5). *Cret.*
Andrioporidae (22). *Cret.-Eoc.*
Pelmatoporidae (30). *Cret.-Rec.*
Francoporinae (2). *Cret.*
Opisthornithoporinae (1). *Cret.*
Kelestominae (3). *Cret.- Rec.*
Pelmatoporinae (7). *Cret.-Mio.*
Tricephaloporinae (5). *Cret.-Rec.*
Diacanthoporinae (1). *Cret.*
Castanoporinae (10). *Cret.-Eoc.*
Pnictoporinae (1). *Cret.*
Ascophora *(suborder)*, with zooecial hydrostatic system (305;15). *Cret.-Rec.*
Porinidae (7). *Cret.-Eoc.*
Cyclicoporidae (7). *Eoc.-Rec.*
Hippothoidae (8). *Cret.-Rec.*
Euthyroididae (1). *Rec.*
Umbonulidae (2). *Eoc.-Rec.*
Petraliidae (11). *Eoc.-Rec.*
Gigantoporidae (13). *Cret.-Rec.*
Stomachetosellidae (12). *Eoc.-Rec.*
Schizoporellidae (20;2). *Cret.-Rec.*
Hippoporinidae (21). *Cret.-Rec.*
Exochellidae (6). *Cret.-Rec.*
Microporellidae (4;4). *Mio.-Rec.*
Eurystomellidae (1). *Pleisto.-Rec.*
Mucronellidae (23;2). *Cret.-Rec.*
Tubucellariidae (5). *Eoc.-Rec.*
Reteporidae (21). *Cret.-Rec.*
Adeonidae (18;4). *Eoc.-Rec.*
Cheiloporinidae (14). *Cret.-Rec.*
Parmulariidae (3). *Cret.-Rec.*
Phylactelliporidae (7). *Cret.-Rec.*
Phylactellidae (10). *Cret.-Rec.*
Crepidacanthidae (4). *Cret.-Rec.*
Celleporidae (14). *Cret.-Rec.*
Pasytheidae (3). *Eoc.-Rec.*
Catenicellidae (14;3). *Tert.-Rec.*
Savignyellidae (5). *Rec.*
Sclerodomidae (3). *Rec.*
Onchoporidae (5). *Rec.*
Euthyridellidae (4). *Rec.*
Bifaxariidae (1). *Rec.*
Bitectiporidae (1). *Tert.*
Nephroporidae (1). *Cret.*
Platyglenidae (1). *Cret.*
Prostomariidae (1). *Tert.*
Mamilloporidae (10). *Eoc.-Rec.*
Orbituliporidae (10). *Cret.-Rec.*
Conescharellinidae (5). *Tert.-Rec.*
Fusicellariidae (1). *Cret.*
Myriozoidae (2). *Mio.-Rec.*
Lekythoporidae (6). *Tert.-Rec.*
Phylactolaemata *(class)*, fresh-water bryozoans with tentacles arranged in horseshoe-shaped manner around mouth, which has overhanging lip (9). *Cret.-Rec.*

Summary of Classification of Bryozoa

	Suborders	Families	Genera	Subgenera
Ctenostomata	4	16	43	—
Cyclostomata	9	34	303	29
Trepostomata	2	10	105	—
Cryptostomata	—	13	127	—
Cheilostomata	2	82	632	17
Gymnolaemata	17	155	1210	46
Phylactolaemata	—	1	9	—
Ectoprocta	17	156	1219	46
Entoprocta	—	2	8	—
Total	17	158	1227	46

DISTRIBUTION

North America, undoubtedly the most favored continent for reading Paleozoic history, is equally favored for the study of fossil bryozoans, as many of its marine limestones and shales abound in their remains. The Eurasian land mass presents many Paleozoic outcrops but they are more or less disconnected, and the fossils are not so well known. In Asia, the Salt Range of India has yielded Permian Bryozoa, while in Europe the Ural Mountains region, areas in Great Britain, and the Baltic provinces expose most of the Paleozoic strata with such fossils. Approximately 4 times as many species have been described from the North American Paleozoic as from all the rest of the world.

Ordovician formations above the Canadian abound in stony Bryozoa (Trepostomata, Cryptostomata) (Fig. 3*A*), although representatives of the Cyclostomata and a few species of Ctenostomata may be found. In the Silurian, bryozoans are not so common, Cryptostomata being developed more than Trepostomata. In the Devonian and Carboniferous, the Trepostomata became much reduced in numbers and finally disappeared, while the Cryptostomata developed a wealth of species, especially of the lacelike *Fenestella* (Fig. 3*B*) and its allies. The Ctenostomata remain as sparsely represented as before, but the Cyclostomata increased in number by development of the great family Fistuliporidae.

Beginning with the Mesozoic, a decided change occurs in these fossils. The Cryptostomata and Trepostomata apparently disappeared, the Ctenostomata became exceedingly rare, but the Cyclostomata developed many species, with zoaria quite similar to those of Paleozoic Trepostomata. These remained the predominating type until Late

Cretaceous time, when the Cheilostomata, which appeared first in the Jurassic, expanded greatly in numbers. D'ORBIGNY alone has described not less than 537 species of Upper Cretaceous Cyclostomata and 300 Cheilostomata, although many are synonyms. This unusual profusion in the Mesozoic is known mainly in European strata, for in North America and elsewhere these rocks so far have yielded comparatively few Bryozoa (Fig. 4*A*).

Both North America and Europe are noted for their Cenozoic bryozoan faunas. The Atlantic and Gulf coastal plains of North America and the northern and southern slopes of the Alps, as well as numerous other scattered European areas, are rich in Cheilostomata and Cyclostomata, the former predominating. Southern Australian Tertiary strata likewise afford bryozoans in abundance.

In the Recent seas, the Cheilostomata flourish in the highest stage of their perfection and beauty in numerous species described from all the oceans from tide level down to great depths. The voyages of the British "Challenger" and the American "Albatross" resulted in finding many new species which have since been greatly augmented by various other expeditions and the activity of local students. The seaweeds tossed up so abundantly along certain coasts afford fertile collecting places in the holdfasts of their branches, for they contain many incrusting and delicate branching forms of Cheilostomata and Cyclostomata (Fig. 4*B*).

Information concerning stratigraphic and geographic distribution of bryozoans is indexed in following paragraphs by citation of the authors and dates of more important publications. Space does not allow publication of complete references; for these one must consult monographic works or various standard bibliographies. For sake of brevity, an apostrophe (') is used to indicate the first 2 numerals of all dates between 1850 and 1950, others being given in full.

The oldest fossil reported to be a bryozoan is a supposed trepostome in Lower Cambrian rocks of western England. From Upper Cambrian strata of western Canada another presumed bryozoan, described under the name *Archaeotrypa,* is tentatively classed as a ceramoporoid cyclostome, but it may be a tabulate coral. These Cambrian records of the occurrence of bryozoans are dubious. Also, an abundant ctenostome described as *Heteronema priscum,* from Upper Cambrian sandstone of the Baltic region (13), is now considered to come from basal Ordovician beds; the fossil has been renamed *Marcusodictyon priscum.*

Higher formations in Estonia, which are assigned to Middle Ordovician, contain 18 additional genera, including 4 cyclostomes, 11 trepostomes, and 3 cryptostomes. Thus, all main types of Bryozoa, except cheilostomes, appear very early in the Paleozoic succession. The oldest discovered cheilostomes are described from Middle Jurassic (Bajocian) rocks of northwestern France.

Stratigraphically Arranged Summary of Publications on Bryozoans

Cambrian

L.CAM.: *Eng. (Shrops.),* COBBOLD, '31 (trep.).
U.CAM.: *Can.(B.C.),* FRITZ, '47 (?cycl.—*Archaeotrypa*).

Ordovician

L.ORD.: *U.S.(Ark.),* U.S.Natl.Mus.coll. (trep.—*Nicholsonella*); *U.S.(Mo.),* CULLISON, '38 (cycl.—*Crepipora*).——*Est.,* Zone A2 (basal Ord.), BASSLER, '11 (cten.—*Marcusodictyon*).——*Wales,* L. ARENIG, LEWIS, '26 (cycl.—*Bolopora*).
M.ORD.(CHAZYAN): *NE. N. Am. (N. Y.-Vt.-Ont.-Que.),* HALL, 1847; BILL., '59; SEELY, '06; TWENHOFEL, '38.
M.ORD.(BLKRIV.): *U.S.(Appalach.),* BASSLER, '11, '19, 1952; BUTTS, '40-41; ULR., '82.——*U.S. (Tenn.),* BASSLER, '32; CORYELL, '21; SAFFORD, '51, '69; ULR., '82, '90, '93, '03; WILSON, '49.——*U.S. (Miss.V.),* LOEBLICH, '42; SHROCK & RAASCH, '37; ULR., '82, '90, '93, '96.——*NE.N.Am.(N.Y.-Ont.),* FOORD, '83; HALL, 1847; ULR., '82, '90, '93; WILSON, '21.——*Est.,* Zone B2 (Walchow), EICHW., 1829, 1832, 1840, '60; DYBOWSKI; '77, BASSLER, '11 (cycl.—*Fistulipora;* 2 crypt.—*Stictoporella, Arthroclema;* 6 trep.—*Nicholsonella, Dianulites, Esthoniopora, Hemiphragma, Dittopora, Diplotrypa*); Zone B3 (Kunda), BASSLER, '11 (3 cycl.—*Anolotichia, Mitoclema, Coscinotrypa;* crypt.—*Phyllodictya;* 11 trep. incl.—*Stigmatella, Leioclema, Orbipora, Batostoma, Hallopora*).
M.ORD.(TRENTON): *U.S.(Miss.V.),* BASSLER, '03, '06, '11, '32; BRADLEY, '30; BUTTS, '40-41; NICH., '81; NICKLES, '05; ULR., '82-83, '86, '90, '93; ULR.-B., '04; WILSON, '49.—— *N.E.N.Am.(N.Y.-Vt.-Ont.-Que.),* AMI, '92, '95; BASSLER, '11; BILL., '62; CALEY, '36, '43; FOORD, '83; HALL, 1847, 1850, '51; MATHER, '17; NICH., '75, '79, '81; PARKS, '28; RUEDEMANN, '01, '13; SPROULE, '36; ULR., '90, '93; WHITEAVES, '97; WILSON, '21.
M.ORD.(UNDIFF.): *Can.(Que.),* FRITZ, '41.——

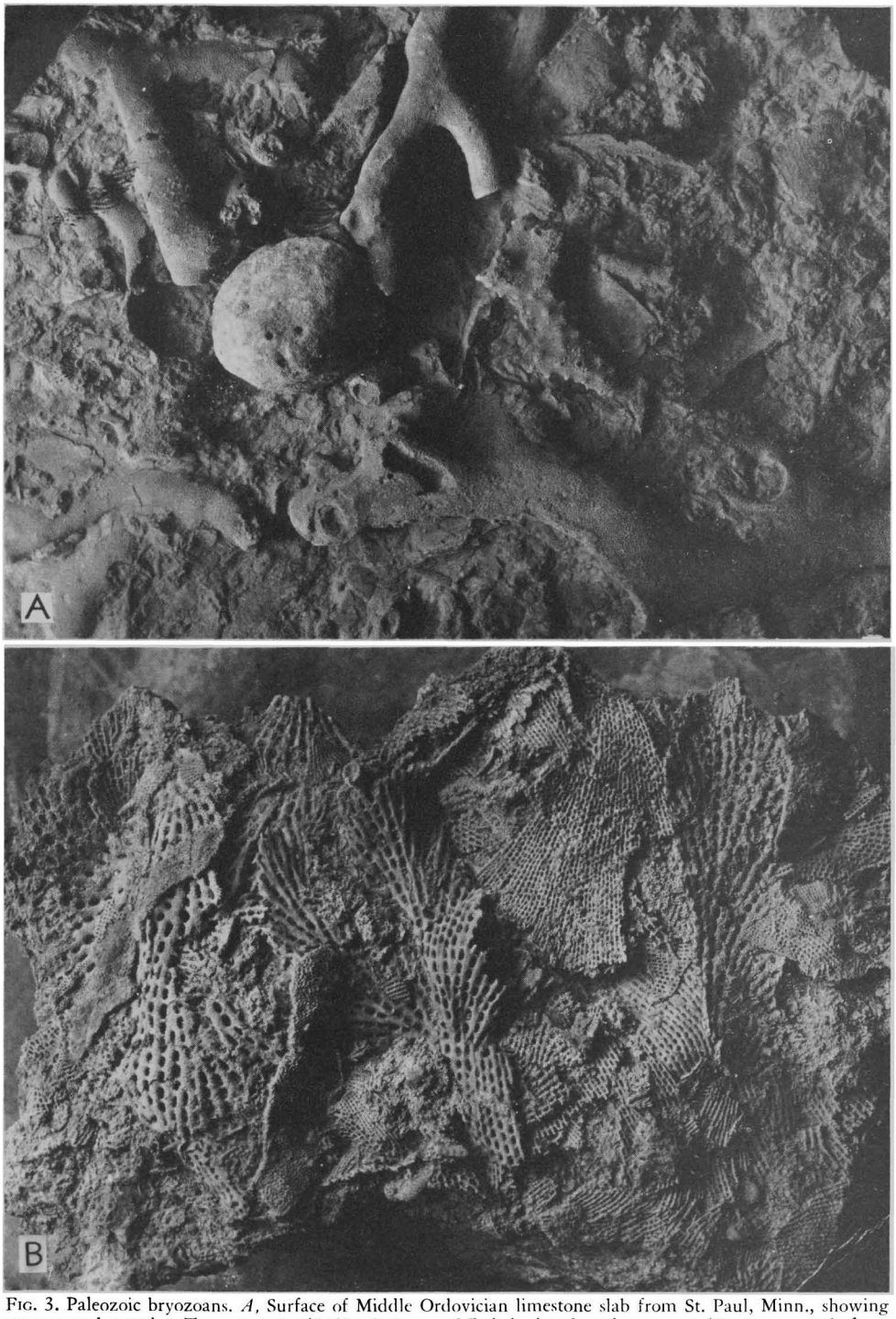


FIG. 3. Paleozoic bryozoans. *A*, Surface of Middle Ordovician limestone slab from St. Paul, Minn., showing ramose and massive Trepostomata (×1). *B*, Lower Mississippian lacy bryozoans (Cryptostomata) from Columbia, Ill. (×1); most of the fossils are species of *Fenestella* and *Polypora*.

FIG. 4. Mesozoic and Cenozoic bryozoans. *A*, Fragments of solid branching Cyclostomata and sheetlike Cheilostomata from Upper Cretaceous (Maastrichtian) chalky limestone near Maastricht, Holland (×1). *B*, Delicate branching Cheilostomata of Recent age from the Pacific Coast in California (×1).

Scot., NICH., '81; NICH.-E., '77; REED, '26.——*Baltic*, BASSLER, '11; BEKKER, '21; DYBOWSKI, '77; EICHW., '56, '60; ÖPIK, '27; TOOTS, 1952.

U.ORD.(EDEN.): *U.S.(OhioV.)*, BASSLER, '03, '04, '06, '11, '13; CUMINGS, '08; CUMINGS-G., '13; JAMES, '75, '78-84, '93-'96; NICH., '74-74, '79, '81; NICKLES, '05; ULR., '70, '80-84, '90, '93; WALCOTT, '79.

U.ORD. (EDEN.-MAYSV.): *NE.N.Am.(N.Y.-Ont.)*, ARMSTRONG, '45; CALEY, '40; DYER, '25; FRITZ, '26; PARKS & DYER, '22; RUEDEMANN, '25.

U.ORD.(MAYSV.): *U.S.(OhioV.)*, BASSLER, '03, '06, '13, '32; BOULE, '06; CUMINGS, '04, '12; CUMINGS-G., '13, '15; M.EDW.-H., '51, '54; HALL, 1847; JAMES, '78-84, '93-96; JAMES & JAMES, '87-88; MILLER & DYER, '75, '78; NICH., '74-75, '79, '81; NICKLES, '05; D'ORB., 1850; ULR., '79, '82-83, '90, '93, '03; ULR.-B., '04; WILSON, '49.——*U.S.(Appalach.)*, BASSLER, '11; BUTTS, '40-41.——*Can.(Ont.)*, CALEY, '40; FRITZ, '26; PARKS & DYER, '22.

U.ORD.(RICHMOND.): *U.S.(OhioV.)*, BASSLER, '03, '06, '13; CUMINGS, '08, '12; CUMINGS-G., '13; JAMES, '78, '82; NICH., '73-75, '79, '81; NICKLES, '02, '05; ROM., '60, '66; ULR., '78-79, '82, '89-90; ULR.-B., '04; WHITF., '78.——*U.S. (Miss. V.)*, BASSLER, '03, '11, '13, '32; HUSSEY, '26; NICH., '75; ROM., '60, '66; ULR., '88, '90, '93; ULR.-B., '04; WHITF., '78, '82.——*Can.(Man.)*, NICH., '74-75; OK., '43; ROM., '60; ULR., '80, '89; WHITEAVES, '95.——*Can.(Ont.-Que.)*, BASSLER, '29; BILL., '66; DYER, '25; FOERSTE, '25; FRITZ, '26; ULR., '90.——*N.Am.(Arct.)*, OAKLEY, '38; ROY, '41; TROEDSSON, '29.

U.ORD.(UNDIFF.): *Eng.*, MCCOY, 1850.—*Fr.*, DREYFUSS, '48; PRANTL, '39-41.——*Balt.*, BASSLER, '11; DYBOWSKI, '77; WIMAN, '02.——*Italy*, NEKH., '26; VINASSA, '10, '15, '41.

ORD.(UNDIFF.): *Can.(Arct.)*, TEICHERT, '37.——*Arg.*, KEYSER, '25; RUSCONI, '48.——*Czech.*, BOUCEK, '28; KETTNER, '13; PERNER, '09; POČTA, '02; POUBA, '48; PRANTL, '39.——*Italy*, VINASSA, '42.——*Asia*, GORTANI, '34; OZAKI, '33; REED, '35; YABE-H., '20.——*Austral.*, CROCKFORD, '43.

Silurian

L.SIL.: *Can.(Que.)*, BASSLER, '27-28; BILL., '66.——*Ont.-N.Y.*, HALL, '52; HALL-W., '75; NICH. & HINDE, '74-75, '79.——*U.S.(Ohio-Miss.V.)*, CULBERTSON, '26; FOERSTE, '87, '89, '95; SAVAGE, '27; ULR., '90.

M.SIL.(CLINT.): *Can.(Que.)*, BASSLER, '27; BILL., '66; VINE, '81-82, '84.——*U.S.(N.Y.)*, BASSLER, '06; GRABAU, '91, '01; HALL, '52; RINGUEBERG, '86; ULR.-B., '04.——*U.S.(OhioV.)*, BASSLER, '06; HALL, '52.

M.SIL.(CLIFT.): *U.S.(OhioV.)*, BASSLER, '06; HALL, '52, '76, '79, '82-83; ROM., '66; ULR.-B., '04.——*U.S.(Appalach.)*, BASSLER, '39.

M.SIL.(LOCKPORT.): *NE. N. Am.*, CLAYPOLE, '80; GRUBBS, '39; NICH., '75; ROEMER, '60, '62.

M.SIL.(UNDIFF.): *Eng.*, M.EDW.-H., '51; FOORD, '84; GOLDF., 1831; LONSD., 1839; NICH.-F., '85; SHRUBSOLE, '80; VINE, '81-82, '84-85, '87.——*Balt.*, BASSLER, '39; HENNIG, '05-06, '08; ULR., '90; ULR.-B., '04; VINE, '81, '84.

U.SIL. (TONOL.): *U.S.(Appalach.-N.Y.)*, BASSLER, '23, '39.

U.SIL.(KEYS.): *U.S.(Appalach.-N.Y.)*, BASSLER, '23, '39; BUTTS, '40-41; ULR.-B. '13.

SIL.(UNDIFF.): *Can.*, TEICHERT, '37; WHITEAVES, '01, '05.——*Greenl.*, POULSEN, '34.——*Eire*, Portlock, 1834.——*Wales*, LEWIS, '33.——Isle Man, LEWIS, '34——*Fr.*, PRANTL, '40, '43.——*Czech.*, BASSLER, '35, '39; POČTA, '94, '02; PRANTL, '32, '34-39.——*Pol.*, PRENIK, '24.——*Asia*, NEKH., '33, '36.——*Austral.*, CHAPMAN, '03; CROCKFORD, '41-42.

Devonian

L.DEV.(HELD.): *U.S.(Appalach.-N.Y.)*, BASSLER, '39; HALL, '74, '80-83; HALL-S., '87; ULR.-B., '18.——*U.S.(Tenn.)*, BASSLER, '39; HALL-S., '87.

L.DEV.(DEERPARK.): *U.S.(N.Y.)*, BASSLER, '39; BILL., '74; CLARKE, '00.——*U.S.(Mo.)*, TANSEY, '24.——*Can.(Que.)*, BASSLER, '39; BILL., '74; CLARKE, '07; FRITZ, '38-40, '41, '44.

L. DEV. (ONESQUETH.): *N.Y.-Ont.*, BASSLER, '39; HALL, '83, '86; HALL-S., '87; NICH., '74; ROM., '92; ULR., '86, '90, '96.

L.DEV.(UNDIFF.): *Belg.*, ASSELBERGHS, '46; MAILLIEUX, '36; SALÉE, '19.——*Ger.*, DAHMER, '46.

M.DEV.(UNDIFF.): *U.S.(N.Y.)*, BASSLER, '39; GRABAU, '99-00; HALL, '81, '83-84, '91; HALL-S., '87; NICH., '74; ROLLE, '51.——*U.S.(Mich.)*, BASSLER, '39; DEISS, '32; DUNCAN, '39; MCNAIR, '32, '37; NICH., '74; ROM., '66; ULR., '90; WINCHELL, '66.——*U.S.(Ohio)*, BAKER, '42; BASSLER, '39; MCNAIR, '37, '43; STEWART, '27.——*U.S.(Mo.)*, BRANSON, '22.——*U.S.(Wis.)*, BASSLER, '11, '39; ULR., '90.——*Can.(Ont.)*, BASSLER, '11, '39; FRITZ, '30; HALL, '84; HALL-S., '87; NICH., '74-75; NICH.-E., '77; ROM., '66; WHITEAVES, '98.——*Colom.*, MCNAIR, '40.——*Sib.*, SCHOENMANN, '27.——*Mongol.*, NEKH., '26.——*Austral.*, BASSLER, '39; CROCKFORD, '41-42.

U.DEV.(UNDIFF.): *U.S.(N.Y.)* MCNAIR, '43.——*U.S.(Ill.-Iowa)*, BASSLER, '39; FENTON-F., '24; HALL-W., '73; PROUT, '66; ROM., '66; ULR., '90; WHITE, '76.——*U.S.(Mo.)*, BRANSON, '22.——*U.S. (N.Mex.)*, BASSLER, '39; FRITZ, '44.——*Can.*, NICH., '75; WHITEAVES, '91.

DEV.(UNDIFF.): *Eng.*, ETH.-F., '84; PHILLIPS, 1841; WHIDBOURNE, '95.——*Fr.*, DOLLFUSS, '88; FRECH, '85, '86; LEMAITRE, '33; NICH.-F., '85; OEHLERT, '88; DE VERNEUIL & HAIME, '52.——*Ger.*, FRECH, '85, '96; GOLDF., 1827; NICH., '79; NICH.-F., '85; QUENST., '81; ROLLE, '51; SCHLÜTER, '85; SOLLE, '37, 1950, 1952; TOOTS, 1951.——*Portugal*, DE ANDRAHE, '45.——*Czech.*, KETTNER, '19; POČTA, '94; PRANTL, '28-29, '32, '33, '35, '37-39, '42.——*Pol.*, GÜRICH, '96.——*Italy*, GORTANI, '11.——*Asia*, KRASNOPAYEVA, '35; NEKH., '26, '40; REED, '22.——*N.Z.*, ALLAN, '35; SHIRLEY, '38.

Mississippian (Lower Carboniferous)

L.MISS.(KIND.): *U.S.(Iowa)*, ULR., '90.

L.MISS.(OSAG.): *U.S.(Miss.V.)*, BASSLER, '32; GIRTY, '15; KEYES, '94; MEEK-W., '65, '68; PROUT, '58, '60; ROM., '66; ULR., '88, '90; WELLER, '09; WINCHELL, '63.

U.MISS.(MERAMEC.): *U.S.(Miss.V.)*, BASSLER, '39; CUMINGS, '05-06; GIRTY, '11; HALL, '57; PROUT, '58, '60; ROM., '66; ULR., '84, '88, '90; WELLER, '08, '20.——*U.S.(Appalach.)*, BUTTS, '41.

U.Miss.(Chest.): *U.S.(Miss.V.)*, Bassler, '39, '41; Butts, '41; Easton, '42-43; Girty, '10; Haas, '46; McFarlan, '42; Prout, '58-60; Ulr., '84, '90; Weller, '20.——*U.S.(Ariz.)*, Hernon, '35.

Miss.(L.Carb.)(Undiff.): *U.S.*, Condra-E., '44; Simpson, '94; Ulr.-B., '04.——*Can.(N.Scot.)*, Bell, '29; Dawson, '78.——*Can.(B.C.)*, Fritz, '42.——*Bol.*, d'Orb., 1842.——*Eng.*, Lee, '12; Munro, '12; Phillips, 1836, 1841; Shrubsole, '79, '81; Vine, '77-79, '81, '88, '90; Young, '81, '83; Y.-Y., '74-75, '80, '83, '88-89.——*Eire*, McCoy, 1844.——*Belg.*, DeKon., 1842-44, '71; Kaisin, '42.——*Ger.*, Nekh., '32.——*Russ.*, Nikif., '27, '33; Stuck., '01, '07; Tolmachoff, '31.——*Sib.*, Nekh., '26; Tolmachoff, '24, '36.——*Turkestan*, Nikif., '26, '33.——*Mal.*, Oakley, '48.——*Austral.*, Chapman, '20; Crockford, '47, '49; DeKon., '76, '98.

Pennsylvanian (Upper Carboniferous)

L.Penn.: *U.S.(Ark.-Okla.)*, Coryell, '24; Harlton, '33; Mather, '15.

M.Penn.: *U.S.(OhioV.)*, Foerste, '87; Meek, '75; Morningstar, '22; Ulr., '90.——*U.S.(Ill.)*, Foerste, '87; Meek, '72; Ulr., '90; Ulr.-B. '04; White, '78; Worthen, '75.——*U.S.(Mo.-Kans.-Okla.)*, Beede & Rogers, '01; Condra, '02; Girty, '15; Warthin, '30.——*U.S.(Tex.)*, Plummer & Moore, '21.

U.Penn.: *U.S.(Mo.-Kan.-Okla.)*, Beede & Rogers, '01; Condra, '02; Condra-E., '44; Elias, '37; Moore-D., '44; Rogers, '00; Sayre, '30.——*U.S.(Tex.)*, Moore, '29-30; Plummer & Moore, '21.

Penn. (U. Carb.) (Undiff.): *U.S.(N.Mex.-Utah)*, Condra-E., '44; Prout, '58.——*Can.(B.C.)*, Warren, '27.——*Arct.(Ellesm.)*, Tschernyschev & Stepanow, '16.——*Peru*, Chronic, '49.——*Arg.*, Reed, '27.——*Balk.*, Prantl, '34, '39.——*Russ.*, Frederiks, '15, '20; Shulga, '33, '36.——*Sib.*, Nekh., '35.——*Austral.*, Crockford, '47. '49.

Carboniferous (Undifferentiated)

Carb.: *Aus.*, DeKon., '73; Heritsch, '30-31; Johnsen, '06.——*Russ.*, Bolkhowitz & Markoff, '26; Frederiks, '32; Keyserling, 1846; Lee, '09; Ludwig, '61-62; Nikif., '33, '38; Toots, 1951.——*Turk.*, Nikif., '34.——*Mongol.*, Nekh., '35.——*India*, DeKon., '63.——*Austral.*, Nich.-E., '86.

Permian

Permocarb.: *Bol.-Peru*, Bassler, '36; Chronic, '49; Meyer, '14; d'Orb., 1842.——*Iran*, Douglas, 1836.——Kashmir, Diener, '99.

L.Perm.: *U.S.(Nebr.-Kans.-Okla.)*, Condra, '02; Elias, '37; Meek, '72; Moore-D., '44; Rogers, '00.——*Russ.*, Nikif., '38-39; Shulga, '33, '36, '39, '41, '49; Stuck., '95; Trizna, '39.——*Arct.(Spitz.-N.Zem.)*, Nikif., '36; Toula, '75.

U.Perm.: *U.S.(Okla.-Tex.)*, Girty, '08; Moore, '39; Moore-D., '44; Prout, '58.——*U.S.(Ariz.)*, Condra-E., '44-45.——*Can.(B.C.)*, Fritz, '32, '46.

Perm.(Undiff.): *Col.*, Royo & Gomez, '45.——*Eng.*, King, 1850.——*Ger.*, Geinitz, '61, '66; Korn, '30.——*Aus.*, Johnsen, '06.——*Italy*, Gregorio, '30.——*Russ.*, Likharev, '25; Nikif., '38-39; Shulga, '41; Stuck., '95; Trizna, '39; Yakovlev, '45.——*Turk.*, Metz, '39; Nikif., '33.——*Tibet*, Merla, '34; Metz, '46; Nikif., '33.——*China*, Girty, '08; Grabau, '31; Minato, '43; Reed, '27, '33; Yabe-S., '42; Yoh, '32.——*Japan*, Ozawa, '25.——*Indochina*, Colani, '19; Mansuy, '13-14, '20.——*India*, DeKon., '63; Reed, '25, '31; Waag. & Pichl, '85; Waag.-W., '86.——*E.Indies (Timor)*, Bassler, '29.——*Austral.-Tasm.*, Bretnall, '26; Crockford, '41, '43-46; Eth., '91-92, '21; Hosking, '31; Hummell, '15; Lonsd., 1845.

Triassic

Trias.(Undiff.): *Arg.*, Rusconi, '48.——*Italy*, Gregorio, '30.——*Rumania*, Kühn, '36.——*Hung.* Papp, '00; Vinassa, '11.——*Russ.*, Nekh., '49.——*N.Z.*, Wilckens, '27.

Jurassic

M.Jur.: *Eng.-Fr.*, Brauns, '79; Canu, '98, '13; Canu-B., '22, '29; Friren, '92; Gregory, '96; Haime, '54; Lamx., 1821; Lang, '04; Mich., 1840--46; d'Orb., '51-52; Vine, '82-93; Walford, '84, '87, '89, '94.

Jur.(Undiff.): *U.S.(Tex.)*, Albritton, '38; Cragin, '05.——*Fr.*, Canu, '13; Haime, '54; Orieux, '40; Sauvage, '89.——*Belg.*, Joly, '36.——*Ger.*, Goldf., 1825-33; Koch & Dunker, 1837; Kühn, '35, '39; Roemer, 1836; Wolfer, '13.——*Balk.*, Prantl, '38.——*Pol.*, Reuss, '67.——*Switz.*, Peterhans, '27.——*Eur.*, Canu-B., '22, '26, '29.

Cretaceous

L.Cret. (Neocom.): *Fr.*, Corroy, '25.——*Switz.*, Baschong, '21; Canu, '02; Canu-B., '26; Gregory, '99, '09; deLoriol, '63, '68; d'Orb., '51-54.——*Ger.*, Gregory, '09; Koch & Dunker, 1837; Roemer, 1840; Voigt, '24, '30.——*Russ.*, Bailey, '48; Gregory, '09.

L.Cret.(Apt.): *Eng.*, Canu-B., '26; Gregory, '09; Keeping, '83; Pitt, '49; Vine, '89.——*Fr.*, Gregory, '09; d'Orb., '54.

L.Cret.(Alb.): *Eng.*, Gregory, '09; Vine, '85.——*Fr.*, d'Orb., '54.

U.Cret.(Cenom.): *Fr.*, Canu, '97, '00; Canu-B., '22; Gregory, '09; LeCointre, '12; d'Orb., '51; Pergens, '89.——*Ger.*, Goldf., 1827; Gregory, '99, '09; Reuss, '72; Simonowitsch, '71; Voigt, '42.——*Czech.*, Gregory, '99, '09; Novak, '77; Počta, '92; Prantl, '38; Reuss, 1846.——*Tunisia*, Canu, '03.

U.Cret.(Turon.): *Eng.*, Brydone, '18; Gregory, '99, '09; Lang, '16.——*Fr.*, Canu, '97; d'Orb., '51-54; Pergens, '92.——*Ger.*, Reuss, '74; Voigt, '24.——*Czech.*, Novak, '77; Prantl, '38——*Tunisia*, Peron, '93.

U.Cret.(Coni.): *Eng.*, Brydone, '17, '30; Gregory, '09; Lang, '16; Lev., '12; Thomas, '39.——*Fr.*, Allegre, '36; Filliozat, '07-08; Gregory, '99, '09; Lang, '16; Lev., '12; d'Orb., '51-54; Pergens, '93.

U.Cret.(Santon.): *Eng.*, Brydone, '16-17, '29; Gregory, '09; Lang, '16; d'Orb., '51-54; Thomas, '35.——*Fr.*, Canu, '00; Gregory, '99, '09.——*Ger.*, Voigt, '24.——*Egypt*, Canu, '04.

U.Cret.(Camp.): *Eng.*, Brydone, '06, '09-18, '29-'30, '36; Gregory, '99, '09; Lang, '16, '18, '21-22.——*Fr.*, Gregory, '09; Lang, '21; d'Orb., '53.——

Ger., Beissel, '65; Goldf., 1827-33; Gregory, '99; Hag., 1839-40, 1846; Lang, '16, '21-22; Lev., '25; Marsson, '87; Pergens, '93; Voigt, '23-24, '29-30. ——*Swed.*, Gregory, '99, '09; Hennig, '92, '94; Voigt, '30.

U.Cret.(Maastr.): *Holl.*, Goldf., 1826-33; Gregory, '99; Hag., '51; Hamm, '81; Meunier & Pergens, '85; Pergens, '94; Quenst., '81; Ubaghs, '58, '65; Voigt, '30.——*Belg.*, Gregory, '09; Pergens, '87.——*Fr.*, Canu, '20; Canu-B., '22; Gillard, '40, '42.——*Ger.*, Voigt, 1951.——*Sp.*, Barrosa, '44.

U.Cret.(Dan.): *Denm.*, Berthelsen, '48; Lev., '25; Pergens & Meunier, '86; Voigt, '23, '30.——*Swed.*, Gregory, '99, '09; Hennig, '92; Voigt, '30.——*Ger.*, Voigt, '25, '28.——*Aus.*, Kühn, '30.

U.Cret.(Undiff.): *U.S.(Tenn.)*, Canu-B., '26.——*U.S.(Colo.)*, White, '83.——*Arg.*, Canu, '11.——*Eng.*, Brydone, '06-18, '29-30, '36, '42; Vine, '84-95, '98.——*Fr.*, Jullien, '86; d'Orb., '51-54.——*Ger.*, Schonfelder, '33.——*Italy*, Seguenza, '82.——*N. Afr.*, Zuffardi-Commerci, '27.——*S. Afr.*, Lang, '08.

Cret.(Undiff.): *Can.(Georges Bank)*, Bassler, '36.——*Braz.*, White, '87.——*Eng.*, Caster, '32.——*N.Afr.*, Allegre, '33.——*S.Afr.*, Lang, '06.——*Madag.*, Canu, '22.——*India*, Chiplonker, '39; Stoliczka, '42.

Paleocene

Paleoc.(Mont.): *Belg.*, Canu, '00, '07; Meunier & Pergens, '86.

Paleoc.(Midway.): *U.S.(GulfMex.)*, Canu-B., '20.

Eocene

L.Eoc.(Led.): *Belg.-Fr.*, Canu-B., '29; Darteville, '33, '39; Meunier & Pergens, '86.

L.Eoc.(Wilcox.): *U.S.(N.J.)*, Canu-B., '33; Gabb-H., '60, '62; Lonsd., 1845; Voigt, '42.——*U.S.(Md.-Va.)*, Canu-B., '20; Ulr., '01.——*U.S.(Gulf Mex.)*, Canu-B., '20.

M.Eoc.(Lut.): *Eng.*, Busk, '66; Davis, '34; Gregory, '93; Vine, '89, '91.——*Fr.*, Buge, '46; Buge & Balavoine, '01; Canu, '07-08, '10, '13, '18.——*Ger.*, Beutler, '08; Koschinsky, '85.——*Sp.*, Faura & Canu, '17.——*Tunisia*, Canu, '04.

M.Eoc.(Claib.): *U.S.(N.Car.-S.Car.)*, Canu-B., '20; Gabb-H., '62; Lonsd., 1845.——*U.S.(GulfMex.)*, Canu-B., '20; Gabb-H., '62; Gregorio, '90; Lea, 1833.

U.Eoc.(Barton.): *Fr.*, Canu, '07, '10-12; Canu & Caillot, '32; Morellet, '48.——*Ger.*, Reuss, '64.——*Pol.*, Pazdro, '29; Pergens, '89.——*Hung.*, Pergens, '96.——*Italy*, Canu-B., '20; Gottardi, '86; Reuss, 1847, '68-69; Waters, '91-92, '19.

U.Eoc.(Jackson.): *U.S.(N.Car.-S.Car.-Ga.)*, Canu-B., '20.——*U.S.(GulfMex.)*, Canu-B., '20; McQuirt, '41.

Eoc.(Undiff.): *Afr.*, Cipolla, '34; Pfender, '34; Zuffardi-Commerci, '48.——*N.Z.*, Uttley, '49.

Oligocene

L.Oligo.: *Belg.*, Canu-B., '31.——*Ger.*, Francke, '39; Reuss, '67; Stoliczka, '62.——*U.S.(GulfMex.)*, Canu-B., '20.

M.Oligo.: *Ger.*, Reuss, '65; *Fr.*, Canu, '14, '17; Reuss, '69.——*U.S.(GulfMex.)*, Canu-B., '20.

U.Oligo.: *Ger.*, Gorgas, '41; Reuss, '58, '64.——*Aus.*, Stach, '36.——*U.S.(GulfMex.)*, Canu-B., '20; McQuirt, '41.——*C.Am.(C.Z.)*, Canu-B., '19.——*W.Indies*, Canu-B., '19, '23.

Oligo.(Undiff.); *Pol.*, Reuss '67.——*Arg.*, Canu, '08.——*N.Z.*, Brown, '48, 1952; Uttley, '48.

Miocene

L.Mio.(Aquit.-Burdig.): *Fr.*, Canu, '06-07, '09, '13, '16-17; Duv., '21, '24; Vig., '49.——*Sp.*, Faura & Canu, '16.——*Italy*, Canu, '13.——*U.S.(Fla.)*, Canu-B., '23.——*W.Indies*, Canu-B., '19, '23.——*W.Indies*, Canu-B., '19, '23.——*C.Am.*, Canu-B., '19.

M.Mio.(Helv.): *Fr.*, Balavoine, '48; Buge, '48; Canu, '09, '17; Canu-L., '25, '27-28, '30, '33-34; Duv., '20-21, '24; Vig., '49.——*Italy*, Canu, '13.——*Egypt*, Canu, '04, '12.——*Crete*, Kühn, '36.——*U.S.(Md.-Va.)*, Canu-B., '23; Ulr.-B., '04.——*Austral.*, Canu-B., '35; MacGill., '95; Maple., '98-04, '08, '10, '12-13, '18; Stach, '32-37; T-Woods, '76.——*N.Z.*, Brown, '48, 1952; Stoliczka, '64; T-Woods, '80; Uttley, '49; Waters, '87.

U.Mio.(Tort.): *Fr.*, Canu, '13.——*Aus.-Hung.*, Reuss, '47-48, '74.——*Czech.*, Canu, '13.——*U.S.(Va.-N.Car.-S.Car.-Fla.)*, Canu-B., '23; Gabb-H., '62; Lonsd. 1845.

Mio.(Undiff.): *Fr.*, Canu, '07-10, '20; Pergens, '87, '91.——*Italy*, Scotti, '36.——*Aus.*, Kühn, '25.——*Yugo.*, Pergens, '87.——*Russ.*, Nicolaescu, '32; Pergens, '89; Reuss, '69; Saula-Bocce, '43; Sinzow, '92.——*Libya*, Panzera, '32.——*Kenya*, Thomas, '30.——*CanaryI.*, Darteville, '37.——*Iran*, Darteville, '45.——*Japan*, Sakakura, '36.——*U.S.(La.)*, McQuirt, '41.——*C.Am.*, Gabb-H., '62.——*Colom.*, Tolmachoff, '34.——*Arg.*, Canu, '04, '08; Conte, '49.

Pliocene

Plio. (Undiff.): *Eng.*, Busk, '59.——*Holl.-Belg.*, Canu, '20; Lagaaij, 1952.——*Fr.*, Canu, '13.——*Sp.*, Barrosa, '45; Faura & Canu, '16.——*Italy*, Cipolla, '21; Manzoni, '69, '75; Namias, '90-91; Neviani, '95, '98; Waters, '78.——*Cyprus-Rhodes*, Manzoni, '77; Pergens, '87; Reed, '35.——*N.Afr.*, Buge, '47; Canu, '13.——*U.S.(S.C.-Fla.)*, Canu-B., '23; Tuomey & Holmes, '57.——*C.Am.*, Canu-B., '28.——*Arg.*, Canu, '08.——*Japan*, Sakakura, '35.——*Austral.*, Stach, '35.——*N.Z.*, Brown, 1952; Uttley, '49.

Tertiary (Undifferentiated)

Tert.: *Ger.*, Reuss, '51; Roemer, '63.——*Italy*, Cipolla, '26; Gioli, '89; Manzoni, '69-71; Neviani, '00, '05; Seguenza, '79.——*Sp.*, Barrosa, '49.——*Hung.*, Karössy, '40.——*Russ.*, Mokrinskii, '15-16.——*Greece*, Mitzopoulos, '40.——*N.Afr.*, Canu, '04; Cipolla, '26, '29, '33.——*Tasm.*, T.Woods, '77.——*Antarct.*, Wilckens, '24.

Pleistocene

Pleisto.: *Italy*, Canu, '20; Cipolla, '24-25; Neviani, '91, '95-96.——*Can.(Que.)*, Dawson, '59.——*U.S.(Atl.Coast)*, Canu-B., '23.——*C.Am.*, Canu-B., '23.—— *U.S.(Calif.)*, Canu-B., '23; Gabb-H.,

'62.——*Arg.*, CANU, '08.——*Japan*, SAKAKURA, '35, '38.——*Antarct.*, HENNIG, '11.

Recent

ARCT.: ABRIKOSOV, '45; BIDENKAP, '00, '05; BORG, '26; HINCKS, '80; KLUGE, '06, '29; LEV., '16; NORGAARD, '96-97, '00, '03-06, '18, '23; NORMAN, '03, '05; OSBURN, '19, '28, '30; RIDLEY, '81; SMITT, '66, '77-78; WATERS, '00, '04.

N.ATL.(WEST): CANU-B., '28; HINCKS, '88-89, '92; HUTCHINS, '45; LEIDY, '55; MARCUS, '41; OSBURN, '10, '12-14, '27, '32-33, '40, '44, '47; ROGICK & CROASDALE, '49; SMITT, '72-73.

N.ATL.(EAST): BARROSA, '12, '15; BORG, '26; BUSK, '58-60, '81, '84, '86; CALVET, '28, '31; CANU-B., '25, '28; COUCH, 1844; HARMER, '91, '33; HASSALL, 1840-41; HINCKS, '60, '62, '77; JOHNSON, 1847; JULLIEN, '82; JULLIEN & CALVET, '03; LANDSBOROUGH, '52; LEV., '94, '09; LOPPENS, '06, '48; MARCUS, '19, '26, '40; MOORE, '37; NOBRE, '04, '37: NORDGAARD, '24-25; NORMAN, '09; ORTMANN, '94; OSBURN, '26; PERGENS, '89; SILÉN, '43, '46-47; WATERS, '99, '18.

S.ATL.: BORG, '44; BUSK, '84, '86; CANU-B., '28; HASENBANK, '32; JULLIEN, '91; MARCUS, '37-39, '41-42, '49; D'ORB., 1839; RIDLEY, '81; WATERS, '05.

MEDIT.: ANTIPA, '41; AUDOUIN, 1826; BARROSA, '15-35, '49; CALVET, '02, '27; CANU, '04, '12; CANU-B., '25, '28, '30; FRIEDEL, '18; HELLER, '67; HINCKS, '86-88; NEVIANI, '39; PERGENS, '89; SAVIGNY, 1809; WATERS, '79, '90, '97, '10, '18, '22-23, '25.

S.AFR.COAST: BUSK, '52, '54, '84, '86; HINCKS, '80, '91; LEV., '09; MARCUS, '22; O'DONOGHUE, '24; O'DONOGHUE & DEWATTEVILLE, '35, '37, '40.

INDIANO.: BUSK, '86; CANU-B., '29; HARMER, '15, '24, '26, '34; HASENBANK, '32; HINCKS, '84, '87; KIRKPATRICK, '88; MARCUS, '21-22; ROBERTSON, '21; THORNELEY, '05; WATERS, '13-14.

ANTARCT.: BORG, '26, '44; BUSK, '79, '86, '88; CALVET, '09; HARMER, '34; HASENBANK, '32; HASTINGS, '43; KLUGE, '01-03, '23; LIVINGSTONE, '11-14, '28; THORNELEY, '24; WATERS, '98, '04.

SW.PAC.: BORG, '44, BRETNALL, '22; BUSK, '84, '86; CANU-B., '29; HARMER, '26; HASENBANK, '32; HASTINGS, '32; HINCKS, '81, '83-85, '91, '93; HUTTON, '73, '80, '96; KIRKPATRICK, '90; LEV., '09; MACGILL., '79-91; MAPLE., '05, '09; MARCUS, '22; SILÉN, '46; UTTLEY, '49; WATERS, '89, '06, '21; WILSON, '80.

S.PAC.: BUSK, '84; CANU-B., '29-30; HARMER, '23; HASTINGS, '30; LEV., '09; MARCUS, '21; OSBURN, 1950, 1952; WATERS, '89.

N.PAC.: BORG, '33; BUCHNER, '24; BUSK, '84; CANU-B., '27-29; HARMER, '26; HINCKS, '82, '84; MAPLE., '08-09; MATAWARI, '48; O'DONOGHUE & O'DONOGHUE, '23, '25-26; OKADA, '17-21, '23, 28-29, '33-34; OKADA & MATAWARI, '35; D'ORB., 1839, 1846; ORTMANN, '80, '90; OSBURN, 1950, 1952; ROBERTSON, '00, '04-06, '08, '10; SAKAKURA, '35; SILÉN, '24, '41-42, '47; YANAGI & OKADA, '18.

SYSTEMATIC DESCRIPTIONS

Phylum BRYOZOA Ehrenberg, 1831

[=Polyzoa J. V. THOMPSON, 1830]

Minute, almost exclusively marine colonial animals, comprising a very few forms without hard parts, some with a membranous covering partly chitinous, and a vast majority with a calcareous skeleton. The body contains a U-shaped alimentary canal with mouth and anus, the mouth being surrounded by slender ciliated tentacles which function in gathering food. Reproduction of individuals within the variously shaped colonies is by budding, but fertilized ova produced by some members of the colony are ultimately liberated as free-swimming larvae, which later become attached and initiate growth of new colonies. *?U.Cam., Ord.-Rec.*

Subphylum ENTOPROCTA Nitsche, 1869

[=Calyssozoa A. H. CLARK, 1921; Kamptozoa CORI, 1927]

Soft-bodied animals without hard parts and lacking a body cavity; a ring of tentacles borne on a fleshy ridge (lophophore) encloses both mouth and anus, the tentacles being folded into a vestibule closed by a sphincter when they are retracted. *Rec.*

The comparatively few species assigned to this assemblage are interpreted either to represent the most primitive expression of the Bryozoa or to be referable to an independent phylum less highly organized than the bryozoans. In the Entoprocta, the tentacles of the naked stalked polypide are folded or rolled inward during retraction, coming to rest in a vestibule closed by a circular muscle; they are not pulled downward by withdrawing the lophophore which supports them (Fig. 5). The body wall is not strengthened by chitin or calcium carbonate, and no open space (coelome) occurs between it and the alimentary canal. Excretory and reproductive organs are present, with ducts leading to the vestibule.

Individuals formed by budding are characterized by extreme isolation from one

another, and in this respect they differ from almost all other bryozoans, among which neighboring members of the colony normally are in close contact. In the typically entoproctous genus *Loxosoma,* no colony is formed even though new individuals develop by budding from old ones, for each zooid breaks away when it has matured, and leads an independent existence. Other genera of the Entoprocta exhibit a colonial mode of growth in which a threadlike duct (stolon) at intervals emits a cylindrical stalk that expands terminally as the body of a zooid. Best-known genera include *Loxosoma* KEFERSTEIN, 1863; *Urnatella* LEIDY, 1851; and *Pedicellina* M. SARS, 1839 (Fig. 5). They are confined to fresh waters. No representatives of the Entoprocta are known as fossils.

Subphylum ECTOPROCTA Nitsche, 1869

Lophophore circular or horseshoe-shaped, surrounding mouth but not the anus; tentacles retractile into an inwardly folded delicate sheath (introvert) formed by part of the body wall. Fluid-filled body cavity surrounding the alimentary canal contains reproductive organs. Body wall membranous or calcareous. Exclusively colonial and almost entirely marine. *?U.Cam., Ord.-Rec.*

Class GYMNOLAEMATA Allman, 1856

Lophophore circular, without a lip (epistome) overhanging the mouth; body cavities not connected and body wall not muscular. *?U.Cam., Ord.-Rec.*

This division, bearing a name which signifies "naked [unprotected] throat," contains an overwhelming majority of all known bryozoans, fossil and Recent. Almost exclusively they are marine. Some have a membranous or chitinous zooecial covering around the polypides, but most have a calcareous skeleton.

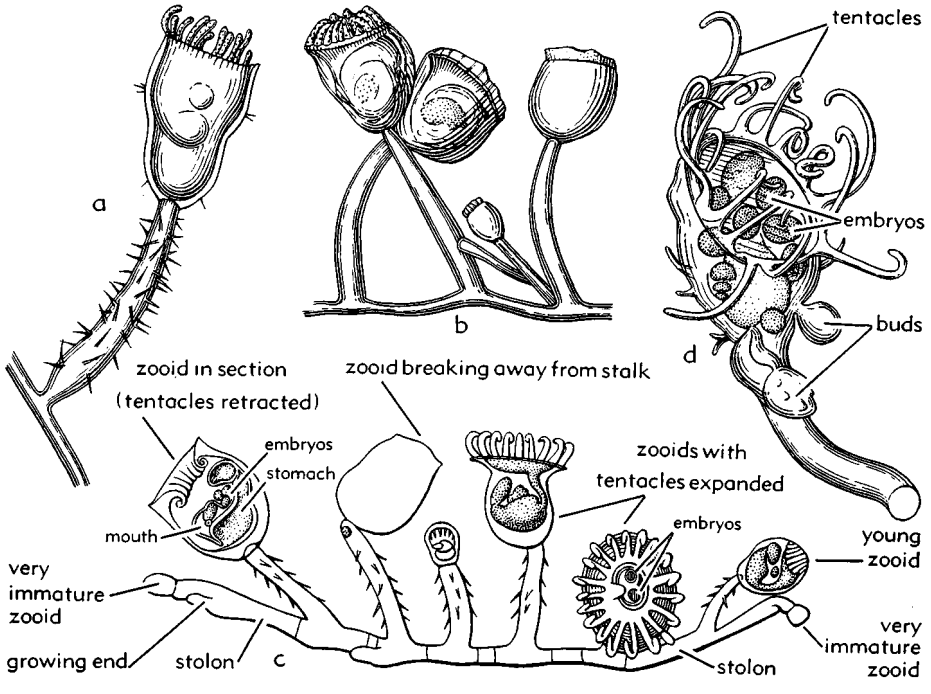


FIG. 5. Morphological features of Entoprocta.

a-c, Pedicellina cernua PALLAS, Rec., NE.Atl. *a,* Zooid with spinose stalk (peduncle), polypide with extended tentacles; flexuous stolon at lower left (×36). *b,* Zooids in various growth stages, ×20. *c,* Colony showing growing end of stolons, embryos, and young to mature zooids, ×22 (167).

d, Loxosoma cerriferum HARMER, Rec., E.Ind., female zooid showing embryo within circle of tentacles and various stages of buds, enlarged (164).

Order CTENOSTOMATA Busk, 1852

[=Cheiloctenostomata SILEN, 1942 *(partim)*]

Zooids developed by budding from a slender tubular stolon, generally isolated. Zooecia membranous, with terminal aperture closed by a flexible fold of the body wall bearing a comblike row of setae. Specialized reproductive individuals (gonozooids) occur in some families. *Ord.-Rec.*

Zooids of the Ctenostomata resemble the Entoprocta in being isolated from one another and developed by budding from internodes of a distinct tubular stolon or stem. They may unite laterally to form sheets, but in both types of zoarium the body wall of the zooids is uncalcified and generally quite soft. The threadlike stolon gives off cylindrical stalks, each of which dilates at its end into the body of the zooid. In all known living ctenostomes, the zooecia are membranous, being little capable of preservation as fossils. In some, however, the stolon becomes partially calcified and thus may be preserved in rocks. Also, some Ctenostomata are able (possibly by chemical solution) to excavate a place for themselves in substance of the shell or other host which they incrust, and the size and shape of such excavations may serve for identification of fossil species.

The Ctenostomata are typically marine, but a few genera live in estuaries, for which reason and others, they have been judged to be progenitors of the exclusively freshwater class Phylactolaemata.

Illustration of the anatomy of zooids of a

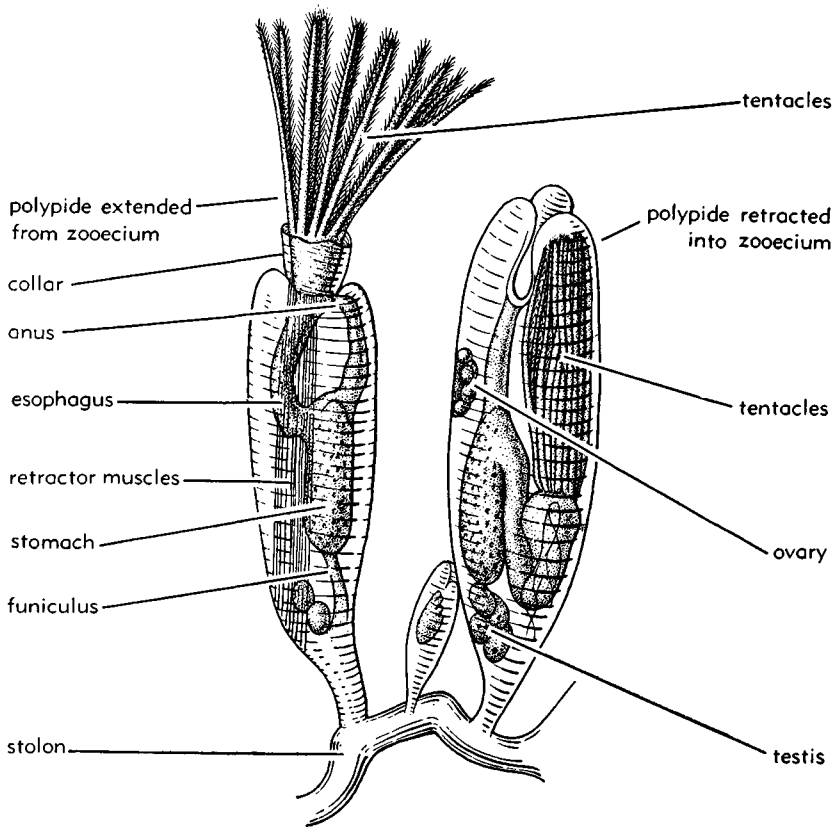


FIG. 6. Morphological features of a typical ctenostome (*Farrella repens* FARRE, Rec., E.Atl.) showing adult zooids and a young one growing from a stolon, the tentacles of one individual extended and in another retracted *(after van Beneden)*.

Recent ctenostome (Fig. 6) makes evident the similarity in structure of these bryozoans to representatives of other orders. The pinnately arranged stolons of *Ropalonaria* (Ord.-Perm.), indicated by excavations in shells or corals, are perhaps the most common Paleozoic fossils belonging to this group, although the chainlike *Allonema* (Sil.-Penn.) and radially arranged bulbous vesicles of *Eliasopora* (Sil.-Miss.) often are found. The threadlike species are interesting because (excepting the doubtful *Archaeotrypa* from Upper Cambrian rocks) the oldest known bryozoan is a ctenostome of this type, named *Marcusodictyon priscum;* it occurs in lowermost Ordovician strata of Estonia. Many of the known Paleozoic Ctenostomata formerly were regarded as trilobite eggs, sponge borings, or foraminifers (39,116). Possibly the slightly calcified zoaria of all known Paleozoic ctenostomes represent creeping bases which supported the zooids.

Mesozoic and Tertiary ctenostomes seem to be rare, for little has been published about them. The few recorded forms are most like *Ropalonaria.*

In Recent seas, some ctenostome species are very abundant as individuals and widely distributed (70,75). *Alcyonidium* and related genera grow as soft incrustations or build masses 6 inches high, and in these the zooecia are closely united. In *Bowerbankia,* erect branches of the zoarium bear tufts of zooecia at regular intervals; in *Amathia,* the branches have a spiral arrangement.

The classification of Recent Ctenostomata adopted here is that which prevailed before SILÉN (1942) published studies in which he combined the ctenostomes with cheilostomes as Cheiloctenostomata. In view of the great time interval between Early Ordovician, when the oldest known ctenostome appeared and middle Mesozoic, when the first cheilostomes became established, close relationship between these divisions of the Bryozoa seems improbable.

Suborder CARNOSA Gray, 1841

[=Halcyonellea HINCKS, 1880]

Aperture at distal extremity of box-shaped zooid closed by circular folds of the body wall; collar present. Zooids budding laterally from ancestrula in direct line with each other. *Rec.*

Family ALCYONIDIIDAE Johnston, 1849

Alcyonidium LAMX.. 1821 [**Alcyonium gelatinosum* LINNÉ, 1766] [=*Halodactylus* FARRE, 1837]. Zoarium a gelatinous crust or with fleshy cylindrical expansions. Zooecia in contact. *Rec.*——FIG. 7, 7. **A. gelatinosum* (LINNÉ), Atl.; *7a,* ×1; *7b,* ×20, edge view of zooecia; *7c,* zooecia, ×40 (167).
Benedinipora PERGENS, 1888; **Clavopora** BUSK, 1874; **Lobiancopora** PERGENS, 1888.

Family FLUSTRELLIDRIDAE Bassler, nov.

[=emend. Flustrellidae Hincks, 1880]

Flustrellidra BASSLER, nov. [*pro Flustrella* GRAY, 1848 (*non* EHR., 1839, *nec* D'ORB., 1852)] [**Flustra hispida* FABRICIUS, 1780]. Movable lip acts as an operculum. *Rec.,* N.Atl.
Elzerina LAMX., 1816; **Pherusa** LAMX., 1821.

Suborder PALUDICELLEA Allman, 1856

Zooids with proximal ends prolonged and narrow, stolon-like. *Rec.*

Family VICTORELLIDAE Hincks, 1880

Paludicella GERVAIS, 1836; **Pottsiella** HARMER, 1915; **Victorella** SAVILLE-KENT, 1870.

Family ARACHNIDIIDAE Hincks, 1880

Arachnidium HINCKS, 1877 [**A. hippothoides*]. Creeping or stolonate network of zooecia connected by slender fibers with zooecia arising at crossings. *Rec.* ——FIG. 7,3. **A. hippothoides,* Irish Sea; ×25 (167).
Arachnoidea MOORE, 1903; **Platypolozoon** ANNANDALE, 1912.

Family NOLELLIDAE Harmer, 1915

[emend. Cylindroeciidae HINCKS, 1880]

Nolella GOSSE, 1855 [**N. stipata*] [=*Cylindroecium* HINCKS, 1880]. Incrusting, basal part with spinose dilatations with tall zooecia. *Rec.*——FIG. 7,4. *N. dilatata* (HINCKS) (type of *Cylindroecium*), NE.Atl.; *4a,* basal part with spines, ×25; *4b,* zooecia arising from base, ×25 (167).
Anguinella VAN BENEDEN, 1845.

Suborder VESICULARINA Johnston, 1847

Zooids developed from erect free thick stolon. *Rec.*

Family VESICULARIIDAE Hincks, 1880

Vesicularia J. V. THOMPSON, 1830 [**Sertularia spinosa* LINNÉ, 1766]. Zoarium repent or erect, rooted by a fibrous base. *Rec.*——FIG. 7,2. **V. spinosa* (LINNÉ), NE.Atl.; tip of branch, zooecia stripped away, ×25 (167).

Avenella DALYELL, 1847 [**A. fusca*]. Tubular repent stolon with erect solitary zooecia, 20 to 24

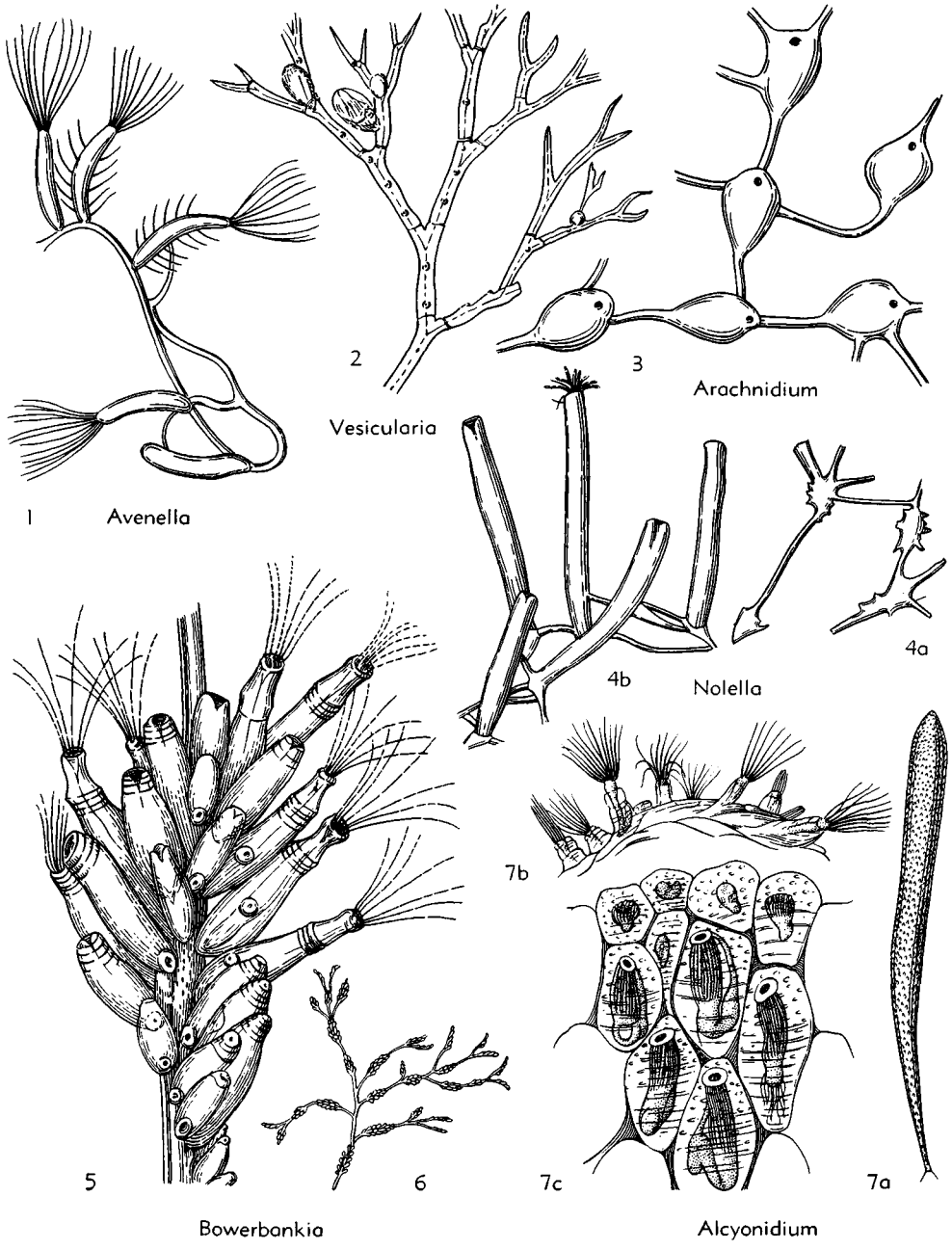


FIG. 7. Alcyonidiidae, Arachnidiidae, Nolellidae, Vesiculariidae (p. G33-G35).

tentacles in a circle. *Rec.*——Fig. 7,*1*. **A. fusca*, NE.Atl.; ×25 (167).

Bowerbankia Farre, 1887 [**Sertularia imbricata* Adams, 1800]. Zoarium repent or erect. Zooecia oval, disjunct, clustered, subspirally arranged. *Rec.*——Fig. 7,*5*. *B. pustulosa* Ellis-S., Atl.; polypide expanded, ×25 (167).——Fig. 7,*6*. **B. imbricata* (Adams), Atl.; ×1 (167).

Amathia Lamx., 1812; **Cryptopolyzoon** Dendy, 1889; **Hislopia** Carter, 1858; **Norodoniana** Jullien, 1880; **Zoobotryoon** Ehr., 1831.

Suborder STOLONIFERA Ehlers, 1876

Zoarium formed by lateral budding from delicate creeping stolon which expands at intervals, zooids generally arising in pairs; zooecial apertures closed with collar as in Carnosa. *Ord.-Rec.*

Family WALKERIIDAE Bassler, nov.

[=emend. Valkeriidae Hincks, 1880] *(Rec.)*

Walkeria Fleming, 1823 [**Sertularia uva* Linné, 1766] [=*Valkeria* Fleming, 1828]. Zoarium erect with ovate, clustered zooecia, contracted below, deciduous. *Rec.*——Fig. 8,5. **W. uva* (Linné), Atl.; ×15 (167).

Monastesia Jullien, 1888.

Family MIMOSELLIDAE Hincks, 1851

(Rec.)

Mimosella Hincks, 1851; **Hypophorella** Ehlers, 1876.

Farrella Ehr., 1838 [*pro Lagenella* Farre, 1837 (*non* Ehr., 1835)] [**Lagenella repens* Farre, 1837] [=*Laguncula* van Beneden, 1845]. Zoarium repent. Zooecia elliptical, scattered, with bilabiate aperture. *Rec.*——Fig. 8,*1*. **F. repens* (Farre), Atl.; ×25 (167).

Family BUSKIIDAE Hincks, 1880

(Rec.)

Buskia Alder, 1857.

Family TRITICELLIDAE Sars, 1874

(Rec.)

Triticella Dalyell, 1848.

Family ROPALONARIIDAE Bassler, nov.

[=emend. Rhopalonariidae Nickles-B., 1900]

Zoarium of fusiform internodes or cells connected by delicate tubular stolons pinnately arranged and becoming partly embedded by excavating surface of host. Zooecia unknown, probably deciduous and developed by budding from a subcentrally located pore in the internodes (1). *Ord.-Perm.*

Ropalonaria Ulr., 1879 [**R. venosa*] [=*Rhopalonaria* Miller, 1889] Represented by clublike excavations in host, species distinguished chiefly by variations in stolon dimensions. *Ord.-Perm.*—— Fig. 8,*4*. **R. venosa*, U.Ord.(Richmond.), Ohio; *4a*, incrusting *Streptelasma*, ×1; *4b*, ×25 (222).

Family VINELLIDAE Ulrich & Bassler, 1904

Creeping base of single delicate tubular threads, locally segregated or proceeding from more or less definite centers. Pores in single row on stolon but numerous on internodes of segmented forms; zooecia unknown, probably deciduous (1). *Ord.-Cret.*

Vinella Ulr., 1890 [**V. repens*]. Delicate tubular stolons radially arranged with single row of small pores. *Ord.-Cret.*——Fig. 8,2. **V. repens*, M.Ord. (Blkriv.), Minn.; *2a*, on brachiopod, ×1; *2b*, ×25 (222).——Fig. 8,*3*. *V. radiata* Ulr.-B., U.Ord.(Maysv.), Ohio; ×1 (222).

Allonema Ulr.-B., 1904 [**A. botelloides*]. Parasitic base comprising strings of sausage-like bulbous vesicles (internodes) with minutely punctate surface; porelike depression near end of vesicle probably marks point where erect zooid was attached. *Sil.-Penn.*——Fig. 8,*6*. **A. botelloides*, Sil., Gotl.; *6a,b*, ×10; *6c*, ×25 (223).

Condranema Bassler, 1952 [*pro Heteronema* Ulr.-B., 1904 (*non* Dujardin, 1841, *nec* Keller, 1889)] [**Heteronema capillare* Ulr.-B., 1904]. Simple or locally jointed, delicate creeping stolons without apparent order; pores in single row. *Ord.-Perm.*——Fig. 8,*8*. **C. capillare* (Ulr.-B.), Sil., Gotl.; ×10 (223).

Marcusodictyon Bassler, 1952 [**Heteronema priscum* Bassler, 1911]. Like *Condranema* but stolons unite to form generally 6-sided polygons. *Ord.*—— Fig. 8,*7*. **M. priscum* (Bassler), L.Ord., Est.; *7a*, on brachiopod, ×10; *7b*, one colony growing over another, ×25 (131).

Vinelloidea Canu, 1913 [**V. crussolensis*]. Like *Vinella* but stolons twisted, not regularly arranged. *Jur.*——Fig. 8,*9*. **V. crussolensis*, U.Jur. (Oxf.), Fr.; ×10 (136).

Family ASCODICTYIDAE Miller, 1889

[as Ascodictyonidae]

Parasitic threadlike branching stolons with bulbous pyriform minutely punctate vesicles isolated or in stelliform clusters; zooecia unknown (1). *Sil.-Perm.*

Ascodictyon Nich.-E., 1877 [**A. fusiforme*]. Elongate pyriform vesicles with connecting threads little developed. *Sil.-Perm.*——Fig. 9,*3*. **A. fusiforme*, M.Dev., Mich.; ×10 (223).

Bascomella MORNINGSTAR, 1922 [**B. gigantea*]. Large ovoid to fusiform irregularly arranged vesicles connected by narrow tubular stolons, both embedded in host, generally preserved as internal molds. *Penn.-Perm.*——FIG. 9,*5*. **B. gigantea*, Penn., Ohio; ×10 (194).

Eliasopora BASSLER, 1952 [**Ascodictyon stellatum* NICH.-E., 1877]. Like *Ascodictyon* but vesicles oval, grouped in radiating clusters, connected at intervals by stolons. *Sil.-Miss.*——FIG. 9,*2*. **E. stellata* (NICH.-E.), Dev., N.Y.; ×25 (223).——FIG. 9,*1*. *E. siluriensis* (VINE), Sil., N.Y.; ×10 (223).

Family TEREBRIPORIDAE d'Orbigny, 1847

Zoarium a network of small canals perforating superficial enamel of shells. Zooe-

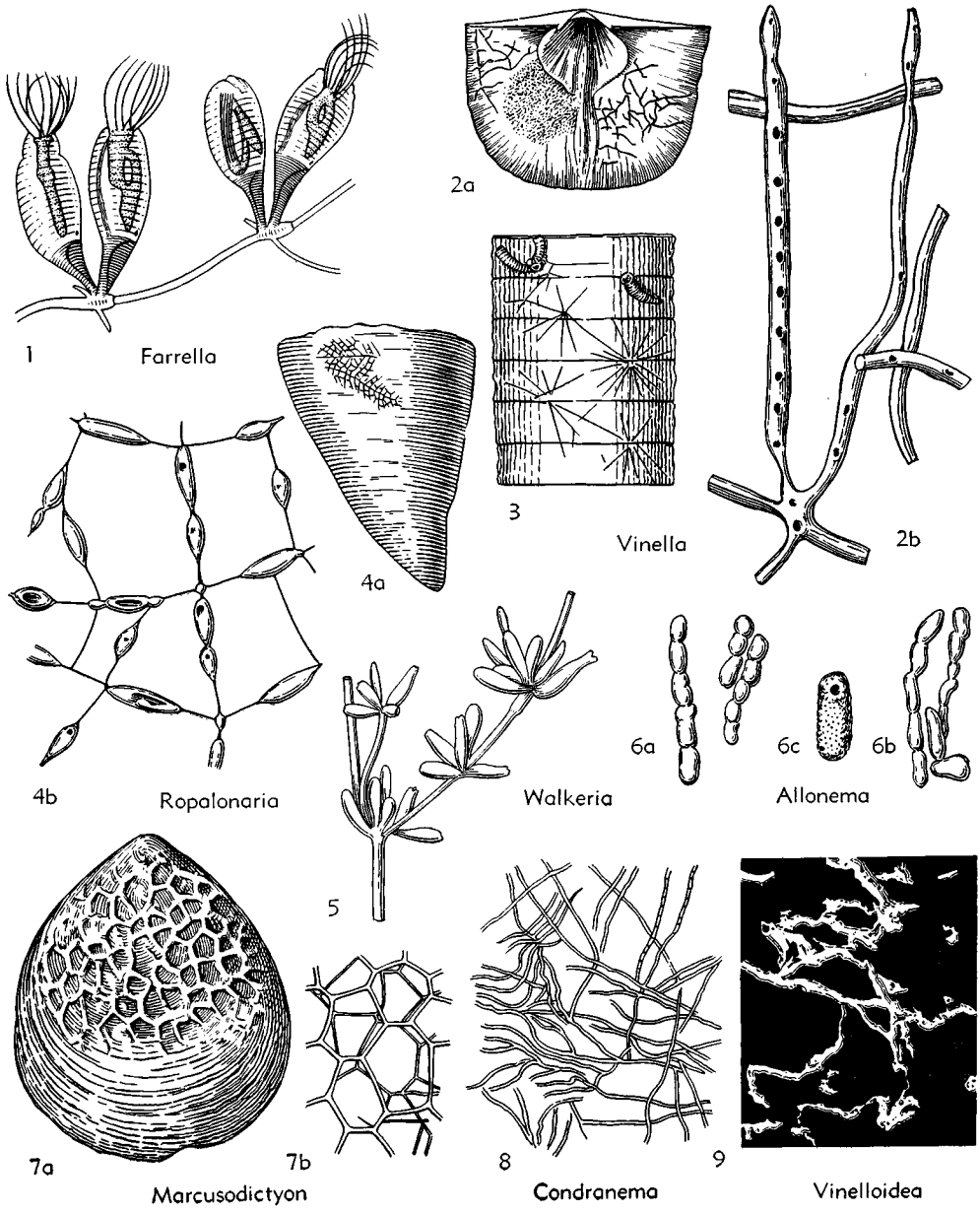


FIG. 8. Walkeriidae, Mimosellidae, Ropalonariidae, Vinellidae (p. G35).

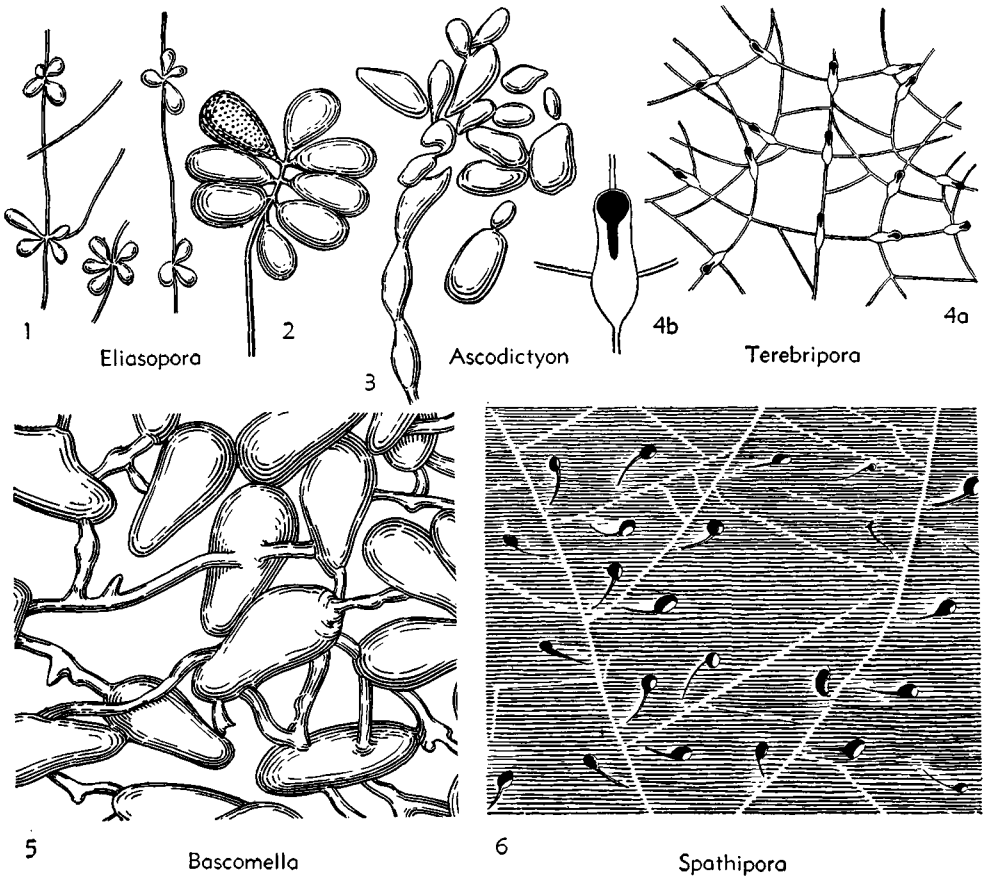


FIG. 9. Ascodictyidae, Terebriporidae (p. G35-G37).

cial apertures with rimule, not operculated; no gonozooid. *Tert.-Rec.*

Terebripora D'ORB., 1842 [**T. ramosa*]. Primary stolons joined to zooecia by secondary ones. *Jur.-Rec.*——FIG. 9,*4*. **T. ramosa*, Rec., Atl.; *4a*, ×25; *4b*, ×50 (137).

Spathipora FISCHER, 1866 [**S. sertum*]. Zoaria lack secondary stolons. Zooids thin, elongate, fusiform, with long peduncle attached to stolons and arranged alternately. *Mio-Rec.*——FIG. 9,*6*. **S. sertum*. Mio.(Helv.), Fr.; ×25 (137).

Family PENETRANTIIDAE Silén, 1946

Penetrantia SILÉN, 1946 [**P. densa*]. Primary stolons perforating host, connected to zooids by short secondary stolons entering near distal end. Zooids operculated, gonozooid present. *Rec.*

Family IMMERGENTIIDAE Silén, 1946

Immergentia SILÉN, 1946 [**I. californica*]. Perforating zoaria without secondary stolons. *Rec.*

Order CYCLOSTOMATA Busk, 1852

[=Centrifugines D'ORB., 1852; Stenolaemata BORG, 1926 (*partim*); Stenostoma MARCUS, 1936 (*partim*)]

Zooecia consisting of simple calcareous tubes, generally without transverse partitions (diaphragms), with plain, rounded, uncontracted aperture, not closed by an operculum; walls thin, minutely porous (with pseudopores), lacking the more complicated structures developed in Cheilostomata and Trepostomata. Reproduction in an ovicell, consisting of an enlarged single zooecium (gonoecium) with special opening (oeciopore) terminated externally by a peristome-like rim (oeciostome), or an inflation of the zoarial surface (gonocyst) covering several apertures. Appendicular organs wanting. The zoarium assumes many different forms of growth, from delicate

jointed threadlike branches to solid masses 10 or more centimeters in diameter, commonly variable in a genus but fairly constant in a species. *Ord.-Rec.*

CLASSIFICATION

Prior to 1900, the families and genera of Cyclostomata were based almost entirely on zoarial growth form and zooecial arrangement, resulting in proposal of several complicated artificial classifications, as noted in a review by GREGORY (1909), whose classification in general is still held, in spite of radical changes by others. BORG (9,11), from studies on Recent bryozoans without notice of fossil forms, has proposed a new order (Stenolaemata) for a combination of the Cyclostomata and Trepostomata. GREGORY (63) inadvisedly referred the Heteroporidae and Cerioporidae to the Trepostomata, overlooking the presence of ovicells, porous walls with pseudopores, and other features that are distinctly cyclostomatous characters.

The distinction between families of Cyclostomata, like other orders of bryozoans, is or should be based on their larval forms, each family being characterized by a special kind of larva. The known larvae of the Cyclostomata are very similar to each other and difficult to discriminate, but fortunately they show differences in evolution of the embryos in ovicells of very different size, form, and position. The first tube of a zoarium is the **ancestrula,** with its lower part comprising a dilated blister-like expansion, called the protoecium, in which the histolysis of the fixed larva and its replacement by the first normal polypide living in the ancestrula occurs. In the Cyclostomata, the aperture invariably is more or less circular, the operculum and cardelles are wanting, leaving the ovicell as the single remaining essential character shown by the zooecia.

The value of the ovicell in classification of the Cyclostomata is therefore of utmost importance, but, unfortunately, its study formerly was much neglected. Some species of Cyclostomata possibly did not develop ovicells, but the majority of them, after some search, undoubtedly will reveal specimens showing this organ. Indeed, one of the most interesting features in the study of the Cyclostomata is the search for ovicelled specimens among the many described species where now no ovicell is known. A beginning toward a natural classification of the Cyclostomata was made by CANU early in the century, and in 1920 CANU & BASSLER amplified this subject. The student is referred to their work for more details and references to other researches on the group.

MORPHOLOGICAL FEATURES

In spite of general simplicity of organization, the Cyclostomata exhibit various features which can be used in connection with the ovicell for classification. For example, in many Cyclostomata accessory tubes **(kenozooecia** are developed either on the frontal or the dorsal side of the zoarium. These tubes are closed or open special sorts of zooecia which appear to lack a polypide. Thin sections of the zoarium frequently are necessary to determine the nature of such accessory tubes. The dorsal side of many branching forms is occupied in some species by short tubes called **nematopores,** which appear at the surface as threadlike structures and in thin sections as narrow upwardly directed tubes. Somewhat similar tubes on the dorsal side grow in the opposite direction, that is, toward the zoarial base. Certain Cyclostomata exhibit pores on the dorsal side which are as large as polypide tubes but distinguished by their polygonal orifice. These are termed **tergopores.** Somewhat similar pores on the frontal side, but covered by calcareous closures, are known as **dactylethrae;** another curious development on the frontal side is cylindrical tubes **(cancelli)** closed by a finely perforated lamella and garnished in the interior with numerous spinules. Still other forms of tubes in this order are ramifications of the polypidian tubes, termed **vacuoles** and **mesopores.** The physiologic function of these various accessory tubes is unknown, but they are constant in their development and are therefore of value in classification.

The method of division **(gemmation)** of the zooecial tubes in the Cyclostomata also is quite important. In one method (peripheral), the tubes bifurcate at all heights and in all directions. In another (oriented), gemmation occurs in a definite manner on a single or on 2 sides of a basal lamella or

of an axial zone. Thin sections are indispensable in the study of this order.

The study of many Cyclostomata, particularly those forming solid calcareous zoaria, requires thin sections. The preparation of such sections is discussed in this article under "Technique."

In addition to the ovicells and other features just mentioned, the size of the apertures and distances between them are important in specific identifications. Probably the simplest and most trustworthy method of identifying closely allied species is by preparation of uniformly magnified photographs of the zoarial surface. The magnification of 12 and 25 diameters for the Cyclostomata has been found most useful and is recommended for comparative purposes. Polyembryony occurs wherein many larvae result from the budding of a single embryo.

DISTRIBUTION

The Cyclostomata are first known in the Lower Ordovician and continue until the end of the Paleozoic era, fairly well de-

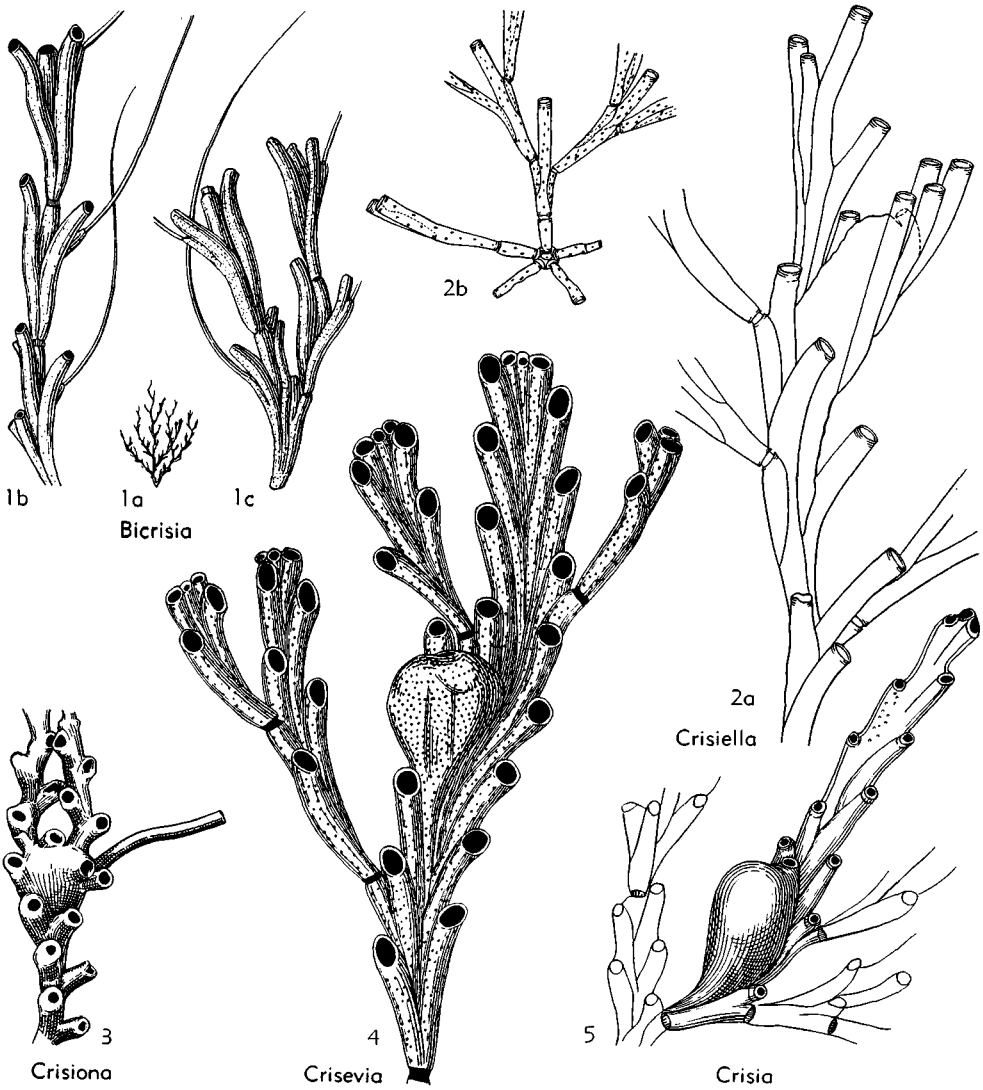


FIG. 10. Crisiidae (p. G40).

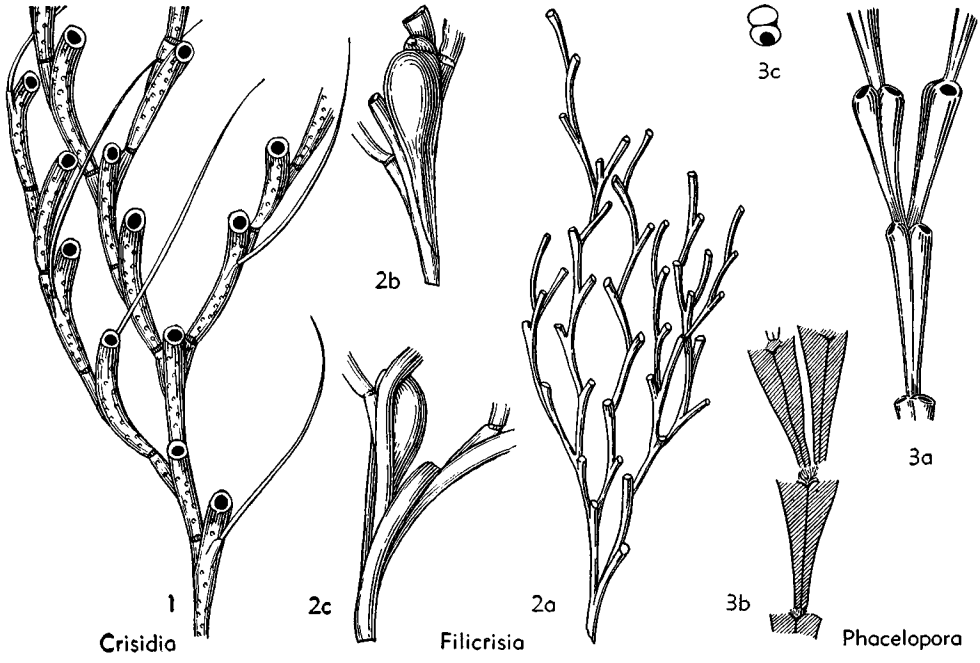


FIG. 11. Crisiidae, Phaceloporidae (p. G40, G41).

veloped in numbers but of less importance than the 2 strictly Paleozoic orders, Trepostomata and Cryptostomata. In the early and middle Mesozoic, they constitute the predominating order, but in the Cretaceous, the Cheilostomata assume first place and continue so until the present. The Paleozoic forms have been described by ULRICH and other workers mentioned under the Trepostomata. The Mesozoic species have been the subject of numerous publications, among which may be mentioned those by GREGORY (63) and D'ORBIGNY. The Cenozoic Cyclostomata likewise have received much attention (13,24,75).

Suborder ARTICULATA Busk, 1859

[=Radicata BUSK, 1858; Camptostega BORG, 1926]

Zoaria mostly articulated, with rhizoids; erect primary zooid separated by joint from primary disk. Zooecia tubular, with calcareous walls; vestibular sphincter present; ovicell (where known) dilated in middle part (9). *Sil.-Rec.*

Family CRISIIDAE Johnston, 1847

Zoaria erect, richly branched, mostly articulated, joints corneous. Zooecia tubular, in single or double series, opening on one side only; ovicell symmetrical, sacciform, isolated, paralleling zooecial axis, with terminal large oeciopore (24). *Cret.-Rec.*

Crisia LAMX., 1812 [**Sertularia eburnea* LINNÉ, 1758] [=*Lafoea* LAMX., 1821]. Biserial, 3 or more zooecia in sterile segments, 5 or more in fertile. *Eoc.-Rec.*——FIG. 10,*5*. **C. eburnea* (LINNÉ), Rec., Atl.-Eur.; zoarium with ovicell, ×25 (202).

Bicrisia D'ORB., 1853 [**Crisidia edwardsiana* D'ORB., 1839]. Sterile segments of 2 zooecia and fertile of 3 to 5; gonozooids on dorsal side, free for much of length. *Rec.*——FIG. 10,*1*. **B. edwardsiana* (D'ORB.), Patag.; *1a*, zoarium, ×1; *1b,c*, front, back, ×25 (202).

Crisevia MARCUS, 1937 [**C. pseudosolena*]. Rec. ——FIG. 10,*4*. **C. pseudosolena*, Braz.; ×25 (185).

Crisidia M.EDW., 1838 [*Falcaria* OKEN, 1815 (*non* HARWORTH, 1809)] [**Sertularia cornuta* LINNÉ, 1758]. Uniserial, one zooecium to a segment and gonozooid only member of its internode.——FIG. 11,*1*. **C. cornuta* (LINNÉ), Rec., Atl.; ×25 (202).

Crisiella BORG, 1924 [**Crisia producta* SMITT, 1864]. Sterile segments of 3 to 7 zooecia, fertile commonly with more than 20. *Rec.*——FIG. 10,*2*. **C. producta* (Smitt), Atl.; *2a*, fertile internode, ×25; *2b*, part with primary disc, ×25 (137).

Crisiona CANU-B., 1928 [**C. baculifera*]. Zoarium not articulated. Ovicell a triangular sac with flat area on one exterior face. *Cret.-Rec.*——FIG. 10,*3*. **C. baculifera*, Rec., Hawaii; ×25 (137).

Filicrisia D'ORB., 1853 [**Crisia geniculata* M.EDW., 1838]. Sterile segments with 1 to 3 zooecia, fertile with 3 to 5, most internodes with single one, ovicell adherent full length. *Rec.*——FIG. 11,*2*. **F. geniculata* (M.EDW.), E.Atl.; *2a*, branch without ovicell, ×25; *2b,c*, ovicell, front and back, ×50 (202).

Unicrisia D'ORB., 1853 [**U. compressa*]. Uniserial; ?jointed. *Cret.(Senon.)*, Fr.

Family PHACELOPORIDAE Miller, 1889

Zoarium erect, articulated; each segment a short cone-shaped bundle of 2 or more equal conical parallel zooecia with subterminal end slightly contracted; apertures circular. Ovicell unknown (114). *Sil.-Dev.*

Phacelopora ULR., in MILLER, 1889 [**P. pertenuis* ULR., 1890].——FIG. 11,*3*. **P. pertenuis* ULR., Sil.(U.Medin.), Ill.; *3a*, segments; *3b*, long. sec.; *3c*, distal end of segment; all ×25 (222).

Suborder TUBULOPORINA Milne-Edwards, 1838

[Parailelata WATERS, 1887; Tubulata GREGORY, 1896; Acamptostega BORG, 1926]

Zoaria ramose, sheetlike, to massive, erect or incrusting. Zooecia tubular, apertures circular; ovicells mostly comprise expanded zooecia with special orifice (oeciopore). Numerous larvae budded from single embryo (polyembryony) (11). *Ord.-Rec.*

Family DIASTOPORIDAE Gregory, 1899

Zoaria incrusting linear series or expansions, erect bifoliate sheets, solid or hollow stems, jointed segments, or small masses. Zooecia simple open tubes; ovicells unknown (24). *Ord.-Rec.*

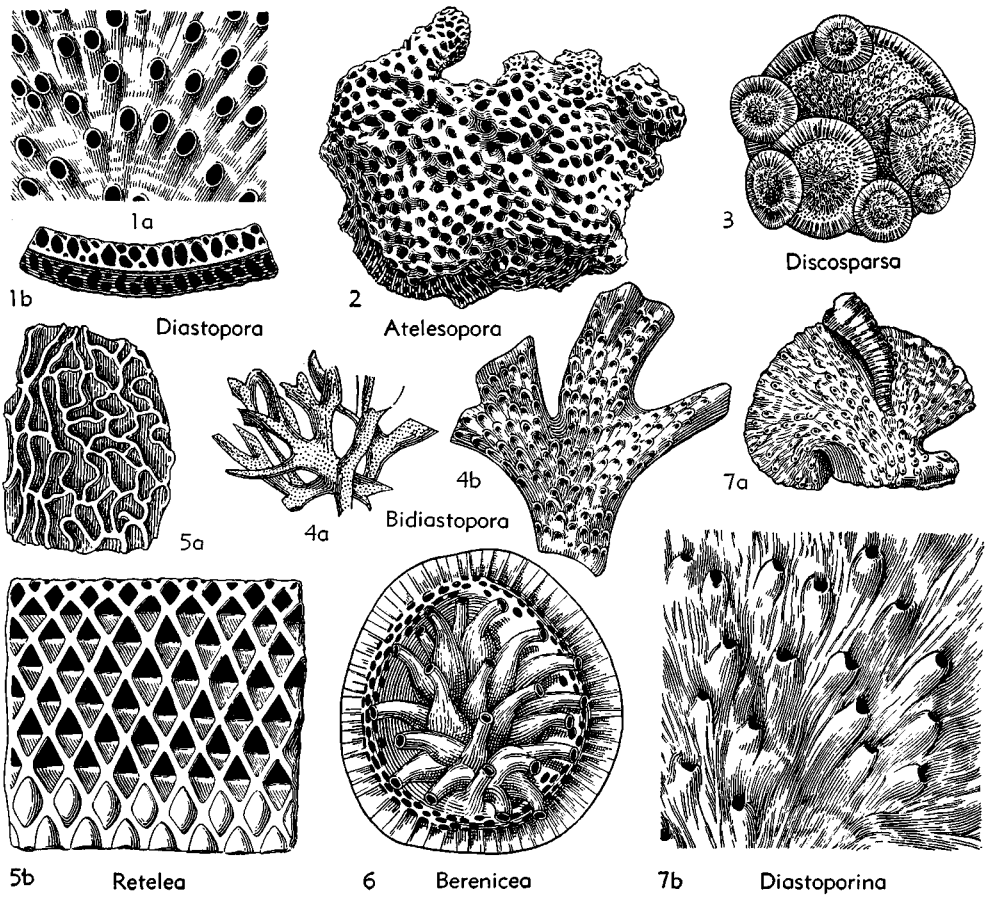


FIG. 12. Diastoporidae (p. G42, G43).

Diastopora LAMX., 1821 [**D. foliacea*]. Erect, bifoliate. *Jur.-Rec.*——FIG. 12,*1*. **D. foliacea*, Jur. (Bath.), Fr.; *1a,b*, surface and edge, ×10 (202).

Atelesopora CANU-B., 1923 [**A. reptans*]. Incrusting salient masses of expanded tubes without peristomes. *Tert.*——FIG. 12,*2*. **A. reptans*, Mio., S.Car.; ×10 (131).

Berenicea LAMX., 1821 [**B. prominens*]. Thin unilamellar, subcircular incrusting sheets without ovicells. *Ord.-Rec.*——FIG. 12,*6*. **B. prominens*, Rec., Medit.; ×25 (202).

Bidiastopora D'ORB., 1849 [**Diastopora cervicornis* MICH., 1846]. Like *Diastopora* but zoaria many-branched stems. *Jur.-Cret.*——FIG. 12,*4*. **B. cervicornis* (MICH.), Jur.(Bath.), Fr.; *4a* ×1; *4b*, ×5 (189).

Cellulipora D'ORB., 1849 [**C. ornata* D'ORB., 1851]. Massive, composed of lamina-bounded angular groups of zooecia packed together. *U.Cret.*——FIG. 13,*2*. **C. ornata* D'ORB., Cenom., Fr.; *2a*, ×1; *2b*, surface, ×2 (202).

Clinopora MARSSON, 1887 [**Entalophora lineata* BEISSEL, 1868]. Narrow, erect, cylindrical branches, surface longitudinally striate. *U.Cret.*——FIG. 13,*5*. **C. lineata* (BEISSEL), Camp., Ger.; *5a*, branch, ×10; *5b*, transv. sec., ×10 (186).

Corynotrypa BASSLER, 1911 [**Hippothoa delicatula* JAMES, 1878]. Like *Stomatopora* but proximal part of zooecium constricted for union with preceding one. *Ord.-Cret.*——FIG. 13,*7*. **C. delicatula* (JAMES), Ord.(Eden.), Ohio; ×25 (131).——FIG. 13,*8*. *C. curta*, Ord.(Richmond.), Wis.;

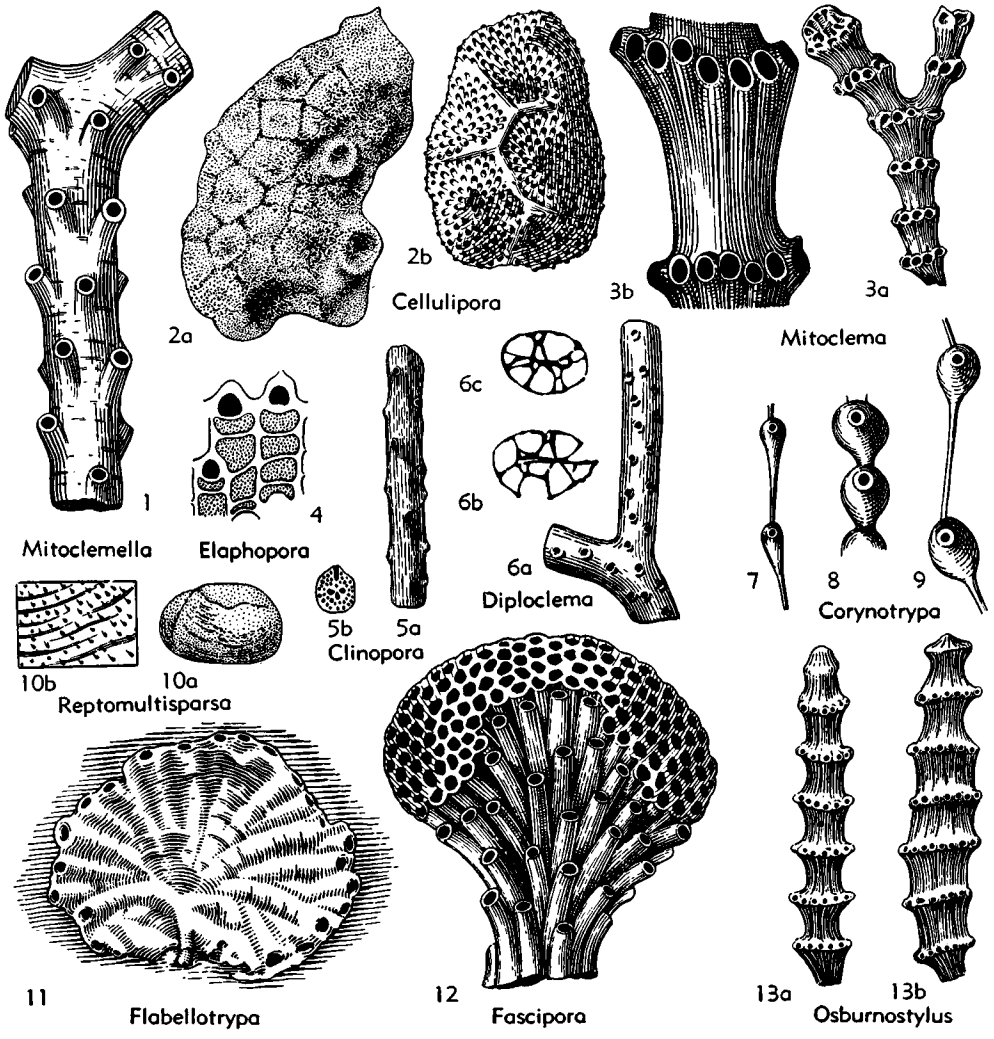


FIG. 13. Diastoporidae (p. G42, G43).

×25(131).——Fig. 13,9. *C. abrupta*, Ord.(Richmond.), Ill.; ×25 (131).

Diastoporina Ulr., 1890 [**D. flabellata*]. Bifoliate flabelliform zoarium with prostrate immersed subtubular zooecia. *Ord.*——Fig. 12,7. **D. flabellata*, Trenton., Minn.; *7a*, frond with attached annelid, ×5; *7b*, surface, ×25 (222).

Diploclema Ulr., 1889 [**D. trentonense* Ulr., 1890]. Like *Mitoclema* but zooecia diverge from mesotheca. *Ord.-Sil.*——Fig. 13,6. **D. trentonense* Ulr., Ord.(Trenton.), N.Y.; *6a*, branch, ×10; *6b,c*, transv. secs., ×25 (222).

Discosparsa d'Orb., 1852 [**D. simplex*]. Small cupuliform attached zoaria. Zooecia radially arranged on upper surface in various growth stages. *Cret.*——Fig. 12,3. *D. marginata* d'Orb., Coni., Fr.; ×5 (202).

Elaphopora Lang, 1926 [**E. cervina*]. Erect flattened bifurcating stems. Short tubular zooecia with surface crossed by transverse partitions. *Jur.*——Fig. 13,4. **E. cervina*, Portl., Eng.; ×25 (175).

Fascipora d'Orb., 1853 [**Diastopora pavonina* Mich., 1845] [=*Fasciporina* d'Orb., 1853]. Erect bundles of zooecia with flat upper margin. *U.Cret.*——Fig. 13,12. **F. pavonina* (Mich.), Cenom., Fr.; ×10 (202).

Flabellotrypa Bassler, 1952 [**F. rugulosa*]. Like *Sagenella* but zooecia open only along outer edges of zoarium. *Sil.-Dev.*——Fig. 13,11. **F. rugulosa*, Dev.(Held.), Tenn.; ×15 (131).

Kukersella Toots, 1952 [**K. bassleri*]. Like *Mitoclema* but tubes in immature region bear many diaphragms. *Ord.* Kuckers, Est.

Mitoclema Ulr., 1882 [**M. cinctosum*]. Narrow erect cylindrical branches. Long tubular zooecia, apertures in transverse parallel rows. *Ord.-Sil.*——Fig. 13,3. **M. cinctosum*, Ord. (Blkriv.), Tenn.; *3a*, ×10; *3b*, ×25 (*3a*, 131; *3b*, 222).

Mitoclemella Bassler, 1952 [**Mitoclema mundulum* Ulr., 1890]. Like *Mitoclema* but apertures in steeply ascending spirals. *Ord.*——Fig. 13,1. **M. mundula* (Ulr.), Trenton., Minn.; ×25 (222).

Osburnostylus Bassler, 1952 [**O. typicalis* Bassler, 1951]. Like *Mitoclema* but zoarium of jointed segments about 4 mm. long. *Ord.*——Fig. 13,13. **O. typicalis* Bassler, Blkriv., Va.; *13a,b*, ×10 (131).

Reptomultisparsa d'Orb., 1853 [**Diastopora microstoma* Mich., 1846] [=*Semimultisparsa* d'Orb., 1853]. Like *Berenicea* but multilamellate. *Jur.-Cret.*——Fig. 13,10. **R. microstoma* (Mich.), Jur.(Bath.), Fr.; *10a*, zoarium, ×1; *10b*, surface, ×5 (189).

Retelea d'Orb., 1853 [**R. pulchella*]. Possibly same as *Reticulipora*. *U.Cret.*——Fig. 12,5. **R. pulchella*, Senon., Fr.; *5a*, zoarium, ×1; *5b*, surface, ×25 (202).

Reticulipora d'Orb., 1849 [**Apsendesia dianthus* Mich., 1847] [=*Holostoma* Lonsd., 1850 (*non* Nitsche, 1816)] Reticulate bifoliate zoarium with apertures on edges of branches. *Jur.-Cret.*——Fig. 14,9. **R. dianthus* (Mich.), Jur.(Bath.), Fr.; *9a,b*, side and upper edge, ×10 (202).

Rhipidopora Marsson, 1887 [**R. flabellum*]. Cylindrical stem ending above in a lamellar expansion without apertures. *U.Cret.*——Fig. 14,5. **R. flabellum*, Camp., Ger.; ×10 (186).

Rosacilla Roemer, 1840 [**R. flabelliformis*]. Possibly same as *Berenicea*. *Cret.*, Ger.

Sagenella Hall, 1851 [**S. membranacea* (=*Diastopora consimilis* Lonsd., 1839)] [=*Diastoporella* Vine, 1883 (obj.)]. Incrusting multiserial expansions with surface of tubes marked by strong transverse wrinkles. *Sil.*——Fig. 14,3. **S. consimilis* (Lonsd.), Clint., N.Y.; *3a*, ×10; *3b*, ×25 (*3a*, 132; *3b*, 131).

Semifascipora d'Orb., 1853 [**S. variabilis*]. Cupuliform with apertures on a series of ridges radiating from the axial tube. *U.Cret.*——Fig. 14,10. **S. variabilis*, Maastr., Fr.; ×10 (202).

Siphoniotyphlus Lonsd., 1850 [**S. plumatus*] [=*Lanceopora* Reuss, 1874 (*non* d'Orb., 1852); *Epidictyon* Marsson, 1887]. Compressed, narrow, bifoliate branches with zooecia marked by fine longitudinal lines. *Cret.*——Fig. 14,8. **S. plumatus*, Eng.; ×10 (158).

Spiropora Lamx., 1821 [**S. elegans*] [=*Cricopora* Blainv., 1834 (obj.)]. Ramose, erect, with apertures in parallel, well-separated uniserial verticels. *Jur.-Rec.*——Fig. 14,7. **S. elegans*, Jur.(Bath.), *7a,b*, ×10 (158).

Stomatopora Bronn, 1825 [*pro Alecto* Lamx., 1821 (*non* Leach, 1814)] [**Alecto dichotoma* Lamx., 1821]. Adnate zoaria of uniserial subtubular zooecia branching at characteristic angles to form indefinite polygons. Ovicells not observed in typical uniserial species but reported (11) in triserial portion of a Recent form. *Ord.-Rec.*——Fig. 14,1. **S. dichotoma* (Lamx.), Jur.(Bath.), Fr.; ×10 (174).——Fig. 14,2. *S. parvipora* Canu-B., Eoc. (Jackson), Miss.; protoecium with adjacent zooecia, ×25 (131).

Tubigerina Canu, 1911 [**T. clavata*]. Incrusting flabellate, with several rows of apertures in transverse fascicles. *Cret.-Rec.*——Fig. 14,4. **T. clavata*, Cret.-Eoc. (Rocanean), Arg.; ×10 (136).

Voigtopora Bassler, 1952 [**Alecto calypso* d'Orb., 1850]. Like *Stomatopora* but zooecia broad, elliptical, slightly constricted at base and marked by transverse lines. *U.Cret.*——Fig. 14,6. **V. calypso* (d'Orb.), Senon., Fr.; ×25 (131).

Family TUBULIPORIDAE Johnston, 1838

[=Idmoneidae Busk, 1859; Crisinellidae Miller, 1889]

Typically adnate with salient tubes joined in broad fascicles but commonly narrow, erect, dichotomously dividing branches bearing circular zooecial apertures in transverse

rows on both sides of the frontal medial line. Basal (dorsal) side smooth or marked by layers of some form of tubular pores (kenozooecia). Ovicell generally on frontal crest with longer axis parallel to the zooecial one and formed after calcification of tubes on which it rests (24). *Dev.-Rec.*

Tubulipora LAMARCK, 1816 [**T. transversa* (=*Millepora liliacea* PALLAS, 1766)] [=*Obelia* LAMX., 1821 (*non* PERON & LESUEUR, 1810); *Criserpia* M.EDW., 1838; *Phalangella* GRAY, 1848 (*non* HAMM, 1881)]. Incrusting pyriform to

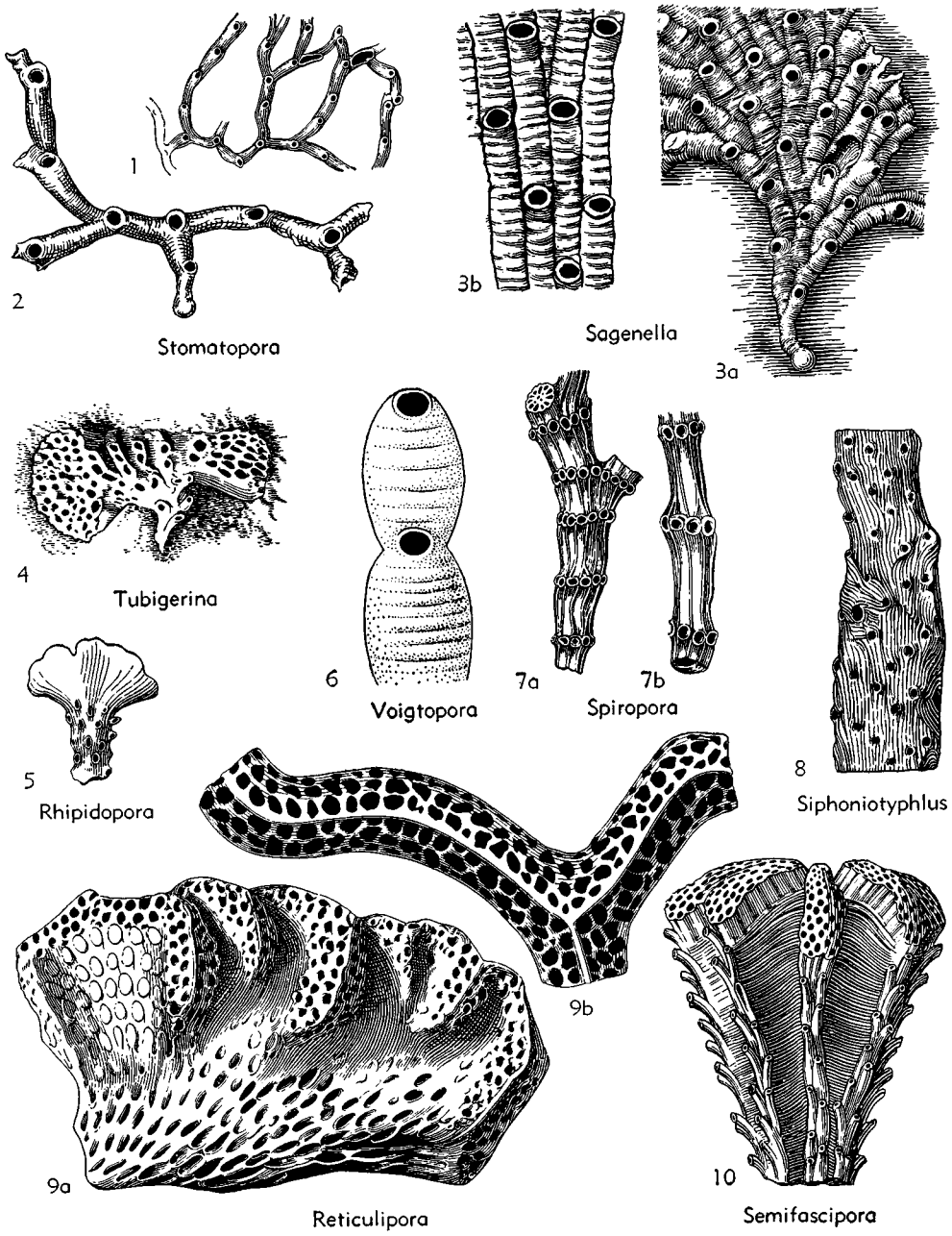


FIG. 14. Diastoporidae (p. G43).

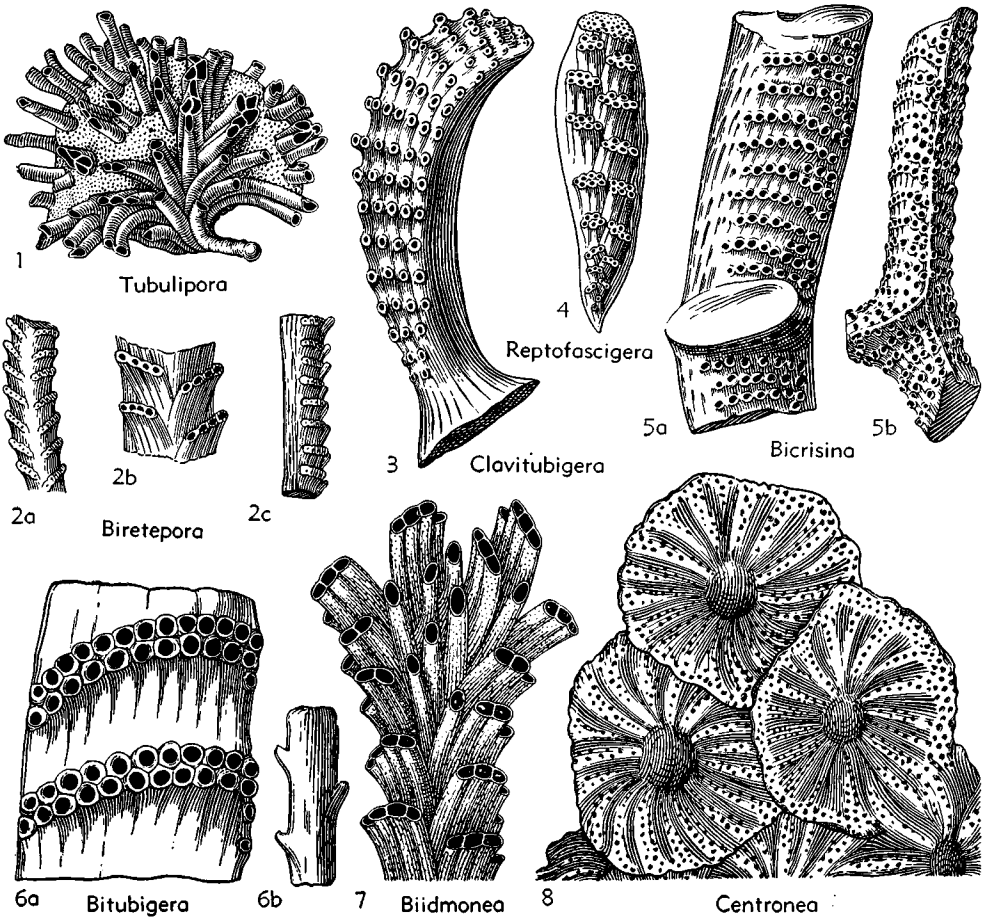


FIG. 15. Tubuliporidae (p. G44-G48).

flabelliform, becoming partly erect with zooecia in obliquely transverse fascicles. Ovicell irregular, spread out between several fascicles. Oeciostome much smaller than zooecial orifice. *Eoc.-Rec.*——FIG. 15,*1*. **T. liliacea* (PALLAS), Rec., Medit.; ovicell-bearing zoarium, ×10 (137).

Bicrisina D'ORB., 1853 [**Reticulipora cultrata* D'ORB., 1853]. Like *Crisisina* but ovicell not known. *Cret.*——FIG. 15,*5*. **B. cultrata* (D'ORB.), Maastr., Fr.; *5a,b,* front, side, ×10 (202).

Biidmonea CALVET, 1903 [**B. fayalensis*]. Narrow branches with zooecial arrangement as in *Tubulipora;* ovicell not known. *Rec.*——FIG. 15,*7*. **B. fayalensis,* Azores; ×10 (135).

Biretepora D'ORB., 1849 [**Retepora disticha* GOLDF., 1831]. Possibly *Crisisina* but ovicell unknown. *U.Cret.*——FIG. 15,*2*. **B. disticha* (GOLDF.), Maastr., Holl.; *2a,b,* front, ×5, ×10; *2c,* side, ×5 (160).

Bitubigera D'ORB., 1853 [**Idmonea biseriata* PHILLIPI, 1844]. Like *Crisisina* but zooecia in biserial rows; ovicell not known. *Oligo.*——FIG. 15,*6*. **B. biseriata* (PHILLIPI), Ger.; *6a,* front, ×25; *6b,* back, ×15 (186).

Centronea CANU-B., 1920 [**Multitubigera micropora* REUSS, 1869]. Like *Platonea* but zoarium orbicular, ovicell median. *Eoc.*——FIG. 15,*8*. **C. micropora* (REUSS), Priabon., Italy; compound zoarium, ×5 (137).

Clavicava D'ORB., 1854 [**C. compressa*] [=*Claviclava* GREGORY, 1909]. Like *Crisisina. L.Cret.*——17,*1*. **C. compressa,* Neocom., Fr.; ×10 (202).

Clavitubigera D'ORB., 1853 [**C. convexa*]. Possibly *Crisisina;* ovicell unknown. *U.Cret.*——FIG. 15,*3*. **C. convexa,* Senon., Fr.; side, ×10 (202).

Crisinella HALL, 1883 [**Crisina? scrobiculata* HALL, 1883]. Like *Crisisina* but ovicell unknown. *Dev.*——FIG. 16,*1*. **C. scrobiculata* (HALL), M.Dev. (Onond.), N.Y.; *1a,b,* back, front, ×20 (162).

Crisisina D'ORB., 1850 [**C. cenomana*] [=*Coelo-*

phyma HAG., 1851]. Like *Idmonea* but erect, with smooth back and celluliferous front bearing ovicell on edges of median crest. *Cret.-Rec.*——FIG. 16,*3*. *C. laevis* (HAG.), Cret.(Maastr.), Holl.; *3a,b,* front, back, with ovicells, ×5 (186).——FIG. 16,*4*. **C. cenomana,* Cret.(Cenom.), Fr.; *4a,b,* front, back, ×10 (202).

Erkosonea CANU-B., 1920 [**E. semota*]. Like *Crisisina* but back bears club-shaped distally directed tubes closed by a lamella (dactylethra-type of kenozooecia). *Eoc.*——FIG. 16,*2*. **E. semota,* Jackson., Miss.; *2a,* back, showing dactylethrae; *2b,* normal front; *2c,* front with broken ovicell; *2d,* long. sec., dactylethrae at right, ×20 (137).

Idmidronea CANU-B., 1920 [**Idmonea maxillaris* LONSD., 1845]. Like *Crisisina* but back bears proximally directed tubes (firmatopore-type of kenozooecia). *Eoc.*——FIG. 16,*7*. *I. cultrer* CANU-B.,

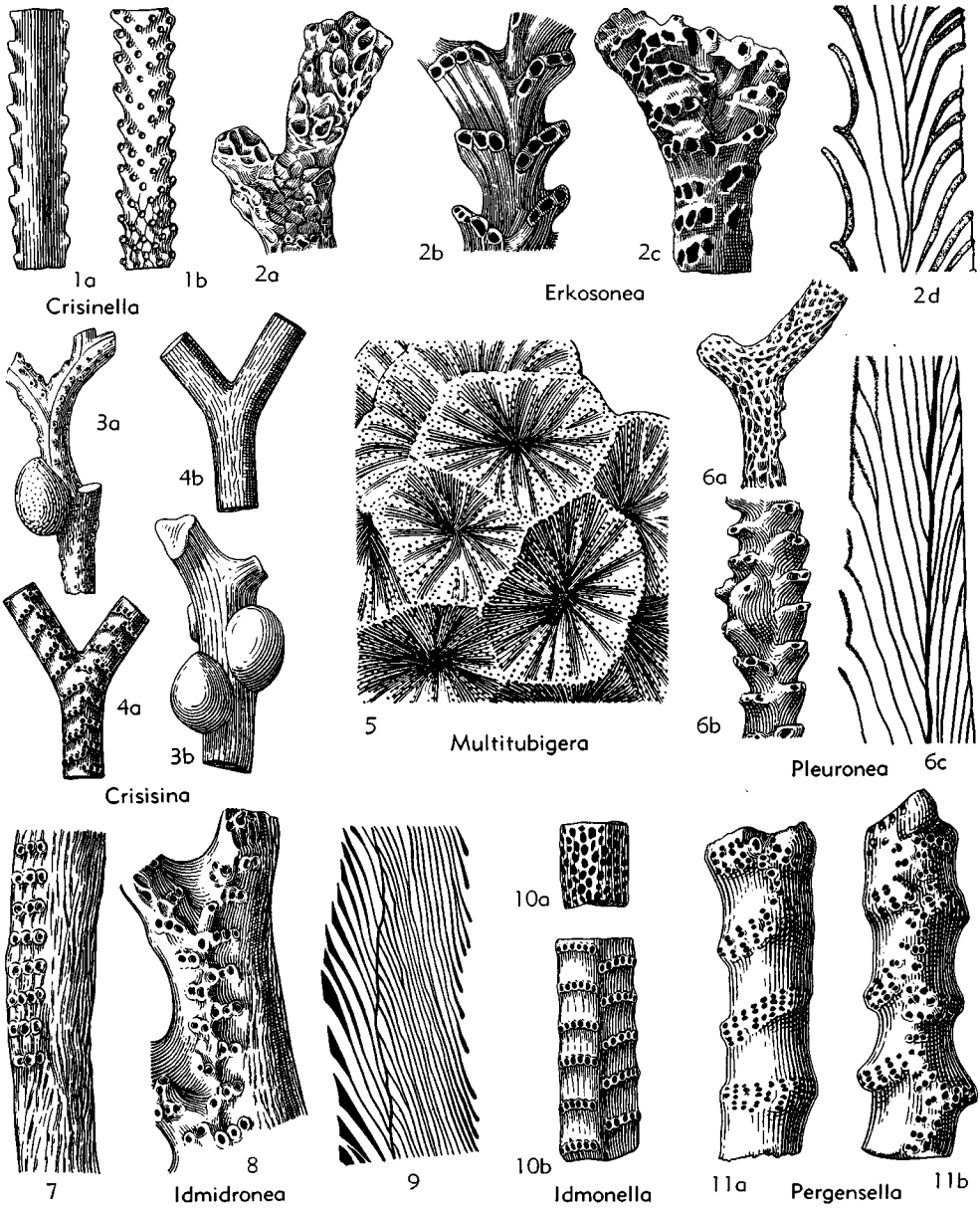


FIG. 16. Tubuliporidae (p. G45-G48).

Claib., N.Car.; side, ×10 (131).——Fig. 16,*8. I. rosacea* Canu-B., Claib., N.Car.; front, ×10 (131). ——Fig. 16,*9. I. coronopus* (Defrance), Fr.; long. sec., ×10 (137).

Idmonea Lamx., 1821 [**I. triquetra*] [=*Reptotubigera* d'Orb., 1853]. Incrusting, simple or branched stems with ridges bordered by thin flat selvage and apertures in transverse alternate series. Ovicell on zoarial median crest pierced by zooecia. *Jur.*——Fig. 17,*9. *I. triquetra,* Bath., Fr.; *9a,* attached zoarium, ×1; *9b,* front, ×25 (161).

Idmonella Lev., 1925 [**I. insignis*]. Like *Crisisina* but with mesopore-like kenozooecia on back. *U. Cret.*——Fig. 16,*10. *I. insignis,* Camp., Ger.; *10a,b,* back, front, ×10 (186).

Mesonea Canu-B., 1920 [**Retepora radians* La-

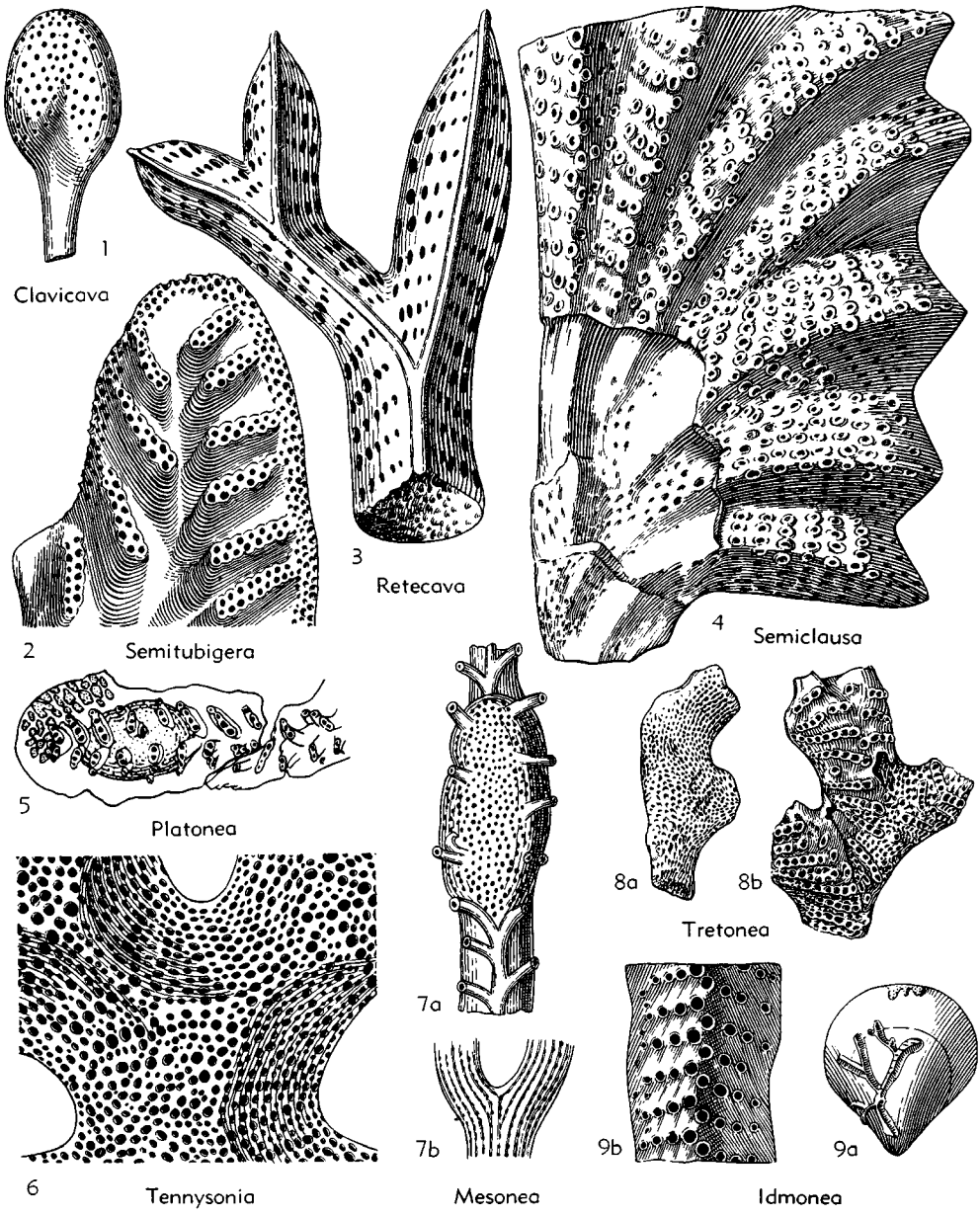


Fig. 17. Tubuliporidae (p. G45-G48).

MARCK, 1816]. Like *Crisisina* but back with tergopore-type kenozooecia and broad porous ovicell on front. *Eoc.-Rec.*——FIG. 17,*7*. **M. radians* (LAMARCK), Rec., Austral.; *7a*, front with ovicell, ×25; *7b*, back, ×10 (*7a*, 230; *7b*, 137).

Multitubigera D'ORB., 1853 [**M. gregaria*]. Like *Centronea* but ovicell unknown. *U.Cret.*——FIG. 16,*5*. **M. gregaria*, Maastr., Fr.; front, ×5 (202).

Pergensella GREGORY, 1899 [**Idmonea geniculata* HAG., 1851]. Like *Crisisina* but with apertures in lateral series of 3 to 8 rows and a median series of 3 to 4 rows. *U.Cret.*——FIG. 16,*11*. **P. geniculata* (HAG.), Maastr., Holl.; *11a,b*, side, front, ×5 (186).

Platonea CANU-B., 1920 [**Reptotubigera philippsae* HARMER, 1915]. Incrusting like *Idmonea* but with ovicell spread out between the fascicles occupying the full zoarial width. *Oligo.-Rec.*——FIG. 17,*5*. **P. philippsae* (HARMER), Rec., Pac.; front with ovicell, ×15 (137).

Pleuronea CANU-B., 1920 [**Idmonea fenestrata* BUSK, 1859]. Like *Mesonea* but ovicell on sides and back with large imperfectly oriented tergopore-type kenozooecia. *Eoc.-Plio.*——FIG. 16,*6*. **P. fenestrata* (BUSK), Plio.(Crag), Eng.; *6a,b*, back, front, ×10; *6c*, long. sec., tergopores at right, ×25 (137).

Reptofascigera D'ORB., 1853 [**R. alternata*]. Like *Bitubigera* but adnate zooecia in biserial rows. *U.Cret.*——FIG. 15,*4*. **R. alternata*, Santon., Fr.; ×10 (202).

Retecava D'ORB., 1854 [**Retepora clathrata* GOLDF., 1827] [=*Spiridmonea* HENNIG, 1894]. Erect laterally compressed branches with rod of rudimentary zooecia at back. *Cret.*——FIG. 17,*3*. **R. clathrata* (GOLDF.), L.Cret.(Valang.), Switz.; front, ×10 (202).

Semiclausa D'ORB., 1853 [**S. alternata*]. Compound zoarium with apertures on pinnate ridges. *U.Cret.*——FIG. 17,*4*. **S. alternata*, Maastr., Holl.; front, ×5 (202).

Semitubigera D'ORB., 1853 [**S. lamellosa*]. Adnate lamina with zooecia in biserial rows. *Cret.-Eoc.*——FIG. 17,*2*. **S. lamellosa*, Maastr., Fr.; front, ×10 (202).

Tennysonia BUSK, 1867 [**T. stellata*]. Erect branching stalks with straight uniserial lines of apertures separated by several rows of mesopores on front; back smooth. *Cret.-Rec.*——FIG. 17,*6*. **T. stellata*, Rec., S.Afr.; front, ×5 (137).

Tretonea CANU-B., 1920 [**T. levis*]. Like *Tennysonia* but both sides bear mesopore-like kenozooecia and front has lobate ovicell. *Eoc.*——FIG. 17,*8*. **T. levis*, Jackson., Ga.; *8a,b*, back, front, ×10 (137).

Family MULTISPARSIDAE Bassler, 1935
[=emend. Macroeciidae CANU, 1918]

Incrusting or erect bifoliate zoaria characterized by greatly enlarged, elongate ovicells paralleling the tube axis and displacing the short broad zooecia (24). *Jur.*

Multisparsa D'ORB., 1853 [**Bidiastopora luceana* D'ORB., 1850] [=*Macroecia* CANU, 1928]. Bifoliate, dichotomously branched. Ovicell broadly elliptical, with large transverse oeciostome. *Jur.*——FIG. 18,*3*. **M. luceana* (D'ORB.), M.Jur.(Bath.), Fr.; *3a*, zoarium, ×1; *3b*, surface, ×25 (*3a*, 202; *3b*, 136).

Atractosoecia CANU-B., 1922 [**Berenicea edwardsi* CANU, 1913]. Incrusting; ovicell a long fusiform sac with terminal rounded oeciostome. *Jur.*——FIG. 18,*6*. **A. edwardsi* (CANU), M.Jur.(Bath.), Fr.; surface with ovicell, ×10 (137).

Family ONCOUSOECIIDAE Canu, 1918

Incrusting, lobate or narrow erect zoaria, with dilated isolated ovicell paralleling axis of tubes developed at the same time; tubes not disarranged (24). *Jur.-Rec.*

Oncousoecia CANU, 1918 [**Tubulipora lobulata* HASSALL, 1841]. Incrusting to erect. Ovicell a dilation of entire visible part of zooecium, with large oeciopore. *Cret.-Rec.*——FIG. 18,*1*. **O. lobulata* (HASSELL), Rec., Atl.; surface with ovicell, ×25 (137).

Dacryopora TERQUEM, 1855 [**Berenicea archiaci* HAIME, 1854]. Like *Oncousoecia* but ovicell doubtful. *Jur.* Ger.

Filisparsa D'ORB., 1853 [**F. neocomiensis*] [=*Phormonotos* MARSSON, 1887]. Erect, narrow dichotomous branches with irregularly placed zooecial apertures on front; back smooth. *Cret.-Rec.*——FIG. 18,*7*. **F. neocomiensis*, L.Cret.(Neocom.), Fr.; *7a,b*, front, back, ×10 (202).——FIG. 18,*8*. *F. crassa* D'ORB., L.Cret.(Neocom.), Fr.; *8a,b*, back, front, ×25 (202).

Leptopora D'ORB., 1849 (*non* WINCHELL, 1863) [**L. elegans*]. Like *Proboscina* but ovicell unknown. *U.Cret.*——FIG. 18,*2*. **L. elegans*, Cenom., Fr.; ×10 (202).

Penciletta GRAY, 1848 [**Tubipora penecillata* FABRICIUS, 1780]. Like *Proboscina*, ovicell unknown. *Rec.*, Atl.

Proboscina AUDOUIN, 1826 (*non* RONDANI, 1856) [**P. boryi*] [=*Phalangella* HAMM, 1881 (*non* GRAY, 1848); *Peristomoecia* CANU-B., 1920]. Incrusting. Single zooecium enlarged to form ovicell. *?Ord., Jur.-Rec.*——FIG. 18,*5*. **P. boryi*, Rec., Red Sea; zoarium with ovicell (?inaccurate, BORG, 1944), ×10 (130).——FIG. 18,*4*. *P. divergens* WATERS, Rec., Atl.; *4a,b*, specimens with ovicells, ×10, ×25 (230).

Family TERVIIDAE Canu & Bassler, 1920

Zoaria with ovicell (gonozooecium) typically on noncelluliferous back, with its

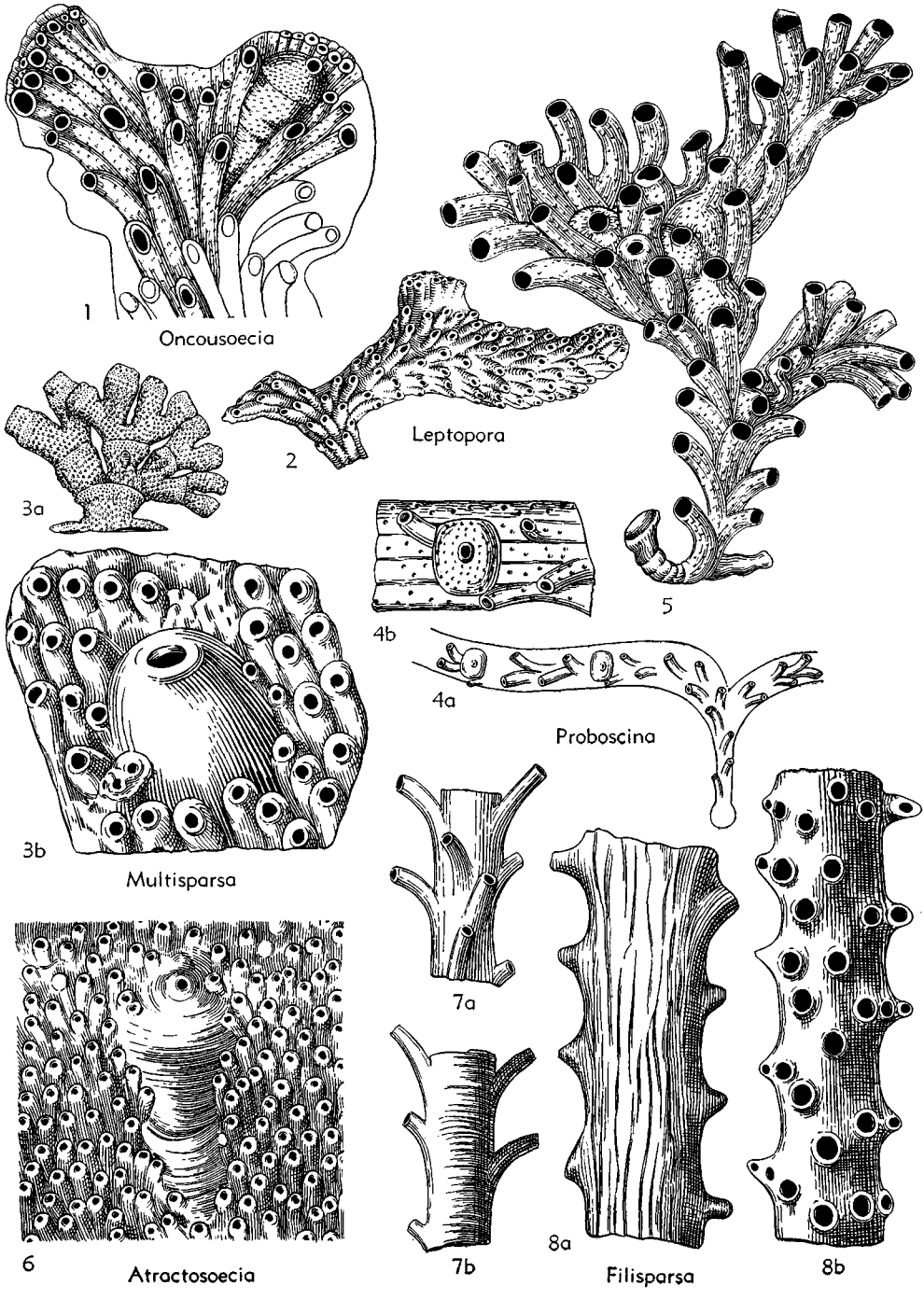


FIG. 18. Multisparsidae, Oncousoeciidae (p. G48).

longitudinal axis paralleling that of zooecia formed after their calcification. Oeciostome terminal, directed distally, placed at a bifurcation so as to open on frontal side (24). *Tert.-Rec.*

Tervia JULLIEN, 1882 [**T. solida*]. Erect branches with long ovicell and zooecial tubes visible on back. *Eoc.-Rec.*——FIG. 19,*2*. **T. solida*, Rec., E.Atl.; *2a,b*, back, front, ×10 (137).——FIG. 19,*3*. *T. jellyae* HARMER, Rec., Queensl.; *3a,b*, front, back, with ovicell, ×10 (164).

Lagonoecia CANU-B., 1920 [**L. lamellifera*]. Like *Tervia* but with symmetrical globular ovicell attached to edge of back. *Eoc.*——FIG. 19,*4*. **L. lamellifera*, Wilcox., Ala.; front with ovicell, ×10 (137).

Nevianopora BORG, 1944 [**Idmonea milneana* D'ORB., 1839]. Apertures in uninterrupted transverse series with ovicell on middle median of front just below bifurcation. *Rec.*, S.Atl.

Prosthenoecia CANU, 1918 [**Reptotubigera lateralis* D'ORB., 1853]. Zoarium short, idmoneiform, with much elongated ovicell and large terminal oeciostome on celluliferous side. *Eoc.*——FIG. 19,*1*. **P. lateralis* (D'ORB.), Lut., Fr.; *1a,b*, specimen with ovicell, front and side, ×10 (137).

Family ENTALOPHORIDAE Reuss, 1869

[=Mecynoeciidae CANU, 1918]

Erect, slender, solid cylindrical stems or bifoliate convoluted fronds with apertures opening on all sides. Ovicells developed parallel with zooecial length, formed before them, thus disarranging their position; oeciostome anterior, small nonterminal (24, 25). *Jur.-Rec.*

Entalophora LAMX., 1821 [**E. cellarioides*] [=*Intricaria* DEFRANCE, 1822; *Mecynoecia* CANU, 1918]. Zoarium slender, cylindrical, ramose. Symmetrical ovicell with transverse oeciostome. (Many forms belonging here but not showing ovicell have been erroneously named.) *Jur.-Rec.*——FIG. 19,*8*. **E. cellarioides*, Jur.(Bath.), Fr.; *8a*, branch, ×25; *8b*, surface with ovicell, ×15 (*8a*, 202; *8b*, 131).

Anguisia JULLIEN, 1882 [**A. verrucosa*]. Slender bifurcating branches. Zooecia verrucose, uniserial; ovicell at bifurcations. *Rec.*——FIG. 19,*6*. **A. verrucosa*, Medit.; *6a,b*, ×25 (169).

Bientalophora BORG, 1944 [**Pustulopora regularis* MACGILL., 1883]. Like *Entalophora* but kenozooids form network through which zooecia protrude. *Rec.*, Austral.

Bisidmonea D'ORB., 1853 [**B. antiqua* (=*Spiropora tetragona* LAMX., 1821)]. Tetragonal branches with ovicells at angled edges; zooecia partly closed by facets, leaving small orbicular aperture. *Jur.*——FIG. 19,*7*. **B. tetragona* (LAMX.), M.Jur. (Bath.), Fr.; *7a*, long. sec., ×10; *7b*, fragment with ovicell, ×10; *7c,d*, transv. sec., surface, ×25 (*7a,b*, 202; *7c,d*, 137).

Brachysoecia CANU-B., 1922 [**B. convexa*]. Like *Microecia* but stems cylindrical with zooecia partly closed by facets; ovicell very short, with transverse oeciostome. *U.Cret.*——FIG. 20,*4*, **B. convexa*, Cenom., Fr.; *4a*, distal part of branch, ×10; *4b*, surface with ovicell, ×25; *4c*, long. sec., ×10 (137).

Cardioecia CANU-B., 1922 [**Bidiastopora neocomiensis* D'ORB., 1853]. Slender bifoliate branches with heart-shaped ovicells. *L.Cret.*——FIG. 19,*5*. **C. neocomiensis* (D'ORB.), Valang., Switz.; *5a*, distal part of zoarium; *5b*, surface with ovicells; *5c*, long. sec.; all ×10 (*5a*, 202; *5b,c*, 137).

Cisternifera WALFORD, 1894 [**C. inconstans*]. Like *Entalophora* but with so-called cistern cells (?avicularia); supraoral ovicells reported. *Jur.*——FIG. 20,*5*. **C. inconstans*, Lias., Eng.; ×10 (229).

Clavisparsa D'ORB., 1853 [**C. clavata*]. Zoarium club-shaped, ?with ovicell; may be *Entalophora*. *U.Cret.*——FIG. 20,*11*. **C. clavata*, Santon., Fr.; ×10 (202).

Clypeina MICH., 1844 [**C. marginoporella*]. Like *Umbrellina* but with hollow top (?young stage). *Cret.-Eoc.*, Fr.

Exochoecia CANU-B., 1920 [**E. rugosa*]. Bifoliate, surface reticulate; ovicell large, restricted to edge of zoarium. *Oligo.*——FIG. 20,*12*. **E. rugosa*, Vicksb., Ala.; *12a*, fragment with ovicells, ×10; *12b*, surface, ×25 (137).

Mesenteripora BLAINV., 1830 [**M. michelini*] [=*Trigonoecia* CANU-B., 1922 (obj.)]. Erect bifoliate convoluted fronds with apertures on both sides; ovicell wrinkled, pyriform. *Jur.*——FIG. 20,*8*. **M. michelini*, M.Jur.(Bath.), Fr.; *8a*, zoarium, ×1; *8b*, surface with ovicells, ×10 (*8a*, 202; *8b*, 137).

Microecia CANU, 1918 [**Berenicea sarniensis* NORMAN, 1864]. Typically incrusting; ovicell very small, not salient and spread between a few tubes. *Cret.-Rec.*——FIG. 20,*9*. **M. sarniensis* (NORMAN), Rec., E.Atl.; ×10 (200).——FIG. 20,*10*, *M. flabellata* CANU-B., Eoc.(Claib.), N.Car.; surface with ovicell, ×25 (137).

Nematifera CANU-B., 1922 [**Elea reticulata* D'ORB., 1853]. Like *Mesenteripora* but zooecia with facets, short, bordered exteriorly by salient thread. *L. Cret.*——FIG. 20,*3*. **N. reticulata* (D'ORB.), Valang., Switz.; *3a*, fragment, ×10; *3b*, surface, ×25; *3c*, long. sec., ×10 (*3a*, 202; *3b,c*, 137).

Pergensia WALFORD, 1894 [**P. nidulata*]. Like *Entalophora* but with hollow central tubes and globose ovicell (peristomial) enveloping end of aperture. *Jur.*——FIG. 20,*1*. **P. nidulata*, Eng.; *1a*, zoarium, ×10; *1b*, median long. sec., ×10 (229).

Peripora D'ORB., 1850 [**P. ligeriensis* (*Pustulopora pseudospiralis* MICH., 1845)]. Cylindrical stems

with zooecial apertures in 2 or more spirals. *U. Cret.*——Fig. 20,*2*. **P. pseudospiralis* (Mich.), Cenom., Fr.; ×10 (202).

Pustulopora Blainv., 1834 [**Ceriopora pustulosa* Goldf., 1827] [=*Stigmatopora* Hamm, 1881 (*non* Kaup, 1853); *Hammia* Gregory, 1899 (obj.)]. Thick solid branches with apertures on spiral ridges. *Cret.*——Fig. 20,*7*. **P. pustulosa* (Goldf.), Maastr., Holl.; ×5 (157).

Umbrellina Reuss, 1872 [**U. stelzneri*]. Zoarium peg-shaped, with apertures on broad flat-topped summit. *U.Cret.*——Fig. 20,*6*. **U. stelzneri*,

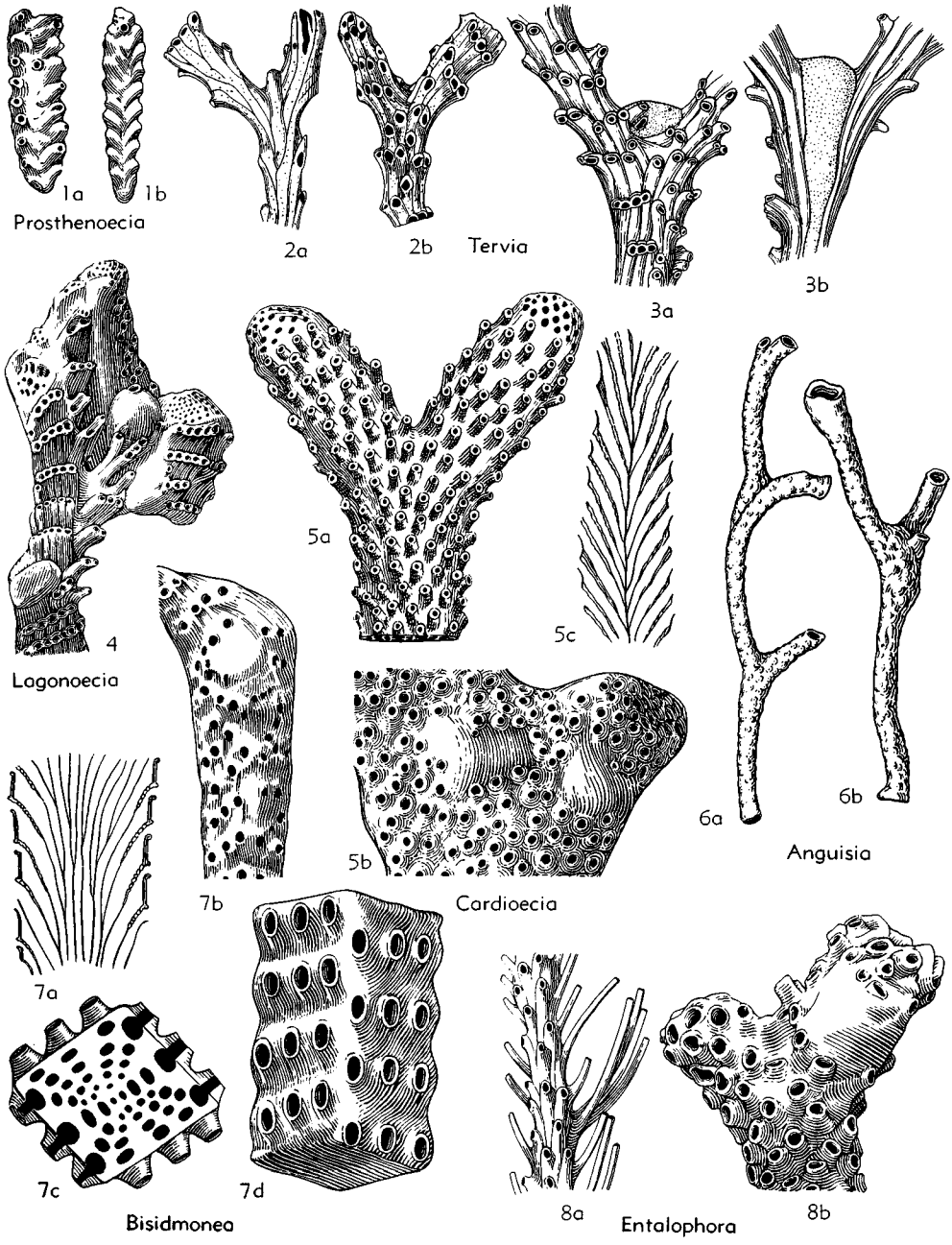


Fig. 19. Terviidae, Entalophoridae (p. G50).

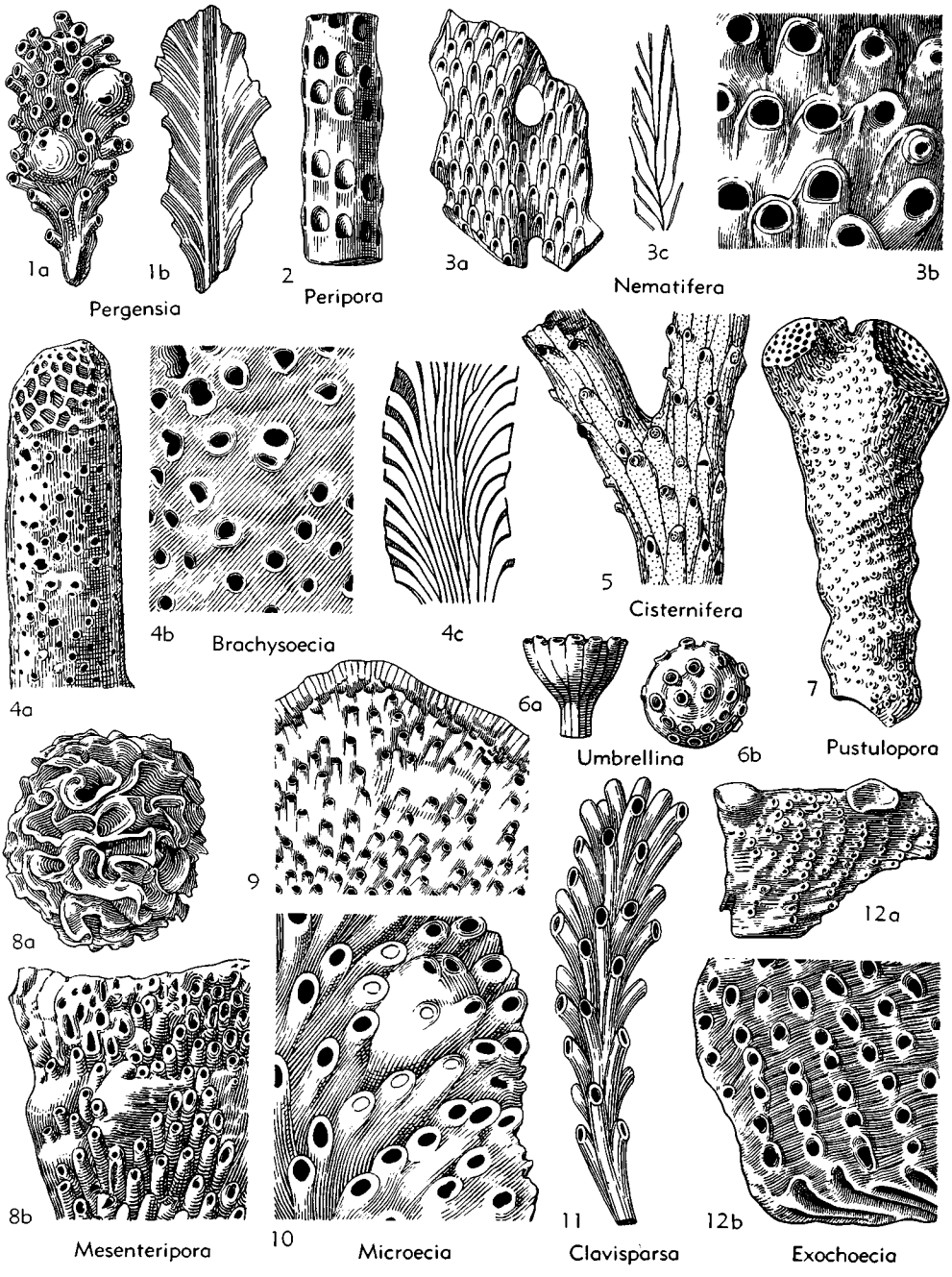


FIG. 20. Entalophoridae (p. G50, G51).

Cenom., Ger.; *6a,b,* side, top, ×10 (210).

Family DIAPEROECIIDAE Canu, 1918

Zoaria incrusting, ramose, orbicular, tubular, or jointed, with globular ovicell formed after calcification of zooecial tubes, which without disarrangement project through it (24,25). *Jur.-Rec.*

Diaperoecia CANU, 1918 [**Pustulopora intricaria* BUSK, 1876]. Incrusting or ramose. Oeciostome transversely elliptical, adjacent to a zooecial aperture. No adventitious tubes. *Cret.-Rec.*——FIG. 21,*1*. **D. intricaria* (BUSK), Rec., Austral.; part of zoarium with ovicell, ×10 (164).

Crisulipora ROBERTSON, 1910 [**C. occidentalis*]. Erect zoarium of flexible joints as in Crisiidae but ovicell comprises an internodal inflation perforated by zooecia, not a single expanded zooecium. *Oligo.-Rec.*——FIG. 21,*5*. **C. occidentalis*, Rec., Calif.; part of zoarium with ovicell, ×10 (211).

Desmediaperoecia CANU-B., 1920 [**Tubulipora campicheana* WATERS, 1887]. Like *Diaperoecia* but tubes arranged in small fascicles which penetrate ovicell. *Tert.*——FIG. 21,*9*. **D. campicheana* (WATERS), N.Z.; part of zoarium with ovicell, ×10 (137).

Diplosolen CANU, 1918 [*pro Diplopora* JULLIEN, 1886 (*non* MACGILL., 1881, *nec* GÜMBEL, 1866)] [**Tubulipora obelia* JOHNSTON, 1838]. Like *Diaperoecia* but with adventitious tubules (nano-

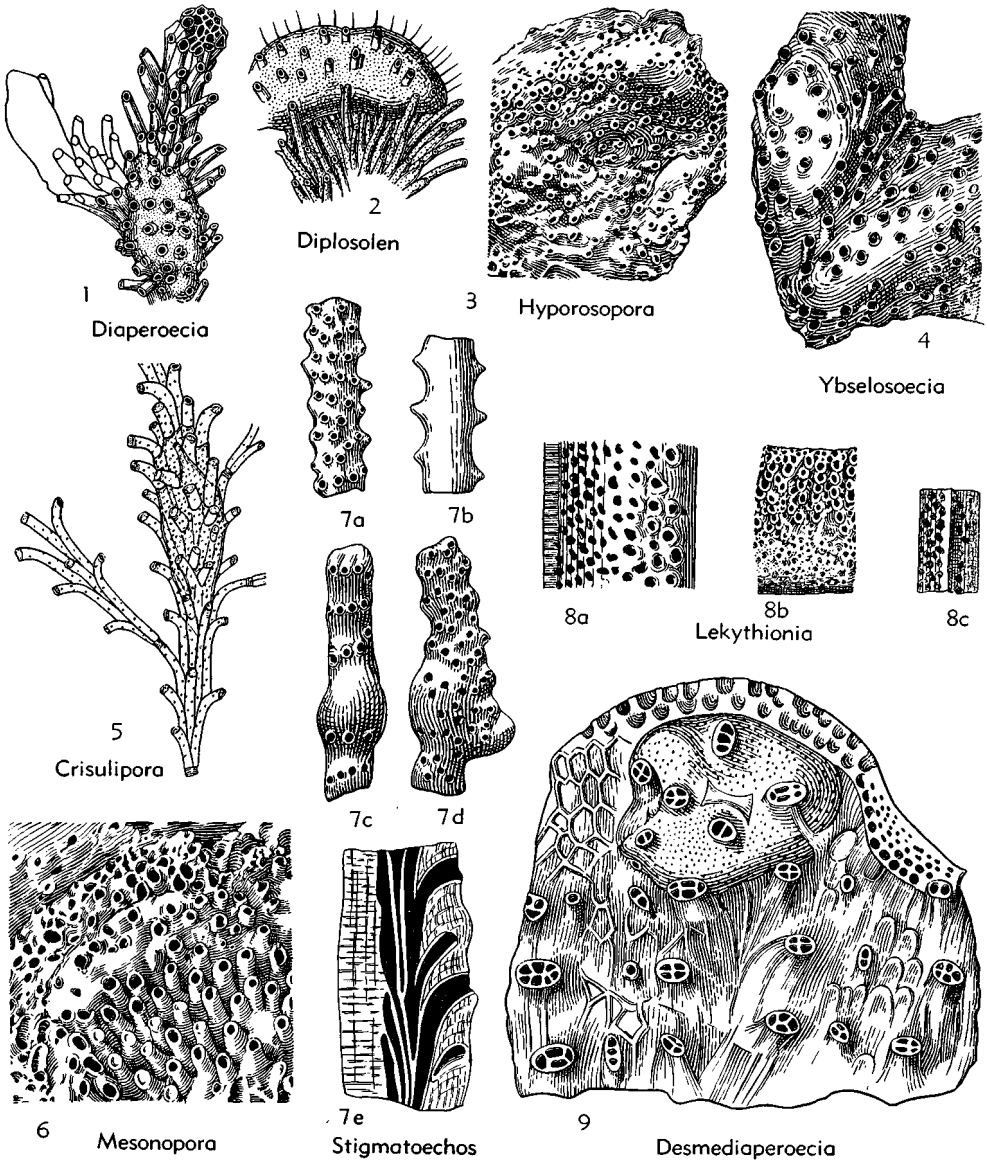


FIG. 21. Diaperoeciidae (p. G53, G54).

zooids) among the zooecia. *Cret.-Rec.*——Fig. 21,2. **D. obelia* (Johnston), Rec., Atl.; part of zoarium with ovicell, ×10 (230).

Hyporosopora Canu-B., 1929 [**H. typica*]. Like *Diaperoecia* but with transverse ovicell and no central oeciostome. *Jur.*——Fig. 21,3. **H. typica*, M.Jur.(Bath.), Fr.; part of zoarium with 3 ovicells, ×10 (137).

Lekythionia Canu-B., 1920 [**Reticulipora dichotoma* Gabb-H., 1862]. Erect, bifoliate expansions with adventitious tubes and bottle-shaped oeciostome. *Eoc.*——Fig. 21,8. **L. dichotoma* (Gabb-H.), Wilcox., N.J.; *8a-c*, front, surface, side, ×10 (137).

Mesonopora Canu-B., 1929 [**M. typica*]. Oeciostome a small short tube in ovicell center. *Jur.*——Fig. 21,6. **M. typica*, M.Jur.(Bath.), Fr.; ×10 (137).

Stigmatoechos Marsson, 1887 [**S. punctatus*]. Flat narrow stems, smooth on one side, apertures and large ovicell traversed by them on other. *Cret.*——Fig. 21,7. **S. punctatus*, Camp., Ger.; *7a,b*, front, back, ×10; *7c,d*, fragments with ovicells, ×10; *7e*, long. sec., ×25 (*7a,b,e*, 186; *7c,d*, 137).

Ybselosoecia Canu-L., 1933 [**Pustulopora palmata* Busk, 1859]. Erect slender branches. Oeciostome at distal extremity of ovicell. *Tert.-Rec.*——Fig. 21,4. **Y. palmata* (Busk), Plio., Eng.; part of zoarium with ovicells, ×10 (136).

Family PLAGIOECIIDAE Canu, 1918

Zoaria incrusting, cylindrical or bifoliate, hollow or solid erect stems. Ovicell smooth, formed before calcification of zooecial tubes which are thus disarranged; longer ovicell axis at right angle to that of zooecia; oeciostome small. Adventitious tubes absent (24, 25). *Jur.-Rec.*

Plagioecia Canu, 1918 [**Tubulipora patina* Lamarck, 1816]. Incrusting or free, zooecial tubes radiating from centers of growth; ovicell a long transverse sac near zoarial margin. *Jur.-Cret.*——Fig. 22,8. **P. patina* (Lamarck), Rec., Atl.; zoarium with transverse ovicell, ×10 (137).

Cavaria Hag., 1851 [**C. pustulosa*]. Cylindrical stems with hollow axial tube crossed by diaphragms. Ovicell globular, transverse. *U.Cret.*——Fig. 22,6. **C. pustulosa*, Maastr., Holl.; *6a,b*, fragments, with ovicell in *6a*, ×10; *6c,d*, secs., transv., long., ×10 (*6a,c,d*, 186; *6b*, 137).

Desmatelesia Canu-L., 1933 [**Tubulipora coerulea* Canu-B., 1929]. Like *Desmeplagioecia* but no pores between fascicles; ovicell perforated by both tubes and fascicles. *Mio.-Rec.*——Fig. 22,12. **D. coerulea* (Canu-B.), Rec., SW.Pac.; ×10 (131).

Desmeplagioecia Canu-B., 1920 [**Diastopora lineata* MacGill., 1885]. Like *Plagioecia* but with zooecia grouped in fascicles. *Cret.-Rec.*——Fig. 22,9. **D. lineata* (MacGill.), Rec., SW.Pac.; ×10 (164).

Laterotubigera d'Orb., 1853 [**L. cenomana*]. Possibly *Notoplagioecia;* ovicell not known. *U.Cret.*——Fig. 22,10. **L. cenomana*, Cenom., Fr.; ×5 (202).

Liripora MacGill., 1887 [**Diastopora fasciculata* MacGill., 1885]. Incrusting, flabellate; ovicell not known. *Cret.-Rec.*——Fig. 22,2. **L. fasciculata* (MacGill.), Rec., SW.Pac.; ×25 (181).

Notoplagioecia Canu-B., 1922 [**N. farringdonensis*]. Free cylindrical stems with irregularly convex ovicell replacing many tubes. *L.Cret.*——Fig. 22,7. **M. farringdonensis*, Apt., Eng.; *7a*, fragment with broken ovicell; *7b*, long. sec.; *7c*, distal part of zoarium; all ×10 (137).

Reticrisina Gregory, 1899 [**Reticulipora obliqua* d'Orb., 1859]. Laterally much compressed reticulated branches with ovicell as in *Plagioecia. Cret.*——Fig. 22,4. **R. obliqua* (d'Orb.), Coni., Fr.; *4a*, side, ×10; *4b*, front, ×5 (202).

Semilaterotubigera d'Orb., 1853 [**S. annulata*]. Like *Notoplagioecia;* ovicell not known. *U.Cret.*——Fig. 22,11. **S. annulata*, Coni., Fr.; *11a*, ×1; *11b*, surface, ×10; *11c*, transv. sec., ×10 (202).

Stathmepora Canu-B., 1922 [**S. flabellata*]. Bifoliate flabellate fronds with tubes in rectilinear fascicles. *Cret.-Pleisto.*——Fig. 22,5. **S. flabellata*, Pleisto., Calif.; zoarium with ovicell, ×10 (137).

Terebellaria Lamx., 1821 [**T. ramosissima*]. Erect branches with successive colonies at their end, and with zones of apertures separated by interzones of dactylethrae; ovicell transversely convex. *Jur.*——Fig. 22,1. **T. ramosissima*, M.Jur.(Bath.), Fr.; *1a*, surface with ovicells; *1b*, distal part of zoarium; *1c*, long. sec.; all ×10 (*1a,c*, 202; *1b*, 131).

Tubigera d'Orb., 1853 [**T. antiqua* (=*Retepora disticha* Goldf., 1827)]. Slender erect branches with apertures in parallel rows; ovicell not known. *U.Cret.*——Fig. 22,3. **T. disticha* (Goldf.), Maastr., Fr.; ×10 (202).

Family HASTINGSIIDAE Borg, 1944

Zoaria erect, irregular, with zooecia single or in fascicles opening generally on front. Gonozooids in the axils, kenozooecia on basal side rare. *Rec.*

Hastingsia Borg, 1944 [**H. irregularis*]. *Rec.*, Antarct.

Family FRONDIPORIDAE Busk, 1875

[=Fascigeridae d'Orb., 1853]

Zoaria ramose, incrusting, or massive. Zooecial tubes cylindrical, equal in diameter throughout, bundled; ovicell globular, located between fascicles and traversed by iso-

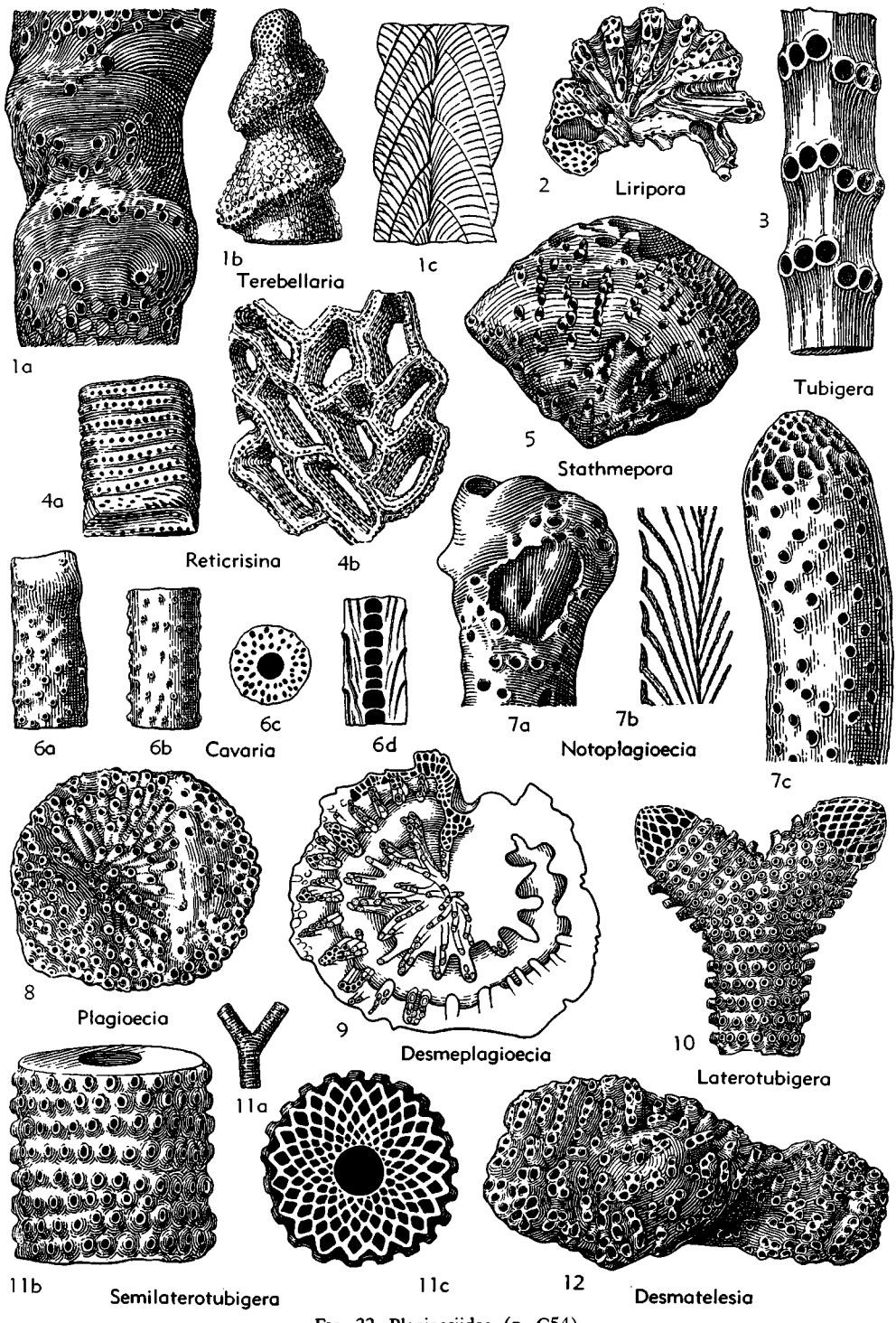


FIG. 22. Plagioeciidae (p. G54).

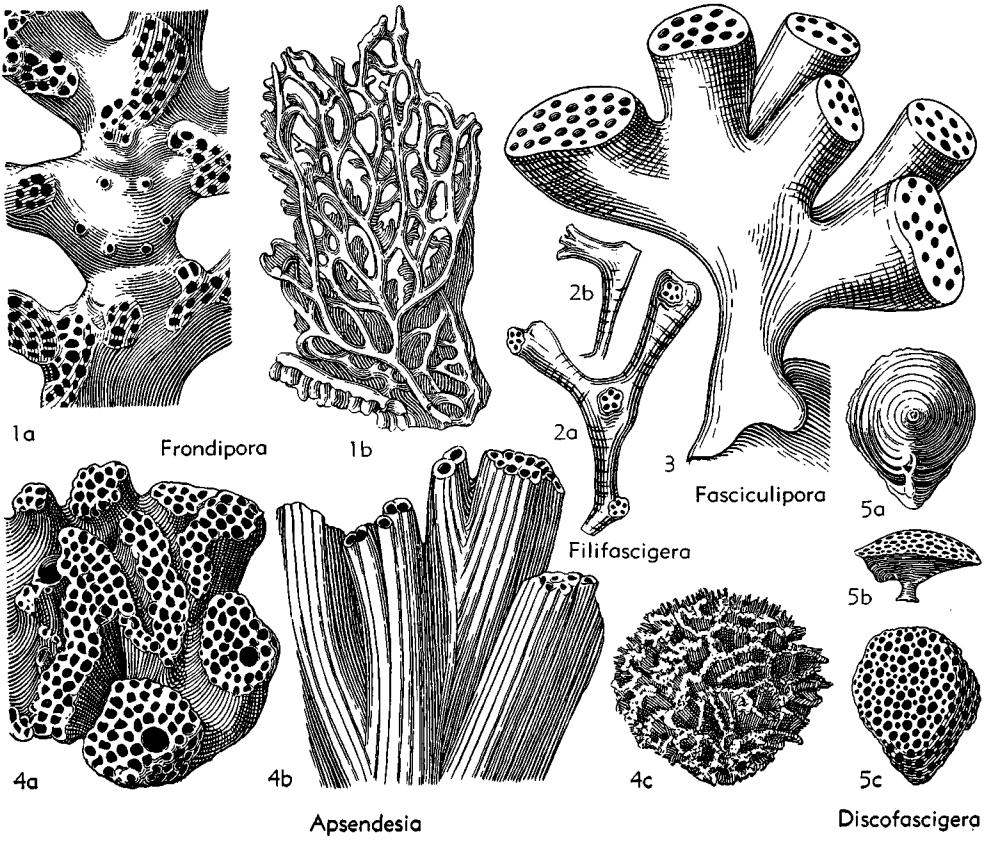


FIG. 23. Frondiporidae (p. G56).

lated tubes (Fascigeridae invalid because type genus lacking) (24). *Jur.-Rec.*

Frondipora LINK, 1807 [**Millepora reticulata* LINNÉ, 1758] [=*Krusensterna* TILESIUS & LAMX., 1821; *Rhyzopora* D'ORB., 1849 (obj.)]. Erect, slender many-branched stems with apertures bunched on front. *Eoc.-Rec.*——FIG. 23,*1*. **F. reticulata* (LINNÉ), Rec., Medit.; *1a*, front with ovicell, ×10; *1b*, zoarium, ×1 (*1a*, 137; *1b*, 134).

Apsendesia LAMX., 1821 [**A. cristata*] [=*Pelagia* LAMX., 1821 (*non* PERON, 1803); *Defrancia* BRONN, 1825]. Massive, developing from a small cup-shaped disc. Zooecia in irregularly sinuous fascicles with apertures terminal. *Jur.-Cret.*——FIG. 23,*4*. **A. cristata*, M.Jur.(Bath.), Fr.; *4a,b*, fascicles in end and side views, ×10; *4c*, zoarium, ×1 (137).

Discofascigera D'ORB., 1853 [**D. ligeriensis*]. Small discoid bundle of short zooecia. *Cret.-Mio.*——FIG. 23,*5*. **D. ligeriensis*, Cret.(Santon.), Fr.; *5a-c*, back, side, front, ×10 (202).

Fasciculipora D'ORB., 1846 [**F. ramosa*]. Like *Frondipora* but fascicles long, opening at end of branches. Ovicell an elongate tube with apertures at bifurcations. *Jur.-Rec.*——FIG. 23,*3*. **F. ramosa*, Rec., S.Atl.; ×10 (134).

Filifascigera D'ORB., 1853 [**Tubulipora megaera* LONSD., 1845] [=*Seriefascigera* HAMM, 1881]. Narrow incrusting zoaria with tubes grouped in salient fascicles opening at intervals in clusters. *Cret.-Rec.*——FIG. 23,*2*. **F. megaera* (LONSD.), Eoc.(Wilcox.), N.J.; *2a,b*, front, edge, ×10 (222).

Meandropora D'ORB., 1849 [*pro Fascicularia* M. EDW., 1830]. Zoarium massive, zooecia in irregularly anastomosing fascicles which project on surface as tortuous ridges. *Plio.*, Eng.

Paraquataia RUSCONI, 1948 [**P. tellechea*]. *?Ord.*, Arg.

Family THEONOIDAE Busk, 1859

[=Actinoporidae VIG., 1949]

Zoaria typically erect fronds, but also cylindrical stems, adnate discs, and incrusting sheets. Zooecia comprise simple short open tubes with apertures in crowded bands, either along raised ridges or at edges of fronds. Ovicells incompletely known (63, 102). *Jur.-Rec.*

Theonoa LAMX., 1821 [**T. clathrata*] [=*Tilesia* LAMX., 1821; *Phyllofrancia* MARSSON, 1887]. Erect fronds or massive, with apertures in multiserial raised bands diverging from base to upper edge. Ovicell not known. *Jur.-Cret.*——FIG. 24,*1*. *T. grandis* MARSSON, Cret.(Camp.), Ger.; zoarium, ×10 (186).——FIG. 24,*2*. **T. clathrata,* M.Jur. (Bath.), Fr.; surface, ×2 (202).

Actinopora D'ORB., 1853 [**A. regularis* (=*Cerio-pora stellata* KOCH & DUNKER, 1837)] [=*Repto-*

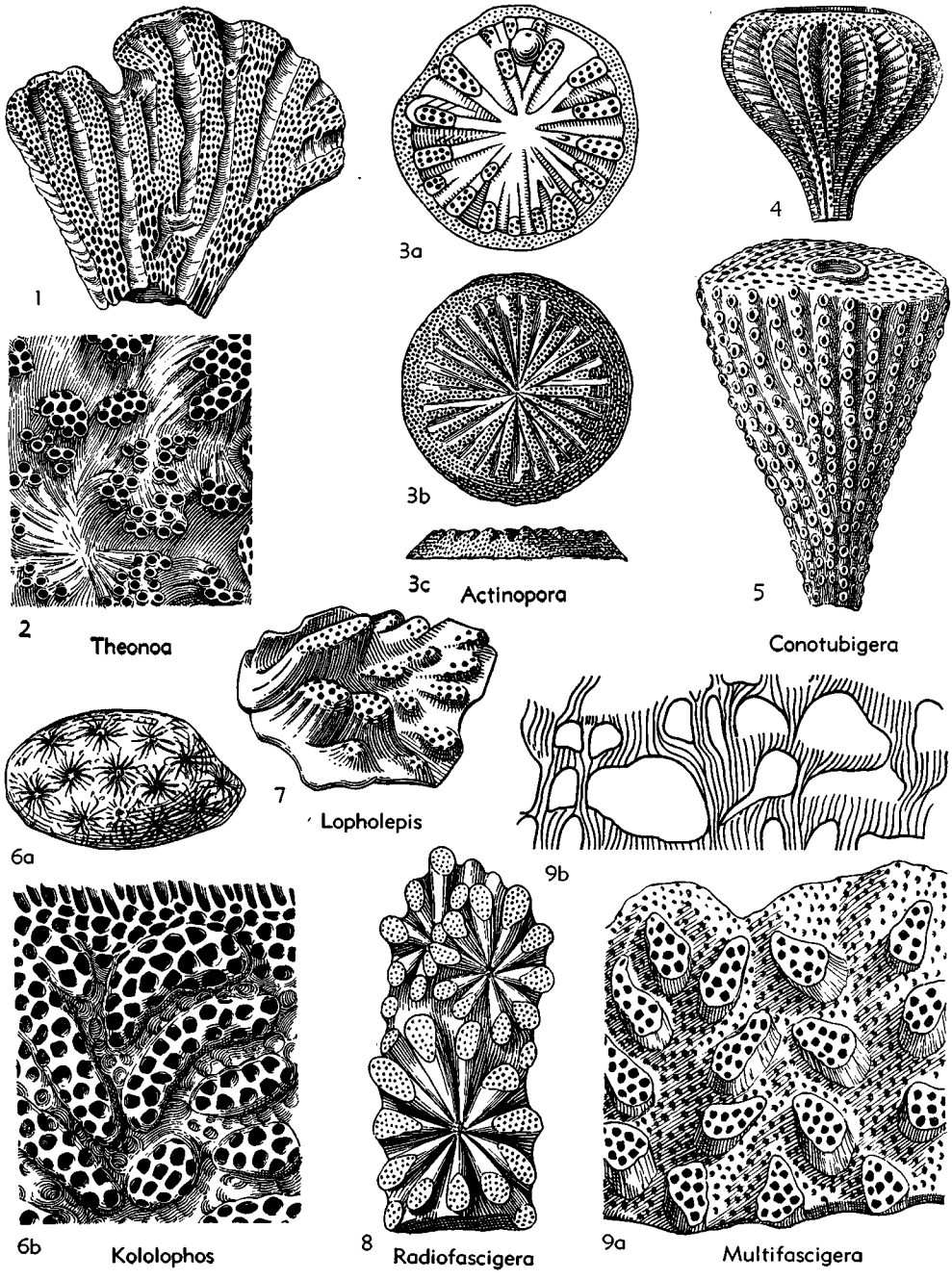


FIG. 24. Theonoidae (p. G57, G58).

pora DE LORIOL, 1868]. Flat adnate disc with apertures opening in one or more rows on ridges radiating from central depression. Ovicell a small ovoid capsule with terminal oeciostome interrupting an intermediate fascicle. *Cret.-Rec.*

A. (Actinopora). Origin of radiating ridges central; apertures biserial on each ridge. *Cret.-Rec.* ——FIG. 24,*3*. **A. stellata* (KOCH & DUNKER), Cret.(Neocom.), Ger.; *3a*, zoarium with ovicell, ×5; *3b,c*, summit and edge views, ×5 (202).

A. (Discotubigera) D'ORB., 1853 [**Defrancia michelini* HAG., 1851]. Like *A. (Actinopora)* but apertures triserial. *Cret.*, Holl.

A. (Radiotubigera) D'ORB., 1853 [**R. organisms*]. Like *A. (Actinopora)* but apertures uniserial. *Cret.*, Fr.

A. (Unitubigera) D'ORB., 1853 [**U. discus*]. Resembles *A. (Radiotubigera)*. *Cret.*, Switz.

A. (Pavotubigera) D'ORB., 1853 [**P. flabellata*]. Like *A. (Actinopora)* but origin of ridges eccentric. *Cret.*, Fr.

Conotubigera D'ORB., 1853 [**C. irregularis*]. Zoarium erect cylindrical, obconical, or clavate, with apertures on vertical ridges. *Cret.*, Eur.

C. (Conotubigera). Apertures uniserially arranged. *Cret.*——FIG. 24,*5*. **C. (C.) irregularis*, U.Cret. (Maastr.), Fr.; ×10 (202).

C. (Serietubigera) D'ORB., 1853 [**S. francquana*]. Like *C. (Conotubigera)* but apertures biserial. *Cret.*, Eur.——FIG. 24,*4*. **C. (S.) francquana*, U.Cret.(Maastr.), Fr.; ×10 (202).

Kololophos GREGORY, 1896 [**Constellaria terquemi* HAIME, 1854]. Incrusting sheets with zooecia in numerous interrupted radial groups. *M.Jur.*—— FIG. 24,*6*. **K. terquemi* (HAIME), Baj., Fr.; *6a*, zoarium, ×1; *6b*, surface, ×10 (161).

?Locularia HAMM, 1881 [**L. semipatina*]. Zoarium divided into compartments by vertical partitions. *U.Cret.*, Holl.

Lopholepsis HAG., 1851 [**L. radians*]. Broad incrustations with crowded apertures at end of erect bundles of zooecia. *U.Cret.*——FIG. 24,*7*. **L. radians*, Maastr., Holl.; ×10 (160).

Multifascigera D'ORB., 1853 [**M. campicheana*] [=*Meandrocavea* D'ORB., 1853]. Massive, superposed lamellae, each formed of subcolonies with *Actinopora* growth form. *Cret.*——FIG. 24,*9*. **M. campicheana*, L.Cret.(Valang.), Switz.; *9a*, surface, ×10; *9b*, long. sec., ×5 (*9a*, 202; *9b*, 137).

?Patenaria HAMM, 1881 [**P. depressa*]. (?Cytisidae VOIGT, 1953). *U.Cret.*, Holl.

Radiofascigera D'ORB., 1853 [**R. ramosa*]. Subcylindrical branches composed of numerous confluent, radially arranged zooecial clusters; ovicell as in *Actinopora*. *Cret.-Rec.*——FIG. 24,*8*. **R. ramosa*, L.Cret.(Valang.), Switz.; ×5 (202).

Seguenziella NEVIANI, 1900 [**Patinella manzonii* SEGUENZA, 1879]. Like *Actinopora* but ovicell unknown. *Tert.(Plio.)*, Italy.

Suborder CANCELLATA Gregory, 1896

[Pachystega BORG, 1926]

Zoaria chiefly subcylindrical ramose, but a few forms discoid; walls cancellate (traversed by tubules classed as cancelli, mesopores, vacuoles, nematopores). *Jur.-Rec.*

This group of cyclostome bryozoans was differentiated initially on the basis of structural characters observed in the Horneridae and Petaloporidae; subsequently, GREGORY (1909) added the family which he named Desmeporidae (=Cytididae). Passageways penetrating the zoarial walls are of various sorts. Cancelli, first employed (BUSK) for structures now termed mesopores, are defined (GREGORY, 1896) as closed tubes or irregular spaces between zooecia. Mesopores are minute nontabulate tubes parallel to zooecia which open on the zoarial surface adjacent to the zooecial apertures. Vacuoles are small, obliquely disposed, recurved tubules opening on any part of the zoarium, generally along the floor of longitudinal furrows (sulci); they may be abundant on the back of zoaria where zooecial apertures are lacking. Nematopores are distally directed threadlike perforations, which generally are abundant along the back of zoaria, opening on this surface.

Family HORNERIDAE Gregory, 1899

Zoaria ramose, erect, attached by expanded base. Zooecia with lamellose or squamose walls traversed by vacuoles which open on all sides of zoarium; zooecial apertures confined to front. Ovicell large, sac-shaped, symmetrically placed on back of zoarium, with lateral oeciostome (24,63). *Eoc.-Rec.*

Hornera LAMX., 1821 [**H. frondiculata*] [=*Retihornera* KIRCHENPAUER, 1869]. Vacuoles opening at base on longitudinal sulci both on front and back. *Eoc.-Rec.*——FIG. 25,*1*. **H. frondiculata*, Rec., Medit.; *1a*, zoarium, ×1; *1b,c*, back, front; *1d*, ovicell; *1e*, long. sec.; *1b-e*, ×25 (*1a,e*, 137; *1b,c*, 135; *1d*, 230).

Crassohornera WATERS, 1887 [**C. waipukurensis*]. Like *Hornera* but sulci lacking on front. *Tert.*—— FIG. 25,*2*. *C. arbuscula* REUSS, Eoc. (Barton.), Italy; *2a,b*, front, back with ovicell, ×10 (230).

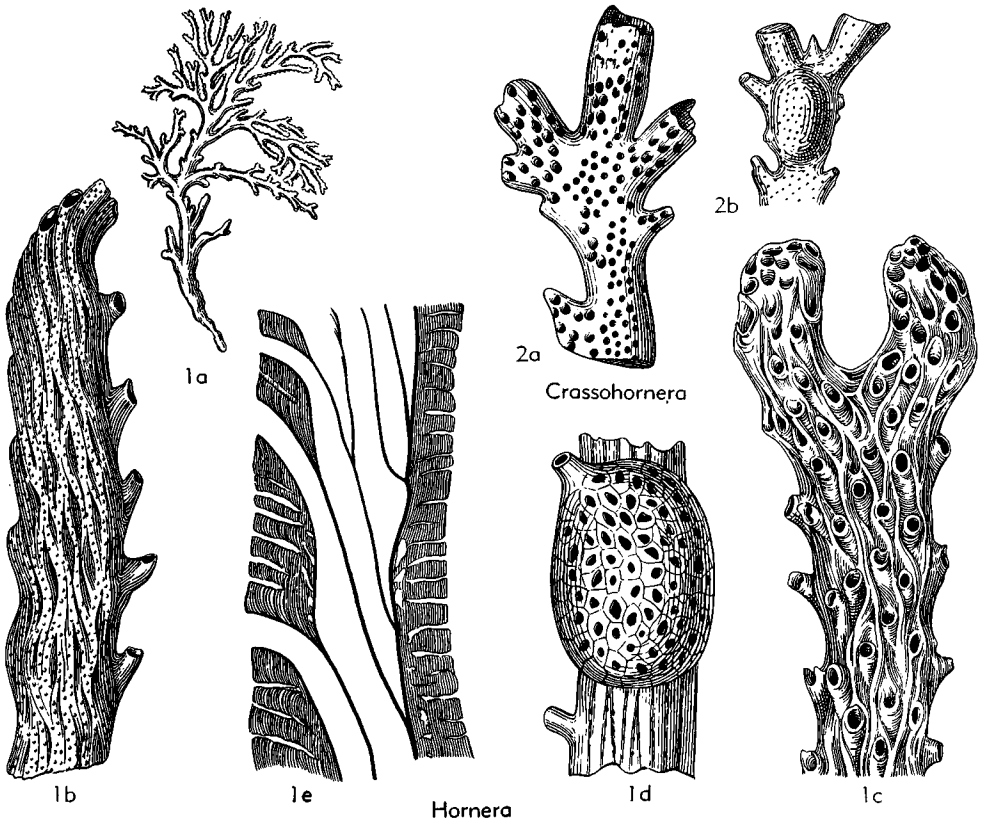


FIG. 25. Horneridae (p. G58).

Family CYTIDIDAE d'Orbigny, 1854

[as Cytisidae] [=Desmeporidae GREGORY, 1909]

Zoaria mostly erect, ramose, but some are frondose or discoidal. Zooecia long, tubular, commonly in bundles with apertures grouped in fascicles on sides or surface. Ovicell globular, paralleling zooecial axis and formed after consolidation of subjacent peristomes. Nematopores (upwardly directed threadlike tubes, kenozooecia) generally on back (25). *Jur.-Rec.*

Cytis D'ORB., 1854 [**C. lanceolata*]. An erect square stem with apertures in raised groups along longitudinal projecting crests on all sides of zoarium. *U.Cret.*——FIG. 26,*1*. **C. lanceolata*, Coni., Fr.; ×10 (202).

Bicavea D'ORB., 1853 [**Fasciculipora urnula* D'ORB., 1850] [=*Multicrisina* D'ORB., 1853]. Vase-shaped or knoblike, with radial fascicles of zooecia on upper surface; ovicell not known. *U.Cret.*——FIG. 26,*2*. **B. urnula* (D'ORB.), Maastr., Fr.; ×10 (202).

Chartecytis CANU-B., 1926 [**C. compressa*]. Erect compressed fronds. Zooecia thick-walled with elongate lozenge-shaped apertures lacking peristome. Elliptical ovicell near bifurcations. *L.Cret.*——FIG. 26,*3*. **C. compressa*, Valang., Switz.; *3a*, zoarium, ×1; *3b*, broken ovicell, ×10; *3c*, surface, ×25 (137).

Cyrtopora HAG., 1851 [**C. elegans*]. Solid cylindrical stems with fascicles of 3 to 6 zooecial tubes opening on all sides. No nematopores. *U.Cret.*——FIG. 26,*6*. **C. elegans*, Maastr., Holl.; *6a*, zoarium, ×1; *6b,c*, surface, transv. sec., ×10 (202).

Desmepora LONSD., 1850 [**Idmonea semicylindrica* ROEMER, 1840] [=*Semicytis* D'ORB., 1854]. Like *Osculipora* but has widened noncylindrical tubes. Vacuoles and nematopores all around zoarium. *Cret.*——FIG. 27,*1*. **D. semicylindrica* (ROEMER), Camp., Ger.; *1a,b*, front, side with ovicell, ×10; *1c*, fragment, ×1; *1d*, long. sec., ×10 (137).

Diplodesmopora CANU-B., 1922 [**D. opposita*]. Erect, slender stems. Zooecia in 2 rows of tubes to a fascicle with transversely arranged apertures confined to front. Ovicell smooth, globular, at edge of zoarium. Nematopores abundant along

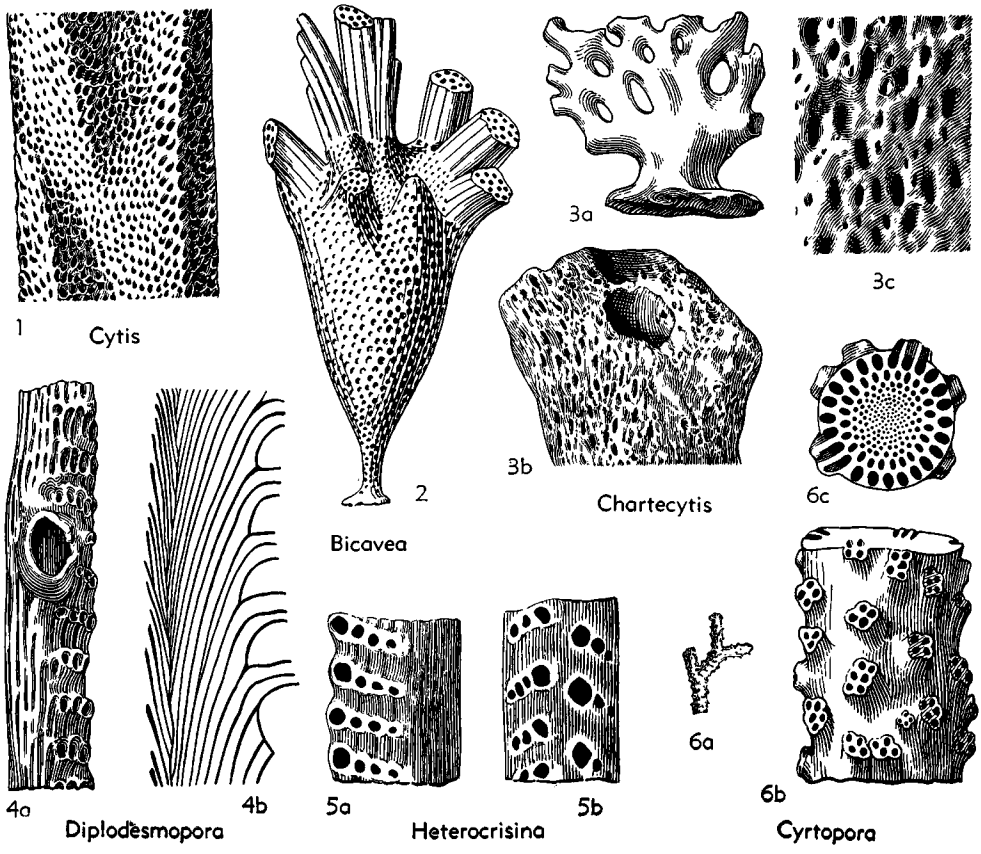


FIG. 26. Cytididae (p. G59, G60).

back. *Cret.*——FIG. 26,*4*. **D. opposita*, Coni., Fr.; *4a*, edge with ovicell, ×10; *4b*, long. sec., ×10 (137).

Discocytis, D'ORB., 1854 [**Pelagia eudesi* MICH., 1844]. Cupuliform, with cup-shaped head; grouped radiating zooecia form ridges on summit. Ovicells large, ovoid, near periphery on back. Base a thick layer of nematopores. *U.Cret.*——FIG. 27,*3*. **D. eudesi* (MICH.), Cenom., Fr.; *3a*, back, showing ovicells and openings of nematopores, ×5; *3b*, front, ×5; *3c*, zoarium, ×1 (*3a,b*, 202; *3c*, 137).

Echinocava D'ORB., 1854 [*pro Echinopora* D'ORB., 1849 (*non* LAMARCK, 1816)] [**Ceriopora raulini* MICH., 1841] Solid, ramose, with fascicles extending above surface as spines or blunt projections. *Cret.*——FIG. 27,*4*. **E. raulini* (MICH.), Alb., Belg.; *4a,b*, ×1, ×10 (202).

Heterocrisina GABB-H., 1860 [**H. abbottii*]. Like *Diplodesmopora* but with a single row of tubes to fascicle. *Eoc.*——FIG. 26,*5*. **H. abbottii*, Wilcox., N.J.; *5a,b*, edge, front, ×10 (154).

Homoeosolen LONSD., 1850 [**H. ramulosus*]. Like *Truncatulipora* but no nematopores. *Cret.*——FIG. 27,*2*. **H. ramulosus*, Eng.; *2a-c*, front, back, front with ovicell, ×10 (137).

Hypocytis ORTMANN, 1890 [**H. asteriscus*]. Like *Supercytis* but apertures open at end of bundle only on lower side. *Rec.*, Japan.

Osculipora D'ORB., 1849 [**Retepora truncata* GOLDF., 1827]. Differs from *Desmepora* in lacking vacuoles and nematopores on front. *U.Cret.*——FIG. 29,*2*. **O. truncata* (GOLDF.), Maastr., Holl.; *2a,b*, edge, back, ×10; *2c*, front, ×5 (137).——FIG. 29,*3*. *O. repens* HAG., Maastr., Fr.; front with ovicell, ×10 (137).

Plethopora HAG., 1851 [**P. verrucosa*] [=*Pledopora* HAG., 1850 *(nom.nud.); Polyphyma* HAMM, 1881. Zoarium short, ramose; cylindrical tubes grouped in salient orbicular bundles. Nematopores present. *U.Cret.*——FIG. 28,*1*. **P. verrucosa*, Maastr., Holl.; *1a*, zoarium, ×5; *1b*, surface, ×10 (160).

Plethoporella CANU-B., 1922 [**Monticulipora ramulosa* D'ORB., 1850]. Structure like ramose *Ceriopora* but has large smooth ovicells. *U.Cret.*——FIG. 28,*2*. **P. ramulosa* (D'ORB.), Maastr., Fr.; *2a*, surface, ×5; *2b*, ovicell, ×10; *2c*, zoarium,

×1; *2d*, long. sec., ×5 (*2a,b,d*, 137; *2c*, 202).

Retenoa GREGORY, 1909 [**Frondipora campicheana* D'ORB., 1853]. Erect stems. Zooecia with lozenge-shaped apertures on one side only; smooth convex ovicell on back. *L.Cret.*——FIG. 28,*4*. **R. campicheana* (D'ORB.), Valang., Switz.; *4a-c*, edge with ovicell, long. sec., front, ×10 (137).

Semicytella BASSLER, 1934 [*pro Semicytis* CANU-B., 1922 (*non* D'ORB., 1854)] [**Semicytis disparilis* D'ORB., 1854]. Like *Truncatulipora* but mesopores occur between apertures along branchlets (pinnules). *Cret.*——FIG. 28,*5*. **S. disparilis* (D'ORB.), Coni., Fr.; *5a*, zoarium, ×1; *5b,c*, front, back, ×10 (202).

Stephanodesma HAMM, 1881 [**S. bifurcata*]. Zoarium goblet-shaped. *U.Cret.(Maastr.)*, Holl.

Supercytis D'ORB., 1854 [**S. digitata*]. Like *Homoeosolen* but attached by short stalk; branches

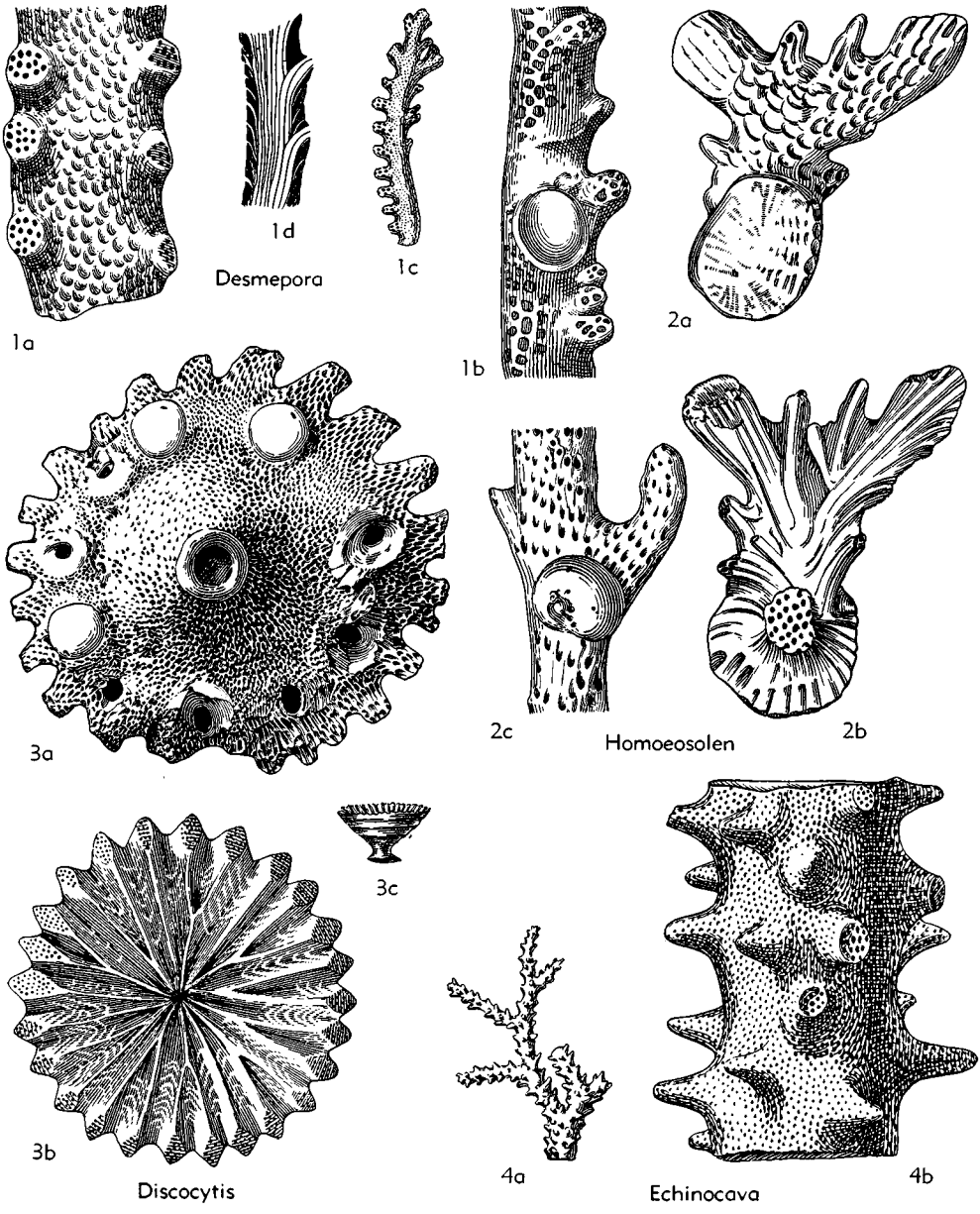


FIG. 27. Cytididae (p. G59, G60).

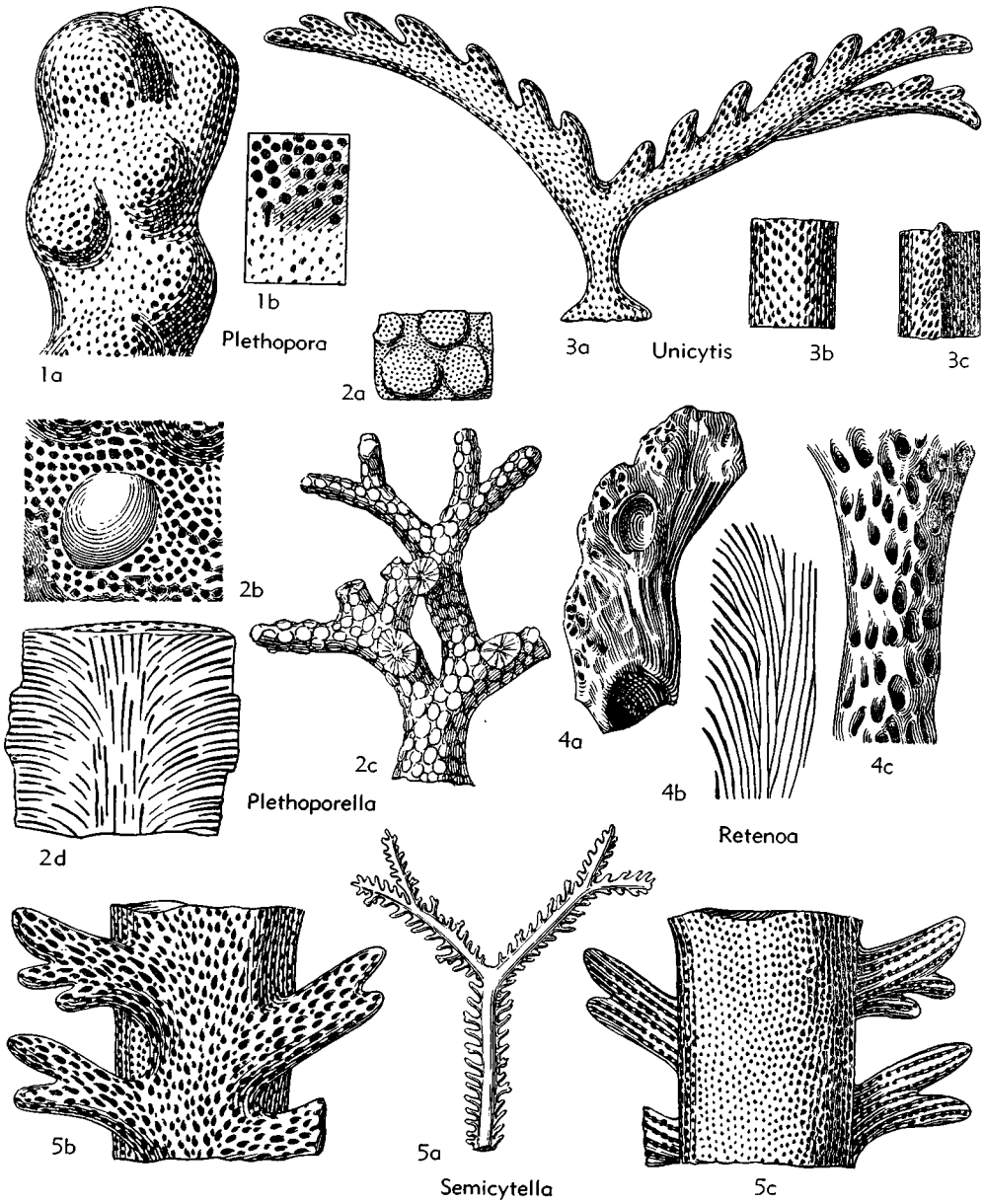


FIG. 28. Cytididae (p. G60-G62).

diverge subhorizontally. *Cret.*——FIG. 29,*4*. **S. digitata*, Maastr., Fr.; *4a*, front with ovicell, ×10; *4b,c*, back, side, ×5 (202).

Tetrapora QUENST., 1858 [**T. suevica*]. *Jur.*, Ger.

Truncatulipora BASSLER, *nom. nov.* [*pro Truncatula* HAG., 1851 (ref. 65, p. 34) (*non* LEACH, 1847)] [**Truncatula filix* HAG., 1851]. Like *Homozosolen* but ovicells dorsally placed between pinnules; apertures elongate, oblique; nematopores present. *U.Cret.*——FIG. 29,*1*. **T. filix* (HAG.), Maastr., Holl.; *1a,b*, front, ×5; *1c*, back, ×5; *1d*, ovicell, ×10 (*1a-c*, 160; *1d*, 137).

Unicytis D'ORB., 1854 [**U. falcata*]. Like *Truncatulipora* but with pinnules formed of 2 alternate bundles. *U.Cret.*——FIG. 28,*3*. **U. falcata*, Senon., Fr.; *3a*, zoarium, ×5; *3b,c*, back, front, ×10 (202).

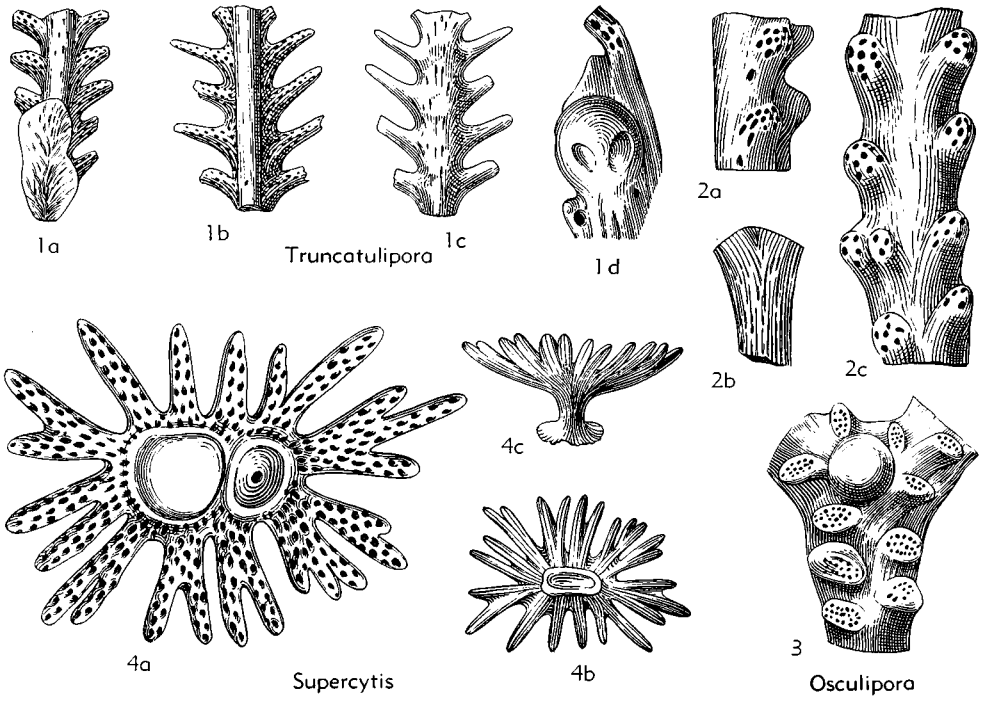


FIG 29. Cytididae (p. G60-G62).

Family PETALOPORIDAE Gregory, 1899

[=Ascosoeciidae CANU, 1919; Crisinidae BORG, 1944]

Zoaria erect, dendroid. Zooecia opening on all sides of branches or only one; walls perforated by the zooecial tubes; oeciostome commonly median (25,63). *Cret., ?Rec.*

Petalopora LONSD., 1850 [**Chrysaora pulchella* ROEMER, 1840] [=*Cavea* (obj.), *Clavicavea, Reptocavea* D'ORB., 1853; *Parascosoecia* CANU, 1919]. Slender cylindrical branches with zooecia opening on all sides and numerous mesopores longitudinally arranged. Ovicell large, elongate, perforated by zooecia. *Cret.*——FIG. 30,*1. P. costata* D'ORB., Fr.; *1a,* surface, ×25; *1b,* ovicell, ×10; *1c,d,* secs., long., transv., ×25 (*1a,c,d,* 202; *1b,* 137).

Atagma LONSD., 1850 [**Ceriopora papularia* MICH. (=*A. lonsdalei* GREGORY, 1899]. Ramose, with the axial bundle covered by several lamellae and mesopores in circular broad-banded series .*Cret.*

?Bivestis HAMM, 1881 [**B. macropora*]. Ramose with central branch covered by another layer of zooecia; may be *Multizonopora.* (?Eleidae VOIGT, 1953). *U.Cret.(Maastr.),* Belg.

Cavarinella MARSSON, 1887 [**Cavaria ramosa* HAG., 1851]. Like *Petalopora* but with axial cavity divided into compartments by partitions. *U.Cret.* ——FIG. 30,*2.* **C. ramosa* (HAG.), Maastr., Holl.; *2a,b,* secs., long., transv., ×10; *2c,* surface, ×10 (160).

Choristopetalum LONSD., 1849 [**C. impar*]. Allied to *Petalopora. L.Cret.(Apt.),* Eng.

Coelocochlea HAG., 1851 [**C. torquata*]. Hollow stems with angular, spirally arranged ridges and numerous minute mesopores. *U.Cret.*——FIG. 30,*3.* **C. torquata,* Maastr., Holl.; ×10 (160).

Crisina D'ORB., 1853 [**C. normaniana*]. Like *Reteporidea* but salient unsymmetrical ovicell covers zoarial width, zooecial tubes short, club-shaped, with thick dilated walls; no frontal mesopores but back is smooth, perforated by scattered vacuoles. *Cret.-Rec.*

Filicrisina D'ORB., 1853 [**F. retiformis*] [=*Phormopora* MARSSON, 1887]. Slender cylindrical dichotomous branches with laterally placed ovicell and apertures in quincunx arrangement on front; back with lozenge-shaped dactylethrae pierced by salient tubules. *Cret.*——FIG. 30,*5. F. verticillata* D'ORB., Santon., Fr.; *5a,b,* back, front, ×15 (202).

Grammanotosoecia CANU-B., 1922 [**G. contorta*]. Zoarium bifoliate. Zooecial tubes long, cylindrical, without peristome; ovicell orbicular. Mesopores numerous. *Cret.*——FIG. 30,*6.* **G. contorta* Santon., Fr.; *6a,* surface, ×10; *6b,* ovicell, ×10 (137).

Grammascosoecia CANU-B., 1922 [**Ceriopora dichotoma* GOLDF., 1827]. Bifoliate; tubes short,

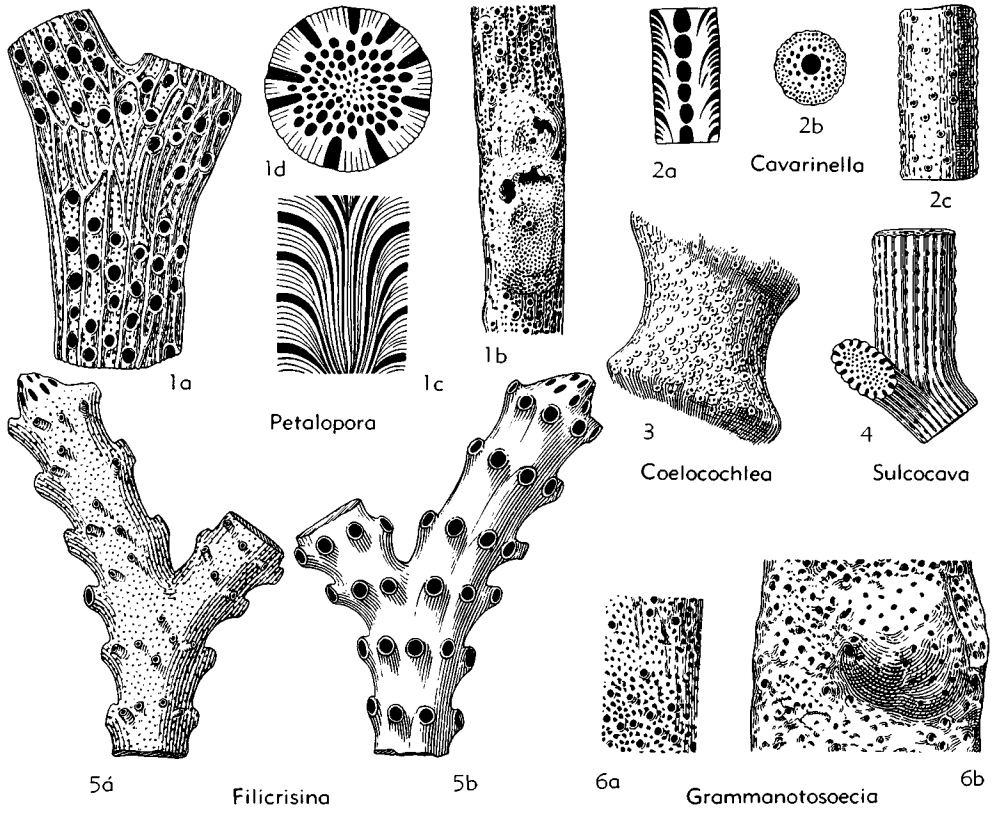


FIG. 30. Petaloporidae (p. G63, G64).

with gemmation on mesotheca only developed in older growth stages. *Cret., ?Rec.*——FIG. 31,*2*. **G. dichotoma* (GOLDF.), Maastr., Holl.; *2a-c,* secs., tang., transv., long., ×15 (137).

Hemicellaria D'ORB., 1850 [**H. ramosa*] [=*Semicellaria* D'ORB., 1853 (obj.)]. Small, solid, ramose. Zooecial apertures somewhat irregular. Mesopores deep, numerous; back with much lamellar tissue bearing vacuoles. *Cret.*——FIG. 31,*4*. **H. ramosa,* Maastr., Fr.; *4a,b,* front, transv. sec., ×10; *4c,* zoarium, ×1 (202).

Laterocavea D'ORB., 1853 [**L. dutempleana*]. Slender-branched, compressed fronds with cylindrical zooecia and many mesopores arranged around a central line. Edges of fronds formed of mesopores only and bearing ovicell. *L.Cret.*——FIG. 31,*1*. **L. dutempleana,* Apt., Fr.-Eng.; *1a,* front, ×25; *1b,c,* long. sec., edge, ×10 (137).

Multicavea D'ORB., 1853 [**M. magnifica*] [=*Ascosoecia* CANU, 1919]. Like *Petalopora* but peristomes arranged in radial rows. *Cret.*——FIG. 31,*6*. **M. magnifica,* Maastr., Fr.; *6a,* surface, ×10; *6b,* ovicell, ×10 (*6a,* 202; *6b,* 137).

Multizonopora D'ORB., 1853 [**Heteropora ramosa* ROEMER, 1850 (=*H. arborea* KOCH & DUNKER, 1827)] [=*Zonatula* HAMM, 1881]. Like *Petalopora* but composed of many superimposed laminae. *L.Cret.*——FIG. 31,*3*. **M. arborea* (KOCH & DUNKER), Neocom., Ger.-Fr.; *3a,* zoarium, ×1; *3b,* surface, ×10 (202).

Reteporidea D'ORB., 1849 [**Retepora lichenoides* GOLDF., 1827] [=*Crisidmonea* MARSSON, 1887; *Polyascosoecia* CANU-B., 1920]. Zoarium free, arborescent, front with divergent mesopores, back with proximally bent vacuoles (25). *U.Cret.,* Eur.

Siphodictyum LONSD., 1849 [**S. gracile*] [=*Filicavea* D'ORB., 1853]. Like *Laterocavea* but adventitious pores are vacuoles, not mesopores; ovicell unknown. *L.Cret.,* Eng.

Sparsicavea D'ORB., 1853 [**S. carantina*]. Like *Petalopora* but radiating ridges on surface connect zooecia separated by irregularly distributed mesopores between ridges. *U.Cret.*——FIG. 31,*5*. **S. carantina,* Turon., Fr.; ×25 (202).

Sulcocava D'ORB., 1854 [**S. cristata*] [=*Laterocava* D'ORB., 1854]. Slender bifoliate branching stems covered partly by thin lamellar tissue; mesopores absent but represented by tear-shaped pores in sulci. Ovicell spread out over broad side of zoarium. *U.Cret.*——FIG. 30,*4*. **S. cristata,* Santon., Fr.; ×10 (202).

Family PSEUDIDMONEIDAE Borg, 1944

Zoaria erect, ramose. Zooecial apertures on frontal side in transverse or oblique series; gonozooecium simple, unlobed, its middle and distal points located on basal part of zoarium (11). *Rec.*

Pseudidmonea Borg, 1944 [**Idmonea fissurata* Busk, 1886]. S.Atl.

Family CALVETIIDAE Borg, 1944

Zoaria erect, cylindrical. Zooecial apertures open all around; ovicells located only at bifurcations (11). *Rec.*

Calvetia Borg, 1944 [**C. dissimilis*]. S.Atl.

Family STEGOHORNERIDAE Borg, 1944

Gonozooids in axil or with middle (inflated) and distal portions on basal side of stem, gymnocyst partly calcified (11). *Rec.*

Stegohornera Borg, 1944 [**Hornera violacea* Sars, 1835]. Atl.

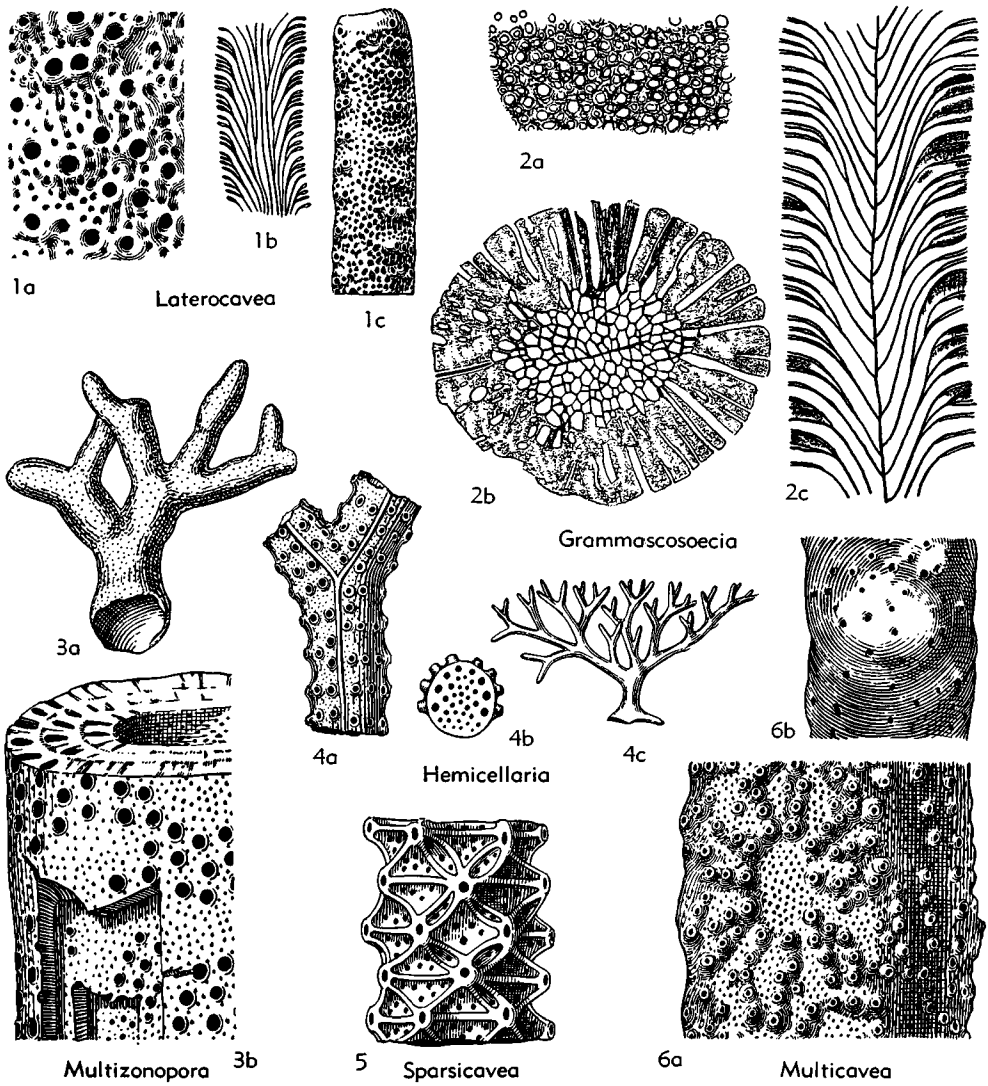


Fig. 31. Petaloporidae (p. G63, G64).

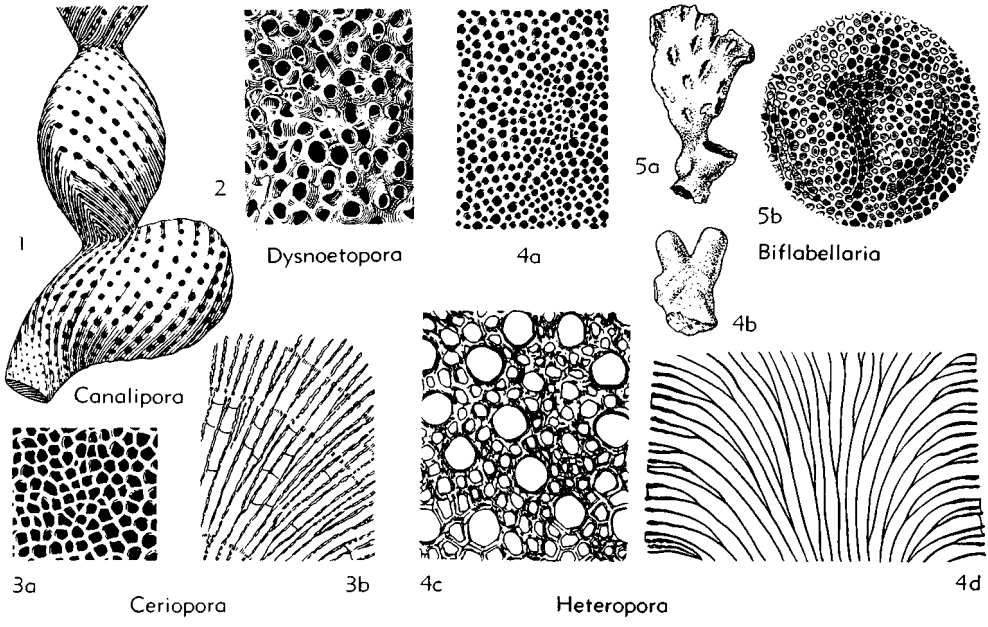


FIG. 32. Heteroporidae (p. G66, G67).

Suborder CERIOPORINA Hagenow, 1851

[=Heteroporina BORG, 1933]

Zoaria generally thick, solid or hollow branches, or dense variously shaped lamellar masses, composed of adjoined simple, prismatic or cylindrical zooecial tubes with horizontal diaphragms; mesopores common. Superficially resemble Trepostomata but differ in having typical cyclostomatous vesicular walls and ovicells developed at right angles to the zooecial axis; regularly spaced monticules, such as occur in trepostomes, are not developed. *Trias.-Rec.*

Family HETEROPORIDAE Waters, 1880

[=Cerioporidae HENNIG, 1894; Canuellidae, BORG, 1944]

Zoaria varied in form but all exhibiting minutely porous or vesicular wall structure denoting pseudopores; longitudinal thin sections show that the vesicles (variable in size) are formed by contraction of the membranous ectocyst in front of the pseudopores (24,63). *Trias.-Rec.*

Ceriopora and allied genera without mesopores were formerly classified as Cerioporidae but the presence or absence of mesopores in the Cyclostomata is not a diagnostic family character. Since ovicells remain undiscovered in the type species of *Heteropora,* the Heteroporidae should be maintained for the numerous genera without known ovicells and the Tretocycloeciidae for those with brood chambers. Naturally, future discoveries may furnish bases for changing this arrangement.

Heteropora BLAINV., 1830 [**Ceriopora cryptopora* GOLDF., 1827] [=*Thalamopora* HAG., 1846 (*non* MICH., 1844); *Nodicrescis* D'ORB., 1854]. Zoaria erect, arborescent with smooth surface. Zooecial tubes long, cylindrical to prismatic, separated by many thin-walled angular mesopores. Ovicell reported by VOIGT (1953). *Trias.-Rec.*——FIG. 32,*4*. **H. cryptopora* (GOLDF.), Maastr., Holl.; *4a,* surface, ×10; *4b,* zoarium, ×1; *4c,d,* secs., ×25, ×10 (137).

Acanthopora D'ORB., 1849 (*non* Y.-Y., 1876) [**Chrysaora spinosa* MICH., 1843]. Like *Neuropora* but the thickened peristome borders bear small conical points. *Jur.-Cret.*——FIG. 34,*4*. **A. spinosa* (MICH.), Jur.(Bath.), Fr.; *4a,* surface, ×25; *4b,* zoarium, ×1 (202).

Biflabellaria PERGENS, 1894 [**B. apathyi*]. Zoarium flabelliform, bifoliate, with numerous pyriform depressions (maculae) occupied only by mesopores. Zooecia dimorphic. *Cret.*——FIG. 32,*5*. **B. apathyi,* Maastr., Holl.; *5a,* zoarium, ×1; *5b,* surface, ×10 (202).

Borgiola STRAND, 1933 [**Canuella rugosa* BORG, 1933] [=*Canuella* BORG, 1933 (*non* SCOTT, 1893)]. Erect, branching, with irregular elevated areas separated by depressions. *Rec.*, Japan.

Canalipora HAG., 1850 [**Ceriopora articulata* HAG., 1839] [=*Cabalipora* DE MORGAN, 1882; *Tuberculipora* PERGENS & MEUNIER, 1887]. Zoaria globular, apertures quincuncially arranged, with curved ridges between rows. *U.Cret.*——FIG. 32,*1*. **C. articulata* (HAG.), Camp., Ger.; ×10 (160).

Ceriopora GOLDF., 1827 [**C. micropora*] [=*Semimulticava, Reptonodicava* D'ORB., 1854]. Like *Heteropora* but without mesopores; zooecia with few to many horizontal diaphragms. [Discovery of a *Corymbopora*-like ovicell in *C. tumulifera* CANU-B. (BALAVOINE, 1950) with aid of X-rays does not require reference of the Cerioporidae to the Corymboporidae because the ovicell of the type species *(Ceriopora micropora)* must still be validated.] *Trias.-Mio.*——FIG. 32,*3*. **C. micropora*, Cret.(Maastr.), Holl.; *3a,b*, secs., ×10 (*3a*, 202; *3b*, 137).

Cerioporella LEV., 1925 [**Ceriopora gutta* VOIGT, 1924]. Small globular zoaria with branches composed of mesopores on which new colonies are built. *U.Cret.* (*Dan.*), Ger.-Denm.

Defranciopora HAMM, 1881 [**Defrancia cochloidea* HAG., 1851]. Several superposed saucer-shaped subcolonies. *Cret.*——FIG. 33,*1*. **D. cochloidea* (HAG.), Maastr., Holl.; *1a*, top, ×10; *1b*, side, ×5 (202).

Densipora MACGILL., 1881 [**D. corrugata*]. Incrusting; zooecia with blunt processes aligned with mesopores between strong ridges; ovicell not known. *Rec.*, SW.Pac.

Dysnoetopora CANU-B., 1926 [**D. celleporoides*]. Zoaria solid, ramose. Zooecia club-shaped, some with salient orbicular peristomes, some irregularly polygonal, undeveloped, and some elongated into form of avicularia with teeth. *Cret.*——FIG. 32,*2*. **D. celleporoides*, Ripley, Tenn.; ×10 (137).

Filicava D'ORB., 1854 [**F. triangularis*]. Erect, triangular branches with zooecia outlined by 3 narrow nonporiferous ridges. *U.Cret.*——FIG. 33,*5*. **F.*

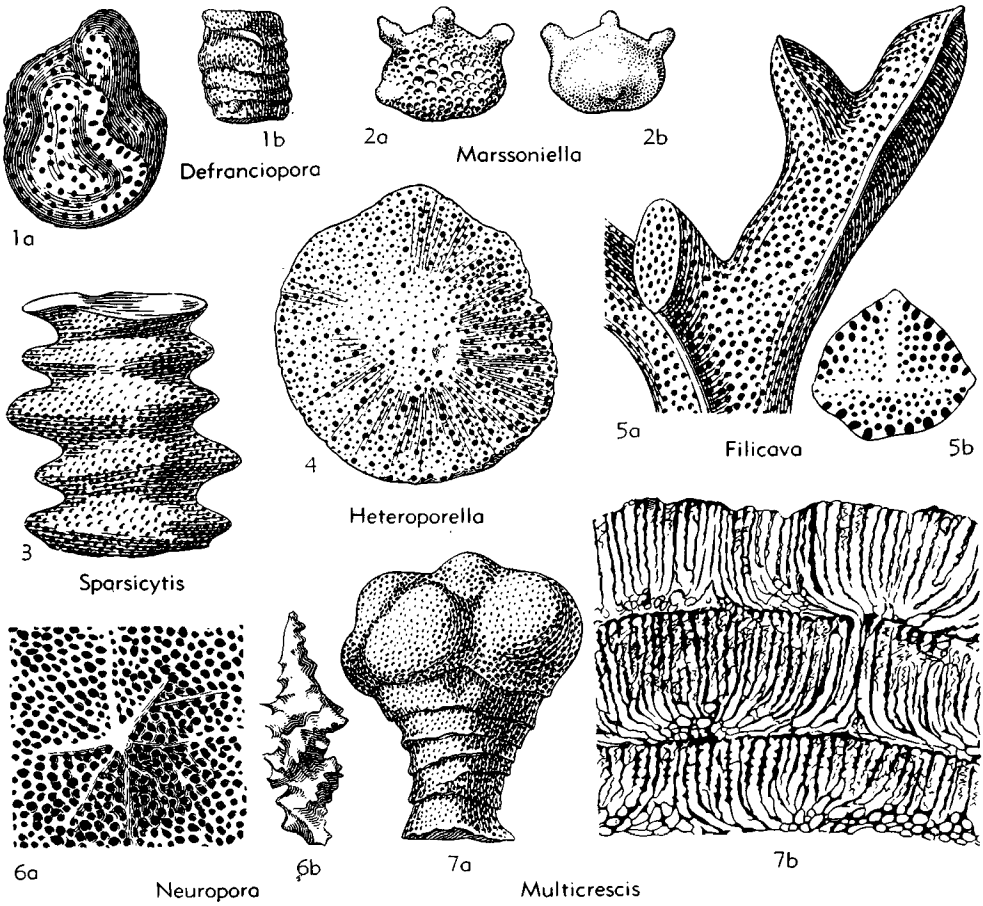


FIG. 33. Heteroporidae (p. G67-G69).

triangularis, Maastr., Fr.; *5a, 5b,* side, top, ×10 (202).

Globulipora PERON, 1893 [**G. africana*]. Globular cellular bodies, internal structures not defined (?calcareous alga). *U.Cret.,* Tunis.

Heteroporella BUSK, 1859 [**H. radiata*]. Discoid, adnate zoarium with polygonal zooecia and many mesopores radially arranged. *Cret.-Plio.*——FIG. 33,*4*. **H. radiata,* Plio.(Crag), Eng.; ×10 (134).

Marssoniella LEV., 1925 [**M. reticulata*]. Top-shaped stalked colonies with zooecial apertures only on upper surface, mesopores elsewhere. *U. Cret.*——FIG. 33,*2*. **M. reticulata,* Dan., Denm.; *2a,b,* front, back, ×10 (177).

Multicrescis D'ORB., 1854 [**M. variabilis*] Zoarium massive or branched, composed of superposed thin layers of zooecia; apertures bearing nodose spines or visors. *Cret.-Mio.*——FIG. 33,*7*. **M. variabilis,* Cret.(Cenom.), Fr.; *7a,* side, ×5; *7b,* long. sec., ×10 (202).

Neofungella BORG, 1933 [**Heteropora claviformis* WATERS, 1904] Simple, capitate zoarium with short peduncle; ovicell unknown. *Rec.,* Antarct.

Neuropora BRONN, 1825 [*pro Chrysaora* LAMX., 1821 (*non* PERON, 1809)] [**Chrysaora spinosa* LAMX., 1821]. Zoarium claviform or arborescent, surface traversed by irregular veinules of solidified tubes, radiating from special center. Zooecia polygonal, apertures with short visors. *Jur.-Cret.*——FIG. 33,*6*. **N. spinosa* (LAMX.), M.Jur.(Bath.), Fr.; *6a,* surface, ×10; *6b,* zoarium, ×1 (202).

Neuroporella HENNIG, 1894 [**N. ignabergensis*]. Like *Neuropora* but formed of incrusting uni- or multilamellar masses. *U.Cret.,* Swed.

Ramia GREGORIO, 1930 [**Ceriopora elegantula* GREGORIO, 1930]. *Trias.,* Sicily.

Reptomulticava D'ORB., 1854 [**Alveolites (Micropora) heteropora* ROEMER, 1839] [=*Semicava* D'ORB., 1854; *Reptocea* KEEPING, 1883 (*non* D'ORB., 1854)]. Like *Ceriopora* but zoaria multilamellar, branched, or massive; zooecia short, expanding rapidly. *Cret.-Mio.*——FIG. 34,*1*. **R. heteropora* (ROEMER), Cret.(Neocom.), Ger.; *1a,* long. sec., ×10; *1b,* zoarium, ×1; *1c,* surface, ×10 (137).

Seminodicrescis D'ORB., 1854 [**S. nodosa*]. Erect hollow branches with nodosities of zooecia and mesopores. *Cret.*——FIG. 34,*2*. **S. nodosa,* Apt., Fr.; *2a,* surface, ×10; *2b,* zoarium attached to shell, ×1 (*2a,* 202; *2b,* 137).

Sparsicytis FILLIOZAT, 1907 [**Plethopora (Monticulipora) cervicornis* D'ORB., 1854]. Ramose;

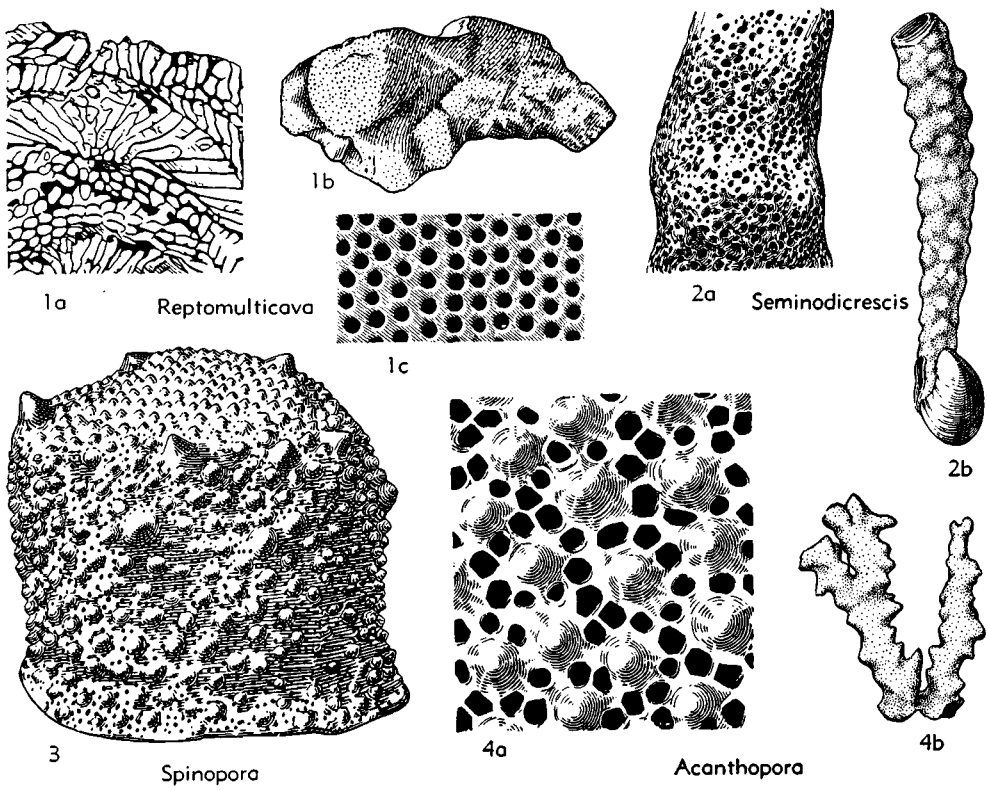


FIG. 34. Heteroporidae (p. G66-G70).

zooecial apertures opening on horizontally elongated prominences separated by areas of mesopores. *Cret.*——Fig. 33,*3*. **S. cervicornis* (d'Orb.), Coni., Fr.; ×5 (202).

Spinopora Blainv., 1830 [**Ceriopora mitra* Goldf., 1827]. Like *Neuropora* but surface bears very salient, smooth tuberosities without veinules; zooecial tubes with internal spines. *U.Cret.*——

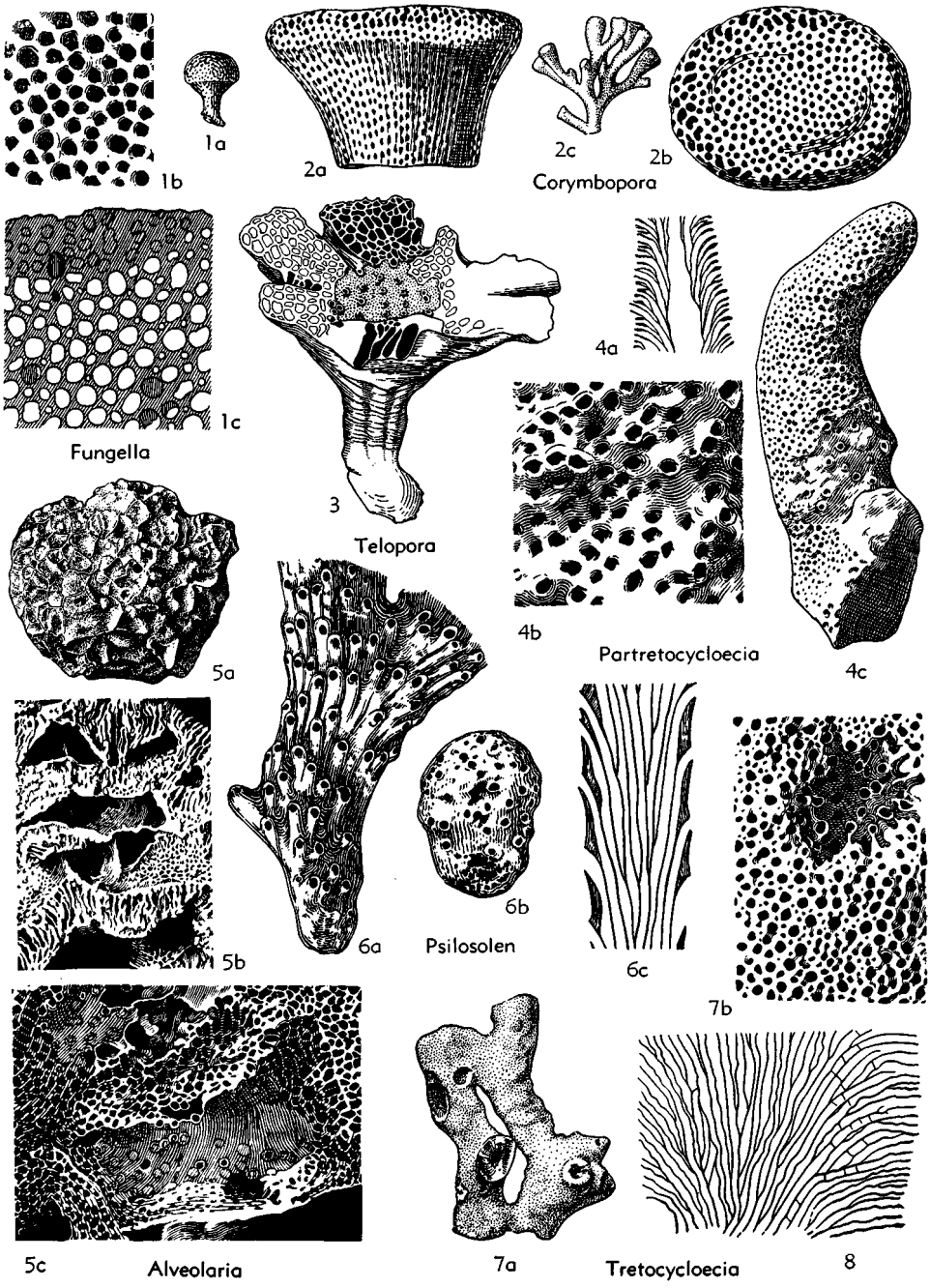


Fig. 35. Corymboporidae, Tretocycloeciidae (p. G70).

FIG. 34,*3*. **S. mitra* (GOLDF.), Cenom., Ger.; ×5 (137).

Family CORYMBOPORIDAE Smitt, 1866

Zoaria erect, club-shaped or bushy, with distal ends expanded, larger young zooecia at top, sides marked by numerous pores comprising remnants of old zooecia. Ovicell perpendicular to zooecial axis, restricted to top (64). *Cret.-Rec.*

Corymbopora MICH., 1846 [**C. menardi*] [=*Corymbosa* D'ORB., 1853 (obj.)]. Tips of branches flat or curved, occupied by ovicell which resembles a branched trench when broken. *U. Cret.-Rec.*——FIG. 35,*2*. **C. menardi*, Cret. (Cenom.), Fr.; *2a,b*, ×10, side, top, ×10; *2c*, zoarium, ×1 (202).

Dartevillea BORG, 1944 [**D. cylindrica*]. Cylindrical peduncle arising from a disc with ovicell at top. *Rec.*, S.Atl.

Fungella HAG., 1851 [**F. dujardini*]. Club-shaped zoarium with narrow peduncle; ovicell unknown. *Cret.*——FIG. 35,*1*. **F. dujardini*, Maastr., Holl.; *1a*, zoarium, ×1; *1b,c*, surface, tang. sec., ×10 (137).

Family TRETOCYCLOECIIDAE Canu, 1919

Zoaria erect, arborescent, smooth. Zooecia cylindrical to polygonal (autozooecia), with vesicular walls bearing diaphragms and separated by numerous small mesopores (kenozooecia). No gonozooecia but a flat, smooth orbicular structure extending at right angles across a number of zooecial tubes and adjacent mesopores (in some) constitutes a zoarial brood chamber (24,25,26). *Cret.-Rec.*

Tretocycloecia CANU, 1910 [**Heteropora dichotoma* REUSS, 1847]. Zoarium arborescent. Brood chamber embracing several zooecia and mesopores which cross at right angles. *Cret.-Rec.*——FIG. 35,*7*. *T. tortilis* (LONSD.), Mio., Va.; *7a*, zoarium, ×1; *7b*, surface with broken ovicell, ×10 (137). ——FIG. 35,*8*. **T. dichotoma* (REUSS), Mio. (Helv.), Fr.; long. sec., ×10 (137).

Alveolaria BUSK, 1859 [**A. semiovata*]. An aggregation of club-shaped bodies united by their basal lamellae, composed of cylindrical tubes without mesopores. Brood chamber irregular, not salient, placed at center of each subcolony. *Oligo.-Plio.* ——FIG. 35,*5*. **A. semiovata*, Plio., Eng.-Holl.; *5a*, zoarium, ×1; *5b*, long. sec., ×5; *5c*, surface with ovicell, ×10 (137).

Coscinoecia CANU-L., 1934 [**C. radiata*]. Like *Tretocycloecia* but oeciostome larger than zooecial apertures. *Mio.*, Fr.

Paratretocycloecia BUGE & BALAVOINE, 1951 [**P. parisiensis*]. Like *Tretocycloecia* but with surface of brood chamber reticulate (possibly clusters of mesopores). *Eoc.(Lut.)*, Fr.

Partretocycloecia CANU, 1919 [**Cavaria dumosa* ULR., 1901]. Hollow ramose branches to massive, with short club-shaped tubes accompanied by mesopores. Brood chamber perforated by a group of tubes, each with single mesopore. *Eoc.-Oligo.* ——FIG. 35,*4*. **P. dumosa* (ULR.), Eoc.(Wilcox.), Md.; *4a*, long. sec., ×10; *4b*, surface, ×25; *4c*, branch, ×10 (137).

Psilosolen CANU-B., 1922 [**P. capitiferox*]. Free cylindrical branches with apertures on all sides and brood chamber covering their ends. *Pleisto.-Rec.*——FIG. 35,*6*. **P. capitiferox*, Pleisto., Calif.; *6a*, fragment, ×10; *6b*, terminal brood chamber, ×10; *6c*, long. sec., ×25 (137).

Telopora CANU-B., 1920 [**Supercytis watersi* HARMER, 1915] Brood chamber surmounting colony, spreading over its entire width. *Mio-Rec.*—— FIG. 35,*3*. **T. watersi* (HARMER), Rec., E.Indies; ×10 (164).

Family CAVIDAE d'Orbigny, 1854

[=Ceriocavidae CANU-B., 1922; Monticuliporidae BASSLER, 1935]

Zoaria solid cylindrical or bifoliate, resembling Trepostomata in growth form but different in developing ovicells and in having vesicular wall structure with pseudopores. Ovicell a long transverse, convex, symmetrical vesicle with a large median salient tubular oeciostome and having special walls developed above the peristomes so as to enclose a number of zooecial tubes (25). *Jur.-Cret.*

Cava D'ORB., 1854 [**Ceriopora dumetosa* MICH., 1846] [=*Grammecava* CANU-B., 1922 (obj.)]. Zoarium dichotomously branching, bifoliate; zooecial tubes short, without peristome, their recurved extremity much widened with vesicular walls and commonly closed by facets. *Jur.*——FIG. 36,*4*. **C. dumetosa* (MICH.), M.Jur.(Bath.), Fr.; *4a*, zoarium, ×1; *4b-d*, secs., ×10 (137).

Ceriocava D'ORB., 1849 [**Ceriopora pustulosa* MICH., 1826 (=*Millepora corymbosa* LAMX., 1821)] [=*Monticulipora* D'ORB., 1849 (obj.) (*non* D'ORB., 1850); *Nodicava* D'ORB., 1854]. Ramose solid stems; long zooecial tubes with diaphragms in the cylindrical part and vesicular walls in the outer, wider portion. Ovicell a transverse smooth vesicle. *Jur.-Cret.*——FIG. 36,*5*. **C. corymbosa* (LAMX.), M.Jur.(Bath.), Fr.; *5a*, surface with ovicell, ×10; *5b,c*, secs., long., transv., ×10; *5d*, zoarium, ×1 (*5a-c*, 137; *5d*, 202).

Diplocava CANU-B., 1926 [**D. incondita*]. Like *Ceriocava* but with dimorphic zooecia, groups of large open ones separated by zones of small ones with facets. Ovicell not known. *L.Cret.*——FIG. 36,6. **D. incondita,* Valang., Switz.; *6a,* long. sec., ×10; *6b,c,* zooecia without and with facets, ×25 (137).

Haplooecia GREGORY, 1896 [**Millepora straminea* PHILLIPS, 1829]. Like *Ceriocava* but terminal walls not vesicular, diaphragms and mesopores absent, facets constant, and apertures terminal, without peristome. Ovicell not known. *Jur.-Cret.*——FIG. 36,3. **H. straminea* (PHILLIPS), M.Jur.(Bath.), Eng.; surface, ×25 (137).

Ripisoecia CANU-B., 1922 [**Millepora conifera* LAMX., 1821] [=*?Polytrema* RISSO, 1826; *?Crescis, ?Reptomulticrescis* D'ORB., 1854]. Small club-shaped stems composed of long, cylindrical zooecial tubes with peristomes, mesopores closed by calcareous lamella. Ovicell a fan-shaped smooth vesicle, striated transversely. *Jur.*——FIG. 36,1. **R. conifera* (LAMX.), Bath., Fr.; *1a,* surface with ovicell, ×10; *1b,* zoaria, ×1; *1c,* long. sec., ×10 (*1a,c,* 137; *1b* (202).

Zonopora D'ORB., 1849 [**Ceriopora spiralis* GOLDF., 1827; SD D'ORB., 1849] [=*Spiroclausa* D'ORB., 1853; *Spirofascigera* HAMM, 1881]. Slender screw-shaped zoarium with zooecia in spirally arranged

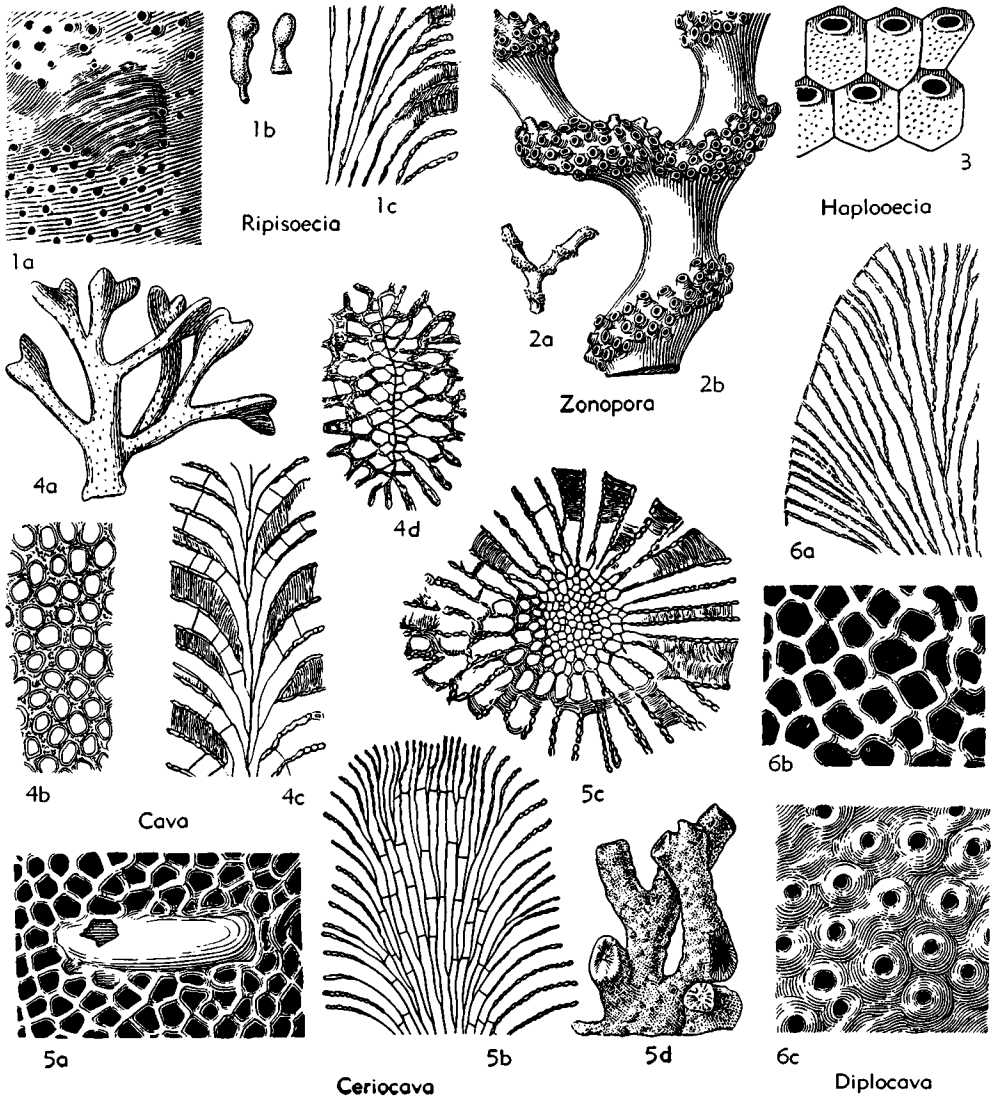


FIG. 36. Cavidae (p. G70-G72).

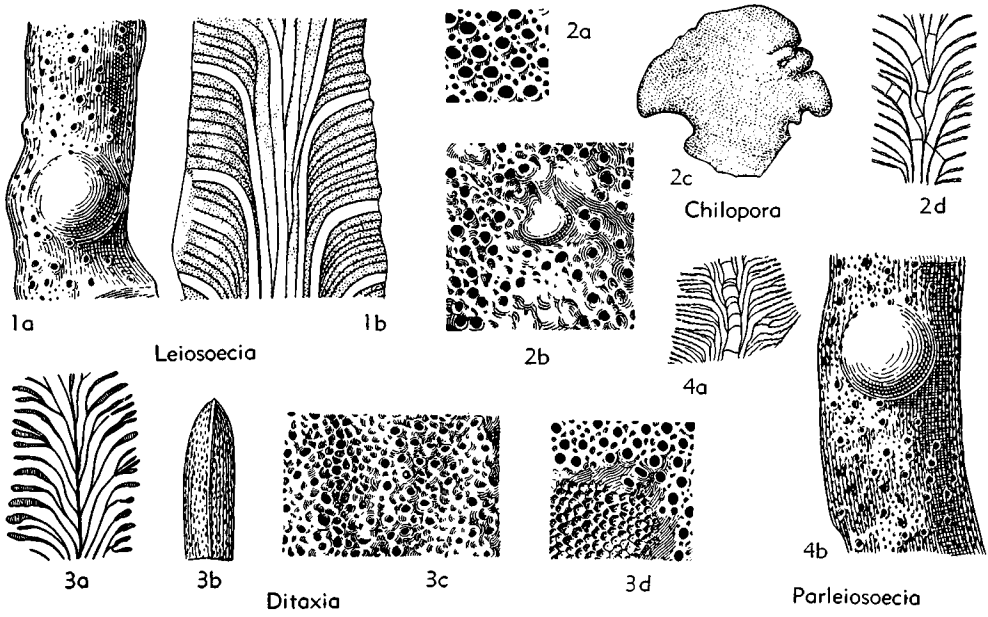


FIG. 37. Leiosoeciidae (p. G72).

bands separated by dactylethrae. Ovicell a smooth elongate sac located between spirals. *Cret.*——FIG. 36,*2*. **Z. spiralis* (GOLDF.), Maastr., Holl.; *2a*, zoarium, ×1; *2b*, side, ×5 (202).

Family LEIOSOECIIDAE Canu & Bassler, 1920

Zoaria solid ramose, hollow, or bifoliate fronds with smooth orbicular ovicell placed above and obstructing a number of zooecial tubes but not perforated by them; numerous minute mesopores (24,25). *Jur.-Eoc.*

Leiosoecia CANU-B., 1920 [**Multicrescis parvicella* GABB-H., 1860]. Zoarium solid, ramose. Zooecia cylindrical, with vesicular walls separated by regular parietal mesopores. Ovicell large, smooth, convex. *Eoc.*——FIG. 37,*1*. **L. parvicella* (GABB-H.), Wilcox., N.J.; *1a*, fragment with ovicell, ×10; *1b*, long. sec., ×25 (137).

Chilopora HAIME, 1854 [**C. guernoni*]. Erect bifoliate fronds. Zooecial apertures with salient curved lip (lunarium) along their lower edge separated by numerous mesopores. Ovicell very small, smooth, convex. *Jur.-Cret.*——FIG. 37,*2*. **C. guernoni*, Jur.(Bath.), Fr.; *2a,b*, surface without and with ovicell, ×10; *2c*, zoarium, ×1; *2d*, long. sec., ×10 (137).

Ditaxia HAG., 1851 [**Ceriopora anomalopora* GOLDF., 1827] [=*Semimulticrescis, Semicrescis* D'ORB., 1854; *Polytaxia* HAMM, 1881 (obj.)]. Like *Chilopora* but has a larger ovicell, thick median lamella and thickened tube extremities. *Cret.*——FIG. 37,*3*. **D. anomalopora* (GOLDF.), Maastr., Holl.; *3a*, long. sec., ×10; *3b*, edge, ×5; *3c,d*, surface, ×10 (*3a,c*, 137; *3b,d*, 202).

Parleiosoecia CANU-B., 1920 [**P. jacksonica*]. Like *Leiosoecia* but tubes club-shaped, abruptly bent distally. Mesopores numerous, with vesicular walls. Central hollow with partitions. *Eoc.*——FIG. 37,*4*, **P. jacksonica*, Jackson., Ga.; *4a*, surface with ovicell, ×10; *4b*, long. sec. with central partition, ×10 (137).

Suborder RECTANGULATA Waters, 1887

[=Calyptrostega BORG, 1926]

Zoarium developed from an expanded funnel-shaped common bud (BORG, 1944); basal wall adherent to substratum not separated by a joint from the primary disc. Special coelomic spaces (alveoli) between zooids and where covering a fertile zooecium form a zoarial brood chamber at right angles to terminal zooecial axis, with an oeciostome which may be larger than zooecial apertures. *Cret.-Rec.*

Family LICHENOPORIDAE Smitt, 1866

[=Disporellidae BORG, 1944]

Zoarium wartlike, discoid, simple, or composite, adnate, with tubular zooecia

opening on upper surface, arranged in more or less distinct series (fascicles) radiating from a free central area and separated by alveoli. Between the fascicles are adventitious tubes (so-called "cancelli") with spicules, closed by a finely perforated lamella (11,24,63). *Cret.-Rec.*

Lichenopora DEFRANCE, 1823 [**L. turbinata*]. Zoarium composed of mono- or multiserial fascicles with central depression on the upper surface from which rows of zooecia radiate. Ovicell a brood chamber located near zoarial center. *Cret.-Rec.*

L. (Lichenopora) Monoserial fascicles. *Cret.-Rec.* ——FIG. 38,*1*. **L. turbinata*, M.Eoc., Fr.; ×10 (136).——FIG. 38,*2*. *L. radiata* AUDOUIN, Rec., Atl.; ×10 (167).——FIG. 38,*3*. *L. holdsworthi* BUSK, Rec., Ceylon; ×25 (230).

L. (Bimulticavea) D'ORB., 1853 [**B. variabilis*]. Compound, with massive superposed lamellar

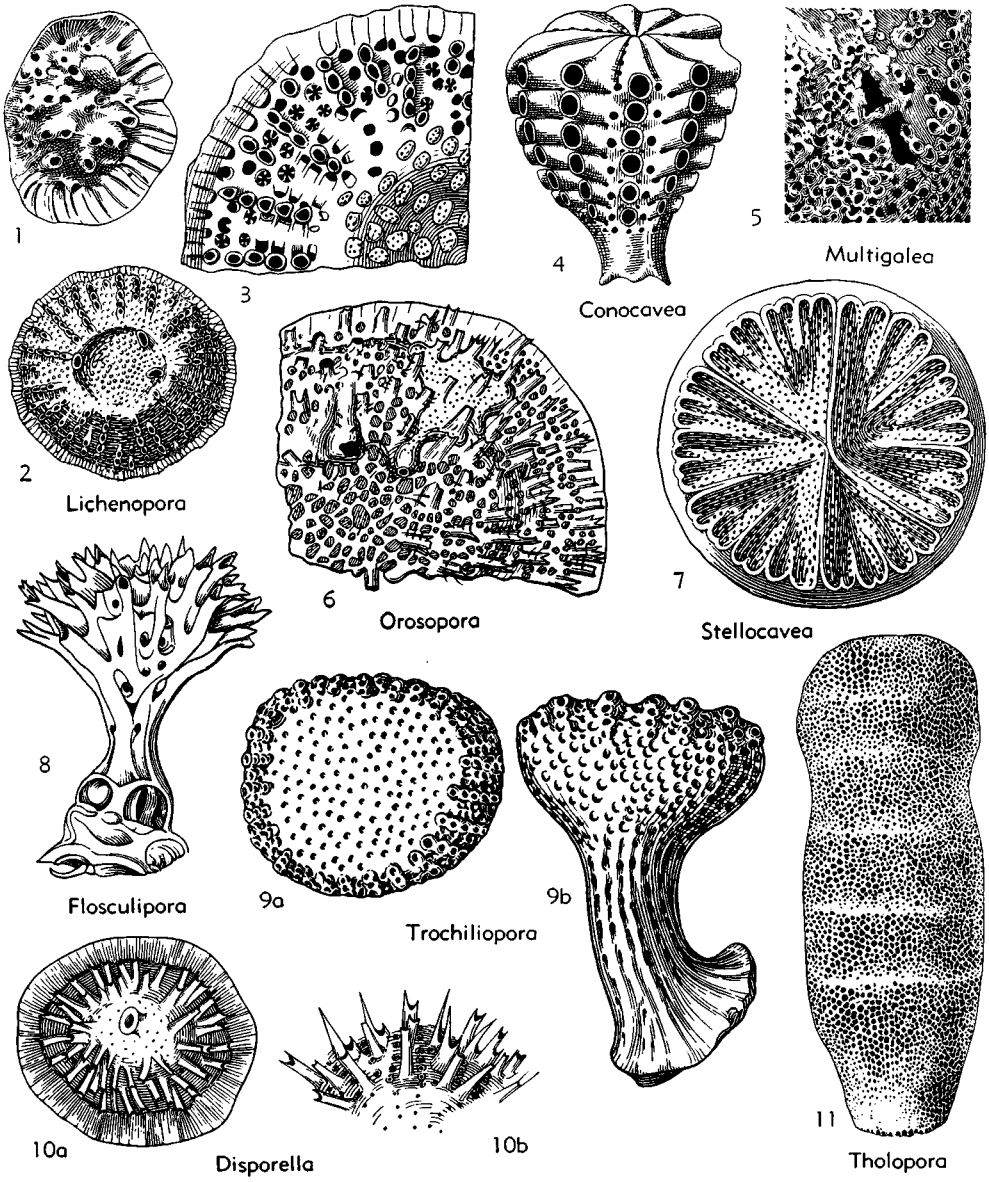


FIG. 38. Lichenoporidae (p. G73, G74).

zoarium. *U.Cret.(Maastr.)*, Fr.

L. (Coronopora) GRAY, 1848 [**Tubulipora truncata* FLEMING, 1828] [=*Coronopa* BUSK, 1860]. Apertures crowning an erect stem. *Rec.*, NE.Atl.

L. (Discocavea) D'ORB., 1853 [**D. irregularis*]. Apertures uniserial. *U.Cret.(Maastr.)*, Fr.

L. (Domopora) D'ORB., 1849 [**Ceriopora diadema* GOLDF., 1827]. Like *L. (Discocavea)* but with superposed colonies. *Cret.*, Ger.

L. (Paricavea) D'ORB., 1854 [**P. perforata*]. Like *L. (Discocavea)* but budded laterally. *U.Cret. (Maastr.)*, Fr.

L. (Pyricavea) D'ORB., 1853 [**P. francqana*]. Pyriform colonies connected by short cylindrical stems. *U.Cret.(Maastr.)*, Fr.

L. (Radiocavea) D'ORB., 1853 [**Tubulipora elegans* MICH., 1846]. Entirely incrusting. *U.Cret. (Cenom.)*, Fr.

L. (Radiopora) D'ORB., 1849 [**Ceriopora formosa* MICH., 1846]. Massive multilamellar zoarium with radially arranged uniserial zooecia separated by wide areas of adventitious tubes. *U.Cret. (Cenom.)*, Fr.

L. (Semimulticavea) D'ORB. [**Ceriopora landrioti* MICH., 1841]. Compound zoarium of confluent superposed growths of *L. (Discocavea)* type. *L.Cret.(Valang.)*, Switz.

L. (Stellihagenowia) BASSLER, *nom. nov.* [*pro Stellipora* HAG., 1851 (Bryo. Maastr. Kreide, p. 44) (*non* HALL, 1847)] [**Stellipora bosquetiana* HAG., 1851]. Resembles *L. (Radiopora)*. *U.Cret. (Maastr.)*, Holl.

L. (Tecticavea) D'ORB., 1854 [**T. boletiformis*]. Superposed colonies. *U.Cret.(Maastr.)*, Belg.

L. (Unicavea) D'ORB., 1853 [**U. vassiacensis*]. Short uniserial fascicles. *L.Cret.(Apt.)*, Fr.

Actinotaxia HAMM, 1881 [**A. magna*]. ?Like *Stellocavea* but compound (unfigured). *U.Cret*, Holl.

Conocavea CALVET, 1911 [**C. richardi*]. Zoarium conical, with lateral surface occupied by salient series of tubular zooecia separated by depressions with intermediate pores. *Rec.*——FIG. 38,*4*. **C. richardi*, Azores, ×10 (135).

Cuvilliera PFENDER, 1934 [**C. egyptiensis*]. Allied to *Lichenopora*. *Eoc.*, Egypt.

Disporella GRAY, 1848 [**D. hispida*] [=*Discoporella* BUSK, 1859 (obj.)]. Zoaria discoidal to oval, elongate or irregular because of secondary colonies, surrounded by a lamina. Zooecia arranged quincuncially or in clusters around a free central area occupied by alveoli, which are not closed unless brood chambers are plainly separated (11). *Rec.*——FIG. 38,*10*. **D. hispida*, Rec., E.Atl.; *10a*, colony with oeciostome, ×15; *10b*, tubes with visors, ×15 (137).

Favosipora MACGILL., 1885 [**F. rugosa* MACGILL., 1887]. Zoarium adherent, raised at intervals in irregular elevated rounded ridges with a distinct lamina. Zooecia large, unequal, closely packed. *Rec.*, SW.Pac.

Flosculipora MACGILL., 1887 [**F. pygmaea*]. Like *Lichenopora* but zoarium small, pedunculate, composed of smooth tubes with cancelli intervening towards the top. *Rec.*——FIG. 38,*8*. **F. pygmaea*, Rec., SW.Pac., ×10 (181).

Multigalea CANU-B., 1926 [**Reptomulticava canui* GREGORY, 1909]. Orbicular, irregularly superposed subcolonies with elongate, many-branched, star-shaped ovicell. Cancelli small, denticulate in interior zooecia with exterior triangular fragile visors. *L.Cret.*——FIG. 38,*5*. **M. canui* (GREGORY), Apt., Eng.; surface with ovicell, ×10 (137).

Orosopora CANU-B., 1920 [**Discoporella ciliata* BUSK, 1875]. Like *Lichenopora* but ovicell placed near zoarial margin, not at center. *Rec.*——FIG. 38,*6*. **D. ciliata* (BUSK), Rec., S.Atl., ×10 (230).

?Radiocavaria HAMM, 1881 [**R. fallax*]. Like *Cavaria* but with central tube, zooecia in stellate groups (?Petaloporidae VOIGT, 1953). *U.Cret.*, Holl.

Stellocavea D'ORB., 1853 [**S. francqana*] [=*Carinifer* HAMM, 1881; *Camerapora, Clausicamerapora, Curvacamerapora* MEUNIER & PERGENS, 1885]. Zoarium adnate, discoid, upper surface radially ridged, supported by lamina formed of upgrowth of under surface. Apertures generally biserial, opening along the ridges. *Cret.*——FIG. 38,*7*. **S. francqana*, Maastr., Holl.; ×10 (202).

Tholopora GREGORY, 1909 [**Ceriopora clavata* GOLDF., 1827]. Blunt cylindrical stems of superposed layers, center of each crowded with cancelli from which uniserial rows of apertures radiate with lines of cancelli between. *U.Cret.*——FIG. 38,*11*. **T. clavata* (GOLDF.), Cenom., Ger.; ×5 (157).

Trochiliopora GREGORY, 1909 [**T. humei*]. Constricted attached stem with cancelli surmounted by an expanded head with apertures in vertical series around the margin. *Cret.*——FIG. 38,*9*. **T. humei*, Santon., Eng.; *9a,b*, top, side, ×5 (158).

Suborder DACTYLETHRATA Gregory, 1896

Zoaria adnate to erect, branching or multilamellar, with long cylindrical zooecia separated by dactylethrae (club-shaped polygonal tubes without polypides); mesopores, real cancelli, and avicularia absent. Ovicell unknown. *Cret.*

Family CLAUSIDAE d'Orbigny, 1854

Dactylethrae short, frontal tubes closed by a finely perforated calcareous lamella, equal to zooecia in diameter (63). *Cret.*

Clausa D'ORB., [**Ceriopora heteropora* D'ORB., 1853]. [=*Claviclausa, Multiclausa* D'ORB., 1853]

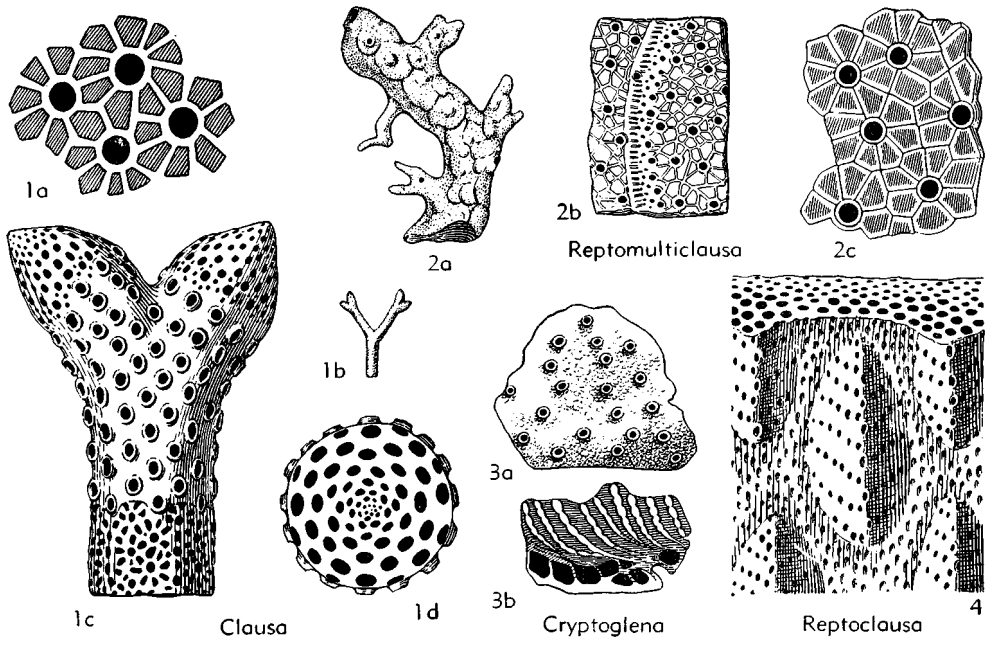


FIG. 39. Clausidae (p. G74, G75).

Stems formed of zooecia separated by dactylethrae. *Cret.*——FIG. 39,*1*. **Clausa heteropora* (D'ORB.), Cenom., Eur.; *1a*, worn surface showing dactylethrae, ×25; *1b*, zoarium, ×1; *1c,d*, distal extremity, transv. sec., ×10 (202).

Cryptoglena MARSSON, 1887 [**C. adspersa*]. Zoarium irregularly lobed, thick, unilaminar, with zooecia well separated by a single row of dactylethrae. *U.Cret.*——FIG. 39,*3*. **C. adspersa*, Camp., Ger.; *3a,b*, surface, edge, ×25 (186).

Reptoclausa D'ORB., 1853 [**R. neocomiensis*]. Incrusting, tubes grouped in idmoneiform fascicles with spaces between occupied by real zooecia and dactylethrae. *L.Cret.*——FIG. 39,*4*. **R. neocomiensis*, Valang., Switz.; surface, ×10 (202).

Reptomulticlausa D'ORB., 1853 [**R. papularia* (=*R. orbignyi* GREGORY, 1899)] [=*Clausimultelea, Semimulticlausa* D'ORB., 1853]. Zoarium adnate, massive, multilamellar. Dactylethrae abundant, widely separating the zooecia. *U.Cret.*——FIG. 39,*2*. **R. papularia*, Cenom., Fr.; *2a*, zoarium, 1; *2b,c*, surface, ×10, ×25 (202).

Suborder SALPINGINA Hagenow, 1851

[=Stigmatoporina HAMM, 1881; Metopoporina MARSSON, 1887; Melicertitina PERGENS, 1890]

Zoaria with ovicells (gonocysts), tubular zooecia with facets, and other cyclostomatous characters, but also having avicularia (eleocellaria), generally a diagnostic feature of the Cheilostomata. *Jur.-Cret.*

Family ELEIDAE d'Orbigny, 1852

[=Meliceritidae PERGENS, 1890]

Zoaria typically erect, slender, compressed stems. Zooecia long, tubular, with trumpet-shaped distal expansions, closed at the surface by perforated facet. Ovicell a large pyriform globular sac (gonocyst) with terminal oeciostome, formed on completely consolidated distal zooecia, its axis paralleling that of the tubes. Avicularia generally present as long spatulate openings, termed eleocellaria (25,63). *Jur.-Cret.*

Elea D'ORB., 1853 [**Bidiastopora lamellosa* D'ORB., 1850]. Slender compressed ramose stems; zooecia with short, hexagonal facet. Eleocellaria not known. *U.Cret.* ——FIG. 40,*1*. **E. lamellosa* (D'ORB.), Santon., Fr.; *1a,b*, surface, ×10, ×25; *1c*, fragment, ×1; *1d*, transv. sec., ×10 (202).

Cyclocites CANU-B., 1922 [**C. primogenitum*]. Like *Meliceritites* but facet-orifice circular, eleocellaria not known. *Jur.*——FIG. 40,*8*. **C. primogenitus*, Bath., Fr.; *8a,b*, surfaces with facets complete and destroyed, ×25, ×10; *8c*, surface with 2 ovicells, ×25 (137).

Foricula D'ORB., 1853 [**F. pyrenaica*]. Cylindrical solid stems, zooecia with long spatulate eleocellaria and walls pierced by small pores. *U.Cret.*——FIG. 40,*2*. **F. pyrenaica*, Cenom., Fr.; *2a*, fragment, ×1; *2b,c*, surface, transv. sec., ×10 (202).

Meliceritella Lev., 1925 [**Hornera steenstrupi* Pergens & Meunier, 1886]. Slender stems with transverse rows of closed zooecia on back. *U.Cret.*——Fig. 40,*6*. **M. steenstrupi* (Pergens & Meunier), Dan., Denm.; *6a,b,* front, back, ×25 (177).

Meliceritites Roemer, 1840 [**Ceriopora gracilis* Goldf., 1827][=*Escharites* Roemer, 1840 (*non* Schloth., 1820); *Vaginopora* Hag., 1846; *Chisma* Lonsd., 1849; *Inversaria* Hag., 1851; *Multelea, Multinodelea, Nodelea* d'Orb., 1853]. Erect cylindrical, branching stems with tubes expanded at their extremity, lozenge-shaped facets with semicircular orifice and eleocellaria. Ovicell a heart-shaped gonocyst. *Cret.*——Fig. 40,*4*. **M. gracilis* (Goldf.), Cenom., Ger.; *4a,* facets, ×25; *4b,* branched stem with ovicell, ×10 (137).——Fig. 40,*5*. *M. magnifica* d'Orb., Coni., Fr.; *5a,* ovicell, ×10; *5b,c,* secs., transv., long., ×10 (137).

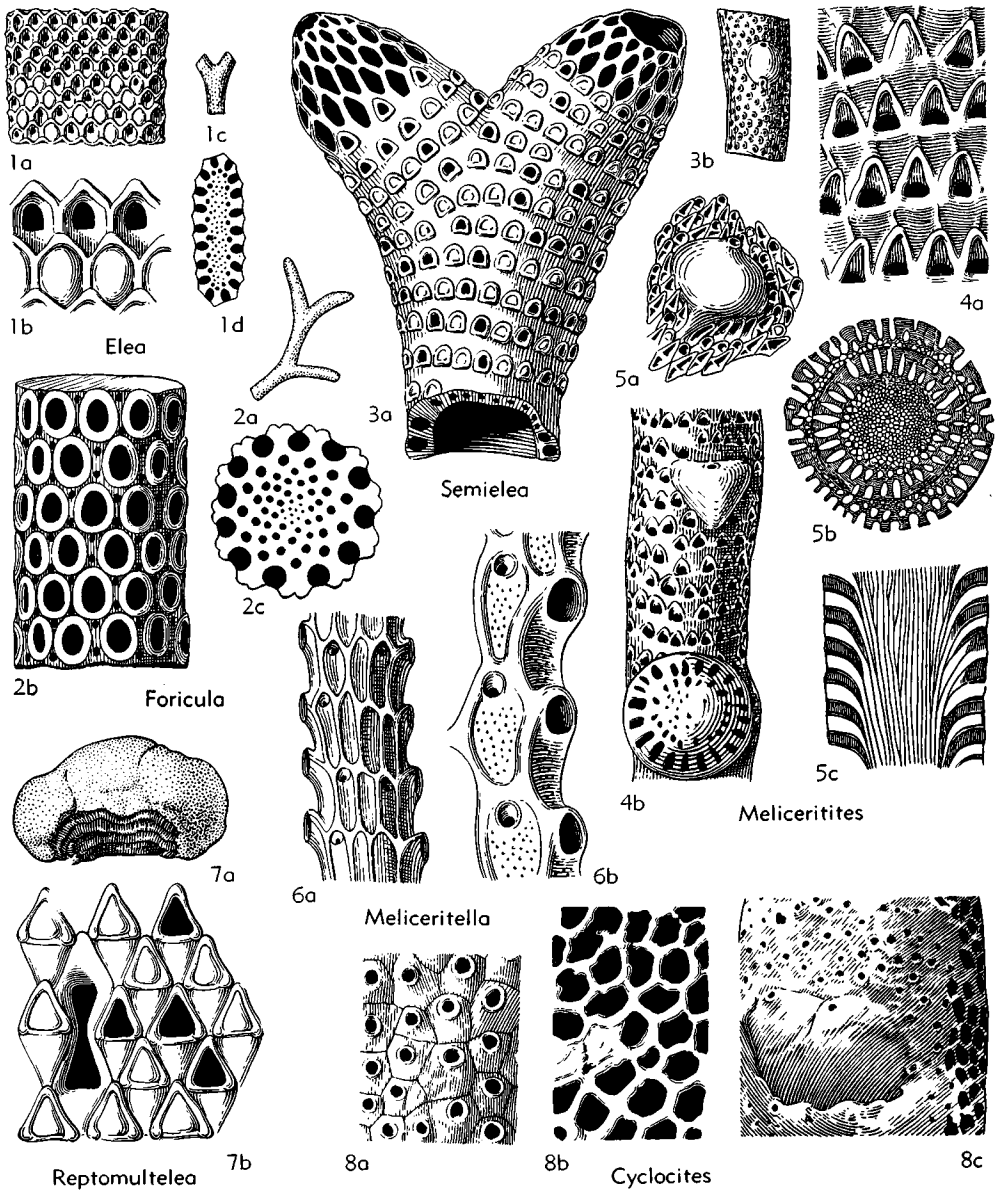


Fig. 40. Eleidae (p. G75-G77).

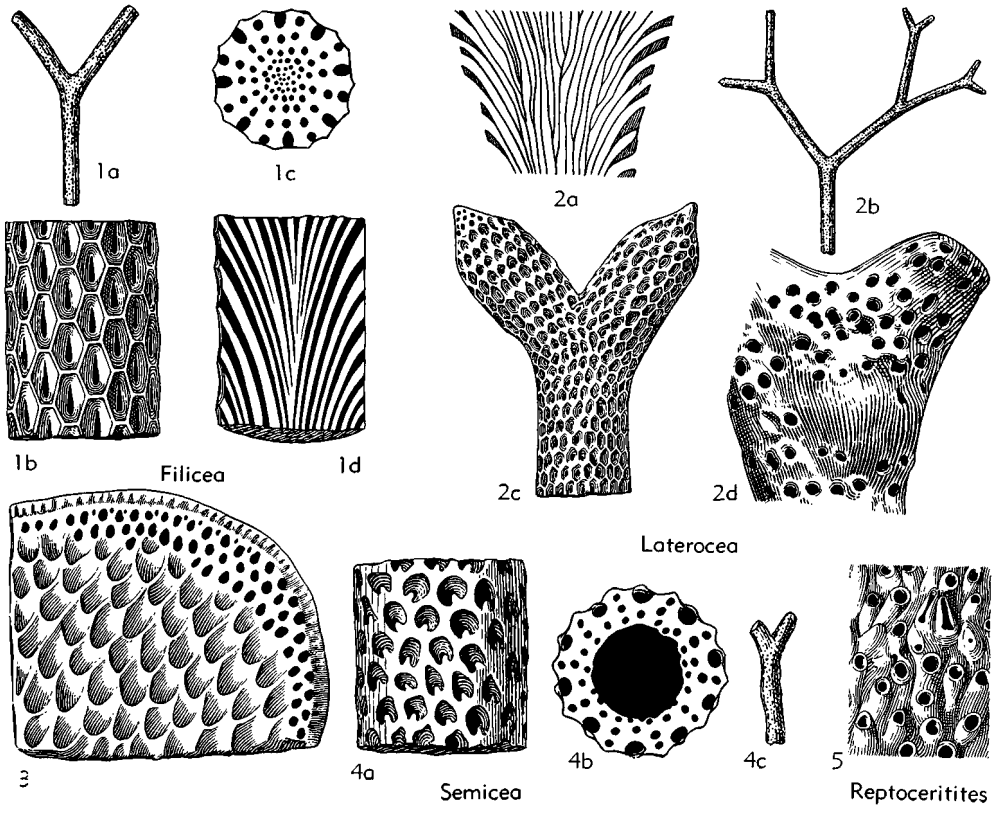


FIG. 41. Semiceidae (p. G77).

?Pennipora HAMM, 1881 [**P. beyrichii*]. Distinguished by feather-shaped arrangement of tubes and mesopores in longitudinal section (*fide* VOIGT, 1952). (?Heteroporidae VOIGT, 1953). *U.Cret. (Maastr.)*, Holl.

Reptoceritites GREGORY, 1899 [**R. rowei*]. Single adnate layer with eleocellaria and some closed zooecia. *Cret.*——FIG. 41,*5*. **R. rowei*, Eng.; ×10 (158).

Reptomultelea D'ORB., 1853 [**R. tuberosa*]. Like *Reptoceritites* but zoarium multilamellar. *Cret.*——FIG. 40,*7*. **R. tuberosa*, Cenom., Fr.; *7a*, zoarium, ×1; *7b*, surface with eleocellaria, ×10 (202).

Semielea D'ORB., 1853 [**S. vielbanci*] [=*Reptelea, Semimultelea* D'ORB., 1853]. Hollow cylindrical branches with apertures in transverse rows and well-developed heart-shaped ovicells. *Cret.*——FIG. 40,*3*. **S. vielbanci*, Senon., Fr.; *3a*, branch, ×25; *3b*, fragment with ovicell, ×10 (*3a*, 202; *3b*, 137).

Family SEMICEIDAE Buge, 1952

[=emend. Ceidae D'ORB., 1854]

Zoaria as in Eleidae but zooecia consist of conical tubes with walls dilated distally, apertures funnel-shaped, lacking a peristome. Facets perforated by an orbicular aperture. Ovicell convex, somewhat embedded in the zooecia (25,102). *Cret.*

Semicea D'ORB., 1854 [*pro Cea* D'ORB., 1854 (*non* WALKER, 1837)] [**S. tubulosa*] [=*Reptocea* D'ORB., 1854; *Ceata* STRAND, 1928]. Hollow ramose zoarium with oral tongue well developed in aperture. *Cret.*——FIG. 41,*3*. *S. lamellosa* D'ORB., Fr.; surface, ×10 (202).——FIG. 41,*4*. **S. tubulosa*, Coni., Fr.; *4a*, surface, ×10; *4b*, transv. sec., ×10; *4c*, zoarium, ×1 (202).

Filicea D'ORB., 1854 [**F. regularis*] [=?*Cinctipora* HUTTON, 1873]. Solid cylindrical branches bearing zooecial orifices on all sides, with tubes radiating from an imaginary central axis. *U.Cret.*——FIG. 41,*1*. **F. regularis*, Maastr., Fr.; *1a*, zoarium, ×1; *1b*, surface, ×10; *1c,d*, secs., transv., long., ×10 (202).

Laterocea D'ORB., 1854 [**L. simplex*]. Like *Filicea* but tubes are cylindrical, dilated with thick walls at their extremity, tending to be arranged in transverse lines. Ovicell convex. *U.Cret.*——FIG. 41,*2*. **L. simplex*, Coni., Fr.; *2a*, long. sec., ×10; *2b*, zoarium, ×1; *2c*, surface, ×10; *2d*, fragment with ovicell, ×10 (*2a,d*, 137; *2b,c*, 202).

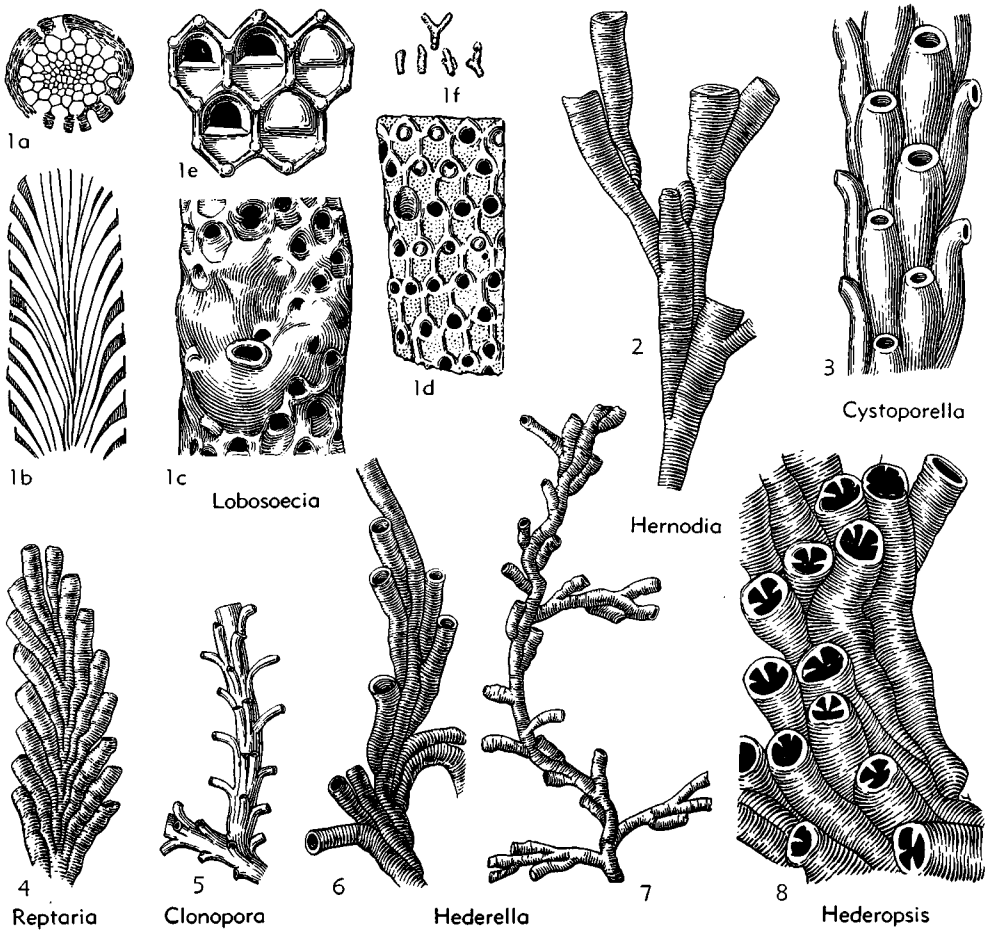


FIG. 42. Lobosoeciidae, Reptariidae (p. G78-G80).

Family LOBOSOECIIDAE Canu & Bassler, 1922

Zoaria slender, cylindrical, solid, dichotomously dividing. Zooecial areas hexagonal with orbicular aperture. Ovicell lobed, convex, formed after consolidation of subjacent tubes; oeciostome central, with large crescent-shaped oeciopore larger than the apertures. Differs from Eleidae, which have similar zooecial areas, in the lobed ovicell and central, instead of terminal oeciostome (25). *Cret.*

Lobosoecia CANU-B., 1922 [**Pustulopora semiclausa* MICH., 1846]. *Cret.*——FIG. 42,*1*. **L. semiclausa* (MICH.), Cenom., Fr.; *1a,b*, secs., transv., long., ×10; *1c*, ovicell, ×25; *1d,e*, surface, ×25, ×50; *1f*, fragments, ×1 (*1a-c, f*, 137; *1d,e*, 202).

Suborder HEDERELLOIDEA Bassler, 1939

Zoarium, derived from a bulbous ancestrula, incrusting, or rising into solid cylindrical narrow branches of tubular zooecia with perforated walls. Individual tubes budded from lateral wall of preceding zooecium, the ends of each separated by a terminal plate, probably perforated; apertures transversely elliptical, terminal, equalling the tube diameter. *Sil.-Penn.*

Family REPTARIIDAE Simpson, 1897

Characters of the suborder (7; PRANTL, 1938; SOLLE, 1952). *Sil.-Penn.*

Reptaria ROLLE, 1851 [**R. stolonifera*] [=*Bryozoon*

BARRANDE, 1868; *Ptilionella* HALL, 1883]. Incrusting parallel-edged branches. Short adjacent zooecia of equal length arising alternately from basal portions of preceding ones and bending laterally outward in plane of their host. *Sil.-Dev.*——FIG. 42,*4*. **R. stolonifera,* Dev.(Hamilton), N.Y.; ×5 (131).

Clonopora HALL, 1883. [**C. semireducta*]. Erect, narrow, cylindrical branches. Elongate slender tubular zooecia, cohering in part of their length, then bending outward and becoming free; apertures terminal, not contracted, annular or spirally around branch. *L.Dev.*——FIG. 42,*5*. **C. semireducta,* Onond., Falls Ohio, Ind.-Ky.; ×5 (162).

Cystoporella BASSLER, *nom. nov.* [*pro Cystopora* HALL, 1883[1] (*non* POMEL, 1872)][**Cystopora geniculata* HALL, 1883]. Like *Clonopora* but zooecial tubes flask-shaped terminally constricted. *L. Dev.*——FIG. 42,*3*. **C. geniculata* (HALL), Onond., Falls Ohio, Ind.-Ky.; ×10 (162).

Hederella HALL, 1883 [**Alecto canadensis* NICH., 1874] [=*Nicholsonia* DAVIS, 1885 (*non* WAAG.-W., 1886); *Thamnocoelum* POČTA, 1894]. Zoarium attached. Zooecia short, cylindrical, bending alternately right and left from a tubular axis, annulated and striated transversely; apertures terminal, transversely elliptical. A prolific genus (60 or more species). *Sil.-Penn.*

H. (Hederella).——FIG. 42,*7*. *H. (H.) filiformis* (BILL.), Dev.(Hamilton), Ont.; ×4 (131).

H. (Bassleria) SOLLE, 1952 [**H. alpenensis* BASSLER, 1939]. Dev., Mich.

H. (Rhenanerella) SOLLE, 1952 [**H. applicata* SOLLE, 1937]. Dev., Ger.

H. (Paralhederella) SOLLE, 1952 [**H. parallela* BASSLER, 1939]. Dev., N.Y.——FIG. 42,*6*. **H. (P.) parallela* (BASSLER), Dev.(Hamilton), N.Y.; ×10 (162).

[1] HALL, J. (1883) Trans. Albany Inst., vol. 10, p. 161.

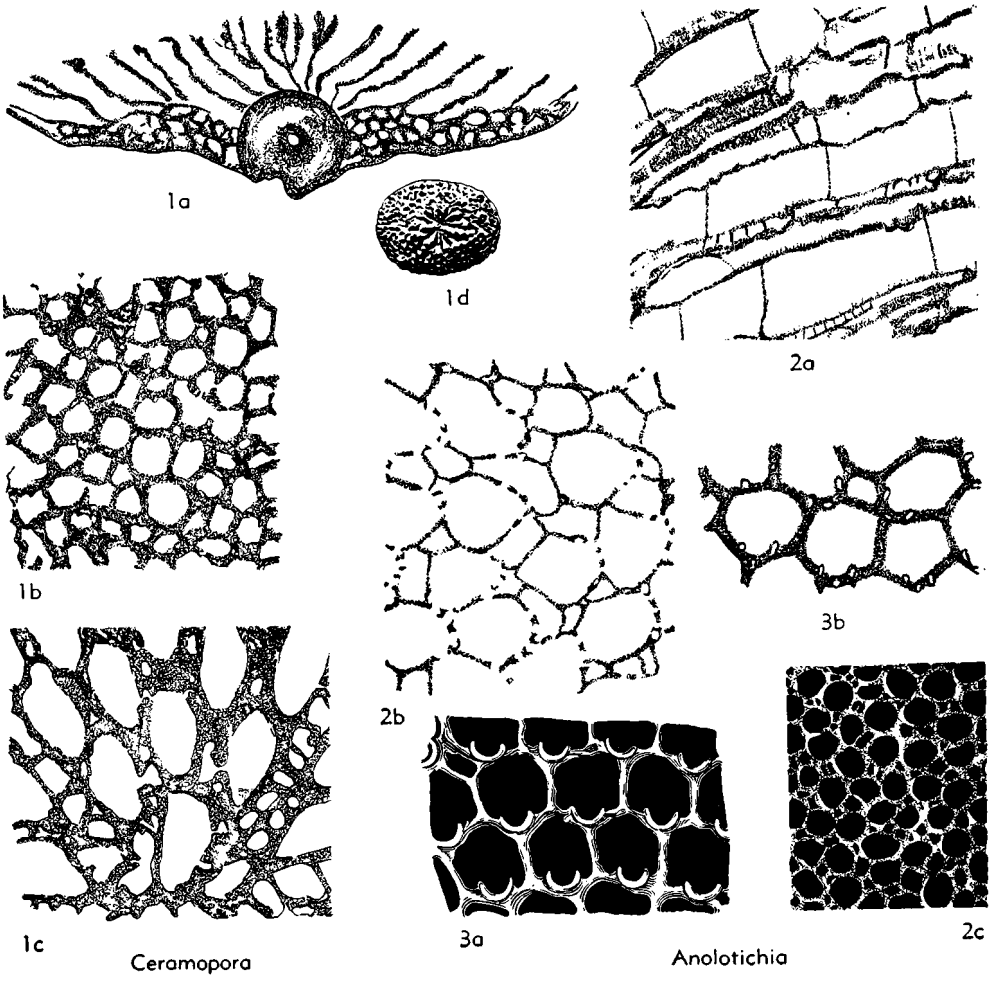


FIG. 43. Ceramoporidae (p. G81).

H. (Magnederella) SOLLE, 1952 [**H. magna* HALL, 1881]. Dev., N.Y.

Hederopsis BASSLER, 1937 [**H. typicalis* BASSLER, 1939]. Like *Hederella* but a basal part of tube has a well-defined longitudinal septum joined by 2 transverse partitions, outlining 2 rows of compartments. *Dev.*——FIG. 42,*8*. **H. typicalis* BASSLER, Onond., Falls Ohio, Ind.-Ky.; ×5 (131).

Hernodia HALL, 1883 [**H. humifusa*]. Growth as in *Hederella* but zooecia elongate, club-shaped, each budding alternately at acute angle from midpart of preceding one. *Dev.*——FIG. 42,*2*. **H. humifusa*, Hamilton, N.Y.; ×5 (162).

Suborder CERAMOPOROIDEA Bassler, 1913

Zoaria widely varied in shape, characterized by minutely porous structure of the zooecial walls formed of irregularly granulose laminated tissue; connection between tubes by mural communication pores. A feature typical of Trepostomata found in many ceramoporoids is divisibility of the zoarium into well-defined immature and mature zones. Ovicells are known in a few forms. *?Cam., Ord.-Perm.*

Family CERAMOPORIDAE Ulrich, 1882

[=Ceramoporellidae SIMPSON, 1897]

Zoaria incrusting, ramose, massive, or bifoliate; maculae and monticules at regular intervals. Zooecia tubular, proximally

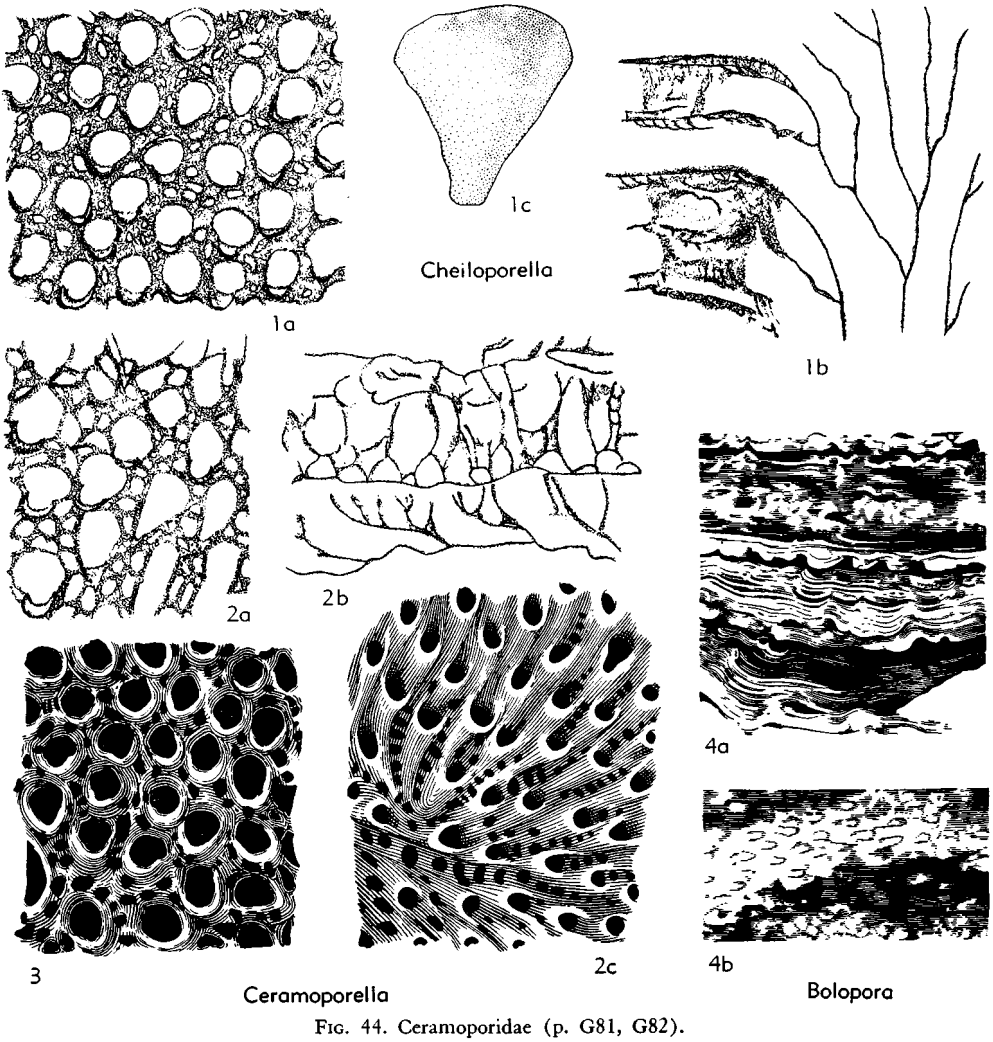


FIG. 44. Ceramoporidae (p. G81, G82).

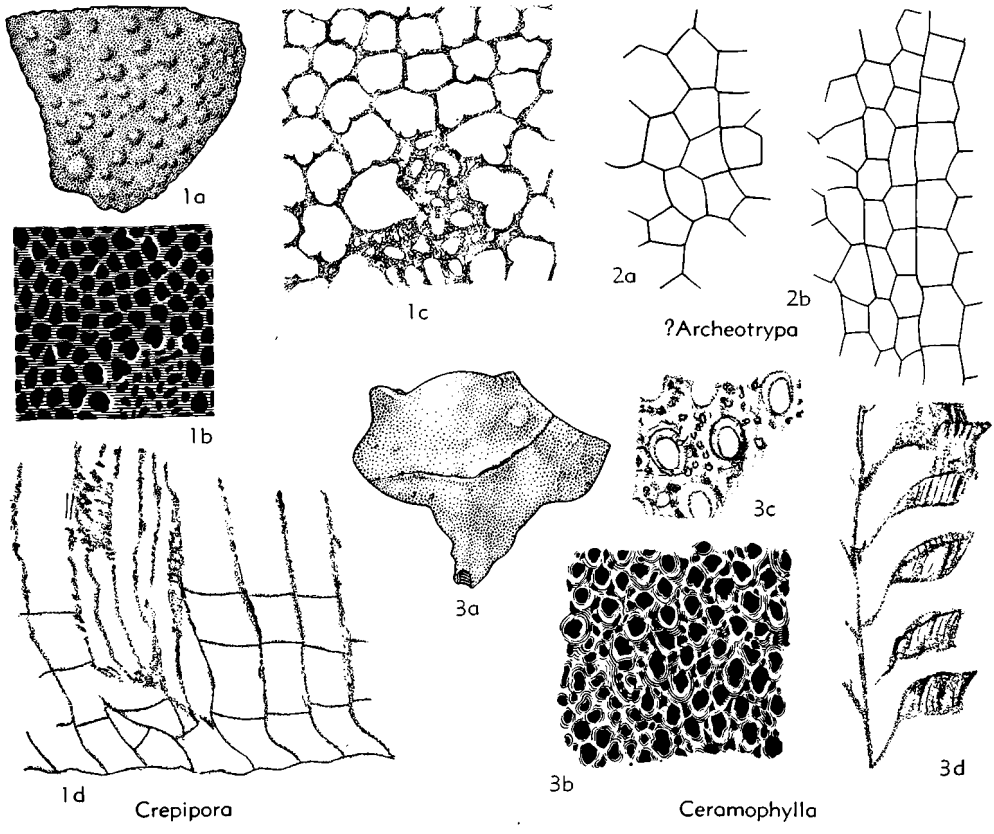


FIG. 45. Ceramoporidae (p. G81, G82).

prostrate, then extending obliquely or directly to the surface, commonly with a few diaphragms; apertures generally oblique, with part of proximal margin elevated as an overarching hood (lunarium). Mesopores more or less common (3,112,114,115; Nickles-B, 1900). *?Cam., Ord.-Dev.*

Ceramopora HALL, 1851 [**C. imbricata*]. Zoarium discoidal to massive. Zooecia large, irregular, with indefinite wall structure and large mural pores, radiating from depressed maculae; apertures oblique, with prominent but poorly defined lunaria. Mesopores large, irregular. *Ord.-Dev.*——FIG. 43,*1*, **C. imbricata,* Sil. (Clint.), N.Y.; *1a,* long. sec. of small zoarium attached to crinoid ossicle, ×10; *1b,c,* tang. secs., basal layer, and near periphery showing zooecia and mesopores, ×20; *1d,* zoarium, ×2 (131).

Anolotichia ULR., 1890 [**A. ponderosa*]. Incrusting, ramose, or massive. Zooecia long, subpolygonal, with remote diaphragms; lunarium elevated, traversed by 2 to 6 minute, vertical, closely tabulated tubules. Mesopores few. *Ord.-Sil.*——FIG. 43,*2*, **A. ponderosa,* Ord.(Richmond.), Ill.; *2a,b,* secs., long., tang., ×20; *2c,* surface, ×10 (222).——FIG. 43,*3*. *A. impolita* ULR., Blkriv., Minn.; *3a,b,* surface, tang. sec., ×20 (222).

?Archaeotrypa FRITZ, 1947 [**A. prima*]. Small flat poorly preserved zoarium with wall structure like *Crepipora* and ?lunaria but also resembling a small-celled tabulate coral such as *Lichenaria.* If bryozoan, the oldest known genus. *U.Cam.*——FIG. 45,*2*. **A. prima,* Front Range, Alba.; *2a,b,* secs., tang., long., ×10 (153).

Bolopora LEWIS, 1926 [**B. undosa*]. Doubtful, possibly a massive bryozoan or hydrocoralline. *L.Ord.*——FIG. 44,*4*. **B. undosa,* Arenig., N.Wales; *4a,* long. sec., ×25; *4b,* tang. sec., ×10 (178).

Ceramophylla ULR., 1893 [**C. frondosa*]. Like *Ceramoporella* but zoarium erect, bifoliate. *Ord.*——FIG. 45,*3*. **C. frondosa,* Blkriv., Minn.; *3a,* zoarium, ×1; *3b,* surface, ×10; *3c,d,* secs., ×20 (222).

Ceramoporella ULR., 1882 [**C. distincta* ULR., 1890] [=*Ceramporella* CUMINGS-G., 1913]. Incrusting, thin layers of short, tubular zooecia with prominent hoodlike lunaria and oval, oblique apertures encircled by abundant mesopores. *Ord.-Sil.*

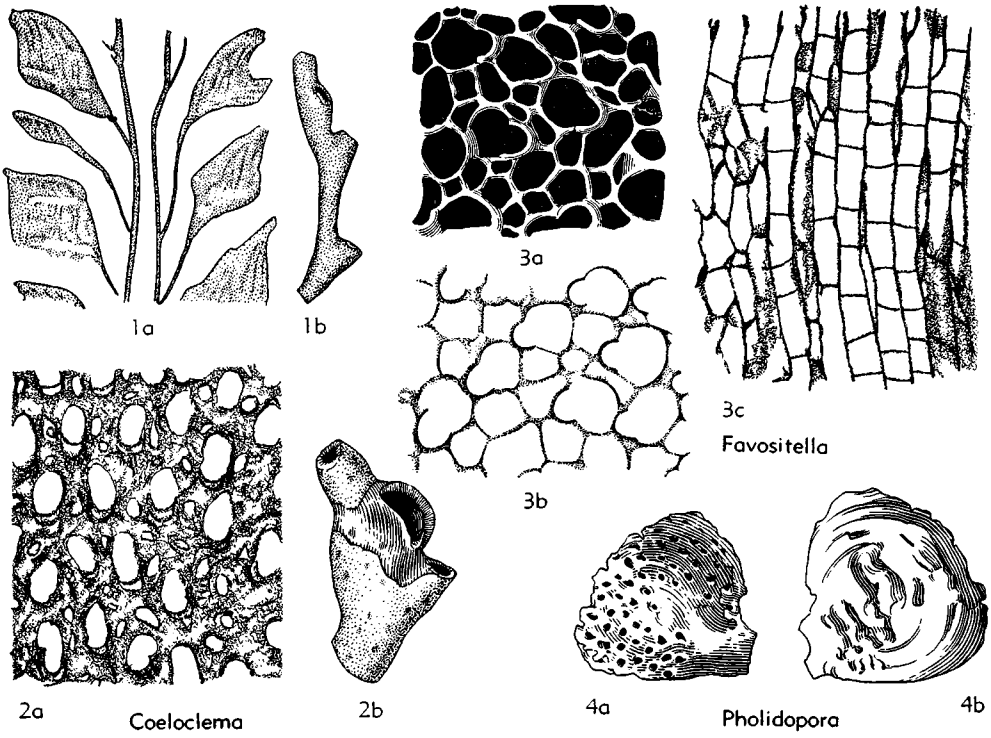


Fig. 46. Ceramoporidae (p. G82).

——Fig. 44,*2*. **C. distincta* Ulr., Eden., Ohio; *2a,b,* secs., ×20; *2c,* surface, ×20 (222).——Fig. 44,*3*. *C. interporosa* Ulr., Trenton., Minn.; surface, ×20 (222).

Cheiloporella Ulr., 1882 [**Fistulipora flabellata* Ulr., 1879 (=*Ceramopora nicholsoni* James, 1875)][=*Chiloporella* Miller, 1889]. Erect flabellate fronds. Zooecial tubes long, with few diaphragms, walls much thickened by laminar tissues near surface; apertures ovate, with conspicuously elevated lunarium. Mesopores numerous small. *Ord.*——Fig. 44,*1*. **C. nicholsoni* (James), Maysv., Ohio; *1a,b,* secs., tang., long., X20; *1c,* zoarium, ×1 (222).

Coeloclema Ulr., 1882 [**Diamesopora vaupeli* Ulr., 1890 (=*Ceramopora alternata* James, 1878)]. Like *Ceramoporella* but zoarium of ramose hollow branches, lined internally with a striated and thicker walled epitheca. *Ord.-Sil.*——Fig. 46,*1*. **C. alternatum* (James), Ord.(Eden.), Ohio; *1a,* long. sec., ×20; *1b,* zoarium, ×1; (222).——Fig. 46,*2*. *C. concentricum* (James), Ord.(Eden.), Ohio; *2a,* tang. sec., ×20; *2b,* zoarium, ×1 (222).

Crepipora Ulr., 1882 [**C. simulans* Ulr., 1890]. Incrusting to massive, like *Ceramoporella* except that zooecia are long tubular, thin-walled, with diaphragms, lunaria erect; mesopores restricted to maculae. *Ord.-Sil.*——Fig. 45,*1*. **C. simulans* Ulr., Ord.(Maysv.), Ohio; *1a,* zoarium, ×1; *1b,* surface, ×10; *1c,d,* secs., ×20 (222).

Favositella Eth.-F., 1884 (*non* Mansuy, 1912) [**Favosites interpuncta* Quenst., 1881] [=*Bythotrypa* Ulr., 1893]. Zoarium massive. Zooecial tubes long, with thin diaphragms and ovicell-like (?brown body) structures; apertures nearly direct, with large well-raised lunarium. Mesopores numerous, forming loose vesicular tissue. *Ord.-Sil.*——Fig. 46,*3*. *F. laxata* (Ulr.) (type of *Bythotrypa*), Ord.(Blkriv.), Minn.; *3a,* surface, ×20; *3b,* tang. sec., ×20; *3c,* long. sec., ×10 (222).

Haplotrypa Bassler, 1936 [**H. typica*]. Incrusting to lamellate discoidal zoarium with ceramoporoid wall structure but lunaria, diaphragms and mesopores absent. *Sil.*——Fig. 47,*3*. **H. typica,* Clinton., Ind.; *3a,b,* secs., ×20 (131).

Pholidopora Grubbs, 1939 [**P. concentrica*]. Zoarium thin lamellate with concentrically wrinkled epitheca; zooecia oblique, imbricating with strong lunaria and a few partial diaphragms. Maculae and mesopores absent. *Sil.*——Fig. 46,*4*. **P. concentrica,* Niag., Ill.; *4a,b,* zoarium, top, base, ×5 (159).

Scenellopora Ulr., 1882 [**S. radiata*]. Pedunculate; macula surrounded by zooecia or an incrusting

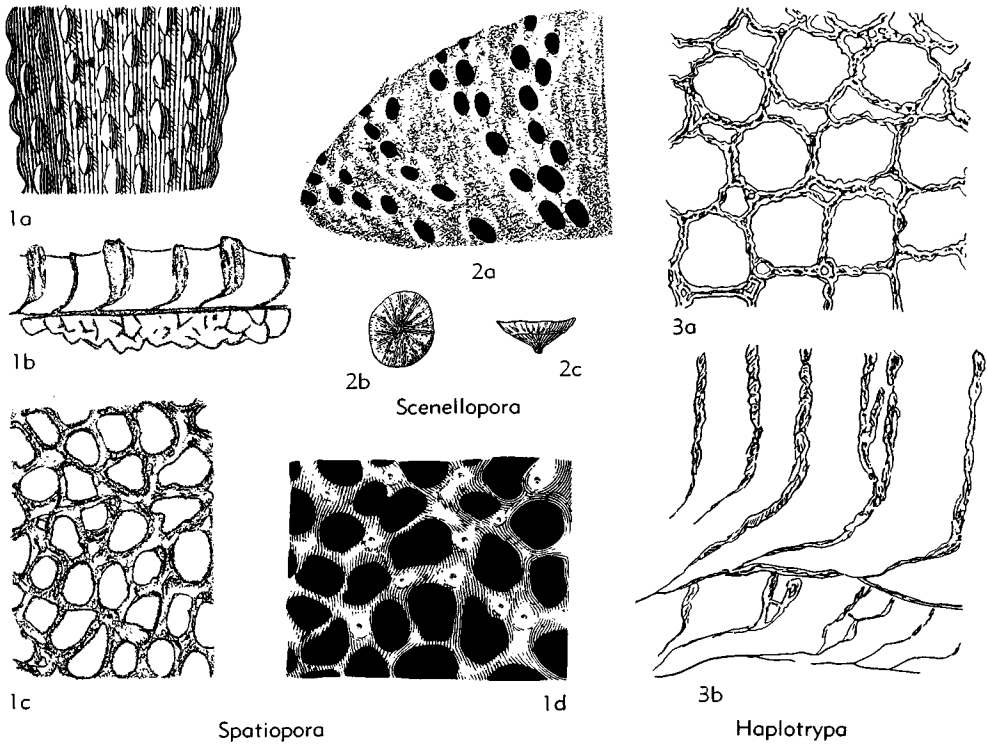


FIG. 47. Ceramoporidae (p. G82, G83).

group of maculae; epithecate base. *Ord.*——FIG. 47,*2*. **S. radiata,* Blkriv., Tenn.; *2a,* surface, ×10; *2b,c,* zoarium, ×1 (222).

Spatiopora ULR., 1882 [**S. aspera* ULR., 1883]. Thin crusts generally on orthoceroid shells composed of short, nearly direct thin-walled zooecia with ceramoporoid structure and blunt spines (acanthopores) at angles; mesopores and lunaria absent; elongated monticules common. *Ord.-Sil.* ——FIG. 47,*1*. **S. aspera* ULR., Ord.(Maysv.), Ohio; *1a,* surface, ×1; *1b,c,* secs., long., tang., ×20; *1d,* surface, ×20 (222).

Family FISTULIPORIDAE Ulrich, 1882

[=Botrylloporidae MILLER, 1889; Chilotrypidae, Fistuliporinidae, Odontotrypidae, Selenoporidae SIMPSON, 1897; Cheilotrypidae MOORE-D., 1944]

Like Ceramoporidae in growth and general structure, lunaria, and maculae, but zooecial interspaces occupied by vesicles having convex walls on side toward zoarial surface. Ovicells in some genera (68,98,112, 114; NICKLES-B., 1900). *Ord.-Perm.*

This family name is employed on the basis of retention of *Fistulipora* as *nomen conservandum* (ICZN pend.).

Fistulipora MCCOY, 1850 [*nom. conserv.*, ICZN pend. (*non* RAF., 1831)] [**F. minor*] [=*Didymopora* ULR., 1882; *Cyclotrypa* MOORE-D., 1944 (*non* ULR., 1896)]. Zoaria lamellate, free or incrusting; ramose, or massive; commonly with regular maculae or monticules. Zooecia cylindrical, with straight diaphragms; apertures rounded, with lunaria moderately developed, not projecting into the tubes. *Sil.-Perm.*——FIG. 48,*1*. **F. minor,* L. Carb., Eng.; *1a,* tang. sec., McCOY's type specimen, ×25; *1b,c,* secs, tang., long., ×20 (131).

Botryllopora NICH., 1874 [**B. socialis*]. Small, circular, incrusting, commonly joined laterally in a group with large vesicles along junction lines; surface marked by ridges radiating from disc centers (maculae), each ridge formed by double row of zooecial tubes with few diaphragms; apertures circular, without lunaria; depressed spaces between ridges with vesicles. *M.Dev.*——FIG. 48,*3*, **B. socialis,* Hamilton, N.Y.; *3a,* zoaria, ×1; *3b,c,* secs., long., tang., ×20 (222).

Buskopora ULR., 1886 [**B. dentata*] [=*Glossotrypa, Odontotrypa* HALL, 1886]. Zoarium thin lamellate. Zooecial tubes with diaphragms; prominent lunaria projecting as strong bidenticulate process. *L.Dev.*——FIG. 49,*2*. **B. dentata,* Onond., Falls Ohio, Ky.-Ind.; *2a,b,* surface, ×20, ×5 (*2a,* 222; *2b,* 162).

Cheilotrypa ULR., 1884 [**C. hispida*] [=*Chilotrypa* MILLER, 1889]. Slender ramose fistuliporoids with expanding and contracting axial tube lined by epitheca. Vesicles filled by dense stereom near surface. *Sil.-Perm.*——FIG. 48,*2*. **C. hispida*, U.Miss.(Chest.), Ky.; *2a*, zoarium, ×1; *2b-d*, secs., long., transv., tang., ×20 (222).

Cliotrypa ULR.-B., 1929 [**C. ramosa*]. Slender, cylindrical, solid, smooth branches. Zooecial tubes with ovicell-like inflations; semidiaphragms projecting into mature region; lunaria distinct. *Miss.*——FIG. 48,*4*. **C. ramosa*, Osag., Ky.; *4a,b*, secs., ×20 (131).

Coelocaulis HALL-S., 1887 [**Callopora venusta* HALL, 1874]. Hollow, ramose stems. Zooecial apertures circular, surrounded by elevated peristomes; lunaria weak or absent. *Sil.-Dev.*——FIG. 50,*4*. **C. venusta* (HALL), L.Dev.(Held.), N.Y.; *4a*, fragment, ×10; *4b*, surface, ×20 (162).

Cycloidotrypa CHAPMAN, 1920 [**C. australis*]. Like *Cyclotrypa*. L.Carb., N.S.W.

Cyclotrypa ULR., 1896 [**Fistulipora communis* ULR., 1890]. Thick laminar to massive. Zooecial tubes with distant diaphragms; apertures circular, with peristomes, lunaria almost obsolete. *Sil.-Perm.*——FIG. 50,*5*. **C. communis* (ULR.), Dev., Iowa; *5a,b*, secs., ×20 (222).

Diphtheropora DEKON., 1873 [**D. regularis*] (=*?Eridopora*). Small incrusting patches with thin-walled oblique zooecia. *L.Carb.*, Belg.

Duncanoclema BASSLER, 1952 [**Fistuliporella marylandica* ULR.-B., 1913]. Solid twiglike stems with structure as in *Fistulipora* but lunaria pierced by 6 to 8 pores like those of *Anolotichia*. *L.Dev.*——FIG. 50,*1*. **D. marylandicum* (ULR.-B.), Held., Md.; *1a,b*, secs., ×25; *1c*, fragment, ×1 (223).

Dybowskiella WAAG.-W., 1886 [*pro Dybowskia* WAAG.-W., 1885 (*non* DALL, 1879) [**D. grandis*]

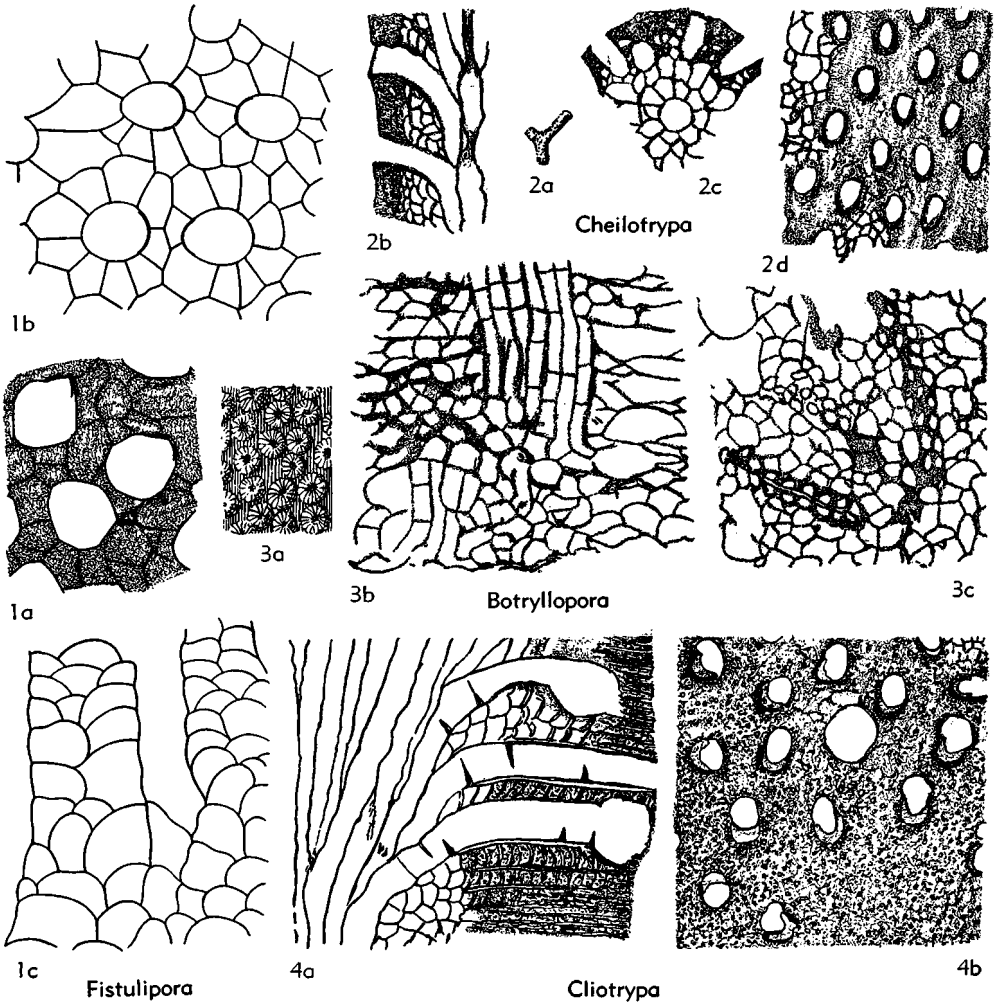


FIG. 48. Fistuliporidae (p. G83, G84).

[=*Triphyllotrypa* MOORE-D., 1944]. Zoaria solid or hollow thick branches or masses. Zooecia evenly spaced, especially characterized by strong lunaria with ends indenting the tubes like pseudosepta, giving them a trilobate cross section. *Perm.*——FIG. 49,*1*. **D. grandis*, SaltR., India; *1a,b*, secs., ×20 (228).

Eridopora ULR., 1882 [**E. macrostoma*] [=*Pileotrypa* HALL, 1886]. Thin, incrusting expansions with subtriangular to ovoid oblique apertures, very prominent overarching lunaria. *Dev.-Perm.*——FIG. 50,*3*. **E. macrostoma*, U.Miss.(Chest.), Ky.; *3a*, surface, ×20; *3b,c*, secs., ×20 (222).

Favicella HALL-S., 1887 [**Thallostigma inclusa* HALL, 1883] [=*Fistuliporidra* SIMPSON, 1897]. Thin lamellate expansions. Apertures circular, with peristome, situated in polygonal areas formed by coalescing angular ridges traversing the interspaces; lunaria weak or absent. *Dev.*——FIG. 50,*2*, **F. inclusa* (HALL), Hamilton, N.Y.; *2a*, long. sec., ×6, *2b*, surface, ×20 (162).

Fistuliphragma BASSLER, 1934 [**Fistulipora spinulifera* ROM., 1866]. Solid tuberculate branches. Zooecial tubes, with hemiphragms; lunaria poorly developed. *Dev.-Miss.*——FIG. 49,*3*. **F. spinulifera* (ROM.), M.Dev.(Traverse), Mich.; *3a,b*, secs., ×20; *3c*, zoarium, ×1 (222).

Fistuliporella SIMPSON, 1897 [**Lichenalia constricta* HALL, 1883]. Like *Fistulipora* but spine-like prolongations of interstitial walls appear as

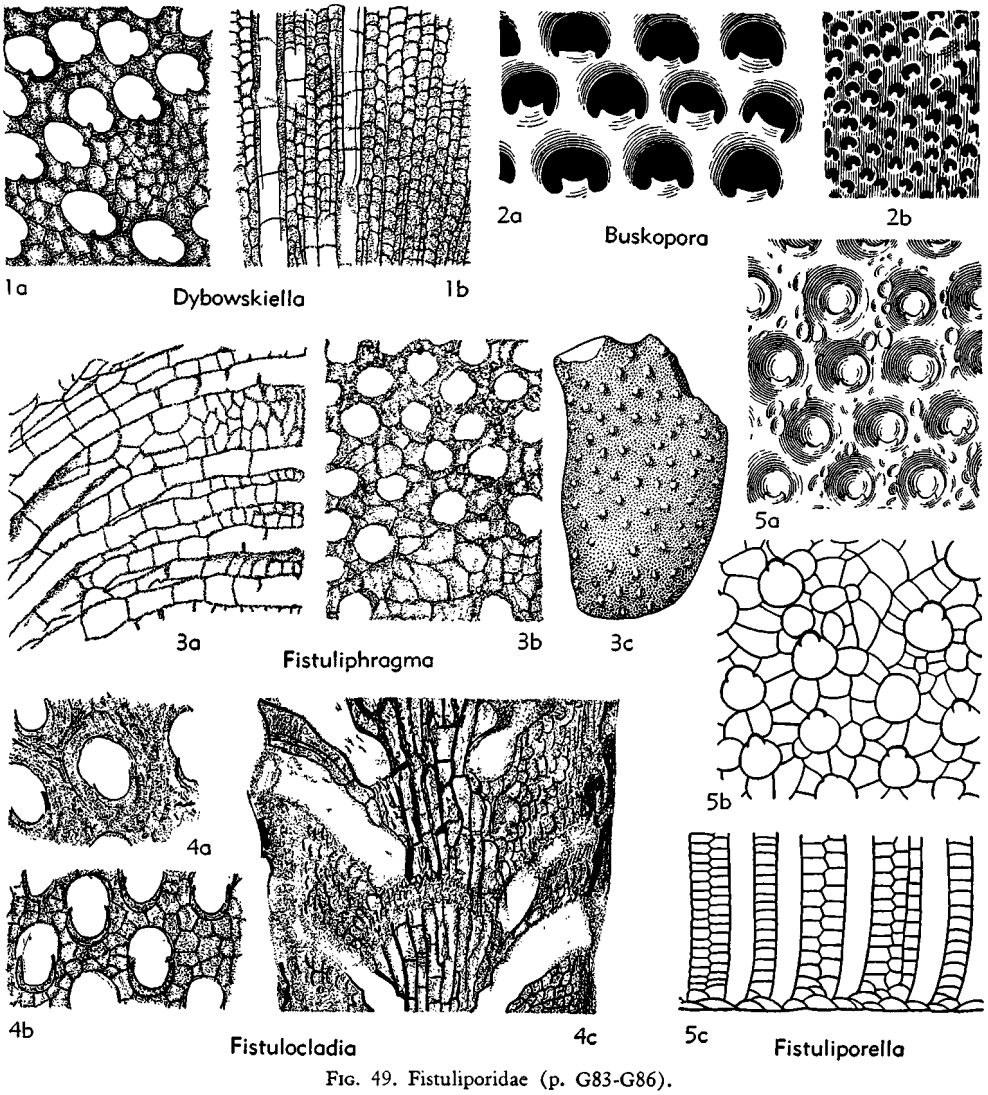


FIG. 49. Fistuliporidae (p. G83-G86).

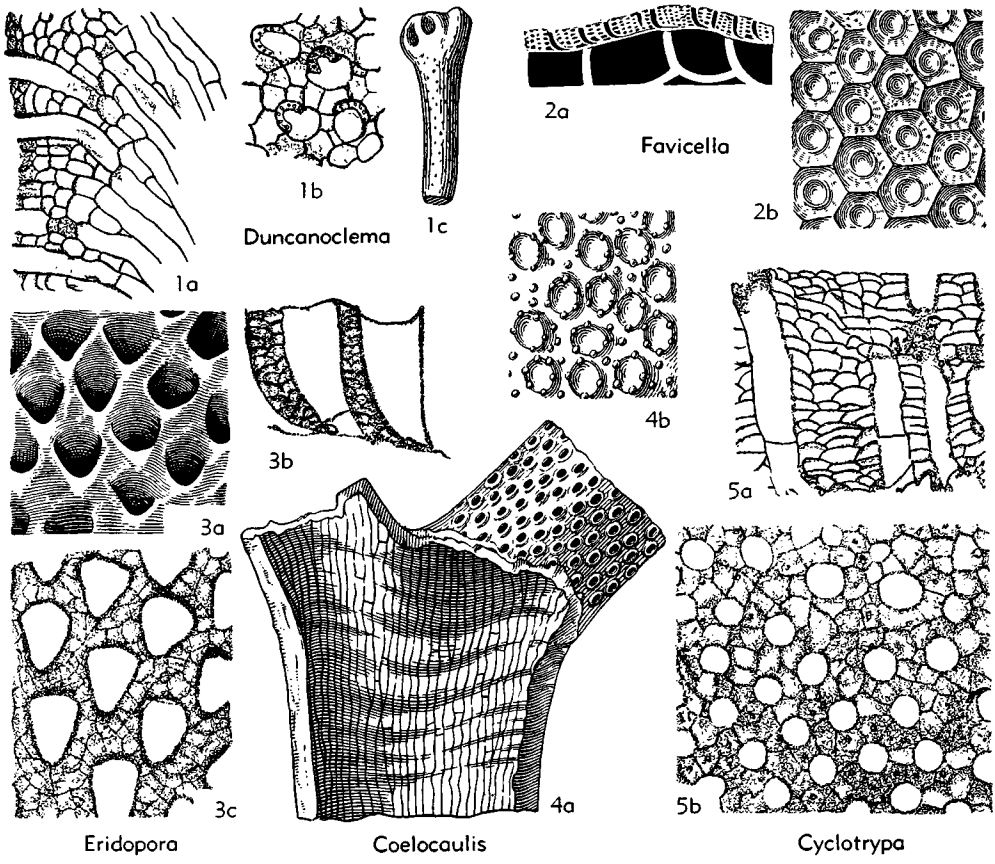


FIG. 50. Fistuliporidae (p. G84, G85).

granulations or spines on the surface. Lunaria sharply elevated. *Sil.-Dev.*——FIG. 49,*5*. **F. constricta* (HALL), Dev., N.Y.; *5a*, surface, ×20; *5b,c*, secs., ×20 (163).

Fistulocladia BASSLER, 1929 [**F. typicalis*]. Slender, solid, cylindrical, smooth branches with structure of *Fistulipora* but developing a central bundle of 5 or more narrow tabulate mesopore-like tubes and mature region with close vesicles thickened by laminated tissue. *Perm.*——FIG. 49,*4*. **F. typicalis*, Timor; *4a,b*, tang. secs., *4c*, long. sec., ×20 (131).

Fistulotrypa BASSLER, 1929 [**F. ramosa*]. Slender, solid branches. Zooecial tubes broad, in contact throughout immature zone but boxlike interzooecial structures of laminated tissue in very short mature zone. Lunaria weak. *Miss.-Perm.*——FIG. 51,*1*. **F. ramosa*, Perm., Timor; *1a,b*, secs., ×20 (131).

Lichenotrypa ULR., 1886 [**L. cavernosa* (=*Lichenalia longispina* HALL, 1883)]. First growth stages like *Fistulipora* but in mature zoaria acanthopores project as large spines and thin apertural walls leave numerous subangular openings between them. *Dev.*——FIG. 51,*2*. **L. longispina* (HALL), Onond., Falls Ohio, Ky.-Ind.; surface, ×10 (222).

Pinacotrypa ULR., 1889 [**Fistulipora elegans* ROM., 1866] [=*Fistulicella, Fistuliporina* SIMPSON, 1897]. Lamellate expansions. Zooecia with few diaphragms; lunaria weak; interspaces generally occupied by a single series of angular mesopores wider than the zooecia. *Dev.*——FIG. 51,*4*. **P. elegans* (ROM.), Hamilton, N.Y.; *4a,b*, secs., ×10 (223).

Selenopora HALL, 1886 [**Lichenalia circincta* HALL, 1883]. Like *Fistulipora* but lunaria strong, overarching, situated in polygonal vestibular areas formed by ridges traversing interspaces. *Dev.*——FIG. 51,*3*. **S. circincta* (HALL), Onond., Falls Ohio, Ky.-Ind.; surface, ×20 (162).

Strotopora ULR., 1889 [**S. foveolata* ULR., 1890]. Hollow branches with fistuliporoid structure bearing some large abruptly spreading cells (?broken

ovicells). *Dev.-Miss.*——FIG. 51,*5*. **S. foveolata* ULR., Miss.(Osag.), Iowa; surface, ×10 (222).

Xenotrypa BASSLER, 1952 [**Fistulipora primaeva* BASSLER, 1911]. Zoaria small, dome-shaped. Zooecia without diaphragms; lunaria weak. Vesicular interzooecial spaces traversed by large, thick, dense, granulose acanthopore-like tubes. *Ord.*——FIG. 51,*6*. **X. primaeva* (BASSLER), Russ.; *6a,b*, secs., ×20 (131).

Family HEXAGONELLIDAE Crockford, 1947

[as Hexagonellinae]

Zoaria bifoliate, with fistuliporoid structure; surface generally marked by solid noncelluliferous maculae and diverging narrow ridges. Zooecia tubular, rounded, proximally parallel to mesotheca, which has fine median tubules, distally bending outward but not at a right angle; lunaria poorly developed; complete diaphragms but no hemisepta. Interzooecial spaces with vesicular structure filled by dense tissue near surface but no vertical double plates between zooecia, as in Sulcoreteporidae (45,68,114). *Dev.-Perm.*

Hexagonella WAAG.-W., 1886 [**H. ramosa*]. Zoarial surface divided into hexagonal areas by thin ridges of mesopore-like structures surrounding the maculae. Lunaria weak or absent. *Perm.*——FIG. 52,*1*. **H. ramosa*, SaltR., India; *1a*, zoarium, ×1; *1b*, surface, ×5; *1c,d*, secs., ×25 (*1a,c*, 131; *1b,d*, 228).

Coscinotrypa HALL-S., 1887 [*pro Coscinium* KEYSERLING, 1846 (*non* ENDLICHER, 1836)] [**Coscinium cribriforme* PROUT, 1859]. Flattened bifoliate branches, inosculating at short distances forming a broad frond with circular to elliptical fenestrules. *Ord.-Perm.*——FIG. 52,*2*. **C. cribriformis* (PROUT),

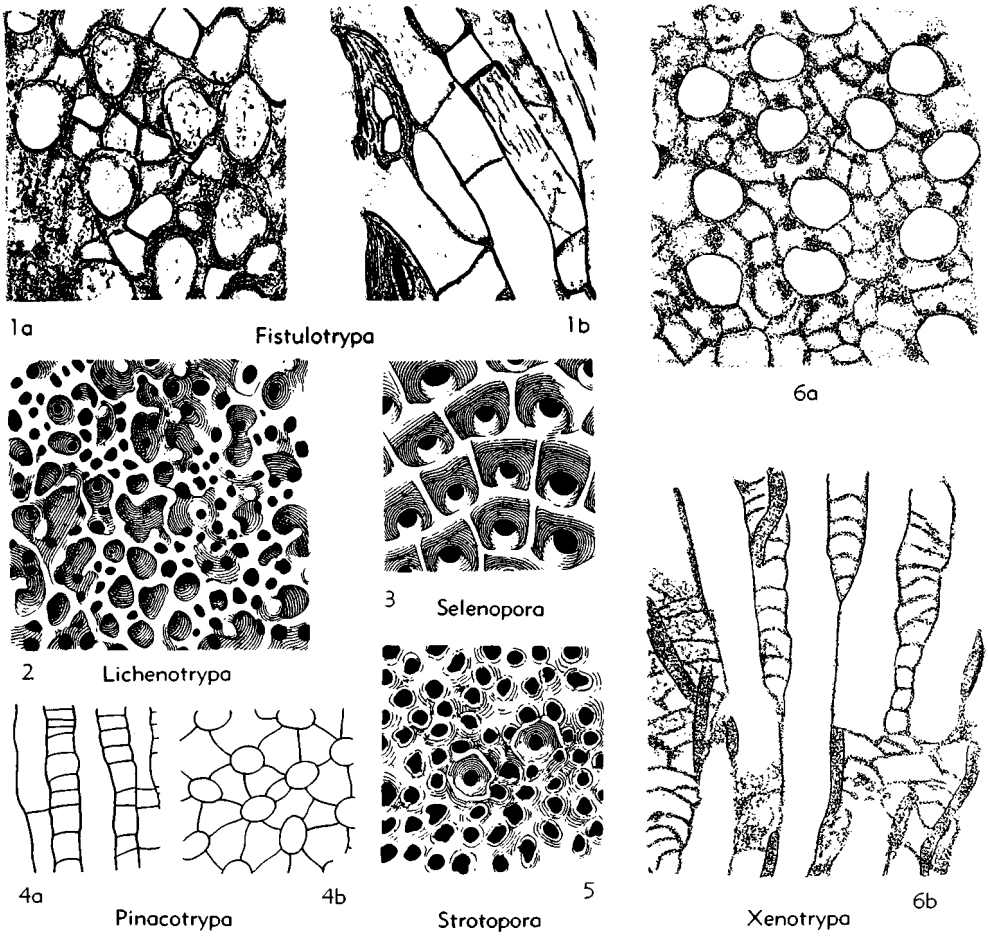


FIG. 51. Fistuliporidae (p. G86, G87).

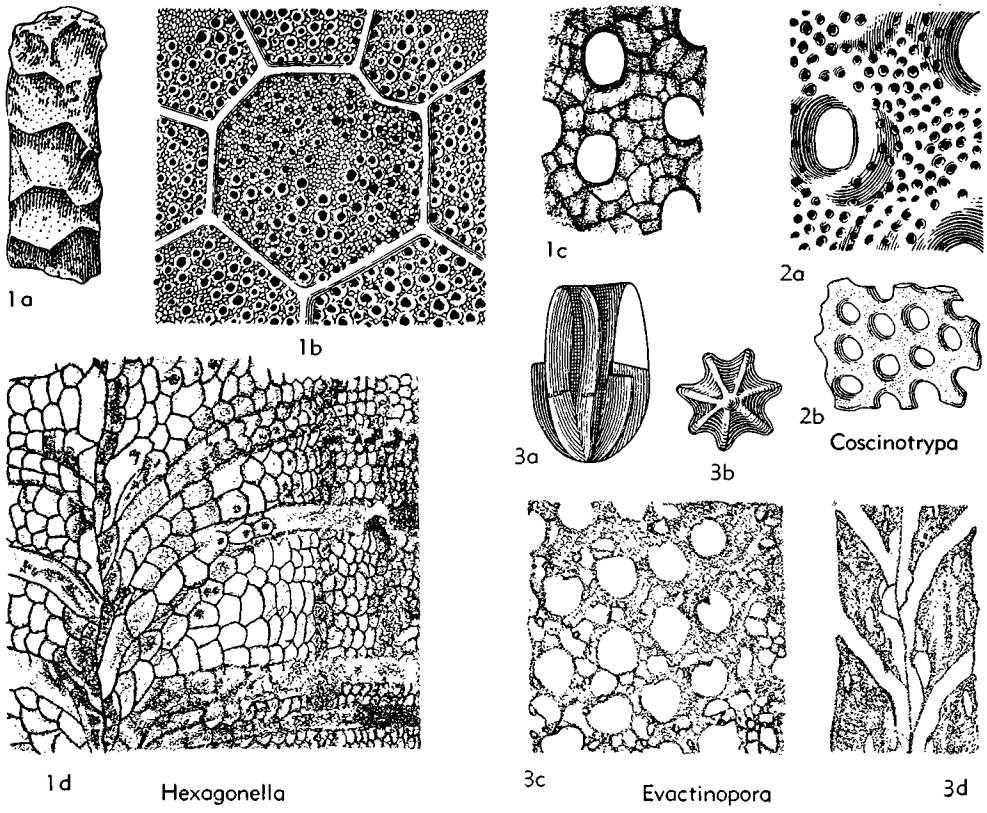


FIG. 52. Hexagonellidae (p. G87, G88).

Dev., Ky.; *2a,* surface, ×5; *2b,* fragment, ×1 (162).

Evactinopora MEEK-W., 1865 [**E. radiata*]. Zoaria composed of 3 or more vertical radiating bifoliate leaves arranged in a stellate or cruciform fashion. Internal structure as in *Hexagonella. Miss.*——FIG. 52,*3*. **E. radiata,* Osag., Mo.; *3a,b,* zoarium, side, top, ×1; *3c,d,* secs., ×20 (222).

Fistulamina CROCKFORD, 1947 [**F. inornata*]. Broad straplike bifoliate bifurcating branches with nonporiferous margins, surface without maculae. Apertures small, distinct, with lunaria. Vesicular structure replaced by dense tissue near surface. *L.Carb.,* N.S.W.

Glyptopora ULR., 1884 [**Coscinium plumosum* PROUT, 1860] [=*Glyptotrypa* MILLER, 1889]. Thin bifoliate expansions, surfaces traversed by salient ridges or unilaminate bases on which coalescing ridges of the upper surface are developed to form large leaves. Surface with prominent elongate, dimple-like maculae. *Miss.-Perm.* ——FIG. 53,*1*. **G. plumosa* (PROUT), Miss. (Warsaw), Ill.-Mo.; *1a,* surface, ×10; *1b,* zoarium, ×1 (222).

Meekopora ULR., 1889 [**Fistulipora? clausa* ULR., 1890]. Flat narrow bifurcating to broad bifoliate fronds. Apertures circular to oblique, lunarium present but not indenting the cavity. Maculae prominent; interzooecial vesicular structure well developed. *Sil.-Perm.*——FIG. 53,*2*. **M. clausa* (ULR.), Miss.(Chest.), Ky.; *2a,* zoarium, ×1; *2b,c,* secs., ×20 (222).

Meekoporella MOORE-D., 1944 [**M. dehiscens*]. Like *Meekopora* but growth in bifoliate sheets joined at angles of about 120° forming large polygonal inverted pyramidal chambers. *Penn.*—— FIG. 53,*3*. **M. dehiscens,* Kans.; side of chamber split along mesotheca (zooecial apertures not visible), ×1 (193).

Phractopora HALL, 1883 [**P. cristata*]. Like *Glyptopora* but junction angles celluliferous, thicker than any other part of the leaves. *Dev.-Miss.*——FIG. 53,*5*. **P. cristata,* Dev.(Onond.), Falls Ohio, Ky.-Ind.; *5a,* zoarium, ×1; *5b,* surface, ×5 (162).

Prismopora HALL, 1883 [**P. triquetra*]. Triangular bifurcating or trifurcating branches with zooecia arising from mesothecae, radiating from the center to the margins. *Dev.-Perm.*——FIG. 53,*4*. **P.*

triquetra. Dev.(Onond.), Falls Ohio, Ky.-Ind.; *4a,* zoarium, ×1; *4b,* transv. sec., ×5; *4c,* surface, ×20 (162).

Scalaripora HALL, 1883 [**S. scalariformis*]. Like *Prismopora* but faces of triangular branches crossed by salient transverse ridges. *M.Dev.*——FIG. 53,6. **S. scalariformis,* Onond., Falls Ohio, Ky.-Ind.; *6a,* zoarium, ×1; *6b,c,* side, end, ×5 (162).

Family GONIOCLADIIDAE Nikiforova, 1938

Slender branched bifoliate fistuliporoids which differ from Hexagonellidae in bifurcation of the branches at right angles to the mesotheca and in their anastomosing or pinnate zoaria. Lack of hemisepta and vertical double plates between the zooecia distinguish them from sulcoreteporid Cryptostomata. Lunaria weak or absent (SHULGA, 1933). *Miss.-Perm.*

Goniocladia ETH., 1876 [*pro Carinella* ETH., 1873 (*non* JOHNSTON, 1833)] [**Carinella cellulifera* ETH., 1873]. Zoarium reticulate, composed of angular bifoliate branches with zooecia opening on both sides of the median lamina which bisects

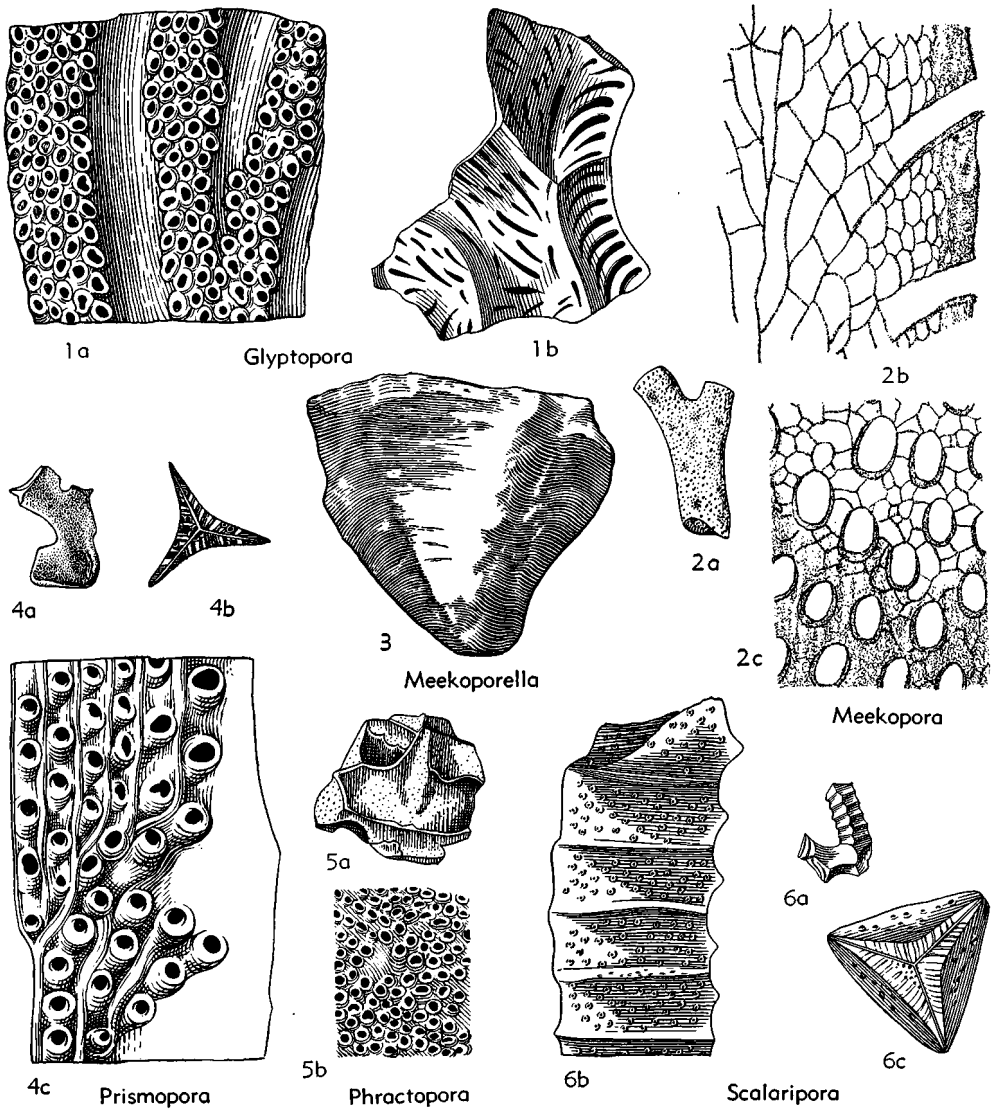


FIG. 53. Hexagonellidae (p. G88, G89).

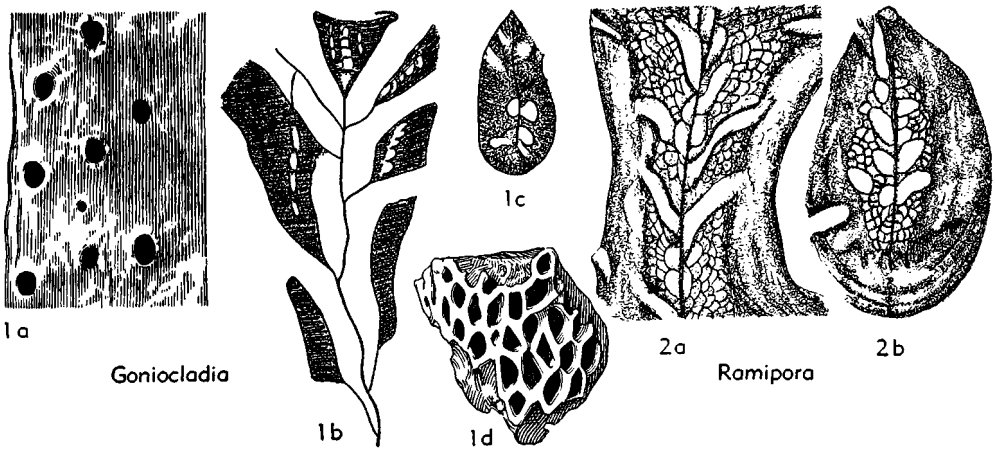


FIG. 54. Goniocladiidae (p. G89, G90).

the branch and projects as a keel on the front and a flat area on the back; fenestrules polygonal. *Miss.-Perm.*——FIG. 54,*1*. **G. cellulifera* (ETH.), Perm., Eng.; *1a*, surface, ×20; *1b*, long. sec., ×20; *1c*, transv. sec., ×10; *1d*, zoarium, ×1 (131).

Ramipora TOULA, 1875 [**R. hochstetteri*]. Like *Goniocladia* but zoarium dendroid, branches extended or short, ending bluntly. *Carb.-Permocarb.*, Spitz.

R. (Ramipora) Irregularly pinnate zoaria.

R. (Ramiporidra) NIKIF., 1938. *Permocarb.*—— FIG. 54,*2*. **R. (R.) uralica* (STUCK.), *Permocarb.*, Russ.; *2a,b*, secs., ×10 (198).

R. (Ramiporalia) SHULGA, 1933 [**Ramiporalia dichotoma*]. *Carb.*, Russ.

R. (Aetomacladia) BRETNALL, 1926 [**A. ambrosioides*]. Zooecia in 3 or 4 rows on each side of mesotheca. *Carb.*, Austral.

R. (Ramiporella) SHULGA, 1933 [**Ramiporella asymmetrica*]. *Carb.*, Russ.

Volgia STUCK., 1905 [**Coscinium arborescens*] [=*Ramiporina* SHULGA, 1933]. Zoarium arborescent composed of primary branches giving off secondary branches in verticels and these bearing branches of third order. *Perm.*, Russ.

Order TREPOSTOMATA Ulrich, 1882

[=Stenolaemata BORG, 1926 *(partim)*]

Zoaria mostly massive, lamellate, or stemlike, comprising typical so-called stony bryozoans. Zooecia consist of long calcareous tubes, generally intersected by many partitions (diaphragms), each tube being divisible into an immature region in the axial part of the zoarium characterized by thin walls, wide spacing of diaphragms, and contact with other zooecia on all sides, and a mature region near the zoarial surface characterized by thickened walls, close spacing of diaphragms, and intervention of special cells (mesopores, acanthopores) between zooecia. Monticules or maculae, comprising regularly spaced clusters of cells smaller or larger than average, commonly well defined on zoarial surface (1,5,6,7,8). *Ord.-Perm., ?Trias.*

MORPHOLOGICAL FEATURES

This order seemingly is limited to the Paleozoic era, when it flourished in an abundance of species forming stony colonies and even coral-like reefs which contributed largely to the building of many formations. These colonies are invariably calcareous, consisting generally of solid masses which may attain considerable size (diameter and thickness exceeding 50 cm.), or branching growths composed of long, coherent, prismatic, or cylindrical tubes with terminal apertures. Each tube is composed of an inner axial **(immature)** region and an outer, peripheral **(mature)** region. This change in the character of the tubes, which is basis for the name of the order (*trepos*, change), is accompanied by development in the mature zone of additional features known as mesopores, acanthopores, cystiphragms, hemiphragms, and heterophragms, as well as more numerous diaphragms.

The Trepostomata include the greater portion of the so-called monticuliporoids, which for a long time were regarded as corals described mainly as species of *Chaetetes* or *Monticulipora*. MILNE-EDWARDS & HAIME regarded them as anthozoan corals, whereas NICHOLSON assigned them to the Octocoralla because the "corallites" seem to agree with those of *Heliolites* in microscopic structure and supposed increase by intermural gemmation or fission. Their bryozoan nature was long insisted on by ULRICH, who in establishing the order published many proofs of their affinities with undoubted Bryozoa. This relationship was confirmed by CUMINGS (6), who discovered that the budding plan of at least 6 Ordovician trepostome genera was precisely the same as in typical Recent bryozoans; that is, the free-swimming larva upon becoming sedentary gave rise to (1) the **protoecium,** an attached circular disc, followed by (2) the **ancestrula,** a tubular zooid seen also in the Cyclostomata and other orders, and then (3) several **primary individuals** developed by budding from the ancestrula. These primitive structures are separated from the rest of the colony by a considerable thickening of their posterior walls. Among corals, development from the larva is direct the moment it becomes sedentary, and therefore the presence of the protoecium alone is practically conclusive as to the systematic position of the Trepostomata as bryozoans.

Some trepostomes are incrusting and consist of one or many superposed layers, but most either build ramose twiglike stems, flat or undulating fronds, thin bifoliate expansions, or hemispherical to rounded masses as much as 2 feet (60 cm.) in diameter. Such massive zoaria arise from the manner in which the trepostome zooecia **(autopores)** develop directly superposed on one another so as to form long tubes by continued terminal budding of the same zooid or repeated addition of new zooids in positions of old ones. The tubes are intersected by straight or nearly straight partitions **(diaphragms)** or strongly curved ones **(cystiphragms, heterophragms),** which seemingly represent the covers and floors of successive zooecial layers. The diaphragms may be incomplete **(semidiaphragms, hemiphragms)** or provided with a central opening **(perforate diaphragms).** Generally few or wanting in the immature zone, they become numerous and commonly crowded in the outer mature zone, where also the zooecia of many genera are separated by more or less closely tabulated slender angular tubes **(mesopores)** and spiniform tubules **(acanthopores).** Zooecial covers with a small subcentral opening may occur. The hemiphragms are diaphragms covering only half the zooecial diameter; heterophragms are small cystlike semidiaphragms of laminated tissue continuous with the walls.

One characteristic of the Trepostomata, shared with Cryptostomata and some Cyclostomata (Fistuliporidae), is the presence at regular intervals over the zoarial surface of elevated clusters of cells **(monticules),** that differ in size from the average, or flat to gently depressed areas **(maculae)** of such cells. The size, shape, elevation, and distance apart of the monticules or maculae are usually specific characters. Monticules vary from small sharp tubercles through rounded nodes to elevated rings completely encircling slender branches. The maculae are inconspicuous in some zoaria but prominent in others; in one family (Constellariidae), they form distinctive star-shaped regions. The significance of monticules and maculae is unknown.

The spinelike projections on the zoarial surface formed by acanthopores are visible in thin sections as slender tubules included in the wall substance, but with a definite cone-in-cone structure of their own, pierced by a minute central opening which may be interrupted by crowded transverse diaphragms. The acanthopores commonly traverse the mature region and undoubtedly represent zooids with some definite function, possibly like the avicularia or vibracula of the Cheilostomata; **megacanthopores** and **micracanthopores** are large and small forms of acanthopores which are well developed in definite positions in some trepostomes, as in the cryptostomes.

For many years, identification of the Trepostomata was based on external features such as zoarial form, size and shape of zooecial apertures, and surface characters of tubercles or maculae. This led to so much confusion that members of the order were considered to have little value in identifying

stratigraphic horizons. Experience has shown that the internal structure of these bryozoans gives the true specific characters, and so the preparation of thin sections for study under the microscope becomes indispensable in their study. When a species once has been thoroughly studied in this manner, so as to correlate internal and external characters, generally it can be identified without preparation of thin sections. Etching smoothed surfaces with acid brings out structural details quite clearly under a hand lens.

CLASSIFICATION

Two main divisions of the Trepostomata are defined by minute structure of the walls between adjoining zooids (1). Among the 10 famiiles now recognized in the order, 6 are composed of genera in which the calcareous substance of adjoining zooecial tubes is amalgamated together so that one wall cannot be distinguished from its neighbor (Amalgamata). In the other 4 families (Integrata), the walls retain their identity, so that where the zooecia adjoin, their boundaries are marked by a dark line representing probably remains of animal matter which filled this space during life of the organisms. The narrow area may be occupied by light-colored tissue, in which case the outer boundaries of the wall of each zooecium can be seen clearly. In certain

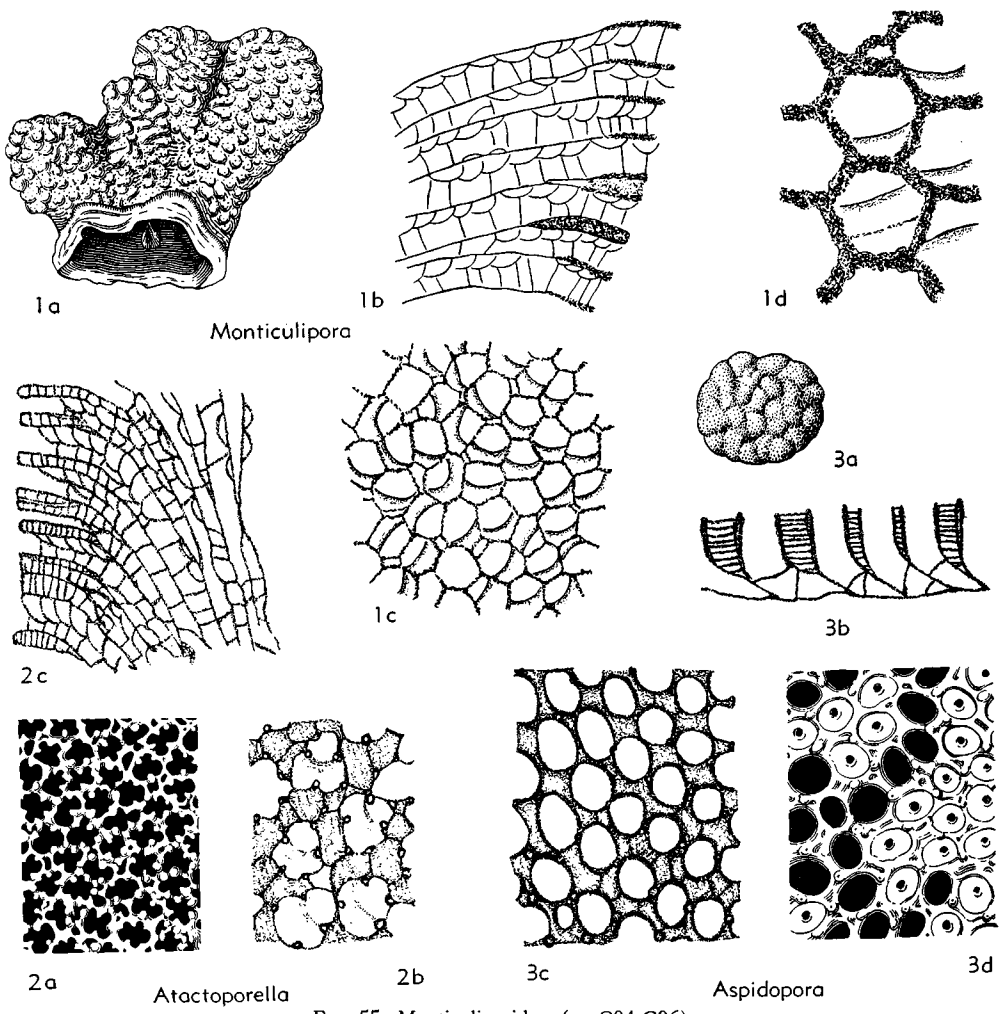


FIG. 55. Monticuliporidae (p. G94-G96).

genera, the amalgamation or distinctness of the walls is difficult to determine, especially if mesopores are numerous. Compared with most other orders, the Trepostomata seem to be poorly represented in described genera and species, but it should be pointed out that many areas and formations known to contain these fossils remain for study. Even such classic regions as the Trentonian of New York have received comparatively little attention for more than a century and abundant species in Blackriveran formations of the Appalachian Valley are largely undescribed.

Bryozoans of the post-Paleozoic suborder Cerioporina of the Cyclostomata, commonly known as the heteroporoids, so much resemble trepostomes exteriorly that they were classified erroneously as Trepostomata by J. W. Gregory in 1909. In consequence, Borg (9,11) included the Trepostomata with Cyclostomata under the new name Stenolaemata, ignoring the fact that highly characteristic features of the Cyclostomata, such as ovicell and wall structure with pseudopores, are totally absent in true Trepostomata. Species of so-called Trepostomata of Triassic age described by Vinassa (12) need restudy; probably they will prove to belong to the Cerioporina.

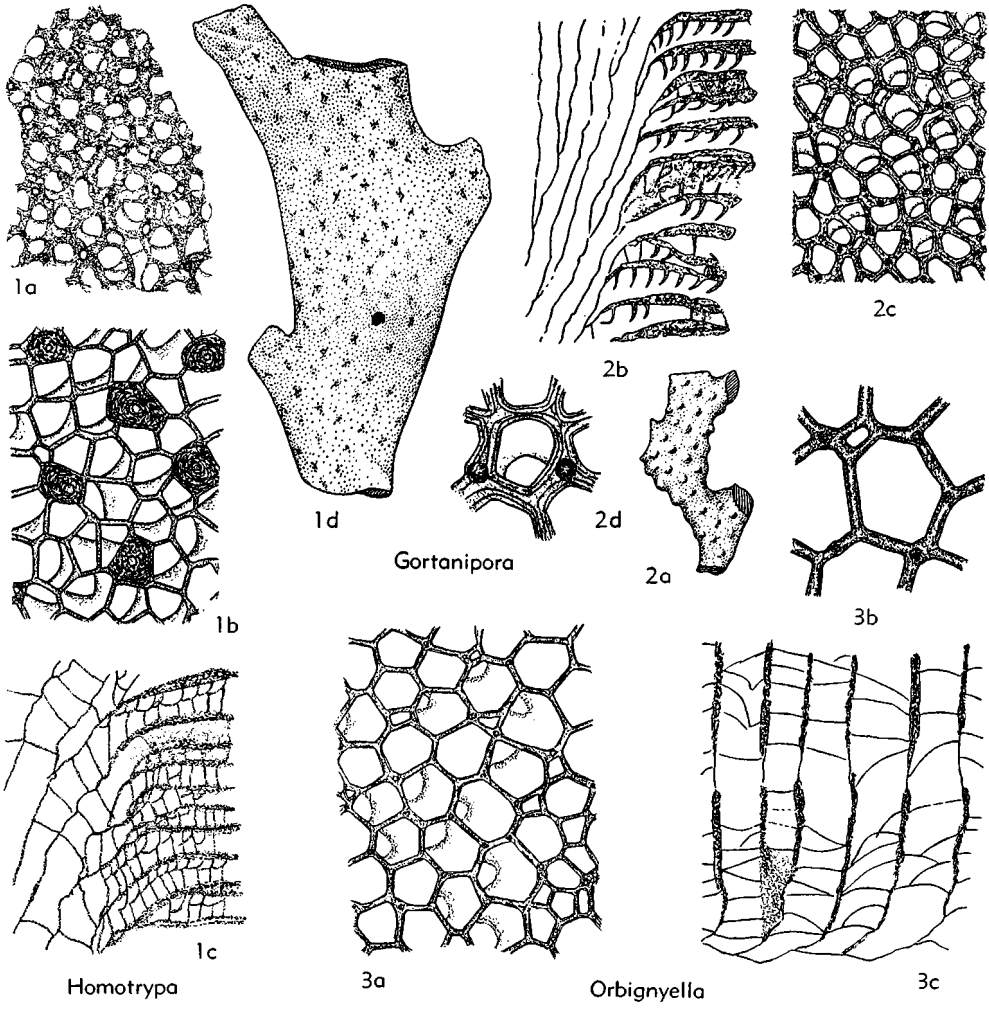


Fig. 56. Monticuliporidae (p. G96).

Suborder AMALGAMATA Ulrich & Bassler, 1904

Trepostomata with boundaries of adjacent zooecia obscured by more or less complete coalescence of their walls. *Ord.-Perm.*

Family MONTICULIPORIDAE Nicholson, 1881

[=Prasoporidae Simpson, 1897]

Zoarium incrusting, ramose, frondescent, bifoliate, or massive; generally with regularly spaced monticules. Zooecial tubes characterized by presence of incomplete curved partitions (cystiphragms) in addition to straight diaphragms; apertures polygonal. Acanthopores and angular mesopores with numerous diaphragms commonly present (3,112,115; Nickles-B., 1900). *Ord.-Dev.*

Monticulipora d'Orb., 1850 [*nom. conserv.*, ICZN pend. (*non* d'Orb., 1849)]. [**M. mammulata* d'Orb., 1850] [=*Monticuliporella* Bassler, 1935]. Typically massive, but also incrusting to fron-

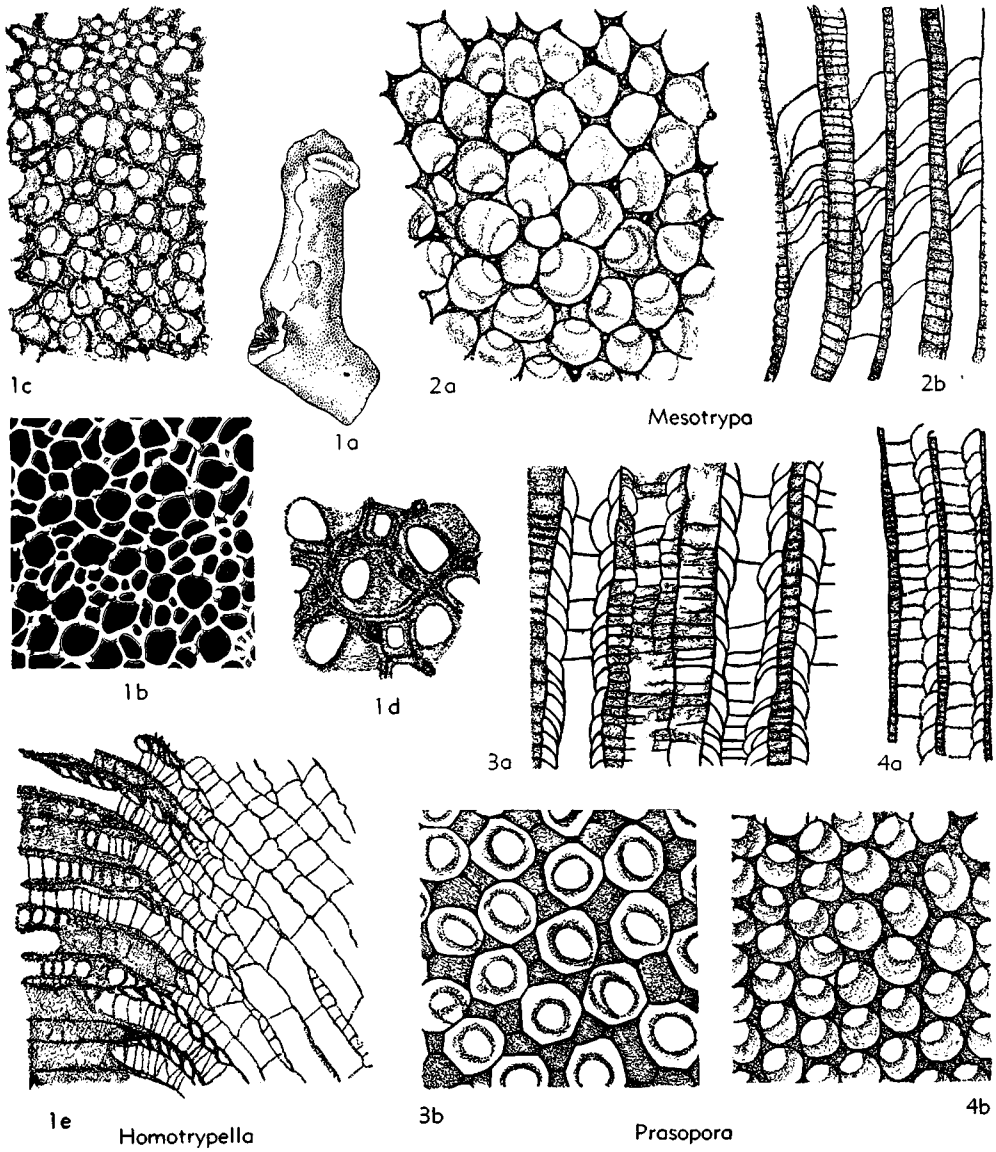


Fig. 57. Monticuliporidae (p. G96).

dose. Zooecia thin-walled, polygonal, with cystiphragms and diaphragms in both immature and mature regions. Small acanthopores with granulose walls common; mesopores few, with diaphragms. *Ord.*——FIG. 55,*1*. **M. mammulata*, Ord.(Maysv.), Ohio; *1a*, massive zoarium (chosen as type by M.EDW.-H., 1851), ×1; *1b*, long. sec., ×25; *1c,d*, tang. sec., ×25, ×50; (*1b-d* from frondose type described as *M. molesta* NICH., 1881, but figured as D'ORBIGNY's type of *M. mammulata* by BOULE, 1906) (*1a*, 131; *1b-d*, 223).

Aspidopora ULR., 1882 [**A. areolata* ULR., 1883]. Thin free epithecate expansions with few cystiphragms, small acanthopores, and closely tabulate large mesopores. *Ord.-Sil.*——FIG. 55,*3*. **A. areolata*, Ord.(Eden.), Ohio; *3a*, zoarium, ×1; *3b,c*, secs., ×20; *3d*, surface showing zooecial closures, ×20 (222).

Atactoporella ULR., 1883 [**A. typicalis*]. Incrusting, but also ramose to massive. Zooecia thin-walled, lined by cystiphragms and diaphragms, with apertures indented by so many small acanthopores as to become petaloid; large tabulate mesopores. *Ord.*——FIG. 55,*2*. **A. typicalis*, Ord.(Eden.),

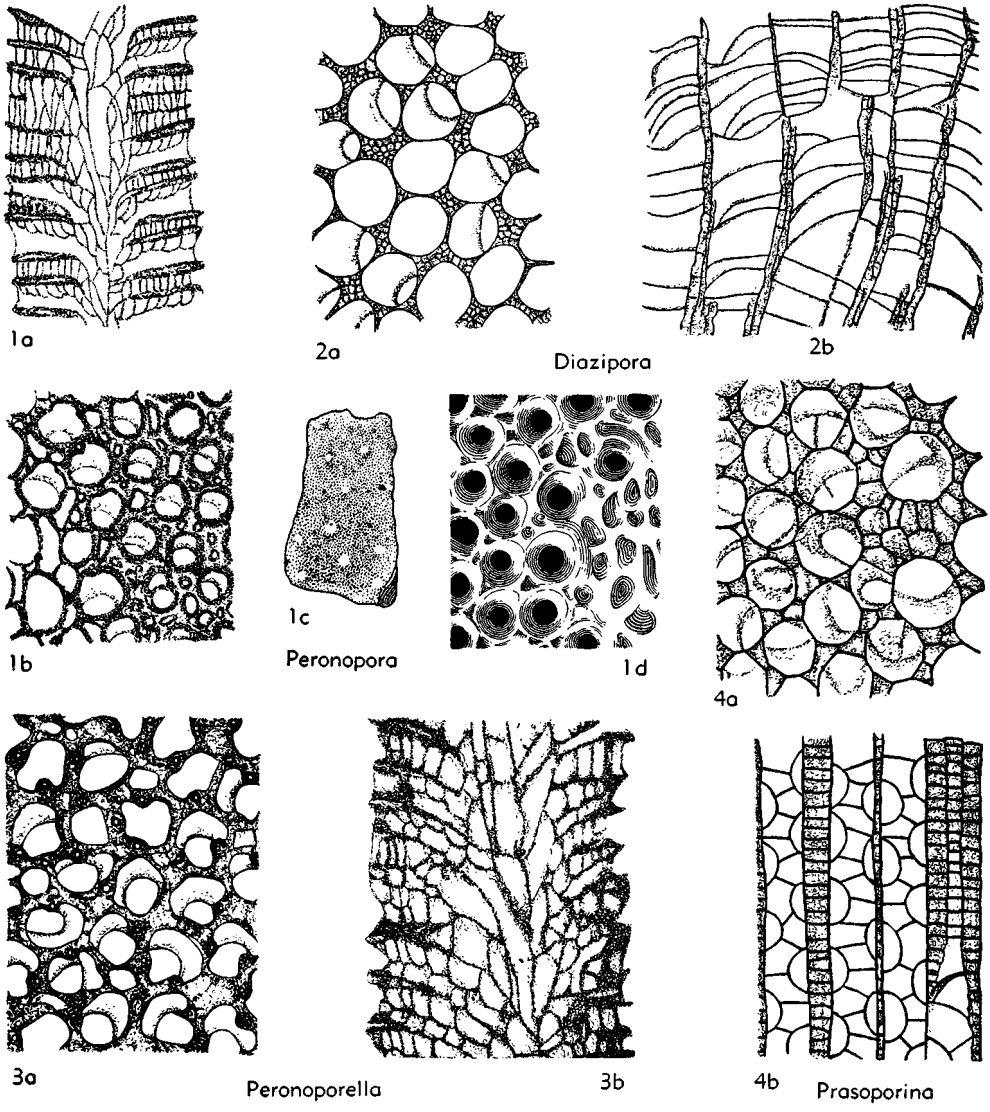


FIG. 58. Monticuliporidae (p. G96, G97).

Ky.; *2a,* surface, ×20; *2b,c,* tang. and long. secs., ×50, ×20 (222).

Diazipora VINASSA, 1920 [**Mesotrypa milleporacea* BASSLER, 1911]. Lamellate. Zooecia thin-walled, with many gently curved diaphragms; mesopores very minute, grouped, tabulate. *M.Ord.*——FIG. 58,*2*. **D. milleporacea* (BASSLER), M.Ord., Est.; *2a,b,* secs., ×20 (225).

Gortanipora VINASSA, 1920 [**Homotrypa bassleri* NICKLES, 1902] [=*Gorgantipora* BASSLER, 1935]. Like *Homotrypa* but with well-developed isolated cystiphragms, restricted to mature zone; diaphragms absent. *Ord.*——FIG. 56,*2*. **G. bassleri* (NICKLES), Richmond., Ohio; *2a,* zoarium, ×1; *2b,* long. sec., ×20; *2c,d,* tang. secs., ×20, ×50 (225).

Homotrypa ULR., 1882 [**H. curvata*] [=*Canavaripora, Cadornipora* VINASSA, 1920]. Frondescent to ramose. Cystiphragms with diaphragms restricted to mature zone; mesopores only in clusters. *Ord.-Sil.*——FIG. 56,*1*. **H. curvata,* Ord.(Maysv.), Ohio; *1a,b,* tang. secs., large acanthopores in *1b,* ×20, ×25; *1c,* long. sec., ×20; *1d,* zoarium, ×1 (222).

Homotrypella ULR., 1886 [**H. instabilis*]. Like *Homotrypa* but has numerous tabulate mesopores and cystiphragms in early part of zooecial mature zone. *Ord.*——FIG. 57,*1*. **H. instabilis,* Blkriv., Minn.; *1a,* zoarium, ×1; *1b,* surface, ×20; *1c,d,* tang. secs., ×20, ×50; *1e,* long. sec., ×20 (222).

Mesotrypa ULR., 1893 [**Diplotrypa infida* ULR., 1886]. Small discoidal or conical free masses with basal epitheca. Zooecia with obliquely curved diaphragms crowded in mature zone, with acanthopores and closely tabulate mesopores. *Ord.*——FIG. 57,*2*. **M. infida* (ULR.), Blkriv., Minn.; *2a,b,* tang. and long. secs., ×20 (222).

Orbignyella ULR.-B., 1904 [**O. sublamellosa*]. Lamellate. Zooecia angular, with sharply defined walls and curved diaphragms. Acanthopores well developed but mesopores lacking. *Ord.*——FIG. 56,*3*. **O. sublamellosa,* Blkriv., Tenn.; *3a,b,* tang. secs., ×25, ×50; *3c,* long. sec., ×25 (223).

Peronopora NICH., 1881 [**Chaetetes frondosus* NICH., 1874 (*non* D'ORB., 1854) (=*Chaetetes decipiens* ROM., 1866)]. Bifoliate convolute growth. *Ord.*——FIG. 58,*1*. **P. decipiens* (ROM.), Richmond., Ind.; *1a,b,* secs., ×20; *1c,* fragment, ×1; *1d,* surface, ×20 (222).

Peronoporella CUMINGS-G., 1913 [**P. dubia*]. Like *Homotrypella* but immature region very short. *Ord.*——FIG. 58,*3*. **P. dubia,* Richmond., Ind.; *3a,b,* secs., ×50 (144).

Prasopora NICH.-E., 1877 [**P. grayae*] [=*Prasoporella* VINASSA, 1920]. Free discoid to hemispherical masses. Zooecia lined by overlapping cystiphragms connected by diaphragms. Mesopores small, angular, closely tabulate. *Ord.*——FIG. 57,*3*. **P. grayae,*

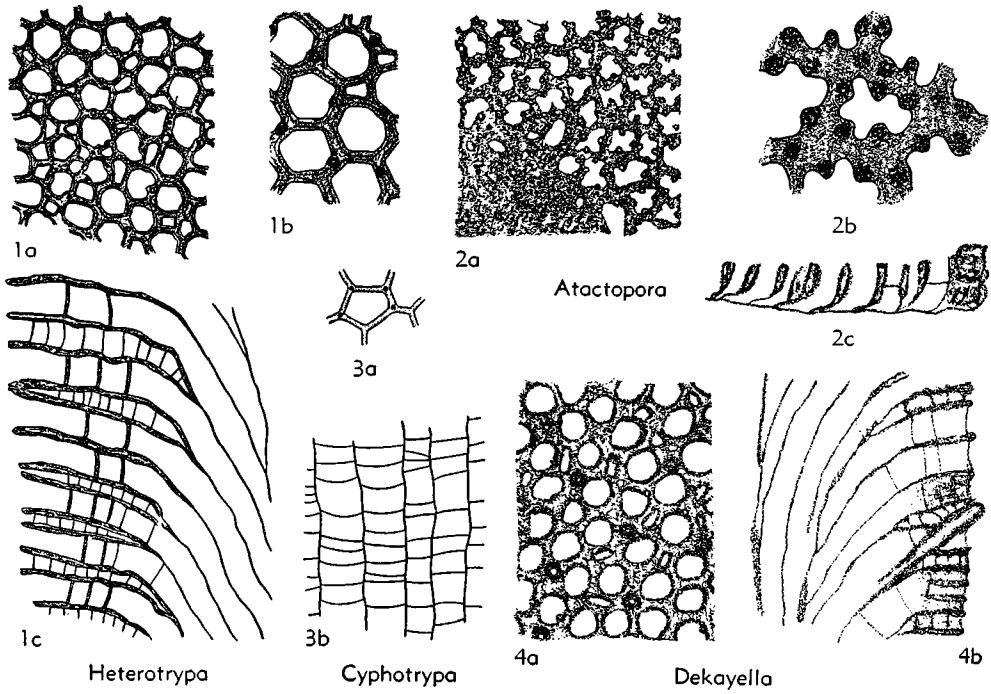


FIG. 59. Heterotrypidae (p. G97, G98).

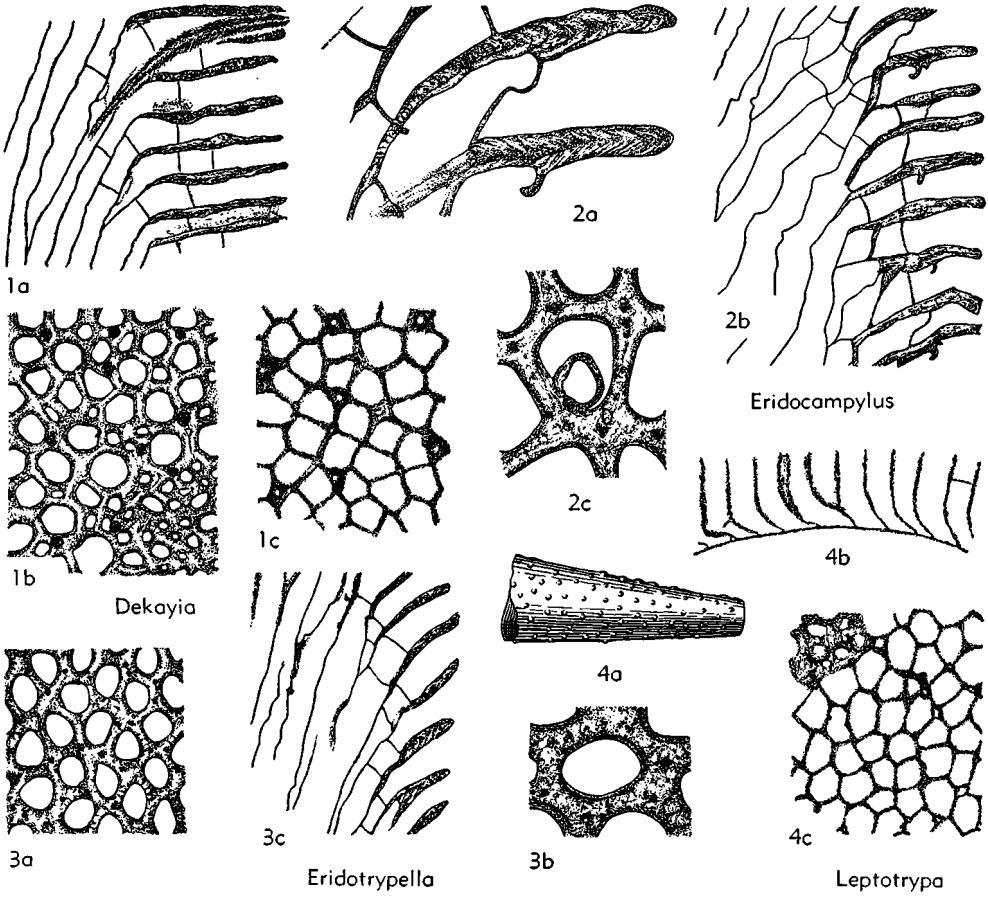


FIG. 60. Heterotrypidae (p. G98).

Caradoc., Scot.; *3a,b,* secs., ×25 (131).——FIG. 57,*4. P. simulatrix* ULR., L.Trenton., Ky.; *4a,b,* secs., ×20 (222).

Prasoporina BASSLER, 1952 [**Monticulipora selwynii* NICH., 1881]. Like *Prasopora* but cystiphragms are isolated subglobular structures connected with opposite wall by a few diaphragms. *Ord.*——FIG. 58,*4.* **P. selwynii* (NICH.), Trenton., Ont.; *4a,b,* secs., ×20 (222).

Family HETEROTRYPIDAE Ulrich, 1890

Zoarium typically erect flabellate but also incrusting to massive. Zooecia angular, with straight diaphragms and no cystiphragms; walls fused but retaining light-colored dotted or lined central band. Mesopores few; acanthopores well defined, commonly large (3,54,112,114,115; NICKLES-B., 1900). *Ord.-Dev.*

Heterotrypa NICH., 1879 [**Monticulipora frondosa* D'ORB., 1850]. Frondescent. Mesopores closely tabulate; acanthopores of one kind only. *Ord.*——FIG. 59,*1.* **H. frondosa* (D'ORB.), Maysv., Ohio; *1a,b,* tang. secs., ×20, ×25; *1c,* long. sec., ×20 (223).

Atactopora ULR., 1879 [**A. hirsuta*]. Thin incrustations with conspicuous solid elevations (monticules), generally found on cephalopod shells. Zooecial apertures floriform, strongly indented by acanthopores. Mesopores lacking. *Ord.*——FIG. 59,*2.* **A. hirsuta,* Eden., Ky.; *2a,b,* tang. secs., ×20, ×50; *2c,* long. sec., ×20 (*2a,c,* 222; *2b,* 131).

Cyphotrypa ULR.-B., 1904 [**Leptotrypa acervulosa* ULR., 1893]. Massive, attaining width of 25 cm. Zooecia thin-walled, with diaphragms in recurrent mature zones. Mesopores absent; acanthopores well developed. *Ord.-Dev.*——FIG. 59,*3.* **C. acervulosa* (ULR.), Trenton., Iowa; *3a,b,* secs., ×25, ×20 (223).

Dekayella ULR., 1882 [**D. obscura* ULR., 1883]. Like *Dekayia* but has many mesopores; sets of

large and small acanthopores. *Ord.*——FIG. 59,*4*. **D. obscura* ULR., Eden., Ohio; *4a,b,* secs., ×20 (222).

Dekayia M.EDW.-H., 1851 [**D. aspera*]. Ramose. Mesopores and diaphragms practically absent; acanthopores large. *Ord.*——FIG. 60,*1*. **D. aspera,* Maysv., Ohio; *1a,* long. sec.; *1b,* tang. sec. near surface; *1c,* tang. sec. well below surface; all ×20 (*1a,c,* 131; *1b,* 222).

Eridocampylus DUNCAN, 1939 [**E. ulrichi*]. Ramose. Zooecia with amalgamate walls, modified curved diaphragms (heterophragms), and small cystoid structures of thick laminated tissue projecting from walls. *M.Dev.*——FIG. 60,*2*. **E. ulrichi,* Traverse, Mich.; *2a,b,* long. secs. showing heterophragms, ×50, ×20; *2c,* tang. sec., ×50 (147).

Eridotrypella DUNCAN, 1939 [**Batostomella obliqua* ULR., 1890]. Ramose. Like *Eridotrypa* but has heterotrypoid wall structure; zooecia with thick transversely dotted bands. Mesopores absent. *M.Dev.*——FIG. 60,*3*. **E. obliqua* (ULR.), Traverse, Mich.; *3a,b,* tang. secs., ×20, ×50; *3c,* long. sec., ×20 (147).

Leptotrypa ULR., 1883 [**L. minima*]. Incrusting, with sharp monticules. Zooecial walls thin, diaphragms nearly wanting. Mesopores rare; acanthopores few. *Ord.*——FIG. 60,*4*. **L. minima,* Maysv., Ohio; *4a,* zoarium, ×1; *4b,c,* secs., ×20 (222).

Leptotrypella VINASSA, 1920 [**Chaetetes barrandei* NICH., 1874]. Like *Eridotrypella* but has well-developed laminated acanthopores. *M.Dev.*——FIG. 61,*2*. **L. barrandei* (NICH.), Hamilton, Ont.; *2a,* zoarium, ×1; *2b,* surface, ×20; *2c,d,* tang. secs., ×20, ×50; *2e,* long. sec., ×20 (225).

Petigopora ULR., 1882 [**P. gregaria* ULR., 1883]. Small circular incrusting patches with structure of *Dekayia*. *Ord.*——FIG. 61,*3*. **P. gregaria* ULR., Maysv., Ohio; *3a,* zoaria, ×1; *3b,c,* secs., ×20 (222).

Stigmatella ULR.-B., 1904 [**S. crenulata*] [=*D'Annunziopora, D'Annunzioporina* VINASSA, 1920]. Typically ramose, also incrusting to massive. Zooe-

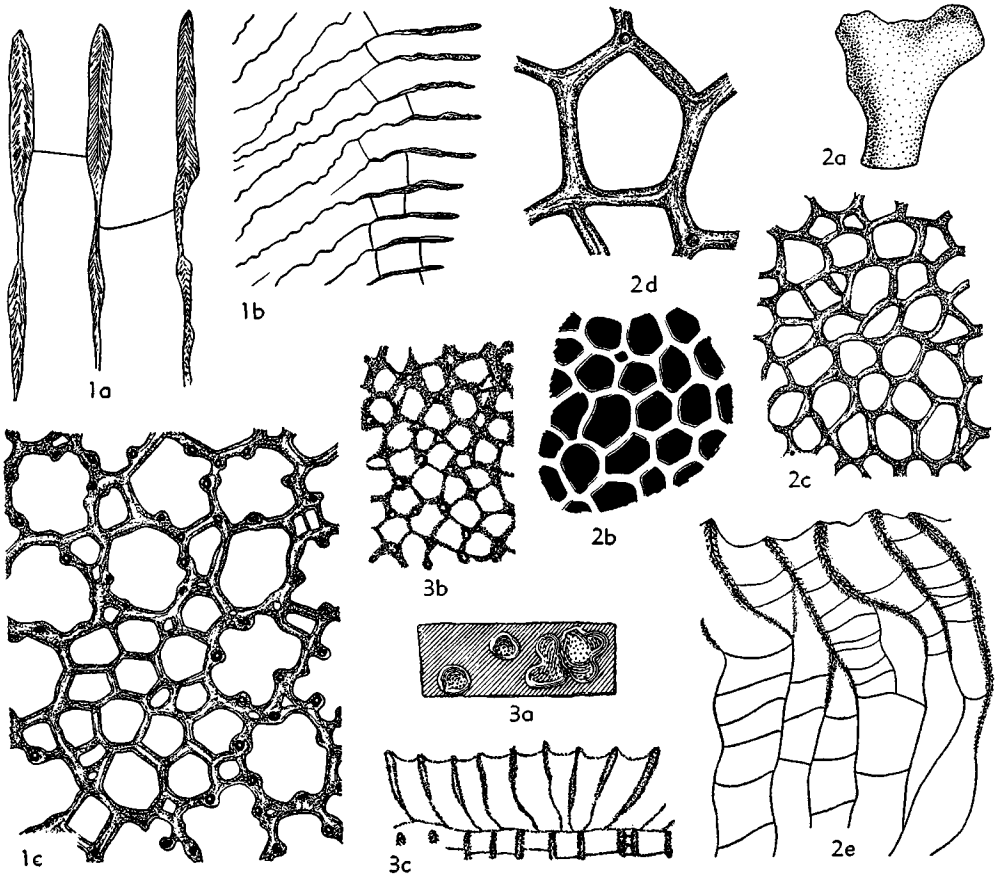


FIG. 61. Heterotrypidae (p. G98, G99).

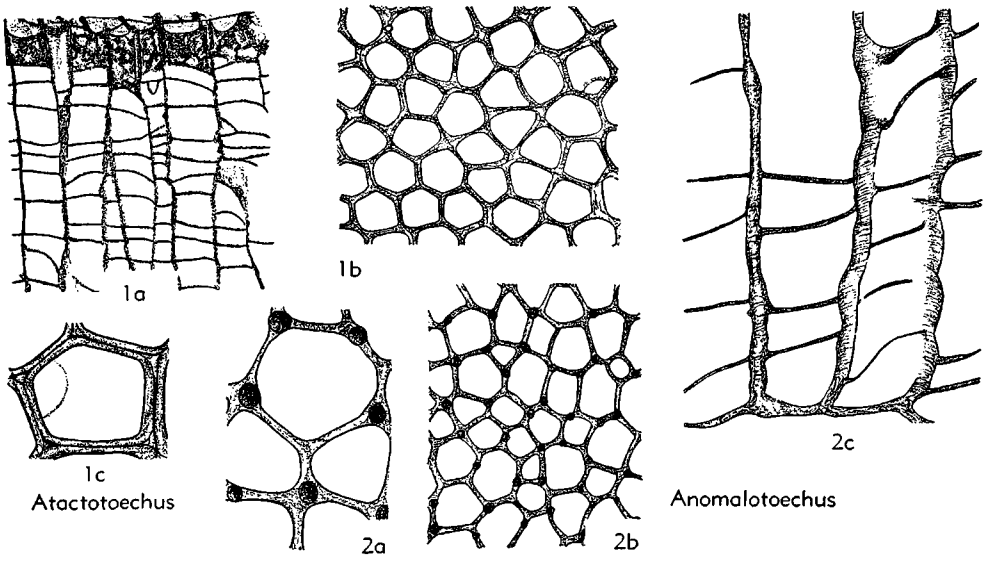


FIG. 62. Atactotoechidae (p. G99).

cial tubes crenulated. Acanthopores in periodically developed mature zones. *Ord.*——FIG. 61,*1*. **S. crenulata; 1a,b,* secs., ×50, ×20; *1c,* tang. sec. showing acanthopores, ×50 (223).

Family ATACTOTOECHIDAE Duncan, 1939

Zoaria ramose to massive. Zooecia angular, with laminated amalgamate walls which are granular only in early mature region; straight diaphragms or gently curved cystiphragms. Mesopores absent; acanthopores of nongranular laminated tissue (54). *Dev.*

Atactotoechus DUNCAN, 1939 [**A. typicus*]. Cystiphragms in mature zone resemble slightly curved diaphragms. Acanthopores few. *Dev.*——FIG. 62,*1*. **A. typicus,* Traverse, Mich.; *1a,* long. sec., ×20; *1b,c,* tang. secs., ×20, ×50 (147).

Anomalotoechus DUNCAN, 1939 [**A. typicus*]. Differs from *Atactotoechus* in having many acanthopores and lacking bands of crowded gently curved diaphragms and zones of thickened walls. *M.Dev.*——FIG. 62,*3*. **A. typicus,* Traverse, Mich.; *3a,b,* tang. secs., ×50, ×20; *3c,* long. sec., ×50 (147).

Family BATOSTOMELLIDAE Miller, 1889

[=Bythoporidae MILLER, 1889]

Zoaria generally slender, ramose. Zooecia with thick walls more or less fused in mature region; diaphragms straight. Mesopores and acanthopores commonly present (3,54, 114; NICKLES-B., 1900). *Ord.-Dev.*

Batostomella ULR., 1882 [**Chaetetes gracilis* NICH., 1874][=*Bythopora* ULR., 1890 (*non* MILLER & DYER, 1878); *Leptotrypellina* VINASSA, 1920]. Slender to thick smooth branches. *Ord.*——FIG. 63,*1*. **B. gracilis* (NICH.), Maysv., Ohio; *1a,b,* secs., ×50, ×20; *1c,* zoarium, ×1; *1d,* surface, ×25 (222).

Batostomellina VINASSA, 1920 [**Trematopora granulifera* HALL, 1852]. Slender solid branches. Zooecia with oval apertures, no diaphragms. Acanthopores so numerous as to obscure mesopores. *Sil.*——FIG. 63,*2*. **B. granulifera* (HALL), Clint., N.Y.; *2a,b,* secs., ×25 (162).

Bythopora MILLER & DYER, 1878 [**B. fruticosa* (=*Helopora dendrina* JAMES, 1878)]. Very slender branching stems. Zooecia with thin mature region, oblique apertures, thick channeled interspaces. *Ord. (Maysv.),* Ohio.

Callotrypa HALL-S., 1887 [**Callopora macropora* HALL, 1874]. Apertures oval, with equally elevated peristomes; internal structure unknown. *L.Dev.*——FIG. 63,*4*. **C. macropora* (HALL), Held., N.Y.; *4a,* zoarium, ×1; *4b,* surface, ×5 (162).

Canutrypa BASSLER, 1952 [**C. francqana*]. Ramose. Zooecia polygonal, thick-walled in mature zone, mostly with large cystiphragms which may be spherical, suggesting ovicells. Mesopores closely tabulate. *Dev.*——FIG. 63,*3*. **C. francqana,* Ferques, Fr.; *3a,b,* secs., ×20 (131).

Eridotrypa ULR., 1893 [**E. mutabilis*][=*Badogliopora, Badoglioporina, Diplotrypella, Eridotrypina* VINASSA, 1920]. Bifurcating branches. Zooecia thick-walled, oblique, with diaphragms. *Ord.*——FIG. 63,*5*. **E. mutabilis,* Blkriv., Minn.; *5a,* zoarium, ×1; *5b,* surface, ×20; *5c,d,* tang. secs., ×50, ×20; *5e,* long. sec., ×20 (222).

Esthoniopora Bassler, 1911 [**E. communis*]. Zoarium hemispherical, with basal epitheca. Zooecia thin-walled, polygonal, with semidiaphragms. Mesopores and acanthopores lacking. *Ord.*——Fig. 64,*1*. **E. communis*, Est.; *1a,b*, zoarium, ×1; *1c,d*, secs., ×20 (131).

Geinitzella Waag.-W., 1886 [**Coralliolites columnaris* Schloth., 1813]. Unrecognizable until types restudied. *Perm.*, Ger.

Orbipora Eichw., 1856 [*pro Orbitulites* Eichw., 1829 (*non* Lamarck, 1801)][**Orbitulites distinctus* Eichw., 1829]. Zoarium massive, hemispherical, with basal epitheca. Zooecia lack diaphragms. Acanthopores large and numerous; mesopores absent. *Ord.*——Fig. 64,*2*. **O. distincta* (Eichw.), Est.; *2a,b*, zoarium, ×1; *2c,d*, secs., ×20., ×5 (131).

Trematella Hall, 1886 [**Trematopora glomerata* Hall, 1883]. Slender branches. Zooecia angular, thick-walled; internal structure little known. *Dev.*——Fig. 64,*3*. **T glomerata* (Hall), Onond.

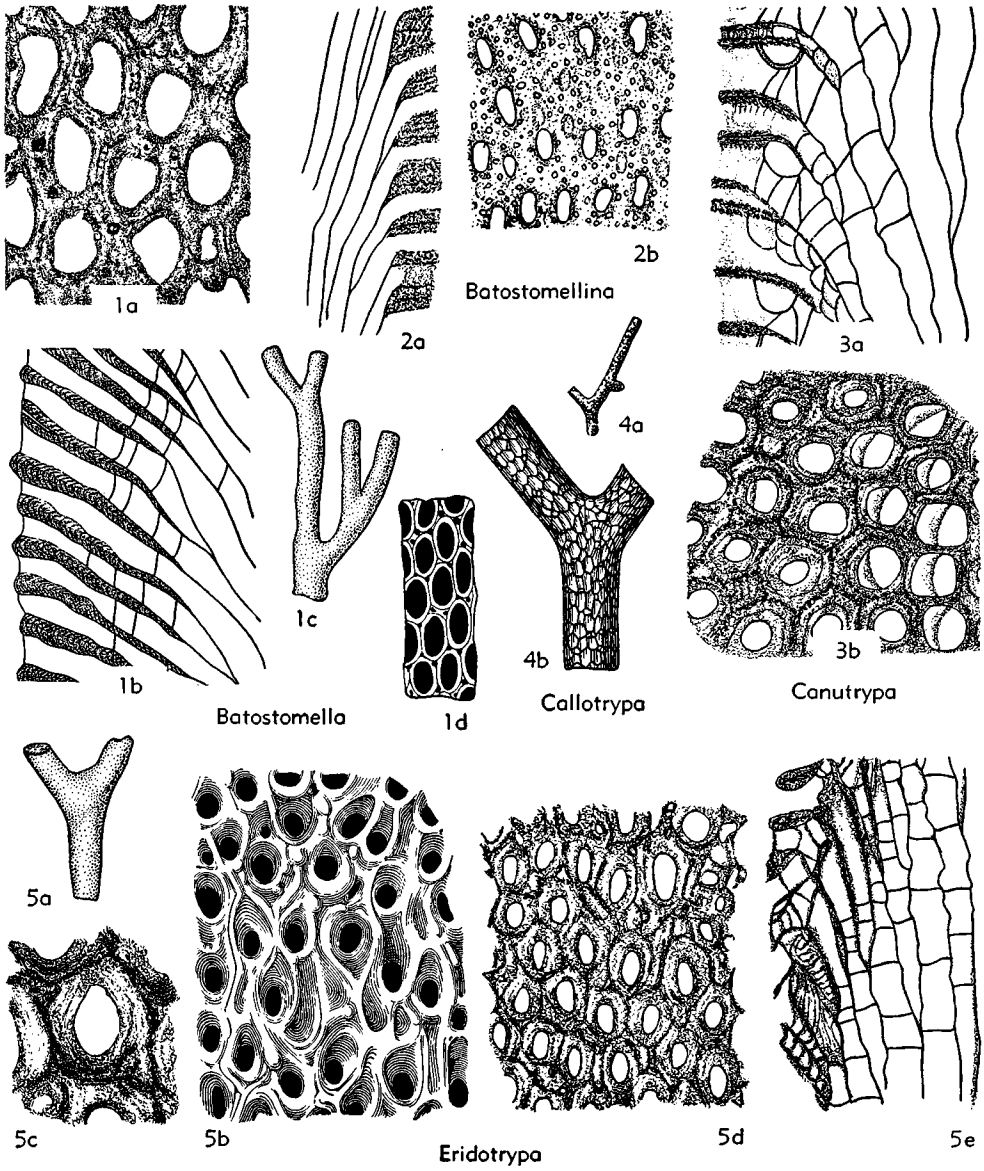


Fig. 63. Batostomellidae (p. G99).

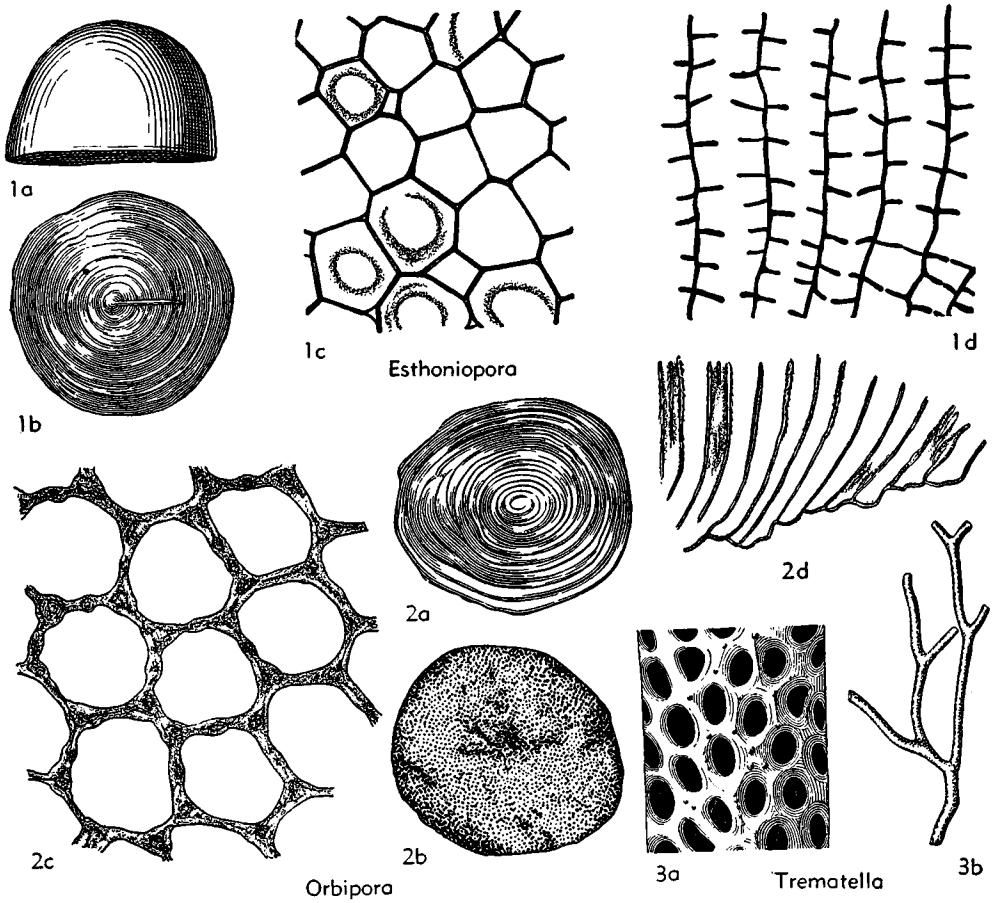


FIG. 64. Batostomellidae (p. G100).

Falls, Ohio; *3a,* surface, ×20; *3b,* zoarium, ×1 (162).

Family STENOPORIDAE Waagen & Wentzel, 1886

[as Stenoporinae]

Zoarium incrusting, ramose frondescent, massive, or bifoliate. Zooecia angular, with laminate amalgamate walls thickened intermittently in simple forms but distinctly beaded (moniliform) in typical genera; diaphragms generally present, complete in primitive forms but in others centrally perforated, or extending part way across tubes (hemiphragms, heterophragms), or lacking entirely. Acanthopores mostly well developed, including large (megacanthopores) and small (micracanthopores); mesopores may occur (8,54). ***Sil.-Perm.***

Stenopora LONSD., 1844 [**S. tasmaniensis*][=*Tubuliclidea* LONSD., 1844 (obj.); *Ulrichotrypa* BASSLER, 1929]. Ramose or massive. Zooecia thick-walled, with well-developed monilae; without diaphragms. A megacanthopore on distal side of each zooecial tube and many micracanthopores between tubes, mostly at zooecial angles; mesopores lacking (8). *Miss.-Perm.*——FIG. 65,*1*. **S. tasmaniensis,* Perm., Tasm.; *1a,b,* secs., ×20 (142).

Amphiporella GIRTY, 1911 [**A. maculosa*]. Broad flat fronds. Like *Tabulipora* but mesopores more numerous (8). *Miss.*——FIG. 65,*4*. **A. maculosa,* Chest., Ark.; *4a,b,* secs., ×20 (131).

Anisotrypa ULR., 1883 [**A. symmetrica*]. Hollow or solid branches. Zooecial walls with indistinct monilae. Acanthopores and mesopores absent. *Miss.*——FIG. 65,*2*. **A. symmetrica,* Chest., Ky.; *2a,b,* zoarium, ×1; *2c,d,* secs., ×20; *2e,* surface, ×20 (131).

Calacanthopora DUNCAN, 1939 [**C. prima*]. Incrusting. Zooecial walls completely amalgamate;

without diaphragms. Megacanthopores abundant; mesopores absent. *M.Dev.*——Fig. 65,*3*. **C. prima*, Traverse, Mich.; *3a,b*, secs., ×25, ×50 (147).

Callocladia Girty, 1911 [**C. elegans*]. Hollow branches as in *Anisotrypa* but mesopores, acanthopores, and perforate diaphragms present (8). *Miss.*——Fig. 65,*5*. **C. elegans*, Chest., Ark.; *5a,b*, secs., ×20 (131).

Chondraulus Duncan, 1939 [**C. granosus*]. Massive. Zooecia with wall structure obscured by granules and minute tubules; thin complete diaphragms. Mesopores and acanthopores absent. *M.Dev.*——Fig. 66,*2*. **C. granosus*, Traverse, Mich.; *2a,b*, tang. secs., ×50, ×20; *2c*, long. sec., ×20 (147).

Coeloclemis Girty, 1911 [**C. tumida*]. Hollow epithecate stems. Like *Anisotrypa* but lacks diaphragms and has acanthopores (8). *Miss.*——Fig. 66,*1*. **C. tumida*, Chest., Ark.; *1a*, tang. sec., ×20; *1b,c*, long. secs., ×20, ×5 (131).

Diplostenopora Ulr.-B., 1912 [**Escharopora siluriana* Weller, 1903]. Bifoliate. Zooecia with walls not beaded; diaphragms centrally perforate. Acanthopores few. *Dev.*——Fig. 66,*3*. **D. siluriana* (Weller), Held., N.J.; *3a,b*, secs., ×25, ×20 (223).

Dyoidophragma Duncan, 1939 [**D. typicalis*]. Incrusting layers. Zooecia thick-walled, with thin complete diaphragms and irregular thick hemiphragms. Megacanthopores prominent. *M.Dev.*——Fig. 67,*4*. **D. typicalis*, Traverse, Mich.; *4a,b*, tang. secs., ×20, ×50; *4c,d*, long. secs., ×50, ×20 (147).

Dyscritella Girty, 1911 [**D. robusta*]. Like ramose *Leioclema* but zooecia thick-walled, lacking diaphragms (8). *Miss.*——Fig. 66,*4*. **D. robusta*, Chest., Ark.; *4a-c*, secs., ×20, ×25, ×20 (131).

Eostenopora Duncan, 1939 [**E. picta*]. Laminar. Zooecial walls intermittently thickened. Micracanthopores crowded, granular; mesopores absent. *M. Dev.*——Fig. 67,*2*. **E. picta*, Traverse, Mich.; *2a-c*, secs., ×50, ×20, ×50 (147).

Koninckopora Lee, 1912 [**Calamopora inflata* De-

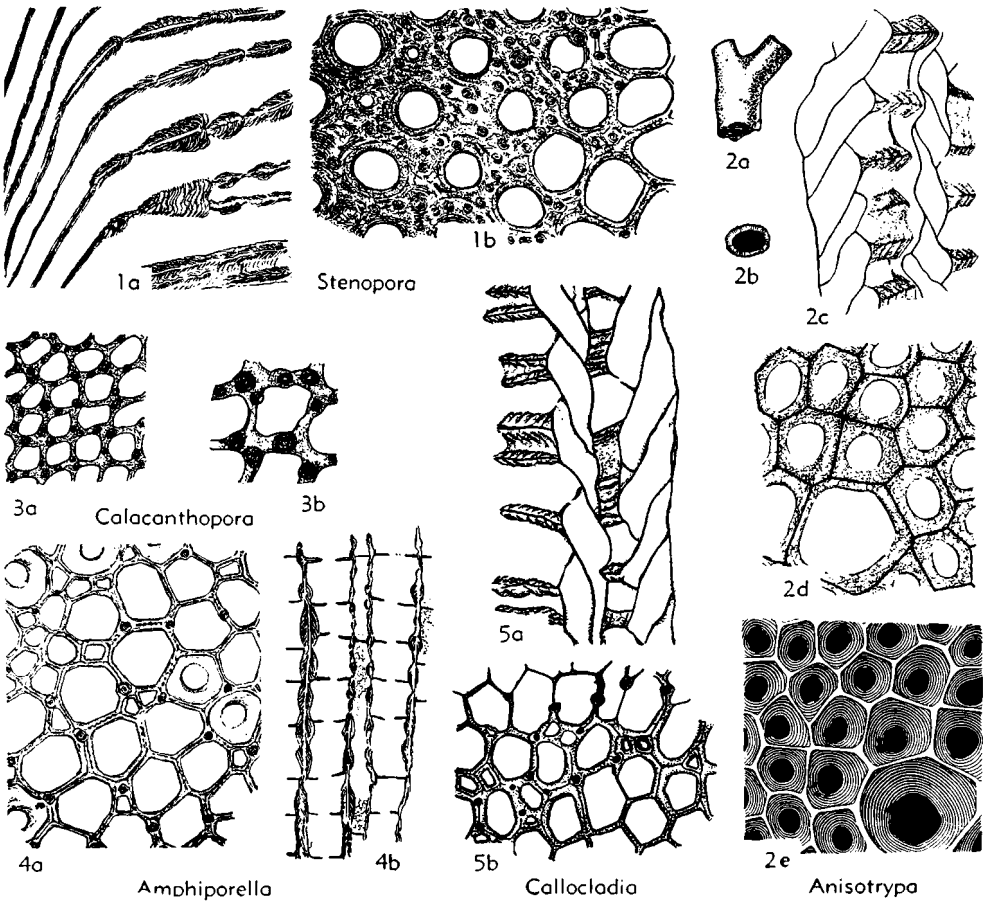


Fig. 65. Stenoporidae (p. G101, G102).

KON., 1842]. ?Green alga (WOOD, 1943). *Carb.*, Belg.

Leeporina VINASSA, 1920 [**Discrytella nana* LEE, 1912]. Slender solid stems. Zooecia with centrally perforate diaphragms but confined to immature region. Mesopores lack tubulae. *Carb.*——FIG. 66,*5*. **L. nana* (LEE), Eng.; *5a,b*, secs., ×20 (176).

Leioclema ULR., 1882 [**Callopora punctata* HALL, 1858] [=*Thallostigma* HALL, 1883; *Lioclema* VINASSA, 1920]. Incrusting, ramose, or massive. Zooecia without beaded walls; apertures petaloid; diaphragms complete. Mesopores tabulate; megacanthopores common. *Ord.-Perm.*——FIG. 67,*3*. **L. punctata* (HALL), Miss.(Warsaw), Iowa; *3a,b*, secs., ×20, ×50 (223).

Lioclemella FOERSTE, 1895 [**Callopora ohioensis* FOERSTE, 1887]. Like *Leioclema* but zoarium cylindrical, pointed at base for attachment. *Ord.-Sil.*——FIG. 67,*1*. **L. ohioensis* (FOERSTE), Sil.(Medin.), Ohio; *1a,b*, secs., ×20, ×25; *1c*, zoarium, ×1 (223).

Lioporidra BASSLER, 1952 [*pro Liopora* GIRTY, 1915 (*non* NICH.-E., 1878)] [**Liopora subnodosa* GIRTY, 1915]. Thin lamellate. Zooecia without diaphragms but bearing spinelike projections from walls. Mesopores numerous. *M.Penn.*——FIG. 68,*1*. **L. subnodosa* (GIRTY), Desmoin., Mo.; *1a,b*, secs., ×20 (156).

Microcampylus DUNCAN, 1939 [**M. typicus*]. Like *Stenoporella* but mesopores numerous, acanthopores large, granules in zooecial walls. *M.Dev.*——FIG. 68,*3*. **M. typicus*, Traverse, Mich.; *3a,b*, long. secs., ×20, ×50; *3c,d*, tang. secs., ×20, ×50 (147).

Pycnopora GIRTY, 1911 [**P. regularis*]. Thin lamellar expansions. Like *Leioclema* but zooecia have undulating walls and semidiaphragms; mesopores lack tubulae (8). *Miss.*——FIG. 68,2. **P. regularis*, Chest., Ark.; *2a,b*, secs., ×20 (131).

Rhombotrypella NIKIF., 1933 [**R. astragaloides*]. Solid cylindrical branches. Zooecia thick-walled in mature zone, with monilae, thin-walled and with

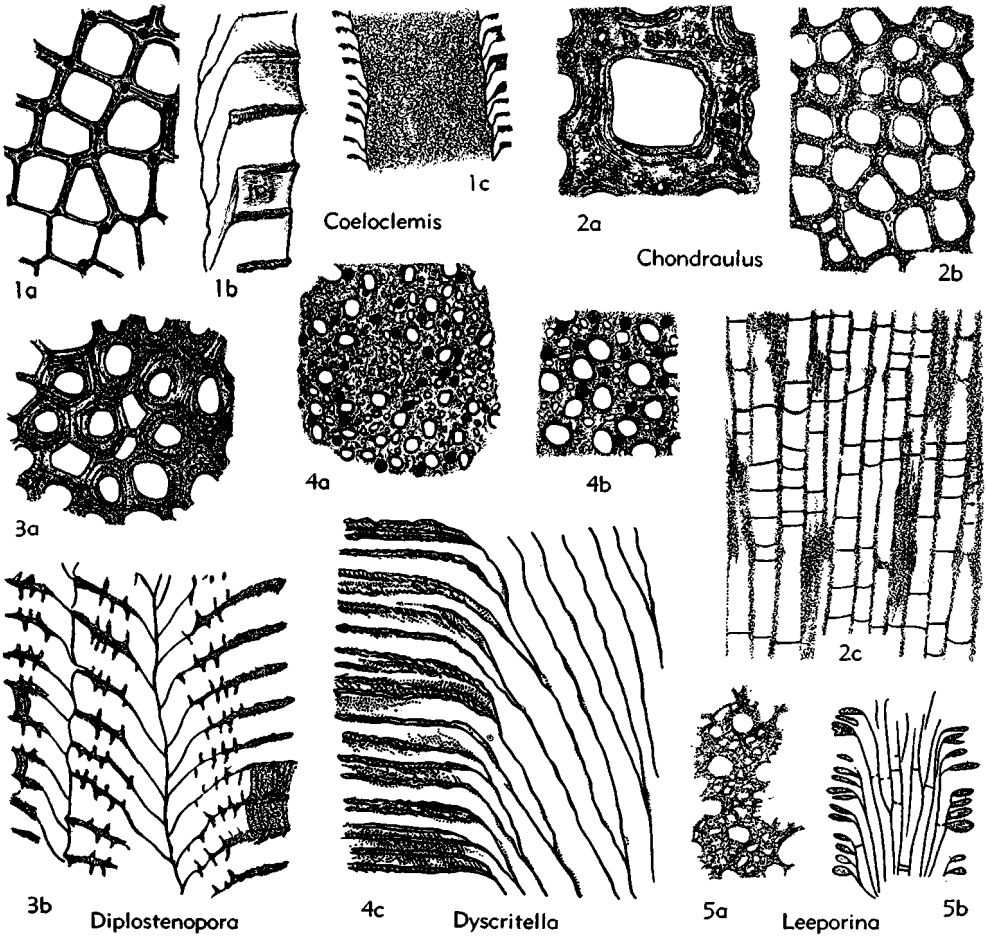


FIG. 66. Stenoporidae (p. G102, G103).

quadrate cross section in axial region. Megacanthopores and micracanthopores present. *Carb.*——Fig. 69,*3*. **R. astragaloides*, M.Carb., Russ.; *3a-c*, secs. long., transv., tang., ×20 (198).

Stenocladia Girty, 1911 [**S. frondosa*]. Like *Leioclema* but bifoliate, zooecia and mesopores without tabulae (8). *Miss.*——Fig. 69,*1*. **S. frondosa*, Chest., Ark.; *1a,b*, secs., ×20 (131).

Stenodiscus Crockford, 1945 [**S. moniliformis*]. Like *Tabulipora* but has thin nonperforate diaphragms. *Perm.*——Fig. 68,*4*. **S. moniliformis*, Tasm.; *4a,b*, secs., ×10 (142).

Stenophragmidium Bassler, 1952 [*pro Stenophragma* Munro, 1912 (*non* Skuse, 1890)] [**Stenophragma lobatum* Munro, 1912]. Like *Stenopora* but has hemiphragms projecting from one side of zooecial walls only. *Carb.*——Fig. 69,*4*. **S. lobatum* (Munro), Eng.; *4a,b*, secs., ×20 (131).

Stenoporella Bassler, 1936 [**S. romingeri*]. Like *Tabulipora* but beaded structure of zooecial walls

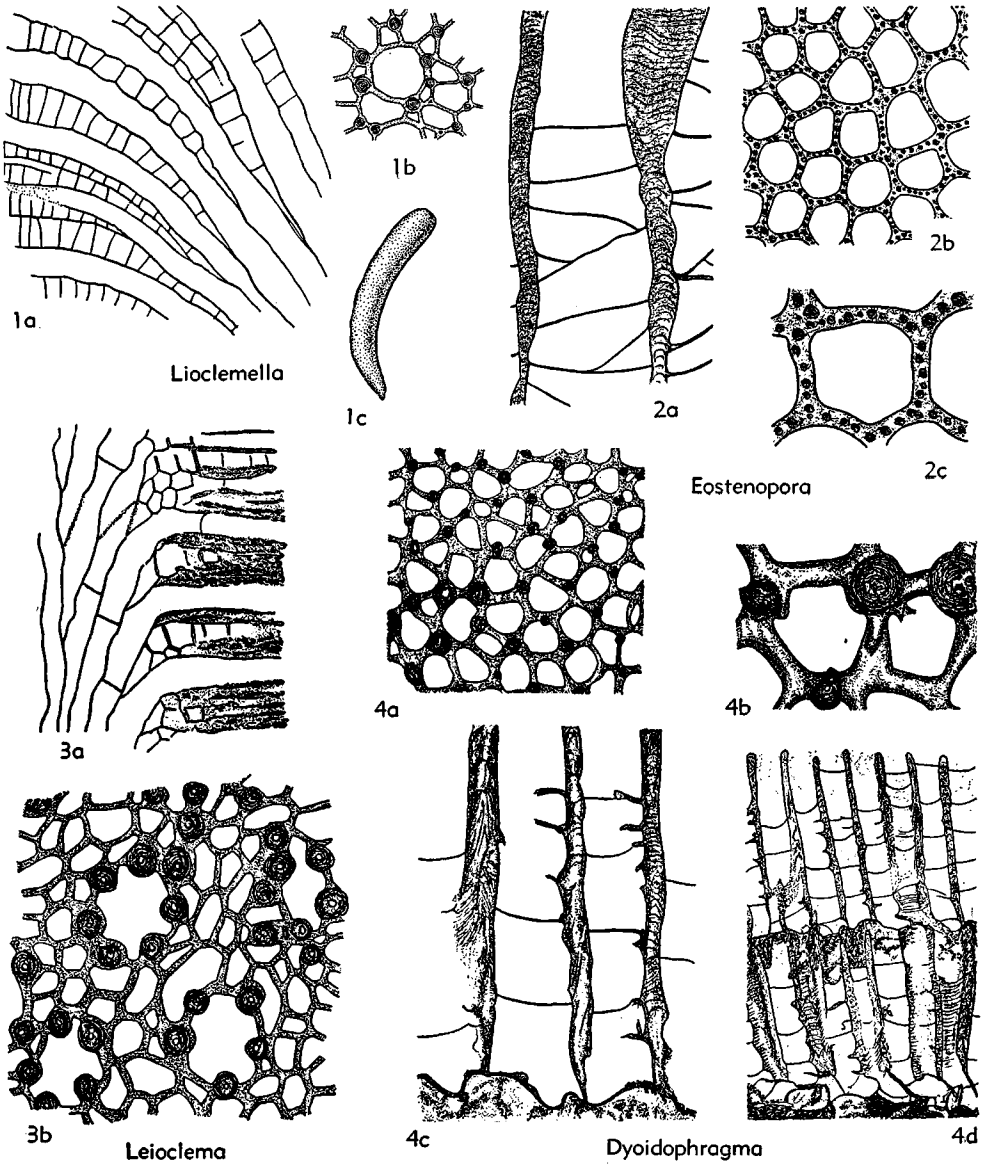


Fig. 67. Stenoporidae (p. G102, G103).

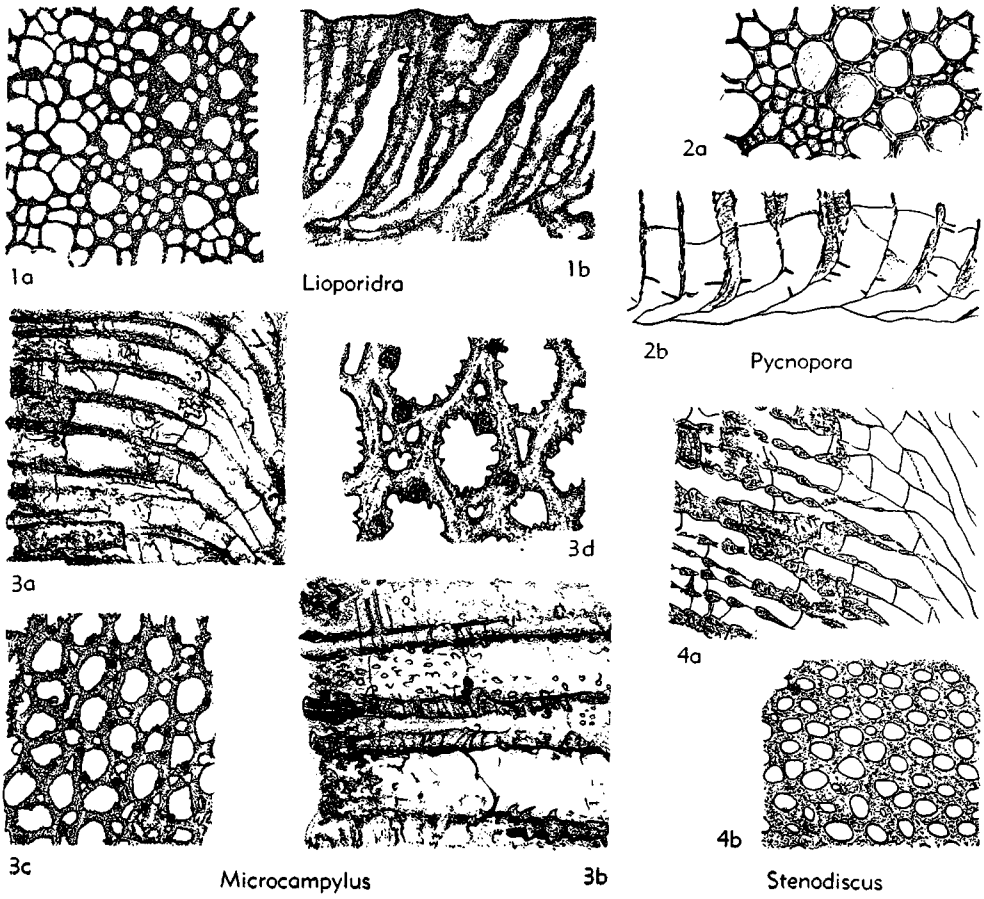


FIG. 68. Stenoporidae (p. G103, G104).

nearly obsolete and hemiphragms occur as blunt spines. *Miss.*——FIG. 69,*2*. **S. romingeri*, Chest., Ark.; *2a,b*, tang. secs., ×25, ×20; *2c*, long. sec., ×20 (131).

Stereotoechus DUNCAN, 1939 [**S. typicus*]. Laminar. Zooecia with slightly beaded walls and complete diaphragms. Acanthopores distinct; mesopores absent. *M.Dev.*——FIG. 70,*4*. **S. typicus*, Traverse, Mich.; *4a,b*, tang. secs., ×20, ×50; *4c*, long. sec., ×20 (147).

Tabulipora YOUNG, 1883 [**T. scotica* LEE, 1912 (=*Stenopora urei* YOUNG, *partim*)]. Like *Stenopora* but has centrally perforate diaphragms. *Carb.*——FIG. 70,*1*. **T. scotica* LEE, SCOT.; *1a,b*, secs., ×20 (176).

Tabuliporella NIKIF., 1933 [**T. nalivkini*]. Ramose. Zooecia thick-walled, with eccentrically perforate diaphragms. Mesopores nontabulate; acanthopores absent. *Carb.*——FIG. 70,*2*. **T. nalivkini*, L.Carb., Turkestan; *2a,b*, secs., ×20 (198).

Trachytoechus DUNCAN, 1939 [**T. typicus*]. Massive. Zooecia with laminate wall tissue, few nearly straight diaphragms, and curved heterophragms which appear fringed on proximal side. Mesopores and acanthopores absent. *M.Dev.*——FIG. 70,*3*. **T. typicus*, Traverse, Mich.; *3a-c*, tang. secs., ×20, ×50, ×50; *3d,e*, long. secs. showing heterophragms, ×20, ×50 (147).

Family CONSTELLARIIDAE Ulrich, 1890

Zoarium incrusting, laminar, frondescent, to massive. Stellate clusters of mesopores closed at the surface and abundant hollow spines or granules that replace true acanthopores generally isolate the zooecia; straight complete diaphragms in zooecia and mesopores (3,112,114; NICKLES-B., 1900). *Ord.-Sil.*

Constellaria DANA, 1846 [**Ceriopora constellata* VAN CLEVE, in DANA, 1846]. Erect fronds with

surface marked by depressed stellate clusters of mesopores. *Ord.*——Fig. 71,*1*. **C. constellata* (Van Cleve), Maysv., Ohio; *1b*, zoarium, ×1; *1a,c,d*, tang. secs., *(a)* cluster, ×20, *(c)* normal zooecia, ×50, *(d)*, immature region, ×20; *1e*, long. sec., ×20 (222).

Dianulites Eichw., 1829 [**D. fastigiatus*] [=*Hexaporites* Pander, 1830]. Zoarium massive, erect. Zooecia angular, thin-walled; mesopores large; both with minute granular structure and few diaphragms. *Ord.*——Fig. 71,*3*. **D. fastigiatus*, M.Ord., Est.; *3a,b*, zoarium, top and side, ×1; *3c*, long. sec. with wide-spaced diaphragms in mesopores, ×10; *3d,e*, tang. secs., ×20, ×50 (131).

Hennigopora Bassler, 1952 [**Callopora florida* Hall, 1852]. Like *Nicholsonella* but with numerous acanthopores indenting zooecia and interspaces with polygonal vesicles. *Sil.*——Fig. 71,*2*. **H. florida* (Hall), Clint., N.Y.; *2a,b*, secs., ×20; *2c,d*, zoarium, ×1, ×5 (131).

Idiotrypa Ulr., 1883 [**I. parasitica*]. Incrusting to lamellate. Zooecia and mesopores with closely spaced minutely perforate diaphragms; walls traversed by tubuli. *Sil.*——Fig. 71,*4*. **I. parasitica*, Clint., N.Y.; *4a,b*, secs., ×20; *4c*, surface, ×20 (222).

Nicholsonella Ulr., 1889 [**N. ponderosa* Ulr., 1890]. Ramose to frondescent. Zooecia separated by tabulate mesopores filled by calcareous deposits. *Ord.*——Fig. 72,*4*. **N. ponderosa* Ulr., Blkriv., Ill.; *4a,b*, secs., ×20; *4c*, surface, ×20 (222).——

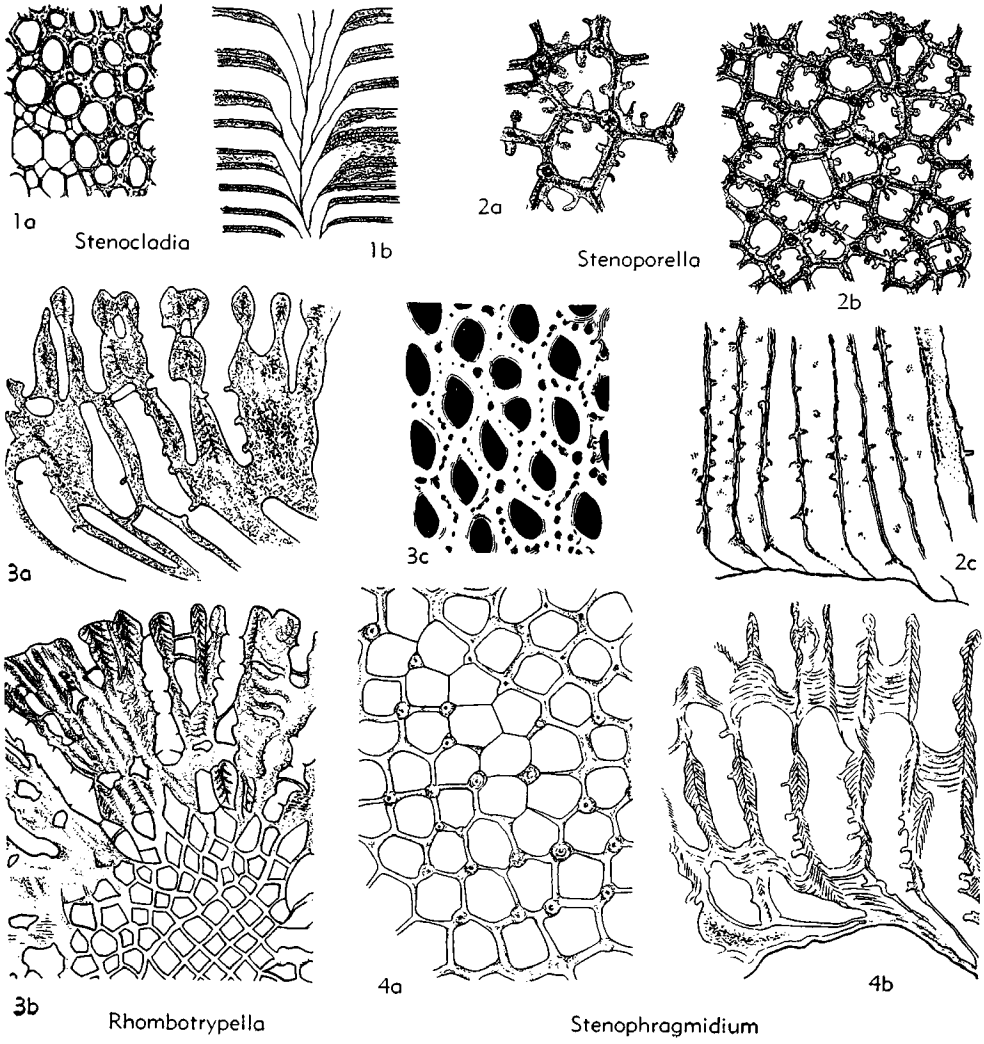


Fig. 69. Stenoporidae (p. G103, G104).

FIG. 72,*5*. *N. pulchra* ULR., Blkriv., Tenn.; *5a*, zoarium, ×1; *5b*, long. sec., ×20; *5c*, surface, ×10 (222).

Revalotrypa BASSLER, 1952 [**Nicholsonella gibbosa* BASSLER, 1911]. Like *Nicholsonella* but diaphragms nearly absent in zooecia and mesopores. Granular wall structure as in *Dianulites*. *Ord.*——FIG. 72,*1*. **R. gibbosa* (BASSLER), Est.; *1a*, long. sec., ×10; *1b,c*, tang. secs., ×20, ×50; *1d,e*, zoarium from side and base, ×1 (131).

Stellipora HALL, 1847 [*non* HAG., 1951] [**S. antheloidea*] [=*Revalopora* VINASSA, 1920]. Like *Constellaria* but has lamellate incrusting growth and mesopores are restricted to monticules. *Ord.*——FIG. 72,*2*. **S. antheloidea*, Trenton., N.Y.; *2a*, zoarium, ×1; *2b,c*, secs., ×20; *2d*, surface, ×5 (131).——FIG. 72,*3*. *S. apsendesoides* BASSLER, Est.; a single star, ×5 (131).

Suborder INTEGRATA Ulrich & Bassler, 1904

Walls of adjacent zooecial tubes not coalesced but separated by a dark divisional

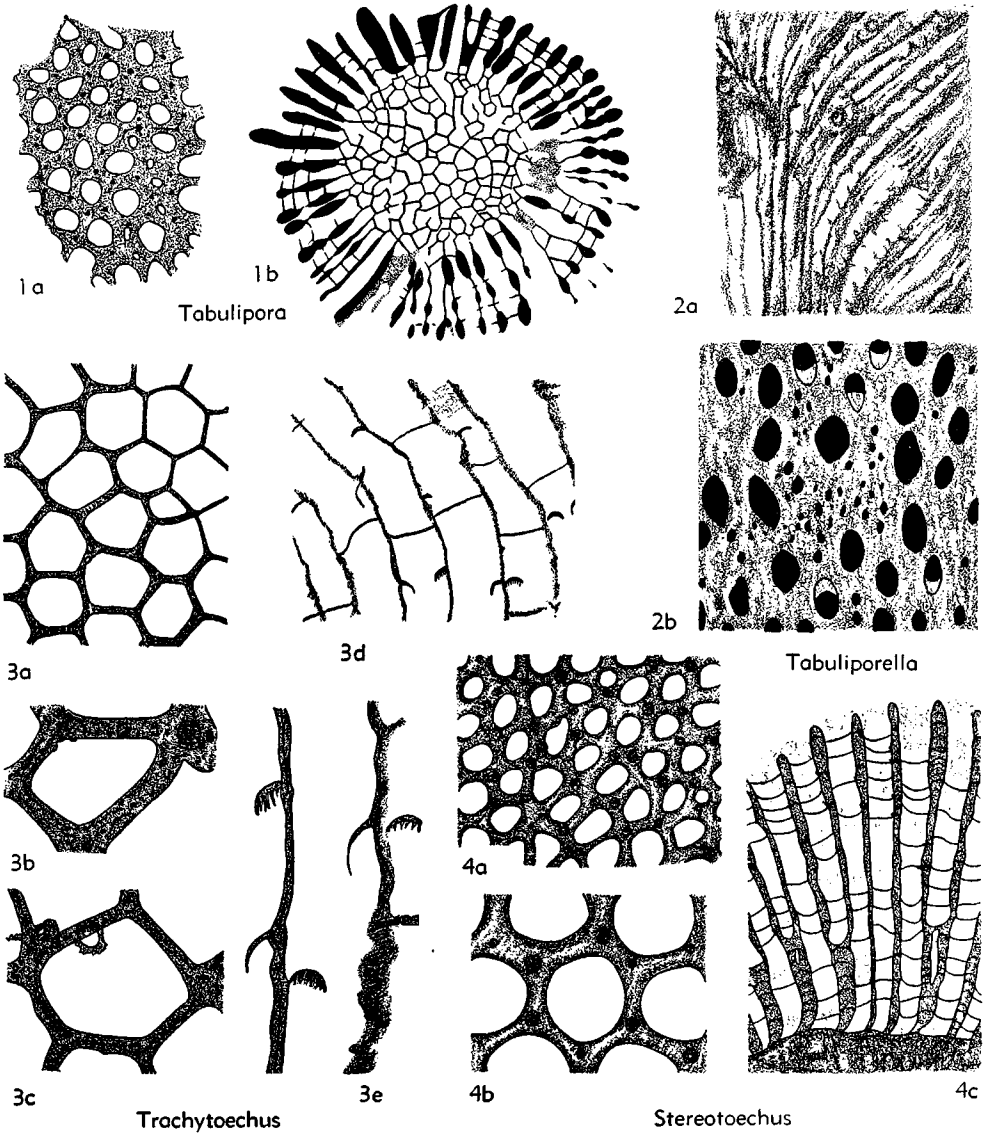


FIG. 70. Stenoporidae (p. G105).

line or by light-colored tissue, with individual wall boundaries distinctly visible. *Ord.-Perm., ?Trias.*

Family AMPLEXOPORIDAE Miller, 1889

Zoarium ramose to bifoliate. Zooecia comparatively simple prismatic tubes. Acanthopores commonly abundant; mesopores absent (112,114; NICKLES-B., 1900). *Ord.-Dev.*

Amplexopora ULR., 1882 [**A. cingulata*]. Ramose. Zooecia with complete diaphragms. Acanthopores numerous. *Ord.*——FIG. 73,*1*. **A. cingulata*, Maysv., Ky.; *1a*, long. sec., ×20; *1b*, surface ×20; *1c,d*, tang. secs., ×20, ×50 (222).

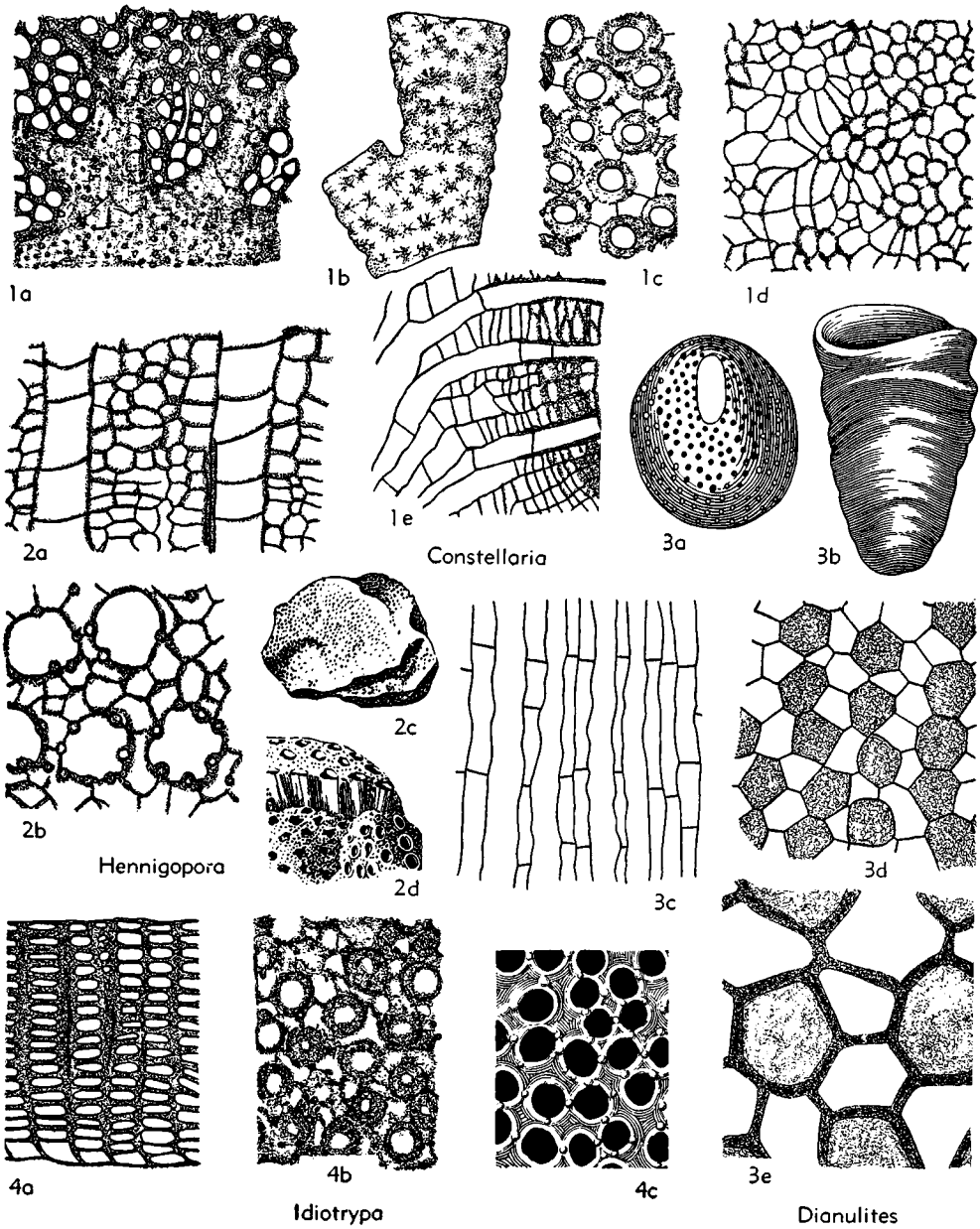


FIG. 71. Constellariidae (p. G105, G106).

Discotrypa ULR., 1882 [**Chaetetes elegans* ULR., 1879]. Free or incrusting expansions. Zooecia thin-walled, apertures rhomboidal. Acanthopores lacking. *Ord.-Dev.*——FIG. 73,*4*. **D. elegans* (ULR.), Ord.(Maysv.), Ohio; *4a*, long. sec.; *4b*, surface; *4c*, tang. sec.; all ×20 (222).

Monotrypella ULR., 1882 [**M. aequalis*]. Lacks acanthopores. *Ord.*——FIG. 73,*3*. **M. aequalis*, Edén., Ky.; *3a*, surface, ×20; *3b,c*, secs., ×20 (222).

Petalotrypa ULR., 1889 [**P. compressa* ULR., 1890]. Leaflike, bifoliate. Zooecia with polygonal apertures separated by some mesopore-like interspaces (not true mesopores). Acanthopores small. *Sil.-Carb.*——FIG. 73,*2*. **P. compressa* ULR., M.Dev., Iowa; *2a,b*, secs., ×20; *2c*, zoarium, ×1 (222).

Rhombotrypa ULR.-B., 1904 [**Chaetetes quadratus* ROM., 1866] [=*Acanthotrypina* VINASSA, 1920]. Zooecia of axial region quadrate in section. *Ord.-Dev.*——FIG. 73,*5*. **R. quadratus* (ROM.),

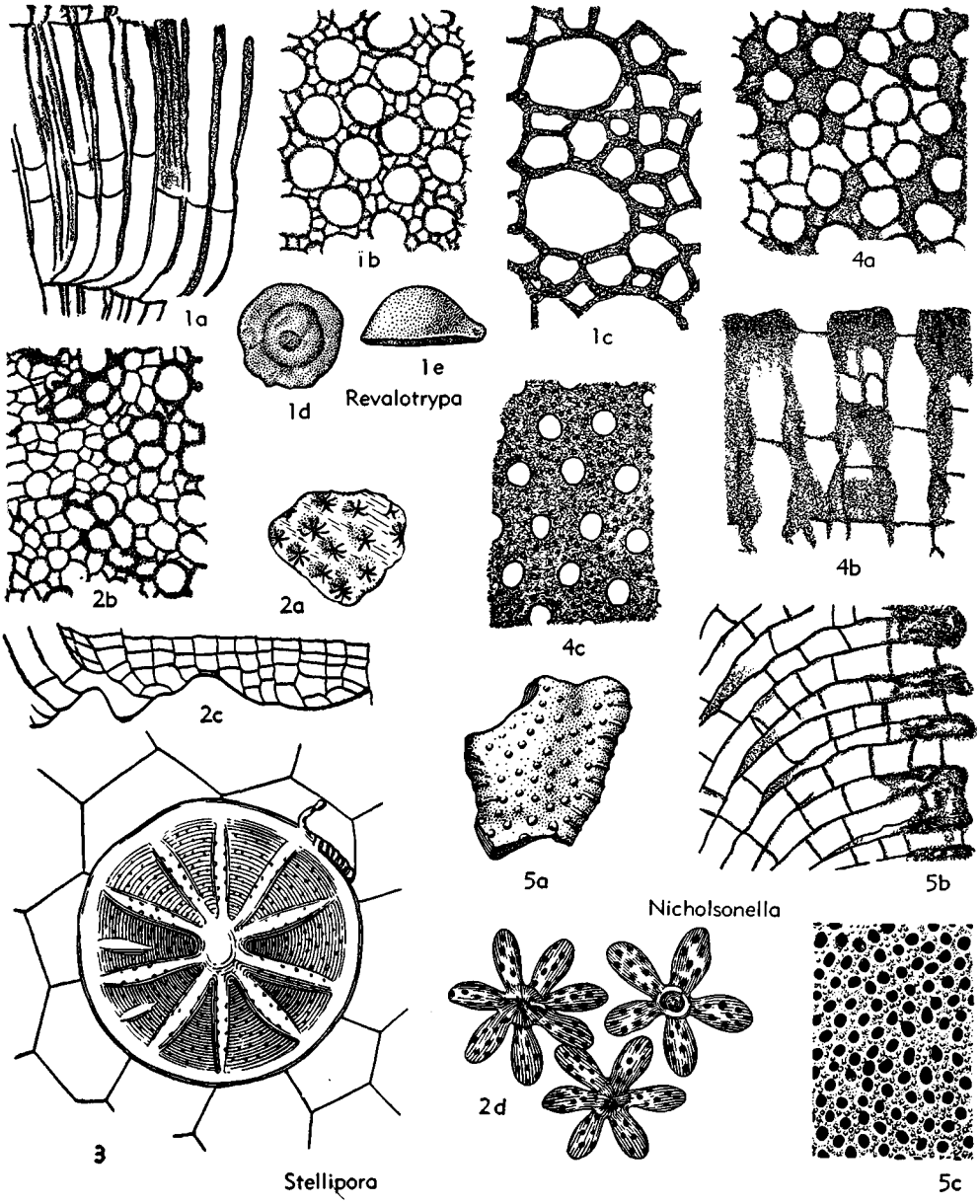


FIG. 72. Constellariidae (p. G106, G107).

Ord.(Richmond.), Ohio; *5a*, transv. sec., ×5; *5b,c*, tang. secs., ×20, ×50; *5d*, long. sec., ×20; *5e*, zoarium, ×1 (*5a,c,d*, 197; *5b,e*, 131).

Family HALLOPORIDAE Bassler, 1911

[=emend. Calloporidae Ulr., 1890]

Generally ramose. Zooecial tubes subcir-

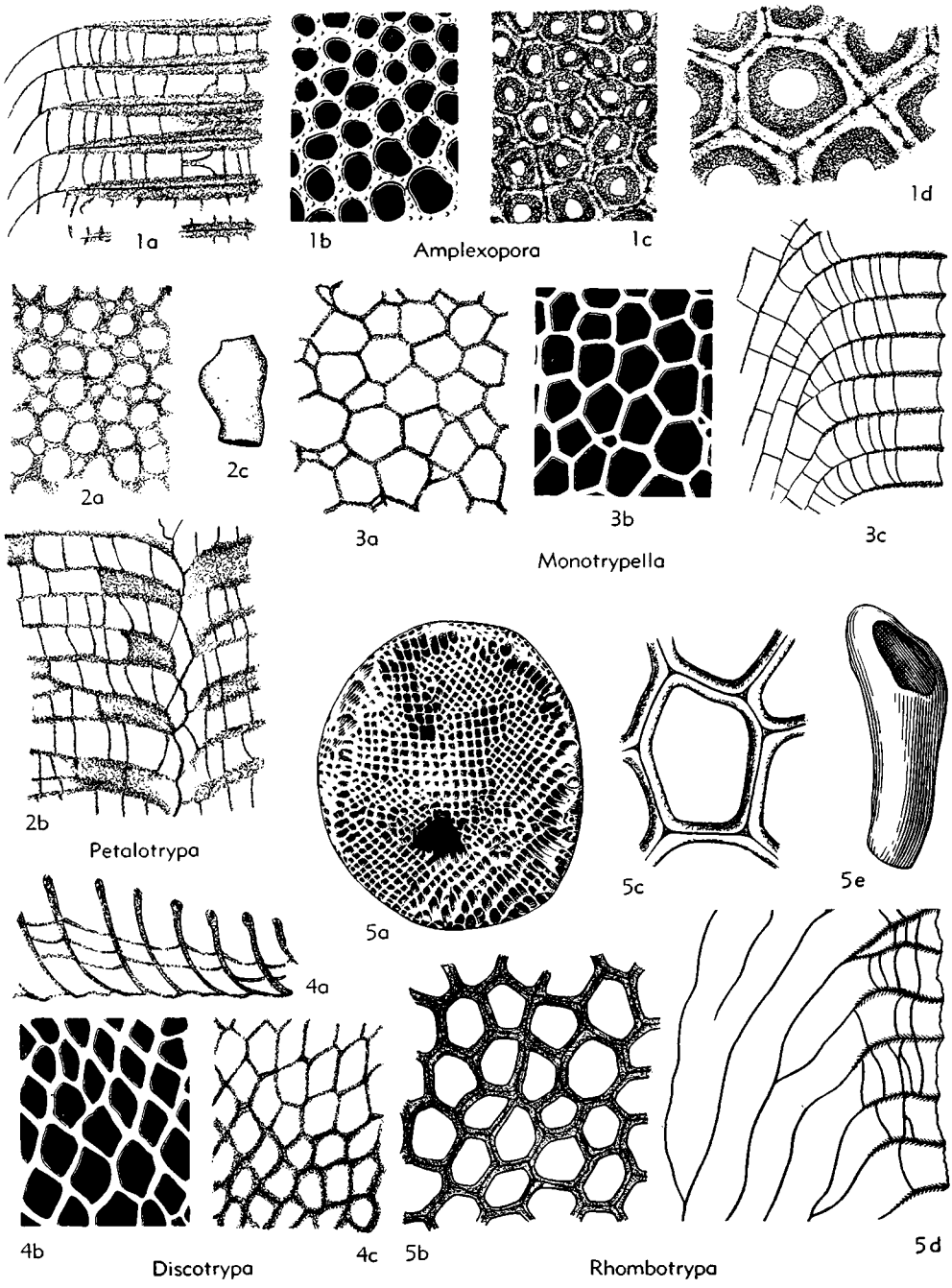


Fig. 73. Amplexoporidae (p. G108-G110).

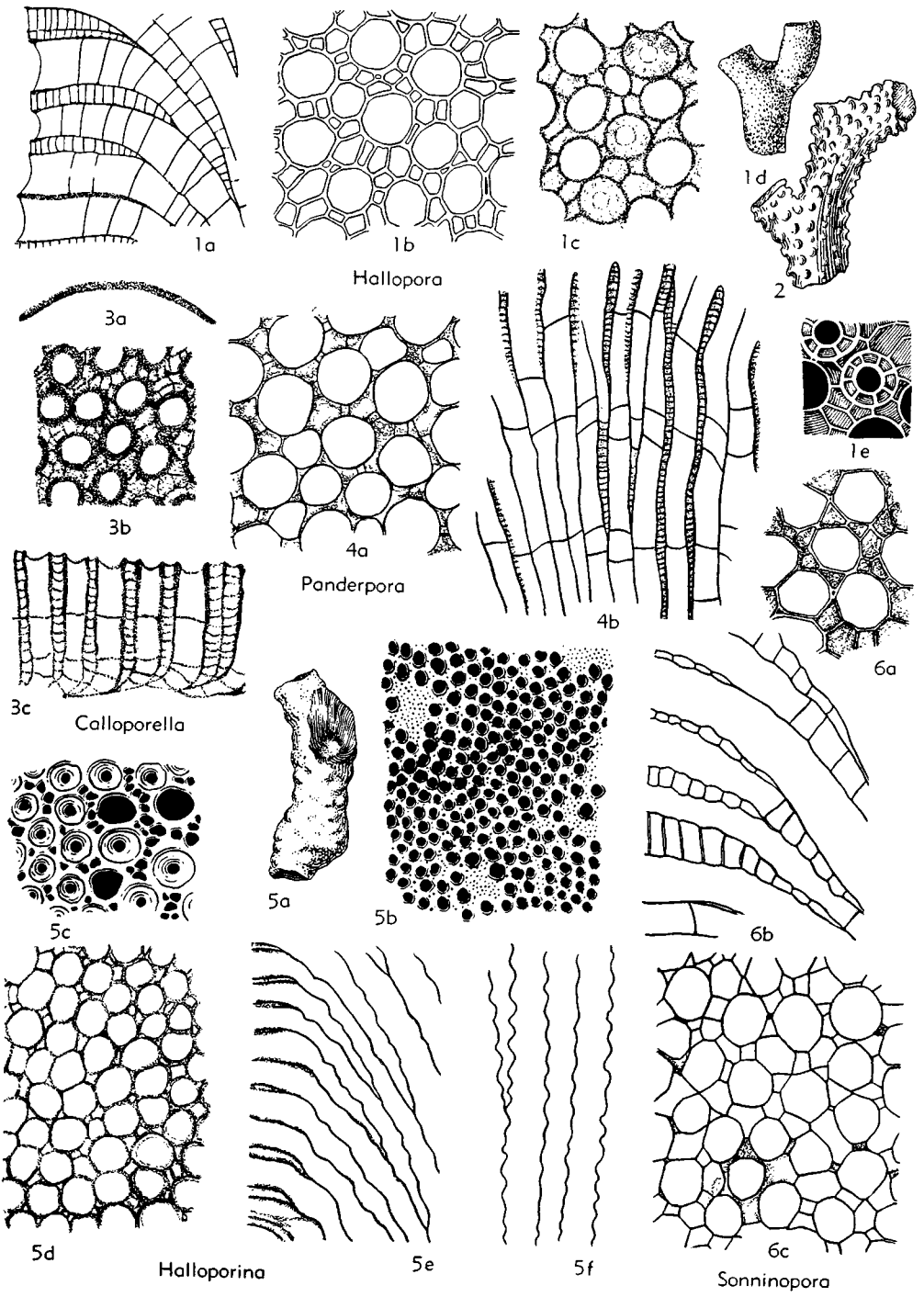


FIG. 74. Halloporidae (p. G112, G113).

cular, generally with diaphragms, which may be more numerous and closely spaced in the immature region than the mature. Mesopores common, closely tabulate; acanthopores virtually lacking (3,114,115; NICKLES-B., 1900). *Ord.-Dev.*

Hallopora BASSLER, 1911 [*pro Callopora* HALL, 1851 (*non* GRAY, 1848)] [**Callopora elegantula* HALL, 1852]. Ramose; intertwined branches may form clumps 30 cm. wide. Zooecial apertures commonly closed by ornamented perforate covers which become diaphragms when left behind during growth. *Ord.-Dev.*——FIG. 74,*1*. **H. elegantula* (HALL), Sil.(Clint.), N.Y.; *1a-c,* secs., ×20; *1d,* fragment, ×1; *1e,* surface, ×25 (*1a,c,* 222; *1b,d,e,* 131).——FIG. 74,*2*. *H. ramosa* D'ORB., Ord.(Maysv.), Ohio; zoarium with monticules, ×1 (222).

Calloporella ULR., 1882 [**C. harrisi* ULR., 1883 (=*Monticulipora (Heterotrypa) circularis* JAMES, 1862)] [=*Halloporella* VINASSA, 1920 (obj.)]. Zoarium thin, discoid, convex. Mesopores angular, closely tabulate. *Ord.*——FIG. 74,*3*. **C. circularis* (JAMES), Richmond., Ohio; *3a,* edge view of zoarium, ×1; *3b,c,* secs., ×25, ×20 (222).

Halloporina BASSLER, 1913 [*pro Calloporina* ULR.-B., 1904 (*non* NEVIANI, 1895)] [**Callopora crenulata* ULR., 1893]. Like *Hallopora* but zooecia have strongly crenulate walls and lack diaphragms. *Ord.*——FIG. 74,*5*. **H. crenulata* (ULR.), Blkriv., Minn.; *5a,* zoarium, ×1; *5b,* surface with maculae, ×10; *5c,* surface showing perforate zooecial covers (diaphragms), ×20; *5d-f,* secs., ×20 (222).

Panderpora BASSLER, 1952 [**Hallopora dybowskii* BASSLER, 1911]. Hemispherical. Zooecia with wide-spaced curved diaphragms. Mesopores narrow, closely tabulate. *Ord.*——FIG. 74,*4*. **P. dybowskii* (BASSLER), Est.; *4a,b,* secs., ×20, ×10 (131).

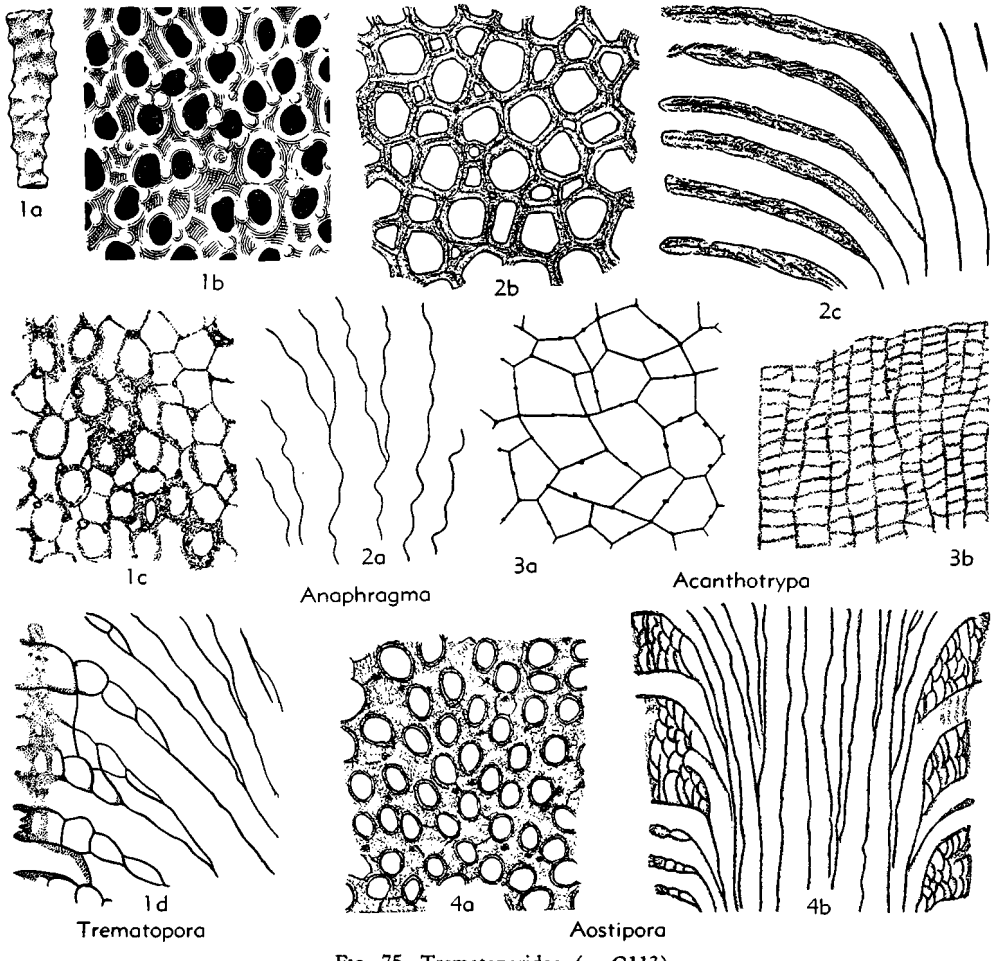


FIG. 75. Trematoporidae (p. G113).

Sonninopora VINASSA, 1920 [**Hallopora tenuispinosa* BASSLER, 1911]. Like *Hallopora* but peripheral mature region has minute acanthopores. *M.Ord.*——FIG. 74,*6*. **S. tenuispinosa* (BASSLER), Est.; *6a-c*, secs., ×25, ×20, ×20 (131).

Family TREMATOPORIDAE Miller, 1889

[=Diplotrypidae ULRICH, 1890]

Zoaria ramose, hemispherical, or massive; characterized by general looseness and obscurity of structure unlike other trepostomes. Distinguished from Halloporidae chiefly by presence of acanthopores and closed mesopores (3,114,115; NICKLES-B., 1900). *Ord.-Dev., ?Trias.*

Trematopora HALL, 1851 [**T. tuberculosa*]. Ramose, with prominent monticules. Zooecial apertures circular, with peristomes. Solid interspaces contain small acanthopores and distinctly moniliform granular mesopores. *Ord.-Sil.*——FIG. 75,*1*. **T. tuberculosa*, Sil.(Clint.), N.Y.; *1a*, zoarium, ×1; *1b*, surface, ×20; *1c,d*, secs., ×20 (131).

Acanthotrypa VINASSA, 1915 [**Monticulipora (Monotrypa) carnica*]. Massive. Like *Monotrypa* but zooecia have many regularly spaced diaphragms and minute acanthopores. *Ord.*——FIG. 75,*3*. **A. carnica* (VINASSA), NE.Italy (Carnic Alps); *3a,b*, secs., ×10, ×5 (225).

Anaphragma ULR.-B., 1904 [**A. mirabile*]. Like *Batostoma* but diaphragms entirely absent and walls crenulate in immature region. *Ord.*——FIG. 75,*2*. **A. mirabilis*, Richmond., Ill.; *2a-c*, secs., ×20 (223).

Aostipora VINASSA, 1920 [**Trematopora cystata* BASSLER, 1911]. Smooth slender cylindrical stems. Zooecia without diaphragms. Interspaces of mature region filled with cystose vesicles. *M.Ord.*——FIG. 75,*4*. **A. cystata* (BASSLER), Est.; *4a,b*, secs., ×20 (131).

Batostoma ULR., 1882 [**Monticulipora (Heterotrypa) implicata* NICH., 1881] [=*Acanthotrypella* VINASSA, 1920]. Irregular branches rising

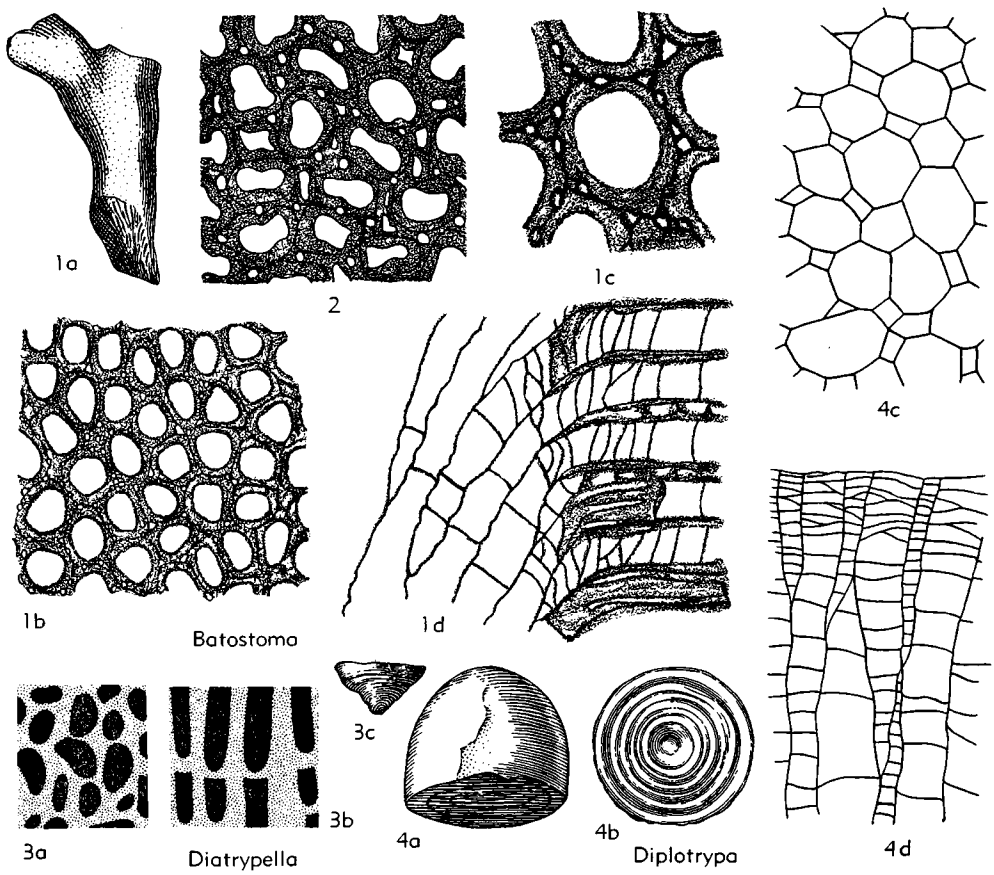


FIG. 76. Trematoporidae (p. G113, G114).

from large basal expansion. Zooecia thick-walled in mature region, somewhat uneven diaphragms numerous. Mesopores common, irregular; large acanthopores abundant. *Ord.*——FIG. 76, *1. B. minnesotense* ULR., Blkriv., Minn.; *1a,* zoarium, ×1; *1b,c,* tang. secs., ×20, ×50; *1d,* long. sec., ×20 (222).——FIG. 76,*2. *B. implicatum* (NICH.), Eden., Ohio; tang. sec., ×25 (222).

Diatrypella VINASSA, 1911 [**Monotrypa (Diatrypella) baconica*]. *Trias.,* Italy.——FIG. 76,*3. **D. baconica; 3a,b,* secs., ×10; *3c,* zoarium, from side, ×1 (225).

Diplotrypa NICH., 1879 [**Favosites petropolitanus* PANDER, 1830] [=*Diplotrypina* VINASSA, 1920]. Like *Monotrypa* but has mesopores. *Ord.*——FIG. 76,*4. **D. petropolitanus* (PANDER), Est.; *4a,b,* zoarium from side and base, ×1; *4c,d,* secs., ×20 (131).

Dittopora DYBOWSKI, 1877 [**D. clavaeformis*]. Club-shaped. Like *Hemiphragma* but has a pair of large acanthopores with each zooecium and numerous other small ones. *M.Ord.*——FIG. 77,*1. **D. clavaeformis,* Est.; *1a,b,* secs., ×20; *1c,* zoarium, ×1 (131).

Hemiphragma ULR., 1893 [**Batostoma irrasum* ULR., 1886] [=*Balticopora, Balticoporella* VINASSA, 1920]. Like *Batostoma* but diaphragms incomplete (hemiphragms) in mature region. *Ord.*——

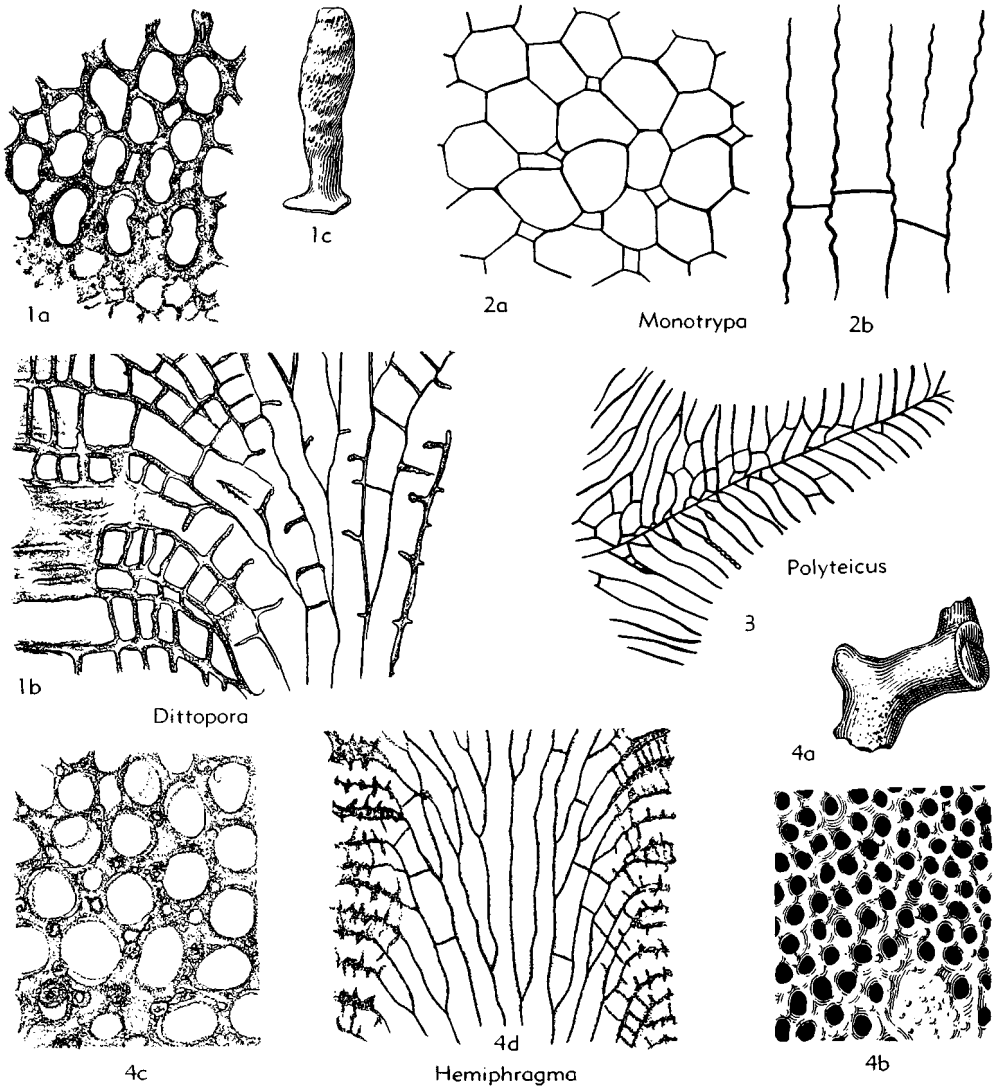


FIG. 77. Trematoporidae (p. G114, G115).

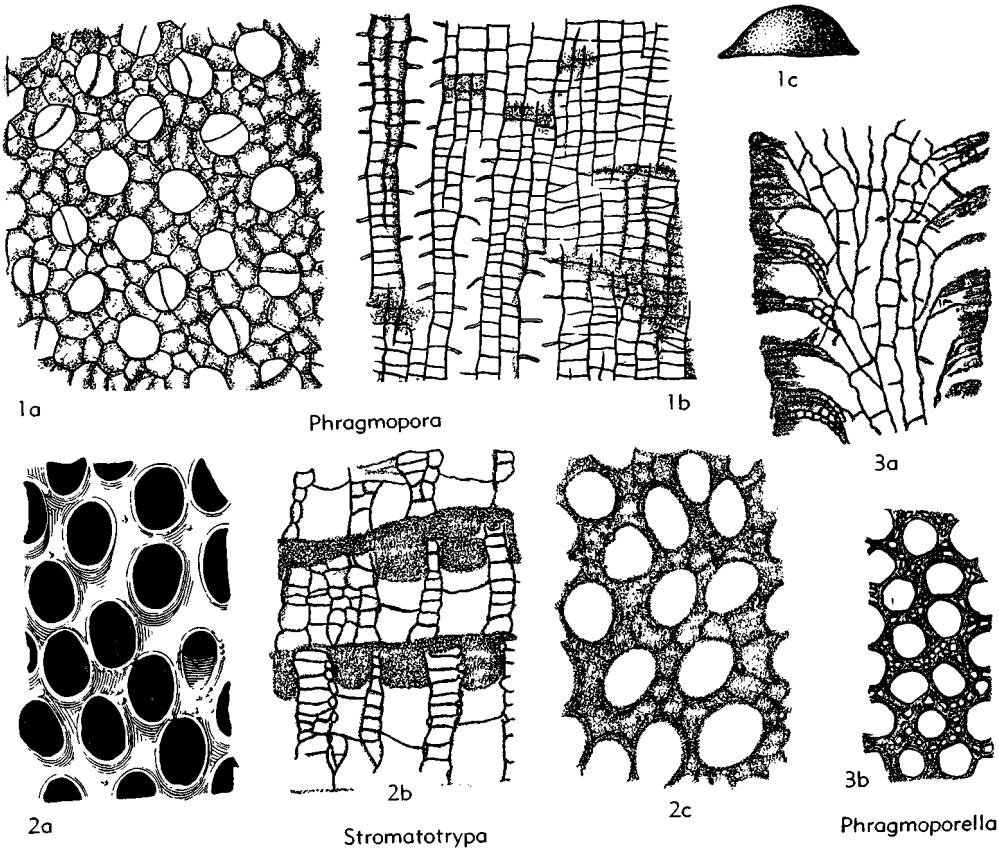


FIG. 78. Trematoporidae (p. G115).

FIG. 77,*4*. **H. irrasum* (ULR.), Blriv., Minn.; *4a*, zoarium, ×1; *4b*, surface, ×10; *4c,d*, secs., ×20, ×10 (222).

Monotrypa NICH., 1879 [**Chaetetes undulatus* NICH., 1875] [=*Pachytheca* SCHLÜTER, 1885; *Ptychonema* HALL-S., 1887]. Massive. Zooecia angular, with undulating thin walls. Mesopores absent. *Ord.-Dev.*——FIG. 77,*2*. **M. undulata* (NICH.), Ord.(Trenton.), Ont.; *2a,b*, secs., ×20 (197).

Phragmopora VINASSA, 1920 [**Hemiphragma multiporatum* BASSLER, 1911]. Dome-shaped. Like *Hemiphragma* but zooecia thin-walled, with hemiphragms throughout, and mesopores numerous, closely tabulate. Acanthopores absent. *M.Ord.*——FIG. 78,*1*. **P. multiporata* (BASSLER), Est.; *1a,b*, secs., ×20; *1c*, zoarium, ×1 (131).

Phragmoporella VINASSA 1920 [**Hemiphragma maculatum* BASSLER, 1911]. Slender cylindrical branches with conspicuous maculae. Zooecia with wide-spaced hemiphragms. Mesopores minute, closely tabulate; acanthopores absent. *M.Ord.*——FIG. 78,*3*. **P. maculata* (BASSLER), Est.; *3a,b*, secs., ×20 (131).

Polyteicus POČTA, 1902 [**Monotrypa novaki* PERNER, 1900]. Like *Monotrypa* but surface bears one or more bifoliate lamellae with apertures. *Ord.*——FIG. 77,*3*. **P. novaki* (PERNER), Czech.; sec., ×5 (205).

Stromatotrypa ULR., 1893 [**S. ovata*]. Superposed lamellae. Zooecia oval; papillose interspaces at surface denote mesopores. *Ord.*——FIG. 78,*2*. **S. ovata*, Blkriv., Minn.; *2a*, surface, ×20; *2b,c*, secs., ×20 (222).

Family PHYLLOPORINIDAE Ulrich, 1890

[=Subreteporidae MILLER, 1889; Chainodictyonidae NICKLES-B., 1900]

Zoaria composed of anastomosing or reticulating slender branches attached at base, with 2 to 8 rows of apertures on front (celluliferous) side and none on the other (back), which is longitudinally striate. Zooecia comprise gently curved tubes with long immature region; diaphragms widely spaced or lacking and no hemisepta; aper-

tures generally without peristome. Mesopores with closely spaced diaphragms and acanthopores, surficially marked by spines, may be present in the mature region. The assemblage is intermediate between Cryptostomata, which it resembles in zoarial form, and Trepostomata, which it matches in internal structure. Assignment of the family to the Trepostomata is based on lack of proved diagnostic cryptostome structures (46,49,114,115; NICKLES-B., 1900; BASSLER, 1952). *Ord.-Perm.*

Phylloporina ULR., 1887 [**Retepora trentonensis* NICH., 1871 (=*R. fenestrata* HALL, 1850)]. Anastomosing branches with 4 to 8 rows of apertures. Elongate angular zooecial tubes separated by closely tabulate mesopores. *Ord.*——FIG. 79,*4*. **P. fenestrata* (HALL); *4a,b,* secs., ×20, Trenton., Ont.; *4c,d,* back, front, ×10, Trenton., N.Y.——FIG. 79,*5*. *P. sublaxa* ULR., Blkriv., Minn.; *5a,b,* back, front, ×10 (222).

Bashkiriella NIKIF., 1939 [**B. ornata*]. Zoarium like *Subretepora* but zooecia converge toward middle of branch; acanthopores stellate. *Carb.*——FIG. 79, *3*. **B. ornata,* Fenestellidae ser., Russ.; sec., ×20 (198).

Carinophylloporina BASSLER, 1952 [**C. typica*]. Like *Phylloporina* but fenestrules hexagonal, with sharp keel dividing 4 to 6 longitudinal rows of apertures in 2 sets. *Ord.*——FIG. 80,*1*. **C. typica,* Blkriv.(Edinburg), Va.; *1a,b,* frontal side, ×10, ×20; *1c,* back, ×10 (131).

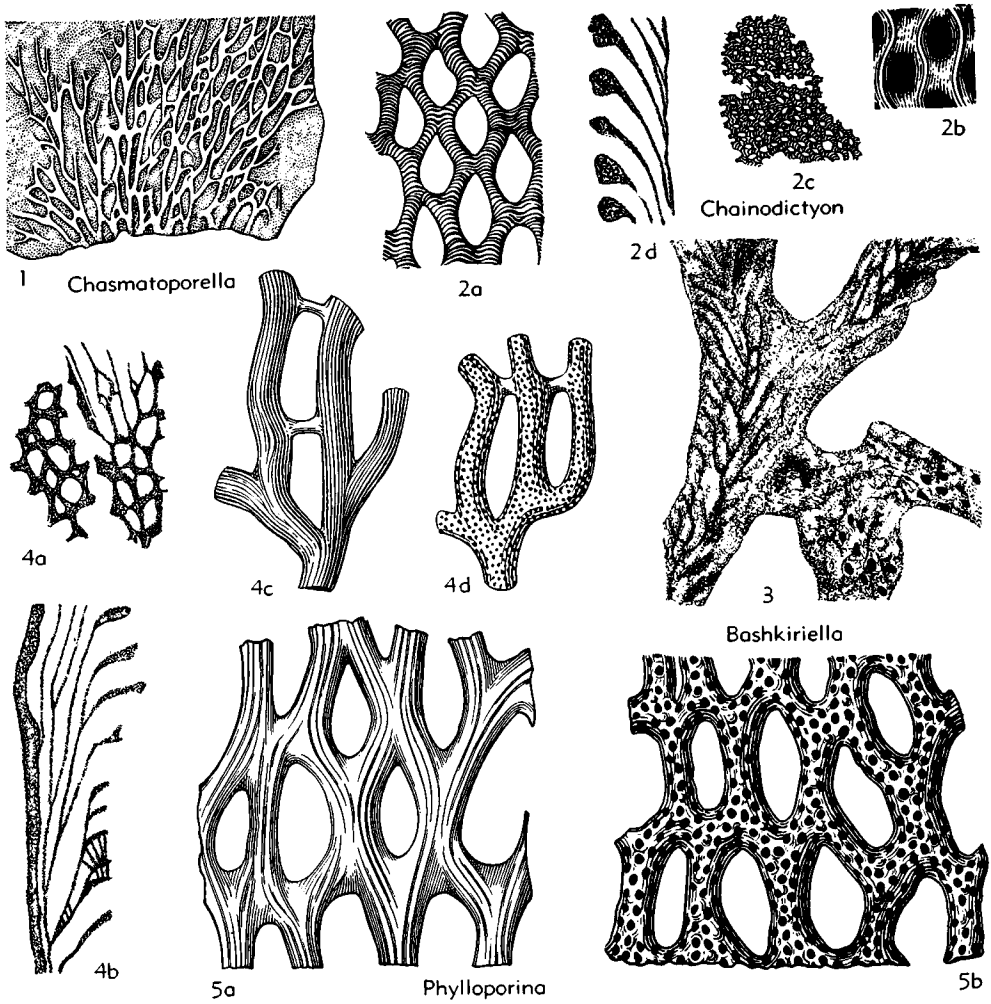


FIG. 79. Phylloporinidae (p. G116, G117).

Chainodictyon FOERSTE, 1887 [**C. laxum*]. Like *Phylloporina* but zooecia shorter and without diaphragms; mesopores absent; back concentrically undulated. *Penn.-Perm.*——FIG. 79,*2*. **C. laxum*, Penn., Ohio; *2a,b*, back and front, ×5, ×15; *2c*, zoarium, ×1; *2d*, long. sec., ×10 (222).

Chasmatoporella NEKH., 1936 [**C. metzi*]. Dichotomously branching, with 2 rows of zooecia separated by keel and uniting at 4 or more diameters apart. *Ord.*——FIG. 79,*1*. **C. metzi*, NE.Italy (Carnic Alps); zoarium, ×1 (195).

Moorephylloporina BASSLER, 1952 [**M. typica*]. Like *Phylloporina* but fenestrules polygonal, small; frontal with 2 rows of well-spaced circular apertures divided by threadlike keel bearing minute perforated nodes (?acanthopores) at regular intervals. *M.Ord.*——FIG. 80,*2*. **M. typica*, Blkriv. (Edinburg), Va.; *2a,b*, back, front, ×20 (131).

Oeciophylloporina BASSLER, 1952 [**O. typicalis*]. Like *Subretepora* but branches bear 3 or 4 rows of circular apertures, fenestrules elongate; ovicell-like structures on frontal; granular longitudinal striae on back. *M.Ord.*——FIG. 80,*3*. **O. typicalis*, Blkriv.(Edinburg), Va.; *3a,b*, front, back, ×20 (131).

Pseudohornera ROEMER, 1876 [**Retepora diffusa* HALL, 1852][=*Drymotrypa* ULR., 1890 (obj.); *Thamnocella* SIMPSON, 1897]. Branches bifurcating but not anastomosing, with zooecia rising from a thin double plate. *Ord.-Sil.*——FIG. 81,*2*. **P. diffusa* (HALL), Sil.(Clint.), N.Y.; *2a*, zoarium, ×1; *2b,c*, back, front, ×5; *2d-f*, secs., ×20 (131).

Sardesonina BASSLER, 1952 [**Phylloporina corticosa* ULR., 1886]. Branches broad, closely reticulate, with 4 to 6 rows of apertures on frontal side traversed by strongly undulating carinae. *Ord.*——FIG. 81,*4*. **S. corticosa* (ULR.), Blkriv., Minn.; *4a*, zoarium, ×1; *4b,c*, secs., ×20, ×10; *4d,e*, back, front, ×10 (222).

Subretepora D'ORB., 1849 [**Intricaria reticulata* HALL, 1847][=*Chasmatopora* EICHW., 1860]. Characters relatively ill known. Reticulate branches with 2 or more rows of short-tubed granular zooe-

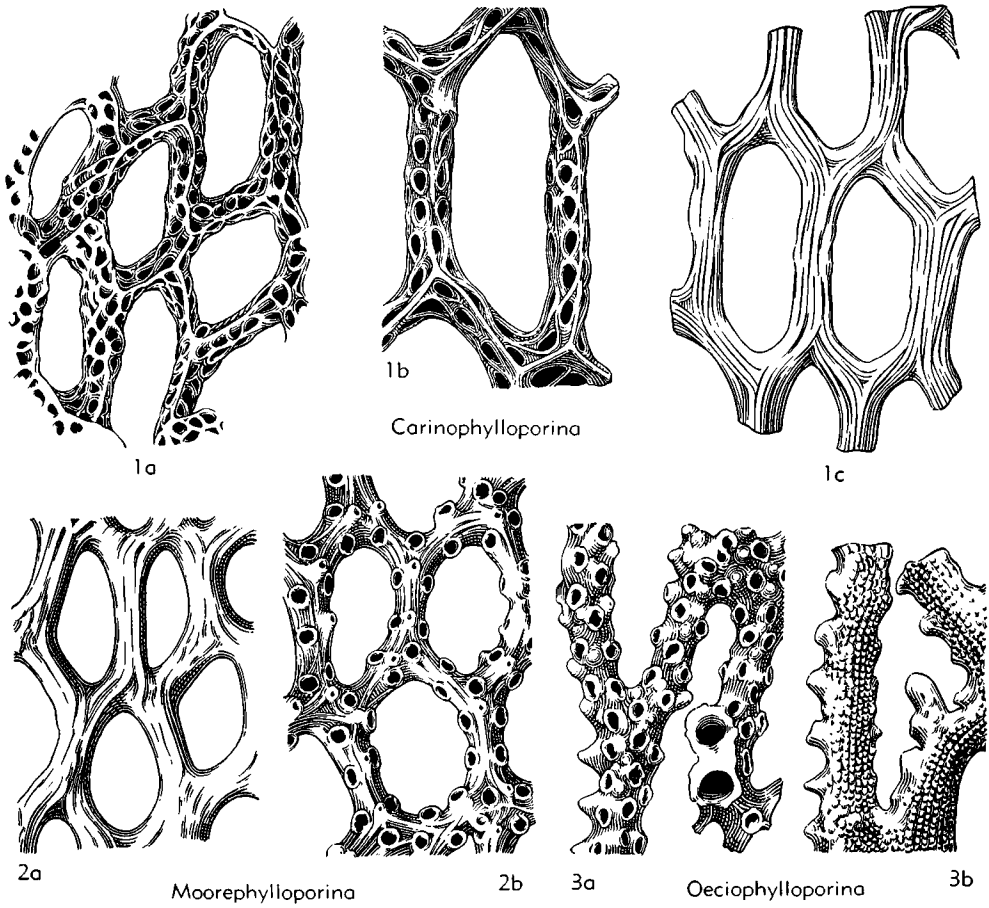


FIG. 80. Phylloporinidae (p. G116, G117).

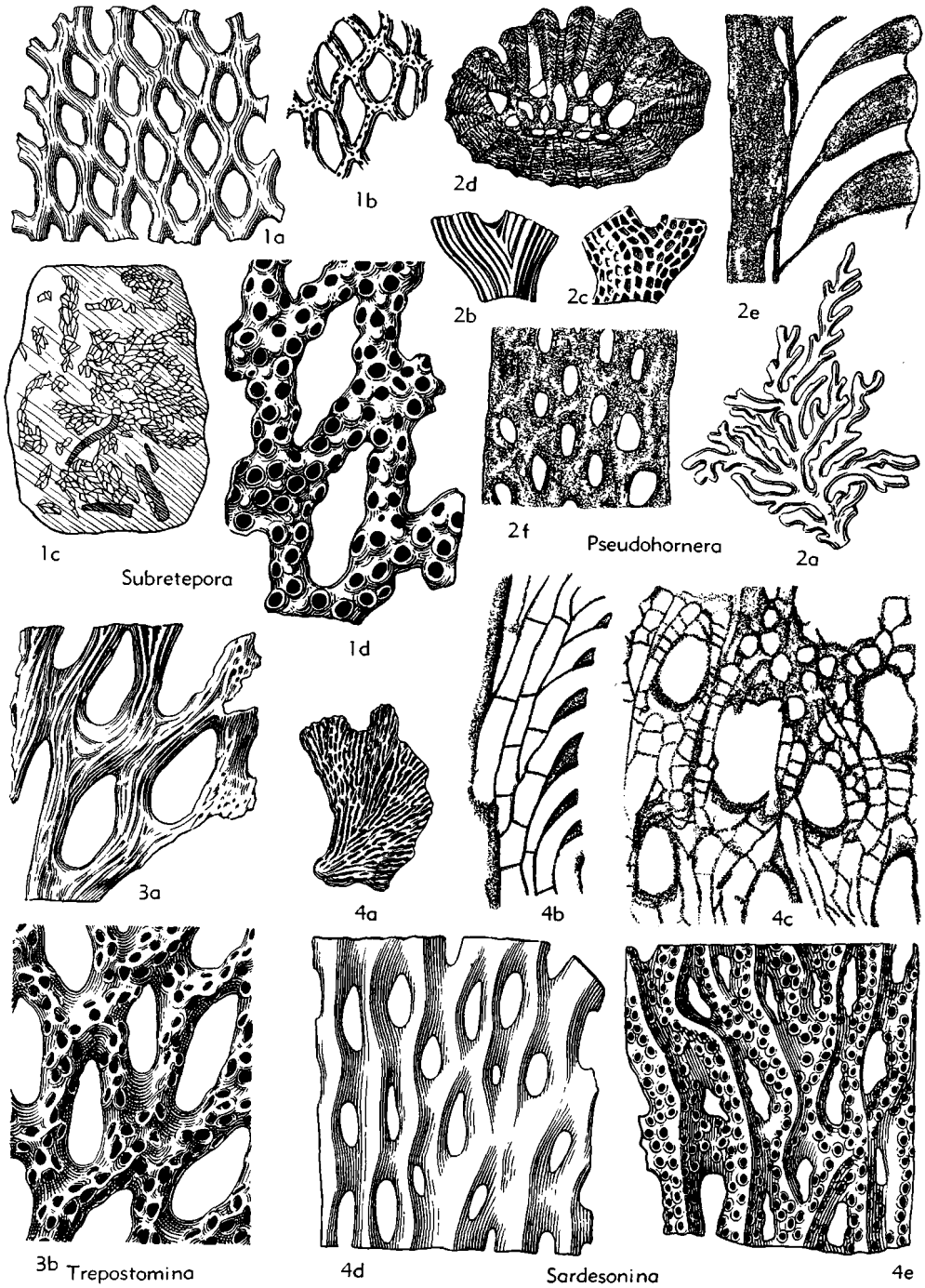


FIG. 81. Phylloporinidae (p. G117-G119).

cia with diaphragms, apertures separated by irregularly placed nodes (acanthopores); back with delicate striations; mesopores absent. *Ord.-Sil.*——FIG. 81,*1*. **S. reticulata* (HALL), Ord.(Trenton.), N.Y.; *1a,b*, back, front, ×10; *1c*, zoarium, ×1; *1d*, front, ×20 (*1a,c*, 149; *1b,d*, 222).

Trepostomina BASSLER, 1952 [**T. crassa*]. Reticulate branches, elongate fenestrules; front with 3 to 5 rows of elliptical to angular zooecial apertures; back closely striate. *M.Ord.*——FIG. 81,*3*. **T. crassa*, Blkriv.(Edinburg), Va.; *3a,b*, back, front, ×10 (131).

Order CRYPTOSTOMATA Vine, 1883

Zoaria mostly delicate reticulate fronds or slender branching stems of cylindrical or ribbon-like form, all calcareous. Zooecia as in Trepostomata, with well-marked differentiation of immature and mature regions, but the boundary between them more abrupt and the tubes much shorter; the distal part of each zooecial tube is a vestibule that extends from the aperture at the surface to the position of the orifice near the inner boundary of the mature zone, defined in many forms by shelflike hemisepta projecting from the walls. Interspaces between adjacent vestibules commonly filled by vesiculose coenosteum or solid stereom, which may be traversed by acanthopores. *Ord.-Perm.*

MORPHOLOGICAL FEATURES

This order is characterized by relative shortness of the zooecial tubes and concealment of their orifice (*cryptos*, hidden) at the bottom of a tubular shaft or vestibule which is surrounded by solid, laminated, or vesicular calcareous tissue. The primitive zooecium is regularly pyriform to oblong, quadrate or hexagonal in shape, with the orifice at its distal extremity. Since this is a prevailing character of the Cheilostomata, it is possible the Cryptostomata are really Paleozoic cheilostomes. The cryptostomes differ from typical cheilostomes, however, (1) in the absence of ovicells and avicularia; (2) in the much greater deposit of calcareous material on the zooecial front; (3) in the common development of successive layers of zooids one directly over another so as to form a continuous zooecial tube; and (4) in the presence of regularly spaced maculae or monticules composed of specialized cells in expanded lamellate zoaria. The 2 last-cited distinctions are suggestive of the Trepostomata, but the Cryptostomata differ from them in having a much shorter immature region (primitive cell), a more abrupt passage to the mature region, and a vestibule.

Some ramose Cryptostomata have relatively long thin-walled prismatic tubes in the axial region, with or without diaphragms, precisely as in ramose trepostomes and cyclostomes. They are distinguished from both these orders, however, by presence of semidiaphragms called hemisepta, one of which (superior hemiseptum) may extend downward and forward from the posterior (proximal) side of the base of the vestibule into the primitive cell, and the other (inferior hemiseptum) rising from the bottom of the cell (distal wall). The purpose of the hemisepta is unknown, although possibly they served as supports for a movable operculum. Acanthopores are common, as in the Trepostomata; in many zoaria they include very large ones (megacanthopores), generally located at the distal end of a zooecium, and small ones (micracanthopores) surrounding the aperture.

Relationship of the Cryptostomata to Cheilostomata is suggested by similarity of zoarial forms and markings of zooecial surfaces. In many typical Cryptostomata, the zoarium consists of 2 thin layers of zooecia growing back to back into erect sword-shaped, ramose, ribbon-like or fan-shaped expansions (Ptilodictyidae, Stictoporellidae, Rhinidictyidae, Sulcoreteporidae). In other Cryptostomata, the zoaria are lacelike expansions (Fenestellidae, Acanthocladiidae) consisting of only a single layer of cells with the back side covered by a dense layer of striated or minutely granulose tissue. In another prolific section, the zoaria are ramose, with zooecia arising from a real or imaginary axis and opening on all sides of narrow cylindrical stems (Rhabdomesidae, Arthrostylidae). Mostly these zoaria are continuous, but in some delicate, erect forms they are regularly divided into segments, articulating with each other or only at the base.

Most cryptostome bryozoans can be identified from surface characters of the zooecia

and zoarium, but in some, particularly the bifoliate and solid ramose species, thin sections are as essential for study as in the Trepostomata.

DISTRIBUTION

The order first appears in Ordovician rocks, reaches greatest development in Devonian and Mississippian deposits, and disappears in the Upper Permian. Many Ordovician genera and species have been described and illustrated by ULRICH (5,8) and BASSLER (13), Silurian by BASSLER (14), Devonian by HALL & SIMPSON (15), Carboniferous by ULRICH (5), and Permian by BASSLER (16).

Family FENESTELLIDAE King, 1850

[=Enalloporidae, Sphragioporidae, Thamniscidae MILLER, 1889; Fenestrellinidae BASSLER, 1935]

Zoaria forming reticulate expansions composed of rigid branches, laterally joined by regularly spaced nonporiferous crossbars (dissepiments) or by coalescence at opposed sinuous bends so as to leave open spaces (fenestrules) of circular, elliptical, or quadrangular form extending through the zoarium; branches rarely free, not laterally connected. Zooecia consisting of short recumbent tubes embedded in minutely porous calcareous tissue which is progressively modified by secretion of fine-grained dense laminae (sclerenchyme); proximal part of zooecia commonly delimited by a superior hemiseptum forming a semi-closed chamber which appears rounded, quadrate, or polygonal in longitudinal sections; primary orifice anterior (distal), semielliptical in outline, truncate behind; external apertures rounded, rimmed by a peristome, opening invariably on the side of branches that is termed front (obverse), but in exceptionally well-preserved specimens closed by a centrally perforate lid; the reverse side of branches, termed back, opposite the zooecial mouths, may be smooth, longitudinally striate, granulose, or nodose. Mesopores lacking but acanthopores represented by spines on the front side of branches, generally regularly spaced along a keel, may occur (68,111,114; NICKLES-B., 1900). *Ord-Perm.*

The zoarial characters of fenestellid bryozoans are quite constant and of great systematic importance. The nature of zooecial cavities closely resembles that observed in the Ptilodictyidae and Rhinidictyidae, and the same is true of the primary and external orifices.

The ability of bryozoans to deposit fine-grained calcareous tissue, lamina on lamina, whenever and wherever needed for support of the zoarium, probably is best exemplified in the Fenestellidae. By localized secretion of sclerenchyme, the relatively simple fronds of *Fenestella* type were built into unusual structures such as distinguish *Archimedes, Lyropora, Lyroporella,* and other unique genera. Similarly, specialized skeletal extension of acanthopore spines produced strange, delicate superstructures on the front side of zoarial fronds, as in *Hemitrypa, Isotrypa, Cervella,* and *Unitrypa.*

The terms front and back, for the celluliferous (obverse) and noncelluliferous (reverse) sides of the fenestellid frond, are adopted because of their simplicity.

Fenestella LONSD., 1839 [*nom. conserv.,* ICZN pend. (*non* BOLTON, 1798)][**Fenestella antiqua* LONSD., 1839 (*nom. conserv.,* ICZN pend.)(*non Gorgonia antiqua* GOLDF., 1826 = *Fenestella antiqua* (GOLDF.) = *Fenestrella subantiqua* D'ORB., 1849 = *Fenestella subantiqua* D'ORB.)(*nom. conserv.,* ICZN pend.)][=*Fenestrella* D'ORB., 1850]. Zoarium funnel- or fan-shaped. Zooecia in 2 rows on each branch with 2 to 8 apertures in a single row adjoining one fenestrule. Front of branches with or without median keel and acanthopore spines present or absent. *Ord.-Perm.*——FIG. 82,*1*. **F. antiqua* LONSD., Sil.(Wenlock.), Eng.; front, ×10 (179).

Anastomopora SIMPSON, 1897 [*pro Reteporella* SIMPSON, 1895 (*non* BUSK, 1884)][**Fenestella cinctuta* HALL, 1884][=*Reteporidra* NICKLES-B., 1900]. Thin fan-shaped fronds with thick lateral margins of lamellose tissue; branches anastomosing, fenestrules oval. Zooecial apertures in 3 to 7 rows on each branch. *Dev.*——FIG. 82,*2*. **A. cinctuta* (HALL), M.Dev., N.Y.; *2a,b,* front and back, ×5 (163).

Archimedes OWEN, 1838 [**Fenestella (Archimedes) wortheni* HALL, ?1856; SD MILLER, 1889][=*Archimedipora* D'ORB., 1849]. Zoarial network like *Fenestella,* with 2 rows of apertures along branches, supported by a screwlike axis of laminated tissue that encloses proximal edge of the spirally twisted frond. *Miss.-Perm.*——FIG. 82,*5*. **A. wortheni* HALL, L.Miss.(Warsaw), Ill.; *5a,b,* spiral axis, long. sec. and surface., ×1 (222).——FIG. 82,*6*. *A. communis* ULR., U.Miss.(Chest.), Ky.; long. sec. of axis showing zooecial layers coated by lamel-

lar tissue, ×25 (131).——Fig. 82,*7*. *A. proutana* Ulr., U.Miss.(Chest.), Ky.; spiral axis, ×1.——Fig. 82,*8*. *A. sublaxa* Ulr., U.Miss.(Chest.), Ill.; axis and part of fronds, ×1 (222).

Bicorbis Condra-E., 1945 [*pro Bicorbula* Condra-E., 1945 (*non* Fischer, 1887)][**Bicorbula arizonica* Condra-E., 1945]. Zoarium double-layered, basket-like, with upper meshwork like *Polypora* and lower one of dense laminated tissue. *Perm.*——Fig. 82,*4*. **B. arizonica* (Condra-E.), M.Perm., Ariz.; long. sec., ×20 (141).

Cervella Chronic, 1949 [**C. cervoidea*]. *Fenestella*-type frond with superstructure of stellate processes developed from acanthopore-like spines along midline of branch fronts. *Perm.*——Fig. 82,*3*. **C. cervoidea*, L.Perm., Peru; *3a,b*, back and front, ×5, ×10 (139).

Enallopora d'Orb., 1849 [**Gorgonia perantiqua* Hall, 1847][=*Protocrisina* Ulr., 1889]. Narrow bifurcating branches not laterally joined; a row of front-facing apertures along each margin of branch and irregularly placed additional ones between on front; back with small pores. *Ord.*——Fig. 83,*4*. **E. perantiqua* (Hall), Trenton., N.Y.; *4a,b*, front and back, ×10 (162).

Fenestepora Frederiks, 1915 [**Fenestella jabensis* Waagen & Pichl, 1886]. Like *Fenestella* but with row of small cells along carina. *U.Carb.*, Russ.

Fenestralia Prout, 1858 [**F. sanctiludovici*]. Like *Fenestella* but with 2 rows of apertures on each

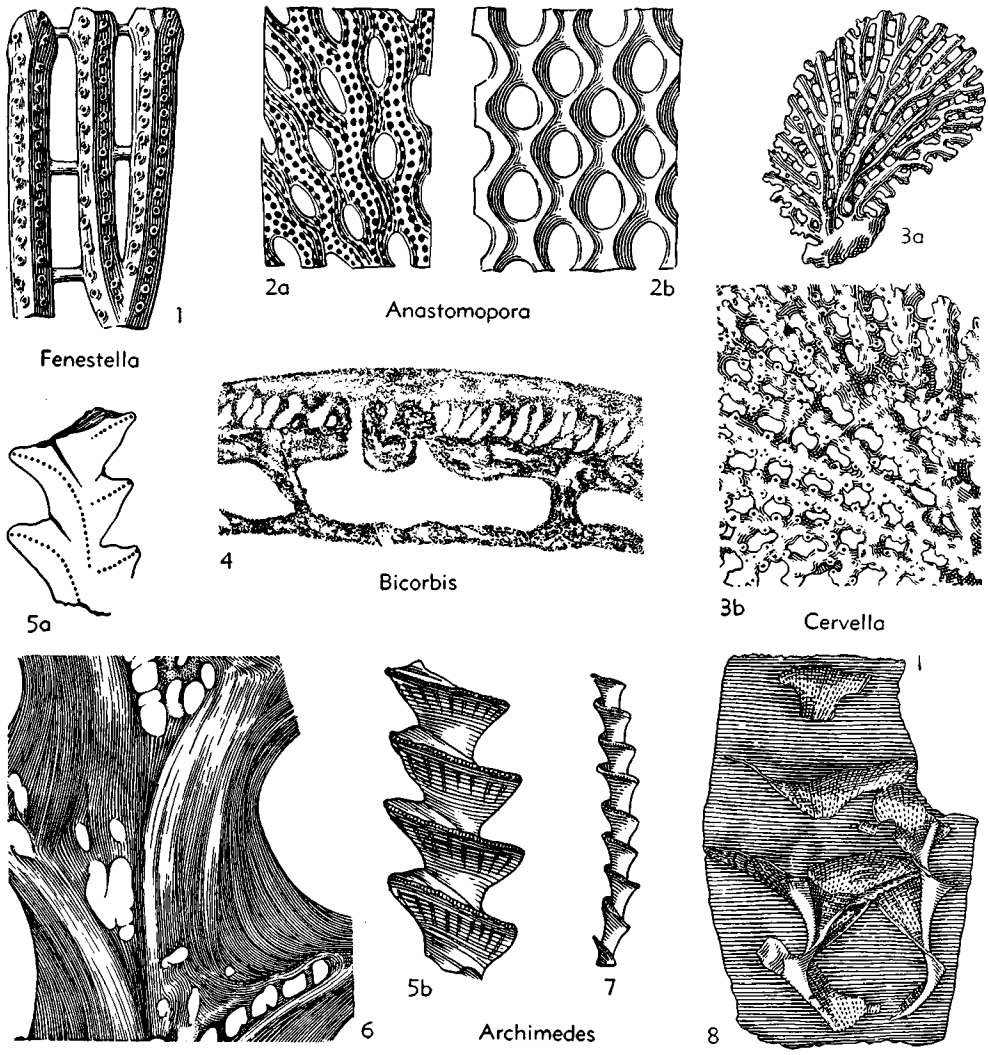


Fig. 82. Fenestellidae **(p. G120, G121).**

side of median keel. *Miss.*——Fig. 83,7. **F. sanctiludovici,* Meramec., Mo.; *7a,* front, ×5; *7b,* back, ×1 (217).

Fenestrapora Hall, 1885 [**F. biperforata*]. Like *Fenestella* but back and wide keel summits on front bear pores or pits. *Dev.*——Fig. 83,8. **F. biperforata,* M.Dev., N.Y.; *8a,b,* back, front, ×20 (162).

Fenestrellina d'Orb., 1849 [**Fenestella crassa* McCoy, 1844] [=*Actinostoma* Y.-Y., 1874; *Flabelliporina* Simpson, 1895]. Dissepiments widely separated and fenestrules very long, as in *Thamniscus;*

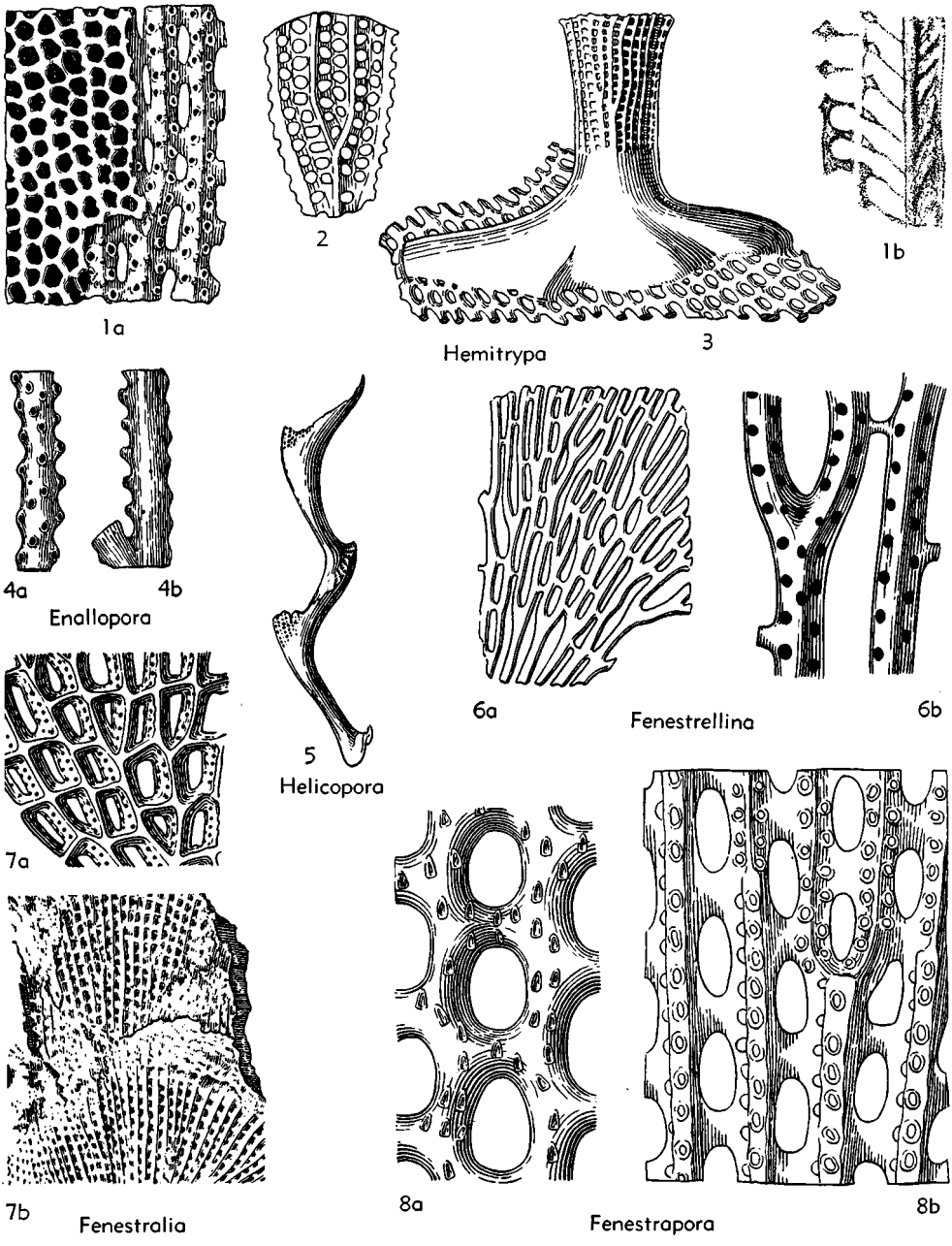


Fig. 83. Fenestellidae (p. G121-G123).

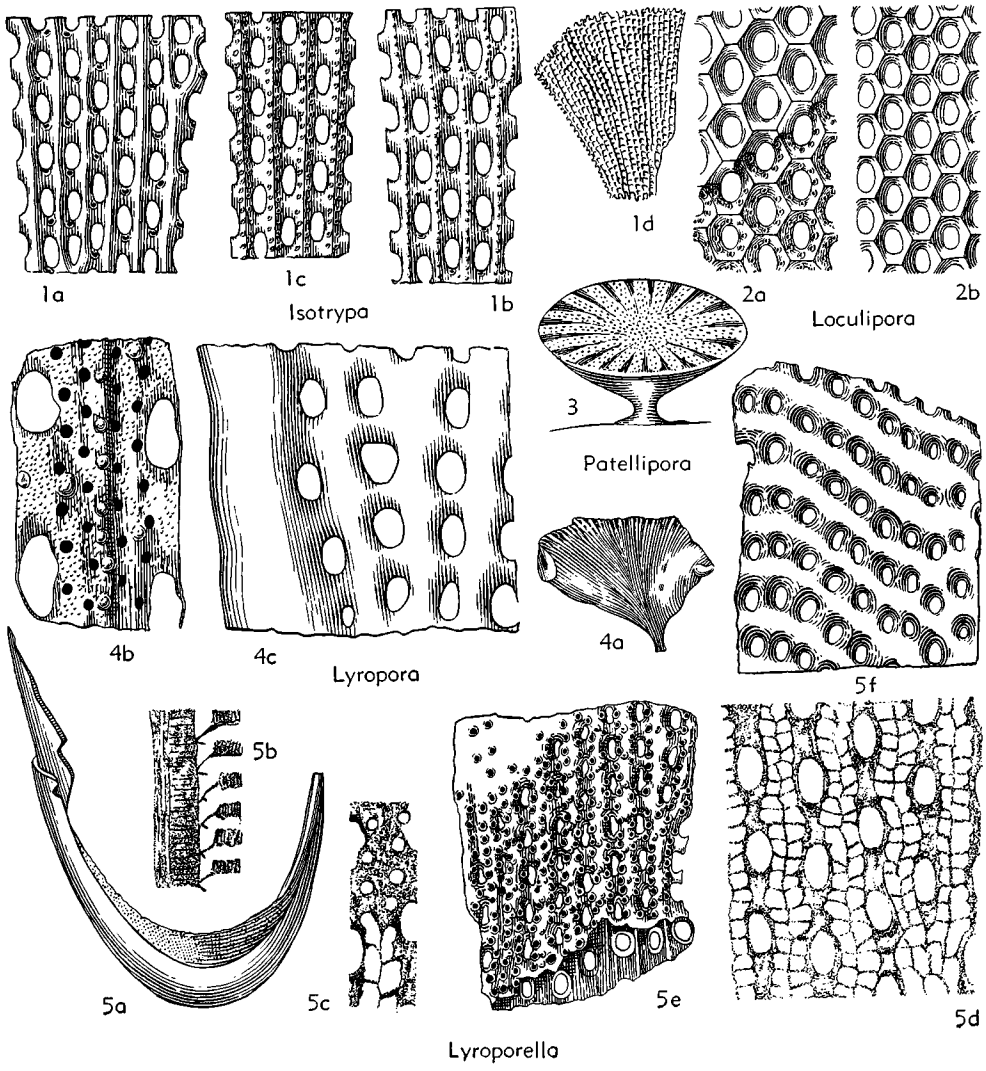


FIG. 84. Fenestellidae (p. G123-G125).

front with keel and 2 rows of apertures, as in *Fenestella*. *Carb.-Perm.*——FIG. 83,*6*. **F. crassa* (McCOY), L.Carb., Ire.; *6a*, back, ×1; *6b*, front, ×10 (180).

Helicopora CLAYPOLE, 1881 [**H. latispiralis*]. Network of *Fenestella* type twisted in loose spire around flexuous solid axis of laminated sclerenchyme. *Sil.-Dev.*——FIG. 83,*5*. **H. latispiralis*, Sil.(Niag.), Ohio; axis, ×1 (140).

Hemitrypa PHILLIPS, 1841 [**H. oculata*]. Like *Fenestella* but with reticulate superstructure borne by regularly spaced spines along keels of front side, meshes of upper network corresponding in number and position to zooecial apertures beneath. *Sil.-Perm.*——FIG. 83,*1*. *H. proutana* ULR., Miss. (Warsaw), Ill.; *1a*, front, showing superstructure partly removed, ×15; *1b*, long. sec., showing solid floor of branch (right), obliquely disposed zooecia (middle), and superstructure (left), ×20 (222).——Fig. 83,*2*. **H. oculata*, Dev., Eng.; front, showing superstructure, ×10 (206).——FIG. 83,*3*. *H. cribrosa* HALL, M.Dev., Falls Ohio, Ky.-Ind.; base of zoarium attached to a fenestellid, ×5 (162).

Isotrypa HALL, 1885 [**Fenestella (Hemitrypa) conjunctiva* HALL, 1883] [=*Amorphotrypa* WHIDBOURNE, 1897; *Tectuliporella* SIMPSON, 1895]. Like *Fenestella* but with superstructure formed by strongly elevated keels connected laterally by crossbars, so that front and back of zoarium appear

almost identical. *Dev.*——Fig. 84,*1*. **I. conjunctiva* (Hall), Onond., Ont.; *1a,b*, back, with pore at edge of each dissepiment, ×5; *1c*, front, with superstructure removed, ×5; *1d*, front, with superstructure in place, ×1 (162).

Loculipora Hall, 1885 [**Fenestella perforata* Hall, 1884][=*Tectulipora* Hall, 1885; *Entopora* Maurer, 1885]. Dissepiments greatly reduced, carinae of branches and dissepiments so expanded and coalesced that front and back of zoarium are closely similar. *Sil.-Dev.*——Fig. 84,*2*. **L. perforata* (Hall), M.Dev.(Hamilton), N.Y.; *2a,b*, front, back, ×5 (162).

Lyropora Hall, 1857 [**Fenestella (Lyropora) subquadrans*][=*Lyroporidra* Simpson, 1897 (obj.); *Dictyoretmon* Whitf., 1909]. Fenestrate zoarium with branches bearing 3 to 5 rows of zooecia, lateral borders of fan-shaped frond consisting of noncelluliferous thick deposit of laminated sclerenchyme; front of branches may bear keel with nodes. *Miss.-Perm.*——Fig. 84,*4*. **L. subquadrans* Hall, U.Miss.(Chest.), Ill.; *4a*, zoarium, ×1; *4b*, front, ×20; *4c*, back, showing a thickened edge, ×10 (222).

Lyroporella Simpson, 1895 [**Fenestella (Lyropora) quincuncialis* Hall, 1857][=*Lyroporina* Simpson, 1897]. Like *Lyropora* but branches have only 2 rows of zooecia. *Miss.*——Fig. 84,*5*. **L. quincuncialis* (Hall), Chest., Ill.; *5a*, zoarium, network incomplete, ×1; *5b-d*, secs., ×20; *5e-f*, front and back, ×10 (222).

Minilya Crockford, 1944 [**M. duplaria*]. Like *Fenestella* but nodes along keel disposed zigzag, their number and position corresponding to arrangement of interlocked alternating zooecia of the 2 rows on each branch. *Penn.-Perm.*——Fig. 85,*1*. **M. duplaria*, Perm., W.Austral.; *1a*, tang. sec., ×10; *1b*, front, ×10 (142).

Patellipora Rom., 1887 [**P. stellata*]. Zoarium saucer-shaped, stalked; upper surface with radiat-

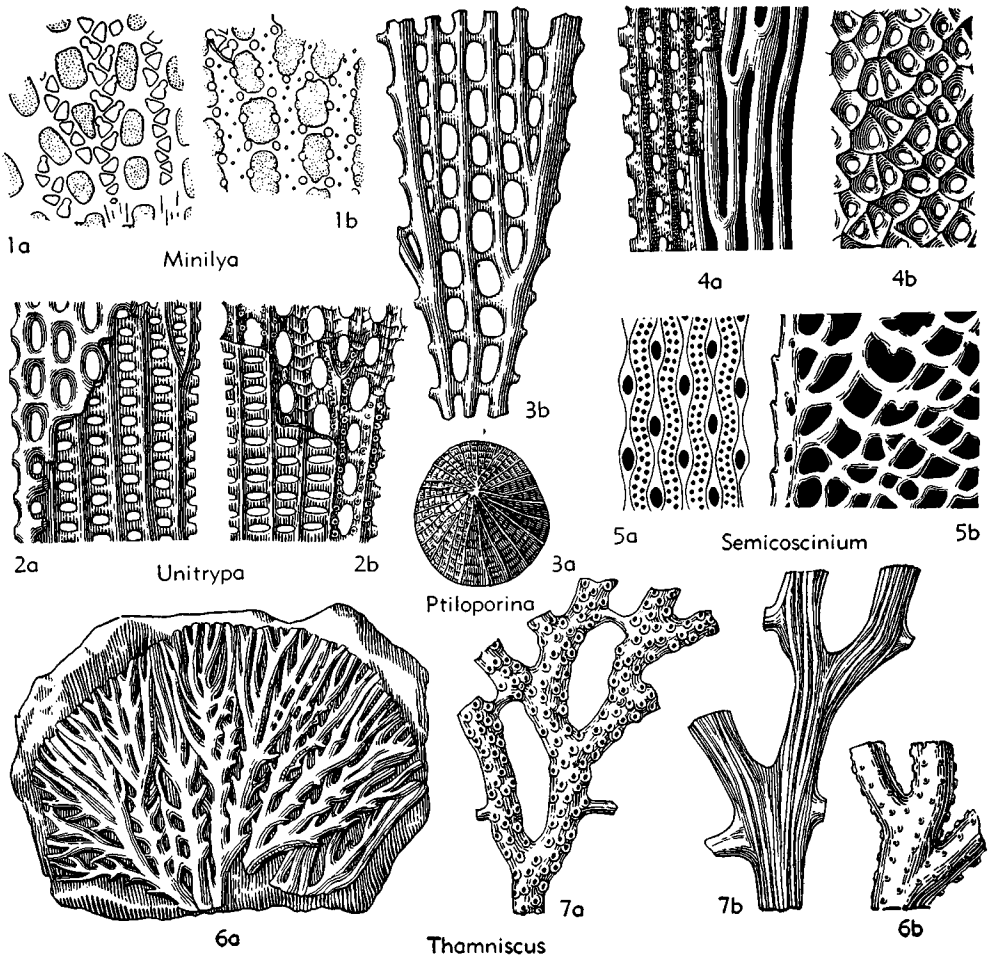


Fig. 85. Fenestellidae (p. G124-G127).

ing branches which bear rows of zooecia. *Dev.*——Fig. 84,*3*. **P. stellata*, erratic in drift, Mich.; zoarium, ×1 (212).

Polypora McCoy, 1844 [**P. dendroides*][=*Flabelliporella, Polyporella* Simpson, 1895; *Polyporina* Frederiks, 1920]. Like *Fenestella* but has 3 to 8 rows of zooecia on each branch; median keel absent but may be represented by row of nodes. *Ord.-Perm.*——Fig. 86,*7*. **P. dendroides*, L.Carb., Ire.; *7a,b*, front, ×1, ×5 (180).

Protoretepora DeKon., 1876 [**Fenestella ampla* Lonsd., 1844][=*Phyllopora* King, 1849 (*non* Ehr., 1834)]. Like *Polypora* but zooecial apertures occur on dissepiments. *Carb.-Perm.*——Fig. 86,*2*. **P. ampla* (Lonsd.), Carb., N.S.W.; front, ×20 (179).——Fig. 86,*1*. **P. ehrenbergi* (Geinitz), Perm., Ger.; *1a*, curved conical zoarium, ×1; *1b*, front, ×10 (155).

Pseudoisotrypa Prantl, 1932 [**P. bohemica*]. Like *Isotrypa* but branches and superstructure flexuous, resembling anastomosis. *Dev.*, Czech.

Pseudounitrypa Nekh., 1926 [**P. sibirica*]. Spines along keels produced laterally at summit as inclined concave scales which may join to form superstructure. *Carb.*——Fig. 86,*4*. **P. sibirica*, L. Carb., Russ.; oblique tang. sec. intersecting branches (below), spines (middle), and superstructure (top), ×0.67 (195).

Ptiloporella Hall, 1885 [**Fenestella (Ptiloporella) laticrescens* Hall-S., 1887][=*Pinnaporella* Simpson, 1897 (*non* Simpson, 1895)]. Like *Fenestella* but normal branches diverge pinnately from con-

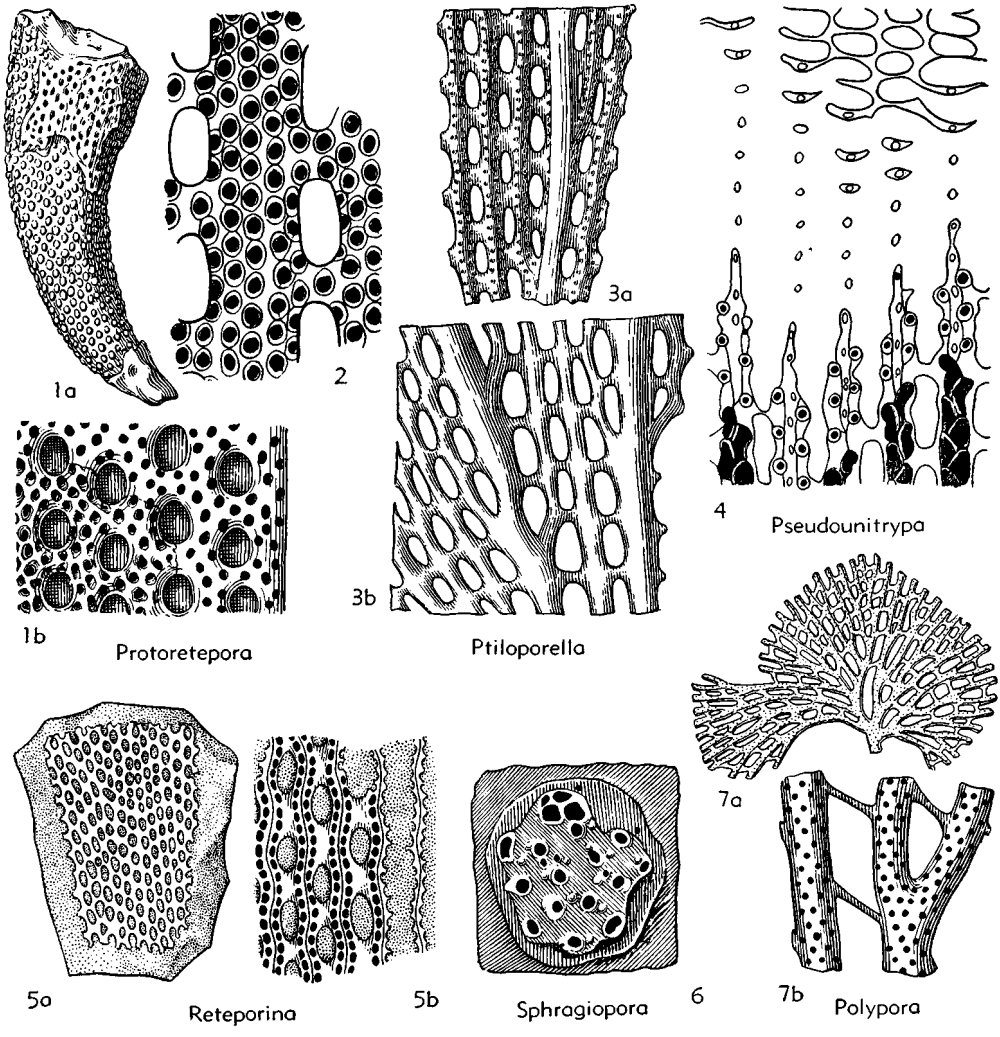


Fig. 86. Fenestellidae (p. G125, G126).

siderably thickened main branches. *Sil.-Dev.*——Fig. 86,*3*. **P. laticrescens* Hall-S., Dev.(Onond.), Ont.; *3a,b,* front and back, ×5 (162).

Ptiloporina Hall, 1885 [**Fenestella (Ptiloporina) conica* Hall-S., 1887][=*Pinnaporella* (*non* Simpson, 1897), *Pinnaporina* Simpson, 1895]. Like *Ptiloporella* but branches have 3 or more rows of zooecia and no carina. *Dev.*——Fig. 85,*3*. **P. conica* Hall-S., Onond., Ont.; *3a,* zoarium, ×1; *3b,* back, ×5 (162).

Reteporina d'Orb., 1849 [**Retepora prisca* Goldf., 1826][=*Heteroprisca* Nekh., 1929 (obj.)]. Poorly known; may be senior synonym of *Semicoscinium*. *Dev.*——Fig. 86,*5*. **R. prisca* (Goldf.), M. Dev., Ger.; *5a,* back, ×1; *5b,* front, ×5 (157).

Semicoscinium Prout, 1859 [**S. rhomboideum*][=*Carinopora, Cryptopora* Nich., 1874; *Cycloporina* Simpson, 1895; *?Cyclopelta* Borneman, 1884]. Zoarium funnel-shaped, celluliferous on outer side, fenestrules subrhomboidal on back, branches with 2 rows of zooecia and high median keel expanded at top. *Sil.-Dev.*——Fig. 85,*4*. *S. interruptum* Hall-S., M.Dev., Falls Ohio, Ky.-Ind.; *4a,* front, with expanded keels removed at left, ×5 (163).——Fig. 85,*5*. **S. rhomboideum,* M.Dev., Falls Ohio, Ky.-Ind.; *5a,* front, weathered, ×5; *5b,* back, ×5 (208).

Seriopora Počta, 1894 [**S. petala*]. Dissepiments reduced to minimum. *Dev.*, Czech.

Sphragiopora Ulr., 1889 [**S. parasitica* Ulr., 1890]. Minute incrusting patches; ?juvenile stage of fenestellid. *Miss.-Perm.*——Fig. 86,*6*. **S. parasitica* Ulr., U.Miss.(Chest.), Ill.; front, ×20 (222).

Thamniscus King, 1849 [**Keratophytes dubius* Schloth., 1820][=*Thamniscides* King, 1849]. Like *Polypora* but dissepiments far apart or nearly absent. *Sil.-Perm.*——Fig. 85,*6*. **T. dubius* (Schloth.), Perm., Ger.; *6a,* back, ×1; *6b,* front, ×5 (170).——Fig. 85,*7*. *T. ramulosus* Ulr., U. Miss. (Chest.), Ill.; *7a,b,* front, back, ×10 (222).

Unitrypa Hall, 1885 [**Fenestella (Hemitrypa) lata* Hall, 1883]. Like *Fenestella* but has reticulate superstructure on front consisting of imbricate lamellae (scalae) which correspond in num-

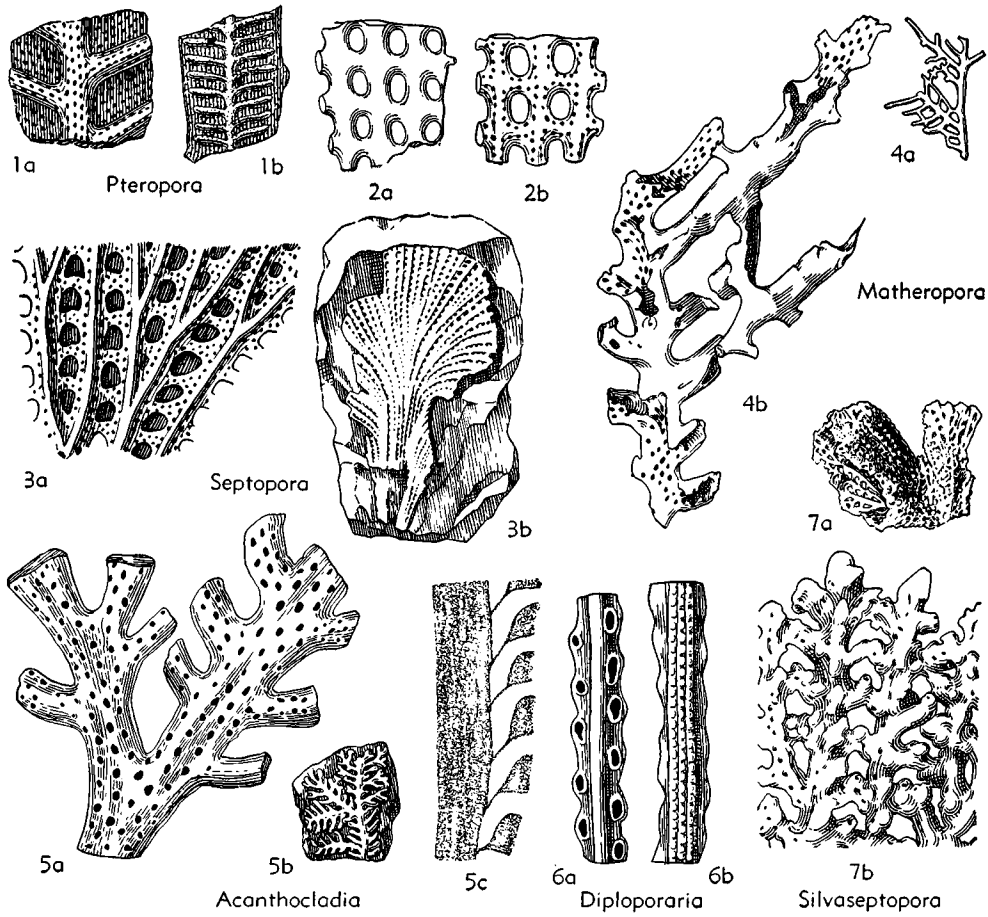


Fig. 87. Acanthocladiidae (p. G127, G128).

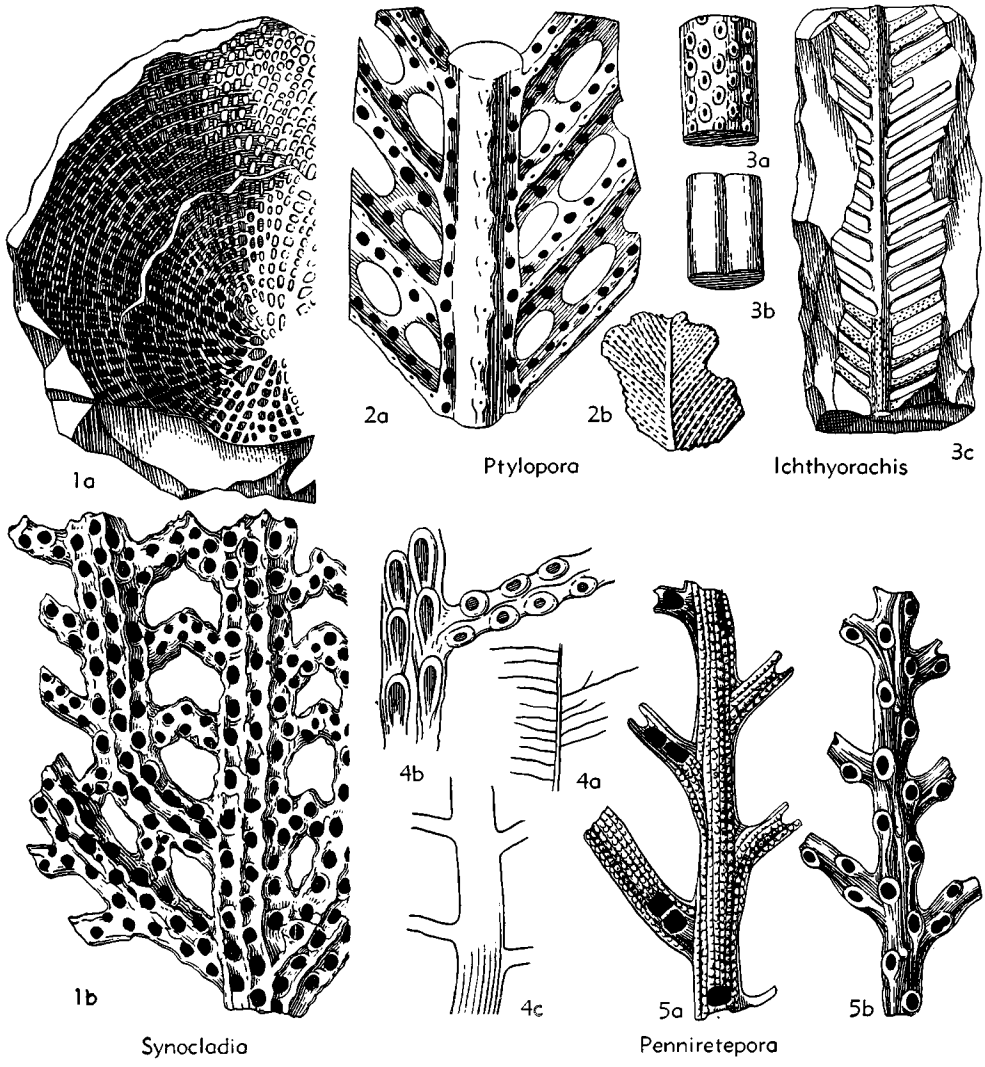


FIG. 88. Acanthocladiidae (p. G128).

ber to zooecia, the whole borne by projections of keels on the branches. *Sil.-Dev.*——FIG. 85,*2*. **U. lata* (HALL), M.Dev.(Onond.), Ont.; *2a*, back, mostly showing underside of superstructure, ×5; *2b*, front, with superstructure in place at left, ×5 (162).

Utropora POČTA, 1894 [**U. nobilis*]. Zooecial apertures on sides of branches, distinction between front and back lost. *Dev.*, Czech.

Family ACANTHOCLADIIDAE Zittel, 1880

Zoarium composed of strong stems with branches generally diverging obliquely and remaining free or uniting with adjacent branches, the side branches with or without connecting crossbars (dissepiments) which may bear zooecia (111,114; NICKLES-B., 1900). *Sil.-Perm.*

Acanthocladia KING, 1849 [**Keratophytes anceps* SCHLOTH., 1820]. Coarse stipes with 3 or more rows of zooecia; short oblique side branches closely and regularly spaced, commonly without dissepiments. *Penn.-Perm.*——FIG. 87,*5*. **A. anceps* (SCHLOTH.), *Perm.*, Ger.; *5a*, front, ×10; *5b*, zoarium, ×1; *5c*, long. sec., ×20 (170).

Diploporaria NICKLES-B., 1900 [*pro Diplopora* Y.-Y., 1875 (*non* GÜMBEL, 1866)] [**Glauconome*

marginalis Y.-Y., 1875]. Like *Penniretepora* but side branches very few. *Carb.-Perm.*——Fig. 87,6. **D. marginalis* (Y.-Y.), L.Carb., Scot.; *6a,b,* front, back, ×20 (233).

Filites Počta, 1894 [**F. cribrosus*. Resembles *Penniretepora. Dev.*, Czech.

Ichthyorachis McCoy, 1844 [**I. newenhami*] [=*Ichthyorhachis* Agassiz, 1845). Like *Ptylopora* but main stem bears 5 or more rows of zooecia and side branches generally 3 rows; dissepiments lacking. *Dev.-Carb.*——Fig. 88,*3*. **I. newenhami,* L.Carb., Ire.; *3a,b,* fragment of main stem, front and back, ×10; *3c,* front, ×1 (180).

Lyrocladia Shulga, 1931 [**L. permica*]. *Perm.*, Russ.

Matheropora Bassler, *nom. nov.* [*pro Dictyocladia* Mather, 1915[1] (*non* Pomel, 1872)] [**Dictyocladia triseriata* Mather, 1915]. Like *Acanthocladia* but main stems have 4 or 5 rows of zooecia and side branches partly joined by dissepiments. *Penn.-Perm.*——Fig. 87,*4*. **M. triseriata* (Mather), L. Penn.(Morrow.), Ark.; *4a,* zoarium, ×1; *4b,* front, ×5 (187).

Penniretepora d'Orb., 1849 [**Retepora pluma* Phillips, 1836][=*Acanthopora* Y.-Y., 1875; *Pinnatopora* Vine, 1883; *Glauconome* auctt. (*non* Goldf., 1826)]. Slender main stem and short, regularly spaced, oblique side branches without dissepiments; 2 rows of zooecia on stem and branches. *Dev.-Perm.*——Fig. 88,*4*. **P. pluma* (Phillips), L.Carb., Eng. (Yorks.); *4a,* zoarium, ×1; *4b,c,* front and back, ×20 (206).——Fig. 88,*5*. *P. bellula* (Ulr.), L. Penn., Ill.; *5a,b,* back, front, ×20 (222).

Pteropora Eichw., 1855 (*non* Hall, 1883)[**P. pennula*]. Like *Ichthyorachis* but side branches connected by celluliferous tissue. *Ord.*——Fig. 87,*1*. **P. pennula,* M.Ord., Est.; *1a,b,* front, ×5, ×1 (149).

Ptylopora McCoy, 1844 [**P. pluma*][=*Ptilopora* Agassiz, 1846; *Dendricopora* DeKon., 1876]. Zoarium pinnate, with strong main stem and long oblique side branches connected by dissepiments generally non-celluliferous but in some with apertures; 2 rows of zooecia divided by node-bearing keel on stem and side branches. *Dev.-Perm.*——Fig. 88,*2*. **P. pluma,* L.Carb., Ire.; *2a,* front, ×10; *2b,* zoarium, ×1 (180).

Samaria Stuck., 1888 (*non* Raganof, 1893)[**S. volgensis*]. *L.Carb.*, Russ.

Septopora Prout, 1859 [**S. cestriensis*][=*Loculiporella* Frederiks, 1920]. Primary and secondary branches numerous, the latter joined to adjacent primaries; 2 rows of zooecia on all branches; back with scattered pores; union of secondaries (pinnae) may form dissepiment-like structures with apertures. *Miss.-Perm.*——Fig. 87,*2*. *S. laevis* Eichw., Carb., Russ.; *2a,b,* back, front, ×5 (149).——Fig. 87,*3*. **S. cestriensis,* U.Miss.(Chest.), Ill.; *3a,* front, ×5; *3b,* zoarium, ×1 (208).

Silvaseptopora Chronic, 1949 [**S. incaica*]. Like *Septopora* but front bears prominent spines along keels, largest with treelike branching. *Perm.*——Fig. 87,*7*. **S. incaica,* Peru; *7a,* zoarium, ×1; *7b,* front, ×5 (139).

Synocladia King, 1849 [**Retepora virgulacea* Phillips, 1829]. Like *Septopora* but branches coarser and bearing 3 or more rows of zooecia. *Miss.-Perm.*——Fig. 88,*1*. **S. virgulacea* (Phillips), Perm., Eng.; *1a,* back, ×1; *1b,* front, ×10 (170).

Syncladiopsis Gregorio, 1930 [**S. elegans*]. *Perm.*, Sicily.

Family ARTHROSTYLIDAE Ulrich, 1888

Zoaria composed of numerous subcylindrical articulated segments forming small pinnate or bushy growth or continuous dichotomously dividing branches. Zooecia radially arranged about a central axis, opening on all sides of the segments or only on one side, the other being longitudinally striate and lacking apertures (3,114,115; Nickles-B., 1900). *Ord.-Dev.*

Arthrostylus Ulr., 1888 [*pro Arthronema* Ulr., 1882 (*non* Eschscholtz, 1825)][**Helopora tenuis* James, 1878]. Very delicate subquadrate segments articulating terminally to form bushy zoaria, with zooecia in 3 rows between longitudinal ridges, the 4th face with striae only. *Ord.*——Fig. 89,*1*. *A. obliquus* Ulr., Blkriv., Minn.; *1a,b,* side and back, ×20 (222).——Fig. 89,*2*. **A. tenuis* (James), Eden., Ohio; *2a,* zoarium, ×1; *2b-d,* front and 2 back views, ×25 (222).

Arthroclema Bill., 1862 [**A. pulchellum*]. Segments celluliferous on all sides, articulated terminally and laterally to form a pinnate zoarium. *Ord.*——Fig. 89,*3*. **A. pulchellum,* Trenton., Ont.; *3a,* zoarium, ×1; *3b,c,* segments, one showing lateral socket, ×20 (222).

Arthrostyloecia Bassler, 1952 [**A. nitida*]. Differs from *Arthrostylus* in having distinct oval peristomes around apertures, some enlarged as cup-shaped structures resembling ovicells. *Ord.*——Fig. 89,*7*. **A. nitida,* Blkriv., Va.; *7a,* front; *7b,c,* back of segment with basal joint and front; all ×20 (131).

Glauconomella Bassler, 1952 [**Glauconome disticha* Goldf., 1836]. Zoarium continuous, pinnate, with short side branches joined obliquely to stem, lacking apertures on back; basal articulation not observed. *Ord.-Sil.*——Fig. 89,*4*. *G. plumula* (Wiman), Ord.(from drift), Gotl.; *4a,b,* front, back, ×10 (232).——Fig. 89,*5*. **G. disticha* (Goldf.), Sil. (Wenlock.), Eng.; *5a,* front, ×10; *5b,* zoarium, ×1 (157).

Helopora Hall, 1851 [**H. fragilis*]. Like *Arthrostylus* but segments larger, apertures on all sides,

[1]Mather, K. F., 1915, Denison Univ. Bull. Sci. Lab., vol. 18, p. 131.

and acanthopores present. *Ord.-Sil.*——Fig. 90,*1*. **H. fragilis*, Sil. (Medin.), N.Y.; *1a-d*, secs., ×20 (222).

Heminematopora [**H. virginiana*]. Differs from *Nematopora* in having longitudinally striate back lacking apertures. *Ord.*——Fig. 89,*8*. **H. virginiana*, Blkriv., Va.; *8a,b*, front, back, ×20; *8c*, front of branch with broken basal point, ×20 (131).

Hemulrichostylus Bassler, 1952 [**H. lineata*]. Like *Ulrichostylus* but jointed only at base and has broad striate back. *Ord.*——Fig. 89,*6*. **H. lineata*, Blkriv., Va.; *6a,b*, front, back, ×20 (131).

Nematopora Ulr., 1888 (*non* Duv., 1920) [**Trematopora minuta* Hall, 1876]. Zoarium dichotomously branched, continuous, articulated only at base; apertures on all sides. *Ord.-Sil.*——Fig. 90,*5*. **N. minuta* (Hall), Sil.(Clinton.), N.Y.; *5a*, surface, ×10; *5b,c*, secs., ×20 (131).——Fig. 90,*6*. *N. delicatula* Ulr., Ord.(Trenton.), Ill.; branch with basal joint, ×20 (131).——Fig. 90,*7*. *N. ovalis* Ulr., Ord.(Trenton.), Minn.; surface, ×20 (222).

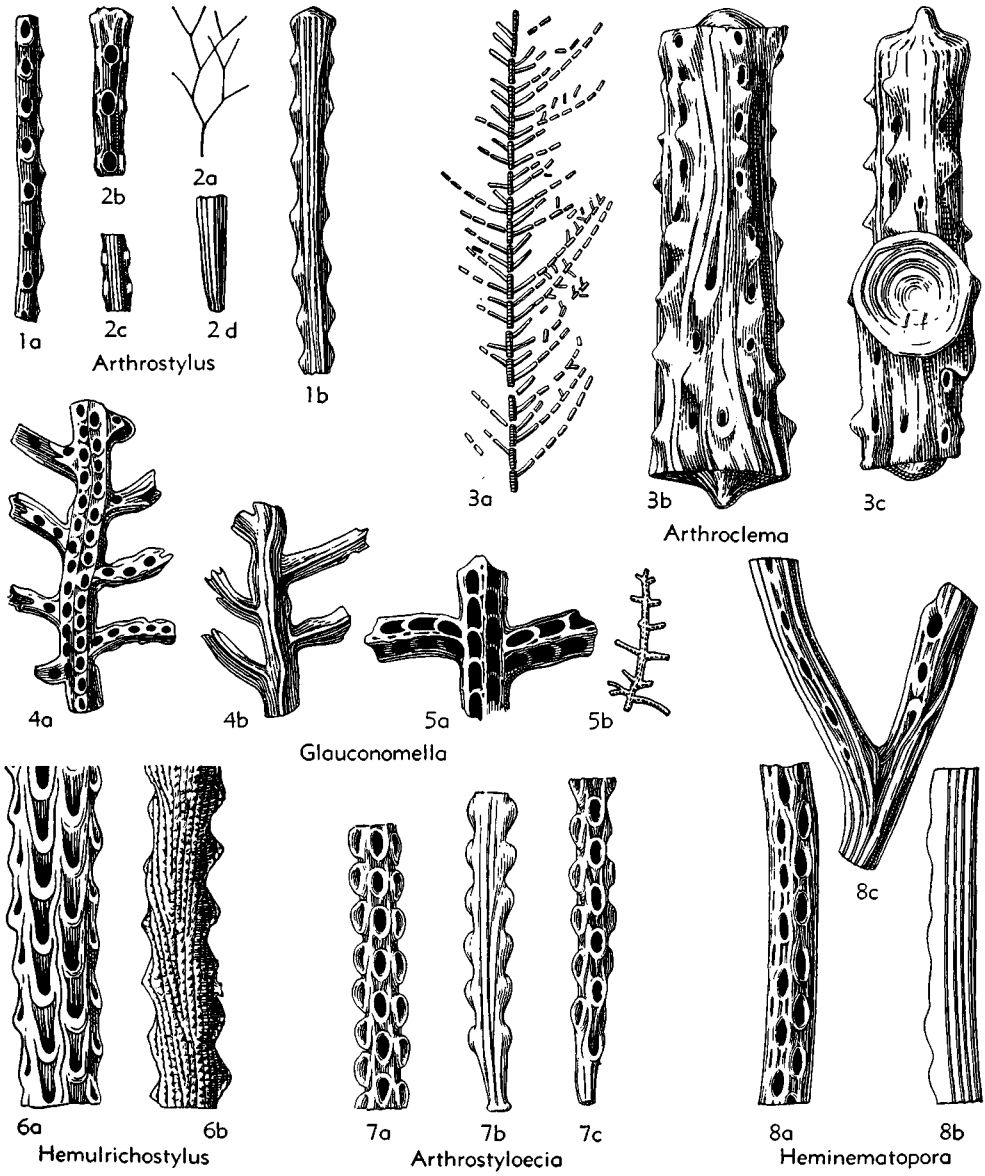


Fig. 89. Arthrostylidae (p. G128, G129).

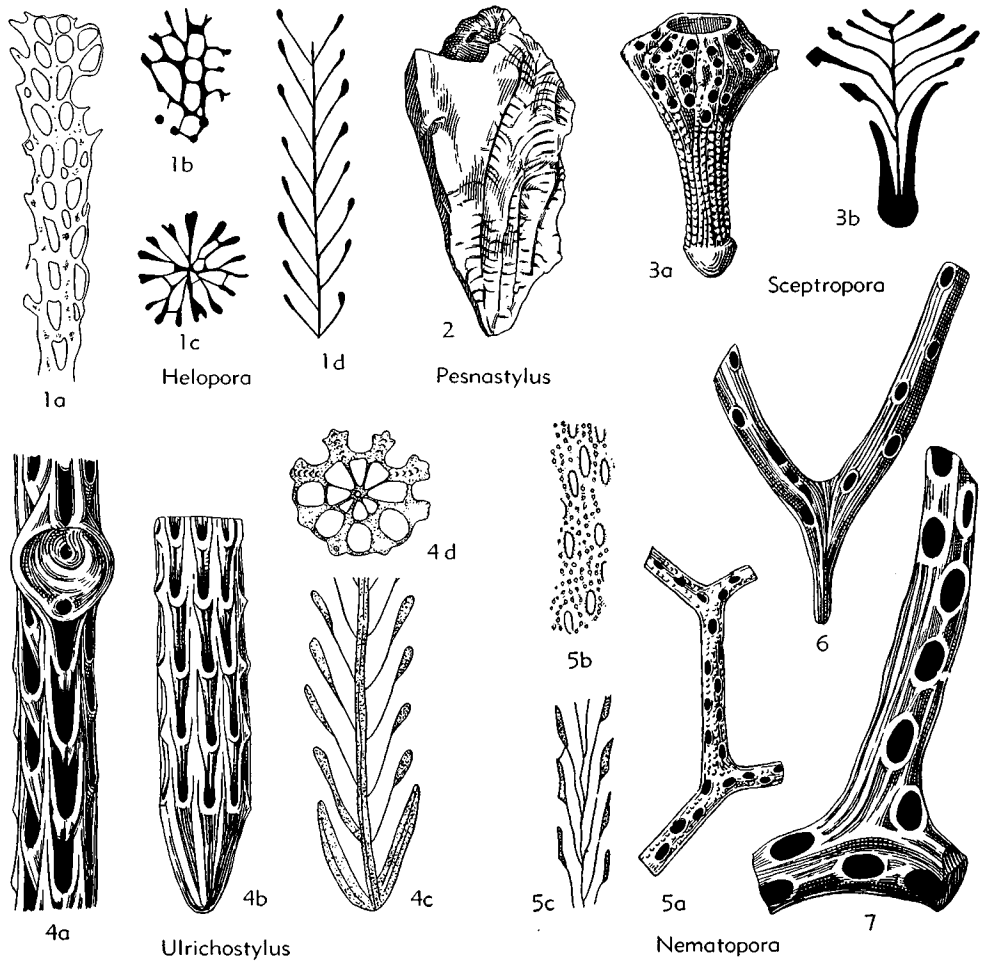


FIG. 90. Arthrostylidae (p. G128-G130).

Pesnastylus CROCKFORD, 1941 [**P. humei*]. Zoarium pinnate, probably articulated at base. *Sil.*——FIG. 90,*2*. **P. humei*, N.S.W.; zoarium, ×1 (142).

Sceptropora ULR., 1888 [**S. facula*]. Segments proximally slender and striate all around, distally much expanded and bearing apertures in several linear series. *Ord.*——FIG. 90,*3*. **S. facula*, Richmond., Minn.; *3a*, segment, ×20; *3b*, long. sec., ×20 (222).

Ulrichostylus BASSLER, 1952 [**Helopora divaricatus* ULR., 1893]. Slender cylindrical stems, with 8 or more longitudinal rows of apertures; articular faces at base and one side. *Ord.*——FIG. 90,*4*. **U. divaricatus* (ULR.), Blkriv., Minn.; *4a*, stem with lateral socket; *4b*, basal part of segment; *4c,d*, secs.; all ×20 (*4a*, 131; *4b-d*, 222).

Family RHABDOMESIDAE Vine, 1883

[as Rhabdomesontidae]

[=Rhomboporidae SIMPSON, 1895; Bactroporidae SIMPSON, 1897]

Zoaria slender cylindrical, unarticulated, branched or unbranched, generally solid stems with an immature axial region of thin-walled tubes and strongly differentiated cortex-like mature zone of thickened structure. Zooecial tubes typically curved or abruptly bent toward surface, with or without diaphragms in immature region and commonly bearing hemisepta near inner edge of mature region; apertures mostly elliptical, within a more or less defined sloping vestibule which may be rhombic

hexagonal in form. Acanthopores abundant in most genera, including notably enlarged ones (megacanthopores) and small ones (micracanthopores); mesopores commonly absent (114; NICKLES-B., 1900; BASSLER, 1952). *Sil.-Perm.*

Rhabdomeson Y.-Y., 1874 [**Millepora gracilis* PHILLIPS, 1841]. Differs from *Rhombopora* in having a hollow axial epithecate tube from which zooecia extend obliquely outward. *Miss.-Perm.*——FIG. 91,*1*. **R. gracile* (PHILLIPS), L.Carb., Eng.; *1a*, surface, ×20; *1b,c*, secs., ×20 (131).

Acanthoclema HALL, 1886 [**Trematopora alternata* HALL, 1883]. Zoarium with filiform axis; apertures in longitudinal series defined by ridges, with a megacanthopore between each pair of apertures. *Dev.-Miss.*——FIG. 91,*3*. **A. alternata* (HALL), M.Dev.(Onond.), N.Y.; *3a*, zoarium, ×1; *3b,c*, surface, ×5, ×20 (162).

Ascopora TRAUTSCHOLD, 1876 [**Millepora rhombifera* PHILLIPS, 1836]. Like *Rhabdomeson* but axis comprises a bundle of parallel immature tubes. *Carb.-Perm.*——FIG. 91,*5*. **A. rhombifera* (PHIL-

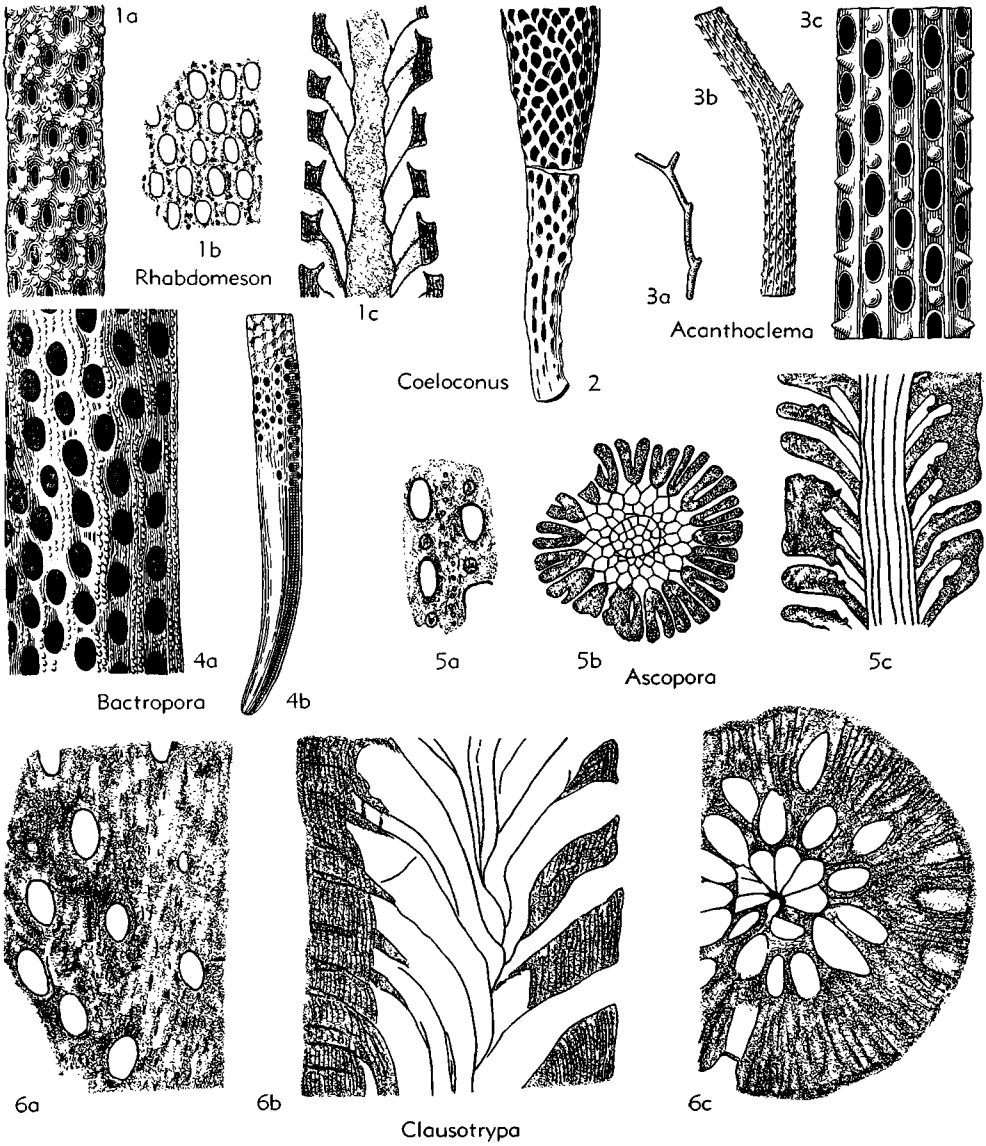


FIG. 91. Rhabdomesidae (p. G131, G132).

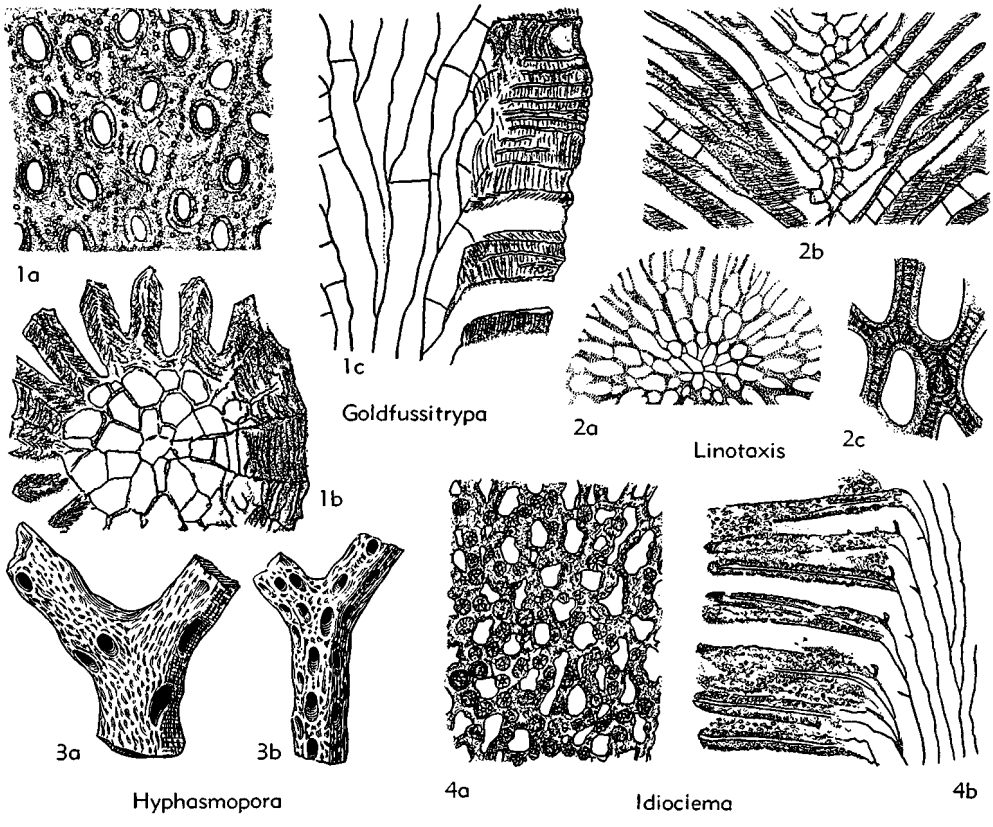


FIG. 92. Rhabdomesidae (p. G132).

LIPS), L.Carb., Eng.; *5a-c,* secs., tang. (×25), transv. (×10), long. (×10) (198).

Bactropora HALL-S., 1887 [**Trematopora? granistriata* HALL, 1883]. Resembles *Rhombopora;* proximal extremity pointed. *Dev.-Miss.*——FIG. 91,*4. *B. granistriata* (HALL), M.Dev.(Hamilton), N.Y.; *4a,b,* surface, ×20, ×5 (162).

Clausotrypa BASSLER, 1929 [**C. separata*]. Like *Streblotrypa* but zooecia arise from axial line in ascending spirals; mesopores closed by laminated tissue. *Miss.-Perm.*——FIG. 91,*6. *C. separata,* Perm., Timor; *6a-c,* secs., tang., long., transv., ×20 (131).

Coeloconus ULR., 1889 [**C. rhombicus* ULR., 1890]. Like *Rhabdomeson* but axial hollow expands distally like whole zoarium. *Miss.*——FIG. 91,*2. *C. rhombicus* ULR., Warsaw, Ill.; surface, ×10 (222).

Goldfussitrypa BASSLER, 1952 [**Rhombopora esthonia* BASSLER, 1911]. Zooecia with diaphragms in immature region, no hemisepta, thick-walled mature zone with abundant micracanthopores. *Ord.*——FIG. 92,*1. *G. esthonia* (BASSLER), M. Ord., Est.; *1a-c,* secs., tang., transv., long., ×20 (131).

Hyalotoechus MCNAIR, 1942 [**H. duncani*]. Like *Rhombopora* but has heterophragms projecting from thickened walls of mature region, no diaphragms. *Dev.*——FIG. 93,*1. *H. subannulata* (ULR.), M.Dev., Iowa; *1a,b,* secs., ×20; *1c,* surface, ×10; *1d,* zoarium, ×1 (222).——FIG. 93,*2. *H. duncani,* Chemung., N.Y.; *2a,b,* secs., ×20 (182).

Hyphasmopora ETH., 1875 [**H. buskii*]. Like *Streblotrypa* but one side nearly all occupied by minute pits representing mesopores. *Carb.-Perm.*——FIG. 92,*3. *H. buskii,* L.Carb., Scot.; *3a,b,* back, front, ×15 (151).

Idioclema GIRTY, 1911 [**I. insigne*]. Like *Rhombopora* but lacks diaphragms, megacanthopores as large as zooecia. *Miss.*——FIG. 92,*4. *I. insigne,* Chest., Ark.; *4a,b,* secs., ×25 (131).

Linotaxis BASSLER, 1952 [**Orthopora? magna* MCNAIR, 1942]. Like *Rhombopora* but zooecia develop from linear axis, without hemisepta; single large megacanthopore at distal edge of each aperture. *U.Dev.*——FIG. 92,*2. *L. magna* (MCNAIR), ?Chemung., N.Y.; *2a-c,* secs., transv. (×25), long. (×25), tang. (×50) (131).

Megacanthopora MOORE, 1929 [**M. fallacis*]. Megacanthopores unusually large, containing diaphragms, commonly oriented oblique to surface; may be synonym of *Rhombopora*. *Penn.*——FIG. 95,*7*. **M. fallacis*, U.Penn., Tex.; *7a,b*, secs., ×25 (131).

Nemataxis HALL, 1886 [**N. fibrosus*]. Thick stems annulated by low transverse monticules. Zooecia developed from a filiform axis, without diaphragms but bearing inferior and superior hemisepta, thick-walled in mature zone, with oval apertures. Micracanthopores numerous. *Dev.*——FIG. 93,*3*. **N. fibrosus*, M.Dev.(Onond.), Ont.; *3a,b*, secs., ×20; *3c*, surface, ×5 (*3a*, 162; *3b,c*, 131).

Nemataxidra BASSLER, 1952 [**N. piercensis*]. Like *Nemataxis* internally but lacks hemisepta and mature zone not sharply differentiated. *Ord.*——FIG. 93,*4*. **N. piercensis*, Blkriv., Tenn.; *4a-c*, secs., ×25 (131).

Nematotrypa BASSLER, 1911 [**N. gracilis*]. Slender solid branches. Zooecia very small, developed from filiform axis, containing hemisepta. Minute open tabulate mesopores with micracanthopores at their angles fill interspaces. *Ord.*——FIG. 94,*1*. **N. gracilis*, Est.; *1a,c*, secs., tang. (×50), transv. (×25), long. (×25) (131).

Nicklesopora BASSLER, 1952 [**Rhombopora elegantula* ULR., 1884]. Like *Rhombopora* but lacking diaphragms, hemisepta, and megacanthopores; a single row of micracanthopores around each aperture. *Miss.*——FIG. 94,*2*. **N. elegantula* (ULR.), L.Miss.(Osag.), Ky.; *2a*, zoarium, ×1; *2b,c*, secs., ×20 (222).

Orthopora HALL, 1886 [**Trematopora regularis* HALL, 1874]. Differs from *Rhombopora* in prominence of longitudinal rows of apertures separated by nodose ridges. *Sil.-Dev.*——FIG. 94,*4*. *R. rhombifera* (HALL), L.Dev., W.Va.; *4a,b*, secs., ×20

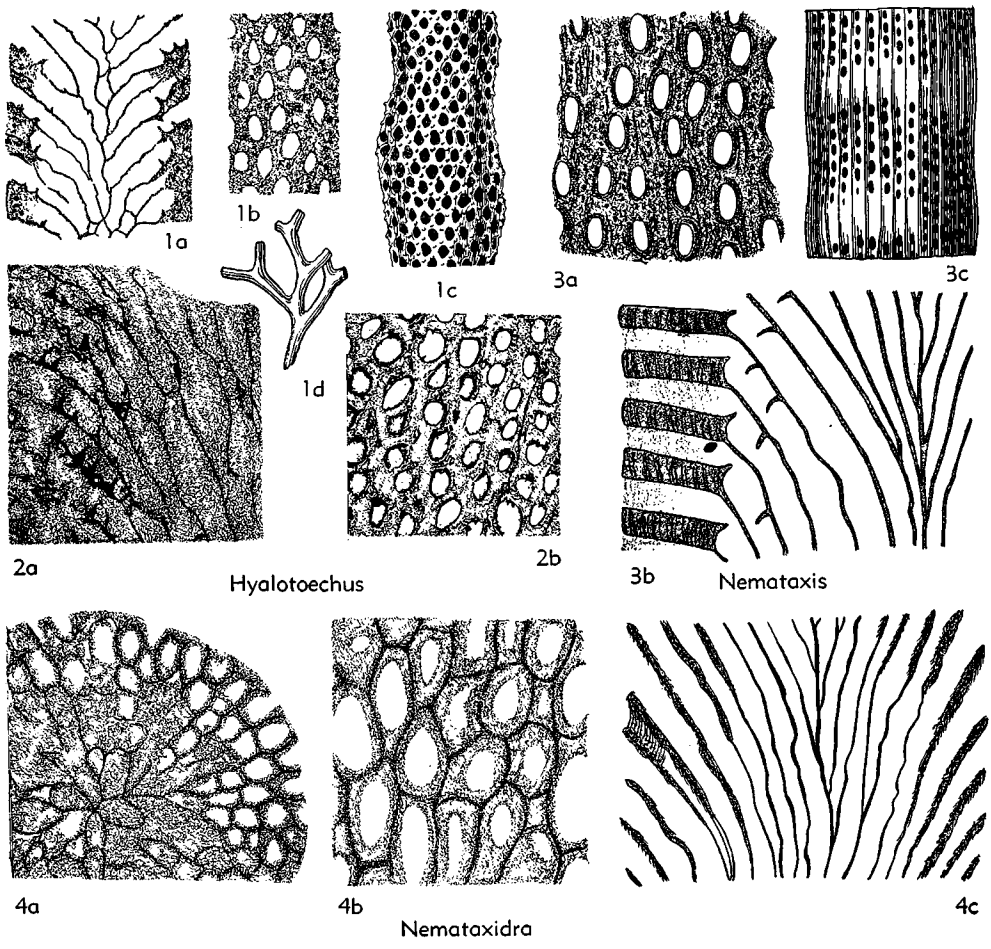


FIG. 93. Rhabdomesidae (p. G132, G133).

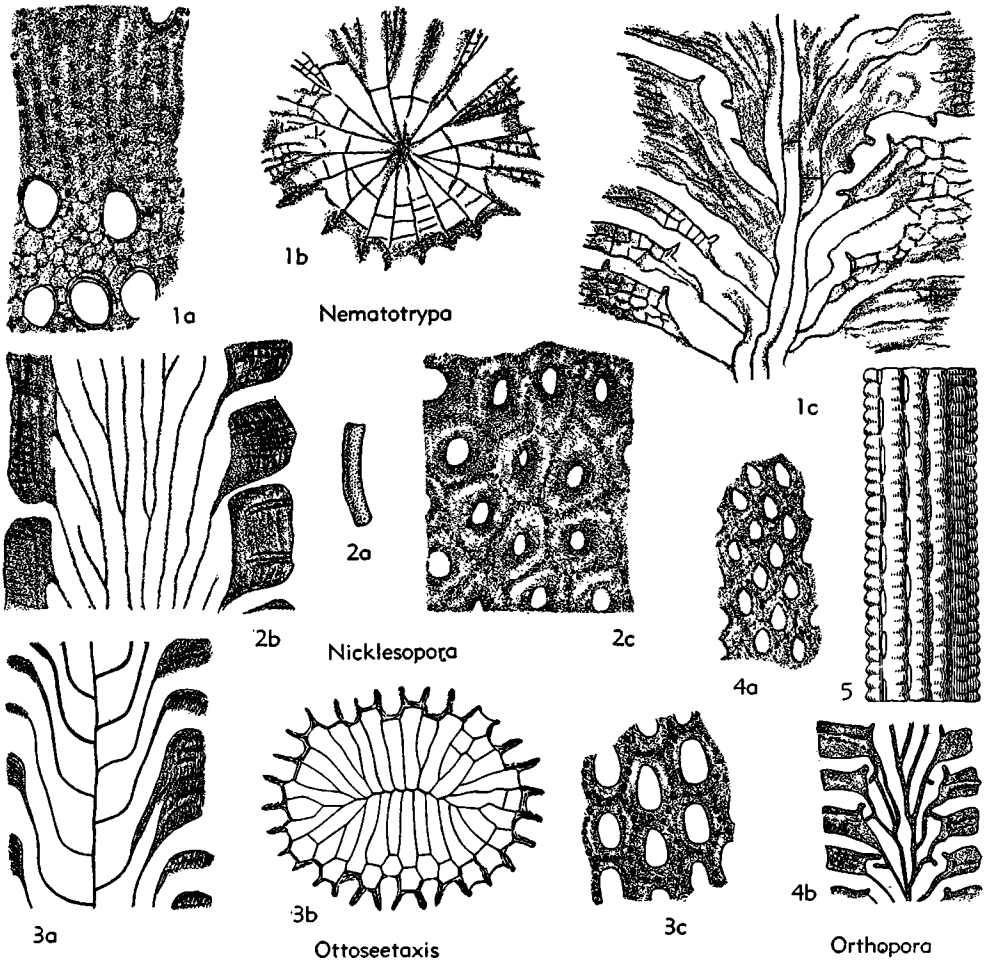


FIG. 94. Rhabdomesidae (p. G133, G134).

(223).——FIG. 94,*5*. **O. regularis* (HALL), L.Dev. (Held.), N.Y.; surface, ×20 (162).

Ottoseetaxis BASSLER, 1952 [**O. bipartitus*]. Slender bifoliate stems lacking external indication of mesotheca; broad immature but narrow mature zone. Zooecia lack diaphragms and hemisepta. Micracanthopores in single row around apertures; no mesopores. *Ord.*——FIG. 94,*3*. **O. bipartitus*, Blk-riv., Tenn.; *3a-c*, secs., ×25 (131).

Petaloporella PRANTL, 1935 [**P. bohemica*]. Like *Streblotrypa* but without hemisepta. *Dev.*——FIG. 95,*1*. **P. bohemica*, Czech.; *1a,b*, secs., ×10 (207).

Rhombocladia ROGERS, 1900 [**R. delicata*]. Like *Rhombopora* but lens-shaped transversely, apertures restricted to front, back smooth. *Penn.-Perm.*——FIG. 95,*3*. **R. delicata*, U.Penn., Kans.; *3a,b*, secs., ×20 (192).

Rhombopora MEEK, 1872 [**R. lepidodendroides*]. Solid slender branching stems, thick-walled in mature region. Zooecia with few diaphragms, no hemisepta; oval apertures within sloping hexagonal vestibules aligned in regular oblique rows. Micracanthopores around each aperture and a megacanthopore at distal edge of each; mesopores lacking. *Dev.-Perm.*——FIG. 95,*4*. **R. lepidodendroides*, L. Perm., Nebr.; *4a-c*, secs., tang., transv., long., ×20 (222).

Rhomboporella BASSLER, 1936 [**R. typica*]. Like *Rhombopora* but zooecial tubes rhombic or quadrate in transverse sections. *Carb.-Perm.*——FIG. 96,*3*. **R. typica*, Carb., Bol.; *3a-c*, secs., ×20; *3d*, zoarium, ×1 (131).

Saffordotaxis BASSLER, 1952 [**Rhombopora incrassata* ULR., 1888]. Like *Rhombopora* but a row of megacanthopores surrounds each aperture. *Miss.*——FIG. 95,*5*. **S. incrassata* (ULR.), L.Miss. (Osag.), Ky.; *5a*, surface, ×10; *5b,c*, secs., ×20 (222).

Spirillopora GÜRICH, 1896 [**S. anguillata*]. Twisted stems with zooecia in spiral rows. *L.Dev.*, Pol.

Streblascopora BASSLER, 1952 [**Streblotrypa fasciculata* BASSLER, 1929]. Like *Streblotrypa* but has axial bundle of parallel tubes. *Perm.*——FIG. 96,*1*. **S. fasciculata* (BASSLER), Timor; *1a-c*, secs., ×20 (131).

Strebloclada CROCKFORD, 1944 [**S. excavata*]. Like *Rhombocladia* but lacks acanthopores. *Perm.*——FIG. 96,*2*. **S. excavata*, W.Austral.; *2a,b*, front, back, ×20 (142).

Streblotrypa VINE, 1885 [**S. nicklesi*]. Like *Rhombopora* but apertures in longitudinal rows with several mesopores between each pair of apertures. *Dev.-Perm.*——FIG. 95,*6*. **S. nicklesi*, U.Miss. (Chest.), Ill.; *6a*, zoarium, ×1; *6b*, surface, ×20; *6c*, long. sec., ×20 (222).

Syringoclemis GIRTY, 1911 [**S. biserialis*]. Hollow cylindrical stem; zooecia, mesopores, and acanthopores as in *Leioclema* but structure seen in long. secs. cryptostomatous. *Miss.*——FIG. 96,*4*. **S. biserialis*, Chest., Ark.; *4a-c*, secs., ×20 (131).

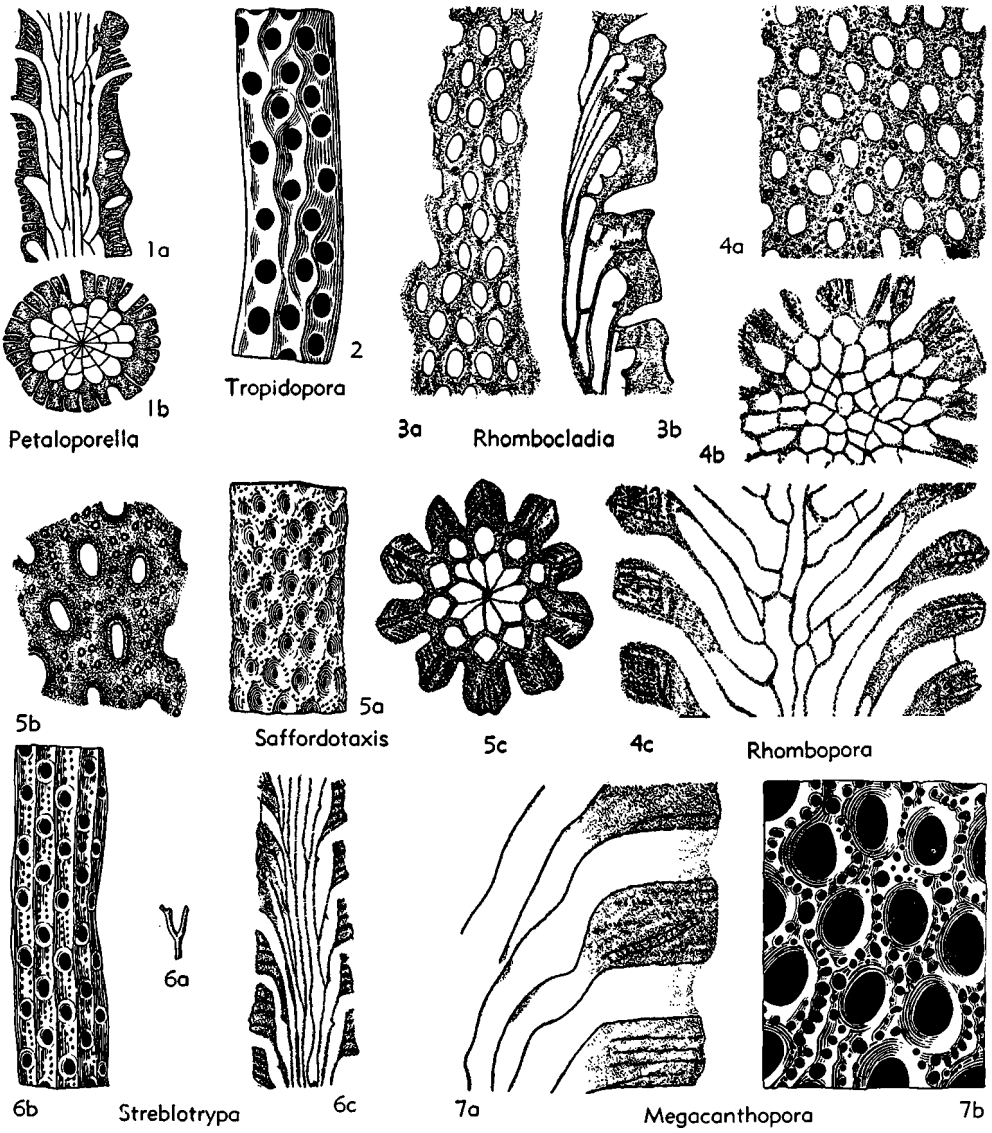


FIG. 95. Rhabdomesidae (p. G133-G136).

Tropidopora HALL, 1886 [**T. nana*]. Apertures in irregular longitudinal rows separated by sinuous ridges. *Dev.*——FIG. 95,*2*. **T. nana*, Onond., N.Y.; surface, ×20 (162).

Family PTILODICTYIDAE Zittel, 1880

[as Ptilodictyonidae]
[=Clathroporidae SIMPSON, 1897]

Zoaria bifoliate, with monticules or maculae in broad forms, articulating proximally with a basal expansion. Zooecia developed from median lamina (mesotheca), forming 2 layers that grow back to back, without median tubuli; hemisepta common. Mesopores rare (3,114; NICKLES-B., 1900). *Ord.-Dev.*

Ptilodictya LONSD., 1839 [**Flustra lanceolata* GOLDF., 1826][=*Heterodictya* NICH., 1875]. Falciform to broad fronds with longitudinally arranged oblong zooecia. *Ord.-Dev.*——FIG. 97,*1*. *P. expansa* HALL, L.Sil.(Brassfield), Ohio; *1a,b*, secs., tang., long., ×20 (222).——FIG. 97,*2*. *P. nebulosa* (HALL), L.Dev.(Held.), N.Y.; *2a*, surface with monticules, ×5; *2b*, zoarium, ×1 (162).——FIG. 97,*3*. **P. lanceolata* (GOLDF.), Sil.(Wenlock.), Eng.; zoarium, ×1 (157).

Arthropora ULR., 1882 [**Stictopora (Ptilodictya) shafferi* MEEK, 1872][=*Crateripora* ULR., 1879]. Numerous small equal articulated segments in one plane, attached to socket on an expanded base (*Crateripora erecta* ULR.). *Ord.*——FIG. 98,*1*. **A. shafferi* (MEEK), Maysv., Ohio; *1a*, zoarium, ×1; *1b*, part of base, ×10; *1c*, surface, ×20; *1d*, long. sec., ×20 (222).

Clathropora HALL, 1852 [**C. frondosa* HALL, 1892]. Like *Ptilodictya* but with articulating base and forming a network of oval fenestrules. *Sil.-Dev.*——FIG. 97,*7*. **C. frondosa*, Sil.(Clint.), N.Y.; *7a,b*, zoarium, ×1, ×5; *7c,d*, secs., tang., long., ×20 (131).

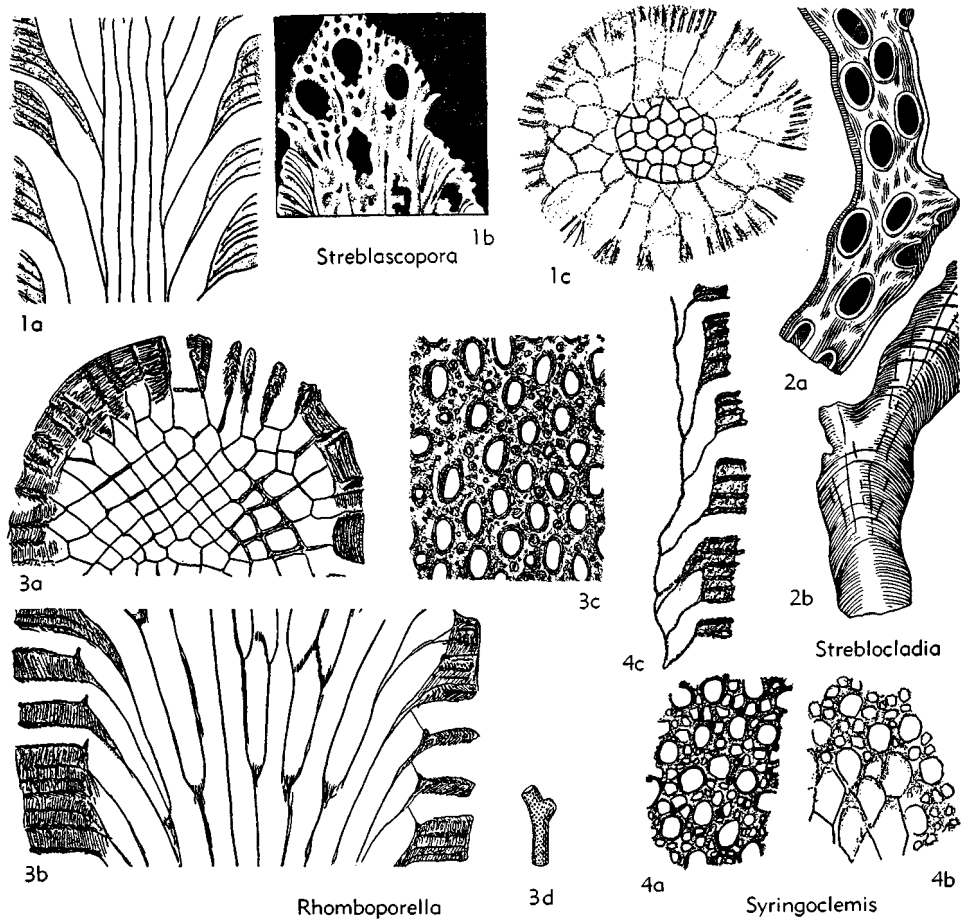


FIG. 96. Rhabdomesidae (p. G134, G135).

Escharopora HALL, 1847 [**E. recta*][=*Nicholsonia* WAAG.-W., 1886]. Like *Ptilodictya* but apertures arranged in intersecting series; articulating with a basal expansion. *Ord.*——FIG. 98,*4*. **E. recta*, Trenton., N.Y.; *4a*, basal expansion, ×10; *4b*, zoarium, ×1; *4c*, surface, ×20 (162).——FIG. 98,*5*. *E. angularis* ULR., Blkriv., Minn.; zoarium, ×10 (222).

Graptodictya ULR., 1882 [**Ptilodictya perelegans* ULR., 1878][=*Graptopora* ULR., 1882 (*nom. nud.*)(*non* SALTER, 1858)]. Like *Arthropora* but zoarium is a single or inosculating frond jointed only at base. *Ord.*——FIG. 98,*3*. **G. perelegans* (ULR.), Richmond., Ohio; *3a*, zoarium, ×1; *3b*, surface, ×20; *3c*, long. sec., ×25 (*3a,b*, 222; *3c*, 131).

Phaenopora HALL, 1851 [**P. explanata* HALL, 1852]. Like *Ptilodictya* but mesopores in interspaces between ends of apertures. *Ord.-Dev.*——FIG. 97,*4*. *P. lirata* HALL, L.Dev., N.Y.; *4a*, zoarium, ×5; *4b*, surface, ×20 (162).——FIG. 97,*5*. **P. explanata* HALL, Sil.(Medin.), Ont.; *5a*, zoarium, ×1; *5b*, surface, ×20 (162).——FIG. 97,*6*. *P. constellata* HALL, Sil.(Clint.), N.Y.; *6a,b*, secs., tang., long., ×20 (222).

Stictoporina HALL-S., 1887 [**Trematopora claviformis* HALL, 1883]. Branching segments with articulating base and intersecting apertures. *Dev.*——FIG. 98,*2*. **S. claviformis* (HALL), Hamilton, N.Y.; zoarium, ×5 (162).

Family STICTOPORELLIDAE Nickles & Bassler, 1900

[=Heliotrypidae, ?Stictoporidae MILLER, 1889; Intraporidae SIMPSON, 1897]

Like Ptilodictyidae but zoarium without articulation between upper part and ex-

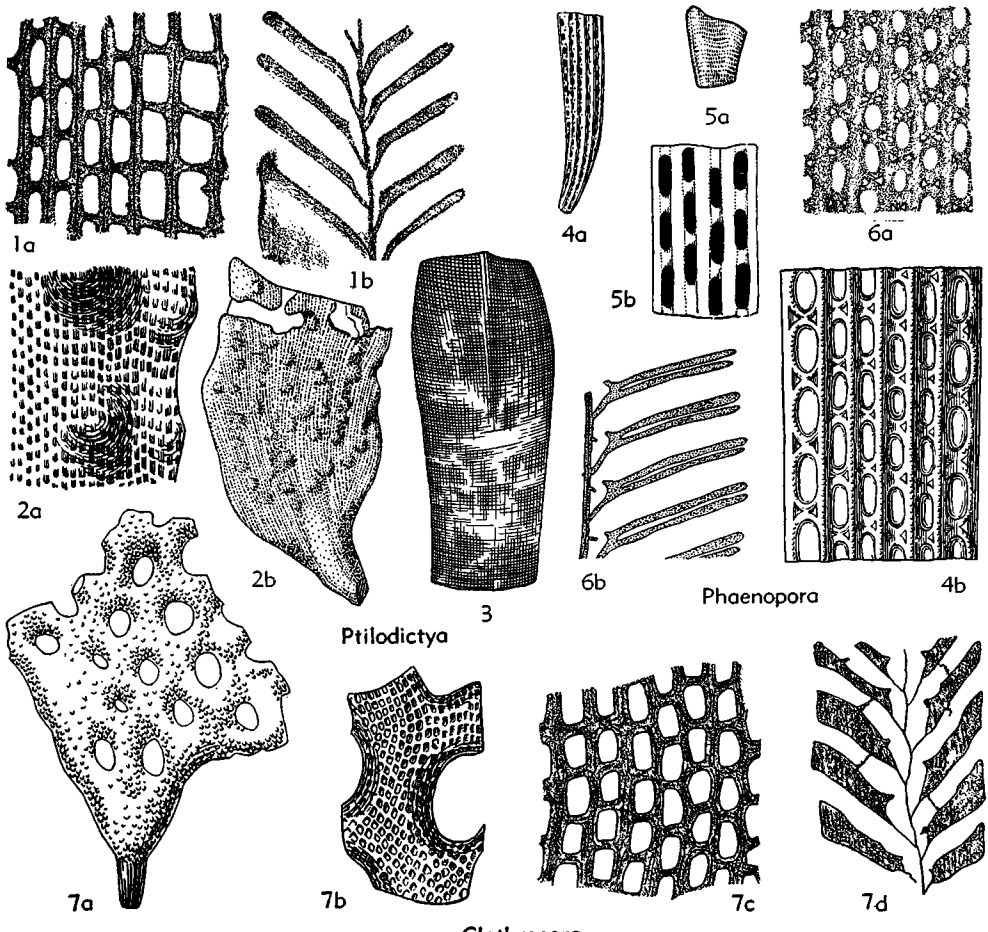


FIG. 97. Ptilodictyidae (p. G136, G137).

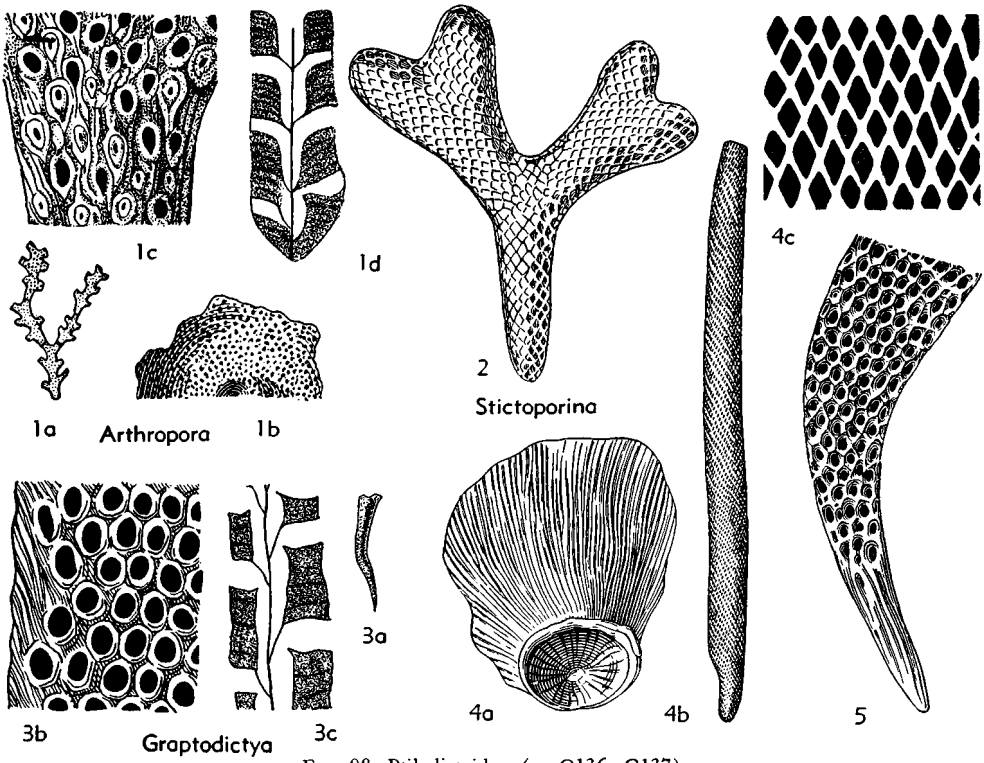


FIG. 98. Ptilodictyidae (p. G136, G137).

panded base, and mesopores present commonly (NICKLES-B., 1900). *Ord.-Miss.*

Stictoporella ULR., 1882 [**S. interstincta* (=*Ptilodictya flexuosa* JAMES, 1878)] [=*Micropora* EICHW., 1855 (*non* GRAY, 1848); *Lemmatopora* POČTA, 1894]. Zoaria narrow cribrose or leaflike, with elliptical apertures at bottom of a sloping area; thick-walled nontabulate mesopores between apertures and lining zoarial margins. *Ord.*——FIG. 99,*1*. **S. flexuosa* (JAMES), Eden., Ohio; *1a,b,* secs., long., tang., ×25 (222).——FIG. 99,*2*. *S. cribrosa* ULR., Blkriv., Minn.; *2a,* zoarium, ×1; *2b,* surface, ×20 (222).

Coscinella HALL-S., 1887 [**C. elegantula*]. Explanate frond of anastomosing branches. Zooecia tubular, resting on mesotheca with direct vestibules; apertures circular, irregularly disposed. Tabulate mesopores opening at surface as minute angular pits occupy spaces between vestibules and margins of fenestrules. *Dev.*——FIG. 99,*5*. **C. elegantula,* Hamilton, Ont.; *5a,* zoarium, ×1; *5b,c,* secs., tang., long., ×20 (163).

Heliotrypa ULR., 1883 [**H. bifolia*]. Zoarium with maculae. Zooecia subtubular, prostrate on mesotheca, with superior hemiseptum; thick-walled vestibules traversed obliquely by tubuli, apertures circular. Mesopores common. *Miss.*——FIG. 99,*4*. **H. bifolia,* Chest.(Glen Dean), Ky.; *4a,* surface with macula, ×20; *4b,c,* secs., tang., long., ×50, ×20 (222).

Intrapora HALL, 1883 [**I. puteolata*]. Like *Taeniodictya* but tabulate mesopores numerous. *Dev.*——FIG. 99,*8*. **I. puteolata,* Onond., Falls Ohio, Ky.-Ind.; *8a,* zoarium, ×1; *8b,* surface, ×20 (162).

Ptilotrypa ULR., 1890 [**P. obliquata*]. Zoarium compressed or frondescent; surface with irregular longitudinally channeled areas resembling maculae. Zooecia long, oblique tubes with few diaphragms; apertures ovate, some with accessory pore at extremity. *Ord.*——FIG. 99,*7*. **P. obliquata,* Richmond., Ill.; *7a,b,* secs., ×20; *7c,* surface, ×10 (222).

?Stictopora HALL, 1847 [**S. elegantula*] [?=*Stictotrypa* ULR., 1890]. Slender ribbon-like bifoliate branches. Zooecial tubes long, without hemisepta: apertures with distinct peristomes; interspaces wide, without mesopores (may belong in Rhinoporidae). *Ord.*——FIG. 99,*6*. **S. elegantula,* Trenton., N.Y.; *6a,* zoarium, ×1; *6b,* surface, ×20 (162).

Taeniodictya ULR., 1888 [**T. interpolata*]. Branches compressed. Zooecia short, tubular, oblong, both hemisepta present; apertures subcircular in sloping vestibule; interspaces ridgelike. *Sil.-Miss.*——FIG. 99,*3*. **T. interpolata,* Waverlian, Ohio; *3a,* surface, ×20; *3b,* zoarium, ×1 (222).

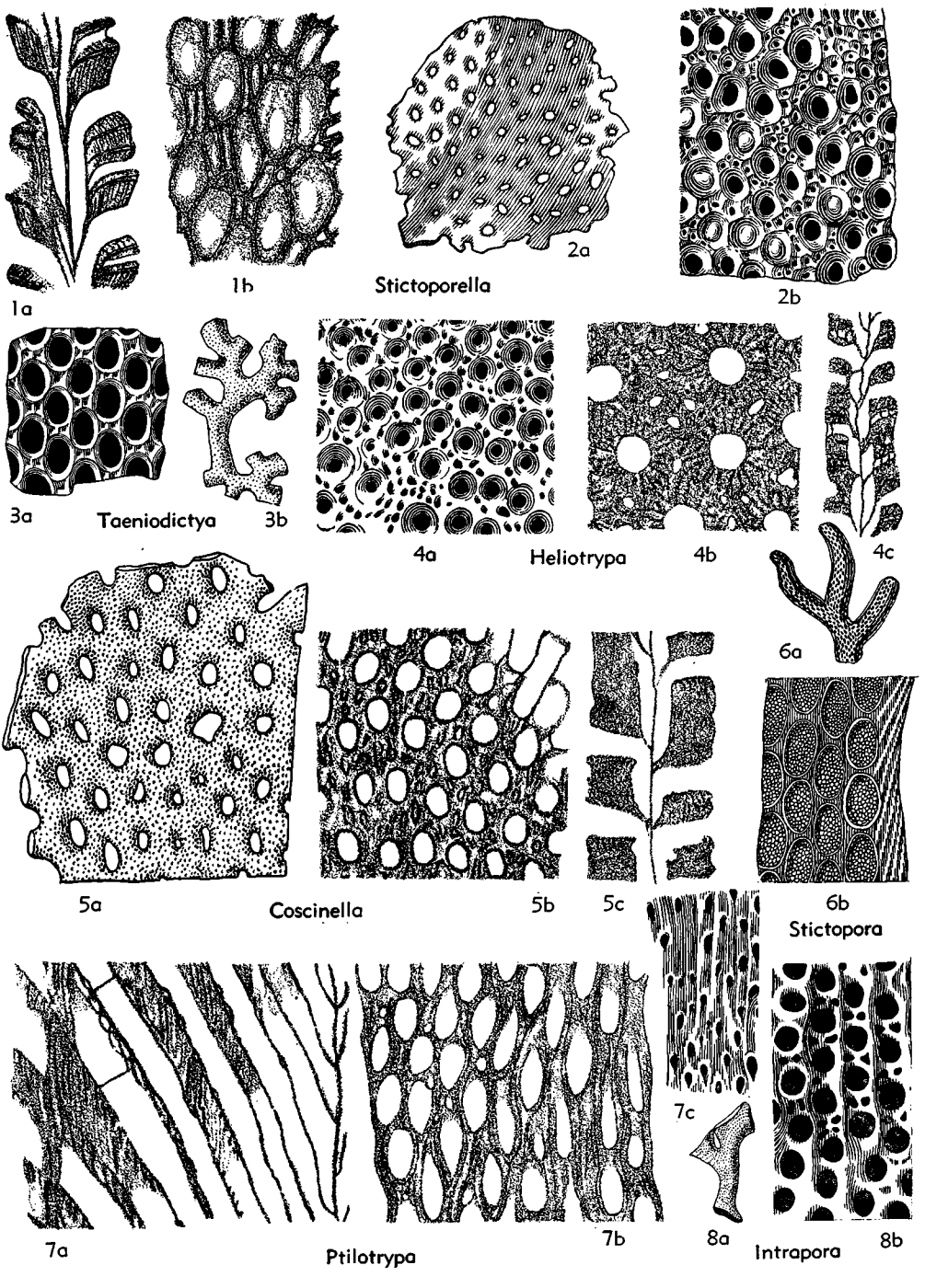


FIG. 99. Stictoporellidae (p. G138).

Family RHINIDICTYIDAE Ulrich, 1895
[as Rhinidictyonidae]

Zoarium bifoliate or rarely trifoliate, continuous or jointed compressed branches or erect expansions. Zooecia subquadrate proximally, arranged longitudinally, apertures elliptical to subcircular; inferior hemiseptum and lunarium absent. Median tubuli between laminae of the mesotheca and between rows of zooecia. Mesopores absent, but vesicular tissue common (3,114,115; NICKLES-B., 1900). *Ord.-Carb.*

Rhinidictya ULR., 1882 [**R. nicholsoni*] [=*Stictopora* ULR., 1882 (*non* HALL, 1847)]. Narrow, compressed, dichotomously dividing, straight-edged bifoliate branches, attached by a continuous expanded base. Apertures in longitudinal series between slightly flexuous ridges which bear a crowded row of small blunt spines; median tubuli in mesotheca. *Ord.*——FIG. 100,*1*. **R. nicholsoni*, Blkriv., Ky.; *1a,b*, secs., ×20; *1c*, zoarium, ×5; *1d*, surface, ×20 (222).

Dicranopora ULR., 1882 [**Ptilodictya internodia* MILLER & DYER, 1878]. Like *Rhinidictya* but zoarium jointed; segments straplike, rarely simple, commonly bifurcating; extremities thickened. *Ord.-Dev.*——FIG. 100,*4*. **D. internodia* (MILLER & DYER), Maysv., Ohio; *4a*, zoarium, ×1; *4b*, proximal part of segment, ×20; *4c,d*, secs., ×25 (222).

Eurydictya ULR., 1889 [**E. montifera* ULR., 1890]. Like *Rhinidictya* but zoarium a broad, simple or irregularly divided bifoliate expansion, with sur-

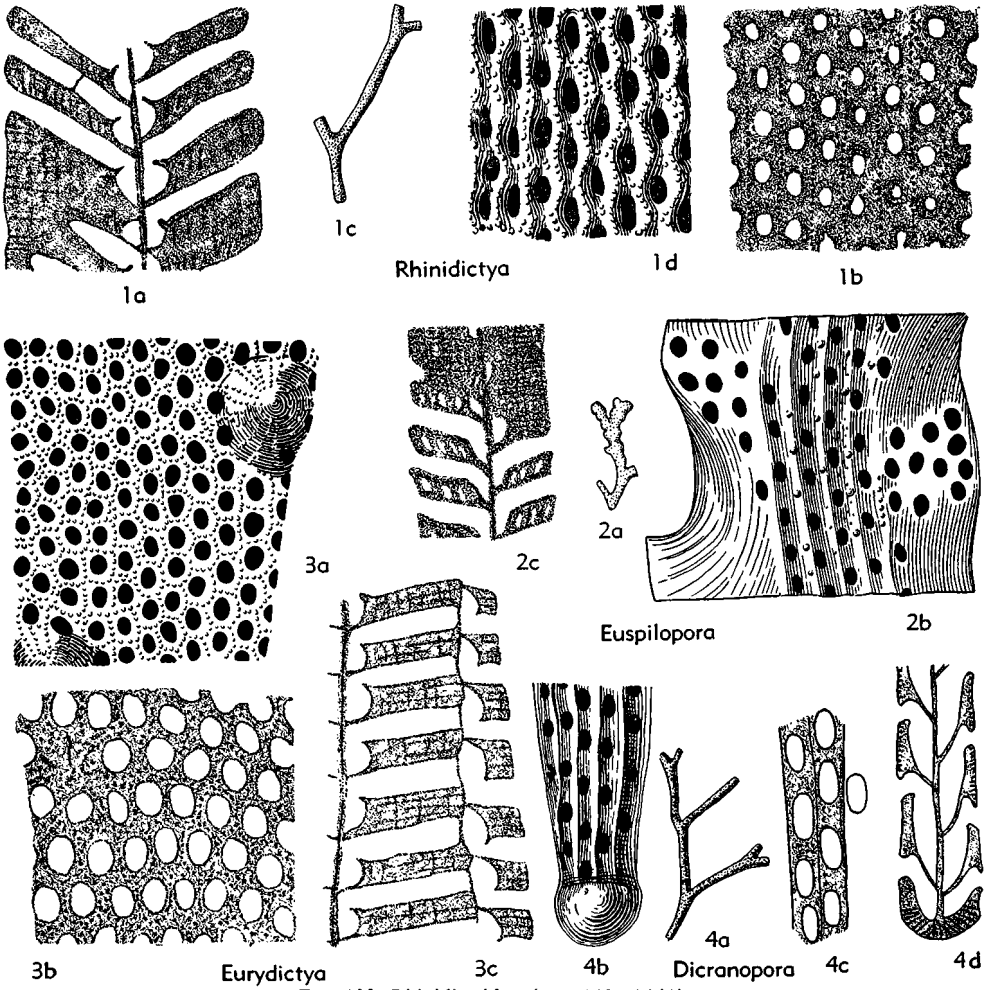


FIG. 100. Rhinidictyidae (p. G140, G141).

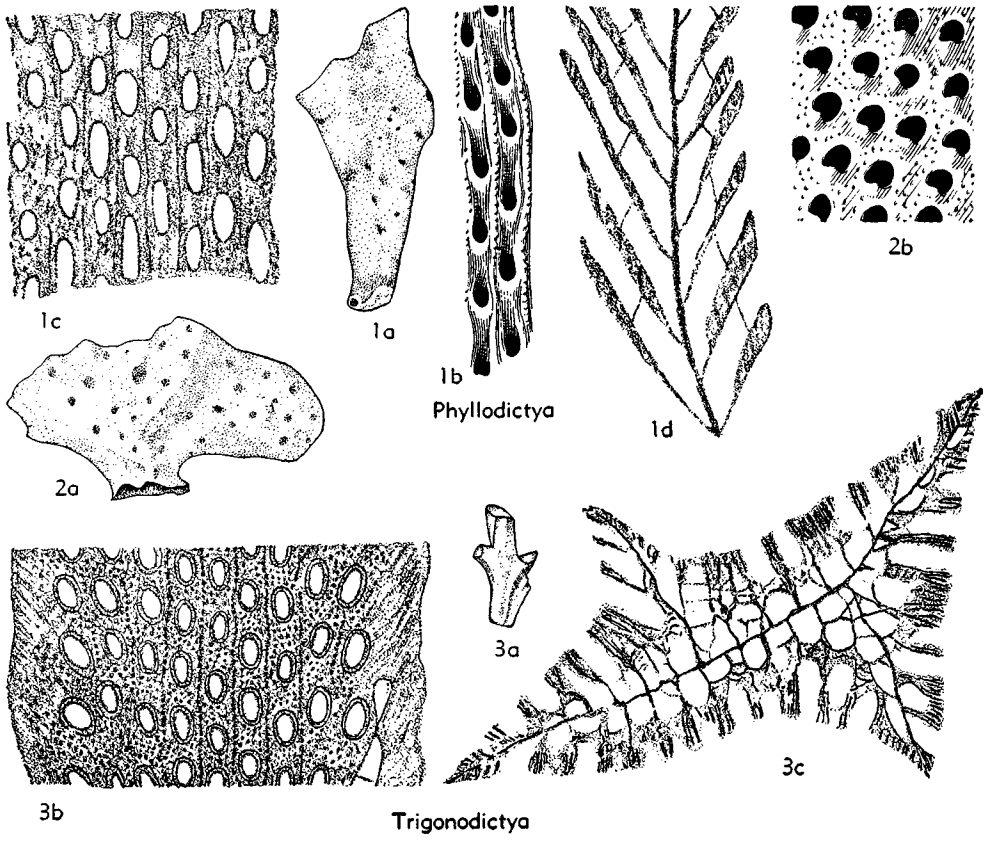


FIG. 101. Rhinidictyidae (p. G141, G142).

face bearing more or less conspicuous, small solid maculae or monticules. *Ord.*——FIG. 100,*3*. ***E. montifera*** ULR., Richmond., Ill.; *3a,* surface; *3b,* tang. sec.; *3c,* long. sec. showing normal zooecia on one side of mesotheca (left) and superposed thin layer of secondary, oppositely oriented zooecia (right); all ×20 (222).

Euspilopora ULR., 1889 [**E. serrata* ULR., 1890]. Small, irregularly divided branches with wavy edges. Zooecia erect, without hemisepta; oval apertures in 4 or more longitudinal rows between node-bearing ridges along middle of branches and in clusters on either side of these rows. Vesicles between zooecia and tubuli normal to surface in interspaces between zooecial clusters. *Dev.*——FIG. 100,*2*. *E. serrata* ULR., M.Dev., Iowa; *2a,* zoarium, ×1; *2b,* surface, ×20; *2c,* long. sec., ×20 (222).

Goniotrypa ULR., 1889 [**G. bilateralis*]. Like *Dicranopora* but with prominent median ridge on both sides of segments. *Ord.*——FIG. 102,*4*. ***G. bilateralis,*** Richmond., Manitoba; surface, ×20 (222).

Hemidictya CORYELL, 1921 [**H. lebanonensis*]. Like *Pachydictya* but has hemisepta. *Ord.* Blkriv., Tenn.

Pachydictya ULR., 1882 [**P. robusta*]. Broad bifoliate fronds with maculae (or monticules); less commonly narrow bifurcating stipes. Zooecia erect, with well-spaced diaphragms but no hemisepta; apertures oval, crowded. Vesicles between zooecia, filled by calcareous tissue near surface and traversed by tubuli. *Ord.-Sil.*——FIG. 102,*2*. ***P. robusta,*** Blkriv., Tenn.; *2a,* zoarium, ×1; *2b,* tang. sec., ×20; *2c,* surface, ×20 (222).——FIG. 102,*3*. *P. foliata* ULR., Blkriv., Minn.; long. sec., ×20 (222).

Phyllodictya ULR., 1882 [**P. frondosa*]. Broad bifoliate frond with expanded base. Zooecial tubes straight, oblique to mesotheca, with few diaphragms, no hemisepta; apertures strongly oblique. Interspaces filled with vesicles, traversed by tubuli, which appear as papillae at surface. *Ord.*——FIG. 101,*1*. *P. varia* ULR., Blkriv., Minn.; *1a,* zoarium, ×1; *1b,* surface, ×20; *1c,d,* secs., ×20 (222).——FIG. 101,*2*. ***P. frondosa,*** Blkriv., Ky.; *2a,* zoarium, ×1; *2b,* surface, ×20 (222).

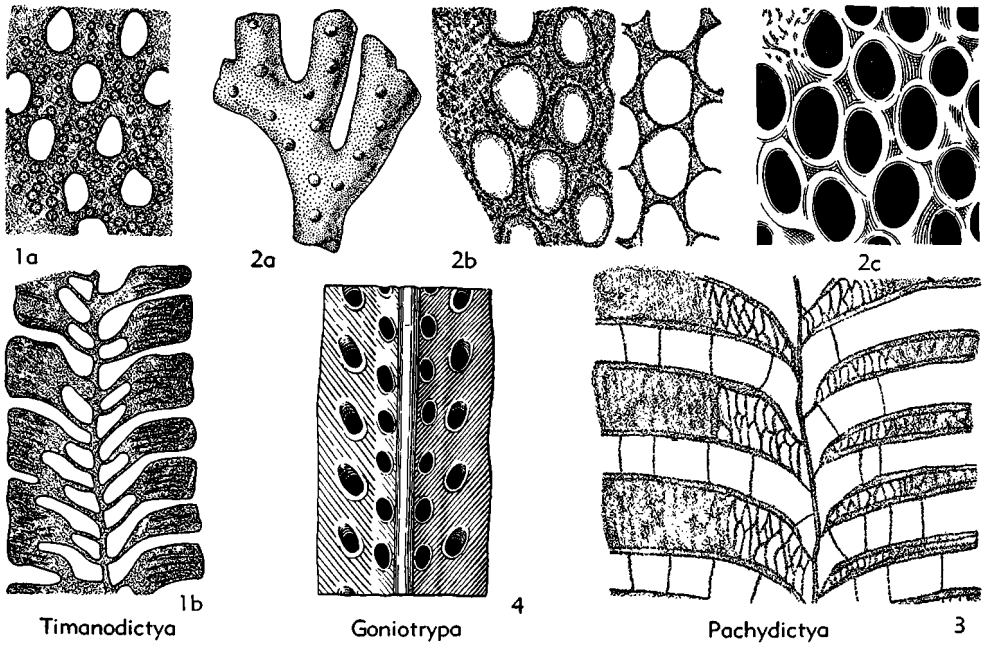


FIG. 102. Rhinidictyidae (p. G141, G142).

Timanodictya NIKIF., 1938 [**Coscinium dichotoma* STUCK., 1887]. Bifoliate dichotomous ribbon-like branches. Zooecial apertures in diagonally intersecting rows. Noncelluliferous maculae with stellate acanthopores at regular intervals; interzooecial spaces with acanthopores, no vesicles. *Carb.-Perm.*——FIG. 102,*1*. **T. dichotoma* (STUCK.), Carb., Russ.; *1a,b*, secs., ×25, ×10 (198).

Timanotrypa NIKIF., 1938 [**T. foliata*]. Like *Timanodictya* but zoarium a symmetrical expansion. *Carb.*, Russ.

Trigonodictya ULR., 1893 [**Pachydictya conciliatrix* ULR., 1886]. Differs from *Pachydictya* in triangular cross section of zoarium. *Ord.-Sil.*——FIG. 101,*3*. **T. conciliatrix* (ULR.), Blkriv., Minn.; *3a*, zoarium, ×1; *3b,c*, secs., tang., transv., ×20 (222).

Family SULCORETEPORIDAE Bassler, 1935

[=emend. Cystodictyonidae ULR., 1884]
[=Acrogeniidae, Thamnotrypidae SIMPSON, 1897]

Zoaria bifoliate, ribbon-like or frondose, branching in plane of mesotheca. Zooecia normally arranged in longitudinal series enclosed by double walls, without diaphragms but with hemisepta in some genera, vestibules tubular; apertures with peristome and more or less well-developed lunarium. Vesicles in interzooecial spaces, commonly filled by calcareous deposits near surface (68,114; NICKLES-B., 1900). *Sil.-Perm.*

Sulcoretepora D'ORB., 1849 [**Flustra parallela* PHILLIPS, 1836][=*Cystodictya* ULR., 1882; *Arcanopora* VINE, 1883 (obj.); *Stictocella* SIMPSON, 1897]. Narrow ribbon-like branches with subparallel, nonporiferous margins. Zooecia prostrate proximally, erect distally, with more or less distinct hemisepta and generally prominent lunarium. Interspaces on surface smooth, granulose, or finely striate, but in worn specimens may appear pitted, showing vesicles. *Dev.-Perm.*——FIG. 103,*1*. **S. parallela* (PHILLIPS), L.Carb., Eng.; surface, lunaria lacking, ×10 (206).——FIG. 103,*2*. *S. gilberti* (MEEK), M.Dev.(Onond.), Falls Ohio, Ky.-Ind.; *2a*, surface, lunaria prominent, ×20; *2b*, proximal part of zoarium, ×5; *2c,d*, secs., long., tang., ×20 (222).

Acrogenia HALL, 1883 [**A. prolifera*]. Narrow articulated segments dichotomously branching at each joint; cylindrical rootlets at base. *Dev.*——FIG. 103,*3*. **A. prolifera*, M.Dev.(Hamilton, N.Y.; *3a*, proximal part of segment, ×5; *3b*, transversely cut segment showing surface, mesotheca, and rhombic cross section, ×10; *3c*, zoarium, ×1 (162).

Ceramella HALL-S., 1887 [**C. scidacea*]. Thin broad erect expansions with oval to circular apertures on

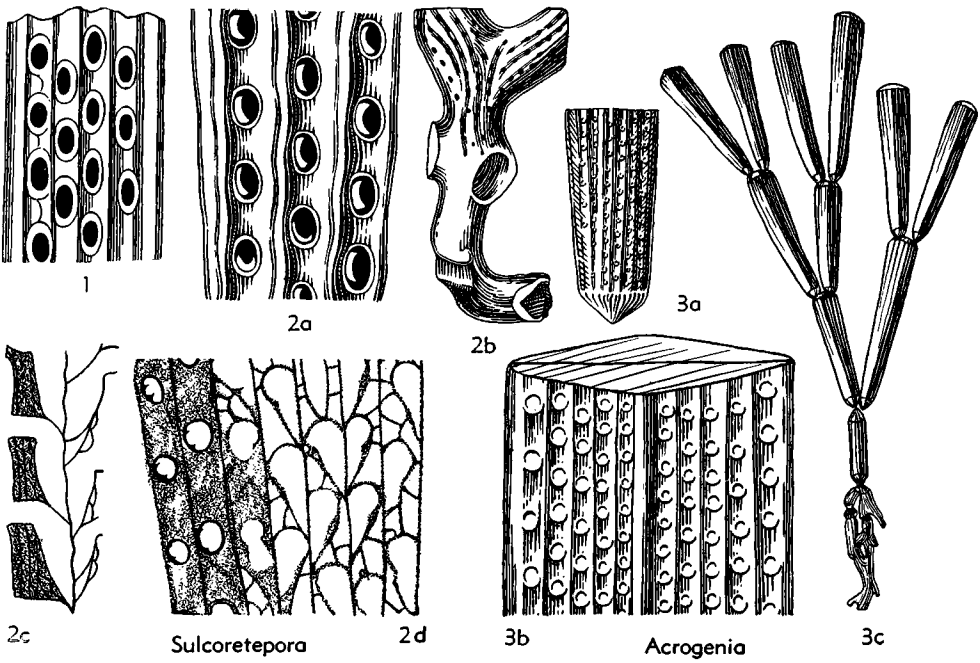


FIG. 103. Sulcoreteporidae (p. G142).

each face; surface marked by elongate maculae. *Dev.*——FIG. 104,*5*. **C. scidacea,* Hamilton, N.Y.; *5a,* surface with macula, ×5; *5b,* fragment, ×1 (162).

Dichotrypa ULR., 1889 [**D. foliata* ULR., 1890]. Like *Sulcoretepora* but zoarium a broad, thin expansion with maculae. Lunaria weak. *Dev.-Miss.* ——FIG. 104,*6*. **D. foliata* ULR., M.Dev., Iowa; *6a,b,* secs., long., tang., ×20 (222).——FIG. 104, *7*. *D. flabellum* ROM., Miss.(Meramec.), Ind.; *7a,* basal part of zoarium, ×1; *7b,* surface with macula, ×10 (222).

Ptilocella SIMPSON, 1897 [**Ptilodictya parallela* HALL-S., 1887]. Ensiform, with pointed, striate base, margins striate, noncelluliferous. Apertures circular in longitudinal rows separated by ridges. *Dev.*——FIG. 104,*3*. **P. parallela* (HALL-S.), Hamilton, N.Y.; *3a,* zoarium, ×1; *3b,* surface, ×10 (163).

Semiopora HALL, 1883 [**S. bistigmata*]. Like *Sulcoretepora* but lunaria absent and 2 small adjoined mesopores between pairs of zooecia. *Dev.*——FIG. 104,*4*. **S. bistigmata,* Hamilton, Ont.; *4a,* surface, ×10; *4b,* zoarium, ×1 (163).

Taeniopora NICH., 1874 [**T. exigua*] [=*Pteropora* HALL, 1883 (*non* EICHW., 1860); *Stictoporidra* SIMPSON, 1897]. Distinguished from *Sulcoretepora* by a longitudinal ridge or keel dividing each face into equal parts. *Dev.*——FIG. 104,*2*. **T. exigua,* Hamilton, Ont.; *2a,* surface, ×5; *2b,* zoarium, ×1 (162).

Thamnotrypa HALL-S., 1887 [*pro Thamnopora* HALL, 1883 (*non* STEININGER, 1831)] [**Thamnopora divaricata* HALL, 1883]. Very narrow stipe of rectangularly lateral branches with 2 (rarely 3) longitudinal rows of apertures separated by a prominent ridge on each face. *Dev.*——FIG. 104,*1*. **T. divaricata* (HALL), Onond., N.Y.; *1a,* surface, ×5; *1b,* zoarium, ×1 (162).

Family RHINOPORIDAE Miller, 1889

Zoaria variable, unilaminar or bifoliate, ramose or sheetlike. Zooecia simple, oblong or rhomboidal, prone along basal membrane; diaphragms and hemisepta absent; vestibules direct, apertures rounded to angular. Mesopores and acanthopores lacking; interzooecial areas generally solid or containing vesicles (2,114; NICKLES-B., 1900). *Sil.*

Rhinopora HALL, 1852 [**R. verrucosa*]. Large, undulating bifoliate expansions; surface commonly smooth, rarely with solid monticules and traversed by slender rounded bifurcating ridges which appear as shallow grooves when surface is worn. Apertures nearly circular, on prominent papillae.

Median tubuli in mesotheca. *Sil.*——Fig. 105,*1*. **R. verrucosa,* Medin., Ont.; *1a,* surface, ×1; *1b,* worn surface showing shallow grooves, ×2 (162).

Diamesopora Hall, 1852 [**D. dichotoma*]. Ramose, hollow stems lined internally by an epitheca. Zooecia simple, hexagonal or rhomboidal, with oval orifice at bottom of tubular vestibule; apertures with peristomes equally elevated or highest posteriorly. Interzooecial spaces compact or horizontally laminated. *Sil.*——Fig. 105,*4*. **D. dichotoma,* Clint., N.Y.; *4a,b,* secs., ×20; *4c,* zoarium, one side broken away below, ×1 (131).

Lichenalia Hall, 1852 [**L. concentrica*]. Like *Rhinopora* but zoarium a thin subcircular unilaminar expansion with concentric basal epitheca, surface traversed by slender bifurcating ridges (canals). Zooecia prostrate, elongate subrhomboidal, with erect subtubular vestibules; apertures rounded, with peristome much elevated on posterior side; interspaces depressed. *Sil.*——Fig. 105,*3*. **L. concentrica,* Clint., N.Y.; *3a,* part of epithecate base, ×1; *3b,* celluliferous side with canals, ×5; *3c,* long. sec., ×20 (131).

Stictotrypa Ulr., 1890 [**Stictopora similis* Hall, 1876] [?=*Stictopora* Hall, 1847]. Narrow ramose bifoliate stems, pointed at base. Apertures circular or elliptical with distinct, evenly elevated peristomes. Interspaces flat or concave, composed of horizontally laminated solid tissue. *Sil.*——Fig. 105,*2*. **S. similis* (Hall), Niag., Ind.; *2a,* fragment, ×5; *2b,c,* secs., ×20 (*2a,* 162; *2b,c,* 222).

Family CYCLOPORIDAE Ulrich, 1890

Zoaria variable in form and structure; includes genera of doubtful affinities, some

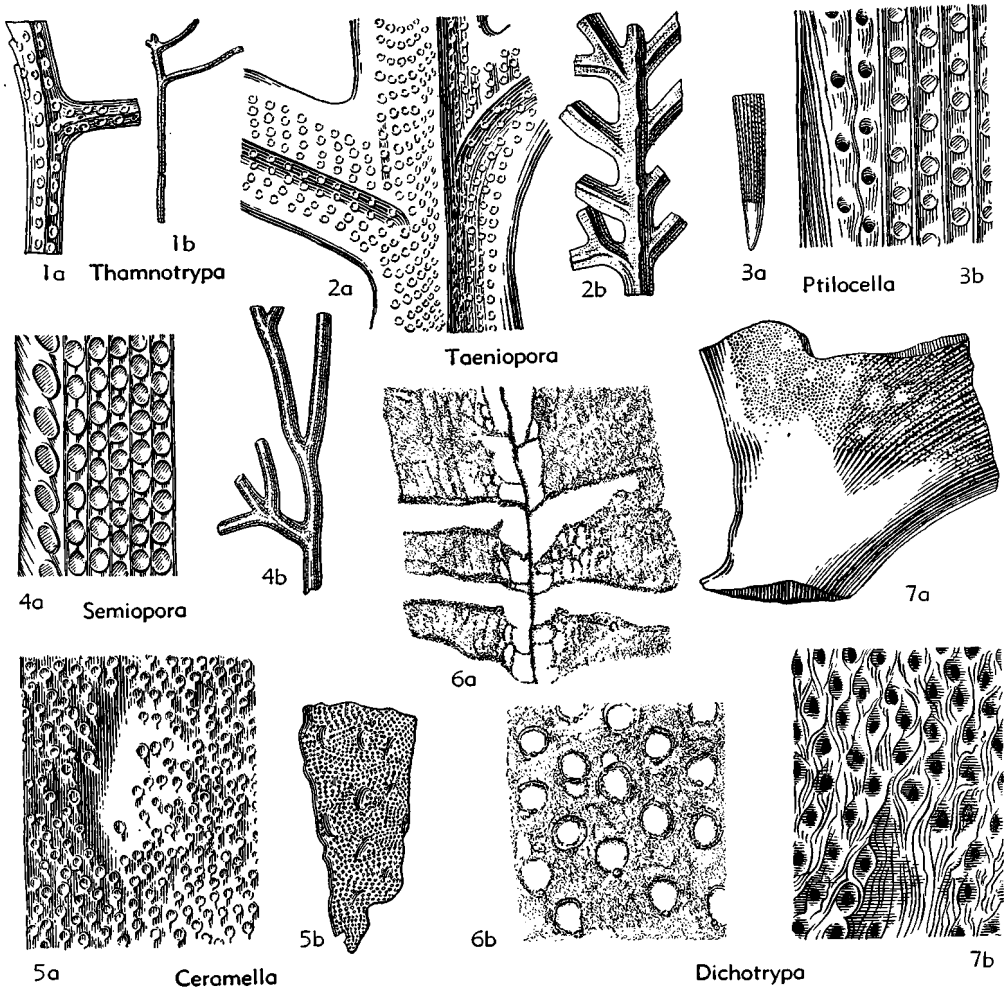


Fig. 104. Sulcoreteporidae (p. G143, G144).

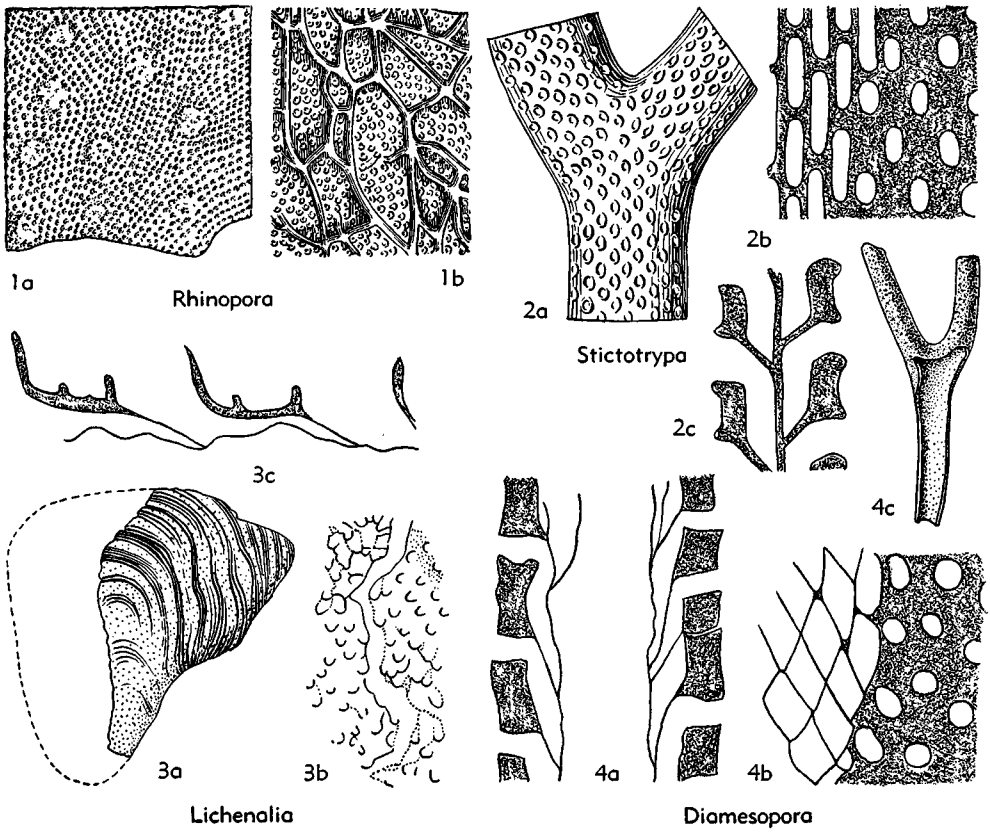


FIG. 105. Rhinoporidae (p. G143, G144).

of which may belong among Cheilostomata (114). *Miss.*

Cyclopora PROUT, 1860 (*non* JULLIEN & CALVET, 1903) [**C. fungia*]. Unilaminar, parasitic or free. Zooecia subtubular, without hemisepta; vestibules rather thick-walled, apertures subcircular, with smooth or granulose peristome. Mesopores open at surface, with thick diaphragms which commonly are centrally perforate; acanthopores may be present. *Dev.-Miss.*——FIG. 106,*1*. **C. fungia,* Miss., Mo.-Ill.; *1a,b,* secs., ×25 (222).

Cycloporella ULR., 1889 [**C. spinifera* ULR., 1890]. Zoarium thin, discoidal. Zooecia subtubular; vestibules with successive superior hemisepta. Irregular mesopores abundant; acanthopores numerous, large. *Miss.*——FIG. 106,*2*. **C. spinifera,* ULR., Osag. (Keokuk), Ill.; *2a,* epithecate base, ×1; *2b,c,* secs., ×25, ×20 (222).

Proutella ULR., 1889 [**Cyclopora discoidea* PROUT, 1860]. Zoarium thin discoid, free; basal concentrically wrinkled epitheca. Zoecia subtubular, thin-walled, with broad, elliptical aperture, surrounded by a narrow hexagonal sloping area; in well-preserved forms apertures have a depressed calcareous plate covering about ⅔ of the opening. With age, the vestibules become elongate and are intersected by incomplete diaphragms. *Miss.*——FIG. 106,*3*. **P. discoidea* (PROUT), Osag. (Keokuk), Ill.; *3a,b,* surface, tang. sec., ×20 (222).

Family ACTINOTRYPIDAE Ulrich, 1890

Thin bifoliate expansions. Apertures indented by projecting ends of 8 to 10 septa-like ridges along sides of vestibules nearly or quite to orifice. Interzooecial spaces filled with layers of vesicles (114). *Miss.-Perm.*

Actinotrypa ULR., 1889 [**Fistulipora peculiaris* ROM., 1866]. May belong among cheilostomes. *Miss.-Perm.*——FIG. 106,*4*. **A. peculiaris* (ROM.), Osag.(Keokuk), Mo.; *4a,* surface, ×20; *4b,c,* secs., showing vesicles ×20 (222).

Family WORTHENOPORIDAE Ulrich, 1893

Bifoliate, branching or palmate. Zooecia very regularly arranged, elongate, rhomboidal; apertures semielliptical, truncated posterior margin somewhat raised; line of junction between zooecia marked on surface by an elevated ridge; elongate triangular space below apertures plain (115). *Miss.*

Worthenopora Ulr., 1889 [**Flustra spatulata* Prout, 1859]. May belong among cheilostomes. *Miss.*——Fig. 106,*6. W. spinosa* Ulr., Osag.(Keokuk), Ill.; *6a,* fragment, ×10; *6b,* zooecia, ×25

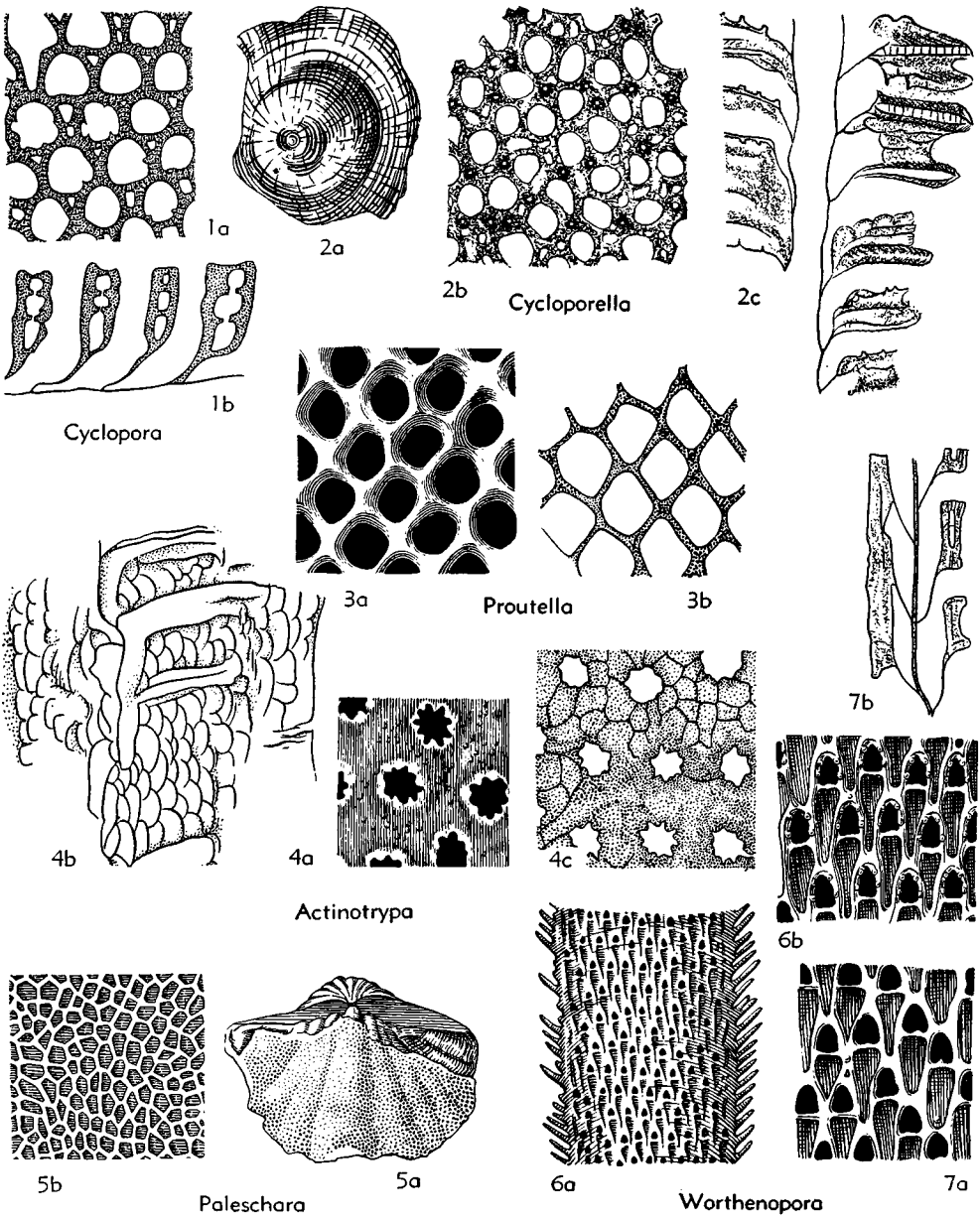


Fig. 106. Cycloporidae, Actinotrypidae, Worthenoporidae, Paleschariidae (p. G145-G147).

(222).——FIG. 106,7. **W. spatulata* (PROUT), Warsaw, Ill.; *7a*, surface, ×25; *7b*, long. sec., ×25 (222).

Family PALESCHARIDAE Miller, 1889

Thin parasitic expansions upon other fossils, especially cephalopod shells. Zooecial tubes thin, very short, without diaphragms or other structures; apertures direct, angular oblong, with groups of larger ones at regular intervals (114). *Ord.-Dev.*

Paleschara HALL, 1874 [**P. incrustans*]. May belong among cheilostomes. *Ord.-Dev.*——FIG. 106,5. **P. incrustans*, Dev.(Held.), N.Y.; *5a*, incrusting zoarium, ×1; *5b*, surface, ×10 (163).

Order CHEILOSTOMATA Busk, 1852

[=Cheiloctenostomata SILEN, 1942 *(partim)*]

Zoaria mostly calcareous but in some families corneous or membranous, generally delicate and highly variable in form; most common are incrusting or free lamellate expansions, slender branching stems, and reticulate fronds. Zooecia almost exclusively short, rounded or angular chambers, arranged serially and in general side by side; orifice distal, smaller in diameter than the zooecium, closed by a hinged operculum, surrounded in many genera by a rim (peristome) that may be extended as a tube (peristomie) with aperture distinct from the operculum-covered orifice, thus resembling cryptostomes. Eggs matured in several sorts of ovicells. Specialized zooids (avicularia, vibracula) common. *?M.Jur., Cret.-Rec.*

MORPHOLOGICAL FEATURES

The Cheilostomata, the dominant group among Cenozoic and Recent Bryozoa, are characterized by closure of the aperture with an **operculum,** hinged chitinous lip *(cheilos),* when the polypide is retracted. The order includes many beautiful sorts of zoarial growth, for the zooecial **frontal wall,** when calcified, commonly exhibits varied patterns of great delicacy. Formerly, differences in these patterns were relied on alone for the discrimination of genera and species and as a result, an unnatural classification prevailed. The calcification of the frontal wall is only one of the bryozoan functions and a natural classification should be based upon all important features.

The Cheilostomata also exhibit the highest type of development in the Bryozoa and for that reason the description of the various animal functions has been reserved for this place. Study of living bryozoans shows that in order of importance these are (1) those concerned with reproduction, including passage of the eggs and escape of the larvae, which calls to attention relations between the zooecial operculum and ovicell; (2) the hydrostatic system, which controls extrusion and retraction of the polypide; and (3) calcification and chitinization, or the nature of skeletal parts. The least important of these formerly was considered alone almost invariably. The characters mentioned are not difficult to determine in Recent forms, but in fossil species, where only the calcareous skeleton remains, often it seems impossible to discover all of them. Fortunately, the form of the zooecial aperture indicates the hydrostatic function and the occurrence of **cardelles** (projections on the orifice edge for hingement of the operculum) reveals the presence and nature of movements of the operculum. The function of reproduction is illustrated by the character and location of the ovicell.

Reproduction.—A classification of the Bryozoa that finally may be judged acceptable is impossible at present, because probably each family should be characterized essentially by the larval form of its constituents; unfortunately, this is known at present for comparatively few families. The fertilized eggs of cheilostomatous Bryozoa are transformed into embryos as in the Cyclostomata and these develop into larvae within special cavities of incubation, which, when visible, are called **ovicells.** The larva called *Cyphonautes,* belonging to the widely distributed *Membranipora pilosa,* is a curious pelagic form with a pair of shell-like covers protecting its sides. Some cheilostome species reveal no ovicells; nothing on the exterior shows their mode of reproduction. Some are oviparous and expel their eggs by an intertentacular organ, but most have some visible ovicell, which is a globular swelling surmounting the zooecial orifice and not a direct modification of the zooe-

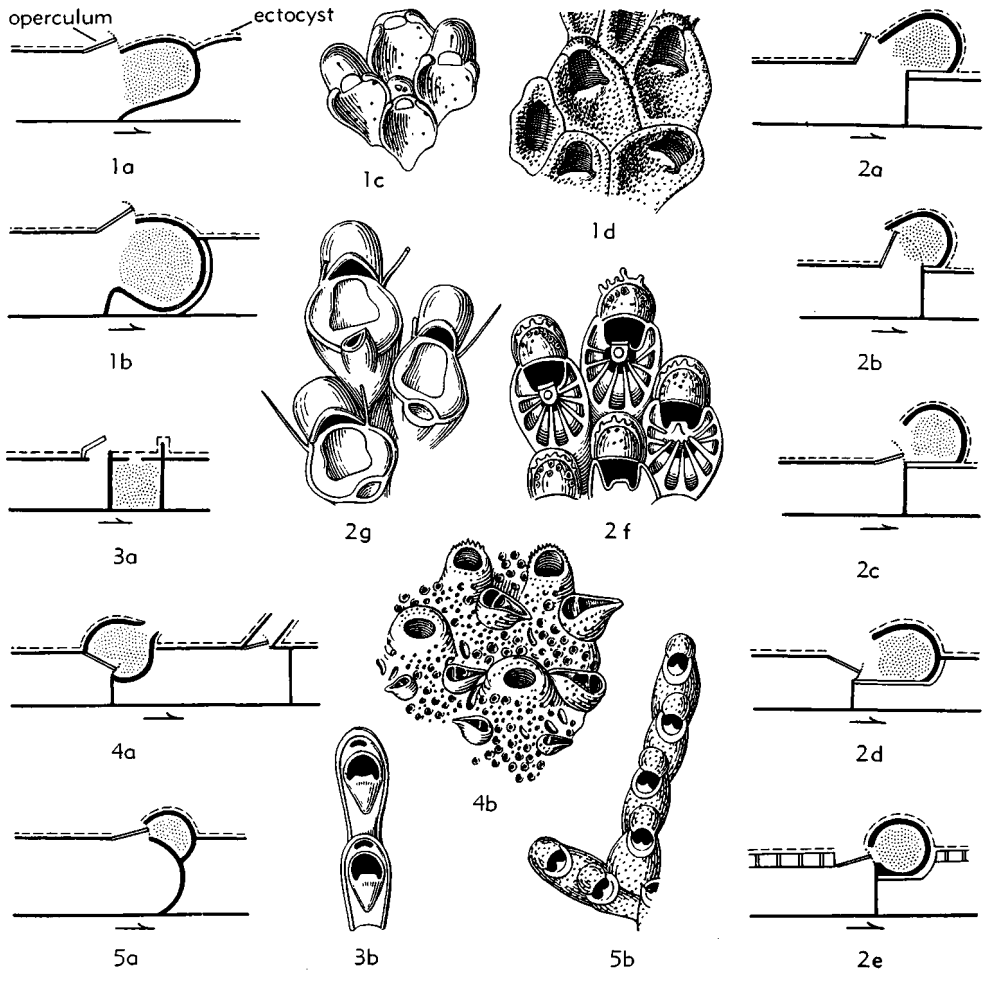


FIG. 107. Types of ovicells in cheilostome bryozoans. (In sections zooecial and ovicell walls are defined by relatively thick black lines, and interior of ovicell is marked by stipple pattern; operculum shown in partly open position; ectocyst shown by thin broken line; arrows indicate direction of growth, with proximal at left and distal at right) (137).

1a-d, **Endozooecial ovicells,** distinguished by location within the zooecium. *1a,* Longitudinal section showing ovicell very widely open toward zooecium and *(1b)* with partial separation by a fold of the zooecial wall; when the operculum shuts, both zooecium and ovicell are fully enclosed. *1c,* Endozooecial ovicells (at left and right) of *Micropora coriacea* ESPER, ×25, with small semicircular opercula shut, closing off the interior spaces of zooecia and ovicells. *1d,* Fragment of *Smittipora levinseni* (CANU-B.), ×40, opercula lost; small endozooecial ovicells may be discerned at distal extremities of the 2 upper zooecia.

2a-g, **Hyperstomial ovicells,** characterized by placement of the ovicell as overlap on distally adjoining zooecium. *2a,* Section of type in which closure of the operculum serves to shut both zooecium and ovicell, as in endozooecial ovicells. *2b,* Type in which the operculum may leave ovicell open when zooecium is closed. *2c,* Type in which ovicell cannot be closed. *2d,* Type with obliquely placed operculum and ovicell impinging strongly on distal zooecium. *2e,* Type in which ovicell opens into tubular area (peristomie) above operculum. *2f, Umbonula verrucosa* ESPER, ×36, with hyperstomial ovicells; *2g, Ramphonotus mina* BUSK, ×50, showing 3 zooecia with hyperstomial ovicells.

3a,b, **Endotoichal ovicells,** distinguished by complete separation of the ovicell from zooecium on proximal side, to which it is related, aperture of the zooecium and opening of the ovicell being in approxi-

cium, as in Cyclostomata. Furthermore, cheilostome ovicells, unlike those of cyclostomes, each of which contains many embryos, hold only a single egg or embryo. An ovicell of particular form and position should characterize all genera of a family, and of course all species of a genus should do likewise. In addition to the ovicell's position, the relationship of operculum to ovicell is quite important. Its various methods of operation are illustrated in the accompanying diagram (Fig. 107), which shows the more important types of structure. A section passing lengthwise through the zooecia is necessary to determine the nature of the ovicell, as well as the general structure. This section requires much care, since the specimen must be mounted on edge longitudinally so that abrasion follows a definite row of cells. Actual dissection of specimens with a fine needle under the microscope often is necessary to determine the kind of ovicell present.

Hydrostatic function.—The discovery of the zooecial hydrostatic function by JULLIEN in 1888 explained many manifestations of the bryozoan which long had remained a mystery. This concerns extrusion and retraction of the polypide and its tentacles and is so important that the suborders (Anasca and Ascophora) of the Cheilostomata are based upon it. In the Anasca, the so-called compensation sac **(compensatrix)** is wanting, and extrusion of the polypide from the zooecium is caused by depression of the chitinous frontal wall through action of parietal muscles. This feature, as well as the general anatomy of the anascan cheilostome polypide, is illustrated in Figure 108. In the Ascophora, the polypide can emerge from the zooecium only if an equal volume of water is introduced to compensate for displacement caused by the extrusion. For this purpose, the compensatrix is located beneath the calcified frontal wall of the zooecium and connected with the aperture (Fig. 109). At the moment of polypide extrusion, muscles attached to the compensatrix contract to enlarge the sac, and the operculum in opening for exit of the polypide, frees the water inlet leading to the sac. A drop of water enters the compensatrix, equalizing space occupied by the polypide. This entrance of water into the sac, the hydrostatic function, is exercised in many ways as indicated by the nature of the frontal wall of the zooecium and operculum. The shape of the operculum is a very diagnostic character and should be given special attention.

Operculum.—The small chitinous operculum, which fits over the zooecial orifice, serves to close at the same time both the opening for exit of the polypide and that leading to the compensation sac, because its anterior (distal) part **(anter)** covers the passage for the polypide and the posterior (proximal) part **(poster)** simultaneously covers the inlet to the compensatrix (Fig. 110). Thus, the shape of these portions of the operculum indicates the nature of the tubes they cover and so illustrates the importance of evidence furnished by the operculum. In one large group of the Ascophora, the orifice of the compensation sac is very small, and the operculum has a corresponding small narrow tongue; in another group, this orifice is quite large, and the corresponding portion of the operculum is large; again a special tube **(spiramen)** may introduce water into the compensatrix (Fig. 110). Finally, the compensation sac may not end in the aperture at all, but may open exteriorly by a special pore **(ascopore).**

The form of the operculum is mostly identical with that of the zooecial orifice, but the latter is not always visible exteriorly in fossil forms, being hidden by excessive calcification of the frontal wall or by avicularia (Fig. 111). The only safe means of determining the true form of the orifice is

(Fig. 107 continued)

mately the same plane. *3a,* Longitudinal section. *3b, Cellaria sinuosa* HASSALL, ×50, showing separate apertures of zooecia and the distally adjointed endotoichal ovicells.

4a,b, **Peristomial ovicells,** in which the ovicell comprises an enlarged section of the peristomie. *4a,* Longitudinal section, showing operculum at base of peristomie, between zooecium and ovicell. *4b, Tubiporella magnirostris* MACGILL., *showing* 2 peristomial ovicells (lower ones).

5a,b, **Recumbent ovicells,** in which the ovicell rests on the distal wall of the zooecium. *5a,* Longitudinal section. *5b, Phylactellipora hincksi* BASSLER, which has recumbent ovicells.

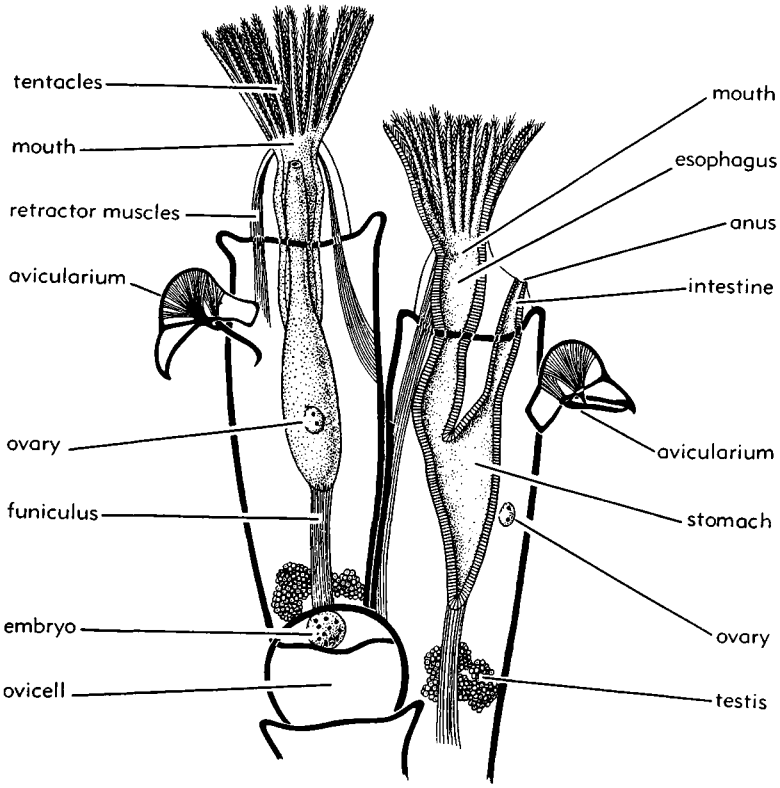


FIG. 108. Anatomy of anascan cheilostome zooids. Two individuals belonging to the common corneous cheilostome, *Bugula avicularia* LINNÉ, Rec., Atl., highly magnified, are illustrated to show various parts *(after Parker & Haswell)*.

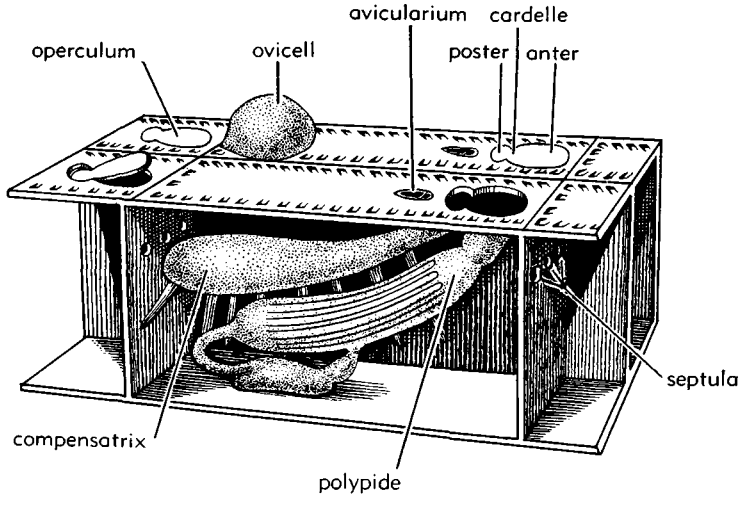


FIG. 109. Diagrammatic sketch of an ascophoran cheilostome showing nature of the frontal wall, operculum, retracted polypide, compensatrix, and an ovicell; communication pores (septula) occur in the walls between zooecia.

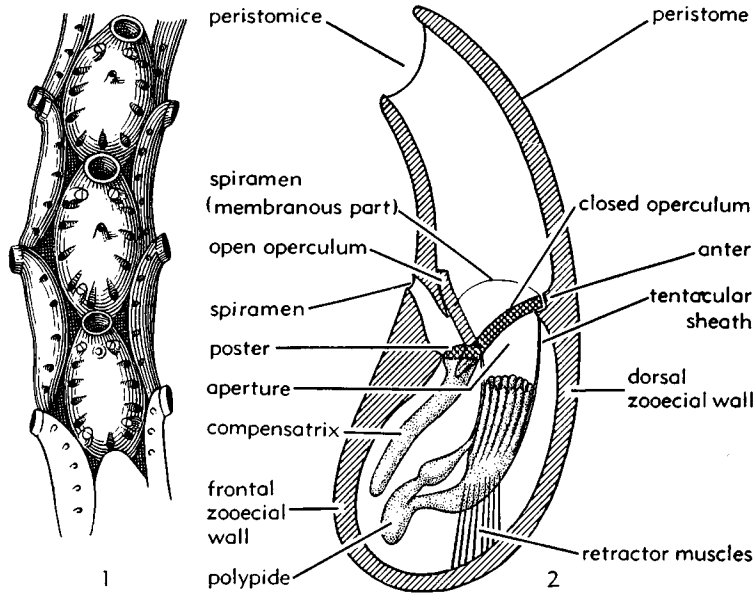


FIG. 110. Characters of ascophoran cheilostomes; *Tessaradoma gracile* SARS, Rec., Atl.; *1*, Frontal side of zoarial branch, ×60. *2*, Longitudinal section, ×200 *(after Hincks & Jullien)*.

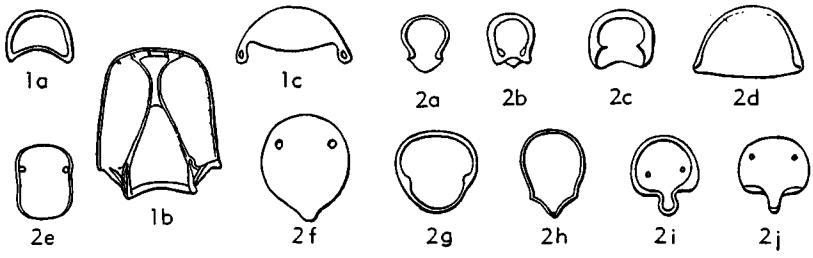


FIG. 111. Opercula of cheilostomes. *1a-c*, Types belonging to anascan genera which lack a compensation sac; *1a, Thalamoporella; 1b, Steginoporella; 1c, Aspidostoma. 1d-m*, Types belonging to ascophoran genera, showing contrast between proximal part (poster) covering entrance to the compensation sac, and distal part (anter) serving for closure of the passageway of the polypide; *2a, Trypostega; 2b, Triphyllozoon; 2c, Smittina; 2d, Holoporella; 2e, Stichoporina; 2f, Bipora; 2g, Escharoides; 2h, Schismopora; 2i, Rhynchozoon; 2j, Schizoporella.*

by examination of the interior of the zooecium by abrading of its basal surface. This preparation is easily made by mounting the fragment to be studied in hard Canada balsam on a glass slip, celluliferous side down, and then rubbing away the superfluous material until the inner side of the calcified frontal wall is revealed, whereupon the true nature of this wall, unchanged by any external influence, may be seen.

The preparation of the operculum, which remains only on Recent forms, is another important but simple operation. In order to prepare slides for viewing under the microscope, a few zooecia with the operculum in place may be scraped off and crushed on the slide in a drop of water and after drying, Canada balsam and cover glass added. Some opercula will be broken, but enough perfect specimens will remain to make the saving of time well worth while.

Formation of zoarial skeleton.—The living tissue of the bryozoan, which by its differentiation gives rise to the various or-

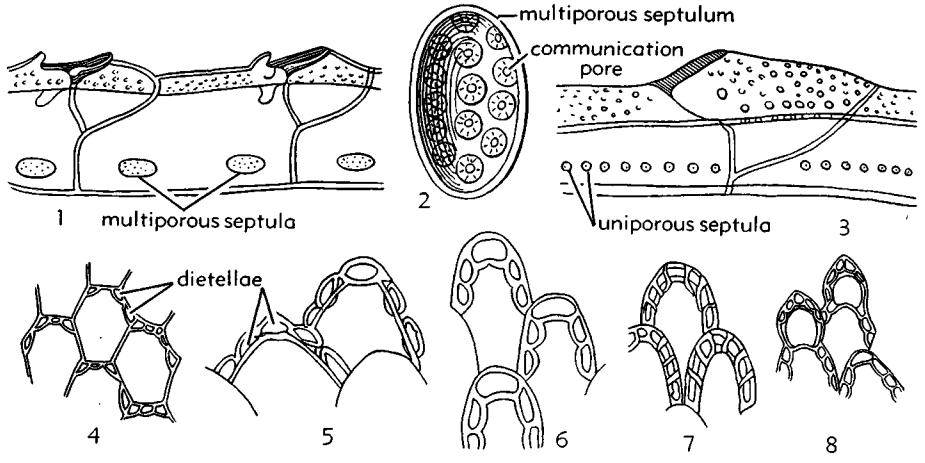


FIG. 112. Wall pores (septula) and pore chambers (dietellae) in distal part of cheilostome zooecia serving as passageways for mesenchymatous fibers that connect adjacent zooids (137). Side wall of *Cheilopora sincera* SMITT showing multiporous septula (rosette plates). *2,* Greatly enlarged multiporous septulum. *3,* Side view of *Hippodina fegeensis* (BUSK), showing uniporous septula. *4-8,* Dietellae seen from basal side of zooecia (much enlarged); *(4) Escharoides prestans* (HINCKS), *(5) Ellisina levata* (HINCKS), *(6) Callopora lineata* (LINNÉ), *(7) Cauloramphus spinifer* (JOHNSTON), *(8) Trypostega venusta* (NORMAN).

gans, is a delicate epithelial membrane **(endocyst)** lining the interior of skeletal parts. The first derived product of the endocyst is the **ectocyst,** a thin outer covering membrane which has no secreting power. Next, the endocyst secretes the **mesenchyme,** which in turn originates organs of the polypide. The calcareous or chitinous secretion forming the zooecial skeleton occurs between the ectocyst and endocyst. The walls may consist simply of a smooth thin calcareous deposit **(olocyst)** or above this a second very porous layer **(tremocyst)** may be secreted, intimately joined with the olocyst or in some readily detachable. A third layer **(pleurocyst),** consisting of a granular deposit with lateral punctations, may also occur. The pores of these several layers are traversed by mesenchymatous fibers which likewise pass from zooecium to zooecium through the lateral walls by small pores called **septula.** These may be uniporous or multiporous but before reaching a septulum the mesenchymatous fibers traverse small lateral chambers **(dietellae)** in the proximal part of the zooecium (Fig. 112).

The discrimination of characteristics of these various zooecial skeletal features is important in determination of genera and species and so it is necessary in study that the following preparations be made. First, thin sections of the wall, particularly the frontal, are needed to show characters of the three layers, olocyst, tremocyst, and pleurocyst. Second, the frontal wall must be abraded to show the occurrence of such structures as dietellae. This is effected by mounting the specimen, frontal side up, in Canada balsam on a slide and after heating to harden the balsam, rubbing it gently on a soft hone.

Avicularia and vibracula.—These are appendicular zooids, highly modified, comprising much reduced individuals that serve special functions. The so-called "bird's head" organ, or **avicularium,** attached to the zooecia of many Cheilostomata consists of a small cell containing a rudimentary polypide; its mobile chitinous mandible keeps up a snapping motion. This peculiarity has led to the belief that the function of avicularia is one of defense, but more probably they have something to do with alimentation or oxygenation of the colony. The **mandibles** are symmetrical objects corresponding to the opercula of normal zooecia, and like them, varying in shape with the species (Figs. 113,114). Preparation of them for study under the microscope is the same as for opercula; generally, both will be found

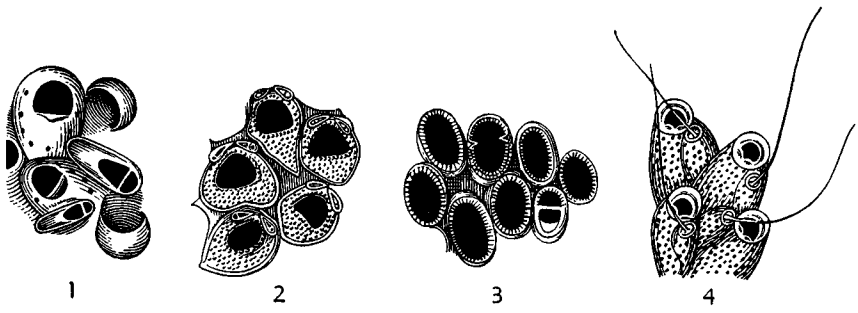


FIG. 113. Types of cheilostome avicularia and vibracula. *1, Holoporella descostilsii* (AUDOUIN), ×25, with large elongate avicularia showing bar for articulation of mandible. *2, Antropora granulifera* (HINCKS), ×30, with small avicularia in pairs at distal edge of zooecia. *3, Crassimarginatella crassimarginata* (HINCKS), ×30, with avicularia very like normal zooecia but distinguished by crossbar for articulation of mandible. *4, Mastigophorella hyndmanni* (JOHNSTON), ×30, zooecia and associated long vibracula (137).

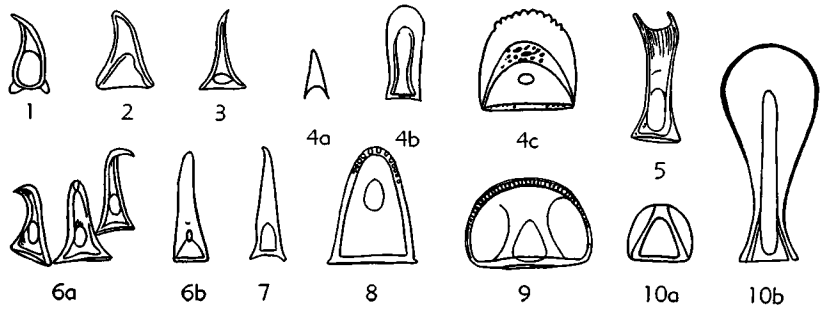


FIG. 114. Types of avicularium mandibles (much enlarged). *1, Adeonellopsis; 2, Escharoides; 3, Schizoporella; 4a-c, Smittina; 5, Triphyllozoon; 6a,b, Retepora; 7, Adeona; 8, Holoporella; 9, Umbonula; 10a,b, Thalamoporella* (137).

on the same slide. The proximal edge of the mandible works against a calcareous bar or a pair of teeth. In fossil forms and many dead specimens of Recent species, the mandible has been lost, but its position is indicated by porelike spaces on the avicularia. The **vibracula** are modified zooids similar to avicularia but differing in possession of a long bristle-like seta in place of the mandible. The porelike excavations marking the location of vibracula in fossils do not show the variation of structure observed in avicularia.

CLASSIFICATION

There are more factors that enter into determination of a cheilostomatous bryozoan than in those of any other order. The absence or presence of a compensation sac must be learned in order to place the species in its proper suborder (Anasca, Ascophora). Then, relationships between operculum and ovicell and between operculum and compensatrix; position of ovicell; form of aperture; nature of frontal wall, which may be chitinous or calcareous and smooth (olocyst), punctate (tremocyst), or radially ribbed (pleurocyst); occurrence of dietellae and septula; presence and nature of avicularia and vibracula; and other structural features are to be observed. Proper description and illustration of a cheilostome species is a considerable task which cannot be accomplished simply by publishing a diagrammatic figure of zooecial surface characters.

Formerly, classification of the Cheilostomata was based on purely zoarial features, but in the latter half of the 19th century zooecial characters were studied more close-

ly, especially by BUSK (17,18), SMITT, HINCKS (4), JULLIEN (19), and CALVET (20). Various works on the structure of the Cheilostomata have been issued by HARMER (21,3b,3c), and WATERS (22,23). In 1909 LEVINSEN (24) published a memoir which is indispensable to the modern student.

The fossil Cheilostomata form the subject of numerous researches, among which the work on French Cretaceous faunas by D'ORBIGNY (25) and various monographs on Tertiary faunas by CANU & BASSLER (26,27, 28,29,30,31,32) should be mentioned. The last-named works contain many text figures illustrating family and generic structure, besides detailed references to the literature.

The earliest known cheilostomes are reported from Middle Jurassic rocks of Normandy, but they are not common in strata older than Cretaceous. They are the dominant group at the present day, and are represented by a very large number of genera and species.

Suborder ANASCA Levinsen, 1909

Zooecial hydrostatic system (compensation sac) for extrusion of polypide from zooecium not present, but a zoarial hydrostatic system (hypostege) occurs between the cryptocyst and ectocyst. This extrusion occurs through depression by parietal muscles of the membranous or chitinous zooecial frontal wall surrounded by an elevated margin. In several families, the outer membranous layer (ectocyst) is covered by an arched porous frontal shield (pericyst), so that the absence of its opening, termed ascopore, suggests the name Anasca. *?M.Jur., Cret.-Rec.*

Division INOVICELLATA Jullien, 1888

Zoaria of delicate creeping stolons with spindle-shaped swellings from which erect uniserial zooecia with an operculum at the distal end arise at intervals. Avicularia, vibracula and permanent ovicells lacking. *Eoc.-Rec.*

Family AETEIDAE Smitt, 1867

Characters of division (106). *Eoc.-Rec.*

Aetea LAMX., 1812 [**Sertularia anguina* LINNÉ, 1758] [=*Anguinaria* LAMARCK, 1816; *Filicella* SEARLES WOOD, 1844; *Salpingia* COPPIN, 1848; *Aeteopsis* BOECK, 1862; *Cercaripora* FISCHER, 1866]. Erect uniserial zooecia form tubular snake-like projections. Creeping stolons generally are only parts found as fossils. *Eoc.-Rec.*——FIG. 115, *5. Aetea* sp., Plio., Italy; creeping stolons, ×25 (183).——FIG. 115,*6.* **A. anguina* (LINNÉ), Rec., Atl.; ×25 (137).

Division SCRUPARIINA Silén, 1941

Primitive cheilostomes characterized by erect, generally uniserial growth, tubular form, and frontal budding of zooecia, with restriction of opesium to part of front; no avicularium or spines. Hyperstomial ovicell in some species. *Cret.-Rec.*

Family SCRUPARIIDAE Busk, 1852

Creeping base, erect branches (70). *Cret.-Rec.*

Scruparia OKEN, 1815 [**Sertularia chelata* LINNÉ, 1758] [=*Unicellaria* BLAINV., 1830; *Scuparia* GRAY, 1848]. Budding at distal end in front, just proximal to opesium; ovicell on dwarfed zooecium. *Rec.*——FIG. 115,*1.* **S. chelata* (LINNÉ), E.Atl.; ×25 (164).

Brettia DYSTER, 1858 [**B. pellucida*]. Uniserial, elongate, narrow zooecia, budding in pairs on dorsal side at distal end. *Rec.*——FIG. 115,*4.* **B. pellucida*, Rec., Wales; ×10 (137).

Bugulella VERRILL, 1879 [**B. fragilis*]. Allied to *Brettia*. Rec., N.Atl.

Eucratea LAMX., 1812 [**Sertularia loricata* LINNÉ, 1758] [=*Loricaria* LAMX., 1821 (*non* LINNÉ, 1758) (obj.); *Notamia* FLEMING, 1828 (*non* RAF., 1819 (obj.); *Gemicellaria* BLAINV., 1830 (obj.); *Loricula* TEMPLETON, 1836 (*non* CURTIS, 1833) (obj.); *Gemmellaria* VAN BENEDEN, 1845 (obj.)]. Biserial zooecia back to back, branches arising from sides near distal end. No ovicell. *Cret.-Rec.*—— FIG. 115,*2. E. labiata* NOVAK, Cret.(Cenom.), Czech.; *2a*, ×1; *2b*, ×10 (234).——FIG. 115,*3.* **E. loricata* (LINNÉ), N.Atl.; *3a*, zoarium, ×1; *3b,c*, side, front, ×25 (*3a*, 211; *3b,c*, 137).

Family LABIOSTOMELLIDAE Silén, 1942

[=Protocheilostomata SILEN, 1942]

Zoaria erect, composed of smooth zooids formed by frontal budding, lacking ovicells, spines, and other appendages; closed by 2 lips, with proximal one representing first

stage of an operculum. Zooids develop from ovoid ancestrula. *Rec.*

Labiostomella SILÉN, 1942 [**Brettia gisléni* SILÉN, 1941]. *Rec.*, W.Pac.——FIG. 115,*7*. **L. gisléni* (SILÉN), Japan; zoarium (schematic) with exaggerated ancestrula, ×20 (216).

Division MALACOSTEGA Levinsen, 1902

Zooecia retaining original frontal membrane with operculum incompletely undifferentiated. *Cret.-Rec.*

Family MEMBRANIPORIDAE Busk, 1854

[=Biflustridae SMITT, 1872; Synaptacellidae MAPLE., 1911; Acanthodesiidae VIG., 1949; Cupuladriidae LAGAAIJ, 1952]

Zoaria generally incrusting, without ovicells, spines, or dietellae (pore chambers); avicularia commonly absent. Dorsal outlines of zooecia mostly rectangular; frontal wall chitinous, with gymnocyst little developed but cryptocyst ranging from a thin border to half of the opesial space (Fig. 116) (24,31). *Cret.-Rec.*

Membranipora BLAINV., 1830 [**Flustra membranacea* LINNÉ, 1767; SD NORMAN, 1903] [=*Nitscheina, Nichtina* CANU, 1900]. Incrusting or erect, bifoliate. Gymnocyst practically wanting; tubercles or knobs produced by folding of rim at distal corners; aperture (opesium) occupying nearly the entire front; no interopesial cavities, cryptocyst barely visible to well developed; intertentacular organ (tower cell) possibly used in expelling larvae; more than 600 described species. *Mio.-Rec.*——FIG. 117,*1*. *M. tuberculata* Bosc, Rec. Atl.; ×25 (137).——FIG. 117,*2*. **M. membranacea* LINNÉ), Rec., Atl.; *2a*, surface, ×25; *2b*, tower cells, ×10 (137).

Acanthodesia CANU-B., 1920 [**Flustra savartii* AUDOUIN, 1826]. Like *Membranipora* but with proximal serrate denticle. *Eoc.-Rec.*——FIG. 118,*4*. **A. savartii* (AUDOUIN), Rec., Medit.; ×25 (230).

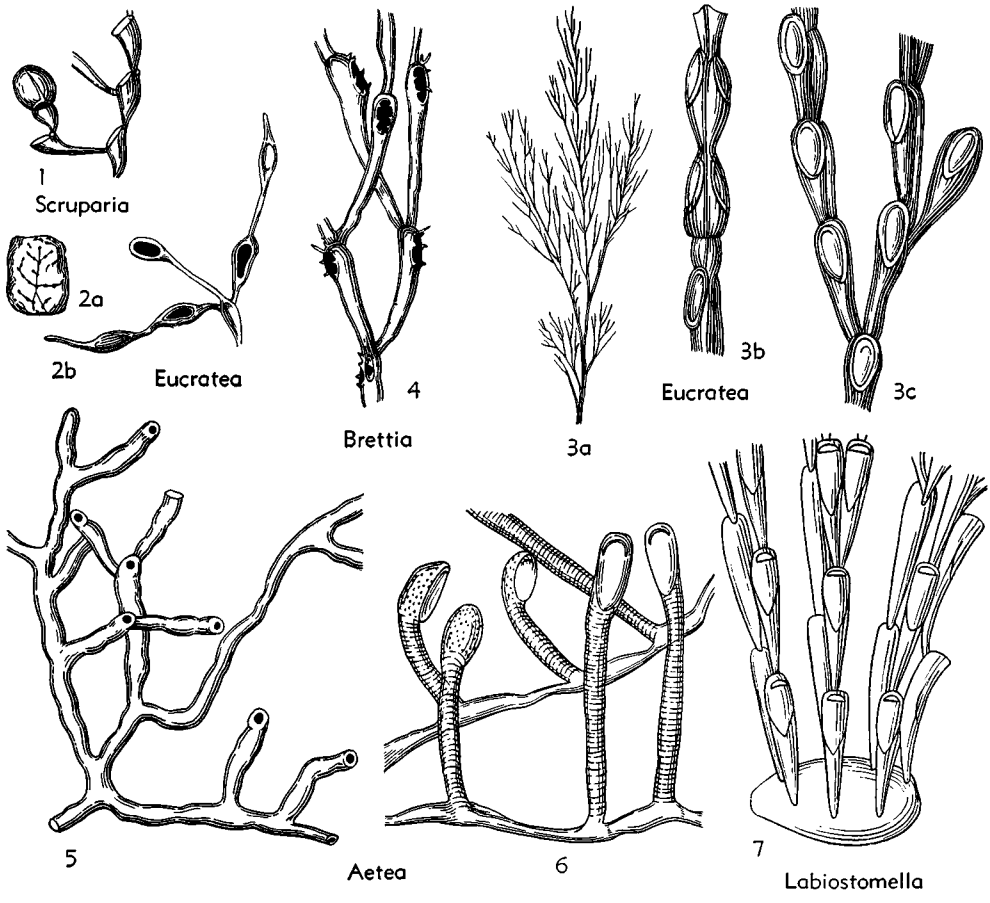


FIG. 115. Aeteidae, Scruparidae, Labiostomellidae (p. G154, G155).

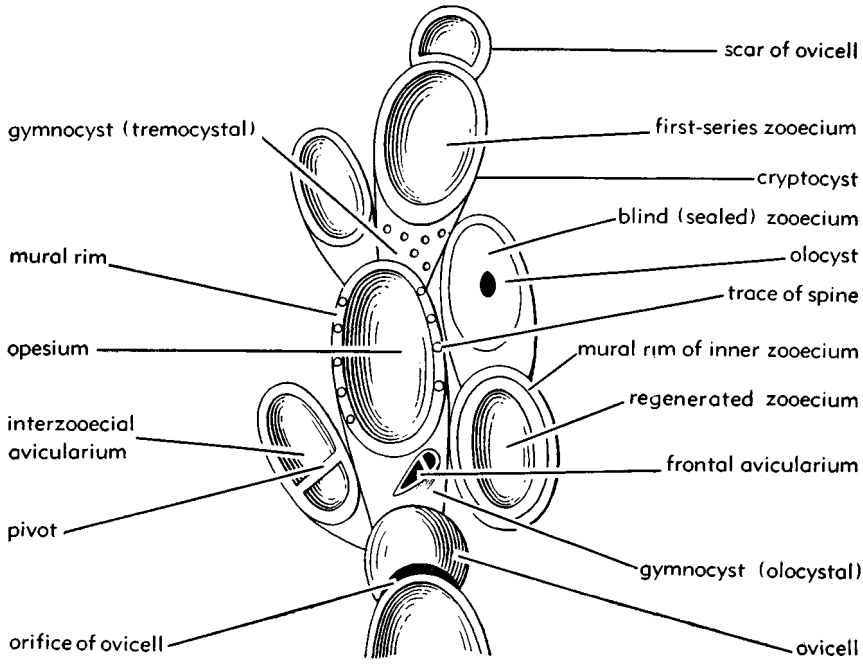


FIG. 116. Morphological features of Membraniporidae.

Adenifera CANU-B., 1917 [**Biflustra armata* HASWELL, 1880]. Distal glandular elevation and thin elongate avicularium on mural rim. *Eoc.-Rec.*——FIG. 117,*4*. **A. armata* (HASWELL), Rec., SW.Pac.; *4a*, ×25; *4b*, avicularium, ×50 (166).

Biflustra D'ORB., 1852 [**B. ramosa*] [=*?Membranipora*]. Bifoliate. *Rec.*, SW.Pac.

Cellarinidra CANU-B., 1927 [**Cellarina clavata* D'ORB., 1851] [=*Cellarina* D'ORB., 1851 (*non* VAN BENEDEN, 1848)]. Articulated, narrow, cylindrical segments with apertures and interopesial avicularia on all sides. *Cret.*——FIG. 117,*5*. **C. clavata* (D'ORB.), Cenom., Fr.; *5a,b*, segment, transv. sec., ×25 (202).

Conopeum GRAY, 1848 [**Flustra lacroixii* AUDOUIN, 1826] [=*Foratella* CANU, 1900 (obj.); *Normanellina* COSSMAN, 1920; *Normaniella* DUVERGIER, 1921]. Simple membranipore with triangular interopesial hollows on small gymnocyst at proximal corners. *Cret.-Rec.*——FIG. 118,*5*. **C. lacroixii* (AUDOUIN), Rec., Medit.; ×25 (137).

Craspedopora CANU-B., 1929 [**C. typica*]. Like *Conopeum* but has excessive deposit of tissue on septula piercing front wall. *Eoc.*——FIG. 118,*7*. **C. typica*, Eoc.(Brux.), Belg.; ×25 (137).

Cupuladria CANU-B., 1919 [**Membranipora canariensis* BUSK, 1859]. Small, free orbicular zoaria with long, distal auriform vibraculum at distal extremity of each zooecium. Inner side shows polygonal compartments. *Mio-Rec.*——FIG. 118,*2*. **C. canariensis* (BUSK), Atl.; *2a,b*, front, back, ×25 (137).

Desmacystis OSBURN, 1950 [**Membranipora sandalia* ROBERTSON, 1900]. Like *Membranipora* but gymnocyst occupies proximal half of zooecium; small, median avicularium. *Rec.*——FIG. 118,*1*. **D. sandalia* (ROBERTSON), E.Atl.; ×30 (204).

Exostesia BROWN, 1948 [**E. didomatatia*]. *Rec.*, SW.Pac.

Gregarinidra BARROSA, 1949 [**Membranipora gregaria* HELLER, 1867]. *Rec.*, E.Atl.

Heliodoma CALVET, 1907 [**H. implicata*]. Like *Cupuladria* but zooecia in a concentric series separated by a row of long vibracula. *Rec.*——FIG. 117,*8*. **H. implicata*, Atl.; ×25 (135).

Otionella CANU-B., 1917 [**O. perforata*]. Discoidal; concave inner side showing zooecial bases and convex outer side bearing apertures and auriculated interzooecial vibracula. *Cret.-Eoc.*——FIG. 118,*3*. **O. perforata*, Eoc.(Claib.), Ala., ×25 (137).

Pseudostege BRYDONE, 1918 [**P. cantiana*]. [=*Pseudostega* BRYDONE, 1918]. Secondary zooecial layer above the primary one. *Cret.*, Eng.

Quadricellaria D'ORB., 1851(*non* SARS, 1863) [**Q. elegans*]. Erect, articulated, quadrangular segments with large membraniporoid zooecia on 2 opposite faces and small ones on others. *Cret.*——FIG. 117,*7*. **Q. elegans*, Senon., Fr.; ×10 (202).

Synaptacella MAPLE., 1911 [**S. asymmetrica*]. Zooecia ovoid, with gymnocyst in a single, free articulated rigid series. *Tert.*——FIG. 117,*3*. **S. asymmetrica,* Austral.; ×25 (184).

Trochopora D'ORB., 1849 [**Lunulites conica* DEFRANCE, 1853][=*Heteractis* GABB-H., 1862]. Cone-shaped, with hexagonal zooecia and symmetrical vibracula in radiating lines on upper surface and rows of pores on underside. *Eoc.-Mio.*——FIG. 118,*6*. **T. conica* (DEFRANCE), Mio. (Helv.), Fr.; ×25 (137).

Vinucularia DEFRANCE, 1829 [**V. fragilis*][=*Heterocella* CANU, 1907 (obj.)] Articulated, narrow, quadriserial with large opesia on diverging zooecia and small ones on converging. *Vincularia* loosely used as general name for rodlike forms. *Eoc.-Rec.*——FIG. 117,*6*. **V. fragilis,* Lut., Fr.; *6a,b,* converging and diverging sides, ×25 (136).

Family ELECTRIDAE Lagaaij, 1952

[=emend. Electrinidae D'ORB., 1851]
[=Tendridae VIG., 1949]

Like Membraniporidae but well-developed gymnocyst occupies proximal part of chitinous front; narrow cryptocyst in a few. No avicularia, ovicells or dietellae. Spines or tubercles occur on opesial border. Cyphonautes larva and intertentacular organ present (24,26). *Cret.-Rec.*

Electra LAMX., 1816 [**Flustra verticillata* ELLIS-S., 1786] [=*Annulipora* GRAY, 1848; *Electrina* D'ORB., 1851 (*non* BAIRD, 1850); *Reptelectrina* D'ORB., 1852]. Incrusting or erect; frontal a smooth gymnocyst, oval with spine-bearing opesium on distal side and flagellum at proximal extremity. *Eoc.-Rec.*——FIG. 119,*1*. **E. verticillata* (ELLIS-S.), Rec., N.Atl.; ×25 (167).——FIG. 119,*2*. *E. pilosa* (LINNÉ), Rec., N.Atl.; ×25 (167).

Aspidelectra LEV., 1909 [**Lepralia melolontha* BUSK, 1852]. *Cribrilina*-like frontal with hollow spines and slits. *Rec.*——FIG. 119,*3*. **A. melolontha* (BUSK), E.Atl.; ×37.5 (134).

Herpetopora LANG, 1914 [**H. anglica*]. Incrusting; uniserial zooecia bilaterally branching, with long, narrow caudal portion. *Cret.-Olig.*——FIG. 119,*8*. **H. anglica,* Cret.(Senon.), Eng.; ×25 (175).

Heterooecium HINCKS, 1892 [**Membranipora am-*

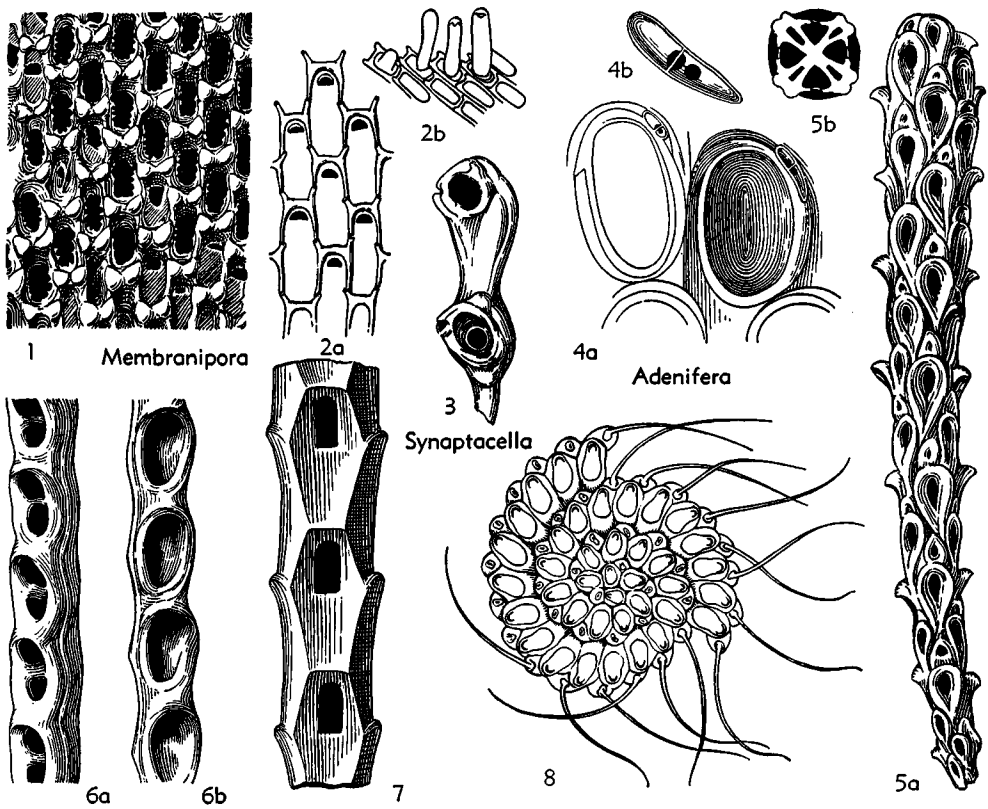


FIG. 117. Membraniporidae (p. G155-G157).

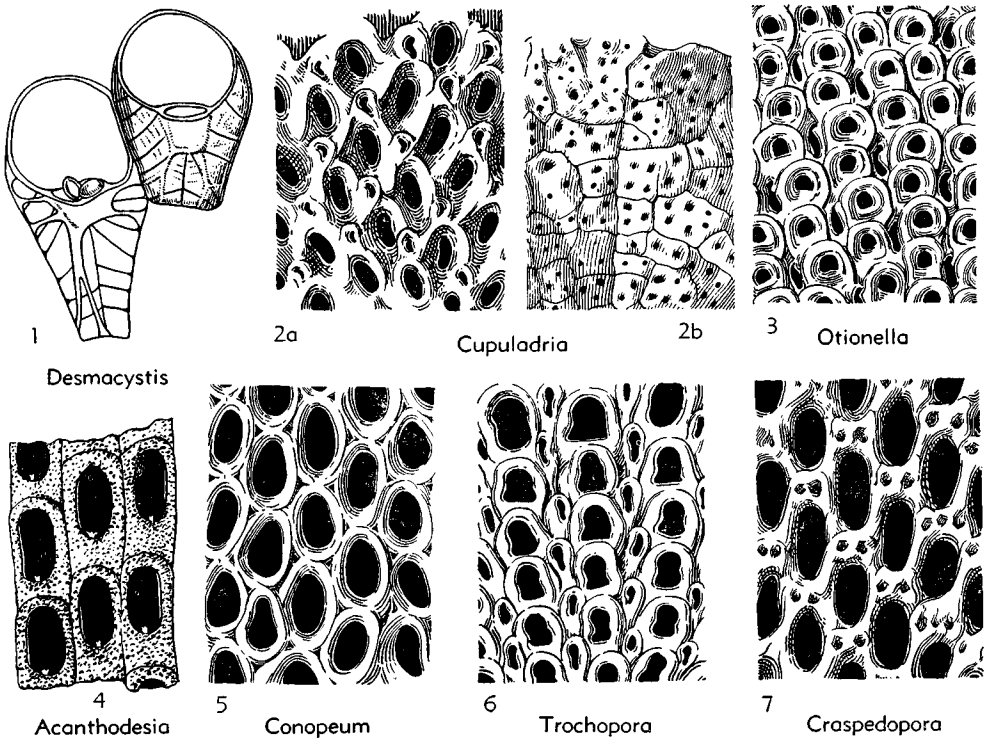


FIG. 118. Membraniporidae (p. G155-G157).

plectens HINCKS, 1881]. Like *Tendra* with acanthostegous ovicell but opercular valve and a flagellum are at proximal end of aperture. *Rec.*——FIG. 119,*4*. **H. amplectens* (HINCKS), Austral.; ×37.5 (177).

Mystriopora LANG, 1915 [**M. möckleri*]. Incrusting, pleuroserial zooecia with entire oval opesia, short caudal portion, and zooeciules (?avicularia). *Cret.-Tert.*——FIG. 119,*9*. **M. möckleri*, Cenom., Eng.; ×25 (175).

Pyripora D'ORB., 1849 [**Criserpia pyriformis* MICH., 1847] [=*Pyriflustrina, Pyriflustrella* D'ORB., 1853; *Charixa, Distelopora, Rhammatopora* LANG, 1915]. Uniserial or pauciserial pyriform zooecia with unilateral branching. *Cret.-Rec.*——FIG. 119,*5*. **P. pyriformis* (MICH.), Mio., Fr.; ×25 (136).——FIG. 119,*6*. *P. catenularia* (JAMESON), Rec., Atl.; ×25 (167).

Taphrostoma CANU, 1908 [**T. spinosum*]. Aperture divided by a transverse semicircular trench for insertion of operculum. *Eoc.*——FIG. 119,*10*. **T. spinosum*, Barton., Fr.; surface, ×25 (136).

Tendra NORDMAN, 1839 [**T. zostericola*]. Like *Membranipora* but with acanthostegous ovicells occupying space between frontal membrane (ectocyst) and an overlying double row of united hollow-arched spines. Opercular valve at distal end of ovicell. *Rec.*——FIG. 119,*7*. **T. zostericola*, Blk.S.; *7a,b*, ×37.5 (137).

Tretosina CANU-B., 1927 [**T. arcifera*]. Bifoliate; with cryptocyst, a proximal serrate denticle and narrow, transverse slit in distal part of zooecium. *Tert.*——FIG. 119,*11*. **T. arcifera*, Mio., Austral.; ×25 (137).

Family FLUSTRIDAE Smitt, 1867

Zoaria erect, corneous, flexible, foliaceous, composed of subrectangular contiguous multiserial membraniporoid zooecia with endozooecial ovicell and simple interzooecial avicularia (31). *Rec.*

Flustra LINNÉ, 1761 [**Eschara foliacea* LINNÉ, 1758] [=*Flustrina* VAN BENEDEN, 1849 (*non* D'ORB., 1852)]. Founded to replace *Eschara*. Zoarium typically bilamellar, bearing zooecia with salient mural rim and multiporous septula in lateral walls.——FIG. 120,*1*. **F. foliacea* (LINNÉ), N.Atl.; *1a*, ×1; *1b*, ×25; *1c*, ×10 (137).

Carbasea GRAY, 1848 [**Flustra carbasea* ELLIS-S., 1786]. Unilaminate, frondose zoarium. Avicularia and ovicells absent. (?Subgenus of *Flustra*). *Rec.*, Atl.

Chartella GRAY, 1848 [**Flustra papyracea* ELLIS-S., 1786]. Ovicells well developed. (?Subgenus of *Flustra*). *Rec.*——FIG. 120,*2*. **C. papyracea* (ELLIS-S.), Atl.; *2a*, ×1; *2b*, ×25 (137).

Retiflustra LEV., 1909 [**Retepora cornea* BUSK, 1852]. An open network; avicularia as large as zooecia. *Rec.*, SW.Pac.

Sarsiflustra JULLIEN, 1903 [**Flustra abyssicola* SARS, 1872]. Avicularia lyriform, as large as zooecia. *Rec.*, NW.Atl.

Spiralaria BUSK, 1861 [**S. florea*] [=*Spiralis* LEV., 1909]. Narrow spirally wound ribbon-shaped lamina. *Rec.*, SW.Pac.

Terminoflustra SILÉN, 1942 [**Flustra barleei* BUSK, 1860]. Square avicularian chambers at bifurcation of zooecial rows. *Rec.*, Atl.

Family HINCKSINIDAE Canu & Bassler, 1927

[=Pseudolepraliidae SILEN, 1942; Antroporidae VIG., 1949]

Similar to Membraniporidae but with endozooecial ovicells. Avicularia, vibracula, dietellae and spines may occur (24). *Cret.-Rec.*

Hincksina NORMAN, 1903 [**Membranipora flustroides* HINCKS, 1880]. Incrusting. Membranous area

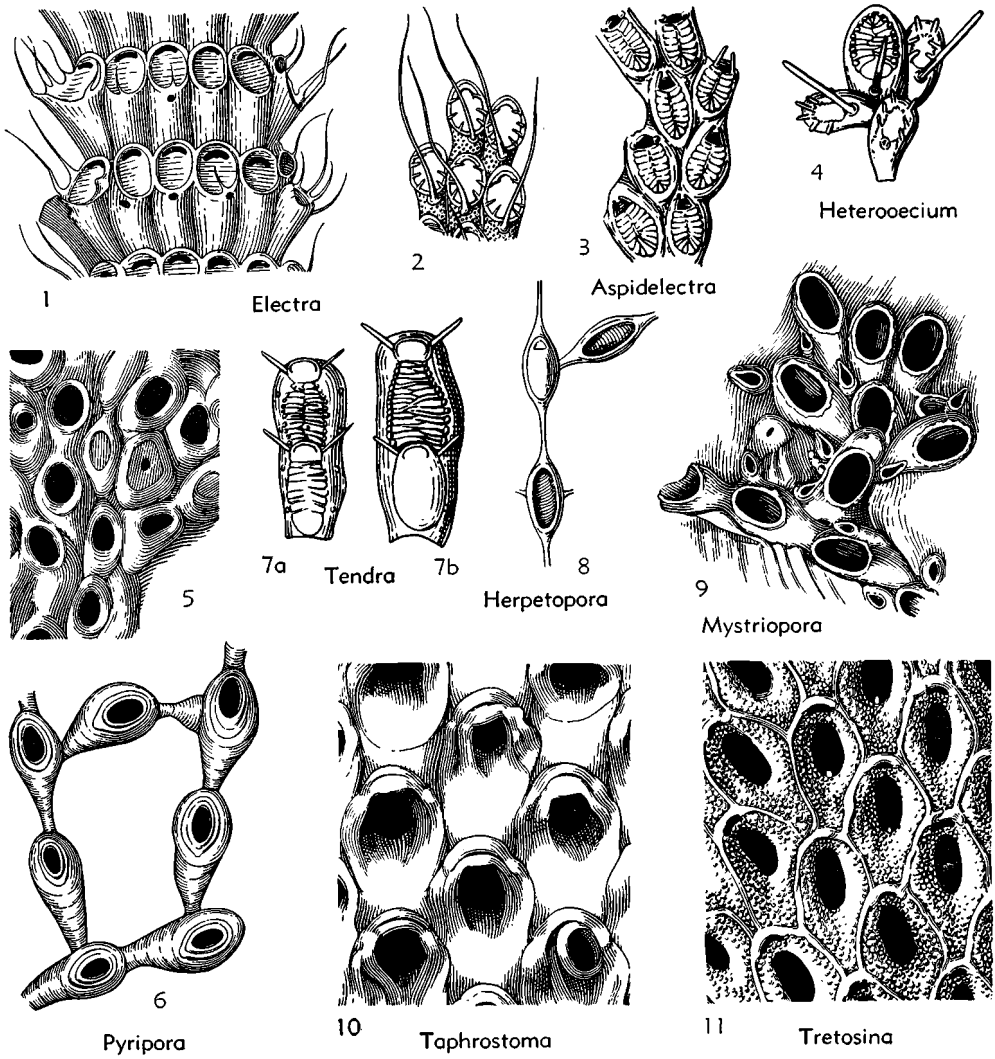


FIG. 119. Electridae (p. G157, G158).

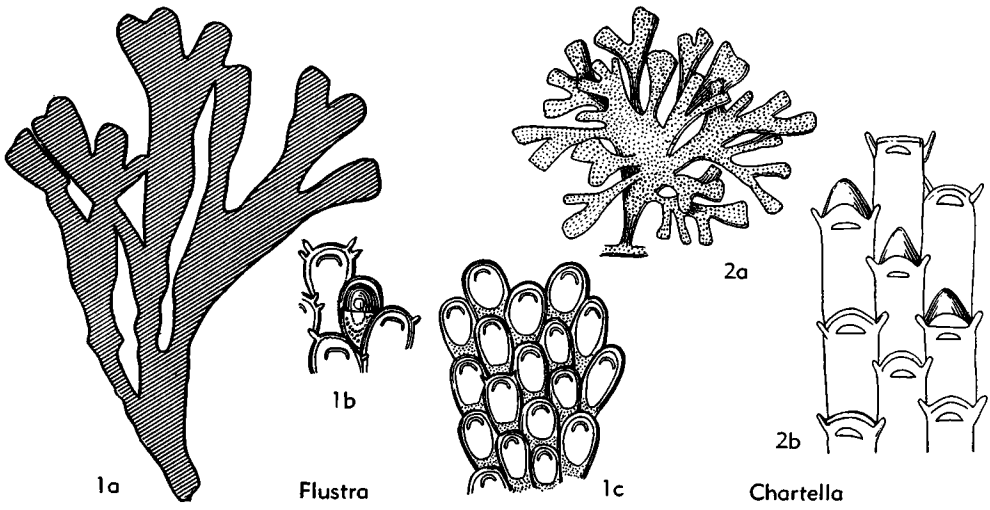


FIG. 120. Flustridae (p. G158, G159).

entire, mural rim with numerous spines, ovicell small; avicularia interzooecial. *Eoc.-Rec.*——FIG. 121,*1*. *H. megavicularia* CANU-B., Eoc.(Claib.), N.C.; ×25 (137).——FIG. 121,*2*. **H. flustroides* (HINCKS), Rec., NE.Atl., ×100 (167).

Antropora NORMAN, 1903 (*non* LANG, 1916) [**Membranipora granulifera* HINCKS, 1880] [=*Dacryonella, Membrendoecium* CANU-B., 1917; *Canua* DAVIS, 1934]. Opesium surrounded by heavy cryptocyst; pair of avicularia at distal end of aperture. *Oligo.-Rec.*——FIG. 121,*3*. *A. pyriformis* (CANU-B.), Oligo.(Vicksb.), Ala.; ×25 (137).——FIG. 121,*4*. **A. granulifera* (HINCKS), E.Atl.; ×25 (167).——FIG. 121,*5*. *A. papillata* (BUSK) (type of *Membrendoecium*), Rec., SW. Pac.; ×50 (134).

Aplousina CANU-B., 1927 [**A. gigantea*]. Simple incrusting zooecia with small but prominent ovicells; no spines. *Cret.-Rec.*——FIG. 121,*7*. **A. gigantea*, Rec., GulfMex.; ×25 (137).

Biselenaria GREGORY, 1893 [*pro Diplotaxis* REUSS, 1867 (*non* KIRBY, 1837)] [**Diplotaxis placentula* REUSS, 1867]. Like *Vibracellina* but zoarium orbicular with porous base. *Eoc.-Oligo.*——FIG. 122,*7*. **B. placentula* (REUSS), *Oligo.*, Ger.; *1a,b*, front, back, ×25 (137).

Cauloramphus NORMAN, 1903 [**Flustra spinifera* JOHNSTON, 1832]. Frontal area membranous with thick lateral walls bearing stout spines and some tall stalked pedunculate avicularia. Ovicells inconspicuous. *Rec.*——FIG. 121,*8*. **C. spiniferum* (JOHNSTON), N.Atl.; ×25 (167).

Cranosina CANU-B., 1933 [**Membranipora coronata* HINCKS, 1881]. Zooecia distinct, with thick granulated mural rim and transverse setiform avicularia. *Cret.-Rec.*——FIG. 122,*6*. **C. coronata* (HINCKS), Rec., SW.Pac.; ×37.5 (167).

Cribrendoecium CANU-B., 1917 [**C. tenuicostulatum*]. Zooecia with costulate surface and large interzooecial avicularia. *Eoc.*——FIG. 122,*1*. **C. tenuicostulatum*, Claib., N.C.; ×20 (137).

Ellisina NORMAN, 1903 [**Membranipora levata* HINCKS, 1882 (*non* NORMAN, 1903)] [=*Ellisinidra* CANU-B., 1933]. A small transverse dependent interzooecial avicularium above each zooecium. *Cret.-Rec.*——FIG. 122,*4*. **E. levata* (HINCKS), Rec., E.Pac.; ×25 (167).

Ogivalina CANU-B., 1917 [**O. eximipora*]. Large *Onychocella*-like zooecia with well-developed ovicell and cryptocyst. *Eoc.*——FIG. 122,*5*. **O. eximipora*, Claib., N.Car.; ×25 (137).

Pseudolepralia SILÉN, 1942 [**P. ellisinae*]. Gymnocyst to operculum, small endozooecial ovicell, avicularia near aperture. *Rec.*——FIG. 121,*6*. **P. ellisinae*, N.W.Pac.; ×30 (216).

Setosellina CALVET, 1906 [**S. roulei*]. Like *Vibracellina* but threadlike vibraculum at distal end of each zooecium. *Eoc.-Rec.*——FIG. 122,*2*. **S. roulei*, Rec., E.Atl.; ×25 (137).

Vibracellina CANU-B., 1917 [**V. capillaria*]. Incrusting. Zooecia elongate, with opesium entire and interzooecial vibracula. *Eoc.-Rec.*——FIG. 122, *3*. **V. capillaria*, Eoc.(Claib.), Tex.; ×25 (137).

Family CALLOPORIDAE Norman, 1903

[=Alderinidae CANU-B., 1927; Tegellidae, Allantoporidae VIG., 1949]

Incrusting, with zooecia generally bearing small gymnocyst, cryptocyst confined to descending part; hyperstomial ovicell (24, 31). *Cret.-Rec.*

Callopora GRAY, 1848 (*non* HALL, 1851) [**Flustra lineata* LINNÉ, 1758] [=*Dermatopora* HAG., 1851;

Filiflustrella, Reptoflustrina D'ORB., 1853]. Zooecia with large opesial area, narrow cryptocyst, spines on marginal walls and sessile avicularia with acute mandibles. *Cret.-Rec.*——FIG. 123,*2*. **C. lineata* (LINNÉ), Rec., N.Atl.; ×37.5 (134).

Acanthoporella DAVIS, 1934 [**Cauloramphus triangularis* CANU-B., 1923]. Spines and small avicularia on mural rim. *Pleisto.-Rec.*——FIG. 123,*8*. **A. triangularis* (CANU-B.), Pleisto., Calif.; ×25 (137).

Acanthoporidra DAVIS, 1934 [**Membranipora angusta* ULR., 1901]. Terminal spines and distal round avicularium without pivot; dietellae and septules prominent. *Tert.*——FIG. 123,*5*. **A. angusta* (ULR.), Eoc.(Wilcox.), Md.; ×25 (222).

Akatopora DAVIS, 1934 [**A. clausentina*]. Like *Callopora* but with lacunae in interzooecial tissue and lacking avicularia. *Eoc.*——FIG. 124,*1*. **A. clausentina*, Lut., Eng.; ×25 (146).

Alderina NORMAN, 1903 [**Membranipora imbellis* HINCKS, 1860]. Membranous front with crenulated walls; no lateral spines or avicularia; dietellae present; ovicell with rib or depressed area. *Cret.-Rec.*——FIG. 123,*1*. **A. imbellis* (HINCKS), Rec., Atl.; ×25 (167).

Allantopora LANG, 1914 [**Hippothoa irregularis* GABB-H., 1860]. Zooecia uniserial to multiserial, with circle of spines around aperture. *Cret.-Rec.*——FIG. 123,*7*. **A. irregularis* (GABB-H.), Eoc. (Wilcox.), N.J.; ×25 (137).

Ammatophora NORMAN, 1903 [**Membranipora nodulosa* HINCKS, 1880]. Cryptocyst forms ⅔ of area; no avicularia. *Cret.-Rec.*——FIG. 124,*6*. **A. nodulosa* (HINCKS), Rec., E.Atl.; ×25 (167).

Amphiblestrum GRAY, 1848 [**A. membranaceum* (=*Membranipora flemingii* BUSK, 1854)]. Like *Callopora* but spines rare, partially calcified; cryptocyst and gymnocyst present. *Cret.-Rec.*

A. (Amphiblestrum). *Cret.-Rec.*——FIG. 123,*3*. **A. membranaceum*, Rec., N.Atl.; ×37.5 (134).

A. (Bathypora) MACGILL., 1885 [**B. porcellana*]. *Rec.*, SW.Pac.

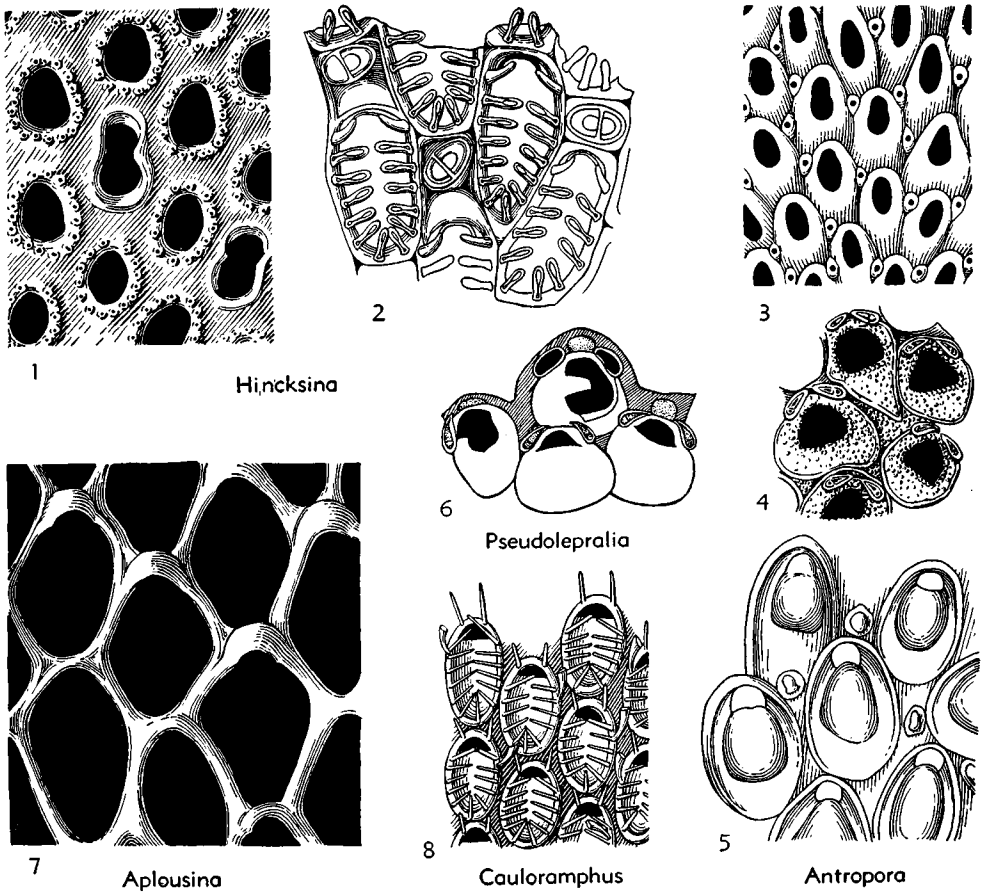
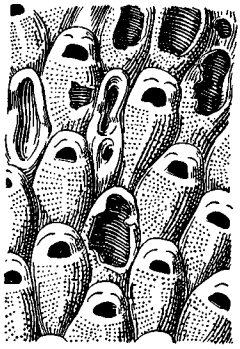


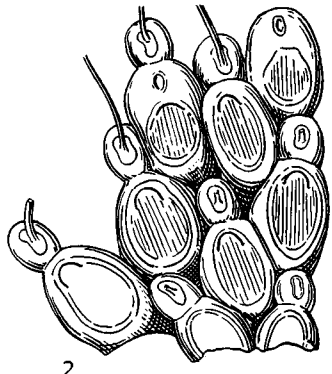
FIG. 121. Hincksinidae (p. G159, G160).

Bactrellaria MARSSON, 1887 [**B. rugica*]. Like *Stamenocella* but zooecia open on one side of a triserial branch. *Cret.*——FIG. 123,*4*. **B. rugica*, Camp., Ger.; *4a,b*, ×25 (186).

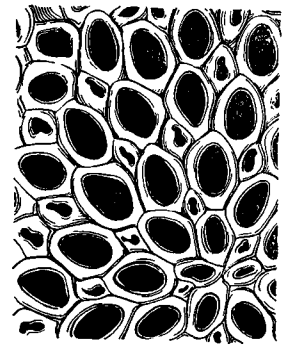
Bidenkapia OSBURN, 1950 [**Membranipora spitsbergensis* BIDENKAP, 1897]. Gymnocyst almost covered by a large transverse avicularium. *Rec.*, Spitz.



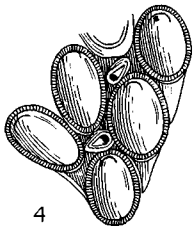
1 Cribrendoecium



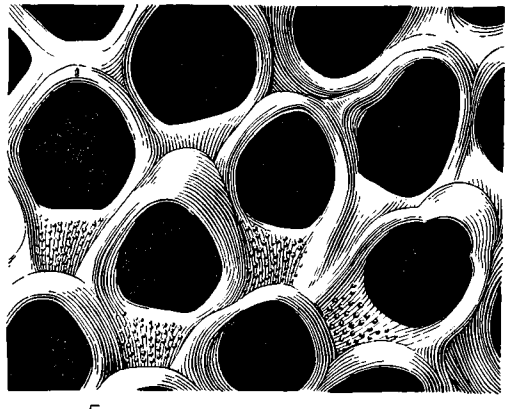
2 Setosellina



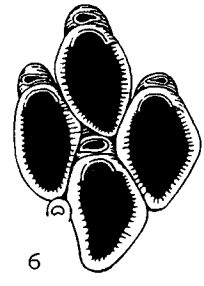
3 Vibracellina



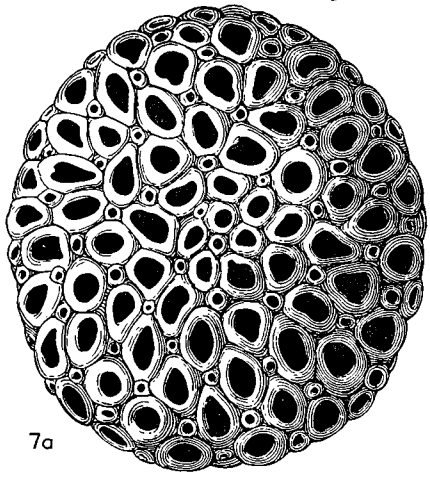
4 Ellisina



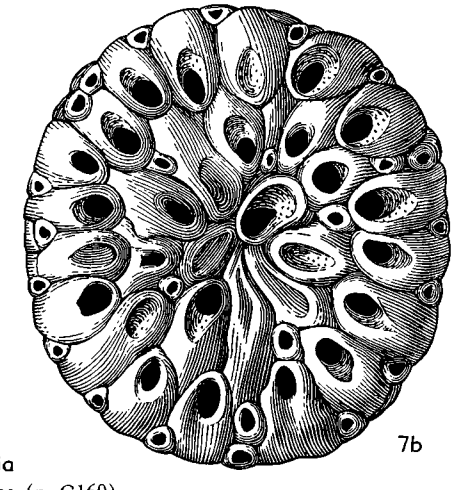
5 Ogivalina



6 Cranosina



7a



7b Biselenaria

FIG. 122. Hincksinidae (p. G160).

Copidozoum HARMER, 1926 [**Membranipora plana* HINCKS, 1880]. Normal interzooecial avicularium with mandible broad at base and narrowed into a long, linear point. *Rec.*——FIG. 123,*6*. **C. planum* (HINCKS), SW.Pac.; ×25 (167).

Crassimarginatella CANU, 1900 [**Membranipora crassimarginata* HINCKS, 1880] [=*Oochilina* NORMAN, 1903 (obj.); *Grammella* CANU, 1917 (obj.)]. Heavy lateral walls; elliptical opesium with no spines. Large interzooecial avicularium with solid theta-shaped pivot. *Cret.-Rec.*——FIG. 124,*10*. **C. crassimarginata* (HINCKS), Rec., E.Atl.; ×25 (137).

Doryporella NORMAN, 1903 [**Lepralia spathulifera* SMITT, 1867]. Gymnocyst occupying most of frontal, small oval avicularium. *Rec.*, N.Atl.

Flustrellaria D'ORB., 1853 [**F. fragilis*] [=*Ornatella* CANU, 1900]. Mural rim with hollow spines; no avicularia. *Cret.*——FIG. 124,*12*. **F. fragilis*, Cenom., Fr.; ×25 (202).

Foveolaria BUSK, 1884 [**F. elliptica*; SD CANU, 1900]. Erect bifoliate narrow branches. Zooecia embedded in pit of thickened ectocyst. *Rec.*——FIG. 124,*9*. **F. elliptica*, SW.Pac.; ×25 (134).

Frurionella CANU-B., 1925 [**F. parvipora*]. Like *Foveolaria* but frontal comprises an olocyst with scattered pores. *Cret.*——FIG. 124,*13*. **F. parvipora*, Ripley, Tenn.; ×25 (137).

Hapsidopora LANG, 1917 [**H. arcuata*]. Uniserial branching. Pyriform zooecia with small avicularia placed distally and laterally. *Cret.*——FIG. 124,*3*. **H. arcuata*, Cenom., Eng.; ×25 (175).

Larnacicus NORMAN, 1903 [**Membranipora cornigera* BUSK, 1860]. Distal end of zooecia divided into chambers; gymnocyst and interzooecial avicularia

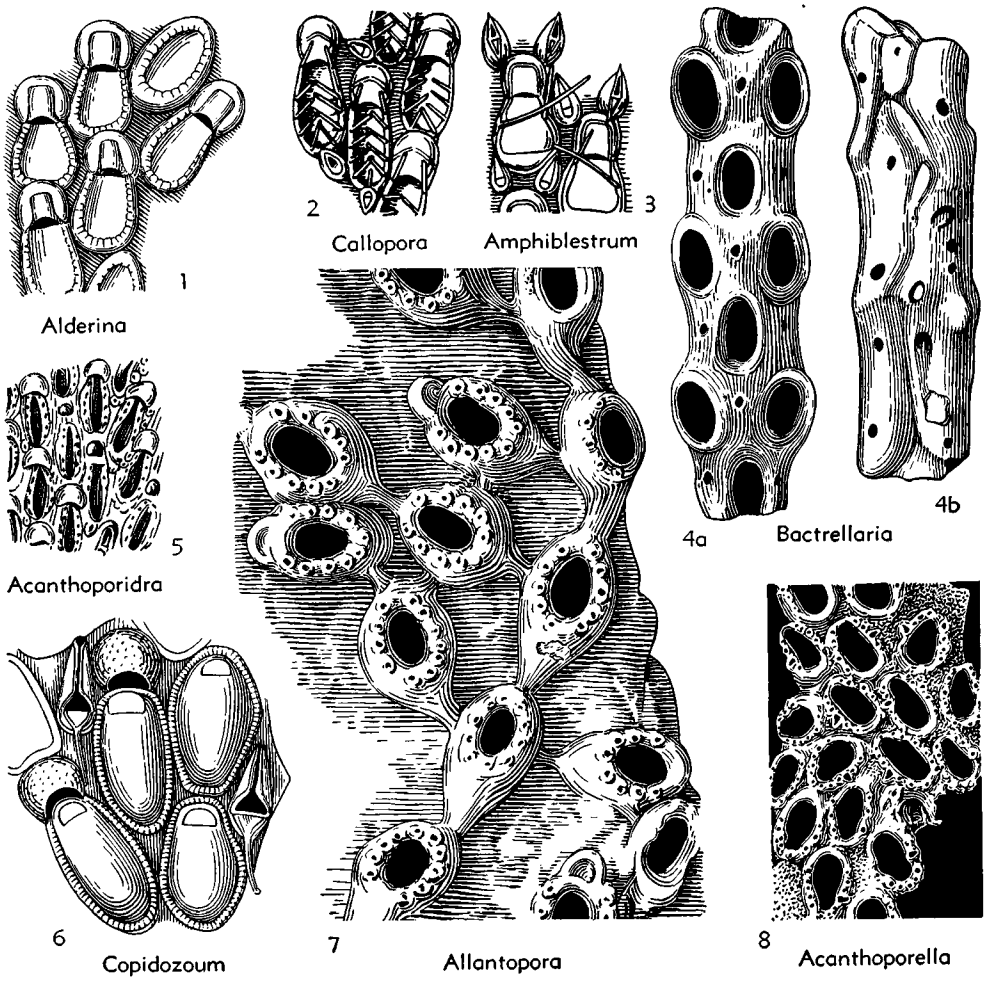


FIG. 123. Calloporidae (p. G161-G163).

with pivot present. *Rec.*——Fig. 124,*4*. **L. cornigera* (Busk), N.Atl.; ×37.5 (200).

Marginaria Roemer, 1841 [**M. elliptica*]. *Cret.*, Ger.

Marssonopora Lang, 1914 [**Cellepora dispersa* Hag., 1839]. Uniserial pyriform zooecia narrowed proximally to a thin tube, separated by filiform zooeciules. *Cret.*——Fig. 124,*2*. **M. dispersa* (Hag.), Camp., Ger.; ×25 (175).

Membraniporidra Canu-B., 1917 [**M. porrecta*]. Free, bifoliate or incrusting. Like *Alderina* but ovicell deeply imbedded and dietellae wanting. *Cret.-Rec.*——Fig. 124,*7*. **M. porrecta,* Eoc. (Claib.), N.C.; ×25 (137).——Fig. 124,*8*. *M. trigemma* Canu-B., Eoc.(Claib.), N.Car.; ×25 (137).

Mollia Lamx., 1816 [**Eschara patellaria* Moll, 1803]. Like *Retevirgula* in tubular zooecial connections but lacking avicularia and spines. *Cret.-Rec.*——Fig. 124,*5*. **M. patellaria* (Moll), Rec., Atl.; ×25 (137).

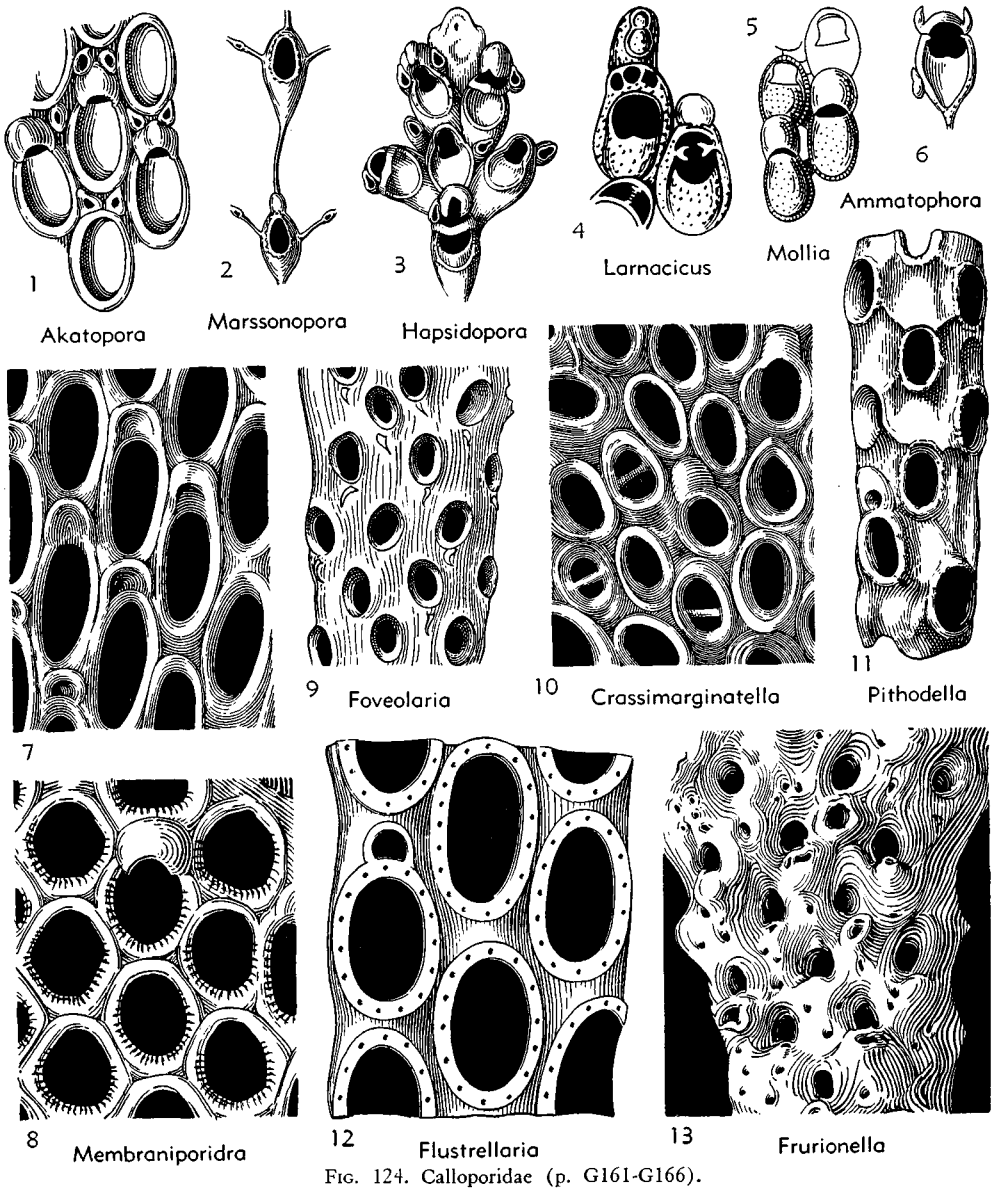


Fig. 124. Calloporidae (p. G161-G166).

Parellisina OSBURN, 1940 [**Membranipora curvirostris* HINCKS, 1862]. Avicularia vicarious (interzooecial), associated with vestigial zooecia (kenozooecia). *Rec.*——FIG. 125,*7*. **P. curvirostris* (HINCKS), Rec., Atl.; ×25 (204).

Periporosella CANU-B., 1917 [**P. tantilla*]. Bifoliate lamellae; zooecia elongate rectangular, each surrounded by 12 to 16 dietellae. *Cret.-Eoc.*——FIG. 125,*1*. **P. tantilla*, Eoc.(Claib.), N.Car.; *1a,b*, ovicells, dietellae, ×25 (137).

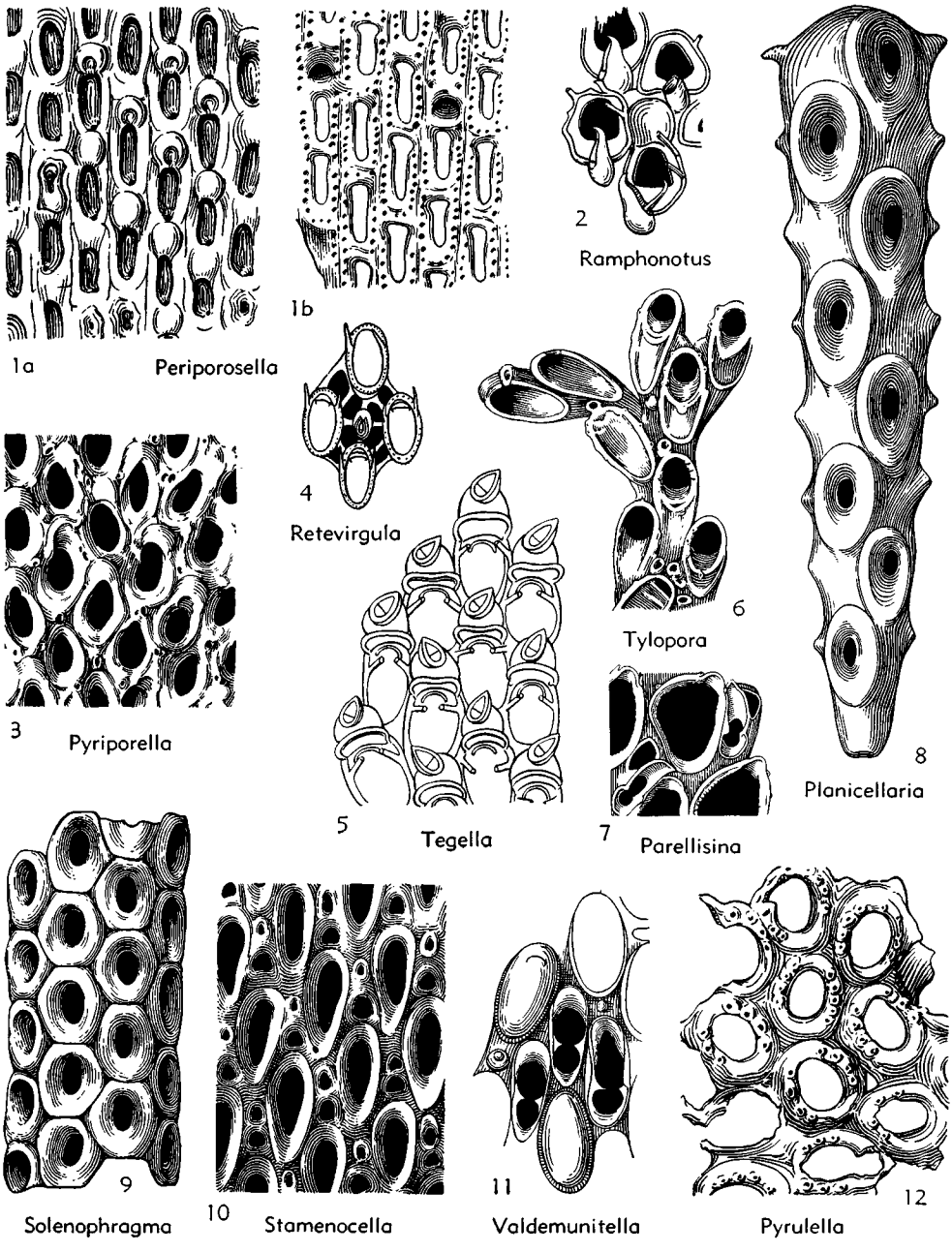


FIG. 125. Calloporidae (p. G165, G166).

Pithodella MARSSON, 1887 [**P. cincta*]. Narrow rods probably related to *Stamenocella*. *Cret.*——FIG. 124,*11*. **P. cincta*, Camp., Ger.; ×25 (186).

Planicellaria D'ORB., 1851 [**P. oculata*]. Articulated segments with thick-walled apertures. *Cret.*——FIG. 125,*8*. **P. oculata*, Senon., Fr.; ×25 (202).

Pyriporella CANU, 1911 [**P. ameghinoi*]. Pyriform zooecia with gymnocyst and small interzooecial avicularia. *Cret.*——FIG. 125,*3*. **P. ameghinoi*, Rocanean, Arg.; ×25 (136).

Pyrulella HARMER, 1926 [**Membranipora pyrula* HINCKS, 1881]. Ovicell closed by opercular valve; opesium oval, surrounded by spines. *Cret.-Rec.*——FIG. 125,*12*. **P. pyrula* (HINCKS), Rec., SW. Pac.; ×25 (137).

Ramphonotus NORMAN, 1894 [**R. minax* BUSK, 1860][=*Rhynchotella* CANU, 1900]. Large avicularium on pedicle near opesial proximal border. *Cret.-Rec.*——FIG. 125,*2*. **R. minax* BUSK, Rec., N.Atl.; ×25 (167).

Retevirgula BROWN, 1945 [**Membranipora acuta* HINCKS, 1885]. Like *Callopora* but zooecia dissociated, united by tubular connecting processes. *Rec.*——FIG. 125,*4*. **R. acuta* (HINCKS), SW.Pac.; ×15 (133).

Solenophragma MARSSON, 1887 [**S. baculinum*]. Longitudinal canals in center of zoarium. *Cret.*——FIG. 125,*9*. **S. baculinum*, Camp., Ger.; ×25 (186).

Stamenocella CANU-B., 1917 [**S. mediaviculifera*]. Erect slender, thin, bilamellar branches with long, flat gymnocyst supporting small avicularium and fragile ovicell. *Cret.-Mio.*——FIG. 125,*10*. **S. mediaviculifera*, Eoc.(Jackson.), Ga.; ×25 (137).

Tegella LEV., 1909 [**Flustra unicornis* FLEMING, 1828]. Like *Callopora* but pore chambers absent. *Cret.-Rec.*——FIG. 125,*5*. **T. unicornis* (FLEMING), Rec., N.Atl.; ×25 (177).

Tylopora LANG, 1917 [**T. lorea*]. Like *Hapsidopora* but caudal portion much reduced and apertures dimorphic. *Cret.*——FIG. 125,*6*. **T. lorea*, Turon., Eng.; ×25 (175).

Valdemunitella CANU, 1900 [**Membranipora valdemunita* HINCKS, 1885]. Like *Crassimarginatella* but with spatula-like avicularia. *Rec.*——FIG. 125, *11*. **V. valdemunita* (HINCKS), SW.Pac.; ×25 (136).

Family CHAPERIIDAE Jullien, 1888

[=Chaperiellidae STRAND, 1928; Chapperiidae BASSLER, 1935]

Incrusting or bilamellar. Aperture large, provided interiorly with a pair of calcareous plates, horizontal projections from the walls opposite and beneath the operculum ("occlusor laminae" of HARMER) which afford attachment for opercular muscles. Zooecial front without pores. *Oligo.-Rec.*

Chaperia JULLIEN, 1881 [**C. australis* (?=*Flustra acanthina* LAMX., 1825)][=*Chapperia* WILLEY, 1900 (obj.); *Chaperiella* STRAND, 1928 (obj.); *Chaperiopsis* UTTLEY, 1949]. Internal calcareous plates converge toward distal wall; avicularium trumpet-shaped. Hyperstomial ovicell prominent among conspicuous spines along the distal rim. *Oligo.-Rec.*——FIG. 126,*1*. **C. acanthina* (LAMX.), Rec., S.Atl.; ×25 (169).——FIG. 126,*2*. *C. bilaminata* (WATERS), Rec., S.Afr.; ×25 (230).

Patsyella BROWN, 1948 [**Monoporella capensis dentata* WATERS, 1887]. Like *Chaperia* but ovicell ?endozooecial and opesia of ovicelled zooecia much larger than others. *Oligo.-Rec.*——FIG. 126,*3*. **P. dentata* (WATERS), Plio., N.Z.; ×25 (133).

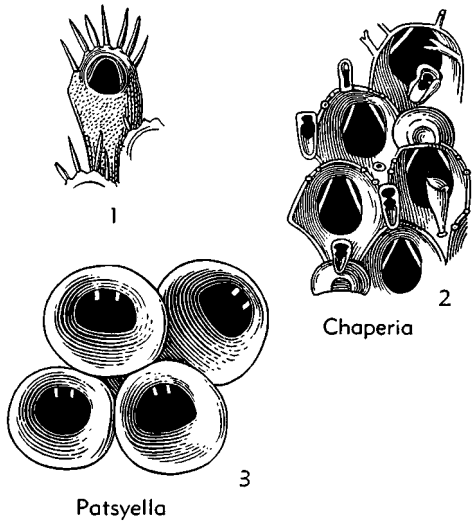


FIG. 126. Chaperiidae (p. G166).

Family HIANTOPORIDAE MacGillivray, 1895

Zooecial front a pericyst, as in Arachnopusiidae, but developed from an enlarged spine or spines forming incomplete cover with large, irregular pores (31). *Cret.-Rec.*

Hiantopora MACGILL., 1887 [**Lepralia ferox* MACGILL., 1868][=*Membrostega* JULLIEN, 1903 (obj.)]. Pericyst of large pores caused by branching of spines above ectocyst. *Cret.-Rec.*——FIG. 127,*2*. **H. ferox* (MACGILL.), Rec., SW.Pac.; ×25 (137).

Tremogasterina CANU, 1911 [**T. problematica*]. Pericyst complete, perforated by 1 or 2 large pores; large interopesial avicularia. *Cret.-Rec.*——FIG. 127,*3*. *T. celleporoides* (BUSK), Rec., SW.Pac.; ×25 (137).

Tremopora ORTMANN, 1890 [**T. dendracantha*]. Like *Hiantopora* but ectocyst more visible because mural rim bears only 1 or 2 branched oral spines. *Mio.-Rec.*——FIG. 127,*1*. **T. dendracantha*, Rec., NW.Pac.; ×25 (203).

Family ARACHNOPUSIIDAE Jullien, 1888

Incrusting. Zooecial front a pericyst, arched calcified shield above membranous ectocyst, perforated by large pores. Shield not formed by radial costae but by irregular projections from margins (31). *Eoc.-Rec.*

Arachnopusia Jullien, 1886 [**Lepralia monoceros* Busk, 1854]. Pericyst formed by coalescence of branched spines. Elliptical avicularium near aperture. *Oligo.-Rec.*——Fig. 127,*4*. **A. monoceros* (Busk), Rec., Straits Magellan; ×25 (134).

Anexechona Osburn, 1950 [**A. ancorata*]. Salient peristome absent but with large vicarious avicularia. *Rec.*——Fig. 127,*6*. **A. ancorata*, Gulf Calif.; ×50 (204).

Exechonella Canu-B., 1927 [**Hiantopora magna* MacGill., 1895]. Like *Arachnopusia* but larger orbicular frontal pores and zooecial peristomes more developed. *Eoc.-Rec.*——Fig. 127,*5*. **E. magna* (MacGill.), Rec., SW.Pac.; ×25 (181).

Hippexechonella Vig., 1949 [**Cyclicopora grandis* Duvergier, 1920]. Like *Exechonella* but aperture has 2 cardelles. *Mio.*——Fig. 127,*7*. **H. grandis* (Duvergier), Aquit., Fr.; ×25 (148).

Division COILOSTEGA Levinsen, 1902

[=Coelostega Harmer, 1926]

Horizontal lamina of cryptocyst so much developed that commonly it extends forward around aperture; lateral (parietal) muscles operating frontal membrane above the cryptocyst pass downward to dorsal wall distally to the lamina by way of notches (opesiular indentations) at the sides or through special foramina on either side (opesiules). Distal end of polypide more or less enclosed in a calcified polypide tube, when opesiules are well developed. Interzooecial avicularia or vibracula generally present. Ovicells hyperstomial or endozooecial. *?M.Jur., Cret.-Rec.*

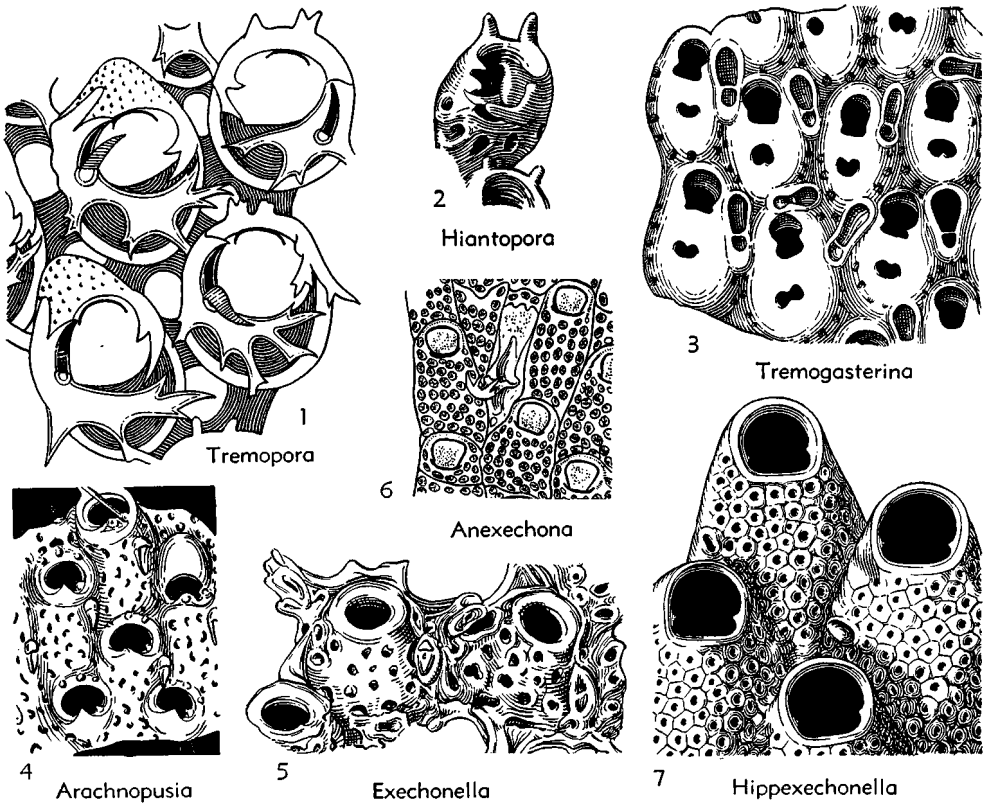


Fig. 127. Hiantoporidae, Arachnopusiidae (p. G166, G167).

Family ONYCHOCELLIDAE Jullien, 1881

Ovicell endozooecial. No gymnocyst; cryptocyst calcified, depressed, traversed by parietal muscles through lateral opesiular indentations. Onychocellaria and avicularia with mandibles winged at base present (24). *?M.Jur., Cret.-Rec.*

Onychocella JULLIEN, 1882 [**O. marioni*] [=*?Reptocelleporaria* D'ORB., 1852; *Periteichisma* KOSCHINSKY, 1885]. Hexagonal zooecia with subtrifoliate opesium and flat cryptocyst surrounded by salient rim. Onychocellaria asymmetrical, with wing on one side. *?M.Jur., Cret.-Rec.*——FIG. 128,*1. O. angulosa* REUSS, Eoc.(Claib.), N.Car.; ×25 (137).

Collura JULLIEN, 1881 [**Eschara athulia* D'ORB., 1851]. Apertures with thick collar-like rim. *Cret.* ——FIG. 128,*4. *C. athulia* (D'ORB.), Maastr., Fr.; ×25 (202).

Distefanella CIPOLLA, 1922 [**D. altavillae*]. *Plio.*, Italy.

Floridina JULLIEN, 1881 [**Mollia antiqua* SMITT,

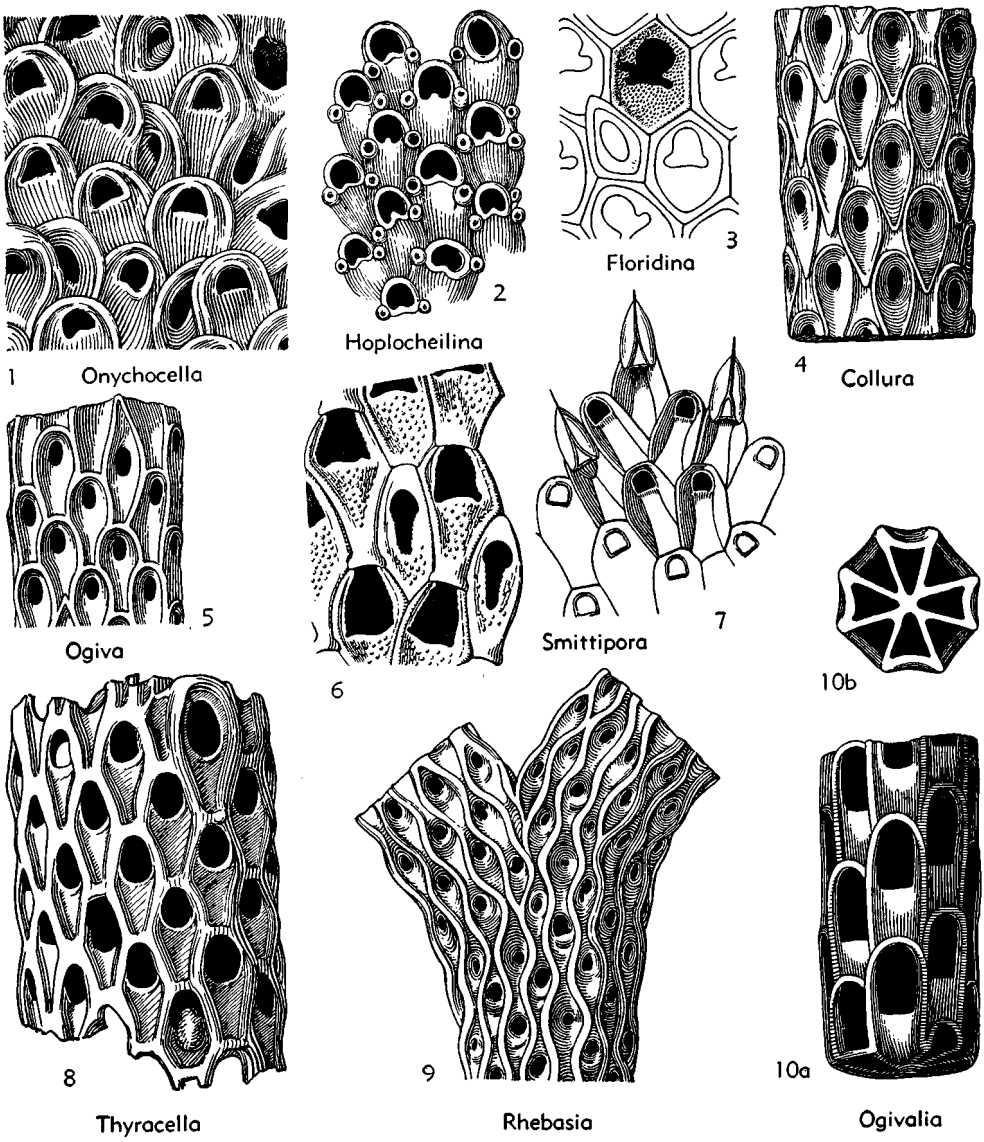


FIG. 128. Onychocellidae (p. G168, G169).

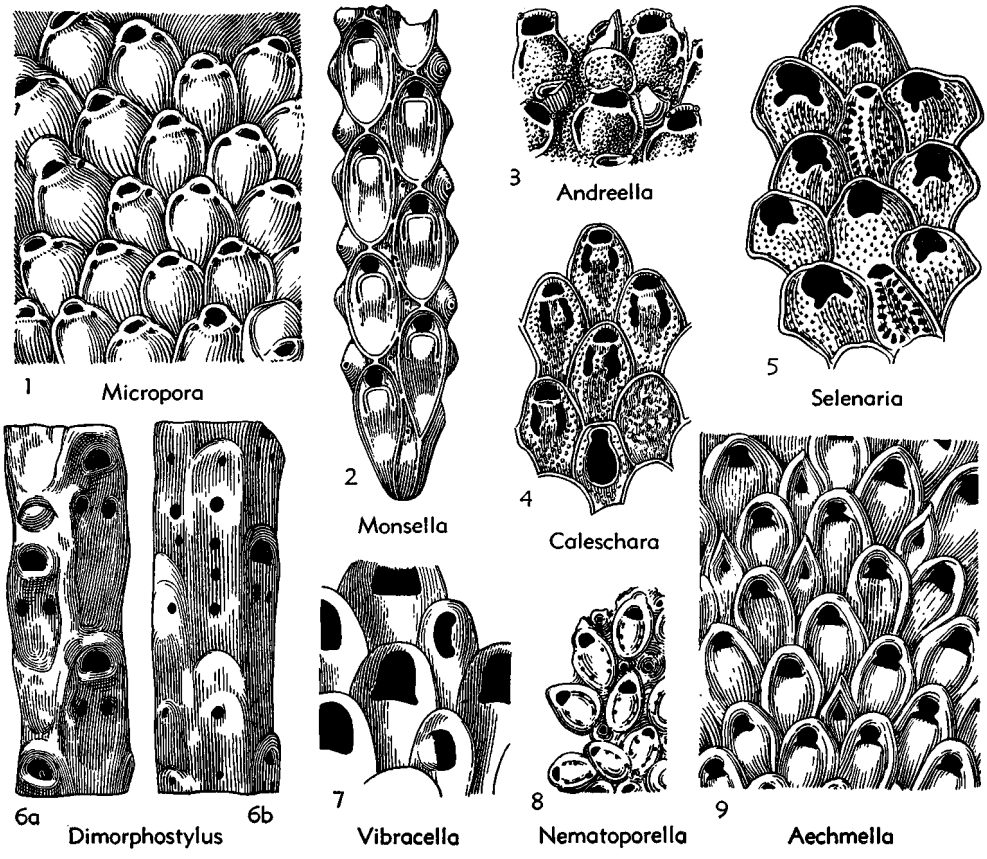


FIG. 129. Microporidae (p. G170, G171).

1872]. Aperture trifoliate, with large symmetrical opesiular indentations and straight avicularia with bimembranous mandible (onychocellaria). *Cret.-Rec.*——FIG. 128,*3*. **F. antiqua* (SMITT), Rec., Gulf Mex.; ×25 (137).

Hoplocheilina CANU, 1911 [**Eschara osculifera* REUSS, 1872]. Opesiules round shallow indentations; 2 large oval avicularia. *Cret.*——FIG. 128,*2*. **H. osculifera* (REUSS), Cenom., Ger.; ×25 (137).

Ogiva JULLIEN, 1881 [**Eschara actea* D'ORB., 1851]. Opesium elliptical, opesiules indistinct, avicularia elongate. *Cret.*——FIG. 128,*5*. **O. actea* (D'ORB.), Coni., Fr.; ×10 (202).

Ogivalia JULLIEN, 1881 [**Vincularia elegans* D'ORB., 1839]. Slender cylindrical branches. *Cret.-Rec.*——FIG. 128,*10*. **O. elegans* (D'ORB.), Rec., S.Atl.; *10a,b*, front, transv. sec., ×25 (137).

Rhebasia JULLIEN, 1881 [**Eschara dorilas* D'ORB., 1851]. Branches with oval apertures at distal end of zooecia, margins confluent laterally. *Cret.*——FIG. 128,*9*. **R. dorilas* (D'ORB.), Coni., Fr.; ×25 (202).

Semieschara D'ORB., 1852 [**S. flabellata*]. Probably worn unilamellate *Onychocella. Cret.*, Fr.

Smittipora JULLIEN, 1881 [**Vincularia abyssicola* SMITT, 1874][=*Diplopholeos, Rectonychocella, Velumella* CANU-B., 1917]. Like *Onychocella* but onychocellaria have straight mandible with 2 membranes. *Cret.-Rec.*——FIG. 128,*6*. *S. (Velumella) levinseni* CANU-B., Rec., Atl.; ×25 (137).——FIG. 128,*7*. **S. abyssicola* (SMITT), Rec., GulfMex.; ×25 (137).

Thyracella VOIGT, 1930 [**Eschara vigelius* PERGENS, 1893]. Long, straight onychocellaria larger than zooecia; large elliptical opesium. *Cret.*——FIG. 128,*8*. **T. vigelius* (PERGENS), Maastr., Holl.; ×25 (131).

Family MICROPORIDAE Hincks, 1880

[=Selenariidae HARMER, 1926]

Like Onychocellidae but onychocellaria replaced by avicularia and opesiular indentations changed to true perforations (opesi-

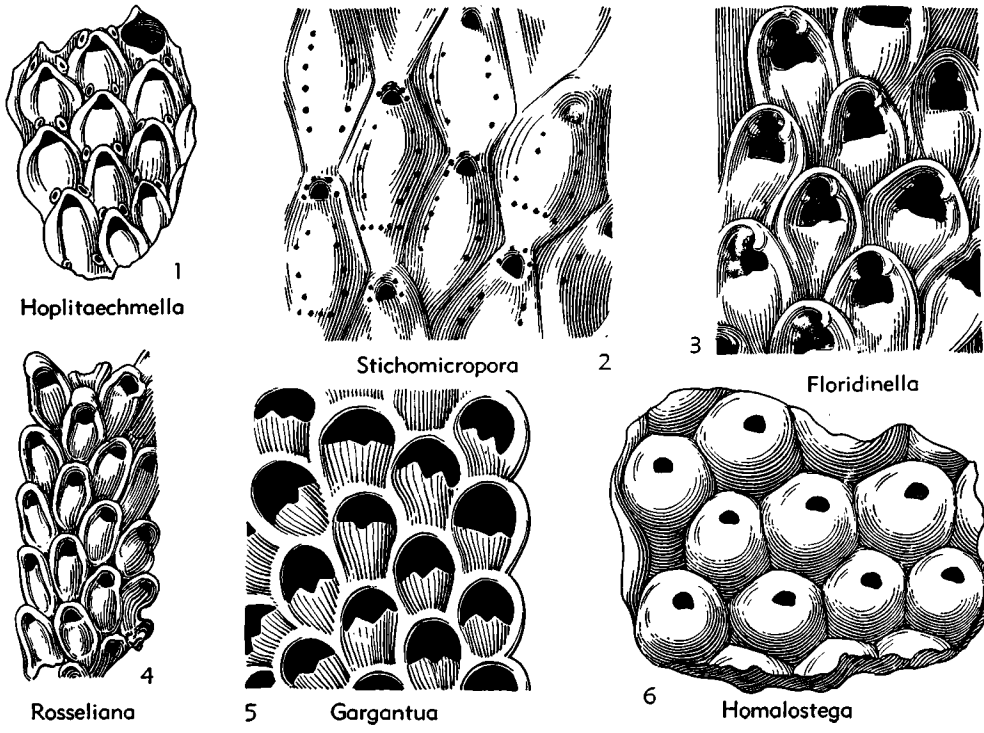


FIG. 130. Microporidae (p. G170, G171).

ules, micropores). No calcified polypide tube. Opesium semicircular (24). *Cret.-Rec.*

Micropora GRAY, 1848 (*non* EICHW., 1885) [**M. coriacea* (=*Flustra coriacea* ESPER, 1791][=*?Reptescharinella* D'ORB., 1853; *Peneclausa* JULLIEN, 1888 (obj.)]. Incrusting. Cryptocyst covers entire front except aperture and 2 small opesiules; small median avicularium at distal edge of aperture. *Cret.-Rec.*——FIG. 129,*1*. **M. coriacea* (ESPER), Rec., N.Atl.; ×25 (137).

Aechmella CANU-B., 1917 [**A. filimargo*]. Like *Floridina* but with avicularia. *Cret.-Mio.*——FIG. 129,*9*. **A. filimargo,* Eoc.(Jackson.), Ala.; ×25 (137).

Andreella JULLIEN, 1888 [**Micropora uncifera* BUSK, 1884]. Cryptocyst complete, perforated laterally by cross-shaped opesiules. *Rec.*——FIG. 129,*3*. **A. uncifera* (BUSK), Cape Horn; ×25 (134).

Caleschara MACGILL., 1880 [**Eschara denticulata* MACGILL., 1868]. Large salient ovicell, long linear opesiules. No avicularia. *Eoc.-Rec.*——FIG. 129,*4*. **C. denticulata* (MACGILL.), Rec., SW.Pac.; ×25 (181).

Dimorphostylus VOIGT, 1928 [**D. tetrastichus*]. Articulated, rod-shaped segments with zooecia on front only; 2 opesiules. *Cret.*——FIG. 129,*6*. **D. tetrastichus,* Dan. (drift), Ger.; *6a,b,* front, back, ×50 (227).

Floridinella CANU-B., 1917 [**F. vicksburgica*]. Like *Floridina* but without onychocellaria and avicularia; large broad opesiular indentations. *Cret.-Rec.*——FIG. 130,*3*. **F. vicksburgica,* Oligo.(Vicksb.), Ala.; ×25 (137).

Gargantua JULLIEN, 1888 [**Cellepora bidens* BUSK (*non* HAG., 1851)]. Minute avicularia; opesiules incomplete. *Cret.-Rec.*——FIG. 130,*5*. **G. bidens* (BUSK), Cret.(Maastr.), Holl.; ×25 (137).

Homalostega MARSSON, 1887 [**Cellepora convexa* HAG., 1839]. *Cret.*——FIG. 130,*6*. **H. convexa* (HAG.), Camp., Ger.; ×25 (186).

Hoplitaechmella VOIGT, 1949 [**Cellepora vespertilio* HAG., 1839]. Avicularia include 2 sets, large vicarious and minute paired. *Cret.*——FIG. 130,*1*. **H. vespertilio* (HAG.), Camp., Ger.; ×15 (227).

Monsella CANU, 1900 [**Planicellaria eocena* MEUNIER & PERGENS, 1886]. Articulated zoaria with long polypidian lamella and linear slits for opesiules. *Paleoc.*——FIG. 129,*2*. **M. eocena* (MEUNIER & PERGENS), Montian, Belg.; ×25 (136). [Monsellinae VIG., 1949].

Nematoporella CANU-B., 1927 [*pro Nematopora* DUVERGIER, 1921 (*non* ULR., 1888)][**Nematopora ovata* DUVERGIER, 1921]. Incrusting. Several pairs

of opesiules and avicularia replaced by vibracula. *Mio.*——Fig. 129,*8*. **N. ovata* (Duvergier), Burdig., Fr.; ×25 (148).

Rosseliana Jullien, 1888 [**Flustra rosselii* Audouin, 1826]. Frontal a cryptocyst with semicircular opesium, opesiules poorly outlined, no avicularia. *Oligo.-Rec.*——Fig. 130,*4*. **R. rosselii* (Audouin), Rec., Medit.; ×25 (137).

Selenaria Busk, 1854 [**S. maculata*]. Like *Vibracella* but avicularia with convex perforated frontal. *Eoc.-Rec.*——Fig. 129,*5*. **S. maculata,* Rec., SW. Pac.; ×25 (134).

Selenariopsis Maple., 1913 [**S. gabrieli*]. Dome-shaped. Zooecia quadrate in radial series. *Tert.,* Austral.

Steraechmella Lagaaij, 1952 [**S. buski* (=*Membranipora bidens* Busk, 1889, pl. 2, fig. 4a)]. Like *Aechmella* but without avicularia. *Plio.,* Eng.

Stichomicropora Voigt, 1949 [**S. sicksi* Voigt, 1920]. Like *Micropora* but with transverse row of spicules across frontal to protect ovicells. *Cret.*——Fig. 130,*2*. **S. sicksi* Voigt, Camp., Ger.; ×20 (227).

Vibracella Waters, 1891 [**Cellepora trapezoidea* Reuss, 1847]. Free orbicular zoaria, lateral opesiular indentations, auriform avicularia; well-developed cryptocyst. *Cret.-Plio.*——Fig. 129,*7*. **V. trapezoidea* (Reuss), Eoc., Italy; ×25 (210).

Family LUNULITIDAE Lagaaij, 1952

[=emend. Lunularidae Lev., 1909]

Zoaria free, thin, cupuliform to short, conical disks. Zooecia with more or less developed cryptocyst. Avicularia auriculate, with long, setose mandibles at proximal edge of each zooecium. Opesiular indentations inconstant. Ovicells endozooecial or absent (24). *Cret.-Rec.*

Lunulites Lamarck, 1816 [*non Lunulite* Lamarck, 1812 (invalid vernacular name)] [**L. radiatus*] [=*Pavolunulites, Reptolunites* d'Orb., 1852; *Oligotresium* Gabb-H., 1862; *Lunularia* Busk, 1884; *Dimiclausa* Gregorio, 1890]. Zooecia in radial rows, with radicular and hydrostatic zooecia present. Ovicell endozooecial. *Cret.-Eoc.*——Fig. 131, *2. L. vicksburgensis* (Conrad), Oligo.(Vicksb.), Miss.; *2a,b,* back, front, ×25 (137).——Fig. 131, *3. L. distans* (Lonsd.), Eoc.(Claib.), N.Car.; with ovicell, ×25 (137).——Fig. 131,*4*. *L. angulosa* (d'Orb.), Cret.(Senon.), Fr.; ×10 (137).

Volviflustrellaria Brydone, 1936 [**Membranipora tavernensis* Brydone, 1936]. Zooecia as in *Lunulites* but zoarium spindle-shaped. *Cret.,* Eng.

Family CALPENSIIDAE Canu & Bassler, 1923

Zoaria incrusting, linear to cupuliform, or articulated club-shaped. Zooecia with well-developed cryptocyst bearing one or more opesiules (26). *Cret.-Rec.*

Calpensia Jullien, 1888 [**Membranipora impressa* Moll, 1803 (=*Cellepora nobilis* Esper, 1796; *Membranipora calpensis* Busk, 1854]. Incrusting masses formed layer upon layer. Opesium semilunar; cryptocyst complete with 2 opesiules. No avicularia. *Plio.-Rec.*——Fig. 131,*1*. **C. nobilis* (Esper), Rec., E.Atl.; ×25 (137).

Corynostylus Canu-B., 1919 [**C. labiatus*]. Articulated, club-shaped segments. Zooecia with gymnocyst. *Mio.*——Fig. 131,*8*. **C. labiatus,* W. Indies; ×25 (137).

Discoporella d'Orb., 1852 (*non* Busk, 1859) [**Lunulites umbellata* Defrance, 1823] [=*Discoflustrella* d'Orb., 1853]. Zoarium wide cup-shaped. Zooecia porous with 2 rounded opesiules and large vibracula on outer surfaces. *Mio-Rec.*——Fig. 131,*9*. **D. umbellata* (Defrance), Mio., Fr.; ×25 (137).

Hemiseptella Lev., 1909 [**Vincularia labiata* Busk, 1884]. Incrusting. Opesium disymmetric, bordered on one side by spines; a single avicularium. *Mio.-Rec.*——Fig. 131,*7*. **H. labiata* (Busk), Rec., SW.Atl.; ×25 (230).

Microporina Lev., 1909 [**Salicornaria borealis* Busk, 1855]. Erect, jointed segments. Zooecial front a cryptocyst with many pores and 2 small opesiules. No ovicells but a few small avicularia. *Cret.-Rec.*——Fig. 131,*5*. *M. elongata* (Hincks), Rec., SE.Atl.; ×25 (167).——Fig. 131,*6*. **M. borealis* (Busk), Rec., NW.Atl.; ×50 (137).

Poricellaria d'Orb., 1852 [**P. alata*] [=*Diplodidymia* Reuss, 1869]. Zoarium erect. Zooecia in 4 rows with cryptocyst perforated laterally by a single long opesiule and 2 small pores before aperture. *Eoc.-Rec.*——Fig. 131,*11*. **P. alata,* Eoc. (Lut.), Fr.; ×37.5 (137).

Verminaria Jullien, 1888 [**Membranipora oblonga* Busk, 1859]. Incrusting. Opesium subterminal, many opesiules on each side. *Plio.*——Fig. 131,*10*. **V. oblonga* (Busk), Crag, Eng.; ×25 (134).

Family STEGINOPORELLIDAE Bassler, nov.

[=emend. Steganoporellidae Hincks, 1884]
[=Labioporellidae Harmer, 1926]

Zooecia generally dimorphic, comprising ordinary A-zooecia and enlarged B-zooecia (avicularia) with structurally different operculum (mandible); the zooecia are also dithalamic, divided by a descending lamina of cryptocyst into 2 chambers, the proximal one holding the polypide and the distal one containing parietal and opesiular muscles. No true avicularia, no ovicell (24). *Eoc.-Rec.*

Steginoporella SMITT, 1873 [**S. elegans;* SD JULLIEN, 1888 (=*Membranipora magnilabris* BUSK, 1854] [=*Steganoporella* HINCKS, 1884]. Incrusting to erect bifoliate. Calcified part of frontal area a depressed cryptocyst. Zooecia of 2 sorts; small A-zooecia and large B-zooecia, with enlarged operculum. *Eoc.-Rec.*——FIG. 132,*1*. **S. magnilabris* (BUSK), Rec., GulfMex.; *1a,b,* ×25 (*1a,* 137; *1b,* 164).

Gaudryanella CANU, 1907 [**G. variabilis*]. Like *Steginoporella* but zooecia bear 2 nonsymmetrical indentations, lack the B-zooecia, and their crypto-

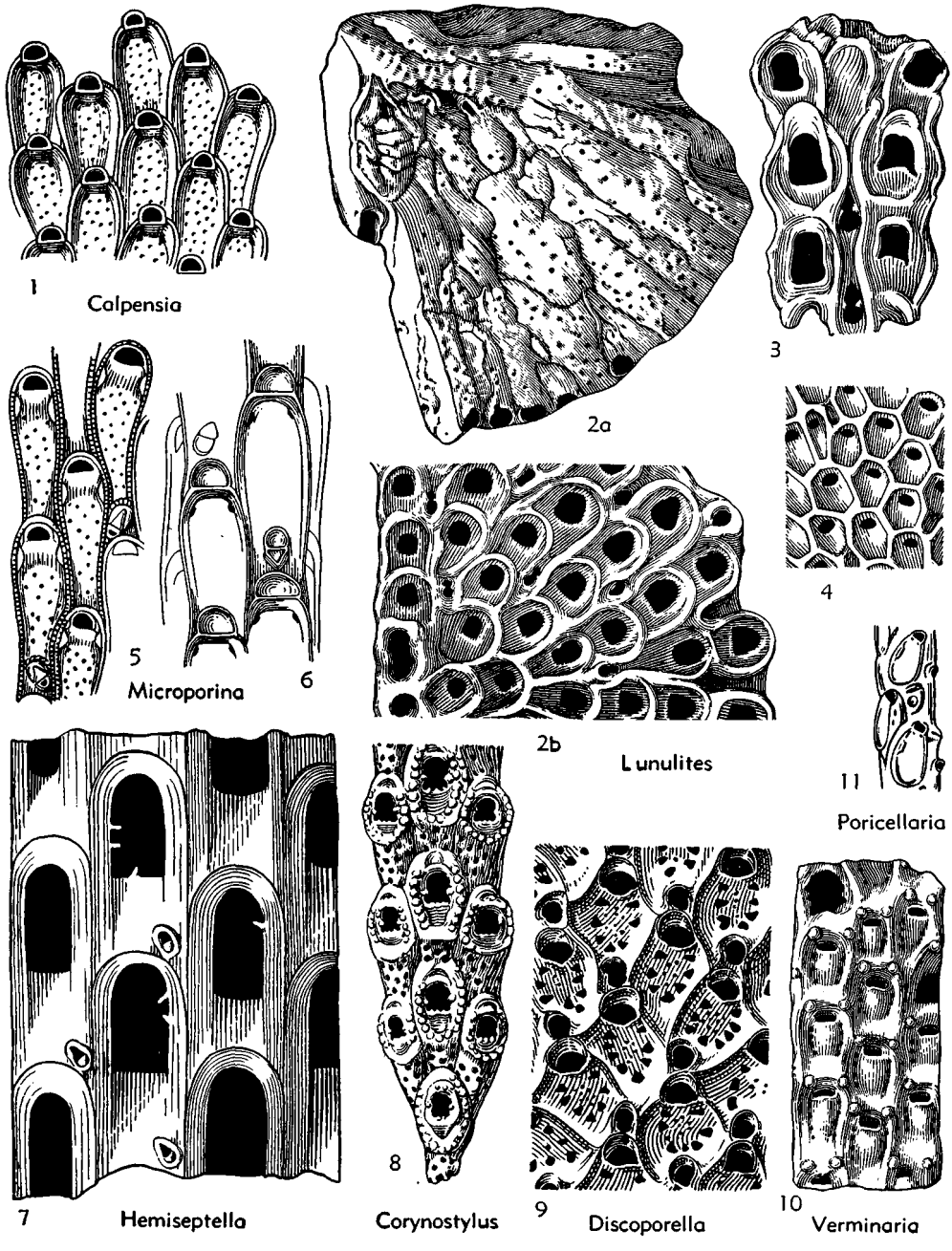


FIG. 131. Lunulitidae, Calpensiidae (p. G171).

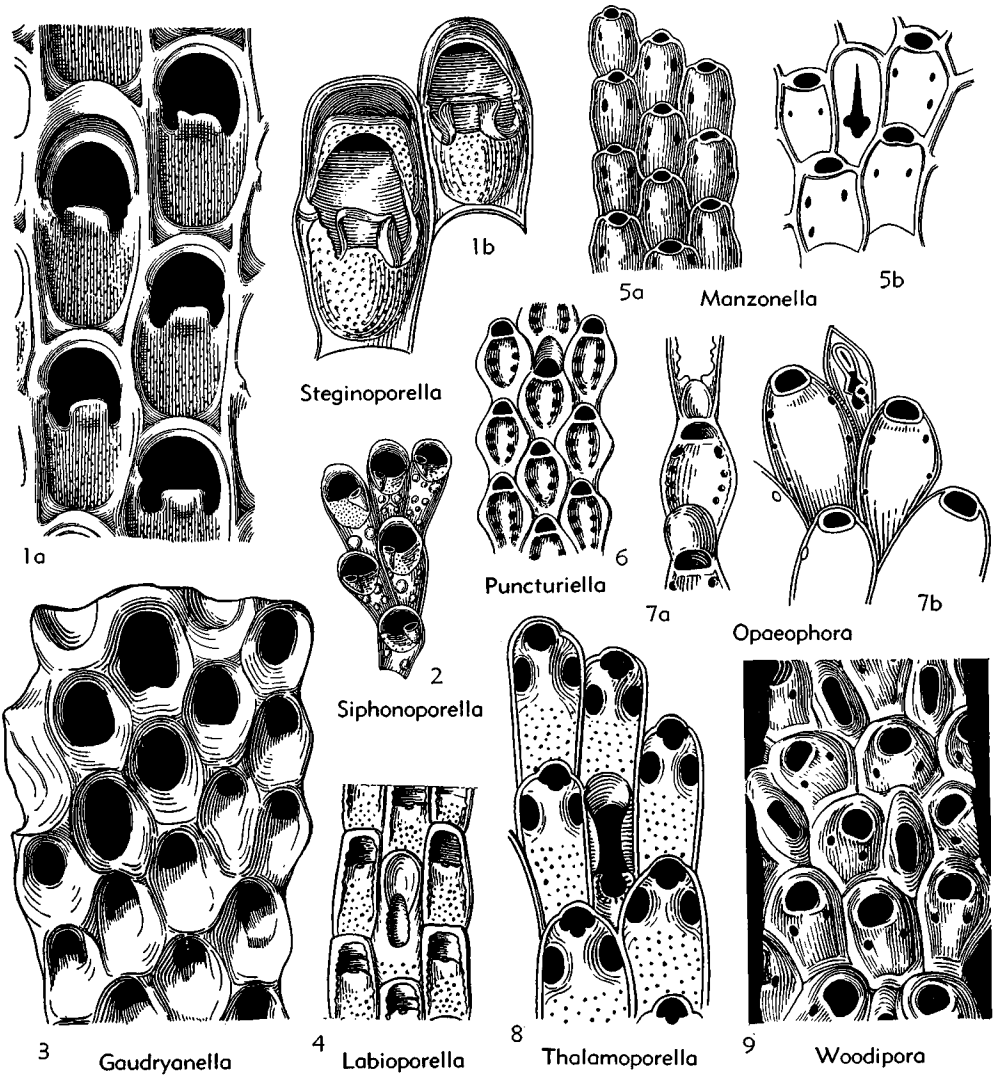


FIG. 132. Steginoporellidae, Thalamoporellidae (p. G172-G174).

cyst is small. *Eoc.*——FIG. 132,*3*. **G. variabilis,* Lut., Fr.; ×25 (136).

Labioporella HARMER, 1926 [*pro Labiopora* LEV., 1909 (*non* MOJSISOVICS, 1878)] [**Labiopora crenulata* LEV., 1909]. Opesium small, not surrounded by porous cryptocyst; large vicarious avicularia. *Mio.-Rec.*——FIG. 132,*4*. **L. crenulata* (LEV.), Rec., SW.Pac.; ×25 (177).

Siphonoporella HINCKS, 1880 [**S. nodosa*]. Like *Steginoporella* except that cryptocyst does not surround opesium, and polypidian tube is lateral, trumpet-shaped, and continued forward prominently; opesium large. *Tert.-Rec.*——FIG. 132,*2*. **S. nodosa,* Rec., SW.Pac.; ×25 (137).

Family THALAMOPORELLIDAE
Levinsen, 1902

Incrusting, lamellar, or narrow erect branches. Zooecia with polypidian tube, large prominent hyperstomial ovicells, opesiules separated from aperture, and large spatulate or 3-pointed avicularia replacing zooecia. Calcareous, compass-shaped spicules free in zooecial cavity (26). *Cret.-Rec.*

Thalamoporella HINCKS, 1887 [**Flustra rozieri* AUDOUIN, 1826]. Two large opesiules pierce the

porous cryptocyst and a large interzooecial avicularium forms base of each new series of zooecia. *Oligo.-Rec.*——Fig. 132.*8*. **T. rozieri* (Audouin), Rec., Medit.; ×25 (230).

Manzonella Jullien, 1888 [**Membranipora exilis* Manzoni, 1869]. Opesiules well formed, may be multiple; inverted dagger-shaped avicularia. *Plio.*——Fig. 132,*5*. **M. exilis* (Manzoni), Italy; *5a,b*, ×25 (*5a*, 183; *5b*, 196).

Opaeophora Brown, 1948 [*pro Foraminella* Lev., 1909 (*non* Sowerby, 1835)] [**Haploporella lepida* Hincks, 1881]. Much like *Manzonella* but a longitudinal series of small opesiules lines zooecial sides. *Rec.*——Fig. 132,*7*. **O. lepida* (Hincks), SW.Pac.; *7a,b*, ×25 (167).

Puncturiella Lev., 1925 [**P. gudumensis*]. Zooecia short, with a row of 6 to 8 opesiules along each lateral wall. *Cret.*——Fig. 132,*6*. **P. gudumensis*, Dan., Denm.; ×25 (177).

Thairopora MacGill., 1882 [*pro Diplopora* MacGill., 1881 (*non* Gümbel, 1866)] [**Membranipora dispar* MacGill., 1869] [=*Diploporella* MacGill., 1885; *Pergensina* Jullien, 1888]. Like *Thalamoporella* but no ovicell known. *Rec.*, SW. Pac.

Woodipora Jullien, 1888 [**Membranipora holostoma* Busk, 1859]. Cryptocyst entirely developed; 2 opesiules, rounded opesium, and short oval avicularia. *Cret.-Plio.*——Fig. 132,*9*. **W. holostoma* (Busk), Plio. (Crag), Eng.; ×25 (134).

Family ASPIDOSTOMATIDAE Jullien, 1888

[=Macroporidae Uttley, 1949]

Incrusting, bifoliate or narrow cylindrical branches. Zooecia with raised margins, short polypidian tubes with marginal flanges and 2 opesiules as narrow incisions in aperture. Hyperstomial ovicells normal in aspect (26). *Cret.-Rec.*

Aspidostoma Hincks, 1881 [**A. crassum* (=*Eschara gigantea* Busk, 1854)]. Zooecia mostly concave near orifice which is semilunar, deeply buried, limited at top by salient horseshoe-shaped lamella. Ovicell immersed in distal zooecium. *Cret.-Rec.*——Fig. 133,*1*. **A. giganteum* (Busk), Rec., SW. Atl., Antarct.; *1a*, ×25 (167); *1b*, ×25 (134).

Crateropora Lev., 1909 [**C. falcata*]. Zooecia in distinct longitudinal rows; very short polypidian lamella, opesiules, and reticulocellaria (avicularia or onychocellaria with cryptocyst perforated by pores). *Cret.-Rec.*——Fig. 134,*1*. **C. falcata*, Rec., SW.Pac., ×25 (177).

Euritina Canu, 1900 [**Eschara eurita* d'Orb., 1851]. Narrow branches. Cryptocyst well developed, with 2 longitudinal grooves forming 3 facettes; opesiules minute. *Cret.-Eoc.*——Fig. 133,*2*. **E. eurita* (d'Orb.), Cret.(Turon.), Fr.; ×25 (137).

Macropora MacGill., 1895 [**M. centralis;* SD Canu-B., 1917 (?=*Lepralia grandis* Hutton, 1873)] [=*Macroporella, Macroporina* Uttley, 1949]. Differs from *Monoporella* in absence of opesiules and peristomial spines. *Cret.-Rec.*——Fig. 133,*4*. **M. centralis*, Tert., Austral.; ×25 (181).——Fig. 133,*5*. *M. crassitina* Waters, Mio., Austral.; ×25 (230).

Megapora Hincks, 1877 [**Lepralia ringens* Busk, 1856]. Strongly developed partly depressed gymnocyst, apertures with vestibular arch and spines. *Rec.*——Fig. 133,*3*. **M. ringens* (Busk), NE.Atl.; ×37.5 (167).

Monoporella Hincks, 1881 [**Haploporella nodulifera* Hincks, 1881] [=*Chrossotoechia* Canu-L., 1925; *Haploporella* Hincks, 1881]. Incrusting. Apertures with 2 small lateral indentations and porous cryptocyst perforated by 2 small opesiules; small polypidian lamella. *Cret.-Rec.*——Fig. 133,*6*. **M. nodulifera* (Hincks), Rec., SW.Pac.; ×25 (167).

Odontionella Canu-B., 1917 [**Membranipora hians* Hincks, 1885 (=*M. cyclops* Busk, 1854)]. Disymmetrical opesiular indentations. Avicularia placed on gymnocyst. *Plio.-Rec.*——Fig. 133,*7*. *O. occultata* Waters, Tert., N.Z.; ×25 (230).——Fig. 133,*8*. **O. cyclops* (Busk), Rec., SW.Pac.; ×50 (167).

Rhagasostoma Koschinsky, 1885 [**R. hexagonum*]. Large interzooecial avicularia. *Eoc.-Mio.*——Fig. 133,*9*. **R. hexagonum*, Eoc.(Lut.), Ger.; ×25 (172).

Family SETOSELLIDAE Levinsen, 1909

Incrusting, unilamellar or bifoliate. Zooecia with opesiulated cryptocyst. Endotooechial ovicell at zooecial distal extremity (31). *Cret.-Rec.*

Setosella Hincks, 1877 [**Membranipora vulnerata* Busk, 1860]. Vibracula present and 2 long opesiules placed low. *Rec.*——Fig. 134,*4*. **S. vulnerata* (Busk), NE.Atl.; ×25 (134).

Lagarozoum Harmer, 1926 [**L. profundum*] [=*Entomaria* Canu-L., 1927]. Ovicell with 2 lateral fissures and opened by frontal pore; short elevated convex polypidian lamella, spines and reticulocellaria. *Eoc.-Rec.*——Fig. 134,*2*. *L. spiniferum* (Canu), Mio.(Helv.), Fr.; ×25 (136).

Setosinella Canu-B, 1933 [**S. prolifica*]. Like *Setosella* but ovicell not closed by operculum, vibracula replaced by setiferous avicularia. *Tert.*——Fig. 134,*5*. **S. prolifica*, Eoc., N.J.; ×25 (137).

Family COTHURNICELLIDAE Bassler, 1935

[=emend. Chlidoniidae Busk, 1884]

Zoarium jointed, arising from a stolonate network. Zooecia in unilinear rows, with deeply depressed cryptocyst pierced by a

transverse slit. No ovicells or avicularia. (31). *Rec.*

Cothurnicella W. THOMPSON, 1858 [*pro Chlidonia* LAMX., 1824 (*non* HÜBNER, 1816)] [**C. daedala* (=*Cellaria pyriformis* BERTOLINI, 1810)] [=*Chlidonibrya* STRAND, 1928]. Apertures without semielliptical opesia. *Rec.*——FIG. 134,*8*. **C. pyriformis* (BERTOLINI), SW.Pac.; ×10 (137).

Crepis JULLIEN, 1882 [**C. longipes*]. Apertures with semielliptical opesia and a large cryptocyst. *Rec.*

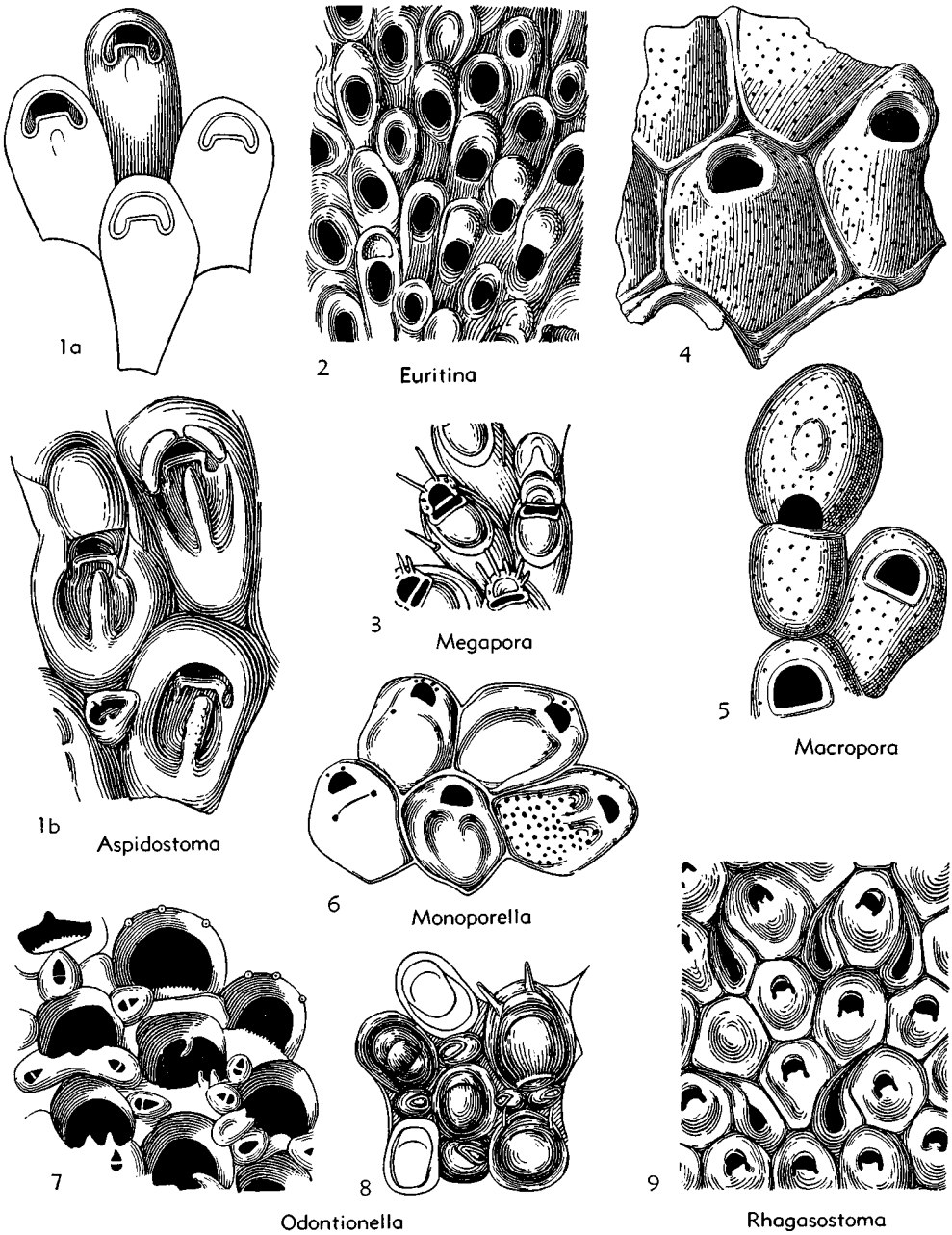


FIG. 133. Aspidostomatidae (p. G174).

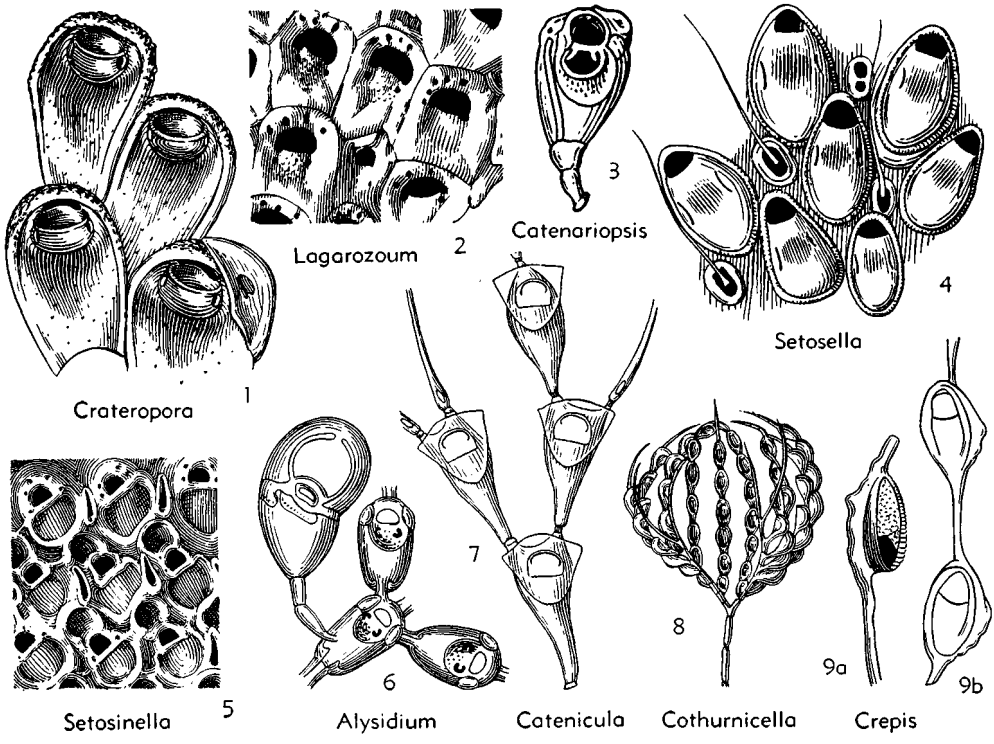


FIG. 134. Aspidostomatidae, Setosellidae, Cothurnicellidae, Alysidiidae (p. G174-G176).

——FIG. 134,*9*. **C. longipes*, E.Atl.; *9a,b*, ×25 (137).

Family ALYSIDIIDAE Levinsen, 1909

Zoarium jointed, with zooecia and gonozooecia springing from stolonate network. Zooecia with simple opercular valve and 2 opesiules, depressed cryptocyst in distal half. Ovicell bivalved, no avicularia (31). *Tert.-Rec.*

Alysidium BUSK, 1852 [**A. parasiticum*]. Cryptocyst calcified, ovicell bivalved, gonozooecia borne by stemlike kenozooecia. *Rec.*——FIG. 134,*6*. **A. parasiticum*, SE.Atl.; ×50 (134).

Catenariopsis MAPLE., 1899 [**C. morningtonensis*] [?=*Alysidium*]. Zooecia incrusting, pyriform ventricose, unilinear; cryptocyst partly calcified. *Tert.* ——FIG. 134,*3*. **C. morningtonensis*, Austral.; ×50 (184).

Catenicula O'DONOGHUE, 1924 [**C. corbulifera*]. Ovicell of gonoecium multivalve. *Rec.*——FIG. 134,*7*. **C. corbulifera*, SE.Atl.; ×50 (201).

Division PSEUDOSTEGA Levinsen, 1909

Zoaria erect, cylindrical or bilamellate. Zooecia in longitudinal series, frontal area formed by an imperforate depressed cryptocyst. Hydrostatic system external, confined to the hypostege (cavity between ectocyst and cryptocyst of each zooecium). Avicularia vicarious, replacing zooecia in the series; spines and pores wanting. Ovicell typically endotoichal with independent opening (special pore) buried at the base of the distal (succeeding) zooecium. *Cret.-Rec.*

Family CELLARIIDAE Hincks, 1880

[=Euginomidae, Meliceritidae VIG., 1939]

Zoaria typically erect, branched, with chitinous joints and long, rounded internodes. A pair of teeth on the proximal margin of aperture and 2 small lateral indentations deprived of denticles; operculum bilaminar with straight or concave proximal margin and pair of supporting denticles (26). *Cret.-Rec.*

Cellaria ELLIS-S., 1786 [**Eschara fistulosa* LINNÉ, 1758; SD HARMER, 1923] [=*Salicornaria* SCHWEIGGER, 1819; *Farcimia* FLEMING, 1828 (*non*

POURTALÈS, 1870; *Salicornia* BLAINV., 1830; *Melicerita* JULLIEN, 1888 (*non* M.EDW., 1836)]. Zoarium with narrow cylindrical articulated segments. *Eoc.-Rec.*——FIG. 135,*1*. **C. *fistulosa* (LINNÉ)*, Rec., N.Atl.; *1a,* ×1; *1b,* ×37.5; *1c,* ×25 (*1a,c,* 167; *1b,* 137).

Atelestozoum HARMER, 1926 [**A. obliquum*]. Bifoliate. Zooecia with elevated vertical walls marking off angular areas on surface. *Rec.*——FIG. 135, *2*. **A. obliquum,* E.Indies; ×25 (164).

Cryptostomaria CANU-B., 1927 [**C. crassatina*]. Ovicell without apparent orifice forms semicircular convexity at base of zooecia. *Rec.*——FIG. 135,*6*. **C. crassatina,* SW.Pac.; ×25 (137).

Dimorphocellaria VOIGT, 1930 [**Cellaria goldfussi* REUSS, 1847]. Articulated segments with dimorphic zooecia, normal ones with semicircular apertures. *Cret.*——FIG. 135,*7*. **D. goldfussi* (REUSS), Maastr., Holl.; ×25 (131).

Eschariceliaria VOIGT, 1924 [**E. polymorpha*]. Bi-

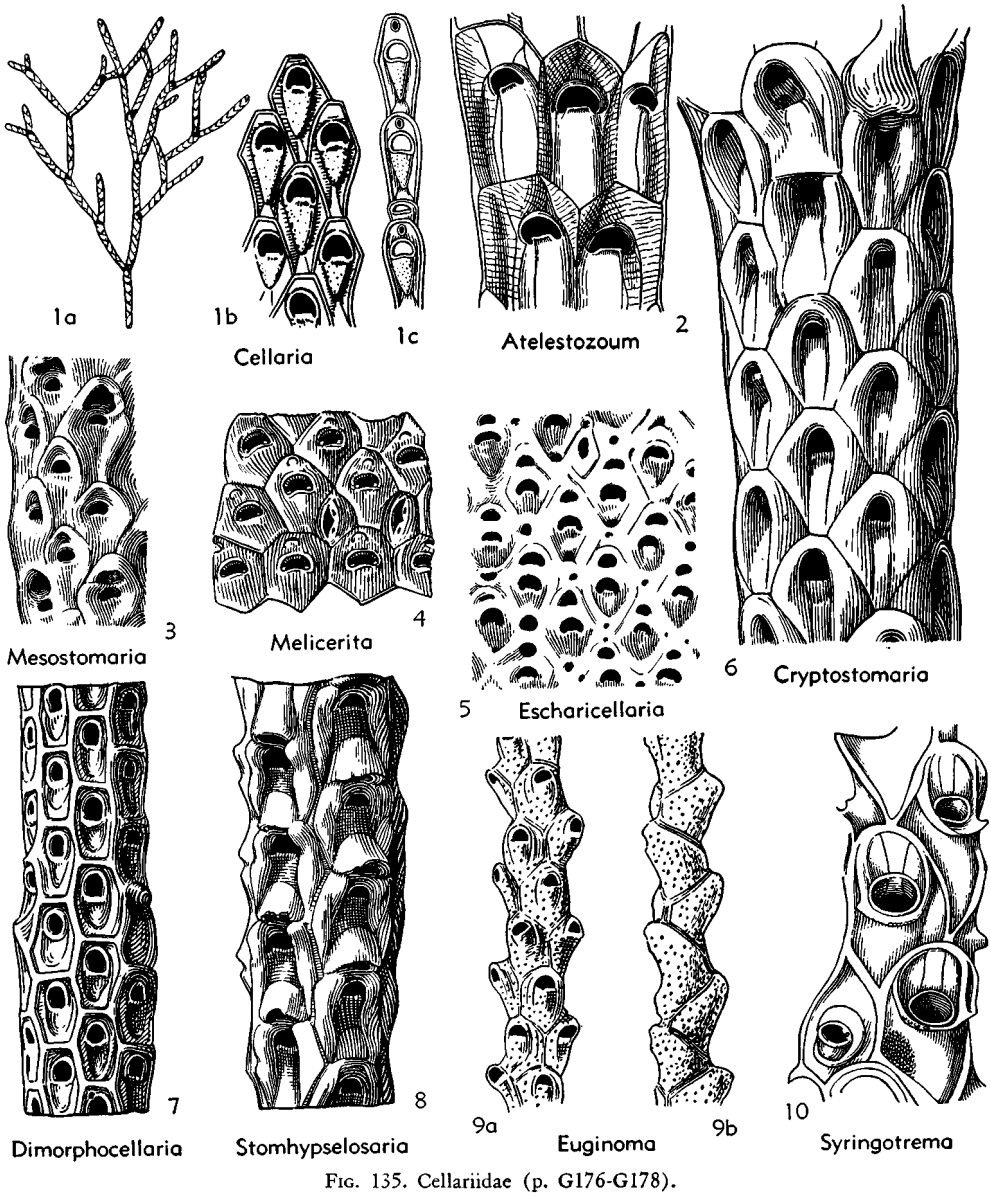


FIG. 135. Cellariidae (p. G176-G178).

lamellar, dichotomous, unarticulated branches. Zooecia with smooth flat cryptocyst, semicircular opesium; interzooecial avicularia. *Cret.*——Fig. 135,*5*. **E. polymorpha,* Senon., Ger.; ×25 (227).

Euginoma Jullien, 1882 [**E. vermiformis*] [=*Enginoma* Jullien, 1882 (error)]. Bilinear zoarium, zooecia opening on one side only. *Rec.*——Fig. 135,*9*. **E. vermiformis,* E.Atl.; *9a,b*, ×25 (169).

Hemistylus Voigt, 1928 [**H. virgula*]. Narrow articulated rods with zooecial apertures on one side only. *Cret.,* Ger.

Mawsonia Livingstone, 1928 [**Cellaria membranacea* Thorneley, 1924]. Cylindrical branches of fused internodes with oval zooecial apertures and falciform interzooecial avicularia. *Rec.,* Antarct.

Melicerita M.Edw., 1836 (*non* Jullien, 1888) [**M. charlesworthii* Morris, 1843] [=*Meliceritina* Ehr., 1839; *Ulidium* Searles Wood, 1844 (obj.)]. Zoarium bilaminar, not articulated. *Cret.-Plio.*——Fig. 135,*4*. **M. charlesworthii* Morris, Plio., Eng.; ×25 (134).

Mesostomaria Canu-B., 1927 [**M. strictoramae*]. Slender free fronds. Aperture central with special peristome and no denticles. Ovicell convex, with large orifice. *Mio.-Rec.*——Fig. 135,*3*. **M. strictoramae,* Rec., SW.Pac.; ×25 (137).

Pseudocellaria Livingstone, 1928 [**Aspidostoma obliquum* Thorneley, 1924]. Zoarium bilaminate, no avicularia, operculum crescentic. *Rec.,* Antarct.

Stomhypselosaria Canu-B., 1927 [**S. condylata*]. Like *Cryptostomaria* but aperture terminal and ovicell a salient convexity at base of distal zooecium. *Eoc.-Rec.*——Fig. 135,*8*. **S. condylata,* Rec., SW.Pac.; ×25 (137).

Syringotrema Harmer, 1926 [**S. auriculatum*]. Free cylindrical unjointed zoaria attached by chitinous rootlets. Zooecia in pentagonal areas outlined by raised walls, with orifices removed from distal ends. *Rec.*——Fig. 135,*10*. **S. auriculatum,* E. Indies; ×25 (164).

Family MEMBRANICELLARIIDAE Levinsen, 1909

Erect, narrow to broad bifoliate branches. Opesium median or anterior, not terminal, completely surrounded by cryptocyst. Avicularia or interzooecial onychocellaria present. Ovicells hyperstomial, emerging through variously shaped openings, not located on distal zooecium (31). *Cret.-Rec.*

Membranicellaria Lev., 1909 [**Melicerita dubia* Busk, 1885]. Avicularia with wide mandibles. *Rec.*——Fig. 136,*1*. **M. dubia* (Busk), SE.Atl.; ×25 (134).

Dictuonia Jullien, 1881 [**Eschara aceste* d'Orb., 1851]. Apertures lozenge-shaped; straight onychocellaria. *Cret.*——Fig. 136,*3*. **D. aceste* (d'Orb.), Maastr., Fr.; ×10 (202).

Erinella Canu-B., 1927 [*pro Erina* Canu, 1908 (*non* Swainson, 1833)] [**Erina patagonica* Canu, 1908]. Like *Membranicellaria* but has onychocellaria. *Mio.*——Fig. 136,*7* **E. patagonica* (Canu), Arg.; ×25 (136).

Omoiosia Canu-B., 1927 [**Vincularia maorica* Stoliczka, 1865]. Narrow branches with hexagonal dimorphic zooecia bearing anterior or median opesia. Straight onychocellaria. *Tert.-Rec.*——Fig. 136,*2*. **O. maorica* (Stoliczka), Tert., N.Z.; ×25 (137).

Family COSCINOPLEURIDAE Canu, 1913

Erect, bifoliate, narrow branches. Zooecia with semilunar, marginated, anterior apertures; hyperstomial ovicells embedded in distal zooecia; onychocellaria straight (24). *Cret.-Eoc.*

Coscinopleura Marsson, 1887 [**Eschara elegans* Hag., 1840]. Zoarial margins bordered by large vibracula with porous front. *Cret.*——Fig. 136,*5*. **C. digitata* (Morton), Eoc.(Wilcox.), N.J.; *5a,b*, zooecia with vibracula, and with ovicells, ×25 (137).——Fig. 136,*6*. **C. elegans* (Hag.), Camp., Ger.; ×25 (160).

Escharifora d'Orb., 1852 [**E. argus*]. Orbicular avicularia; zooecial front occupied by pores. *Cret.*——Fig. 136,*4*. **E. argus,* Santon., Fr.; ×25 (202).

Division CELLULARINA Smitt, 1867

Zoaria erect, ramose, flexible or jointed, attached by radicles; formed of unilaminar, narrow, commonly biserial branches, probably derived from incrusting membraniporoid ancestors which have become free except at the base of attachment. Zooecia not heavily calcified, all generally facing the same way. Heterozooecia mostly sessile or pedunculate avicularia or highly differentiated vibracula. Spines, modified in some into frontal scutes, protect opesia. Ovicell mainly hyperstomial. *Eoc.-Rec.*

Family FARCIMINARIIDAE Busk, 1884

Slender, erect, prismatic segments forming dichotomously branched tufts. Zooecia membraniporoid, without cryptocyst, generally in pairs back to back, facing in opposite directions. Sessile avicularia only, commonly paired on the gymnocyst. Zooecia in 4 to 6 series in longitudinal rows around a central axis; ovicell endozooecial. Regarded

as transitional between membraniporoids and scrupocellariids (24). *Eoc.-Rec.*

Farciminaria Busk, 1852 [**F. aculeata*]. Zoarium chitinous, not jointed, fixed in the sand by many radicles. Lateral margins and frontal membrane of zooecia with spinelike processes. Ovicell with many kenozooecia. *Rec.*——Fig. 137,*4*. **F. aculeata*, SW.Pac.; ×25 (134).

Columnella Lev., 1914 [*pro Columnaria* Lev., 1909 (*non* Goldf., 1826)] [**Columnaria borealis* Lev., 1909] [=*Levinsenella* Harmer, 1926 (*non* Pratt, 1902)]. Erect quadrangular branches. Zooecia in 4 series, without spines. Ovicell prominent. Single median avicularium attached to distal wall of zooecium. *Rec.*——Fig. 137,*3*. **C. borealis* (Lev.), N.Atl.; ×25 (177).

Didymozoum Harmer, 1923 [*pro Didymia* Busk, 1852 (*non* LePeletier & Serville, 1825)] [**Didymia simplex* Busk, 1852]. Biserial, branching with ovicell between 2 zooecia at bifurcations. *Rec.*——Fig. 137,*1*. **D. simplex* (Busk), SW.Pac.; ×25 (134).

Farciminellopsis Silén, 1952 [**F. gracilis*]. *Rec.*, NW.Pac.

Farciminellum Harmer, 1926 [**Farciminaria hexagona* Busk, 1884]. Bilaminar flattened branches. Zooecia elongate, bearing many short spines on front and kenozooecia without orifice or operculum on back. *Rec.*——Fig. 137,*5*. **F. hexagona* (Busk), SW.IndianO.; ×25 (134).

Kenella Lev., 1909 [**Flustra biseriata* Busk, 1884]. Biserial. No spines or avicularia. *Rec.*, E.Indies.

Nellia Busk, 1852 [**N. oculata*]. Zoarium of deli-

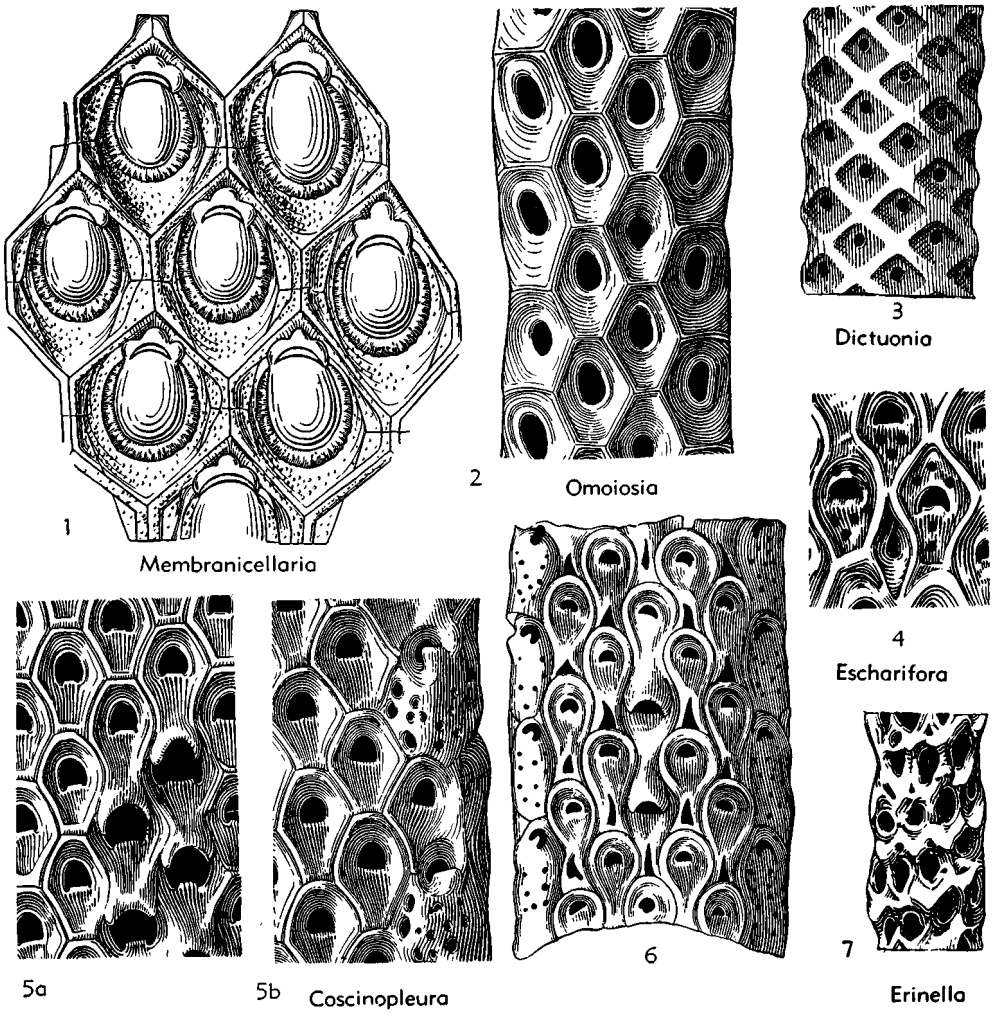


Fig. 136. Membranicellariidae, Coscinopleuridae (p. G178).

cate, erect 4-sided joints. Zooecia elongate, lacking spines. Ovicell small, endozooecial, deeply immersed. Pair of small avicularia on basal gymnocyst. *Eoc.-Rec.*——Fig. 137,*2*. **N. oculata,* Rec., Torres Strait; *2a,b,* ×25 (134).

Family BUGULIDAE Gray, 1848

[=Euplozoidae Harmer, 1923; Halophylidae Vig., 1949]

Zoaria erect, nonarticulated, flexible, radicelled, chitinous, unilaminar. Zooecia sub-

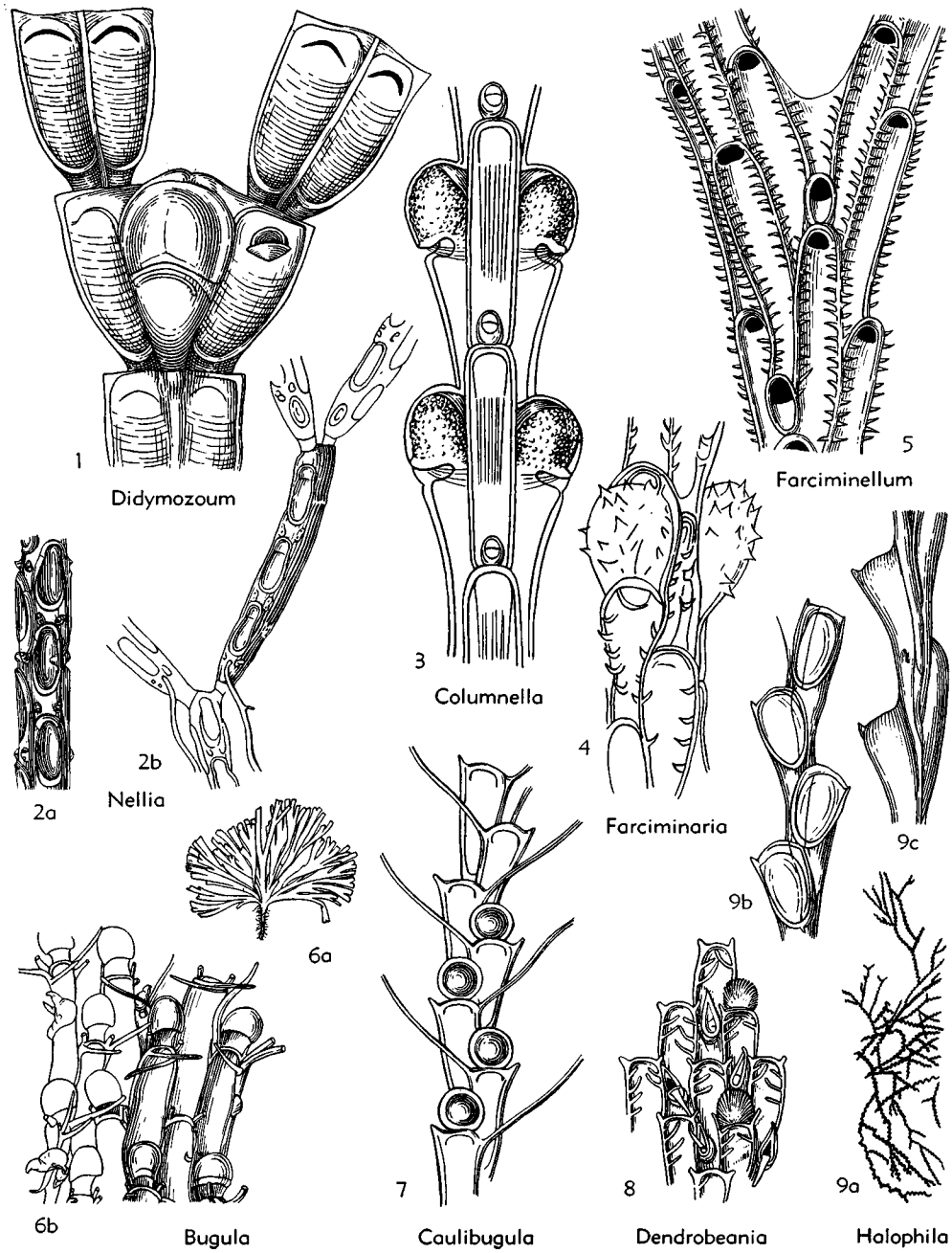


Fig. 137. Farciminariidae, Bugulidae (p. G179-G181).

rectangular, all opening in same direction on front side; gymnocyst absent or very small. Ovicell hyperstomial. Avicularia pedunculate, "bird's head" type, short, pedicellate; no vibracula or scutum. Larva higher (longer) than wide (31). *Rec.*

The Bugulidae, although dropped in recent years in favor of Bicellariellidae (Lev., 1909), is retained here because the name Bugulidae has priority and because of judgment that the different shape of larvae and club-shaped zooecia and presence of a gymnocyst in the Bicellariellidae are sufficient for family distinction. The bizarre zooecial shape of so many species of Beaniidae (Canu-B., 1927) seems sufficient as a family character of its own.

Bugula Oken, 1815 [**Sertularia neritina* Linné, 1758][=*Acamarchis* Lamx., 1816; *Bugulina, Avicularia, Crisularia* Gray, 1848; *Avicella* van Beneden, 1848; *Ornithopora, Ornithoporina* d'Orb., 1852]. Bushy zoaria with biserial to multiserial rows of zooecia. Capitate, pedunculate avicularia on lateral zooecia.——Fig. 137,*6*. **B. neritina* (Linné), Atl.; *6a,b*, ×1, ×25 (137).

Bugularia Lev., 1909 [**Carbasea dissimilis* Busk, 1852]. Sessile avicularia on much reduced proximal gymnocyst. SW.Pac.

Camptoplites Harmer, 1923 [**Bugula bicornis* Busk, 1881]. Avicularia with long flexible peduncle. SE.IndianO.

Caulibugula Verrill, 1900 [*pro Stirparia* Goldstein, 1880 (*non* Leuckhardt, 1841)][**C. armata*][=*Stirpariella* Harmer, 1923]. Zoarium biserial, with jointed stem of long narrow kenozooecia.——Fig. 137,*7*. **C. armata*, Rec., Bermuda; ×50 (137).

Dendrobeania Lev., 1909 [**Flustra murrayana* Johnston, 1847]. Erect fronds with 3 or more parallel rows of zooecia bearing freely movable avicularia.——Fig. 137,*8*. **D. murrayana* (Johnston), Rec., N.Atl.; ×25 (137).

Euoplozoum Harmer, 1923 [**Cellularia cirrata* Busk, 1884]. Biserial, with large zooecia, alternating. SW.Pac.

Eupaxia Hasenbank, 1932 [**E. incarnata*]. W.IndianO.

Halophila Gray, 1843 [**H. johnstoniae*]. Biserial; no ovicell or avicularia.——Fig. 137,*9*. **H. johnstoniae*, Rec., N.Z.; *9a*, ×1; *9b,c*, front, back, ×25 (137).

Himantozoum Harmer, 1923 [**Bugula mirabilis* Busk, 1884]. Biserial, asymmetrical zooecia with median row of symmetrical ones. E.Atl.

Kinetoskias Daniellsen, 1868 [**K. smitti*][=*Naresia* W. Thompson, 1872; *Cinetoscias* von Martens, 1879]. Arct.

Semibugula Kluge, 1929 [**S. biruli*]. Arct.

Semikinetoskias Silén, 1942 [**S. dubia*]. NW.Pac.

Sessibugula Osburn, 1950 [**S. translucens*]. Incrusting, gymnocyst with paired avicularia. Gulf Calif.

Watersia Lev., 1909 [**Flustra militaris* Waters, 1887]. SW.Pac.

Family BICELLARIELLIDAE Levinsen, 1909

Zoaria free, bushy, with radical fibers. Zooecia little calcified, club-shaped, with narrowed gymnocyst; planes of opesium and front oblique. Avicularia long, pedunculate; vibracula and scuta absent. Ovicell hyperstomial and free. Larvae wider than high (31). *Rec.*

Bicellariella Lev., 1909 [*pro Bicellaria* Blainv., 1830 (*non* MacQuart, 1823)][**Sertularia ciliata* Linné, 1758]. Zooecia twinned, constricted into a distal funnel-shaped part, a median elongate cylindrical part, and proximal tubular part.—— Fig. 138,*1*. **B. ciliata* (Linné), N.Atl.; *1a,b*, back, front, ×25 (134).

Bicellarina Lev., 1909 [**Bicellaria alderi* Busk, 1860]. Like *Bicellariella* but zooecia not constricted into 3 parts.——Fig. 138,*2*. **B. alderi* (Busk), NE.Atl.; *2a,b*, back, front, ×25 (134).

Calyptozoum Harmer, 1926 [**C. operculatum*]. Zooecia extremely elongate, alternating. IndianO.

Cornucopina Lev., 1909 [**Bicellaria grandis* Busk, 1852]. Long, funnel-shaped zooecia with ovicell on distal margin.——Fig. 138,*5*. **C. grandis* (Busk), SW.Pac.; ×50 (134).

Corynoporella Hincks, 1888 [**C. tenuis*]. Slender, uniserial elongate zooecia with an articulated buguloid avicularium attached to side of opesium. Gulf St.Lawrence.

Dimetopia Busk, 1852 [**D. cornuta*][=*Bifrons* MacGill., 1860]. Zooecia in alternate pairs, back to back.——Fig. 138,*3*. **D. cornuta*, SW.Pac.; ×25 (134).

Dimorphozoum Lev., 1909 [**Flustra nobilis* Hincks, 1891]. W.IndianO.

Erymophora Hastings, 1943 [**Brettia gracilis* Nichols, 1911]. Uniserial, with longitudinal connecting tubes. SW.Pac., Antarct.

Klugella Hastings, 1943 [**Flustra echinata* Kluge, 1914]. SW.Pac.

Petalostegus Lev., 1909 [**Catenaria bicornis* Busk, 1884]. Zooecial front covered with leaflike spines. ——Fig. 138,*4*. **P. bicornis* (Busk), S.Pac.; ×50 (134).

Family BEANIIDAE Canu & Bassler, 1927

Zooecia recumbent, more or less separated, attached by radicles, little calcified,

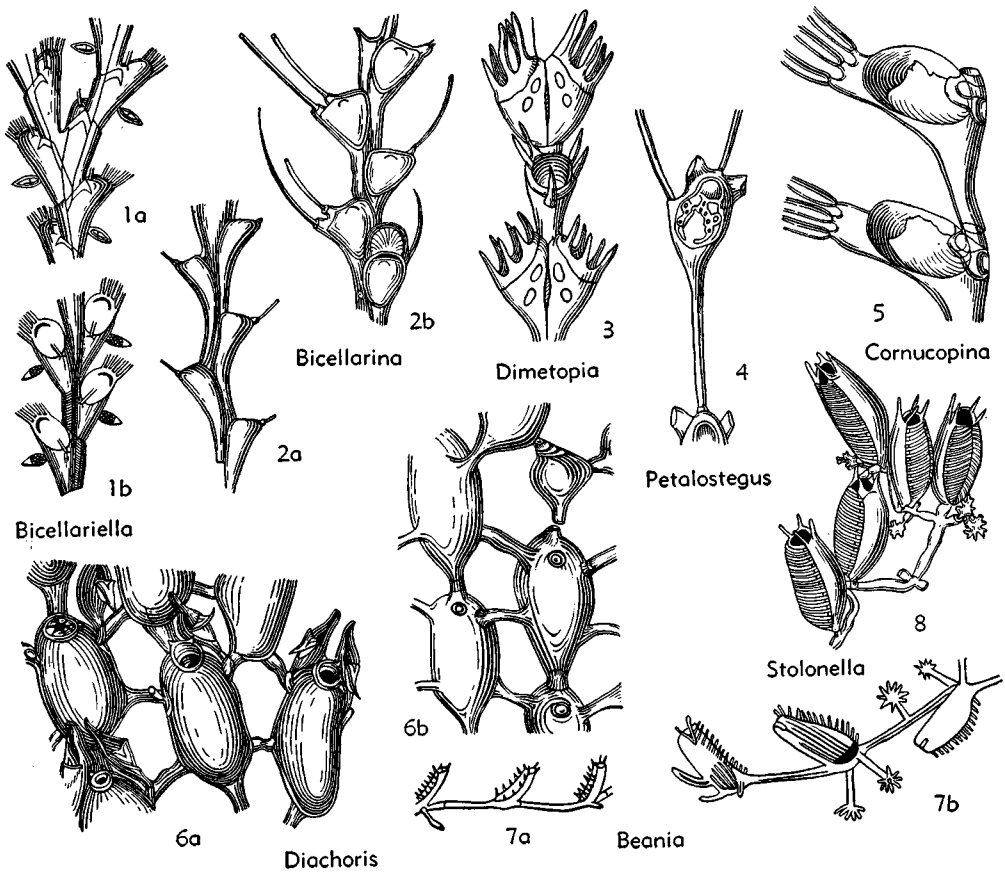


FIG. 138. Bicellariellidae, Beaniidae (p. G181, G182).

uni- or multiserial, all facing in one direction and jointed by stoloniform prolongations; no gymnocyst; opesia occupy all of front; avicularia commonly pedunculate (31). *Rec.*

Beania JOHNSTON, 1840 [**B. mirabilis*]. Zoarium uniserial, without connecting tubes, to laminate, with zooecia connected by 4 or 6 radiating tubes; mural rim with areal spinules and apertural spines. ——FIG. 138,*7*. **B. mirabilis*, E.Atl.; *7a,b*, side, front, ×16.7 (168).

Chaunosia BUSK, 1867 [**Diachoris hirtissima* HELLER, 1867]. Multiserial with 2 connecting tubes. Adriatic.

Diachoris BUSK, 1852 [**D. crotali*][=*Diachoseris* ORTMANN, 1889]. Multiserial, with 6 connecting tubes. S.Atl.-SW.Pac.——FIG. 138,*6*. *D. magellanica* BUSK, Straits Magellan; *6a,b*, front, back, ×25 (134).

Stolonella HINCKS, 1883 [**S. clausa*]. Like *Beania* but areal spines jointed together at extremities to form false cribrimorph front above ectocyst. E.Ind. O.——FIG. 138,*8*. **S. clausa*, W.Austral.; ×25 (167).

Family SCRUPOCELLARIIDAE Levinsen, 1909

Zoaria free, erect, unilaminar, radicellate, mostly articulated. Zooecia attached to each other; front sessile. Avicularia, dorsal vibracula, or avicularia and scutum in opesium partially protecting aperture (31). *Eoc.-Rec.*

Scrupocellaria VAN BENEDEN, 1845 [**Sertularia scruposa* LINNÉ, 1758][=*Crisina* VAN BENEDEN, 1850 (*non* D'ORB., 1853); *Licornia, Savignella* VAN BENEDEN, 1850]. Biserial branches not attached to each other; avicularia, vibracula and scutum; ovicell hyperstomial. *Rec.*——FIG. 139,*1*. **S. scruposa* (LINNÉ), N.Atl.; *1a-c*, front, back, ovicell, ×25 (134).

Amastigia Busk, 1852 [**A. nuda*][=*Caberiella* Lev., 1909; *Anderssonia* Kluge, 1914; *Anderiola* Strand, 1928]. Fibrous radicular bundles on zoarial margin. *Rec.,* S.Atl.

Bugulopsis Verrill, 1880 [**Cellularia peachi* Busk, 1851]. Like *Tricellaria* but without avicularia. *Rec.*——Fig. 139,*5*. **B. peachi* (Busk), N. Atl.; *5a,b,* ×1, ×25 (134).

Caberea Lamx., 1816 [**C. dichotoma;* SD Harmer, 1923] [=*Selbia* Gray, 1843; *Scutularia* Busk, 1860]. Not regularly jointed. Long denticulated cilium on back; spines, scutum and frontal avicularium present. *Oligo.-Rec.*——Fig. 139,*2*. *C. ellisi* Fleming, Rec., Atl.; *2a,b,* front, back, ×25 (211).

Cabereopsis Hasenbank, 1932 [**C. elongata*]. *Rec.,* IndianO.

Canda Lamx., 1816 [**C. arachnoides*]. Not articulated but branches united by cross radicles. *Eoc.-Rec.*——Fig. 139,*3*. **C. arachnoides,* Rec., Timor; *3a,* ×1; *3b,c,* ×25 (137).

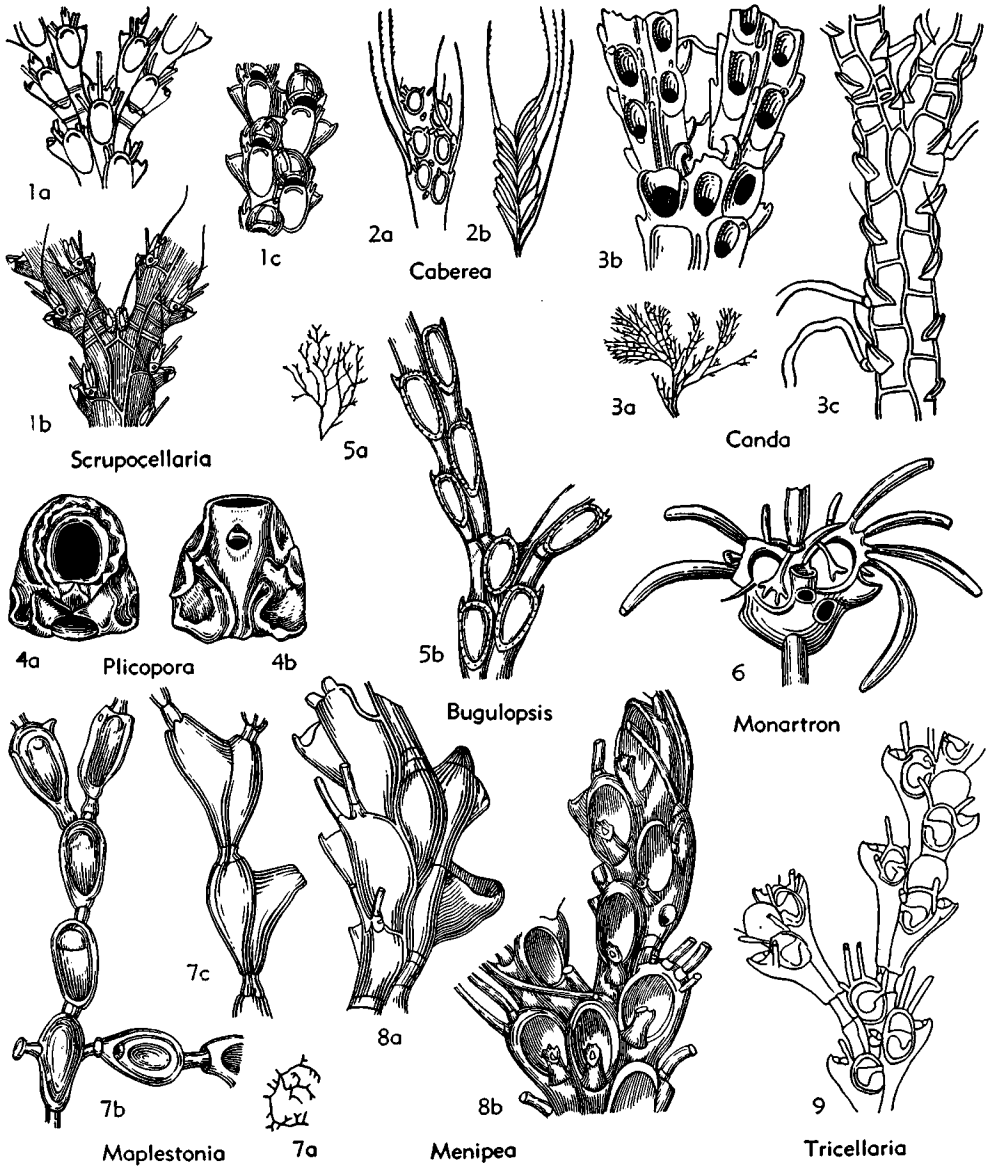


Fig. 139. Scrupocellariidae (p. G182-G184).

Craspedozoum MacGill., 1886 [**Membranipora roborata* Hincks, 1881] [=*Flabellaris* Waters, 1898; *Flabellina* Lev., 1902 (obj.)]. *Rec.* SW.Pac.

Hoplitella Lev., 1909 [**Carbasea armata* Busk, 1852]. Not articulated, multiserial. No ovicells. *Rec.*, S.Atl.

Jubella Jullien, 1882 [**J. enucleata*]. No heterozooecia on back. *Rec.*, E.Atl.

Maplestonia MacGill., 1885 [**M. cirrata*]. Articulated with segments of 1 or 2 zooecia. Ovicell endozooecial. *Rec.*——Fig. 139,*7*. **M. cirrata*, SW. Pac.; *7a*, ×1; *7b,c*, ×50 (181).

Menipea Lamx., 1812 [**Cellaria cirrata* Ellis-S., 1786][=*Emma* Gray, 1843]. Biserial, articulated, with segments of 2 to 5 zooecia. Endozooecial ovicells. *Rec.*——Fig. 139,*8*. **M. cirrata* (Ellis-S.), IndianO. *8a,b*, ×25 (137).

Monartron Canu-B., 1929 [**Menipea cyathus* W. Thompson, 1858]. Uniserial, with short segments. *Rec.*——Fig. 139,*6*. **M. cyathus* (W. Thompson), SW.Pac., ×50 (137).

Notoplites Harmer, 1923 [**N. rostratus*]. Articulated, biserial, with long internodes. *Rec.*, E.Indies.

Plicopora MacGill., 1895 [**P. daedala*]. Uniserial, with each internode a single zooecium. *Tert.*——Fig. 139,*4*. **P. daedala*, SW.Pac.; *4a,b*, front, back, ×25 (181).

Rhabdozoum Hincks, 1882 [**R. wilsoni*]. Segments at end of long radicular pedicels. *Rec.*, SW.Pac.

Tricellaria Fleming, 1828 [**Cellaria ternata* Ellis-S., 1786][=*Cellarina* van Beneden, 1848; *Ternicellaria* d'Orb., 1849]. Short internodes of 2 or 3 zooecia; no dorsal vibracula or avicularia. *Rec.*——Fig. 139,*9*. **T. ternata* (Ellis-S.), N.Atl.; ×25 (137).

Family EPISTOMIIDAE Gregory, 1903

[=emend. Notamiidae Hincks, 1880]

Zoaria erect or partially prostrate, commonly jointed, attached by rootlets. Zooecia in back-to-back pairs, each beginning in short tubular processes. Avicularia sessile or pedunculate (31). *Rec.*

Epistomia Fleming, 1828 [**Sertularia bursaria* Linné, 1858]. Two long avicularia above zooecial pairs.——Fig. 140,*1*. **E. bursaria* (Linné), E.Atl.; ×25 (137).

Synnotum Pieper, 1881 [**Gemellaria avicularis* Pieper, 1881 (=*Loricaria aegyptiaca* Audouin, 1826)][=*Mononota* Pieper, 1881 (obj.)]. Sessile lateral avicularia and an articulated one at summit. ——Fig. 140,*2*. **S. aegypticum* (Audouin), Adriatic; *2b*, ×25; *2a*, ×50; (137).

Division CRIBRIMORPHA Lang, 1916

[=Acanthostega Levinsen, 1902]

Zooecia with more or less of front membranous, protected by a roof formed of fused overarching circumareal spines; parietal muscles as in Malacostega; no compensation sac. *Cret.-Rec.*

The position of this division comprising the Cribrilinidae of Hincks (1880), Pelmatoporidae, and several other families of Lang (1916), mainly Cretaceous, has been under question since Levinsen (1902) proposed the name Acanthostega for it. Harmer (1926) recognized Lang's designation Cribrimorpha instead, interpreting the assemblage as a transitional group with relations to both Anasca and Ascophora. Other students have classified them as Ascophora, judging that early assumption of ascophoran characters by some genera should determine systematic position of the division. Osburn (1940, 1950) preferred to leave them since the ascophoran type of zooecial front is not yet well developed. Lang has summed up his extensive studies of Cretaceous families in catalogs of Cretaceous Bryozoa (Lang, 1921, 1922).

Family CRIBRILINIDAE Hincks, 1880

[=Costulae Jullien, 1888]

Zooecia with membranous frontal area covered by 2 rows of flattened ribs (costulae) directed from their outer border to the median line where they unite intimately but leave a shield (pericyst) perforated by pores or slits. Ovicell hyperstomial (31). *Cret.-Rec.*

Cribrilina Gray, 1848 [**Lepralia punctata* Hassall,

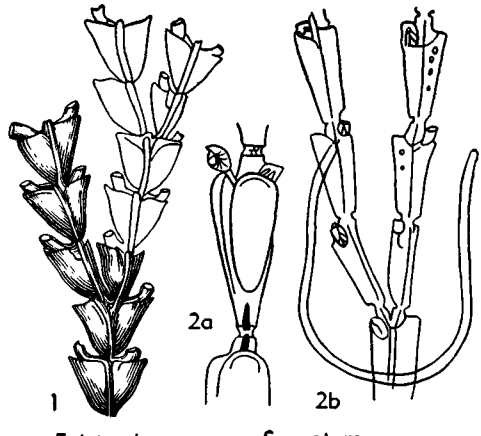


Fig. 140. Epistomiidae (p. G184).

1841]. Zooecial front a pericyst of fused costules so united along their length to give appearance of large perforations in regular rows. Orifice semilunar without marginal spines. Dietellae present, frontal shield without spiramen, with rows of transverse pores between the costae. *Eoc.-Rec.*——

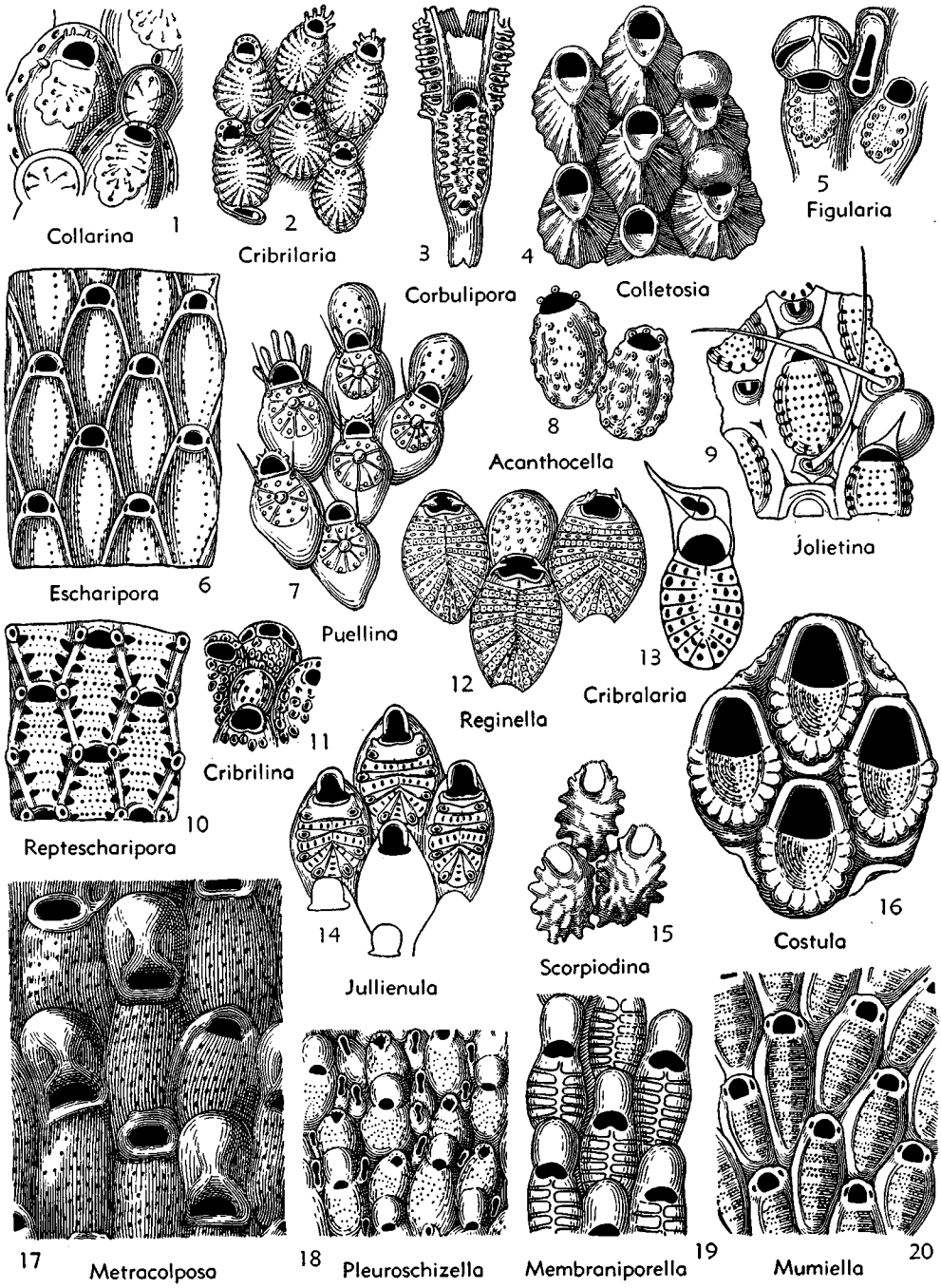


FIG. 141. Cribrilinidae (p. G184-G186).

FIG. 141,*11*. **C. punctata* (HASSALL), Rec., Ire.; ×37.5 (177).

Acanthocella CANU-B., 1917 [**Cribrilina tubulifera* HINCKS, 1881]. Like *Cribrilina* but with tubular lumen pores. *Eoc.-Rec.*——FIG. 141,*8*. **A. tubulifera* (HINCKS), Rec., SW.Pac.; ×25 (167).

Collarina JULLEN, 1886 [**Lepralia cribrosa* WATERS, 1879 (*non* HELLER, 1867)]. Zooecia with border pierced by wide pores except proximally. *Cret.-Rec.*——FIG. 141,*1*. **C. cribrosa* (WATERS), Rec., Medit.; ×25 (137).

Colletosia JULLIEN, 1886 [**Lepralia endlicheri* REUSS, 1874]. Zooecial front with radiating ribs separated by wide furrows without pores. *Mio.*——FIG. 141,*4*. **C. endlicheri* (REUSS), Tort., Aus.; ×25 (210).

Corbulipora MACGILL., 1895 [**C. ornata*]. Erect, narrow branches. Elongate quadrate zooecia with elliptical aperture; front covered by vertical ribs turning abruptly inward, uniting to form a flat plate. *Eoc.-Mio.*——FIG. 141,*3*. **C. ornata*, Tert., Austral.; ×25 (181).

Costula JULLIEN, 1886 [**Escharella arge* D'ORB., 1852]. Distal half of zooecial front with membraniporoid orifice; proximal half with minute ribs separated by small pores, all directed to a central point. *Cret.*——FIG. 141,*16*. **C. arge* (D'ORB.), Maastr., Fr.; ×25 (202).

Cribralaria SILÉN, 1942 [**C. curvirostris*]. Like *Cribrilina* but ovicell immersed in square vicarious avicularia. *Rec.*——FIG. 141,*13*. **C. curvirostris*, NW.Pac.; ×25 (216).

Cribrilaria CANU-B., 1929 [**Eschara radiata* MOLL, 1803]. Front bearing costulae with lumen and intercostular furrows with lacunae, oral spines, and interzooecial avicularia. *Eoc.-Rec.*——FIG. 141,*2*. **C. radiata* (MOLL), Rec., Atl.; ×25 (167).

Escharipora D'ORB., 1852 [**E. inornata*]. *Cret.*——FIG. 141,*6*. **E. inornata*, Maastr., Fr.; ×25 (202).

Figularia JULLIEN, 1886 [**Lepralia figularis* JOHNSTON, 1847] [=*Figulina* LEV., 1909 (obj.)]. Costular area limited to centro-distal region of zooecial front. Ovicell large, with median suture and 2 pear-shaped lateral perforations. Avicularia large, interzooecial. *Eoc.-Rec.*——FIG. 141,*5*. **F. figularis* (JOHNSTON), Rec., Atl.; ×25 (167).

Jolietina JULLIEN, 1886 [**Cribrilina lateromarginata* BUSK, 1884]. Ovicell endozooecial; aperture semicircular; large interzooecial, long, sporadic vibracula. *Rec.*——FIG. 141,*9*. **J. lateromarginata* (BUSK), SW.Atl.; ×25 (167).

Jullienula BASSLER, *nom.nov.* [*pro Lyrula* JULLIEN, 1886[1] (*non* WOLLARTON, 1878)] [**Cribrilina hippocrepis* HINCKS, 1882]. Aperture inverted, lyriform, without marginal spines; frontal formed by a few voluminous ribs separated by usually wider furrows with pores. *Rec.*——FIG. 141,*14*. **J. hippocrepis* (HINCKS), NE.Pac.; ×25 (167).

[1]JULLIEN, J., 1886, Soc. zool. Fr. Bull., vol. 11, p. 606.

Lepralina KÜHN, 1925 [**L. auriculata*]. *Mio.*, Aus.

Membraniporella SMITT, 1873 [**Lepralia nitida* JOHNSTON, 1838; SD NORMAN, 1903] [=*?Reptescharella, Semieschariporа* D'ORB., 1853]. Incrusting to erect, with zooecial front formed of coalesced depressed spines (costules) recumbent over the membranous ectocyst and partly separated by transverse slits (lacunae). *Cret.-Rec.*——FIG. 141,*19*. **M. nitida* (JOHNSTON), Rec., NE.Atl.; ×25 (167).

Metracolposa CANU-B., 1917 [**M. robusta*]. Like *Cribrilina* but costules separated by lacunae; ovicell large, deeply embedded in distal zooecium, with larger aperture. *Eoc.*——FIG. 141,*17*. **M. robusta*, Claib., N.Car.; ×25 (137).

Mumiella JULLIEN, 1888 [**Semieschariporа mumia* D'ORB., 1852]. Frontal of flattened parallel ribs separated by wide spaces with many rows of small pores. Small avicularium on each side of aperture. *Cret.*——FIG. 141,*20*. **M. mumia* (D'ORB.), Senon., Fr.; ×25 (202).

Pleuroschizella CANU, 1918 [**P. anaticula*]. Aperture with rimule and spines; ovicelled zooecia larger and without rimule. Numerous small narrow interzooecial avicularia. *Eoc.*——FIG. 141,*18*. **P. anaticula*, Lut., Fr.; ×25 (136).

Puellina JULLIEN, 1886 [**Cribrilina gattyae* BUSK, 1854]. Costular shield occupying distal half of frontal, lacunae very small; prominent oral marginal spines. *Tert.-Rec.*——FIG. 141,*7*. **P. gattyae* (BUSK), Rec., NE.Atl.; ×25 (167).

Reginella JULLIEN, 1886 [**Cribrilina furcata* HINCKS, 1882]. Like *Lyrula* but aperture is arched in front with mucronate inferior lip and marginal spines. *Rec.*——FIG. 141,*12*. **R. furcata* (HINCKS), NE. Pac.; ×25 (167).

Repteschariporа D'ORB., 1853 [**R. meudonensis*]. Pair of round avicularia borders aperture laterally. *Cret.*——FIG. 141,*10*. **R. meudonensis*, Maastr., Fr.; ×25 (202).

Scorpiodina JULLIEN, 1886 [**Lepralia scorpioides* MANZONI, 1869]. Frontal of fused robust ribs giving rise to irregular excrescences. *Tert.*——FIG. 141,*15*. **S. scorpioides* (MANZONI), Mio., Aus.; ×25 (183).

Family MYAGROPORIDAE Lang, 1916

Zoaria incrusting or erect. Zooecia about 0.66 mm. long; costae spiniform, widely separated, those forming the apertural bar seldom fused; 4 apertural spines. Ovicells hyperstomial, lacking pelmata (broken ends of large spines) and pelmatidia (same but smaller). Avicularia small, subcircular; much interzooecial tissue (79). *Cret.*

Myagropora LANG, 1916 [**M. muscipula*].——FIG. 142,*1*. **M. muscipula*, Coni., Eng.; ×37.5 (175).

Family OTOPORIDAE Lang, 1916

Like Myagroporidae but avicularian rostra elongate, tending to curve; little or no interzooecial secondary tissue (79). *Cret.*

Otopora Lang, 1916 [**O. auricula*]. Incrusting, unilaminar; costae firmly fused in mid-line and close together laterally.——Fig. 142,*6*. **O. auricula,* Cenom., Eng.; ×37.5 (175).

Anaptopora Lang, 1916 [**A. disjuncta*]. Like *Otopora* but with widely separated thin costae not fused along mid-line, first pair like others.——Fig. 142,*5*. **A. disjuncta,* Cenom., Eng.; ×37.5 (175).

Anotopora Lang, 1916 [**A. inaurita*]. Erect, cylindrical; no avicularia; costae thin, widely separated, first pair larger than rest and standing vertically.——Fig. 142,*7*. **A. inaurita,* Cenom., Eng.; ×37.5 (175).

Family CTENOPORIDAE Lang, 1916

Like Myagroporidae but costae fused firmly to subjacent ground tissue forming a complete intraterminal front wall (79). *Cret.*

Ctenopora Lang, 1916 [**C. pecten*]. Incrusting, multiserial.——Fig. 142,*3*. **C. pecten,* Cenom., Eng.; ×50 (175).

Family THORACOPORIDAE Lang, 1916

Ovicell hyperstomial, lacking pelmata and pelmatidia. Symmetrical apertural bar present, costae spinelike, widely separated; 4 apertural spines. Long spatulate avicularia (79). *Cret.*

Thoracopora Lang, 1916 [**T. costata*]. Incrusting,

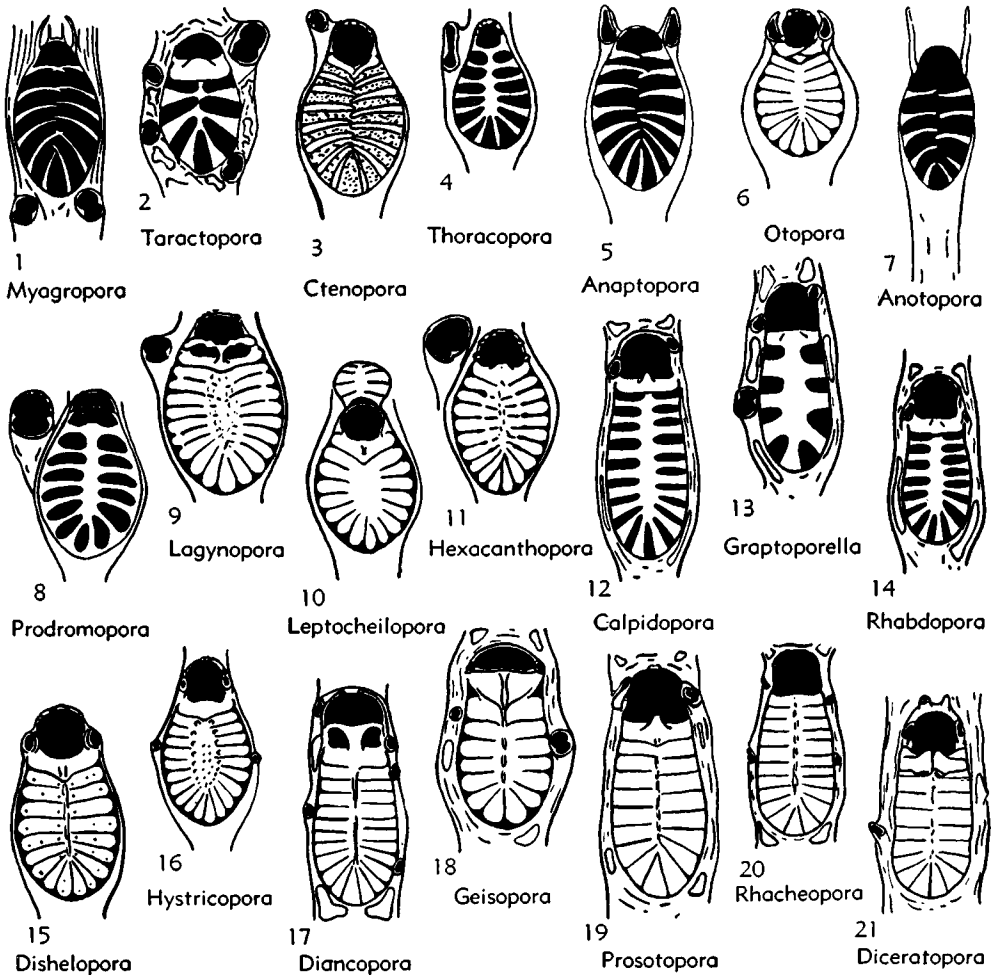


Fig. 142. Myagroporidae, Otoporidae, Ctenoporidae, Thoracoporidae, Taractoporidae, Lagynoporidae, Calpidoporidae, Dishelopоridae, Rhacheoporidae (p. G186-G189).

unilaminar.——Fig. 142,*4*. **T. costata,* Santon., Eng.; ×50 (175).

Family TARACTOPORIDAE Lang, 1916

Like Thoracoporidae but costae flattened, widely spaced, and wide proximally; avicularia subcircular, much interzooecial secondary tissue, 4 apertural spines and well-formed apertural bar (79). *Cret.*

Taractopora Lang, 1916 [**T. confusa*]. Incrusting, unilaminar.——Fig. 142,*2*. **T. confusa,* Coni., Eng.; ×50 (175).

Family LAGYNOPORIDAE Lang, 1916

[as Lagynoporinae]

Ovicell hyperstomial, lacking pelmata and pelmatidia; apertural bar present, costae closely spaced, commonly 6 apertural spines and large subcircular avicularia (79). *Cret.*

Lagynopora Lang, 1916 [**L. lagena*]. Incrusting, unilaminar. Median process of apertural bar fused with proximal pair of apertural spines to form proximal shield of a secondary aperture; costae wide, closely spaced; 4 to 6 apertural spines.——Fig. 142,*9*. **L. lagena,* L.Senon., Eng.; ×37.5 (175).

Canupora Kühn, 1930 [**C. prima*]. *Dan.*, Aus.

Hexacanthopora Lang, 1916 [**H. sexspinosa*]. Most adult zooecia (epheboecia) with 6 apertural spines.——Fig. 142,*11*. **H. sexspinosa,* Santon., Eng.; ×37.5 (175).

Prodromopora Lang, 1916 [**P. praecursor*]. Like *Lagynopora* but adult zooecia with only 4 apertural spines, thin, widely separated costae and median process of apertural bar also thin.——Fig. 142,*8*. **P. praecursor,* Santon., Eng.; ×37.5 (175).

Leptocheilopora Lang, 1916 [**L. tenuilabrosa*] [=*?Reptoporella* d'Orb., 1853]. No median process on proximally bent apertural bar; 4 minute apertural spines; avicularia rare.——Fig. 142,*10*. **L. tenuilabrosa,* Santon., Eng.; ×37.5 (175). [Leptocheiloporinae Lang, 1916].

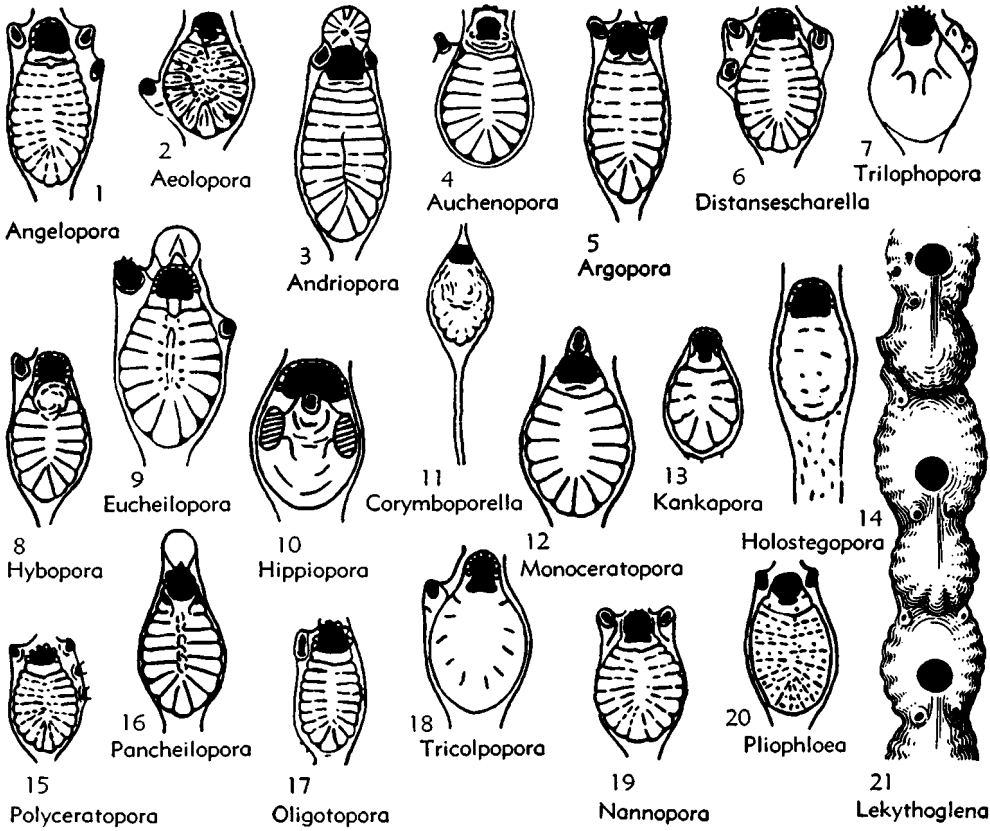


Fig. 143. Andrioporidae (p. G189, G190).

Family CALPIDOPORIDAE Lang, 1916

Multiserial zooecia, about 0.75 mm. long, with endozooecial ovicells lacking pelmata; costae widely separated, much interzooecial tissue; avicularia small, tending to have curved rostra (79). *Cret.*

Calpidopora Lang, 1916 [**C. diota*]. Median area of fusion narrow; avicularia with pointed apertures in pairs.——Fig. 142,*12*. **C. diota*, Cenom., Czech.; ×37.5 (175).

Graptoporella Bassler, nov. [*pro Graptopora* Lang, 1916 (*non* Salter, 1858; *nec* Ulr., 1882)] [**G. scripta*]. Erect, unilaminar. Broad median area of fusion; costae few; avicularia blunt.——Fig. 142, *13*. **G. scripta*, Santon., Fr.; ×37.5 (175).

Rhabdopora Lang, 1916 [**R. virgata*]. Incrusting. Median fused area narrow; avicularia sporadic or located proximally to aperture.——Fig. 142,*14*. **R. virgata*, Turon., Fr.; ×37.5 (175).

Family DISHELOPORIDAE Lang, 1916

Multiserial zooecia, large, long (0.6-1.0 mm.); endozooecial ovicells with pelmatidia; costae closely spaced; little interzooecial secondary tissue (79). *Cret.*

Dishelopora Lang, 1916 [**D. biscuspis*]. Incrusting. Apertural spines of distal pair do not fuse to form distal shield.——Fig. 142,*15*. **D. biscuspis*, Senon., Eng.; ×37.5 (175).

Hystricopora Lang, 1916 [**H. horrida*]. Erect. Distal pair of spines fuse to form shield.——Fig. 142,*16*. **H. horrida*, Coni., Fr.; ×37.5 (175).

Family RHACHEOPORIDAE Lang, 1916

Like Disheloporidae but zooecia long, delicate; endozooecial ovicells, pelmatidia absent or inconspicuous; costae closely spaced, flattened, with upturned edges forming a median seam; 4 apertural spines (79). *Cret.*

Rhacheopora Lang, 1916 [**R. suta*]. Erect cylindrical. Apertural bar with no median process, spines simple; no secondary aperture.——Fig. 142,*20*. **R. suta*, L.Senon., Eng.; ×37.5 (175).

Diancopora Lang, 1916 [**D. ancora*]. Like *Rhacheopora* but unilaminar; secondary aperture present.——Fig. 142,*17*. **D. ancora*, L.Senon., Eng., ×37.5 (175).

Diceratopora Lang, 1916 [**D. bivia*]. Incrusting, unilaminar. Proximal shield formed by fusion of pair of apertural avicularia over apertural bar.——Fig. 142,*21*. **D. bivia*, Senon., Eng.; ×37.5 (175).

Geisopora Lang, 1916 [**G. protecta*]. Incrusting unilaminar, with only slight remnant of median seam.——Fig. 142,*18*. **G. protecta*, Camp. Ger.; ×37.5 (175).

Prosotopora Lang, 1916 [**P. arrecta*]. Like *Rhacheopora* but ovicelled zooecia have a modified secondary aperture.——Fig. 142,*19*. **P. arrecta*, Santon., Eng.; ×37.5 (175).

Family ANDRIOPORIDAE Lang, 1916

Zoaria mostly incrusting; with uniserial and multiserial small zooecia (0.3-0.5 mm. long), symmetrical apertural bar, closely placed costae, 6 apertural spines and little interzooecial secondary tissue. Ovicells hyperstomial, lacking pelmata and pelmatidia (79). *Cret.-Eoc.*

Andriopora Lang, 1916 [**A. homunculus*]. Costae not specially flattened or laterally fused without median row of pores or median slit. Zoarium uniserial, generally with avicularia and intraterminal front wall composed of intimately fused costae. *Cret.*——Fig. 143,*3*. **A. homunculus*, Turon., Eng.; ×50 (175). [Andrioporinae Lang, 1916].

Aeolopora Lang, 1916 [**A. distincta*]. Multiserial, apertural spines thickened, median area of fusion surrounded by ring of solid spines (original distal ends of costae). *Cret.*——Fig. 143,*2*. **A. distincta*, Santon., Eng.; ×50 (175).

Angelopora Lang, 1916 [**A. nuntia*]. Multiserial, incrusting, with rudimentary proximal apertural shield; no margin of spines on median area of fusion; numerous avicularia. *Cret.*——Fig. 143,*1*. **A. nuntia*, Senon., Eng.; ×50 (175).

Argopora Lang, 1916 [**A. segnis*]. Multiserial, incrusting, zooecia with no secondary aperture, no margin of tubercles in the median area of fusion and apertural bar not forming a hump; numerous avicularia. *Cret.*——Fig. 143,*5*. **A. segnis*, Senon., Eng.; ×50 (175).

Auchenopora Lang, 1916 [**A. guttur*]. Multiserial, developing a secondary aperture with proximal shield formed by apertural bar. *Cret.*——Fig. 143, *4*. **A. guttur*, Dan., Denm.; ×50 (175).

Corymboporella Lang, 1917 [*pro Corymbopora* Lang, 1916 (*non* Mich., 1846)] [**Corymbopora religata* Lang, 1916]. Uniserial, zooecia bearing a long cauda; intraterminal front wall with traces of costae. Avicularia absent. *Cret.*——Fig. 143,*11*. **C. religata* (Lang), Cenom., Czech.; ×50 (175).

Distansescharella d'Orb., 1853 [**Cellepora familiaris* Hag., 1839]. Multiserial, incrusting. Zooecia small, squat, widely separated by numerous avicularia or zooeciules, median area of fusion not surrounded by spines. *Cret.-Eoc.*——Fig. 143,*6*. *D. d'orbignyi*, Coni., Fr.; ×50 (175).

Eucheilopora Lang, 1916 [**E. labiosa*]. Apertural bar produced into a proximally directed median spine; cribriline aspect. *Cret.*——Fig. 143,*9*. **E. labiosa*, Coni., Eng.; ×50 (175).

Hippiopora LANG, 1916 [**H. equestris*]. Multiserial. No secondary aperture; avicularium on middle of apertural bar; secondary tissue covers front wall. *Cret.*——FIG. 143,*10*. **H. equestris,* Camp., Eng.; ×50 (175).

Holostegopora LANG, 1916 [**H. epsomensis*]. Zoarium erect, cylindrical, with completely fused, solid intraterminal front wall. *Cret.*——FIG. 143,*14*. **H. epsomensis,* Santon., Eng.; ×50 (175).

Hybopora LANG, 1916 [**H. gibba*]. Like *Kankapora* but with hump of secondary tissue on apertural bar, a few avicularia and more numerous costae. *Cret.*——FIG. 143,*8*. **H. gibba,* Cenom., Czech.; ×50 (175).

Kankapora LANG, 1916 [**K. kankensis*]. Multiserial, incrusting. No secondary aperture, median area of fusion not surrounded by a circle of tubercles, avicularia absent, apertural bar does not form a hump and spines decidedly thickened. *Cret.*——FIG. 143,*13*. **K. kankensis,* Cenom., Czech.; ×50 (175).

Lekythoglena MARSSON, 1887 [**L. ampullacea*]. Erect, cylindrical zoarium with frontal wall more or less completely fused; hyperstomial ovicell with radial structure. *Cret.*——FIG. 143,*21*. **L. ampullacea,* Camp., Ger.; ×25 (186).

Monoceratopora LANG, 1916 [**M. unicornis*]. Multiserial, with proximal pair of axial spines enlarged and distal pair minute. Avicularia few, arranged medially and distally to zooecia. *Cret.*——FIG. 143,*12*. **M. unicornis,* Santon., Eng.; ×50 (175).

Nannopora LANG, 1916 [**Reptescharella pygmaea* D'ORB., 1852]. Small squat zooecia with no secondary aperture. Furrows between costae plainly visible. *Cret.-Eoc.*——FIG. 143,*19*. **N. pygmaea* (D'ORB.), Senon., Fr.; ×50 (175).

Oligotopora LANG, 1916 [**O. novaki* (=*Lepralia pediculus* NOVAK, 1877)]. Multiserial, incrusting. No secondary aperture or circle of spines around median area; avicularia few and pointed; apertural spines thickened. *Cret.*——FIG. 143,*17*. **O. pediculus* (NOVAK), Turon., Czech.; ×50 (175).

Pancheilopora LANG, 1916 [**P. magnilabrosa*]. Like *Eucheilopora* but apertural bar forms a proximal shield of secondary aperture. *Cret.*——FIG. 143,*16*. **P. magnilabrosa,* Camp., Eng.; ×50 (175).

Pliophloea GABB-H., 1862 [**Flustra sagena* MORTON, 1834] [=*Barroisina* JULLIEN, 1886]. Erect, bilamellar. Costae more or less flattened, some fused neighbors with median row of pores; furrows between the costae visible. *Cret.-Eoc.*——FIG. 143,*20*. **P. sagena* (MORTON), Eoc.(Wilcox.), N.J.; ×50 (175). [Pliophloeinae LANG, 1921].

Polyceratopora LANG, 1916 [**Lepralia euglypha* NOVAK, 1877]. Apertures semicircular, primitive; fusions between costae plainly visible; avicularia numerous. *Cret.*——FIG. 143,*15*. **P. euglypha* (NOVAK), Cenom., Czech.; ×50 (175).

Tricolpopora LANG, 1916 [**T. trisinuata*]. Like *Nannopora* but costae fused to form a solid front wall. *Cret.*——FIG. 143,*18*. **T. trisinuata,* Coni., Fr.; ×50 (175).

Trilophopora LANG, 1916 [**T. trifida*]. Incrusting, unilaminar. Intraterminal front wall completely fused, leaving only traces of costal furrows and pores. *Cret.*——FIG. 143,*7*. **T. trifida,* Dan., Denm.; ×50 (175).

Schistacanthopora LANG, 1916 [**S. fissa*]. Incrusting, unilaminar. Costae with median slit. *Cret., Maastr.,* Fr. [Schistacanthoporinae LANG, 1916].

Family PELMATOPORIDAE Lang, 1916

Multiserial zooecia (0.5-1.5 mm. long) with endozooecial ovicells; intraterminal front walls of zooecia formed of hollow terminal spines (costae) bent over archlike, fused with each other in middle lines, then bent vertically with broken ends generally forming 2 rows of conspicuous pelmata (large) and pelmatidia (small). Avicularia numerous, monomorphic, small with blunt apertures (79). *Cret.-Rec.*

Subfamily FRANCOPORINAE Lang, 1916

Costules fused in narrow mid-line area that projects distally as indentation of the aperture. *Cret.*

Francopora LANG, 1916 [**F. canui*]. Erect, cylindrical. Primary pelmatidia only present, widely separated costae with weak band of fusion. *Cret.*——FIG. 144,*1*. **F. canui,* Coni., Fr.; ×50 (175).

Baptopora LANG, 1916 [**B. immersa*]. Erect, unilaminar. Pelmatidia partly covered by secondary tissue in which zooecia are immersed; avicularia at right angles to zooecia. *Cret.*——FIG. 144,*2*. **B. immersa,* Coni., Fr.; ×50 (175).

Subfamily OPISTHORNITHOPORINAE Lang, 1916

Like Francoporinae but costules closely appressed, mid-line fused area not projecting into aperture, and with large avicularia, occurring singly and directed obliquely. *Cret.*

Opisthornithopora LANG, 1916 [**Reptescharella flabellata* D'ORB., 1852]. Incrusting. Costae close together. *Cret.*——FIG. 144,*3*. **O. flabellata* (D'ORB.), Coni., Fr.; ×50 (175).

Subfamily KELESTOMINAE Lang, 1922

Opposite costae near aperture bifurcate toward mid-line forming a spiramen. *Cret.-Rec.*

Kelestoma MARSSON, 1887 [**K. elongatum*]. Incrusting. Zooecia elongate; each half of apertural

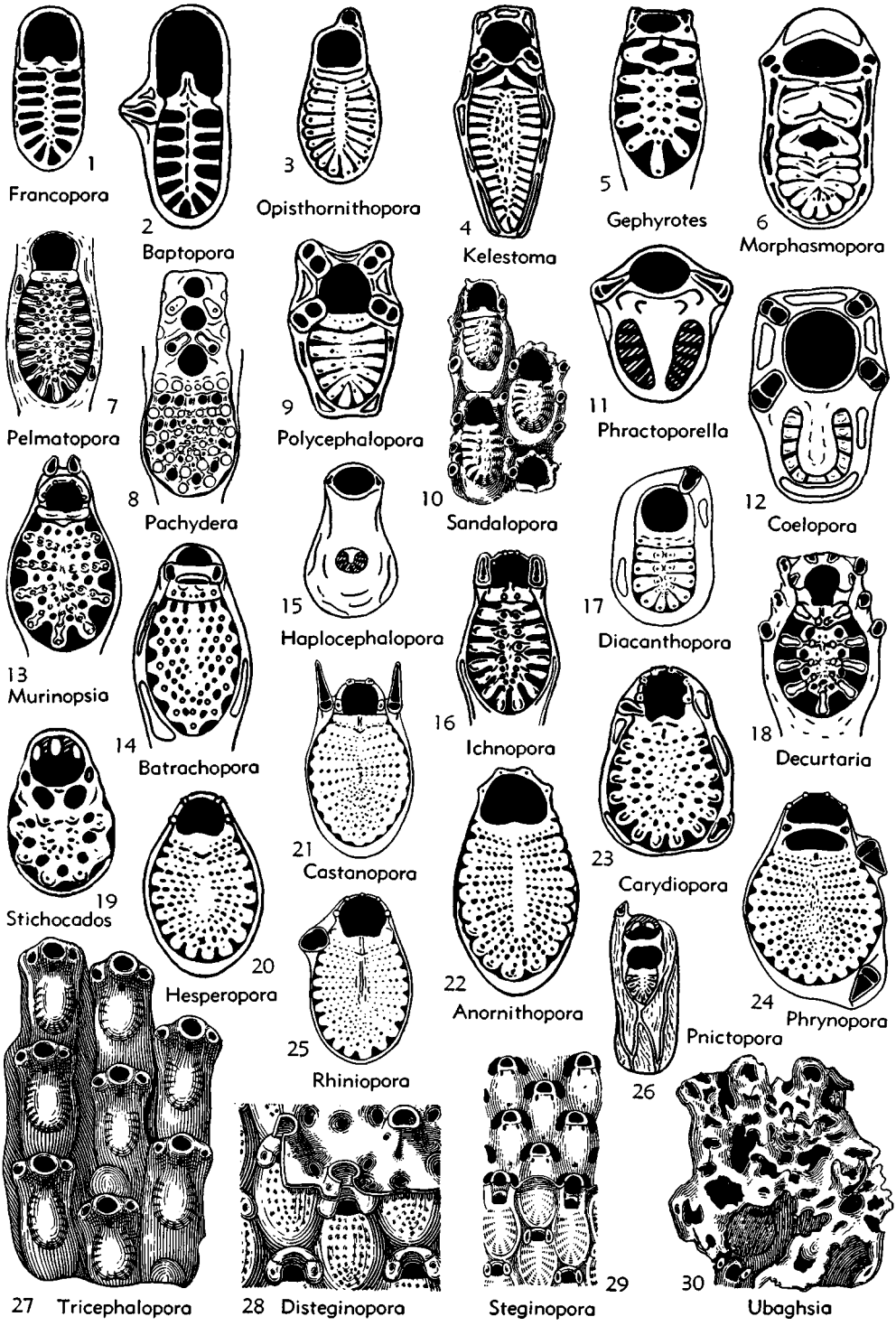


FIG. 144. Pelmatoporidae (p. G190-G193).

bar bifid; costae numerous. Primary pelmatidia only. *Cret.-Eoc.*——Fig. 144,*4*. **K. elongatum*, Camp., Ger.; ×37.5 (175).

Gephyrotes Norman, 1903 [**Escharipora figularis nitidopunctata* Smitt, 1868]. The 2 distal costules bifurcate to form spiramen. *Cret.-Rec.*——Fig. 144,*5*. **G. figularis nitidopunctata* (Smitt), Rec., N.Atl.; ×37.5 (175).

Morphasmopora Lang, 1916 [**Cribrilina jukesbrownei* Brydone, 1906]. Costae relatively few, nearly touching. *Cret.*——Fig. 144,*6*. **M. jukesbrownei* (Brydone), Camp., Eng.; ×50 (175).

Subfamily PELMATOPORINAE Lang, 1916

Costae with pelmata and corresponding lateral costal connections, mid-line area of fusion relatively wide. *Cret.-Mio.*

Pelmatopora Lang, 1916 [**P. pero*]. Incrusting, generally unilaminar. Secondary aperture consists of a distal shield formed only of a rim of secondary tissue and a pair of avicularia-like structures. *Cret.*——Fig. 144,*7*. **P. pero*, Santon., Eng.; ×25 (175).

Batrachopora Lang, 1916 [**B. ranunculus*]. Secondary aperture formed of both proximal and distal shields. *Cret.*——Fig. 144,*14*. **B. ranunculus*, Camp., Ger.; ×37.5 (175).

Decurtaria Jullien, 1886 [**Semieschariporа cornuta* Beissel, 1865] [=*Prosoporella* Marsson, 1887]. Distinguished by collar-like distal shield of secondary aperture and absence of any proximal shield. *Cret.-Mio.*——Fig. 144,*18*. **D. cornuta* (Beissel), Maastr., Ger.; ×37.5 (175).

Ichnopora Lang, 1916 [**I. vestigium*]. Like *Pelmatopora* with a secondary aperture of a proximal shield only. *Cret.*——Fig. 144,*16*. **I. vestigium*, Senon., Eng.; ×37.5 (175).

Murinopsia Jullien, 1886 [**Semieschariporа galeata* Beissel, 1865] [=*Lagodiopsis* Marsson, 1887]. Distal shield a rim of secondary tissue connecting apertural spines. Avicularia, a group in front of aperture. *Cret.*——Fig. 144,*13*. **M. galeata* (Beissel), Maastr., Ger.; ×37.5 (175).

Pachydera Marsson, 1887 [**P. grandis*]. Secondary aperture is a tubular structure extended forward by fusion of the proximal and distal shields. *Cret.*——Fig. 144,*8*. **P. grandis*, Camp., Ger.; ×25 (175).

Sandalopora Lang, 1916 [**S. soccata*]. Like *Pelmatopora* but secondary aperture is only an imperfect proximal shield formed by a median projection of the apertural bar. *Cret.*——Fig. 144,*10*. **S. soccata*, Coni., Eng.; ×25 (175).

Subfamily TRICEPHALOPORINAE Lang, 1922

Mid-line area of frontal broadly fused, aperture well rounded, with 2 or 4 adjoining, generally rounded avicularia. *Cret.-Rec.*

Tricephalopora Lang, 1916 [**Cribrilina triceps* Marsson, 1887]. Generally incrusting. Each half of apertural bar not bifid. Avicularia blunt, circular in outline. *Cret.*——Fig. 144,*27*. **T. triceps* (Marsson), Camp., Ger.; ×25 (186).

Coelopora Lang, 1917 [*pro Antropora* Lang, 1916 (*non* Norman, 1903)] [**Antropora cavernosa* Lang, 1916]. Zoarium erect, solid, cylindrical. *Cret.-Rec.*——Fig. 144,*12*. **C. cavernosa* (Lang), Camp., Ger.; ×25 (175).

Haplocephalopora Lang, 1916 [**H. uniceps*]. Erect, cylindrical. Avicularia a small apertural pair on the prolonged apertural rim. *Cret.*——Fig. 144,*15*. **H. uniceps*, Dan., Denm.; ×25 (175).

Phractoporella Lang, 1917 [*pro Phractopora* Lang, 1916 (*non* Hall, 1883)] [**Phractopora constrata* Lang, 1916]. *Cret.*——Fig. 144,*11*. **P. constrata* (Lang), Camp., Ger.; ×37.5 (175).

Polycephalopora Lang, 1916 [**P. hydra*] [=*Multescharipora* d'Orb., 1853]. Like *Tricephalopora* but has 3 to 5 apertural avicularia. *Cret.*——Fig. 144,*9*. **P. hydra*, Camp., Ger.; ×37.5 (175).

Subfamily DIACANTHOPORINAE Lang, 1922

Bilamellar, costae bearing a proximal pelma and distal pelmatidia. *Cret.*

Diacanthopora Lang, 1916 [**D. bispinosa*]. *Cret.*——Fig. 144,*17*. **D. bispinosa*, Dan., Denm.; ×25 (175).

Subfamily CASTANOPORINAE Lang, 1916

Costae numerous, with pelmatidia of several orders and corresponding lateral fusions; mid-line area of fusion not sharply differentiated. *Cret.-Eoc.*

Castanopora Lang, 1916 [**C. castanea*]. Zoaria generally incrusting, unilamellar. Large zooecia. Pair of distally directed avicularia with long rostra. *Cret.*——Fig. 144,*21*. **C. castanea*, Camp., Ger.; ×25 (175).

Anornithopora Lang, 1916 [**A. involucris*]. Like *Carydiopora* but without avicularia. *Cret.*——Fig. 144,*22*. **A. involucris*, Camp., Eng.; ×50 (175).

Carydiopora Lang, 1916 [**C. nucula*]. Zooecia small, with few costae and numerous, variously oriented avicularia. *Cret.*——Fig. 144,*23*. **C. nucula*, Santon., Eng.; ×37.5 (175).

Disteginopora d'Orb., 1852 [**Eschara horrida* d'Orb., 1850] [=*Disteganopora* Canu, 1922; *Thoracophora* Jullien, 1886]. Erect, bilamellar *Steginopora* with distal unbranched apertural spines. Lower layer with regular transverse rows of tremopores. *Cret.*——Fig. 144,*28*. **D. horrida* (d'Orb.), Maastr., Fr.; ×50 (175).

Hesperopora LANG, 1916 [**H. occidentalis*]. Differs from *Anornithopora* in secondary aperture not perforated by fenestrae, finer costae, and solid apertural ring. *Cret.-Eoc.*——FIG. 144,*20*. **H. occidentalis*, Eoc.(Wilcox.), N.J.; ×50 (175).

Phrynopora LANG, 1916 [**P. bufo*]. Like *Rhiniopora* but with secondary aperture. *Cret.*——FIG. 144,*24*. **P. bufo*, Camp., Ger.; ×25 (175).

Rhiniopora LANG, 1916 [**R. aspera*]. Like *Carydiopora* but has 2 kinds of avicularia, one with long and the other short rostra. *Cret.*——FIG. 144,*25*. **R. aspera*, Camp., Ger.; ×25 (175).

Steginopora D'ORB., 1853 [**S. ornata*]. With tertiary front wall formed by upgrowth and lateral expansion of paired apertural avicularia. *Cret.*——FIG. 144,*29*. **S. ornata*, Senon., Fr.; ×50 (202).

Stichocados MARSSON, 1887 [**S. verruculosus*]. Like *Carydiopora* but with few costae and few or no avicularia. *Cret.*——FIG. 144,*19*. **S. verruculosus*, Camp., Ger.; ×37.5 (175).

Ubaghsia JULLIEN, 1886 [**Steginopora reticulata* UBAGHS, 1865]. Like *Disteginopora* but apertural spines are more irregularly arranged. *Cret.*——FIG. 144,*30*. **U. reticulata* (UBAGHS), Maastr., Holl.; ×5 (175).

Subfamily PNICTOPORINAE Lang, 1922

Frontal wall greatly reduced, with secondary tissue much developed; avicularia few, pointed. *Cret.*

Pnictopora LANG, 1916 [**P. suffocata*]. Erect, cylindrical. Halves of apertural bar not bifid. Avicularia few, pointed. *Cret.*——FIG. 144,*26*. **P. suffocata*, Senon., Eng.; ×25 (175).

Suborder ASCOPHORA Levinsen, 1909

[=Camarostega LEV., 1902]

Characterized by zooecia with calcified frontal surface, beneath which a compensation sac (compensatrix) serves as hydrostatic system for protrusion or withdrawal of the tentacles. This sac generally opens at proximal border of the aperture but a more proximally placed special pore (ascopore) may constitute opening for the sac. The hinged operculum is so constructed that the larger distal part moves upward for passage of the tentacles while coincidently the proximal part swings downward to allow entrance of a compensating equal volume of water to the compensatrix. *Cret.-Rec.*

Family PORINIDAE d'Orbigny, 1852

[=Acroporidae CANU, 1913]

Zoaria free, erect, cylindrical to narrow bifoliate branches. Zooecia indistinct, with thick front perforated by an ascopore, opening below operculum; aperture buried at bottom of a long peristomie. Ovicell hyperstomial, deeply immersed, invisible exteriorly. Frontal and peristomial avicularia present (24). *Cret.-Eoc.*

Porina D'ORB., 1852 [**Eschara gracilis* LAMARCK, 1816; SD LANG, 1917] [=*Acropora* REUSS, 1869 (*non* OKEN, 1815); *Acroporana* STRAND, 1928]. Front a thick tremocyst with tubules; ascopore at midlength; avicularia on peristome. *Cret.-Rec.*——FIG. 145,*3*. *P. saillans* (CANU-B.), Oligo., Ala.; ×25 (137).

Beisselina CANU, 1913 [**Eschara striata* GOLDF., 1828]. Like *Porina* but pores and ascopore large, commonly replaced by small avicularia, hiding zooecial form. *Cret.-Eoc.*——FIG. 145,*8*. **B. striata* (GOLDF.), Maastr., Holl.; ×25 (137).

Beisselinopsis VOIGT, 1951 [**B. hiltermanni*]. Zoarium flabelliform, bifoliate, with pointed base. *Cret.*, Ger.

Columnotheca MARSSON, 1887 [**C. cribrosa*]. Slender cylindrical branches. Zooecial apertures in transverse rows; ascopore inconspicuous. *Cret.*——FIG. 145,*7*. **C. cribrosa*, Camp., Ger.; ×25 (186).

Gastropella CANU-B., 1917 [**G. ventricosa*]. Like *Porina* but front smooth, with a few lateral areolae and large central ascopore. *Paleoc.*——FIG. 145,*4*. **G. ventricosa*, Midway., Ark.; ×25 (137).

Pachythecella CANU-B., 1934 [*pro Pachytheca* CANU, 1913 (*non* SCHLÜTER, 1885)] [**Porina filiformis* D'ORB., 1852]. Cylindrical stems; zooecial front a thick olocyst with small ascopore opening exteriorly distant from peristome. *Cret.-Eoc.*——FIG. 145, *2*. **P. filiformis* (D'ORB.), Camp., Ger.; ×10 (202).

Rotiporina BRYDONE, 1930 [**Acropora producta* HAG., 1840]. Circular stems or segments; zooecia in longitudinal rows. *Cret.*——FIG. 145,*1*. **R. producta* (HAG.), Camp., Ger.; ×10 (160).

Family CYCLICOPORIDAE Hincks, 1884

Typically incrusting, with zooecial front a tremocyst. Ovicell hyperstomial, closed by operculum. Compensation sac opens in aperture which is entire, without rimule or cardelles (24). *Eoc.-Rec.*

Cyclicopora HINCKS, 1884 [**C. praelonga* (=*Lepralia longipora* MACGILL., 1882)]. Incrusting. Frontal pores in quincunx; aperture entire, somewhat concave proximally. *Eoc.-Rec.*——FIG. 145,*6*.

***C. longipora* (MacGill.)**, Rec., SW.Pac.; ×50 (181).

Aptonella Canu-B., 1928 [**A. violacea*]. Operculum pyriform, operating in a locella; 2 small avicularia converge above aperture. *Rec.*——Fig. 145,*11*. **A. violacea*, SW.Atl.; ×25 (137).

Cyclocolposa Canu-B., 1920 [**C. perforata*]. Like *Cyclicopora* but zooecial front a granular pleurocyst with double row of areolar pores. Ovicell embedded in distal zooecium. *Mio-Plio.*——Fig. 145,*12*. **C. perforata*, Plio., S.Car.; ×25 (137).

Houzeauina Pergens, 1889 [**Eschara parallela* Reuss, 1869]. Bifoliate. Zooecial front an olocyst with areolae, an avicularium on mid-line. *Eoc.*——Fig. 145,*10*. **H. parallela* (Reuss), Priabon., Italy; ×25 (210).

Kymella Canu-B., 1917 [**Cyclicopora polaris* Waters, 1904]. Bilaminate. Zooecial front a pleurocyst with one row of minute, widely spaced areolae; aperture with wide rimule. *Rec.*——Fig. 145, *5*. **K. polaris* (Waters), Antarct.; ×25 (230).

Magnea Vig., 1949 [**M. pileata*]. Incrusting. Zooecia separated by a series of zooeciules; aperture entire; front with olocyst. No avicularia. *Mio.*——

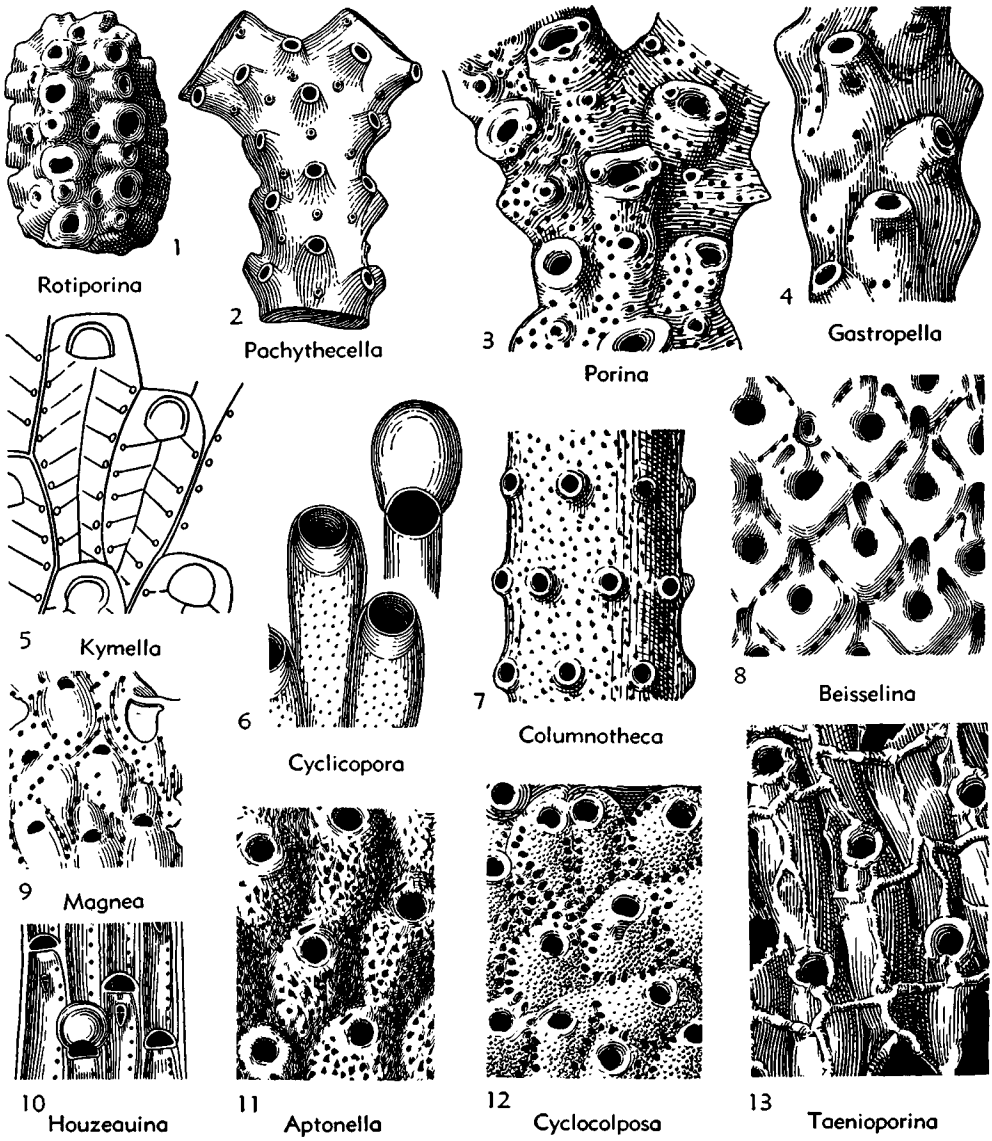


Fig. 145. Porinidae, Cyclicoporidae (p. G193-G195).

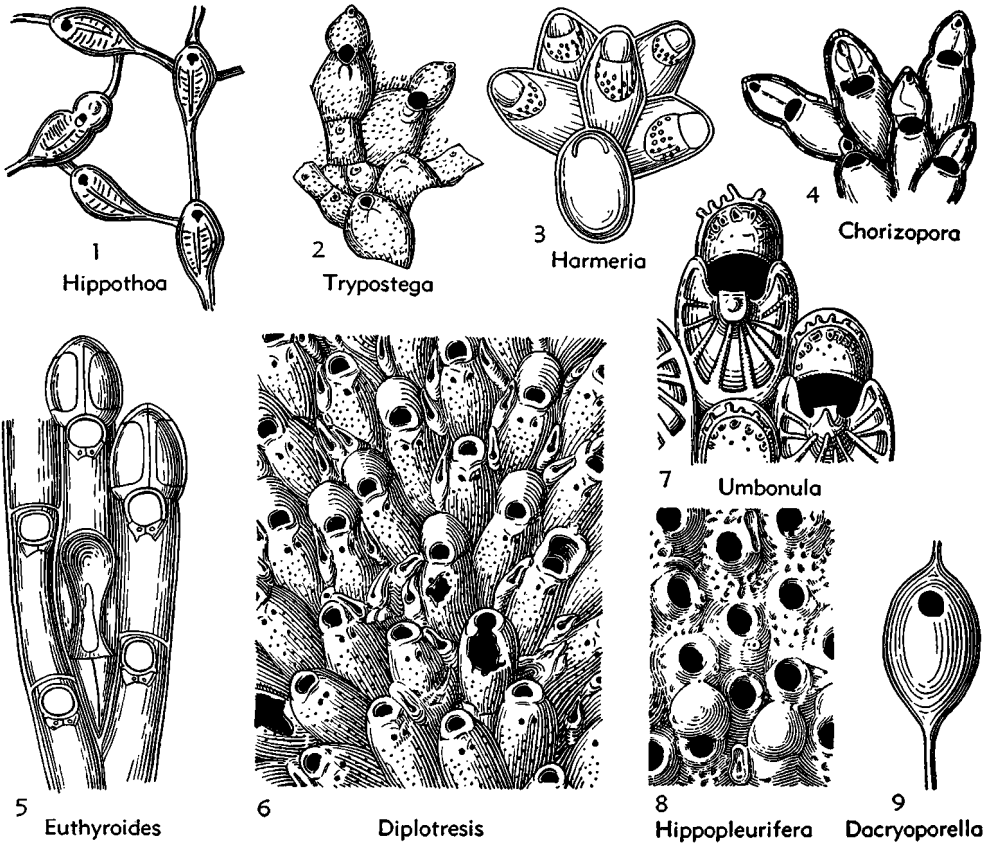


FIG. 146. Hippothoidae, Euthyroididae, Umbonulidae (p. G195, G196).

FIG. 145,*9*. **M. pileata,* Helv., Fr.; ×25 (224).

Taenioporina MARSSON, 1887 [**Eschara arachnoidea* GOLDF., 1826]. Bilamellate. Zooecial surface marked off in rectangular areas by elevated threads. *Cret.*——FIG. 145,*13*. **T. arachnoidea* (GOLDF.), Maastr., Holl.; ×25 (131).

Family HIPPOTHOIDAE Levinsen, 1909

[=Chorizoporidae VIG., 1949]

Incrusting sheets or unilinear series. Zooecia without covering membrane, calcified from behind in successive zones forward, leaving more or less salient lines of growth (24). *Cret.-Rec.*

Hippothoa LAMX., 1821 [**H. divaricata*] [=*Celleporella* GRAY, 1848; *Hippothoida* VINE, 1893; *Diazeuxia* JULLIEN, 1888]. Zooecia generally in single series, with front a transversely wrinkled olocyst, apertures with sinus and strong cardelles; gonozooecia small, without polypide, conspicuous ovicell covered by kenozooecia. No avicularia, spines, or vibracula. *Cret.-Rec.*——FIG. 146,*1*. **H. divaricata,* Rec., Medit.; ×25 (167).

Chorizopora HINCKS, 1880 [**Flustra brongniarti* AUDOUIN, 1828]. Zooecia more or less distant, connected by tubular network; aperture semicircular with inferior margin entire. Ovicell endozooecial, with avicularia. *Tert.-Rec.*——FIG. 146,*4*. **C. brongniarti* (AUDOUIN), Rec., Medit.; ×25 (167).

Dacryoporella LANG, 1934 [*pro Dacryopora* LANG, 1914 (*non* TERQUEM, 1885)] [**D. gutta*]. Incrusting, uniserial, branching bilaterally, with long, thin caudal part; apertures semicircular. *Cret.*——FIG. 146,*9*. **D. gutta* (LANG), Senon., Eng.; ×25 (175).

Diplotresis CANU-B., 1933 [**Microporella sparsiporosa* ULR.-B., 1907]. Zooecia with 2 frontal pores like ascopores and zooeciules, with pointed beak irregularly arranged between them. Ovicell hyperstomial, closed by operculum. *Eoc.*——FIG. 146,*6*. **D. sparsiporosa* (ULR.-B.), Wilcox., N.J.; ×25 (137).

Haplopoma LEV., 1909 [**Flustra impressa* AUDOUIN,

1826]. Median ascopore proximal to aperture; frontal with scattered pores; no avicularia. *Mio.-Rec.,* Red Sea.——Fig. 155,*13*. **H. impressa* (Audouin), Rec., Medit.; ×25 (177).

Harmeria Norman, 1903 [**Lepralia scutulata* Busk, 1855]. Discoid. Zooecia with small frontal area of numerous pores, no covering membrane. Ovicell and avicularia absent. *Rec.*——Fig. 146,*3*. **H. scutulata* (Busk), N.Atl.; ×25 (177).

Hincksipora Osburn, 1952 [**Mucronella spinulifera* Hincks, 1880]. Frontal a thick pleurocyst; ovicell endozooecial. *Rec.,* Bering Sea.——Fig. 147,*10*. **H. spinulifera* (Hincks), ×25 (204).

Trypostega Lev., 1909 [**Lepralia venusta* Norman, 1864]. Zooecia surmounted distally by small, elongate zooeciules; aperture keyhole-shaped, with cardelles. *Eoc.-Rec.*——Fig. 146,*2*. **T. venusta* (Norman), Rec., E.Atl.; ×25 (167).

Family EUTHYROIDIDAE Levinsen, 1909

[as Euthyroidae]

Zoaria free, *Flustra*-like. Zooecia slightly calcified, without pores or ectocyst. Large interzooecial avicularia. Ovicell hyperstomial, with ectoecium bearing a pair of large fenestrae (31). *Rec.*

Euthyroides Harmer, 1903 [**Carbasea episcopalis* Busk, 1852].——Fig. 146,*5*. **E. episcopalis* (Busk), SW.Pac.; ×50 (134).

Family UMBONULIDAE Canu, 1904

Like Petraliidae but with prominent umbo on zooecial front below aperture and median avicularium; cardelles and lyrules absent (Hastings, 1949). *Eoc.-Rec.*

Umbonula Hincks, 1880 [*pro Umbonella* Hincks, 1880 (*non* Adams, 1865)] [**Cellepora verrucosa* Esper, 1791]. Incrusting, unilamellar. Frontal a pleurocyst with costules separated by areolae. *Eoc.-Rec.*——Fig. 146,*7*. **U. verrucosa* (Esper), Rec., NE.Atl.; ×25 (137).

Hippopleurifera Canu, 1927 [**Eschara sedgwicki* M.Edw., 1838]. Like *Umbonula* but has minute hinge teeth and peristome with spines. *Mio.-Rec.*——Fig. 146,*8*. **H. sedgwicki* (M.Edw.), Plio. (Crag), Eng.; ×50 (136).

Family PETRALIIDAE Levinsen, 1909

[=Hippopodinidae Lev., 1909]

Zoaria unilaminate, radiculate. Zooecia large, with tremocyst of conspicuous pores. Proximal margin of apertures with 1 to 3 teeth (lyrules) above operculum and adjacent pair of cardelles; aperture encircled by a shield placed next to the tremocyst, a perforated area at distal extremity of each zooecial dorsal. Ovicell large, hyperstomial, recumbent, finely perforate (31; Stach, 1936). *M.Eoc.-Rec.*

Petralia MacGill., 1869 [**P. undata*]. Subcircular fenestrules. Ovicell deeply immersed in distal zooecium. Aperture circular without cardelles or lyrules but suboral mucro with avicularium present; shield a smooth pad around aperture, with 2 small lateral avicularia. *Rec.*——Fig. 147,*1*. **P. undata,* SW. Pac.; *1a,b,* ×20, ×33.3 (235).

Coleopora Canu-B., 1927 [**C. verrucosa*]. Zooecia exceptionally large, frontal a tremocyst with small pores; aperture at bottom of high flaring tube representing raised peristomial shield. Ovicell not closed by operculum. *Mio.-Rec.*——Fig. 147,*9*. **C. verrucosa,* Rec., SW.Pac.; ×25 (137).

Cycloperiella Canu-B., 1920 [**C. rubra*]. Frontal a tremocyst with large pores; ovicell entirely covering aperture. *Mio.-Rec.*——Fig. 147,*11*. **C. rubra,* Mio., N.Car.; ×25 (137).

Discopora Lamarck, 1816 [**Cellepora verrucosa* Lamarck, 1816; SD Gray, 1848] [=*Mucropetraliella* Stach, 1936]. Unilaminate, fenestrate. Zooecial front a tremocyst with mucro, bearing suboral avicularium; apertures subcircular, with cardelles and a lyrula. *Rec.*——Fig. 147,*3*. **D. verrucosa* (Lamarck), SW.Pac.; *3a,* ×25; *3b,* operculum, ×75 (235).

Hippopetraliella Stach, 1939 [**Lepralia dorsiporosa* Busk, 1884]. Unilaminate. A pair of cardelles placed close to the highly concave entire proximal rim. *Rec.*

H. (Hippopetraliella). Rim smooth. SW.Pac.——Fig. 147,*5*. **H. (H.) dorsiporosa* (Busk), SW. Pac.; ×25 (235).

H. (Serripetraliella) Stach, 1936 [**S. chuakensis hastingsae*].——Fig. 147,*6*. **H. (S.) hastingsae,* SW.Pac.; ×25 (235).

Hippopodina Lev., 1909 [**Lepralia feegeensis* Busk, 1884]. Zooecia large, inflated, granulose, with small tremopores; apertures large, elliptical, with pair of cardelles but no proximal teeth, elongate avicularia at each side. Ovicell deeply embedded, hyperstomial, large. *Eoc.-Rec.*——Fig. 147,*2*. **H. feegeensis* (Busk), S.Pac.; *2a,* ×25; *2b,* with ovicell, ×25 (181).

Pachycleithonia Canu-B., 1930 [**P. nigra*]. Primary orifice (aperture closed by operculum) distinct at surface. Gigantic zooecia with tremocyst; aperture with 2 large condyles, operculum very thick, colored black. *Rec.,* E.Pac.

Petraliella Canu-B., 1927 [**Escharella bisinuata* Smitt, 1873]. Unilaminate. Zooecial front regularly placed tremopores; aperture subcircular with pair of well-developed cardelles, 2 or more teeth on proximal border, and median lyrule; peristomial shield broad, not elevated. Ovicell not closed by

operculum. *Mio.-Rec.*——Fig. 147,*8*. **P. bisinuata* (Smitt), Rec., GulfMex.; ×50 (236).

Robertsonidra Osburn, 1952 [**Schizoporella oligopus* Robertson, 1896]. *Rec.*, E.Pac.——Fig. 147,*7*. **R. oligopus* (Robertson), ×65 (204).

Sinupetraliella Stach, 1936 [**Petralia litoralis* Livingstone, 1932]. Unilaminate. Zooecia with suboral mucro and lacking lyrule. *Mio.-Rec.*

Utinga Marcus, 1949 [**Mucronella castanea* Busk, 1884]. Like *Petraliella* but lacks the 2 large sinuses in proximal rim of aperture. *Rec.*——Fig. 147,*4*. **U. castanea* (Busk), SW.Atl.; ×20 (185).

Family GIGANTOPORIDAE Bassler, 1935

[=emend. Galeopsidae Jullien, 1904]
[=Tessaradomidae Jullien, 1903]

Incrusting, erect, cylindrical or bilamellar branches. Ovicell hyperstomial, opening into

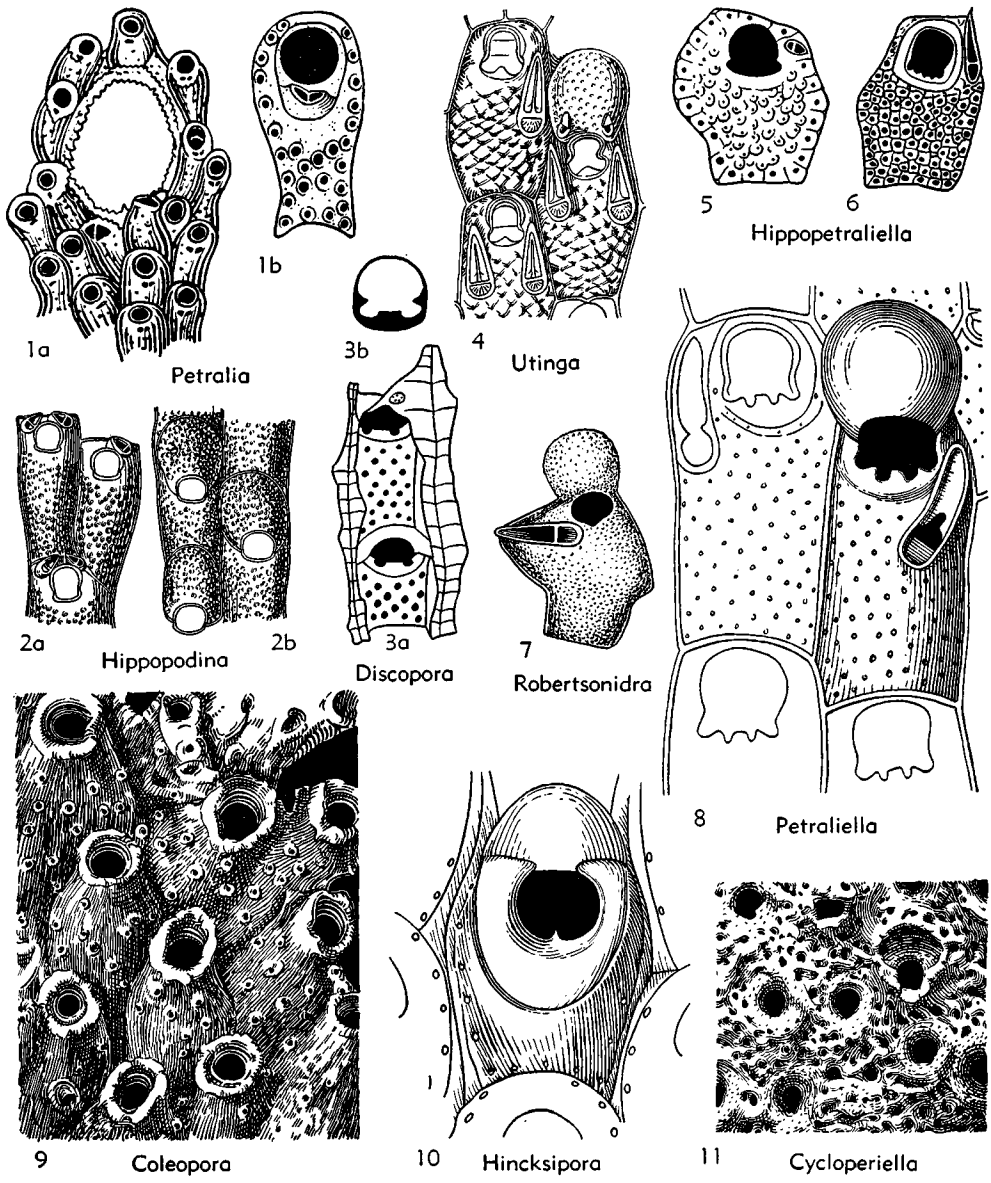


Fig. 147. Hippothoidae *(Hincksipora)*, Petraliidae (p. G196, G197).

peristomice above aperture. Characterized by large pore (spiramen) leading into the peristomie for passage of water going to the compensatrix. Pair of avicularia directed across aperture (24,31). *Cret.-Rec.*

Gigantopora RIDLEY, 1881 [**G. lyncoides;* SD CANU-B., 1917][=*Galeopsis* JULLIEN, 1903]. Incrusting to erect cylindrical branches. Frontal an olocyst; spiramen as large as aperture, the latter with rimule. *Cret.-Rec.*——FIG. 148,*1*. **G. lyncoides,* Rec., SW.Atl.; *1a,b,* ×25 (171).——FIG. 148,*2*. *G. rabidus* (JULLIEN), Rec., E.Atl.; ×25 (169).——FIG. 148,*3*. *G. pupa* JULLIEN, Rec., Pac.; ×25 (169).

Cosciniopsis CANU-B., 1927 [**C. coelatus*]. Incrusting. Ovicell closed by operculum and porous, like tremocyst frontal; aperture with cardelles placed low. *Eoc.-Rec.*——FIG. 148,*5*. **C. coelatus,* Rec., SW.Pac.; ×25 (137).——FIG. 148,*6*. *C. vestita* HINCKS, Rec., S.Pac.; ×25 (167).

Cylindroporella HINCKS, 1877 [**Lepralia tubulosa* NORMAN, 1868][=*Porinula* LEV., 1916]. Zooecia incrusting, with long tubular free peristomie bearing salient spiramen at its base; frontal tremocyst with stellate pores. No avicularia. *Rec.*——FIG. 149,*1*. **C. tubulosa* (NORMAN), N.Atl.; ×25 (167).

Dightonia BROWN, 1948 [**D. inarmata*]. Coarsely perforate frontal wall; aperture subcircular, with shallow, rounded median sinus; ovicell deeply immersed, with radiating, slitlike areolae. Avicularia and spines wanting. *Tert.*——FIG. 149,*3*. **D. inarmata,* M.Oligo., N.Z.; ×25 (133).

Gephyrophora BUSK, 1884 [**G. polymorpha*]. Incrusting. Zooecial front a tremocyst, aperture with proximal rimule. Prominent avicularium on each side of peristome pointing across aperture, in some meeting to form a bridge. *Oligo.-Rec.*——FIG. 149, *2*. **G. polymorpha,* Rec., S.Atl.; ×25 (230).

Hemicosciniopsis VIG., 1949 [**H. incrustans*]. Bilaminate. Zooecia with peristomie; aperture with 2 cardelles, different in form from ovicelled zooecium. *Mio.*——FIG. 149,*5*. **H. incrustans,* Aquit., Fr.; ×25 (224).

Pachystomaria MACGILL., 1895 [**P. parvipuncta*]. Unilaminate. Small spiramen near peristome; 2 oral avicularia, one large with curved pivot oriented distally, the other small, elliptical or triangular. *Tert.*——FIG. 148,*4*. **P. parvipuncta,* Mio., S.Austral.; ×25 (181).

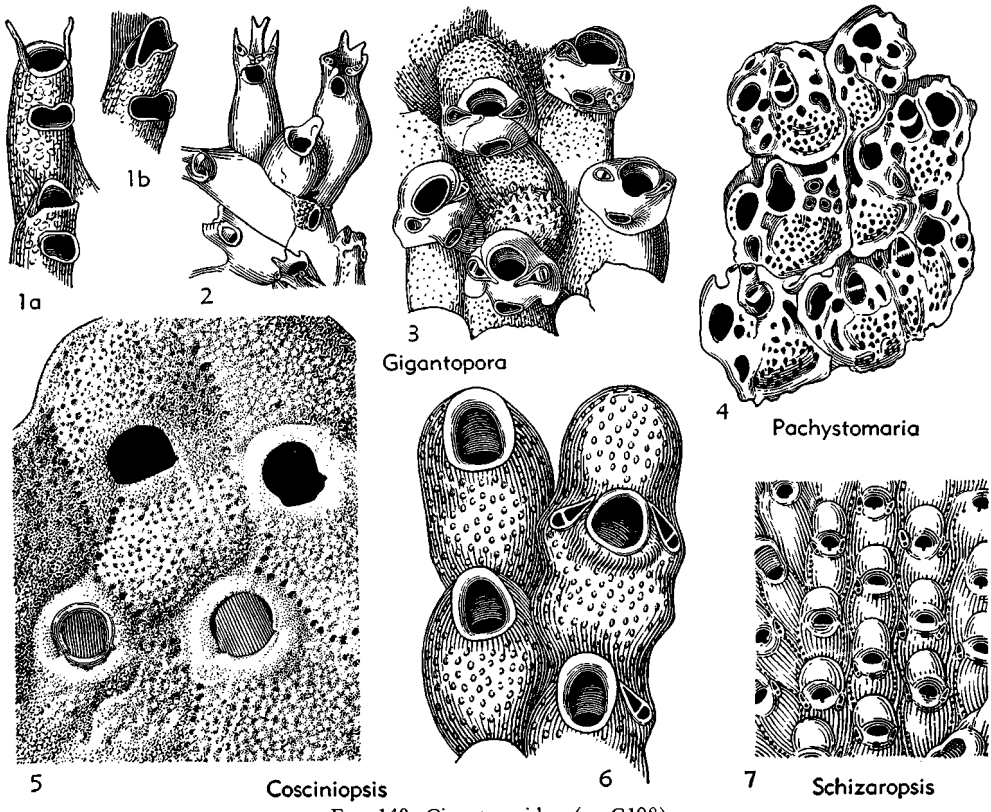


FIG. 148. Gigantoporidae (p. G198).

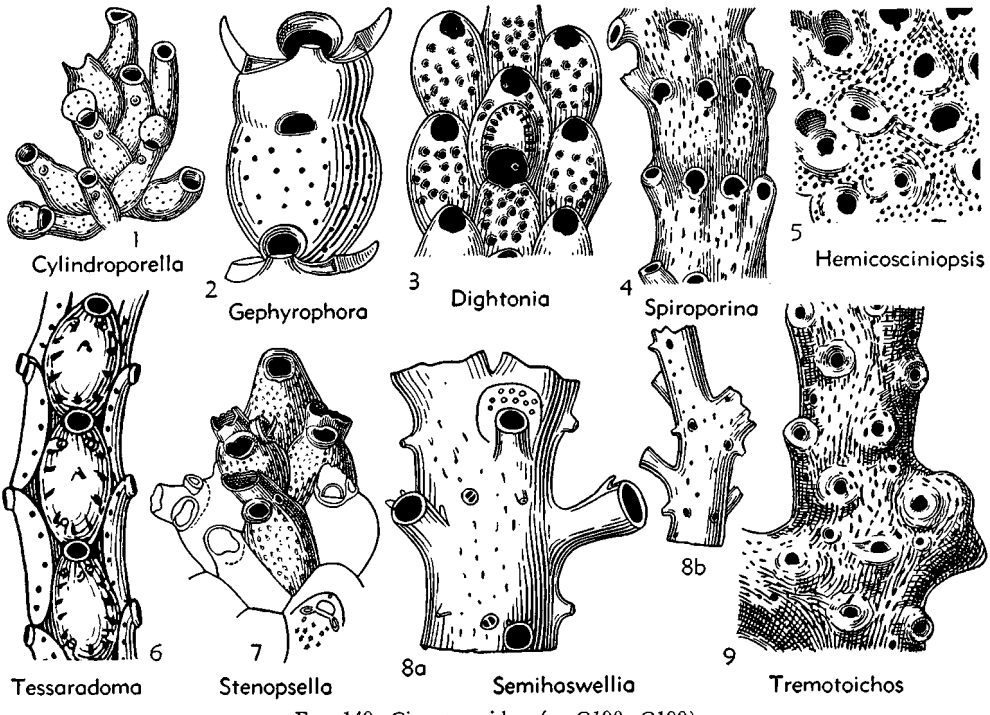


FIG. 149. Gigantoporidae (p. G198, G199).

Schizaropsis CANU-B., 1917 [**S. convexa*]. Zooecial front with small lateral areolae and pleurocyst; aperture with straight proximal border notched by narrow rimule; spiramen little visible, almost as large as peristomice. Two small avicularia. *Eoc.*——FIG. 148,*7*. **S. convexa,* Jackson., Miss.; ×25 (137).

Semihaswellia CANU-B., 1917 [**Porina proboscidea* WATERS, 1889]. Like *Spiroporina* but zooecia only on one side of cylindrical zoarium; both frontal and dorsal tremocyst with sulci but dorsal also with avicularia. *Eoc.-Rec.*——FIG. 149,*8*. **S. proboscidea* (WATERS), Rec., W.Indies; *8a,b,* ×25, ×10 (230).

Spiroporina STOLICZKA, 1864 [**S. vertebralis* (=*Myriozoum australiense* HASWELL, 1880)] [=*Haswellia* BUSK, 1884 (obj.); *Haswellina* LIVINGSTONE, 1928 (obj.)]. Zooecial front a thick tremocyst; aperture notched by very wide rimule; spiramen a small salient tube. *Tert.-Rec.*——FIG. 149,*4*. **S. vertebralis,* Tert., N.Z.; ×25 (134).

Stenopsella BASSLER, 1952 [*pro Stenopsis* CANU-B., 1927 (*non* RAF., 1815)] [**Porina fenestrata* SMITT, 1873]. Zooecial front a tuberose tremocyst; aperture subquadrangular, without cardelles; spiramen large, oval and salient; peristome elongated into tube. Small avicularia. *Eoc.-Rec.*——FIG. 149,*7*. **S. fenestrata* (SMITT), Rec., GulfMex.; ×25 (236).

Tessaradoma NORMAN, 1868 [**Pustulipora gracilis* SARS, 1850]. Erect branches. Zooecial front a pleurocyst with areolae; aperture with cardelles, operculum in opening closes spiramen. *Rec.*——FIG. 149,*6*. **T. gracilis* (SARS), N.Atl.; ×37.5 (167).

Tremotoichos CANU-B., 1917 [**T. rectifurcatum*]. Like *Semihaswellia* but spiramen rarely placed on zooecial median axis. *Eoc.*——FIG. 149,*9*. **T. rectifurcatum,* Claib., N.Car.; ×25 (137).

Family STOMACHETOSELLIDAE Canu & Bassler, 1917

[=Metrocryptidae VIG., 1949]

Erect, solid, cylindrical to narrow bifoliate branches. Zooecia generally with a thick tremocyst frontal built up around the simple apertural orifice (peristomice), which become notched by a rimule spiramen (sinus), in some guarded by small avicularia. Ovicell hyperstomial, embedded in the distal zooecium, opening in the peristomie above the aperture. No lyrule, cardelles or peristome with spines (28,31). *Eoc.-Rec.*

Stomachetosella CANU-B., 1917 [**S. crassicollis*]. Bifoliate branches. Tremocyst of wide-mouthed tubules. Ovicelled zooecia with a straighter rimule-

spiramen, ovicell entirely surrounding aperture. No avicularia. *Oligo.-Rec.*——Fig. 150,*1*. **S. crassicollis*, Oligo. (Vicksb.), Alaska; ×25 (137).

Cigclisula Canu-B., 1927 [**Escharoides occlusa* Busk, 1884]. Like *Stomachetosella* but with large sporadic interzooecial avicularia and special oral glands; ovicell frontal perforated by large grill-like pores. *Rec.*——Fig. 150,*2*. **C. occlusa* (Busk), SW.IndianO.; *2a,b*, ×25 (134).

Diastosula Canu-B., 1927 [**Myriozoum marionense* Busk, 1884]. Cylindrical branches. Frontal walls of zooecia very thick, smooth; aperture oval, with wide pseudorimule bordered by 2 peristomial avicularia. Ovicell bears triangular area bordered by pores. *Rec.*——Fig. 150,*4*. **D. marionense* (Busk), NW.Atl.; ×25 (134).

Enoplostomella Canu-B., 1917 [**E. defixa*]. Like *Stomachetosella* but cylindrical stems bear ovicells not entirely surrounding peristomice, so that a small avicularium occurs in the peristomie. *Oligo.-Rec.*——Fig. 150,*9*. **E. defixa*, Oligo.(Vicksb.), Ala.; ×25 (137).

Leiosella Canu-B., 1917 [**L. rostrifera*]. Like *Stomachetosella* but frontal is an olocyst, and peristomie of ovicelled zooecia is a lunar crescent without rimule-spiramen. *Oligo.-Rec.*——Fig. 150, *6*. **L. rostrifera*, Oligo.(Vicksb.), Ala.; ×25 (137).

Metradolium Canu-B., 1917 [**M. dissimile*]. Like *Stomachetosella* but ovicelled zooecia differ in form from others in having a peristomice like a lunar crescent, without rimule-spiramen. *Eoc.*——Fig. 150,*7*. **M. dissimile*, Claib., N.Car.; ×25 (137).

Metrocrypta Canu-B., 1917 [**M. bucculenta*]. Cylindrical bifurcated stems. Frontal a tremocyst with tubules; rimule-spiramen wide, shallow. *Eoc.*——Fig. 150,*5*. **M. bucculenta*, Claib., N.Car.; ×25 (137).

Ochetosella Canu-B., 1917 [**O. jacksonica*]. Narrow cylindrical branches. Frontal an olocyst with lateral areolae, covered by a pleurocyst; rimule-spiramen a small canal supported by a peristomial projection. *Eoc.*——Fig. 150,*10*. **O. jacksonica*, Claib., N.Car.; ×25 (137).

Pachyegis Osburn, 1952 [**Porella princeps* Norman, 1903]. Incrusting; proximal border without sinus. *Rec.*, N.Pac.——Fig. 150,*12*. **P. princeps*, ×30 (204).

Posterula Jullien, 1903 [**Escharoides sarsi* Smitt, 1867]. Zooecial front a thick pleurocyst with areolar pores; peristomice with pseudorimule surrounded by avicularia. Ovicell concealed, closed by operculum. *Rec.*——Fig. 150,*8*. **P. sarsi* (Smitt), N.Atl.; ×25 (169).

Ragionula Canu-B., 1927 [**Eschara rosacea* Busk, 1856]. Short, branching stems. Zooecial front a thick granular pleurocyst; aperture semicircular with a pseudorimule bordered by small peristomial avicularium. *Rec.*——Fig. 150,*3*. **R. rosacea* (Busk), N.Atl.; ×25 (134).

Schizemiella Canu-B., 1917 [**S. claibornica*]. Bilamellar. Zooecia indistinct, with tremocystal front and schizoporellidan aperture with wide rimule and inconstant rimule-spiramen. *Eoc.*——Fig. 150, *11*. **S. claibornica*, Claib., Ala.; ×25 (137).

Family SCHIZOPORELLIDAE Jullien, 1903

[=Escharellidae Lev., 1909]

Generally incrusting. Aperture semilunar, with inferior border bearing a slit (rimule) giving access to the compensatrix. Ovicell hyperstomial, operculum semilunar (24). *Cret.-Rec.*

Schizoporella Hincks, 1877 [**Lepralia unicornis* Johnston, 1847] [=*Schizopodrella* Canu-B., 1917 (obj.)]. Frontal a tremocyst, avicularium on each side of aperture which bears a narrow rounded sinus (rimule). *Eoc.-Rec.*——Fig. 151,*6*. **S. unicornis* (Johnston), Rec., NE.Atl.; ×25 (167).

Arthropoma Lev., 1909 [**Flustra cecilii* Audouin, 1826; SD Canu-B., 1920]. Rimule straight, rectangular; operculum with mobile small tongue in middle of straight proximal border. *Eoc.-Rec.*——Fig. 151,*5*. **A. cecilii* (Audouin), Rec., Medit.; ×25 (167).

Characodoma Maple., 1900 [**C. halli*]. Elongate quadrate internodes with uniserial row of zooecia on each side. *Tert.*——Fig. 151,*8*. **C. halli*, Mio., S.Austral.; ×25 (137).

Cribella Jullien, 1903 (*non* Forbes, 1840) [**C. nova*]. Frontal tremocyst with small pores; aperture large, almost circular; rimule wide, indistinct. *Rec.*——Fig. 151,*4*. **C. nova*, NW.Atl.; ×25 (131).

Dakaria Jullien, 1903 [**D. chevreuxi*]. Like *Cribella* but rimule more distinct and not so wide. No avicularia. *Eoc.-Rec.*——Fig. 151,*7*. **D. chevreuxi*, Rec., SE.Atl.; ×25 (169).

Emballotheca Lev., 1909 [**Lepralia quadrata* MacGill., 1880]. Bifoliate. Tremocyst with large pores covering frontal and ovicell; apertures with cardelles and wide rounded rimule. Avicularia. *Eoc.-Rec.*——Fig. 151,*3*. **E. quadrata* (MacGill.), Rec., SW.Pac.; ×25 (177).

Escharina M.-Edw., 1836 [**Eschara vulgaris* Moll, 1803] [=*Mastigophora* Hincks, 1880; *Schizolavella* Canu-B., 1920 (obj)]. Laterally placed long thin avicularia. *Oligo-Rec.*——Fig. 152,*6*. **E. vulgaris* (Moll), Rec., Medit.-Atl., ×25 (167).

Gemelliporidra Canu-B., 1927 [**G. typica*]. Zoaria multilamellar. Zooecia very large, with coarse spiny tremocyst, apertures marked by a small poster and a very large orbicular anter; 2 irregular oral avicularia. *Pleisto.-Rec.*——Fig. 151,*9*. **G. typica*, Rec., GulfMex.; ×25 (137).

Hippodiplosia Canu, 1916 [**H. verrucosa*]. Bilamellar. Zooecial front a coarse tremocyst with

spines; avicularia and wide aperture with cardelles. *Eoc.-Rec.*——Fig. 151,*1*. **H. verrucosa*, Mio., Fr.; ×25 (136).

Phonicosia Jullien, 1888 [**P. jousseaumi*]. Like *Arthropoma* but with spines and without mobile tongue of operculum. *Eoc.-Rec.*——Fig. 152,*5*. **P. jousseaumi*, Rec., Straits Magellan; ×25 (137).

Schismoporella Gregory, 1893 [**Cellepora schizogaster* Reuss, 1847]. Aperture orbicular with large sinus; frontal with special pore. *Tert.*——Fig. 152, *1*. **S. schizogaster* (Reuss), Mio., Aus.; ×25 (210).

Schizobrachiella Canu-B., 1920 [**Hemeschara sanguinea* Norman, 1868]. Like *Schizoporella* but

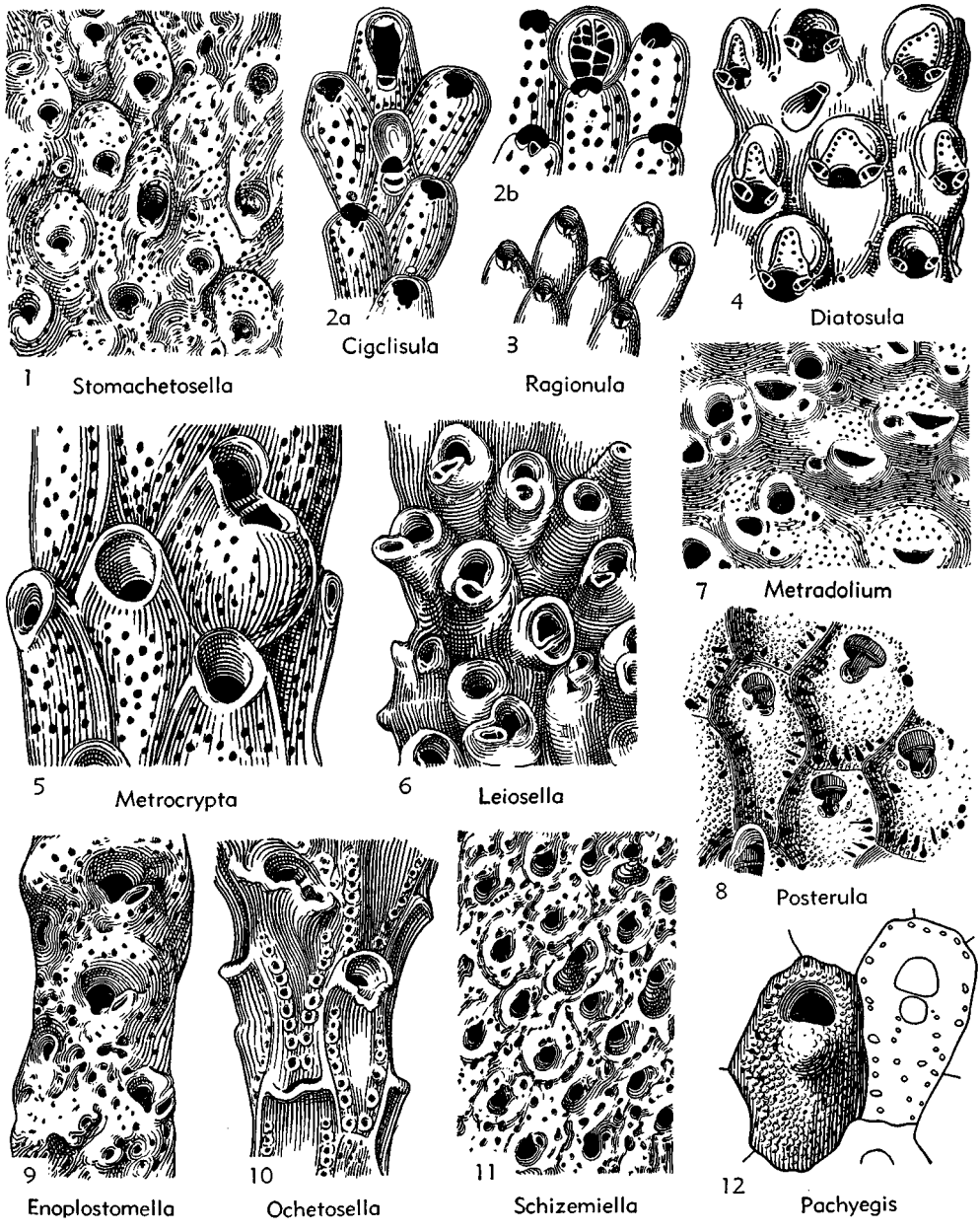


Fig. 150. Stomachetosellidae (p. G199, G200).

no avicularia. *Mio.-Rec.*——Fig. 152,7. **S. sanguinea* (Norman), Rec., NE.Atl.; ×25 (167).

Schizomavella Canu-B., 1917 [**Lepralia auriculata* Hassell, 1842]. Like *Schizoporella* but with median avicularium on frontal and small oral glands. *Eoc.-Rec.*

S. (Schizomavella) . *Eoc.-Rec.*, Br.I.

S. (Metroperiella) Canu-B., 1917 [**Schizoporella lepralioides* Calvet, 1903]. Ovicell surrounds aperture. *Eoc.-Rec.*——Fig. 152,2. **S. (M.) lepralioides* (Calvet), Rec., E.Atl.; ×25 (137).

Schizoporellopsis Maple., 1898 [**S. abnormis*]. Zooecia short with semicircular aperture followed by longer ones with sinus. *Tert.*——Fig. 151,2. **S. abnormis*, Mio., Austral.; ×40 (184).

Sphenella Duvergier, 1924 [**S. polymorpha*]. *Mio. (Helv.)*, Fr.

Stellatopora Livingstone, 1929 [**S. splendida*]. Like *Schizoporella* but with frontal wall perforated by stellate pores. *Rec.*, N.Z.

Stephanollona Duvergier, 1921 [**S. spinifera*]. Frontal a granular pleurocyst surrounded by areolar pores. *Mio.*——Fig. 152,3. **S. spinifera*, Helv., Fr.; 3*a*, ×25; 3*b*, dietellae, ×25 (148).

Stephanotrema Vig., 1949 [**Dakaria stricta* Duvergier, 1920]. Like *Dakaria* but with avicularia. *Mio.*, Fr.

Stylopoma Lev., 1909 [**Eschara spongites* Pallas, 1766]. Like *Schizoporella* but ovicell huge, entirely covering aperture and avicularia. *Mio.-Rec.*——Fig. 152,4. **S. spongites* (Pallas), Rec., Gulf Mex.; 4*a*,*b*, ×25 (4*a*, 177; 4*b*, 137).

Systenostoma Marsson, 1887 [**S. asperulum*]. Narrow, bifoliate, cylindrical zoaria with tremocyst frontal and keyhole apertures. *Cret.*

Family HIPPOPORINIDAE Bassler, 1935

[as Hippoporininae] [= Hippozeugosellidae Vig., 1949]

Zoarium mostly incrusting. Zooecial front generally an olocyst or pleurocyst; proximal

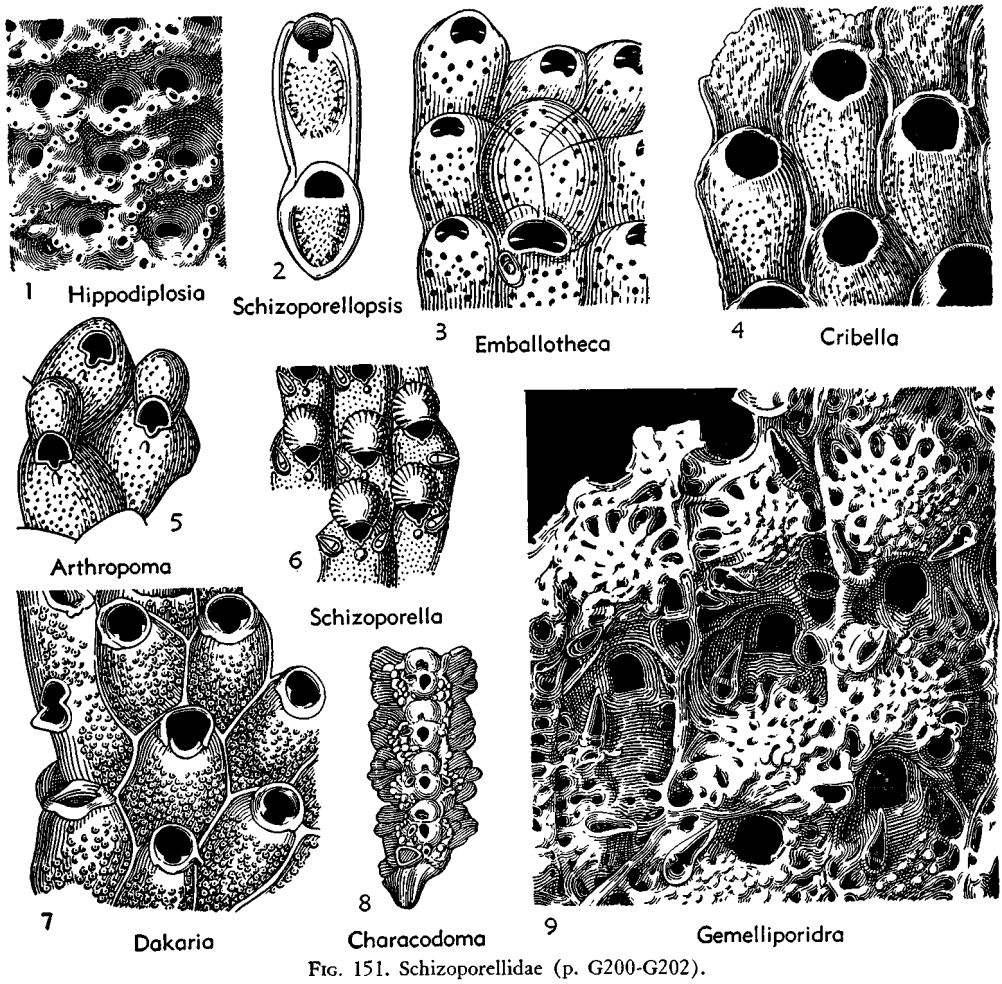


Fig. 151. Schizoporellidae (p. G200-G202).

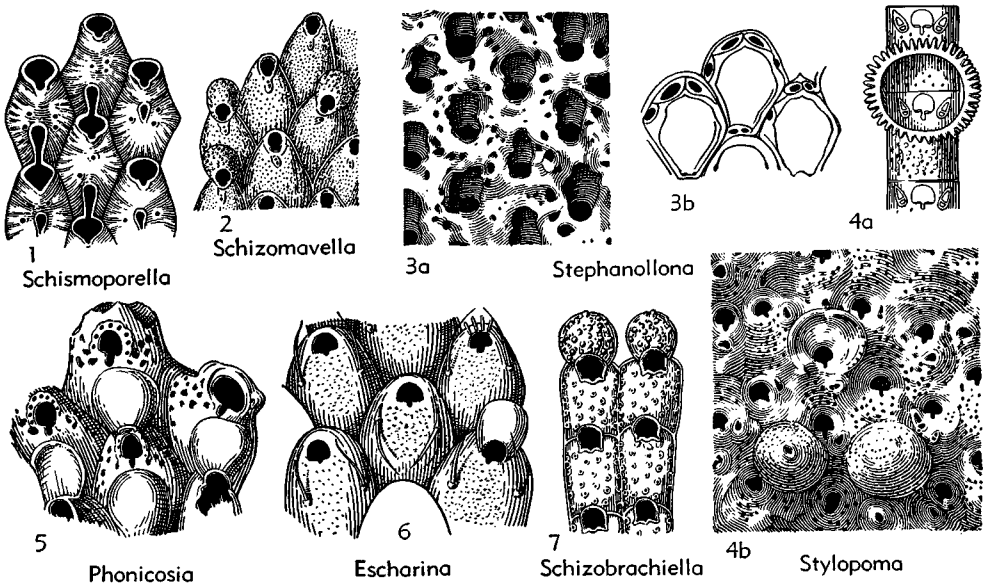


FIG. 152. Schizoporellidae (p. G200-G202).

border without sinus; aperture horseshoe-shaped with 2 lateral denticles (cardelles) serving as pivot for operculum. Ovicell hyperstomial. Compensation sac opens into poster of aperture (24). *Cret.-Rec.*

Hippoporina NEVIANI, 1895 [**Cellepora pertusa* ESPER, 1796; SD WATERS, 1918]. Frontal an olocyst; aperture elongate, with cardelles placed low. *Cret.-Rec.*——FIG. 153,*1*. *H. integra* NEVIANI, Pleisto., Italy; ×25 (196).

Aimulosia JULLIEN, 1888 [**A. australis*]. Frontal a pleurocyst with areolae; small avicularium adjacent to semilunar aperture. *Eoc.-Rec.*——FIG. 153,*2*. **A. australis*, Rec., S.Atl.; ×25 (169).

Bactridium REUSS, 1848 [**B. hagenowi*; SD D'ORB., 1852] [=*Hippozeugosella* CANU-B., 1917 (obj.)]. Zooecia biserial on one or both sides of the free, narrow branches. *Cret.-Rec.*——FIG. 153,*3*. **B. hagenowi*, Eoc., N.Italy; *3a,b*, ×25 (210).——FIG. 153,*4*. *B. arcuata* (CANU-B.), Eoc.(Jackson.), Miss., ×25 (137).

Balantiostoma MARSSON, 1887 [**Cellepora marsupium* HAG., 1846]. Olocyst frontal. *Cret.*——FIG. 153,*5*. **B. marsupium* (HAG.), Camp., Ger.; ×25 (186).

Buffonellodes STRAND, 1928 [*pro Buffonella* JULLIEN, 1888 (*non* KEFERSTEIN, 1868)] [**B. rimosa*]. Frontal and ovicell an olocyst; aperture with straight proximal border bearing small rimule and small avicularium in front. *Cret.-Rec.*——FIG. 153,*6*. **B. rimosa*, Rec., SW.Atl.; ×25 (169).

Chiastosella CANU-B., 1934 [**Schizoporella daedala* MACGILL., 1882]. Unilaminar. Zooecia with spines on distal margin of peristome, narrow subcircular sinus, double row of areolar pores, and 2 long laterally directed avicularia. *Tert.-Rec.*——FIG. 153,*7*. **C. daedala* (MACGILL.), SW.Pac.; *7a,b*, ×25, ×20 (181).

Clithriellum BROWN, 1948 [**C. oamurense*]. Free erect narrow branches with areolae and smooth frontal. *Tert.*——FIG. 153,*10*. **C. oamurense*, Oligo., N.Z.; ×10 (133).

Gemelliporella CANU-B., 1920 [**G. vorax* CANU-B., 1923]. Incrusting to narrow cylindrical branches. Zooecia with granular pleurocyst, aperture keyhole-shaped; operculum in locella. Ovicell deeply embedded in distal zooecium. *Mio.-Plio.*——FIG. 153,*11*. **G. vorax*, Mio., N.Car.; ×25 (137).

Gemelliporina BASSLER, 1936 [**Gemellipora glabra* SMITT, 1872]. Erect narrow cylindrical branches with frontal pleurocyst, keyhole-shaped aperture and no oral avicularia. *Mio.-Rec.*——FIG. 153,*12*. **G. glabra* (SMITT), Rec., GulfMex.; ×25 (131). [Gemelliporininae VIG., 1949].

Hippadenella CANU-B., 1917 [**Flustra margaritifera* QUOY & GAYMARD, 1833]. Frontal a thick pleurocyst with areolae and apertures; small median avicularium with glandlike body. *Mio.-Rec.*——FIG. 153,*14*. **H. margaritifera* (QUOY & GAYMARD), Rec., SW.Atl.; ×50 (137).

Hippomenella CANU-B., 1917 [**Lepralia mucronelliformis* WATERS, 1899]. Zoarium bilamellar. Frontal an olocyst with pleurocyst and areolar pores; oral spines and pair of pointed avicularia directed out-

ward. *Eoc.-Rec.*——Fig. 153,*8*. **H. mucronelliformis* (Waters), Rec., E.Atl.; ×25 (230).

Hippomonavella Canu-B., 1934 [**Lepralia praeclara* MacGill., 1895]. Frontal an olocyst with one row of areolar pores and apertures, cardelles placed low, an oral avicularium and ovicell porous. *Tert.-Rec.*——Fig. 154,*4*. **H. praeclara* (MacGill.), Tert., Austral.; ×25 (181).

Hippoporella Canu, 1917 [*Lepralia hippopus* Smitt, 1867] [=*Hippoponella* Canu-B., 1920 (obj.)]. Like *Hippoporina* but frontal has areolar pores. *Eoc.-Rec.*——Fig. 154,*5*. **H. hippopus* (Smitt), Rec., N.Atl.; ×25 (177).

Hippoporidra Canu-B., 1927 [**Cellepora edax* Busk, 1861] [=*Hippotrema* Canu-B., 1927]. Incrusting on gastropods, with accumulated zooecia; frontal with areolar pores; aperture keyhole-shaped, with strong cardelles; ovicell with distinct frontal area. *Mio.-Rec.*——Fig. 154,*1*. **H. edax* (Busk), Rec., NE.Atl.; *1a,b*, ×1, ×25 (134). ——Fig. 154,*2*. *H. janthina* Smitt, Rec., Gulf Mex.; ×25 (230).

Hipposera Vig., 1949 [**Hippodiplosia formosa* Duvergier, 1923]. Frontal a tremocyst with large pores, few avicularia, elliptical apertures with cardelles. *Mio.*——Fig. 154,*6*. **H. formosa* (Duvergier), Aquit., Fr.; ×25 (224).

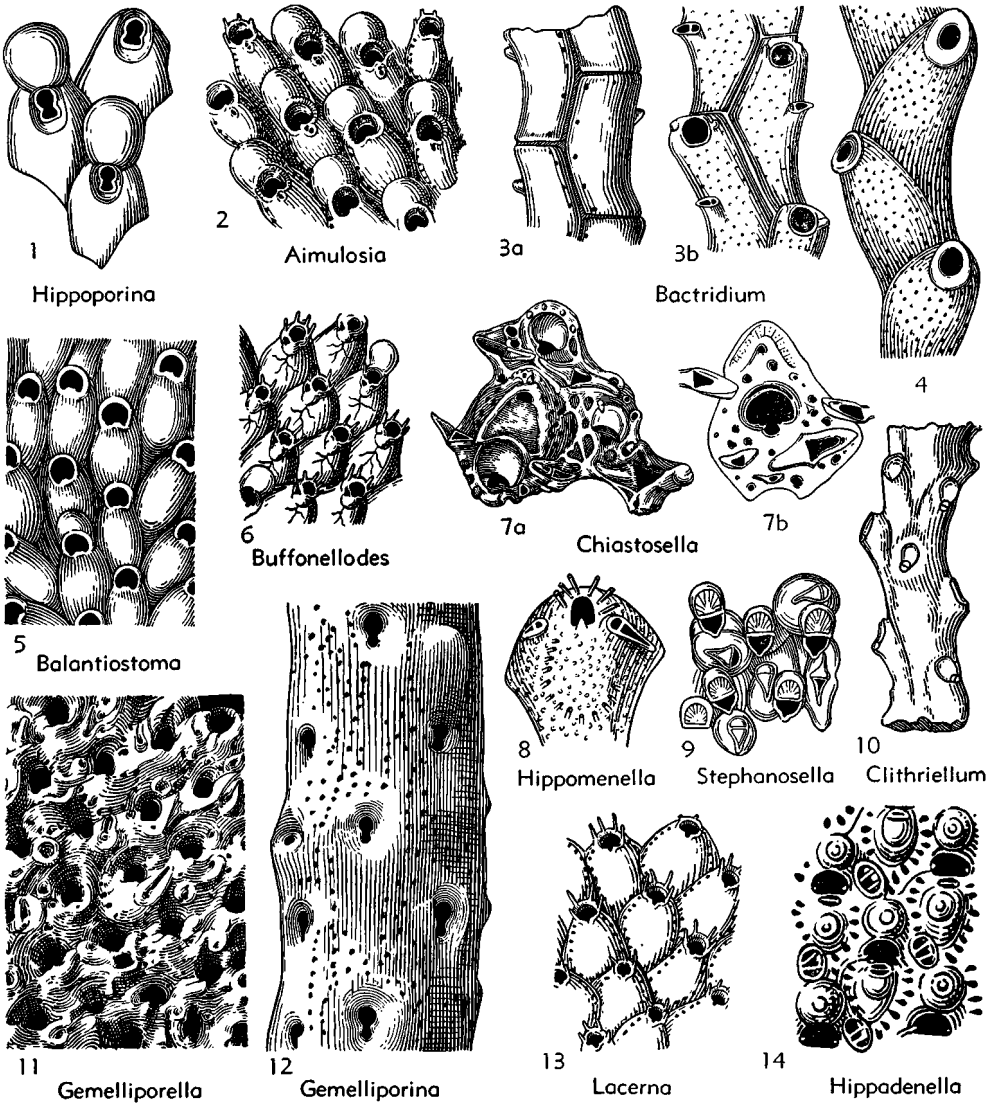


Fig. 153. Hippoporinidae (p. G203-G205).

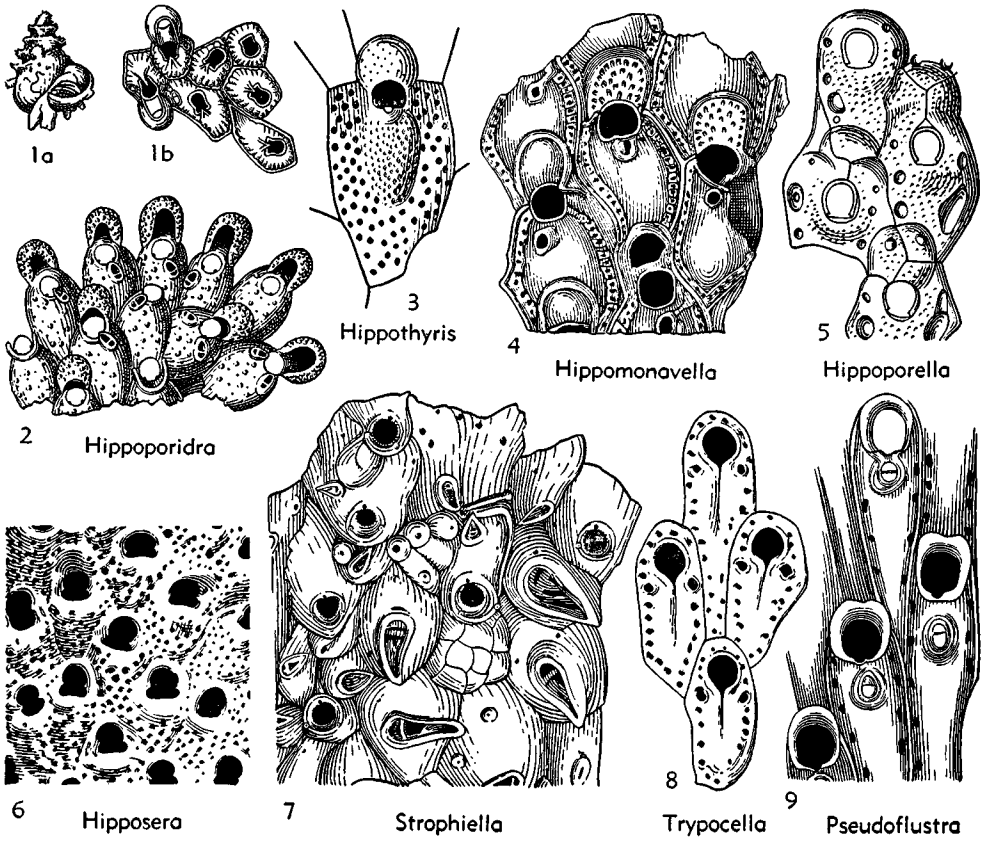


FIG. 154. Hippoporinidae (p. G204, G205).

Hippothyris OSBURN, 1952 [**H. emplasta*]. *Rec.*, E.Pac.——FIG. 154,*3*. **H. emplasta*, ×30 (204).

Lacerna JULLIEN, 1888 [**L. hosteensis*]. Frontal incomplete, pleurocyst with areolae; apertures with oral spines; no avicularia. *Eoc.-Rec.*——FIG. 153,*13*. **L. hosteensis*, Rec., SW.Atl.; ×25 (169).

Pseudoflustra BIDENKAP, 1897 [**Flustra solida* SIMPSON, 1853]. Narrow lamellar segments united by radicle fibers. Frontal an olocyst with a row of areolae and bearing a median avicularium. *Rec.*——FIG. 154,*9*. **P. solida* (SIMPSON), N.Atl.; ×25 (137).

Stephanosella CANU-B., 1917 [**Eschara biaperta* MICH., 1845][=*Buffonellaria* CANU-B., 1927]. Frontal a smooth olocyst with veinlike markings in young, thick and irregular in old age; ovicell radially sculptured; sinus broadly V-shaped; large lateral avicularium. *Eoc.-Rec.*——FIG. 153,*9*. **S. biaperta* (MICH.), Mio., Fr.; ×25 (167).

Strophiella JULLIEN, 19[illegible]3 [**S. tuberigera*]. Aperture with circular rim[illegible]e, interzooecial avicularium on ordinary zooecia and triangular on ovicelled ones. *Rec.*——FIG. 154,*7*. **S. tuberigera*, E.Atl.; ×25 (169).

Trypocella MAPLE., 1902 [**T. excavata*]. Elongate zooecia with orbicular aperture bearing acute sinus. *Tert.*——FIG. 154,*8*. **T. excavata*, Mio., Austral.; ×25 (184).

Family EXOCHELLIDAE Bassler, 1935

[as Exochellinae] [=Peristomellae CANU-B., 1917; Didymosellidae BROWN, 1952]

Aperture oblique, without lyrule, rimule or cardelles. Ovicell hyperstomial, embedded in distal zooecium, opening above oblique aperture and below frontal mucro in a chamber (locella) where the operculum operates (24). *Cret.-Rec.*

Exochella JULLIEN, 1888 [**Mucronella tricuspis* HINCKS, 1881; SD CANU, 1908]. Incrusting. Peristome with median and 2 lateral teeth, coalesced in some; frontal surrounded by areolae. Spines and generally an avicularium on one side. *Cret.-Rec.*

——Fig. 155,*1. E. longirostris* Jullien, Rec., SW. Atl.; ×25 (169).

Bathosella Canu-B., 1917 [**Mucronella aspera* Ulr., 1901]. Uni- and bilamellar. Zooecia indistinct, with frontal a thick olocyst more or less covered by pleurocyst; areolae rare. Avicularia simple, irregularly placed. No spines. *Cret.-Eoc.*——Fig. 155,*8. *B. aspera* (Ulr.), Eoc.(Wilcox.), Md.; ×25 (137).

Didymosella Canu-B., 1917 [**Lepralia larvalis* MacGill., 1869]. Unilamellar. Frontal with tremocyst and spines; 2 large pores open into zooecia under operculum. Large triangular transverse marginal avicularium with pivot. *Oligo.-Rec.*——Fig. 155,*3. **D. larvalis* (MacGill.), Rec., SW.Pac.; ×50 (181).——Fig. 155,*4. D. crassa* Canu-B., Oligo.(Vicksb.), Ala.; ×25 (137).

Escharoides M.Edw., 1836 [**Cellepora coccinea*

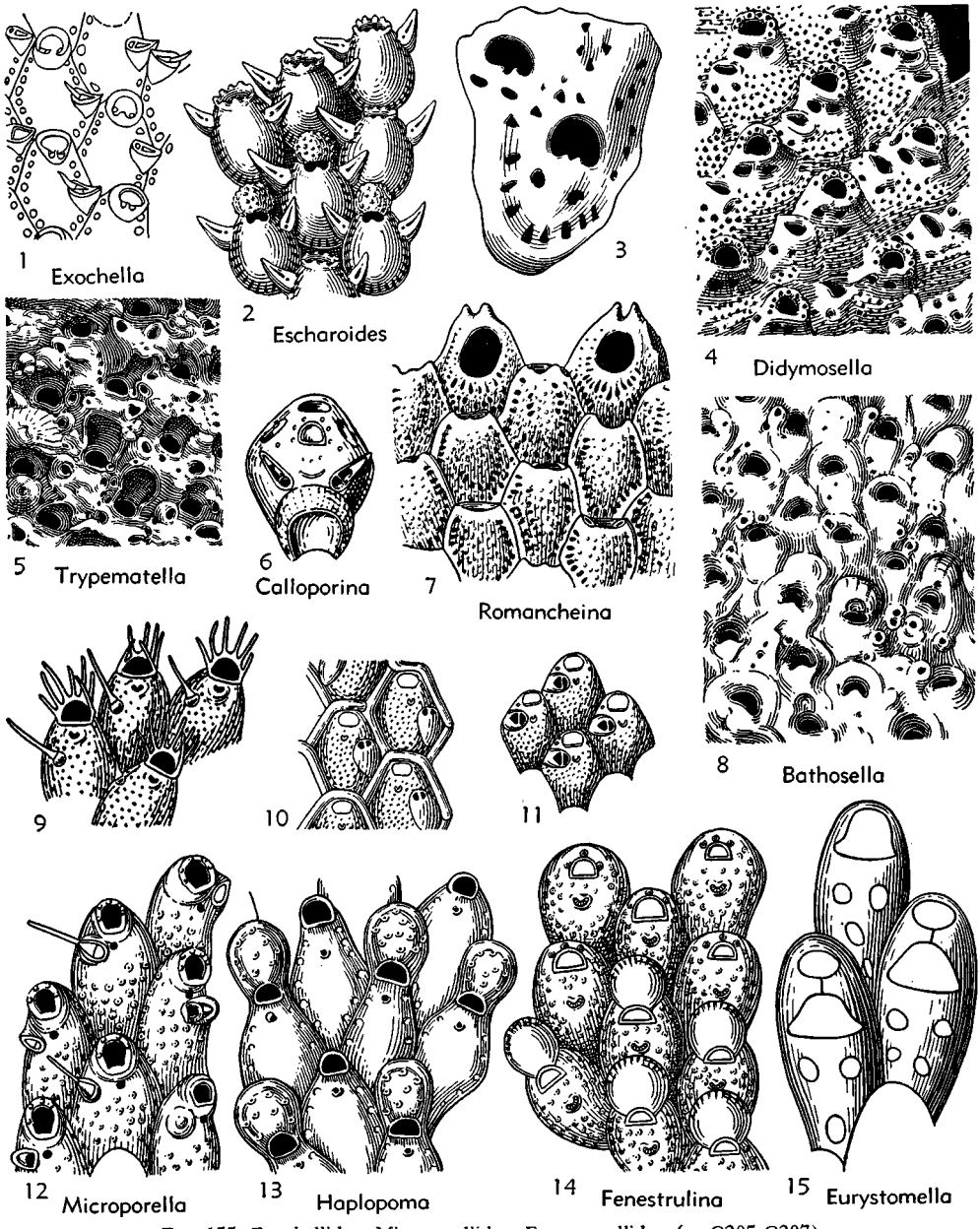


Fig. 155. Exochellidae, Microporellidae, Eurystomellidae (p. G205-G207).

ABILDGAARD, 1805; SD NORMAN, 1903] [=*Distansescharellina* D'ORB., 1852; *Escharoidea* MARTENS, 1885; *Peristomella* LEV., 1902 (obj.)]. Frontal with areolae and pleurocyst; mucro very salient, small and triangular; 4 distal spines on peristome. Large transverse avicularia. *Eoc.-Rec.* ——FIG. 155,*2*. **E. coccinea* (ABILDGAARD), Rec., N.Atl.; ×25 (137).

Romancheina JULLIEN, 1888 [**R. martiali*]. Incrusting. Frontal a tremocyst with small pores; ovicell much smaller than zooecia. Avicularia thin, transverse, triangular. *Eoc.-Rec.*——FIG. 155,*7*. **R. martiali*, Rec., SW.Atl.; ×25 (169).

Trypematella CANU-B., 1920 [**T. papulifera*]. Frontal with lateral areolar pores (pleurocyst on olocyst); 2 large avicularia below aperture. *Pleisto.* ——FIG. 155,*5*. **T. papulifera*, Calif.; ×25 (137).

Family MICROPORELLIDAE Hincks, 1880

Incrusting, bifoliate. Aperture more or less circular with straight, entire inferior border. Ovicell hyperstomial, closed by operculum. Orifice of compensatrix (ascopore, micropore, frontal pore) distinct, removed proximally from aperture (24,26). *Mio.-Rec.*

Microporella HINCKS, 1877 [**Eschara ciliata* PALLAS, 1766] [=*Bimicroporella* CANU, 1904]. Frontal with nonstellate tremopores, lateral avicularium, without lines of growth. Aperture semilunate; peristome with spines. Operculum semielliptical. *Mio.-Rec.*

M. (Microporella) . *Mio.-Rec.*——FIG. 155,*9*. **M. (M.) ciliata* (PALLAS), Rec., NE.Atl.; ×35 (167).

M. (Diporula) HINCKS, 1879 [**Eschara verrucosa* PEACH, 1873]. Horseshoe-shaped apertures. *Plio.-Rec.*——FIG. 155,*12*. **M. (D.) verrucosa* (PEACH), Rec., Atl.; ×25 (167).

M. (Ellipsopora) CANU-B., 1923 [**Eschara flabellaris* BUSK, 1852]. Transverse elliptical apertures. *Rec.*——FIG. 155,*11*. **M. (E.) flabellaris* (BUSK), SE.Atl.; ×25 (177).

M. (Flustramorpha) GRAY, 1848 [**Flustra marginata* KRAUSS, 1837]. Pouchlike vibracula and radicular fibers. *Rec.*——FIG. 155,*10*. **M. (F.) marginata* (KRAUSS), Rec., SE. Atl.; ×25 (177).

Calloporina NEVIANI, 1895 [**Cellepora decorata* REUSS, 1848]. Frontal with lateral areolar pores, pleurocyst, costules, avicularia and circular ascopore. *Mio.-Rec.*——FIG. 155,*6*. **C. decorata* (REUSS), Mio., Aus.; ×35 (177).

Fenestrulina JULLIEN, 1888 [**Cellepora malusii* AUDOUIN, 1826]. Frontal with stellate tremopores, no avicularia. *Mio.-Rec.*——FIG. 155,*14*. **F. malusii* (AUDOUIN), Rec., Medit.; ×25 (177).

Stephanopora KIRKPATRICK, 1888 [**S. cribrispinata*]. Secondary cribriform roof formed by broad branched processes given off from peristome and walls. *Rec.*

Family EURYSTOMELLIDAE Levinsen, 1909

Incrusting. Zooecia strongly calcified, thick-walled, without covering membrane, spines, or avicularia but with several large openings (fenestrae). Ovicell a kenozooecium, with large uncalcified part in the frontal wall (30). *Pleisto.-Rec.*

Eurystomella LEV., 1909 [**Lepralia foraminigera* HINCKS, 1883; SD CANU-B., 1923].——FIG. 155, *15*. **E. foraminigera* (HINCKS), Rec., S.Pac.; ×50 (177).

Family MUCRONELLIDAE Levinsen, 1902

[=Smittinidae LEV., 1909; Phoccanidae VIG., 1949]

Incrusting, lamellar to bilaminate. Zooecial front generally perforate only around margin, with oral spines commonly present, peristome produced and channeled in front. Ovicell hyperstomial, embedded in distal zooecium, opening in the peristomie. Protecting organ guarding entrance to the compensation sac occurs in the aperture (lyrula) or close to the peristomie (mucron). Peristomial median avicularium present (Fig. 156) (24). *Cret.-Rec.*

Mucronella HINCKS, 1880 [**Lepralia peachi* JOHNSTON, 1847]. Incrusting. Like *Smittina* but lyrula is present in place of an avicularium. *Eoc.-Rec.* ——FIG. 158,*5*. **M. peachi* (JOHNSTON), Rec., E. Atl.; ×35 (167).

Bryocryptella COSSMAN, 1906 [*pro Cryptella* JULLIEN, 1903 (*non* WEBB & BERTHELOT, 1833)] [**Cryptella torquata* JULLIEN, 1903]. Erect narrow branches with claviform zooecia on one side only. Frontal a pleurocyst with minute areolae but no ribs; apertures with median avicularium but no lyrula or cardelles. *Rec.*——FIG. 157,*2*. **B. torquata* (JULLIEN), E.Atl.; ×25 (200).

Codonellina CANU-B., 1934 [*pro Codonella* CANU-B., 1927 (*non* HAECKEL, 1873)][**Lepralia galeata* BUSK, 1854]. Frontal a tremocyst with ovicell porous and marginated. Median avicularium before aperture which is orbicular and with 2 false cardelles; oral glands. *Rec.*——FIG. 157,*3*. **C. galeata* (BUSK), S.Atl.; ×20 (134).

Cryptostomella BASSLER, *nom. nov.* [*pro Cryptostoma* MARSSON, 1887 (ref. 96, p. 96) (*non* BLAINV., 1818)] [**Cryptostoma gastroporum* MARSSON, 1887]. *Cret.*——FIG. 158,*4*. **C. gastroporum* (MARSSON), Camp., Ger.; ×20 (186).

Cyphonella KOSCHINSKY, 1885 [**C. nodosa*]. Slen-

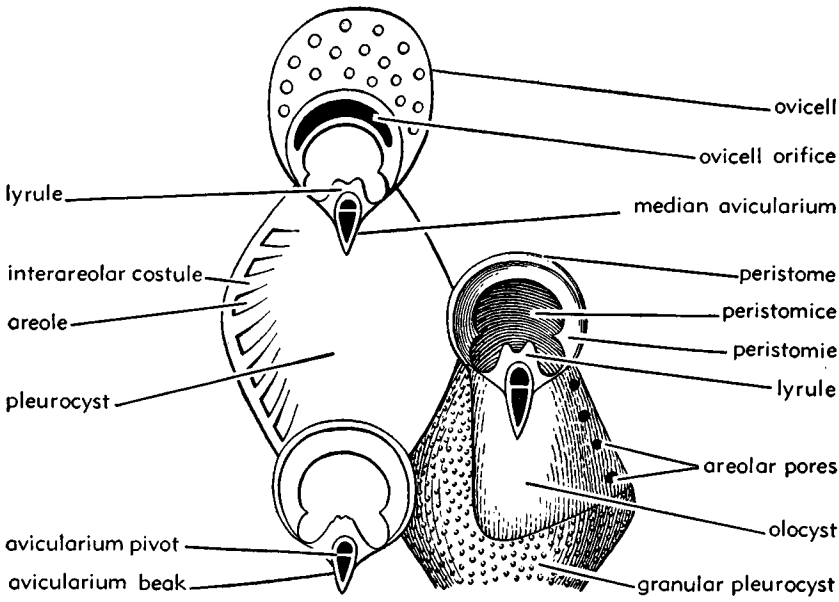


FIG. 156. Morphological features of the Mucronellidae.

der rods. Zooecia with strong frontal tremopores. *Eoc.*——FIG. 157,*9*. **C. nodosa*, Lut., Ger.; ×25 (172).

Cystisella CANU-B., 1917 [**Eschara saccata* BUSK, 1856]. Erect branches and incrusting. Zooecial frontal an olocyst covered by a long avicularian chamber containing a pair of large glands. *Eoc.-Rec.*——FIG. 157,*5*. **C. saccata* (BUSK), Rec., Atl.; ×25 (177).

Hemicyclopora NORMAN, 1894 [**Lepralia polita* HINCKS, 1880]. Cardelles placed low, olocyst and spines present. *Mio.-Rec.*——FIG. 157,*11*. **H. polita* (HINCKS), Rec., NE.Atl.; ×25 (167).

Hemismittina VIG., 1949 [**Porella regularis* REUSS, 1865]. Differs from *Smittina* in absence of lyrula and peristomial notch and in having a large avicularian chamber. *Mio.*, Ger.

Jaculina JULLIEN, 1903 [**J. blanchardi*]. Like *Retepora* but with single row of zooecia; frontal olocyst. *Rec.*, Azores.

Malleatia JULLIEN, 1903 [**M. rara*]. Like *Jaculina* but zooecial front with minute pores and small avicularia. Lyrula and rimule with small triangular avicularium present. *Rec.*——FIG. 158,*3*. **M. rara*, E.Atl.; *3a,b*, ×25 (169).

Marguetta JULLIEN, 1903 [**M. pulchra*]. Free, bilamellar. Frontal bordered by areolar pores; no lyrula or cardelles; aperture entire, mucronate, with median avicularium. *Eoc.-Rec.*——FIG. 158,*7*. **M. pulchra*, E.Atl.; ×25 (169).

Palmicellaria ALDER, 1864 [**P. elegans*]. Slender erect branches with elongate zooecia bearing thick high peristome, granular pleurocyst, frontal and areolar pores but no lyrula or cardelles. *Mio-Rec.*——FIG. 157,*12*. **P. elegans*, N.Atl.; ×10 (167).

Parasmittina OSBURN, 1952 [**Lepralia jeffreysi* NORMAN, 1876]. Frontal a pleurocyst, avicularium median, lyrula well developed, porous ovicell. *Mio.-Rec.*

Phoceana JULLIEN, 1903 [**P. columnaris*]. Slender branches. Semicircular apertures with high peristome serving as a pseudolyrula; no cardelles. ?Ovicell. *Eoc.-Rec.*——FIG. 157,*4*. **P. columnaris*, Rec., E.Atl.; ×25 (169).

Plagiosmittia CANU-B., 1917 [**P. regularis*]. Narrow bilamellar fronds. Zooecia in parallel longitudinal rows, frontal tremocyst and median avicularium in peristomie. *Eoc.-Oligo.*——FIG. 157,*10*. **P. regularis*, Eoc.(Claib.), N.Car.; *10a,b*, ×25 (137).

Porella GRAY, 1848 [**P. cervicornis* (=*Millepora compressa* SOWERBY, 1805)][=*Marsillea* NEVIANI, 1895 (obj.); *Levinseniula* COSSMAN, 1920]. Like *Smittina* but frontal is an olocyst or pleurocyst with median suboral avicularium; lyrula and cardelles absent. Ovicell imperforate. *Eoc.-Rec.*——FIG. 157,*7*. **P. compressa* (SOWERBY), Rec., N.Atl.; ×25 (167).

Rhamphostomella VON LORENZ, 1886 [**R. costata*]. Incrusting. Frontal an olocyst with costules; asymmetrical sinus with lyrula. Large oblique salient avicularium before aperture. *Eoc.-Rec.*——FIG. 158,*6*. **R. costata*, Rec., N.Atl.; ×35 (137).

Rimulostoma VIG., 1949 [**Peristomella costulata* DUVERGIER, 1920. Incrusting. Frontal a costulate pleurocyst; aperture orbicular with proximal rim-

ule. *Mio.*——Fig. 157,*6*. **R. costulata* (Duvergier), Burdig., Fr.; ×25 (224).

Schizosmittina Vig., 1949 [**S. planovicellata*]. Zoarium bifoliate. Frontal tremocyst; compensation sac opens by rimule in peristomie. *Tert.*——Fig. 158, *1*. **S. planovicellata,* Mio.(Helv.), Fr.; ×25 (224).

Smittina Norman, 1903 [*pro Smittia* Hincks, 1879 (*non* Holmgren, 1869)][**Lepralia landsborovii* Johnston, 1847]. Frontal a granular or costate pleurocyst with marginal areolae or a tremocyst; lyrula and cardelles well developed; suboral median avicularium. Ovicell with pores. *Eoc.-Rec.*

S. (Smittina). *Eoc.-Rec.*——Fig. 157,*1*. **S. landsborovii* (Johnston), Rec., NE.Atl.; ×25 (167).

S. (Reussia) Neviani, 1895 [**Eschara regularis* Reuss, 1865]. *Tert.*, Ger.

Smittinella Canu-B., 1934 [**Eschara tatei* T.-Woods, 1877]. Like *Smittina* but proximal sinus of peristomice covered by peristome which thus is pierced by a spiramen. *Tert.*——Fig. 158,*8*. **S. tatei* (T.-Woods), Mio., S.Austral.; ×25 (131).

Smittoidea Osburn, 1952 [**Lepralia reticulata* Johnston, 1847]. Frontal a pleurocyst with areolae; well-developed lyrula and median suboral avicularium; ovicell with pores. *Mio.-Rec.*——Fig. 157, *8*. **S. reticulata* (Johnston), Rec., Atl.; ×25 (137).

Vibraculina Neviani, 1895 [**V. conti*]. Stout

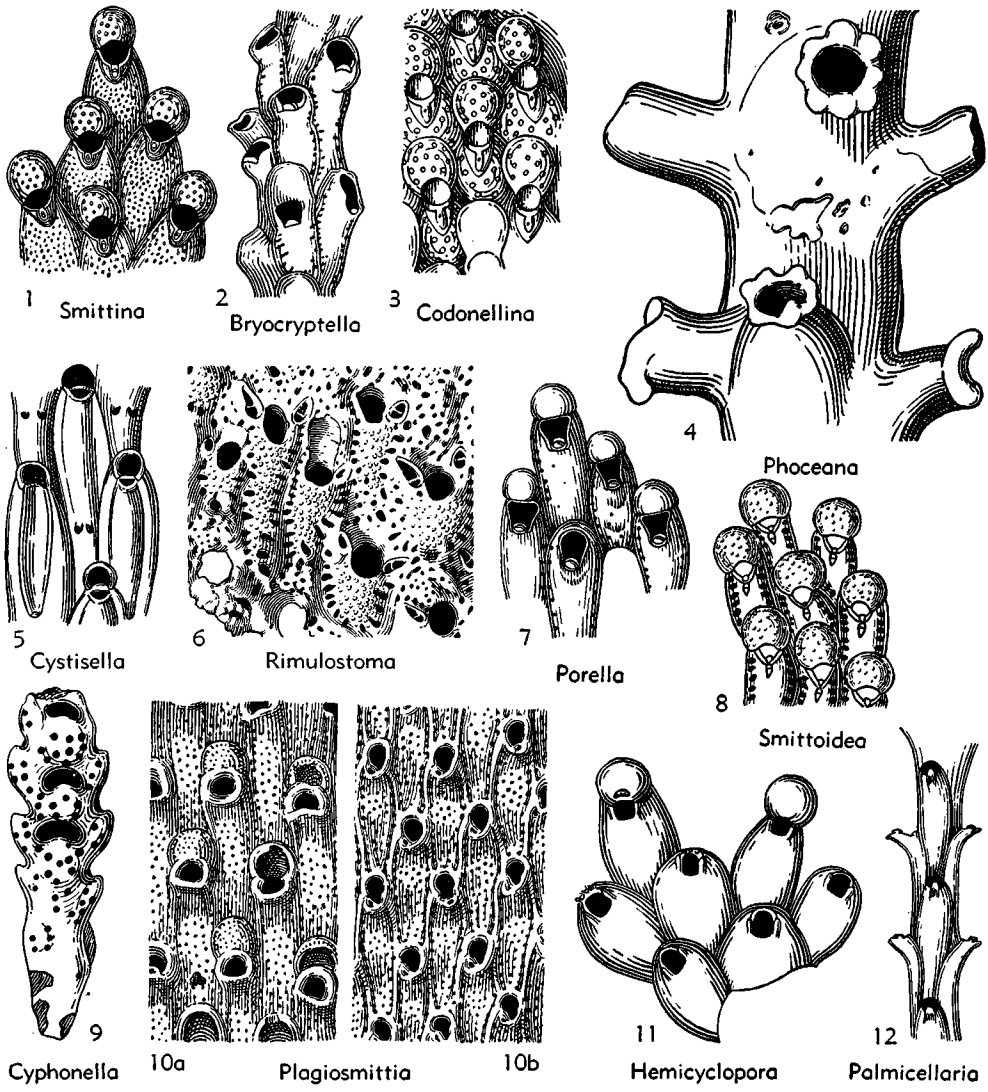


Fig. 157. Mucronellidae (p. G207-G209).

branches, large zooecia and median avicularia. *Tert.*——Fig. 158,2. **V. conti,* Plio., Italy; ×25 (196).

Family TUBUCELLARIIDAE Busk, 1884

Zoaria erect, cylindrical or bilamellar, commonly jointed, radiculate. Zooecia tubular, with much produced peristomie; thick-walled porous zooecial front pierced by an ascopore; avicularia rare. Ovicell peristomial, formed by swelling of the much elongated peristomie (24). *Eoc.-Rec.*

Tubucellaria d'Orb., 1853 [**Cellaria cereoides* Ellis-S., 1786]. Articulated, erect cylindrical segments. Zooecia with frontal ascopore just proximal

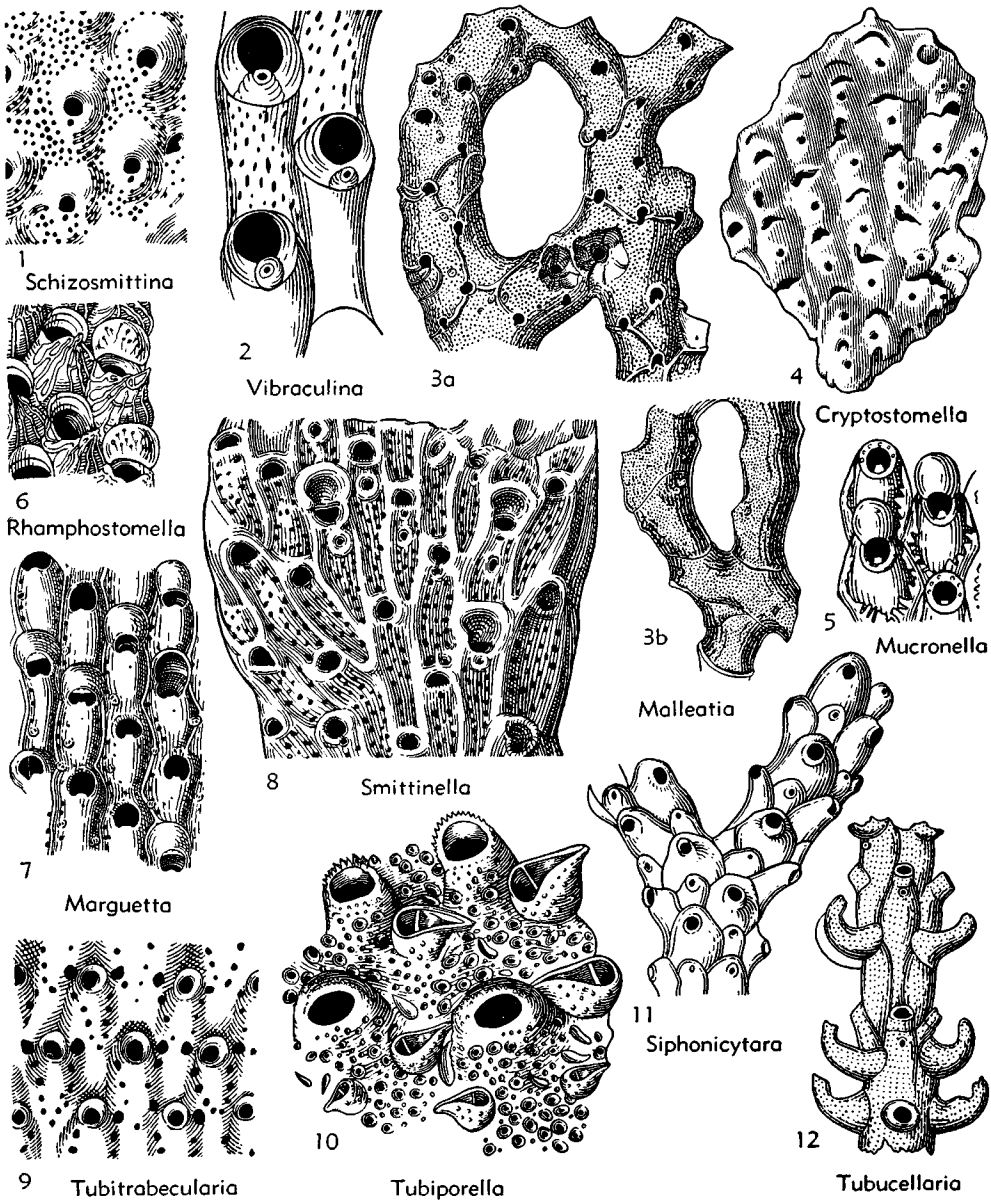


Fig. 158. Mucronellidae, Tubucellariidae (p. G207-G211).

to long peristomie. No avicularia. *Eoc.-Rec.*——FIG. 158,*12*. **T. cereoides* (ELLIS-S.), Rec., Medit.; ×10 (230).

Siphonicytara BUSK, 1884 [**S. serrulata*]. Continuous quadriserial branches. Zooecia flattened, with extended tubular peristomies and a circular median pore. *Rec.*——FIG. 158,*11*. **S. serrulata*, E.Indies; ×10 (134).

Tubiporella LEV., 1909 [**Lepralia magnirostris* MACGILL., 1883]. Foliaceous unilamellar expansions. Large avicularium at level of ascopore on each zooecium. *Tert.-Rec.*——FIG. 158,*10*. **T. magnirostris* (MACGILL.), Rec., SW.Pac.; ×25 (181).

Tubitrabecularia CANU-B., 1934 [**Eschara elevata* T.-WOODS, 1876]. Branched. Frontal an olocyst with peristomies strengthened by a trabecular network. *Tert.*——FIG. 158,*9*. **T. elevata* (T.-WOODS), Mio., Austral.; ×25 (137).

Tubucella CANU-B., 1917 [**Eschara mammillaris* M.EDW., 1836]. Zoarium fixed bilamellar. Peristomiale equal in length to frontal. Avicularia rare. *Eoc.*, Fr.

Family RETEPORIDAE Smitt, 1867

[=Sertellidae JULLIEN, 1903; Lepraliellidae VIG., 1949]

Zoarium generally erect or reticulate, not jointed. Zooecial front with row of areolar pores; peristomie well developed bearing rimule or spiramen (reteporidan pores); oral avicularia and spines. Projections (vibices) on back not connected with zooecia.

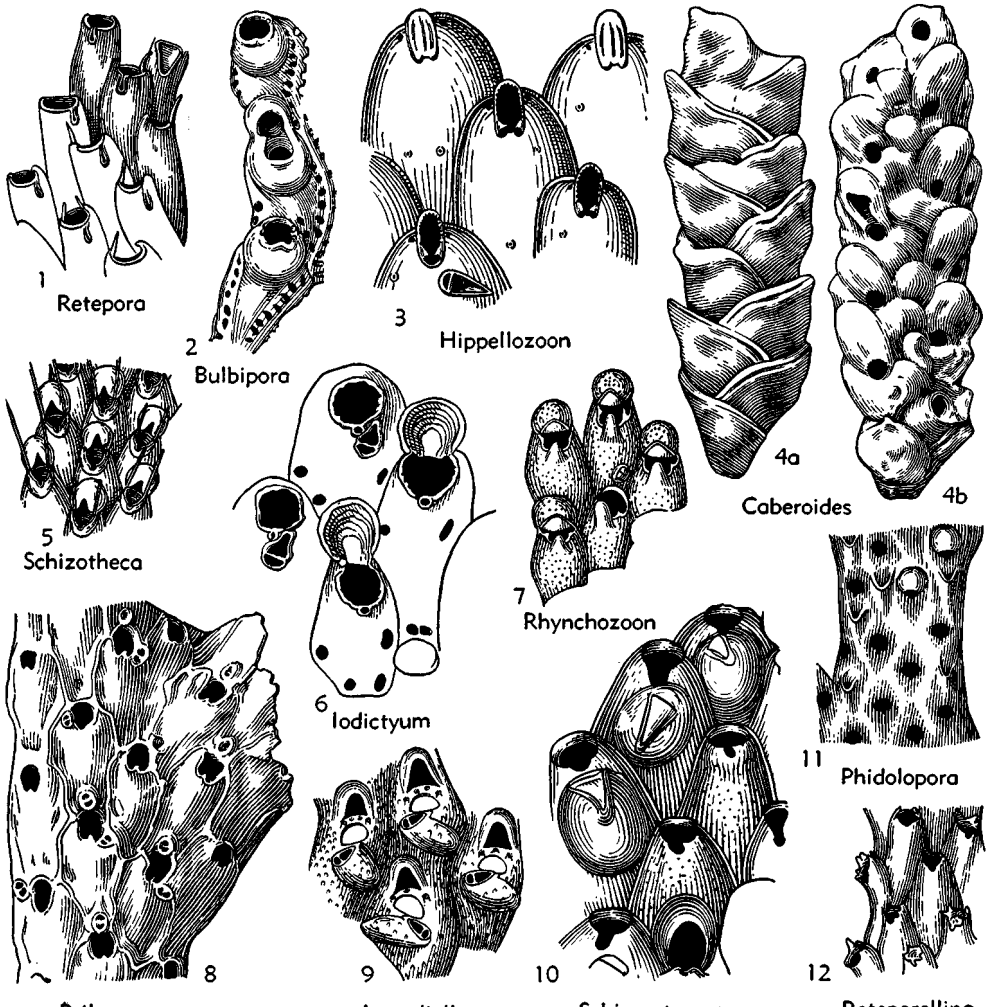


FIG. 159. Reteporidae (p. G212, G213).

Ovicell hyperstomial, deeply immersed in distal part of zooecium, opening widely or by a slot in the peristomie. (24,26,70). *Cret.-Rec.*

Retepora LAMARCK, 1801 [**Millepora cellulosa* LINNÉ, 1767][=*Elasmopora* KING, 1848 (obj.)]. Narrow, nonanastomosed branches arising from expanded base. Aperture entire, peristomie bearing a deep rimule-spiramen. Ovicell with a simple fissure. *Eoc.-Rec.*——FIG. 159,*1*. **R. cellulosa* (LINNÉ), Rec., N.Atl.; ×25 (167).

Bulbipora MACGILL., 1895 [**B. areolata*]. Incrusting. Ovicells wide open, smooth; areolae well marked. *Tert.*——FIG. 159,*2*. **B. areolata,* S.Australl.; ×25 (181).

Caberoides CANU, 1908 [**C. canaliculata*]. Zoarium jointed. Zooecia biserial, with row of vibracula on front and elongate vibracula only on back. *Eoc.*——FIG. 159,*4*. **C. canaliculata,* Lut., Fr.; *4a,b,* back, front, ×25 (136).

Diplonotos CANU-B., 1930 [**D. costulatum*]. Reticulate, both sides covered by vibices, zooecia located on edge of branches. *Rec.*——FIG. 160,*5*. **D. costulatum,* E.Pac.; ×25 (137).

Hippellozoon CANU-B., 1917 [**Retepora novaezelandiae* WATERS, 1895]. Fenestrate. Zooecial apertures with 2 cardelles; labial avicularium and reteporidan pore absent. *Rec.*——FIG. 159,*3*. **H. novaezelandiae* (WATERS), N.Z.; ×25 (230).

Hippopozoon CANU-B., 1929 [**H. typicum*]. Like *Hippellozoon* but incrusting and with oral avicularium. *Eoc.*——FIG. 160,*8*. **H. typicum,* Belg.; ×25 (137).

Iodictyum HARMER, 1933 [**Retepora phoenicea* BUSK, 1854]. Fenestrate. Ovicell with projecting lip (labellum) bearing a median keel. *Rec.*——FIG. 159,*6*. **I. phoenicea* (BUSK), SW.Pac.; ×50 (164).

Lepraliella LEV., 1916 [**Cellepora ramulosa contigua* SMITT, 1867]. Zooecia with vestibular spine-bearing arch; aperture with cardelles; frontal a tremocyst. Ovicell widely open. *Rec.*——FIG. 159, *9*. **L. contigua* (SMITT), Balt.; ×25 (177).

Phidolopora GABB-H., 1862 [**P. labiata*]. Reticulate. Frontal an olocyst; aperture semilunar, with concave proximal rim and a rimule-spiramen. *Pleisto.-Rec.*——FIG. 159,*11*. **P. labiata,* Pleisto., Calif.; ×25 (154).

Plagiopora MACGILL., 1895 [**P. disticha*]. Erect narrow branches with biserial apertures on one side only. *Tert.*——FIG. 160,*3*. **P. disticha,* S. Austral.; *3a,b,* ×25 (181).

Psileschara BUSK, 1860 [**P. maderensis* BUSK, 1861]. Like *Plagiopora*. *Rec.*——FIG. 160,*2*. **P. maderensis* BUSK, E.Atl.; ×25 (134).

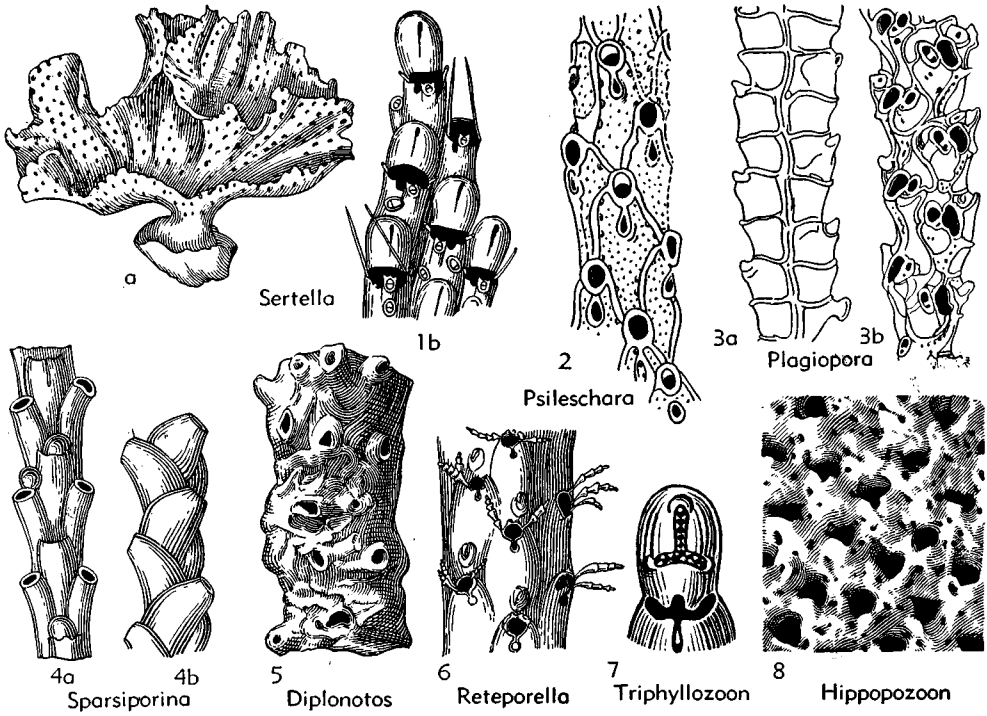


FIG. 160. Reteporidae (p. G212, G213).

Psilosecos CANU-B., 1933 [**Escharinella muralis* GABB-H., 1862]. Bifoliate branches with zooecial front an olocyst and aperture bearing a lyrula. *Eoc.*——FIG. 159,*8*. **P. muralis* (GABB-H.), Wilcox., N.J.; ×25 (137).

Reteporella BUSK, 1884 [**R. flabellata*][=*Radulina* MEISSNER, 1902]. Free branches in one plane, not reticulate. Apertures orbicular, with long labial fissure and 1 to 3 flat articulated spines on each side. *Rec.*——FIG. 160,*6*. **R. flabellata,* S.IndianO.; ×25 (134).

Reteporellina HARMER, 1933 [**Retepora denticulata* BUSK, 1884]. Like *Reteporella* but zoarium not fenestrate and small pyriform ovicell. *Rec.*——FIG. 159,*12*. **R. denticulata* (BUSK), S.Pac.; ×25 (134).

Rhynchozoon HINCKS, 1895 [*pro Rhynchopora* HINCKS, 1877 (*non* KING, 1850)][**Lepralia bispinosa* JOHNSTON, 1847]. Incrusting. Olocyst with marginal areolae; aperture with an asymmetrical sinus. Ovicell entire. *Rec.*——FIG. 159,*7*. **R. bispinosa* (JOHNSTON), North Sea; ×25 (167).

Schizoretepora GREGORY, 1893 [**Retepora tessellata* HINCKS, 1878][=*Schizellozoon* CANU-B., 1917]. Fenestrate zoarium. Ovicell widely open with semicircular slit. No reteporidan pore. Poster of aperture has wide sinus. *Rec.*——FIG. 159,*10*. *S. imperati* (BUSK), SW.Pac.; ×25 (134).

Schizotheca HINCKS, 1877 [**Lepralia fissa* BUSK, 1858]. Incrusting. Zooecial aperture sinuate and notched. Ovicell terminal, with broad fissure. *Rec.*——FIG. 159,*5*. **S. fissa* (BUSK), NE.Atl.; ×25 (167).

Sertella JULLIEN, 1903 [**Retepora beaniana* KING, 1846; SD CANU-B., 1920][=*Ellipsia* JULLIEN, 1903]. Reticulate. Zooecial front smooth, with areolar pores. Ovicell with long median fissure. *Rec.*——FIG. 160,*1*. **S. beaniana* (KING), Rec., E.Atl.; *1a,b,* ×1, ×25 (137).

Sparsiporina D'ORB., 1852 [**Retepora elegans* REUSS, 1848]. Linear, erect, compressed branches with 3 or 4 rows of apertures. *Tert.*——FIG. 160,*4*. **S. elegans* (REUSS), Mio., Aus.; *4a,b,* front, back, ×25 (137).

Triphyllozoon CANU-B., 1917 [*Retepora monilifera* MACGILL., 1860]. Fenestrate. Apertures entire; trifoliate fissure in ovicell. *Rec.*——FIG. 160,*7*. **T. monilifera* (MACGILL.), SW.Pac.; ×50 (230).

Uniretepora D'ORB., 1849 [**Retepora granulosa* MICH., 1847][(?=*Hornera*)]. *Tert.,* Fr.

Family ADEONIDAE Jullien, 1903

[=Adeonellidae, Inversiulidae, Smittistomidae VIG., 1949]

Zoaria incrusting to erect, anastomosing. Zooecial front a thick pleurocyst with tubular areolar pores (parietal areolae) closed over at the surface and connecting with septulae arranged in line with them; primary aperture at bottom of deep peristomial tube. Ovicells developed on special gonozooecia larger than the ordinary zooecia. Rubbing away one face of the zoarium, so as to reveal the areolae, is a sure test for the family (24). *Eoc.-Rec.*

Adeona LAMX., 1812 [**A. grisea* LAMX., 1816; SD GREGORY, 1893][=*Reptoporellina* D'ORB., 1853; *Multiporina* GABB-H., 1862 (*non* D'ORB., 1852); *Dictyopora* MACGILL., 1868 (obj.); *Reptadeonella* BUSK, 1884; *Heckelia* NEVIANI, 1895]. Typically bilamellar anastomosing. Frontal thick, with ascopore opening into compensatrix near center. Gonozooecia larger and with wider apertures than ordinary zooecia. *Tert.-Rec.*——FIG. 161,*1*. **A. grisea* LAMX., Rec., SW.Pac.; *1a,b,* ×0.5, ×25 (181).

Adeonella BUSK, 1884 [**A. polymorpha*][=*Reussina* NEVIANI, 1895]. Narrow, flat bilamellar branches. Peristomie perforated by spiramen but no median ascopore. *Eoc.-Rec.*——FIG. 161,*9*. **A. polymorpha,* Rec., SW.Pac.; ×50 (134).

Adeonellopsis MACGILL., 1886 [**A. foliacea*][=*Cribricella* CANU, 1904 (*non* LEV., 1909)]. Like *Adeonella* with one or more ascopores grouped at base of a cribriform area in middle line. *Eoc.-Rec.*

A. (Adeonellopsis). *Eoc.-Rec.*——FIG. 161,*4*. **A. (A.) foliacea,* Rec., SW.Pac.; ×25 (181).

A. (Lobopora) LEV., 1902 [**Eschara coscinophora* REUSS, 1847] [=*Cribricella* CANU, 1904 (obj.) (*non* LEV., 1909)]. Mio., Eur.

A. (Ovaticella) MAPLE., 1900 [**O. turbinata*]. *Tert.,* Austral.

A. (Poricella) CANU, 1904 [**P. macconica*]. *Eoc.,* Tunisia.

Anarthropora SMITT, 1868 [**Lepralia monodon* BUSK, 1868]. Incrusting. Like *Triporula* but lacks the 2 proximal avicularia. *Eoc.-Rec.*——FIG. 161,*2*. **A. monodon* (BUSK), Rec., NE.Atl.; ×25 (134).

Bracebridgia MACGILL., 1886 [**Mucronella pyriformis* BUSK, 1884][=*Porostoma* CANU, 1907]. Like *Adeonella* but suboral and larger vicarious avicularia present. *Eoc.-Rec.*——FIG. 161,*8*. **B. pyriformis* (BUSK), Rec., SW.Pac.; ×50 (177).

Calvetina CANU, 1908 [**C. ventricosa*]. Bilamellar. Zooecia celleporoid with porous front bearing a large avicularium and gonozooecia with large elliptical aperture. *Eoc.*——FIG. 161,*11*. **C. ventricosa,* Lut., Fr.; ×25 (136).

Cyclostomella ORTMANN, 1889 [**C. articulata*]. Erect branches. Zooecia narrow, elongate, articulated. *Rec.*——FIG. 161,*10*. **C. articulata,* NW. Pac.; ×20 (203).

Dimorphocella MAPLE., 1903 [**D. pyriformis*]. An ascopore on gonozooecia only, oral sinus on other zooecia. *Tert.*——FIG. 161,*5*. **D. pyriformis,* Austral.; ×25 (184).

Duvergiera VIG., 1949 [**Meniscopora? patens* DUVERGIER, 1928]. Incrusting. Frontal a tremocyst; peristome orbicular with cardelles. *Mio.*——FIG. 161,*7*. **D. patens* (DUVERGIER), Burdig., Fr.; ×25 (224).

Inversiula JULLIEN, 1888 [**I. nutrix*]. Frontal a tremocyst with stellate pores. Avicularia but no spines, no ovicells. Convexity of ascopore turned toward elliptical aperture. *Mio.-Rec.*——FIG. 161, *3*. **I. nutrix*, Rec., SW.Atl.; ×25 (169).

Laminopora MICH., 1842 [**L. contorta*] [=*Tremadeona* CANU-B., 1920]. Narrow bilamellar branches. Zooecial front a tremocyst with nonstellate pores; aperture very elongate with 2 cardelles. *Mio.-Rec.* ——FIG. 161,*6*. **L. contorta*, Rec., Atl.; ×25 (230).

Meniscopora GREGORY, 1893 [**M. bigibbera*]. Bifoliate expansion. Frontal with lateral areolae. No ascopore on either gonozooecia or ordinary zooecia. *Paleoc.-Mio.*——FIG. 162,*7*. **M. bigibbera*, Paleoc., Eng.; ×40 (158).

Schizostomella CANU-B., 1927 [*pro Schizostoma* CANU, 1907 (*non* LEA, 1842)] [**Schizostoma crassum* CANU, 1908]. Bilamellar. Frontal with large oval gonozooecia. *Eoc.*——FIG. 162,*5*. **S. crassum* (CANU), Lut., Fr.; ×25 (137).

Schizotremopora VIG., 1949 [**Meniscopora irregularis* CANU, 1915]. Bilamellar. Tremocyst with rimule; marginal zooecia wider than axial ones. *Mio.*——FIG. 162,*1*. **S. irregularis* (CANU), Aquit., Fr.; ×25 (224).

Smittistoma CANU, 1907 [**Eschara mortisagum* STOLICZKA, 1862]. Bilamellar. Like *Smittina* but bears large gonozooecia and oral avicularia. *Eoc.* ——FIG. 162,*8*. **S. mortisagum* (STOLICZKA), Latt., Ger.; ×25 (137).

Teichopora GREGORY, 1893 [**T. clavata*]. Foliaceous. Pyriform zooecia with large orbicular apertures, marginal areolae and avicularium just below orifice. Gonozooecia irregularly placed. *Eoc.*——FIG. 162,*4*. **T. clavata*, Barton., Eng.; ×50 (158).

Trigonopora MAPLE., 1902 [**T. vermicularis*] [=*Metrarabdotos* CANU, 1914]. Incrusting to bila-

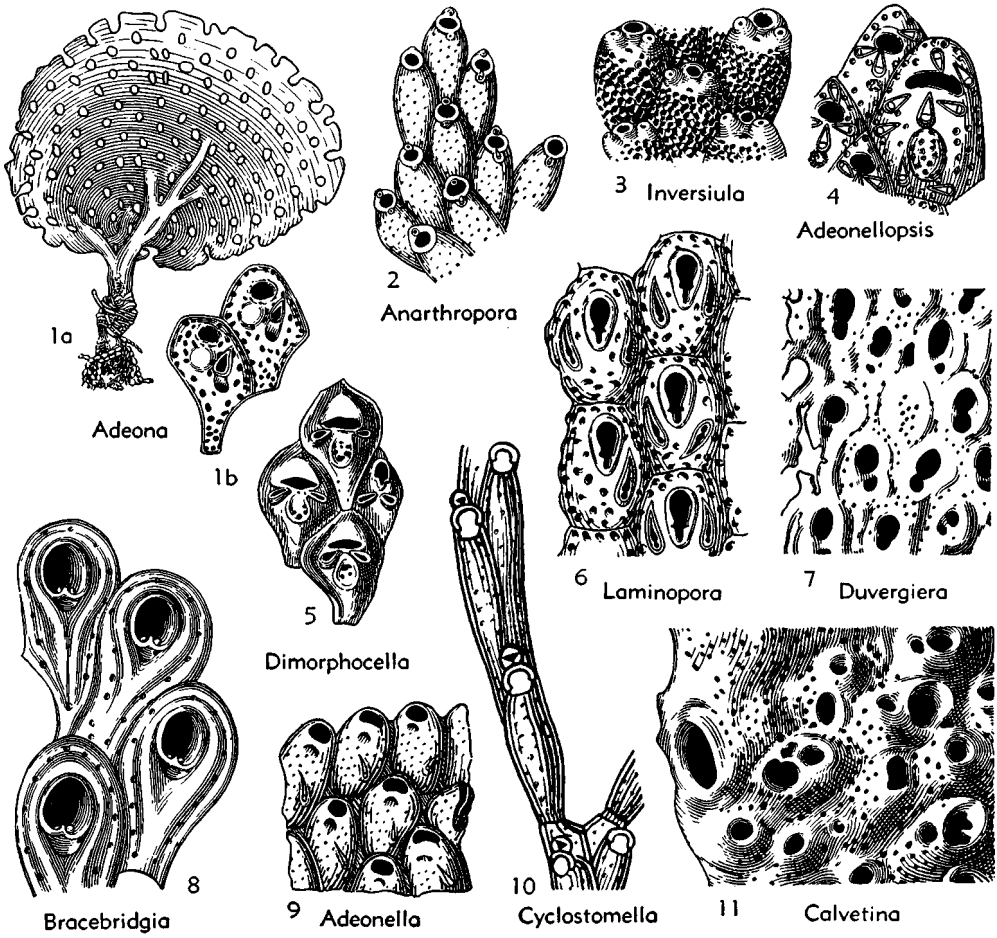


FIG. 161. Adeonidae (p. G213, G214).

mellar fronds. Zooecial front a pleurocyst with areolae; ordinary apertures semilunar, with rounded sinus and cardelles. Very large ovicells borne on gonozooecia with much larger lunate apertures. *Eoc.-Rec.*——Fig. 162,*2*. *T. monilifera* (M.Edw.), Plio., Eng.; ×25 (134).——Fig. 162,*3*. **T. vermicularis,* Mio., Austral.; ×25 (131).

Triporula Canu-B., 1927 [**Escharipora stellata* Smitt, 1873]. Incrusting. Frontal with semicircular apertures and stellate pores; 3 avicularia; no ovicell or spines. *Mio.-Rec.*——Fig. 162,*6*. **T. stellata* (Smitt), Rec., GulfMex.; ×25 (236).

Family CHEILOPORINIDAE Bassler, 1936

[=Cryptosulidae, Watersiporidae Vig., 1949]

Zoarium incrusting to bilamellar. Frontal wall thin, with tremocyst pores; aperture without peristome, anterior and posterior parts separated by 2 cardelles. Ovicell endozooecial (24). *Cret.-Rec.*

Cheiloporina Canu-B., 1923 [**Hippoporina circumcincta* Neviani, 1896]. Incrusting. Apertures with cardelles and pair of small converging avicularia. Ovicell aperture broader than others. *Eoc.-Rec.*——Fig. 163,*2*. *C. haddoni* (Harmer), Rec., SW.Pac.; ×25 (164).

Cheilopora Lev., 1909 [**Discopora sincera* Smitt, 1867]. Incrusting. Frontal with minute tremocystal pores in quincunx. No cardelles. *Rec.*——Fig. 163,*7*. **C. sincera* (Smitt), N.Atl.; ×25 (199).

Cianotremella Canu, 1911 [**C. gigantea*]. Incrusting. Frontal smooth. Ovicell opens by a large salient transverse pore. *Cret.*——Fig. 163,*4*. **C. gigantea,* Rocanean, Arg.; ×25 (136).

Cryptosula Canu-B., 1925 [**Eschara pallasiana* Moll, 1803]. Incrusting, lamellate. Frontal with wide open pores and broad aperture. No external ovicell. *Plio.-Rec.*——Fig. 163,*10*. **C. pallasiana* (Moll), Rec., NE.Atl.; ×25 (137).

Cucullipora MacGill., 1895 [**C. tetrasticha*]. Ribbon-like, bifoliate. Aperture elongate with cardelles at mid-height. Tremocyst of large pores. *Tert.*——Fig. 163,*1*. **C. tetrasticha,* Mio., S.Austral.; ×25 (181).

Diploecium Kirkpatrick, 1888 [**D. simplex*]. Like *Tetraplaria* but segments with only 2 zooecia. *Rec.*——Fig. 163,*6*. **D. simplex,* IndianO.; *6a,b,* with ovicell, ×25 (171).

Enantiosula Canu-B., 1930 [**E. manica*]. Superposed lamellae. Frontal tremocyst; operculum bell-shaped; 2 large, converging oral avicularia. *Rec.*——Fig. 163,*11*. **E. manica,* E.Pac.; ×25 (137).

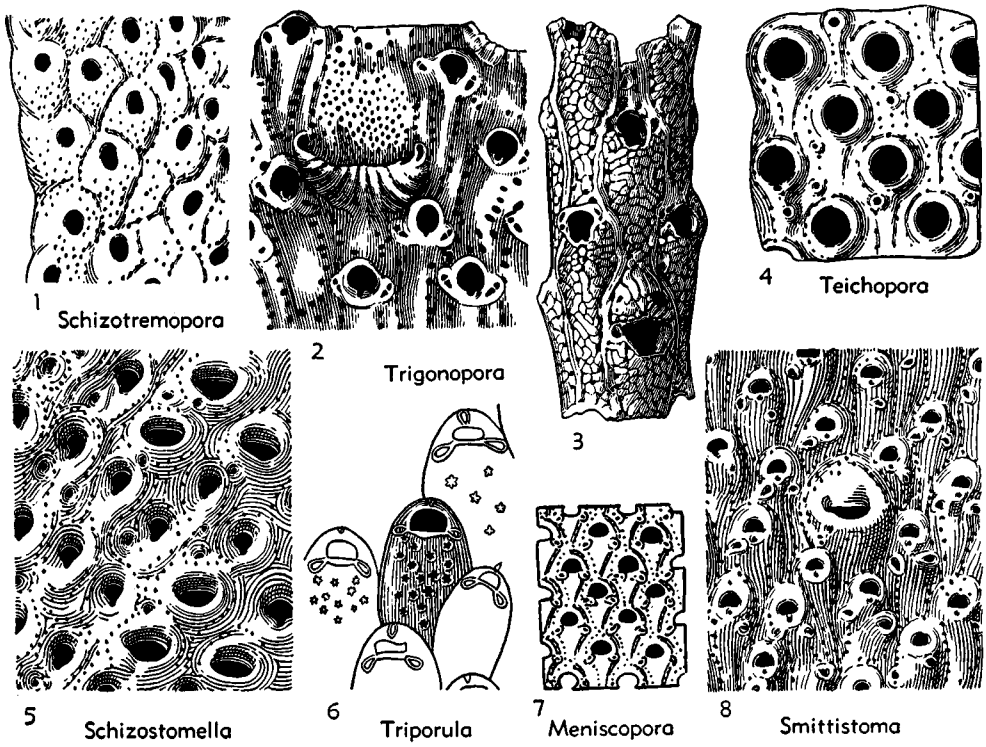


Fig. 162. Adeonidae (p. G214, G215).

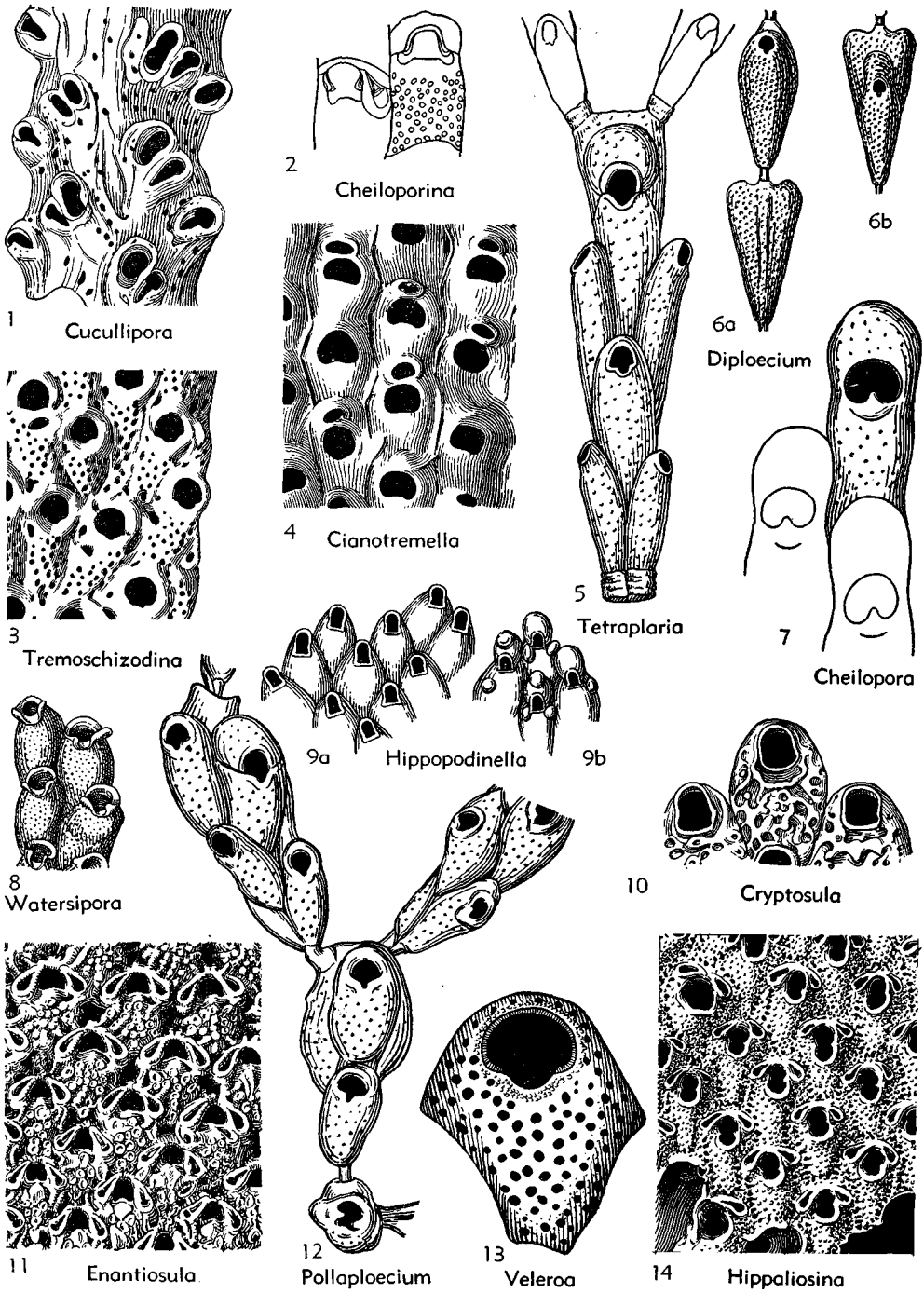


FIG. 163. Cheiloporinidae (p. G215-G217).

Hippaliosina CANU, 1918 [**Escharella rostrigera* SMITT, 1872]. Incrusting. Frontal a granular pleurocyst with prominent areolae. Aperture elongate with distinct cardelles and avicularium on each side. *Cret.-Rec.*——FIG. 163,*14*. **H. rostrigera* (SMITT), Rec., Gulf Mex.; ×25 (137).

Hippopodinella BARROSO, 1926 [**Lepralia adpressa* BUSK, 1854]. Generally incrusting on gastropods. Frontal a tremocyst with minute pores and lateral walls perforated by parietal dietellae. Aperture with cardelles. *Plio.-Rec.*——FIG. 163,*9*. **H. adpressa* (BUSK), Rec., SE.Pac.; *9a,b*, normal zooecia, ovicells, ×25 (134).

Pollaploecium MAPLE., 1909 [**P. gilbertensis*]. Like *Tetraplaria* but segments of 6 to 8 zooecia. *Rec.*——FIG. 163,*12*. **P. gilbertensis*, C.Pac.; ×25 (184).

Tetraplaria T.WOODS, 1878 [**T. australis*][=*Bigemellaria* MACGILL., 1895; *Arborella* OSBURN, 1914]. Zoarium erect, jointed, with 4 longitudinal alternating rows of zooecia, back to back. *Eoc.-Rec.*——FIG. 163,*5*. **T. australis*, Tert., Austral., ×25 (204).

Tremoschizodina DUVERGIER, 1921 [**T. pisciformis*]. Bilamellar. Frontal a tremocyst with small pores unpigmented. Aperture with broad proximal sinus (rimule). Avicularia rare but large. *Mio.-Rec.*——FIG. 163,*3*. **T. pisciformis*, Mio.(Helv.), Fr.; ×25 (148).

Veleroa OSBURN, 1952 [**V. veleronis*]. Like *Watersipora* in nature of frontal and absence of ovicell. *Rec.*, E.Pac.——FIG. 163,*13*. **V. veleronis*, ×60 (204).

Watersipora NEVIANI, 1895 [**Lepralia cucullata* BUSK, 1854]. Incrusting, dark-pigmented. Frontal a tremocyst with large pores. Aperture with broad rounded sinus and conspicuous cardelles. *Mio-Rec.*——FIG. 163,*8*. **W. cucullata* (BUSK), Rec., E. Medit.; ×25 (135).

Family PARMULARIIDAE Maplestone, 1912

Zoaria small bilamellar basally attached by stolons. Zooecia with tremocyst frontal and hyperstomial ovicells closed by operculum (31). *Cret.-Rec.*

Parmularia MACGILL., 1887 [**Eschara obliqua* MACGILL., 1868]. Zoarium irregularly lobed, bilamellar; zooecia with tremocyst frontal and schizoporidan aperture. *Tert.-Rec.*——FIG. 164,*8*. **P. obliqua* (MACGILL.), Rec., SW.Pac.; ×25 (181).

Bathystomella STRAND, 1928 [*pro Bathystoma* MARSSON, 1887 (*non* FITZINGER, 1874)][**Eschara cordiformis* HAG., 1846]. Zooecia convex; frontal with large tremocystal pores; deeply buried apertures. *Cret.*——FIG. 164,*9*. **B. cordiformis* (HAG.), Camp., Ger.; ×25 (160).

Lanceopora D'ORB., 1851 (*non* REUSS, 1874) [**L. elegans*][=*Lanceolopora* JELLY, 1889]. Probably same as *Parmularia* although zooecia figured with circular aperture. *Rec.*——FIG. 164,*7*. **L. elegans*, E.Indies; ×25 (202).

Family PHYLACTELLIPORIDAE Bassler, nov.

Incrusting. Zooecia with well-developed peristomie bearing a protective organ (lyrula, mucron) for the compensatrix. Aperture entire or with cardelles. Ovicell hyperstomial, recumbent, with large orifice on distal wall and closed by special operculum. Frontal a tremocyst with small pores and in some with areolae (24). *Cret.-Rec.*

Phylactellipora BASSLER, *nom. nov.* [*pro Phylactella* CANU-B., 1929 (ref. 31, p. 407)(*non* HINCKS, 1880)][**Lepralia collaris* NORMAN, 1867]. Zooecia with circular aperture, bearing cardelles and a lyrula. Peristome funnel-shaped, ovicell salient, globular. *Eoc.-Rec.*——FIG. 164,*1*. *P. hincksi* BASSLER, *nom. nov.* [*pro Phylactella labrossa* HINCKS, 1880 (ref. 75, p. 357, pl. 41, fig. 1-2)(*non* BUSK, 1854)], Rec., Atl., Eng.; ×25 (167).

Cheilonella KOSCHINSKY, 1885 [**C. gigas*]. Large uniserial zooecia with smooth frontal, fine marginal pores and minute proximal denticles. *Eoc.*——FIG. 164,*2*. **C. gigas*, Lut., Ger.; ×25 (172).

Hippolyrula VIG., 1949 [**Peristomella crassilabiata* DUVERGIER, 1920]. Frontal a granular pleurocyst, much developed peristomie, delicate cardelles and lyrula. *Mio.*——FIG. 164,*5*. **H. crassilabiata* (DUVERGIER), Burdig., Fr.; ×25 (224).

Phylactellina STACH, 1936 [**P. cowandillensis*]. *Tert.*, Austral.

Pleurolyrula VIG., 1949 [**Perigastrella lata* DUVERGIER, 1920]. Like *Hippolyrula* but cardelles absent. *Mio.*——FIG. 164,*6*. **P. lata* (DUVERGIER), Burdig., Fr.; ×30 (224).

Pleuromucrum VIG., 1949 [**P. saucatensis*]. Like *Pleurolyrula* but mucron replaces lyrula. *Mio.*——FIG. 164,*3*. **P. saucatensis*, Burdig., Fr.; ×25 (224).

Tremolyrula VIG., 1949 [**T. incrustans*]. Orbicular aperture, peristomie with lyrula; tremocyst of very fine pores. *Mio.*——FIG. 164,*4*. **T. incrustans*, Helv., Fr.; ×25 (224).

Family PHYLACTELLIDAE Canu & Bassler, 1917

[=Perigastrellidae VIG., 1949]

Incrusting. Like Phylactelliporidae but no organs for protection of compensatrix developed in the peristomie. Ovicell recumbent (24,31). *Cret.-Rec.*

Phylactella HINCKS, 1880 [**Lepralia labrosa* BUSK, 1854; SD CANU-B., 1920] [=*Alysidota* BUSK, 1856 (*non* AGASSIZ, 1846) (obj.); *Alysidotella* STRAND, 1928 (obj.)]. Like *Phylactellipora* but has no lyrula. *Eoc.-Rec.*——FIG. 165,*2*. **A. labrosa* (BUSK), Rec., Atl., Ire.; ×25 (134).

Hemiphylactella VIG., 1949 [**H. pulchra*]. Like *Hippophylactella* but with pleurocyst frontal. *Mio.*——FIG. 165,3. **H. pulchra*, Burdig., Fr.; ×25 (224).

Hippophylactella VIG., 1949 [**Phylactella aquitanica* DUVERGIER, 1920]. Frontal a well-developed tremocyst; cardelles placed low; thick orbicular peristome. *Mio.*——FIG. 165,*9*. **H. aquitanica* (DUVERGIER), Aquit., Fr.; ×30 (224).

Lagenipora HINCKS, 1877 (*non* WATERS, 1899) [**L. socialis*]. Zooecia flask-shaped with free tubular extremity; frontal a fine tremocyst. No special organs. *Cret.-Rec.*——FIG. 165,*4*. **L. socialis*, Rec., NE.Atl.; ×25 (167).

Nimba JULLIEN, 1903 [**N. praetexta*]. Like *Nimbella* but with frontal pleurocyst, cardelles separated by a rimule. *Rec.*——FIG. 165,*5*. **N. praetexta*, E.Atl.; ×25 (169).

Nimbella JULLIEN, 1903 [**N. limbata*]. Uniserial zooecia with smooth frontal, keyhole-shaped aperture, 2 cardelles and a rimule; expanded peristome like an areola with large pores. *Rec.*——FIG. 165, *6*. **N. limbata*, E.Atl.; ×25 (169).

Perigastrella CANU-B., 1917 [**Discopora coccinea labiata* SMITT, 1867]. Frontal with areolae and pleurocyst. Aperture semicircular entire with oral spines. *Cret.-Rec.*——FIG. 165,*1*. **P. labiata* (SMITT), Rec., Atl.; ×25 (137).

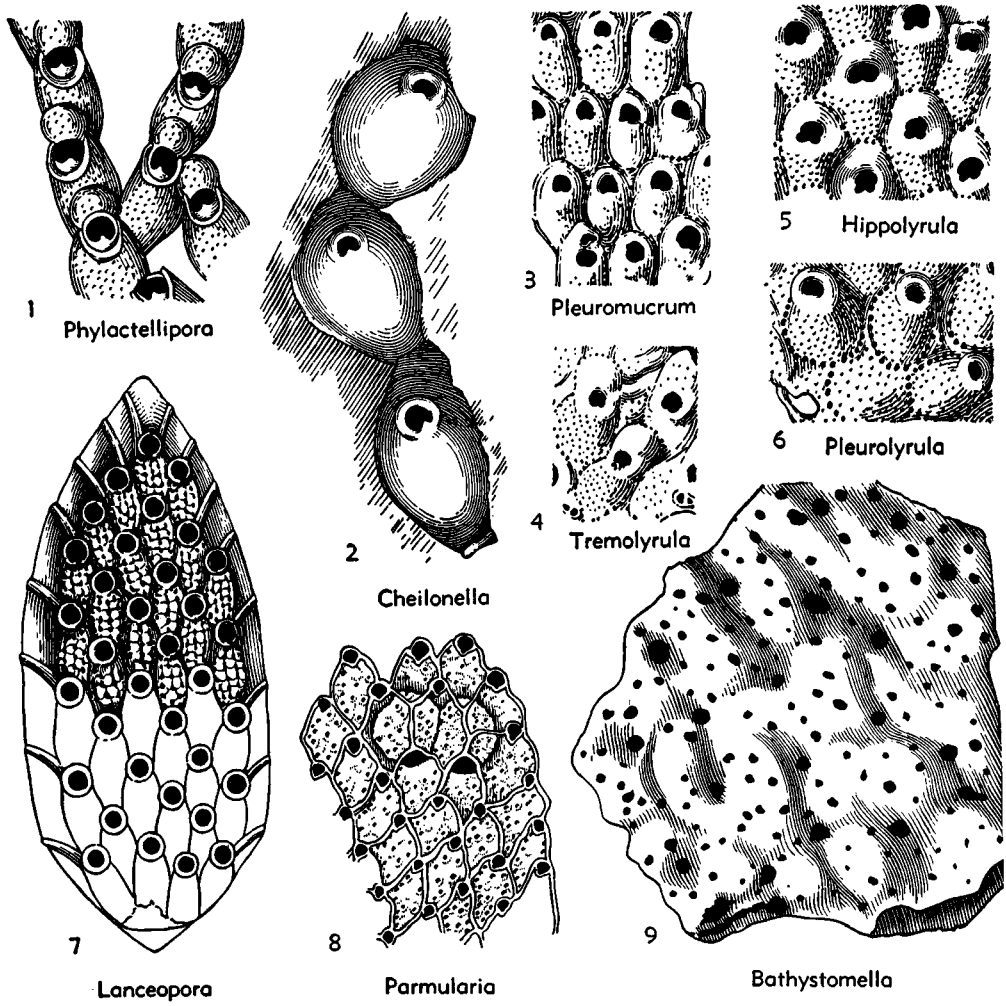


FIG. 164. Parmulariidae, Phylactelliporidae (p. G217).

Psilopsella CANU-B., 1927 [**P. uniseriata*]. Large uniserial zooecia surrounded by parietal dietellae, frontal outlined by large areolae. *Rec.*——FIG. 165,*8*. **P. uniseriata*, SW.Pac.; ×10 (131).

Temachia JULLIEN, 1882 [**T. opulenta*]. Suberect zooecia narrowed like bottle neck; tremocyst. *Rec.*, E.Atl.

Teuchopora NEVIANI, 1895 [**Alecto castrocariensis* MANZONI, 1875]. Biserial generally lageniform zooecia with tremopores and salient peristomie.

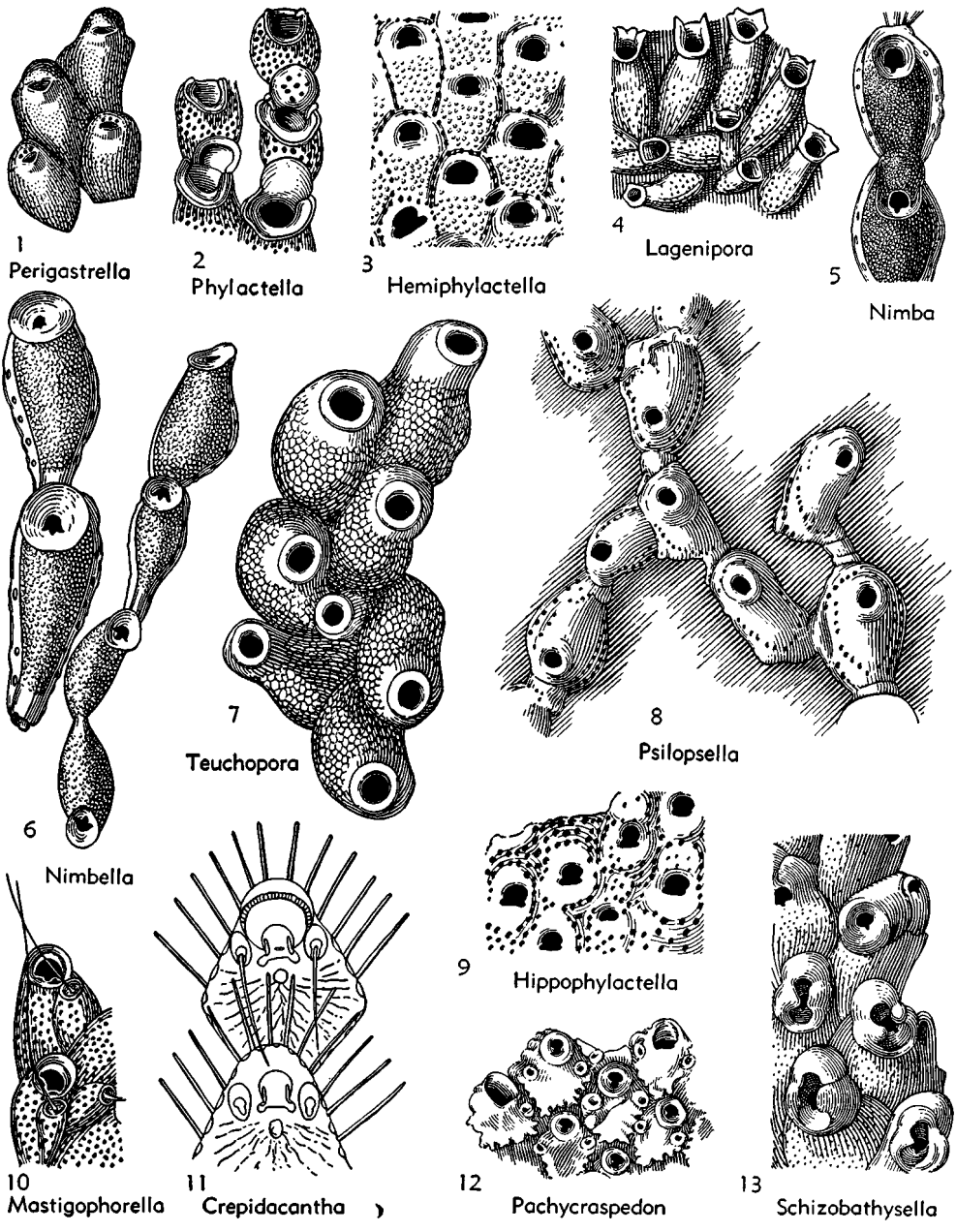


FIG. 165. Phylactellidae, Crepidacanthidae (p. G218-G220).

Plio.——Fig. 165,7. **T. castrocariensis* (Manzoni), Italy; ×25 (183).

Family CREPIDACANTHIDAE Levinsen, 1909

[=Schizobathysellidae Vig., 1949]

Incrusting. Zooecial apertures with chitinized operculum, well-developed cardelles, long oral and marginal setiform spines corresponding to parietal dietellae, and paired avicularia. Ovicell hyperstomial, recumbent, closed by operculum. Frontal a fine-pored tremocyst (24,31). *Cret.-Rec.*

Crepidacantha Lev., 1909 [**C. poissoni crinispina* Lev., 1909]. Aperture broad proximally, without sinus, cardelles especially developed; long setiform spines and paired avicularia prominent. *Cret.-Rec.*——Fig. 165,*11*. **C. crinispina* (Lev.), Rec., SW. Pac.; ×50 (177).

Mastigophorella Bassler, *nom.nov.* [*pro Mastigophora* Hincks, 1877[1] (*non* Felder, 1875)][**Lepralia hyndmanni* Johnston, 1847]. Aperture semilunar, with narrow sinus in straight proximal border; pores of tremocyst well marked; lateral vibracula. *Eoc-Rec.*——Fig. 165,*10*. **M. hyndmanni* (Johnston), Rec., N.Atl.; ×25 (167).

Pachycraspedon Koschinsky, 1885 [**P. clarum*]. Like *Mastigophora* but frontal smooth or granulose. *Eoc.*——Fig. 165,*12*. **P. clarum,* Ger.; ×25 (172).

Schizobathysella Canu-B., 1917 [**S. sacciferа*]. Frontal of minute tremopores; aperture with salient peristomie interrupted by large incomplete spiramen. Avicularium vibraculoid. *Eoc.*——Fig. 165,*13*. **S. saccifera,* Claib., N.Car.; ×25 (137).

Family CELLEPORIDAE Busk, 1852

[=Aulopocellidae, Kleidionellidae, Schismoporidae, Tegminulidae Vig., 1949]

Zoaria incrusting, ramose, or massive. Zooecia erect, heaped up and unoriented except at zoarial growing edge. Oral and vicarious avicularia of many sizes, shapes, and variously posed. Ovicell hyperstomial, recumbent (24). *Cret.-Rec.*

Waters (1913) divided the family into groups pased on apertural characters, as holostomatous (without sinus) and schizostomatous (with sinus); Canu & Bassler (1920) added a clithridiate (keyhole) group. Vigneaux (1949) defined these as new families. Until better known, it seems preferable to unite them and with addition of 2 other families of Vigneaux to designate the whole assemblage by the well-known, although poorly defined name of Celleporidae.

[1]Hincks, T., 1877, Ann. Mag. Nat. Hist., ser. 4, vol. 20, p. 527.

Cellepora Linné, 1767 [**C. pumicosa;* SD Hincks, 1880]. Cumulate (celleporid) zooecia. Name employed loosely for many species of doubtful affinities. *Eoc.-Rec.*——Fig. 166,*1*. **C. pumicosa,* Rec., Atl.; *1a,b,* ×25 (167).

Acanthionella Canu-B., 1917 [**Escharifora typica* Gabb-H., 1862]. Narrow bifoliate branches. Aperture oval with a long lyrula. Frontal a thick olocyst with avicularia. *Cret.-Eoc.*——Fig. 166,*8*. **A. typica* (Gabb-H.), Eoc.(Wilcox.), N.J.; ×25 (154).

Aulopocella Maple., 1903 [*pro Solenopora* Maple., 1903 (*non* Dybowski, 1877)][**Solenopora tubulifera* Maple., 1903]. Celleporid with recumbent ovicell. Oval aperture with a tubular process bearing circular pore at summit. *Rec.*——Fig. 166,*14*. **A. tubulifera* (Maple.), SW.Pac.; ×25 (184).

Costazia Neviani, 1895 [**Cellepora costazii* Audouin, 1826][=*Cycloporella* Neviani, 1895; *Lagenipora* Waters, 1899 (*non* Hincks, 1877); *Siniopelta* Lev., 1909 (obj.)]. Aperture sinuate; frontal bordered by pores and tall, erect process on each side of aperture. *Oligo-Rec.*——Fig. 166,*9*. **C. costazii* (Audouin), Rec., Medit.; *9a,b,* ovicells, normal zooecia, ×25 (167).

Dentiporella Barroso, 1926 [**Cellepora sardonica* Waters, 1879]. Incrusting. Toothed anter; pleurocyst; aperture with cardelles. *Rec.*——Fig. 166,*4*. **D. sardonica* (Waters), Medit.; ×25 (230).

Harmerella Lagaaij, 1952 [**Cellepora dichotoma* Hincks, 1852]. Lateral spiramen in proximal lip of peristome and suboral avicularium on opposite side of lip. *Rec.,* Eng.

Holoporella Waters, 1909 [**Cellepora descostilsii* Audouin, 1828; SD Canu-B., 1917]. Proximal lip of aperture more or less straight. Ovicell widely open. *Eoc.-Rec.*——Fig. 166,*2*. **H. descostilsii* (Audouin), Rec., Medit.; ×25 (230).

Kleidionella Canu-B., 1917 [**K. grandis*]. Bilamellar fronds. Zooecia with thick olocyst, aperture oval to keyhole-shaped, no lyrula. *Cret.-Oligo.*——Fig. 166,*13*. **K. grandis,* Claib., N.Car.; ×25 (137).

Monocerina Neviani, 1900 [**Cellepora monoceros* Reuss, 1847]. *Mio.,* Aus.

Omalosecosa Canu-B., 1925 [**Cellepora ramulosa* Linné, 1767] [=*Cellepora* Linné, 1767 (obj.)]. Erect narrow, branches. Zooecia with smooth frontal and semicircular apertures with concave proximal border. *Plio-Rec.*——Fig. 166,*7*. **O. ramulosa* (Linné), Rec., N.Atl.; ×25 (137).

Osthimosia Jullien, 1888 [**O. evexa*]. Thick branches. Zooecia with pleurocyst; frontal surrounded by areolae; aperture with proximal rimule, no spines. *Eoc.-Rec.*——Fig. 166,*5*. **O. evexa,* Rec., SW.Atl.; ×25 (169).

Schismopora MacGill., 1888 [**Cellepora coronopus* Searles Wood, 1850] [=*Cyclopora* Jullien, 1903 (*non* Prout, 1860)]. Small rounded massive zoaria with recumbent ovicell bearing small pores; frontal an olocyst, with proximal sinus and con-

spicuous suboral avicularia. *Eoc.-Rec.*——Fig. 166, *15. *S. coronopus* (Searles Wood), Rec., NE.Atl.; ×25 (137).

Tegminula Jullien, 1882 [**T. venusta*]. Urceolate, irregularly erect zooecia with smooth frontal, circular aperture surmounted by tubular peristome.

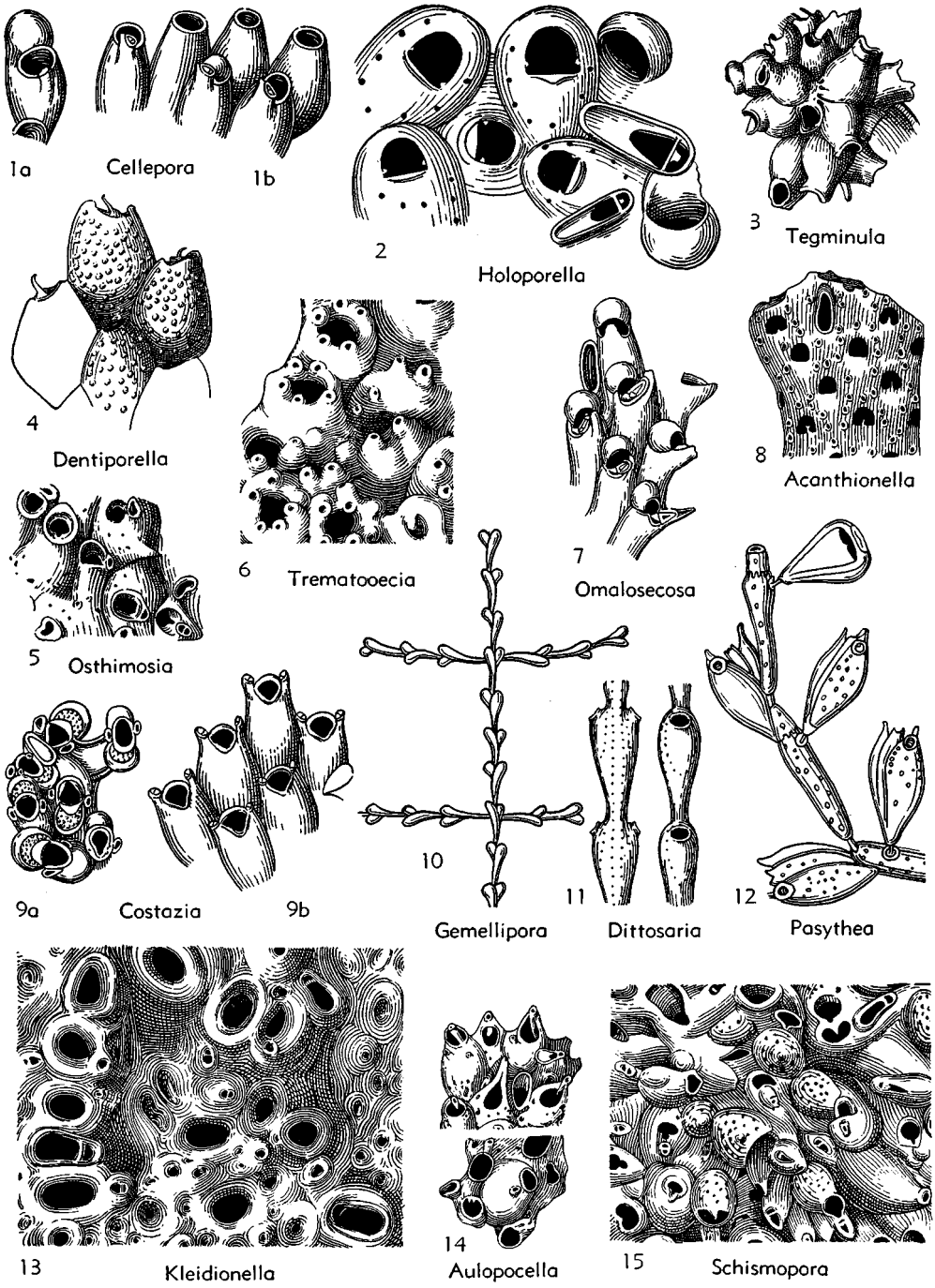


Fig. 166. Celleporidae, Pasytheidae (p. G220-G222).

Rec.——Fig. 166,*3*. **T. venusta,* Rec., E.Atl.; Gulf Gascogne; ×25 (169).

Trematooecia Osburn, 1940 [**Lepralia turrita* Smitt, 1873]. Incrusting. Zooecia erect, unoriented; frontal with large marginal areolae, aperture with thick peristomes bearing strong spines, ovicell with large central pore. *Pleisto.-Rec.*——Fig. 166,*6*. **T. turrita* (Smitt), Rec., GulfMex.; ×20 (137).

Family PASYTHEIDAE Davis, 1934

[=emend. Liriozoidae Lev., 1909]

Zoaria composed of flexible, free, jointed branches arising from creeping stolons. Zooecia slender, elongate, with scattered pores; arranged in pairs or triads; apertures with broad shallow sinus. Avicularia and ovicells not known (31). *Eoc.-Rec.*

Pasythea Lamx., 1812 [**Cellaria tulipifera* Ellis-S., 1786] [=*Liriozoa* Lamx., 1816 (obj.); *Tuliparia* Blainv., 1834 (obj.); *Epicaulidium* Hincks, 1880]. Branches formed of an axis of kenozooecia, with zooecia emerging from opposite sides in paired triads. *Rec.*——Fig. 166,*12*. **P. tulipifera* (Ellis-S.), W.Indies; ×25 (137).

Dittosaria Busk, 1866 [**D. wetherelli*] [=*Notamia* Gregory, 1893; *Gemellaria* Canu-B., 1920]. Calcareous erect branches, internodes of 2 to 4 zooecia back to back, apertures of each row facing in same direction. Frontal an olocyst with 1 to 3 rows of areolae. *Eoc.*——Fig. 166,*11*. **D. wetherelli,* Ypres., Eng.; ×25 (134).

Gemellipora Smitt, 1872 [**G. eburnea*]. Like *Pasythea* but kenozooecia wanting, zooecia biserial, back to back. *Mio-Rec.*——Fig. 166,*10*. **G. eburnea,* Rec., GulfMex.; ×10 (236).

Family CATENICELLIDAE Busk, 1852

Zoaria delicate, erect, articulated, branching, some with radicles for attachment; each segment (internode) formed of 1, 2 (biglobulus), or 3 (triglobulus) zooecia, all facing in same direction and connected with a number of lateral chambers (suprascapular, scapular, infrascapular, pedal). Frontal porous or provided with fenestrae (chitinous interruptions) occupying sternal area or sunken longitudinal perforated grooves in the calcareous wall (vittae) which seem to correspond to pore chambers. Gonoecia with endozooecial ovicells arranged in different positions according to genus. Compensatrix, opercula and avicularia present. Abundant in Tertiary and Recent of Australasia but little known north of equator (31; Stach, 1935). *Tert.-Rec.*

Catenicella Blainv., 1834 [*pro Catenaria* Lamx., 1824 (*non Zeder,* 1800)] [**C. savignii* (=*Eucratea contei* Audouin, 1826)] [=*Caloporella* MacGill., 1895]. Vittate zooecia with small scattered frontal pores; suprascapular compartments uncalcified. Ovicell pertains to mother zooecium of a triglobulus. (Loosely employed for species of uncertain affinities.) *Rec.*——Fig. 167,*1*. **C. contei* (Audouin), Medit., Atl.; *1a-c,* ×10, ×50, ×50 (137). [Catenicellinae Stach, 1935].

Calpidium Busk, 1852 [**C. ornatum*]. Aperture with triangular sinus ending in a point, 2 strong hinge teeth and sternal area with 5 fenestrae. *Tert.-Rec.*——Fig. 167,*10*. **C. ornatum,* Rec., SW.Pac.;*10a,b,* ×25 (134).

Catenicellopsis J. B. Wilson, 1880 [**C. delicatula*]. Like *Catenicella* but ovicell perforated all over; unusual mode of branching. *Rec.*——Fig. 167,*8*. **C. delicatula,* SW.Pac.; ×25 (231).

Claviporella MacGill., 1895 [**Catenicella geminata* W. Thompson, 1858]. Like *Catenicella* but aperture clithridiate, sternal structure aberrant. *Tert.-Rec.*——Fig. 167,*3*. **C. geminata* (W. Thompson), Rec., SW.Pac.; ×50 (181).

Cornuticella Canu-B., 1927 [**Catenicella cornuta* Busk, 1852]. Vittate species with tuberculate imperforate ovicell at end of mother zooecium of a globulus. *Rec.*——Fig. 167,*9*. **C. cornuta* (Busk), SW.Pac.; ×50 (134). [Cornuticellinae Stach, 1935].

Costaticella Maple., 1899 [**Catenicella lineata* MacGill., 1895] [=*Costicella* Lev., 1909; *Costaticellina* Stach, 1934]. Sternal area formed by a number of generally hollow spines springing from sternal sinus and separated by fissures. *Tert.-Rec.*——Fig. 167,*14*. **C. lineata* (MacGill.), Tert., Austral.; *14a,b,* ×50, ×25 (181).

Cribricellina Canu-B., 1927 [*pro Cribricella* Lev., 1909 (*non* Canu, 1904)] [**Catenicella rufa* MacGill., 1868]. Sternal area perforated by scattered pores; uncalcified suprascapular compartments present. *Tert.-Rec.*——Fig. 167,*12*. **C. rufa* (MacGill.), Rec., SW.Pac.; *12a,b,* basal side, gonoecium, ×50 (181).

Digenopora Maple., 1899 [**D. compta* (=*Catenicella retroversa* MacGill., 1895)]. Zooecia with 2 sets of pores or fenestrae, one submarginal, segregated or oval, the other on zooecial frontal below aperture. *Tert.*——Fig. 167,*5*. **D. retroversa* (MacGill.), Austral.; ×25 (184).

Ditaxipora MacGill., 1895 [**Catenicella internodia* Waters, 1881]. Zoarium with multizooecial internodes. Ovicell deeply immersed in distal zooecium. *Tert.*——Fig. 167,*6*. **D. internodia* (Waters), S.Austral.; *6a,b,* back, front, ×25 (137).

Pterocella Lev., 1909 [**Catenicella alata* W. Thompson, 1858]. Lateral chambers form winglike marginal portion along zooecial length. *Tert.-Rec.*——Fig. 167,*7*. **P. alata* (W. Thompson), Rec., Antarct.; ×50 (181).

Scuticella Lev., 1909 [**Catenicella plagiostoma* Busk, 1852] Fenestrate sternal area, noncalcified suprascapular compartments. *Tert.-Rec.*——Fig. 167,*13*. **S. plagiostoma* (Busk), Rec., SW.Pac.; ×25 (137). [Scuticellinae Stach, 1935].

Strongylopora Maple., 1899 [**Catenicella pulchella*

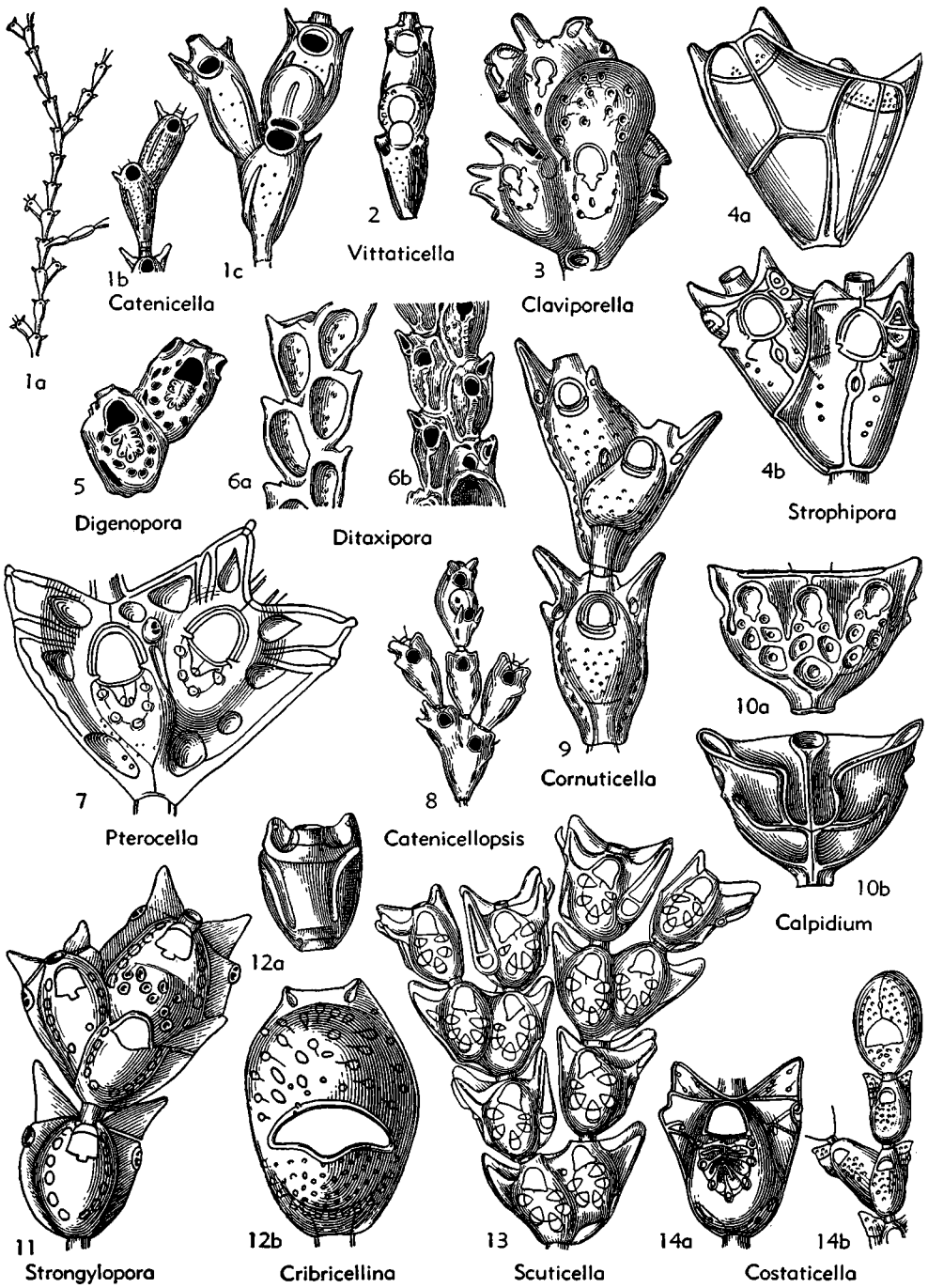


Fig. 167. Catenicellidae (p. G222-G224).

MAPLE., 1880] [=*Hincksiella* LEV., 1909 (obj.)]. Submarginal row of large pores; completely calcified suprascapular compartments. *Tert.-Rec.*——FIG. 167,*11*. **S. pulchella* (MAPLE.), Rec., SW. Pac.; ×50 (137).

Strophipora MACGILL. [**Catenicella harveyi* W. THOMPSON, 1858]. No sternal area. Frontal surface with a thickened longitudinal ridge. *Tert.-Rec.*

S. (Strophipora). *Tert.-Rec.*——FIG. 167,*4*. **S. (S.) harveyi* (W. THOMPSON), Rec., SW.Pac.; *4a,b*, ×25 (137).

S. (Microstomaria) MACGILL., 1895 [**M. tubulifera*]. *Tert.*, Austral.

S. (Stenostomaria) MACGILL., 1895 [**Catenicella solida* WATERS, 1881]. *Tert.*, Austral.

Vittaticella MAPLE., 1900 [*pro Caloporella* MACGILL., 1895 (*non Calloporella* ULR., 1882)] [**Catenicella elegans* BUSK, 1852] [=*Catenaria* LEV., 1909 (*non* LAMX., 1824, *nec* ZEDER, 1800); *Calloporella* LEV., 1909 (*non* ULR., 1882)]. Frontal with fine scattered pores and vittae (grooves) on each side. Aperture with concave thickened proximal rim. *Tert.*——FIG. 167,*2*. **V. elegans* (BUSK), Austral.; ×33.3 (134). [Vittaticellinae STACH, 1933].

Family SAVIGNYELLIDAE Levinsen, 1909

[=emend. Catenariidae D'ORB., 1851]

Erect threadlike slightly calcified branches, jointed chainlike, with only one zooecium per segment. Ovicell recumbent. Zooecia narrow elongate, with avicularia, spines, and scattered pores on frontal surface (30). *Rec.*

Savignyella LEV., 1909 [**Eucratea lafontii* AUDOUIN, 1826] [=*Catenariella* STRAND, 1928 (obj.)]. Aperture with spines, concave poster (but no sinus) and proximally placed avicularium.——FIG. 168,*1*. **S. lafontii* (AUDOUIN), N.Atl., *1a,b*, ×10, ×1 (177).

Chelidozoum STACH, 1935 [**Claviporella vespertilio* MACGILL., 1895]. Like *Savignyella* but lacks suboral avicularium. Austral.——FIG. 168,*4*. **C. vespertilio* (MACGILL.), ×30 (235).

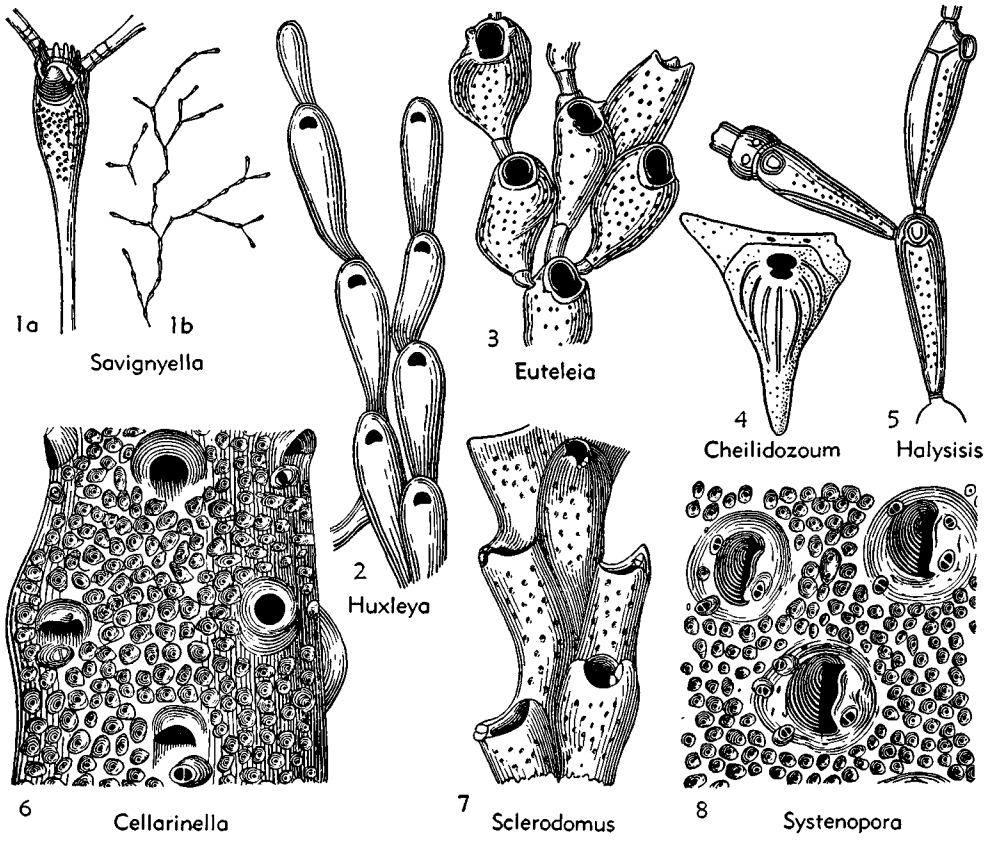


FIG. 168. Savignyellidae, Sclerodomidae (p. G224, G225).

Euteleia MARCUS, 1938 [**E. evelinae*]. Zoaria creeping. Orifice horseshoe-shaped.——FIG. 168,*3*. **E. evelinae*, W.Atl.; ×40 (185).

Halysisis NORMAN, 1909 [**Scruparia diaphana* BUSK, 1860]. Narrow elongate zooecia with rounded aperture and sinus: no spines or avicularium. ——FIG. 168,*5*. **H. diaphana* (BUSK), E.Atl.; ×25 (137).

Huxleya DYSTER, 1858 (*non* CLAPARÈDE & LACHMANN, 1858) [**H. fragilis*]. Aperture semicircular with straight poster but without spines or avicularium.——FIG. 168,*2*. **H. fragilis*, NE.Atl.; ×25 (137).

Family SCLERODOMIDAE Levinsen, 1909

Zoaria free, erect, branched. Zooecia with thick tubulate tremocyst; aperture at bottom of long peristomie. Ovicell hyperstomial, visible only on young zooecia (31). *Rec.*

Sclerodomus LEV., 1909 [**Bifaxaria denticulatus* BUSK, 1884]. Peristomie funnel-shaped, immersed. Ovicell separated from zooecium by thickened crenulate margin of expanded distal wall.——FIG. 168,*7*. **S. denticulatus* (BUSK), SW.Atl.; ×25 (134).

Cellarinella WATERS, 1904 [**C. foveolata*]. Aperture at bottom of long peristomie into which ovicell opens.——FIG. 168,*6*. **C. foveolata*, Antarct.; ×25 (230).

Systenopora WATERS, 1904 [**S. contracta*]. Peristomice auricular, consisting of a longitudinal slit between concave and convex lamellae, latter bearing a proximal avicularium.——FIG. 168,*8*. **S. contracta*, Antarct.; ×25 (230).

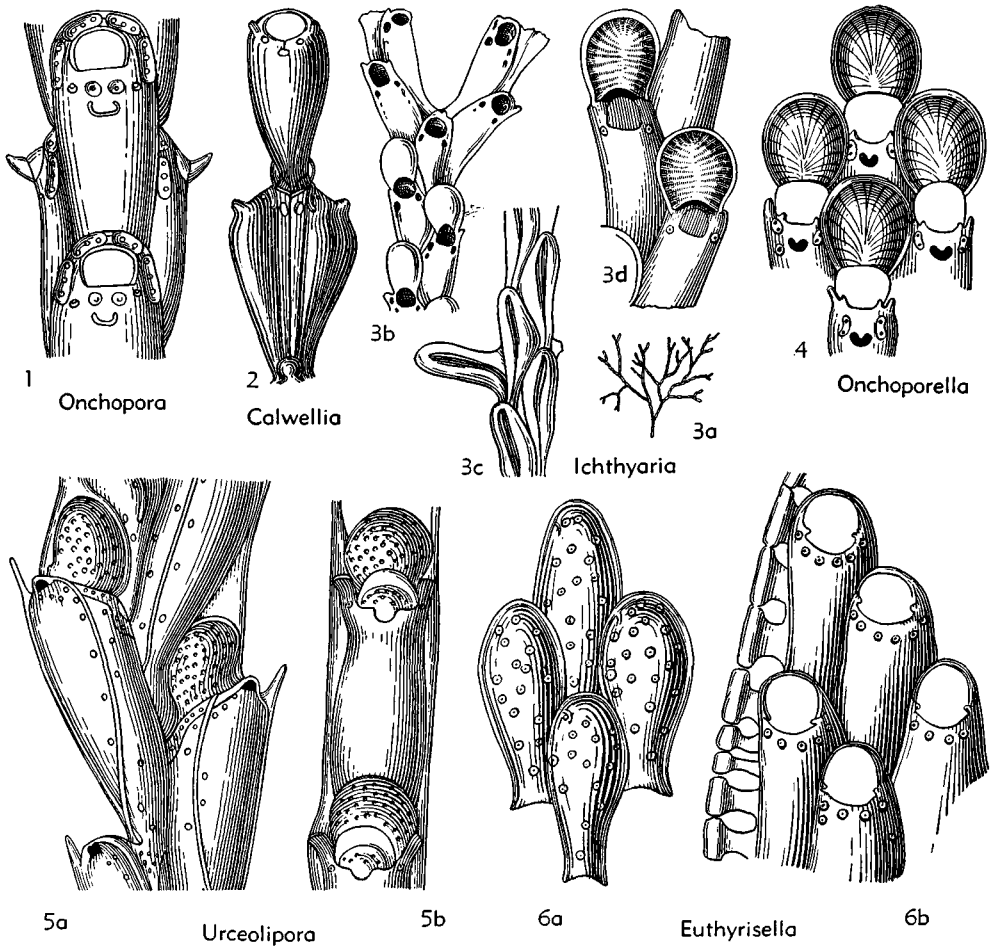


FIG. 169. Onchoporidae, Euthyrisellidae (p. G226, G227).

Family ONCHOPORIDAE Levinsen, 1909

Free, ramified, flexible, slightly calcified branches. Zooecia claviform, ornamented by apertural and frontal septulae. Ascopore crescentic. Ovicell hyperstomial (31). *Rec.*

Onchopora Busk, 1852 [**O. sinclairi*] [=*Malakosaria* Goldstein, 1881 (obj.)]. Bi-quadriserial colonies. Ovicell with free riblike processes. At least 6 apertural septulae with 2 small ones between ascopore and aperture.——Fig. 169,*1*. **O. sinclairi*, N.Z.; ×50 (134).

Calwellia W. Thompson, 1859 [**C. bicornis*]. Horn-shaped zooecia with narrow caudal portion, joined back to back with alternate pairs between.——Fig. 169,*2*. **C. bicornis*, SW.Pac.; ×50 (134).

Ichthyaria Busk, 1884 [**I. oculata*]. Unilamellar, erect, biserial branches. Apertural septulae; ovicell not closed by operculum.——Fig. 169,*3*. **I. oculata*, SW.Atl.; *3a*, ×1; *3b,c*, ×10; *3d*, ovicells, ×25 (134).

Onchoporella Busk, 1884 [**Carbasea bombycina* Busk, 1852 (=*O. buski* Harmer, 1923)]. Unilamellar, foliate zoarium. Zooecial frontal an olocyst; aperture with crescentic ascopore; operculum composite.——Fig. 169,*4*. **O. bombycina* (Busk), SE.Atl.; ×50 (134).

Onchoporoides Ortmann, 1890 [**Carbasea moseleyi* Busk, 1884]. Zoarium unilamellar, clavulate. Ascopore not visible. SW.Pac.

Family EUTHYRISELLIDAE Bassler, nov.

[=emend. Euthyridae Lev., 1909] [=Urceoliporidae Bassler, 1936]

Zoaria free, branched, flexible, with slightly calcified claviform zooecia. Ectocyst kept distended by ridgelike processes from the subjacent olocyst. Ovicell wanting or endozooecial (31). *Rec.*

Euthyrisella Bassler, 1936 [*pro Euthyris* Hincks, 1882 (*non* Quenst., 1869)] [**E. obtecta*]. Two forms of zooecia but no ovicell. Aperture with 2 cardelles; frontal a continuous calcareous layer. ——Fig. 169,*6*. **E. obtecta* (Hincks), SW.Pac.; *6a,b*, ×50 (181).

Neoeuthyris Bretnall, 1921 [*Euthyris woosteri* MacGill., 1891]. SW.Pac.

Pleurotoichus Lev., 1909 [**Euthyris clathratus* Harmer, 1902]. SW.Pac.

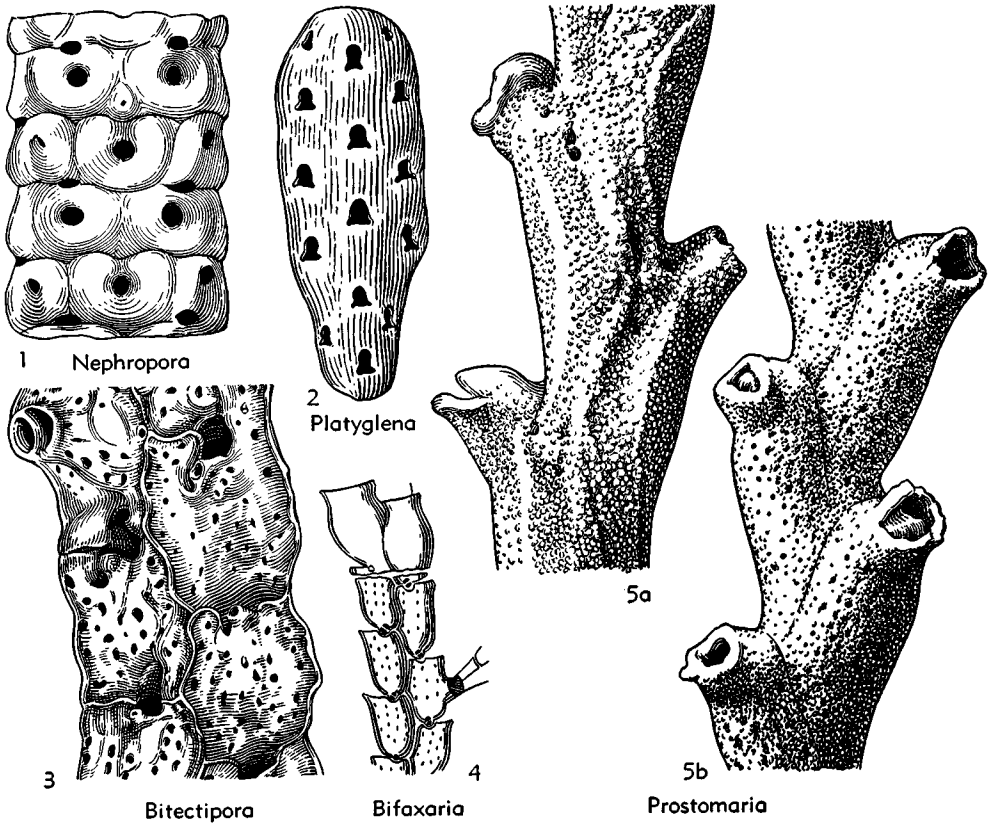


Fig. 170. Bifaxariidae, Bitectiporidae, Nephroporidae, Platyglenidae, Prostomariidae (p. G227).

Urceolipora MacGill., 1881 [**U. nana*] [=*Calymmophora* Busk, 1884]. Aperture with narrow sinus; walls with uniporous septules.——Fig. 169,*5*. **U. nana*, SW.Pac.; *5a,b*, ×50 (181).

Family BIFAXARIIDAE Busk, 1884

Zoaria rigid, continuous or articulated, narrow, branched, with radical tubes. Biserial zooecia, alternate, back to back; small circular avicularium; deeply embedded ovicell (15). *Rec.*

Bifaxaria Busk, 1884 [**B. submucronata*].——Fig. 170,*4*. **B. submucronata*, SW.Atl.; ×10 (134).

Family BITECTIPORIDAE MacGillivray, 1895

Zoaria cylindrical, hollow. Zooecia in longitudinal rows bounded by platelike ridges. Sinus at base of funnel-shaped depression (87). *Tert.*

Bitectipora MacGill., 1895 [**B. lineata*].——Fig. 170,*3*. **B. lineata*, S.Austral.; ×25 (181).

Family NEPHROPORIDAE Marsson, 1887

Zoaria small solid suboval stems. Zooecia kidney-shaped, in longitudinal rows, central aperture surmounted by a small avicularium (96). *Cret.*

Nephropora Marsson, 1887 [**N. elegans*].——Fig. 170,*1*. **N. elegans*, Camp., Ger.; ×25 (186).

Family PLATYGLENIDAE Marsson, 1887

Small stems with zooecia in alternating longitudinal rows. *Onychocella*-like apertures (96). *Cret.*

Platyglena Marsson, 1887 [**P. clava*].——Fig. 170, *2*. **P. clava*, Camp., Ger.; ×25 (186).

Family PROSTOMARIIDAE MacGillivray, 1895

Zoaria erect, branched, with 2 alternating rows of large uniserial zooecia (87). *Tert.*

Prostomaria MacGill., 1895 [**P. gibbericollis*].——Fig. 170,*5*. **P. gibbericollis*, Austral.; *5a,b*, ×25 (131).

Family MAMILLOPORIDAE Canu & Bassler, 1927

Zoaria small, orbicular. Zooecia juxtaposed, without pit (zoarial cavity); proximal border of aperture oriented toward apex. Ovicell hyperstomial, with special interzooecial cavity, closed by the operculum (31). *Eoc.-Rec.*

Mamillopora Smitt, 1873 [**M. cupula*]. Zoarium conical, both sides bearing mammilloid protuberances. Aperture subelliptical with 2 submedian cardelles. Elliptical or oval avicularia between zooecia. Ovicelled zooecia much larger, deeply embedded, with elongate apertures. *Eoc.-Rec.*——Fig. 171,*3*. **M. cupula*, Rec., GulfMex.; ×25 (236).

Anoteropora Canu-B., 1927 [**A. magnicapitata*]. Like *Mamillopora* but with distal large transverse triangular avicularium. Inferior base porous. *Plio.-Rec.*——Fig. 171,*4*. **A. magnicapitata*, Rec., SW. Pac.; ×25 (137).

Ascosia Jullien, 1882 [**A. pandora*]. Zooecia erect, joined only at base. Apertures oval, with 1 or 2 vibracula on sides. Ovicell globular, sunk within hood on back of zooecium. Dorsal formed by convex bases of zooecia. *Rec.*——Fig. 171,*1*. **A. pandora*, E.Atl.; *1a,b*, ×10 (169).

Discoflustrellaria d'Orb., 1853 [**D. clypeiformis*]. Free, convex zoaria with concave base. *Cret.*——Fig. 171,*2*. **D. clypeiformis*, Maastr., Fr.; *2a,b*, ×5 (202).

Discosella Canu, 1925 [**D. porosa*]. *Eoc.*, Fr.-Belg.

Fedora Jullien, 1882 [**F. edwardsi*]. Internodes of large zoaria connected by chitinous tubes. Zooecia subhexagonal, with circular orifice indented on posterior fourth. Ovicell nonsalient, indicated by a smooth bend. Avicularia not constant, lateral outside of orifice. *Rec.*——Fig. 171,*5*. **F. edwardsi*, E.Atl.; *5a,b*, ×25, ×50 (169).

Fedorella Silén, 1947 [**F. minima*]. Like *Fedora* but special chambers absent; ovicells hyperstomial. *Rec.*

Kionidella Koschinsky, 1885 [**K. excelsa*]. Zoarium free, convex to elongate, concave below. Apertures with median cardelles and 2 triangular avicularia with beaks pointing toward apertures. *Eoc.-Oligo.*——Fig. 171,*6*. **K. excelsa*, Lut., Ger.; *6a,c*, ×25, ×2, ×10 (172).

Prattia d'Archiac, 1847 [**P. glandulosa*]. Zoarium long, tubular. Apertures suborbicular, without cardelles; some cells transformed into large oblique avicularia with pivot. Ovicell small. *Eoc.*——Fig. 171,*7*. **P. glandulosa*, Auver., Fr.; ×25 (137).

Stenosipora Canu-B., 1927 [**Stichoporina protecta* Koschinsky, 1885]. Zoaria cupuliform. Zooecia with hexagonal, porous base and convex front; aperture elliptical, bearing 2 low cardelles and 2 lateral avicularia. Ovicell embedded in distal zooecium, no larger than others. *Eoc.*——Fig. 171,*8*. **S. protecta* (Koschinsky), Lut., Ger.; *8a-c*, ×25 (172).

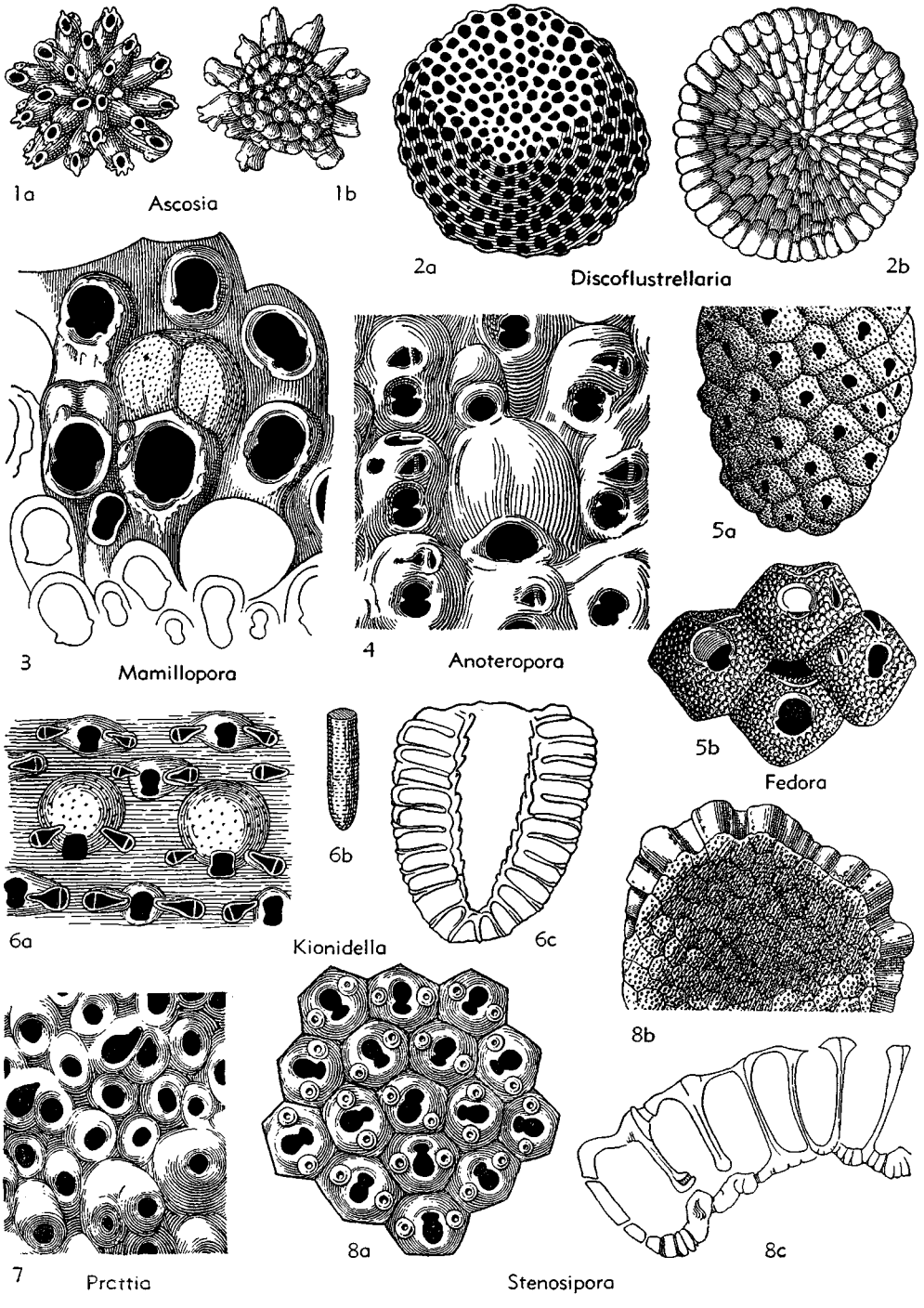


FIG. 171. Mamilloporidae (p. G227).

Family ORBITULIPORIDAE Canu & Bassler, 1923

Zoaria orbicular to cupuliform, with central or terminal pit (zooecial cavity) toward which vertically arranged juxtaposed zooecia are directed. Ovicell hyperstomial, recumbent, oriented toward pit (26). *Cret.-Rec.*

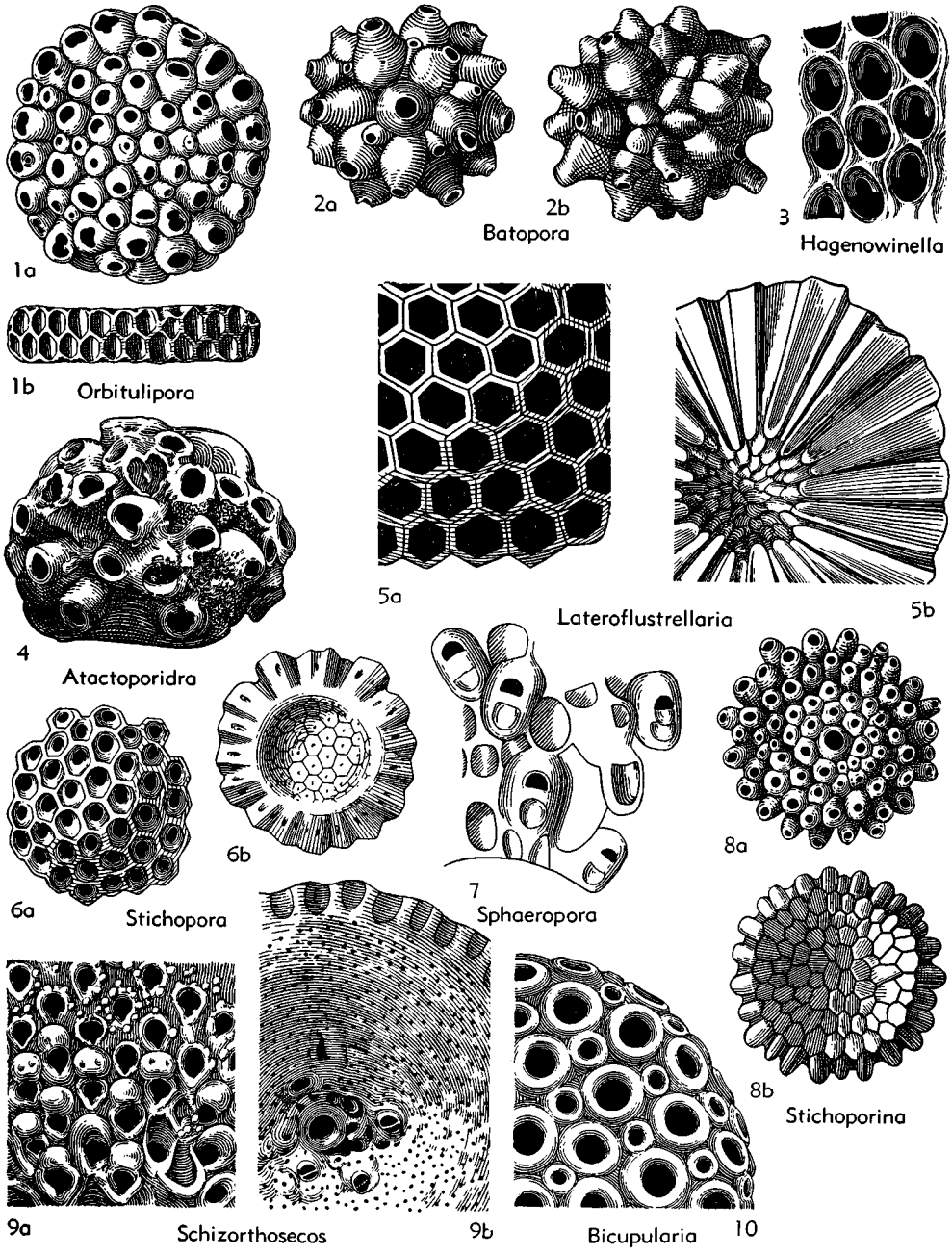


FIG. 172. Orbituliporidae (p. G230).

Orbitulipora STOLICZKA, 1861 [**O. haidingeri*]. Bilamellar. Zooecial front a tremocyst; aperture large with straight lower edge. *Eoc.-Oligo.*——FIG. 172, *1. O. petiolus* LONSD., Tongr., Belg.; *1a,b,* ×25 (218).

Atactoporidra CANU-B., 1931 [*pro Atactopora* CANU-B., 1929 (*non* ULR., 1879)] [**Manon bredaniana* MORREN, 1828]. Claviform. Zooecia accumulated in disorder on each other; aperture suborbicular, with proximal border little concave. *Oligo.*——FIG. 172,*4.* **A. bredaniana* (MORREN), Tongr., Belg.; ×25 (136).

Batopora REUSS, 1867 [**B. stoliczkai*]. Zoarium conical to rounded, 2 superposed lamellae. Frontal a granular olocyst; aperture small, nearly round, with straight lower edge. *Eoc.-Oligo.*——FIG. 172, *2. *B. stoliczkai,* Latt., Ger.; *2a,b,* ×25 (210).

Bicupularia REUSS, 1864 [**B. lenticularis*]. Zoarium cupuliform. Zooecia rounded, with small intermediate openings. *Tert.*——FIG. 172,*10. *B. lenticularis,* Ger.; ×25 (210).

Hagenowinella CANU, 1900 [**Cellepora vaginata* HAG., 1851]. Zoarium uni- or bilamellar. Zooecia bearing horseshoe-shaped lamella attached to superior part of mural rim. *Cret.*——FIG. 172,*3. *H. vaginata* (HAG.), Maastr., Holl.; ×10 (136).

Lateroflustrellaria D'ORB., 1853 [**L. hexagona*]. Zoarium convex, with deep hexagonal zooecia radiating in quincunx around ancestrula. *Cret.*——FIG. 172,*5. *L. hexagona,* Maastr., Fr.; *5a,b,* ×10 (202).

Schizorthosecos CANU-B., 1917 [**Orbitolites interstitia* LEA, 1833]. Zoarium free, thin, cupuliform. Apertures oval, with rounded proximal rimule; numerous zooeciules. Inner face marked by hexagons perforated by tremopores. *Eoc.*——FIG. 172,*9. *S. interstitia* (LEA), Claib., Ala.; *9a,b,* ×25 (137).

Sphaeropora HASWELL, 1881 [**S. fossa*] [=*Sphaerophora* BASSLER, 1935 (*non* ZETTERSTEDT, 1849)]. Zoarium multilaminate. Apertures with straight lower edge. *Mio.-Rec.*——FIG. 172,*7. *S. fossa,* Rec., SW.Pac.; ×25 (166).

Stichopora HAG., 1846 [**S. clypeata*]. Concavo-convex disks of zooecia with equal hexagonal cells in quincunx; basal side smooth but with traces of zooecia. *Cret.*——FIG. 172,*6. *S. clypeata,* Maastr., Ger.; *6a,b,* ×5 (160).

Stichoporina STOLICZKA, 1862 [**S. reussi*] [=*Discoescharites* ROEMER, 1863]. Unilaminate disks with zooecia directed toward central pit; interior side showing bases of juxtaposed zooecia. *Eoc.-Rec.*——FIG. 172,*8. *S. reussi,* Latt., Ger.; *8a,b,* ×10 (218).

Family CONESCHARELLINIDAE Levinsen, 1909

Zoaria varied in form, hanging in thin tubes from foreign objects, with ancestrula and later-formed zooecia separated from substratum. Zooecia prismatic, hexagonal, erect, juxtaposed; apertures terminal, with distal sinus accompanied by a proximal pore (terms reversed on basal side). Avicularia abundant. Ovicells hyperstomial. The mode of formation of the zoarium has produced a peculiar reversal of the aperture (and ooecium) to the basal wall of the zooecium. (Type family of Ascophora, division Simostomia, section Gymnocystidae, SILÉN, 1937). (24; SILÉN, 1947). *Tert.-Rec.*

Conescharellina D'ORB., 1852 [**C. angustata*]. Zoarium cone-shaped, outer layer composed of hexagonal zooecia arranged from apex to the flat zoarial base; heterozooecia form inner layer and flat base; cones suspended base downward by several thin tubes. Aperture on distal wall, with its sinus distal toward growing edge of zoarium. Avicularia small, placed at inner zooecial angles. *Tert.-Rec.*——FIG. 173,*6. *C. angustata,* Rec., SW.Pac.; *6a,b,* ×25 (202).

Bipora WHITELEGGE, 1887 [**Eschara umbonata* HASWELL, 1881] [=*Zeuglopora* MAPLE., 1909]. Bifoliate, fan-shaped. Apertures with proximal rimule. *Rec.*——FIG. 173,*3. *B. umbonata* (HASWELL), SW.Pac.; ×25 (166).

Crucescharellina SILÉN, 1947 [**C. japonica*]. Zoarium flattened, divided into branches and suspended by several chitinous tubes so that it rests horizontally; zooecia confined to upper surface of zoarium, heterozooecia to lower surface. Ovicells not known. *Rec.*——FIG. 173,*4. *C. japonica,* NW. Pac.; ×5 (216).

Flabellopora D'ORB., 1852 [**F. elegans*]. Zoaria bifoliate, flat, flabelliform, vertically placed. Zooecia hexagonal, in linear rows issuing from ancestrular base and covering both sides of colony. Aperture excentric, suborbicular, with small proximal pore and distal sinus. Avicularia common. *Rec.*——FIG. 173,*2. *F. elegans,* W.Pac.; *2a,b,* ×25 (202).

Trochosodon CANU-B., 1927 [**T. linearis*]. Differs from *Conescharellina* in its convex zoarium and absence of avicularia. *Rec.*——FIG. 173,*5. *T. linearis,* SW.Pac.; *5a,b,* ×25 (131).

Family FUSICELLARIIDAE d'Orbigny, 1851

Zoaria comprising fusiform, elongate, jointed segments with acuminate ends. Zooecial structure doubtful. *Cret.*

Fusicellaria D'ORB., 1851 [**F. pulchella*].——FIG. 173,*1. *F. pulchella,* Turon., Fr.; *1a,* ×1; *1b,c,* ×25 (202).

Family MYRIOZOIDAE Smitt, 1867

Zoaria incrusting or free-branching stems. Zooecia juxtaposed, with thick frontal, formed of a tremocyst with tubules. Ovicell hyperstomial, lodged in depression in distal zooecium. Uniporous septules or diatellae present (26). *Mio.-Rec.*

Myriozoum Donati, 1750 [*Millepora truncata* Pallas, 1766] [=*Myriopora* Blainv., 1830; *Myrioporina* Ehr., 1830; *Leieschara* Sars, 1862]. Zoar-

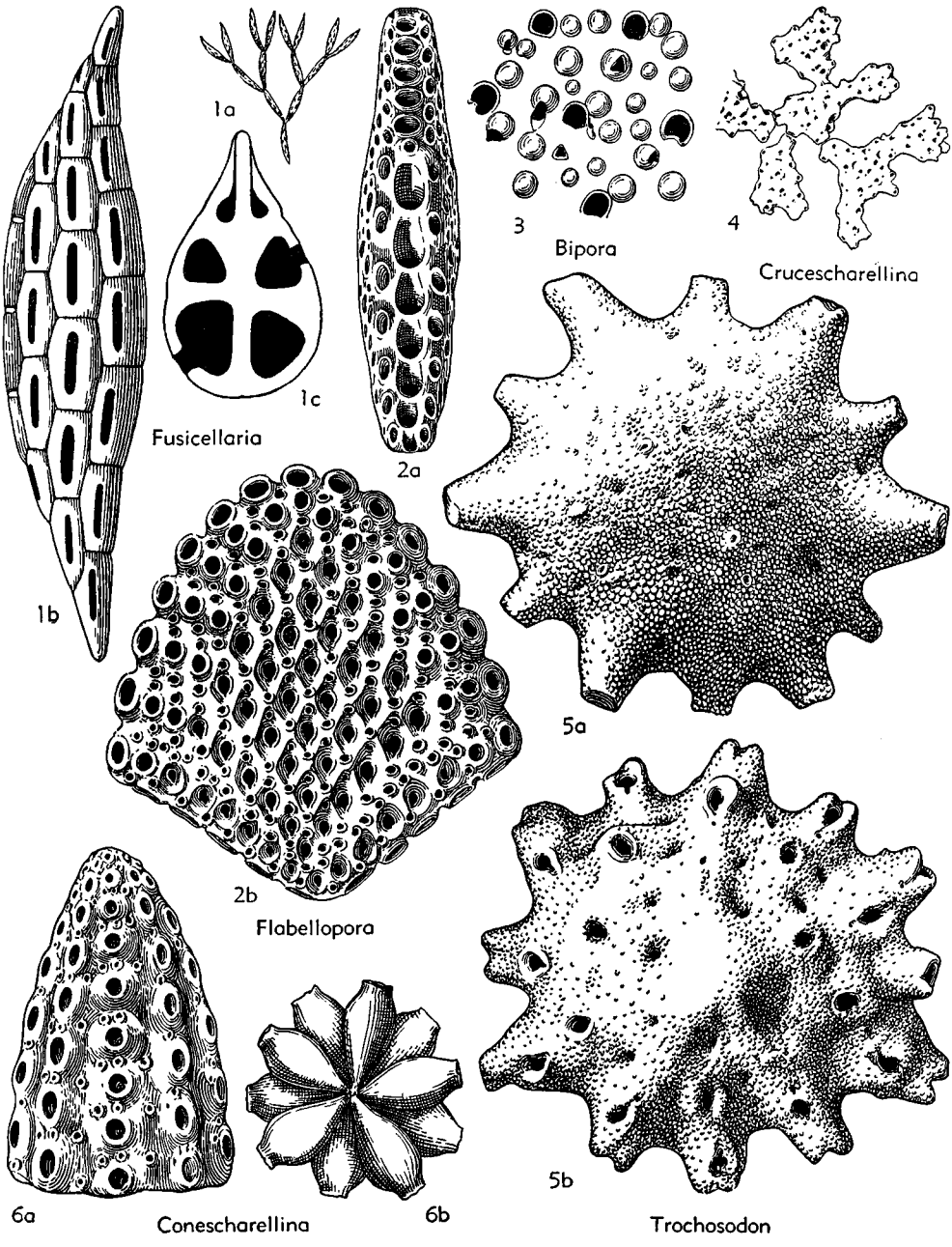


Fig. 173. Conescharellinidae, Fusicellariidae (p. G230).

ium free, cylindrical branches. *Mio.-Rec.*——Fig. 174,*1*. **M. truncata* (Pallas), Rec., Medit.; *1a,b*, ×10, ×25 (183).

Myriozoella Lev., 1909 [**Myriozoum crustaceum* Smitt, 1868]. Like *Myriozoum* but zoarium incrusting, dietellae present. *Rec.*——Fig. 174,*2*. **M. crustacea* (Smitt), N.Atl.; *2a,b*, ×25 (236).

Family LEKYTHOPORIDAE Levinsen, 1909

Zoaria incrusting, orbicular, or free-branching. Zooecia with long tubular peristomie followed by salient peristome bearing

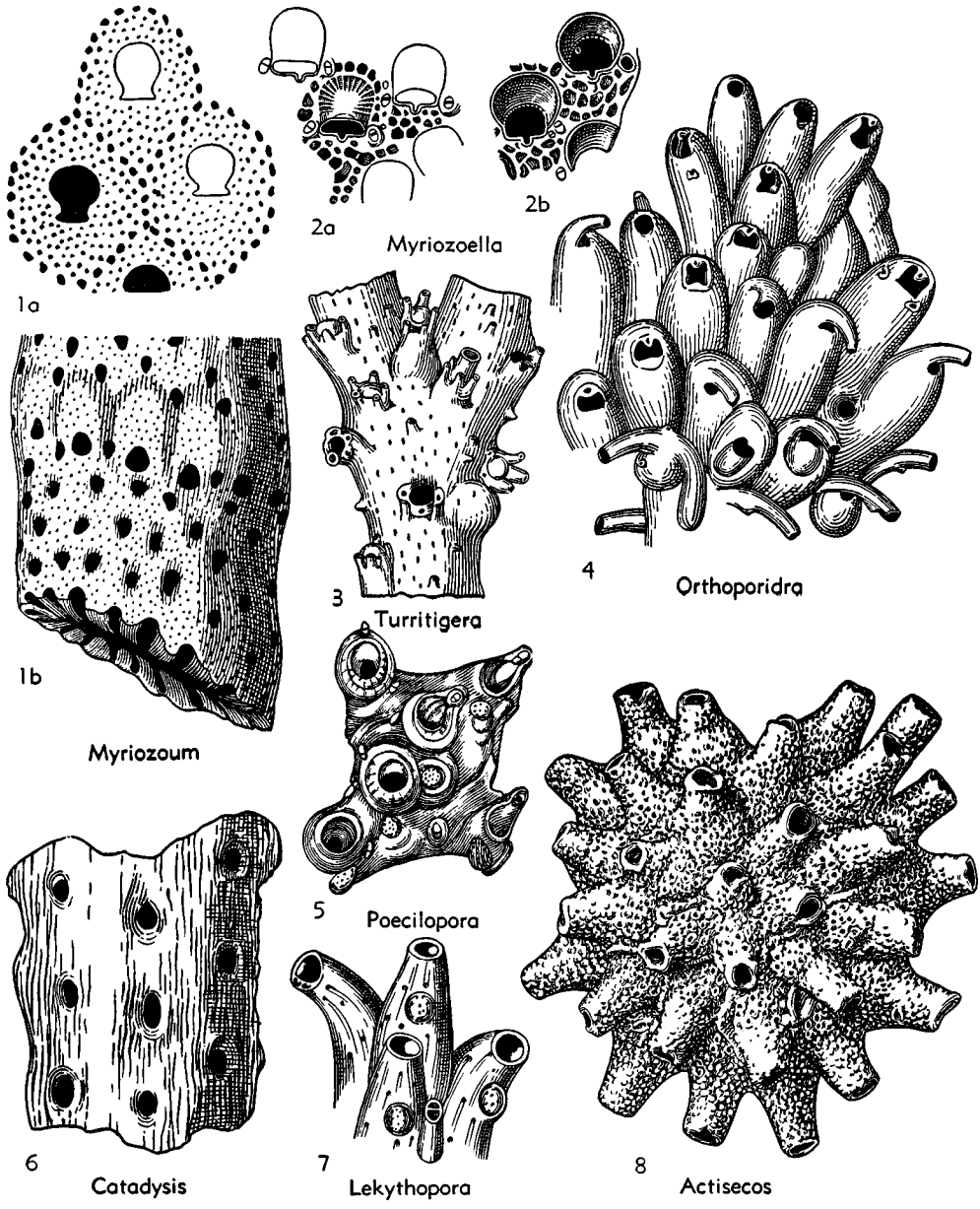


Fig. 174. Myriozoidae, Lekythoporidae (p. G231-G233).

1 to 5 avicularia. Aperture buried at base of peristomie on proximal, instead of distal side of ovicell opening. Family characterized by position of ovicell opening (31). *Tert.-Rec.*

Lekythopora MacGill., 1883 [**L. hystrix*]. Incrusting. Peristomie free above ovicell, with very salient peristome bearing small avicularium. Interzooecial avicularia. *Tert.-Rec.*——Fig. 174,*7*. **L. hystrix*, Rec., SW.Pac.; ×25 (181).

Actisecos Canu-B., 1927 [**A. regularis*]. Orbicular convex zoarium with hexagonal zooecial bases on inner face. *Rec.*——Fig. 174,*8*. **A. regularis*, SW. Pac.; ×25 (131).

Catadysis Canu-B., 1927 [**Schizoporella challengeriana* Waters, 1888]. Cylindrical branches. Zooecia indistinct, with frontal longitudinally striate, walls much thickened by tremocyst with very small tubes. *Rec.*——Fig. 174,*6*. **C. challengeriana* (Waters), SW.Atl.; ×25 (230).

Orthoporidra Canu-B., 1927 [*pro Orthopora* Waters, 1904 (*non* Hall, 1886)][**Orthopora compacta* Waters, 1904]. Colony free, branched. Zooecia with long and partially free peristomie, terminated by peristome bearing long process with avicularium. *Rec.*——Fig. 174,*4*. **O. compacta* (Waters), Antarct.; ×25 (230).

Poecilopora MacGill., 1886 [**P. anomala*]. Erect, bilaminate, branched. Zooecia indistinct, with sinus in aperture; peristome first an elevation surmounted by a small avicularium, becomes a tumid ring. *Rec.*——Fig. 174,*5*. **P. anomala*, Antarct.; ×25 (181).

Turritigera Busk, 1884 [**T. stellata*]. Zooecia on one side of the erect colony with thick walls, united by connecting tubes; aperture at bottom of peristomie with proximal rimule; peristome bears small salient avicularia. *Rec.*——Fig. 174,*3*. **T. stellata*, SW.Atl.; ×25 (134).

Class PHYLACTOLAEMATA Allman, 1856

Fresh-water Ectoprocta characterized by horseshoe-shaped arrangement of tentacles around the mouth, which is protected by an overhanging lip (epistome); mineralized skeleton lacking. *Cret.-Rec.*

By reason of their fresh-water habitat, the Phylactolaemata are specialized for existence under conditions where change of temperature and danger of drying up are ever present. A peculiarity is the habit of dying down in winter with formation of so-called **statoblasts,** which are hard-shelled reproductive bodies consisting of internal buds protected by a chitinous shell, capable of resisting unfavorable conditions for a relatively long period and then forming new zooids. Sexual reproduction also occurs as in other bryozoans. The Phylactolaemata have a body structure somewhat similar to that of the Ctenostomata, belonging to the class Gymnolaemata, some of which also show a tendency to live in fresh water. The exclusively fresh-water Phylactolaemata may have been derived from these Ctenostomata. Quite common in a zone about 2 feet below the water surface, their colonies are found attached to plants or stones, locally in currents but mostly in still water.

In the Phylactolaemata, the outermost layer of the body wall is a flexible uncalcified cuticle (ectocyst), beneath which follow in succession the ectoderm, muscular layers, and the coelomic epithelium. The zoarium may consist of gelatinous masses of varying size, of aggregations of parallel tubes, or of single branching tubes, in all of which the body cavities of the zooids are continuous with each other, whereas among species of the Gymnolaemata each zooid has its own body wall. As in the Entoprocta, the body wall is uncalcified, and fossil forms are not to be expected. Protrusion of the polypide is effected by contraction of the muscular body wall which compresses the fluid of the body cavity. The tentacles may interlace to form a sort of cage in which infusoria used for food are imprisoned.

Cristatella (Fig. 175), a typical member of the Phylactolaemata, consists of a slug-shaped gelatinous mass, as much as 8 inches long but only 0.5 inch wide, with a flattened sole upon which it crawls. The protruding polypides form a delicate fringe along the upper side, while around the edge of the mass a zone of budding tissue gives rise to new zooids. *Fredericella,* another typical genus, is a member of the deep-water fauna of lakes in Switzerland. *Plumatella* forms aggregations of parallel tubes. *Lophopus* and *Pectinatella,* like *Cristatella,* show powers of locomotion. Owing probably to their reproduction by statoblasts, these genera have wide geographical distribution, being found in Europe, North America, South America, Africa, and Australia.

Although species of Phylactolaemata are comparatively few, they give rise to such in-

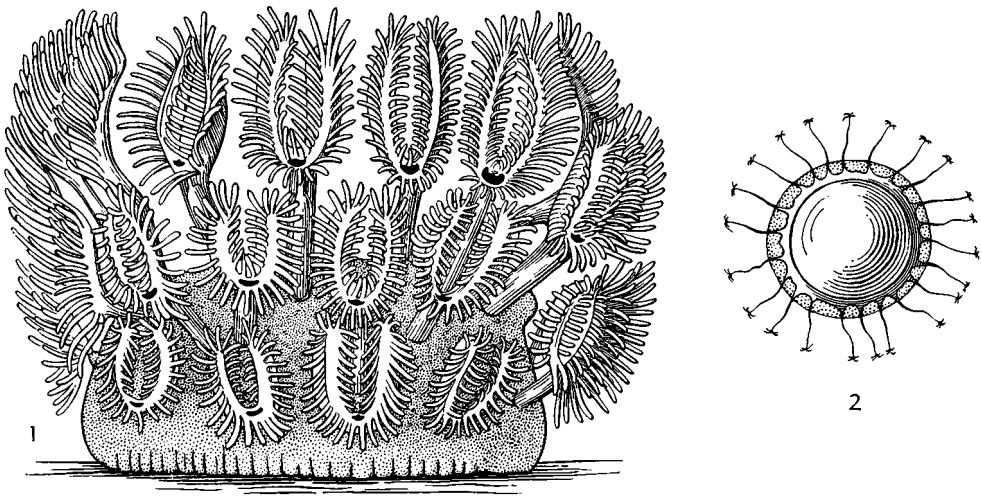


FIG. 175. Typical member of the Phylactolaemata, the fresh-water bryozoan *Cristatella mucedo* CUVIER, Rec., Eng., ×24. *1*, Slug-shaped body of the colony, which is able to move about slowly; the horseshoe-shaped lophophores of the individual zooids are prominent. *2*, Statoblast reproductive body of the same species, ×28 (137).

teresting phenomena that literature on these bryozoans is quite extensive. The monographs of ALLMAN (1856) and JULLIEN (1885) should be consulted for a general review, as also the more recent papers on North American faunas by MARY D. ROGICK (1934-1949). Other students are BRAEM (1890, 1897), CORI (1893), DAVENPORT (1890, 1891, 1893), MARCUS (1894), and ANNA B. HASTINGS (1929).

These soft-bodied animals cannot be expected to be found fossil except under unusual conditions of preservation. The fresh-water Cretaceous (Cenomanian) beds of Bohemia have yielded an organism incrusting a *Unio* resembling the Recent genus *Plumatella*. Although the structure is too imperfectly preserved for certain identification, this specimen, 8 mm. long with branches 0.6 to 1.00 mm. wide (*Plumatellites proliferus* FRIC, 1901; Plumatellidae FRIC, 1901), may be accepted as a fossil representative of the Phylactolaemata. Certain organisms supposed to be statoblasts of this order have been described from the Quaternary.

Important genera of Phylactolaemata are *Cristatella* CUVIER (1798), *Fredericella* ALLMAN (1884), *Hyallinella* JULLIEN (1885), *Australella* ANNANDALE (1910), *Lophopodella* ROUSSELET (1904), *Lophopus* DUMORTIER (1835), *Pectinatella* LEIDY (1852), *Plumatella* LAMARCK (1852), and *Rhabdopleura* ALLMAN (1867).

UNRECOGNIZED GENERIC NAMES APPLIED TO BRYOZOANS

Acerviclausa GABB-H., 1860, *Eoc.*, N.J.
Angularia BUSK, 1881 (no species), *Rec.*
Anellina GREGORIO, 1930 (?fistuliporoid cyclostome), *Perm.*, Italy.
Aprutinopora PARONA, 1909, *Cret.*, Italy.
Archaeopora EICHW., 1860, *Ord.*, Balt.
Arboricladia NEKH., 1933 (*nom. nud.*), *L.Carb.*, E.Asia.
Bauneia PETERHANS, 1927, *Jur.*, Switz.
Buccula EICHW., 1860, *Carb.*, Russ.
Buskia REUSS, 1864 (*non* ALDER, 1857), *Oligo.*, Ger.
Buskia T.WOODS, 1877 (*non* ALDER, 1857).
Cambroporella KORDA, 1950.
Ceidmonea PERGENS, 1892, *Cret.*, Holl.
Celleporaria LAMX., 1821, *Rec.*, SW.Pac.
Celleporina GRAY, 1848 (?=*Costazia*), *Rec.*, Atl.
Celleporina D'ORB., 1852 (*non* GRAY, 1848), *Rec.*, Atl.
Cellomma STECHOW, 1921 (*nom. nud.*), *Rec.*, SE. Atl.
Cellularia PALLAS, 1766, *Rec.*, Atl.
Coeleschara BUSK, 1860 (*nom. nud.*), *Rec.*
Cumulipora MÜNSTER, 1835, *Tert.*, Ger.
Cupularia BLAINV., 1830.
Cycleschara ROEMER, 1863, *Tert.*, Ger.

Diaphragmopora McFarlan, 1926, *U.Miss.*, Ky.

Dioptropora Marsson, 1887 (?cheilostome), *Cret.*, Ger.

Disteichia Sharpe, 1853, *Sil.*, Portugal.

Ennallipora Gabb-H., 1862, *Mio.*, Va.

Eschara Linné, 1758, *Rec.*

Escharella Gray, 1848, *Rec.*, N.Atl.

Escharella d'Orb., 1852 (*non* Gray, 1848), *Cret.*, Holl.

Escharellina d'Orb., 1852, *Mio.*, Aus.

Escharinella d'Orb., 1852 (types lost), *Cret.*, Fr.

Escharopsia Gregorio, 1882, *Cret.*, Italy.

Escharopsis Verrill, 1879, *Rec.*, Atl.

Favositella Mansuy, 1912 (*non* Eth.-F., 1884) (stenoporoid trepostome), *Dev.*, China.

Filiflustra d'Orb., 1852 (membraniporoid cheilostome), *Cret.*, Fr.

Filiflustrellaria d'Orb., 1853 (membraniporoid cheilostome), *Cret.*, Fr.

Filiflustrina d'Orb., 1853, *Cret.*, Fr.

Flabellaria Gray, 1848 (*non* Lamarck, 1816). *Rec.*, Fr.

Flabellina Gregorio, 1930 (*non* Voigt, 1934, *nec* Lev., 1902), *Perm.*, Italy.

Flustrella Ehr., 1839, *Cret.*

Flustrella d'Orb., 1852 (*non* Ehr., 1839, *nec* Gray, 1848), *Cret.*, Fr.

Flustrina d'Orb., 1852 (*non* van Beneden, 1850), *Cret.*, Fr.

Glauconome Goldf., 1829, *Tert.*, Ger. (based on unrecognizable *Vincularia*-type of bryozoan).

Hemeschara Busk, 1850 [=*Hemieschara* Reuss, 1869] (unilamellar ascophoran cheilostome), *Rec.*

Herentia Gray, 1848, *Rec.*, Atl.

Heteroflustra Lev., 1909 (no type) (unplaced Flustridae).

Heterotrypella Vinassa, 1921 (undefined), *Ord.*

Holopora Počta, 1902, *Dev.*, Czech.

Keruniella Stechöw, 1921 *(nom. nud.)*.

Kirchenpaueria Kirchenpauer, 1869.

Latereschara d'Orb., 1853, *Cret.*, Fr.

Lepralia Johnston, 1838. This generic name, widely but loosely used in early literature, has been employed by various workers in later years for unidentified or unidentifiable Hipporinidae. Since the species first listed by Johnston *(L. hyalina)* belongs to *Hippothoa* Lamx., 1821, Norman (1903, p. 99) proposed to designate the second named species *(L. nitida)* as type of *Lepralia*, overlooking the fact that Smith (1873) had chosen this species as type of *Membraniporella*. Other species included by Johnston are so involved generically that *Lepralia* is here treated as undeterminable. *Rec.*

Liriozoaria van Beneden, 1849 *(nom. nud.)*, *Rec.*

Membraniporina Lev., 1909 (no type) (unplaced Membraniporidae), *Cret.-Rec.*

Mesosecos Faura Sans & Canu, 1916, *Eoc.*, Sp.

Microstoma Gray, 1848 (*non* Cuvier, 1817), *Rec.*, NE.Atl.

Millestroma Gregory, 1898, *Cret.*, Egypt.

Monopora Canu, 1910 (*non* Salensky, 1884).

Monotrypella Vinassa, 1911 (*non* Ulr., 1882), *Trias.*, Aus.

Multescharellina d'Orb., 1852, *Cret.*, Ger.

Multescharinella d'Orb., 1852, *Mio.*, Aus.

Multinodicrescis d'Orb., 1854 *(nom. nud.)*, *Cret.*, Fr.

Multiporina d'Orb., 1852 (*non* Gabb-H., 1862), *Cret.*, Fr.

Myriolithes, Eichw., 1860 (monticuliporoid trepostome), *Ord.*, Balt.

Nebrodensia Gregorio, 1930 (fenestellid cryptostome), *Trias.*, Italy.

Nebulipora McCoy, 1850, *Sil.*, Eng.

Nicholsonelloides McFarlan, 1926 *(nom. nud.)*, *Miss.*, Ill.

Nicholsonia Bogatirev, 1899 (*non* Davis, 1885, *nec* Waagen-W., 1886) (monticuliporoid), *Dev.*, Russ.

Palaeoflustra Jullien, 1896, *Carb.*, Fr.

Patinella Gray, 1848 (?=*Plagioecia* Canu, 1918), *Rec.*, Atl.

Petalotrypella Vinassa, 1920, *Trias.*, Timor.

Poikilia Jullien, 1903 (no species), *Rec.*, Atl.

Polyeschara Reuss, 1867, *Oligo.*, Ger.

Porellina d'Orb., 1851 [?=*Umbonula*], *Mio.*, Aus.

Pseudostromatopora Simioniscu, 1927, *Cret.*, Rumania.

Pumiscaria Gabb-H., 1862, *Rec.*, W.Atl.

Reptescharellina d'Orb., 1852, *Cret.*, Fr.

Reptoflustra d'Orb., 1851, *Rec.*, Medit.

Reptoflustrella d'Orb., 1852, *Cret.*, Fr.

Reptolatereschara d'Orb., 1852, *Rec.*, SE.Atl.

Reptonodicrescis d'Orb., 1854, *Jur.*, Fr.

Reptoporina d'Orb., 1852 (membraniporoid cheilostome), *Cret.*, Fr.

Semicelleporaria d'Orb., 1853, *Mio.*, Fr.

Semiescharella d'Orb., 1853, *Rec.*, Medit.

Semiescharellina d'Orb., 1852 (type lost), *Cret.*, Fr.

Semiescharinella d'Orb., 1852, *Cret.*, Fr.

Semiflustra d'Orb., 1853, *Rec.*, E.Indies.

Semiflustrella d'Orb., 1853 (membraniporoid cheilostome), *Cret.*, Fr.

Semiflustrina d'Orb., 1853 [?=*Callopora*], *Cret.*, Fr.

Semiporina d'Orb., 1852, *Eoc.*, Fr.

Semizonopora Loriol, 1863 (heteroporoid cyclostome), *Cret.*, Switz.

Siphonella Hag., 1850 (*non* Macquart, 1835), *Cret.*, Holl.

Sphaerostyomella Yabe & Sugiyama, 1935, *Perm.*, Japan.

Spirella Hag., 1851, *Cret.*, Holl.

Sulcopora d'Orb., 1849 [?=*Rhinidictya*], *Ord.*, N.Y.

Tata van Beneden, 1849 (membraniporoid), *Rec.*, Atl.

Trochopora KETTNER, 1913 (*non* D'ORB., 1849) [?=*Diplotrypa*], *Dev.*, Czech.
Tuberculopora RINGUEBERG, 1886, *Sil.*, N.Y.
Vaginopora DEFRANCE, 1828 (*non* HAG., 1846).
Vetofistula ETH., 1917 [**V. mirabilis*], *Dev.*, Austral.
Vincularina D'ORB., 1851, *Cret.*, Fr.
Zeapora PENECKE, 1893 (trepostome), *Dev.*, Alps.

GENERIC NAMES APPLIED TO BRYOZOANS BUT BELONGING TO OTHER ORGANISMS

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Chaetetes FISCHER, 1837 (tabulate coral), *Dev.-Carb.*
Crisioides MICH., 1846 (?auloporoid coral), *Carb.*, Belg.
Cymbalopora HAG., 1851 (foraminifer), *Cret.*, Holl.
Mastopora EICHW., 1860 (?sponge related to *Pasceolus*), *Ord.*, Balt.
Melobesia LAMX., 1812 (calcareous alga), *Rec.*, Fr.
Omniretepora D'ORB., 1849 (?cladoporoid tabulate coral), *Dev.*, Ky.-Ind.
Orbitolites LAMARCK, 1801 (foraminifer), *Eoc.*, Ala.-Miss.
Paronipara CAPEDER, 1904 (?coral), Italy.
Ptychocladia ULR.-B., 1904 (foraminifer), *Penn.*, Ill.
Rhabdinopora EICHW., 1855 (graptolite), *Ord.*, Balt.
Rhaphidopora NICH.-F., 1886 (?tabulate coral related to *Chaetetes*), *Dev.*, Ger.
Sertularia LINNÉ, 1758 (hydroid), *Rec.*

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