TREATISE ON INVERTEBRATE PALEONTOLOGY

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By DOROTHY HILL

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Part A. INTRODUCTION.
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Part R. ARTHROPODA 4, Volume 3 (Hexapoda).
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EDITORIAL PREFACE

INTRODUCTION

The present volume is the second of a number of revised editions of parts of the *Treatise on Invertebrate Paleontology* planned for publication during the next several years, directed and edited by CURT TEICHERT. The first volume of the *Treatise,* Part G, was published in 1953. Seven more parts followed in the 1950's. Experience has shown that after a period of about 10 years, many volumes, or at least sections of volumes, begin to decline in usefulness, except in fields where progress in research is slow. The first revised edition was that of Part V, published in 1970. The description of the phylum Archaeocyatha formed only a small section (p. *E*1-*E*20) of the first Part E. It was authored by V. J. OKULITCH and published in 1955. When planning began for a revised edition of Part E, Dr. OKULITCH, because of other pressing commitments, found it impossible to undertake this task and Professor DOROTHY HILL accepted the assignment. The increase in volume from 20 pages in the first edition to 152 pages in this revision accurately reflects the increase in knowledge of this group in the intervening period.

In general, style and format of the revised editions and supplements conform with those of earlier *Treatise* volumes. Much of the contents represents the results of new research by many paleontologists.

The general Editorial Preface prepared by R. C. MOORE which has been reprinted, with modifications, in all parts of the *Treatise* is included here because it also applies to revised editions.

The aim of the *Treatise on Invertebrate Paleontology,* as originally conceived and consistently pursued, is to present the most comprehensive and authoritative, yet compact statement of knowledge concerning invertebrate fossil groups that can be formulated by collaboration of competent specialists in seeking to organize what has been learned of this subject up to the mid-point of the present century. Such work has value in providing a most useful summary of the collective results of multitudinous investigations and thus constitutes 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 is yielding needed foundation for future research.

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 bear the assigned index letter joined with numbers beginning with 1 and running consecutively to the end of the part.

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, (6) paleoecology, and (7) systematic description of genera, subgenera, and higher taxonomic units. 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 editors with aid furnished by advice from representatives of the societies which have undertaken to sponsor the *Treatise.* It is the editors' responsibility to consult with authors and coordinate their work, seeing that manuscript properly incorporates features of adopted style. Especially they are called on to formulate policies in respect to many questions of nomenclature and procedure. The subject of family and subfamily names is reviewed briefly in a following section of this preface, and features of *Treatise* style in generic descriptions are explained.

A generous grant of $35,000 was made in 1948 by the Geological Society of America for initial work in preparing *Treatise* illustrations. Additional grants were made by The Geological Society of America in 1971 ($6,200) and 1972 ($6,000). Administration of expenditures has been in charge of the editors and most of the work by photographers and artists has been done under their direction at the University of Kansas, but sizable parts of this program have also been carried forward in Washington, London, Ottawa, and many other places.

In December, 1959, the National Science Foundation of the United States, through its Division of Biological and Medical Sciences and the Program Director for Systematic Biology, made a grant in the amount of $210,000 for the purpose of aiding the completion of yet-unpublished volumes of the *Treatise*. Payment of this sum was provided to be made in installments distributed over a five-year period, with administration of disbursements handled by the University of Kansas. An additional grant (No. GB 4544) of $102,800 was made by the National Science Foundation in January, 1966, for the two-year period 1966-67, and this was extended for the calendar year 1968 by payment of $25,700 in October, 1967. This grant was extended further by payments of $57,800 in 1968 for calendar year 1969, and $66,600 each for calendar years 1970-71 (Grant Nos. GB8345, GB18390, GB27274). These funds are used primarily to maintain editorial operations at the University of Kansas and to provide assistance to authors needed in preparation of manuscripts and illustrations. Grateful acknowledgment to the Foundation is expressed on behalf of the societies sponsoring the *Treatise*, the University of Kansas, and innumerable individuals benefited by the *Treatise* project.

ZOOLOGICAL NAMES

Many questions arise in connection with zoological names, especially including those that relate to their acceptability and to alterations of some which may be allowed or demanded. Procedure in obtaining answers to these questions is guided and to a large extent governed by regulations published (1961) in the *International Code of Zoological Nomenclature* (hereinafter cited simply as the *Code*). The prime object of the *Code* is to promote stability and universality in the scientific names of animals, ensuring also that each name is distinct and unique while avoiding restrictions on freedom of taxonomic thought or action. Priority is a basic principle, but under specified conditions its application can be modified. This is all well and good, yet nomenclatural tasks confronting the zoological taxonomist are formidable. They warrant the complaint of some that zoology, including paleozoology, is the study of animals rather than of names applied to them.

Several ensuing pages are devoted to aspects of zoological nomenclature that are judged to have chief importance in relation to procedures adopted in the *Treatise*. Terminology is explained, and examples of style employed in the nomenclatural parts of systematic descriptions are given.

TAXA GROUPS

Each taxonomic unit (taxon, pl., taxa) of the animal and protistan kingdoms belongs to a rank in the adopted hierarchy of classificatory divisions. In part, this hierarchy is defined by the *Code* to include a species-group of taxa, a genus-group, and a family-group. Units of lower rank than subspecies are excluded from zoological nomenclature and those higher than superfamily of the family-group are not regulated by the *Code*. It is natural and convenient to discuss nomenclatural matters in general terms first and then to consider each of the taxa groups separately. Especially important is the provision that within each taxa group classificatory units are coordinate (equal in rank), whereas units of different taxa groups are not coordinate.

FORMS OF NAMES

All zoological names are divisible into groups based on their form (spelling). The first-published form (or forms) of a name is defined as original spelling (*Code*, Art. 32) and any later-published form (or forms) of the same name is designated as subsequent spelling (Art. 33). Obviously, original and subsequent spellings of a given name may or may not be identical and this affects consideration of their correctness. Further, examination of original spellings of names shows that by no means all can be distinguished as correct. Some are incorrect, and the same is true of subsequent spellings.

Original Spellings

If the first-published form of a name is consistent and unambiguous, being identical wherever it appears, the original spelling is defined as correct unless it contravenes some stipulation of the *Code* (Arts. 26-31), unless the original publication contains clear evidence of an inadvertent error, in the sense of the *Code,* or among names belonging to the family-group, unless correction of the termination or the stem of the type-genus is required. An unambiguous original spelling that fails to meet these requirements is defined as incorrect.

If a name is spelled in more than one way in the original publication, the form adopted by the first reviser is accepted as the correct original spelling, provided that it complies with mandatory stipulations of the *Code* (Arts. 26-31), including its provision for automatic emendations of minor sort.

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

Subsequent Spellings

If a name classed as a subsequent spelling is identical with an original spelling, it is distinguishable as correct or incorrect on the same criteria that apply to the original spelling. This means that a subsequent spelling identical with a correct original spelling is also correct, and one identical with an incorrect original spelling is also incorrect. In the latter case, both original and subsequent spellings require correction wherever found (authorship and date of the original incorrect spelling being retained).

If a subsequent spelling differs from an original spelling in any way, even by the omission, addition, or alteration of a single letter, the subsequent spelling must be defined as a different name (except that such changes as altered terminations of adjectival specific names to obtain agreement in gender with associated generic names, of family-group names to denote assigned taxonomic rank, and corrections for originally used diacritic marks, hyphens, and the like are excluded from spelling changes conceived to produce a different name). In certain cases species-group names having variable spellings are regarded as homonyms as specified in Art. 58 of the *Code.*

Altered subsequent spellings other than the exceptions noted may be either intentional or unintentional. If demonstrably intentional, the change is designated as an emendation. Emendations are divisible into those classed as justifiable and those comprising all others classed as unjustifiable. Justifiable emendations are corrections of incorrect original spellings, and these take the authorship and date of the original spellings. Unjustifiable emendations are names having their own status in nomenclature, with author and date of their publication; they are junior objective synonyms of the name in its original form.

Subsequent spellings that differ in any way from original spellings, other than previously noted exceptions, and that are not classifiable as emendations are defined as incorrect subsequent spellings. They have no status in nomenclature, do not enter into homonymy, and cannot be used as replacement names.

AVAILABLE AND UNAVAILABLE NAMES

Available Names

An available zoological name is any that conforms to all mandatory provisions of the *Code.* Such names are classifiable in groups which are usefully recognized in the *Treatise,* though not explicitly differentiated in the *Code.* They are as follows:

1) So-called *"inviolate names"* include all available names that are not subject to any sort of alteration from their originally published form. They comprise correct original spellings and commonly include correct subsequent spellings, but include no names classed as emendations. Here belong most genus-group names (including

those for collective groups), some of which differ in spelling from others by only a single letter.

2) Names may be termed *"perfect names"* if, as originally published (with or without duplication by subsequent authors), they meet all mandatory requirements, needing no correction of any kind, but nevertheless are legally alterable in such ways as changing the termination (e.g., many species-group names, family-group names). This group does not include emended incorrect original spellings (e.g., *Oepikina,* replacement of *Öpikina*).

3) *"Imperfect names"* are available names that as originally published (with or without duplication by subsequent authors) contain mandatorily emendable defects. Incorrect original spellings are imperfect names. Examples of emended imperfect names are: among species-group names, *guerini* (not *Guérini*), *obrienae* (not *O'Brienae*), *terranovae* (not *terra-novae*), *nunezi* (not *Nuñezi*), *Spironema rectum* (not *Spironema recta,* because generic name is neuter, not feminine); among genus-group names, *Broeggeria* (not *Bröggeria*), *Obrienia* (not *O'Brienia*), *Maccookites* (not *McCookites*; among family-group names, Oepikidae (not Öpikidae), Spironematidae (not Spironemidae, incorrect stem), Athyrididae (not Athyridae, incorrect stem). The use of "variety" for named divisions of fossil species, according to common practice of some paleontologists, gives rise to imperfect names, which generally are emendable (*Code,* Art. 45e) by omitting this term so as to indicate the status of this taxon as a subspecies.

4) *"Vain names"* are available names consisting of unjustified intentional emendations of previously published names. The emendations are unjustified because they are not demonstrable as corrections of incorrect original spellings as defined by the *Code* (Art. 32,c). Vain names have status in nomenclature under their own authorship and date. They constitute junior objective synonyms of names in their original form. Examples are: among species-group names, *geneae* (published as replacement of original unexplained masculine, *geni,* which now is not alterable), *ohioae* (invalid change from original *ohioensis*); among genus-group names, *Graphiodactylus* (invalid change from original *Graphiadactyllis*); among family-group names, Graphiodactylidae (based on junior objective synonym having invalid vain name).

5) An important group of available zoological names can be distinguished as *"transferred names."* These comprise authorized sorts of altered names in which the change depends on transfer from one taxonomic rank to another, or possibly on transfers in taxonomic assignment of subgenera, species, or subspecies. Most commonly the transfer calls for a change in termination of the name so as to comply with stipulations of the *Code* on endings of family-group taxa and agreement in gender of specific names with associated generic names. Transferred names may be derived from any of the preceding groups except the first. Examples are: among species-group names, *Spirifer ambiguus* (masc.) to *Composita ambigua* (fem.), *Neochonetes transversalis* to *N. granulifer transversalis* or vice versa; among genus-group names, *Schizoculina* to *Oculina (Schizoculina)* or vice versa; among family-group names, Orthidae to Orthinae or vice versa, or superfamily Orthacea derived from Orthidae or Orthinae; among suprafamilial taxa (not governed by the *Code*), order Orthida to suborder Orthina or vice versa. The authorship and date of transferred names are not affected by the transfers, but the author responsible for the transfer and the date of his action may appropriately be recorded in such works as the *Treatise.*

6) Improved or *"corrected names"* include both mandatory and allowable emendations of imperfect names and of suprafamilial names, which are not subject to regulation as to name form. Examples of corrected imperfect names are given with the discussion of group 3. Change from the originally published ordinal name Endoceroidea (TEICHERT, 1933) to the presently recognized Endocerida illustrates a "corrected" suprafamilial name. Group 6 names differ from those in group 5 in not being dependent on transfers in taxonomic rank or assignment, but some names are classifiable in both groups.

7) *"Substitute names"* are available names expressly proposed as replacements for invalid zoological names, such as junior

homonyms. These may be classifiable also as belonging in groups 1, 2, or 3. The glossary appended to the *Code* refers to these as "new names" *(nomina nova)* but they are better designated as substitute names, since their newness is temporary and relative. The first-published substitute name that complies with the definition here given takes precedence over any other. An example is *Marieita* LOEBLICH & TAPPAN, 1964, as substitute for *Reichelina* MARIE, 1955 (*non* ERK, 1942).

8) *"Conserved names"* include a relatively small number of species-group, genus-group, and family-group names which have come to be classed as available and valid by action of the International Commission on Zoological Nomenclature exercising its plenary powers to this end or ruling to conserve a junior synonym in place of a rejected "forgotten" name *(nomen oblitum)* (Art. 23,b). Currently, such names are entered on appropriate "Official Lists," which are published from time to time.

It is useful for convenience and brevity of distinction in recording these groups of available zoological names to employ Latin designations in the pattern of *nomen nudum* (abbr., *nom. nud.*) and others. Thus we recognize the preceding numbered groups as follows: 1) *nomina inviolata* (sing., *nomen inviolatum,* abbr., *nom. inviol.*), 2) *nomina perfecta (nomen perfectum, nom. perf.),* 3) *nomina imperfecta (nomen imperfectum, nom. imperf.),* 4) *nomina vana (nomen vanum, nom. van.),* 5) *nomina translata (nomen translatum, nom. transl.),* 6) *nomina correcta (nomen correctum, nom. correct.),* 7) *nomina substituta (nomen substitutum, nom. subst.),* 8) *nomina conservata (nomen conservatum, nom. conserv.).*

Additional to the groups differentiated above, the *Code* (Art. 17) specifies that a zoological name is not prevented from availability a) by becoming a junior synonym, for under various conditions this may be re-employed, b) for a species-group name by finding that original description of the taxon relates to more than a single taxonomic entity or to parts of animals belonging to two or more such entities, c) for species-group names by determining that it first was combined with an invalid or unavailable genus-group name, d) by being based only on part of an animal, sex of a species, ontogenetic stage, or one form of a polymorphic species, e) by being originally proposed for an organism not considered to be an animal but now so regarded, f) by incorrect original spelling which is correctable under the *Code*, g) by anonymous publication before 1951, h) by conditional proposal before 1961, i) by designation as a variety or form before 1961, j) by concluding that a name is inappropriate (Art. 18), or k) for a specific name by observing that it is tautonymous (Art. 18).

It is worthy of mention that names published for collective groups (see later discussion under "Genus-Group Names") are authorized by the *Code* (Art. 42c) for use in zoological nomenclature and therefore may be construed to be available names which are treated for convenience exactly as if they were generic names.

Unavailable Names

All zoological names which fail to comply with mandatory provisions of the *Code* are unavailable names and have no status in zoological nomenclature. None can be used under authorship and date of their original publication as a replacement name *(nom. subst.)* and none preoccupies for purposes of the Law of Homonymy. Names identical in spelling with some, but not all, unavailable names can be classed as available if and when they are published in conformance to stipulations of the *Code* and they are then assigned authorship and take date of the accepted publication. Different groups of unavailable names can be discriminated as follows.

9) *"Naked names"* include all those that fail to satisfy provisions stipulated in Article 11 of the *Code,* which states general requirements of availability. In addition they include names, if published before 1931, that were unaccompanied by a description, definition, or indication (Arts. 12, 16), as well as names published after 1930 that lacked accompanying statement of characters purporting to serve for differentiation of the taxon, or definite bibliographic reference to such a statement, or that were not proposed expressly as replacement (nom. subst.) of a pre-existing available name (Art. 13,a) or that were unaccompanied by definite fixation of a type species by original designation or indication (Art. 13,b). Ex-

amples of "naked names" are: among species-group taxa, *Valvulina mixta* PARKER & JONES, 1865 (=*Cribrobulimina mixta* CUSHMAN, 1927, available and valid); among genus-group taxa, *Orbitolinopsis* SILVESTRI, 1932 (=*Orbitolinopsis* HENSON, 1948, available but classed as invalid junior synonym of *Orbitolina* D'ORBIGNY, 1850); among family-group taxa, Aequilateralidae D'ORBIGNY, 1846 (lacking type-genus), Hélicostègues D'ORBIGNY, 1826 (vernacular not latinized by later authors, Art. 11,e,iii), Poteriocrinidae AUSTIN & AUSTIN, 1843 (=fam. Poteriocrinoidea AUSTIN & AUSTIN, 1842) (neither 1843 or 1842 names complying with Art. 11,e, which states that "a family-group name must, when first published, be based on the name then valid for a contained genus," such valid name in the case of this family being *Poteriocrinites* MILLER, 1821).

10) *"Denied names"* include all those that are defined by the *Code* (Art. 32,c) as incorrect original spellings. Examples are: Specific names, *nova-zelandica, mülleri, 10-brachiatus;* generic names, *M'Coyia, Størmerella, Römerina, Westgårdia;* family name, Růžičkinidae. Uncorrected "imperfect names" are "denied names" and unavailable, whereas corrected "imperfect names" are available.

11) *"Impermissible names"* include all those employed for alleged genus-group taxa other than genus and subgenus (Art. 42,a) (e.g., supraspecific divisions of subgenera), and all those published after 1930 that are unaccompanied by definite fixation of a type species (Art. 13,b). Examples of impermissible names are: *Martellispirifer* GATINAUD, 1949, and *Mirtellispirifer* GATINAUD, 1949, indicated respectively as a section and subsection of the subgenus *Cyrtospirifer; Fusarchaias* REICHEL, 1949, without definitely fixed type species (=*Fusarchaias* REICHEL, 1952, with *F. bermudezi* designated as type species).

12) *"Null names"* include all those that are defined by the *Code* (Art. 33,b) as incorrect subsequent spellings, which are any changes of original spelling not demonstrably intentional. Such names are found in all ranks of taxa.

13) *"Forgotten names"* are defined (Art. 23,b) as senior synonyms that have remained unused in primary zoological literature for more than 50 years. Such names are not to be used unless so directed by ICZN.

Latin designations for the discussed groups of unavailable zoological names are as follows: 9) *nomina nuda* (sing., *nomen nudum,* abbr., *nom. nud.*), 10) *nomina negata (nomen negatum, nom. neg.),* 11) *nomina vetita (nomen vetitum, nom. vet.),* 12) *nomina nulla (nomen nullum, nom. null.),* 13) *nomina oblita (nomen oblitum, nom. oblit.).*

VALID AND INVALID NAMES

Important distinctions relate to valid and available names, on one hand, and to invalid and unavailable names, on the other. Whereas determination of availability is based entirely on objective considerations guided by Articles of the *Code,* conclusions as to validity of zoological names partly may be subjective. A valid name is the correct one for a given taxon, which may have two or more available names but only a single correct name, generally the oldest. Obviously, no valid name can also be an unavailable name, but invalid names may include both available and unavailable names. Any name for a given taxon other than the valid name is an invalid name.

A sort of nomenclatorial no-man's-land is encountered in considering the status of some zoological names, such as *"doubtful names," "names under inquiry,"* and *"forgotten names."* Latin designations of these are *nomina dubia, nomina inquirenda,* and *nomina oblita,* respectively. Each of these groups may include both available and unavailable names, but the latter can well be ignored. Names considered to possess availability conduce to uncertainty and instability, which ordinarily can be removed only by appealed action of ICZN. Because few zoologists care to bother in seeking such remedy, the "wastebasket" names persist.

SUMMARY OF NAME GROUPS

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

DEFINITIONS OF NAME GROUPS

nomen conservatum (nom. conserv.). Name unacceptable under regulations of the *Code* which is made valid, either with original or altered spelling, through procedures specified by the *Code* or by action of ICZN exercising its plenary powers.

nomen correctum (nom. correct.). Name with intentionally altered spelling of sort required or allowable by the *Code* but not dependent on transfer from one taxonomic rank to another ("improved name"). (*See Code,* Arts. 26-b, 27, 29, 30-a-3, 31, 32-c-i, 33-a; in addition change of endings for suprafamilial taxa not regulated by the *Code.*)

nomen imperfectum (nom. imperf.). Name that as originally published (with or without subsequent identical spelling) meets all mandatory requirements of the *Code* but contains defect needing correction ("imperfect name"). (*See Code,* Arts. 26-b, 27, 29, 32-c, 33-a.)

nomen inviolatum (nom. inviol.). Name that as originally published meets all mandatory requirements of the *Code* and also is not correctable or alterable in any way ("inviolate name").

nomen negatum (nom. neg.). Name that as originally published (with or without subsequent identical spelling) constitutes invalid original spelling, and although possibly meeting all other mandatory requirements of the *Code,* cannot be used and has no separate status in nomenclature ("denied name"). It is to be corrected wherever found.

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

nomen nullum (nom. null.). Name consisting of an unintentional alteration in form (spelling) of a previously published name (either available name, as *nom. inviol., nom. perf., nom imperf., nom. transl.*; or unavailable name, as *nom. neg., nom. nud., nom. van.,* or another *nom. null.*) ("null name").

nomen oblitum (nom. oblit.). Name of senior synonym unused in primary zoological literature in more than 50 years, not to be used unless so directed by ICZN ("forgotten name").

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

nomen substitutum (nom. subst.). Replacement name published as substitute for an invalid name, such as a junior homonym (equivalent to "new name").

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

nomen vanum (nom. van.). Name consisting of an invalid intentional change in form (spelling) from a previously published name, such invalid emendation having status in nomenclature as a junior objective synonym ("vain name").

nomen vetitum (nom. vet.). Name of genus-group taxon not authorized by the *Code* or, if first published after 1930, without definitely fixed type species ("impermissible name").

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

NAME CHANGES IN RELATION TO TAXA GROUPS

SPECIES-GROUP NAMES

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

GENUS-GROUP NAMES

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

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

Kurnatiophyllum THOMPSON, 1875 [**K. concentricum;* SD GREGORY, 1917] [=*Kumatiophyllum* THOMPSON, 1876 *(nom. null.); Cymatophyllum* THOMPSON, 1901 *(nom. van.); Cymatiophyllum* LANG, SMITH & THOMAS, 1940 *(nom. van.)*].

Stichophyma POMEL, 1872 [**Manon turbinatum* RÖMER, 1841; SD RAUFF, 1893] [=*Stychophyma* VOSMAER, 1885 *(nom. null.); Sticophyma* MORET, 1924 *(nom. null.)*].

Stratophyllum SMYTH, 1933 [**S. tenue*] [=*Ethmoplax* SMYTH, 1939 *(nom. van. pro Stratophyllum); Stratiphyllum* LANG, SMITH & THOMAS, 1940 (*nom. van. pro Stratophyllum* SMYTH) (non *Stratiphyllum* SCHEFFEN, 1933)].

Placotelia OPPLIGER, 1907 [**Porostoma marconi* FROMENTEL, 1859; SD DELAUBENFELS, 1955] [=*Plakotelia* OPPLIGER, 1907 *(nom. neg.)*].

Walcottella DELAUBENFELS, 1955 [*nom. subst., pro Rhopalicus* SCHRAMM, 1936 (*non* FÖRSTER, 1856)].

Cyrtograptus CARRUTHERS, 1867 [*nom. correct.* LAPWORTH, 1873 (*pro Cyrtograpsus* CARRUTHERS, (1867), *nom. conserv.* proposed BULMAN, 1955 (ICZN 1963, p. 105, Opinion 650)].

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

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

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

Subfamily STYLININAE d'Orbigny, 1851
[*nom. transl.* EDWARDS & HAIME, 1857 (*ex* Stylinidae D'ORBIGNY, 1851)]

Superfamily ARCHAEOCTONOIDEA Petrunkevitch, 1949
[*nom. transl.* PETRUNKEVITCH, 1955 (*ex* Archaeoctonidae PETRUNKEVITCH, 1949)]

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

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

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

Family STREPTELASMATIDAE Nicholson, 1889
[*nom. correct.* WEDEKIND, 1927 (*pro* Streptelasmidae NICHOLSON, 1889, *nom. imperf.*)]

Family PALAEOSCORPIIDAE Lehmann, 1944
[*nom. correct.* PETRUNKEVITCH, 1955 (*pro* Palaeoscorpionidae LEHMANN, 1944, *nom. imperf.*)]

Family AGLASPIDIDAE Miller, 1877
[*nom. correct.* STØRMER, 1959 (*pro* Aglaspidae MILLER, 1877, *nom. imperf.*)]

Superfamily AGARICIICAE Gray, 1847
[*nom. correct.* WELLS, 1956 (*pro* Agaricioidae VAUGHAN & WELLS, 1943, *nom. transl.* WELLS, 1956, *ex* Agaricidae GRAY, 1847)]

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

It may happen that long-used family-group names are invalid under strict application of the *Code*. In order to retain the otherwise invalid name, appeal to ICZN is needful. An example of use of *nom. conserv.* in this connection, as cited in the *Treatise,* is the following.

Subfamily OMPHALOTROPIDINAE Thiele, 1927
[*nom. conserv.*, ICZN (pending)] [=Realiinae PFEIFFER, 1858, *nom. correct.*, KOBELT, 1906 (*ex Realiea* PFEIFFER, 1858)]

FAMILY-GROUP NAMES; REPLACEMENTS

Family-group names are formed by adding letter combinations (prescribed for family and subfamily but not now for others) to the stem of the name belonging to genus (nominate genus) first chosen as type of the assemblage. The type genus need not be the oldest in terms of receiving its name and definition, but it must be the first-published as name-giver to a family-group taxon among all those included. Once fixed, the family-group name remains tied to the nominate genus even if its name is changed by reason of status as a junior homonym or junior synonym, either objective or subjective. Seemingly, the *Code* (Art. 39) requires replacement of a family-group name only in the event that the nominate genus is found to be a junior homonym, and then a substitute family-group name is accepted if it is formed from the oldest available substitute name for the nominate genus. Authorship and date attributed to the replacement family-group name are determined by first publication of the changed family group-name, but for purposes of the Law of Priority, they take the date of the replaced name. Numerous long-used family-group names are incorrect in being *nomina nuda,* since they fail to satisfy criteria of availability (Art. 11,e). These also demand replacement by valid names.

The aim of family-group nomenclature is greatest possible stability and uniformity, just as in case of other zoological names. Experience indicates the wisdom of sustaining family-group names based on junior subjective synonyms if they have priority of publication, for opinions of different workers as to the synonymy of generic names founded on different type species may not agree and opinions of the same worker may alter from time to time. The retention similarly of first-published family-group names which are found to be based on junior objective synonyms is less clearly desirable, especially if a replacement name derived from the senior objective synonym has been recognized very long and widely. To displace a much-used family-group name based on the senior objective synonym by disinterring a forgotten and virtually unused family-group name based on a junior objective synonym because the latter happens to have priority of publication is unsettling.

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

FAMILY-GROUP NAMES; AUTHORSHIP AND DATE

All family-group taxa having names based on the same type genus are attributed to the author who first published the name for any of these assemblages, whether tribe, subfamily, or family (superfamily being almost inevitably a later-conceived taxon). Accordingly, if a family is divided into subfamilies or a subfamily into tribes, the name of no such subfamily or tribe can antedate the family name. Also, every family containing differentiated subfamilies must have a nominate *(sensu stricto)* subfamily, which is based on the same type genus as that for the family, and the author and date set down for the nominate subfamily invariably are identical with those of the family, without reference to whether the author of the family or some subsequent author introduced subdivisions.

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

SUPRAFAMILIAL TAXA

International rules of zoological nomenclature as given in the *Code* (1961) are limited to stipulations affecting lower-rank categories (infrasubspecies to superfamily). Suprafamilial categories (suborder to phylum) are either unmentioned or explicitly placed outside of the application of zoological rules. The *Copenhagen Decisions on*

Zoological Nomenclature (1953, Arts. 59-69) proposed to adopt rules for naming suborders and higher taxonomic divisions up to and including phylum, with provision for designating a type genus for each, hopefully in such manner as not to interfere with the taxonomic freedom of workers. Procedures for applying the Law of Priority and Law of Homonymy to suprafamilial taxa were outlined and for dealing with the names for such units and their authorship, with assigned dates, when they should be transferred on taxonomic grounds from one rank to another. The adoption of terminations of names, different for each category but uniform within each, was recommended.

The Colloquium on zoological nomenclature which met in London during the week just before the XVth International Congress of Zoology convened in 1958 thoroughly discussed the proposals for regulating suprafamilial nomenclature, as well as many others advocated for inclusion in the new *Code* or recommended for exclusion from it. A decision which was supported by a wide majority of the participants in the Colloquium was against the establishment of rules for naming taxa above family-group rank, mainly because it was judged that such regulation would unwisely tie the hands of taxonomists. For example, if a class or order was defined by some author at a given date, using chosen morphologic characters (e.g., gills of pelecypods), this should not be allowed to freeze nomenclature, taking precedence over another later-proposed class or order distinguished by different characters (e.g., hinge-teeth of pelecypods). Even the fixing of type genera for suprafamilial taxa might have small value, if any, hindering taxonomic work rather than aiding it. At all events, no legal basis for establishing such types and for naming these taxa has yet been provided.

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

1) The name of any suprafamilial taxon must be a Latin or latinized uninominal noun of plural form, or treated as such, a) with a capital initial letter, b) without diacritical mark, apostrophe, diaeresis, or hyphen, and c) if a component consisting of a numeral, numerical adjective, or adverb is used, this must be written in full (e.g., Stethostomata, Trionychi, Septemchitonina, Scorpiones, Subselliflorae). No uniformity in choice of ending for taxa of a given rank is demanded (e.g., orders named Gorgon*acea,* Millepor*ina,* Rugos*a,* Scleractin*ia,* Stromatopor*oidea,* Phalang*ida*).

2) Names of suprafamilial taxa may be constructed in almost any way, a) intended to indicate morphological attributes (e.g., Lamellibranchiata, Cyclostomata, Toxoglossa), b) based on the stem of an included genus (e.g., Bellerophontina, Nautilida, Fungiina), or c) arbitrary combinations of letters, (e.g., Yuania), but none of these can be allowed to end in -idae or -inae, reserved for family-group taxa. A class or subclass (e.g., Nautiloidea), order (e.g., Nautilida), or suborder (e.g., Nautilina) named from the stem of an included genus may be presumed to have that genus (e.g., *Nautilus*) as its objective type. No suprafamilial name identical in form to that of a genus or to another published suprafamilial name should be employed (e.g., order Decapoda Latreille, 1803, crustaceans, and order Decapoda Leach, 1818, cephalopods; suborder Chonetoidea Muir-Wood, 1955, and genus *Chonetoidea* Jones, 1928). Worthy of notice is the classificatory and nomenclatural distinction between suprafamilial and family-group taxa which respectively are named from the same type genus, since one is not considered to be transferable to the other (e.g., suborder Bellerophontina Ulrich & Scofield, 1897; superfamily Bellerophontacea M'Coy, 1851; family Bellero-

phontidae M'Coy, 1851). Family-group names and suprafamilial names are not coordinate.

3) The Laws of Priority and Homonymy lack any force of international agreement as applied to suprafamilial names, yet in the interest of nomenclatural stability and the avoidance of confusion these laws are widely applied by zoologists to taxa above the family-group level wherever they do not infringe on taxonomic freedom and long-established usage.

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

Order CORYNEXOCHIDA Kobayashi, 1935

[*nom. transl.* Moore, 1955 (*ex* suborder Corynexochida Kobayashi, 1935)]

b) A name revised from its previously published form merely by adoption of a different termination, without changing taxonomic rank, is an "altered name" *(nom. correct.)*. Examples follow.

Order DISPARIDA Moore & Laudon, 1943

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

Suborder AGNOSTINA Salter, 1864

[*nom. correct.* Harrington & Leanza, 1957 (*pro* suborder Agnostini Salter, 1864)]

c) A suprafamilial name revised from its previously published rank with accompanying change of termination (which may or may not be intended to signalize the change of rank) is construed to be primarily a *nom. transl.* (compare change of ending for family-group taxa -idae to -inae, or vice versa, and to superfamily) but if desired it could be recorded as *nom. transl. et correct.*

Order ORTHIDA Schuchert & Cooper, 1931

[*nom. transl.* Moore, 1952 (*ex* suborder Orthoidea Schuchert & Cooper, 1931)]

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

Subclass ENDOCERATOIDEA Teichert, 1933

[*nom. transl.* Teichert, 1964 (*ex* superorder Endoceratoidea Shimanskiy & Zhuravleva, 1961, *nom. transl. ex* order Endoceroidea Teichert, 1933)]

Order ENDOCERIDA Teichert, 1933

[*nom. correct.* Teichert, 1964 (*pro* order Endoceroidea Teichert, 1933)]

Suborder ENDOCERINA Teichert, 1933

[*nom. correct.* Teichert, 1964 (*pro* suborder Endoceracea Schindewolf, 1935, *nom. transl. ex* order Endoceroidea Teichert, 1933)]

TAXONOMIC EMENDATION

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

Most zoologists, including paleozoologists, who have signified emendation of zoological names refer to what they consider a material change in application of the name such as may be expressed by an importantly altered diagnosis of the assemblage covered by the name. The abbreviation *"emend."* then may accompany the name, with statement of the author and date of the emendation. On the other hand, a multitude of workers concerned with systematic zoology think that publication of *"emend."* with a zoological name is valueless, because more or less alteration of taxonomic sort is introduced whenever a subspecies, species, genus, or other assemblage of animals is incorporated under or removed from the coverage of a given zoological name. Inevitably associated with such classificatory expansions and restrictions is some degree of emendation affecting diagnosis. Granting this, still it is true that now and then somewhat radical revisions are put forward, generally with published statement of reasons for changing the application of a name. To erect a signpost at such points of most significant change is worthwhile, both as aid to subsequent workers in taking account of the altered nomenclatural usage and as indication that not to-be-overlooked discussion may be found at a particular place in the literature. Authors of contributions to the *Treatise* are encouraged to include records of all specially noteworthy emendations of this nature, using the abbreviation *"emend."* with the name to which it refers and citing the author and date of the emendation.

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

STYLE IN GENERIC DESCRIPTIONS

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 two sorts of citations are as follows:

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

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

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

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

It is judged desirable to record the manner of establishing the type species, whether by original designation or by subsequent designation.

Fixation of type species originally. The type species of a genus or subgenus, according to provisions of the *Code,* may be fixed in various ways originally (that is, in the publication containing first proposal of the generic name) or it may be fixed in specified ways subsequent to the original publication. Fixation of the type species of a genus or subgenus in an original publication is stipulated by the *Code* (Art. 68) in order of precedence as 1) *original designation* (in the *Treatise* indicated as OD) when the type species is explicitly stated or (before 1931) indicated by "n. gen., n. sp." (or its equivalent) applied to a single species included in a new genus, 2) defined by use of *typus* or *typicus* for one of the species included in a new genus (adequately indicated in the *Treatise* by the specific name), 3) established by *monotypy* if a new genus or subgenus includes only one originally included species which is neither OD nor TYP (in the *Treatise* indicated as M), and 4) fixed by *tautonymy* if the genus-group name is identical to an included species name not indicated as type belonging to one of the three preceding categories (indicated in the *Treatise* as T).

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

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

Muriceides STUDER, 1887 [**M. fragilis* WRIGHT & STUDER, 1889; SM WRIGHT & STUDER, 1889].

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

It should be noted that *subsequent designation* of a type species is admissible only for genera established prior to 1931. A new genus-group name established after 1930, and not accompanied by fixation of a type species through original designation or original indication, is invalid (*Code*, Art. 13,b). Effort of a subsequent author to "validate" such a name by subsequent designation of a type species constitutes an original publication making the name available under authorship and date of the subsequent author. This provision of the *Code* has not been consistently applied in previous *Treatise* volumes, but is rigidly adhered to in the present volume.

HOMONYMS

Most generic names are distinct from all others and are indicated without ambiguity by citing their originally published spelling accompanied by name of the author and date of first publication. If the same generic name has been applied to two or more distinct taxonomic units, however, it is necessary to differentiate such homonyms, 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, *nom. subst.* [*pro Callopora* HALL, 1851 (*non* GRAY, 1848)].

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

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

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

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

Identical family-group names not infrequently are published as new names by different authors, the author of the later-introduced name being ignorant of previous publication(s) by one or more other workers. In spite of differences in taxonomic concepts as indicated by diagnoses and grouping of genera and possibly in assigned rank, these family-group taxa are nomenclatural homonyms, based on the same type genus, and they are also synonyms. Wherever encountered, such synonymic homonyms are distinguished in the *Treatise* as in dealing with generic names.

SYNONYMS

Citation of synonyms is given next following record of the type species and if two or more synonyms of differing date are recognized, these are arranged in chronological order. Objective synonyms are indicated by accompanying designation "(obj.)," others being understood to constitute subjective synonyms. Examples showing *Treatise* style in listing synonyms follow.

Calapoecia Billings, 1865 [**C. anticostiensis;* SD Lindström, 1883] [=*Columnopora* Nicholson, 1874; *Houghtonia* Rominger, 1876].

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

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

Lyopora Nicholson & Etheridge, 1878 [**Palaeopora? favosa* M'Coy, 1850] [=*Liopora* Lang, Smith & Thomas, 1940 (*non* Girty, 1915)].

Some junior synonyms of either objective or subjective sort may take precedence desirably over senior synonyms wherever uniformity and continuity of nomenclature are served by retaining a widely used but technically rejectable name for a generic assemblage. This requires action of ICZN using its plenary powers to set aside the unwanted name and validate the wanted one, with placement of the concerned names on appropriate official lists.

ABBREVIATIONS

Abbreviations used in this division of the *Treatise* are explained in the following alphabetically arranged list.

Abhandl., *Abhandlung(en)*
Abstr., Abstract
Afr., Africa, -an
Aldan., Aldanian
Am., America, -n
Amg., Amgian
Antarct., Antarctic(a)
approx., approximately
art., article
Atdaban., Atdabanian

Baykal., Baykalia
Bazaikh., Bazaikha
B.C., British Columbia
Biol., Biologicheskaya
Botom., Botomian
Bull., Bulletin
Byull., Byulleten

Calif., California
Cam., Cambrian
Can., Canada
coll., collection(s)
Comm., Commission, Committee
Contrib., Contribution(s)

Dev., Devonian
diagram., diagrammatic
diam., diameter

E., East
ed., edited, editor
edit., edition
emend., *emendatus(-a)*
Eng., England
enl., enlarged
et al., *et alii* (and others, persons)
Eu., Europe
Exped., Expedition
ext., exterior

fam., family
fig., figure(s)

gen., genus
Geol., Geological, *Geologicheskaya, Geologicheskoe,* Geology
Geol.-razvd., *Geologo-razvedochnogo*
Glav., *Glavnogo*

hom., homonym
hor., horizon

ICZN, International Commission on Zoological Nomenclature
Inst., *Institut,* Institute
int., interior
Izdatel., *Izdatelstvo*

Jour., Journal

Kenyad., Kenyadian

L., **low.**, Lower
Len., Lenian
long., longitudinal

m., meter
M., **mid.**, Middle
M, monotypy
med., median
Mem., Memoir(s), *Memoria, Memorie*
Mém., *Mémoire(s)*
mm., millimeter(s)
mod., modified
Mon., Monograph
Mont., Montagne
Mts., Mountains

n., **n**, new
N., North
N.Am., North America(n)
Natl., National
Nev., Nevada
no., number
nom. conserv., *nomen conserva-*

tum (conserved name)
nom. correct., *nomen correctum* (corrected or intentionally altered name)
nom. dub., *nomen dubium* (doubtful name)
nom. imperf., *nomen imperfectum* (imperfect name)
nom. neg., *nomen negatum* (denied name)
nom. nov., *nomen novum* (new name)
nom. nud., *nomen nudum* (naked name)
nom. null., *nomen nullum* (null, void name)
nom. oblit., *nomen oblitum* (forgotten name)
nom. subst., *nomen substitutum* (substitute name)
nom. transl., *nomen translatum* (transferred name)
nom. van., *nomen vanum* (vain, void name)
nom. vet., *nomen vetitum* (impermissible name)
Nomencl., Nomenclature
NW., Northwest
N.Y., New York

obj., objective
OD, original designation
opp., opposite

p., page(s)
Paleont., Paleontological, *Paleontologicheskikh*
pl., plate(s), plural
Platf., Platform
Precam., Precambrian
Proc., Proceedings
Proteroz., Proterozoic

Quart., Quarterly

R., River
reconstr., reconstructed, -ion
Rept., Report(s)

S., South
Sanash., Sanashtykgolian
Sci., Science, Scientific, *Scientifique*
SD, subsequent designation
sec., section(s)
ser., serial, series, *seriia*
sér., *séries*
Sess., Session
Sib., Siberia
Sil., Silurian
SM, subsequent monotypy
sp., species
Spec., Special
subfam., subfamily
superfam., superfamily
syn., synonym

tang., tangential
Tasousekt., Tasousektian
Terr., Territory, -ies
Timghit., Timghitian
Tommot., Tommotian
Trans., Transactions
Transbayk., Transbaykalia
transl., translated, -ion
transv., transverse

U., **up.**, Upper
Univ., *Universität, Université, Universitet,* University
Uprav., *Upravleniya*
USA, United States of America
USSR, Union of Soviet Socialist Republics

v., **vol.**, volume(s)

W., West

Zeitschr., *Zeitschrift*
Zool., Zoological, *Zoologie, Zoologisch,* Zoology

REFERENCES TO LITERATURE

Each part of the *Treatise* is accompanied by a selected list of references to paleontological literature consisting primarily of recent and comprehensive monographs available but also including some older works recognized as outstanding in importance. The purpose of giving these references is to aid users of the *Treatise* in finding detailed descriptions and illustrations of morphological features of fossil groups, discussions of classifications and distribution, and especially citations of more or less voluminous literature. Generally speaking, publications listed in the *Treatise* are not original sources of information concerning taxonomic units of various rank but they tell the student where he may find them; otherwise it is necessary to turn to such aids as the *Zoological Record* or NEAVE's *Nomenclator Zoologicus*. References given in the *Treatise* are arranged alphabetically by authors and accompanied by index numbers which serve the purpose of permitting citation most concisely in various parts of the text; these citations of listed papers are enclosed invariably in parentheses and, except in Parts C and N, are distinguishable from dates because the index numbers comprise no more than 3 digits. The systematic descriptions given in part C are accompanied by a reference list containing more than 2,000 entries with the index numbers marked by an asterisk, and in Part N (containing over 1,000 entries), they are italicized.

The following is a statement of the full names of serial publications which are cited in abbreviated form in the lists of references in the present volume. The information thus provided should be useful in library research work. The list is alphabetized according to the serial titles which were employed at the time of original publication. Those following in brackets are those under which the publication may be found currently in the *Union List of Serials,* the United States Library of Congress listing, and most library card catalogues. The names of serials published in Cyrillic are transliterated; in the reference lists these titles, which may be abbreviated, are accompanied by transliterated authors' names and titles, with English translation of the title. The place of publication is added (if not included in the serial title).

The method of transliterating Cyrillic letters that is adopted as "official" in the *Treatise* is that suggested by the Geographical Society of London and the U.S. Board on Geographic Names. It follows that names of some Russian authors in transliterated form derived in this way differ from other forms, possibly including one used by the author himself. In *Treatise* reference lists the alternative (unaccepted) form is given enclosed by square brackets (e.g., Chernyshev [Tschernyschew], T.N.).

List of Serial Publications

Académie Impériale des Sciences, St. Pétersbourg, Mémoires (Zapiski Imperatorskoy Akademii Nauk, Leningrad).
Acta Palaeontologica Sinica. Peking.
Akademie der Wissenschaften und der Literature zu Mainz, mathematisch-naturwissenschaftliche Klasse, Abhandlungen. Wiesbaden.
Akademiya Nauk Gruzinskoy SSR, Soobshcheniya. Tiflis.
Akademiya Nauk Kazakhskoy SSR, Izvestiya. Alma-Ata.
Akademiya Nauk SSSR, Doklady. Moskva.
Akademiya Nauk SSSR, Geologicheskikh Institut, Trudy. Moskva.
Akademiya Nauk SSSR, Instituta Morfologii Zhivotnykh im. A. N. Severtsova, Trudy. Moskva, Leningrad.
Akademiya Nauk SSSR, Institut Paleontologicheskikh, Trudy. Moskva.
Akademiya Nauk SSSR, Izvestiya, Seriya Geologicheskaya. Moskva.
Akademiya Nauk SSSR, Mongolskaya Komissiya, Trudy. Moskva.
Akademiya Nauk SSSR, Paleontologicheskiy Zhurnal. Moskva.
Akademiya Nauk SSSR, Sibirskoe Otdelenie, Institut Geologii i Geofiziki, Trudy. Novosibirsk.
Akademiya Nauk SSSR, Soobshcheniya DVF SO. Leningrad.
American Journal of Science and Arts, New Haven, Conn.
Annales des Sciences Naturelles, Zoologie. Paris.
Arkticheskii i Antarkticheskii Nauchno-issledovatelckii Institut, Trudy. Leningrad.
Australasian Association for the Advancement of Science, Reports. Sydney.
Australia Bureau of Mineral Resources, Geology and Geophysics, Bulletins. Canberra.
Biological Reviews (*see* Cambridge Philosophical Society). Cambridge, Eng.
Breviora geologica asturica. Oviedo, Spain.
British Museum (Natural History), Bulletins. London.
Cambridge Philosophicay Society, Biological Reviews and Biological Proceedings. Cambridge, Eng.
Canada, Geological Survey of, Deartment of Mines and Resources, Mines and Geology Branch, Bulletins; Memoirs. Ottawa.
Deutsche Geologische Gesellschaft, Zeitschrift. Berlin, Hannover.
Estudios Geológicos, Instituto de Investigaciones Geológicas "Lucas Mallada." Madrid.
Ezhegodnik Russkago Paleontologicheskago Obshchestva. Petrograd.
Fieldiana, Geology. Chicago.
Geological Magazine. London, Hertford.
Geological Society of America, Bulletins; Memoirs; Special Papers. Boulder, Colo.
Geological Society of Australia, Journals. Sydney, Adelaide.
Geological Society of London; Memoirs; Proceedings; Quarterly Journals; Transactions.
Geologicheskii Vestnik, Izd. Geologicheskago Komiteta. Petrograd.
Harvard University, Museum of Comparative Zoology, Bulletins. Cambridge, Mass.
Journal of Paleontology. Tulsa, Okla.
Kansas, The University of, Paleontological Contributions, Papers. Lawrence, Kans.
Kyancutta Museum, South Australia, Memoirs.
Materialy po geologii Krasnoyarskogo kraya, Zapadno-Sibirskogo Geologicheskogo Tresta.
Materialy po geologii i Polezynym Iskopaemym Dalnyago Vostoka. Vladivostok.
Materialy po geologii zapadnoi Sibiri. Tomsk.
Moskovskoe Obshchestvo Ispytatelei Prirody, Byulleten. Moskva.
Nauchno-issledovatelskii Institut Geologii Arktiki, Trudy. Leningrad.
Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Abhandlungen. Stuttgart.
Nova Acta Leopoldina (Nova Acta Academiae Caesareae Leopoldino-Carolinae Germanicae naturae curiosorum). Halle.
Paleontographical Society, Monographs. London.
Royal Society of Canada, Proceedings and Transactions. Ottawa.
Royal Society of Edinburgh, Transactions.
Royal Society of New Zealand, Transactions. Wellington.
Royal Society of South Australia, Memoirs; Proceedings; Transactions. Adelaide.
Senckenbergiana Lethaea (Senckenbergische Natur-

forschende Gesellschaft, Wissenschaftliche Mitteilungen). Frankfurt.
Senckenbergische Naturforschende Gesellschaft, Abhandlungen. Frankfurt.
Service des Mines et de Carte Géologique du Maroc, Notes et Mémoires. Rabat.
Sibirskogo Nauchno-Issledovatelskogo Instituta Geologii, Geofiziki i Mineralnogo Syrya (SNIIGGIMS), Trudy. Moskva.
Société Géologique de France, Comptes Rendus des Séances; Bulletin; Mémoires. Paris.
Tomsk, Gosudarstvennyi Universitet, Trudy.
United States Geological Survey, Bulletins. Washington, D.C.
United States National Museum, Bulletins; Proceedings. Washington, D.C.
Vsesoyuznyi Nauchno-Issledovatelskii Geologicheskii Institut, Trudy (VSEGEI). Moskva.
Zapadno-Sibirskogo Geologicheskogo Tresta. Tomsk.
Zentralblatt für Mineralogie, Geologie und Paläontologie. Stuttgart.
Zoological Society of London, Proceedings.

SOURCES OF ILLUSTRATIONS

At the end of figure captions a name and date are given to supply record of the author of illustrations used in the *Treatise*, reference being made either (1) to publications cited in reference lists or (2) to the names of authors with or without indication of individual publications concerned. Previously unpublished illustrations are marked by the letter "n" (signifying "new") with the name of the author.

STRATIGRAPHIC DIVISIONS

Classification of rocks forming the geologic column as commonly cited in the *Treatise* in terms of units defined by concepts of time is reasonably uniform and firm throughout most of the world as regards major divisions (e.g., series, systems, and rocks representing eras) but it is variable and unfirm as regards smaller divisions (e.g., substages, stages, and subseries), which are provincial in application. Users of the *Treatise* have suggested the desirability of publishing reference lists showing the stratigraphic arrangement of at least the most commonly cited divisions. Accordingly, a tabulation of European and North American units, which broadly is applicable also to other continents, is given here.

Generally Recognized Divisions of Geologic Column

EUROPE

ROCKS OF CENOZOIC ERA
NEOGENE SYSTEM[1]
Pleistocene Series (including Recent)
Pliocene Series
Miocene Series
PALEOGENE SYSTEM
Oligocene Series
Eocene Series
Paleocene Series

ROCKS OF MESOZOIC ERA
CRETACEOUS SYSTEM
Upper Cretaceous Series
Maastrichtian Stage[2]
Campanian Stage[2]
Santonian Stage[2]
Coniacian Stage[2]
Turonian Stage
Cenomanian Stage

Lower Cretaceous Series
Albian Stage

NORTH AMERICA

ROCKS OF CENOZOIC ERA
NEOGENE SYSTEM[1]
Pleistocene Series (including Recent)
Pliocene Series
Miocene Series
PALEOGENE SYSTEM
Oligocene Series
Eocene Series
Paleocene Series

ROCKS OF MESOZOIC ERA
CRETACEOUS SYSTEM
Gulfian Series (Upper Cretaceous)
Navarroan Stage
Tayloran Stage
Austinian Stage
Eagle Fordian Stage
Woodbinian (Tuscaloosan) Stage

Comanchean Series (Lower Cretaceous)
Washitan Stage

Aptian Stage
Barremian Stage[3]
Hauterivian Stage[3]
Valanginian Stage[3]
Berriasian Stage[3]

JURASSIC SYSTEM

Upper Jurassic Series
Portlandian Stage[4]
Kimmeridgian Stage
Oxfordian Stage

Middle Jurassic Series
Callovian Stage (or Upper Jurassic)
Bathonian Stage
Bajocian Stage

Lower Jurassic Series (Liassic)
Toarcian Stage
Pliensbachian Stage
Sinemurian Stage
Hettangian Stage

TRIASSIC SYSTEM

Upper Triassic Series
Rhaetian Stage[5]
Norian Stage
Carnian Stage

Middle Triassic Series
Ladinian Stage
Anisian Stage

Lower Triassic Series
Scythian Stage

ROCKS OF PALEOZOIC ERA

PERMIAN SYSTEM

Upper Permian Series
Tatarian Stage[6]
Kazanian Stage[7]
Kungurian Stage

Lower Permian Series
Artinskian Stage[8]
Sakmarian Stage
Asselian Stage

CARBONIFEROUS SYSTEM

Upper Carboniferous Series
Stephanian Stage

Westphalian Stage
Namurian Stage

Lower Carboniferous Series
Visean Stage

Tournaisian Stage
Strunian Stage

DEVONIAN SYSTEM

Upper Devonian Series

Fredericksburgian Stage
Trinitian Stage

Coahuilan Series (Lower Cretaceous)
Nuevoleonian Stage

Durangoan Stage

JURASSIC SYSTEM

Upper Jurassic Series
Portlandian Stage
Kimmeridgian Stage
Oxfordian Stage

Middle Jurassic Series
Callovian Stage (or Upper Jurassic)
Bathonian Stage
Bajocian Stage

Lower Jurassic Series (Liassic)
Toarcian Stage
Pliensbachian Stage
Sinemurian Stage
Hettangian Stage

TRIASSIC SYSTEM

Upper Triassic Series
Rhaetian Stage
Norian Stage
Carnian Stage

Middle Triassic Series
Ladinian Stage
Anisian Stage

Lower Triassic Series
Scythian Stage

ROCKS OF PALEOZOIC ERA

PERMIAN SYSTEM

Upper Permian Series
Ochoan Stage
Guadalupian Stage

Lower Permian Series
Leonardian Stage
Wolfcampian Stage

PENNSYLVANIAN SYSTEM
Virgilian Stage
Missourian Stage
Desmoinesian Stage
Bendian Stage
Morrowan Stage

MISSISSIPPIAN SYSTEM
Chesteran Stage
Meramecian Stage
Osagian Stage
Kinderhookian Stage

DEVONIAN SYSTEM

Chautauquan Series (Upper Devonian)

Famennian Stage	Conewangoan Stage
	Cassadagan Stage
Frasnian Stage	**Senecan Series (Upper Devonian)**
	Chemungian Stage
	Fingerlakesian Stage
Middle Devonian Series	**Erian Series (Middle Devonian)**
Givetian Stage	Taghanican Stage
	Tioughniogan Stage
Couvinian Stage	Cazenovian Stage
Lower Devonian Series	**Ulsterian Series (Lower Devonian)**
Emsian Stage	Onesquethawan Stage
Siegenian Stage	Deerparkian Stage
Gedinnian Stage	Helderbergian Stage
SILURIAN SYSTEM	**SILURIAN SYSTEM**
Ludlow Series	**Cayugan Series**
Wenlock Series	**Niagaran Series**
Landovery Series	**Medinan Series**
ORDOVICIAN SYSTEM	**ORDOVICIAN SYSTEM**
	Cincinnatian Series (Upper Ordovician)
	Richmondian Stage
Ashgill Series	Maysvillian Stage
	Edenian Stage
Caradoc Series	**Champlainian Series (Middle Ordovician)**
	Mohawkian Stage
	Trentonian Substage
	Blackriveran Substage
Llandeilo Series	Chazyan Stage
Llanvirn Series	Whiterockian Stage
Arenig Series	**Canadian Series (Lower Ordovician)**
Tremadoc Series[9]	
CAMBRIAN SYSTEM	**CAMBRIAN SYSTEM**
Upper Cambrian Series	**Croixian Series (Upper Cambrian)**
	Trempealeauan Stage
	Franconian Stage
	Dresbachian Stage
Middle Cambrian Series	**Albertan Series (Middle Cambrian)**
Lower Cambrian Series	**Waucoban Series (Lower Cambrian)**
ROCKS OF PRECAMBRIAN ERA	**ROCKS OF PRECAMBRIAN ERA**
PROTEROZOIC SYSTEM	**PROTEROZOIC SYSTEM**
Belt Series	Vendian, Riphean, Vindhyan, Adelaidean, and equivalents

CURT TEICHERT AND RAYMOND C. MOORE

[1] Considered by some to exclude post-Pliocene deposits.
[2] Classed as division of Senonian Subseries.
[3] Classed as division of Neocomian Subseries.
[4] Includes Purbeckian deposits.
[5] Interpreted as lowermost Jurassic by some authors.
[6] Includes some Lower Triassic and equivalent to upper Thuringian (Zechstein) deposits.
[7] Equivalent to lower Thuringian (Zechstein) deposits.
[8] Equivalent to upper Autunian and part of Rotliegend deposits.
[9] Classed as uppermost Cambrian by some geologists.

PART E

ARCHAEOCYATHA

By Dorothy Hill
[University of Queensland]

CONTENTS

INTRODUCTION

The Archaeocyatha were, geologically speaking, a very short-lived group that inhabited the carbonate-shelf and reef environments of the Early Cambrian and early Middle Cambrian seas. They are possibly the only phylum of animals to have become extinct. They were among the first to develop mineral skeletons and used calcium carbonate for this purpose. From the beginning of their study they have excited interest in their systematic position and in the nature of their soft parts, and both of these are subjects of lively controversy in current literature. The relations of the phylum to the Protista on the one hand and to the Porifera or Coelenterata on the other are by no means fully apparent; indeed, the phylum invites speculation on the nature of the soft parts.

The individual skeleton, the cup, is fundamentally an inverted cone; most cups have two fairly widely spaced walls and a central cavity, some have only one wall.

Since publication of the first edition of *Treatise,* Part E, in 1955, our knowledge of the phylum has grown perhaps more spectacularly than that of any other. The great importance placed upon it by those Russian geologists interested in the correlation of Lower Cambrian sequences throughout the USSR has resulted in an increasingly extensive literature. Archaeocyathan species have been found to be of stratigraphic and provincial value; several successive assemblages of species (or "horizons") have been distinguished. The succession of genera in the USSR is also well established and is applicable in other parts of the world.

Archaeocyathan skeletons are aesthetically pleasing and the mental reconstruction of their elegant structures from thin sections is intellectually satisfying. Indeed, for students their attractions rival those of corals.

MORPHOLOGICAL FEATURES

GENERAL FEATURES OF SKELETON

The Archaeocyatha are an extinct phylum of animals that formed calcareous skeletons, the basic form of which is an inverted cone, called the **cup.** This may be erect or curved, slowly or rapidly expanding, and may have holdfasts. **Compound** skeletons, **catenulate** or **dendroid,** are not common. Some cups are one-walled; most have two walls and a normally empty **central cavity** (Fig. 1,2). The walls are perforate and are connected across the inner space termed the **intervallum** by perforate radial longitudinal plates **(septa)** (Fig. 2), by radial **rods,** by perforate transverse plates **(tabulae),** by small, arched or sagging imperforate plates **(dissepiments),** or by radial or inclined hexagonal tubules with perforate walls. The pores of the walls may be screened or protected by various formations but only exceptionally on their intervallar surfaces.

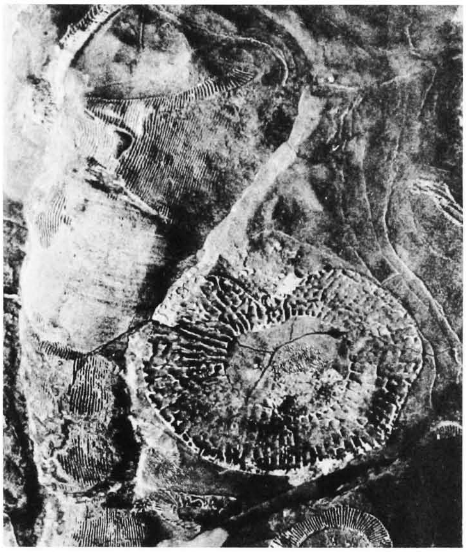


FIG. 1. Etched specimens from the Ajax Limestone, South Australia. On the left, *Thalamocyathus trachealis* (TAYLOR) with finely porous outer wall removed from most of the large elongately conical two-walled cup to display outer edges of septa; on the right, a cross section of an irregularan cup, showing inner and outer walls connected by irregularly radial septa, and empty central cavity (Taylor, 1910).

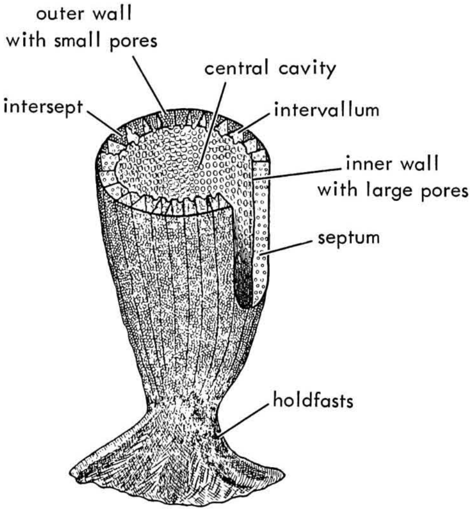


FIG. 2. Reconstruction of the skeleton of an archaeocyathan (Regulares, Ajacicyathina), a two-walled septate conical cup with central cavity and supported basally by holdfasts, ×13 (Vologdin, 1962c).

MICROSTRUCTURE

The skeletal elements of Archaeocyatha commonly consist of a very finely granular mosaic of calcite, the grains being about 0.01 or 0.02 mm. in diameter, arranged with their *c*-axes in random directions, and commonly of a uniform color. Some forms have coarser grain, others, irregular grains. Such variations are possibly due to diagenetic change. Another common diagenetic change is replacement of the calcite by silica. In a few, an alternation of bands occurs. These bands are light and dark in transmitted light, and white and more densely white in reflected light, almost certainly representing growth layering. The darker (and denser) bands may represent either greater original concentration of organic matter or possibly concentrations of finer crystalline grains, as also may spots seen in sections of a few specimens (Fig. 3).

The skeletal matter differs from that of corals in the seeming absence of acicular

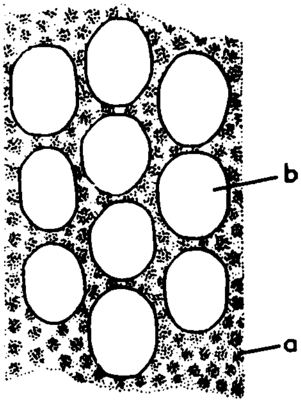


FIG. 3. Granular microstructure shown in median longitudinal section of septum of *Ajacicyathus gigantoporus* ZHURAVLEVA, ×50 [*a*, patch of denser granularity; *b*, pore] (Zhuravleva, 1960b).

crystals, though their original presence is suspected in a few species. The septa never show median dark lines such as appear where the needles of two halves of a coral septum meet, nor is there ever a dark line at the junction of one plate with another, such as forms in corals where plates having differently oriented fabrics are in contact or where one plate is formed later than another. All appearances in thin section suggest complete continuity of the skeletal elements, but this appearance conceivably may be due to recrystallization of the original. Dissepiments, which are always very thin, may form an exception to this rule of continuity, for they seem to have been formed later than those parts of septa or walls that they touch.

Although septa and walls may be analyzed as constructed of longitudinal pillars and transverse rods, the pillars do not seem to be analogous with the trabeculae of corals. No median dark axis is seen in them, and they lack any appearance of fibrosity.

All the skeletal elements except the dissepiments are perforate. In none are spicules discernible. Further, no element by itself can be considered to be a spicule, and no axial canal like that of sponge spicules has been observed.

Secondary thickening of all elements except dissepiments has been observed; such thickening is usually growth-layered. Thickening may be effected as follows. First, layers invest the outside of the outer wall; next, the inside of the outer wall and the septa are invested simultaneously; then both sides of the inner wall become coated until finally all space in the lower part of the cup may be filled; in some species all pores are closed off, but in others the pore

FIG. 4. External form in solitary Archaeocyatha (*facing page*).

1. Slenderly conical and erect form of *Dokidocyathus simplicissimus* BEDFORD & BEDFORD, ×0.3 (R. Bedford & W. R. Bedford, 1936).

2. Slenderly conical form with basal holdfasts, shown by *Tumuliolynthus karakolensis* ZHURAVLEVA, ×1 (Rozanov & Missarzhevskiy, 1966).

3. Cylindrical form of *Sigmocoscinus sigma* BEDFORD & BEDFORD, ×0.7 (R. Bedford & W. R. Bedford, 1936).

4. Curved conical form of *Kotuyicyathus kotuyikensis* ZHURAVLEVA, ×1 (Zhuravleva, 1960b).

5. Transversely annulated, annulation not involving inner wall, as seen in *Pycnoidocyathus synapticulosus* BEDFORD & BEDFORD, ×0.3 (R. Bedford & W. R. Bedford, 1936).

6. Transversely annulated type, annulations involving inner wall, as shown by *Orbicyathus mongolicus* VOLOGDIN; *6a*, ext. view, ×2; *6b,c*, tang. sec. of two rings, ×4 (Vologdin, 1937b).

7. Longitudinally ribbed and fluted externally, with basal holdfasts, exemplified by *Beltanacyathus ionicus* BEDFORD & BEDFORD, ×0.3 (R. Bedford & J. Bedford, 1936).

8. Conical, suddenly expanding form of *Paranacyathus subartus* ZHURAVLEVA, ×0.7 (Zhuravleva, 1960b).

9. Broadly conical form of *Cryptoporocyathus junicanensis* ZHURAVLEVA, ×5 (Zhuravleva, 1960b).

10. Subspherical form of *Fransuasaecyathus subtumulatus* ZHURAVLEVA, ×5 (Zhuravleva, 1960b).

11. Bowl-shaped form, with irregular longitudinal folds affecting both walls, shown by *Coscinoptycta convoluta* (TAYLOR), ×0.7 (Taylor, 1910).

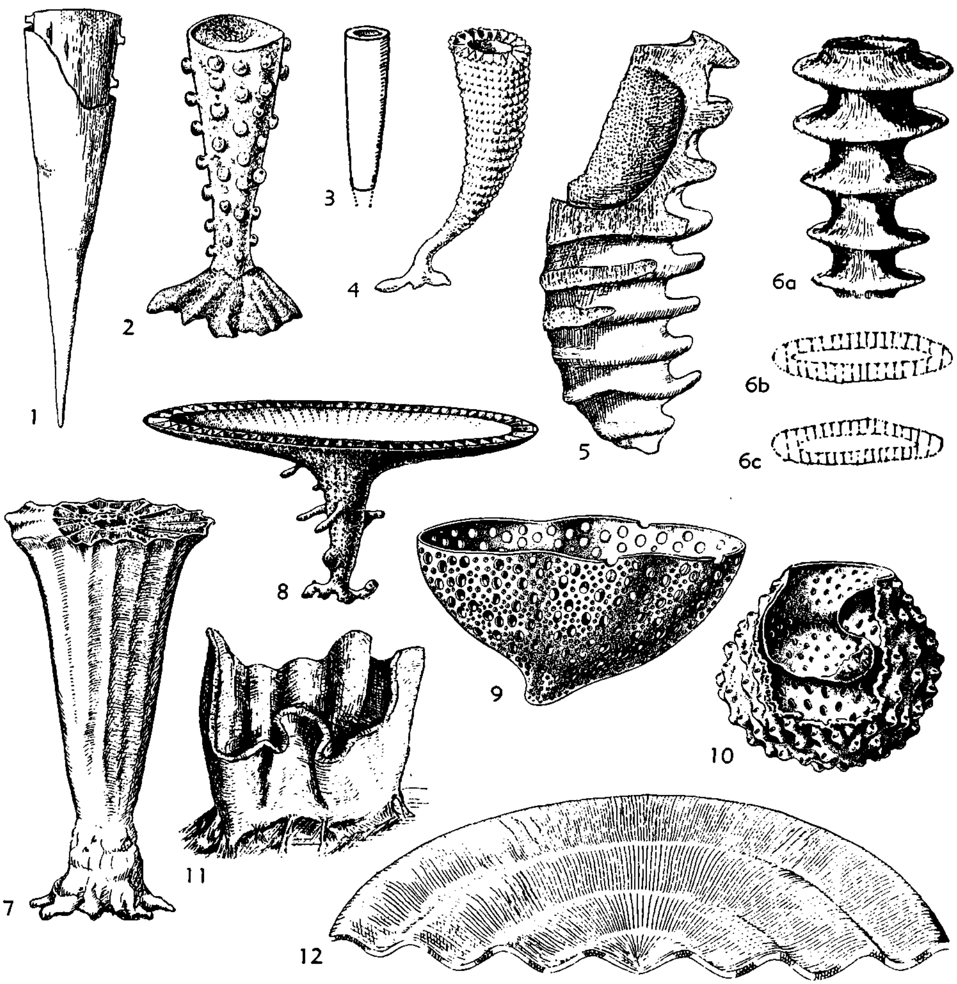
12. Discoid form, with concentric waves (cut in half diametrically), seen in *Okulitchicyathus discoformis* (ZHURAVLEVA), ×0.16 (Zhuravleva, 1960b).

openings may remain free; sinuous canal-like spaces opposite them and through the secondary thickening enable them to maintain communication with the environment.

The secondary thickening may be lamellar, lamellar-granular, granular, or of columnar calcite, and is distinct from the nonorganic clear columnar calcite deposited during diagenesis.

EXTERNAL FORM

The calcareous skeletons of both solitary and colonial Archaeocyatha are known. The skeleton of an individual is termed a cup. Of solitary cups, the great majority are slenderly conical (Fig. 4,*1-2*), especially in the class Regulares; most slender cones are erect or suberect, but some are curved (Fig. 4,*4*), the curvature normally decreasing during growth; some become cylindrical in the adult stage (Fig. 4,*3*). Periodic expansions of the intervallum may affect both walls in parallel or only the outer wall, and there may be transverse or annular (Fig. 4,*5-6*) or longitudinal (Fig. 4,*7*) flutings that may affect only the inner wall around the central cavity. Broadly conical and saucer-shaped cups are not common (Fig. 4,*8-9,11*). Some large bowl-shaped cups with narrow intervallar rims have irregular longitudinal folds in their rims



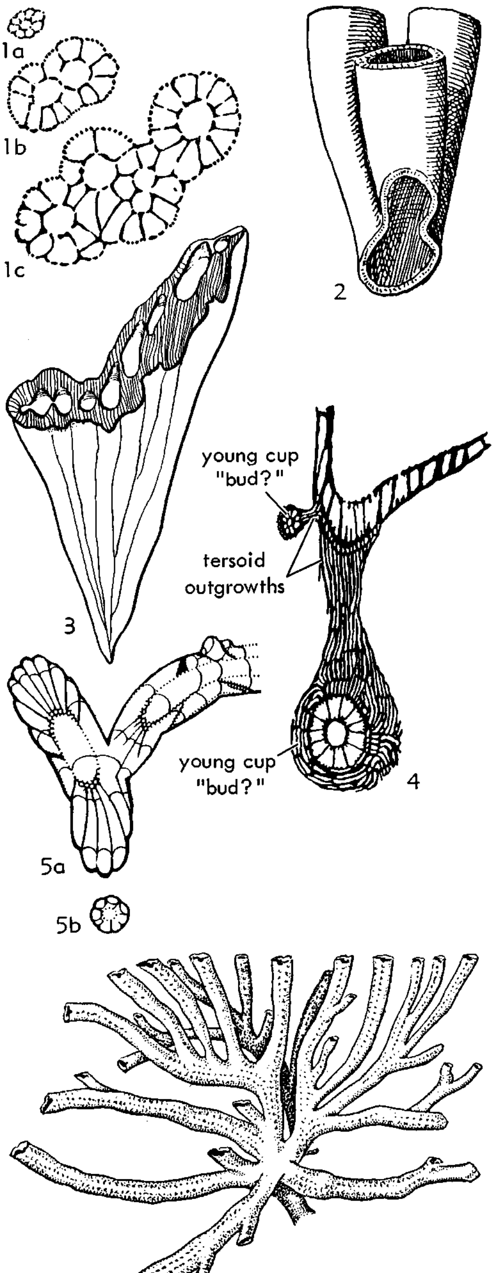


FIG. 5. External form in colonial Archaeocyatha.——*1a-c*. Massive; serial sections through colony of *Ajacicyathus sanaschticolensis* VOLOGDIN, ×3 (Vologdin, 1937b).——*2*. Dendroid; increase by opposed indenting of intervallum, in *"Archaeocyathus" aequitriens* BEDFORD & BEDFORD, ×0.7 (R. Bedford & J. Bedford, 1937).——*3*. Catenulate; *Salairocyathus (Polystillicidocyathus) erbosimilis* DEBRENNE, ×1.5 (Debrenne, 1959b).——*4*. Pseudocolony? Linkage of cups by tersioid outgrowths (Taylor, 1908).——*5*. Dendroid, new cup arising from intervallum; *5a*, oblique thin section, and *5b*, transv. sec. of *Loculicyathus frondosus* VOLOGDIN, ×2.5 (Vologdin, 1962c).——*6*. Dendroid form of *Archaeolynthus polaris* (VOLOGDIN), ×0.7 (Zhuravleva, 1960b).

(Fig. 4,*11*); others have irregular dents. Discoid cups, in which the angle of the cone is approximately 180° are found in a few species (Fig. 4,*12*); the discs may be concentrically waved. A small number of species, especially in two-walled cups without septa, have subspherical, hemispherical, or irregularly bulbous cups that may not be attached to substrates (Fig. 4,*10*). In the Irregulares, expansions and contractions may be very irregular, and in many, fingerlike protrusions occur. The shape of the older part of the cup may be hidden under outgrowths of tubular, heel-like, or irregular form that acted as holdfasts. In many one-walled cups (and in a few two-walled cups) the upper edge arches over the cavity, leaving only a small orifice.

The colonial habit is rare, and form of colonies is less varied than in corals. In a **catenulate colony** the cups are contiguous in a row or chain and the outer wall fails to develop between neighbors (Fig. 5,*3*); a few cups in such a colony may have no central cavity. In a **massive colony** cups are massed together without outer walls between them, but each has its own central cavity (Fig. 5,*1*). In a **dendroid colony** each individual cup is a branch isolated from the others except at its point of origin in either the inner or the outer wall (Fig. 5,*2,5-6*). In some Irregulares, the buds originate from the outer part of the intervallum and the outer wall. A few species of Irregulares have fingerlike projections of the central cavity that cause the intervallum to bulge outward beyond the normal conical outline to form wider projections of the intervallum (Fig. 5,*2*). Lateral outgrowths from one or more cups may surround neighboring cups of the same species, giving the appearance of a colony (Fig. 5,*4*).

OUTGROWTHS FROM CUP

Lateral expansions affecting a sector or the whole circumference of the archaeocyathan cup are quite common and fall into two groups.

Group I consists of expansions from the intervallum in which are skeletal elements usually similar to those in the original intervallum. Among included types are the following: 1) **Slender, tubular processes,** commonly of the width of an interseptal space, hollow or crossed by dissepiments (Fig. 6,*15*). These are commonest in the Irregulares. 2) **Tersiae,** or **tersioid processes;** these are fingerlike, as wide as several interseptal spaces; they contain septa, and dissepiments, normally somewhat thicker than those of the cup from which they originate (Fig. 6,*1,5*). They form in many genera of Irregulares and in a few Regulares. 3) **Intervallar expansion in width,** near the base of the cup, acting as a holdfast, with the form of a talon, a pedestal, or a heel (Fig. 6,*4*). 4) **Exocyathoid expansions;** these are formed by the growth of an additional intervallum, in sectors or circumferentially, the septa of the addition being continuous or discontinuous with those of the original intervallum (Fig. 6,*3,6*). When the expansion is external the outer wall may be repeated; expansions into the central cavity (Fig. 6,*7,11,14*) are less readily relatable to the septa and perhaps may be complex outgrowths of the inner wall. Exocyathoid expansions normally appear to have had an adherent function, and occur in both Regulares and Irregulares (Fig. 6,*13*). Those of Coscinocyathina have been called labyrinthomorph (Fig. 6,*9*), those of some Regulares exocyathoid, and those of some Irregulares metaldetimorph (Fig. 6,*8*). Originally, separate generic names were given to these three types.

Group II consists of expansions of dense skeletal tissue applied outside the outer wall. They are found basally only, at a cup height of 2 to 5 mm. and always have an adherent function. Types distinguished are as follows: 1) **Dense skeletal tissue without canals or spaces,** commonly seen in small, slenderly conical Regulares (Fig. 6,*12*). 2) **Dense skeletal tissue pierced by canals** proceeding from the pores of the outer wall and parallel with the outer surface of the mass (Fig. 6,*2*). 3) **Dense skeletal tissue laminate,** the laminae parallel to the outer surface of the mass being separated by similar parallel spaces (Fig. 6,*10*). This type is rare.

SIZE OF CUP

The diameter of the overwhelming majority of archaeocyathan cups ranges from 10 to 20 or 25 mm. The height is normally proportional to the diameter; and for the above diameter, the height may be 80 to 150 mm. Some species, especially one-walled, or two-walled cups without septa, never attain an adult diameter greater than 1.5 to 3 mm., though nearly all one-walled forms have a diameter of 4 to 6 mm. at a height of 15 to 25 mm. The maximum diameter known is 500 to 600 mm. in the disc-shaped *Okulitchicyathus* where the cup has the relative minimum height of 6 to 10 mm. The maximum known height is 250 to 300 mm. Microscopic forms regarded by VOLOGDIN as planktonic archaeocyathans are here considered to be probably not referable to the phylum.

Small forms were prevalent on the Siberian Platform when the phylum first appeared in Early Cambrian (Sunnaginian) times, and again in Tolbachanian (Botomian) times when, it is thought, the seas became highly enriched in magnesium salts. Maximum size of Archaeocyatha individuals both in height and diameter, as well as abundance, is attained in strata containing bioherms, but the largest species are found in the interbiohermal pockets. Species with small adult diameters accompany the large species in strata with bioherms.

OUTER WALL

The outer wall of two-walled Archaeocyatha is homologous with the single wall of one-walled Archaeocyatha. It shows considerable diversity of structure, though less than that of the inner wall (Fig. 7,8). Present knowledge indicates that the outer wall is imperforate at the extreme base, or tip, of the cup. It then becomes simply porous. In cups with complex pores in adult stages this simply porous stage lasts only fleetingly.

Simply perforate, thin walls are fairly

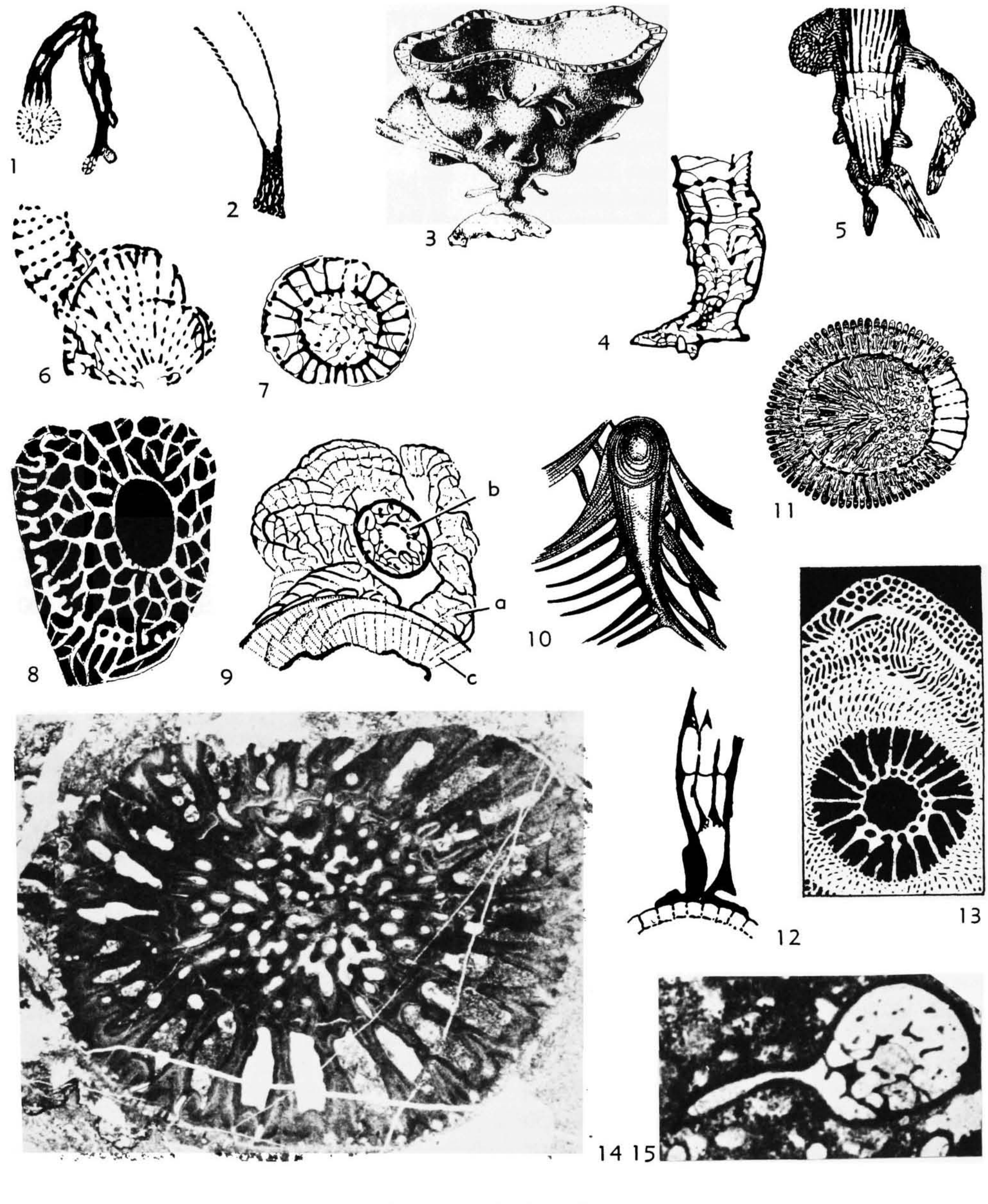


FIG. 6. Outgrowths from the cup.

1. Tersioid process in *Robustocyathus robustus* ZHURAVLEVA, ×2.5 (Zhuravleva, 1960b).

2. Holdfast of dense skeletal tissue without canals of *Tumuliolynthus tubexternus* (VOLOGDIN), ×4 (Zhuravleva, 1949).

3. Unconformable intervallar segment and irregular processes in *Paranacyathus subartus* ZHURAVLEVA, ×1 (Zhuravleva, 1960b).

4. Expansion in width of intervallar space to form adherent talon in *Bicyathus bateniensis* (VOLOGDIN), ×3 (Vologdin, 1959c).

5. Tersioid processes in *Paranacyathus* sp., ×2.5 (Zhuravleva, 1959b).

6. Exocyathoid processes, one doubling the intervallum and outer wall, and the other unconformable; thin section, ×3 (Zhuravleva, 1960b).

7. Outgrowths into central cavity; dissepiments common in the Regulares. They may be described as **perforate,** when the area occupied by wall tissue is greater than that occupied by the pores (Fig. 7,*1,10*); or **retiform,** when the pores are so closely spaced that the wall is netlike (Fig. 7,*11*). The pores may be rounded, oval, polygonal, or chinklike in outline (Fig. 7,*10,11,12*), or, as in many Irregulares, they may be irregular in outline and in arrangement (Fig. 7,*2*). Commonly pores are arranged in longitudinal rows, one to eight such rows to an intersept (Fig. 9). The pores of neighboring rows may be opposite (Fig. 7,*20*) or alternate (Fig. 7,*10*). In many species the wall tissue between the rows, especially in the midline of the intersept, is thicker than that between the pores of a row, giving the appearance of a low longitudinal rib, projecting either outward or inward or both. Spines may project from the tissue between four pores. The lower lip of a pore may be produced like a spine (Fig. 7,*17*), or like an uncurved or only slightly curved scale (Fig. 7,*13*), or as a bract with a concave upper surface like a half cupule; or the upper lip may be produced into a peak like the projection from the brim of a man's cap. From the whole rim of a large pore, a domelike tumulus may develop, pierced by one opening or by many smaller ones (Fig. 7,*18*); a smooth tumulus with one opening is a simple tumulus and the opening may be central or on the upper or lower surface (Fig. 7,*19*; 8,*2*). A tumulus with many pores is commonly knobby, a small pore piercing each knob.

Where simply porous walls are thick, length of the pores may be greater than their diameter so that they may be called **pore-canals** (Fig. 7,*15*). Where the skeletal tissue between these pore-canals is thin, or formed of louvre-like or resupinate plates, the pore-canals may be termed pore-tubes. Pore-canals and pore-tubes commonly are circular but may be hexagonal in section (Fig. 7,*3*), and are arranged in opposite or alternate longitudinal rows, one to four to an interseptal space. They may be straight and perpendicular to the wall surfaces, oblique, or geniculate, either V- (Fig. 7,*4*) or inverted V-shaped. The outer upper or lower lip of the pore-canal or pore-tube may be produced into a peak or a bract (Fig. 7,*5*). Pore canals that branch outward, giving finer porosity on the outer surface of the wall than on the inner one, are known in *Cryptoporocyathus* (Fig. 7,*22*). The description "with branching pores" earlier was used for a wall with a finely porous outer (supplementary) sheath (Fig. 7,*14*).

Some external walls consist only of a series of troughed or S-shaped annuli applied at regular short intervals to the outer ends of the septa (Fig. 7,*16*) or of rows of scales forming annuli (Fig. 7,*7*).

Walls may be developed with an external sheath. The sheath is commonly perforate, and its perforations are always

FIG. 6. *(Continued from facing page.)*

and rods? in *Loculicyathus* sp., ×3 (Krasnopeeva, 1960).

8. Exocyathoid expansion from an irregularan cup, thin section, ×2; *"Metaldetimorpha" yorkei* BEDFORD & BEDFORD (R. Bedford & J. Bedford, 1937).

9. Exocyathoid expansion [*a, "Labyrinthomorpha tolli"* VOLOGDIN, associated with *b, Protopharetra laxa* BORNEMANN, and *c, Coscinocyathus dianthus* BORNEMANN], thin section, ×5 (Vologdin, 1959c).

10. Dense, laminate, basally adherent skeletal tissue, *Tumulocyathus* sp., ×40 (Zhuravleva, 1960b).

11. Outgrowths into central cavity, lined by secondary thickening interpreted by VOLOGDIN as calcified soft parts, *Ajacicyathus demboi* VOLOGDIN, transv. sec., ×10 (Vologdin, 1962d).

12. Holdfast formed of dense skeletal tissue in *Loculicyathus salairicus* VOLOGDIN, ×3 (Vologdin, 1962b).

13. Exocyathoid expansion forming holdfast for *Beltanacyathus ionicus* BEDFORD & BEDFORD, thin section, ×2 (R. Bedford & J. Bedford, 1937).

14. Outgrowths into central cavity, lined by secondary thickening, in *Robustocyathus robustus* (VOLOGDIN), interpreted by VOLOGDIN as calcified soft parts, ×?4 (Vologdin, 1962b).

15. Slender tubular process with dissepiment in *Protopharetra polymorpha* BORNEMANN, ×2 (Zhuravleva, 1960b).

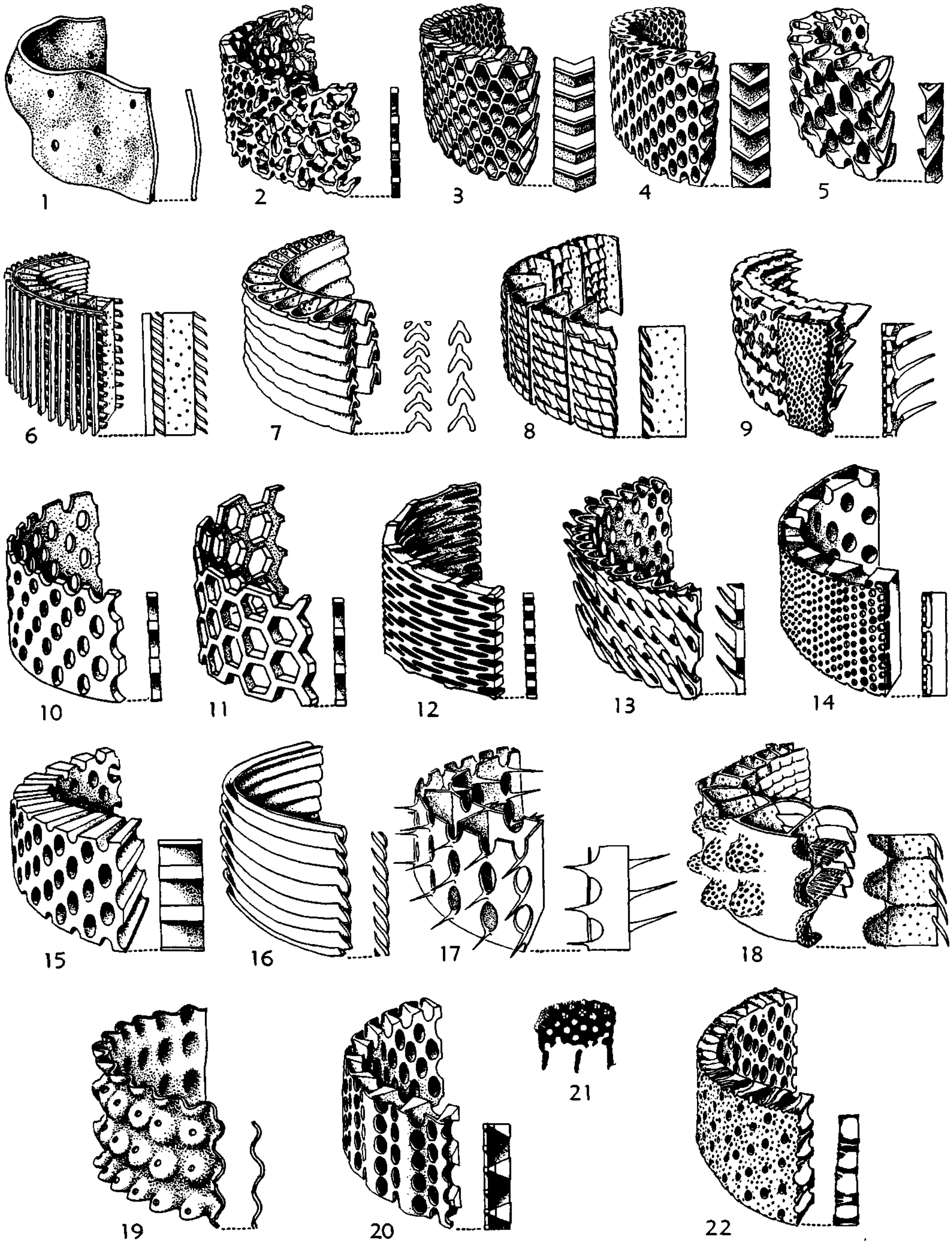


FIG. 7. Outer wall structures, diagrammatic.

1. Thin perforate wall with scattered small pores in *Bicyathus* sp. (mod. Debrenne, 1964).

2. Thin retiform wall with irregular pores (mod. Debrenne, 1964).

3. Thick wall with hexagonal geniculate pore-tubes, in *Coscinocyathus* (mod. Debrenne, 1964).

4. Thick wall with cylindrical geniculate pore-finer than those of the coarse framework it sheaths (Fig. 7,*21*). It may be a network growing tangentially from the thinned outer edges of the coarse framework (Fig. 7,*20*), or it may be suspended from short rods extending outward from the framework (Fig. 7,*14*). In some Irregulares with much imperforate dissepimental tissue, an imperforate pellis or pellicle is considered by DEBRENNE (1964) to be present (Fig. 10). A clathrate wall consists of a fine grill of tenuous longitudinal plates applied to a series of thin annuli (Fig. 7,*8*); the grill of longitudinal laths may develop without the second system of transverse plates.

The outer wall of some Archaeocyatha is formed by conjunction of the downturned peripheral edges of the tabulae and an external microporous sheath may cover it (Fig. 7,*9*). An outer wall may be formed in some by lamellar thickening of the peripheral ends of the septa (e.g., *Anthomorpha*). In older forms of *Protopharetra* and *Dictyocyathus* the wall is not independent of the intervallar elements but is formed by them. Some Irregulares have an aporose external wall (*Archaeopharetra*), which may show growth lineation as in the epitheca of a coral.

INTERVALLUM

GENERAL FEATURES

The space between the outer and inner skeletal walls in Archaeocyatha is the intervallum. It becomes defined when the inner wall appears; in the Regulares this is commonly at a cup diameter between 0.13 and 0.2 mm., and in the Irregulares at a slightly greater cup diameter—0.5 to 0.7 mm. In a few species width of the intervallum is proportional to width of the central cavity, expressed as intervallum coefficient = width of intervallum/width of central cavity. In other species the width of the intervallum varies little once the adult characters are stabilized.

The two walls are commonly connected

FIG. 7. *(Continued from facing page.)*

canals (mod. Debrenne, 1964).

5. Thick wall with cylindrical, oblique pore-canals whose outer lower lips are extended as bracts, thus forming geniculate pore-tubes in *Porocyathus* (mod. Debrenne, 1964).

6. Clathrate wall, composed of longitudinal laths applied to oblique annuli that are in turn applied to outer edges of septa, in *Botomocyathus zelenovi* ZHURAVLEVA (Hill, n).

7. Wall of opposed peaks forming wide inverted V's at the outer edges of neighboring septa in *Annulocyathus pulcher* VOLOGDIN (Hill, n).

8. Wall of slightly resupinate louvers in three longitudinal series connecting outer edges of neighboring septa (Hill, n).

9. Wall formed from downturned edges of tabulae and with external microporous sheath (mod. Debrenne, 1964).

10. Simply perforate thin wall, circular pores in alternating rows in *Ajacicyathus* (mod. Debrenne, 1964).

11. Retiform thin wall with hexagonal pores, shown in *Erismacoscinus* (mod. Debrenne, 1964).

12. Thin wall with alternating chinky or slit-like pores (mod. Debrenne, 1964).

13. Perforate thin wall with an obtuse bract springing obliquely from the outer lower lip of each pore, the rows of pores alternating (mod. Debrenne, 1964).

14. Thick wall with conical pore-canals, covered by microporous sheath (mod. Debrenne, 1964).

15. Thick wall with horizontal pore-canals (mod. Debrenne, 1964).

16. Annulate wall formed by a series of resupinate horizontal shelves applied to outer edges of septa (mod. Debrenne, 1964).

17. Perforate thin wall with acutely pointed bract springing horizontally from the lower rim of each pore, the rows of pores concordant, shown in *Robustocyathus spinosus* ZHURAVLEVA (Hill, n).

18. Thin wall with tumuli each with several small pores (mod. Debrenne, 1964).

19. Thin wall with tumuli each with small, circular pore (mod. Debrenne, 1964).

20. Thick wall with conical pore-canals, covered with coarsely porous sheath (Hill, n).

21. Obliquely tangential thin section of a wall with a finely porous sheath developed externally, shown in *Ladaecyathus* (Hill, n).

22. Thick wall with large and small pore-canals, the latter opening from the surface through the wall segments into the large pores, shown in *Cryptoporocyathus junicanensis* ZHURAVLEVA (Hill, n).

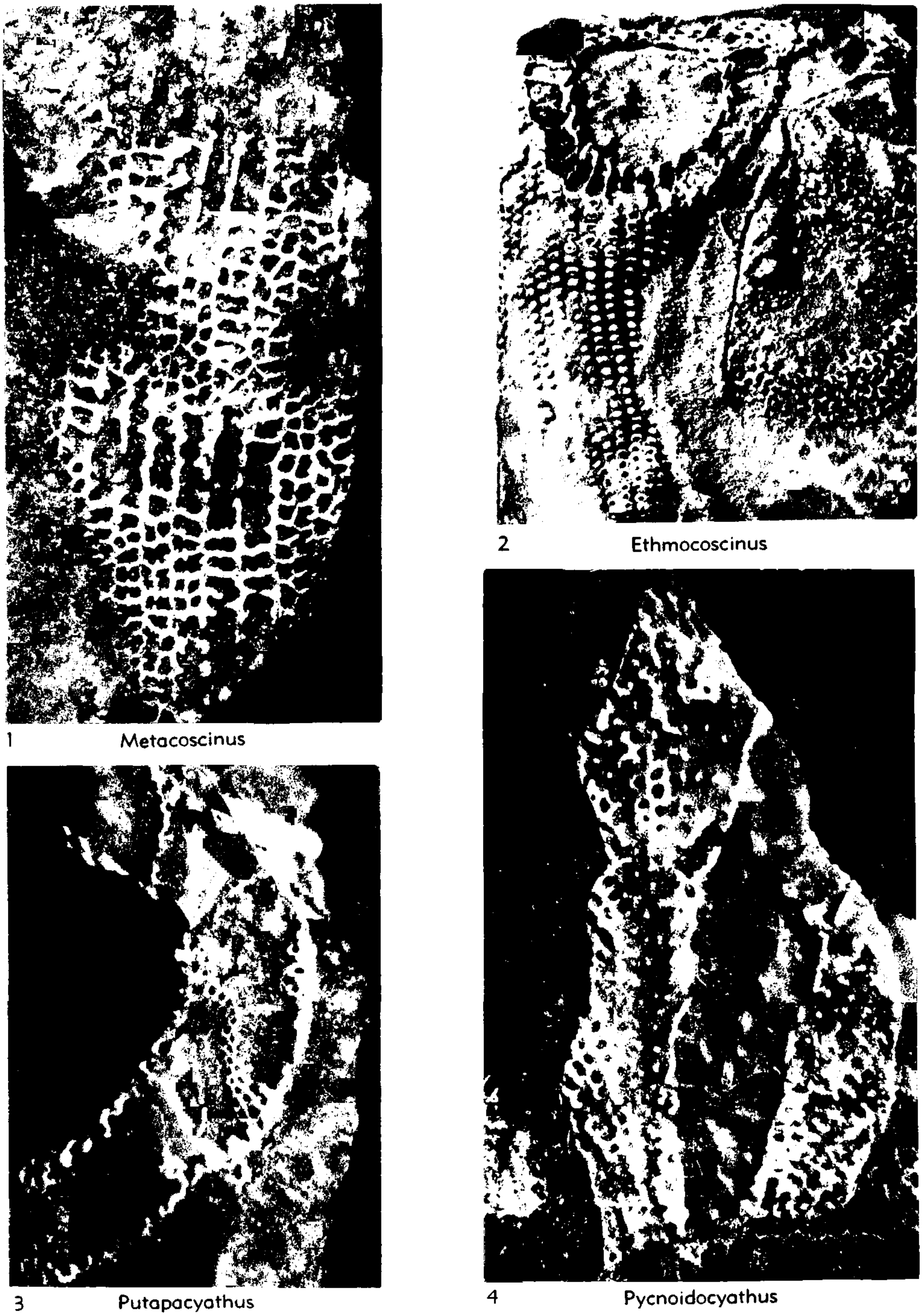


FIG. 8. Etched silicified specimens from the Ajax Limestone, South Australia.——*1.* Outer wall and outer edges of septa of *Metacoscinus reteseptatus* BEDFORD & BEDFORD, ×6 (Debrenne, 1969a).——*2.* Outer

and the intervallar space divided into interradial loculi by various types of radial skeletal elements—septa, pillars, rods, or tubules. **Septa** are more or less regular plates that divide the intervallar space into interseptal loculi, and interseptal segments of the walls may be referred to as **intersepts.**

The radial coefficient RK (number of radial elements/diameter of cup) is a useful magnitude, if for a given species the width of the interradial space is constant. In many species, however, this width increases slightly with growth of the cup. The size of pores and distance apart of the longitudinal rows of pores in the outer wall increase perceptibly with increase in diameter of the cup, so that the expression Rk defined as number of longitudinal rows of pores per intersept/diameter of cup is also useful in the description of species.

The intervallum is divided transversely except in the relatively small suborder Ajacicyathina and in the order Syringocnemidida. Transverse skeletal elements are tabulae (porous or pectinate) and imperforate dissepiments. Normally only the dissepiments may extend into the central cavity. The height of the intertabular loculi is seldom constant in a species.

SEPTA

In the two-walled Regulares, except in the suborder Dokidocyathina (with radial skeletal elements formed by radial rods arranged in horizontal planes), and the Putapacyathida (with the walls connected only by tabulae), the walls are connected by unwaved normally porous radial longitudinal plates or septa (Fig. 11,*1-11*). In the Regulares the pores are simple, rounded, or oval and arranged in longitudinal rows. In the Coscinocyathina these rows diverge from the middle of the septum toward the inner and the outer walls, and range in number up to 20; the pores are also arranged in transverse lines that curve perpendicularly to the rows they cross, with curvature the same as that of the tabulae

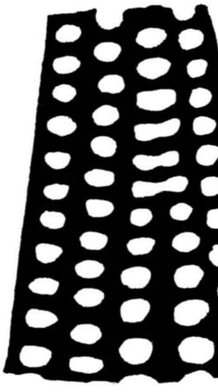


FIG. 9. Development of new longitudinal series of pores in intersept of outer wall shown by *Ajacicyathus sunnaginicus* ZHURAVLEVA, ×100 (Zhuravleva, 1960b).

(Fig. 11,*5*). New longitudinal rows appear near the axis of divergence of the rows. In the Nochoroicyathina the rows are in horizontal lines parallel to the tabulae. Normally the size of the pores is fairly constant in any one species, but some species have a few large pores in the older parts of the septum, and more and smaller pores higher up (Fig. 11,*2,3*). The pores of septa have

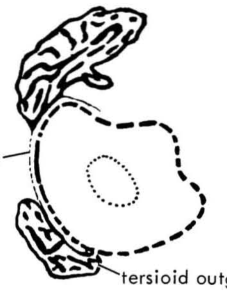


FIG. 10. Pellis of *Capsulocyathus subcallosus* ZHURAVLEVA, ×1.7 (Zhuravleva, *et al.*, 1964).

FIG. 8. *(Continued from facing page.)*

wall of *Ethmocoscinus papillipora* (BEDFORD & BEDFORD), with tumuli, each with single pore, ×4 (Hill, 1965).——*3*. Partial transverse section of *Putapacyathus regularis* BEDFORD & BEDFORD, showing walls and part of tabula, ×8 (Hill, 1965).——*4*. Longitudinal section of *Pycnoidocyathus decipiens* BEDFORD & BEDFORD, showing walls and septa, ×6 (Hill, 1965).

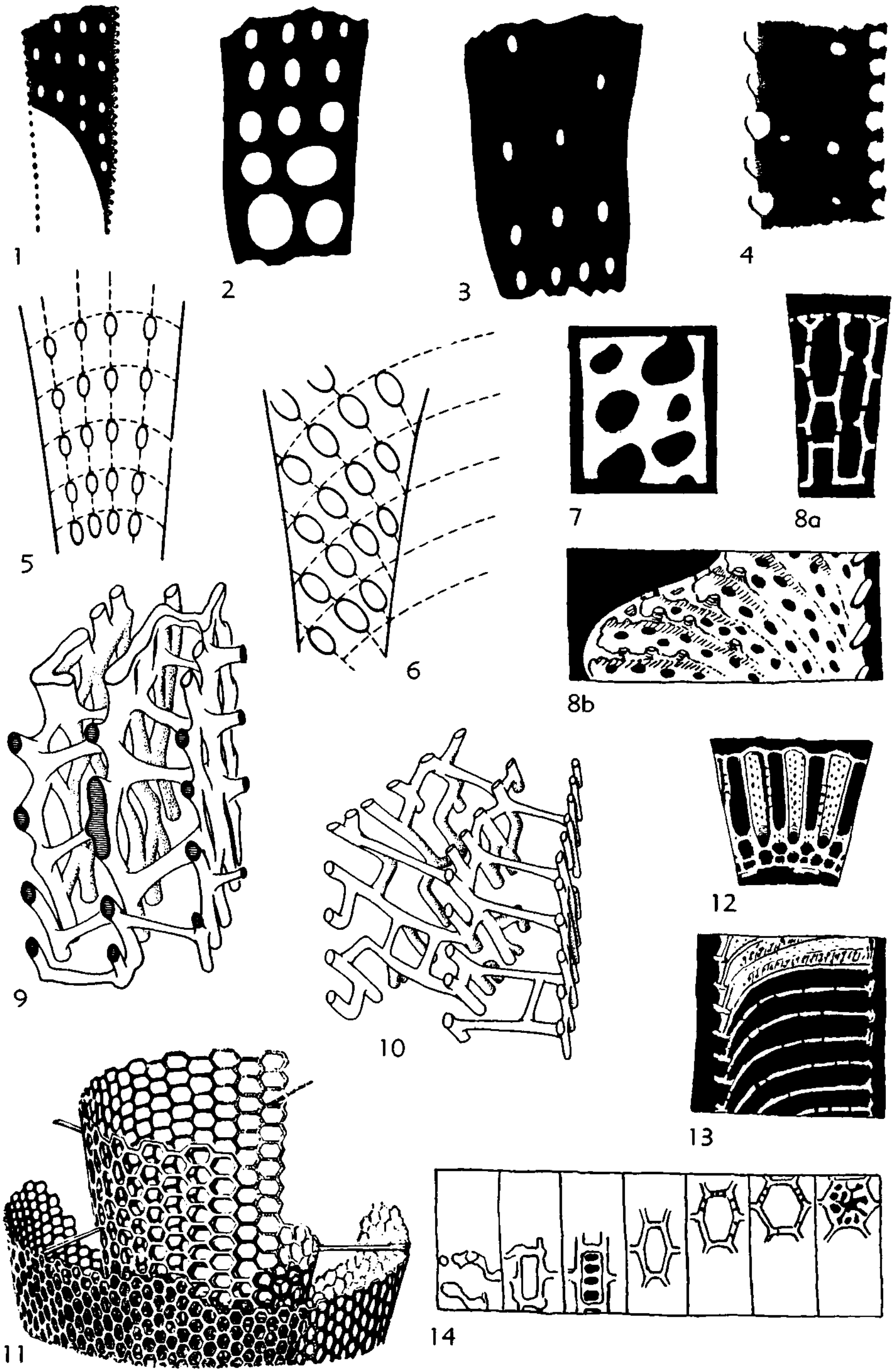


FIG. 11. Intervallar structures: septa and tubuli.

1. Growth of a new septum in *Ajacicyathus* sp., lateral view, outer wall to right, ×15 (Zhuravleva, 1960b).

2. Decreasing size of pores with growth of septum no screening devices or projections from their rims. Where the pores are large and close the septum becomes retiform, but commonly width of septal tissue between the pores is subequal to the diameter of the pores. In a few species the septa are porous only at their junction with one or both walls, where wall pores may be excavated in them to form stirrup pores (Fig. 11,*4*). Septal thickness commonly is characteristic for a species, but a few species have septa thicker in the middle of the intervallum, whereas in others the septa thicken at their junction with the walls. Especially in retiform septa one can analyze the septal tissue into longitudinal pillars and radial bars.

In the Anthomorphidae the septa are described as aporose plates showing a median dark zone surrounded on each side by clear, nonlaminated carbonate.

In the two-walled Irregulares the septa commonly are neither straight nor flat-sided, but appear irregularly waved or may be composed of irregularly sized and curving segments (taeniae); the name taeniae has also been used as a general term for septa of the Irregulares, but in view of the variety in methods of construction of the radial longitudinal plates in the class, the still more general term "septa," used for the radial longitudinal plates of Regulares, is preferred here, supplemented by phrases descriptive of the particular construction.

The commonly unequal to ragged pores of the irregularian septa in many genera are arranged in longitudinal rows curving slightly upward and outward from the inner wall (Fig. 11,*6*), and in transverse rows parallel to the curvature of tabulae; in some of these the septa may be waved in similar longitudinal curves, with crest of the waves occurring between the longitudinal rows. Where the crests of neighboring septa are opposite to one another and connected by synapticulae, a *Syringocnema*-like tubular boxwork is obtained.

In many Irregulares the radial elements are irregularly retiform due to their large unequal pores (Fig. 11,*7*); they then appear to consist of cylindrical or laterally flattened unequal pillars directed upward and outward from the inner to the outer wall, united in the radial plane by irregular rods (Fig. 11,*8*). This suggests that possibly the irregularian septum is built up from the rodlike skeletal elements of the early family Dictyocyathidae. In the young stages of this family no particular orientation of the rods is evident (Fig. 11,*9,10*), but in adult stages of some the radial skeletal elements consist of radial rows of longitudinal pillars that may be directed upward and outward from the inner wall with connection to one another in the radial plane by rods and to those of neighboring radial rows by synapticulae (Fig. 11,*11*). A very coarsely porous septum may thus be formed. Septal pores are unscreened and have no outgrowths from their rims.

Radial longitudinal pillars as such are

FIG. 11. *(Continued from facing page.)*

in *Ajacicyathus sunnaginicus* ZHURAVLEVA; lateral view of septum, ×30 (Zhuravleva, 1960b).

3. Decrease in number of pore-rows with growth of septum in *Erbocyathus heterovallum* (VOLOGDIN); lateral view of septum, ×30 (Zhuravleva, 1960b).

4. Septum with stirrup pores at outer (to left) and inner wall of *Tumulocyathellus unicumus* ZHURAVLEVA; lateral view, ×30 (Zhuravleva, 1960b).

5. Pore arrangement common in Regulares Coscinocyathina in diverging longitudinal rows and curving transverse rows (Zhuravleva, 1960b).

6. Pore arrangement common in Irregulares, in longitudinal rows curving upward and outward from inner to outer wall (Zhuravleva, 1960b).

7. Pores of different diameter and form in septum of Irregulares (Repina, *et al.*, 1964).

8. Pores of septum of *Pycnoidocyathus synapticulosus* TAYLOR; *8a*, part of transv. sec.; *8b*, lateral view of septum; ×3 (R. Bedford & W. R. Bedford, 1936).

9. Septa of *Volvacyathus* (Debrenne, 1964).

10. Rods and bars of *Dictyocyathus (Dictyocyathus)*, outer wall to left (Debrenne, 1964).

11. Radial rods between inner and outer walls of *Dokidocyathus regularis* ZHURAVLEVA, ×7.5 (Zhuravleva, 1960b).

12-14. Hexagonal tubuli of *Syringocnema favus* TAYLOR (R. Bedford & W. R. Bedford, 1936).——*12.* In transverse fracture of cup, ×3.——*13.* In longitudinal fracture of cup, ×3.——*14.* Serial sections of single hexagonal tubulus from inner to outer wall, ×6.

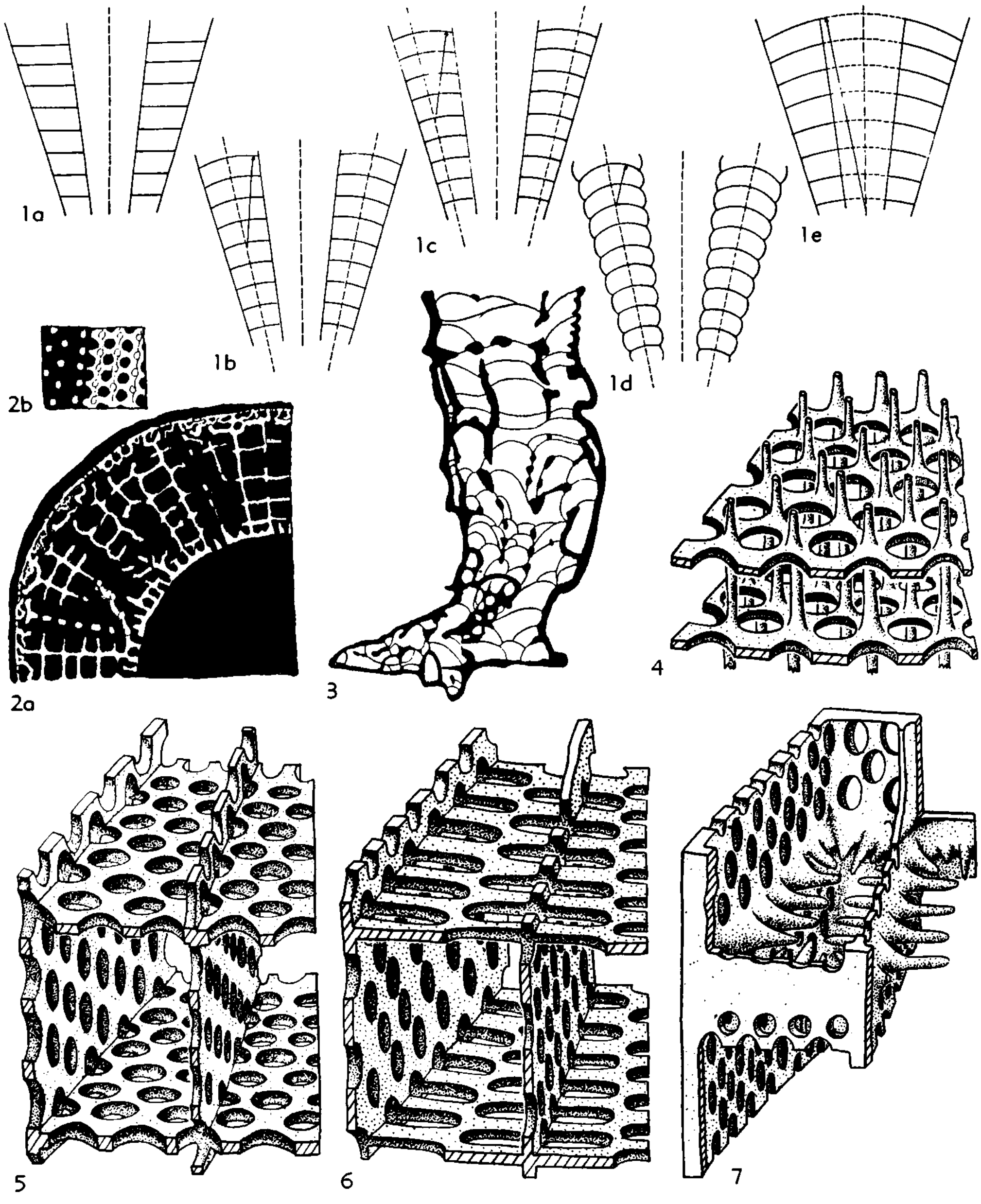


FIG. 12. Intervallar structures: synapticulae, tabulae, and dissepiments.——*1.* Different curvature of tabulae, shown diagrammatically in longitudinal section of the cup; *1a,* horizontal as in *Nochoroicyathus* and rarely in Coscinocyathina; *1b,c,d,* curved with axis of curvature within the intervallum, as in Coscinocyathina and Putapacyathida; *1e,* curved with axis of curvature in central cavity as in Archaeosyconina (Debrenne, 1964).——*2.* Synapticulae connecting septa in *Metafungia reticulata* BEDFORD & BEDFORD; *2a,* part of transv. sec. of cup; *2b,* oblique tang. sec. of septum, ×2.7 (R. Bedford & W. R. Bedford, 1934).——*3.* Dissepiments shown in long. sec. of *Bicyathus bateniensis* (VOLOGDIN) (Vologdin, 1959).——*4.* Harrow-like tabulae in *Hupecyathus* sp. (Debrenne, 1964).——*5.* Tabulae and septa with rounded pores in *Coscinocyathus* sp. (Debrenne, 1964).——*6.* Tabulae with slit-like pores in *Retecoscinus* sp. (Debrenne, 1964).——*7.* Pectinate tabulae in Nochoroicyathina (Debrenne, 1964).

present in the intervallar framework of the Archaeosyconidae. They curve upward and outward from inner to outer wall and perpendicularly to the tabulae, and may be homologous with the "pillars" of septal tissue between the longitudinal rows of pores in septa.

TUBULI

In the order Syringocnemidida the intervallum is filled with prismatic, porous-walled tubuli alternating in position in superposed rows; commonly the later young stages have randomly disposed rods and bars in the intervallum, the tubuli appear only after the inner wall is developed (Fig. 11,*12-14*). The tubuli are directed upward and outward from the inner wall, steeply upward at first, but then flattening to meet the outer wall almost at right angles.

TABULAE

Tabulae are the perforate horizontal skeletal elements that connect inner and outer walls surrounding the central cavity (Fig. 12,*1*,*4-7*). In the Regulares they may be convex upward, quite flat, or absent; where they are convex the crest of the curvature lies midway between inner and outer wall (Fig. 12,*1a-e*); commonly the tabulae of neighboring interseptal loculi are on the same level. Tabulae are commonly porous, with round or oval pores (Fig. 12,*5*); in *Retecoscinus* the pores are slit- or chink-like (Fig. 12,*6*). Tabulae become retiform when the diameter of the pores is greater than the width of skeletal material between the pores; the pores are never protected by spinules or rims. In one suborder with flat tabulae, the Nochoroicyathina, the tabulae are pectinate (Fig. 12,*7*); in each loculus the tabula consists of two opposed rows of cylindrical spines, that is, each tabula is formed of two combs, with teeth not quite meeting in the radial midline of the intervallum; these spines themselves may carry smaller spinules. Pectinate tabulae are of sporadic development. In the Irregulares only curved porous tabulae are known, but the curvature is centered within the central cavity. Synapticulae may be so positioned as to form a floor like a tabula (Fig. 12,*2*). In the Archaeosyconidae each tabula extends as a complete plate right around the cup, and the radial longitudinal pillars may be discontinuous above it (Fig. 12,*4*).

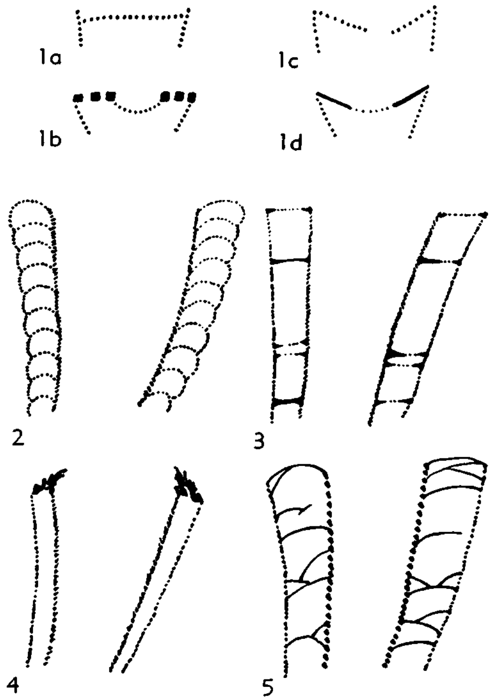


FIG. 13. Distal surface of cup (all from Zhuravleva, 1960b).——*1*. Pelta in single-walled cups, diagrammatic long. secs; *1a*, flat, porous pelta without central orifice in *Archaeolynthus polaris* (VOLOGDIN); *1b*, flat pelta with central orifice screened by porous membrane, in *Archaeolynthus uralocyathoides* ZHURAVLEVA; *1c*, curved porous pelta with central orifice, in *Archaeolynthus sibiricus* (TOLL); *1d*, curved aporose pelta with central orifice screened by porous membrane, in *Archaeolynthus uralocyathoides* ZHURAVLEVA.——*2*. Coscinocyathine with curved tabulae.——*3*. Nochoroicyathine with pectinate tabulae.——*4*. Ajacicyathine with hirsute cap.——*5*. Dictyocyathine, with dissepiments.

DISSEPIMENTS

These imperforate thin plates are nearly always convex as seen from above and may be either horizontally based, or inclined toward either the outer or the inner wall (Fig. 12,*3*). They cross interradial spaces in the intervallum and also may be found in the central cavity. They appear to have formed later than the septa against which they abut and are always thinner than the septa; only

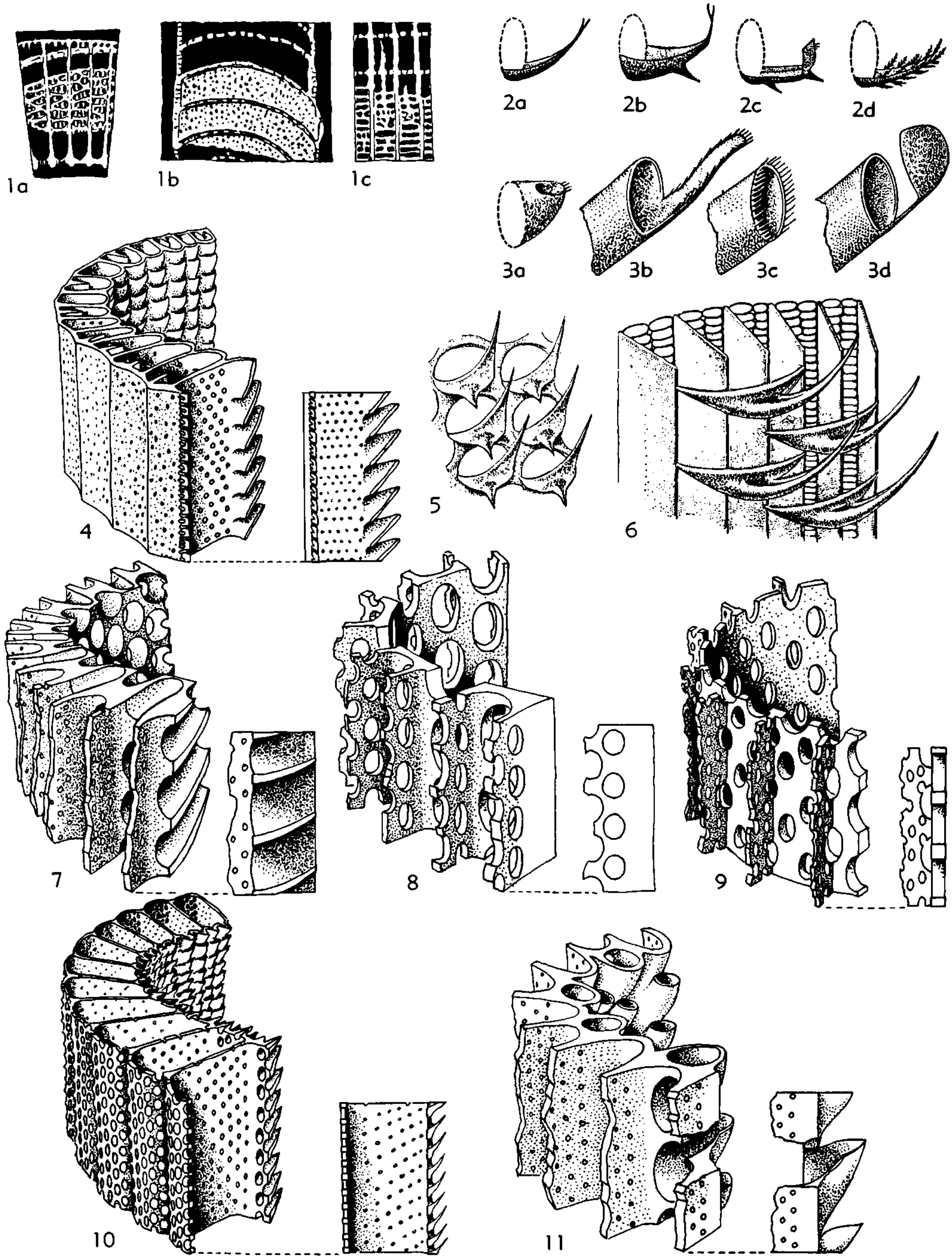


FIG. 14. Inner wall of Archaeocyatha.

1. Wall with rectangular pores and lintels, *Pycnoidocoscinus pycnoideum* BEDFORD & BEDFORD; *1a*, part of transv. sec.; *1b*, part of radial long. sec.; *1c*, tang. sec. inner wall, all ×2.7 (R. Bedford & W. R. Bedford, 1936).

2. Four types of spines projecting from the lower in rare cases are layers of secondary thickening seen on their upper surfaces. Very small dissepiments may be concentrated at the periphery of the intervallum in Irregulares, and may take over the binding function of the wall when the thin wall of such species is not preserved. Dissepiments are always the first skeletal elements formed in the apical cavity of Irregulares and are characteristic of this class. They may occur in the intervallum of some Regulares.

UPPER SURFACE OF CUP

It seems probable that individuals of tabulate Archaeocyatha ended their development and existence with the formation of the top tabula, whether porous or pectinate (Fig. 13,*2-3*). In the dissepimented *Loculicyathus* the upper surface is formed by dissepiments (Fig. 13,*5*). In at least one nontabulate species, the intervallum may be closed above by the union of the outer and inner walls in a cap from which spinules project (Fig. 13,*4*). In some single-walled Archaeocyatha a pelta is developed over the cavity, in some by the wall arching or bending over (Fig. 13,*1*).

INNER WALL

Endless variety, far greater than in the outer wall, is found in construction of the inner wall, but, in nearly all species, openings of the inner wall are larger than those of the outer wall (Fig. 14-16).

The inner wall is commonly a simply porous sheath developed at inner ends of the septa; if thin, it has round or hexagonal pores (Fig. 14,*8*), but if thick, horizontal, inclined, or elbowed pore-canals (Fig. 14,*7*; 15,*6*). In some walls pores, then called stirrup-pores, are excavated from the axial edges of the septa (Fig. 14,*9*). Another simple wall is one formed by growth of horizontal lintels between the septa or longitudinal ribs so that rectangular pores, which may have rounded corners, occur (Fig. 14,*1*).

In slightly more complex walls horizontal or inclined or resupinate scales or louvres grow into the central cavity from these lintels (Fig. 14,*4,10*); if the septa or longitudinal ribs also are produced into the central cavity, pore-tubes that are oblong or hexagonally prismatic spaces may be formed. Such pore-tubes may be geniculate upward or downward (Fig. 15,*6*), or be resupinate. In *Porocyathus* slats extend upward and inward to the intervallum opposite those that extend upward and inward to the axial cavity so that geniculate pore-tubes are formed.

Tuberculate and tumulose inner walls have perforate tubercles or tumuli springing from the rims of the pores (Fig. 14,*3*).

A spinose inner wall has spiny processes springing from beneath each pore, axially with an excavate upper surface, and curving upward and inward to the central cavity (Fig. 14,*2,5*; 15,*7*). In *Leptosocyathus* the bases of the spinose processes each extend across three interseptal loculi (Fig. 14,*6*). In others the spines may be interconnected by lateral and dorsal and ventral spinules *(Clathricyathus robustus)* (Fig. 15,*8*). In a bracted inner wall the lower lip of the pore is produced inward and upward into the central cavity, in some resupinately, and when the sides of neighboring bracts join, pore-tubes are formed (Fig. 14,*11*).

FIG. 14. *(Continued from facing page.)*

rims of pores; *2a-d,* diagram. (Zhuravleva, 1960b).

3. Tumulose and tubulose wall pores with protective hairs and screens; *3a-d,* diagram. (Zhuravleva, 1960b).

4. Wall of curved louvres, diagram., in *Beltanacyathus ionicus* BEDFORD & BEDFORD (Hill, n).

5. Spinose inner wall of *Archaeofungia suvorovae* ZHURAVLEVA, the spines partially screening the pores (Zhuravleva, 1960b).

6. Scaly inner wall in *Leptosocyathus polyseptus* (LATIN), with each spinose scale extending in front of three intersepts (Zhuravleva, 1960b).

7. Thick wall with straight pore-canals (Debrenne, 1964).

8. Simply porous, thin wall with round pores in one longitudinal row to an intersept (Hill, n).

9. Wall with stirrup pores and two longitudinal rows of simple pores to an intersept (Hill, n).

10. Scaly inner wall, scales laterally contiguous, forming incomplete annuli, in *Cadniacyathus asperatus* BEDFORD & BEDFORD (Hill, n).

11. Wall of pore-tubes projecting into inner cavity (Hill, n).

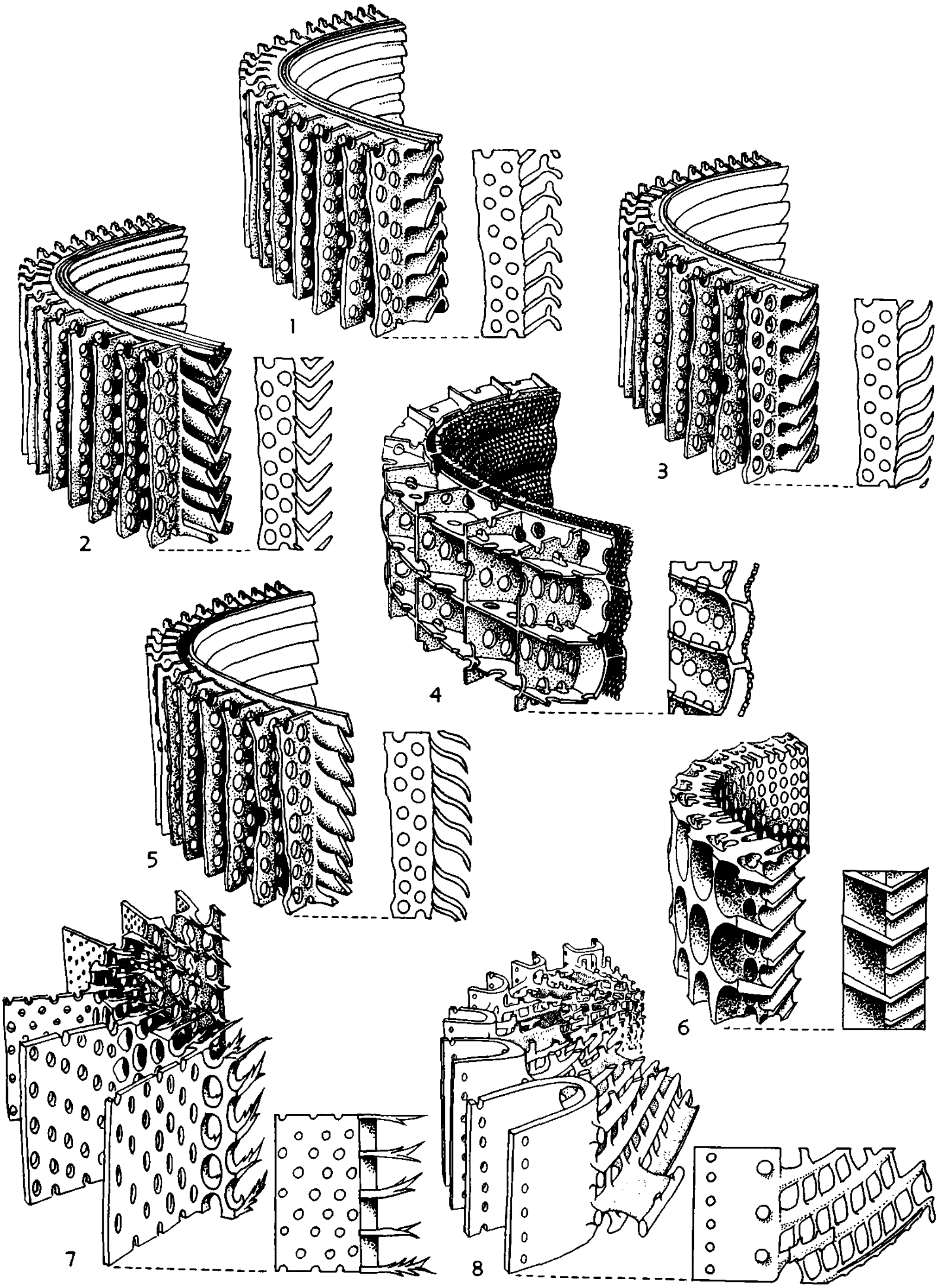


FIG. 15. Inner wall (continued) (Hill, n; all except 6 modified from Debrenne, 1964).——*1*. Annulate wall, annuli of inverted Y section.——*2*. Annulate wall, annuli of V section.——*3*. Annulate wall, annuli of S section.——*4*. Inner wall formed of downturned inner edges of tabulae to which auxiliary screen is

Tubulose inner walls may be formed in many different ways additional to those mentioned above. Pore-tubes may be bent and in more than one series radially (*Formosocyathus*) (Fig. 16,*3*). The inner edge of a pore-tube may be fringed with spines or have resupinate processes extending from its lower sector, or have a perforate domed shield separated from it by an extension of one part of the edge (Fig. 14,*3*).

Septal pore-tubes are partly formed by a transverse (in *Ethmocyathus*) or inclined (in *Ethmophyllum*) opposed waving of the inner edges of the septa so that opposite crests join (Fig. 16,*2*). In *Ethmocyathus* the pore-tubes have hexagonal openings (Fig. 17).

Annulate inner walls are fairly common. In these walls, annulate shelves, which are flat or upright, or inverted U-, V-, or S-shaped in section, are applied to the axial edges of the septa (Fig. 15,*1-3,5*). They may be fringed with spinules (Fig. 16,*4*). In some species the shelves may project slightly into the intervallum between the septal ends.

An inner wall formed by the downturned edges of tabulae is known in *Calyptocyathus*. This has an additional fine screen suspended on short spines (Fig. 15,*4*). Similar additional very fine screens are found lining some inner walls, facing the central cavity (Fig. 16,*1*). These may be porous, supported by the axial edges of pore-tubes, or by projecting spines (Fig. 16,*4*) or they may consist of close, very thin threads (*Ethmocyathus*) applied to the axial edges of pore-tubes (Fig. 17).

CENTRAL CAVITY

The central cavity is the space inside the inner wall. As a rule it is free of skeletal elements, but these may occur in the lower parts of the cup (Fig. 18; see Fig. 75,*4*). Thus dissepiments are found in some and may be continuous with the dissepiments of the intervallum. Radial rods may occur with the dissepiments. The cavity may be filled with secondary thickening deposited parallel to the inner wall and this may be canaliculate. More rarely it may be filled with septate (and tabulate) outgrowths from the intervallum. In some forms the outgrowths may be tubulose, the tubuli being bent and having porous and secondarily thickened walls. In discoid cups the central cavity scarcely can be regarded as a cavity. In some sections of a cateniform colony opposite intervalla are in contact without any intervening cavity.

SOFT PARTS

No impressions of the soft parts of Archaeocyatha have been found in mud or fine sand. Some authors hold that accidentally calcified soft parts have been found (Vologdin, 1931, 1948, 1957b, 1962b; Maslov, 1960). These "calcifications," which they suggest occurred because of the absence of putrefactive microorganisms in the water, or because the dead bodies fossilized very rapidly in water that was rich in dissolved bicarbonates of calcium and magnesium, are of two kinds: 1) dense enveloping material sheathing both the septa and the outer and inner surfaces of the walls, and 2) material surrounding canal-like spaces within the central cavity, the canals being continuous with the pores of the inner wall (Fig. 6,*11,14*). Vologdin (1962b) considered that in some instances true skeletal supporting plates exist at the angles between three such surrounded spaces.

Zhuravleva (1959b, 1960b), however, pointed out that the sheathing tissue of the first type, which has something of the appearance of the intracameral deposits of nautiloids, is often banded in such a way as to indicate periodic accretion parallel to its surface. This seems a better explanation than the one of accidental calcification of soft parts. The question of the origin of the second type is more difficult and is bound up with the interpretation of the nature of the archaeocyathan individual. Vologdin interpreted the tubulose structure as due to accidental calcification of a ramify-

Fig. 15. (*Continued from facing page.*)

applied by thin rods, in *Calyptocoscinus* sp.——*5*. Annulate wall, annuli of inverted S section.——*6*. Wall of branching, geniculate pore-tubes, in *Heckericyathus heckeri* (Zhuravleva).——*7*. Spinose inner wall.——*8*. Spinose inner wall with spines connected by transverse and longitudinal spines.

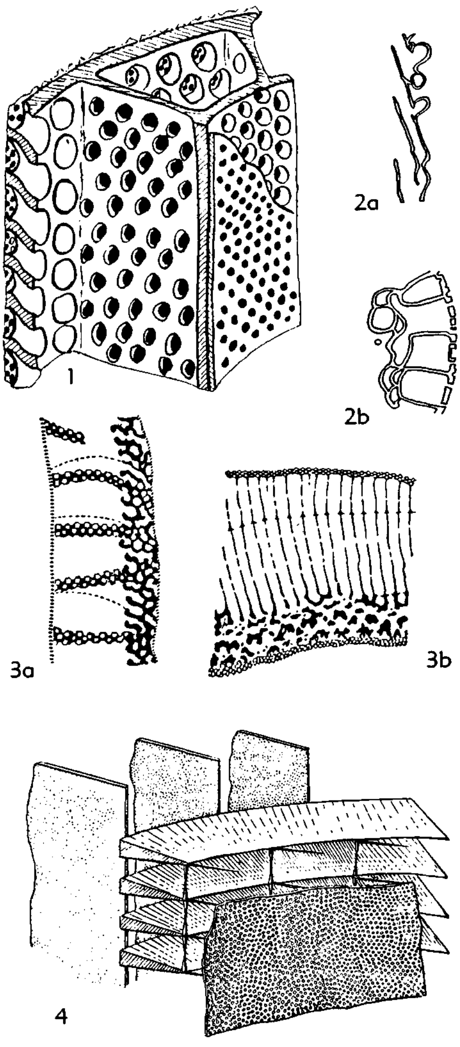


FIG. 16. Inner wall (continued).——*1.* Composite wall; simply porous, with auxiliary microporous screen (Repina, *et al.*, 1964).——*2.* Wall of ethmophylloid pore-tubes formed by the contiguity of waves of the inner edges of neighboring septa; *2a,* long. sec. of wall; *2b,* part of transv. sec. of cup, inner wall to left (Hill, 1965).——*3.* Formosocyathoid wall of tortuous pore-tubes and with a microporous auxiliary screen; *3a,* oblique radial long. sec. of part of cup, inner wall to right; *3b,* part of transv. sec., inner wall below (Vologdin, 1962d).——*4.* Annulate wall with microporous screen supported by radial spines, in *Compositocyathus* (Zhuravleva, 1960b).

ing digestive system; this would suppose an organization higher than that of sponges. ZHURAVLEVA regarded it as formed from an extrusion into the central cavity of soft tissue from the intervallum, this soft tissue then proceeding to secrete septal or dissepimental or tabular skeletal elements; and hers seems the better explanation. FONIN (1961) objected to both interpretations. He was unconvinced of the existence of an "internal digestive organ" in the central cavity, but could not accept that this was normally empty during the life of the individual. Another explanation offered for certain of the calcareous elements in the central cavity is that they were deposited by a second, single-walled archaeocyathan in symbiosis with the first (MASLOV, 1960).

The intervallum and not the central cavity is now generally considered to have been the site of the principal life processes. The pores of the walls are commonly considered to have enabled food-bearing currents to be drawn into the body. ZHURAVLEVA (1960b) and FONIN (1961) agreed that the currents flowed through the outer wall into the intervallum and then out through the central cavity via the inner wall. VOLOGDIN preferred the reverse direction. MASLOV (1961), basing his conclusion on his observation that either perforate or aporose pelta or opercula may develop at the growing end of the cup, considered that currents must have been able to flow either way through the pores of one-walled cups.

In ZHURAVLEVA's view, the skeleton of an archaeocyathan is an external, continuous sheet, formed in a similar way to that of the Protozoa. She considered the protoplasm to be continuous through pores in the septa but thought that the differing development of dissepiments, of skeletal thickening and sometimes of tabulae in neighboring interseptal loculi indicated a certain amount of independent vital activity from loculus to loculus. She thought this indicated that digestion took place not in a distinct layer of epithelial cells, as in coelenterates, but intracellularly, and also that special secretory organs were absent. Her view of the living matter of the archaeocyathan is thus that it consisted of uniform, undifferentiated cells (except for some sex cells), filling the intervallar loculi, the basic life processes taking place intracellularly, digestion and secretion being analogous to these in protozoans and sponges. This view seems to accord well with the facts. However, VOLOGDIN (1962b) thought, as a corollary to his views of "calcification" of the soft tissues, that the latter were cellular, having functional and morphological differentiation, and that there was a system of capillary vessels connecting the various parts of the body in a single organism.

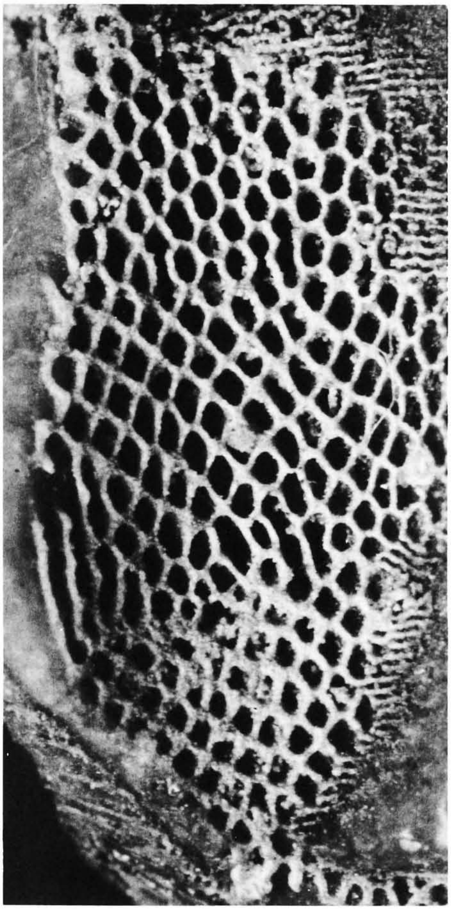


FIG. 17. Inner wall of *Ethmocyathus,* viewed from central cavity, showing inner ends of pore-tubes and part of screen of fine transverse laths (Hill, 1965).

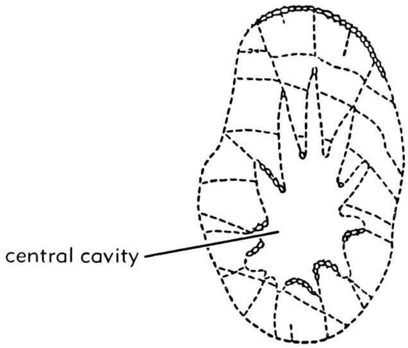


FIG. 18. Central cavity shown in transv. sec. of *Asterocyathus salairicus* VOLOGDIN with inner wall to central cavity longitudinally deeply grooved at septal edges, ×?3.5 (Vologdin, 1962d).

ZHURAVLEVA noted the presence of pores in both septa and tabulae, the continuity of the several skeletal elements and the fact that after injury to some loculi of the living cup, the archaeocyathan could heal the injuries and continue to build the cup. From these observations she concluded that the connection between the groups of cells in neighboring loculi was "incommensurably higher" than that between the cells even in such complex colonial unicellular organisms as the Volvocidae.

She concluded that the Archaeocyatha were the result of nature's first attempt to create a simple multicellular organism, and that with the beginning of a broad proliferation of the sponges, which were of similar ecology, the archaeocyathans were quickly extinguished. She considered the Archaeocyatha to be a multicellular phylum that arose independently from the unicellular organisms, with a degree of differentiation higher than that of the Protozoa, but lower than that of the Porifera.

ONTOGENY

The wide distribution of species and genera, and analogy with coelenterates and sponges, suggest that the Archaeocyatha had a planktonic larval stage that was without skeleton. However, certain small calcareous *problematica* from the Lower Cambrian of the USSR (Fig. 19) have been considered by VOLOGDIN (1932; 1957c) to represent larval or young stages of archaeocyathans and they were named by him "sphaerion," "fistula," and "dolium" stages, and to have been planktonic.

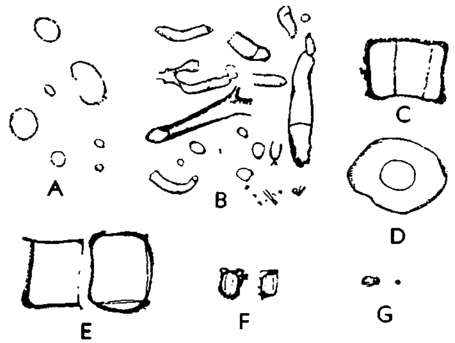


FIG. 19. Small calcareous problematica considered by VOLOGDIN (1931, 1932) to be larval and young stages of Archaeocyatha; *A*, "sphaerion"; *B*, "fistula"; *C-G*, "dolium"; all ×13.

The few studies of ontogeny based on longitudinal or serial transverse sections of individual archaeocyathan cups suggest that postlarval development began with the formation of an aporose curved sheet that became the tip of the cup as the archaeocyathan grew. The edge of this calcareous sheet grew upward and outward to form the outer wall of the conical cup (Fig. 20).

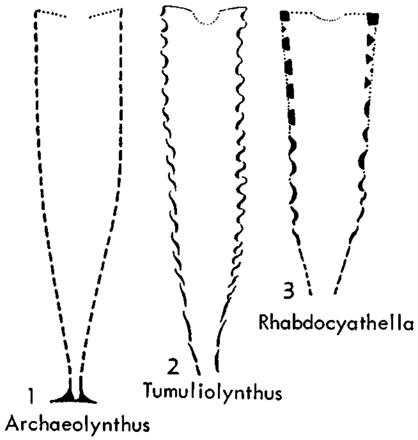


FIG. 20. Ontogenetic stages of development in one-walled cups (Zhuravleva, 1963b).——*1. Archaeolynthus,* showing wall with simple pores throughout.——*2. Tumuliolynthus,* showing adult wall with tumuli.——*3. "Rhabdocyathella,"* showing adult wall thick with external microporous sheath.

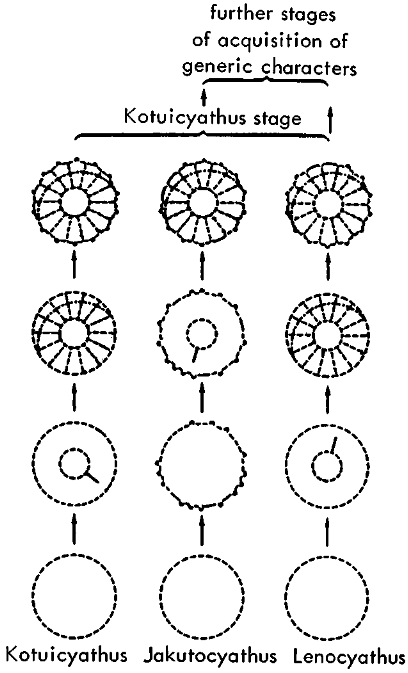


FIG. 21. Ontogenetic stages of development in genera of the family Lenocyathidae. Outer wall tumuli appear before inner wall, septa, and tabulae, in *Jakutocyathus (Jakutocyathus)* and after them in *Kotuyicyathus* and *Lenocyathus,* demonstrating heterochronous parallelism (after Rozanov, 1963).

At a cup diameter of 0.15 to 0.2 mm., simple pores appear. In Irregulares, dissepiments next appear, followed in two-walled forms by disoriented rods, and then by the inner wall, simply porous at least at first, and by some tabulae; in later stages the disoriented rods may be replaced by septa, or, in the Syringocnemididae, by hexagonal tubuli, and either or both walls may become complex. In two-walled Regulares a simply porous inner wall appears with or slightly earlier than the first intervallar structures, which in some are rods, in others are septa; tabulae may then appear, and both walls may become complex, and the complexity may increase; in some, complication of the outer wall may begin before the appearance of the inner wall and septa (Fig. 21).

EVOLUTION

ONTOPHYLETIC SPECULATION

It has been suggested that current classification of the Archaeocyatha is a phyletic one, and that ontogenetic studies support this view. Thus, ZHURAVLEVA (1960b) con-

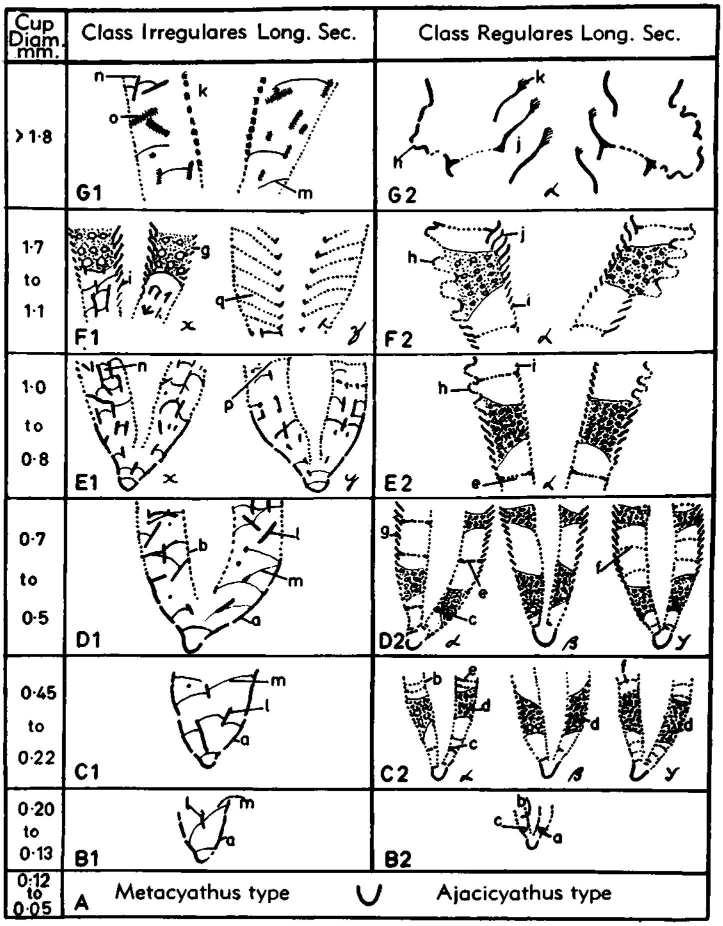


FIG. 22. Ontogenetic stages in Archaeocyatha. The cup diameters at which the different stages appear are shown in the left-hand column; in the middle column are representatives of the Irregulares. *A*, the embryonic, aperforate tip, is common to both classes; *B1-G1* are stages of development in representative Irregulares [*x*, form with tabulae; *y*, form with septa and tabulae; *z*, form with radial tubuli (Syringocnemidida)]; *B2-G2* are stages of development in representative Regulares [α, form with pectinate tabulae (Nochoroicyathina); β, atabulate form (Ajacicyathina); γ, form with porous tabulae (Coscinocyathina)] (after Zhuravleva, 1960b). [Explanation: *a*, outer wall; *b*, inner wall; *c*, radial rods in intervallum; *d*, septa; *e*, pectinate tabula; *f*, porous tabula; *g*, pore-canal of outer wall; *h*, composite tumulus of outer wall; *i*, rudimentary pore-tube of inner wall; *j*, pore-tube of inner wall; *k*, "hairs" at end of pore-tube of inner wall; *l*, rod in intervallum; *m*, dissepiments; *n*, taenia; *o*, taenial spines; *p*, convex tabula; *q*, hexagonal radial tubulus.]

sidered that the class characters (presence or absence of dissepiments before the inner wall appears) are established at a cup diameter of 0.13 to 0.2 mm.; that the inner wall appears between 0.5 and 0.7 mm. in two-walled Irregulares, and between 0.13 and 0.2 mm. in Regulares. She regards the regularian subordinal characters, mainly type of tabulae, as established between 0.22 and 0.45 mm., whereas the subordinal characters of Irregulares do not appear until 0.5 to 0.7 mm. The family (outer wall) characters of Regulares develop between 0.5 and 0.7 mm., but in Irregulares not until 0.8 to 1.0 mm., at which diameters subfamily characters develop in Regulares. Generic

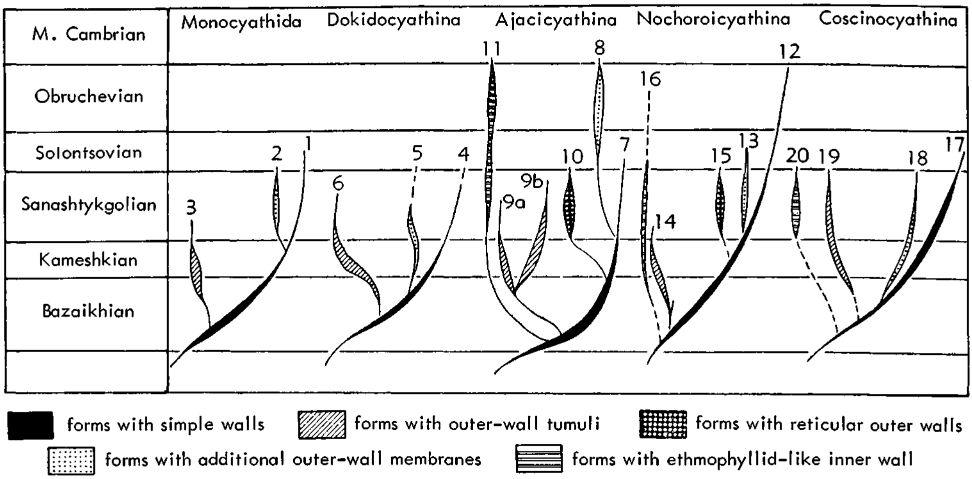


FIG. 23. Assumed phylogenetic relationships within the suborders of Regulares, according to ROZANOV (1963).——*1. Archaeolynthus.*——*2. "Rhabdocyathella."*——*3. Tumuliolynthus.*——*4. Dokidocyathus* and *Vacuocyathus.*——*5. Kidrjasocyathus* and *Uralocyathella.*——*6. Fransuasaecyathus.*——*7.* Ajacicyathidae.——*8.* Erbocyathidae.——*9.* Tumulocyathidae *(9a)* and Annulocyathidae *(9b)*.——*10.* Tercyathidae.——*11.* Ethmophyllidae.——*12.* Nochoroicyathidae.——*13.* Kordecyathidae.——*14.* Lenocyathidae.——*15.* Piamaecyathidae.——*16.* Formosocyathidae.——*17.* Coscinocyathidae.——*18.* Kasyricyathidae.——*19.* Alataucyathidae.——*20. Coscinocyathellus.*

characters appear in both classes between 1.1 and 1.7 mm. cup diameter and specific characters enter thereafter. Figure 22 shows ZHURAVLEVA's hypothesis diagrammatically.

This generalization is very useful, though certainly oversimplified, as shown for instance by Figure 21. Figure 23 shows ROZANOV's views of how the main families in suborders of the Regulares may have developed from an early and primitive stock for each suborder, by trends of development in complication of the outer walls.

PARALLEL EVOLUTION

Numerous trends in archaeocyathan development resulting in parallel, heterochronous, or convergent evolution, have been suggested. Most have been based in part on morphological comparison of bioseries in successive strata and in part on ontogenetic observation. The majority relate to complications in the wall structure (Fig. 21). The end result seems to be greater efficiency in straining currents of water through the wall pores; thus, the outer part of the outer wall is frequently more finely porous than the inner part of this wall, and wide variety in the construction of such double walls is observed; pore-canals, pore-tubes, and tumuli of varied construction develop. Trends towards colony formation occur.

In addition there are trends in reduction, such as reduction in the number of longitudinal pore-rows to an intersept, reduction in the porosity of septa, and reduction in the number of pectinate tabulae (Fig. 24).

INTRASPECIFIC VARIABILITY

Dimensional differences noted between individuals of the same species have been correlated by ZHURAVLEVA (1960b) with differences in depth of floor, in character of bottom, and possibly in rate of flow of currents, in temperature, gas regime, and faunistic composition. Thus, outer wall tumuli may be larger in individuals from deeper seas.

Geographical variation has also been demonstrated by ZHURAVLEVA (1960b). Thus individuals of a species show in space as well as in time, variation in size of cup, range of numbers and size of wall pores and septal pores, frequency of septa, number of spines in the inner wall, and tendency to form colonies.

Growth form of a species may differ in

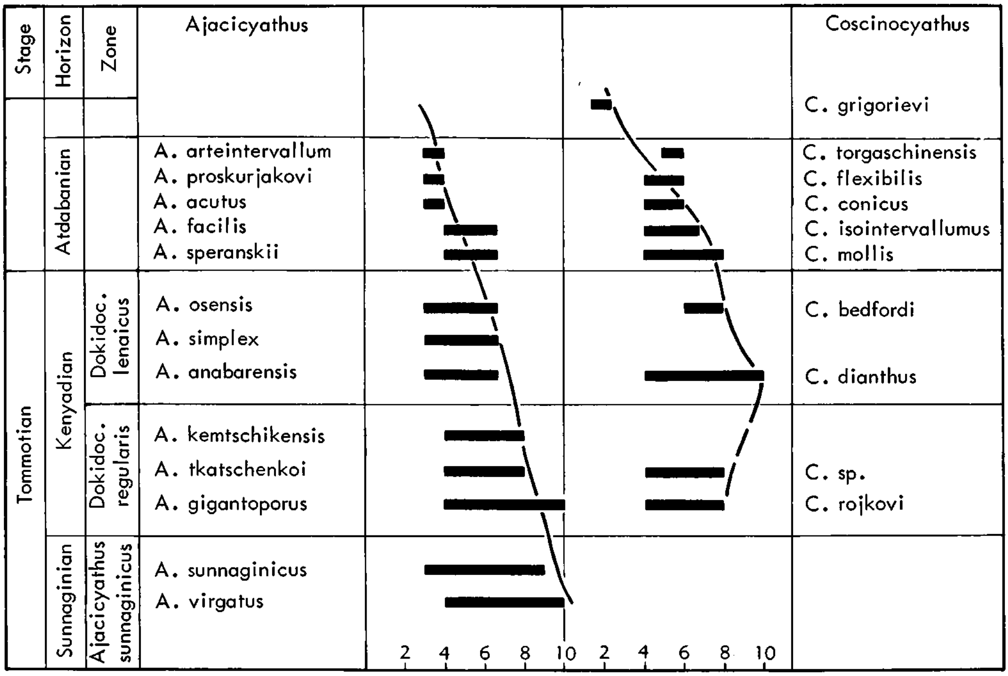


FIG. 24. Trend in reduction in number of longitudinal rows of pores to each intersept of outer wall in *Ajacicyathus* and in *Coscinocyathus* (Rozanov & Missarzhevskiy, 1966).

biohermal and interbiohermal facies (ZHURAVLEVA, 1960b). Thus, *Okulitchicyathus discoformis* (ZHURAVLEVA) may be discoid in the interbiohermal facies, presumably because it was there subject to frequent overturning, but is often of irregular conical form in the bioherms. Biohermal individuals of most species commonly have external adherent processes, interbiohermal individuals usually lack them. Many species have smaller individuals in the bioherms. ROZANOV (1963) noted that latticed walls occur in representatives of two suborders in volcano-terrigenous facies, and considered that such a wall is an adaptive character.

Pectinate tabulae are so rare as to be hard to find in some individuals of one species but are very common in others (R. BEDFORD & J. BEDFORD, 1936, p. 25, 1939, p. 75).

PALEOECOLOGY

The Archaeocyatha are marine, benthic, shallow-water organisms, mainly sessile with adherent outgrowths, but some were probably passively shifting in the bottom layers of the water, especially discoid forms whose shape is thought to be due to repeating overturning. All colonies are basally adherent, and solitary forms may adhere by various types of tubular processes or wide expansions from the base of the cup.

The predilection of the Archaeocyatha for the carbonate sedimentary facies has long been known. They have been considered the reef-builders of the Lower Cambrian, but it would seem that they were less important in this respect than algae. Algal-archaeocyathan bioherms and biostromes were constructed (Fig. 25) but archaeocyathans are also common in the interreef facies and in nonbiohermal limestones. Associated with them in interbiohermal strata are algae and the benthic gastropods, brachiopods, and trilobites, but hyolithids and coniconchs are also found. Where sponges are common, archaeocyathans tend to be rare.

DEPTH

The most favorable depth, as indicated by the studies of ZHURAVLEVA and ZELENOV (1955), ZELENOV (1957), and ZHURAVLEVA (1960b) was from 20 to 30 m. and down to 50 m. (Fig. 26). The evidence on which this is based is the association with the blue-green alga *Renalcis*, the fragmentation of many skeletons, and the dimensions of the bioherms which, with the algae, they were able to construct. Above and below these optimum depths they were smaller and did not construct bioherms. From 50 to 100 m. they are commonly associated with the red alga *Epiphyton*, thin-walled with a narrow intervallum and not fragmented by wave action. They are not known in sediments presumed to have been deposited below 100 m.

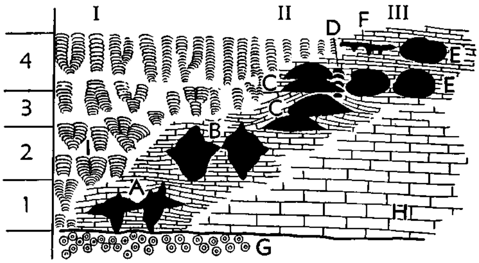


FIG. 25. Migration of archaeocyathan and algal-archaeocyathan bioherms in time and space in the Aldanian of the Siberian Platform, Rivers Lena and Aldan (Zhuravleva, 1966). [Explanation: *A*, littoral archaeocyathan dilophoid; *B*, fringing archaeocyathan dilophoid; *C*, archaeocyathan monolophoid; *D*, pseudostromatolitic algal-archaeocyathan biostrome; *E*, algal-archaeocyathan onkoidal dilophoid; *F*, bedded algal-archaeocyathan biostrome; *G*, onkolites; *H*, limestone without bioherms; *I*, stromatolites; *I*, shallow, littoral zone; *II*, depth over 10 meters; *III*, depth some tens of meters.]

TEMPERATURE

VOLOGDIN (1932) and ZHURAVLEVA (1960b) assumed that the Archaeocyatha were organisms of the warm seas, on the grounds (not always reliable?) that bioherms are constructed always in warm-tropical or near-tropical seas. On the Siberian Platform they are abundant in the varicolored suite of brick-red to violet argillaceous dolomitic limestones which ZELENOV (1957) and others considered formed off land with a hot damp climate.

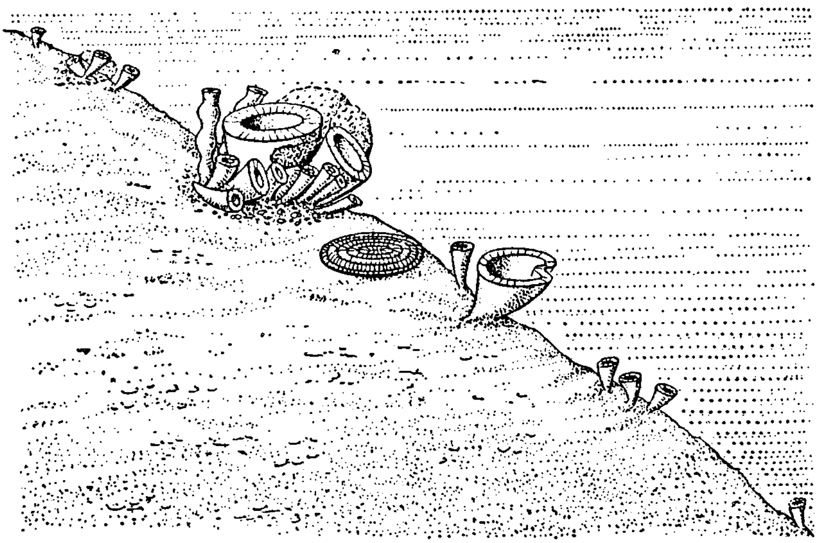


FIG. 26. Archaeocyathan growth-form in relation to depth (Zhuravleva, 1960b). [Explanation: *A*, a few small cups at depths up to 12 m.; *B*, small archaeocyathan bioherm at 20-30 m.; *C*, a few large discoid or conical cups between 30 and 50 m.; *D*, a few small cups between 50 and 60 m.; *E*, occasional cups to a depth of about 100 m.]

SALINITY

The salinity tolerances of Archaeocyatha are thought to be related to the characters of the sediments in which they occur. Zhuravleva (1960) found that they are commonest, and constructed bioherms, in rocks with 46 to 50 percent CaO (=78-91 percent $CaCO_3$), but that they may be quite rich in rocks with a CaO content of only 7 percent. Percentages of 5 to 8 percent MgO were endured by very few species, and with a still greater concentration of MgO, as in lagoonal deposits, the Archaeocyatha disappeared entirely. They were quite tolerant of terrigenous matter, and actually flourished best in sediments that contained 19 to 34 percent of insoluble residues.

GEOGRAPHIC AND STRATIGRAPHIC DISTRIBUTION

Archaeocyatha have been described and illustrated from all continents except South America, from which, however, an occurrence has been reported recently by Debrenne (1964). They are characteristic of the calcareous facies of the Lower Cambrian (but not the Eocambrian), with a maximum in the Botomian Stage of the south Siberian fold belt. Whether they developed during Precambrian time is problematical. Radugin (1966) recently has described as primitive archaeocyathans a number of small calcareous problematica from the Late Proterozoic of Siberia, but these are not appended to this part of the *Treatise*. Only a few genera are known from the early Middle Cambrian *Paradoxides oelandicus* Zone in Australia (Öpik, 1956, 1961) and the Altay Mountains of Siberia (Khomentovskiy *et al.,* 1962), where they include, in the Katun anticline, *Tegerocyathus, Ethmophyllum,* and *Nochoroicyathus*. However, Vologdin (1957a) considered the Elanska faunal horizon at the top of the Lena Stage on the Siberian Platform to be Middle Cambrian, and Öpik (1956, 1961) suggested that the greater, upper, part of the Lena Stage is in the *P. oelandicus* Zone. If either of these contentions is correct, the number of genera ranging into the Middle Cambrian becomes quite large. An Upper Cambrian occurrence in Antarctica has recently been recorded (Webers, 1966), but all other occurrences later than early Middle Cambrian have been discounted (Hill, 1965, 1967). See map (Fig. 27) and Table 3.

SUBDIVISION AND CORRELATION OF THE LOWER CAMBRIAN

Russian work on Cambrian biostratigraphy has been exceptionally vigorous over the last decade and some degree of unanimity has been achieved on the correlation of the various stratal sections on the Siberian Platform and in the Altay-Sayan fold belt, as well as between these two groups of sections. Ranges of archaeocyathan genera in the USSR can thus now be expressed in terms of the four stages into which the Russian Lower Cambrian is currently divided: Tommotian, Atdabanian, Botomian, and Lenian (Rozanov, *et al.,* 1969; Zhuravleva, Korzhunov, & Rozanov, 1969; Meshkova, 1969; Zhuravleva, 1970b).

Previously the Lower Cambrian of the Siberian Platform had been divided into two units, the Aldanian and the Lenian stages. These names are now being used as superstage names. The Tommotian and Atdabanian stages replace the earlier upper or Zhurian Substage of the old Aldanian and the lower or Tolbian Substage has been excised from the Lower Cambrian, named Vendian and transferred to the Precambrian. Also, the Tarynian horizon has been subtracted from the top of the old Aldanian and treated as the lower part of the new Botomian. The old Lenian has been divided into the thus augmented Botomian and the new or restricted Lenian Stages. The old Atdabanian Substage has had added to it the *Profallatopsis* Zone and the equivalent zone of *Retecoscinus zegebarti* (including the beds with bioherms of the second type of Zhuravleva, 1960b) from the top of the old Kenyada horizon. The Tommotian therefore includes the Sunnaginian horizon and the thus restricted Kenyadian horizon. No trilobites are found anywhere in strata currently regarded as Tommotian. These nomenclatorial changes are shown in Table 1.

TABLE 1. *Schemes of Subdivision of Lower Cambrian in the Stratotype Sections (middle Lena R. on Siberian Platform).*

	Conference, 1956, Leningrad				Conference, 1962, Yakutsk			Scheme of ZHURAVLEVA, KORSHUNOV & ROZANOV, 1969: Super-stage	Stage	Sub-stage	Zones and beds with Archaeocyatha
Lower Cambrian	Lenian	Angarian			Lenian			Lenian	Lenian		
		Botomian							Botomian		*Botomocyathus zelenovi-* *Porocyathus squamosus*
	Aldanian	Zhurian	*Judomia-* *Lenocyathus*	Atdabanian	Aldanian	Atdabanian	*Judomia* *Hebediscus* *Lenocyathus*	Aldanian	Atdabanian	Upper	Beds with *Fansycyathus lermontovae*
											Beds with *Nochoroicyathus kokoulini*
										Lower	*Porocyathus pinus*
			Ajacicyathus anabarensis	Kenyadian		Kenyadian	*Ajacicyathus anabarensis*				*Leptosocyathus polyseptus-* *Retecoscinus zegebarti*
										Tommotian	*Dokidocyathus lenaicus*
											Dokidocyathus regularis
			Archaeocyathus polaris	Sunnaginian		Sunnaginian	*Archaeocyathus polaris*				*Ajacicyathus sunnaginicus*
		Tolbian				Yudomian	Not distinguished	Upper Precambrian Yudomian (Vendian) complex			

TABLE 2. *Timestratigraphic and Biostratigraphic Correlation of Lower Cambrian Sequences of Siberian Platform (Zhuravleva, Korshunov, Rozanov, 1969; see also Meshkova, 1969) and of Altay-Sayan Fold Belt (Repina, Khomentovskiy, Zhuravleva, Rozanov, 1964; see also Zhuravleva and others, 1967; Zhuravleva, 1968a; Zhuravleva, 1970b).*

	STAGES	HORIZONS OR SUBSTAGES, SIBERIAN PLATFORM	ZONES OF ARCHAEOCYATHA		HORIZONS, ALTAY-SAYAN REGION	STAGES	
Lower Cambrian	Lenian	Elanskian horizon	*Erbocyathus heterovallum*		Obruchevian horizon	Lenian	Lower Cambrian
		Ketemian horizon	*Clauruscyathus billingsi*		Solontsovian horizon		
	Botomian	Sinsko-Kutorginian (Olekmian) horizon	. . . . *Rozanovicyathus alexi*		Sanashtykgolian horizon	Botomian	
		Tarynian horizon	*Porocyathus squamosus-Botomocyathus zelenovi*				
	Atdabanian	Upper Atdabanian Substage	*Lenocyathus lenaicus*	*Nochoroicyathus kokoulini*	Kameshkian horizon	Atdabanian	
		Lower Atdabanian Substage		*Porocyathus pinus*	Upper Bazaikhian horizon		
				Retecoscinus zegebarti			
	Tommotian	Kenyadian horizon	*Dokidocyathus lenaicus*		Lower Bazaikhian horizon=Kundatian	Tommotian	
			Dokidocyathus regularis		Archaeocyatha absent		
		Sunnaginian horizon	*Ajacicyathus sunnaginicus*				
Vendian		Yudomian complex				Vendian	

Whether the base of the Tommotian will prove acceptable internationally as the base of the Cambrian remains to be seen, but a good case has been argued for this by ROZANOV (1967). Whether the division between the Lower and Middle Cambrian should be drawn at the incoming of the *Paradoxides* fauna as advocated by R. RICHTER & E. RICHTER (1948) or at the extinction of the *Olenellus* fauna as advocated by ÖPIK (1967) also remains to be determined internationally. In the USSR the former boundary is generally adopted, and it is taken between the Elanskian faunal horizon at the top of the Lenian Stage and the *Oryctocephalops-Schistocephalus* Zone at the base af the Amgian Stage of the Siberian Platform. This boundary is here accepted. If ÖPIK's criteria were accepted, the division possibly would fall at the base of the Botomian (incoming of the *Protolenus* fauna).

Table 2 shows the current biostratigraphical correlation between the Lower Cambrian of the Siberian Platform and that of the Altay-Sayan Fold Belt, courteously supplied to me by Mme. I. T. ZHURAVLEVA.

Correlation of the North African, western European, Canadian, Australian, and Antarctic strata bearing Archaeocyatha with those of the USSR is still uncertain. It seems that the North African Amouslekian, Timghitian, and Tasousektian stages range from the Atdabanian into the Botomian (DEBRENNE, 1964; ROZANOV, *et al.*, 1969). In Spain, France, and Sardinia the ranges appear to be within the Atdabanian and Botomian (DEBRENNE, 1964). In western Canada Archaeocyatha range from possibly the Atdabanian Stage into the Botomian; in western U.S.A. (Nevada) the range would seem to be Atdabanian. In South Australia, WALTER (1967) considered the range in the Hawker Group of the Wilkawillina Gorge region to be Kundatian (now upper Tommotian) to Sanashtykgolian (= Botomian). From the Northern Territory of Australia, ÖPIK (1956, p. 41) recorded *Archaeocyathus* from a chert with the trilobites *Xystridura, Oryctocephalus,* and *Peronopsis,* north-northeast of Alexandria, and from the Ranken limestone with *Peronopsis* and *Asaphiscus;* he considered these trilobites to be of early Middle Cambrian age. The South Australian fauna from the Ajax Mine correlates best within the range of upper Atdabanian (Kameshki horizon) to lower Botomian (Taryn horizon). The Antarctic fauna similarly may range from the upper Atdabanian into the Botomian (HILL, 1964a,b; 1965).

RANGES OF GENERA

The ranges of genera are given in Table 3.

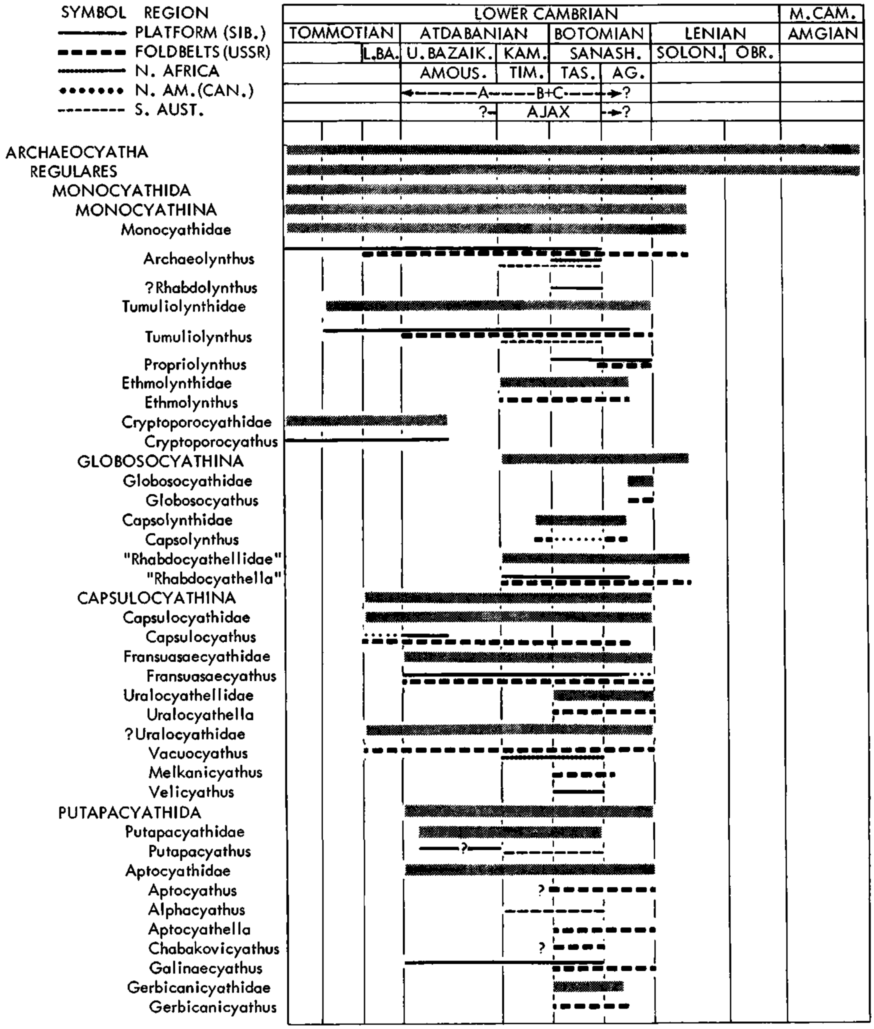
The Russian entries in the table represent two groups of sections; the first, the heavy unbroken line, represents the combined ranges in the various parts of the Siberian Platform. This includes the northwest (Igarka and Norilsk) region, the south (Angara-Lena watershed), the southeast (middle section of R. Lena and R. Aldan), the northeast (lower Lena R. and neighboring Kharaulakh Mts.), and the flanks of the Anabar massif. Data for this are taken mainly from ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, from DATZENKO, ZHURAVLEVA, *et al.*, 1968, and from ROZANOV, *et al.*, 1969, but also from other papers. The second group, entered as heavy dashed lines, applies to Russian sections in the folded regions of the Southern Urals, Kazakhstan, the Altay-Sayan (including Tuva), the ranges beyond (east of) Lake Baykal, and the Far East. Data for these entries have been taken mainly from REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964; ROZANOV & MISSARZHEVSKIY, 1966; ZHURAVLEVA, *et al.*, 1967; KHABAKOV, 1967; KONYUSHKOV, 1967; and YANKAUSKAS & ZHURAVLEVA, 1969.

Ranges for Australia (from BEDFORD & BEDFORD, 1934-39; HILL, 1965; WALTER, 1967; DEBRENNE, 1969) are shown in a medium broken line, those for North Africa (from DEBRENNE, 1964; DEBRENNE & DEBRENNE, 1965) in a fine broken line, and those of western North America (HANDFIELD, 1971) are indicated by a line of small circles.

ZOOGEOGRAPHIC PROVINCES

In view of the tentativeness of intercontinental correlation, it may be too early to delineate paleozoogeographical provinces using archaeocyathan faunas, but ZHURAV-

TABLE 3. *Stratigraphic distribution of archaeocyathan taxa plotted by region: Siberian Platform, Russian folded regions, North Africa, western North America, and Australia* (*Hill*, n).

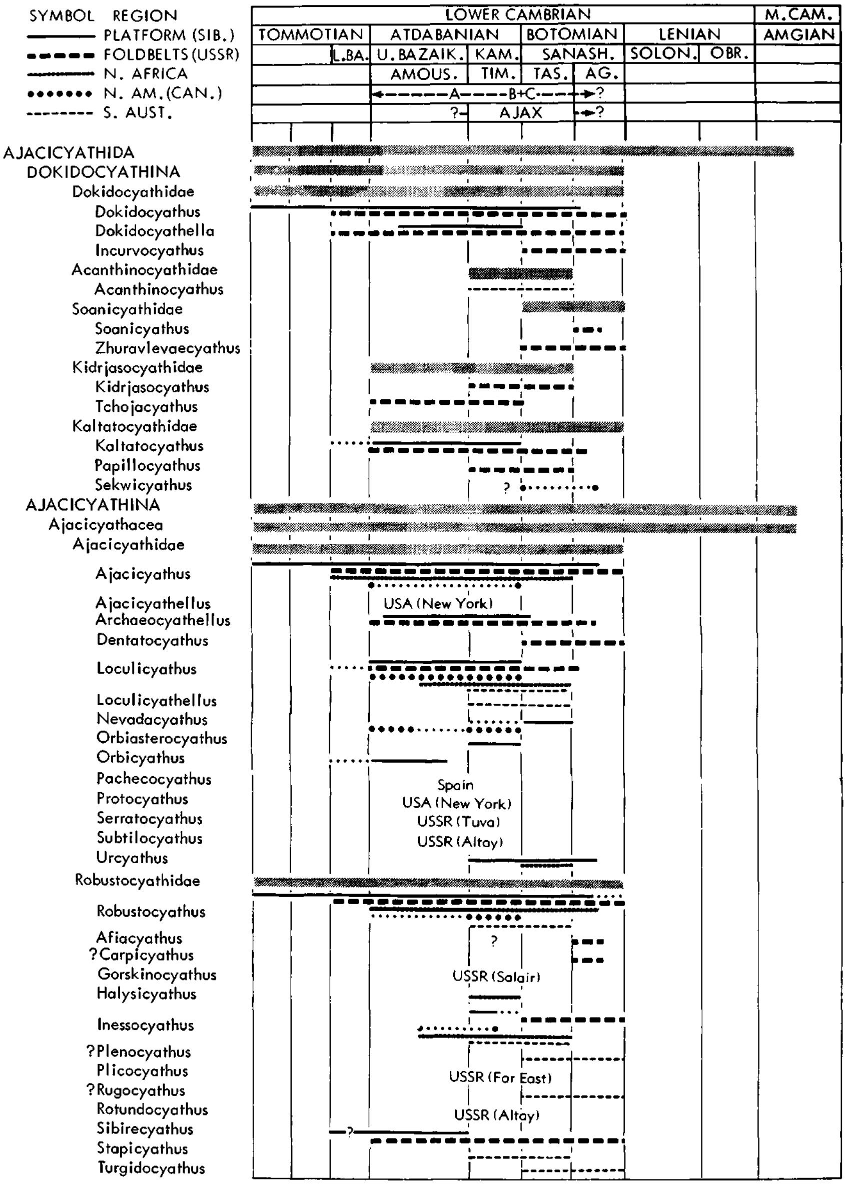


LEVA (1968a) has given a useful preliminary analysis.

Archaeocyatha of Tommotian age are well known only in the USSR; here ZHURAVLEVA has distinguished two subprovinces, that of Yakutia (southeastern part of Siberian Platform), in which Archaeocyatha are relatively common, and that of the Altay-Sayan fold belts where they are sparser. The Tommotian fauna includes representatives of 15 families. Eight of the more important of these, the Monocyathidae, Dokidocyathidae, Ajacicyathidae, Nochoroicyathidae, Coscinocyathidae, Dictyocyathidae, Metacyathidae, and Archaeosyconidae no doubt provided starting points for their respective suborders.

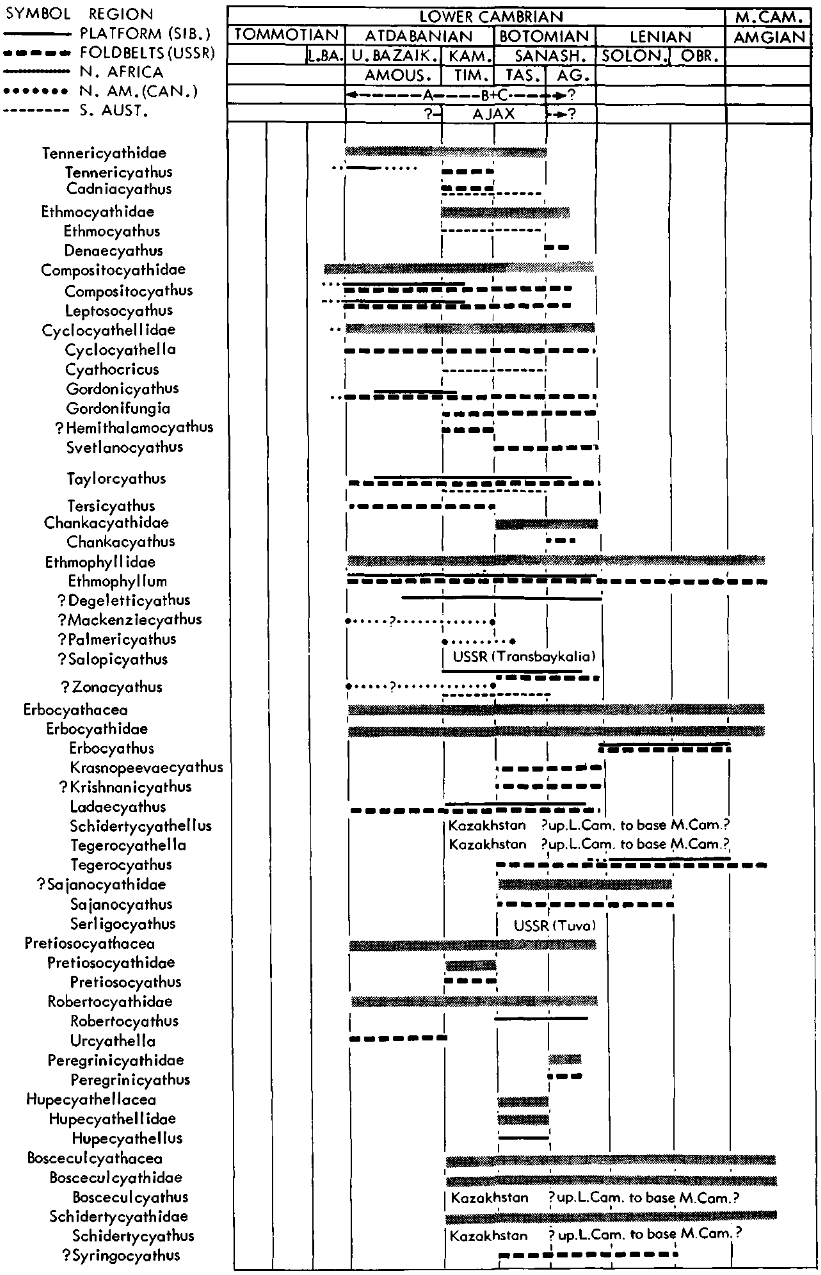
In Atdabanian time, Archaeocyatha greatly diversified, and became more widely distributed, being known from the Urals to the Far East of Asia, as well as in western Europe, North Africa, North America,

Table 3. *(Continued.)*



Australia, and possibly in Antarctica. At least 10 families attained a worldwide distribution. The number of genera present increased almost threefold. Perhaps the more important first occurrences are of the Putapacyathida, Compositocyathidae, Ethmophyllidae, Cyclocyathellidae, and Erbocyathidae. Toward the end of the Atdabanian, it seems possible that three zoogeographical regions were present, Afro-

TABLE 3. *(Continued.)*



European, Siberian, and Australian. The Siberian region is divisible into two as before, the Yakutian and the Sayano-Altay, both widely extended in area.

In Botomian time the Archaeocyatha reached their acme, not only in distribution but also in diversity. ZHURAVLEVA (1968a) distinguished two centers of differentiation,

Table 3. *(Continued.)*

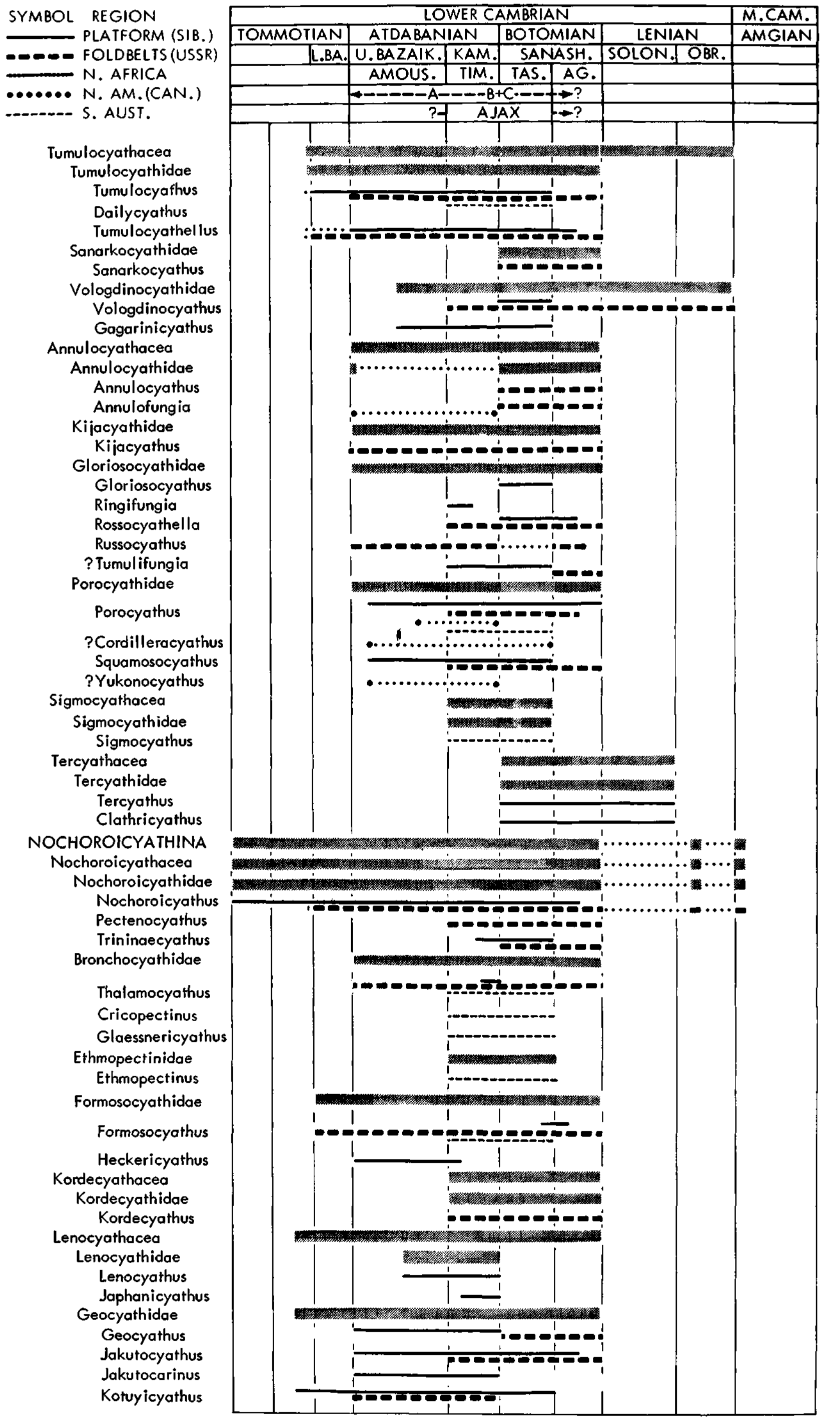
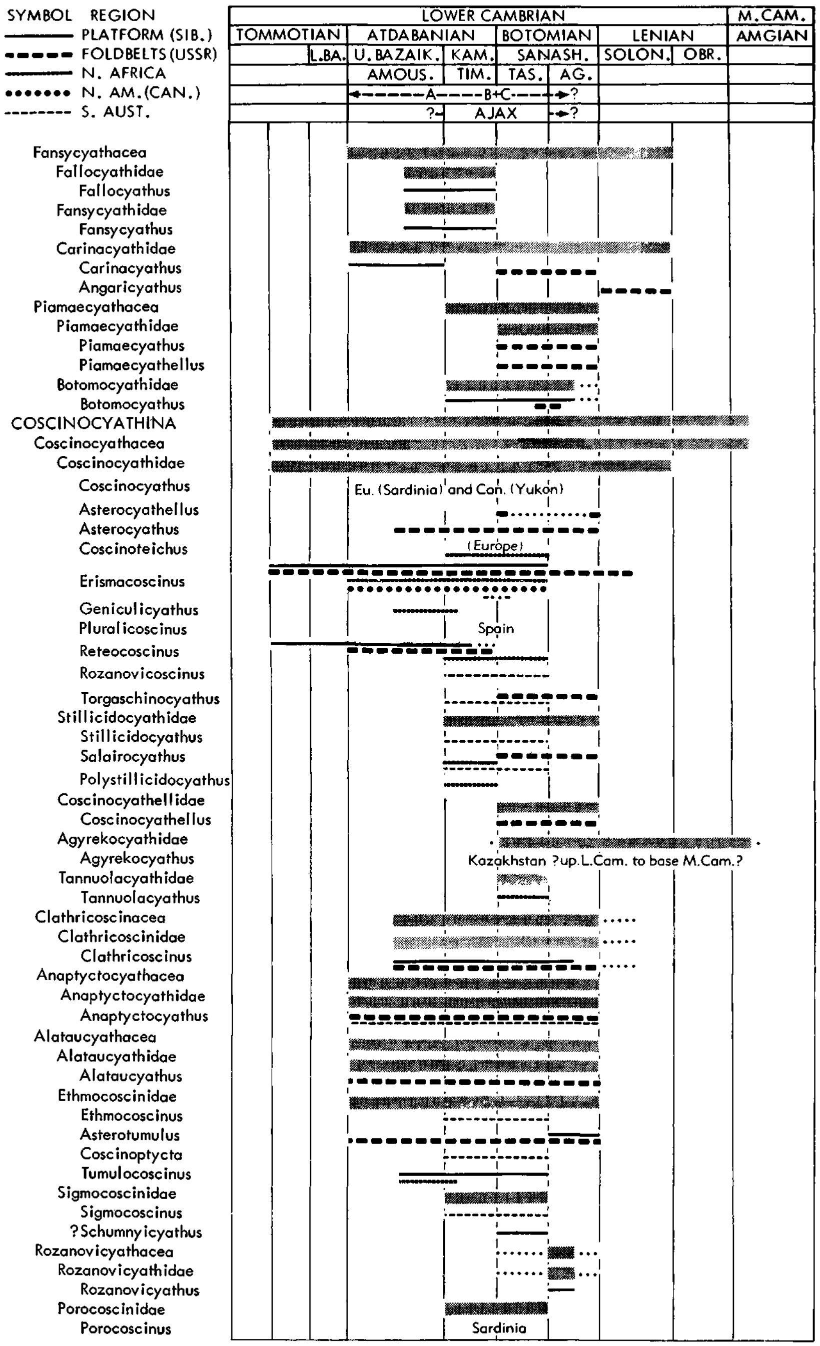
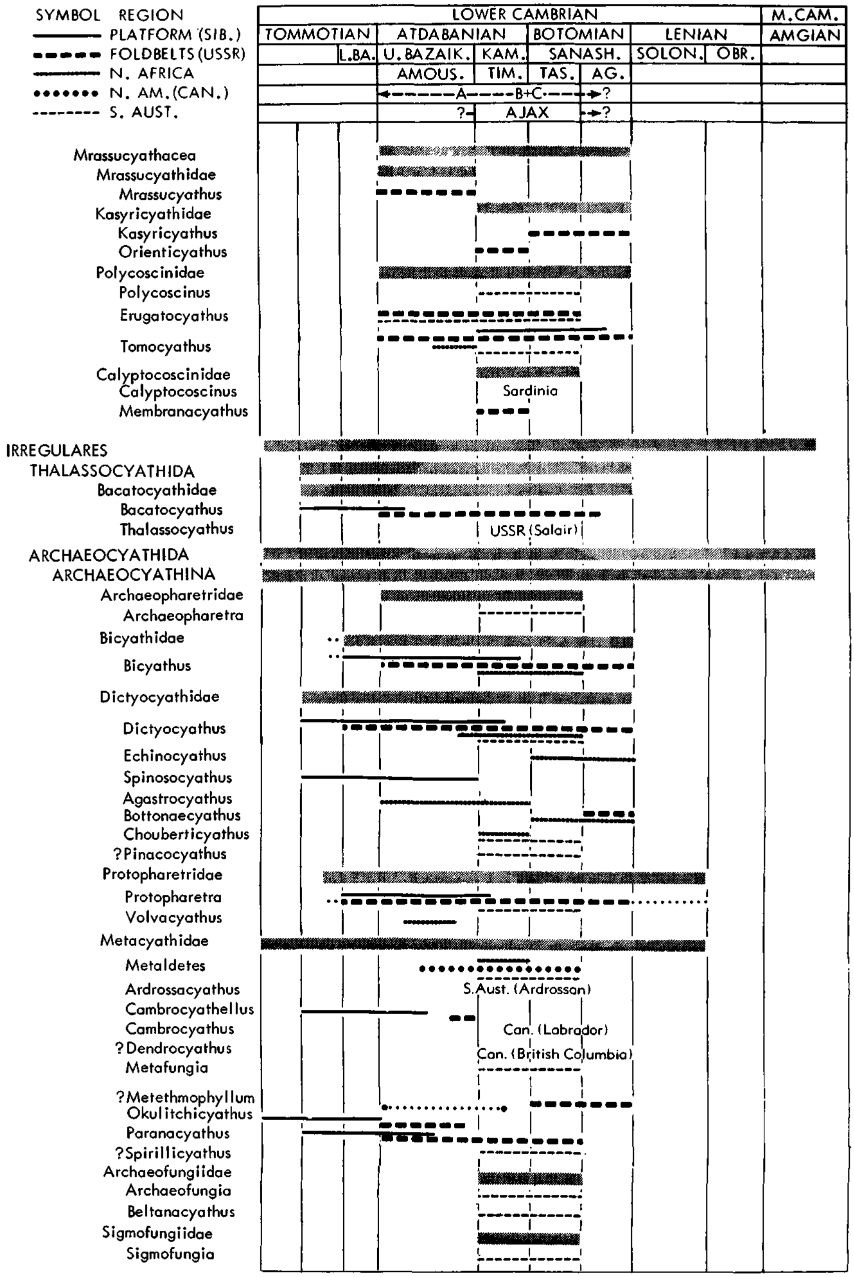


TABLE 3. *(Continued.)*



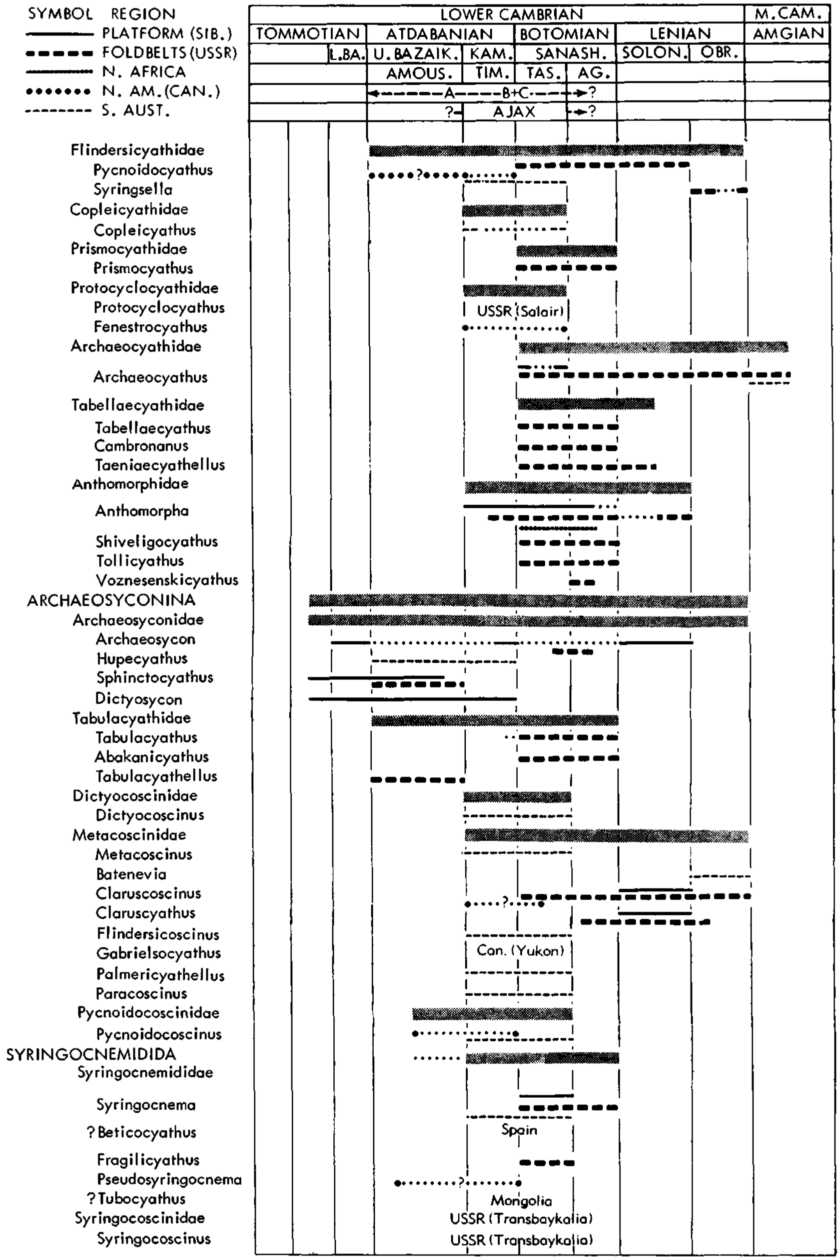
the Pacific-Atlantic and the Australo-Antarctic (Fig. 28). The first is subdivisible into three subregions, North America, Afro-Europe, and Siberia. The Afro-European

TABLE 3. (Continued.)



region is divisible into a northern and a southern, or North African, province which has many genera in common with the rich Siberian subregion. The Siberian subregion is again divisible into a Sayano-Altay province extending from the Urals in the west to Baykalia and the Far East, with some differentiation between the eastern and western parts of this great belt, and a Yakutian province which shows differentia-

TABLE 3. *(Continued.)*



tion between its northern and southern parts.

In Lenian time the tempo of archaeocyathan evolution was greatly retarded, and *Archaeocyathus* is the most widespread genus, but in Siberia the Erbocyathidae and ?Ethmophyllidae also occur, and no provincial differences are noted.

By Amgian time, at the beginning of the Siberian Middle Cambrian, only a few spe-

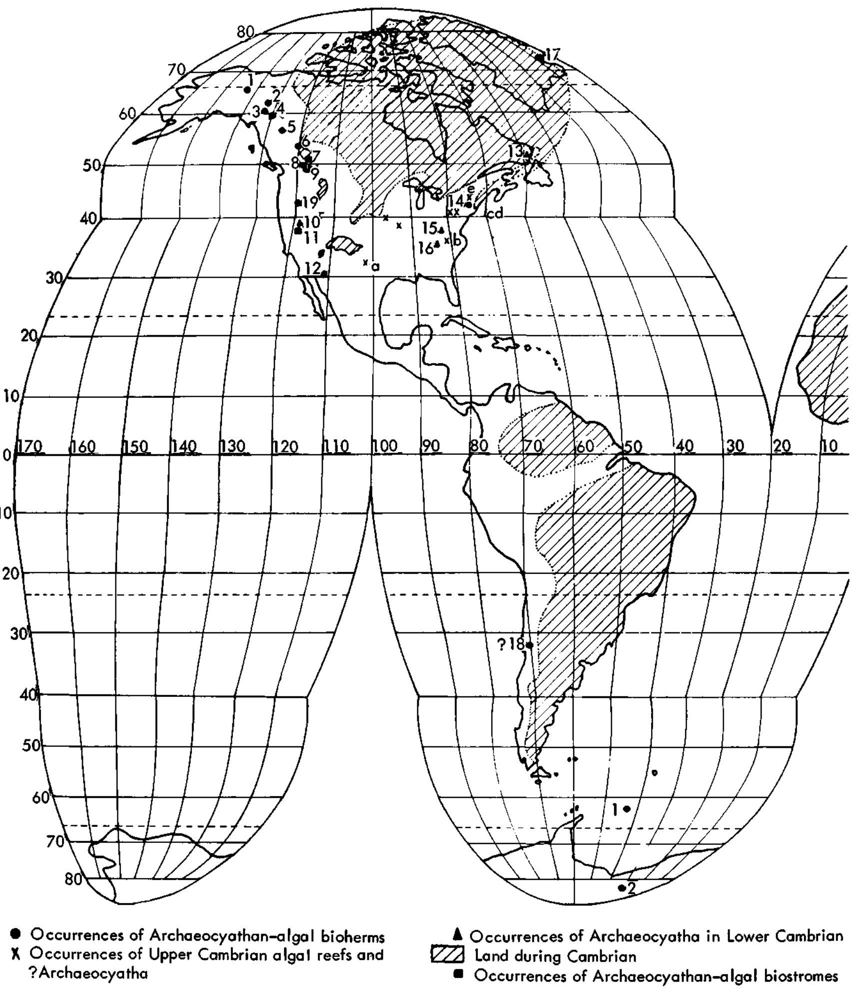


FIG. 27. Occurrences of Archaeocyatha and algal-archaeocyathan reefs in Lower Cambrian seas (Hill, n).

cies were still extant; and, except for a somewhat doubtful survivor in the Upper Cambrian of Antarctica, the phylum may be considered to have become extinct in early Middle Cambrian time.

GLOSSARY OF RECOMMENDED MORPHOLOGICAL TERMS

annulus (pl., **annuli**). Ring-shaped plate taking part in construction of wall.

bar. Elongate, thin skeletal element, rectangular in section.

bract. Scooplike extension from lower half of rim of pore of wall.

central cavity. Axial space enclosed by inner wall.

cup. Archaeocyathan skeleton.

dissepiment. Aporose plate shaped like film of a bubble.

framework. Underlying, coarsely porous wall of a double wall.

inner wall. Wall enclosing central cavity in a two-walled cup.

internal cavity. Space enclosed in one-walled cup.

intersept. That portion of wall between edges of 2

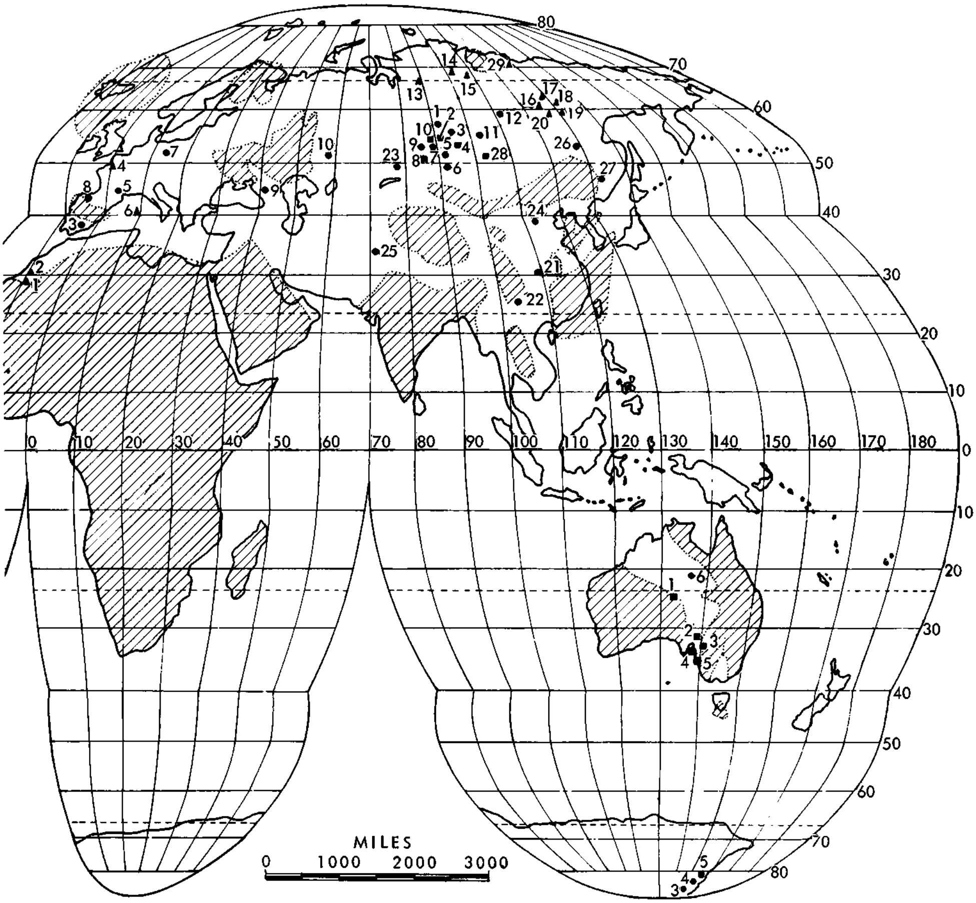


FIG. 27. *(Continued from facing page.)*

neighboring septa.

intervallum. Space between inner and outer walls.

link. Radial lath connecting the walls or vertical pillars of dictyocyathid cups.

loculus (pl., **loculi**). Space between two neighboring septa.

louvre. Wall plate, commonly oblique, developed between edges of 2 neighboring septa or longitudinal ribs.

pariety. Not recommended; replaced by more general term "septum."

peak. Extension shaped like peak of a cap-brim, from upper half of rim of pore of wall.

pectinate tabula. Tabula consisting of two rows of spines like teeth of combs each projecting toward the other from 2 neighboring septa.

pellis. Thin, commonly aporose sheet or sheath outside cup.

pelta. Lidlike flap closing or partly closing internal cavity distally, porous or aporose.

pore. Hole in thin wall, septum or tabula, round, oval, slitlike, rectangular, hexagonal or polygonal or irregular.

pore-canal. Cylindrical or prismatic hole through thick wall; distance between pore-canals commonly greater than their diameter.

pore-tube. Cylindrical or polygonal thin-walled tube formed by horizontal or oblique or curved wall-plates, or by bracts or peaks or by a combination of these.

rod. Thin, elongate cylindrical or prismatic skeletal element.

scale. Flat or but slightly curved plate rising obliquely from the wall below a pore.

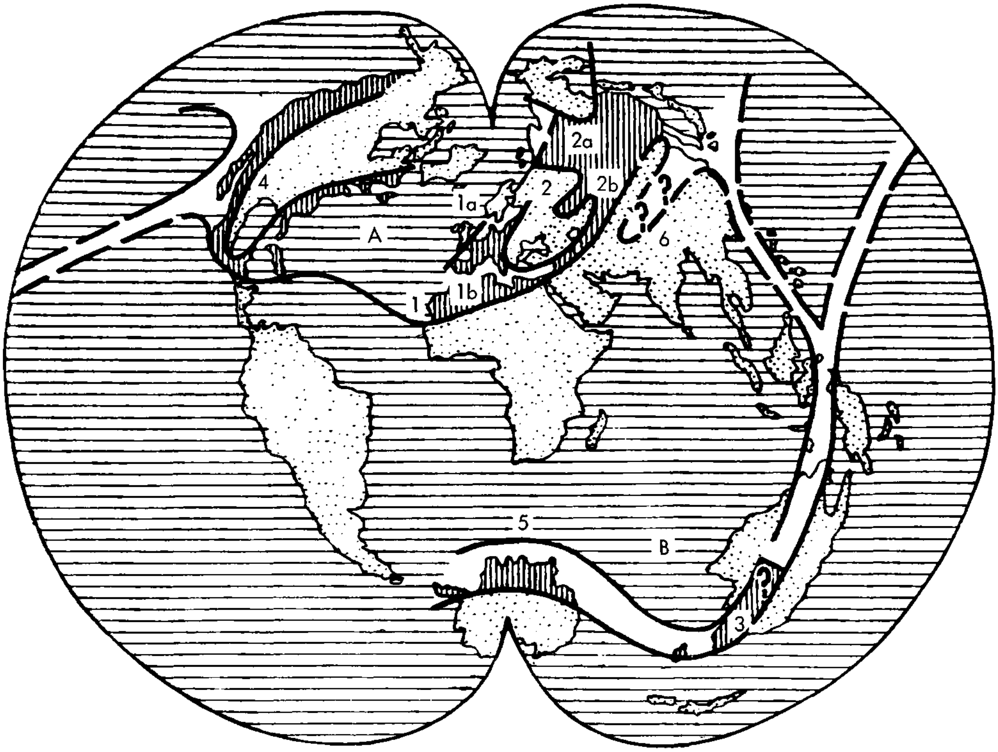


Fig. 28. Archaeocyathan zoogeographic provinces in Botomian time (Zhuravleva, 1968a). [Explanation: *A,* Pacific-Atlantic region *(1,2,4); B,* Australo-Antarctic region *(3,5); 1,* Afro-European subregion (*1a,* northern province; *1b,* southern province); *2,* Siberian subregion (*2a,* Yakutian province; *2b,* Sayano-Altay province); *3,* Australian province; *4,* North American subregion; *5,* Antarctic province; *6,* Indian and Chinese occurrences.]

septum. Radial longitudinal plate connecting walls of a 2-walled cup, commonly flat, waved in some.

sheath (or sheet). Microporous covering to a wall.

spitz. Not recommended; replaced by English term "tip."

synapticula (pl., **synapticulae**). Transverse rod connecting 2 neighboring septa.

tabula (pl., **tabulae**). Transverse porous skeletal element connecting walls of a 2-walled cup.

taenia. Small curved segment of an irregularian septum; usage previously extended, but not supported herein, to mean the whole irregularian septum.

tersioid outgrowth. Holdfast of roughly cylindrical form, consisting of close, subparallel or curved plates connected by dissepiments.

tip. Inversely conical initial part of cup.

tubulus (pl., **tubuli**). Porous-walled, prismatic, radial tubules filling the intervallum of Syringocnemidida.

tumulus (pl., **tumuli**). Small bulge in wall, perforated by one or many pores.

TECHNIQUES OF STUDY

Two different techniques are applicable in the laboratory study of archaeocyathans, differential solution and thin sectioning.

In some localities, such as at the Ajax Mine near Beltana in the Flinders Ranges of South Australia, the calcareous skeletons have been replaced by silica. Silicification is commonly sufficiently delicate not to obscure the finer details of morphology, and the construction of the walls, the septa, and the tabulae can be studied from exposed surfaces when the skeletons are dissolved out from the surrounding limestone by dilute hydrochloric acid.

However, in most specimens, where the skeletons remain calcareous in limestone, thin sections must be prepared. In order to complete the three-dimensional picture of the various structures, transverse, radial longitudinal, and tangential longitudinal sections are required and it is often necessary to take sections slightly obliquely to the structure being studied. Thus, to study a tabula, one needs a thin section within the tabula parallel to its upper and lower surfaces and two at right angles to the upper and lower surfaces of the tabula, one radial to the cup and one tangential. To study a septum one needs three sections, similarly, and one also needs to observe changes in the construction of the septum during ontogeny. To study the walls, several sections are needed; perhaps most useful is a section tangential and slightly oblique to the wall, so that elements projecting inward and outward from the wall can be observed. Changes in the walls during ontogeny also must be noted, by taking sets of sections from the young, intermediate, and adult stages. Very small species must be reconstructed from many random sections.

CLASSIFICATION OF ARCHAEOCYATHA

The systematic position of the Archaeocyatha has been much debated. The first archaeocyathan encountered by a scientist appears to have been a species from Labrador, Canada, that was referred to the coral genus *Cyathophyllum* by BAYFIELD (1845, p. 457). The next, from the variegated suite of the Lower Cambrian of the River Lena, Siberia, was originally determined as a Carboniferous plant, *Calamithes cannaeformis* (*fide* GEKKER, 1928). The first archaeocyathan described as such was *Archeocyathus atlanticus* BILLINGS (1861). BILLINGS at first thought that this fossil might be a coral or a sponge, but later he (1865) listed it under Protozoa. DAWSON (1865) and MEEK (1868) thought that the American archaeocyathans discovered up to that time were Foraminifera. The first representative to be found in Europe (Spain) was considered allied to the Receptaculitidae by ROEMER (1878). BORNEMANN (1884, 1886, 1891) thought the Sardinian archaeocyathans were best regarded as a special division of the Coelenterata. WALCOTT (1886) referred the family to the sponges, but HINDE (1889), after the most detailed microscopic examination and review made up until that time, considered that they were a special family of the stony corals. The first detailed description of Siberian archaeocyathans by VON TOLL (1899) referred them to the calcareous algae. Australian archaeocyathans first were described by ETHERIDGE (1890) and TAYLOR (1910), and TAYLOR concluded that they were a new class closest to calcareous sponges. TAYLOR's estimate received fairly general acceptance, and apart from the discovery and description of Antarctic Archaeocyatha (TAYLOR in DAVID & PRIESTLEY, 1914, p. 236; GORDON, 1920), little work was done on the group for twenty years.

In the decade 1930-40, work was vigorously pursued in Russia and Asia by VOLOGDIN, in Canada by OKULITCH, and in Australia by the BEDFORDS. Recognition of the systematic importance of ontogeny was a considerable step forward. SIMON (1939, 1941) indexed the species and genera described up to that time.[1] OKULITCH (1955) reviewed all earlier work and advocated a division of the Archaeocyatha into three classes: Monocyathea (one-walled), Archaeocyathea (two-walled, with porous septa), and Anthocyathea (two-walled, with aporose septa). These divisions have not proved acceptable and although VOLOGDIN (1962) in the Russian Treatise *(Osnovy Paleontologii)* accepted the Monocyathea for all one-walled cups, these are now divided between the Regulares and the Irregulares. Anthocyathea is now incorporated in Irregulares.

The great surge of Russian work since 1950, by VOLOGDIN and ZHURAVLEVA and their many colleagues, together with work on North African and Australian Archaeocyatha by DEBRENNE, and on Antarctic forms by HILL, has led to wide acceptance

[1] An index of North American Archaeocyatha has been provided by NITECKI (1967).

by paleontologists working on the group of the view that the taxon is an independent phylum, somewhere near the sponges in the animal kingdom. However, this is not acceptable to all zoologists. Thus ZIEGLER & RIETSCHEL (1970) are not convinced that Archaeocyatha are not sponges. ZHURAVLEVA (1959b, 1970a) has given a detailed comparison with the Protozoa, the Porifera, and the Coelenterata. She regards the Archaeocyatha as a primitive phylum of multicellular animals, with a level of organization lying between that of the Protozoa and of the Porifera, and this view is adopted in the *Treatise*. KRASNOPEEVA (1960, 1969) and VOLOGDIN (1962b) seem to prefer a position nearer the Coelenterata.

Fundamentally, like this chapter, DEBRENNE (1964), and HILL (1965), ZHURAVLEVA (1960b) divided the Archaeocyatha into the Regulares and Irregulares, following the pattern set by VOLOGDIN (1937) and others, but she interpolated the class Euarchaeocyatha between the phylum Archaeocyatha and the Regulares and Irregulares, which she considered to be subclasses because the morphological distinctions between them are insignificant in comparison with those by which classes are distinguished in other groups of animals. This interpolated taxon is omitted herein.

Two small groups, the Silurian Aphrosalpingidae MYAGKOVA, 1955, and the Carboniferous to Cretaceous Sphinctozoa STEINMANN, 1882 (=Thalamida), which are homeomorphic with some families of Archaeocyatha, the first with the Syringocnemididae and the second with the Archaeosyconidae, are sometimes included (VOLOGDIN, 1957a, as classes Aphrosalpingoidea and Tabuloidea?) in the Archaeocyatha, or doubtfully compared (ZHURAVLEVA, 1960b), but they are here excluded by me. Aphrosalpingidae might possibly be algae, and Sphinctozoa seem best left in the Porifera as calcareous sponges as SEILACHER (1962) and REID (1968) have done. VOLOGDIN (1962d) included the Syringocnemidida in the Aphrosalpingidea, but this course is not followed herein.

VOLOGDIN (1962c, 1964a) included in the Archaeocyatha a new class, the Cribricyathea, which comprises very small (approx. 1 mm. diam.), one or two-walled cylindrical, isometric, or conical cups in which at least the outer wall is peripterate, i.e., of ribbonlike horizontal elements, or peripteratae, commonly applied to the outer edges of lathlike longitudinal elements so that a lattice is formed; these forms have neither septa nor tabulae, and no bilateral symmetry. VOLOGDIN considered them planktonic. Their characters seem to me to distinguish them from Archaeocyatha, and I prefer to consider them Problematica. However, since they were referred originally to the Archaeocyatha, and since YANKAUSKAS has left them doubtfully in this phylum, I have appended a summary treatment.

In the following the phylum Archaeocyatha is divided into two classes: 1) Regulares: this class comprises one-, or commonly two-walled, cups in which the radial elements and the inner wall of the skeleton appear in ontogeny earlier than the dissepiments (though this generalization is based on very few studies). The radial elements consist either of septa or of rods or bars, the septa having divergent longitudinal rows of pores. Regulares exhibit numerous types of wall construction. 2) Irregulares: in this class dissepiments appear in ontogeny earlier than radial skeletal elements or inner wall, ontogenetic changes are relatively slow. The radial skeletal elements consist of rods, or of straight or wavy septa in which the longitudinal rows of pores curve upward and outward from the inner wall, or the intervallum may be filled with radiating hexagonal tubuli. Porosity of walls and septa is less regular than in Regulares, and there are fewer and simpler types of wall construction.

The presence or absence of an inner wall and the presence or absence of septa or radial tubules serve to divide the classes into orders.

The orders are divided into suborders on the presence or absence of tabulae and on the type of tabulae. Tabulae are of considerable taxonomic interest. KRASNOPEEVA (1955) adopted a family classification in which the presence or absence of tabulae was regarded as of generic value only. But experience seems to show that tabulae are of subordinal value, although RAYMOND (1931) had suggested that their absence might mean they had been resolved by the protoplasm. An interesting problem of classification arises in the Archaeocyatha with pectinate tabulae. The presence of pectinate tabulae in two-walled septate Regulares is considered diagnostic of the suborder Nochoroicyathina, but in some genera and species only 10 percent of individuals may show them. It is suspected that some of the two-walled septate forms without tabulae at present included in the Ajacicyathina may simply be atabulate individuals of nochoroicyathine species and genera, and more properly should be included in the Nochoroicyathina. It could also be argued that the presence or absence of pectinate tabulae is immaterial taxonomically, since it is not universal in a given species, and such a finding would lead to amalgamation into one suborder of the Nochoroicyathina and Ajacicyathina. However, in this volume the principle followed by ZHURAVLEVA and her colleagues is adopted, that when species of genera can be shown to have pectinate tabulae, albeit sporadically, the genera are included in the Nochoroicyathina.

The suborders, particularly in the Regulares, are divided into superfamilies mainly on the type of construction of the outer wall; and the superfamilies into families mainly on the construction of the inner wall. In the Regulares generic characters are commonly based on the subordinate features of wall construction such as forms of canals, forms of annuli, and corrugation of wall. Thus, the classification currently used, particularly of the Regulares, has the advantage of a morphological key. Its value is enhanced if, as many archaeocyathan workers suspect, ontogenetic differentiation of the walls from simply to complexly porous is consistent with phylogenetic differentiation, but far more ontogenetic studies are required to establish this happy conclusion.

In the Irregulares the general irregularity in pores and intervallar structures, combined with the apparently lesser complication of the walls, makes superfamilial, familial and generic classification more difficult, and the taxonomy of this class is at present much more tentative.

In her preliminary new classification of the Irregulares, DEBRENNE (1970b, p. 25) has given the same diagnostic weight to the characters of the intervallum, and to those of inner and outer walls, as in the currently acceptable classification of the Regulares. She considers that the Regulares with two walls may be allotted to five new orders based on the types of their intervallar structures, though it seems to me that the analogous rank in Regulares is the suborder. Her new orders are:

I. CHOUBERTICYATHIDA. Intervallum with rods radial and oblique.

II. ARCHAEOPHARETRIDA. Intervallum with rods and "booklets" [platelets=*plaquettes* (F.)] vertical and oblique.

III. METALDETIDA. Intervallum with "pseudosepta" (defined as plates with wide pores to true radial plates with small, numerous pores, the area of which is less than that of the skeleton), without or with synapticulae, or with synapticulae and "pseudo-tabulae" (defined as synapticulae in horizontal planes reinforced by sieves).

IV. PARANACYATHIDA. Intervallum with stout radial septa without synapticulae and tabulae.

V. PARACOSCINIDA. Intervallum with septa and independent tabulae.

The Syringocnemidida of this *Treatise* is treated not as an order but as a family *incertae sedis* by DEBRENNE (1970b, p. 23), who states that radial, "honeycomb" tubes in some ways resemble the "tube-like structures" built by the wavy sides of septa and flat synapticulae of *Pycnoidocyathus* type; but in other characters, such as the constant diameter of pores and the regular honeycomb construction, *Syringocnema* resembles regular Archaeocyatha.

DEBRENNE (1970b, p. 27) has suggested that five groups each with a different type of outer wall may occur in each of her ordinal ranks, and that each of these five groups, by analogy with Regulares, should be regarded as superfamilies. But she did not give them superfamily names, because of the preliminary nature of her studies on this Class. She has considered, however, that six different types of inner wall could occur in each of the five groups, and each of these types she considers diagnostic of a family.

In what follows I have recognized the tentativeness of Mme. DEBRENNE's classification by placing the families she recognizes within the currently accepted ordinal classification of the Irregulares, and have for the time being included her five new orders in the synonymy of the currently accepted orders.

The ever-increasing precision in the observation of wall structure and of the characters of septa and tabulae requires frequent restudy of type specimens, to see whether previously acceptable definitions of genera are still valid. If, as seems likely, significant differences can be established between pore-canals and pore-tubes, and between pore-tubes of different types, meanings attached to these terms in many of the older definitions must be reevaluated.

OUTLINE OF CLASSIFICATION

The following outline of the Archaeocyatha summarizes taxonomic relationships, geologic occurrence, and numbers of recognized genera and subgenera in each suprageneric group from class to family. A single number refers to genera; where two numbers are given, the second indicates subgenera additional to nominotypical ones.

Main Divisions of Archaeocyatha

Archaeocyatha (*phylum*) (252;7). *L.Cam.-M.Cam. (base), ?U. Cam.*
- Regulares (*class*) (173;4). *L.Cam.-M.Cam.*
  - Monocyathida (*order*) (14;1). *L.Cam.(low. Tommot.-low.Len.).*
    - Monocyathina (*suborder*) (5;1). *L.Cam.(low. Tommot.-low.Len.).*
      - Monocyathidae (2). *L.Cam.(low.Tommot.-low.Len.).*
      - Tumuliolynthidae (1;1). *L.Cam.(up.Tommot.-Botom.).*
      - Ethmolynthidae (1). *L.Cam.(up.Atdaban.-Botom.).*
      - Cryptoporocyathidae (1). *L.Cam.(low.Tommot.-low.Atdaban.).*
    - Globosocyathina (*suborder*) (3). *L.Cam.(up. Atdaban.-low.Len.).*
      - Globosocyathidae (1). *L.Cam.(Botom.).*
      - Capsolynthidae (1). *L.Cam.(up.Atdaban.-Botom.).*
      - "Rhabdocyathellidae" (1). *L.Cam.(up. Atdaban.-low.Len.).*
    - Capsulocyathina (*suborder*) (6). *L.Cam.(up. Tommot.-Botom.).*
      - Capsulocyathidae (1). *L.Cam.(up.Tommot.-Botom.).*
      - Fransuasaecyathidae (1). *L.Cam.(Atdaban.-Botom.).*
      - Uralocyathellidae (1). *L.Cam.(Botom.).*
      - ?Uralocyathidae (3). *L.Cam.(up.Tommot.-Botom.).*
  - Putapacyathida (*order*) (7). *L.Cam.(Atdaban.-Botom.).*
    - Putapacyathidae (1). *L.Cam.(up.Atdaban.* or *low.Botom.).*
    - Aptocyathidae (5). *L.Cam.(Atdaban.-Botom.).*
    - Gerbicanicyathidae (1). *L.Cam.(Botom.).*
  - Ajacicyathida (*order*) (152;3). *L.Cam.-M.Cam. (base).*
    - Dokidocyathina (*suborder*) (11). *L.Cam.(low. Tommot.-up.Botom.).*
      - Dokidocyathidae (3). *L.Cam.(Tommot.-Botom.).*
      - Acanthinocyathidae (1). *L.Cam.(up.Atdaban.* or *low.Botom.).*
      - Soanicyathidae (2). *L.Cam.(Botom.).*
      - Kidrjasocyathidae (2). *L.Cam.(Atdaban.-low.Botom.).*
      - Kaltatocyathidae (3). *L.Cam.(Atdaban.-Botom.).*
    - Ajacicyathina (*suborder*) (85;1). *L.Cam.-base M.Cam.*
      - Ajacicyathacea (*superfamily*) (47;1). *L.Cam.-base M.Cam.*
        - Ajacicyathidae (13;1). *L.Cam.(low.Tommot.-Botom.).*
        - Robustocyathidae (13). *L.Cam.*
        - Tennericyathidae (2). *L.Cam.(Atdaban.-Botom.).*
        - Ethmocyathidae (2). *L.Cam.(?up.Atdaban.-Botom.).*
        - Compositocyathidae (2). *L.Cam.(up.Tommot.-up.Botom.).*
        - Cyclocyathellidae (8). *L.Cam.(up.Tommot.-up.Botom.).*
        - Chankacyathidae (1). *L.Cam.(Botom.).*
        - Ethmophyllidae (6). *L.Cam.(Atdaban.)-M. Cam.(low.Amg.).*
      - Erbocyathacea (*superfamily*) (9). *L.Cam. (Atdaban.-Len.)-base M.Cam.*
        - Erbocyathidae (7). *L.Cam.(Atdaban.-Len.)-base M.Cam.*
        - ?Sajanocyathidae (2). *L.Cam.(Botom.-low. Len.).*
      - Pretiosocyathacea (*superfamily*) (4). *L.Cam. (Atdaban.-Botom.).*
        - Pretiosocyathidae (1). *L.Cam.(up.Atdaban.).*
        - Robertocyathidae (2). *L.Cam.(Atdaban.-Botom.).*
        - Peregrinicyathidae (1). *L.Cam.(Botom.).*

Hupecyathellacea (*superfamily*) (1). *L.Cam.(Botom.).*
Hupecyathellidae (1). *L.Cam.(Botom.).*
Bosceculcyathacea (*superfamily*) (3). *L.Cam.(Botom.-Len.)-?base M.Cam.*
Bosceculcyathidae (1). *L.Cam.(Botom.* or *?Len.)* or *?base M.Cam.*
Schidertycyathidae (2). *L.Cam.(Botom.-Len.)* or *?base M.Cam.*
Tumulocyathacea (*superfamily*) (6). *L.Cam.(up.Tommot.-up.Len.).*
Tumulocyathidae (3). *L.Cam.(up.Tommot.-Botom.).*
Sanarkocyathidae (1). *L.Cam.(Botom.).*
Vologdinocyathidae (2). *L.Cam.(Atdaban.-up.Len.).*
Annulocyathacea (*superfamily*) (12). *L.Cam.(Atdaban.-Botom.).*
Annulocyathidae (2). *L.Cam.(Botom.).*
Kijacyathidae (1). *L.Cam.(Atdaban.-up.Botom.).*
Gloriosocyathidae (5). *L.Cam.(Atdaban.-Botom.).*
Porocyathidae (4). *L.Cam.(Atdaban.-Botom.).*
Sigmocyathacea (*superfamily*) (1). *L.Cam.(up.Atdaban.* or *low.Botom.).*
Sigmocyathidae (1). *L.Cam.(up.Atdaban.* or *low.Botom.).*
Tercyathacea (*superfamily*) (2). *L.Cam.(Botom.-low.Len.).*
Tercyathidae (2). *L.Cam.(Botom.-low.Len.).*
Nochoroicyathina (*suborder*) (22;1). *L.Cam.(Tommot.-Botom.,* rare *Len.), ?M.Cam.(base Amg.).*
Nochoroicyathacea (*superfamily*) (9). *L.Cam.(Tommot.-Botom.,* rare *Len.), ?M.Cam.(base Amg.).*
Nochoroicyathidae (3). *L.Cam.(Tommot.-Botom.,* rare *Len.), ?M.Cam.(base Amg.).*
Bronchocyathidae (3). *L.Cam.(Atdaban.-Botom.).*
Ethmopectinidae (1). *L.Cam.(up.Atdaban.* or *low.Botom.).*
Formosocyathidae (2). *L.Cam.(up.Tommot.-Botom.).*
Kordecyathacea (*superfamily*) (1). *L.Cam.(?up.Atdaban.-Botom.).*
Kordecyathidae (1). *L.Cam.(?up.Atdaban.-Botom.).*
Lenocyathacea (*superfamily*) (5;1). *L.Cam.(mid.Tommot.-Botom.).*
Lenocyathidae (2). *L.Cam.(Atdaban.).*
Geocyathidae (3;1). *L.Cam.(mid.Tommot.-Botom.).*
Fansycyathacea (*superfamily*) (4). *L.Cam.(Atdaban.-low.Len.).*
Fallocyathidae (1). *L.Cam.(Atdaban.).*
Fansycyathidae (1). *L.Cam.(Atdaban.).*
Carinacyathidae (2). *L.Cam.(Atdaban.-low.Len.).*
Piamaecyathacea (*superfamily*) (3). *L.Cam.(up.Atdaban.-Botom.)*
Piamaecyathidae (2). *L.Cam.(Botom.).*
Botomocyathidae (1). *L.Cam.(up.Atdaban.-Botom.).*
Coscinocyathina (*suborder*) (34;1). *L.Cam.(mid.Tommot.-low.Len.)-base M.Cam.*
Coscinocyathacea (*superfamily*) (15;1). *L.Cam.(mid.Tommot.-low.Len.)-base ?M.Cam.*
Coscinocyathidae (10). *L.Cam.(mid.Tommot.-low.Len.).*
Stillicidocyathidae (2;1). *L.Cam.(?up.Atdaban.-Botom.).*
Coscinocyathellidae (1). *L.Cam.(Botom.).*
Agyrekocyathidae (1). *L.Cam.-base M.Cam.*
Tannuolacyathidae (1). *L.Cam.(low.Botom.).*
Clathricoscinacea (*superfamily*) (1). *L.Cam.(Atdaban.-low.Len.)*
Clathricoscinidae (1). *L.Cam.(Atdaban.-low.Len.).*
Anaptyctocyathacea (*superfamily*) (1). *L.Cam.(Atdaban.-Botom.)*
Anaptyctocyathidae (1). *L.Cam.(Atdaban.-Botom.).*
Alataucyathacea (*superfamily*) (7). *L.Cam.(Atdaban.-Botom.).*
Alataucyathidae (1). *L.Cam.(Atdaban.-Botom.).*
Ethmocoscinidae (4). *L.Cam.(Atdaban.-Botom.).*
Sigmocoscinidae (2). *L.Cam.(up.Atdaban.* or *low.Botom.).*
Rozanovicyathacea (*superfamily*) (2). *L.Cam.(Botom.).*
Rozanovicyathidae (1). *L.Cam.(Botom.).*
Porocoscinidae (1). *L.Cam.(up.Atdaban.* or *Botom.).*
Mrassucyathacea (*superfamily*) (8). *L.Cam.(Atdaban.-Botom.).*
Mrassucyathidae (1). *L.Cam.(Atdaban.).*
Kasyricyathidae (2). *L.Cam.(Atdaban.-Botom.).*
Polycoscinidae (3). *L.Cam.(Atdaban.-Botom.).*
Calyptocoscinidae (2). *L.Cam.(Atdaban.-?low.Botom.).*
Irregulares (*class*) (60;3). *L.Cam.-M.Cam.*

Thalassocyathida (*order*) (2). *L.Cam.(Tommot.-Botom.).*
Bacatocyathidae (2). *L.Cam.(Tommot.-Botom.).*
Archaeocyathida (*order*) (52;3). *L.Cam.-M.Cam.*
Archaeocyathina (*suborder*) (36;2). *L.Cam.-M.Cam.*
Archaeopharetridae (1). *L.Cam.(Atdaban.* or *low.Botom.).*
Bicyathidae (1). *L.Cam.(up.Tommot.-Botom.).*
Dictyocyathidae (5;2). *L.Cam.(mid.Tommot.-Botom.).*
Protopharetridae (2). *L.Cam.(mid.Tommot.-low.Len.).*
Metacyathidae (10). *L.Cam.(Tommot.-low.Len.).*
Archaeofungiidae (2). *L.Cam.(up.Atdaban.* or *low.Botom.).*
Sigmofungiidae (1). *L.Cam.(up.Atdaban.-low.Botom.).*
Flindersicyathidae (2). *L.Cam.(?Atdaban.-Len.).*
Copleicyathidae (1). *L.Cam.(up.Atdaban.* or *low.Botom.).*
Prismocyathidae (1). *L.Cam.(Botom.).*
Protocyclocyathidae (2). *L.Cam.*
Archaeocyathidae (1). *L.Cam.(Botom.)-M.Cam.*
Tabellaecyathidae (3). *L.Cam.(Botom.-low.Len.).*
Anthomorphidae (4). *L.Cam.(Atdaban.-low.Len.).*
Archaeosyconina (*suborder*) (16;1). *L.Cam.*
Archaeosyconidae (3;1). *L.Cam.*
Tabulacyathidae (3). *L.Cam.(Atdaban.-Botom.).*
Dictyocoscinidae (1). *L.Cam.(up.Atdaban.* or *low.Botom.).*
Metacoscinidae (8). *L.Cam.(up.Atdaban.-up.Len.).*
Pycnoidocoscinidae (1). *L.Cam.(up.Atdaban.* or *low.Botom.).*
Syringocnemidida (*order*) (6). *L.Cam.*
Syringocnemididae (5). *L.Cam.(?up.Atdaban.-Botom.).*
Syringocoscinidae (1). *L.Cam.*
Class Uncertain (19). *L.Cam.-M.Cam.*
Kazakhstanicyathida (*order*) (1). *Up.L.Cam.-?base M.Cam.*
Kazakhstanicyathidae (1). *Up.L.Cam.-?base M.Cam.*
Order Uncertain (18). *L.Cam.-M.Cam.*
Acanthopyrgidae (1). *L.Cam.*
Family Uncertain (extravallar outgrowths) (12). *L.Cam.-M.Cam.*
Family Uncertain (supposed planktonic or larval Archaeocyatha) (5). *L.Cam.-M.Cam.*
Phylum Uncertain (probably not Archaeocyatha) (45). *Precam.-U.Cam.(U.Sil.), M.Dev.*
Aphrosalpingoida (*class*) (3). *U.Sil.(Ludlow).*
Aphrosalpingida (*order*) (2). *U.Sil.(Ludlow).*
Aphrosalpingidae (1). *U.Sil.(Ludlow).*
Nematosalpingidae (1). *U.Sil.(Ludlow).*
Palaeoschadida (*order*) (1). *U.Sil.(Ludlow).*
Palaeoschadidae (1). *U.Sil.(Ludlow).*
Cribricyathea (*class*) (problematical microfossils) (29). *L.Cam.*
Conoidocyathida (*order*) (3). *L.Cam.*
Conoidocyathidae (3). *L.Cam.*
Cribricyathida (*order*) (13). *L.Cam.*
Cribricyathidae (6). *L.Cam.(Botom.-Solontsov).*
Pyxidocyathidae (6). *L.Cam.(Botom.-Solontsov).*
Capillicyathidae (1). *L.Cam.(Botom.).*
Vologdinophyllida (*order*) (13). *L.Cam.(Aldan.).*
Vologdinophyllacea (*superfamily*) (7). *L.Cam.(Aldan.).*
Leibaellidae (3). *L.Cam.(Aldan.).*
Vologdinophyllidae (4). *L.Cam.(Aldan.).*
Akademiophyllacea (*superfamily*) (6). *L.Cam.(Aldan.).*
Akademiophyllidae (4). *L.Cam.(Aldan.).*
Achorocyathidae (2). *L.Cam.(Aldan.).*
Class Uncertain (3). *L.Cam.(Aldan.-low.Botom.).*
Archaeophyllida (*order*) (2). *?L.Cam.(low.Botom.).*
Archaeophyllidae (2). *?L.Cam.(low.Botom.).*
Order Uncertain (1). *L.Cam.(Aldan.).*
Manacyathidae (1). *L.Cam.(Aldan.).*
Radiocyatha (*class*) (1). *L.Cam.(up.Atdaban.-low.Botom.).*
Hetairacyathida (*order*) (1). *L.Cam.(up.Atdaban.-low.Botom.).*
Hetairacyathidae (1). *L.Cam.(up.Atdaban.-low.Botom.).*
Class Uncertain (probably not Archaeocyatha) (9). *Precam.-U.Cam., M.Dev.*
Order Uncertain (9). *Precam.-U.Cam., M.Dev.*
Matthewcyathidae (1). *M.Cam.*
Korovinellidae (1). *L.Cam.(up.Botom.).*
Family Uncertain (7). *Precam.-U.Cam., M.Dev.*

SYSTEMATIC DESCRIPTIONS

CONTENTS

Phylum ARCHAEOCYATHA Bornemann, 1884

[*nom. transl.* OKULITCH, 1955, p. *E8* (*ex* class Archaeocyathinae BORNEMANN, 1884, p. 706), *nom. correct.* VOLOGDIN, 1937, p. 464] [=Archaeocyathinae TAYLOR, 1910, p. 105 (class); Cyathospongia OKULITCH, 1935, p. 88 (class); Archaeocyathi R. BEDFORD & W. R. BEDFORD, 1936, p. 9 (class); Archaeocyatha VOLOGDIN, 1937, p. 464 (subphylum of Porifera); Pleospongia OKULITCH, 1943 (class); Archaeocyatha OKULITCH, 1955, p. *E8* (phylum); Archaeocyathi KRASNOPEEVA, 1955, p. 17 (phylum); Euarchaeocyathi ZHURAVLEVA, 1960, p. 80 (class)] [equivalent to Archaeocyathaceae SIMON, 1939, p. 5 (superfam.)]

Skeleton in form of calcareous cup composed of porous wall, or more commonly porous outer and inner walls, with central cavity; porous septa, tabulae, and nonporous rods, bars, and dissepiments may form in intervallum. Plates of skeleton not spiculate, of microgranular calcite. *L.Cam.-M.Cam.* (base),*?U.Cam.*

Class REGULARES Vologdin, 1937

[*nom. correct. et transl.* ZHURAVLEVA, 1960, p. 80 (subclass) (*ex* Regularia VOLOGDIN, 1937, class) (use of this term to be avoided, because of its frequent use for major subdivisions of Echinoidea and Cystoidea)] [=Monocyatha OKULITCH, 1943, p. 44 (subclass); Septoidea KRASNOPEEVA, 1953, p. 55 (class); Monocyathea OKULITCH, 1955, p. *E9* (class) (*nom. correct. pro* Monocyatha OKULITCH, 1943)]

Solitary, rarely colonial; outer form of cup conical, ranging from cylindrical to saucer-shaped. Cups with one or more commonly two walls; intervallum with tabulae alone or with septa and commonly with flat or convex tabulae; axis of curvature of convex tabulae in intervallum; longitudinal pore-rows of septa diverge fanwise; dissepiments may be present. In early stages of *Ajacicyathus* type aporose tip widens and extends as one-walled porous cup without dissepiments, then, porous inner wall develops, quickly followed by septa or tabulae or both. *L.Cam.-M.Cam.(Paradoxides oelandicus Zone).*

Order MONOCYATHIDA Okulitch, 1935

[*nom. correct.* OKULITCH, 1955, p. *E9* (*pro* Monocyathina OKULITCH, 1935, p. 90)] [=order Archaeolynthida ZHURAVLEVA, 1957, p. 174]

Solitary, or rarely colonial; small. Cup either conical with one wall, porous except at tip, and in some, a pelta; or saclike and two-walled without pelta, the inner wall like a pocket, closed at base. *L.Cam.(low. Tommot.-low.Len.).*

Suborder MONOCYATHINA Okulitch, 1935

[*nom. transl.* ZHURAVLEVA in ZHURAVLEVA, KONYUSHKOV & ROZANOV, 1964, p. 59 (*ex* order Monocyathina OKULITCH, 1935, p. 90)]

Solitary or rarely colonial; not large. Cup conical or cylindrical, with one wall, porous except in early stages, and commonly with a pelta; without inner membranous sac. *L.Cam.(low.Tommot.-low.Len.).*

Family MONOCYATHIDAE Bedford & Bedford, 1934

[Monocyathidae BEDFORD & BEDFORD, 1934, p. 2] [=Rhabdocnemidae OKULITCH, 1943, p. 45 (*nom. subst. pro* Rhabdocyathidae VOLOGDIN, 1931, p. 52, invalid family-group name based on junior homonym); Archaeolynthidae ZHURAVLEVA, 1949, p. 550; Monocyathinae (*nom. transl.* ZHURAVLEVA, 1963, p. 74); Rhabdocyathellidae ZHURAVLEVA, 1963, p. 114]

Small, solitary or colonial. Single wall, simply porous, or with pore canals. Pelta commonly porous. Adherent outgrowths massive, tubulose. *L.Cam.(low.Tommot.-low.Len.).*

Archaeolynthus TAYLOR, 1910, p. 158 [**Monocyathus porosus* R. BEDFORD & W. R. BEDFORD, 1934, p. 2; SD SIMON, 1939, p. 21] [=*Monocyathus* R. BEDFORD & W. R. BEDFORD, 1934, p. 2 (type, *M. porosus;* SD R. BEDFORD & W. R. BEDFORD, 1936, p. 20); *Rhabdocnema* OKULITCH, 1937, p. 252 (*nom. subst. pro Rhabdocyathus* VON TOLL, 1899, p. 45, non BROOK, 1893) (type, *R. sibiricus,* M), for discussion see HILL, 1965, p. 51; *Rhabdocyathella* VOLOGDIN, 1937, p. 474 (type, *R. lebedevae;* M), for discussion see HILL, 1965, p. 53]. Small, solitary or colonial, conical or cylindrical; wall with simple, rounded or angular pores which are arranged in quincunx and may be protected with spines. Top of cup may be screened by a porous pelta, commonly with central orifice. Tersiae may develop both externally and in central cavity. Anchoring processes tubular. *L.Cam.(low.Tommot.-low.Len.),* USSR (S.Urals-Altay-Sayan-Sib.Platf.-Far East)-Mongolia-N.Afr.-Australia-Antarct.——FIG. 29,*4a*. **A. porosus* (BEDFORD & BEDFORD), lectotype, Botom., S. Australia; ×7 (Hill, 1965).——FIG. 29,*4b*. *A. lebedevae* (VOLOGDIN), Mongolia; thin sec., ×5 (Vologdin, 1940).

?**Rhabdolynthus** ZHURAVLEVA, 1960, p. 91 [**R. conicus;* M]. Cup conical; wall with rounded pores, and with inner side strengthened by short, horizontal rods; anchoring processes massive. One specimen only figured. Wall structure may be questioned. *L.Cam.(low.Botom.),* USSR (central R. Lena).——FIG. 29,*3*. **R. conicus,* Taryn hor., R. Lena; holotype, long. sec., ×?4 (Zhuravleva, 1960).

Family TUMULIOLYNTHIDAE Rozanov, 1966

[Tumuliolynthidae ROZANOV in ROZANOV & MISSARZHEVSKIY, 1966, p. 65]

Small; single wall with pores in tumuli; pelta may occur, but is without dependent saclike membrane; tersioid outgrowths may occur. *L.Cam.(up.Tommot.-Botom.).*

Tumuliolynthus ZHURAVLEVA, 1963, p. 101 [**Rhabdocyathus tubexternus* VOLOGDIN, 1932, p. 65; OD]. Like *Monocyathus* but wall with pores in tumuli. *L.Cam.(up.Tommot.-Botom.),* USSR (S.Urals - Altay - Sayan - Sib.Platf. - Transbayk - Far East)-Mongolia-Australia.

T. (Tumuliolynthus). With pores opening on upper surfaces of tumuli. *L.Cam.(up.Tommot.-low.Botom.),*USSR(S.Urals-Altay-Sayan-Sib.Platf.-Far East)-Mongolia-Australia.——FIG. 29,*1*. **T. (T.) tubexternus* (VOLOGDIN), up.Aldan.-Botom., Altay; *1a,* transv. sec. with secondary thickening, ×?3 (Vologdin, 1940b); *1b,* reconstr., ×15 (Zhuravleva, 1963b); *1c,* long. sec. through tumulus, ×40 (Zhuravleva, 1963b).

T. (Propriolynthus) OKUNEVA, 1967, p. 133 [**Archaeolynthus vologdini* YAKOVLEV, 1956, p. 855; OD]. With pores opening on lower surfaces of tumuli. *L.Cam.(Botom.),* USSR (Tuva-Sib.Platf.-Far East)-Can.(Yukon).——FIG. 29,*5*. **T. (P.) vologdini* (YAKOVLEV), USSR(Far East); tang. sec., ×15 (Okuneva, 1967).

Family ETHMOLYNTHIDAE Zhuravleva, 1963

[*nom. transl.,* herein, *ex* Ethmolynthinae ZHURAVLEVA, 1963, p. 112]

Solitary, single-walled, free of internal skeletal elements; wall with horizontal pore-canals, communicating with one another. *L.Cam.(up.Atdaban.-Botom.).*

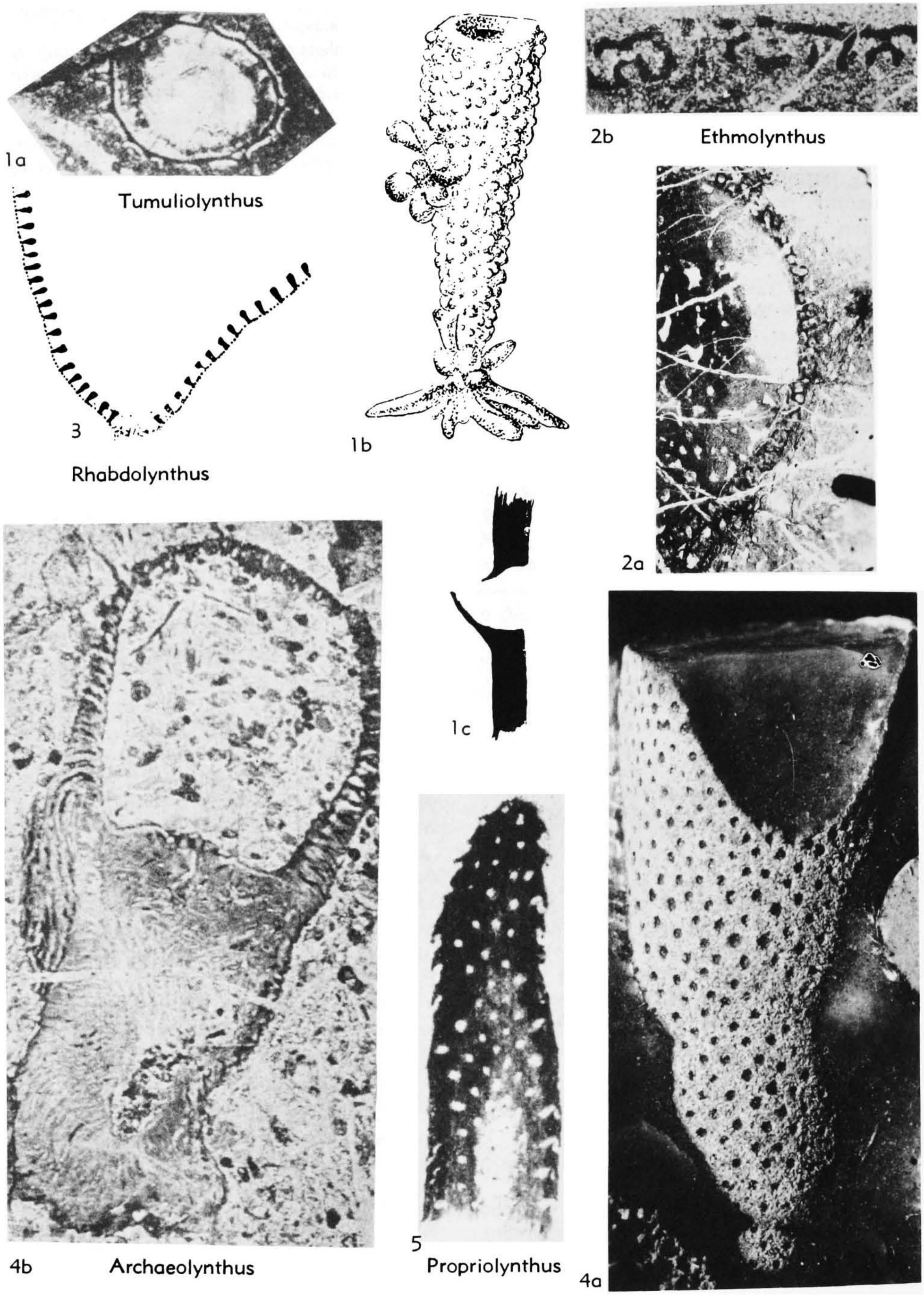
Ethmolynthus ZHURAVLEVA, 1963, p. 112 [**E. rosanovi;* OD]. Solitary, slenderly conical or cylindrical; wall with horizontal intercommunicating pore-canals. *L.Cam.(up.Atdaban.-Botom.),* USSR(Altay-Sayan).——FIG. 29,*2*. **E. rosanovi,* up.Atdaban., Kameshki; *2a,* Tuva, part of transv. sec., ×?4; *2b,* Altay, part of long. sec. of holotype, ×?13.3 (Zhuravleva, 1963b).

Family CRYPTOPOROCYATHIDAE Zhuravleva, 1960

[Cryptoporocyathidae ZHURAVLEVA, 1960, p. 92] [=Cryptaporocyathidae ZHURAVLEVA, 1963, p. 117 *(nom. null.)*]

Solitary, widely conical, without anchoring processes. Single wall thick, with pore-canals of two sizes, the smaller all opening at outer surface and many into the larger. *L.Cam.(low.Tommot.-low.Atdaban.).*

Cryptoporocyathus ZHURAVLEVA, 1960, p. 92 [**C. junicanensis;* OD] [=*Cryptaporocyathus* ZHURAVLEVA, 1963b, p. 117 *(nom. null.)*]. Solitary, widely conical, without anchoring processes. Single wall thick, with pore canals of two sizes, the smaller all opening at outer surface and into larger. *L.Cam.(low.Tommot.-low.Atdaban.),* USSR(Yakutia).——FIG. 4,*8;* 30,*2*. **C. junicanensis,* holotype, up.Tommot.; 30,*2a,b,* long. sec., ×?7 (Zhuravleva, 1963); 4,*8,* reconstr., ×0.75;


1a
Tumuliolynthus
1b
1c
2a
2b
Ethmolynthus
3
Rhabdolynthus
4a
4b
Archaeolynthus
5
Propriolynthus

30,*2c*, long. sec., diagram., ×13 (Zhuravleva, 1960b).

Suborder GLOBOSOCYATHINA Okuneva, 1969

[Globosocyathina Okuneva, 1969, p. 74]

Solitary, cups one-walled, saclike or hemispherical; upper surface with pelta having deep invagination bounded by porous membrane simulating an inner wall; pores of wall may be simple, or with tumuli, or may be canals. Heel-like outgrowths absent. *L.Cam.(up.Atdaban.-low.Len.).*

Family GLOBOSOCYATHIDAE Okuneva, 1969

[Globosocyathidae Okuneva, 1969, p. 75]

Solitary, saclike cups, almost spherical; wall with canals provided with beaks; pelta sparsely porous with deeply invaginated membrane closed at proximal end. *L.Cam. (Botom.).*

Globosocyathus Okuneva, 1969, p. 75 [**G. bellus;* OD]. Solitary, cup saclike, almost spherical; wall with pore-canals provided with beaks; pelta sparsely porous, with a deep invagination bounded by a thin wall. *L.Cam.(Botom.),* USSR(Far East).——Fig. 30,*4*. **G. bellus,* holotype, near Chernigorsk, Primore, Far East; *4a,* long. sec., ×4; *4b,* outer wall, tang. sec., ×13; *4c,* tang. sec., porous membrane, ×13 (Zhuravleva, 1969).

Family CAPSOLYNTHIDAE Okuneva, 1969

[Capsolynthidae Okuneva, 1969, p. 75]

Cup saclike or hemispherical; pores of wall simple or with tumuli. *L.Cam.(up. Atdaban.-Botom.).*

Capsolynthus Osadchaya in Zhuravleva, *et al.,* 1967, p. 26 [**C. helenae;* OD]. Small, solitary, saclike or almost hemispherical, without anchoring processes. Pores of single wall simple, rounded. Pelta flat, aporose, with central orifice from edge of which a porous membrane sags deeply into cavity of the cup. *L.Cam.(up.Atdaban.-Botom.),* USSR(Tuva).——Fig. 30,*3*. **C. helenae,* holotype, Botom., R. Shivelig-Khem.; long. sec., ×4 (Zhuravleva, *et al.,* 1967).

Family "RHABDOCYATHELLIDAE Zhuravleva," 1963

[Rhabdocyathellidae Zhuravleva, 1963, p. 114; invalidly based on a genus whose monotype species, *Rhabdocyathella lebedevae* Vologdin, 1937, p. 474, was transferred to *Archaeolynthus* by Zhuravleva (1963, p. 84)]

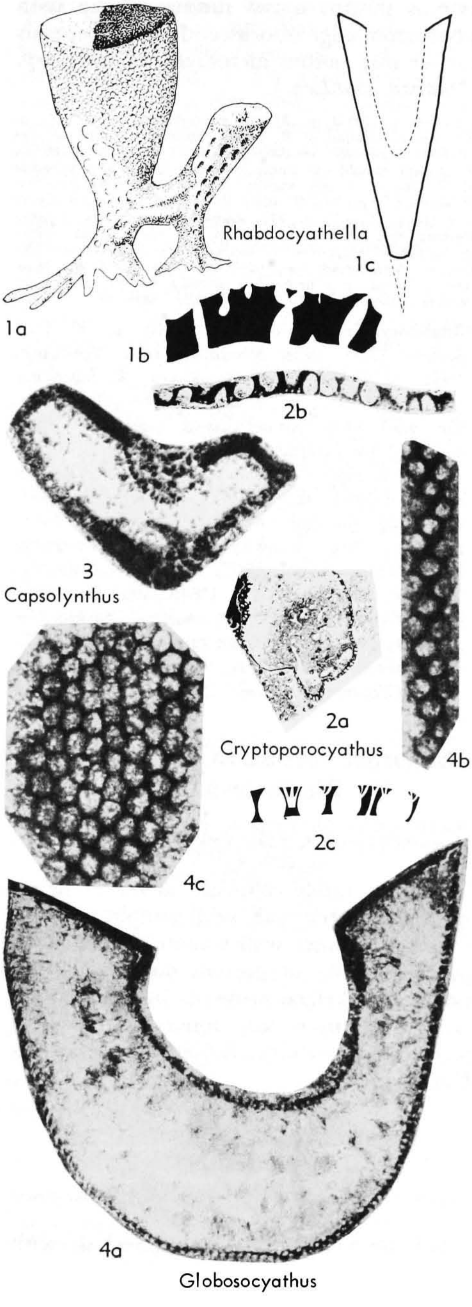


Fig. 30. Cryptoporocyathidae *(2);* Globosocyathidae *(4);* Capsolynthidae *(3);* "Rhabdocyathellidae" *(1)* (p. *E*51, *E*53-*E*54).

Single-walled cups, the wall with pore-canals and modified externally as microporous sheath; upper surface of cup with pelta, from edge of orifice in which depends saclike thin porous membrane. *L.Cam.(up. Atdaban.-low.Len.).*

[ZHURAVLEVA (1963, p. 84) accepted VOLOGDIN'S (1940b, p. 95) invalid citation of *R. baileyi* VOLOGDIN, 1940b, as type of *Rhabdocyathella* VOLOGDIN, 1940. The genus based on *R. baileyi* should be given another name. The holotype of *R. baileyi* is not known, however (*fide* ZHURAVLEVA, *et al.*, 1967, p. 29); further, in this last work, a figure was given (fig. 7, p. 29) showing a cup with a pelta forming the upper surface, from the edge of the orifice in which is suspended a saclike porous membrane like that of *Capsolynthus* and *Globosocyathus*. Until the holotype is found or a neotype is selected for *R. baileyi*, the systematic position of "*Rhabdocyathella*" must be in doubt.]

"Rhabdocyathella" VOLOGDIN, 1940, p. 95 [**R. baileyi*; OD] [*non Rhabdocyathella* VOLOGDIN, 1937, p. 474 (type by monotypy, *R. lebedevae* VOLOGDIN, 1937, p. 474)]. Single-walled cups, the wall with funnel-shaped pore-canals and modified by external microporous sheath; upper surface of cup with pelta from edge of orifice in which depends thin, saclike microporous sheet; anchoring processes massive, tubulose. [Type-specimen not known; definition following ZHURAVLEVA, *et al.*, 1967, p. 29.] *L.Cam.(up. Atdaban.-low.Len.),* USSR(Altay-Sayan-Sib. Platf.).——FIG. 30,*1*. **R. baileyi*, Sayan; *1a*, reconstr., ×?1.33; *1b*, part of transv. sec., ×?27 (Zhuravleva, 1963b); *1c*, long. sec., diagram., ×1.3 (Zhuravleva, *et al.*, 1967).

Suborder CAPSULOCYATHINA Zhuravleva, 1964

[Capsulocyathina ZHURAVLEVA in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 59] [=Uralocyathina DEBRENNE, 1964, p. 113]

Solitary, rarely colonial; saclike or hemispherical; outer wall with simple or complex pores, inner wall eccentric, formed by pushing down of part of outer wall into cavity; no skeletal elements in intervallum. At upper rim of cup inner wall may be produced funnel-like. *L.Cam.(up.Tommot.-Botom.).*

Family CAPSULOCYATHIDAE Zhuravleva, 1964

[Capsulocyathidae ZHURAVLEVA in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 60]

Solitary, saclike or hemispherical, with eccentric inner wall; outer wall with numerous simple pores; inner wall thinner than outer, with numerous, simple pores. *L.Cam.(up.Tommot.-Botom.).*

Capsulocyathus VOLOGDIN, 1962, p. 75 [**C. capsulifer* (not figured, described or separately diagnosed); OD (ZHURAVLEVA in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 61, invalidly chose as type *C. subcallosus* ZHURAVLEVA in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 62)]. Cup oval in transverse section, wall with simple rounded pores and with weakly marked porous inner wall. *L.Cam.(up.Tommot.-Botom.),* USSR(Sib.Platf.-Altay-Sayan-Transbayk-Far East)-Mongolia.——FIG. 31,*1a,b*. *C. irregularis*

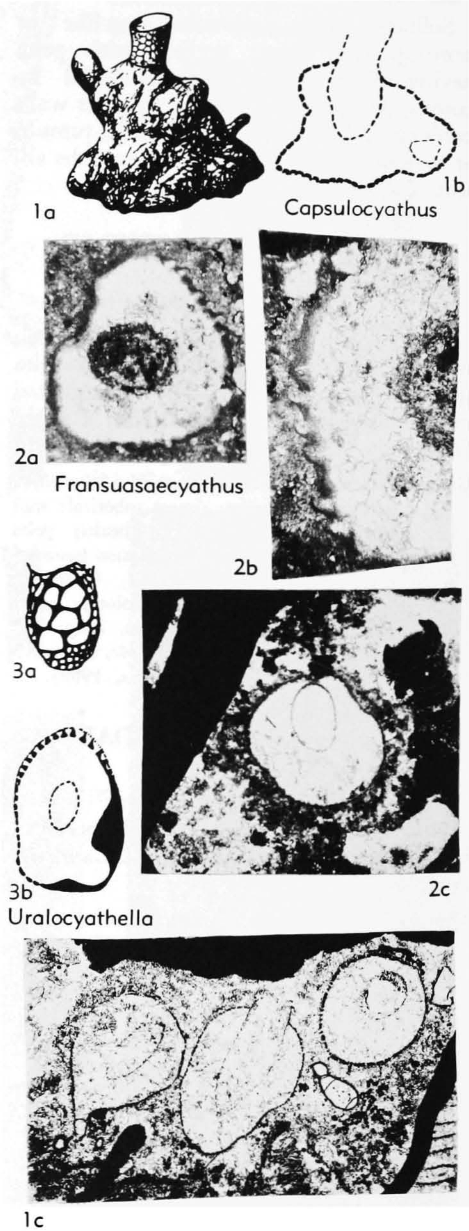


FIG. 31. Capsulocyathidae *(1)*; Fransuasaecyathidae *(2)*; Uralocyathellidae *(3)* (p. E54-E55).

(ZHURAVLEVA), Sanashtykgol, Altay-Sayan; *1a*, reconstr., *1b*, long. sec., both ×?4.5 (Zhuravleva, *et al.*, 1964).——FIG. 31,*1c*. *C. subcallosus* ZHURAVLEVA, Sanash., Sayan; thin secs., ×3 (Zhuravleva, *et al.*, 1964).

Family FRANSUASAECYATHIDAE Debrenne, 1964

[Fransuasaecyathidae DEBRENNE, 1964, p. 113]

Solitary, saclike or hemispherical, with eccentric inner wall; outer wall with pores in tumuli; inner wall thinner than outer, with numerous simple pores. *L.Cam. (Atdaban.-Botom.).*

Fransuasaecyathus ZHURAVLEVA, 1960, p. 103 [**F. subtumulatus;* OD]. Solitary, hemispherical or saclike; pores of outer wall tumulose, of thin inner wall simple, rounded or angulate. *L.Cam. (Atdaban.-Botom.),* USSR(S.Urals-Sayan-Sib. Platf.-Far East).——FIG. 4,*11;* 31,*2*. **F. subtumulatus,* holotype, Atdaban., Yakutia; 4,*11*, reconstr., ×?5; 31,*2a*, transv. sec., ×5; 31,*2b*, part of transv. sec., ×1.6; 31,*2c*, thin sec., ×8 (Zhuravleva, 1960b).

Family URALOCYATHELLIDAE Zhuravleva, 1964

[Uralocyathellidae ZHURAVLEVA, 1964, in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, p. 72]

Solitary, saclike, hemispherical cups with eccentrically arranged inner wall. Outer wall comprises thick main wall with large pores and an outer sheath with small pores. Inner wall thin, with numerous simple pores. *L.Cam.(Botom.).*

Uralocyathella ZHURAVLEVA in ZHURAVLEVA, KRASNOPEEVA, & CHERNYSHEVA, 1960, p. 99 [**U. repinae;* OD]. Solitary, hemispherical. Outer wall with large pores, and external microporous sheath. Inner wall thin, with simple pores. *L.Cam.(Botom.),* USSR(Altay-Sayan).——FIG. 31,*3a*. **U. repinae,* holotype, Sanashtykgol, Sayan; tang. sec. outer wall, ×?32 (Zhuravleva, *et al.*, 1964).——FIG. 31,*3b*, *U. bullata* ZHURAVLEVA, Sanashtykgol, E. Sayan; oblique long. sec., ×?22 (Zhuravleva, *et al.*, 1964).

?Family URALOCYATHIDAE Zhuravleva in Vologdin, 1956

[Uralocyathidae ZHURAVLEVA in VOLOGDIN, 1956, p. 878] [=Vacuocyathidae VOLOGDIN, 1962, p. 77]

Solitary, cylindrical to saclike. Outer wall vaguely porous, inner wall simply porous; no other skeletal elements. *L.Cam.(up. Tommot.-Botom.).*

Vacuocyathus OKULITCH, 1950, p. 392 [**Coelocyathus kidrjassovensis* VOLOGDIN, 1937, p. 478 *(nom. nud.)*, 1939, p. 237; OD] [=*Coelocyathus* VOLOGDIN, 1934, p. 502 *(nom. nud.)*, 1937, p. 472 *(nom. nud.)*, 1939, p. 269 (*non Coelocyathus* SCHLÜTER, 1886, p. 899 (type, *C. socialis*); *nec* SARS, 1857, p. 126); *Uralocyathus* ZHURAVLEVA, 1950, p. 8 *(nom. nud.)*, 1960, p. 102, *nom. subst. pro Coelocyathus* VOLOGDIN, 1939]. Solitary, ?cylindrical. Outer wall with ?simple pores; inner wall commonly eccentric with simple pores; devoid of other skeletal elements. Holotype insufficiently known. *L.Cam.(up.Tommot.-Botom.),* USSR (S.Urals-Transbayk.)-Mongolia-N.Afr.-Eu. (France).——FIG. 32,*1*. **V. kidrjassovensis* (VOLOGDIN), Botom., Urals; *1a,b*, transv. secs., ×?6 (Vologdin, 1939); *1c,d*, transv. secs., ×?5 (Vologdin, 1940b).

Melkanicyathus BELYAEVA, 1969, p. 88 [**M. limitatus;* OD]. Solitary cups with extensive beaks over pores of outer wall and with spine-like beaks over pores of inner wall; intervallum void. *L.Cam.(Botom.),* USSR(Far East).——FIG. 32,*2*. **M. limitatus,* R. B. Melkan, Far East; *2a,b*, transv. and long. sec., ×10 (Zhuravleva, 1969).

Velicyathus DEBRENNE, 1964, p. 125 [**V. levillaini;* OD]. Solitary, cylindroconical; outer wall regularly porous, with simple, close pores; inner wall regularly porous; dissepiments in intervallum. *L.Cam.(Tasousekt.),* N.Afr.(Morocco).——FIG. 32,*3*. **V. levillaini,* holotype; *3a*, part of transv. sec.; *3b*, part of long. sec., both ×2.5 (Debrenne, 1964).

Order PUTAPACYATHIDA Vologdin, 1962

[Putapacyathida VOLOGDIN, 1962, p. 118] [=Putapacyathina (suborder), *nom. transl.* ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 101]

Solitary, rarely colonial. Cup conical or cylindrical in form, composed of commonly complex outer and inner walls; neither radial links nor septa present, but walls are connected by tabulae; dissepiments may occur. *L.Cam.(Atdaban.-Botom.).*

Family PUTAPACYATHIDAE R. Bedford & J. Bedford, 1936

[Putapacyathidae R. BEDFORD & J. BEDFORD, 1936, p. 24] [=Putapacyathacea DEBRENNE, 1970 (superfamily), p. 24]

Cup conical or cylindrical; outer wall with simple pores, inner wall with pore canals, both walls strengthened by alternating longitudinal ribs; only tabulae present in intervallum. *L.Cam.(up.Atdaban.* or *low. Botom.).*

Putapacyathus R. BEDFORD & J. BEDFORD, 1936, p. 24 [**P. regularis;* OD]. Solitary, cups conical

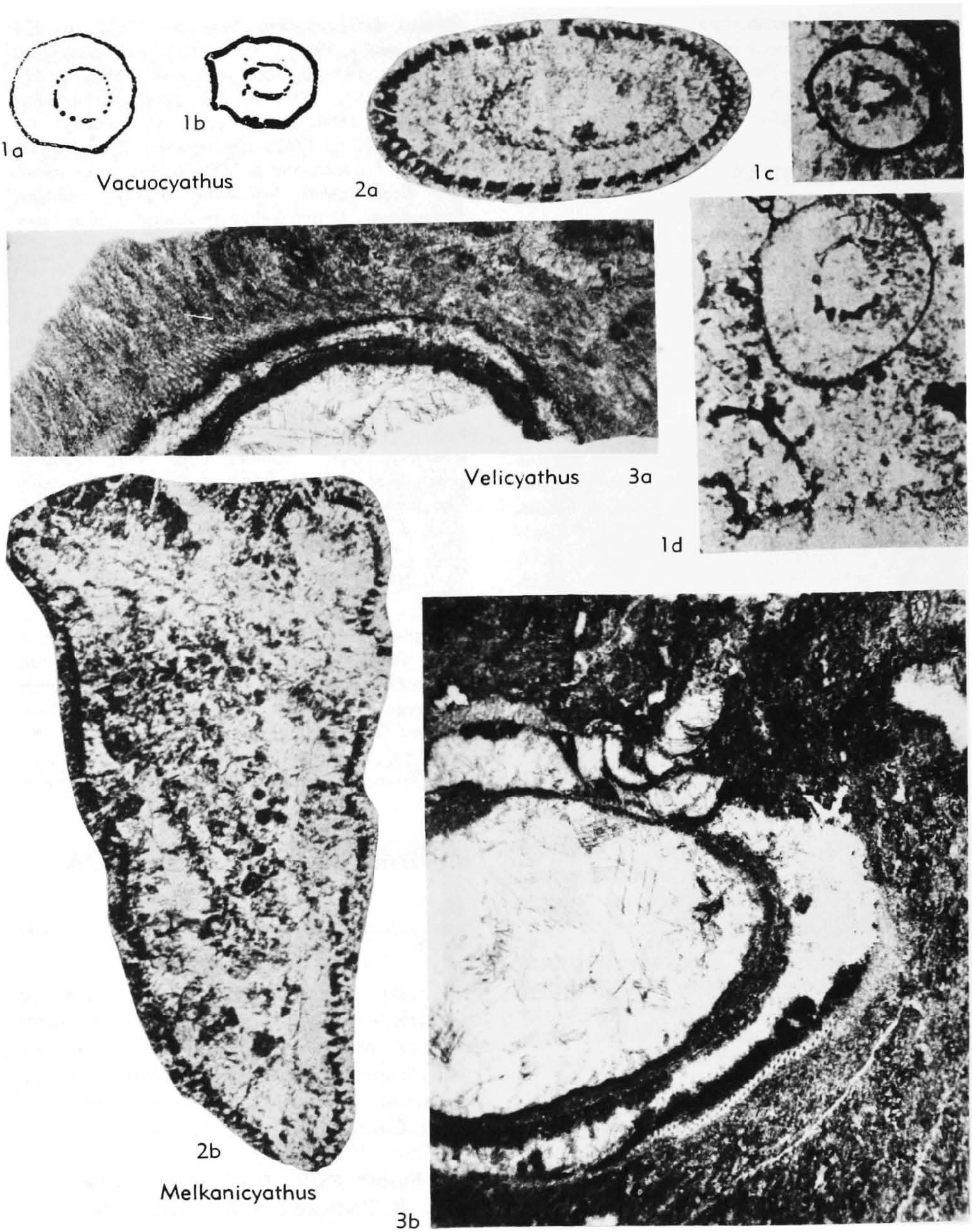


FIG. 32. Uralocyathidae (p. E55).

with outer and inner walls longitudinally ribbed or corrugated, ribs of outer and inner surfaces of wall alternating; outer wall simply porous, inner wall complex with pore canals; without septa or radial links; tabulae present, and in some, dissepiments. *L.Cam.(up.Atdaban.* or *low.Botom.)*, S.Australia-Antarct.-USSR(S.Urals).——FIG. 8,*3*; 33,*3*; 34,*5*. **P. regularis*, holotype, S.Australia (Ajax Mine); 8,*3*, part of etched transv. sec., ×8; 33,*3*, view of inner wall, ×5; 34,*5a,b*, parts of transv. and long. secs., ×8; 34,*5c*, int. view of inner wall, ×5; 34,*5d*, ext. view of outer wall, ×8; 34,*5e*, inner wall, diagram. (Bedford & Bedford, 1936).

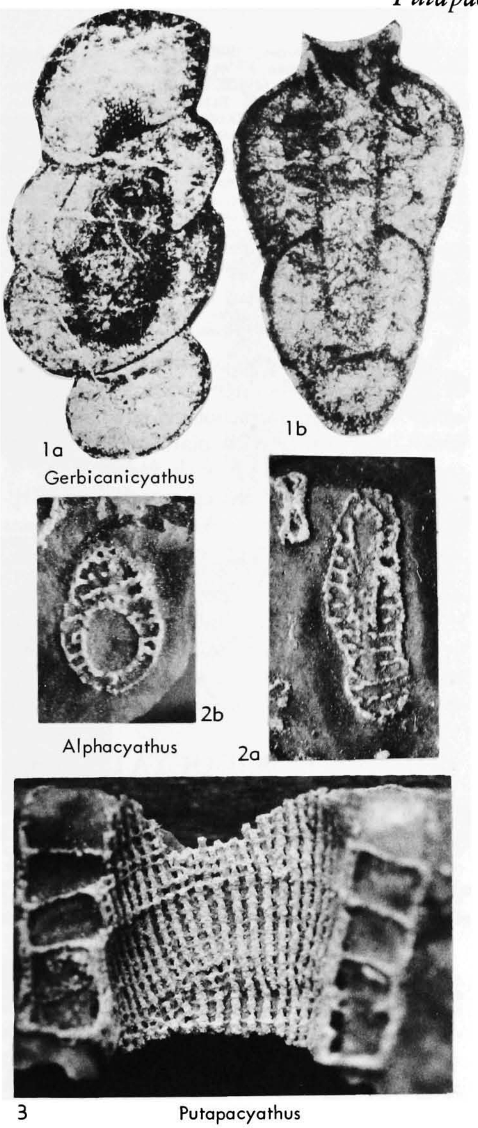


FIG. 33. Putapacyathidae *(3)*; Aptocyathidae *(2)*; Gerbicanicyathidae *(1)* (p. *E*55-*E*58).

Family APTOCYATHIDAE Konyushkov, 1964

[Aptocyathidae KONYUSHKOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 102] [=Aptocyathacea DEBRENNE, 1970 (superfamily), p. 24]

Solitary or colonial; cups conical or cylindrical. Outer and inner walls with simple pores, commonly complicated by longitudinal ribs developed on the intervallar surfaces of the walls. Tabulae and dissepiments present. *L.Cam.(Atdaban.-Botom.)*.

Aptocyathus VOLOGDIN, 1937, p. 471 [**A. gordoni;* M]. Solitary or colonial cups slenderly conical or cylindrical; outer and inner walls represented by longitudinal, inwardly projecting ribs invested with thin sheath having one longitudinal row of round pores between neighboring ribs; tabulae and dissepiments present. *L.Cam.(Botom.)*, USSR(S. Urals-Altay-Sayan).——FIG. 34,*2*. **A. gordoni,* Sanashtykgol, Altay-Sayan; *2a-c,* transv. sec., ×6.7 (Vologdin, 1940, Atlas).

Alphacyathus R. BEDFORD & J. BEDFORD, 1939, p. 72 [**Dictyocyathus annularis* R. BEDFORD & W. R. BEDFORD, 1936, p. 13; OD]. Cup cylindrical or conical; outer wall with small round pores arranged in quincunx; no septa; tabulae with 2

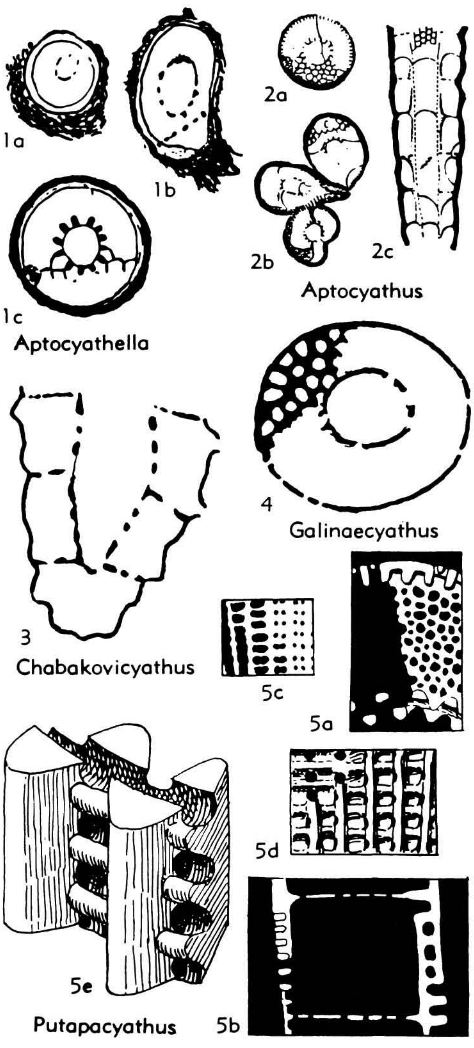


FIG. 34. Putapacyathidae *(5)*; Aptocyathidae *(1-4)* (p. *E*55-*E*58).

circles of large pores between the two walls; inner wall with one horizontal row of pores to each intertabular space (see Debrenne, 1970b, p. 28). *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia.——Fig. 33,*2*. **A. annularis* (Bedford & Bedford), Ajax Mine; *2a,b,* transv., oblique long. secs., ×6 (Hill, 1965).

Aptocyathella Konyushkov in Zhuravleva, Konyushkov, & Rozanov, 1964, p. 111 [**A. prima;* OD]. Cup solitary, small, slenderly conical or cylindrical; outer wall simply porous, inner wall with longitudinal ribs on intervallar face; pores of both walls rounded; tabulae and sparse dissepiments present. *L.Cam.(Botom.),* USSR(W.Sayan-Far East).——Fig. 34,*1*. **A. prima,* Sanashtykgol, W.Sayan; *1a-c,* transv. secs., ×20 (Zhuravleva, Konyushkov, & Rozanov, 1964).

Chabakovicyathus Konyushkov in Zhuravleva, Konyushkov, & Rozanov, 1964, p. 114 [**C. tumulatus;* OD]. Solitary, slenderly conical or cylindrical small cups; outer wall with tumular pores; inner wall with simple rounded pores; tabulae flat or weakly domed. *L.Cam.(?up. Atdaban.-Botom.),* USSR(S.Urals).——Fig. 34,*3*. **C. tumulatus,* ?up.Atdaban. or Botom.; long. sec., ×20 (Zhuravleva, Konyushkov, & Rozanov, 1964).

Galinaecyathus Konyushkov in Zhuravleva, Konyushkov, & Rozanov, 1964, p. 102 [**G. lebedensis;* OD]. Solitary cups small, regularly conical or cylindrical; inner and outer walls with round pores; tabulae and sparse dissepiments present. *L.Cam.(low.Atdaban.-Botom.),* USSR(S. Urals-Altay-Sayan-Sib.Platf.).——Fig. 34,*4*. **G. lebedensis,* L.Cam., USSR; transv. sec. showing inner and outer walls and part of tabula, ×10 (Zhuravleva, Konyushkov, & Rozanov, 1964).

Family GERBICANICYATHIDAE Belyaeva, 1969

[Gerbicanicyathidae Belyaeva, 1969, p. 90]

Solitary; cup conical or cylindrical; outer wall not independent, formed from the upturned edges of the tabulae; inner wall independent; tabulae porous; no septa. *L. Cam.(Botom.).*

Gerbicanicyathus Belyaeva, 1969, p. 90 [**G. emili;* OD]. Solitary; cup widely conical or cylindrical in form; outer wall formed of upturned edges of porous tabulae; inner wall simply porous; no septa. *L.Cam.(Botom.),* USSR(Far East).——Fig. 33,*1*. **G. emili,* holotype, R. Gerbikan, Far East; *1a,* oblique long. sec., ×6; *1b,* paratype, long. sec., ×14 (Zhuravleva, 1969).

Order AJACICYATHIDA R. Bedford & J. Bedford, 1939

[*nom. correct.* Okulitch, 1955, p. E10 (*pro* Ajacicyathina R. Bedford & J. Bedford, 1939, p. 70)] [=order Acanthinocyathida R. Bedford & W. R. Bedford, 1936, p. 11 (*nom. correct.* Vologdin, 1962d, p. 131, *pro* Acanthinocyathina R. Bedford & W. R. Bedford, 1936, p. 11; *nom. subst. pro* Acanthocyathina Okulitch, 1935, p. 90, invalid name based on junior homonym); order Loculicyathida Zhuravleva, 1955a, p. 9, *nom. correct.* Vologdin, 1962d, p. 118 (*pro* Loculocyathida Zhuravleva, 1955a, p. 9, invalid name based on *nom. null.*); order Coscinocyathida Zhuravleva, 1955a, p. 9; superorder Loculicyathina Zhuravleva, 1955, p. 9 (*nom. transl.* Vologdin, 1962d, p. 118, *ex* order Loculicyathida Zhuravleva, 1955a, p. 9); order Nochoroicyathida Zhuravleva in Vologdin, 1956, p. 879; order Dokidocyathida Vologdin, 1957a, p. 205; order Bosceculida Krasnopeeva, 1960, p. 41; order Ethmophyllida Vologdin, 1962d, p. 121; order Cyclocyathellida Vologdin, 1962d, p. 122; order Boscekulida Krasnopeeva, 1969, p. 63 (*nom. null.*)]

Solitary or rarely colonial. Cup cylindrical or conical, with porous outer and inner walls, the pores not infrequently complex. Intervallum with plane septa, or with septa and tabulae, or with radial links in horizontal planes; dissepiments or synapticulae may develop. Anchoring processes massive. In early stages cup is single-walled and simply porous; then appear a porous inner wall and radial links, and later, septa, or tabulae and septa; finally complex pores may appear, first those of outer wall, then those of inner wall. *L.Cam.-M.Cam.(base).*

Suborder DOKIDOCYATHINA Vologdin, 1957

[*nom. transl.* Zhuravleva, 1960b, p. 95 (*ex* order Dokidocyathida Vologdin, 1957a, p. 205)] [=order Acanthinocyathida R. Bedford & W. R. Bedford, 1936, p. 11 (*nom. correct.* Vologdin, 1962d, p. 131, *pro* Acanthinocyathina R. Bedford & W. R. Bedford, 1936, p. 11; *nom. subst. pro* Acanthocyathina Okulitch, 1935, p. 90, invalid name based on junior homonym)]

Solitary, with simply or complexly porous outer and inner walls connected by sparse

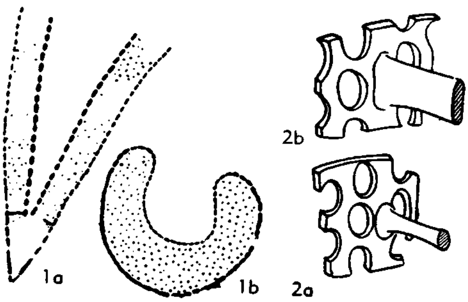


Fig. 35.——*1*. Open conical central cavity *(1a)* of Dokidocyathina compared with *1b,* hemispherical central cavity of Capsulocyathina.——*2*. Radial horizontal links of Dokidocyathina; *2a,* rounded in section; *2b,* flattened and platelike (Zhuravleva, Konyushkov, & Rozanov, 1964).

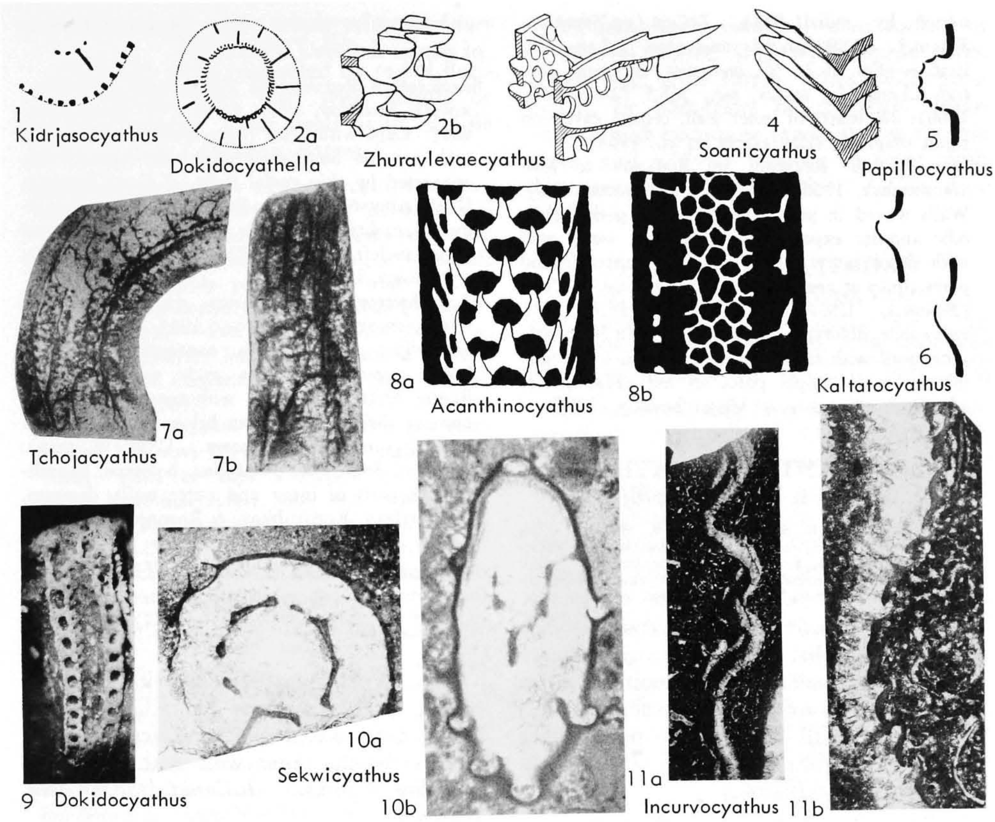


FIG. 36. Dokidocyathidae *(2,9,11)*; Acanthinocyathidae *(8)*; Soanicyathidae *(3-4)*; Kidrjasocyathidae *(1,7)*; Kaltatocyathidae *(5-6,10)* (p. *E* 59-*E*61).

radial horizontal links or by septa with single longitudinal row of pores almost as wide as septum. [DEBRENNE (1970b, p. 33) has discovered that in *Dokidocyathus simplicissimus* the links are parts of septa in which a single longitudinal row of large round or oval pores occurs. The other forms at present placed in this suborder should be investigated to establish whether this condition is general (Fig. 35).] *L.Cam.(low. Tommot.-up.Botom.)*.

Family DOKIDOCYATHIDAE R. Bedford & W. R. Bedford, 1936

[Dokidocyathidae R. BEDFORD & W. R. BEDFORD, 1936, p. 12] [=Dokidocyathacea DEBRENNE, 1970 (superfamily), p. 24]

Cups conical or cylindrical. Outer and inner walls with simple pores; walls connected by sparse radial horizontal links or by coarsely retiform septa with one row of such large round or oval pores that area of pores vastly exceeds area of septal tissue. No tabulae. *L.Cam.(Tommot.-Botom.)*.

Dokidocyathus TAYLOR, 1910, p. 146 [**D. simplicissimus;* M]. Cup cylindrical or conical; outer and inner walls with simple pores. Walls connected by radial horizontal links or by retiform septa with one longitudinal row of very large round or oval pores (see Debrenne, 1970, p. 33). *L.Cam.(Tommot.-Botom.)*, S.Australia-USSR(S. Urals-Sib.Platf.-Altay-Sayan-Transbayk.-Far East).——FIG. 36,9. **D. simplicissimus,* up.Atdaban. or low.Botom., S.Australia (Ajax Mine); long. sec., ×3, showing 2 septa each with 1 long. row of large round or oval pores (photo courtesy MAX DEBRENNE, Paris, negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris).

Dokidocyathella ZHURAVLEVA, 1960b, p. 100 [**D. incognita;* OD]. Outer wall with simple, small pores; inner wall longitudinally ribbed on intervallar side, with large pores each protected by deep bract on side of central cavity; walls connected by radial links. *L.Cam.(up.Tommot.-Botom.),* USSR(Altay-Sayan-central R.Lena-?Far East.——FIG. 36,*2*. **D. incognita,* Atdaban., central R.Lena; *2a,* transv. sec., ×5.5 (Zhuravleva, 1960); *2b,* bracts of inner wall, central cavity on right, diagram. (Zhuravleva, *et al.,* 1964).

Incurvocyathus ROZANOV in ROZANOV & MISSARZHEVSKIY, 1966, p. 50 [**I. voronovae;* OD]. Walls waved in parallel transversely, giving periodic annular expansions of the cup; outer wall with simple pores, inner wall with bracts around pores; links at acute angle to axis of cup. *L.Cam. (Botom.),* USSR(Tuva).——FIG. 36,*11*. **I. voronovae,* holotype; *11a,b,* part of thin long. sec., inner wall with bracted pores to right, outer wall thinner with simple pores to left; *11a,* ×1.3; *11b,* ×7 (Rozanov & Missarzhevskiy, 1966).

Family ACANTHINOCYATHIDAE R. Bedford & W. R. Bedford, 1934

[Acanthinocyathidae R. BEDFORD & W. R. BEDFORD, 1936, p. 11 (*nom. subst. pro* Acanthocyathidae R. BEDFORD & W. R. BEDFORD, 1934, p. 4, invalid name based on junior homonym)] [=Acantinocyathidae ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 99 *(nom. null.)*]

Cup with two walls connected by thin cylindrical radial horizontal or oblique links. Outer wall with long pointed scales projecting upward and very slightly outward from wall above each pore; inner wall with simple pores. *L.Cam.(up. Atdaban.* or *low.Botom.).*

Acanthinocyathus R. BEDFORD & W. R. BEDFORD, 1936, p. 11 [**Acanthocyathus apertus* R. BEDFORD & W. R. BEDFORD, 1934, p. 4; OD] [=*Acanthocyathus* R. BEDFORD & W. R. BEDFORD, 1934, p. 4 (*non* EDWARDS & HAIME, 1848, p. 292, a coral); *Acantinocyathus* ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 100 *(nom. null.)*]. Cup with two walls connected by thin, cylindrical, radial, horizontal links. Outer wall retiform, with long pointed scales rising from wall above each pore and projecting upward and very slightly outward; inner wall retiform with simple pores (see Debrenne, 1969b, p. 306). *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia(Ajax).——FIG. 36,*8*. **A. apertus* (BEDFORD & BEDFORD); *8a,b,* views of etched outer wall and of etched long. sec. showing inner wall, ×2.7 (Bedford & Bedford, 1934).

Family SOANICYATHIDAE Rozanov, 1964

[Soanicyathidae ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 97]

Slenderly conical cups with two concentric walls connected by thin radial links; outer wall with flaring bracts over the pores, inner wall with similar flaring bracts or with annular shelves over horizontal rows of pores. *L.Cam.(Botom.).*

Soanicyathus ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 98 [**S. admirandus;* OD]. Cups with bract rising from lower edge of each pore in both outer and inner walls; walls connected by thin radial links. *L.Cam.(Botom.),* USSR(Altay-Sayan).——FIG. 36,*4*. **S. admirandus,* Sanashtykgol; bracts of inner wall, central cavity to left, reconstr. (Zhuravleva, Konyushkov, & Rozanov, 1964).

Zhuravlevaecyathus ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 98 [**Z. pulchellus;* OD]. Walls connected by radial links; outer wall pores each with upwardly flaring bract; inner wall with upwardly directed annular shelves rising from below each horizontal row of pores. *L.Cam.(Botom.),* USSR(W.Sayan).——FIG. 36,*3*. **Z. pulchellus,* holotype, Sanashtykgol; parts of inner and outer walls, diagram. (Zhuravleva, Konyushkov, & Rozanov, 1964).

Family KIDRJASOCYATHIDAE Rozanov, 1964

[Kidrjasocyathidae ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 95]

Conical or cylindrical cup with two concentric walls connected by radial links or plates; outer wall with supplementary finely porous sheath, inner wall with simple or complex pores. *L.Cam.(Atdaban.-low. Botom.).*

Kidrjasocyathus ROZANOV, 1960, p. 43 [**K. uralensis;* OD] [=*Kidrjassocyathus* ROZANOV, 1960, *nom. null.* in REPINA, *et al.,* 1964, p. 174]. Walls of cup connected by radial horizontal or inclined links, and sometimes by dissepiments; outer wall coarsely porous but with supplementary finely porous external sheath, inner wall with simple large pores. *L.Cam.(up.Atdaban.-low. Botom.),* USSR(S.Ural-E.Sayan).——FIG. 36,*1*. **K. uralensis,* ?low.Botom., S.Ural; part of transv. sec., diagram. (Zhuravleva, Konyushkov, & Rozanov, 1964).

Tchojacyathus ROZANOV, 1960, p. 46 [**T. validus;* OD]. Cups with walls connected by inclined, sometimes inosculated links; dissepiments abundant. Outer wall of S-curved plates forming pore-canals directed irregularly upward and outward; external finely porous sheath present. Inner wall of S-curved plates forming pore-canals directed irregularly upward into central cavity. *L.Cam.(Atdaban.),* USSR(Altay).——FIG. 36,*7*. **T. validus,* holotype, R. Tyrga, Kameshki; *7a,b,* parts of transv. and long. secs., ×3 (Zhuravleva, Konyushkov, & Rozanov, 1964).

Family KALTATOCYATHIDAE Rozanov, 1964

[Kaltatocyathidae ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 92]

Cup with walls connected by radial horizontal links, outer wall with simple or knobby tumuli, inner wall with simple pores. *L.Cam.(Atdaban.-Botom.).*

Kaltatocyathus ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 92 [**K. kaschinae;* OD]. Cup with radial horizontal links connecting an outer wall in which each pore is in simple tumulus to simply porous inner wall. *L.Cam. (Atdaban.-low.Botom.),* USSR(E.Sayan-Far East)-Can.(Yukon).——FIG. 36,*6*. **K. kaschinae,* Atdaban., E.Sayan; long. sec. of pore in tumulus of outer wall, diagram. (Zhuravleva, Konyushkov, & Rozanov, 1964).

Papillocyathus ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 94 [**P. vacuus;* OD]. Small; walls of cups connected by flattened radial horizontal links; outer wall with multiperforate knobby tumuli; inner wall simply porous. *L.Cam.(up.Atdaban.-low.Botom.),* USSR (Altay-Sayan).——FIG. 36,*5*. **P. vacuus,* Sayan; multiperforate, knobby tumulus of outer wall, diagram. (Zhuravleva, Konyushkov, & Rozanov, 1964).

Sekwicyathus HANDFIELD, 1971, p. 34 [**S. nahanniensis;* OD]. Outer wall with spherical tumuli that protrude into intervallum also; tumuli open upward(?) on both sides of wall; intervallum with links flattened in longitudinal plane; inner wall simply porous. *L.Cam.(up.Atdaban.* or *low.Botom.),* Can.(NW.Terr.).——FIG. 36,*10*. **S. nahanniensis,* Sekwi F., NW.Terr.; *10a,* holotype, transv. sec., ×8; *10b,* oblique long. sec. showing subspherical tumuli with pores opening on both sides of wall, ×10 (Handfield, 1971).

Suborder AJACICYATHINA R. Bedford & J. Bedford, 1939

[*nom. transl. et correct.* ZHURAVLEVA, 1960b, p. 106 (*ex* order Ajacicyathina R. BEDFORD & J. BEDFORD, 1939, p. 70)] [=superorder Loculicyathina VOLOGDIN, 1962d, p. 118; order Loculicyathida VOLOGDIN, 1962d, p. 118 (*nom. correct., pro* Loculocyathida ZHURAVLEVA, 1955a, p. 9, invalid name based on *nom. null.*); suborder Boscekulcyathina KRASNOPEEVA, 1969, p. 63; suborder Schidertycyathina KRASNOPEEVA, 1969, p. 63]

Solitary or rarely colonial. Cup cylindrical or conical, with porous outer and inner walls, pores simple or complex. Intervallum with planar septa, without tabulae; synapticulae and dissepiments may occur and latter may penetrate into central cavity. *L.Cam.-base M.Cam.*

Superfamily AJACICYATHACEA R. Bedford & J. Bedford, 1939

[*nom. transl.* ZHURAVLEVA, 1960b, p. 106 (*ex* Ajacicyathidae R. BEDFORD & J. BEDFORD, 1939, p. 73)]

Solitary, rarely colonial. Cup conical or cylindrical. Outer wall with simple pores. Inner wall with simple pores, with pore-canals, or pore-tubes or annulate. Intervallum with porous or rarely almost aporose septa, and without tabulae; in some with dissepiments or synapticulae. *L.Cam.-base M.Cam.*

Family AJACICYATHIDAE R. Bedford & J. Bedford, 1939

[Ajacicyathidae R. BEDFORD & J. BEDFORD, 1939, p. 73] [=?Somphocyathidae OKULITCH, 1935, p. 98; Densocyathidae VOLOGDIN, 1937b, p. 471; Archaeocyathellidae SIMON, 1939, p. 57; Loculocyathidae ZHURAVLEVA, 1955a, p. 9]

Cups conical, may have transverse or longitudinal corrugations. Outer wall with simple pores; pores of inner wall simple or with bracts or scales, and in more than one longitudinal row to each intersept. Intervallum with septa that are porous or very rarely aporose, and in some with dissepiments or synapticulae; without tabulae. *L.Cam.(low.Tommot.-Botom.).*

Ajacicyathus R. BEDFORD & J. BEDFORD, 1939, p. 73 [**Archaeocyathus ajax* TAYLOR, 1910, p. 118; OD] [=*?Somphocyathus* TAYLOR, 1910, p. 134 (type, *S. coralloides;* OD) (for discussion see HILL, 1965, p. 62); *Ventriculocyathus* VOLOGDIN, 1931, p. 51 (type, *V. caulius;* M) (for discussion see HILL, 1965, p. 62); *Densocyathus* VOLOGDIN, 1937b, p. 471 (type, *D. sanaschticolensis;* M) (colonial, for discussion see HILL, 1965, p. 63); *Ascocyathus* VOLOGDIN, 1960, p. 422 (type, *Archaeocyathus arteintervallum* VOLOGDIN, 1931, p. 84; OD) (for discussion see ZHURAVLEVA, 1960, p. 126); *Sclerocyathus* VOLOGDIN, 1960, p. 424 (type, *S. scrofulosus;* OD) (for discussion see HILL, 1965, p. 67)]. Pores of both walls in several longitudinal rows in each intersept; those of inner wall may be protected by simple spines and may include stirrup-pores; septa sparsely porous or aporose; no tabulae. *L.Cam.(low. Tommot.-Botom.),* USSR(S.Urals-Altay-Sayan-Sib.Platf.-Transbayk.-Far East)-Mongolia-N.Afr. (Morocco)-S.Australia-Antarct.-N.Am. (Yukon-B. C.-Nev.).——FIG. 37,*6*. **A. ajax* (TAYLOR), up. Atdaban. or low.Botom., S.Australia (Ajax Mine); *6a,* outer wall and septa; *6b,* inner wall and septa, seen from outside; *6c,* inner wall seen from central cavity; all ×4 (Hill, 1965).

Ajacicyathellus DEBRENNE, 1959, p. 64 [**A. hollardi;* M]. Conical, outer and inner walls crenulate (furrowed at junctions with septa); outer wall with 4 to 5 longitudinal rows of simple pores to an intersept, in quincunx; septa perforate; inner wall thick, with 2 to 3 longitudinal rows of large oval simple pores to an intersept. *L.Cam.(Atdaban.),* N.Afr.(Morocco).

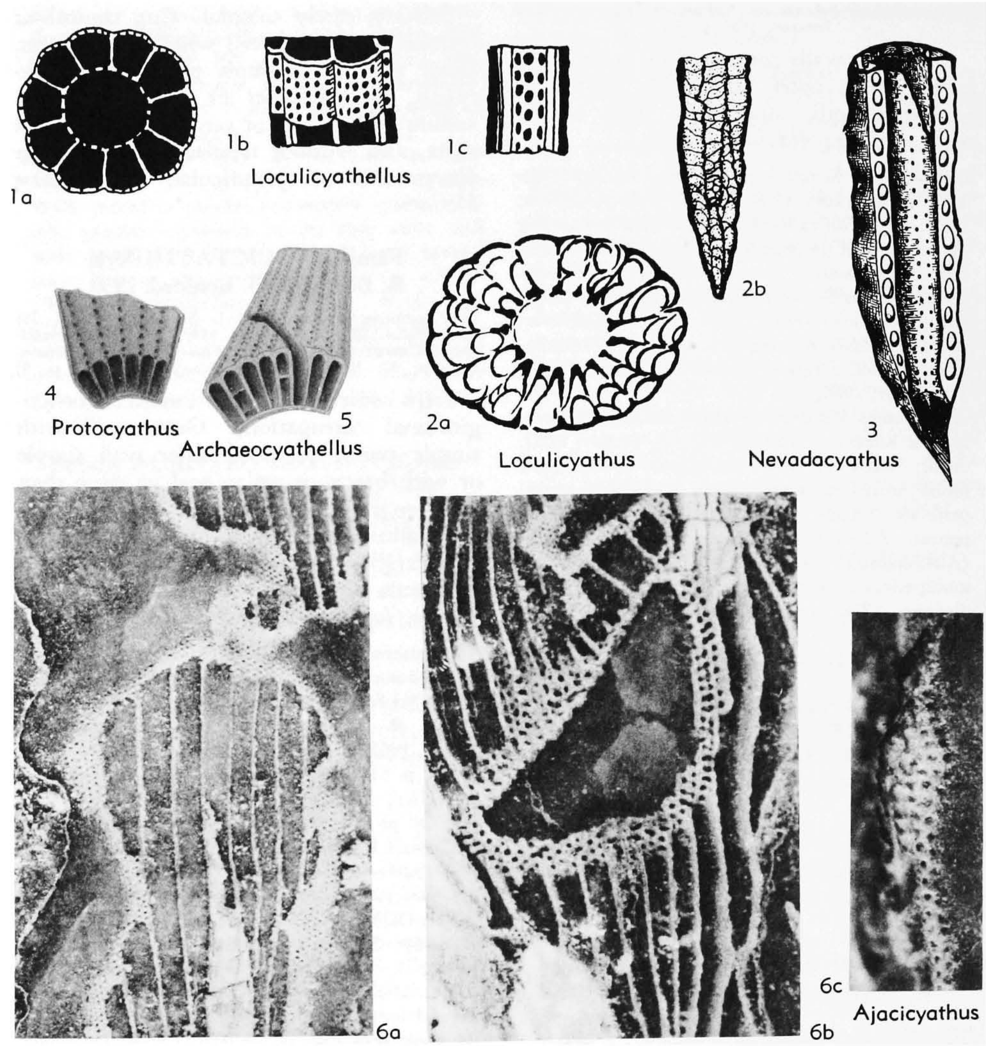


FIG. 37. Ajacicyathidae (p. E61-E65).

Archaeocyathellus FORD, 1873, p. 135 [**Archaeocyathus? rensselaericus* FORD, 1873, p. 211; M]. Very small, conical; outer wall longitudinally furrowed at septa; pores of outer wall alternating in 2 longitudinal rows to each intersept, 1 row close beside each septum; septa ?imperforate, dissepiments (or ?synapticulae) present. Characters of inner wall unknown. Type-species insufficiently known. *L.Cam.*, USA(N.Y.); *L.Cam. (Atdaban.-Botom.)*, USSR(Sayan-Sib.Platf.-Far East).——FIG. 37,*5*. **A. rensselaericus* (FORD), Troy, N.Y.; sector of cup, diagram. (Okulitch, 1943).

Dentatocyathus OKUNEVA, 1967 (quoted in BELYAEVA, 1969, p. 92) [**D. maritimus;* ?OD]. Solitary, cup conical; outer wall simply porous, with cog-like projections between septa, 2 or 3 longitudinal rows of pores to each side of the cog; septa straight, porous; inner wall with simple pores; no tabulae. *L.Cam.(Botom.)*, USSR(Far East.——FIG. 38,*3*. *D. indigenus* BELYAEVA, R. Melkan, Far East; holotype, transv. sec., ×10 (Belyaeva, 1969).

Loculicyathus VOLOGDIN, 1931, p. 54 [**L. tolli* (=*Coscinocyathus irregularis* VON TOLL, 1899, p. 44, for which it was invalid *nom. nov.*); OD] [=*Loculocyathus* VOLOGDIN, 1937b, p. 468 *(nom. null.); Mikhnocyathus* MASLOV, 1957, p. 307 (type, *M. zolaensis;* OD) (for discussion see VORONIN, 1964, p. 20); *Mukhnocyathus* MASLOV,

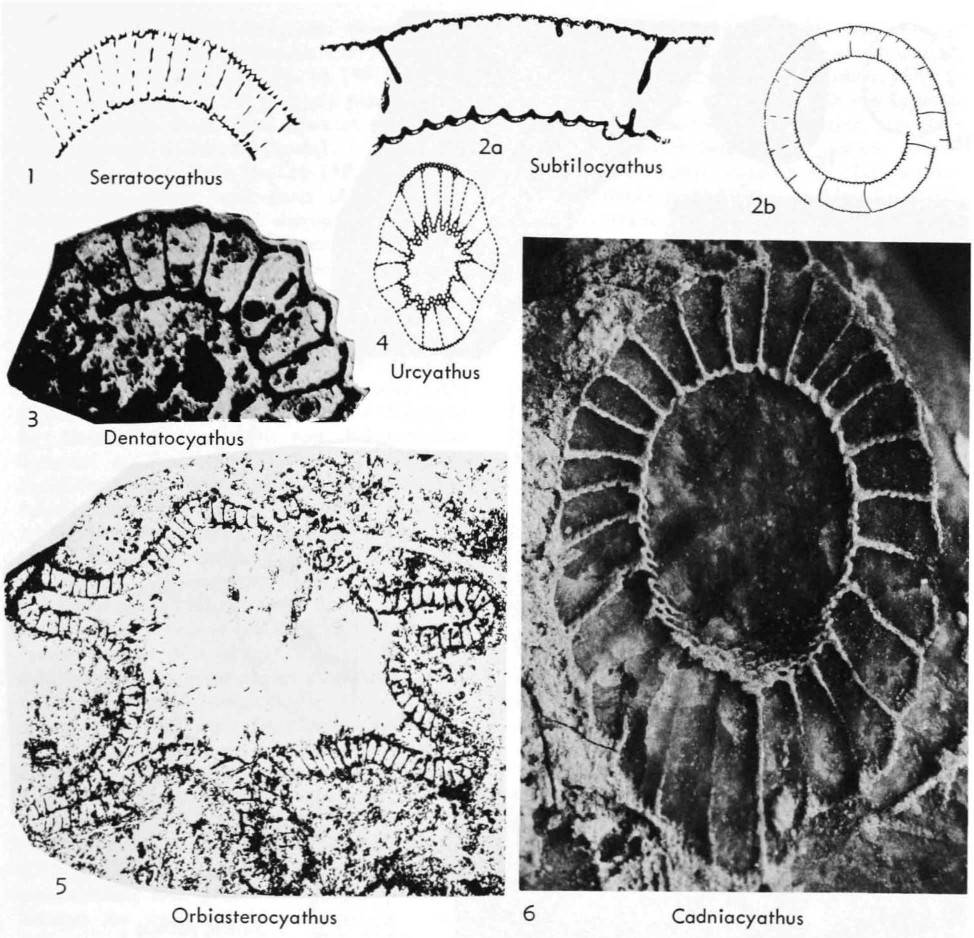


FIG. 38. Ajacicyathidae *(1-5)*; Tennericyathidae *(6)* (p. *E62-E67*).

1957, p. 308 *(nom. null.)*; *?Zolacyathus* VOLOGDIN, 1962, p. 10 (type, *Z. loculosus;* M), incompletely described]. Cup cylindrical, with simply porous outer and inner walls and septa and with dissepiments crossing both intervallum and central cavity; no tabulae. *L.Cam.(Atdaban.-Botom.),* USSR(S.Urals-Sib.Platf.-Altay-Sayan-Transbayk-Far East)-S.Australia-N.Afr.-Can.(Yukon).

L. (Loculicyathus). Outer wall without longitudinal furrow at junction with each septum. *L. Cam.(Atdaban.-Botom.),* USSR(S.Urals-Sib. Platf.-Altay-Sayan-Transbayk.-Far East)-S.Australia-N.Afr.-Can.(Yukon).——FIG. 37,*2*. **L. (L.) irregularis* (VON TOLL), up.Atdaban., Kameshki; *2a,* part of transv. sec., ×2.7; *2b,* long. sec., ×2 (Vologdin, 1931).

L. (Loculicyathellus) DEBRENNE, 1969, p. 310 [**Archaeocyathus floreus* R. BEDFORD & W. R. BEDFORD, 1934, p. 2; OD]. Outer wall with longitudinal furrow at junction with each septum. *L.Cam.(up.Atdaban.* or *low.Botom.),* S. Australia(Ajax Mine).——FIG. 37,*1*. **L. (L.) floreus* (BEDFORD & BEDFORD), holotype; *1a,* transv. sec.; *1b,* outer wall; *1c,* inner view of inner wall, all approx. ×4 (Bedford & Bedford, 1934).

Nevadacyathus OKULITCH, 1943, p. 59 [**Archaeocyathus septaporus* OKULITCH, 1935, p. 101; M]. Cup very small, cylindrical; outer wall with small, sparse, oblique pore-canals (directed upward and inward); inner wall with numerous, small pores; septa with very large pores, commonly in one longitudinal row; no tabulae. *L.Cam.(Atdaban.-low.Botom.),* N.Am.(Nev.)-USSR(Sib.Platf.).——FIG. 37,*3*. **N. septaporus* (OKULITCH), Nev.; reconstr., ×7.5 (Okulitch, 1935).

Orbiasterocyathus ZHURAVLEVA in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964, p. 183 [**O. geri;* OD]. Cups starshaped in trans-

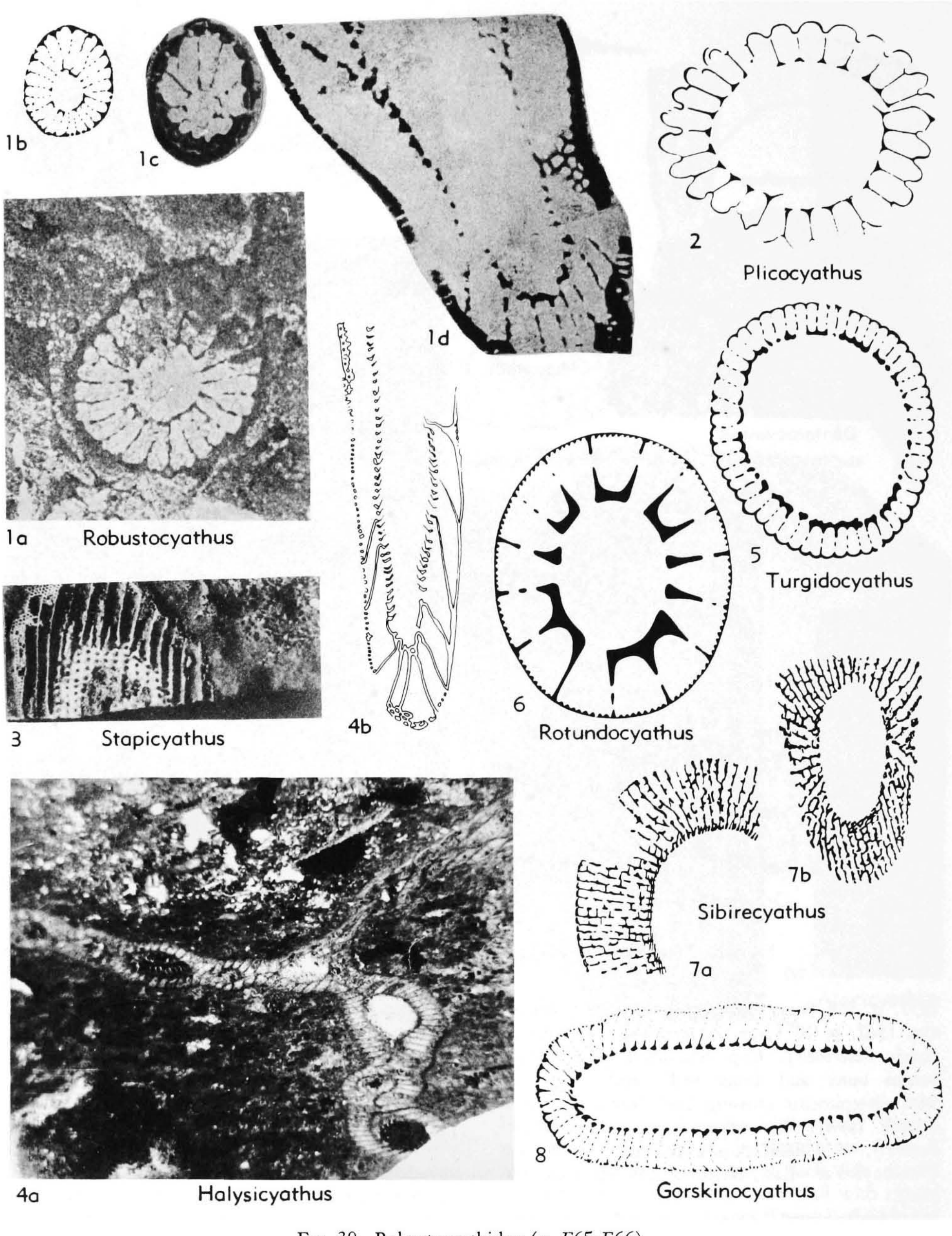


FIG. 39. Robustocyathidae (p. E65-E66).

verse section due to deep longitudinal folds affecting both walls; pores of walls simple; septa porous; no tabulae. *L.Cam.(up.Atdaban.)*, USSR (Shoria Mts.).——FIG. 38,5. **O. geri*, holotype, Kameshki; transv. sec., ×4 (Repina, Khomentovskiy, Zhuravleva, & Rozanov, 1964).

Orbicyathus VOLOGDIN, 1937, p. 470 [**O. mongolicus;* M]. Cup conical, with periodic annular expansions due to both walls being waved in parallel transversely; outer wall with numerous small pores in quincunx; septa porous; inner wall with up to 3 longitudinal rows of simple pores per intersept. Tabulae absent. *L.Cam.(up.Tommot.-Botom.)*, Mongolia-USSR(S.Urals-Sayano-Altay-central R.Lena)-N.Afr.(Morocco).——FIG. 4,6. **O. mongolicus*, Mongolia (L.Kara-Usu); *6a,* reconstr., ×3.5; *6b,c,* tang. sec. through two transv. expansions, ×7 (Vologdin, 1937).

Pachecocyathus Rincón, 1971, p. 81 [**P. cabanasi;* OD]. Outer wall and septa simply porous; inner wall thick, two longitudinal rows of pore-canals to an intersept. *L.Cam.,* Eu.(Spain).

Protocyathus Ford, 1878, p. 124 [**P. rarus;* M]. Very small, conical, with pores of ?outer wall confined to single row of stirrup-pores in each septal furrow, with thin septa, and inner wall of unknown structure. Type-species insufficiently known. *L.Cam.,* USA(N.Y.).——Fig. 37,*4*. **P. rarus,* Troy, N.Y.; sector of cup, diagram. (Okulitch, 1943).

Serratocyathus Vologdin, 1960, p. 424 [**S. echinatus;* OD] [=?*Echinocyathus* Vologdin, 1960, p. 424 (type, *E. bilateralis;* OD) (for discussion see Hill, 1965, p. 66); *non Echinocyathus* Termier & Termier, 1950, p. 47 (type, *E. goundafensis;* OD)]. Cup conical; outer wall with ?pore-canals with short outwardly projecting ?rims; inner wall pores simple; septa thin, radial, plane, porous; no tabulae. *L.Cam.,* USSR(Tuva).——Fig. 38,*1*. **S. echinatus;* part of transv. sec., ×2.7 (Vologdin, 1960).

Subtilocyathus Vologdin, 1960, p. 423 [**Archaeocyathus subtilis* Vologdin, 1932, p. 41; OD]. Cup conical, with finely porous outer and coarsely porous inner walls, connected by few, ?coarsely porous septa; wall pores (?screened with bubble-like sheaths). Imperfectly known. *L.Cam.,* USSR (Altay).——Fig. 38,*2*. **S. subtilis* (Vologdin); *2a,* part of transv. sec., ×13 (Vologdin, 1940b); *2b,* transv. sec., ×2.7 (Vologdin, 1960).

Urcyathus Vologdin, 1940, p. 64 [**U. asteroides;* OD]. Outer wall and septa finely and simply porous; inner wall plicate longitudinally (ribbed between the septa and furrowed at the septa), with several longitudinal rows of simple pores to each flank of plication; tabulae absent. *L.Cam. (Atdaban.-Botom.),* USSR(E.Sayan-Salair)-?Spain-?N.Afr.(Morocco).——Fig. 38,*4*. **U. asteroides,* Salair; oblique transv. sec., ×?2.2 (Vologdin, 1957a).

Family ROBUSTOCYATHIDAE Debrenne, 1964

[Robustocyathidae Debrenne, 1964, p. 140] [=?Leecyathidae Vologdin, 1957c, p. 495]

Outer wall with simple pores; inner wall with single longitudinal row of pores to each intersept; inner wall pores may have bracts; septa porous or almost aporose, may be synapticulate. *L.Cam.*

Robustocyathus Zhuravleva, 1960, p. 133 [**Archaeocyathus robustus* Vologdin, 1937a, p. 25; OD] [=?*Septocyathus* Vologdin, 1937b, p. 468 (type, *S. pedaschenkoi;* M) (for discussion see Voronin, 1964, p. 16); ?*Leecyathus* Vologdin, 1957, p. 495 (type, by OD, *Archaeocyathus yavorskii* Vologdin, 1931, p. 86, has a fringe of tersioid outgrowths)]. Cup slenderly conical, with 2 to 4 longitudinal rows of simple pores to an intersept in outer wall and 1 such row in inner wall; pores of inner wall much larger, may have protective spines or bracts; septa porous; anchoring processes massive, canaliculate. *L.Cam.(low. Tommot.-Botom.),* USSR(S.Urals-Altay-Sayan-Sib. Platf.-Transbayk.-Far East)-N.Am.(B.C.-Nev.)-S. Australia-Antarct.-Spain-N.Afr. (Morocco).——Fig. 39,*1*. **R. robustus* (Vologdin), L.Cam.(up. Tommot.-Botom.), USSR(R.Lena); *1a,b,* ?transv. secs., ×8 (Vologdin, 1937a); *1c,* transv. sec. of cup with secondary thickening of outer wall, ×5.6; *1d,* long. sec. of cup without secondary thickening, ×4.8 (Zhuravleva, 1960b).

Afiacyathus Voronin, 1962, p. 26 [**A. lativallum;* OD]. Cup conical; outer wall with simple pores; septa straight, porous, united by synapticulae; inner wall thick, perforated by straight pore-canals not interconnected, one longitudinal row to each intersept. *L.Cam.(?Atdaban.-Botom.),* USSR (Tuva)-Mongolia-N.Afr. (Morocco)-?N.Am.——Fig. 40,*2*. **A. lativallum,* holotype, Botom., Tuva; *2a,* part of transv. sec., ×2; *2b,* part of oblique long. sec., ×2 (Voronin, 1962).

?**Carpicyathus** Osadchaya, in Zhuravleva, Zardorozhnaya, Osadchaya, Pokrovskaya, Rodionova, & Fonin, 1967, p. 51 [**C. mysticus;* OD]. Solitary, slenderly conical or cylindrical cups; outer wall strong, its short pore-canals each with vertically rising bract, inner wall thick, with two longitudinal rows of pore-canals to an intersept, the pore-canals with bracts sharply bent up into central cavity; septa porous. [Voronin (1969, p. 102) lists this as synonym of *Inessocyathus.*] *L.Cam.(up.Botom.),* USSR(Tuva).——Fig. 40,*1*. **C. mysticus,* holotype; *1a,b,* transv. and long. secs., ×2.7; *1c,* tang. sec. outer wall, ×10; *1d,* part of inner wall, ×10 (Zhuravleva, *et al.,* 1967).

Gorskinocyathus Vologdin, 1960, p. 422 [**Archaeocyathus gorskinensis* Vologdin, 1940b, p. 60; OD]. Outer wall thin and finely porous; inner wall thicker with 1 or 2 longitudinal rows of pores per intersept; septa thin, porous, not radial. *L.Cam.,* USSR(Salair).——Fig. 39,*8*. **G. gorskinensis* (Vologdin); transv. sec., ×4.8 (Vologdin, 1960).

Halysicyathus Debrenne, 1965, p. 143 [**H. multifurcus;* OD]. Colonial, cups associated in *Halysites*-like chain; outer wall with simple pores; inner wall with single longitudinal row of pores to an intersept, each pore with thin-edged peak from its upper edge; septa straight, sparsely porous; no tabulae or dissepiments. *L.Cam.(up.Atdaban.),* N. Afr.(Morocco).——Fig. 39,*4*. **H. multifurcus,* Timghit.; *4a,* holotype, thin sec., ×4 (photo courtesy of Max Debrenne, Paris, negatives in coll. Dr. F. Debrenne, Natl. History Museum, Paris); *4b,* tang. sec., ×8 (Debrenne, 1965).

Inessocyathus Debrenne, 1964, p. 143 [**Archaeocyathus spatiosus* Bornemann, 1887, p. 59; OD].

Outer wall with simple rounded or hexagonal pores, inner wall thickened with one longitudinal row of large pore-canals to an intersept; septa thin, porous, without synapticulae. *L.Cam. (Atdaban.-Botom.),* Eu.(Sardinia-Spain)-USSR

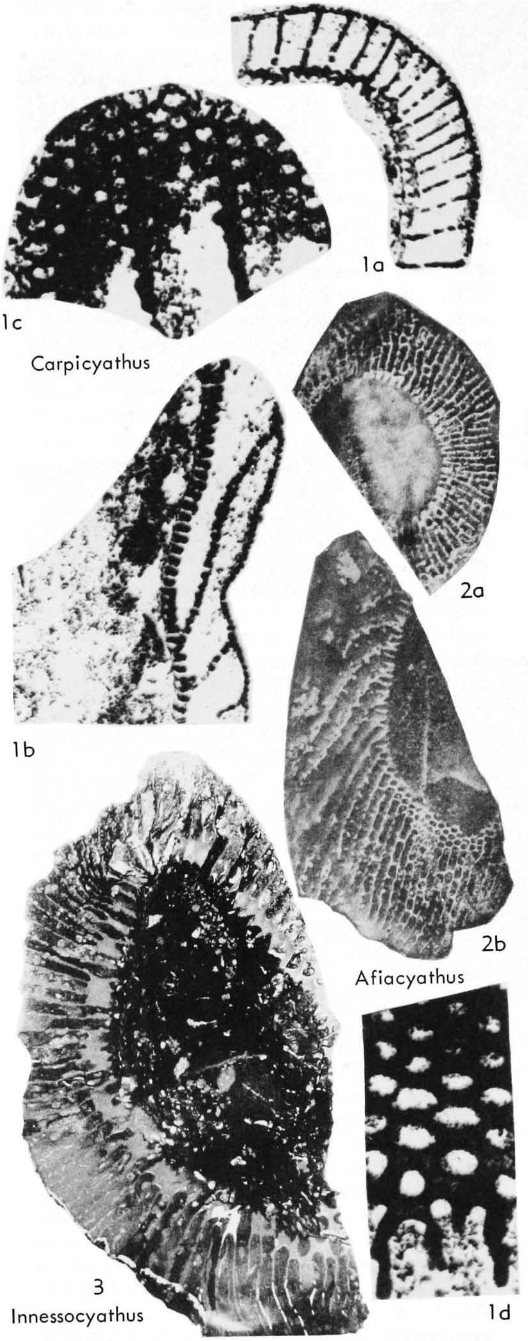


FIG. 40. Robustocyathidae (p. *E65-E66*).

(Altay-Sayan)-Mongolia-N.Afr. (Morocco)-Antarct.-N.Am.(Nev.).——FIG. 40,*3*. **I. spatiosus* (BORNEMANN), Botom., Sardinia; part of transv. sec., ×2 (Debrenne, 1964).

?**Plenocyathus** VOLOGDIN, 1962b, p. 13 [**P. crassiseptatus;* M]. Incompletely figured and not described. *L.Cam.*(*Botom.),* USSR(Sayan).

Plicocyathus VOLOGDIN, 1960, p. 424 [**P. krassnyi;* OD]. Conical cups; porous outer wall longitudinally plicate with deep furrows at outer ends of the septa; inner wall slightly thickened, with a single longitudinal row of large pores; septa indistinctly porous, radial, thickened at inner wall. *L.Cam.,* USSR(Far East).——FIG. 39,*2*. **P. krassnyi;* transv. sec., ×4 (Vologdin, 1960).

?**Rugocyathus** VOLOGDIN, 1962b, p. 13 [**R. venustus;* M]. Incompletely figured and not described. *L.Cam.(Botom.),* USSR(Sayan).

Rotundocyathus VOLOGDIN, 1960, p. 422 [**R. rotaceus;* OD]. Cup conical, with smooth commonly finely porous outer wall; inner wall and septa coarsely porous; septa thickening toward thick inner wall, in which is one longitudinal row of pores to an intersept; no tabulae. [May be senior synonym of *Robustocyathus.*] *L.Cam.,* USSR(Altay).——FIG. 39,*6*. **R. rotaceus;* transv. sec., ×3 (Vologdin, 1960).

Sibirecyathus VOLOGDIN, 1937, p. 468 [**S. naletovi;* M]. Outer wall thin, finely and simply perforate; inner wall with ?1 longitudinal row of pores to an intersept, the pores may be protected by thorns or bracts springing from below; septa porous, connected by synapticulae. *L.Cam.(?up.Tommot.-up.Botom.),* USSR(Altay-Sayan-Sib.Platf.)-Mongolia-Eu.(France [Mont.Noire]-Sardinia)-N.Afr.-?N.Am.(Can.).——FIG. 39,*7*. **S. naletovi,* Atdaban.-Botom., Mongolia; *7a,b,* oblique secs. of two specimens, ×3 (Vologdin, 1937b).

Stapicyathus DEBRENNE, 1964, p. 127 [*nom. transl.* DEBRENNE, 1970b, p. 43, *ex Archaeocyathellus (Stapicyathus)* DEBRENNE, 1964] [**Archaeocyathus stapipora* TAYLOR, 1910, p. 118; OD]. Cup conical; outer wall thin, with simple pores; septa imperforate except at their junctions with inner wall where all pores are stirrup pores, developed in one longitudinal row to each septum. *L.Cam.(up. Atdaban.* or *low.Botom.),* S.Australia-Antarct.——FIG. 39,*3*. **S. stapipora* (TAYLOR), Ajax Mine; tang. long. sec., ×2.4 (Taylor, 1910).

Turgidocyathus VOLOGDIN, 1960, p. 422 [**T. ippolitovensis;* OD]. Cup conical, longitudinally arched between septa; outer wall thin; inner wall thickened, with one (?or two) longitudinal rows of simple pores to an intersept; septa thin, straight, perforate, angles at walls rounded; no tabulae. *L.Cam.(Botom.),* USSR(W.Sayan).——FIG. 39,*5*. **T. ippolitovensis;* transv. sec., ×4 (Vologdin, 1960).

Family TENNERICYATHIDAE Rozanov in Zhuravleva, Korshunov, & Rozanov, 1969

[Tennericyathidae ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 34]

Outer wall pores with short outwardly projecting ?rims; inner wall with several longitudinal rows of pores provided with scales that commonly cover several intersepts or several pore mouths; intervallum with porous septa; no tabulae. *L.Cam. (Atdaban.-Botom.).*

Tennericyathus ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 35 [**T. malycanicus;* OD]. Cup conical, rounded in transverse section; outer wall with simple pores with short outwardly projecting ?rims, septa abundantly porous, inner wall with several longitudinal rows of pores to an intersept, provided with bracts amalgamating with one another to form scales common to several intersepts. *L.Cam.(Atdaban.),* USSR(Sib.Platf.-Altay-Sayan).——FIG. 41,*1*. **T. malycanicus,* R. Lena, near Malykan, Sib.Platf.; *1a,b,* parts of transv. secs., ×20; *1c,* part of long. sec., ×10 (Zhuravleva, Korshunov, & Rozanov, 1969).

Cadniacyathus R. BEDFORD & J. BEDFORD, 1937, p. 36 [**C. asperatus;* OD]. Cup conical, outer wall longitudinally furrowed at the septa; outer wall and septa simply porous; 3 longitudinal rows of opposed pores to each intersept of inner wall; each pore protected by scale projecting inward and upward into central cavity, neighboring scales being contiguous and forming incomplete annuli; tabulae absent. (See Debrenne, 1970b, p. 30.) *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia. ——FIG. 38,*6*. **C. asperatus,* S.Australia (?Ajax Mine); etched oblique transv. sec., ×5 (Hill, 1965).

Family ETHMOCYATHIDAE Debrenne, 1969

[Ethmocyathidae DEBRENNE, 1969, p. 322] [=?Ethmopectinidae DEBRENNE, 1970, p. 34]

Solitary; outer wall simply porous; septa sparsely porous; inner wall a thin porous sheet, with one or two longitudinal rows of pores to an intersept and with narrow annuli projecting into central cavity from sheet. *L.Cam.(?up.Atdaban.-Botom.).*

Ethmocyathus R. BEDFORD & W. R. BEDFORD, 1934, p. 2 [**E. lineatus;* M] [=*?Ethmopectinus* DEBRENNE, 1970, p. 34 (type, *E. walteri;* OD)]. Solitary; outer wall simply porous; septa straight, sparsely porous; inner wall a thin sheet with hexagonal pores (one longitudinal row to an intersept) screened from central cavity by thin, flat, narrow, horizontal annuli. [May be atabulate specimens of *Ethmopectinus* DEBRENNE, 1970b, p. 34.] *L.Cam.(up.Atdaban.* or *low. Botom.),* S.Australia (Ajax Mine).——FIG. 17,*1;* 42,*6*. **E. lineatus;* 17,*1*, holotype, view of inner wall, ×14; 42,*6*, inner wall and septa, diagram. (Debrenne, 1969).

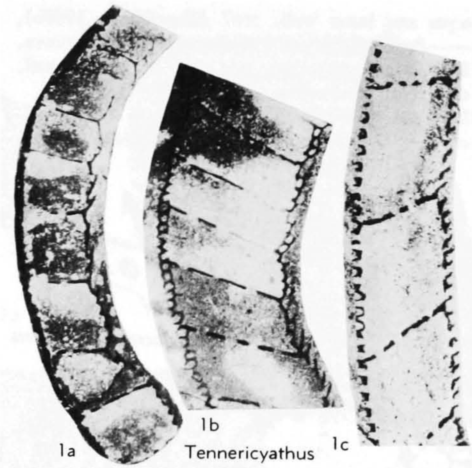


FIG. 41. Tennericyathidae (p. *E*67).

Denaecyathus ZHURAVLEVA in ZHURAVLEVA, ZADOROZHNAYA, OSADCHAYA, POKROVSKAYA, RODIONOVA, & FONIN, 1967, p. 57 [**D. biporosus;* OD]. Cup slenderly conical; outer wall simply porous, septa aporose or sparsely porous; inner wall commonly a thin porous sheet with two longitudinal rows of pores per intersept, and V-shaped annuli attached to sheet. *L.Cam.(Botom.),* USSR(Tuva)-Mongolia.——FIG. 42,*1;* 43,*1*. **D. biporosus,* Tuva; 42,*1*, reconstr. of part of inner wall and septa, enl.; 43,*1a,* holotype, part of transv. sec., ×4; 43,*1b,* part of oblique long. sec., ×7; *1c,* tang. sec. outer wall, ×20; *1d,* part of tang. sec., showing annuli of inner wall, ×7 (Zhuravleva, 1967).

Family COMPOSITOCYATHIDAE Zhuravleva, 1967

[Compositocyathidae ZHURAVLEVA in ZHURAVLEVA, ZADOROZHNAYA, OSADCHAYA, POKROVSKAYA, RODIONOVA & FONIN, 1967, p. 52]

Solitary; outer wall with simple pores; septa sparsely porous or aporose; inner wall of annuli with their axial edges attached to a porous sheet directly or by spines. *L.Cam. (up.Tommot.-up.Botom.).*

Compositocyathus ZHURAVLEVA, 1960, p. 159 [**Thalamocyathus muchattensis* ZHURAVLEVA in ZHURAVLEVA, & ZELENOV, 1955, p. 71; OD]. Slenderly conical cups with simply porous, thin outer wall, narrow intervallum and aporose septa; inner wall constructed of horizontal annuli; a porous sheet is applied to axial edges of annuli or to horizontal spines projecting from them. *L.Cam.(up.Tommot.-Botom.),* USSR(Altay-Sayan-Sib. Platf.).——FIG. 16,*4*. **C. muchattensis* (ZHURAVLEVA), Kenyad., Sib.Platf.; reconstr. of septa and inner wall, ×67 (Zhuravleva, 1960b). ——FIG. 42,2. *C. vladimirskii* ZHURAVLEVA, Bograd, Tuva; view of part of inner wall, diagram. (Zhuravleva, *et al.*, 1967).

?**Leptosocyathus** VOLOGDIN, 1937, p. 470 [**L. curviseptum* (=*Leptocyathus curviseptatus* VOLOGDIN, 1940a, p. 146); OD] [=*Leptocyathus* VOLOGDIN, 1937, p. 468, *nom. null. pro Leptosocyathus* VOLOGDIN; *non Leptocyathus* EDWARDS & HAIME, 1850, a scleractinian]. Cup slenderly conical; outer wall thin with simple pores; septa aporose or sparsely porous; inner wall scaly, the base of the scales wide and each stretching across 2 to 7 intersepts; pores of inner wall large, formed by the spaces between the septal edges and the edges of successive scales. *L.Cam.(up. Tommot.-Botom.),* USSR(S.Urals-Altay-Sayan-Sib. Platf.-Transbayk.-Far East)-Mongolia.——FIG. 14,6; 42,3. *L. polyseptus* (LATIN), up.Tommot.-Atdaban., Sib.Platf.(R.Lena); 14,6, reconstr., showing parts of inner and outer walls, ×40; 42,3, early stage of development, ×5 (Zhuravleva, 1960b).

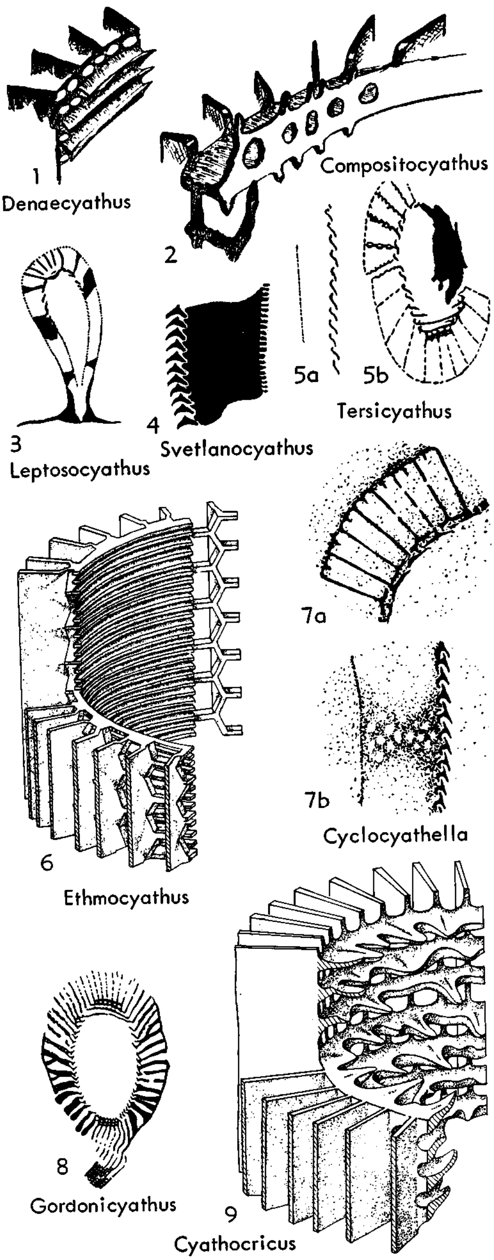


FIG. 42. Ethmocyathidae *(1,6);* Compositocyathidae *(2,3);* Cyclocyathellidae *(4-5,7-9)* (p. E67-E70).

Family CYCLOCYATHELLIDAE Zhuravleva, 1960

[Cyclocyathellidae ZHURAVLEVA in KHALFIN, 1960, p. 104] [=Cyclocyathellidae ZHURAVLEVA, 1959, p. 426, invalid name based on MS generic name; Cyclocyathellidae ZHURAVLEVA, 1960, p. 155, invalid name based on *Cyclocyathella* VOLOGDIN MS in ZHURAVLEVA, 1960, p. 155, generic name without assigned species]

Solitary, cups slenderly conical or cylindrical, without deep transverse wrinklings. Outer wall simple, with two to eight longitudinal rows of rounded or chinklike pores to an intersept. Intervallum with straight, porous or aporose septa. No tabulae. Inner wall of annuli. *L.Cam.(up.Tommot.-up. Botom.).*

Cyclocyathella VOLOGDIN in ZHURAVLEVA, KRASNOPEEVA, & CHERNYSHEVA in KHALFIN, 1960, p. 105 [**Cyclocyathus yakovlevi* VOLOGDIN, 1931, p. 49; OD] [=*Cyclocyathus* SIMON, 1939, p. 27 (type, *C. yakovlevi* VOLOGDIN, 1931, p. 49); *Cyclocyathus* VOLOGDIN, 1931, p. 49, *nom. nud.* (*non Cyclocyathus* EDWARDS & HAIME, 1850, a genus of Scleractinia; *nec Cyclocyathus* DUNCAN & THOMPSON, 1867, a genus of Rugosa); *Cyclocyathella* VOLOGDIN in ZHURAVLEVA, 1960, p. 155, *nom. nud.*]. Solitary, cup conical; outer wall with simple pores, inner wall of annuli; annuli inverted V-shaped in section; septa porous; no tabulae. *L.Cam.(Atdaban.-Botom.),* USSR(Altay-Sayan).——FIG. 42,7. **C. yakovlevi* (VOLOGDIN), up.Atdaban., Kameshki; *7a,* part of transv. sec., ×7; *7b,* part of long. sec., ×5, inner wall to right (Vologdin, 1931).

Cyathocricus DEBRENNE, 1969, p. 318 [**Archaeocyathus tracheodentatus* R. BEDFORD & W. R. BEDFORD, 1934, p. 2; OD] [=?*Cricopectinus* DEBRENNE, 1970, p. 32 (type, *C. dentulus;* OD)]. Outer wall simply porous; septa with sparse pores; inner wall of undulating annuli, horizontal or slightly inclined plates that are neither S- nor V-shaped in section, having a dentate axial rim; no tabulae are known. [May be atabulate spec-

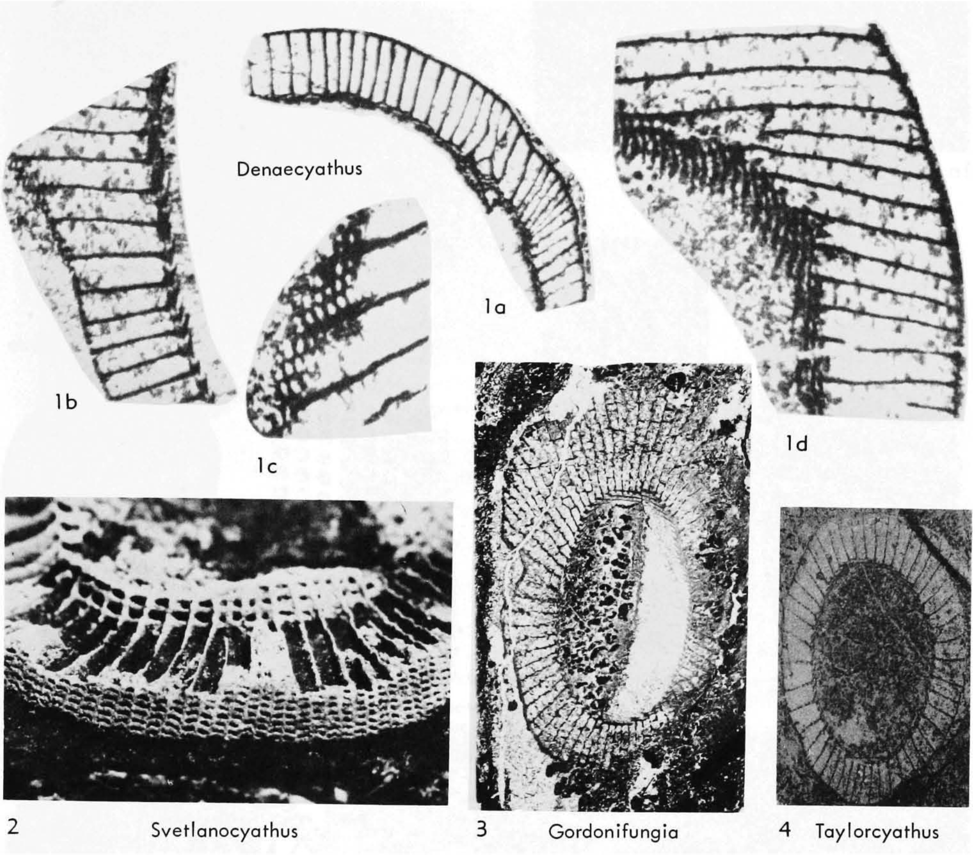


FIG. 43. Ethmocyathidae *(1)*; Cyclocyathellidae *(2-4)* (p. *E*67, *E*69).

imens of *Cricopectinus* DEBRENNE, 1970, p. 32.] *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia. ——FIG. 42,*9*. **C. tracheodentatus* (BEDFORD & BEDFORD), S. Australia (Ajax Mine); inner wall and septa, diagram. (Debrenne, 1969a).

Gordonicyathus ZHURAVLEVA, 1959, p. 426 [**Thalamocyathus gerassimovensis* KRASNOPEEVA, 1955, p. 95; OD]. Solitary; cup conical or cylindrical with simply porous outer wall and septa; without tabulae; inner wall of annuli, V-shaped in section. *L.Cam.(up.Tommot.-up. Botom.),* USSR(Altay-Sayan-Zabaykalia)-S.Australia.——FIG. 42,*8*. **G. gerassimovensis* (KRASNOPEEVA), Botom., Sayan; oblique sec., ×2 (Krasnopeeva, 1955).

Gordonifungia ROZANOV in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964, p. 193 [**G. batinensis;* OD]. Like *Gordonicyathus* but with synapticulae connecting the septa. *L.Cam. (up.Atdaban.-Botom.),* USSR(Kuznetsk Alatau). ——FIG. 43,*3*. **G. batinensis;* holotype, oblique transv. sec., ×2.7 (Rozanov in Repina, *et al.,* 1964).

?**Hemithalamocyathus** TING, 1937, p. 367 [**Archaeocyathus sibiricus* VON TOLL, 1899, p. 40; M]. Type-species insufficiently known. *L.Cam.(up. Atdaban., Kameshki),* USSR(Sayan).

Svetlanocyathus MISSARZHEVSKIY & ROZANOV, 1962, p. 43 [**S. primus;* OD]. Like *Cyclocyathella* but pores of outer wall chinklike and septa aporose. *L.Cam.(Botom.),* USSR(Tuva).——FIG. 42,*4;* 43,*2*. **S. primus,* holotype; 42,*4,* part of long. sec., ×4; 43,*2,* view of prepared part of cup, ×3 (Missarzhevskiy & Rozanov, 1962).

Taylorcyathus VOLOGDIN, 1955, p. 143 [**Cyclocyathus subtersiensis* VOLOGDIN, 1940, p. 63; OD]. Cup slenderly conical; outer wall with small, simple pores; inner wall of annuli S-shaped in section directed upward and inward into central cavity; septa porous; no tabulae. *L.Cam.(Atdaban.-Botom.),* USSR(Altay-Sayan-Sib.Platf.-Transbayk.)-Eu.(Sardinia-France [Montagne Noir])-S. Australia(Ajax).——FIG. 43,*4*. **T. subtersiensis* (VOLOGDIN), USSR(Salair); part of oblique sec., ×2.7 (Vologdin, 1940a).

Tersicyathus VOLOGDIN, 1955, p. 143 [**Cyclocya-*

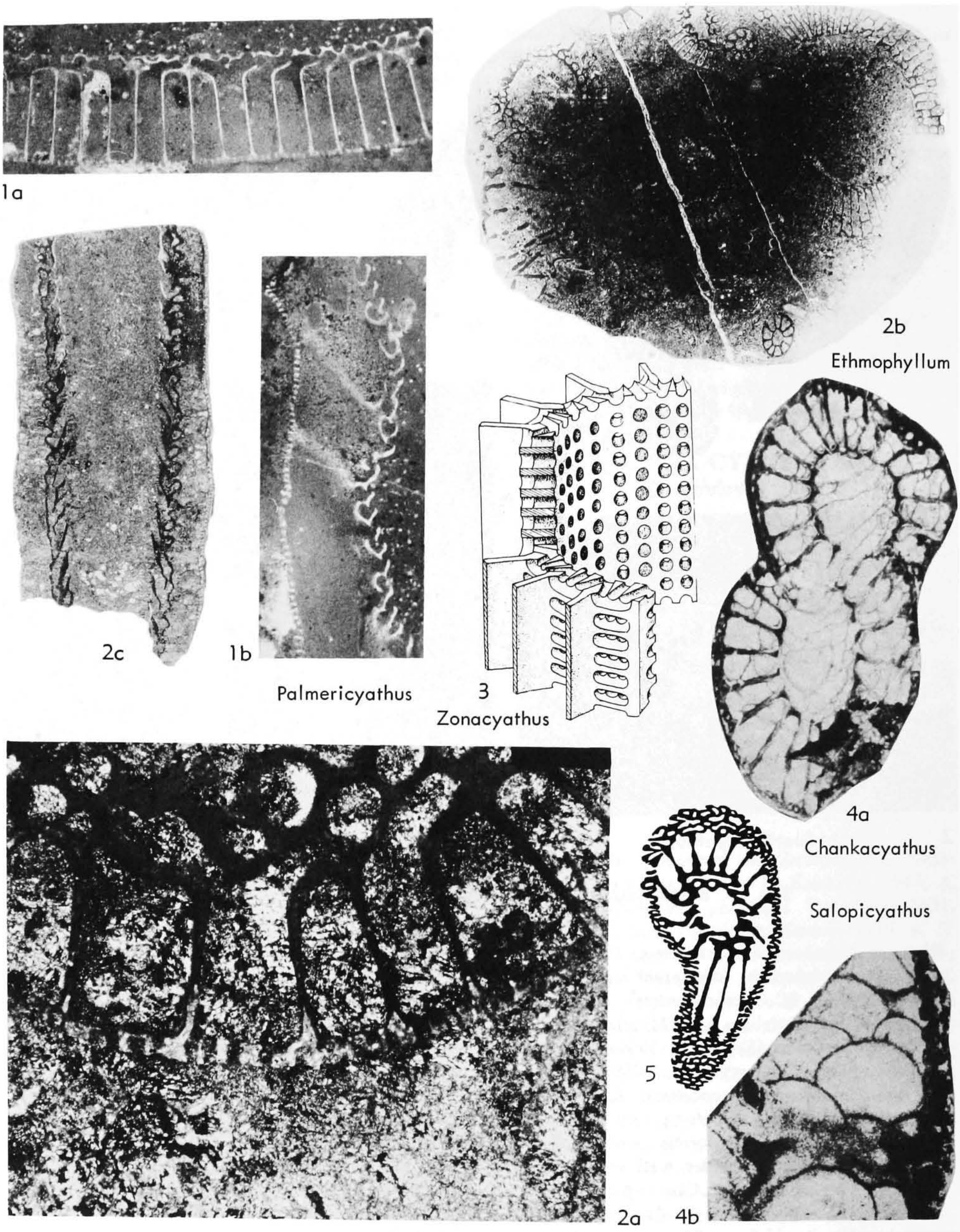


FIG. 44. Chankacyathidae *(4)*; Ethmophyllidae *(1-3,5)* (p. *E*71-*E*73).

thus tersiensis VOLOGDIN, 1931, p. 87; OD]. Cup slenderly conical; outer wall with small simple pores; septa porous; inner wall of annuli S-shaped in section projecting downward into central cavity; no tabulae. *L.Cam.(Atdaban.-low.Botom.)*, USSR(Altay-Sayan-Transbayk.).—FIG. 42,5. **T. tersiensis* (VOLOGDIN), low.Botom., Kuznetsk Alatau; *5a,* part of long. sec., *5b,* oblique transv. sec., both ×1.3 (Vologdin, 1931).

Family CHANKACYATHIDAE Yakovlev, 1959

[Chankacyathidae YAKOVLEV, 1959, p. 91]

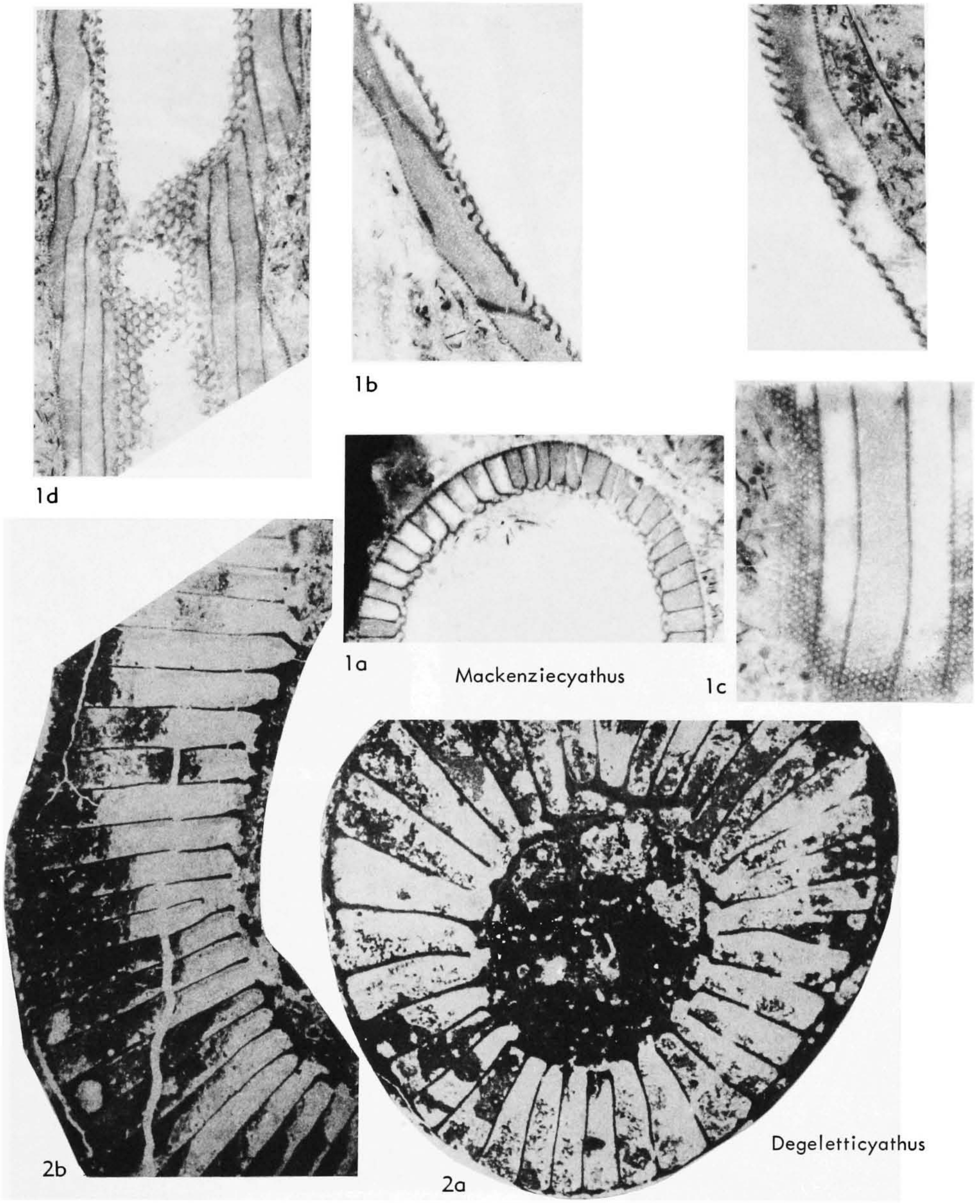


FIG. 45. Ethmophyllidae (p. E73).

Solitary or colonial; cups cylindrical, outer wall with pore-canals; inner wall with simple pores; septa porous; no tabulae; abundant dissepiments. *L.Cam.(Botom.).*

Chankacyathus YAKOVLEV, 1959, p. 91 [**C. strachovi;* ?M]. Pore-canals of outer wall geniculate, opening downward. [See OKUNEVA, 1969, p. 82.] *L.Cam.(Botom.),* USSR(Primore, Far East).——FIG. 44,*4.* **C. strachovi,* neotype; *4a,* transv. sec., ×4; *4b,* part of long. sec., outer wall to right, ×13 (Zhuravleva, 1969).

Family ETHMOPHYLLIDAE Okulitch, 1943

[Ethmophyllidae OKULITCH, 1943, p. 52)

Solitary or colonial; outer wall with

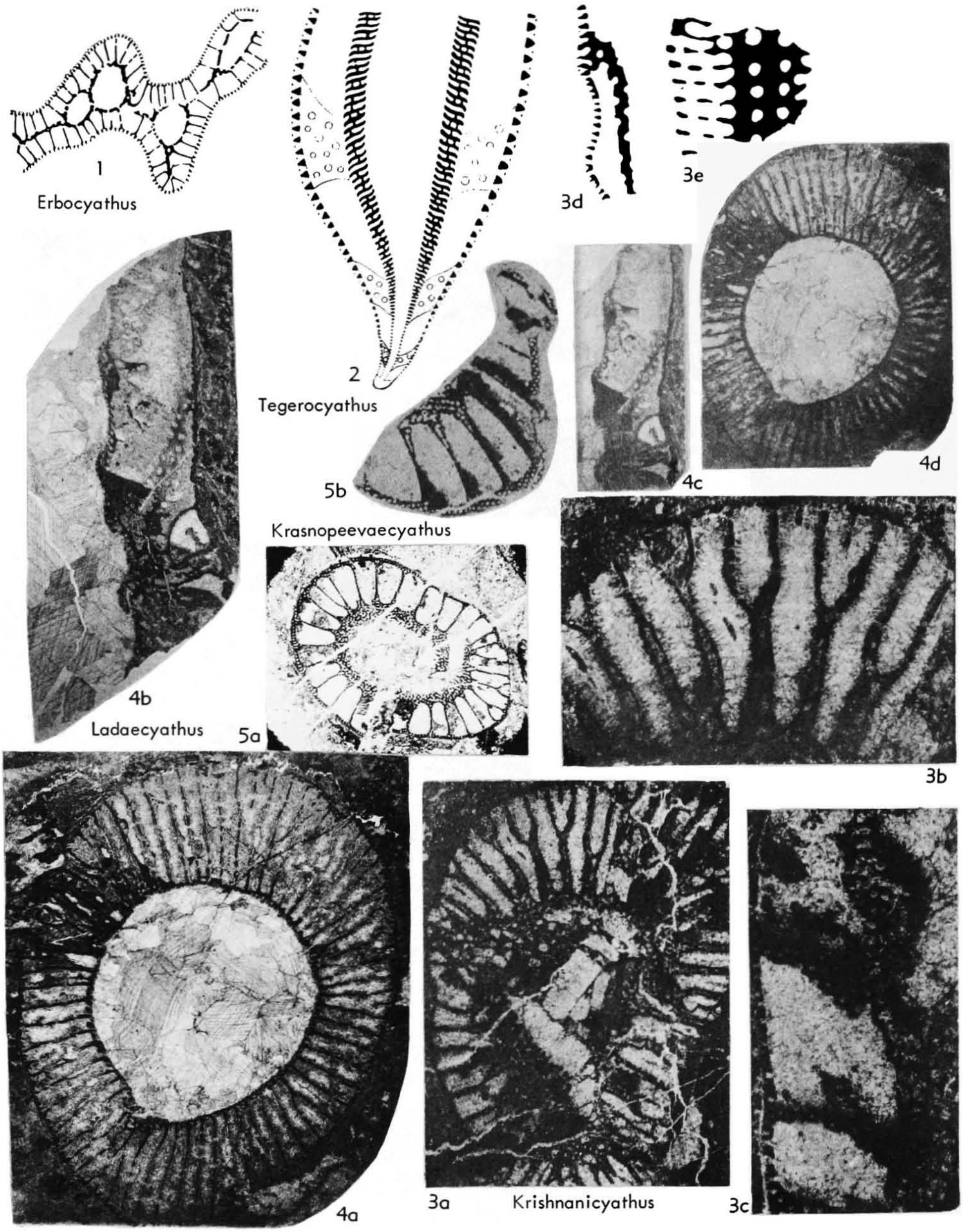


FIG. 46. Erbocyathidae (p. E73-E74).

simple short pore-canals; septa porous; inner wall composed of pore-tubes which are formed by junction of opposed waves in inner edges of neighboring septa and are commonly intercommunicating. *L.Cam.(Atdaban.)-M.Cam.(low.Amg.).*

Ethmophyllum MEEK, 1868, p. 64 [**E. whitneyi*; OD]. Solitary, rarely colonial; cup cylindrical or slenderly conical; outer wall with simple short and curved (or ?geniculate) pore-canals in quincunx; septa porous, inner edges waved; inner wall of pore-tubes formed by junction of opposed waves in inner edges of neighboring septa (Fig.

16,2). *L.Cam.(Atdaban.)-M.Cam.(low.Amg.),* N. Am. (Calif.-Nev.-B.C.)-Antarct.-S.Australia-USSR (S. Urals-Altay-Sayan-Sib. Platf.-Transbayk.-Far East)-Mongolia.——FIG. 44,*2*. **E. whitneyi,* lectotype, L.Cam., Nev.; *2a,* part of transv. sec., ×5; *2b,* same, ×3; *2c,* part of long. sec., ×3 (Hill, 1965).

?Degeletticyathus ZHURAVLEVA in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 36 [**Ethmophyllum? galuschkoi* ZHURAVLEVA, 1960, p. 169; OD]. Large solitary cups of conical form; outer wall with rounded pores; septa with sparse, small pores in median parts and large stirrup pores at their junctions with the inner wall; inner wall thick, with one longitudinal row of stirrup pore-canals to an intersept. *L.Cam. (Atdaban.-Botom.),* USSR (Sib.Platf.).——FIG. 45,*2*. **D. galuschkoi* (ZHURAVLEVA), ?Atdaban., Oy-Muran, Sib.Platf.; *2a,* part of transv. sec., ×7; *2b,* part of long. sec., ×4 (Zhuravleva, Korshunov, & Rozanov, 1969).

?Mackenziecyathus HANDFIELD, 1971, p. 43 [**M. bukryi;* OD]. Cup cylindrical; outer wall with simple pores; inner wall of intercommunicating oblique pore-tubes, two longitudinal rows to an intersept; septa imperforate. *L.Cam.(up.Atdaban.),* Can.(Yukon).——FIG. 45,*1*. **M. bukryi,* holotype; *1a,* transv. sec., *1b,* med. long. sec., both ×2.7; *1c,* tang. sec. outer wall, ×7; *1d,* tang. sec. inner wall, ×2 (Handfield, 1971).

?Palmericyathus HANDFIELD, 1971, p. 44 [**Ethmophyllum lineatum* GREGGS, 1959, p. 66; OD]. Cup solitary; outer wall with simple pores; septa imperforate; inner wall of geniculate pore-tubes, 1.5 to 2 longitudinal rows to an intersept. *L.Cam.(up.Atdaban.* or *low.Botom.),* Can.(B.C.-NW.Terr.).——FIG. 44,*1*. **P. lineatus* (GREGGS), NW.Terr.; *1a,* transv. sec., ×4; *1b,* long. sec., ×5 (Handfield, 1971).

?Salopicyathus VOLOGDIN, 1962, p. 86 [**S. complanatoporosus;* OD] [=*Salopicyathus* VOLOGDIN, 1958, p. 706, *nom. nud.* (occurs only as generic and specific name in list)]. Slenderly conical cup; outer and inner walls with complexly branching intercommunicating pore-canals; septa ?aporose. *L.Cam.,* USSR(Transbayk.).——FIG. 44,*5*. **S. complanatoporosus,* holotype, R.Yangud,Transbayk.; oblique sec., ×4 (Vologdin, 1962c).

?Zonacyathus R. BEDFORD & J. BEDFORD, 1937, p. 36 [**Archaeocyathus retevallum* R. BEDFORD & W. R. BEDFORD, 1934, p. 2; OD]. Solitary; outer wall simply porous; septa sparsely porous to aporose; inner wall has branching pore-tubes with initial tube located in middle of each intersept, then branching so that secondary tubes open in front of septa. Tubes may lengthen and curve into central cavity, never formed by fluting of septa. *L.Cam.(up.Atdaban.-low.Botom.),* S.Australia-USSR (Altay-Sayan)-Mongolia-Can.(Yukon-NW.Terr.-B.C.).——FIG. 44,*3*. *Z. retezona* (TAYLOR), S.Australia(Ajax); inner wall and septa, diagram. (Debrenne, 1969a).

Superfamily ERBOCYATHACEA Vologdin & Zhuravleva, 1956

[*nom. transl.* ZHURAVLEVA, 1960, p. 187 (*ex* Erbocyathidae VOLOGDIN & ZHURAVLEVA, in VOLOGDIN, 1956, p. 879)]

Colonial, rarely solitary, cups slenderly conical, cylindrical; outer wall thick with pore-canals screened externally, elements of screen increasing in number and decreasing in thickness outward; septa porous, outer edges decreasing in thickness to form part of screen; pores of septa may be irregularly disposed; dissepiments may occur; inner wall with simple pores, or pore-canals, or of annuli. *L.Cam.(Atdaban.-Len.)-base M. Cam.*

Family ERBOCYATHIDAE Vologdin & Zhuravleva in Vologdin, 1956

[Erbocyathidae VOLOGDIN & ZHURAVLEVA, in VOLOGDIN, 1956, p. 879 (*nom. nov. pro* Polycyathidae VOLOGDIN, 1928, p. 35, invalid name based on junior homonym)] [=Ladaecyathidae DEBRENNE, 1964, p. 114]

Colonial, rarely solitary, cups slenderly conical or cylindrical; outer wall thick with pore canals screened externally, elements of screen increasing in number and decreasing in thickness outwards; septa porous, pores may be irregularly disposed; dissepiments may occur; inner wall with simple pores or pore canals. *L.Cam.(Atdaban.-Len.)-base M.Cam.*

Erbocyathus ZHURAVLEVA, 1950a, p. 11 [*nom. subst. pro Polycyathus* VOLOGDIN, 1928, p. 32 (type, *P. heterovallum*), *non Polycyathus* DUNCAN, 1876, a coelenterate] [**Polycyathus heterovallum* VOLOGDIN, 1928, p. 32; SD SIMON, 1939, p. 34] [=*Pluralicyathus* OKULITCH, 1950, p. 503 (*nom. subst. pro Polycyathus* VOLOGDIN, 1928, p. 32)]. Colonial; individual cups cylindrical or slenderly conical. Outer wall thick with pore-canals screened externally, elements of screen increasing in number and decreasing in thickness outward; septa widely spaced, each with row of stirrup pores at junction with outer wall, and with sparse pores elsewhere; dissepiments may occur; inner wall with one or two longitudinal rows of simple pores to an intersept; anchoring processes absent. *L.Cam.(Len.),* USSR(Altay-Sayan-Sib. Platf.).——FIG. 46,*1*. **E. heterovallum* (VOLOGDIN), Len., Mt.Dolgiy Mys; transv. sec. of part of colony, ×2 (Vologdin, 1962d).

Krasnopeevaecyathus ROZANOV, in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964, p. 208 [**K. tyrgaensis;* OD]. Outer wall with auxiliary finely porous sheath; septa regularly porous; inner wall complex and crenulate, with complexly intercommunicating pore-tubes extending into central cavity. *L.Cam.(Botom.),* USSR

(Altay).——FIG. 46,5. **K. tyrgaensis;* R. upper Tyrga, Altay; *5a,* transv. sec. holotype, ×2; *5b,* part of oblique long. sec., ×2 (Rozanov, 1964).

?**Krishnanicyathus** VOLOGDIN, 1964, p. 358 [**K. elegans;* OD]. Cup conical; outer wall with wall screened as in *Erbocyathus* [?]; inner wall thick, complexly porous, of intercommunicating ?horizontal pore-canals or ?pore-tubes; ribs of inner wall porous tissue project into intervallum, each rib continuous with inner end of one septum or of two axially confluent septa. No tabulae or dissepiments. *L.Cam.(Botom.),* USSR(Sayan). ——FIG. 46,3. **K. elegans,* R.Abakan, Sayan; *3a,b,* transv. sec., ×2.7,×7; *3c,* oblique long. sec., ×7; *3d,* part of long. sec., ×17; *3e,* partly tang. sec. inner wall, ×7 (Vologdin, 1964).

Ladaecyathus ZHURAVLEVA, 1960a, p. 43 [**Tegerocyathus limbatus* ZHURAVLEVA, 1955, p. 46; OD] [=?*Neocyathus* VOLOGDIN, 1960, p. 422 (type, *Archaeocyathus laevus* VOLOGDIN, 1940b, p. 57; =?*A. laevus* VOLOGDIN, 1932, p. 41)]. Solitary, rarely colonial; outer wall screened as in *Erbocyathus;* septa uniformly porous; inner wall with simple pores in 2 to 5 longitudinal rows to an intersept, bars and ribs between pores with short hairlike outgrowths on side of central cavity, forming screen across mouth of each pore. *L.Cam. (Atdaban.-Botom.),* USSR(Altay-Sayan-Sib.Platf.-Far East)-Can.(Yukon)-Antarct.——FIG. 46,4. **L. limbatus* (ZHURAVLEVA), holotype, Botom., Mt. Martyuhkin, Kuznetsk Alatau; *4a,b,* transv. sec., part of long. sec., ×7; *4c,d,* parts of long. and transv. secs., ×5 (Zhuravleva, 1955).

Schidertycyathellus KONYUSHKOV, 1967, p. 108 [**S. borucaevi;* OD]. Solitary, conical, cylindrical or fungus-like cups; outer wall strong with branching or conical pores covered with thin finely porous sheath; inner wall strong, with straight or somewhat crooked pore-canals; septa closely porous. *Up.L.Cam.-base M.Cam.,* USSR(Kazakhstan).——FIG. 47,1. **S. borucaevi,* Mt. Agyrek, Kazakhstan; oblique sec. holotype, ×6 (Konyushkov, 1967).

Tegerocyathella KONYUSHKOV, 1967, p. 109 [**T. borovikovi;* OD]. Solitary, conical cups; outer wall strong with conical pores widening outward, covered with finely porous sheath; septa aporose, commonly thickening at edges where stirrup-pores are developed; inner wall thick, with rare, somewhat crooked pore-canals; central cavity free of skeletal elements. *Up.L.Cam.-base M.Cam.,* USSR (Kazakhstan).——FIG. 47,2. **T. borovikovi,* Mt. Agyrek, Kazakhstan; oblique sec. holotype, ×5 (Konyushkov, 1967).

Tegerocyathus KRASNOPEEVA, 1953, p. 36 (*fide* ZHURAVLEVA, 1960, p. 192) [**T. edelsteini* (=*Ethmophyllum edelsteini* VOLOGDIN, 1931, p. 47, *fide* ZHURAVLEVA, 1960, p. 193); M]. Solitary, rarely colonial; outer wall as in *Erbocyathus;* inner wall thick, with crooked, intercommunicating pore-canals; septa sparsely porous. *L.Cam. (Botom.-Len.),* USSR(Altay-Sayan-Sib.Platf.).——

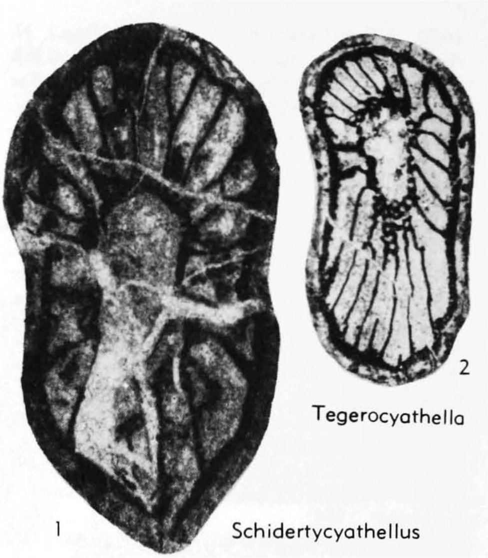


FIG. 47. Erbocyathidae (p. E74).

FIG. 46,2. **T. edelsteini* (VOLOGDIN); diagram. long. sec. showing ontogenetic changes (Zhuravleva, 1960b).

[KRASNOPEEVA (1953b, p. 52, 56) cited *Tegerocyathus* as a new genus, but mentioned and illustrated only two (new) species, *T. potaechini* (cited as *gen. et. sp. nov.*) and *T. tannu-ola.* These two were transferred to *Porocyathus* ZHURAVLEVA, 1960, by ZHURAVLEVA 1960, p. 180. KRASNOPEEVA (1955, p. 90) cited *Tegerocyathus* as a new genus and designated as type-species "*Tegerocyathus abakanensis* (Vol.)." ZHURAVLEVA (1960, p. 193) and ZHURAVLEVA, KRASNOPEEVA, & CHERNYSHEVA (1960, p. 116) included both *E. edelsteini* and *E. abakanensis* in *Tegerocyathus.*]

?Family SAJANOCYATHIDAE Vologdin, 1956

[Sajanocyathidae VOLOGDIN, 1956, p. 879] [=?Serligocyathidae VOLOGDIN, 1959, p. 671]

Colonial, branching; outer wall finely and ?simply porous; septa almost aporose, dissepiments sparse; no tabulae or synapticulae; inner wall thick with curved, intercommunicating pore-canals. Porosity of outer wall insufficiently known (see Zhuravleva, 1960b, p. 188). *L.Cam.(Botom.-low.Len.).*

Sajanocyathus VOLOGDIN, 1940b, p. 81 [**S. ussowi;* OD] [=*Sajanocyathus* VOLOGDIN, 1937, p. 471, *nom. nud.; Sayanocyathus* VOLOGDIN, 1937, p. 479, *nom. nud.* (type, *Sayanocyathus ussovi* VOLOGDIN, 1937, p. 479, M); *Sajanacyathus* DEBRENNE, 1964, p. 114, *nom. null.; ?Leiocyathus* VOLOGDIN, 1959, p. 671 (type, *L. inaequitaenialis,* OD)]. Colonial; outer wall structure uncertain (*fide* ZHURAVLEVA, 1960, p. 188); septa porous, no tabulae or synapticulae; inner wall with curved, intercommunicating pore-canals in 2 to 3 longitudinal rows to an intersept. *L.Cam.(Botom.-low.*

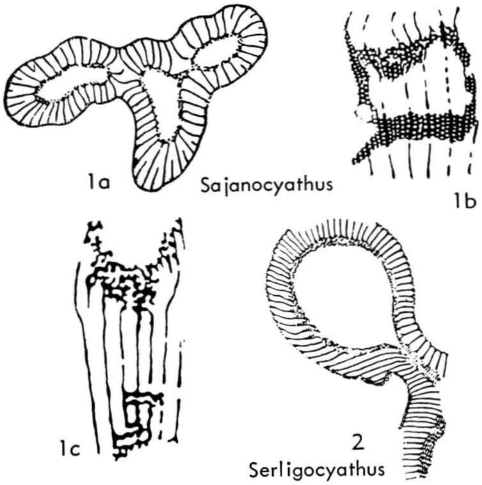


FIG. 48. Sajanocyathidae (p. *E74-E75*).

Len.), USSR(Altay-Sayan).——FIG. 48,*1*. **S. ussowi,* R.Sanashtykgol, Sayan; *1a,* transv. sec. of colony; *1b,* tang. sec. of outer wall, *1c,* tang. sec. of inner wall; all ×3 (Vologdin, 1940b).

Serligocyathus VOLOGDIN, 1959, p. 671 [**S. lukashevi;* OD]. Solitary or colonial; outer wall with ?simple pores; septa aporose; inner wall thick with single longitudinal row of chinky pores to an intersept. *L.Cam.,* USSR (Tuva).——FIG. 48,*2*. **S. lukashevi,* R. Serlig, Tuva; transv. sec. of colony, ×2.7 (Vologdin, 1959b).

Superfamily PRETIOSOCYATHACEA Rozanov, 1969

[Pretiosocyathacea ROZANOV, 1969, p. 112]

Outer wall consists of a framework and an openwork finely porous isolated auxiliary sheath. *L.Cam.(Atdaban.-Botom.).*

Family PRETIOSOCYATHIDAE Rozanov, 1969

[Pretiosocyathidae ROZANOV, 1969, p. 112]

Inner wall with pore-canals. *L.Cam.(up. Atdaban.).*

Pretiosocyathus ROZANOV, in ROZANOV & MISSARZHEVSKIY, 1966, p. 55 [**P. subtilis;* OD]. Outer wall a framework screened with finely porous independent sheet; septa very porous; inner wall thicker, with two longitudinal rows of pore-canals to an intersept, canals not opening into one another. *L.Cam.(up.Atdaban.),* USSR (Kuznetsk Alatau).——FIG. 49,*3*. **P. subtilis,* holotype, Kameshki; part of transv. sec., ×7 (Rozanov in Rozanov & Missarzhevskiy, 1966).

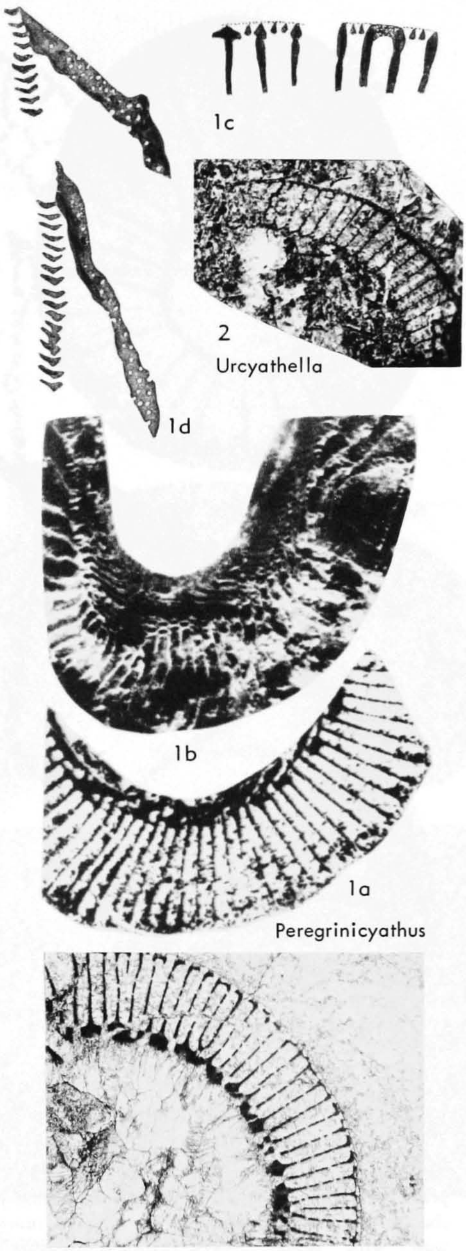


FIG. 49. Pretiosocyathidae *(3);* Robertocyathidae *(2);* Peregrinicyathidae *(1)* (p. *E75-E76*).

Family ROBERTOCYATHIDAE Rozanov, 1969

[Robertocyathidae ROZANOV, 1969, p. 112]

Outer wall a framework with isolated

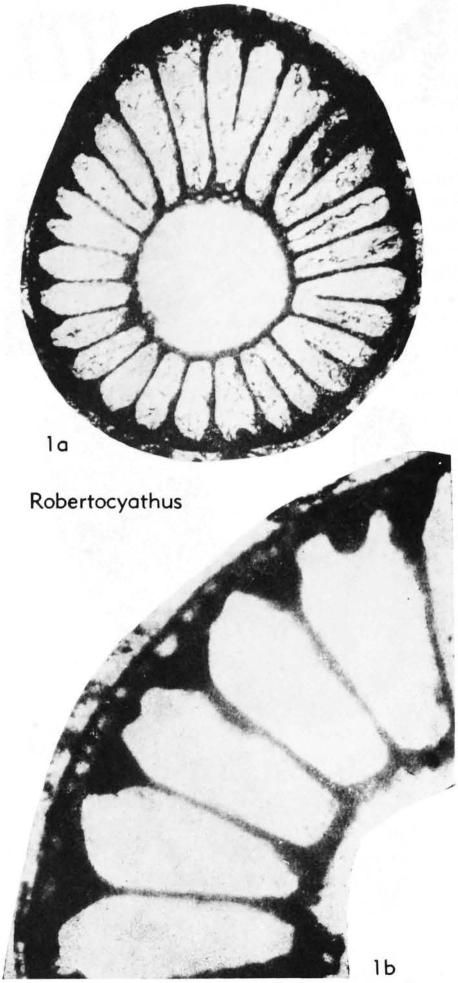


FIG. 50. Robertocyathidae (p. E76).

auxiliary sheath; no tabulae; septa porous; inner wall with simple pores. *L.Cam.(Atdaban.-Botom.)*.

Robertocyathus ROZANOV, 1969, p. 112 [**R. polaris;* OD]. Outer wall with isolated auxiliary sheath; septa evenly porous; no tabulae; inner wall with simple pores. *L.Cam.(Atdaban.-Botom.)*, USSR(Sib.Platf.-Altay-Sayan).——FIG. 50,*1*. **R. polaris,* holotype, Botom., Olenek uplift; *1a,* transv. sec., ×8; *1b,* part of transv. sec., ×13 (Rozanov, 1969).

Urcyathella ZHURAVLEVA, 1961, p. 25 [**U. tercyathoides;* OD]. Solitary; outer wall with simply porous framework invested externally with independent microporous sheath; septa porous; inner wall with angular longitudinal crenulation and with small, simple pores. (Structure of outer wall *fide* ROZANOV, 1969, p. 111). *L.Cam.(Atdaban.)*, USSR(Sayan).——FIG. 49,*2*. **U. tercyathoides,* Bazaikh.; transv. sec., ×4 (Zhuravleva, 1961).

Family PEREGRINICYATHIDAE Zhuravleva, 1967

[Peregrinicyathidae ZHURAVLEVA in ZHURAVLEVA, ZADOROZHNAYA, *et al.*, 1967, p. 74]

Solitary; outer wall coarsely porous with finely porous independent external sheath; septa porous; no tabulae; inner wall of annuli. *L.Cam.(Botom.)*.

Peregrinicyathus ZHURAVLEVA in ZHURAVLEVA, ZADOROZHNAYA, *et al.*, 1967, p. 75 [**P. dorotheae;* OD]. Solitary; outer wall coarsely porous with microporous external sheath; septa porous; inner wall of annuli, V-shaped in section. *L.Cam.(Botom.)*, USSR (Tuva).——FIG. 49,*1*. **P. dorotheae; 1a,* holotype, part of oblique transv. sec., ×4; *1b,* part of oblique transv. sec., ×4; *1c,* outer wall and septa; *1d,* part of long. sec., both ×2 (Zhuravleva, 1967, in Zhuravleva, *et al.*).

Superfamily HUPECYATHELLACEA Rozanov, 1969

[Hupecyathellacea ROZANOV, 1969, p. 111]

Outer wall of cup a framework of pore-canals (or tubes?) of S-form in longitudinal section, covered with microporous external sheath. Septa porous, inner wall of S-shaped pore-tubes; no tabulae or dissepiments. *L.Cam.(Botom.)*.

Family HUPECYATHELLIDAE Rozanov, 1969

[Hupecyathellidae ROZANOV, 1969, p. 111]

Outer wall a framework of pore-canals (?or tubes) of S-form in longitudinal section, covered with microporous external sheath; inner wall of S-shaped pore-tubes; no tabulae. *L.Cam.(Botom.)*.

Hupecyathellus ROZANOV, in DATZENKO, ZHURAVLEVA, *et al.*, 1968, p. 149 [**H. schuberti;* OD]. Framework of outer wall with canals (?or tubes) close to S-form; thin external sheath with consistent vertical rows of sub-rectangular pores; septa regularly porous; inner wall with two longitudinal rows of S-shaped pore-tubes to an intersept. *L.Cam.(Botom.)*, USSR (NW.Sib.Platf.). ——FIG. 51,*2*. **H. schuberti,* holotype, Taryn horizon, R. Sukharikha, Sib. Platf.; *2a,* part of long. sec., ×13; *2b,* part of tang. sec. of outer wall, ×12 (Datzenko, *et al.*, 1968).

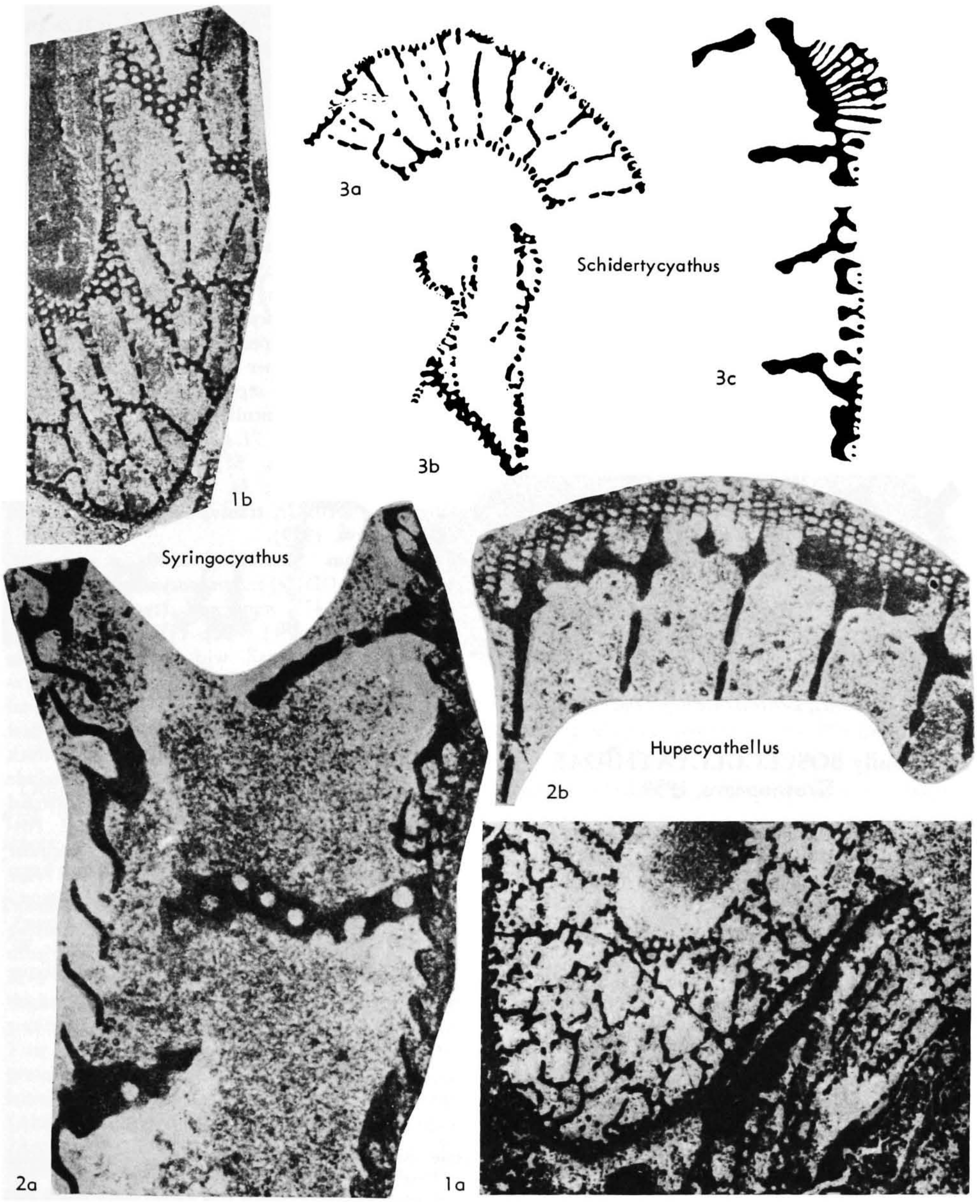


FIG. 51. Hupecyathellidae *(2)*; Schidertycyathidae *(1,3)* (p. *E76*, *E78*).

Superfamily BOSCECULCYATHACEA Krasnopeeva, 1959

[*nom. transl.* HILL, herein (*ex* Bosceculcyathidae KRASNOPEEVA, 1959, p. 7)] [=Bosceculida KRASNOPEEVA, 1960, p. 41 (order); Boscekulida KRASNOPEEVA, 1969, p. 63 (order); Boscekulcyathina KRASNOPEEVA, 1969, p. 63 (suborder); Schidertycyathina KRASNOPEEVA, 1969, p. 63 (suborder)]

Outer wall of cup framework of pore-canals covered with microporous external sheath; inner wall with simple pores (?or pore canals); intervallum with some or no normal ajacicyathoid interseptal loculi, and with vertical polygonal subloculi formed by bending or ?branching of the septa; pore-rows of septal elements vertical or sub-

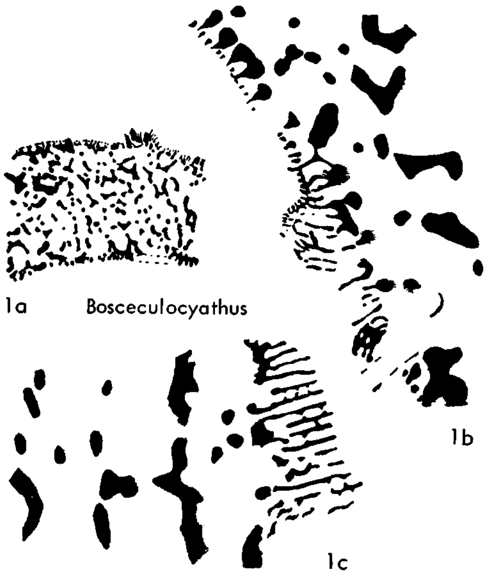


FIG. 52. Bosceculcyathidae (p. E78).

vertical; tabulae absent, dissepiments exceptional. *L.Cam.(Botom.-Len.)-?base M.Cam.*

Family BOSCECULCYATHIDAE Krasnopeeva, 1959

[Bosceculcyathidae KRASNOPEEVA, 1959, p. 7]

Outer wall framework of pore-canals covered with microporous external sheath; inner wall thick with simple pores (?or pore-canals) intervallum with vertical polygonal loculi formed by bending or branching of porous septa; pore rows of septal elements vertical or subvertical; tabulae ?absent and no dissepiments. *L.Cam. (Botom.* or *?Len.)* or *?base of M.Cam.*

Bosceculcyathus KRASNOPEEVA, 1959, p. 7 [**B. agyrekensis;* OD] [=*Boscekulcyathus* KRASNOPEEVA, 1959, p. 7, *nom. null.*]. Characteristics of family. *L.Cam.(Botom.* or *?Len.)* or *?base M.Cam.,* USSR (Kazakh.).——FIG. 52,*1*. **B. agyrekensis,* Mt. Agyrek, Kazakh.; *1a,* part of transv. sec., ×7; *1b,c,* parts of transv. and long. secs. near wall, ×14 (Krasnopeeva, 1959).

Family SCHIDERTYCYATHIDAE Krasnopeeva, 1969

[Schidertycyathidae KRASNOPEEVA, 1969, p. 63]

Outer wall of cup framework of simple pores (?or pore-canals) covered with a microporous external sheath; intervallum with some normal ajacicyathoid interseptal loculi; in other parts of cups septa bend or branch to meet neighbors and form vertical polygonal subloculi; septa porous, longitudinal pore-rows vertical or subvertical; dissepiments exceptional and tabulae absent. *L.Cam.(Botom.-Len.)* or *?base M. Cam.*

Schidertycyathus KRASNOPEEVA, 1959, p. 3 [**S. borucaevi; M*] [=*Schiderticyathus* DEBRENNE, 1964, p. 117, *nom. null.*]. Possibly a junior synonym of *Syringocyathus, q.v.;* below. Outer wall with funnel-shaped pores and a finely porous external sheath; inner wall thick, with simple pores or pore-canals; septa porous, mostly straight, some curved; synapticulae present but rare; dissepiments present? *?L.Cam.,* USSR(Mt.Agyrek, Kazakhstan).——FIG. 51,*3*. **S. borucaevi,* Mt. Agyrek, Kazakhstan; *3a,* transv. sec., ×10; *3b,* long. sec., ×10; *3c,* transv. sec. outer wall, ×14 (Krasnopeeva, 1959).

?Syringocyathus VOLOGDIN, 1940, p. 82 [**S. aspectabilis;* OD] [=*Syringocyathus* VOLOGDIN, 1937, p. 471, 477, *nom. nud.* (type, *S. spirocyathoides nom. nud.*)]. Cup cylindrical; may be compound; outer wall with large pores; septa porous and for the most part regular, some curving and confluent or connected by longitudinal but not radial porous plates so that some vertical polygonal subloculi are formed; inner wall thick with simple pores. [VOLOGDIN's figures preclude neither the presence of a finely porous external sheath to the outer wall, nor synapticulae. Possibly, therefore, *Syringocyathus* may be a member of this family.] *L.Cam.(Botom.-up.Len.* or *?base M.Cam.),* USSR(Altay-Sayan-Kazakh.)-?Antarct.-?Can.——FIG. 51,*1*. **S. aspectabilis* (VOLOGDIN), L.Cam.(Botom.), USSR (R. Sanashtykgol, W. Sayan); *1a,* oblique transv. sec., ×4; *1b,* oblique long. sec., ×4 (Vologdin, 1940b, 1962d).

Superfamily TUMULOCYATHACEA Krasnopeeva, 1953

[*nom. transl.* DEBRENNE, 1964, p. 113 (*ex* Tumulocyathidae KRASNOPEEVA, 1953, p. 56)]

Solitary; outer wall with simple or complex (knobby) tumuli; septa porous; no tabulae or dissepiments; inner wall simple, or with pores provided with plates, bracts or scales. (For discussion see Rozanov, 1969, p. 108.) *L.Cam.(up.Tommot.-up. Len.).*

Family TUMULOCYATHIDAE Krasnopeeva, 1953

[Tumulocyathidae KRASNOPEEVA, 1953b, p. 56]

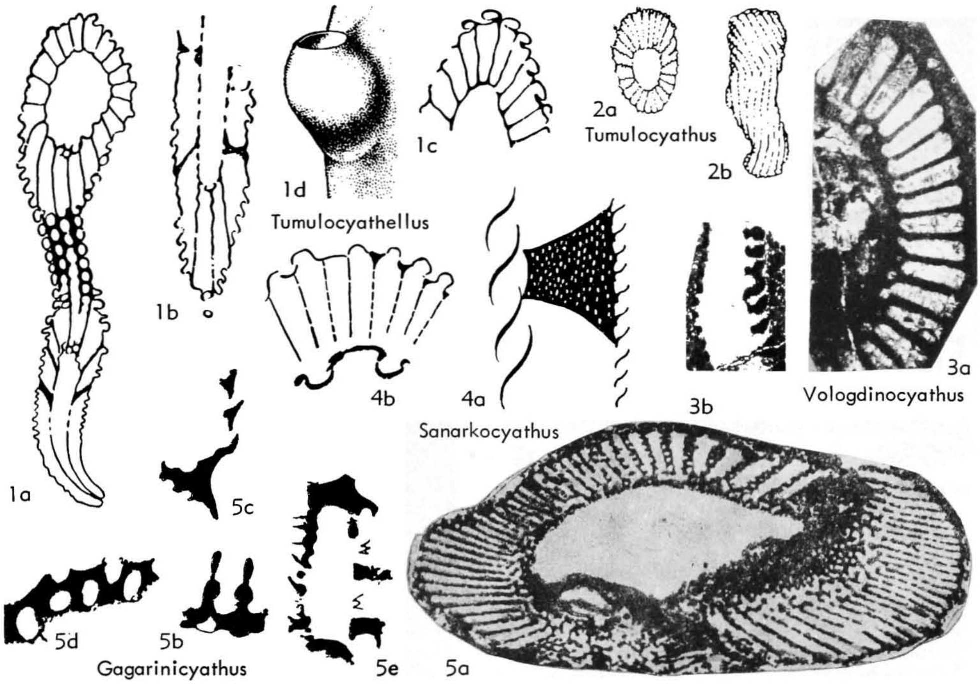


FIG. 53. Tumulocyathidae *(1-2)*; Sanarkocyathidae *(4)*; Vologdinocyathidae *(3,5)* (p. *E*79-*E*80).

Outer wall with pores in tumuli; inner wall with simple pores that may have bracts; septa porous; no tabulae. *L.Cam. (up.Tommot.-Botom.).*

Tumulocyathus VOLOGDIN, 1937, p. 470 [**T. pustulatus;* M]. Outer wall with 1 or 2 longitudinal rows of pores to an intersept, each pore set in a hollow knob or tumulus; septa thin, some thickened at their junction with walls, regularly porous; inner wall simple, within each intersept 1 or 2 longitudinal rows of pores that may be protected by spines or bracts; anchoring processes lamellar. *L.Cam.(up.Tommot.-Botom.),* USSR (Altay-Sayan-Transbayk.-Far East)-Mongolia-?Antarct.-N.Afr.(Morocco).——FIG. 53,*2*. **T. pustulatus,* L.Cam., Mongolia; *2a,b,* oblique transv. and tang. long. secs., ×3 (Vologdin, 1937b).

Dailycyathus DEBRENNE, 1970, p. 32 [**Paranacyathus margarita* BEDFORD, & J. BEDFORD, 1937, p. 34; OD]. Cup large, conical, with narrow intervallum; outer wall with one longitudinal row of pores between 2 adjacent septa, each pore covered by a hemispherical tumulus perforated laterally; septa straight, perforated only by stirrup-pores; inner wall with a longitudinal row of stirrup-pores at each septum; skeletal structures in central cavity, arising from intervallum. *L.Cam.(up.Atdaban.* or *low.Botom.),* S. Australia.

Tumulocyathellus ZHURAVLEVA, 1960, p. 174 [*nom. transl.* REPINA, *et al.*, 1964, p. 194 *(ex Tumulocyathus (Tumulocyathellus)* ZHURAVLEVA, 1960, p. 174)] [**Tumulocyathus admirabilis* VOLOGDIN, 1940b, p. 72; OD]. Like *Tumulocyathus* but septa sparsely porous or with stirrup-pores. *L.Cam. (up.Tommot.-Botom.),* USSR (Altay-Sayan-Transbayk.-Sib.Platf.-?Far East).——FIG. 53,*1a-c*. **T. admirabilis* (VOLOGDIN), Botom., Sayan; *1a,* random sec. through curving cup; *1b,* oblique long. sec.; *1c,* oblique transv. sec.; ×3 (Vologdin, 1940b).——FIG. 11,*4;* 53,*1d*. *T. unicumus* ZHURAVLEVA, low.Botom., R.Botoma, Sib.Platf.; 11,*4,* septum, ×30; 53,*1d,* tumulus of outer wall, ×67 (Zhuravleva, 1960b).

Family SANARKOCYATHIDAE Hill, new family

[Sanarkocyathidae HILL, herein] [=?Sanaricyathidae ROZANOV, 1969, p. 107, name based on assumedly invalid generic name *Sanaricyathus* ROZANOV, 1969, p. 108, *?nom. null. pro Sanarkocyathus* ZHURAVLEVA, 1963a, p. 118]

Outer wall with simple tumuli opening upward; inner wall squamate, one scale to each two or three interseptal loculi; scales S-shaped in section, forming pore-tubes opening downward; septa porous, no tabuli. (For discussion see Rozanov, 1969, p. 107.) *L.Cam.(Botom.).*

Sanarkocyathus Zhuravleva, 1963, p. 118 [**S. mamaevi;* OD] [=*?Sanaricyathus* Rozanov, 1969, p. 108 (*?nom. null. pro Sanarkocyathus* Zhuravleva, 1963a, p. 118)]. Cup conical or cylindrical; outer wall with simple tumuli opening upwards, S-formed in longitudinal section, one longitudinal row to an intersept; septa finely porous; inner wall squamate, one scale to each 2 or 3 interseptal loculi, scales S-shaped in longitudinal section, forming pore-tubes opening downward. *L.Cam. (Botom.),* USSR(S.Urals).——Fig. 53,*4*. **S. mamaevi,* R.Sanarka, S.Urals; *4a,* long. sec., *4b,* transv. sec., both ×4 (Zhuravleva, 1963a).

Family VOLOGDINOCYATHIDAE Yaroshevich, 1957

[Vologdinocyathidae Yaroshevich, 1957, p. 1015]

Solitary; outer wall with tumuli, the pores being near or at the summits of the tumuli; intervallum with septa and without tabulae; inner wall thick, with pore-canals. *L.Cam.(Atdaban.-up.Len.).*

Vologdinocyathus Yaroshevich, 1957, p. 1016 [**V. erbiensis;* OD]. Solitary; outer wall with simple tumuli, pores being at or near summits of tumuli; inner wall thick, with one longitudinal row of intercommunicating horizontal pore-canals to an intersept, pore-canals narrowing appreciably at their outlets to central cavity; septa sparsely porous. *L.Cam.(up.Atdaban.-up.Len.),* USSR (Altay-Sayan-Far East).——Fig. 53,*3*. **V. erbiensis,* up.Len., Kuznetsk Alatau; *3a,b,* parts of transv. and long. secs., ×20 (Yaroshevich, 1957).

Gagarinicyathus Zhuravleva in Datzenko, Zhuravleva, *et al.*, 1958 p. 146 [**G. ethmophylloides;* OD]. Outer wall with weak simple tumuli, one longitudinal row to an intersept; septa porous; inner wall spongy, with large ramifying pore-canals opening into one another horizontally, one longitudinal row to an intersept. *L.Cam. (Atdaban.-low.Botom.),* USSR(NW.Sib.Platf.). ——Fig. 53,*5*. **G. ethmophylloides,* low.Botom., Sib.Platf.; *5a,* oblique transv. sec., ×4; *5b,c,* parts of tang. and long. secs. outer wall, ×19, ×20 (*5b,* showing pore opening); *5d,* part of septum in tang. sec., ×13; *5e,* part of inner wall in long. sec., ×17 (Datzenko, Zhuravleva, *et al.*, 1968).

Superfamily ANNULOCYATHACEA Krasnopeeva, 1953

[*nom transl.* Zhuravleva, 1960, p. 171 (*ex* Annulocyathidae Krasnopeeva, 1953, p. 56)]

Cup solitary, conical or cylindrical; outer wall either with plates of S-formed longitudinal section forming pore-tubes, or with short pore-canals with bracts forming geniculate pore-tubes; septa porous or aporose; no tabulae; inner wall with simple pores, or with different types of pore-tubes, or of annuli. (For discussion see Rozanov, 1969, p. 109.) *L.Cam.(Atdaban.-Botom.).*

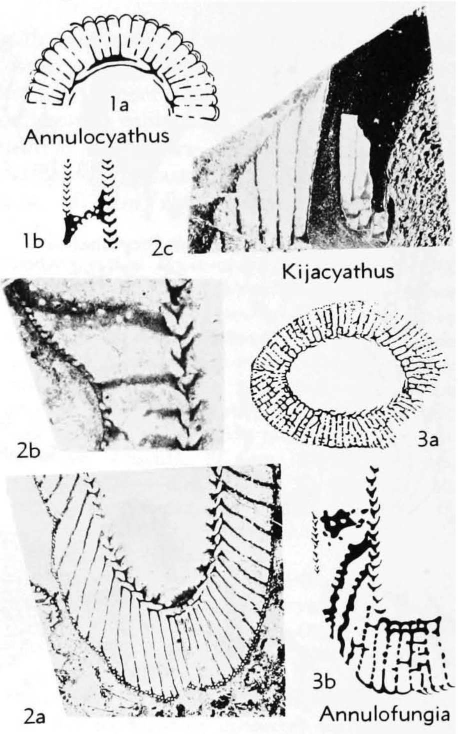


Fig. 54. Annulocyathidae *(1,3);* Kijacyathidae *(2)* (p. E80-E81).

Family ANNULOCYATHIDAE Krasnopeeva, 1953

[Annulocyathidae Krasnopeeva, 1953, p. 56]

Solitary, cup conical or cylindrical; outer wall with short canals with external bracts forming geniculate pore-tubes; septa porous, synapticulae may occur; no tabulae or dissepiments; inner wall of annuli. *L.Cam. (Botom.).*

Annulocyathus Vologdin, 1937, p. 468 [**A. pulcher;* M]. Outer wall with short canals bracted externally to give geniculate pore-tubes; inner wall of annuli S- or V-shaped in section; septa porous; no synapticulae, tabulae or dissepiments. *L.Cam.(Botom.),* USSR(Altay-Sayan-Transbayk.).——Fig. 54,*1*. **A. pulcher,* W. Sayan;*1a,b,* parts of transv. and long. secs., enl. (Repina, *et al.*, 1964).

Annulofungia Krasnopeeva, 1955, p. 99 [**A.*

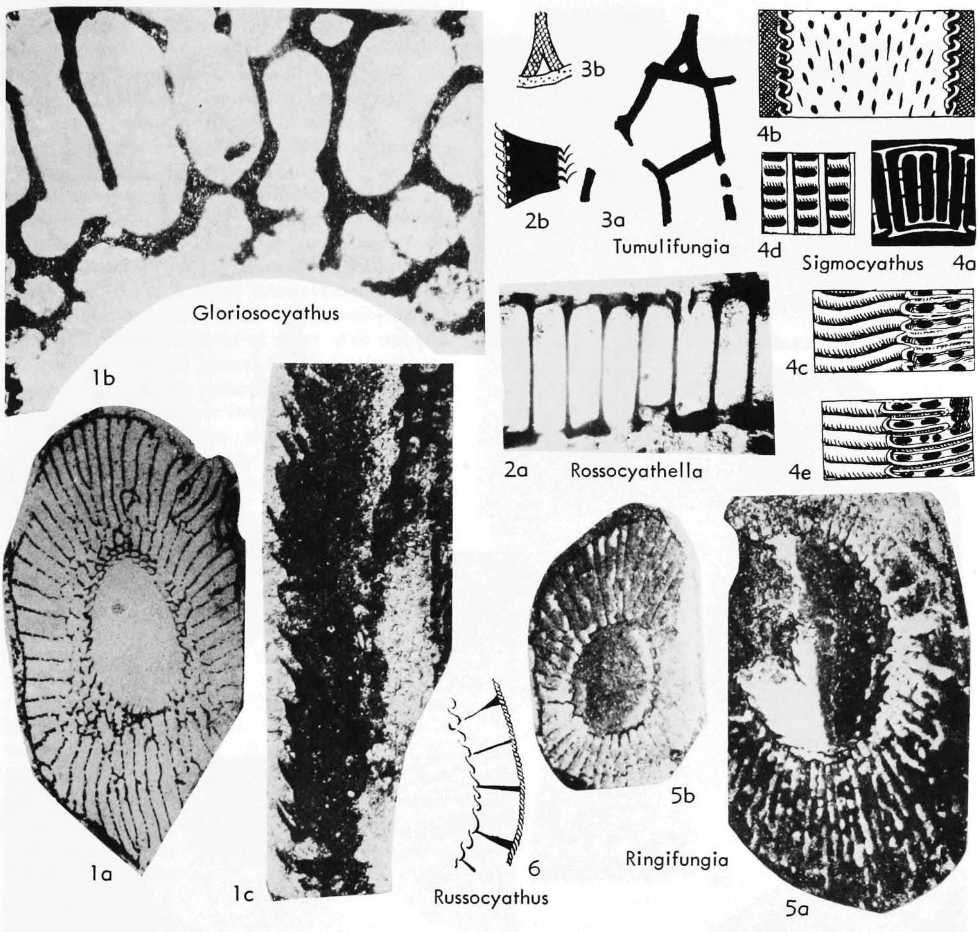


FIG. 55. Gloriosocyathidae *(1-3,5-6)*; Sigmocyathidae *(4)* (p. *E*83-*E*84).

taylori; OD] [=*Annulofungia* KRASNOPEEVA, 1953b, p. 56, *nom. nud.* (summary diagnosis given but no species named); *Annulofungia* KRASNOPEEVA, 1954, p. 602, *nom. nud.* (two species named but no definitions given)]. Like *Annulocyathus* but septa connected by synapticulae. *L.Cam.(Botom.),* USSR(Altay-Sayan); *L.Cam.* (with *Holmia* and *Nevadia*), N.Am.(Nev.).——FIG. 54,*3*. **A. taylori,* up.Botom., USSR (R.Erba, Kuznetsk Alatau); *3a,* transv. sec., ×2; *3b,* oblique long. sec., ×4 (Krasnopeeva, 1955).

Family KIJACYATHIDAE Zhuravleva, 1964

[Kijacyathidae ZHURAVLEVA in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964, p. 195]

Outer wall with S-form plates forming pore-tubes; septa porous; no tabulae or dissepiments; inner wall of annuli of V- or S-section. (For discussion see Rozanov, 1969, p. 108.) *L.Cam.(Atdaban.-up. Botom.).*

Kijacyathus ZHURAVLEVA, 1959, p. 424 [**K. chomentovskii;* OD] [=*Annulocyathella* VOLOGDIN, 1962d, p. 123 (type, *Annulocyathus lavrenovae* KRASNOPEEVA, 1955, p. 99 (=*Annulocyathus lavrenovae* KRASNOPEEVA, 1937, p. 32); OD; for discussion see REPINA, *et al.,* 1964, p. 196)]. Outer wall with S-form plates forming pore-tubes; septa closely porous; inner wall of annuli of V- or S-section. *L.Cam.(Atdaban.-Botom.),* USSR(Altay-Sayan-Transbayk.).——FIG. 54,*2*. **K. chomentovskii,* Atdaban., R.Kiya, Kuznetsk Alatau; *2a,* part of oblique transv. sec. of holotype, ×2.8; *2b,* part of long. sec., ×8.5; *2c,* tang. sec. inner wall, ×5.7 (Zhuravleva, 1959a).

Family GLORIOSOCYATHIDAE Rozanov, 1969

[Gloriosocyathidae ROZANOV, 1969, p. 108]

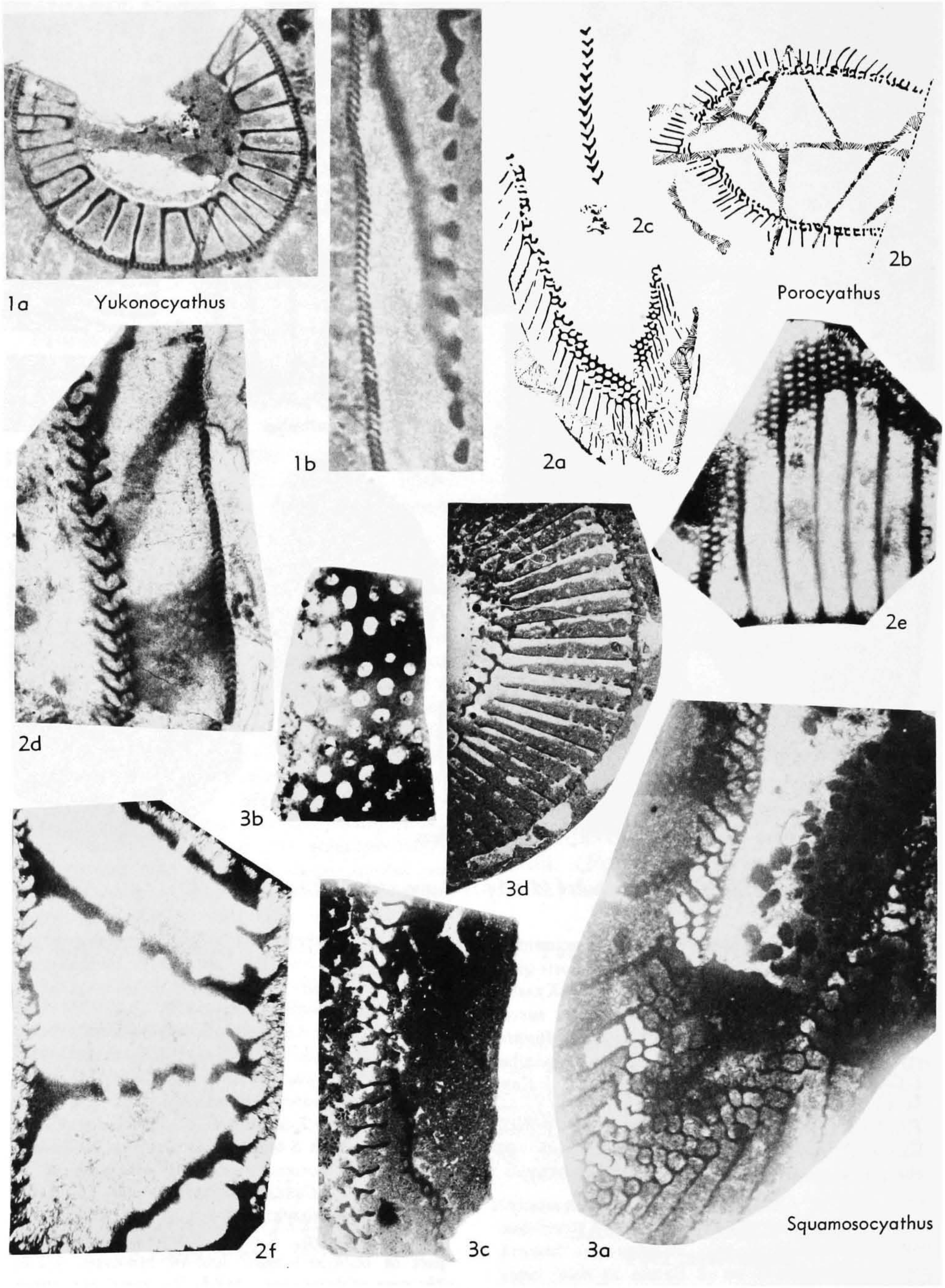


FIG. 56. Porocyathidae (p. E83-E84).

Outer wall of plates of S-form in longitudinal section, forming tubes; inner wall pores provided with bracts, scales or plates of various section; intervallum with porous septa and without tabulae. *L.Cam.(Atdaban.-Botom.).*

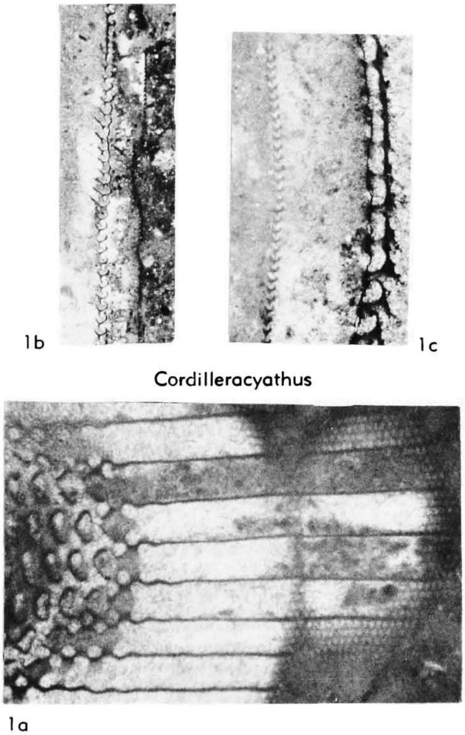


FIG. 57. Porocyathidae (p. E84).

Gloriosocyathus ROZANOV, 1969, p. 108 [**G. permultus;* OD]. Outer wall with pore-canals S-shaped in longitudinal section, inner wall constructed of plates almost flat in longitudinal section; septa porous, in places connected by inner wall plates or by synapticula-like structures. *L.Cam.(Botom.),* USSR(Sib.Platf.).——FIG. 55,*1.* **G. permultus,* Olenek uplift, Sib. Platf.; *1a,* holotype, transv. sec., ×7; *1b,* part of transv. sec. showing inner wall, ×27; *1c,* part of long. sec., inner wall to left, ×13 (Rozanov, 1969).

Ringifungia KORSHUNOV in ZHURAVLEVA, KORSHUNOV & ROZANOV, 1969, p. 38 [**R. vavilovi;* OD]. Solitary, cylindrical; pores of outer wall provided with small S-shaped plates, forming tubes; septa porous, connected by synapticulae which are commonly under-developed; inner wall with one longitudinal row of pores to an intersept, pores screened by scales, mostly common to several intersepts. *L.Cam.(Atdaban.),* USSR(Sib.Platf.).——FIG. 55,*5.* **R. vavilovi,* R.Lena; *5a,* holotype, transv. sec., ×4; *5b,* transv. sec., ×4 (Zhuravleva, Korshunov, & Rozanov, 1969).

Rossocyathella ZHURAVLEVA, 1960, p. 178 [**R. ninaekosti;* OD]. Conical; outer wall with S-shaped plates forming pore-tubes; septa almost aporose; inner wall of geniculate pore-tubes, single longitudinal row to an intersept. *L.Cam.(up.Atdaban.-Botom.),* USSR(Altay-Sayan-Sib. Platf.-Transbayk.).——FIG. 55,*2.* **R. ninaekosti,* low.Botom.(Taryn.), R. Botoma, Yakutia; *2a,* holotype, part of tang. sec., ×13; *2b,* part of long. sec., ×13 (Zhuravleva, 1960b).

Russocyathus ZHURAVLEVA, 1955, p. 104 [**R. basaichensis;* OD]. Solitary; outer wall with S-shaped plates forming pore-tubes; septa aporose; inner wall of larger, S-shaped pore-tubes. *L.Cam. (Atdaban.-Botom.),* USSR(Altay-Sayan).——FIG. 55,*6.* **R. basaichensis,* R. Bazaikha, Sayan; part of long. sec., ×13 (Zhuravleva, 1955).

?Tumulifungia ZHURAVLEVA in DATZENKO, ZHURAVLEVA, *et al.,* 1968, p. 144 [**T. datzenkoi;* OD] [=*Tumulifungia* ZHURAVLEVA in ZHURAVLEVA, ZADOROZHNAYA, *et al.,* 1967, p. 68, invalid name; no diagnosis, no species named, but descriptions and illustrations of *T.* sp. given]. Outer wall with plates of S-form in longitudinal section, forming pore-tubes (see Rozanov, 1969, p. 108); septa synapticulate; inner wall with simple pores that may be toothed with bracts or spines. *L.Cam. (up.Atdaban.-Botom.),* USSR(Sib.Platf.-Tuva-Far East).——FIG. 55,*3.* **T. datzenkoi,* Taryn., R. Sukharikha; *3a,b,* part of transv. sec., diagram. (Datzenko, Zhuravleva, *et al.,* 1968).

Family POROCYATHIDAE Zhuravleva, 1957

[Porocyathidae ZHURAVLEVA MS in VOLOGDIN, 1957, p. 206; ZHURAVLEVA, 1960, p. 179, see below under *Porocyathus*]

Cup slenderly conical or cylindrical; outer wall with short pore-canals with external bracts so that openings are geniculate in longitudinal section; septa close, porous; inner wall with pore-tubes of plates, or with simple pores with bracts or scales. *L.Cam. (Atdaban.-Botom.).*

Porocyathus ZHURAVLEVA in VOLOGDIN, 1957, p. 206 [**Ethmophyllum caveaquadratum* VOLOGDIN, 1932, p. 47; M (ZHURAVLEVA, 1960, p. 180, treated the genus as new and invalidly named *P. pinus* ZHURAVLEVA, 1960, p. 180, as type-species)]. Outer wall with short pore-canals with external bracts so that openings are curved or geniculate in longitudinal section; septa porous; no tabulae; inner wall with pore-tubes formed by plates, bracts or scales; tubes may intercommunicate. [Genus requires redefinition following restudy of VOLOGDIN's type-specimens.] *L.Cam.(Atdaban.-Botom.),* USSR(Altay-Sayan-Sib.Platf.-Transbayk.)-Antarct.-Can.(Yukon).——FIG. 56,*2a-c.* **P. caveaquadratus* (VOLOGDIN), Botom., R. Karagan, Altay; *2a,* oblique long. sec.; *2b,* transv. sec., *2c,* part of long. sec. showing pore-tubes of inner wall, diagram. (Vologdin, 1940b).——FIG. 56,*2d,e. P. squamosus* (ZHURAVLEVA), low. Botom., Yakutia; *2d,* R.Lena, long. sec., ×13; *2e,* R.Botoma, long. sec., ×13 (Zhuravleva, 1960b).——FIG. 56,*2f. P. pinus* ZHURAVLEVA, Atdaban., R.Botoma, Yakutia; holotype, part of ?long. sec., ×?27 (Zhuravleva, 1960b).

?**Cordilleracyathus** HANDFIELD, 1971, p. 49 [**C. blussoni;* M]. Conical or cylindrical cups; outer wall with pore-tubes (?or -canals) of inverted-V-shape; septa aporose; inner wall with pore-tubes of reversed-S section, partitioned so that central cavity has one longitudinal row of pores to each intersept, while intervallar side of wall has 2; spines(?bracts) project upward into central cavity from edge of pore-tubes. *L.Cam.(Atdaban.* or *Botom.),* Can.(Yukon).——FIG. 57,*1*. **C. blussoni,* Atdaban. or Botom.; *1a,* tang. sec. inner and outer walls, ×12; *1b,* radial long. sec. inner and outer walls, ×6.5; *1c,* the same, ×18 (Handfield, 1971).

Squamosocyathus ZHURAVLEVA, 1960, p. 183 [**S. taumatus;* OD]. Slenderly conical or cylindrical cups; outer wall with short pore-canals provided with beaks or scales at angle to canals; intervallum wide, septa porous, no tabulae or dissepiments; inner wall of horizontal or downwardly inclined, strongly bent, intercommunicating pore-tubes, whose mouths may have protective formations. *L.Cam.(Atdaban.-Botom.),* USSR(Altay-Sayan-Sib.Platf.).——FIG. 56, *3*. **S. taumatus,* Atdaban., Yakutia; *3a,* oblique sec., ×7; *3b,c,* holotype, *3b,* septum, ×13, *3c,* long. sec. of inner wall, ×7; *3d,* part of transv. sec., ×7 (Zhuravleva, 1960b).

?**Yukonocyathus** HANDFIELD, 1971, p. 51 [**Y. francesi;* OD]. Cup slenderly conical; outer wall with inclined pore-canals, whose external openings are provided with short protective formations turned down like peak of cap; septa each with pores in single longitudinal row near outer wall; inner wall with one longitudinal row of simple pores to an intersept. *L.Cam.(?Atdaban.),* Can. (Yukon).——FIG. 56,*1*. **Y. francesi; 1a,* transv. sec., ×3; *1b,* long. sec., ×4 (Handfield, 1971).

Superfamily SIGMOCYATHACEA Krasnopeeva, 1953

[*nom. transl.* DEBRENNE, 1970, p. 25 (*ex* Sigmocyathidae KRASNOPEEVA, 1953, p. 56) (as Sygmocyathidae *nom. null.*)]

Both walls of annuli, septa aporose or with remote large pores; no tabulae or synapticulae. *L.Cam.(up.Atdaban.* or *low. Botom.).*

Family SIGMOCYATHIDAE Krasnopeeva, 1953

[*nom. correct.* ZHURAVLEVA, 1960, p. 49 (=Sygmocyathidae KRASNOPEEVA, 1953b, p. 56, *nom. null.,* based on erroneous spelling of generic name)]

Both walls of annuli, S-shaped in longitudinal section; septa aporose or with remote large pores; no tabulae or synapticulae. *L.Cam.(up.Atdaban.* or *low.Botom.).*

Sigmocyathus R. BEDFORD & J. BEDFORD, 1936, p. 23 [**Coscinocyathus didymoteichus* TAYLOR, 1910, p. 140; OD] [=*Hemistillicidocyathus* TING, 1937, p. 368 (type, *Coscinocyathus didymoteichus* TAYLOR, 1910, p. 140), obj.; *Sygmocyathus* KRASNOPEEVA, 1953, p. 56 *(nom. null.)*]. Cups large; both walls of annuli, S-shaped in longitudinal section; septa aporose or sparsely porous; no tabulae or synapticulae. (For discussion see Debrenne, 1970, p. 42.) *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia.——FIG. 55,*4*. **S. didymoteichus* (TAYLOR), Ajax Mine; *4a,* transv. sec., ×2; *4b,* part of radial long. sec., *4c,d,* ext. and int. views of outer wall, *4e,* view of inner wall from central cavity, all ×4 (Bedford & Bedford, 1936).

Superfamily TERCYATHACEA Vologdin, 1937

[*nom. transl.* ZHURAVLEVA, 1960, p. 184 (*ex* Tercyathidae VOLOGDIN, 1937, p. 495)]

Solitary; slenderly conical or cylindrical; outer wall latticed; inner wall of pore-tubes; intervallum with porous septa, without tabulae; dissepiments may occur. *L.Cam. (Botom.-low.Len.).*

Family TERCYATHIDAE Vologdin, 1937

[Tercyathidae VOLOGDIN, 1937, p. 495]

Solitary; slenderly conical or cylindrical; outer wall latticed; intervallum with porous septa, without tabulae; inner wall of pore-tubes. *L.Cam.(Botom.-low.Len.).*

Tercyathus SIMON, 1939, p. 40 [**T. duplex* VOLOGDIN, 1932, p. 55; OD] [=*Tercyathus* VOLOGDIN, 1932, p. 55 (*nom. nud.,* established without designation of type-species)]. Solitary, conical; outer wall clathrate; septa finely porous; inner wall thick with numerous crooked pore-tubes in communication with one another by small pores. *L.Cam.(Botom.-low.Len.),* USSR (Altay-Sayan).——FIG. 58,*1a,b*. **T. duplex,* Botom., R.Lebed, Altay; *1a,b,* parts of transv. and long. secs., ×5(Vologdin, 1932).——FIG. 58,*1c*. *T.* sp., Botom., Kuznetsk Alatau; tang. sec. clathrate outer wall, ×7 (Zhuravleva, 1960b).

Clathricyathus SIMON, 1939, p. 25 [**C. firmus* VOLOGDIN, 1932; OD] [=*Clathricyathus* VOLOGDIN, 1932, p. 50 (*nom. nud.,* established without designation of type-species); *Clathrocyathus* VOLOGDIN, 1937, p. 495 *(nom null.)*]. Solitary, conical; outer wall latticed; septa porous; inner wall thick, of geniculate pore-tubes opening upward and in communication with one another by small pores in their walls; arm of V adjoining septa is shorter than other. *L.Cam.(Botom.-low. Len.),* USSR(Altay-Sayan).——FIG. 58,*2*. **C. firmus,* R.Lebed, Altay; *2a,* part of transv. sec.; *2b,*

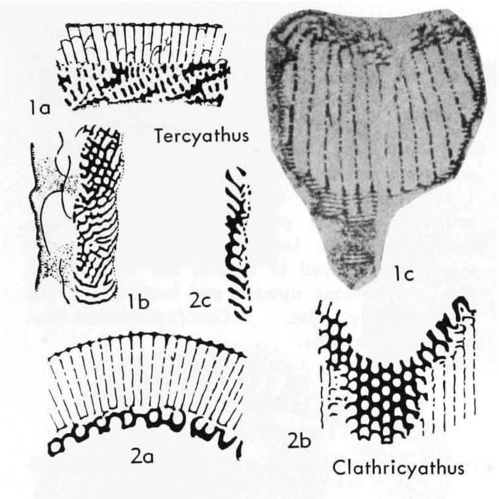


FIG. 58. Tercyathidae (p. E84-E85).

tang. sec. inner wall; *2c,* radial long. sec. of inner wall, intervallum to right, all ×2.6 (Vologdin, 1957a).

Suborder NOCHOROICYATHINA Zhuravleva, 1956

[*nom. transl.* ZHURAVLEVA, 1960b, p. 198 (*ex* order Nochoroicyathida ZHURAVLEVA in VOLOGDIN, 1956, p. 879)] [=Bronchocyathida ZHURAVLEVA in VOLOGDIN, 1957, p. 207]

Solitary Archaeocyatha with simply or complexly porous outer and inner walls; intervallum with straight porous septa and pectinate tabulae; rarely with dissepiments. *L.Cam.(Tommot.-Botom.,* rare in *Len.), ?M.Cam.(base of Amg.).*

Superfamily NOCHOROICYATHACEA Zhuravleva, 1956

[*nom. transl.* ZHURAVLEVA, 1960, p. 198 (*ex* Nochoroicyathidae ZHURAVLEVA in VOLOGDIN, 1956, p. 879)]

Solitary Archaeocyatha with simply porous outer wall; intervallum with straight septa and pectinate tabulae; inner wall with simple pores, pore-tubes or annuli. *L.Cam. (Tommot.-Botom.,* rare in *Len.), ?M.Cam. (base of Amg.).*

Family NOCHOROICYATHIDAE Zhuravleva, 1956

[Nochoroicyathidae ZHURAVLEVA in VOLOGDIN, 1956, p. 879] [=Trininaecyathidae DEBRENNE, 1964, p. 114]

Cups not large. Outer wall thin with simple pores; intervallum narrow, with numerous thin, porous septa and rare, flat, pectinate tabulae; rare dissepiments may occur; inner wall simply sieve-like, but pores may be protected on side of central cavity by spines or bracts. Central cavity free of skeletal elements. *L.Cam.(Tommot.-Botom.,* rare in *Len.), ?M.Cam.(base of Amg.).*

Nochoroicyathus ZHURAVLEVA, 1951, p. 78 [**N. mirabilis;* OD] [=*Howellicyathus* VOLOGDIN, 1962, p. 126 (type, *Coscinocyathus howelli* VOLOGDIN, 1940b, p. 88)]. Outer wall thin with simple pores; intervallum narrow with numerous thin, porous septa, and rare, flat, pectinate tabulae; dissepiments rare; inner wall with simple pores that may be protected on side of central cavity by spines or bracts. *L.Cam.(Tommot.-Botom.,* rare *Len.), ?M.Cam.(base Amg.),* USSR(S.Urals-Altay-Sayan-Sib.Platf.-Transbayk.-Far East).——FIG. 59,*1.* **N. mirabilis,* Tommot., R.Nokhoroi, Sib.Platf.; *1a,* transv. sec. of part of cup showing pectinate tabula and inner wall simply porous with bracts, ×27; *1b,* long. sec. showing nodular swellings representing bases of pectinate tabulae, ×45 (Zhuravleva, 1960b).

Pectenocyathus KASHINA in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, and ROZANOV, 1964, p. 211 [**P. torgaschinicus;* OD]. Outer wall thin, smooth, with simple pores; septa porous; tabulae pectinate; inner wall with simple pores, but plicate

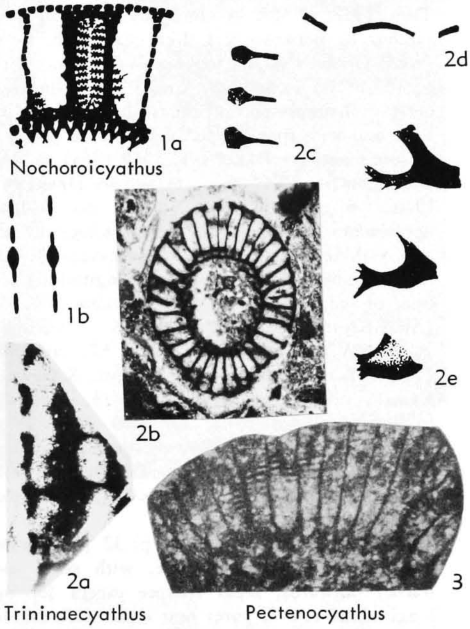


FIG. 59. Nochoroicyathidae (p. E85-E86).

longitudinally, starshaped in transverse section. *L.Cam.(up.Atdaban.-Botom.),* USSR(Altay-Sayan).——FIG. 59,*3*. *P. densus* (VOLOGDIN), L. Cam., R.Bazaikha, Sayan; part of transv. sec. showing pectinate tabula and plicate inner wall, ×10 (Repina, *et al.*, 1964).

Trininaecyathus ZHURAVLEVA, 1960, p. 218 [**T. macroporus;* OD]. Outer wall with large simple pores, 1 longitudinal row to an intersept; intervallum narrow with sparsely porous septa and pectinate tabulae; inner wall wide, of bracted pore-canals opening upward into central cavity. *L.Cam. (Atdaban.-Botom.),* USSR(Altay-Sayan-Sib.Platf.). ——FIG. 59,*2*. **T. macroporus,* Taryn., R.Botoma, Sib.Platf.; *2a,* holotype, part of long. sec., outer wall on left, ×13; *2b,* oblique transv. sec., ×7; *2c,d,* long. and transv. secs. outer wall, and *2e,* long. and oblique long. sec. bracts of pore-canals of inner wall, central cavity to left; all enl. (Zhuravleva, 1960b).

Family BRONCHOCYATHIDAE R. Bedford & J. Bedford, 1936

[Bronchocyathidae BEDFORD & J. BEDFORD, 1936, p. 25] [=Thalamocyathidae ZHURAVLEVA, 1951, p. 98; Glaessnericyathidae DEBRENNE, 1970, p. 35]

Outer wall with simple pores; intervallum with porous septa and sporadic pectinate tabulae; inner wall of annuli. *L.Cam. (Atdaban.-Botom.).*

Thalamocyathus GORDON, 1920, p. 687 [**Archaeocyathus trachealis* TAYLOR, 1910, p. 125; SD TING, 1937, p. 368, by elimination] [=*Bronchocyathus* R. BEDFORD & J. BEDFORD, 1936, p. 25 (type, *Archaeocyathus trachealis* TAYLOR, 1910, p. 125; OD)]. Solitary, conical or cylindrical; outer wall simply porous; intervallum with porous septa and with sporadic pectinate tabulae (in 10% of specimens; see DEBRENNE, 1969 (26a), p. 263, but absent from TAYLOR's syntypes; see DEBRENNE, 1970b, p. 45; lectotype shows no tabulae; nontabulate specimens have morphology of the ajacicyathine *Gordonicyathus* ZHURAVLEVA); annuli of inner wall V-shaped in longitudinal section of cup. *L.Cam.(Atdaban.-Botom.),* USSR (Altay-Sayan-Transbayk.)-Antarct.-S. Australia-?Can.(NW.Terr.).——FIG. 60,*1*. **T. trachealis* (TAYLOR), up.Atdaban. or low.Botom., S.Australia (Ajax Mine); *1a,* ext. view, ×1.6; *1b,* inner wall from intervallum, ×4.8; *1c,* outer wall, ×4.8; *1d,* oblique transv. sec. showing V-shaped annuli, ×4.8 (photos courtesy MAX DEBRENNE, Paris, negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris).

Cricopectinus DEBRENNE, 1970, p. 32 [**C. dentulus;* OD]. Outer wall simple, with pores contracted outwards; septa aporose except for one longitudinal row of pores near outer wall, tabulae pectinate; inner wall complex; horizontal canals serve as apertures for several interseptal loculi and extend into central cavity by an annular shelf with deeply dentate free rims. [Only one specimen known. May be tabulate specimen of *Cyathocricus* DEBRENNE, 1969, p. 318.] *L.Cam. (up.Atdaban.* or *low.Botom.),* S.Australia.

Glaessnericyathus DEBRENNE, 1970, p. 35 [**Bronchocyathus sigmoideus* BEDFORD & J. BEDFORD, 1936, p. 25; OD]. Cup slenderly conical; outer wall with simple pores; septa aporose, sparse tabulae pectinate; inner wall of annuli, annuli somewhat S-shaped in section, but with middle part of S oblique upward and inward, and end parts nearly flat. *L.Cam.(up.Atdaban.-low. Botom.)*,S.Australia.

Family ETHMOPECTINIDAE Debrenne, 1970

[Ethmopectinidae DEBRENNE, 1970, p. 25] [=?Ethmocyathidae DEBRENNE, 1969, p. 322]

Outer wall simply porous; septa porous, tabulae pectinate; inner wall double, one row of rhombic pore-canals to each intersept, screened by horizontal annuli. *L.Cam. (up.Atdaban.* or *low.Botom.).*

Ethmopectinus DEBRENNE, 1970, p. 34 [**E. walteri;* OD] [=?*Ethmocyathus* R. BEDFORD & W. R. BEDFORD, 1934, p. 2 (type, *E. lineatus;* OD)]. Cup conical, outer wall gently fluted, with chinky pores arranged in quincunx; septa porous, tabulae pectinate; inner wall double, one row of rhombic pore-canals to each intersept, screened against central cavity by horizontal annuli. [May be tabulate specimens of *Ethmocyathus lineatus* R. BEDFORD & W. R. BEDFORD, 1934, p. 2.] *L.Cam. (up.Atdaban.-low.Botom.),* S.Australia.

Family FORMOSOCYATHIDAE Rozanov, 1963

[Formosocyathidae ROZANOV, 1963, p. 5]

Outer wall simply porous, septa porous, tabulae pectinate; wide inner wall of intercommunicating, crooked pore-tubes. *L.Cam.(up.Tommot.-Botom.).*

Formosocyathus VOLOGDIN, 1937b, p. 471 [**F. bulynnikovi;* M]. Solitary; outer wall with simple pores; inner wall wide, of intercommunicating crooked pore-tubes; septa porous, tabulae pectinate. *L.Cam.(up.Tommot.-Botom.),* USSR (Altay-Sayan-Sib. Platf.-Transbayk.)-Antarct.——FIG. 60,*3*. **F. bulynnikovi,* Botom., R. Sanashtykgol, Sayan; *3a,* oblique long. sec., ×8; *3b,* part of transv. sec., ×8 (Vologdin, 1940b).

Heckericyathus ZHURAVLEVA, 1960, p. 220 [**Ethmophyllum heckeri* ZHURAVLEVA, 1955, p. 69; OD]. Slenderly conical or cylindrical cups; outer wall simply and finely porous; septa porous; tabulae rare, pectinate; inner wall with 1 to 2

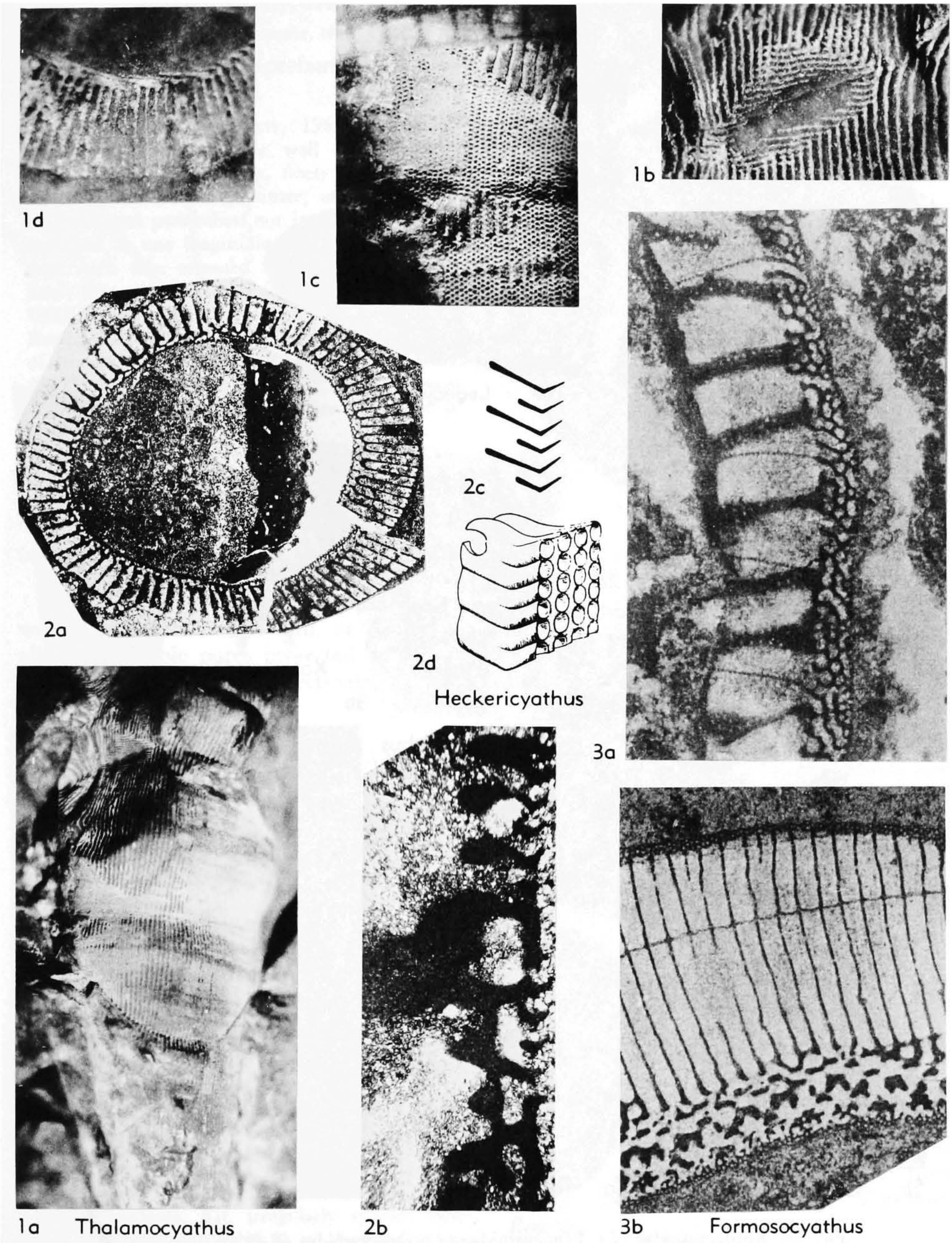


FIG. 60. Bronchocyathidae *(1)*; Formosocyathidae *(2-3)* (p. *E*86-*E*87).

longitudinal rows of geniculate pore-tubes to an intersept; the pore-tubes open upward and may divide into finer ones at central cavity. *L.Cam. (Atdaban.)*, USSR(Sib. Platf.).——FIG. 60,*2*. **H. heckeri* (ZHURAVLEVA), R. Lena, Sib.Platf.; *2a*, transv. sec.; *2b*, oblique long. sec., both ×4.8; *2c*, long. sec. inner wall; *2d*, reconstr., part of inner wall, both ×56 (Zhuravleva, 1960b).

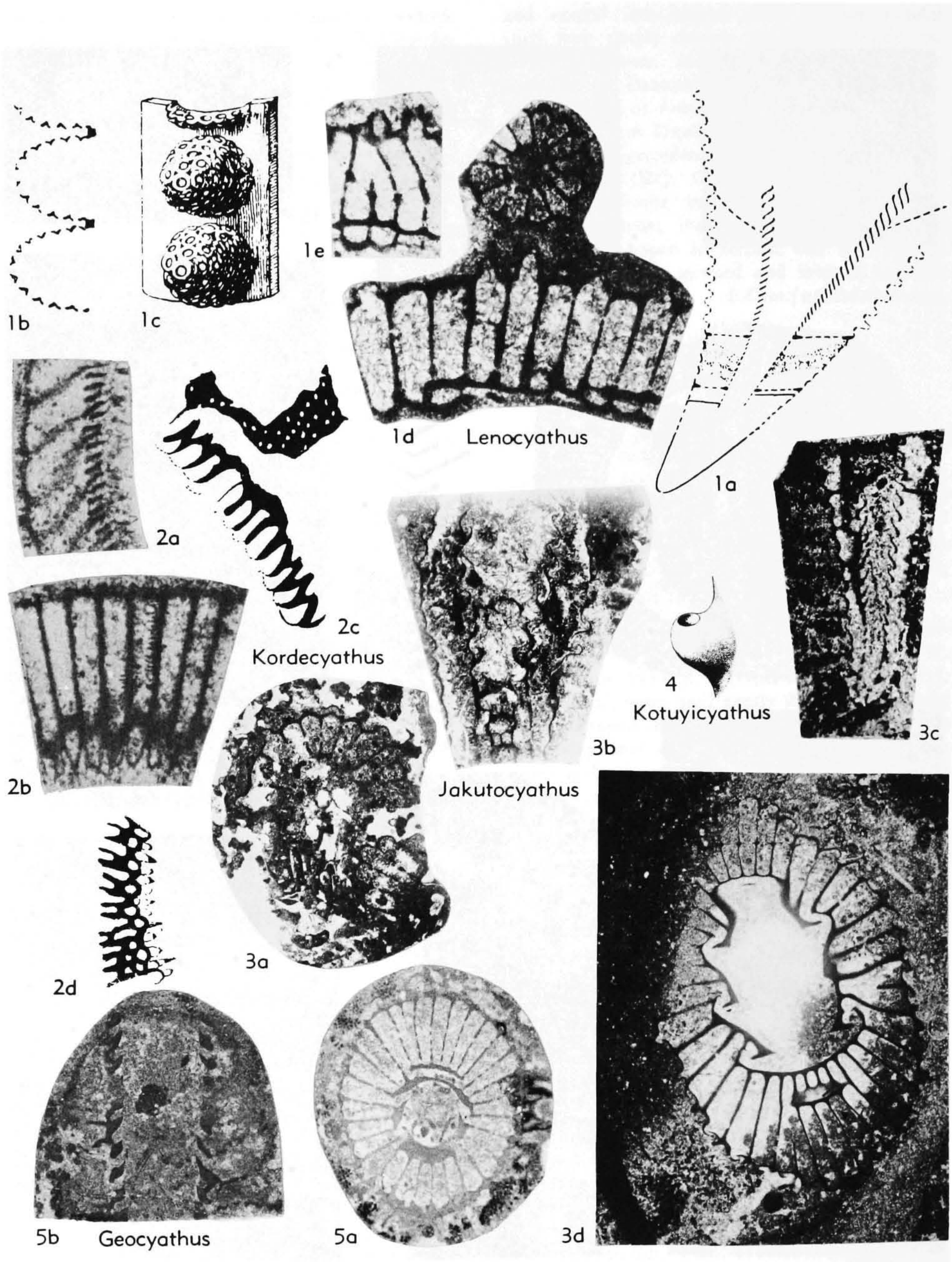


FIG. 61. Kordecyathidae *(2)*; Lenocyathidae *(1)*; Geocyathidae *(3-5)* (p. E89-E90).

Superfamily KORDECYATHACEA Missarzhevskiy, 1961

[*nom. transl.* MISSARZHEVSKIY in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964, p. 218 (*ex* Kordecyathidae MISSARZHEVSKIY, 1961, p. 21)]

Outer wall of large pores screened with auxiliary microporous sheath; septa porous; tabulae pectinate; inner wall of pore-tubes arranged in one longitudinal row to an intersept. *L.Cam.(?up.Atdaban.-Botom.).*

Family KORDECYATHIDAE Missarzhevskiy, 1961

[Kordecyathidae MISSARZHEVSKIY, 1961, p. 21]

Characteristics of superfamily. *L.Cam. (?up.Atdaban.-Botom.).*

Kordecyathus MISSARZHEVSKIY, 1961, p. 21 [**K. shiveligensis;* OD]. Outer wall of large pores screened with an auxiliary, finely porous sheath; septa porous; tabulae pectinate; inner wall wide, of horizontal pore-tubes, not intercommunicating, arranged in one longitudinal row in each intersept; each tube screened from central cavity by finely porous film. *L.Cam.(?up.Atdaban.-Botom.),* USSR(Tuva).——FIG. 61,*2*. **K. shiveligensis,* Botom.; *2a,b,* holotype, oblique long. sec. and part of transv. sec., ×2.4, ×4.8 (Missarzhevskiy, 1961); *2c,d,* long. and transv. secs., part of inner wall, diagram. (Zhuravleva, Zardorozhnaya, *et al.,* 1967).

Superfamily LENOCYATHACEA Zhuravleva, 1956

[*nom. transl.* ZHURAVLEVA, 1960, p. 224 (*ex* Lenocyathidae ZHURAVLEVA in VOLOGDIN, 1956, p. 879)]

Outer wall with pores in tumuli; inner wall of pore-tubes or annuli, or exceptionally with simple pores protected by bracts; septa porous and tabulae pectinate. *L.Cam. (mid. Tommot.-Botom.).*

Family LENOCYATHIDAE Zhuravleva, 1956

[Lenocyathidae ZHURAVLEVA in VOLOGDIN, 1956, p. 879]

Conical or cylindrical cups, sometimes with longitudinal folds. Outer wall with one longitudinal row of compound tumuli to each intersept; intervallum narrow, with porous septa and very rare pectinate tabulae; inner wall of pore-tubes S-shaped or V-shaped in section, in one or two longitudinal rows to an intersept, or of annuli. *L.Cam.(Atdaban.).*

Lenocyathus ZHURAVLEVA in ZHURAVLEVA & ZELENOV, 1955, p. 73 [**L. lenaicus;* OD]. Conical cups, rarely with longitudinal folds; outer wall with 1 longitudinal row of compound tumuli to each intersept; intervallum narrow; septa porous; tabulae pectinate, flat, irregularly spaced; inner wall wide with pore-tubes S- or V-shaped in section, one or two longitudinal rows to each intersept. *L.Cam.(Atdaban.),* USSR(Sib.Platf.).——FIG. 61,*1*. **L. lenaicus,* R. Lena, Sib.Platf.; *1a,* long. sec., diagram.; *1b,* long. sec. outer wall (diagram.); *1c,* view of three tumuli of outer wall(enl.); *1d,* part of transv. sec., outer wall at top, ×16; *1e,* part of transv. sec. through two tumuli, outer wall at top, ×16 (Zhuravleva, 1960b).

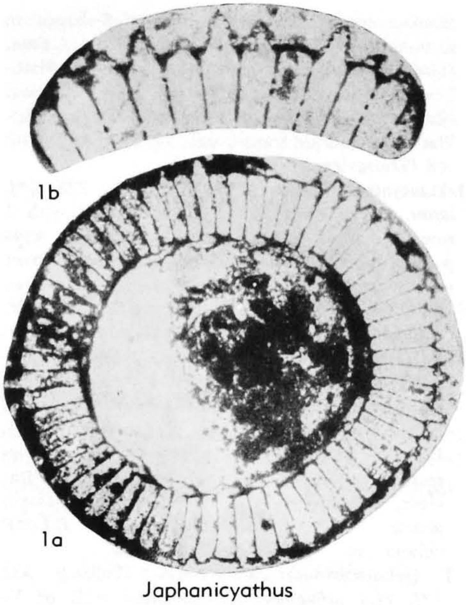


FIG. 62. Lenocyathidae (p. *E*89).

Japhanicyathus KORSHUNOV, in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 45 [**J. genurosus;* OD]. Cup conical with narrow intervallum; outer wall with compound tumuli; septa porous, tabulae pectinate, irregular in arrangement; inner wall of annuli V-shaped in section, some with spines on edges projecting into central cavity. *L.Cam.(?Atdaban.),* USSR(Sib.Platf.).——FIG. 62,*1*. **J. genurosus,* Oy-Muran, Sib.Platf.; *1a,* holotype, part of transv. sec. showing compound tumuli; *1b,* part of transv. sec., ×7.8 (Korshunov, in Zhuravleva, Korshunov, & Rozanov, 1969).

Family GEOCYATHIDAE Debrenne, 1964

[Geocyathidae DEBRENNE, 1964, p. 114] [=Kotuyicyathidae ROZANOV in ROZANOV, MISSARZHEVSKIY, *et al.,* 1969, p. 186]

Outer wall with simple tumuli; intervallum with porous septa and pectinate tabulae; inner wall with simple pores with thornlets or of S- or V-shaped pore-tubes, or of annuli. *L.Cam.(mid. Tommot.-Botom.).*

Geocyathus ZHURAVLEVA, 1960, p. 234 [**Thalamocyathus botomanensis* ZHURAVLEVA in ZHURAVLEVA & ZELENOV, 1955, p. 71 (=*T. botomaensis* ZHURAVLEVA, 1960b, p. 234, *nom. null.*); OD]. Cups not large; outer wall with simple tumuli in one or two rows to each intersept; intervallum with finely porous septa and sparse pectinate tabulae; inner wall annuli, flat or S-shaped in section, their axial edges rising upwards. *L.Cam. (Atdaban.-Botom.),* USSR(Altay-Sayan-Sib.Platf.-Transbayk.).——FIG. 61,*5*. **G. botomanensis* (ZHURAVLEVA), holotype, Atdaban., R.Botoma, Sib. Platf.; *5a,* oblique transv. sec., *5b,* long. sec., both ×8 (Zhuravleva, 1960b).

Jakutocyathus ZHURAVLEVA, 1960, p. 228 [**J. latini;* OD]. Cups not large, outer wall with 1 row of simple tumuli to each intersept; septa porous; tabulae pectinate, irregularly spaced; inner wall wide, of S-shaped or V-shaped pore-tubes, 1 or 2 longitudinal rows to each intersept. *L.Cam. (Atdaban.-Botom.),* USSR(Altay-Sayan-Sib.Platf.).

J. (Jakutocyathus). Inner wall of S-shaped pore-tubes; septa sparsely porous. *L.Cam.(Atdaban.),* USSR(Altay-Sayan-Sib.Platf.).——FIG. 61,*3a-c.* **J. (J.) latini* ZHURAVLEVA, Atdaban.; *3a,b,* R. Botoma, Yakutia, holotype, transv. and long. secs., ×8; *3c,* R.Lena, long. sec., ×12 (Zhuravleva, 1960b).——FIG. 61,*3d. J. (J.) krasnopeevae* (ZHURAVLEVA), low.Botom., R.Lena; oblique sec., ×8 (Zhuravleva, 1960).

J. (Jakutocarinus) ZHURAVLEVA, 1960, p. 232 [**J. (J.) jakutensis;* OD]. Inner wall of V-shaped pore-tubes. *L.Cam.(Atdaban.),* USSR (Sib.Platf.).

Kotuyicyathus ZHURAVLEVA, 1960, p. 226 [**K. kotuyikensis;* OD]. Cups not large; outer wall with pores in simple tumuli; intervallum with porous septa and sparse pectinate tabulae; inner wall with simple pores that may have protective thornlets. *L.Cam.(up.Tommot.-Botom.),* USSR (Kuznetsk Alatau-Sib.Platf.).——FIG. 4,*4;* 61,*4.* **K. kotuyikensis,* up.Tommot., R. Kotuyi, Sib. Platf.; 4,*4,* reconstr., ×1; 61,*4,* tumulus, ×40 (Zhuravleva, 1960b).

Superfamily FANSYCYATHACEA Korshunov & Rozanov, 1969

[*nom. transl.* ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 46 (*ex* Fansycyathidae KORSHUNOV & ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 47)]

Outer wall with oblique pore-tubes, outer mouths provided with bracts or peaks; intervallum with porous septa and pectinate tabulae; inner wall with simple pores, or of geniculate pore-tubes, or of annuli. *L.Cam.(Atdaban.-low.Len.).*

Family FALLOCYATHIDAE Rozanov, 1969

[Fallocyathidae ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 47]

Outer wall with oblique pore-tubes, their outer mouths provided with bracts or peaks; intervallum with porous septa and pectinate tabulae; inner wall with simple pores. *L.Cam.(Atdaban.).*

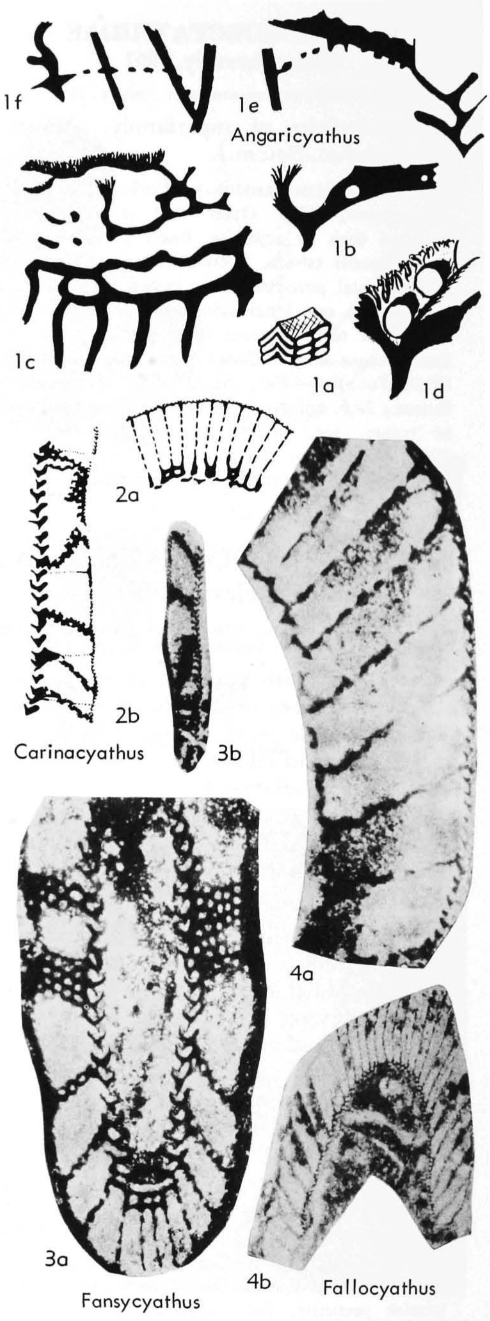


FIG. 63. Fallocyathidae *(4);* Fansycyathidae *(3);* Carinacyathidae *(1-2)* (p. *E*90-*E*91).

Fallocyathus ROZANOV in ZHURAVLEVA, KORSHUNOV,

& ROZANOV, 1969, p. 47 [**F. dubius;* OD]. Outer wall with oblique pore-tubes, their outer mouths provided with bracts; inner wall with simple pores; intervallum with porous septa and very sparse pectinate tabulae. *L.Cam.(Atdaban.),* USSR (Sib.Platf.).——FIG. 63,*4*. **F. dubius,* ?Atdaban., Oy-muran, Sib.Platf.; *4a,* holotype, part of oblique sec., ×27; *4b,* oblique long. sec., ×7 (Rozanov in Zhuravleva, Korshunov, & Rozanov, 1969).

Family FANSYCYATHIDAE Korshunov & Rozanov, 1969

[Fansycyathidae KORSHUNOV & ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 47]

Outer wall with short pore-canals provided with peaks; septa porous, tabulae pectinate; inner wall of annuli. *L.Cam. (Atdaban.).*

Fansycyathus KORSHUNOV & ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 48 [**F. lermontovae;* OD]. Outer wall with short pore-canals provided with peaks; septa porous; tabulae pectinate; inner wall constructed of V-section annuli, widening upward. *L.Cam.(Atdaban.),* USSR(Sib.Platf.).——FIG. 63,*3*. **F. lermontovae; 3a,* long. sec., ×13; *3b,* part of long. sec., outer wall to left, ×4 (Zhuravleva, Korshunov, & Rozanov, 1969).

Family CARINACYATHIDAE Krasnopeeva, 1953

[*nom. correct.* ZHURAVLEVA, 1960, p. 240 (*pro* Carinocyathidae KRASNOPEEVA, 1953b, p. 53)]

Cups cylindrical or slenderly conical without longitudinal folds; outer wall with oblique pore-tubes, their outer mouths provided with bracts or peaks; inner wall of larger oblique pore-tubes with bracts, one or two longitudinal rows to each intersept; intervallum with porous septa and pectinate tabulae. [See ROZANOV, 1969, p. 108.] *L. Cam.(Atdaban.-low.Len.).*

Carinacyathus VOLOGDIN, 1932, p. 37 [**C. loculatus;* M] [=*Carinocyathus* VOLOGDIN, 1937, p. 471, *nom. null.*]. Characters of family. *L.Cam. (Atdaban.-Botom.),* USSR(Altay-Sayan-Sib.Platf.). ——FIG. 63,*2*. **C. loculatus,* Botom., R. Lebed, Altay; *2a,b,* parts of transv. and long. secs., ×4.5 (Vologdin, 1940b).

?**Angaricyathus** ZHURAVLEVA, 1965, p. 7 [**A. cyrenovi;* OD]. Outer wall of geniculate pore-tubes opening downward; septa porous; tabulae pectinate, very rare; inner wall of incomplete and perforate annuli, V-shaped in section, their axial edges fringed; successive annuli connected by one vertical crosspiece to each 3 to 6 interseptal loculi. *L.Cam.(low.Len.),* USSR(N. Baykal uplands).——FIG. 63,*1*. **A. cyrenovi; 1a,* reconstr., geniculate pore-tubes of outer wall, ×45; *1b,* radial long. sec., annulus of inner wall, ×24; *1c,* tang. sec., annuli of inner wall, showing fringe on axial edge, ×19; *1d,* reconstr., annulus of inner wall, ×27; *1e,f,* secs. showing tabulae, ×19 (Zhuravleva, 1965).

Superfamily PIAMAECYATHACEA Zhuravleva, 1960

[*nom. transl.* ZHURAVLEVA, 1960, p. 50 (*ex* Piamaecyathidae ZHURAVLEVA, 1960, p. 44)]

Outer wall latticed, with systems of fine horizontal and longitudinal laths; intervallum with porous septa and pectinate tabulae; inner wall simply porous, or wide, with one to two longitudinal rows of pore-tubes to each intersept, or of annuli. *L.Cam.(up.Atdaban.-Botom.).*

Family PIAMAECYATHIDAE Zhuravleva, 1960

[Piamaecyathidae ZHURAVLEVA, 1960, p. 44]

Outer wall latticed with horizontal and longitudinal systems of laths; intervallum with porous septa and pectinate tabulae; inner wall simply porous, or wide, with 1 or 2 longitudinal rows of pore-tubes to each intersept. *L.Cam.(Botom.).*

Piamaecyathus ZHURAVLEVA, 1960, p. 45 [**P. sajanicus;* OD] [=*Piamaesyathus* ZHURAVLEVA, 1960a, p. 45, *nom. null.*]. Outer wall latticed, with systems of horizontal and longitudinal laths; intervallum with porous septa and pectinate tabulae; inner wall wide, with 1 to 2 longitudinal rows of pore-tubes to each intersept. *L.Cam.(Botom.),* USSR(Altay-Sayan).——FIG. 64,*2*. **P. sajanicus,* W.Sayan; *2a,* oblique long. sec., ×2.8 (Repina, *et al.,* 1964); *2b,c,* part of transv. secs., ×2.8 (*2c* is holotype) (Zhuravleva, 1960a).

Piamaecyathellus ROZANOV in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964, p. 217 [**P. simplex;* OD]. Cup with latticed outer wall, porous septa, pectinate tabulae, and simply porous inner wall. *L.Cam.(Botom.),* USSR(Altay).——FIG. 64,*1*. **P. simplex,* R.B.Isha, Altay; transv. sec., ×2.8 (Repina, *et al.,* 1964).

Family BOTOMOCYATHIDAE Zhuravleva, 1955

[Botomocyathidae ZHURAVLEVA, 1955, p. 628] [=Botomacyathidae VOLOGDIN, 1956, p. 879 (*nom. null.*)]

Cup with latticed (clathrate) outer wall, porous septa, sparse pectinate tabulae, and inner wall of annuli. *L.Cam.(up.Atdaban.-Botom.).*

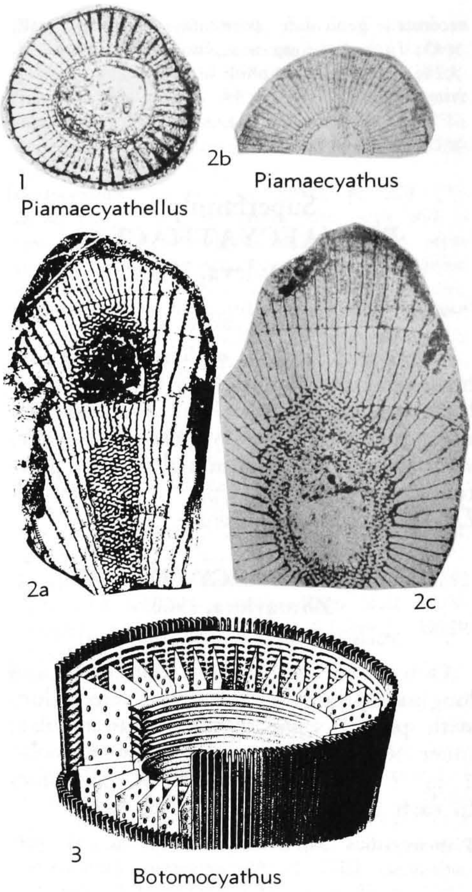


FIG. 64. Piamaecyathidae *(1-2);* Botomocyathidae *(3)* (p. *E*91-*E*92).

Botomocyathus ZHURAVLEVA, 1955, p. 629 [**B. zelenovi;* OD] [=*Botomacyathus* VOLOGDIN, 1956, p. 879 *(nom. null.)*]. Solitary, conical; outer wall clathrate (latticed); septa porous; tabulae pectinate but sparse (see ZHURAVLEVA, KORSHUNOV, and ROZANOV, 1969, p. 50); inner wall of annuli V-shaped in longitudinal section of the cup. *L.Cam.(up.Atdaban.-Botom.),* USSR (Sib.Platf.).——FIG. 64,*3.* **B. zelenovi,* up. Atdaban.-Botom., R.Botoma, Sib.Platf.; reconstr., with part of cup cut away (Zhuravleva, 1960b).

Suborder COSCINOCYATHINA Zhuravleva, 1955

[*nom. transl.* ZHURAVLEVA, 1960, p. 245 (*ex* order Coscinocyathida ZHURAVLEVA, 1955, p. 10)]

Solitary, rarely colonial Archaeocyatha; inner and outer walls simply or complexly porous; intervallum with porous septa and tabulae and, in some, dissepiments; pores of tabulae rounded or slit-like. *L.Cam. (mid.Tommot.-low.Len.)-base M.Cam.*

Superfamily COSCINOCYATHACEA Taylor, 1910

[*nom. transl.* ZHURAVLEVA, 1960, p. 245 (*ex* Coscinocyathidae TAYLOR, 1910, p. 137)] [=Erismacoscinacea DEBRENNE, 1964, p. 166 (*nom. transl.* DEBRENNE, 1970, p. 25, *ex* Erismacoscinidae DEBRENNE, 1964, p. 166)]

Outer wall simply porous or with pore-canals or pseudo-latticed; inner wall with simple pores, or of pore-tubes, or of annuli; septa porous; tabulae with rounded or slit pores. *L.Cam.(mid.Tommot.-low.Len.)-base ?M.Cam.*

Family COSCINOCYATHIDAE Taylor, 1910

[Coscinocyathidae TAYLOR, 1910, p. 137] [=Asterocyathidae VOLOGDIN, 1956, p. 879; Erismacoscinidae DEBRENNE, 1964, p. 166]

Solitary, rarely colonial; cups cylindrical or conical, curved or erect, not infrequently with dents and longitudinal folds. Outer wall with simple or pseudo-latticed pores or pore-canals; intervallum with porous septa, and tabulae with round or slit-like pores, and rare dissepiments; inner wall with simple pores that may be protected by scoops or complex spines or with pore-tubes. *L.Cam.(mid.Tommot.-low.Len.).*

Coscinocyathus BORNEMANN, 1884, p. 705 [**C. tuba;* SD TING, 1937, p. 360 (DEBRENNE, 1970a, p. 207, has requested exemption from application of the Code, and asked for a new type-species, *C. dianthus* BORNEMANN, 1884, p. 704, which is more representative of BORNEMANN's conception, and of general use. If the requests are granted, *Coscinocyathus* will be defined as *Erismacoscinus* (see below) now is, and *Erismacoscinus* will become a junior subjective synonym of *Coscinocyathus.* DEBRENNE, 1970a, p. 207, has proposed a new generic name *Tubicoscinus* for the genus at present based on *C. tuba.*)]. Cup small, conical; outer wall with oblique or very widely geniculate pore-canals; septa and tabulae thin and porous; inner wall with one longitudinal row of pore-tubes to an intersept. *L. Cam.(Atdaban.-Botom.),* USSR(Urals-Altay-Sayan-Baykal.-Far East)-Sardinia-Can. (Yukon-NW. Terr.)-S.Australia-Antarct. [See DEBRENNE, 1964, p. 162; 1970a, p. 207.]——FIG. 65,*1.* **C. tuba,* Botom., Sardinia; *1a,b,* long. secs. of holotype, ×3.2, ×8; *1c,* tang. long. sec. inner wall, ×8 (Debrenne, 1964).

Asterocyathellus VOLOGDIN, 1962, p. 126 [**A.*

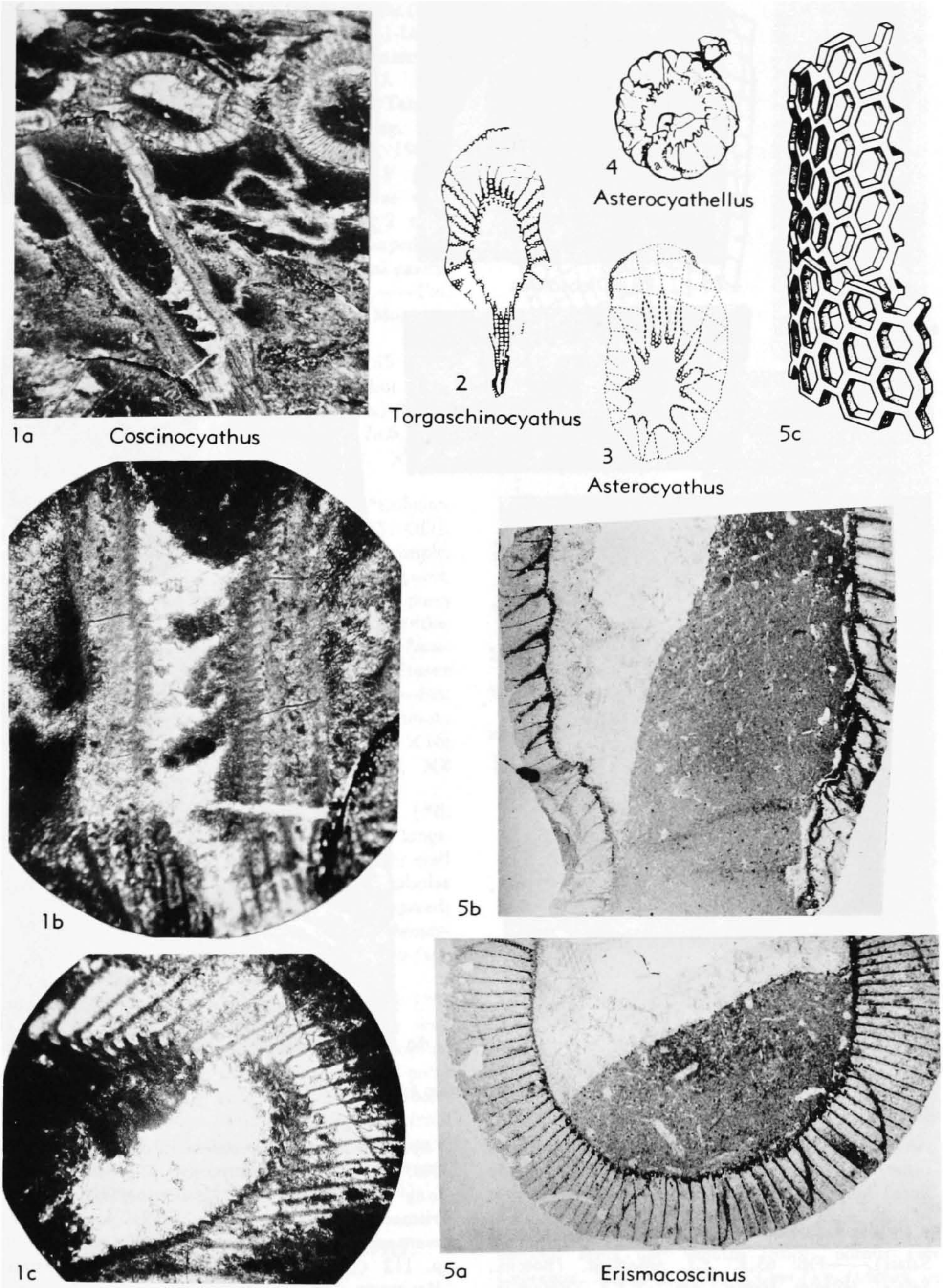


FIG. 65. Coscinocyathidae (p. *E92-E95*).

compositus; OD]. Outer wall furrowed at junctions with septa and finely porous; septa and tabulae finely porous; inner wall finely porous, with one or two longitudinal folds to an intersept. *L.Cam.(?Botom.)*, USSR(Salair).——FIG. 65,*4*. **A. compositus;* transv. sec., ×4 (Vologdin, 1962d).

Asterocyathus VOLOGDIN, 1940, p. 92 [**A. salairi-*

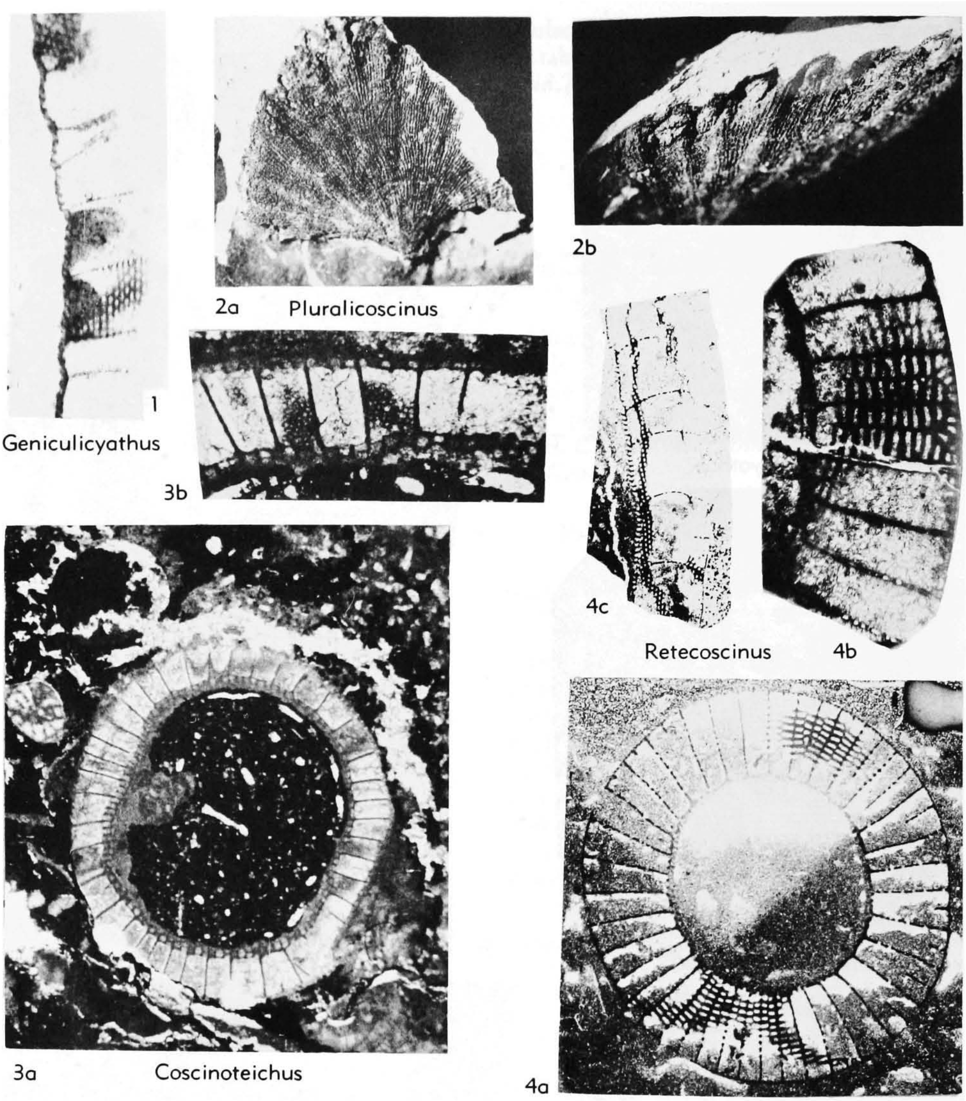


FIG. 66. Coscinocyathidae (p. E94-E95).

cus; OD]. Solitary, rarely colonial; outer and inner walls simply porous, inner wall deeply fluted longitudinally, stellate in transverse section of cup; septa and tabulae simply porous. *L.Cam. (Atdaban.-Botom.),* USSR(S.Urals-Altay-Sayan-Salair).——FIG. 65,*3*. **A. salairicus,* ?Botom., Salair; oblique transv. sec., ×3.2 (Vologdin, 1962d).

Coscinoteichus DEBRENNE, 1964, p. 180 [**C. minimiporus* (=*C. microporosus* DEBRENNE, 1964 (expl. to pl. 26, fig. 1,2), *nom. null.*); OD]. Outer and inner walls thickened, with straight, oblique pore-canals; septa and tabulae finely porous and forming rectangular loculi. *L.Cam. (up.Atdaban.* or *low.Botom.)*,Eu.(Sardinia).——FIG. 66,*3*. **C. minimiporus; 3a,b,* transv. sec., long. sec., ×4.8, ×12 (Debrenne, 1964).

Erismacoscinus DEBRENNE, 1959, p. 65 [**E. marocanus;* M] [=?*Tuvacyathus* VOLOGDIN, 1940, p. 112 (type, *T. mollimurus;* M); *Tuvacyathus* VOLOGDIN, 1937, p. 471, *nom. nud.*]. Cup slenderly conical to cylindrical; may be irregularly folded longitudinally; outer wall with numerous regularly alternating longitudinal rows fine pores to each intersept, inner wall thicker, more than one longitudinal row of simple or stirrup-pores to an intersept; small spikelets of varied form may project from wall between pores. *L.Cam.(mid.*

Tommot.-low.Len.), N.Afr.(Morocco)-Eu.(Sardinia-Spain-France [Montagne Noire])-USSR (Altay-Sayan-Sib. Platf.)-?Mongolia-Antarct.-S. Australia-Can.(Yukon-B.C.).——FIG. 65,*5*. **E. marocanus*, Amouslek., Morocco (Jebel Taïssa), holotype; *5a,* transv. sec., ×3.2; *5b,* long. sec., ×2.4; *5c,* outer wall, diagram.(Debrenne, 1964).

Geniculicyathus DEBRENNE, 1960, p. 118 [**G. varius;* M]. Outer wall, septa and tabulae with simple, rounded pores; inner wall with 2 to 3 longitudinal rows small pore-tubes S-shaped in long. sec. and opening upward into central cavity. *L.Cam.(Atdaban.),* N.Afr.(Morocco).——FIG. 66,*1*. **G. varius,* holotype, Jebel Taïssa, Morocco; long. sec., ×8 (Debrenne, 1961).

Pluralicoscinus DEBRENNE, 1963, p. 135 [**P. alanisensis;* OD]. Like *Erismacoscinus* but colonial, catenulate. *L.Cam.,* Spain(Alanis)-S.Australia.——FIG. 66,*2*. **P. alanisensis; 2a,b,* side view of fan-shaped catenulate colony, ×?1.6, ×?2.4 (Debrenne, 1963).

Retecoscinus ZHURAVLEVA, 1960, p. 247 [**Coscinocyathus retetabulae* VOLOGDIN, 1931, p. 75; OD]. Outer and inner walls and septa with simple, rounded pores; tabulae with 2 rows slit-like pores, 1 row on each side of median radial band, pores of inner wall provided with small bubble-like, breeched covers. *L.Cam.(mid.Tommot.-?low. Botom.),* USSR(Altay-Sayan-Sib.Platf.)-Eu.(France [Montagne Noire])-N.Afr.(Morocco).——FIG. 66,*4*. **R. retetabulae* (VOLOGDIN), up.Tommot., R.Moyero, Sib.Platf.; *4a,b,* transv. sec., ×8, ×16; *4c,* part of long. sec., inner wall to left, ×8 (Zhuravleva, 1960b).

Rozanovicoscinus DEBRENNE, 1970, p. 41 [**R. fonini;* OD]. Cup cylindrical with narrow longitudinal furrows at outer edges of septa; outer wall with round pores arranged in quincunx; tabulae porous, flat, numerous, but irregularly spaced; inner wall with short pore-tubes as in a honeycomb, two or three to an intersept. *L.Cam.(up. Atdaban.-low.Botom.),* S.Australia.

Torgaschinocyathus VOLOGDIN, 1957d, p. 699 [**T. spinosus;* M]. Cup conical, with thin outer wall with simple pores; septa and tabulae thin, porous; inner wall with single longitudinal row of pores to an intersept, each pore with scoop or half-tumulus over its lower part, spine projecting from about center of half-tumulus. *L.Cam.(?Botom.),* USSR(Sayan)-Antarct.——FIG. 65,*2*. **T. spinosus,* Sayan; oblique sec., ×5.6 (Vologdin, 1962d).

Family STILLICIDOCYATHIDAE Ting, 1937

[Stillicidocyathidae TING, 1937, p. 367] [=Salairocyathidae ZHURAVLEVA in VOLOGDIN, 1956, p. 879]

Outer wall simple, inner wall of annuli; septa and tabulae porous. *L.Cam.(?up. Atdaban.-Botom.).*

Stillicidocyathus TING, 1937, p. 367 [**Coscinocyathus aulax* TAYLOR, 1910; OD]. Outer wall with simple pores; inner wall of annuli S-shaped in section; septa and tabulae simply porous (see Debrenne, 1969b, p. 263). *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia.——FIG. 67,*4*. **S. aulax* (TAYLOR), holotype, up.Atdaban. or low.Botom., S.Australia (Ajax Mine); oblique surface showing annuli of inner wall, ×3 (photo, MAX DEBRENNE, Paris, negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris).

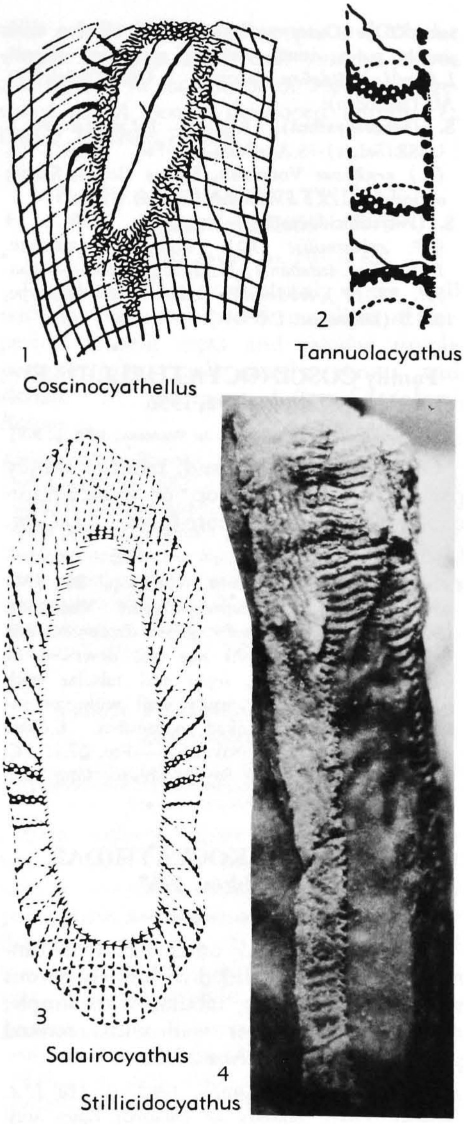


FIG. 67. Stillicidocyathidae *(3-4);* Coscinocyathellidae *(1);* Tannuolacyathidae *(2)* (p. E95-E96).

Salairocyathus VOLOGDIN, 1940, p. 89 [**S. zenko-*

vae; OD]. Outer wall, septa and tabulae with simple pores; inner wall of geniculate annuli. *L.Cam.(up.Atdaban.-Botom.),* USSR(Salair)-N. Afr.(Morocco).

S. (Salairocyathus). Solitary. *L.Cam.(Botom.),* USSR(Salair)-?S.Australia.——FIG. 67,*3*. **S. (S.) zenkovae* VOLOGDIN, Belaya Gorka, Salair; oblique sec., ×5 (Vologdin, 1957a).

S. (Polystillicidocyathus) DEBRENNE, 1959, p. 14 [**P. erbosimilis;* OD]. Colonial, catenulate. *L.Cam.(up.Atdaban.),* N.Afr.(Morocco).——FIG. 5,*3*. **S. (P.) erbosimilis* (DEBRENNE); holotype, ×1.5 (Debrenne, 1959b).

Family COSCINOCYATHELLIDAE Zhuravleva, 1956

[Coscinocyathellidae ZHURAVLEVA in VOLOGDIN, 1956, p. 879]

Outer wall, septa and tabulae simply porous; inner wall wide, of intercommunicating, crooked pore-tubes. *L.Cam. (Botom.).*

Coscinocyathellus VOLOGDIN, 1940, p. 91 [**C. parvus;* OD] [=*Coscinocyathellus* VOLOGDIN, 1937, p. 471 *(nom. nud.),* genus diagnosed, one species *C. parvus* listed but not described or figured]. Outer wall, septa and tabulae with simple rounded pores; inner wall wide, of intercommunicating, crooked pore-tubes. *L.Cam. (Botom.),* USSR(Altay-Sayan).——FIG. 67,*1*. **C. parvus,* R.Sanashtykgol, Sayan; oblique long. sec., ×3.3 (Vologdin, 1940b).

Family AGYREKOCYATHIDAE Konyushkov, 1967

[Agyrekocyathidae KONYUSHKOV, 1967, p. 110]

Solitary or colonial; outer wall with funnel-shaped pores provided with finely porous sheath; septa porous; tabulae with simple, rounded pores; inner wall with crooked pore-canals. *L.Cam.-base M.Cam.*

Agyrekocyathus KONYUSHKOV, 1967, p. 110 [**A. malovi;* OD]. Solitary or colonial; outer wall with funnel-shaped pores provided with finely porous sheath; septa porous; tabulae with simple, rounded pores; inner wall with crooked pore-canals. *?Up.L.Cam.-base of ?M.Cam.,* USSR (Kazakhstan).——FIG. 68,*1*. **A. malovi,* Mt. Agyrek, Kazakhstan; transv. sec. of holotype, ×1 (Konyushkov, 1967).

Family TANNUOLACYATHIDAE Debrenne, 1964

[Tannuolacyathidae DEBRENNE, 1964, p. 188]

Outer wall with simple pores; septa and tabulae porous; dissepiments may be present; inner wall thick and coarsely porous and covered on side of central cavity by finely porous sheath. *L.Cam.(low.Botom.).*

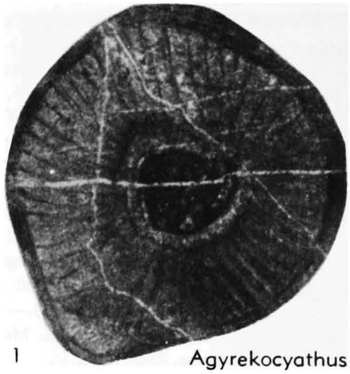


FIG. 68. Agyrekocyathidae (p. *E*96).

Tannuolacyathus VOLOGDIN, 1957, p. 496 [**T. multiplex;* OD]. Outer wall with simple pores; septa and tabulae porous; dissepiments may be present; inner wall thick and coarsely porous and covered on side of central cavity by finely porous sheath. *L.Cam.(low.Botom.),* USSR(Tuva)-N. Afr.(Morocco).——FIG. 67,*2*. **T. multiplex,* Tuva, part of long. sec., central cavity to right, ×5 (Vologdin, 1957c).

Superfamily CLATHRICOSCINACEA Rozanov, 1964

[*nom. transl.* DEBRENNE, 1964, p. 115 (*ex* Clathricoscinidae ROZANOV in REPINA, *et al.*, 1964, p. 223)]

Cups with outer wall formed from downturned edges of tabulae and reinforced by longitudinal ridgelets and finely porous external sheath; intervallum with simply porous septa and tabulae; inner wall with simple pores protected by bracts. *L.Cam. (Atdaban.-low.Len.).*

Family CLATHRICOSCINIDAE Rozanov, 1964

[Clathricoscinidae ROZANOV in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964, p. 223]

Cups with outer wall formed from downturned edges of tabulae and reinforced by longitudinal ridgelets and finely porous external sheath; intervallum with simply porous septa and tabulae; inner wall with simple pores protected by bracts. *L.Cam. (Atdaban.-low.Len.).*

Clathricoscinus ZHURAVLEVA, 1955, p. 627 [**Coscinocyathus infirmus* VOLOGDIN ("1937") in

ZHURAVLEVA, 1955, p. 627; OD]. Solitary or colonial; outer wall formed from downturned edges of tabulae reinforced by finely porous sheath applied to longitudinal ridgelets; septa and tabulae with simple rounded pores; inner wall with simple pores protected by bracts. *L.Cam.(Atdaban.-low.Len.),* USSR(Altay-Sayan-Sib.Platf.-Transbayk.-Far East)-Mongolia.——FIG. 69,*1*. **C. infirmus* (VOLOGDIN), L.Cam., USSR; *1a,* part of long. sec.; *1b,* part of transv. sec.; *1c,* tang. view outer wall and outer edges of tabulae; all ×25; *1d,* bract of inner wall, ×50 [*r,* longitudinal ridgelets; *s,* external sheath; *t,* tabula] (Zhuravleva, 1955).

Superfamily ANAPTYCTOCYATHACEA Debrenne, 1970

[Anaptyctocyathacea DEBRENNE, 1970, p. 25]

Cup conical or cylindrical; outer wall double, a coarsely porous framework, pores screened by sieves (see Debrenne, 1970b, p. 29); septa and tabulae simply porous; inner wall with simple pores. *L.Cam. (Atdaban.-Botom.).*

Family ANAPTYCTOCYATHIDAE Debrenne, 1970

[Anaptyctocyathidae DEBRENNE, 1970, p. 25]

Characteristics of superfamily. *L.Cam. (Atdaban.-Botom.).*

Anaptyctocyathus DEBRENNE, 1969, p. 340, as subgenus of *Alataucyathus* ZHURAVLEVA, 1955, p. 626 [**Coscinocyathus cribripora* R. BEDFORD & W. R. BEDFORD, 1934, p. 3; OD]. Cup conical or cylindrical; outer wall double, a coarsely porous framework, the pores screened by sieves (see Debrenne, 1970b, p. 29); septa and tabulae simply porous; inner wall simple, with two rows of pores to an intersept; toward top of cup the two neighboring pores may coalesce. *L.Cam.(Atdaban.-Botom.),* S.Australia-USSR(Altay-Sayan).——FIG. 69,*4*. **A. cribripora* (BEDFORD & BEDFORD), S. Australia (Ajax Mine), holotype; *4a,* part of transv. sec., *4b,* tang. sec. outer wall; *4c,* tang. sec. inner wall, all ×4 (5,BEDFORD & BEDFORD, 1934).

Superfamily ALATAUCYATHACEA Zhuravleva, 1955

[*nom. transl.* ZHURAVLEVA, 1960, p. 264 (*ex* Alataucyathidae ZHURAVLEVA, 1955, p. 626)] [=Sigmocoscinacea DEBRENNE, 1970, p. 25]

Cup conical or cylindrical; outer wall tumulose or of imperfect annuli; tumuli with one or many pores; septa and tabulae simply porous; inner wall simply porous and stellate in section, or of S-shaped pore-tubes, or of poorly developed annuli. *L. Cam.(Atdaban.-Botom.).*

Family ALATAUCYATHIDAE Zhuravleva, 1955

[Alataucyathidae ZHURAVLEVA, 1955, p. 626]

Cup conical or cylindrical; outer wall with knobby, multipored tumuli or of imperfect annuli; septa and tabulae simply porous; inner wall simply porous and stellate in section. *L.Cam.(Atdaban.-Botom.).*

Alataucyathus ZHURAVLEVA, 1955, p. 626 [**A. jaroschevitschi;* OD]. Cup solitary; outer wall with multipored tumuli; septa and tabulae porous; inner wall with simple pores and with those parts between neighboring septa projecting like low folds into central cavity, or unfolded. *L.Cam.(Atdaban.-Botom.),* USSR(Altay-Sayan).——FIG. 69,*3*. **A. jaroschevitschi,* Kuznetsk Alatau; part of transv. sec., ×15 (Zhuravleva, 1955).

Family ETHMOCOSCINIDAE Zhuravleva, 1957

[Ethmocoscinidae ZHURAVLEVA in VOLOGDIN, 1957, p. 208] [=Tumulocoscininae ZHURAVLEVA, 1960, p. 265; Ethmocoscininae HILL, 1965, p. 110]

Cup solitary; outer wall with simple tumuli each with one pore; septa and tabulae simply porous; inner wall simply porous and unfolded or longitudinally fluted, or formed of single longitudinal row of S-shaped pore-tubes to each intersept. *L.Cam.(Atdaban.-Botom.).*

Ethmocoscinus SIMON, 1939, p. 28 [**Coscinocyathus papillipora* R. BEDFORD & W. R. BEDFORD, 1934, p. 4; OD]. Cup solitary, conical or cylindrical; outer wall with single-pored tumuli, one longitudinal row to an intersept; septa with sparse simple pores and tabulae with polygonal, somewhat irregular pores; inner wall of S-shaped pore-tubes, single longitudinal row to an intersept. *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia-?Can.——FIG. 8,*2;* 69,*8*. **E. papillipora* (BEDFORD & BEDFORD), holotype, S.Australia (Ajax Mine); 8,*4;* 69,*8*, 2 views, both ×4 (Hill, 1965).

Asterotumulus KASHINA in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964, p. 229 [**A. receptori;* OD]. Solitary; outer wall with single-pored tumuli; septa and tabulae simply porous; inner wall longitudinally sharply folded, each intersept projecting into central cavity; pores of inner wall simple. *L.Cam.(Atdaban.-Botom.),* USSR(Sayan-Sib.Platf.).——FIG. 69,*5*. **A. recep-*

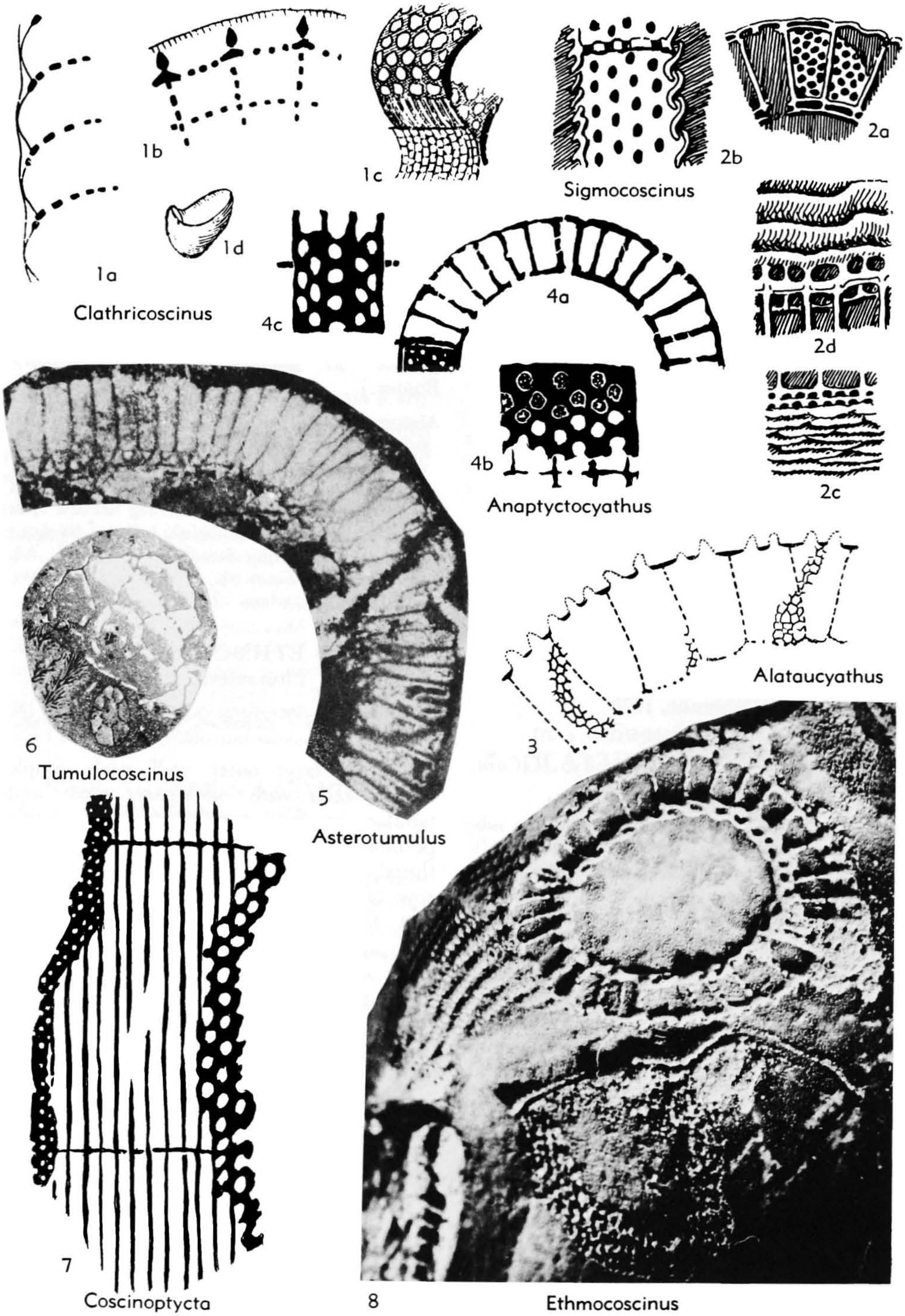


FIG. 69. Clathricoscinidae *(1)*; Anaptyctocyathidae *(4)*; Alataucyathidae *(3)*; Ethmocoscinidae *(5-8)*; Sigmocoscinidae *(2)* (p. *E96-E97*, *E99*).

tori, Bazaikh., Sayan; part of transv. sec., ×6 (Repina, *et al.,* 1964).

Coscinoptycta Broili, 1915, p. 121 [*nom. subst. pro Coscinoptycha* Taylor, 1910, p. 141 (type, *C. convoluta*) (*non Coscinoptycha* Meyrick, 1881, an insect)] [**Coscinoptycha convoluta* Taylor, 1910, p. 141; SD Simon, 1939, p. 26]. Cup large and bowl-shaped with irregular longitudinal folds; outer wall with one longitudinal row of laterally perforated simple tumuli to an intersept; inner wall with 2 or 3 longitudinal rows of pores protected by spines; intervallum very narrow; septa porous to aporose; tabulae remote, with micropores. [Diagnosis by courtesy of Dr. F. Debrenne who has studied the type material.] *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia-Antarct.-Eu.(?Sardinia).——Fig. 4,*11;* 69,*7.* **C. convoluta* (Taylor), S.Australia (Ajax Mine); 4,*11,* reconstr.; 69,*7,* part of long. sec., enl. (Taylor, 1910).

Tumulocoscinus Zhuravleva, 1960, p. 265 [**T. atdabanensis;* OD]. Cup not large; outer wall with single-pored tumuli; septa, tabulae and inner wall with simple pores. *L.Cam.(Atdaban.-low. Botom.),* USSR(Sib.Platf.)-N.Afr.(Morocco).——Fig. 69,*6.* **T. atdabanensis,* R. Lena, Sib.Platf., holotype; transv. sec., ×10 (Zhuravleva, 1960b).

Family SIGMOCOSCINIDAE R. Bedford & J. Bedford, 1939

[Sigmocoscinidae R. Bedford & J. Bedford, 1939, p. 76]

Cup solitary and conical or cylindrical; each intersept of outer wall with lower edges of pores projecting as bracts that may fuse laterally forming imperfect annular shelves; septa and tabulae simply porous; inner wall of annuli, S-shaped in section. *L.Cam.(up.Atdaban.* or *low.Botom.).*

Sigmocoscinus R. Bedford & J. Bedford, 1936, p. 24 [**S. sigma;* OD]. Cup solitary, conical or cylindrical; each intersept of outer wall with several longitudinal rows of pores, pores also arranged in horizontal rows; lower edges of pores project as bracts that may fuse laterally to form imperfect annular shelves; septa and tabulae simply porous, tabulae flat; inner wall of annuli, S-shaped in section. *L.Cam.(up.Atdaban.* or *low. Botom.),* S.Australia.——Fig. 69,*2.* **S. sigma,* S.Australia (Ajax Mine); *2a,* transv. sec.; *2b,* radial long. sec.; *2c,* tang. sec. outer wall; *2d,* tang. sec. inner wall, all ×8 (Bedford & Bedford, 1936).

?**Schumnyicyathus** Zhuravleva, 1968, p. 164 [**S. validus;* OD]. Solitary, cup slenderly conical; outer wall of large rounded pore-tubes, S-formed in longitudinal section, each tube closed externally with finely perforate screen; septa and tabulae simply porous; inner wall of annuli, S-formed in longitudinal section of cup. *L.Cam.(low.Botom.),* USSR(R.Sukharikha, Sib.Platf.).——Fig. 70,*1.* **S. validus; 1a,* part of transv. sec. of inner wall [*cc,* central cavity; *s,* septum; *t,* trace of wall of pore-tube]; *1b,* part of long. sec. outer wall [*i,* intervallum], diagram. (Zhuravleva, 1968b).

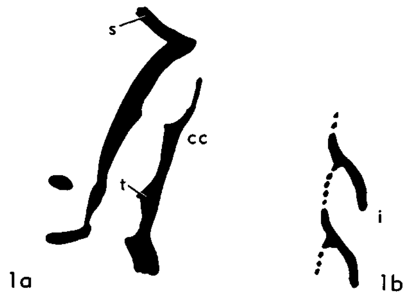


Fig. 70. Sigmocoscinidae (p. E99).

Superfamily ROZANOVICYATHACEA Korshunov, 1969

[Rozanovicyathacea Korshunov in Zhuravleva, Korshunov, & Rozanov, 1969, p. 54]

Outer wall with geniculate canals or S-shaped canals; intervallum with simply porous septa and tabulae; inner wall with simple pores with bracts, or of V-shaped pore tubes. *L.Cam.(Botom.).*

Family ROZANOVICYATHIDAE Korshunov, 1969

[Rozanovicyathidae Korshunov in Zhuravleva, Korshunov, & Rozanov, 1969, p. 54]

Outer wall with geniculate canals or S-shaped canals; septa porous and tabulae with simple or chinky pores; inner wall with large pores with bracts. *L.Cam. (Botom.).*

Rozanovicyathus Korshunov in Zhuravleva, Korshunov, & Rozanov, 1969, p. 54 [**R. alexi;* OD]. Cup conical or cylindrical; outer wall with geniculate canals, opening downwards; septa porous, tabulae with chinky pores; inner wall with one longitudinal row of large pores with bracts to each intersept. *L.Cam.(Botom.),* USSR(Sib. Platf.).——Fig. 71,*1.* **R. alexi,* R. Mukhatta, Sib. Platf.; *1a,* transv. sec., ×6; *1b,* oblique long. sec., ×6 (Zhuravleva, 1969).

Family POROCOSCINIDAE Debrenne, 1964

[Porocoscinidae Debrenne, 1964, p. 190]

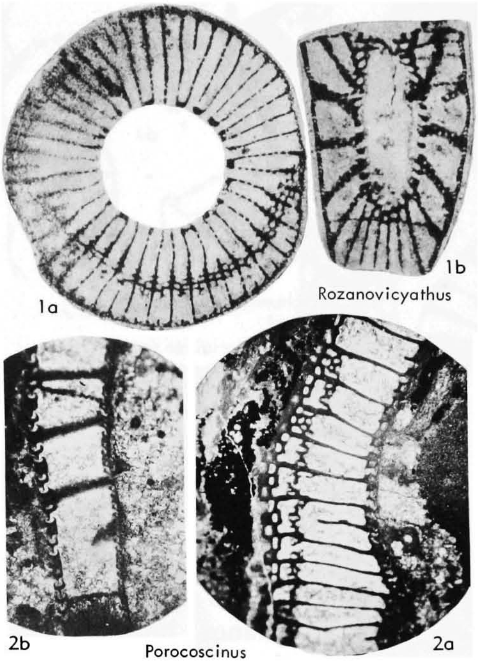


FIG. 71. Rozanovicyathidae *(1)*; Porocoscinidae *(2)* (p. *E*99-*E*100).

Pores of outer wall each protected by bract surrounding its base and sides; septa and tabulae porous; inner wall with rectangular pores, and V-shaped pore-tubes. *L.Cam.(up.Atdaban.* or *Botom.).*

Porocoscinus DEBRENNE, 1964, p. 190 [**P. flexibilis;* OD]. Cup solitary; pores of outer wall each protected by bract rising from its base and sides; septa and tabulae porous; inner wall with rectangular pores, from base of each pore springs, on the intervallar side, a louvre-like plate extending upward into intervallum, and on side of central cavity, a scoop that protects base and sides of pore. *L.Cam.(up.Atdaban.* or *Botom.),* Eu.(Sardinia).——FIG. 71,*2*. **P. flexibilis,* holotype; *2a,b,* parts transv. and long. secs., ×6 (Debrenne, 1964).

Superfamily MRASSUCYATHACEA Vologdin, 1960

[*nom. transl.* ZHURAVLEVA & ROZANOV in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964, p. 130 (*ex* Mrassucyathidae VOLOGDIN in ZHURAVLEVA, KRASNOPEEVA, & CHERNYSHEVA, 1960, p. 130)] [=Calyptocoscinacea DEBRENNE, 1964, p. 115]

Solitary or rarely colonial; outer wall a framework with large pores covered by finely porous external sheath; septa and tabulae porous; inner wall with multipored tumuli, or of intercommunicating pore-canals, simply porous, or of large pores covered by finely porous sheath on side of central cavity. *L.Cam.(Atdaban.-Botom.).*

Family MRASSUCYATHIDAE Vologdin, 1960

[Mrassucyathidae VOLOGDIN in ZHURAVLEVA, KRASNOPEEVA, & CHERNYSHEVA, 1960, p. 130] [=Mrassocyathidae VOLOGDIN, 1956, p. 879, *nom. nud.*]

Solitary; outer wall coarsely porous with finely porous external sheath; septa and tabulae porous; inner wall with multipored tumuli. *L.Cam.(Atdaban.).*

Mrassucyathus KRASNOPEEVA in ZHURAVLEVA, KRASNOPEEVA, & CHERNYSHEVA, 1960, p. 130 [**M. schoriensis;* OD] [=*Mrassocyathus* KRASNOPEEVA in VOLOGDIN, 1956, p. 879, *nom. nud.; Mrassocyathus* KRASNOPEEVA, 1960, p. 38 (type, *M. micropora;* M), *nom. null.*]. Solitary; with longitudinal folds; outer wall coarsely porous with a finely porous external sheath; septa and tabulae porous; inner wall with one to two longitudinal rows of multipored tumuli to each intersept. *L. Cam.(Atdaban.),* USSR(Shoria Mts.).——FIG. 72,*1*. **M. schoriensis,* Bazaikha; part of oblique long. sec., ×5 (Zhuravleva, Krasnopeeva, & Chernysheva, 1960).

Family KASYRICYATHIDAE Zhuravleva, 1961

[Kasyricyathidae ZHURAVLEVA, 1961, p. 29]

Outer wall with large pores and covered by a finely porous external sheath; septa and tabulae porous; inner wall of intercommunicating pore canals. *L.Cam.(Atdaban.-Botom.).*

Kasyricyathus ZHURAVLEVA, 1961, p. 31 [**K. schirokovae;* OD]. Outer wall with large pores and covered by a finely porous external sheath; septa and tabulae porous; inner wall of intercommunicating pore-canals, one longitudinal row to an intersept. *L.Cam.(Botom.),* USSR(Sayan).——FIG. 73,*1*. **K. schirokovae; 1a,* oblique sec., ×6.4; *1b,* part of transv. sec., inner wall of holotype, ×12.8 (Repina, *et al.*, 1964).

Orienticyathus BELYAEVA, 1969, p. 95 [**O. mamontovi;* OD]. Solitary or colonial; cup slenderly conical or cylindrical; outer wall a framework and microporous sheath; septa and tabulae simply porous; inner wall with numerous (up to 13) rows of geniculate pore-canals to an intersept. *L.Cam.(Atdaban.),* USSR(Far East).——FIG. 73,*4*. **O. mamontovi,* R. Gerbikan, Far East; holotype, part of transv. sec., inner wall below, ×12.8 (Zhuravleva, 1969).

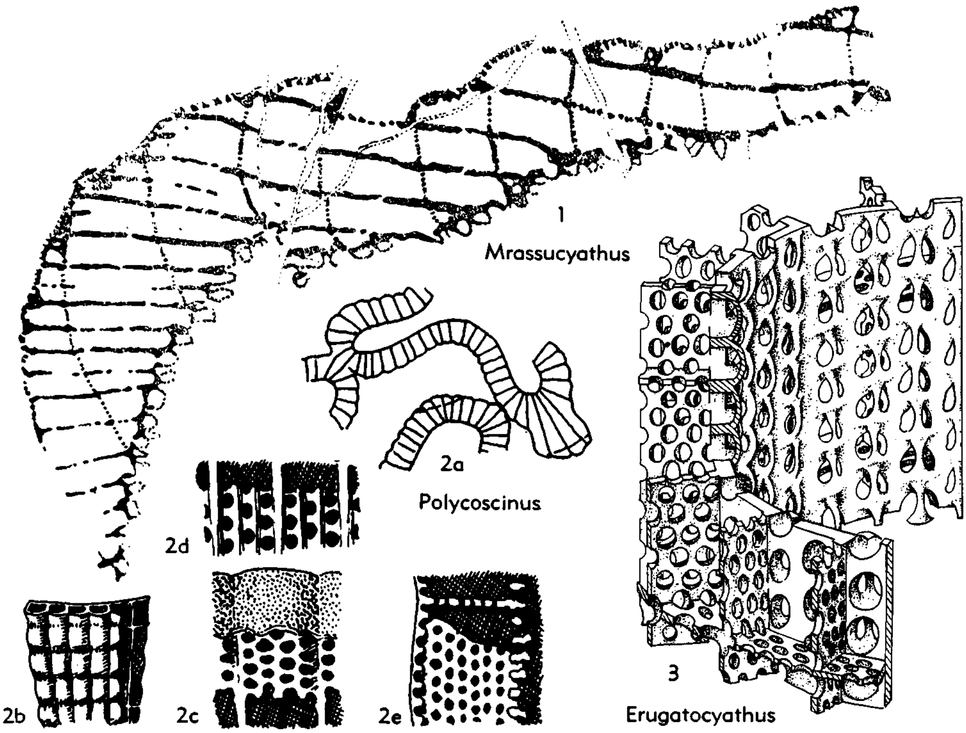


FIG. 72. Mrassucyathidae *(1)*; Polycoscinidae *(2-3)* (p. *E*100-*E*101).

Family POLYCOSCINIDAE Debrenne, 1964

[Polycoscinidae DEBRENNE, 1964, p. 194]

Solitary or colonial; outer wall with large pores and covered by a finely porous external sheath; septa and tabulae porous; inner wall simply porous, may be longitudinally plicate or with spines. *L.Cam. (Atdaban.-Botom.)*.

Polycoscinus R. BEDFORD & J. BEDFORD, 1937, p. 37 [**P. contortus;* OD]. Colonial, increasing by bifurcation; cup longitudinally furrowed at porous septa and transversely furrowed independently of the flat tabulae whose pores are closed; outer wall with large pores in 3 or 4 longitudinal rows to an intersept and covered by finely porous sheath; inner wall with longitudinal ridges toward intervallum and cupules over pores in lower part of cup toward central cavity. *L.Cam.(?Botom.)*, S. Australia("Paint Mine").——FIG. 72,*2*. **P. contortus;* transv. sec. of colony, ×1.3; *2b,* surface view of outer wall, ×2.5; *2c,* tang. sec. outer wall, ×11; *2d,* outer view of inner wall, ×11; *2e,* radial long. sec. showing septum and tabulae, ×11 (Bedford & Bedford, 1937).

Erugatocyathus DEBRENNE, 1969, p. 334 [**Coscinocyathus papillatus* R. BEDFORD & W. R. BEDFORD, 1934, p. 3; OD]. Like *Tomocyathus* but with unfolded inner wall. *L.Cam.(Atdaban.-low. Botom.)*, S.Australia-USSR(Altay-Sayan)-N.Afr. ——FIG. 72,*3*. **E. papillatus* (BEDFORD & BEDFORD), ?Botom., S.Australia("Paint Mine"); reconstr., enl. (Debrenne, 1969a).

Tomocyathus ROZANOV, 1960, p. 663 [**T. operosus;* OD]. Solitary; outer wall with large pores and covered by a finely porous external sheath; septa and tabulae porous; rare dissepiments; inner wall simply porous, longitudinally plicate. *L.Cam. (Atdaban.-Botom.)*, USSR(Altay-Sayan-Sib.Platf.-Far East)-S.Australia-N.Afr.——FIG. 73,*2*. **T. operosus,* Atdaban., R.B.Erba; *2a,* part of transv. sec., ×3; *2b,* holotype, part of transv. sec., ×3 (Rozanov & Missarzhevskiy, 1966).

Family CALYPTOCOSCINIDAE Debrenne, 1964

[Calyptocoscinidae DEBRENNE, 1964, p. 196]

Outer wall with large pores and covered by a finely porous external sheath; septa and tabulae porous; inner wall coarsely

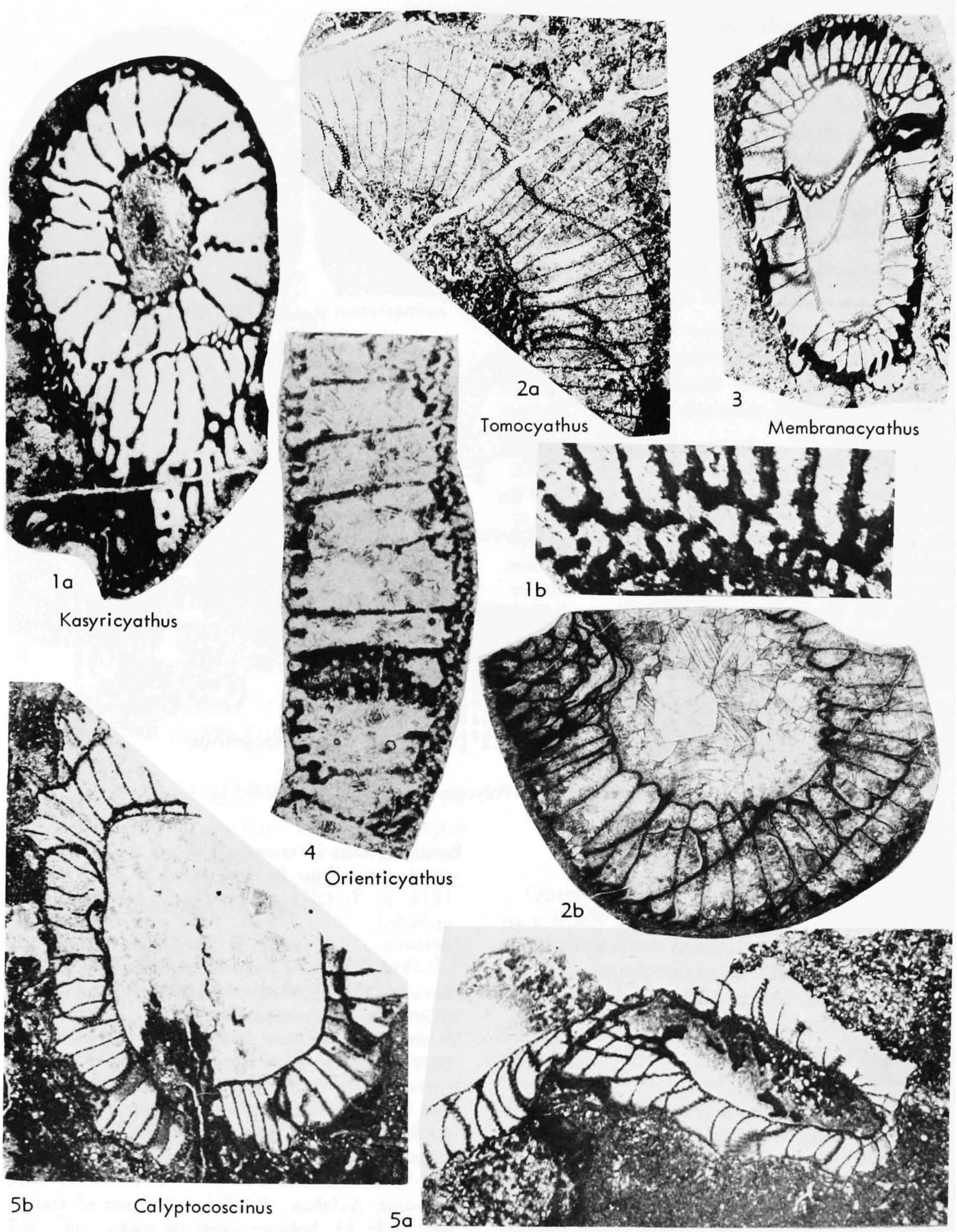


FIG. 73. Kasyricyathidae *(1,4)*; Polycoscinidae *(2)*; Calyptocoscinidae *(3-5)* (p. *E*100-*E*103).

porous and covered on side of central cavity by finely porous sheath. *L.Cam.(Atdaban.-low.?Botom.)*.

Calyptocoscinus DEBRENNE, 1964, p. 196 [**Coscinocyathus cornucopiae* BORNEMANN, 1887, p. 63 *(partim)*; OD]. Slenderly conical, with irregular bourrelets developed between tabulae; outer and inner walls coarse, each with finely porous sheath on side away from intervallum. *L.Cam.(up. Atdaban.-low.?Botom.)*, Eu.(Sardinia).——FIG. 73,5. **C. cornucopiae* (BORNEMANN); Atdaban or low.?Botom.; *5a,b*, parts of long. and transv. secs. of paratype, ×3.8 (Debrenne, 1964).

Membranacyathus Rozanov, 1960, p. 664 [**M. repinae;* OD]. Outer wall with large pores and covered by finely porous external sheath; septa and tabulae porous; inner wall coarsely porous and covered on side of central cavity by finely porous sheath. *L.Cam.(Atdaban.),* USSR(Shoria Mts.).——Fig. 73,*3*. **M. repinae,* Kameshki, Mrassu; oblique sec., holotype, ×3 (Rozanov, 1960a).

Class IRREGULARES Vologdin, 1937

[*nom. correct.* Zhuravleva, 1960, p. 267 (as subclass) (*ex* Irregularia Vologdin, 1937, p. 461)] [=Syringoidea Krasnopeeva, 1953b, p. 55 (class); Anthocyathea Okulitch, 1955, p. *E*18 (*ex* Anthocyatha Okulitch, 1943); Taenioidea Vologdin, 1959a, p. 1134 (class)]

Solitary, rarely colonial; cup conical in outer form, ranging from cylindrical to discoid, outline frequently irregular. Cups with one or commonly two porous walls; intervallum with rods and bars or septa and commonly with tabulae and always with dissepiments; septa are commonly porous, pores arranged in longitudinal rows arching upward and outward from inner wall, at right angles to curvature of tabulae, whose axis of curvature coincides with axis of cup; pores of outer wall may be of irregular outline. In early stages of *Metacyathus* type, aporose tip widens and extends as one-walled porous cup in which first dissepiments and randomly disposed rods and bars arise, then, later than in Regulares, inner wall, and finally septa and tabulae. *L.Cam.-M.Cam.(Paradoxides oelandicus Zone);* one genus in *U.Cam.,* Antarct.

Order THALASSOCYATHIDA Vologdin, 1962

[Thalassocyathida Vologdin, 1962, p. 116] [This name replaces Rhizacyathida Zhuravleva, 1955, p. 629, which was based on *Rhizacyathus* R. Bedford & J. Bedford, 1939, p. 69, an invalid name based on *Protopharetra radix* R. Bedford & J. Bedford, 1937, p. 28 as type-species; Debrenne, 1970, p. 41, concluded that *R. radix* is not an independent species but may be only a part of a tersioid outgrowth]

Cup one-walled, with a single internal cavity in which are rods or bars and dissepiments. *L.Cam.(Tommot.-Botom.).*

Family BACATOCYATHIDAE Zhuravleva, 1960

[*nom. correct.* Hill, 1965, p. 116 (*pro* Batchatocyathidae Zhuravleva, 1960, p. 268)] [=?Thalassocyathidae Vologdin, 1962, p. 116]

Cup one-walled, internal cavity with dissepiments but lacking rods; wall with sparse, simple pores. *L.Cam.(Tommot.-Botom.).*

Bacatocyathus Vologdin, 1940, p. 95 [*nom. correct.* Hill, 1965, p. 116 (*pro Bačatocyathus* Vologdin, 1940, p. 95)] [**B. kazakevici;* OD] [=*Cysticyathus* Zhuravleva, 1955, p. 629 (type, *C. tunicatus;* OD); *Batschatocyathus* Vologdin, 1956, p. 878 *(nom. null.); Batchatocyathus* Zhuravleva, 1960, p. 268 *(nom. null.)*]. Cup solitary, of irregular baggy form, with marked swellings and indentations. Single wall has sparse simple pores, irregularly arranged; only dissepiments in internal cavity. *L.Cam.(Tommot.-Botom.),* USSR(S. Urals-Altay-Sayan-Sib.Platf.).——Fig. 74,*5*. **B. kazakevici,* Tommot.-Botom., Salair; long. sec., ×4 (Zhuravleva, 1963b).

Thalassocyathus Vologdin, 1957, p. 699 [**T. acutatus;* M]. Cup slenderly conical, small, with constrictions; single-walled; in early stages filled with dissepiments and sparse, more or less distinctly porous tabulae [?]. Incompletely described. *L.Cam.(Botom.),* USSR(Sayan).——Fig. 74,*1*. **T. acutatus;* long. sec., ×7.5 (Vologdin, 1957d).

Order ARCHAEOCYATHIDA Okulitch, 1935

[*nom. correct.* Zhuravleva, 1950, p. 9 (*pro* Archaeocyathina Okulitch, 1935, p. 90)] [=Metacyathina R. Bedford & W. R. Bedford, 1936, p. 16 (order); Dictyocyanthina (*sic*) R. Bedford & J. Bedford, 1937, p. 37; Spirocyathida Zhuravleva, 1950, p. 10; Metacyathida Okulitch, 1955, p. *E*14 (order); Dictyocyathida Vologdin, 1956, p. 878 (order); Bicyathida Vologdin, 1956, p. 878 (order); Bicyathina Vologdin, 1962, p. 117 (superorder); Chouberticyathida Debrenne, 1970, p. 25 (order); Archaeopharetrida Debrenne, 1970, p. 25 (order); Metaldetida Debrenne, 1970, p. 25; Paranacyathida Debrenne, 1970, p. 25; Paracoscinida Debrenne, 1970, p. 25]

Solitary or colonial; cup cylindrical, conical or discoid, frequently of irregular outline or with outgrowths. Outer wall simply porous or partially substituted by dissepiments; inner wall commonly with one longitudinal row of simple pores to an intersept, or rarely, of annuli. In intervallum are dissepiments, rods, and bars differently orientated, or septa; septa may be constituted by curved plates (taeniae), and may be flat-sided or waved or interrupted; tabulae may occur. *L.Cam.-M.Cam.(Paradoxides oelandicus Zone).*

Suborder ARCHAEOCYATHINA Okulitch, 1935

[*nom. transl.* Zhuravleva, 1960, p. 271 (*ex* Archaeocyathida Zhuravleva, 1950, p. 9, *nom. correct. pro* Archaeocyathina

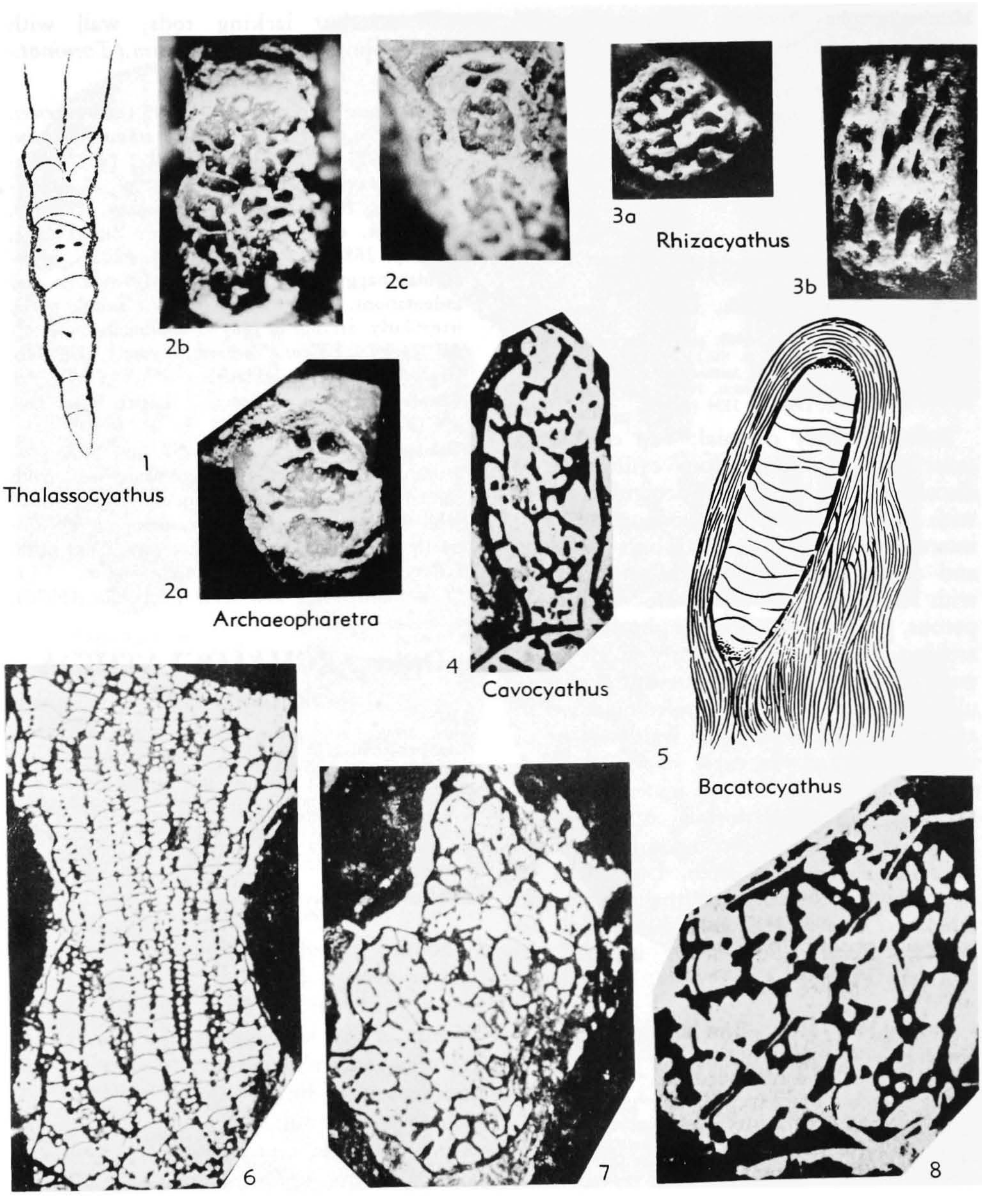


FIG. 74. Bacatocyathidae *(1,5)*; Archaeopharetridae *(2)*; Family Uncertain *(3-4,6-8)* (p. E103, E105, E132).

OKULITCH, 1935, p. 90 (order))] [=Chouberticyathida DEBRENNE, 1970, p. 25 (order); Archaeopharetrida DEBRENNE, 1970, p. 25 (order); Metaldetida DEBRENNE, 1970, p. 25 (order); Paranacyathida DEBRENNE, 1970, p. 25 (order)]

Cup cylindrical, fungoid, discoid or of irregular form; outer wall with simple pores, in some with external microporous sheath; inner wall with simple pores or of annuli; intervallum with radial rods and tangential transverse bars, or with septa, but without tabulae (except in Anthomorphidae). *L.Cam.-M.Cam.(Paradoxides oelandicus Zone).*

Family ARCHAEOPHARETRIDAE Debrenne, 1970

[Archaeopharetridae DEBRENNE, 1970, p. 29] [=Archaeopharetrida DEBRENNE, 1970, p. 25 (order)]

Outer wall non-porous; intervallum with irregular skeletal elements, bar- or platelike, mainly longitudinal or oblique more or less radial, and with dissepiments; inner wall defined at diameter of 2 mm., but may be obscured by presence of skeletal bars and dissepiments in the central cavity. *L.Cam. (Atdaban.* or *low.Botom.).*

Archaeopharetra R. BEDFORD & W. R. BEDFORD, 1936, p. 17 [**A. typica;* OD]. Small cups with an aporose outer wall; a true inner wall is defined late [at a diameter of 2 mm. in typical material], but may be obscured by dissepiments and irregular skeletal elements that are bar- or platelike, mostly placed in longitudinal or oblique positions but more or less radial; the apical part may consist of one wall and dissepiments only. *L.Cam. (up.Atdaban.* or *low.Botom.),* S.Australia.——FIG. 74,*2*. **A. typica,* holotype, S.Australia(Ajax Mine); *2a-c,* 3 views, all ×5 (photo courtesy of MAX DEBRENNE, Paris; negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris).

Family BICYATHIDAE Vologdin, 1937

[Bicyathidae VOLOGDIN, 1937, p. 472] [=?Terektigocyathidae VOLOGDIN, 1962, p. 419]

Solitary or colonial; outer wall with simple pores or aporose; inner wall with simple pores; intervallum with dissepiments and with longitudinal discrete rods, but without septa and tabulae. *L.Cam.(up. Tommot.-Botom.).*

Bicyathus VOLOGDIN, 1939, p. 235 [**B. angustus;* OD] [=*Bicyathus* VOLOGDIN, 1937b, p. 472 *(nom. nud.); Potekhinocyathus* VOLOGDIN, 1957, p. 699 (type, *P. bateniensis;* M); *?Terektigocyathus* VOLOGDIN, 1962, p. 420 (type, *T. primus;* OD); *Potechinocyathus* ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 118 *(nom. null.); Terectigocyathus* ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 118 *(nom null.)*]. Solitary or colonial; cup of cylindrical form, with strong swellings and constrictions. Outer wall with simple pores or aporose; inner wall with simple pores; dissepiments and rare short longitudinal or slightly inclined rods in the intervallum, but no septa or tabulae. *L.Cam.(up.Tommot.-Botom.),* USSR(S. Urals-Altay-Sayan)-Mongolia-N.Afr. (Morocco). ——FIG. 75,*1a,b*. **B. angustus,* Atdaban., S.Urals; *1a,b,* long. and transv. secs., ×10 (Vologdin, 1939).——FIG. 12,*3*. *B. bateniensis* (VOLOGDIN), ?Botom., Kuznetsk Alatau; long. sec., ×7 (Vologdin, 1957).——FIG. 75,*1c,d*. *?B. primus* (VOLOGDIN), ?Botom., Tuva; *1c,d,* transv. and long. secs., ×7 (Vologdin, 1962a).

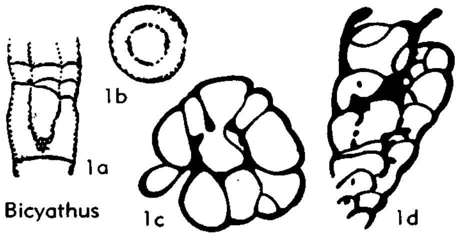


FIG. 75. Bicyathidae (p. E105).

Family DICTYOCYATHIDAE Taylor, 1910

[Dictyocyathidae TAYLOR, 1910, p. 111] [=Chouberticyathida DEBRENNE, 1970, p. 25 (order)]

Solitary, cup of diverse form but not discoid, commonly attached; outer wall aporose or simply porous and connected to inner wall by radial or longitudinal and oblique rods; dissepiments present; synapticulae may connect radial rods; no septa or tabulae; inner wall not distinct, thin, with large pores in one longitudinal row to each interradial strip. Earliest stage with single aporose wall, followed by dissepiments and disoriented rods; central cavity appears later. *L.Cam.(mid.Tommot.-Botom.).*

Dictyocyathus BORNEMANN, 1891, p. 500 [**D. tenerrimus;* M]. Cup conical or cylindrical, or fungoid, with dents and outgrowths and attachment processes; outer wall compact at base, in adult stages formed by densely packed and small intervallar elements; scaffolding of cylindrical or flattened rods in intervallum, reinforced at points of junction; dissepiments commonly present but subordinate; inner wall simply porous, formed by ends of intervallar rods. *L.Cam.(mid.Tommot.-Botom.),* Eu.(Sardinia-Spain)-N.Afr.(Morocco)-S.Australia-?Antarct.-USSR (S.Urals-Altay-Sayan-Sib.Platf.-Transbayk.).

D.(Dictyocyathus). Fingerlike extrusions of intervallum not developed; rods of intervallar mesh without spinules. *L.Cam.(mid.Tommot.-Botom.),* Eu.(Sardinia-Spain)-N.Afr.(Morocco)-S.Australia-?Antarct.-USSR (S.Urals-Altay-Sayan-Sib.Platf.-Transbayk.).——FIG. 76,*3a*. *D. (D.)* sp., diagram. view of long., transv. radial and transv. tang. rods of part of intervallum, ×67 (Zhuravleva, 1960).——FIG. 76,*3b*. *D. (D.) stipatus* DEBRENNE, Morocco; transv. sec., ×5 (Debrenne, 1964).

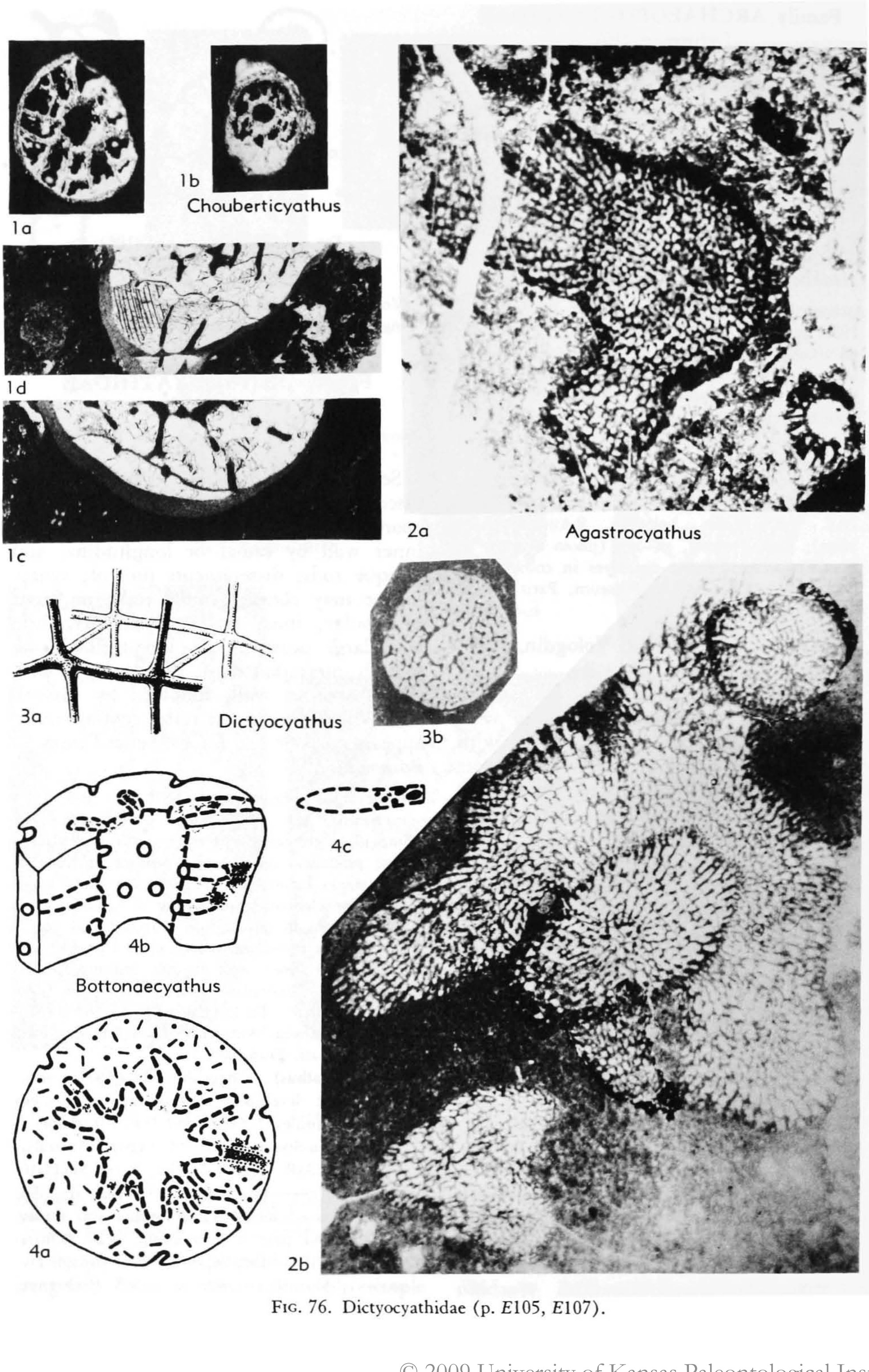


FIG. 76. Dictyocyathidae (p. E105, E107).

D.(Echinocyathus) Termier & Termier, 1950, p. 47 [**E. goundafensis;* OD] [*non Echinocyathus* Vologdin, 1960, p. 424 (type, *E. bilateralis;* OD)]. With fingerlike extrusions of intervallum in the adult stages; rods of intervallar mesh without spinules. *L.Cam.(Botom.),* N.Afr.(Morocco).

D.(Spinosocyathus) Zhuravleva, 1960, p. 276 (as genus) [**Spinosocyathus maslennikovae;* OD]. Without fingerlike extrusions of intervallum in adult stages, but with spinules clothing rods of intervallar mesh. *L.Cam.(mid.Tommot.-low. Atdaban.),* USSR(Sib.Platf.).

Agastrocyathus Debrenne, 1964, p. 209 [**Protopharetra gregaria* Debrenne, 1961, p. 21; OD]. Cup colonial or solitary; outer wall regular net, sheathed with outer pellis or microporous membrane; intervallar network of rods arranged in regular longitudinal rows without marked radial disposition, but with tangential and oblique connecting rods of similar diameter; such network also fills narrow central cavity, so that inner wall is indistinct and marked only by slight thickening of component rods; large subhorizontal dissepiments occur but no tabulae. *L.Cam.(Atdaban.),* N.Afr.(Morocco)-Eu.(Sardinia-France [Montagne Noire]).——Fig. 76,*2a*. **A. gregarius* (Debrenne, Atdaban., Morocco(Talaïnt); thin sec., ×4 (Debrenne, 1964).——Fig. 76,*2b*. *A. chouberti* (Termier & Termier), Atdaban., Morocco; thin sec., ×4 (Debrenne, 1964).

Bottonaecyathus Rodionova in Zhuravleva, Zadorozhnaya, Osadchaya, Pokrovskaya, Rodionova, & Fonin, 1967, p. 87 [**B. astraeformis;* OD]. Solitary, rarely colonial; outer wall indistinct; in intervallum, radial rows of longitudinal and transverse rods, united tangentially by rods as in *Dictyocyathus;* subhorizontal canal-like spaces project from central cavity into or through intervallum and are lined by prolongations of simply porous inner wall. *L.Cam.(Botom.),* USSR (Altay-Sayan)-N.Afr.(Morocco).——Fig. 76,*4*. **B. astraeformis,* Tuva; *4a,* transv. sec., *4b,* long. sec., *4c,* canal; all diagram., enl.(Zhuravleva, Zadorozhnaya, *et al.,* 1967).

Chouberticyathus Debrenne, 1964, p. 208 [**C. clatratus;* OD]. Cup solitary; outer wall aporose; inner wall porous; scaffolding of longitudinal and transverse cylindrical rods in intervallum, with dissepiments. *L.Cam.(up.Atdaban.-Botom.),* N. Afr.(Morocco)-S.Australia.——Fig, 76,*1*. **C. clatratus,* up.Atdaban., Morocco; *1a,b,* transv. secs., holotype, ×3; *1c,d,* parts of transv. and long. secs. paratype, ×4, ×3 (Debrenne, 1964).

?Pinacocyathus R. Bedford & W. R. Bedford, 1934, p. 4 [**P. spicularis;* M]. Outer wall a scaffolding of longitudinal pillars connected by horizontal or slightly oblique rods, inner wall probably a regular net; two walls connected by oblique, or radial horizontal rods; no dissepiments or tabulae observed (see Debrenne, 1970, p. 39).

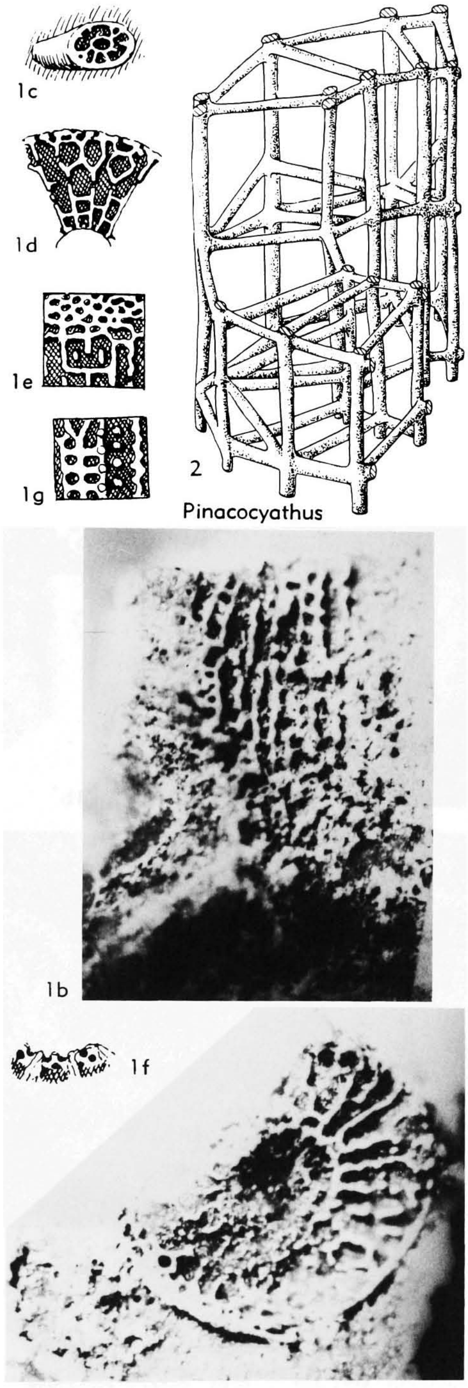


Fig. 77. Dictyocyathidae *(2);* Metacyathidae *(1)* (p. *E*107-*E*108, *E*111-*E*112).

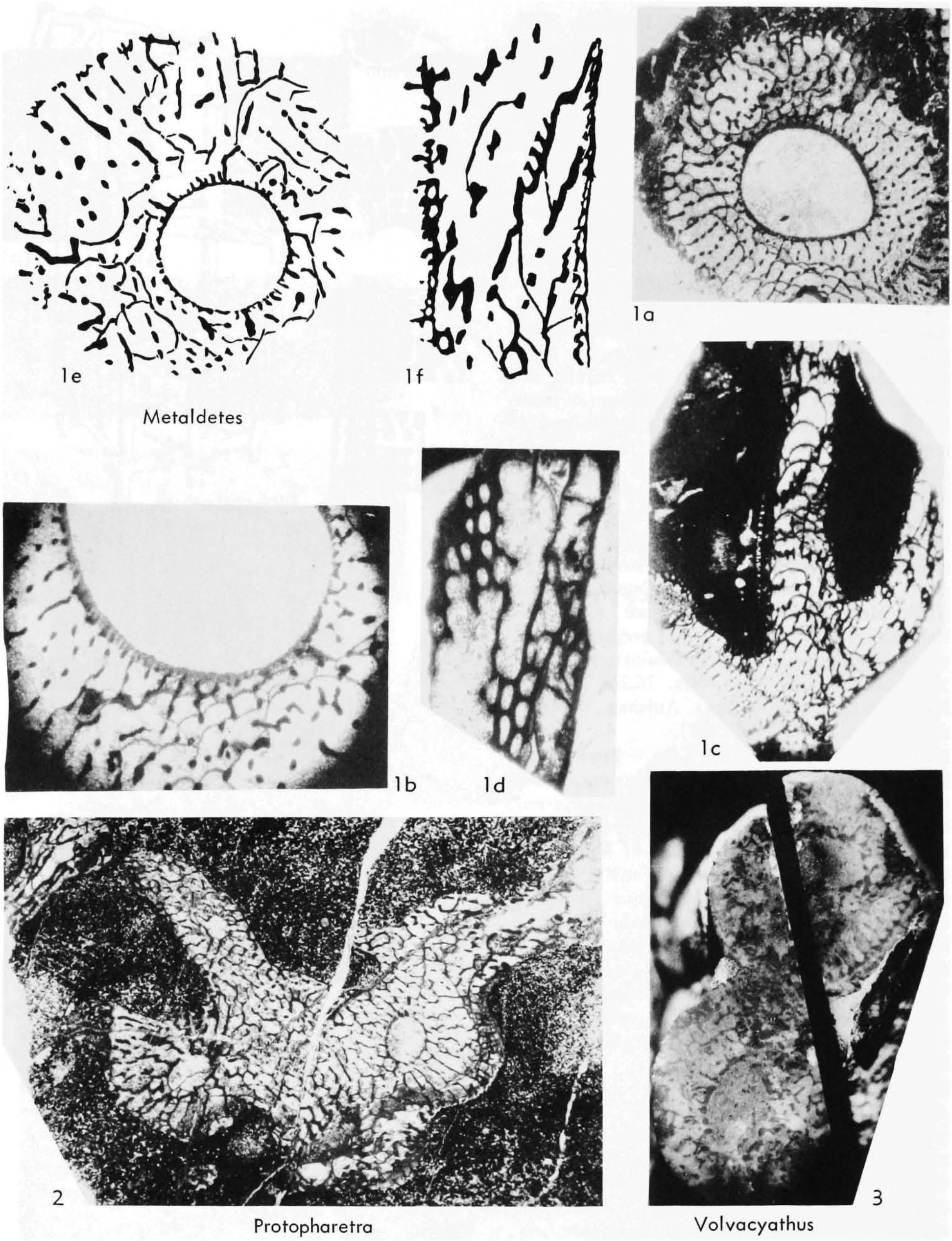


FIG. 78. Protopharetridae *(2,3)*; Metacyathidae *(1)* (p. E109-E111).

L.Cam.(up.Atdaban. or *low.Botom.)*, S.Australia. ——FIG. 77,2. **P. spicularis;* diagram. reconstr., enl. (Debrenne, 1969a).

Family PROTOPHARETRIDAE Vologdin, 1957

[Protopharetridae VOLOGDIN, 1957, p. 209]

Solitary or colonial; cups conical to cylindrical; outer wall with simple or screened pores; in intervallum are dissepiments and small radial platelets connected by thin branches or by synapticulae; inner wall with large pores. *L. Cam.(mid.Tommot.-low.Len.).*

Protopharetra BORNEMANN, 1884, p. 705 [**P. polymorpha;* SD SIMON, 1939, p. 34]. Colonial, rarely solitary; cups conical or cylindrical, with outgrowths and adherent processes; outer wall with simple, commonly very sparse, pores; inner wall appears late in ontogeny, with 1 or 2 longitudinal rows of large pores to each intersept; in the intervallum are dissepiments and small, branching platelets connected to one another by thin branches or by little rods; these platelets are arranged in files widening slightly towards exterior, files being less persistent radially than longitudinally except near inner wall so that septa are not well-defined; the connections between neighboring files are oblique. (See Debrenne, 1964.) *L.Cam.(mid.Tommot.-low.Len.),* Eu. (Sardinia)-N.Afr. (Morocco)-USSR (Urals-Altay-Sayan-Sib. Platf.-Transbayk.)-Mongolia-China-S. Australia-Antarct.-Can. (B.C.)-USA (Nev.).——FIG. 78,2. **P. polymorpha,* paratype, ?Botom., Sardinia; transv. sec., ×2 (Debrenne, 1964).

Volvacyathus DEBRENNE, 1960, p. 118 [**V. proteus;* M]. Cups solitary or compound. The solitary cups have long, wide, initial conical, one-walled stage with dissepiments and disorientated rods, followed by cylindrical stage in which an inner wall and central cavity develop. Outer wall with screened pores in conical part of cup; inner wall with coarse pores arranged in quincunx. Intervallum series of conical envelopes constructed of rods, curved radial plates, synapticulae and dissepiments. Compound forms with two or more secondary cylindrical cups, each with its own central cavity, rising from primary conical cup. *L.Cam.(Atdaban.),* N.Afr.(Morocco)-Eu.(Spain). ——FIG. 78,3. **V. proteus,* Morocco; transv. sec. holotype, ×2 (Debrenne, 1964).

Family METACYATHIDAE R. Bedford & W. R. Bedford, 1934

[Metacyathidae R. BEDFORD & W. R. BEDFORD, 1934, p. 5] [=Cambrocyathidae OKULITCH, 1937, p. 251; Cambrocyathinae (subfamily), *nom. transl.* DEBRENNE, 1964, p. 218; Metaldetida DEBRENNE, 1970, p. 25 (order); Metaldetinae DEBRENNE, 1964, p. 218; Paranacyathida DEBRENNE, 1970, p. 25 (order); Paranacyathidae DEBRENNE, 1970, p. 38]

Outer and inner walls simply porous, in some with pores screened by microporous sheath; septa more or less well-defined, the pores arranged in rows inclined upward and outward from inner to outer wall; no tabulae; dissepiments present; and in some, synapticulae; apical part of cups occupied by rods, plates or dissepiments, without inner wall, septa or central cavity. *L.Cam. (Tommot.-low.Len.).*

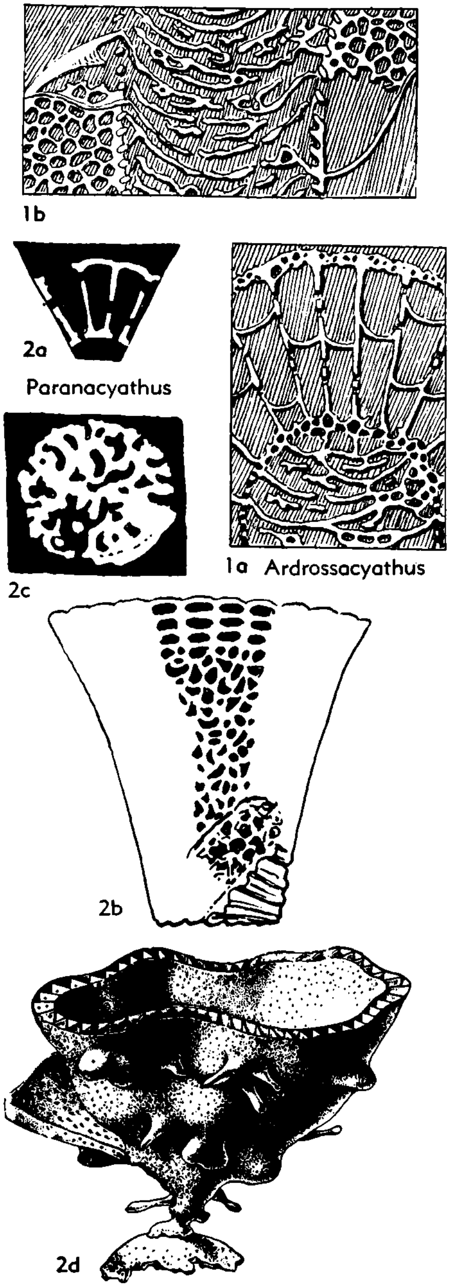


FIG. 79. Metacyathidae (p. E111).

Metaldetes TAYLOR, 1910, p. 151 [**M. cylindricus;* M] [=*Metacyathus* R. BEDFORD & W. R. BEDFORD, 1934, p. 5 (type, *M. taylori,* SD R. BEDFORD & W. R. BEDFORD, 1936, p. 20); *Bedfordcyathus* VOLOGDIN, 1957, p. 209 (type, *Metacyathus ir-*

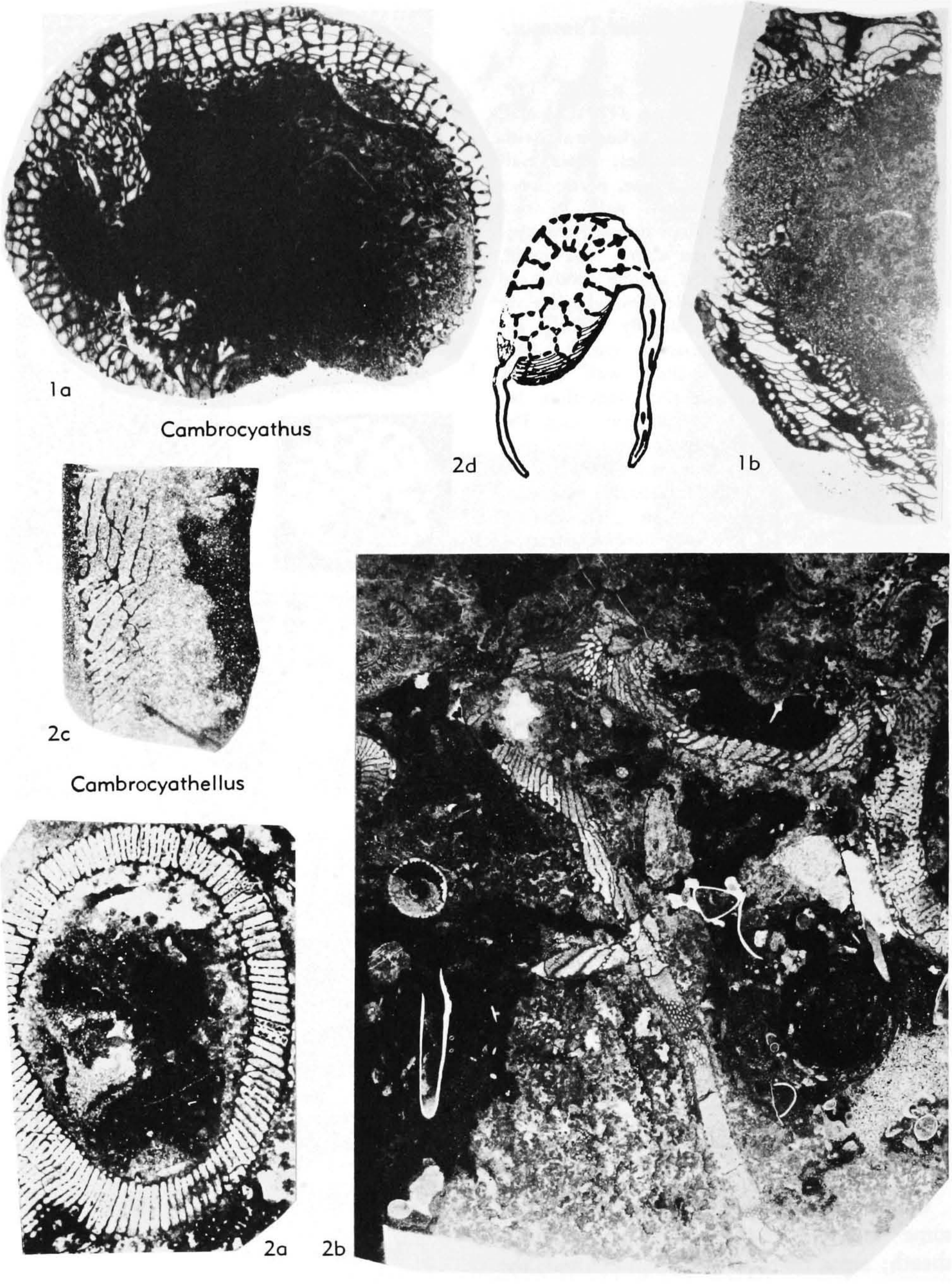


Fig. 80. Metacyathidae (p. E111).

regularis R. Bedford & Bedford, 1934, p. 6; M)]. Solitary, or rarely, colonial; outer wall an irregular framework with microporous sheath linked to the frame by rods; inner wall also of double structure, developing late in ontogeny; apical part of cup filled with irregularly arranged bars, rods, plates and dissepiments; in intervallum developed in later stages, longitudinal skeletal elements are organized into radial septa which may be connected by dissepiments and in some by synapticulae. [For discussion see Debrenne, 1970, p. 36.] *L.Cam.(up.Atdaban.-low.Botom.),* S. Australia-Antarct.-Eu.(Sardinia)-N. Afr.(Morocco)-Can.(?NW.Terr.).——FIG. 78,*1*. **M. cylindricus,* L.Cam., S.Australia(Wilson); *1a,b,* transv. secs. holotype, ×2.7, ×5; *1c,* oblique long. sec., ×2; *1d,* long. sec., ×5 (Debrenne coll., Natl. History Museum, Paris); *1e,f,* parts of transv. and long. secs., ×4.7 (Taylor, 1910).

Ardrossacyathus R. BEDFORD & J. BEDFORD, 1937, p. 31 [**A. endotheca;* OD]. Cup solitary with ?irregularly porous outer wall, straight septa, dissepiments and thin inner wall with short pore-tubes; central cavity filled with dissepiments and ?septal fragments. *L.Cam.,* S.Australia(Ardrossan).——FIG. 79,*1*. **A. endotheca,* Ardrossan; *1a,* part of transv. sec., *1b,* part of long. sec., both ×5.3 (Bedford & Bedford, 1937).

Cambrocyathellus ZHURAVLEVA, 1960, p. 284 [**C. tschuranicus;* OD]. Outer and inner walls commonly thick, with 1 to 2 longitudinal rows pores of large rounded form and uniform size to each intersept; nap of hairlike spines may protect pores of inner wall; septa flat-sided, pores of diverse size and spacing; dissepiments sporadic, more common in young stages, extramural outgrowths from intervallum common; in early stages, intervallum with syringocnemoid structure. *L.Cam.(mid. Tommot.-Atdaban.),* USSR(Sib.Platf.-Far East); *L.Cam.,* Antarct.——FIG. 80,*2*. **C. tschuranicus,* up.Tommot., R.Lena, Sib.Platf.; *2a,* transv. sec. holotype, ×6; *2b,* long. sec., ×4; *2c,* tang. sec., ×6, of other specimens; *2d,* syringocnemoid early stage, ×20 (Zhuravleva, 1960b).

Cambrocyathus OKULITCH, 1937, p. 251 [**Archaeocyathus profundus* BILLINGS, 1865, p. 4; OD]. Cup transversely annulated, but inner wall not affected; outer and inner walls porous, with external outgrowths from intervallum; septa branching, strong, regular, laminated, and perforated by pores in almost horizontal rows; synapticulae sparse, dissepiments copious. *L.Cam.,* Can.(Labrador).——FIG. 80,*1*. **C. profundus* (BILLINGS); *1a,b,* transv. and long. secs., ×3, ×2 (photo courtesy MAX DEBRENNE, Paris, negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris).

?**Dendrocyathus** OKULITCH & ROOTS, 1947, p. 44 [**D. unexpectans;* M]. Outer wall somewhat irregularly porous; inner wall with ?simple pores; septa in intervallum that branch in dendritic manner toward the outer wall; septa connected by synapticulae; imperfectly known. *L.Cam.,* Can. (B.C.). [Type-species=*D. inexpectans* OKULITCH & ROOTS, 1947, p. 192, *nom. null.*]

Metafungia R. BEDFORD & W. R. BEDFORD, 1934, p. 5 [**M. reticulata;* M]. Cup large, conical, basally with large tersioid anchoring processes and with intervallar extrusions into central cavity in young stages; outer wall composed of elements of intervallar mesh reduced in size and compacted and covered with microporous sheath; inner wall with one longitudinal row of pores to an intersept, each pore divided by thin longitudinal rod; septa straight, connected by synapticulae; pores of septa aligned upward and outward from inner wall; dissepiments common in basal parts. (See Debrenne, 1970, p. 36.) *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia.——FIG. 81,*2*. **M. reticulata,* holotype, Ajax; *2a,* transv. sec., ×2; *2b,* inner wall, ×2.7; *2c,* outer wall, ×4 (Hill, 1965).

?**Metethmophyllum** OKULITCH, 1943, p. 78 [**Ethmophyllum meeki* WALCOTT, 1889, p. 34; OD]. Conical, outer wall with numerous irregular pores; intervallum with dissepiments and porous septa but without synapticulae and tabulae; inner wall structure not known. *L.Cam.(?Atdaban.),* USA(Silver Peak, Nev.)-?USSR.

Okulitchicyathus ZHURAVLEVA, 1960, p. 281 [**Ajacicyathus discoformis* ZHURAVLEVA, in ZHURAVLEVA & ZELENOV, 1955, p. 68; OD]. Cup discoid; intervallum narrow with straight septa and rare synapticulae; outer and inner walls each with one longitudinal row of simple pores to intersept, early stages with dissepiments and random rods. *L.Cam.(low.Tommot.-low.Atdaban.),* USSR (Sib.Platf.-?Kuznetsk Alatau).——FIG. 4,*12;* 81,*1*. **O. discoformis* (ZHURAVLEVA), Tommot., R.Lena, Sib.Platf.; 4,*12,* reconstr., ×0.3; 81,*1a,b,* cups from above, ×0.7; 81,*1c,* long. sec., ×1.3 (Zhuravleva, 1960b).

Paranacyathus R. BEDFORD & J. BEDFORD, 1937, p. 34 [*nom. subst. pro Paracyathus* R. BEDFORD & W. R. BEDFORD, 1936, p. 17 (type, *P. parvus;* OD), *non Paracyathus* EDWARDS & HAIME, 1848, p. 318 (type, *P. procumbens;* SD EDWARDS & HAIME, 1850, p. xv), a coelenterate] [**Paracyathus parvus* R. BEDFORD & W. R. BEDFORD, p. 17; OD]. Solitary, or rarely colonial; outer wall with 2 longitudinal rows of irregular pores or 1 row of rectangular pores to an intersept; inner wall with one longitudinal row of large regular pores to an intersept, in quincunx; septa straight, irregularly 'porous'; dissepiments present; early stages single-walled with dissepiments and near outer wall, radially arranged plates. *L.Cam. (mid.Tommot.-Botom.),* S.Australia-USSR(Altay-Sayan-Sib. Platf.-Transbayk.)-Mongolia-N. Afr. (Morocco).——FIG. 79,*2a-c*. **P. parvus* (BEDFORD & BEDFORD), up.Atdaban or low.Botom., S.Australia(Ajax Mine); *2a,* part of transv. sec., ×4; *2b,* ext. view showing irregular pores of early stages, ×4; *2c,* transv. sec. early stage, ×4 (Bedford & Bedford, 1936).——FIG. 79,*2d*. *P. subartus* ZHURAVLEVA, up.Tommot., Sib.Platf.; reconstr., ×0.67 (Zhuravleva, 1960b). [*See* DEBRENNE, 1970, p. 38.]

?**Spirillicyathus** R. BEDFORD & J. BEDFORD, 1937, p. 30 [**S. tenuis;* OD] [=*Spiralicyathus* R. BEDFORD & J. BEDFORD, 1937, expl. to fig. 118, *(nom. null.)*]. Cups small, conical; outer wall microporous, covering spurs rising from outer

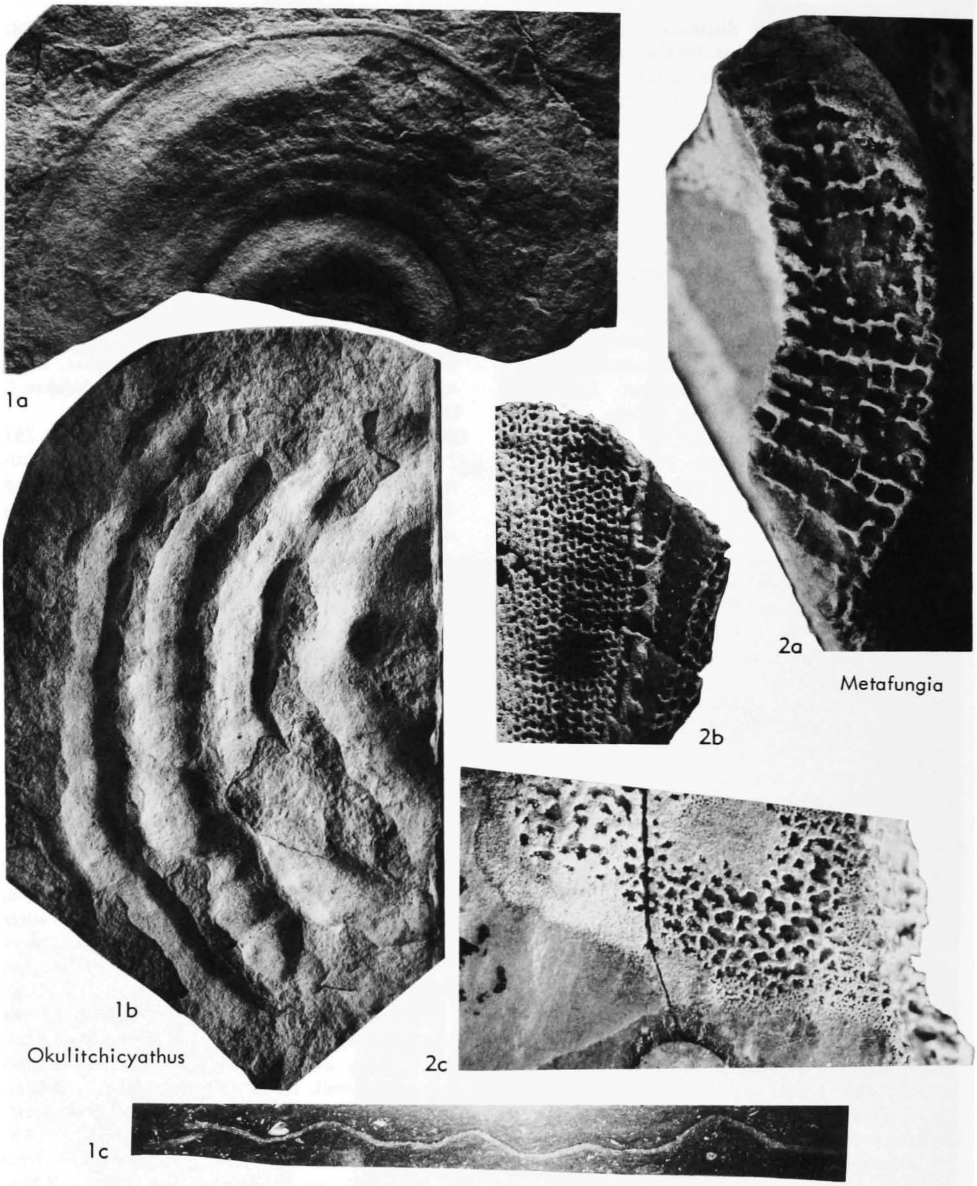


FIG. 81. Metacyathidae (p. E111).

parts of septa; inner wall simply porous, with one or two longitudinal rows of pores to an intersept; septa synapticulate and commonly radial but some branching, no dissepiments known. (See Debrenne, 1970, p. 43.) *L.Cam.(?Botom.),* S.Australia("Paint Mine").——FIG. 77, *1.* **S. tenuis,* Paint Mine, Beltana; *1a,b,* 2 views of holotype, ×8 (photo courtesy MAX DEBRENNE, Paris, negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris); *1c,* tip of cup, ×5.3; *1d,* part of transv. sec., ×5.3; *1e,* part of oblique tang. sec. outer wall, ×5.3; *1f,* view of part of inner wall from intervallum, ×8; *1g,* tang. long. sec., ×5.3 (Bedford & Bedford, 1937).

Family ARCHAEOFUNGIIDAE Vologdin, 1962

[*nom. correct.* HILL, 1965, p. 58 (*pro* Archaeofungidae VOLOGDIN, 1962c, p. 90)] [=?Beltanacyathidae DEBRENNE, 1970, p. 30]

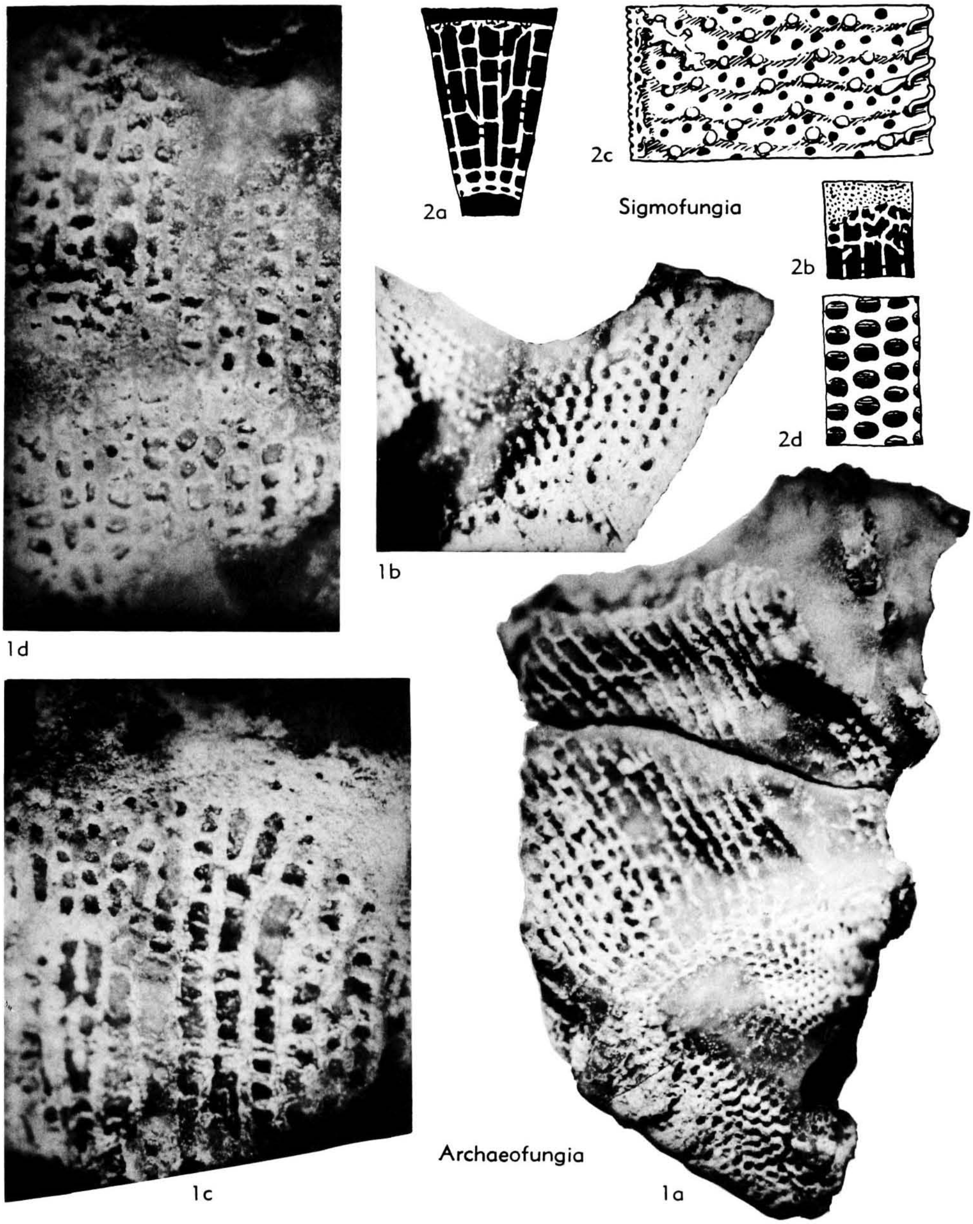


FIG. 82. Archaeofungiidae *(1)*; Sigmofungiidae *(2)* (p. *E*113-*E*114, *E*116).

Solitary; outer wall a framework with irregular pores or pore-tubes and screened with microporous sheath; septa not wavy, with few pores; synapticulae present in some; inner wall with pore-canals or of pore-tubes. *L.Cam.(up.Atdaban.* or *low. Botom.).*

Archaeofungia TAYLOR, 1910, p. 131 [**A. ajax;* M]. Small, conicocylindrical; outer wall irregularly porous and externally with microporous sheath; intervallum with sparsely perforate septa connected by numerous irregularly distributed synapticulae; inner wall with 1 longitudinal row horizontal pore canals to an intersept, alternating with those of neighboring intersepts; external out-

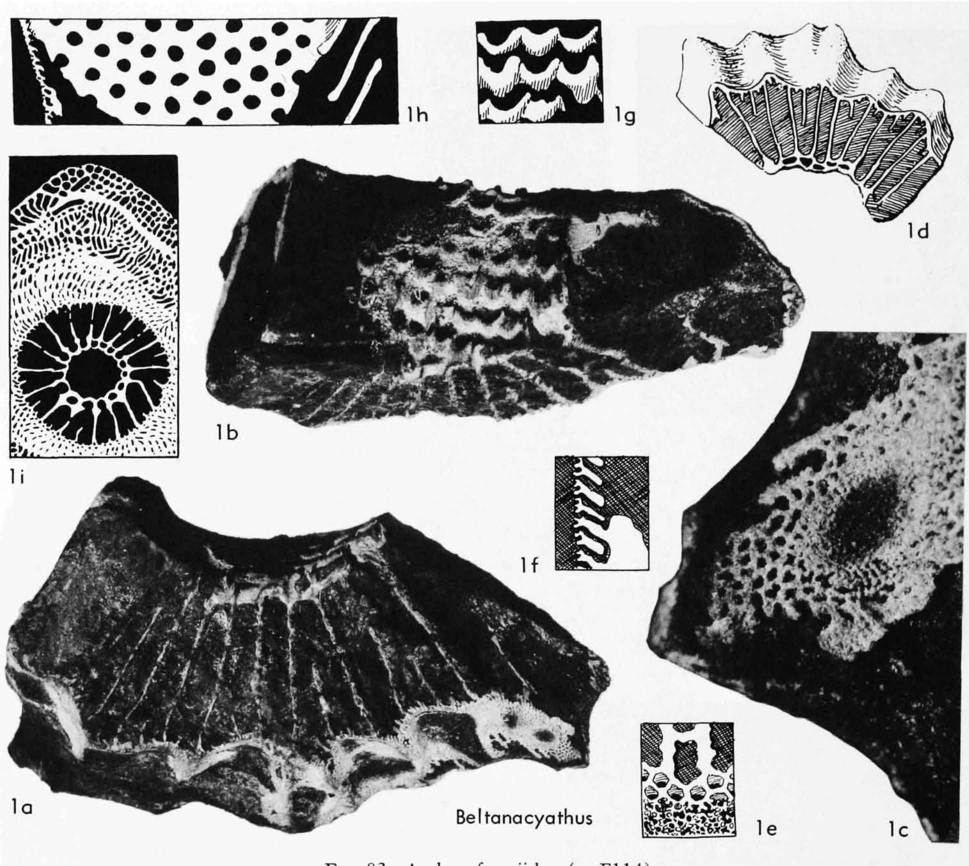


FIG. 83. Archaeofungiidae (p. E114).

growths of base of cone tersioid; basal parts of internal cavity with oblique, intercommunicating tubules, applied to inner wall. *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia.—FIG. 82,*1*. **A. ajax,* Ajax Mine; *1a,* intervallum, inner wall and central cavity, ×4; *1b,* inner wall, ×6; *1c,* intervallum, ×8; *1d,* outer wall, ×8 (photo courtesy MAX DEBRENNE, Paris, negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris). [*See* DEBRENNE, 1970, p. 29.]

Beltanacyathus R. BEDFORD & J. BEDFORD, 1936, p. 23 [**B. ionicus;* OD]. Cups large, conical; outer wall framework of pore-tubes with irregular polygonal mouths, framework covered by independent microporous sheath; septa not waved, regularly porous; minor septa, with one longitudinal row of pores at their outer edges, alternating with septa and extending up to 0.25 radius of intersept; no tabulae or synapticulae; inner wall of pore-tubes formed by louvre-like plates between septa, 1 longitudinal row of louvres to an intersept, each such plate steeply inclined upward and inward to central cavity. (See Debrenne, 1970, p. 30.) *L.Cam.* S.Australia.——FIG. 4,*7;* 83,*1*. **B. ionicus,* holotype, Paint Mine, Beltana; 4,*7,* reconstr.; ×0.3; 83,*1a,* part of transv. sec., ×1.3; 83,*1b,c,* view of part of inner and outer walls, ×1.3, ×7; 83,*1d,* part of transv. sec., ×0.7; 83,*1e,f,* ext. view and radial long. sec. outer wall, ×5; 83,*1g,* int. view inner wall, ×1.9; 83,*1h,* long. sec. showing outer and inner walls and side view of septum, ×1.9; 83,*1i,* transv. sec. near base showing outgrowth, ×1.9 (Bedford & Bedford, 1936).

Family SIGMOFUNGIIDAE R. Bedford & W. R. Bedford, 1936

[*nom. correct.* DEBRENNE, 1970, p. 42 (*pro* Sigmofungidae R. BEDFORD & W. R. BEDFORD, 1936, p. 16)]

Cups cylindrical; outer wall with pores outwardly restricted by upwardly direct processes; septa straight, porous and synapticulate; no tabulae; inner wall of S-shaped louvres lying at inner ends of interseptal loculi, forming pore-tubes directed toward the central cavity. *L.Cam.(up.Atdaban.-low.Botom.).*

Sigmofungia R. BEDFORD & W. R. BEDFORD, 1936, p. 16 [**S. flindersi;* M] [=*Sigmoifungia* R. BED-

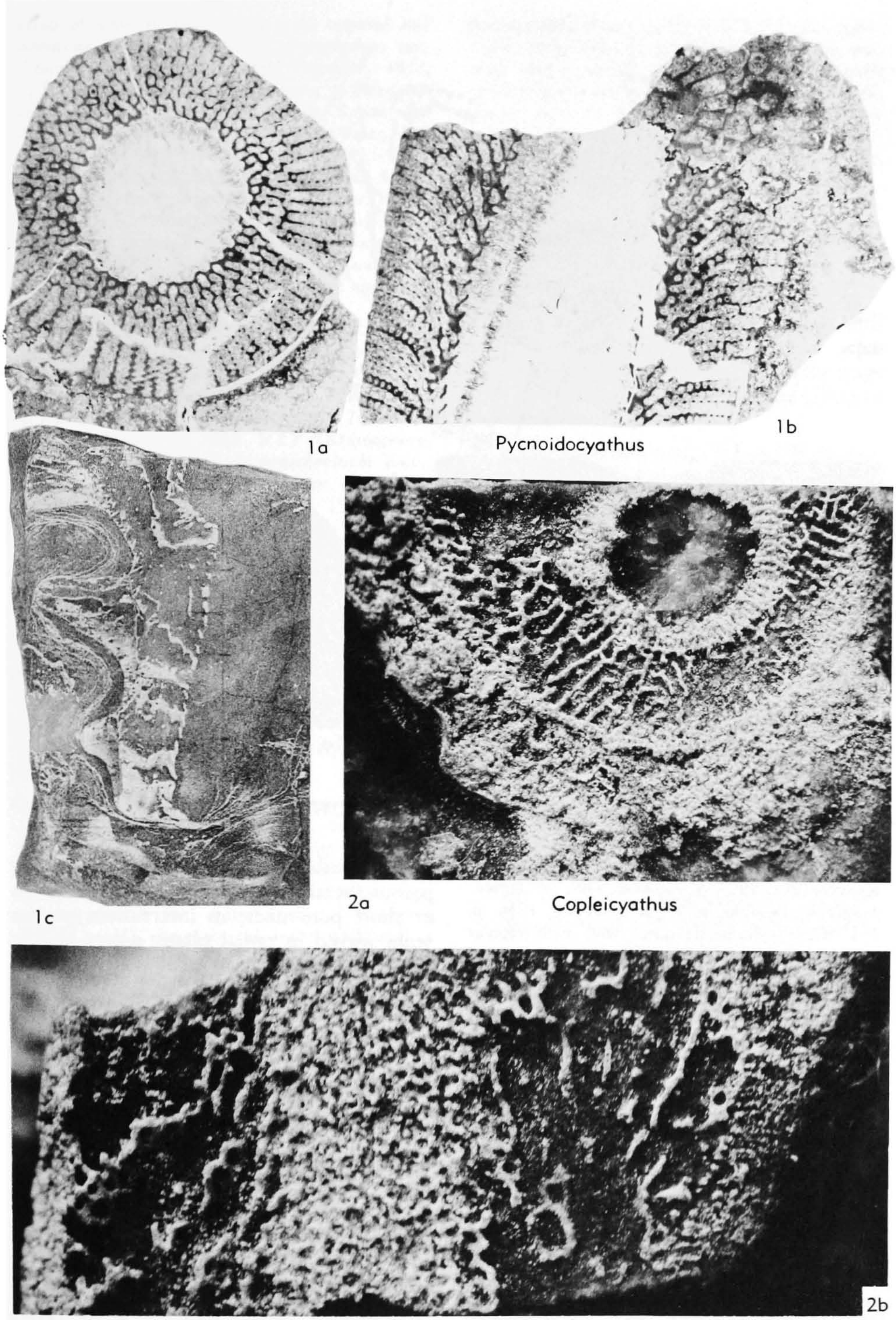


FIG. 84. Flindersicyathidae *(1)*; Copleicyathidae *(2)* (p. E116-E117).

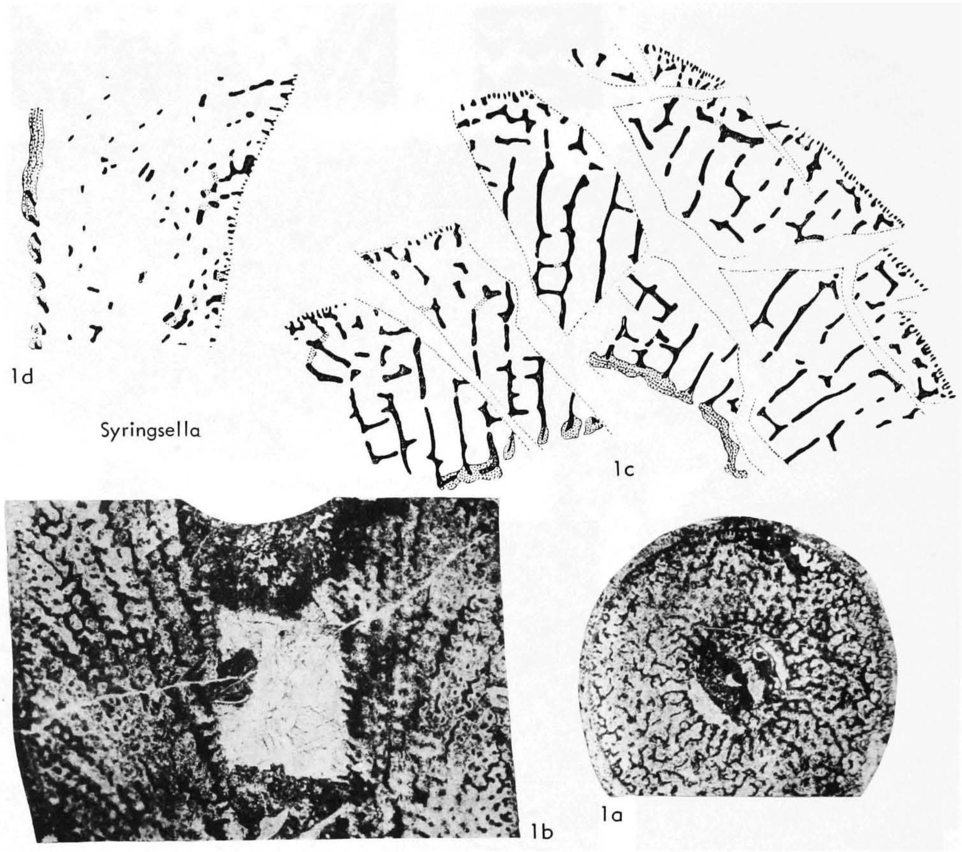


FIG. 85. Flindersicyathidae (p. E117).

FORD & W. R. BEDFORD, 1936, p. 16; *Sygmofungia* KRASNOPEEVA, 1955, p. 75, *nom. null. pro Sigmofungia* R. BEDFORD & W. R. BEDFORD, 1936, p. 16]. Cups cylindrical; outer wall with regular alveoles outwardly restricted by upwardly directed processes; septa porous and synapticulate; no tabulae; inner wall of S-shaped louvre-plates lying at inner ends of interseptal loculi, forming pore-tubes directed upward toward central cavity. (See Debrenne, 1970, p. 42.) *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia.——FIG. 82,2. **S. flindersi; 2a,* part of transv. sec., ×2.7; *2b,* part of tang. sec. outer wall, ×2.7; *2c,* radial long. sec. showing side of septum and S-shaped louvre plates of inner wall, ×5.3; *2d,* tang. long. sec. of inner wall, ×5.3 (Bedford & Bedford, 1936).

Family FLINDERSICYATHIDAE R. Bedford & J. Bedford, 1939

[Flindersicyathidae R. BEDFORD & J. BEDFORD, 1939, p. 78] [=Pycnoidocyathidae OKULITCH, 1950, p. 394; Syringsellidae KRASNOPEEVA, 1961, p. 248]

Solitary; outer wall simply but irregularly porous with or without external microporous sheath; inner wall with simple pores or short pore-tubes; in intervallum porous septa waved in radial plane, waves having angulated crests and troughs, crests and troughlines curving upward and outward from inner wall; crests of neighboring septa opposed and connected by synapticulae; rare dissepiments may occur. *L.Cam.(?Atdaban.-Len.).*

Pycnoidocyathus TAYLOR, 1910, p. 131 [**P. synapticulosus;* SD R. BEDFORD & J. BEDFORD, 1939, p. 78] [=*Flindersicyathus* R. BEDFORD & J. BEDFORD, 1937, p. 28 (type, *F. decipiens;* SD R. BEDFORD & J. BEDFORD, 1939, p. 78); *Spirocyathella* VOLOGDIN, 1939, p. 227 (type, *S. kyzlartauensis;* OD)]. Cup solitary; outer wall with simple pores of irregular arrangement; inner wall with one longitudinal row of short pore-tubes to each intersept, tubes opening upward into central cavity; septa coarsely porous, waved obliquely upward and outward from inner wall; angulated crests of wave of neighboring septa opposed and connected by regularly spaced synapticulae; rare dissepiments may occur. [See Debrenne, 1970, p. 35, 41, for discussion of synonymy of *Flindersicyathus.*] *L.Cam.(?Atdaban.-Len.),* S.Australia-Antarctica-USSR (S. Urals-Altay-Sayan)-Eu. (Spain)-Can.(B.C.-NW.Terr.).——Fig. 84,*1c.* **P. synapticulosus,* up.Atdaban. or low.Botom., S.Australia(Ajax Mine); long. sec., ×1 (Taylor, 1910). ——Fig. 8,*4. P. decipiens* (Bedford & Bedford), up.Atdaban. or low.Botom., S.Australia; long. sec., ×6 (Hill, 1965).——Fig. 84,*1a,b. P. uniserialis* (Hill), Botom., Antarct.; *1a,b,* transv. and long. secs., ×5 (Hill, 1965).

Syringsella Krasnopeeva, 1961, p. 248 [**S. ynyrgensis;* OD]. Like *Pycnoidocyathus* but outer wall with external microporous sheath. *L.Cam.(up. ?Len.),* USSR(Altay-Sayan.——Fig. 85,*1a,b.* **S. ynyrgensis,* holotype, Kuznetsk Alatau; *1a,* transv. sec., *1b,* long. sec., both ×2.7 (Krasnopeeva, 1961).——Fig. 85,*1c,d. S. jaroschevitschi* Krasnopeeva, Kuznetsk Alatau; *1c,* transv. sec., ×2.7; *1d,* long. sec., ×2.7 (Krasnopeeva, 1961).

Family COPLEICYATHIDAE R. Bedford & J. Bedford, 1937

[Copleicyathidae R. Bedford & J. Bedford, 1937, p. 29]

Cup solitary, outer wall simple, but supported by short spurs from septa; septa retiform, straight, synapticulate; no tabulae; inner wall complex, a thick, felted mass opening directly into central cavity. *L.Cam. (up.Atdaban.* or *low.Botom.).*

Copleicyathus R. Bedford & J. Bedford, 1937, p. 29 [**C. confertus;* OD]. Solitary, conical; outer wall simply porous, but supported by short spurs from septa; septa retiform and synapticulate; no tabulae; inner wall complex, a thick, felted mass opening directly into central cavity. [Debrenne (1970, p. 31) compares the inner wall with a second intervallum having three times more crowded septa connected by synapticulae.] *L.Cam. (up.Atdaban.* or *low.Botom.),* S.Australia(Paint Mine, Beltana).——Fig. 84,*2.* **C. confertus; 2a,* etched transv. sec., *2b,* tang. long. sec., both ×8 (Hill, 1965).

Family PRISMOCYATHIDAE Fonin, 1960

[Prismocyathidae Fonin, 1960, p. 725]

Cups solitary, slenderly conical; outer wall with simple round pores; inner wall coarsely porous, ?incomplete; intervallum with coarsely porous, wavy septa, and inconstant dissepiments; central cavity with longitudinal, prismatic, porous tubes. *L. Cam.(Botom.).*

Prismocyathus Fonin, 1960, p. 725 [**P. praesignis;* OD]. Cups solitary, slenderly conical; outer wall with simple round pores; inner wall coarsely porous, wavy septa, and inconstant dissepiments; central cavity with longitudinal, prismatic, porous tubes. *L.Cam.(Botom.),* USSR(Altay-Sayan).——Fig. 86,*1.* **P. praesignis,* holotype, Tuva; *1a,b,* transv. and long. secs., ×4 (Fonin, 1960).

Family PROTOCYCLOCYATHIDAE Vologdin, 1956

[Protocyclocyathidae Vologdin, 1956, p. 878]

Outer wall with simple pores; inner wall annulate; intervallum with porous septa and dissepiments; single-walled early stage with dissepiments and randomly arranged rods. *L.Cam.*

Protocyclocyathus Vologdin, 1955, p. 142 [**Cyclocyathus irregularis* Vologdin, 1940, p. 62; M]. Outer wall with simple pores; inner wall annulate; intervallum with porous septa and dissepiments; single-walled early stage with dissepiments and randomly arranged rods. *L.Cam.,* USSR(Salair). ——Fig. 86,*2.* **P. irregularis* (Vologdin); long. sec., ×5 (Vologdin, 1957a).

Fenestrocyathus Handfield, 1971, p. 72 [**F. complexus;* OD]. Cup cylindro-conical; outer wall fine irregular network of skeletal elements forming an irregular screen; septa closely spaced coarsely porous, pores square to rectangular; synapticulae common, dissepiments sparse; inner wall of annuli S-shaped in section, each annulus with hairlike projections screening pores on central cavity side. *L.Cam.(up.Atdaban.* or *low. Botom.),* Can.(NW.Terr.).——Fig. 86,*3.* **F. complexus; 3a,* med. long. and *3b,* oblique long. secs., ×?4 (Handfield, 1971).

Family ARCHAEOCYATHIDAE Hinde, 1889

[*nom. correct.* Taylor, 1910, p. 105 (*pro* Archaeocyathinae Hinde, 1889, p. 141, family)] [=Spirocyathidae Taylor, 1910, p. 105]

Outer and inner wall with simple pores, may be secondarily thickened; septa irregular, with secondary thickening on sides; some septa proceed from outer to inner wall, others curve from outer wall to join others; septa wavy with coarse, irregular porosity; dissepiments present but not tabulae. *L.Cam.(Botom.)-M.Cam.(Paradoxides oelandicus Zone).*

Archaeocyathus Billings, 1861, p. 4 [**A. atlanticus;* SD Walcott, 1886, p. 75] [Original spelling was *Archeocyathus* Billings, with the *a* of the diphthong dropped; subsequent authors (ex-

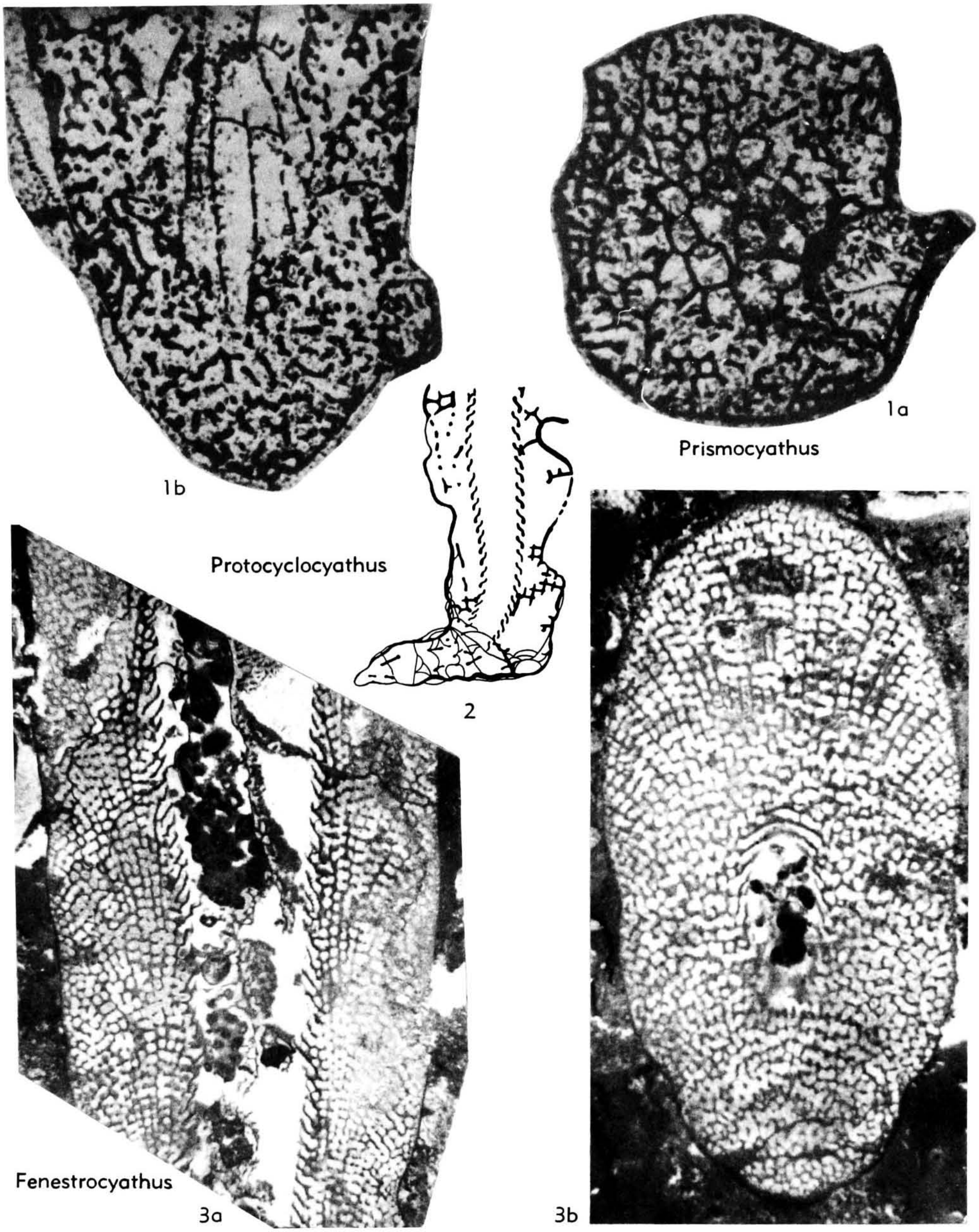


FIG. 86. Prismocyathidae *(1)*; Protocyclocyathidae *(2-3)* (p. *E*117).

cept for MEEK, 1868) have used the diphthong] [=*Spirocyathus* HINDE, 1889, p. 136 (type, *Archaeocyathus atlanticus* BILLINGS, 1861, p. 4); *Retecyathus* SIMON, 1939, p. 36 (=*Retecyathus* VOLOGDIN, 1932, p. 20, *nom. nud.*) (type, *R. laqueus* SIMON, 1939, p. 36; OD)]. Outer and inner walls secondarily thickened and with pore-canals, partly or completely closed by thickening; those of inner wall larger than those of outer wall; septa thick, with secondary thickening on either side; some septa extend from outer to inner wall, others shorter, with some curving from outer wall to join neighbors; septa wavy, with coarse, irregular pores; dissepiments present but not

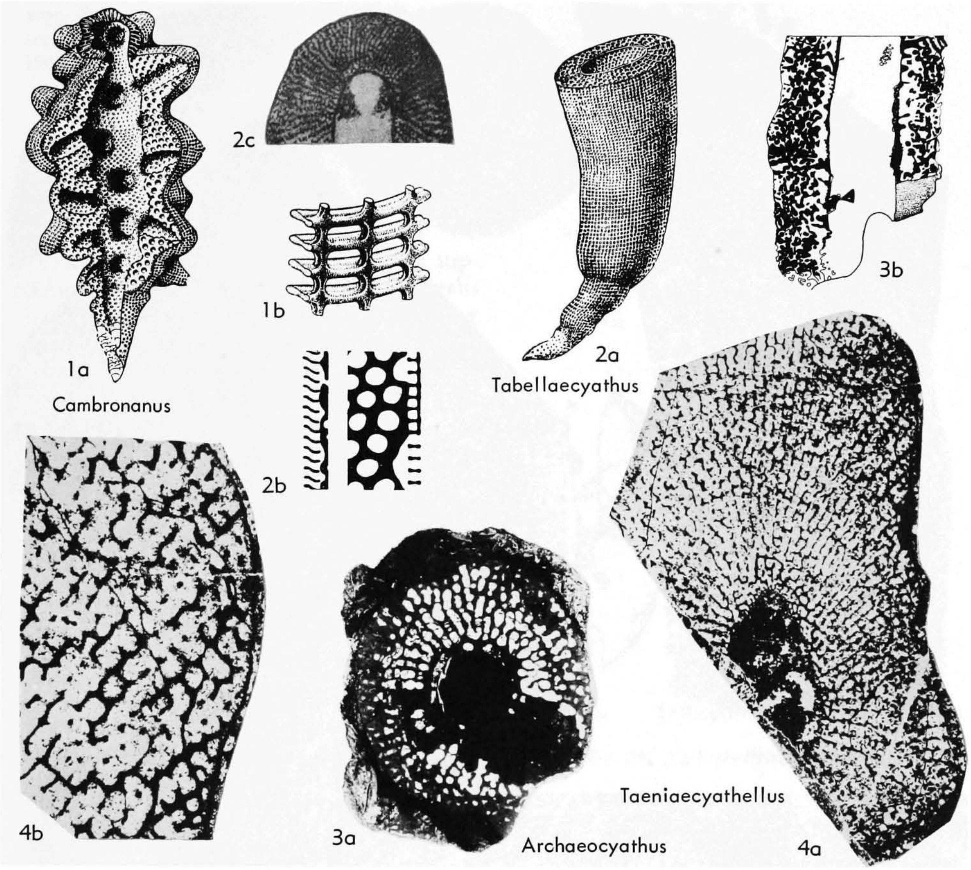


FIG. 87. Archaeocyathidae *(3)*; Tabellaecyathidae *(1-2,4)* (p. E117-E121).

tabulae; synapticulae rare. *L.Cam.(Botom.-Len.)-M.Cam.*, Can.(Labrador)-Antarct.-Australia(S. and C.)-Eu.(Spain)-USSR (S.Urals-Altay-Sayan Transbayk.-Far East)-Mongolia-China.——FIG. 87,*3*. **A. atlanticus*, L.Cam., Labrador; *3a*, transv. sec., ×1.3 (photo courtesy MAX DEBRENNE, Paris, negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris); *3b*, holotype, long. sec., ×0.7 (Debrenne, 1964).

Family TABELLAECYATHIDAE Fonin, 1963

[Tabellaecyathidae FONIN, 1963, p. 15]

Cup slenderly conical or of irregular external form, with abrupt distensions, deep depressions and marked constrictions; outer wall of close, fine horizontal annuli, their outer edges connected externally by close, fine, longitudinal laths (metulae); inner wall of simple pores or of straight or curved short pore-tubes; in intervallum porous septa somewhat wavy, synapticulae and more rarely, dissepiments; central cavity may have extrusions of intervallar tissue. *L.Cam.(Botom.-low.Len.)*.

Tabellaecyathus FONIN, 1963, p. 15 [**T. totus*; OD]. Cup slenderly conical, with very slight depressions and constrictions; outer wall of close fine horizontal annuli, their outer edges connected by close, fine, longitudinal laths; inner wall of straight or slightly curved aporose pore-tubes; fairly porous septa in intervallum, wavy in young stages, straight later, pores in longitudinal rows inclined upward toward outer wall; synapticulae numerous; dissepiments common in young stages, rare later. *L.Cam.(Botom.)*, USSR(Sayan).——FIG. 87,*2*. **T. totus*; *2a*, reconstr., ×1.1; *2b*, part of long. sec., ×16; *2c*, part of transv. sec., ×1.3 (Fonin, 1963).

Cambronanus FONIN, 1963, p. 19 [**C. multicavitatus*; OD]. Cup small, irregularly conical

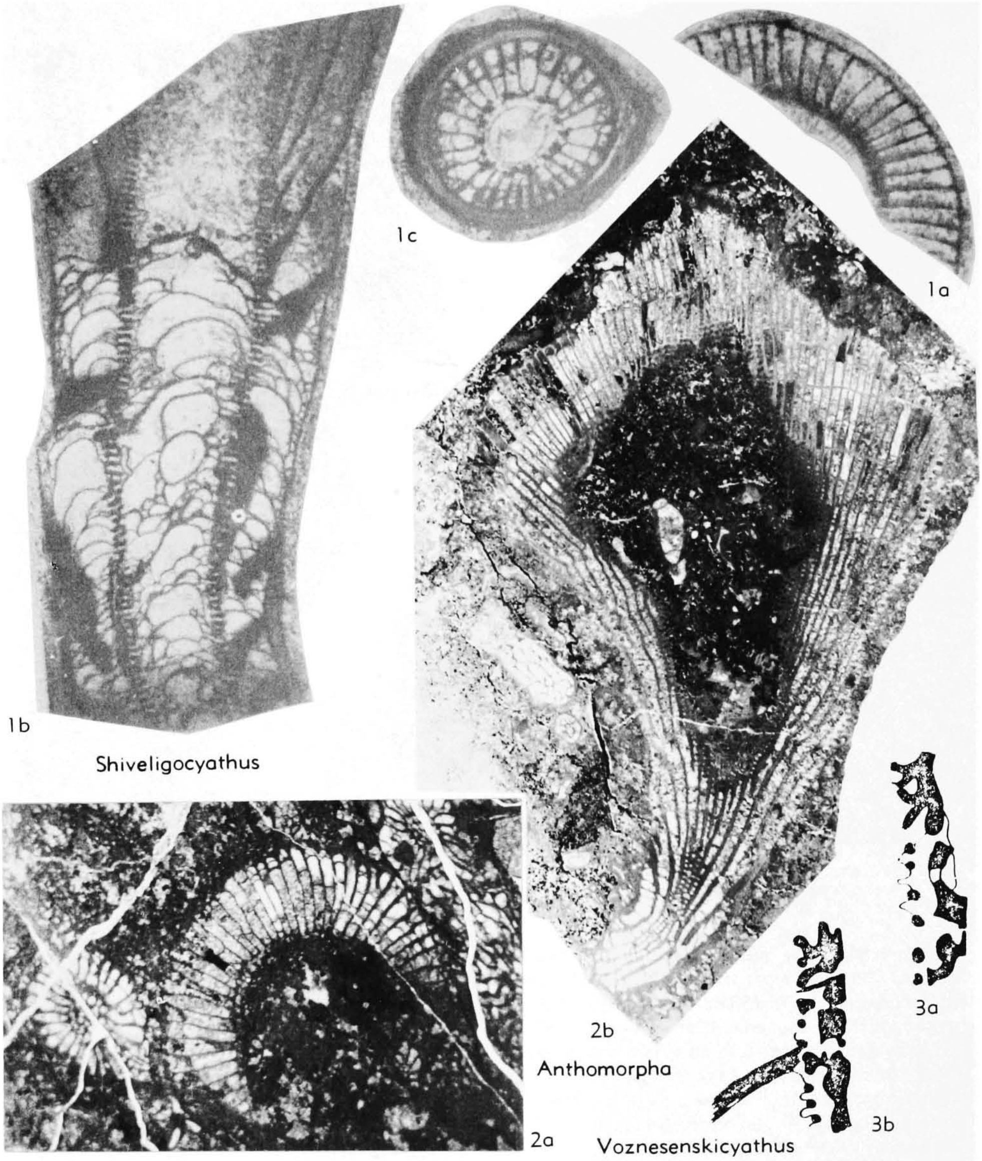


FIG. 88. Anthomorphidae (p. E121).

with marked distensions and constrictions; outer wall of fine close horizontal annuli, their outer edges connected by close, fine, longitudinal laths; wall may be replaced by films of fine dissepimental tissue; inner wall simple, 2 to 6 longitudinal rows of pores to each intersept; septa coarsely porous, thin and retiform, of curved segments, and connected by synapticulae; large fingerlike extensions of central cavity protrude into intervallum, causing it to protrude externally in sympathy. *L.Cam. (Botom.)*, USSR(Sayan).——FIG. 87,*1*. **C. multicavitatus; 1a,* reconstr. showing central cavity and extensions into intervallum, ×4.7; *1b,* outer wall, reconstr., ×40 (Fonin, 1963).

Taeniaecyathellus ZHURAVLEVA, 1960a, p. 45 [**T. semenovi;* OD]. Outer wall of horizontal thin plates and outer sheath; inner wall of intercommunicating pore-tubes; in intervallum, dissepiments and numerous coarsely porous septa, and synapticulae. *L.Cam.(Botom.-low.Len.),* USSR

(Altay-Sayan).——Fig. 87,4. *T. semenovi, holotype, Botom., Sayan.; 4a, part of oblique transv. sec., ×4; 4b, part of long. sec., ×8 (Zhuravleva, 1960a).

Family ANTHOMORPHIDAE Okulitch, 1935

[Anthomorphidae Okulitch, 1935, p. 97] [=Araneocyathidae Vologdin, 1956, p. 878; Anthomorphida Okulitch, 1935, p. 97 (order), *nom. correct.* Okulitch, 1955, p. E18,*ex* Anthomorphina Okulitch, 1935, p. 97 (order)]

Outer wall simply porous, may have supplementary finely porous sheath; inner walls simply porous or of intercommunicating pore-tubes; septa thick, straight, aporose or sparsely porous; dissepiments and finely porous tabulae present. *L.Cam.(Atdaban.-low.Len.).*

Anthomorpha Bornemann, 1884, p. 705 [**A. margarita;* M] [=*Araneocyathus* Simon, 1941, p. 5 (=*Araneocyathus* Vologdin, 1940, p. 59) (type, *A. curvus* Simon, 1941, p. 5; OD); *Araneocyathus* Vologdin, 1937, p. 493, 1940, p. 59, *nom. nud.; Nellicyathus* Fonin in Repina, Khomentovskiy, Zhuravleva, & Rozanov, 1964, p. 247 (type, *N. nelliae;* OD); *Nellisyathus, Nellicyathis, lapsus calami,* Fonin in Repina, Khomentovskiy, Zhuravleva, & Rozanov, 1964, p. 247; *?Utukcyathus* Vologdin in Debrenne, 1964, p. 231 *(nom. nud.)*]. Outer and inner walls strong, with simple pores or stirrup-pores, and connected by aporose or sparsely porous straight septa; dissepiments and microporous tabulae present but not constant. *L.Cam.(up.Atdaban.-low.Len.),* Eu. (Sardinia-France [Montagne Noire])-N.Afr.(Morocco)-USSR(Altay-Sayan-Transbayk.-Far East)-Mongolia.——Fig. 88,2. **A. margarita,* Botom., Sardinia; *2a,* part of transv. sec. holotype, ×4; *2b,* oblique long. sec. paratype, ×3 (Debrenne, 1964).

Shiveligocyathus Missarzhevskiy, 1961, p. 19 [**S. vesiculoides;* OD]. Cup with thin, smooth, simply porous outer wall, with radial, weakly porous to aporose septa and with thick inner wall containing two longitudinal rows of horizontal and intercommunicating pore-canals to each intersept; dissepimental tissue may be copious. *L.Cam.(up.Botom.),* USSR(Tuva).——Fig. 88,*1*. **S. vesiculoides; 1a,b,* parts of transv. and long. secs., each ×2; *1c,* oblique sec., ×2 (Missarzhevskiy, 1961).

Tollicyathus Chernysheva, 1960, p. 77 [**T. ischensis;* OD]. Cup cylindrical; outer wall thick, with large rounded pores and microporous external sheath; septa thick, aporose except for one row of stirrup pores at outer wall; porous tabulae sparse, low domes; dissepiments present. Inner wall thick, with one longitudinal row of simple pores to an intersept. *L.Cam.(Botom.),* USSR (Altay-Tuva).——Fig. 89,*1*. **T. ischensis,* Altay; *1a,b,* transv. and long. secs., ×3.3 (Zhuravleva, Krasnopeeva, & Chernysheva, 1960).

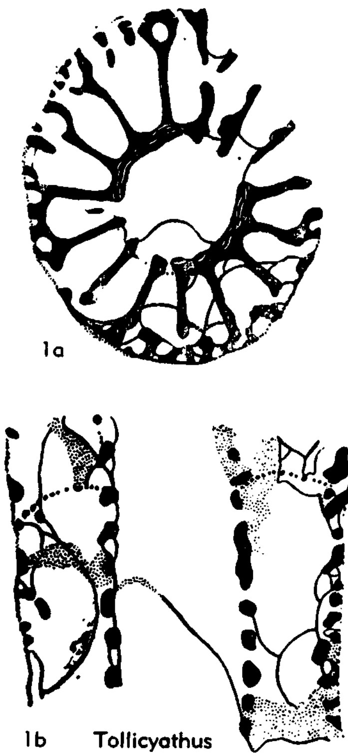


Fig. 89. Anthomorphidae (p. E121).

Voznesenskicyathus Rodionova in Zhuravleva, Zadorozhnaya, Osadchaya, Pokrovskaya, Rodionova, & Fonin, 1967, p. 99 [**V. florens;* OD]. Large, solitary, widely conical cup, with depressions and outgrowths on the outer surface; outer wall with two to three longitudinal rows of pores to an intersept; septa almost straight, almost always aporose; tabulae sparse, irregularly spaced, rare, slightly domed, porous; dissepiments present, profuse in early stages; inner wall thick, with slightly crooked intercommunicating pore-canals, one longitudinal row to an intersept. *L.Cam.(up. Botom.),* USSR(Tuva).——Fig. 88,*3*. **V. florens; 3a,b,* inner wall in long. sec., enl. (Zhuravleva, Zadorozhnaya, *et al.,* 1967).

Suborder ARCHAEOSYCONINA Zhuravleva, 1950

[*nom. correct.* Debrenne, 1964, p. 117, *pro* Archaeosyconiina Zhuravleva, 1960, p. 303 (*nom. transl.* Zhuravleva, 1960, p. 303, *ex* Archaeosyconida Zhuravleva, 1950, p. 10, order)] [=Tabulacyathida Vologdin, 1956, p. 878, *nom. correct.* Hill, herein (*pro* Tabulocyathida Vologdin, 1956, p. 878); Paracoscinida Debrenne, 1970, p. 25]

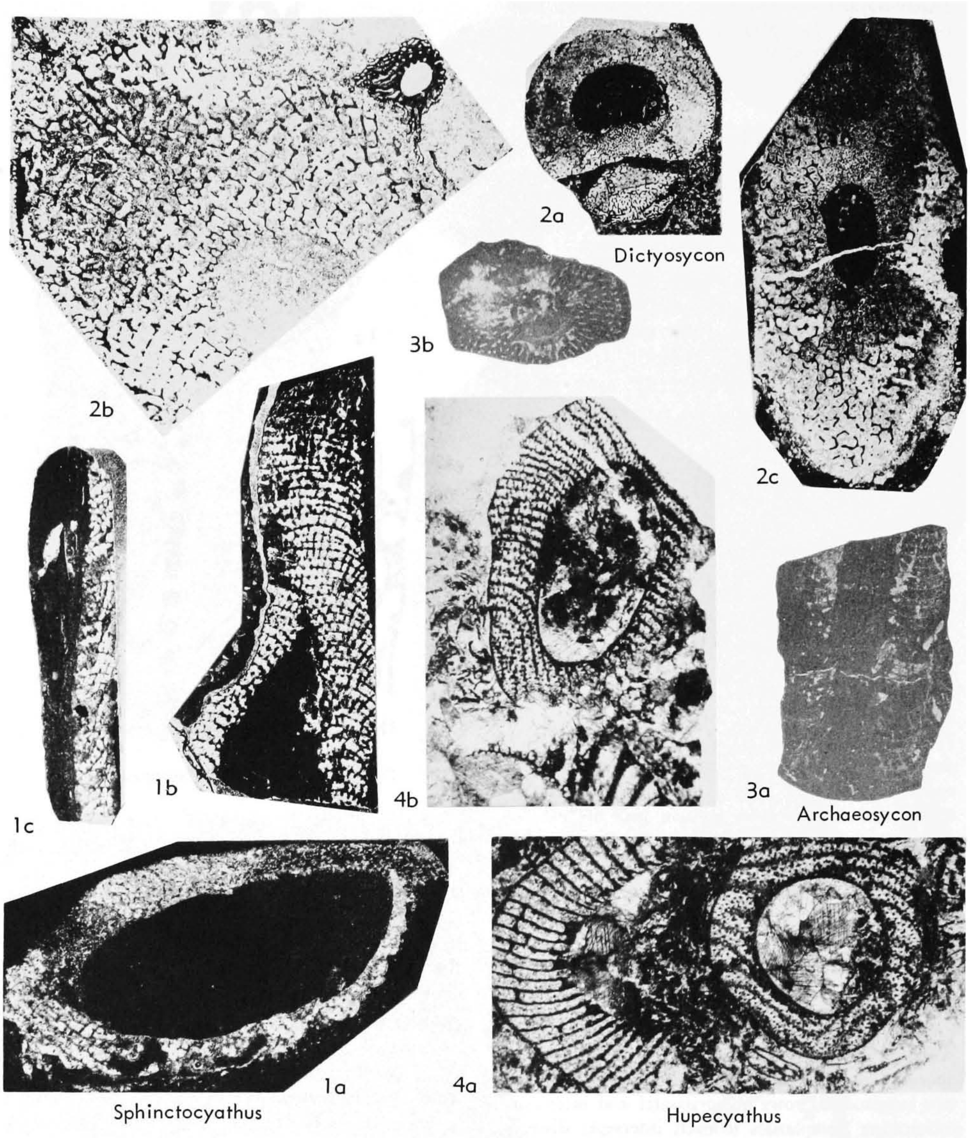


FIG. 90. Archaeosyconidae (p. *E*123).

Cups of diverse form but not mushroom shaped or discoid. Outer wall with simple pores, or rarely may be replaced by pellicle of dissepiments; inner wall formed by ends of intervallar elements or with simple large pores which may have protective scoops. Intervallum with strongly arched, porous tabulae, and either with rods perpendicular to tabulae or with porous septa, straight or wavy. *L.Cam.*

Family ARCHAEOSYCONIDAE Zhuravleva, 1950

[Archaeosyconidae ZHURAVLEVA, 1950, p. 10] [=Archaeosyconiidae ZHURAVLEVA, 1960, p. 304]

Cups with walls not always clearly differentiated from tabulae; intervallum with close, strongly convex porous tabulae and with longitudinal rods perpendicular to tabulae; dissepiments may occur; development of central cavity retarded. *L.Cam.*

Archaeosycon TAYLOR, 1910, p. 111 [**Archaeocyathus billingsi* WALCOTT, 1886, p. 29; M]. Solitary or colonial, cup cylindrical with wide intervallum; outer and inner walls with simple pores; intervallum with porous, domed tabulae; radial rows of longitudinal rods perpendicular to tabulae, and rudimentary septa may occur, synapticulae and dissepiments may be present. *L.Cam.(up.Tommot.-up.Len.),* USSR(Sib.Platf.-Altay-Sayan)-N. Am.(Labrador).——FIG. 90,*3*. **A. billingsi* (WALCOTT), L.Cam., Labrador; *3a,b,* long. sec. and transv. sec., ×1.3 (Okulitch, 1943).

Hupecyathus DEBRENNE, 1964, p. 198 [**H. sphinctoides;* OD]. Solitary, cup conical; outer wall of horizontal or slightly geniculate pore-tubes; inner wall of S-sectioned pore tubes, opening upward; tabulae close, arched, with rods rising from tissue between elliptical, lozenge-shaped or pentagonal pores, rods of same diameter as tissue between pores, and may reach the succeeding tabula. *L.Cam.(Atdaban.),* N.Afr.(Morocco). ——FIG. 90,*4*. **H. sphinctoides,* Amouslek., Ouijane, Morocco; *4a,* transv. sec. holotype, ×2.7; *4b,* part of long. sec. of topotypes, ×2.7 (Debrenne, 1964).

Sphinctocyathus ZHURAVLEVA, 1960, p. 304 [**S. (S.) oimuranicus;* OD]. Solitary or colonial; cups slenderly conical or cylindrical; outer wall with simple rounded or angular pores, inner wall formed by ends of intervallar elements; intervallum with radial longitudinal and transverse rods and strongly arched porous tabulae whose axis of curvature is in midline of intervallum; dissepiments present. *L.Cam.(mid.Tommot.-Atdaban.),* USSR(Yakutia-Altay-Sayan).

S. (Sphinctocyathus). Pores of outer wall of one size; intervallum narrow; tabulae numerous, skeletal tissue transparent. *L.Cam.(up.Tommot.-Atdaban.),* USSR(Sib.Platf.-Kuznetsk Alatau). ——FIG. 90,*1*. **S. (S.) oimuranicus* ZHURAVLEVA, up.Tommot., R.Lena, Oymuran; *1a,* part of transv. sec., ×4; *1b,* holotype, long. sec., ×4; *1c,* long. sec., another specimen, ×4 (Zhuravleva, 1960b).

S. (Dictyosycon) ZHURAVLEVA, 1960, p. 307 [**S. (D.) gravis;* OD]. Pores of outer wall of different sizes; walls rarely preserved, may be replaced by sheath of dissepiments; skeletal tissue dark. *L.Cam.(mid.Tommot.-Atdaban.),* USSR (Sib.Platf.).——FIG. 90,*2*. **S. (D.) gravis* ZHURAVLEVA, up.Tommot., R.Lena, Oymuran; *2a,* transv. sec., ×2.7; *2b,* holotype, oblique sec., ×2.7; *2c,* oblique sec., another specimen, ×4 (Zhuravleva, 1960b).

Family TABULACYATHIDAE Vologdin, 1956

[*nom. correct.* HILL, *herein* (*pro* Tabulathyathidae VOLOGDIN in REPINA, KHOMENTOVSKIY, ZHURAVLEVA, & ROZANOV, 1964, p. 249, *nom. correct. et lapsus calami pro* Tabulocyathidae VOLOGDIN, 1956, p. 878)]

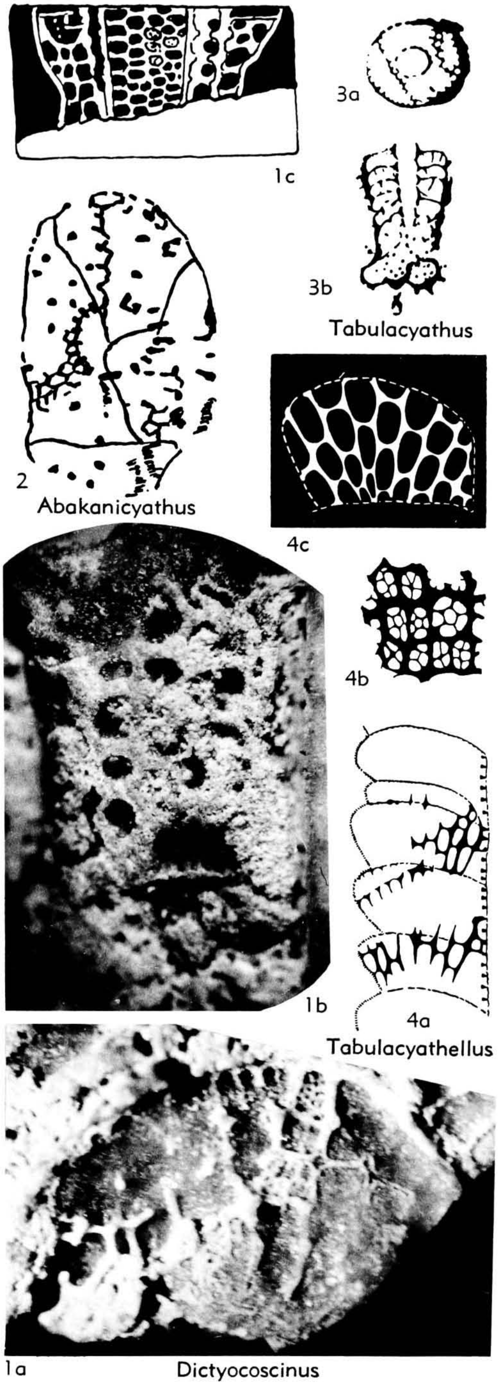


FIG. 91. Tabulacyathidae *(2-4);* Dictyocoscinidae *(1)* (p. E124).

Solitary, slenderly conical with coarsely but regularly porous tabulae, flat or slightly domed; outer and sometimes inner wall formed by downturned edges of tabulae, or outer wall may be independent, porous wall with finely porous external sheath; inner wall may be independent of tabulae and simply porous; in intervallum rare radial longitudinal rods perpendicular to tabulae, or porous septa; dissepiments may be present. *L.Cam.(Atdaban.-Botom.).*

Tabulacyathus Vologdin, 1932, p. 31 [**T. taylori;* M] [=*Tabulocyathus* Vologdin, 1956, p. 878 *(nom. null.)*]. Solitary, slenderly conical with coarsely but regularly porous tabulae, flat or slightly domed; rare radial longitudinal rods or short segments of septa perpendicular to tabulae and not proceeding beyond limits of single intertabular chamber; outer and sometimes inner wall may be formed of downturned edges of tabulae, both walls with simple rounded pores. *L.Cam. ?(up.Atdaban.-Botom.),* USSR(S.Urals-Altay-Far East.——Fig. 91,*3*. **T. taylori,* Botom., Altay; *3a,b,* transv. and long. secs., ×6.7 (Vologdin, 1957a).

Abakanicyathus Konyushkov in Zhuravleva, Konyushkov & Rozanov, 1964, p. 127 [**A. karakolensis;* OD]. Cup solitary, conical or cylindrical. Outer wall simple; inner wall has longitudinal ribs on intervallar side; tabulae porous; longitudinal rods developed within the limits of single intertabular loculus; dissepiments present. *L.Cam.(Botom.),* USSR(Sayan).——Fig. 91,*2*. **A. karakolensis;* transv. sec., ×10 (Zhuravleva, Konyushkov, & Rozanov, 1964).

Tabulacyathellus Missarzhevskiy in Repina, Khomentovskiy, Zhuravleva, & Rozanov, 1964, p. 249 [**T. bidzhaensis;* OD]. Outer wall coarsely porous with reticular external sheath; inner wall of downturned edges of tabulae; septa coarsely porous. *L.Cam.(Atdaban.),* USSR(Kuznetsk Alatau).——Fig. 91,*4*. **T. bidzhaensis,* Bazaikh., Sukhie Solontsy; *4a,* part of long. sec., ×10; *4b,* part of outer wall, ×10; *4c,* part of a septum between 2 tabulae, ×14 (Repina, Khomentovskiy, *et al.,* 1964).

Family DICTYOCOSCINIDAE R. Bedford & W. R. Bedford, 1936

[Dictyocoscinidae R. Bedford & W. R. Bedford, 1936, p. 14]

Cup irregularly conical; outer wall aporose; intervallum with retiform septa connected by synapticulae, and with tabulae formed by fine screens developed between synapticulae that are arranged in curved, floorlike rows; inner wall with pore-tubes. [Debrenne (1970, p. 26, 33), places this family in her order Metaldetida.] *L.Cam. (up.Atdaban.* or *low.Botom.).*

Dictyocoscinus R. Bedford & W. R. Bedford, 1936, p. 14 [**D. beltana;* M]. Cup irregularly conical; outer wall aporose; septa retiform, connected by synapticulae; each tabula formed by fine screens developed between synapticulae that are arranged in floorlike rows; inner wall with pore-tubes leading upward into central cavity. *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia.——Fig. 91,*1*. **D. beltana,* holotype, S.Australia(Ajax Mine); *1a,* transv. sec., ×8; *1b,* septum, ×10 (photos courtesy Max Debrenne, Paris, negatives in coll. Dr. F. Debrenne, Natl. History Museum, Paris); *1c,* tang. long. sec., ×3 (Bedford & Bedford, 1936).

Family METACOSCINIDAE R. Bedford & W. R. Bedford, 1936

[Metacoscinidae R. Bedford & W. R. Bedford, 1936, p. 18] [=?Paracoscinidae Debrenne, 1970, p. 38]

Cup with distinct walls; outer wall may have finely porous external sheath; tabulae porous, arched, with axis of curvature commonly in central cavity, rarely in intervallum; dissepiments present; septa porous, straight, or wavy and ramifying; early stages with dissepiments and rods, not septa. *L.Cam.(up.Atdaban.* or *low.Botom.-up. Len.).*

Metacoscinus R. Bedford & W. R. Bedford, 1934, p. 6 [**M. reteseptatus* (=*Archaeocyathus retesepta* Taylor, 1910, p. 120, see Debrenne, 1970, p. 36); M]. Solitary, conical, with transverse swellings and constrictions not affecting inner wall; outer wall with short funnel-shaped pore-canals; inner wall thin with two longitudinal rows of large pores to an intersept; septa straight and coarsely retiform; tabulae distant, porous; no synapticulae; early stages with dissepiments. *L.Cam. (up.Atdaban.-low.Botom.),* S.Australia.——Fig. 92,*1*. **M. retesepta* (Taylor), Ajax Mine; *1a,* part of outer wall, ×4; *1b,* part of transv. sec., showing tabula, ×4; *1c,* part of inner wall, ×6.7; *1d,* septum, ×4 (Debrenne, 1969a).

Batenevia Krasnopeeva, 1961, p. 249 [**B. pellisi;* OD]. Solitary or colonial; outer wall with pore-canals and an external finely porous sheath; inner wall with short pore-tubes; intervallum with porous arched tabulae; coarsely porous, imperfect, wavy septa and radial longitudinal rods, are joined by synapticulae so that a flindersicyathoid structure is attained. *L.Cam.(up.Len.),* USSR(Kuznetsk Alatau).——Fig. 92,*3*. **B. pellisi;* holotype, *3a,* part of transv. sec., ×6; *3b,* part of long. sec., ×10 (Krasnopeeva, 1961).

Claruscoscinus Handfield, 1971, p. 74 [**Claruscyathus billingsi* Vologdin; OD]. Cup cylindrical; outer wall with simple pores; septa straight, pores

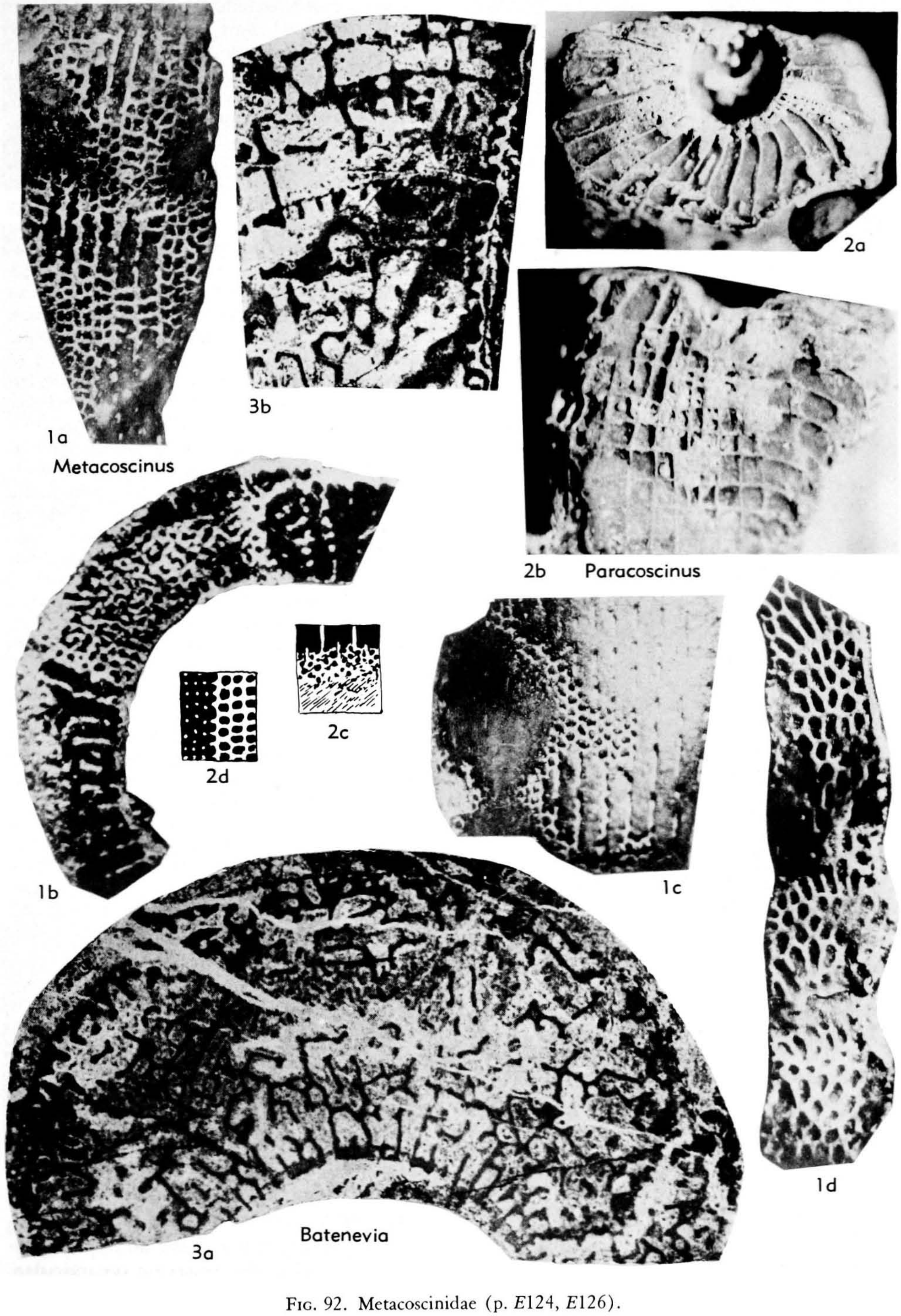


FIG. 92. Metacoscinidae (p. *E*124, *E*126).

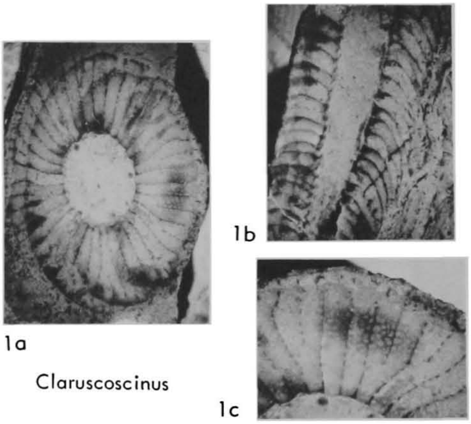


FIG. 93. Metacoscinidae (p. E124, E126).

in upward and outward curving longitudinal rows; tabulae convex upward; inner wall of single longitudinal row of oblique straight or slightly S-curved pore-tubes to an intersept. *L. Cam.(Botom.-up.Len.)*, USSR(Altay-Sayan-Sib. Platf.)-Can.(NW.Terr.-B.C.).——FIG. 93,*1*. **C. billingsi* (VOLOGDIN), ?up.Atdaban. or low. Botom., NW.Terr. or B.C.; *1a*, transv. sec., ×2.5; *1b*, med. long. sec., ×2; *1c*, transv. sec. showing tabula, ×4.3 (Handfield, 1971).

Claruscyathus VOLOGDIN, 1932, p. 25 [**C. cumfundus;* M] [=*Eucyathus* SIMON, 1939, p. 29 (=*Eucyathus* VOLOGDIN, 1937, *nom. nud.*) (type, *Claruscyathus cumfundus* VOLOGDIN, 1932, p. 25); *?Coscinocyathella* VOLOGDIN, 1957, p. 699 (type, *C. nikitini;* M), *non Coscinocyathellus* VOLOGDIN, 1937, p. 471; 1940, p. 91 (type, *C. parvus;* M)]. Solitary or colonial; cup slenderly conical; surface with dents and protrusions; outer wall tightly connected to tabulae and with 2 to 4 longitudinal rows of simple pores to an intersept; inner wall with 1 longitudinal row of simple pores to an intersept; septa straight or wavy, splintering at their outer edges; tabulae numerous, arched so that their axis of curvature coincides with axis of cup; dissepiments common. *L.Cam.(Botom.-up.Len.)*, USSR (Altay-Sayan-Sib.Platf.-Transbayk.)-W. Can.-Antarct.——FIG. 94,*1*. **C. cumfundus*, Botom. or Len., R. Karagan, Altay; *1a,b*, transv. and long. secs., ×2.67 (Vologdin, 1932).

Flindersicoscinus DEBRENNE, 1970, p. 34 [**Flindersicyathus tabulatus* R. BEDFORD & J. BEDFORD, 1937, p. 29; OD]. Outer wall irregular; septa porous, connected by synapticulae; tabulae each a curved floor of synapticulae with secondary connections and thickening but no sieves; inner wall with one longitudinal row of pores to an intersept. [DEBRENNE (1970, p. 34) referred this genus doubtfully to the Pycnoidocyathidae OKULITCH, 1950, p. 394, but because of its tabulae it is here referred to the Archaeosyconina.] *L.Cam.(up. Atdaban.* or *low.Botom.)*, S.Australia(Ajax Mine).

Gabrielsocyathus DEBRENNE, 1964, p. 248 [**Metacoscinus gabrielsensis* OKULITCH, 1955, p. 61; OD]. Outer and inner walls thin, with simple pores; tabulae numerous, regularly spaced, simply porous; septa with rounded pores; dissepiments abundant; central cavity partially or totally filled with intervallar elements. *L.Cam.*, Can.(B.C.-Yukon).——FIG. 94,*3*. **G. gabrielsensis* (OKULITCH), B.C.; *3a,b*, parts of transv. and long. secs., ×?15 (photo courtesy of MAX DEBRENNE, Paris, negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris).

Palmericyathellus DEBRENNE, 1970, p. 37 [**Sigmofungia tabularis* R. BEDFORD & J. BEDFORD, 1937, p. 29; OD]. Outer wall with irregular polygonal pores, several longitudinal rows to an intersept; septa straight, finely porous, synapticulate; tabulae numerous but irregularly spaced; inner wall of S-shaped pore-tubes, their apertures more or less hexagonal. [DEBRENNE, 1970b, p. 38, described the tabulae as consisting "of microporous sieves developed between septa and special synapticulae arranged in horizontal planes, instead of along quincuncial lines as all the others," and placed this genus in the Sigmofungiidae.] *L.Cam.(up. Atdaban.* or *low.Botom.)*, S.Australia(Ajax Mine).

Paracoscinus R. BEDFORD & W. R. BEDFORD, 1936, p. 18 [**P. mirabilis;* M]. Small, solitary, conical; outer wall aporose in tip, in adult stages a framework with coarse rectangular to polygonal pores, covered by microporous sheath; inner wall with simple, rectangular pores in transverse and longitudinal rows, 2 rows to an intersept; septa straight, thick, finely porous; tabulae numerous, thick, nearly flat at inner wall, curved outward and downward, finely porous; no synapticulae; some dissepiments. (See Debrenne, 1970, p. 38.) *L.Cam.(up.Atdaban.* or *low.Botom.)*, S.Australia. ——FIG. 92,*2*. **P. mirabilis*, holotype, S.Australia (Ajax Mine); *2a*, transv. sec., ×4; *2b*, radial long. sec., ×4 (photos courtesy MAX DEBRENNE, Paris, negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris); *2c*, tang. sec. outer wall, *2d*, tang. sec. inner wall, both ×3 (Bedford & Bedford, 1936).

Family PYCNOIDOCOSCINIDAE Debrenne, 1970

[Pycnoidocoscinidae DEBRENNE, 1970, p. 40]

Outer wall with somewhat irregular pores; outwardly screened by a microporous sheath; inner wall with rectangular pores in one longitudinal row to an intersept, may be subdivided by longitudinal or oblique rods; septa porous; tabulae curved with slit-like pores that may have additional partitions parallel to the septa; no synapticulae. *L.Cam.(up.Atdaban.* or *low.Botom.)*.

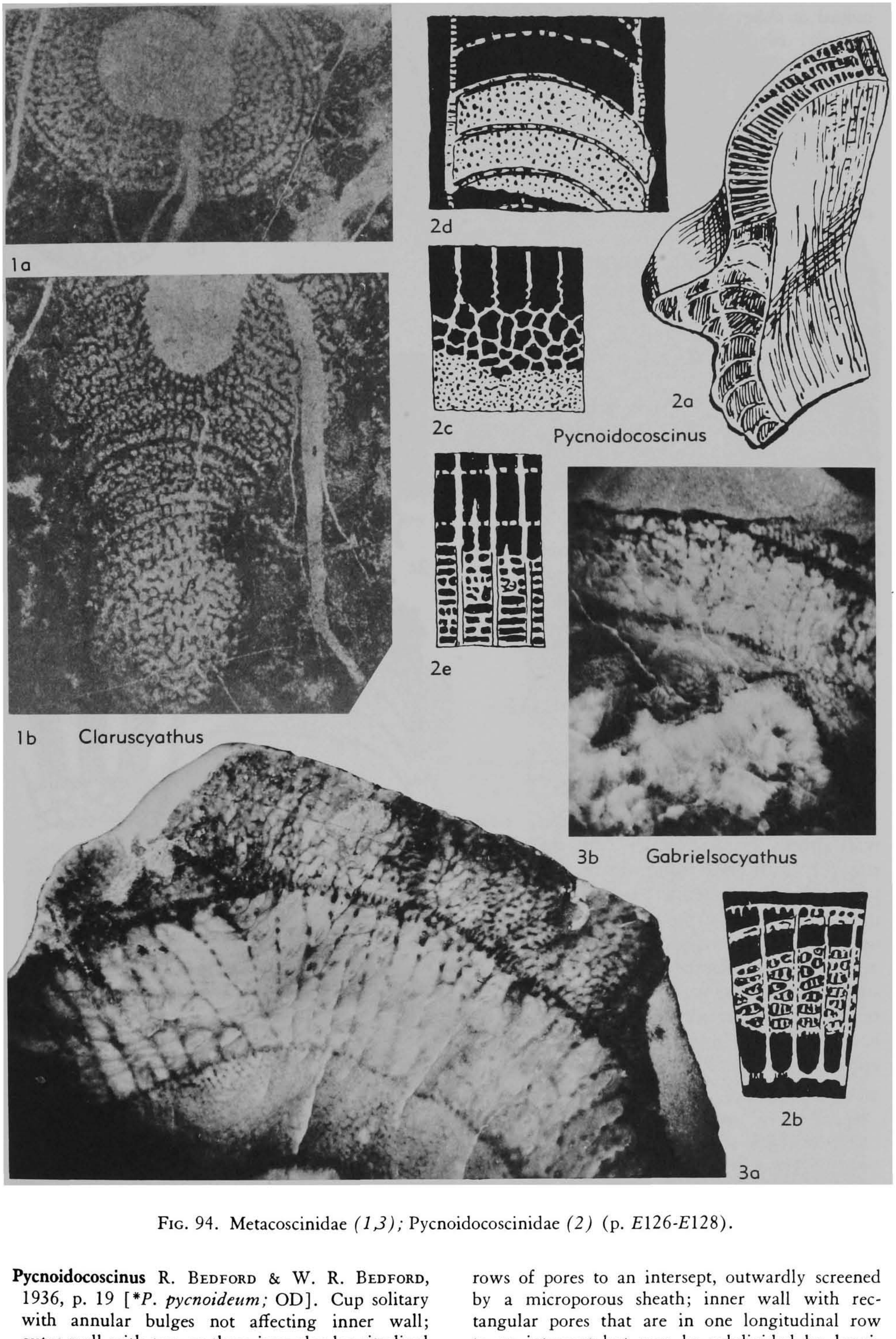


FIG. 94. Metacoscinidae *(1,3)*; Pycnoidocoscinidae *(2)* (p. E126-E128).

Pycnoidocoscinus R. BEDFORD & W. R. BEDFORD, 1936, p. 19 [**P. pycnoideum*; OD]. Cup solitary with annular bulges not affecting inner wall; outer wall with two or three irregular longitudinal rows of pores to an intersept, outwardly screened by a microporous sheath; inner wall with rectangular pores that are in one longitudinal row to an intersept but may be subdivided by longitudinal or oblique rods; septa thinner and porous medially; tabulae strongly arched, with slit-like pores that may be subdivided by radial partitions; no synapticulae. *L.Cam.(up.Atdaban.* or *low. Botom.),* S.Australia-Can.(Yukon).——FIG. 94,*2*. **P. pycnoideum,* S.Australia(Ajax Mine); *2a,* fragment of cup, ×1; *2b,* part of transv. sec., ×4; *2c,* tang. sec. outer wall, ×4; *2d,* radial long. sec., ×4; *2e,* tang. sec. inner wall, ×4 (Bedford & Bedford, 1936).

Order SYRINGOCNEMIDIDA Okulitch, 1935

[*nom. correct.* DEBRENNE, 1964, p. 117, *pro* Syringocnematida ZHURAVLEVA, 1960, p. 51 (*pro* Syringocnemina OKULITCH, 1935, p. 98, and Syringocnemida ZHURAVLEVA, 1950, p. 10, orders)]

Solitary, conical Archaeocyatha; outer wall simply porous; inner wall simply porous or with pore-tubes; intervallum with prismatic, porous-walled tubuli, alternating in position in superimposed rows, and curving upward and outward from inner to outer wall; without septa or tabulae; in early stages, first a one-walled cup in which dissepiments and randomly disposed rods and bars arise, then inner wall, and finally tubuli appear. *L.Cam.*

Family SYRINGOCNEMIDIDAE Taylor, 1910

[*nom. correct.* DEBRENNE, 1964, p. 117, *pro* Syringocnematidae OKULITCH, 1955, p. 49 (*pro* Syringocnemidae TAYLOR, 1910, p. 153, Syringocnemitidae TING, 1937, p. 370)]

Solitary, conical Archaeocyatha; outer wall simply porous; inner wall simply porous or with pore-tubes; intervallum with prismatic, porous-walled tubuli, alternating in position in superposed rows, and curving upward and outward from inner to outer wall; without septa or tabulae; in early stages first a one-walled cup in which dissepiments and randomly disposed rods and bars arise, then inner wall and finally tubuli appear. *L.Cam.(?up.Atdaban.-Botom.).*

Syringocnema TAYLOR, 1910, p. 153 [**S. favus;* M]. Solitary, conical; two-walled; intervallum with prismatic horizontal tubuli that may be downturned at inner ends; tubuli alternating in position in superposed rows, walls of tubuli with simple, round pores; outer wall porous, pores may be at centers of conical outer covers to tubuli; the covers formed by rods rising from angles and edges of ends of tubuli; inner wall of pore-tubes, each with short louvres directed steeply upward and inward; central cavity empty; no known processes of attachment. *L.Cam.(?up.Atdaban.-*

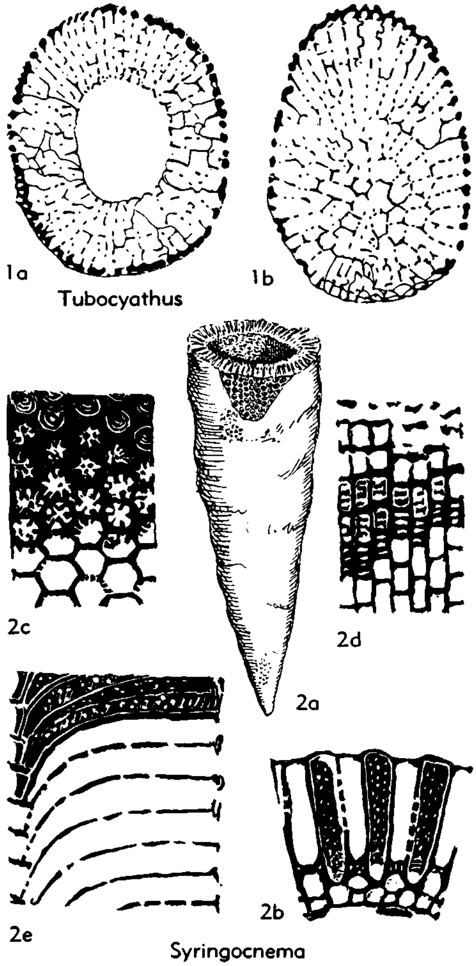


FIG. 95. Syringocnemididae (p. *E*128, *E*130).

Botom.), S.Australia-Antarct.-?N.Am.(Washington)-USSR (Altay-Sayan-Transbayk.).——FIG. 11,*14;* 95,*2*. **S. favus,* up.Atdaban. or low. Botom., S.Australia(Ajax Mine); 11,*14,* series of tang. long. secs. of one tubulus, ×6; 95,*2a,* ext. view, ×0.5; 95,*2b-e,* ×4; 95,*2b,* transv. sec.; 95,*2c,* tang. long. sec. outer wall; 95,*2d,* tang. long. sec. inner wall; 95,*2e,* radial long. sec. (Bedford & Bedford, 1936).

?**Beticocyathus** SIMON, 1939, p. 73 [**B. beticus;* OD]. Mushroom-shaped. Intervallum filled with polygonal tubuli, but in addition septa occur among tubuli at definite distances, including between them 5 to 8 vertical series of radial, 6-sided tubuli. Insufficiently known. *L.Cam.,* Eu. (Spain).

Fragilicyathus BELYAEVA, 1969, p. 98 [**F. zhuravlevae;* OD]. Colonial; outer wall with horizontal pore-canals; intervallum with radially orientated

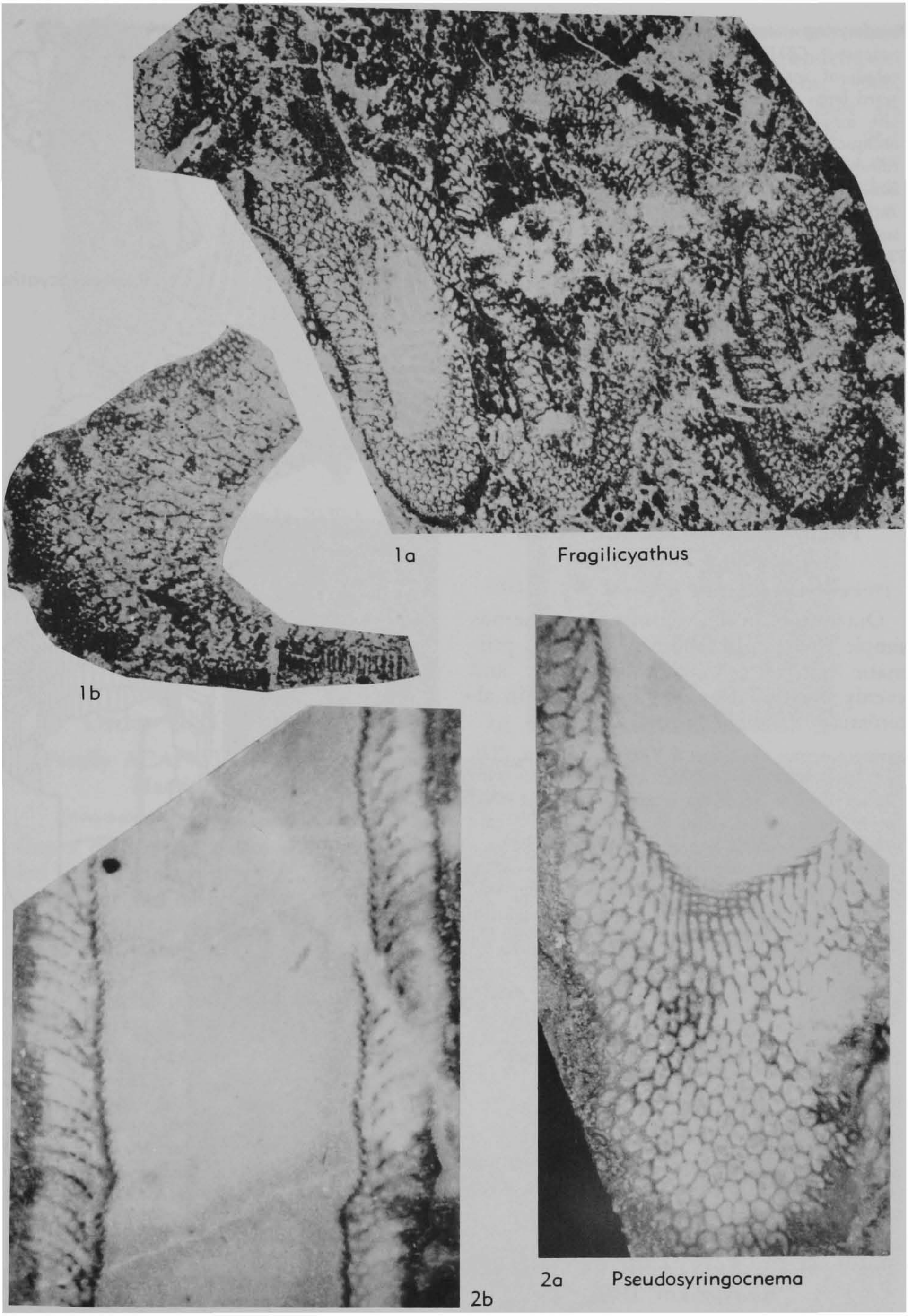


FIG. 96. Syringocnemididae (p. *E*128-*E*130).

prismatic tubuli with porous walls; inner wall with geniculate pore-canals. *L.Cam.(Botom.)*, USSR(Far East).——FIG. 96,*1*. **F. zhuravlevae*, R.B. Melkan, Far East; holotype, *1a*, oblique secs., ×5; *1b*, oblique transv. sec., ×10 (Belyaeva, 1969).

Pseudosyringocnema HANDFIELD, 1971, p. 76 [**P. uniporus;* OD]. Solitary or colonial; hexagonal tubuli of intervallum inclined upward and outward from intervallum, each face of tubulus with one longitudinal row of pores; inner wall of oblique, S-shaped pore-tubes, 2 or 3 to each tubulus in vertical arrangement. *L.Cam.(?Atdaban.),* Can.(Yukon).——FIG. 96,*2*. **P. uniporus; 2a,* oblique long. sec., ×?4; *2b,* med. long. sec., now ×?4 (Handfield, 1971).

?**Tubocyathus** VOLOGDIN, 1937, p. 473 [**T. smolianinovae;* M] [=*Tubicyathus* VOLOGDIN, 1940, p. 114, *nom. null.; Tubulocyathus* VOLOGDIN, 1956, p. 880, *nom. null.*]. Solitary, conical; outer wall thick, intervallum with prismatic tubuli in which pores are large; with dissepiments. [Genus insufficiently known; =*?Prismocyathus* FONIN, 1960, p. 725 (type, *P. praesignis;* OD).] *L.Cam.,* Mongolia.——FIG. 95,*1*. **T. smolianinovae,* Tayshir-Ula Range; *1a,b,* transv. secs., ×3.3 (Vologdin, 1937b).

Family SYRINGOCOSCINIDAE Vologdin & Yazmir, 1967

[Syringocoscinidae VOLOGDIN & YAZMIR, 1967, p. 1375]

Outer and inner walls with numerous simple pores; intervallum of six-sided prismatic transverse tubuli, with finely and evenly porous faces; tubuli arranged in alternating transverse series. *L.Cam.*

Syringocoscinus VOLOGDIN & YAZMIR, 1967, p. 1376 [**S. angulatus;* OD]. Outer and inner walls with numerous simple pores; intervallum of six-sided prismatic transverse tubuli, with finely and evenly porous faces; tubuli arranged in alternating transverse series. *L.Cam.,* USSR(Transbayk.).——FIG. 97,*4*. **S. angulatus; 4a,* diagram.; *4b,* tang. sec., ×10; *4c,* oblique transv. sec., ×3.6 (Vologdin & Yazmir, 1967).

Class UNCERTAIN

Order KAZAKHSTANICYATHIDA Konyushkov, 1967

[Kazakhstanicyathida KONYUSHKOV, 1967, p. 105]

Solitary, one-walled cups; in the inner cavity, only porous tabulae are present, with some rods. *Up.L.Cam.-?base M.Cam.*

Family KAZAKHSTANICYATHIDAE Konyushkov, 1967

[Kazakhstanicyathidae KONYUSHKOV, 1967, p. 106]

Solitary, one-walled cups; in inner cavity, only porous tabulae and some rods are present. *Up.L.Cam.-?base M.Cam.*

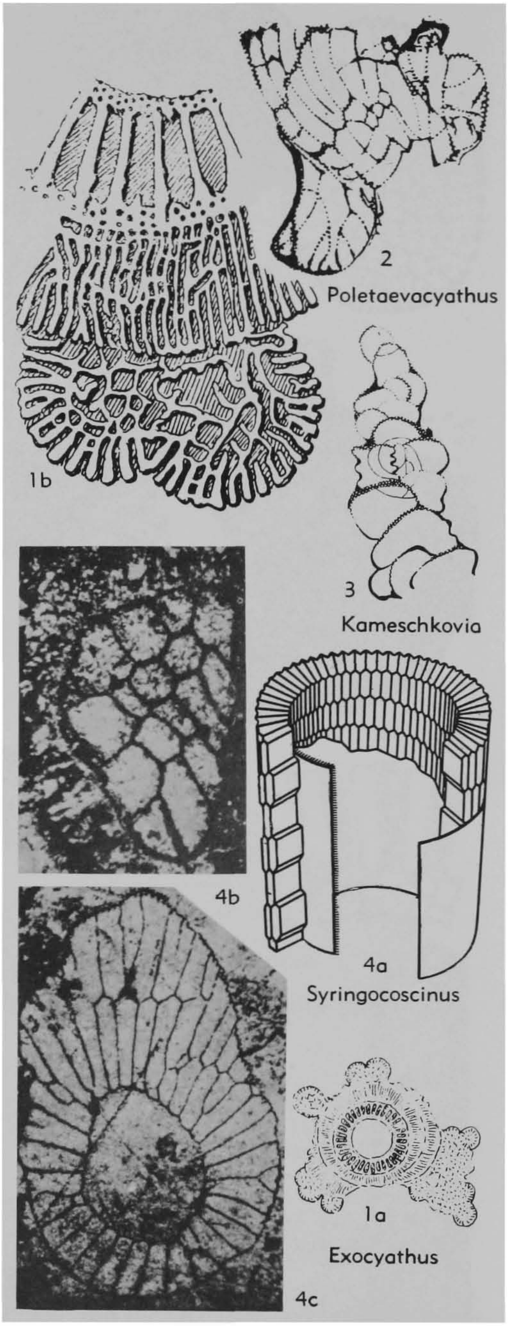


FIG. 97. Syringocoscinidae *(4);* Order and Family uncertain *(1-3)* (p. E130, E132).

Kazakhstanicyathus KONYUSHKOV, 1967, p. 106 [**K. fistulatus;* OD]. Solitary one-walled, conical or cylindrical cups; wall aporose or with simple,

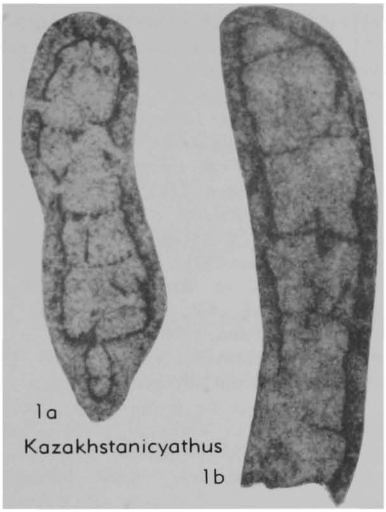


FIG. 98. Kazakhstanicyathidae (p. *E*130-*E*131).

sparse pores; inner cavity with porous tabulae and longitudinally orientated rods. *Up.L.Cam.-?base M.Cam.*, USSR(Kazakhstan, Mt.Agyrek).——FIG. 98,*1*. **K. fistulatus; 1a*, long. sec., ×10; *1b*, holotype, long. sec., ×10 (Konyushkov, 1967).

Order UNCERTAIN

Family ACANTHOPYGRIDAE Handfield, 1971

[Acanthopyrgidae HANDFIELD, 1971, p. 31]

Cup a double-walled cylindrical tube divided into distinct segments by whorls of spines; inner and outer walls perforated by pores in longitudinal rows; spines, linked by a calcified weblike membrane, join proximally forming collar about outer wall; skeletal material is calcite. *L.Cam.*

Acanthopyrgus HANDFIELD, 1967, p. 209 [**A. yukonensis;* OD]. Characters of family. *L.Cam.*, N.Am.(Yukon Terr.-Can.).——FIG. 99,*1;* 100,*1*. **A. yukonensis; 99,1a,* partial whorl of spines showing striations on spines and web, ×8; *99,1b,* two segments showing raised outer pores and size differences in segments, ×8; 100,*1a,b,* radial secs., 100,*1c,* ext. view, enl. (Handfield, 1967).

Family UNCERTAIN

GENERA CONSIDERED TO BE EXTRAVALLAR OUTGROWTHS OF ARCHAEOCYATHA, OR POSSIBLY ENCRUSTING ARCHAEOCYATHA WITHOUT INNER WALL OR CENTRAL CAVITY

Controversy over the forms included herein is long-standing. Views expressed range from 1) that they are independent, encrusting Archaeocyatha (VOLOGDIN, 1940b, 1959d, 1962b), through 2) that they are one of a symbiotic or parasitic pair (MASLOV, 1958, p. 699), to 3) that they are outgrowths from the intervallum of either the cup that is surrounded, or from another

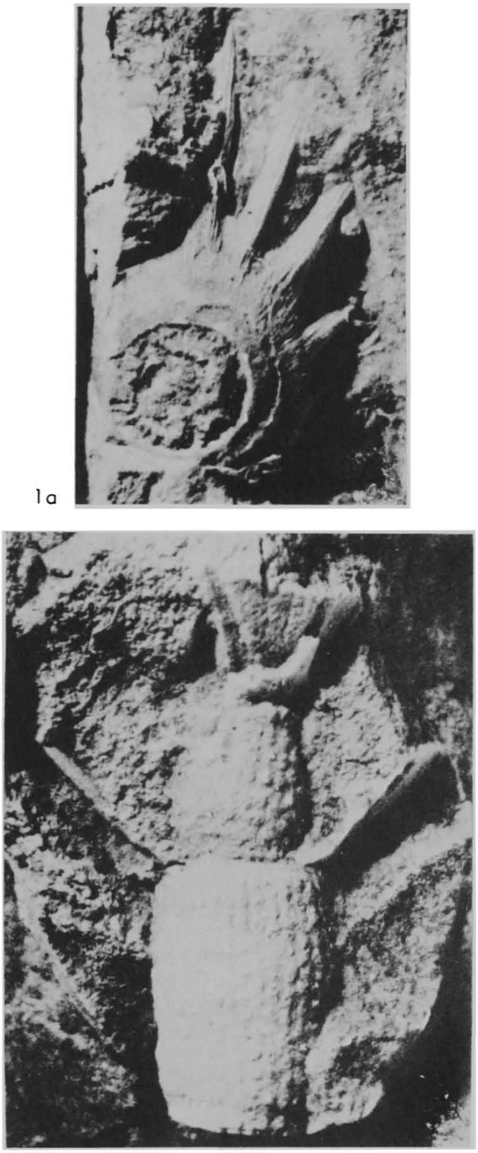


FIG. 99. Acanthopyrgidae (p. *E*131).

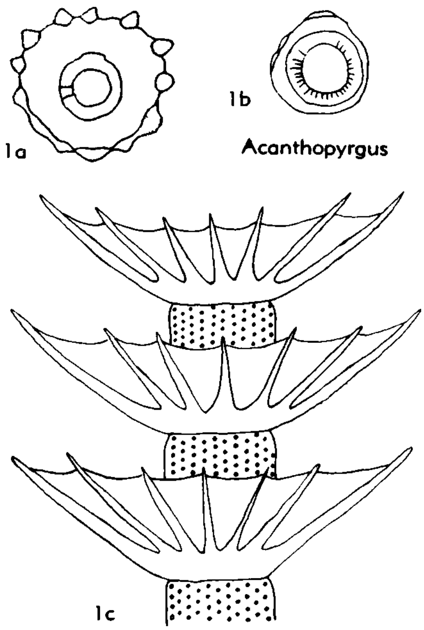


FIG. 100. Acanthopyrgidae (p. E131).

(OKULITCH, 1946a; ZHURAVLEVA, 1960b). A fourth view is also expressed that some are extravallar outgrowths, and others separate, encrusting genera (VOLOGDIN, 1962d).

Listed below are the systematic names given to these problematic forms with localities of their type-species, and references to illustrations of type-species in this *Treatise*.

Cavocyathus FONIN in VOLOGDIN & FONIN, 1966, p. 189 [**C. pusilis;* OD]. ?Tersioid outgrowth. *L.Cam.(up.Atdaban.* or *Botom.),* USSR(Transbayk.).——FIG. 74,*4*. **C. pusilis;* oblique long. sec., ×10 (Vologdin & Fonin, 1966).

Exocyathus R. BEDFORD & J. BEDFORD, 1937, p. 32 [**E. australis;* OD]. *L.Cam.(Botom.),* S.Australia.——FIG. 97,*1*. **E. australis* on *Coscinocyathus australis* TAYLOR, Ardrossan; *1a,* ×1; *1b,* ×5.3 (Bedford & Bedford, 1937).

Falsocyathus FONIN in VOLOGDIN & FONIN, 1966, p. 189 [**F. vastulus;* OD]. ?Tersioid outgrowth. *L.Cam.(up.Atdaban.* or *Botom.),* USSR(Transbayk.).——FIG. 74,*7*. **F. vastulus;* oblique transv. sec., ×10 (Vologdin & Fonin, 1966).

Kameschkovia VOLOGDIN, 1957, p. 210 [**K. perforata;* M] [=*Kameschkovia* VOLOGDIN, 1956, p. 880, *nom. nud.*]. Doubtfully archaeocyathan. *L.Cam.(up.-Botom.),* USSR(R. Sanashtykgol, Sayan.——FIG. 97,*3*. **K. perforata;* ×5 (Vologdin, 1957a).

Labyrinthomorpha VOLOGDIN, 1931, p. 35 [**L. tolli;* M]. *L.Cam.,* USSR(Kameshki, Sayan).——FIG. 101,*1*. **L. tolli,* on *Coscinocyathus taylori* VOLOGDIN; ×1.3 (Vologdin, 1931).

Metaldetimorpha R. BEDFORD & J. BEDFORD, 1937, p. 31 [**M. yorkei;* OD]. *L.Cam.(?Botom.),* S.Australia(Paint Mine, Beltana).——FIG. 101,*2*. **M. yorkei; 2a,* ×0.5; *2b-d,* enl. of facets marked *b,c,d,* on type specimen *(2a),* ×2.67; *2e,* ×5 (Bedford & Bedford, 1937).

Nostrocyathus FONIN in VOLOGDIN & FONIN, 1966, p. 189 [**N. aculeatus;* OD]. ?Tersioid outgrowth. *L.Cam.(up.Atdaban.* or *Botom.),* USSR(Transbayk.).——FIG. 74,*8*. **N. aculeatus;* tang. sec., ×20 (Vologdin & Fonin, 1966).

Poletaevacyathus VOLOGDIN, 1959, p. 88 [**P. obrutchevi;* M]. Doubtfully archaeocyathan. [A figure was given but no formal description. A diagnosis was given by VOLOGDIN, 1962, p. 125.] *L.Cam.(up.Len.),* USSR(Kuznetsk Alatau).——FIG. 97,*2*. **P. obrutchevi;* ×6.7 (Vologdin, 1959c).

Rhizacyathus R. BEDFORD & J. BEDFORD, 1939, p. 69 [**Protopharetra radix* R. BEDFORD & J. BEDFORD, 1937, p. 28; OD]. Small conical form, the interior occupied by longitudinally oriented bars with connections, as in *"Tersia." L.Cam.(up. Atdaban.* or *low.Botom.),* S.Australia.——FIG. 74,*3*. **R. radix* (BEDFORD & BEDFORD); *3a,b,* transv. and long. secs., ×5 (photo courtesy MAX DEBRENNE, Paris, negatives in coll. Dr. F. DEBRENNE, Natl. History Museum, Paris).

Tersia VOLOGDIN, 1931, p. 70 [**T. filiforma;* M]. *L.Cam.,* USSR(R. Lower Tersi, Kuznetsk Alatau).——FIG. 101,*3*. **T. filiforma;* ×2 (Vologdin, 1931).

Tersiella VOLOGDIN, 1962, p. 129 [**Tersia nodosa* VOLOGDIN, 1940a, p. 33; OD]. *L.Cam.,* Mongolia (Tayshiri-ula Range).——FIG. 101,*4*. **T. nodosa* (VOLOGDIN), on *Bicyathus crassimurus* VOLOGDIN; *4a-i,* random secs., ×2 (Vologdin, 1940a).

Usloncyathus FONIN in VOLOGDIN & FONIN, 1966, p. 188 [**U. miculus;* OD]. ?Tersioid outgrowth. *L.Cam.(up.Atdaban.* or *Botom.),* USSR(Transbayk.).——FIG. 74,*6*. **U. miculus;* median long. sec., ×8 (Vologdin & Fonin, 1966).

[The history of the suprageneric placing of these forms is as follows: VOLOGDIN (1931, p. 34) erected the Family Vesiculoidae (an invalid family name) to contain *Labyrinthomorpha* and the problematical *Yakovlevia* (VOLOGDIN, 1931, p. 36) (*non* FREDERICKS, 1925). VOLOGDIN rejected his *Yakovlevia* (type, *Y. granulosa;* M) from the Archaeocyatha in 1940 (VOLOGDIN, 1940a, p. 25) and again in 1962 (VOLOGDIN, 1962c, p. 7) when he considered it a siphonate alga. In 1956 he placed *Labyrinthomorpha* together with *Tersia* in the Family Exocyathidae which R. BEDFORD & J. BEDFORD (1939, p. 82) had erected for *Exocyathus, Ajacia* (an ?alga), and *Metaldetimorpha* and had placed in a new order Crommyocyathina (VOLOGDIN, 1956). Later VOLOGDIN (1957a, p. 210) transferred *Kameschkovia* to the family Palaeoschadidae MYAGKOVA. In 1962 (135, p. 129) VOLOGDIN founded the Order Tersiida to include the Exocyathidae and Rhizacyathidae, and in the Exocyathidae he placed *Exocyathus, Tersia, Tersiella,* and *Metaldetimorpha.* At the same time (135, VOLOGDIN, 1962, p. 125) he founded the Order Labyrinthomorphida to include the Labyrinthomorphidae (135, VOLOGDIN, 1962, p. 125), (*nom. subst. pro* Vesiculoidae VOLOGDIN, 1931, p. 34) with *Labyrinthomorpha* and *Kameschkovia,* and the Poletaevacyathidae (135, Vologdin, 1962, p. 125), with *Poletaevacyathus* the sole genus. The superorder Labyrinthomorphina he founded to embrace his order Labyrinthomorphida and the Coscinocyathida. R. Bedford & J. Bedford (1939, p. 69) founded the family Rhizacyathidae for *Protopharetra radix* (R. Bedford & J. Bedford, 1937, p. 28), and Zhuravleva (1955, p. 629) founded the order Rhizacyathida to include the Rhizacyathidae and the Bicyathidae (Vologdin, 1937b, p. 472). However, Debrenne (1970, p. 41) concluded that the slenderly [3 mm. diam.] cylindrical *R. radix* may be a tersioid outgrowth and thus only part of an unknown species. Fonin in Vologdin & Fonin (1966, p. 187) founded the family Usloncyathidae for *Usloncyathus, Cavocyathus, Falsocyathus,* and *Nostrocyathus,* but it seems to me that these were based on tersioid outgrowths.]

Family UNCERTAIN

SUPPOSED PLANKTONIC OR LARVAL ARCHAEOCYATHA

In his early works Vologdin (1932, p. 10; 1937b, p. 459) described and figured certain minute calcareous bodies as larval and planktonic stages of Archaeocyatha passed through prior to attachment. Roelike hollow calcareous bodies 0.1 to 0.2 mm. in diameter he called the "sphaerion" larval stage; bodies of tubular form, diameter 0.1 or 0.15 mm. to 0.5 mm. he considered a "fistula" stage; bodies 0.4 to 0.8 mm. in diameter with traces of an inner wall were the "conosimilis" stage; barrel-like to cylindrical double-walled bodies 0.2 to 0.3 mm. or more in diameter he called the "dolium" stage.

Zhuravleva (1951, p. 100; 1960, p. 40) suggested that the diameter of the cone of attachment of an archaeocyathan cup was smaller than that of the "larva" and that the "larval" stages were not unlike fragments of epiphyton flora; in her opinion the "larvae" were not Archaeocyatha, and she regarded them as organic problematica.

Vologdin (1957c, p. 493) considered two of the "dolium" cylinders from the Lower Cambrian of the Altay to be planktonic Archaeocyatha Septaidea, referred them to two new genera, *Szecyathus* (type, *S. cylindricus;* OD) and *Lucyathus* (type, *L. elegans;* OD), and placed them in his family Tabulacyathidae. Boyarinov (1962, p. 14) considered that the two genera are synonymous, and that their external form and the structure of the wall suggest that they may be coelenterates like *Conularia.* Yankauskas (1969, p. 131) considered that they may be Cribricyathida.

Calcareous microfossils from the upper Middle Cambrian Tankhai Suite of the R. Amga, Yakutia, herein regarded as organic

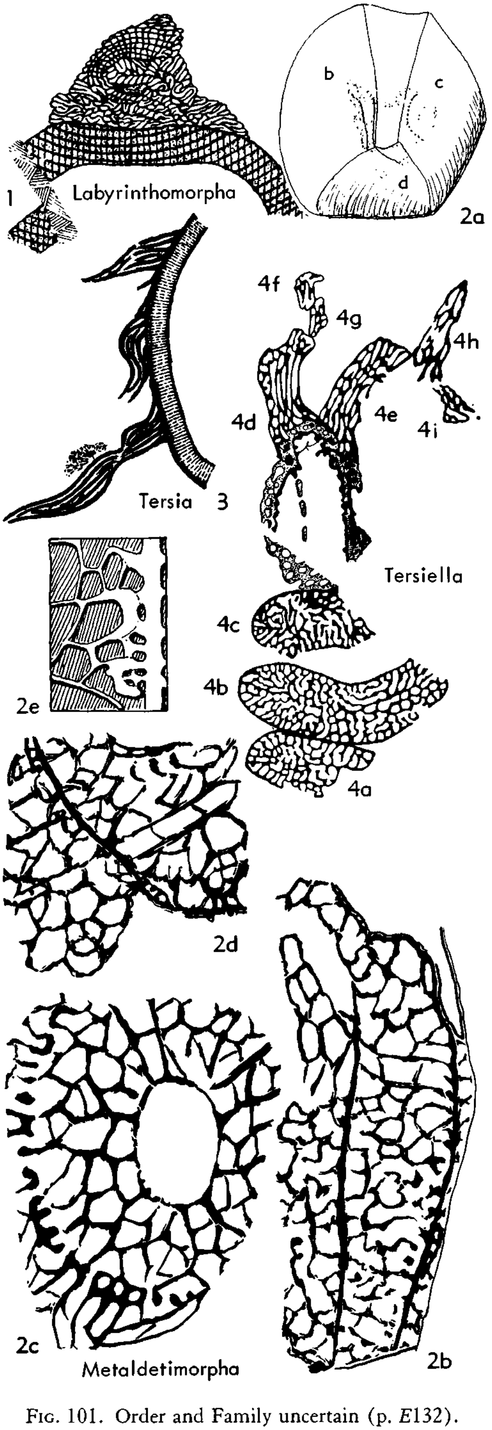


Fig. 101. Order and Family uncertain (p. E132).

Problematica, were considered archaeocyathan by VOLOGDIN (1963, p. 946). VOLOGDIN referred one new species of the genus *Monocyathus* to the family Rhabdocyathidae; to the family Flindersicyathidae he assigned *Tanchocyathus* VOLOGDIN, 1963, p. 947 (type, *T. amgaensis;* OD). One species was assigned to the genus *Archaeocyathus* of the family Archaeocyathidae, and one to *Binatocyathus* VOLOGDIN, 1963, p. 948 (type, *B. obliquiseptatus;* OD) of the Ajacicyathidae.

The conical microfossil 3 mm. long and 1 mm. wide described as *Tunkia* R. BEDFORD & J. BEDFORD, 1936, p. 21 (type. *T. incerta;* M), L.Cam.(Botom.), S.Australia (Ajax Mine, Beltana), has been restudied by HANDFIELD & HANSMAN (1967, p. 1002) and considered not to have archaeocyathan relationships, but to be *incertae sedis.*

Phylum UNCERTAIN, probably not Archaeocyatha

Class APHROSALPINGOIDA Myagkova, 1955

[Aphrosalpingoida MYAGKOVA, 1955, p. 478] [=Aphrosalpingidea VOLOGDIN & MYAGKOVA, 1962, p. 134]

Order APHROSALPINGIDA Myagkova, 1955

[*nom. correct.* VOLOGDIN, 1956, p. 880 (*pro* Aphrosalpingiformes MYAGKOVA, 1955, p. 478)]

This class and order possibly encompass codiacean algae (ZIEGLER & RIETSCHEL, 1970, p. 35).

Family APHROSALPINGIDAE Myagkova, 1955

[Aphrosalpingidae MYAGKOVA, 1955, p. 478, 639]

Aphrosalpinx MYAGKOVA, 1955, p. 639 [**A. textilis;* OD]. *U.Sil.(Ludlow),* USSR(N.Urals).

Family NEMATOSALPINGIDAE Myagkova in Vologdin, 1956

[Nematosalpingidae MYGAKOVA in VOLOGDIN, 1956, p. 880]

Nematosalpinx MYAGKOVA, 1955, p. 478 [**N. dichotomica;* M]. *U.Sil.(Ludlow),* USSR(Urals).

Order PALAEOSCHADIDA Myagkova, 1955

[*nom. correct.* VOLOGDIN, 1956, p. 880 (*pro* Palaeoschadiformes MYAGKOVA, 1955, p. 480)]

Family PALAEOSCHADIDAE Myagkova, 1955

[Palaeoschadidae MYAGKOVA, 1955, p. 480]

Palaeoschada MYAGKOVA, 1955, p. 480 [**P. crassimuralis;* M]. *U.Sil.(Ludlow),* USSR(Urals).

PROBLEMATICAL MICROFOSSILS, CLASS CRIBRICYATHEA VOLOGDIN, 1961

VOLOGDIN (1962c, p. 44; 1964a, p. 1391; 1966, p. 16) grouped a number of calcareous microfossils from the Lower Cambrian of the USSR(Sayano-Altay) into his new class Cribricyathea, composed of three orders, Conoidocyathida (VOLOGDIN, 1964a, p. 1392), Cribricyathida (VOLOGDIN, 1964a, p. 1392), and Pterocyathida (YANKAUSKAS, 1965, p. 438). The class comprises oblong or isometric cups, one-walled or two-walled. The order of size is up to 5 mm. long and 1.5 mm. wide, the majority being smaller, a few larger. The outer wall is constructed of transversely oriented ribbon-like plates (peripteratae, Fig. 102, 103) conjoined at the inner edges with longitudinal rod-like elements (baculae), so that porosity of lattice type may result. An inner wall when present is thin and porous; neither rods nor septa are present in the intervallum, but aporose dissepiments (or ?porous tabulae?) may occur. VOLOGDIN refers some of the species to the Middle Cambrian; these species are found in the Upper Monok Suite of the valley of the R. Abakan in Yakutia, and this suite (*fide* YANKAUSKAS & ZHURAVLEVA, 1969, p. 8) contains a faunal complex not younger than the Sanashtykgol faunal complex of Lower Cambrian age. In all probability, therefore, the range of the class as at present known is Lower Cambrian only. VOLOGDIN considers the class to be overwhelmingly planktonic.

It does not seem to me that these microfossils can reasonably be referred to the Archaeocyatha, and I prefer to regard them as organic Problematica.

Class CRIBRICYATHEA Vologdin, 1961

[Cribricyathea VOLOGDIN, 1961, p. 177 (unseen by author; *fide* VOLOGDIN, 1966, p. 16); Cribricyathea VOLOGDIN, 1964, p. 1392] [=Cribrocyathea VOLOGDIN, 1962, p. 44, as class

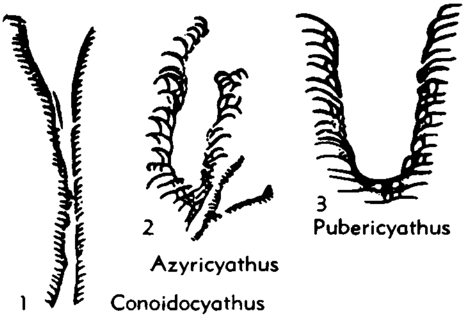


FIG. 102. Conoidocyathidae (p. E135).

of Archaeocyatha; ?Protoarchaeocyatha RADUGIN, 1964, p. 145, footnote]

Cups very small, elongate or isometric, one-walled or two-walled; wall constructed of transversely orientated ribbons (peripteratae) and conjugate with them, longitudinal rods (baculae), giving a lattice-like porosity. Probably planktonic. *L.Cam.*

Order CONOIDOCYATHIDA Vologdin, 1964

[Conoidocyathida VOLOGDIN, 1964, p. 1392]

Cups commonly of conical form, single-walled with wall of peripterate structure. *L.Cam.*

Family CONOIDOCYATHIDAE Vologdin, 1964

[Conoidocyathidae VOLOGDIN, 1964, p. 1392]

Cups more or less conical, opening upward; with one wall of peripteratae and baculi giving quadrate or rounded pores. *L.Cam.*

Conoidocyathus VOLOGDIN, 1964, p. 1392 [**C. artus;* M; genus diagnosed but species figured only (VOLOGDIN, 1964, p. 1392); VOLOGDIN (1966, p. 18) described as new *C. artus* and *C. plumosus* and invalidly named *C. plumosus* as type-species]. Cup conical, opening upward, one-walled, lacking holdfasts; wall with peripteratae and baculi, pores subquadrate. *L.Cam.(Botom.-Len.),* USSR(Altay-Sayan).——FIG. 102,*1*. **C. artus,* Kuznetsk Alatau; holotype, long. sec., ×8 (or ?; Vologdin, 1964a, 1966, gave different magnifications) (Vologdin, 1964a).

Azyricyathus VOLOGDIN, 1964, p. 1392 [**A. transseptatus;* OD; genus diagnosed, but species figured only; VOLOGDIN, 1966, p. 23] [=*Azyrocyathus, Azyrcyathys,* VOLOGDIN, 1966, p. 23, *nom. null.*]. Cups conical or slenderly conical, one-walled; peripteratae successively developing from simple forms to asymmetrically curved with supplementary reversed peripteratae; baculae rounded; pores subquadrate. *L.Cam.(Len.),* USSR(Kuznetsk Alatau).——FIG. 102,*2*. **A. transseptatus;* holotype, long. sec., ×6 (or ?; see above) (Vologdin, 1964a).

Pubericyathus VOLOGDIN, 1964, p. 1392 [**P. phialiformis;* OD; genus diagnosed but species figured only; VOLOGDIN, 1966, p. 20]. Cups slenderly conical and tubular, one-walled; peripteratae regularly spaced, separate, curved in section; at outer edge of cup peripteratae may be in contact by their inner pectinate edges. *L.Cam.(Botom.-Len.),* USSR(Altay-Sayan).——FIG. 102,*3*. **P. phialiformis,* low.Len.; Kuznetsk Alatau; holotype, long. sec., ×8 (or ?; see above) (Vologdin, 1964a).

Order CRIBRICYATHIDA Vologdin, 1964

[Cribricyathida VOLOGDIN, 1964, p. 1392]

Cups two-walled with peripterate outer wall and striate inner wall. *L.Cam.*

Family CRIBRICYATHIDAE Vologdin, 1964

[Cribricyathidae VOLOGDIN, 1964, p. 1392]

Outer wall closed or open upward, formed of peripteratae and baculae; inner wall transversely striate. *L.Cam.(Botom.-Solontsov).*

Cribricyathus VOLOGDIN, 1964, p. 1392 [**C. longus,* OD; genus diagnosed, but species illustrated only; VOLOGDIN, 1966, p. 26]. Outer wall peripterate, pores subquadrate; inner wall striate. *L.Cam. (Botom.-Solontsov),* USSR(Altay-Sayan).——FIG. 103,*1*. **C. longus,* Solontsov, Kuznetsk Alatau; holotype, *1a,* almost tang. long. sec., ×4; *1b,* long. sec. oblique below, ×4 (or ?; Vologdin, 1964a, 1966, gave different magnifications) (Vologdin, 1964a).

Apocyathus VOLOGDIN, 1964, p. 1394 [**A. ovalis,* OD; genus diagnosed, species illustrated only; species described by VOLOGDIN, 1966, p. 34]. Cup oval or a short cylinder closed at its ends. *L.Cam. (Botom.),* USSR(W.Sayan).——FIG. 103,*5*. **A. ovalis,* R. Abakan, W.Sayan; holotype, somewhat oblique long. sec., ×6 (or ?; see above) (Vologdin, 1964a).

Dolichocyathus VOLOGDIN, 1964a, p. 1394 [**D. effiguratus,* OD; genus diagnosed, but species illustrated only; species described by VOLOGDIN, 1966, p. 38]. Cups more or less regularly, slenderly conical, walls latticed; peripteratae and striae conjoin with longitudinal baculae. *L.Cam. (Solontsov),* USSR(Kuznetsk Alatau).——FIG.

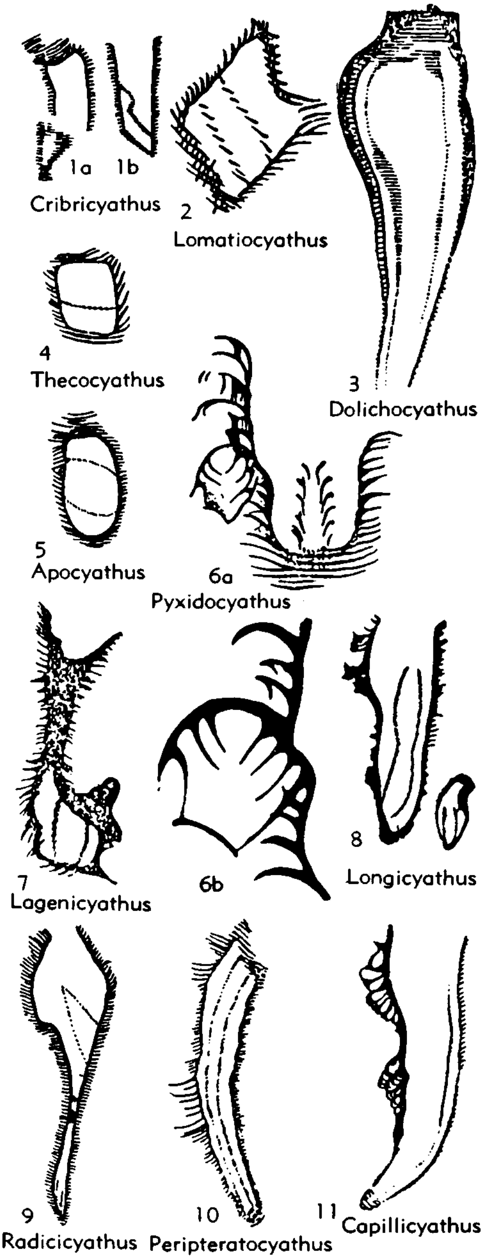


FIG. 103. Cribricyathidae *(1-5,7)*; Pyxidocyathidae *(6,8-10)*; Capillicyathidae *(11)* (p. E135-E137).

103,*3*. **D. effiguratus,* Solontsov; long. sec., ×10 (or ?; see above) (Vologdin, 1964a).

Lagenicyathus VOLOGDIN, 1964, p. 1394 [**L. lamellifer,* OD; genus diagnosed, but species illustrated only; species described by VOLOGDIN, 1966, p. 36] [=*Lageniyfathus* VOLOGDIN, 1964, p. 1394, *nom. null.*]. Cups two-walled, irregular in form, both ends expanded; each wall a peripterate lattice. *L.Cam.(Botom.),* USSR(W.Sayan).——FIG. 103,*7*. **L. lamellifer,* R.Abakan, W. Sayan; holotype, long. sec., ×8 (or ?; see above) (Vologdin, 1964a).

Lomatiocyathus VOLOGDIN, 1964, p. 1392 [**L. clathratus,* OD; genus diagnosed, but species illustrated only; species described by VOLOGDIN, 1966, p. 27] [=*Lematiocyathus* and *Lomaticythus* VOLOGDIN, 1966, p. 16, p. 28, *nom. null.*]. Inner wall irregularly orientated with respect to axis of cup. *L.Cam.(Solontsov),* USSR(Altay-Sayan).——FIG. 103,*2*. **L. clathratus,* Kuznetsk Alatau; long. sec., ×10 (or ?; see above) (Vologdin, 1964a).

Thecocyathus VOLOGDIN, 1964, p. 1392 [**T. tetragonus,* OD; genus diagnosed, species illustrated only; species described by VOLOGDIN, 1966, p. 32] [=*Thecocyathys* VOLOGDIN, 1964, p. 1393; *Thecicyathus* VOLOGDIN, 1966, p. 31, *nom. null.*]. Cup slenderly conical, rounded or subquadrate in section especially in late stages; inner chamber commonly closed, arranged excentrically. *L.Cam. (Botom.,up.Monok Suite),* USSR(W.Sayan).——FIG. 103,*4*. **T. tetragonus,* Botom., R.Kyzas, W. Sayan; oblique sec., ×10 (or ?; see above) (Vologdin, 1964a).

Family PYXIDOCYATHIDAE Vologdin, 1964

[Pyxidocyathidae VOLOGDIN, 1964, p. 1394] [=Pixidocyathidae VOLOGDIN, 1966, p. 16, *nom. null.*]

Cups two-walled, conical or tubular. Outer wall peripterate, but inner wall with simple porosity, with rounded pores. *L.Cam.(Botom.-Solontsov).*

Pyxidocyathus VOLOGDIN, 1964, p. 1394 [**P. gracilis,* M; genus diagnosed, species illustrated only; species described by VOLOGDIN, 1966, p. 40; VOLOGDIN (1966, p. 39) invalidly named *P. plumosus* VOLOGDIN, 1966, p. 39, as type-species] [=*Pixidocyathus* VOLOGDIN, 1966, p. 16, *nom. null.; Puxidocyathus* VOLOGDIN, 1966, p. 40, *nom. null.*]. Cups funnel or goblet-like; inner wall exaxial. *L.Cam.(Botom.),* USSR(W.Sayan).——FIG. 103,*6*. **P. gracilis,* R.Kyzas, W.Sayan; *6a,* long. sec., ×10 (or ?; Vologdin, 1964a, 1966, gave different magnifications); *6b,* part of the same showing bud further enlarged (Vologdin, 1964a).

Longicyathus VOLOGDIN, 1964, p. 1394 [**L. pubescens;* OD; genus diagnosed, species illustrated only; species described by VOLOGDIN, 1966, p. 42]. Cups slenderly conical, some curved; outer wall peripterate, inner wall with round simple pores. Central cavity has lateral position. *L.Cam. (Botom.),* USSR(Altay-Sayan).——FIG. 103,*8*. **L. pubescens,* R. Sanashtykgol, W.Sayan; holotype, long. sec., ×8 (or ?; see above) (Vologdin, 1964a).

Peripteratocyathus VOLOGDIN, 1964, p. 1394 [**P. cirratus;* OD; genus diagnosed, species illustrated only; species described by VOLOGDIN, 1966, p. 47]. Cups slenderly conical or tubular, commonly crooked. Inner wall exaxial, developed the whole length of the cup. *L.Cam.(Solontsov),* USSR (Kuznetsk Alatau).——FIG. 103,*10*. **P. cirratus,* Solontsov, Kuznetsk Alatau; holotype, long. sec., ×8 (or ?; see above) (Vologdin, 1964a).

Radicicyathus VOLOGDIN, 1964, p. 1393 [**R. canaliculatus;* OD; genus diagnosed, species illustrated only; species described by VOLOGDIN, 1966, p. 48] [=*Redicicyathus* and *Radiacicyathus* VOLOGDIN, 1964, p. 1394, *nom. null.*]. Cups tubular with distal distension in which is sited oblique central cavity. *L.Cam.(Solontsov),* USSR (Kuznetsk Alatau).——FIG. 103,*9*. **R. canaliculatus;* holotype, long. sec., ×10 (or ?; see above) (Vologdin, 1964a).

Sunicyathus VOLOGDIN, 1964, p. 1394 [**S. pulcher,* OD; genus diagnosed, species neither described nor illustrated; species described and illustrated by VOLOGDIN, 1966, p. 44]. Cup short, more or less isometric, closed. *L.Cam.(Botom.),* USSR(W. Sayan).

Turricyathus VOLOGDIN, 1964, p. 1394 [**T. procerulus,* OD; genus diagnosed, species neither described nor figured; VOLOGDIN, 1966, p. 45, named *T. turris* VOLOGDIN, 1966, p. 45, type-species]. Cup short, subquadrate in section; inner wall orientated more or less regularly longitudinally, but somewhat exaxial. *L.Cam.(Botom.),* USSR(W.Sayan).

Family CAPILLICYATHIDAE Vologdin, 1964

[Capillicyathidae VOLOGDIN, 1964, p. 1394]

Cups two-walled, slenderly conical outer wall with flat double peripteratae; inner wall with simple round pores. *L.Cam. (Botom.).*

Capillicyathus VOLOGDIN, 1964, p. 1394 [**C. fimbriatus;* OD; genus diagnosed, single species illustrated only; species described by VOLOGDIN, 1966, p. 50]. Cup slenderly conical, peripterate outer wall in little transverse folds, with slitlike pores; development of inner wall lags behind growth of outer wall. *L.Cam.(Botom.),* USSR(W. Sayan).——FIG. 103,*11*. **C. fimbriatus,* R.Kyzas, W.Sayan; holotype, long. sec., ×10 (or ?; Vologdin, 1964a, 1966, gave different magnifications) (Vologdin, 1964a).

Order VOLOGDINOPHYLLIDA Radugin, 1964

[*nom. correct.* HILL, herein, *pro* Vologdinophylloidea RADUGIN, 1964, p. 145] [=Akademiophylloidea RADUGIN, 1964, p. 145; Pterocyathida YANKAUSKAS, 1969, p. 134, *nom. correct. pro* Pterocyathidae YANKAUSKAS, 1965, p. 439 (order)]

Two-walled or one-walled, bilaterally symmetrical, slenderly conical or cylindrical, very small cups (order of diameter 0.5 mm.), straight or cornute; outer wall consists of separate laminar transverse elements (peripteratae, Fig. 104), in general infundibuliform; inner wall transversely annulate or monolithic. *L.Cam.(Aldan.).*

Superfamily VOLOGDINOPHYLLACEA Radugin, 1964

[*nom. transl.* YANKAUSKAS, 1969, p. 134 (*ex* Vologdinophyllidae RADUGIN, 1964, p. 145)]

Conical or cylindrical cups, one-walled, constructed of peripteratae of the first, second, and third types (see Fig. 104). *L.Cam. (Aldan.).*

Family LEIBAELLIDAE Yankauskas, 1965

[Leibaellidae YANKAUSKAS, 1965, p. 439]

One-walled slenderly conical and cylindrical cups with straight orifices and oval or round-loaf transverse section. Walls consist of peripteratae of first or second type (Fig. 104). *L.Cam.(Aldan.).*

Leibaella YANKAUSKAS, 1964 (unseen by HILL); 1965, p. 439 [**L. elovica;* OD; in 1965 genus diagnosed, single species illustrated only; species described by YANKAUSKAS, 1969, p. 138] [=*Coscinophyllina, Coscinophyllum* RADUGIN, 1966 (unseen), *fide* YANKAUSKAS, 1969, p. 138]. One-walled cups straight or weakly curved, the wall formed of peripteratae of the second type (see Fig. 104). *L.Cam.(Aldan.),* USSR(Altay-Sayan).——FIG. 105,*3*. **L. elovica,* R. Mana, E.Sayan; *3a-e,* transv. and long. secs., ×18 (Yankauskas, 1969).

Dubius YANKAUSKAS, 1969, p. 135 [**D. uncatus;* OD]. Cups with very thin aporose wall, rarely with obscurely displayed peripteratae, straight or bent, in some at an obtuse angle to the longitudinal axis. *L.Cam.(Aldan.),* USSR(E.Sayan).——FIG. 105,*1*. **D. uncatus,* R.Mana, E.Sayan; holotype, *1a,b,* long. and transv. secs., ×16 (Yankauskas, 1969).

Ramifer YANKAUSKAS, 1965, p. 439 [**R. giratus;* M; genus diagnosed, single species illustrated only; species described by YANKAUSKAS, 1969, p. 136]. One-walled with single wall formed by peripteratae of the first type (Fig. 104). *L.Cam.(Aldan.),* USSR(Altay-Sayan).——FIG. 105,*2*. **R. giratus,* R.Mana, E.Sayan; holotype, *2a,b,* long. and transv. secs., ×16 (Yankauskas, 1969).

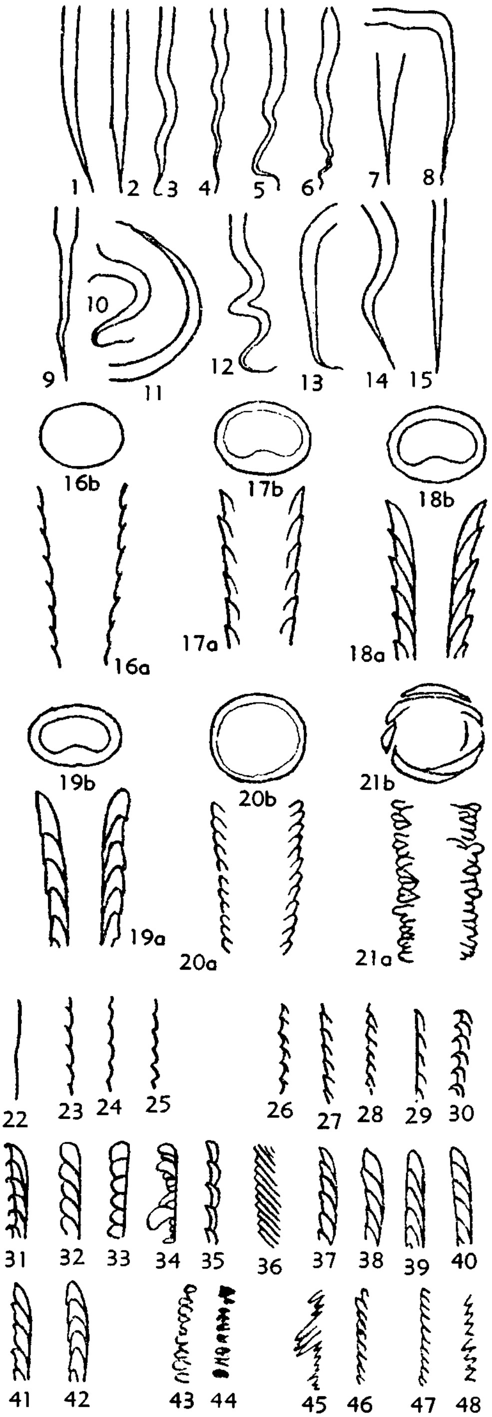


FIG. 104. Morphology of Vologdinophyllida (Yankauskas, 1969).——*1-15*. Form of cup in long. sec.——*16-21*. Types of peripteratae in long. (*a* views) and transv. (*b* views) secs.; *16a,b*, first type; *17a,b*, second type; *18a,b*, third type; *19a,b*, fourth type; *20a,b*, fifth type; *21a,b*, sixth (manacyathid) type.——*22-48*. Morphological variety in peripteratae in radial long. sec., inner surface of wall to right; *22-25*, in first type; *26-30*, in second type; *31-41*, in third type; *42*, in fourth type; *43-44*, in Manacyathidae (sixth type); *45-48*, in fifth type.

Family VOLOGDINOPHYLLIDAE Radugin, 1964

[Vologdinophyllidae RADUGIN, 1964, p. 145] [=Vologdinophillidae YANKAUSKAS, 1965, p. 439, *nom. null.*]

One-walled cups with chambered, ring-chambered or subchambered wall; peripteratae of third and fourth types (see Fig. 104). *L.Cam.(Aldan.)*.

Vologdinophyllum RADUGIN, 1962, p. 8; 1966 (unseen by HILL) [**V. chachlovi;* OD] [=*Hemiphyllum, Miophyllum, Ophyllum, Mesophyllum, Ellipsophyllum, Monophyllum, Vandophyllum, Costophyllum, Anomalophyllum, Dephyllum, Laphyllum, Nefrophyllum, Rombophyllum, Ellipsophyllina, Gonophyllum, Eophyllum, Hemiphyllina, Linsophyllum, Kaphyllum, Thephyllum, Esphyllum, Quadriphyllum, Trapecephyllum, Trigonophyllum, Monstrophyllum, Circophyllum,* all of RADUGIN, 1966 (unseen by HILL); synonymy *fide* YANKAUSKAS, 1969, p. 141]. Cups one-walled, the wall constructed of peripteratae of the third and fourth types (see Fig. 104); walls chambered, or ring-chambered, or very rarely subchambered. Cups characteristically bilaterally symmetrical, elliptical, oval, round-loaf shaped, reniform in transverse section. Inner cavity oval or predominantly reniform in section. *L.Cam. (Aldan.),* USSR(Altay-Sayan).——FIG. 106,*4*. **V. chachlovi; 4a-e,* oblique long. sec., transv. and long. secs., ×20 (Yankauskas, 1969). [=*Vologdinophillum* YANKAUSKAS, 1965, p. 439, *nom. null.*]

[Of these new genera, RADUGIN, 1964, p. 146 gave figures of transverse sections of the following designated (new) type-species, but without diagnoses or descriptions: *Miophyllum biconvexum, Ophyllum planoconvexum, Mesophyllum ordinare, Ellipsophyllum typicum, Vandophyllum khalfini, Dephyllum tadasi, Laphyllum ordinare, Nefrophyllum vasi, Rhombophyllum primum, Ellipsophyllina rara, Linzophyllum (sic) asimmetricum, Kaphyllum irregulare, Tephyllum* [*sic*] *mirabile, Esphyllum originale, Quadriphyllum koptevi, Trapecephyllum unicum, Trigonophyllum inexpectum.* All of these species except *N. vasi, R. primum, E. rara* and *T. inexpectum* were placed by YANKAUSKAS (1969, p. 141) in synonymy with *V. chlachlovi.* For the following generic names, senior homonyms exist for taxa in the animal kingdom: *Circophyllum, Mesophyllum, Rhombophyllum* (as *Rhombophylla*) and *Trigonophyllum* (as *Trigonophylla*); *Monophyllum, Hemiphyllum* and *Anomalophyllum* (as *Anomalophylla*).]

Cardiophyllum RADUGIN, 1964, p. 146 [**C. kelleri;* OD, but figured only; and *fide* YANKAUSKAS, 1969, p. 143] [=*Cardiophyllina, Stapephyllum, Aphyl-*

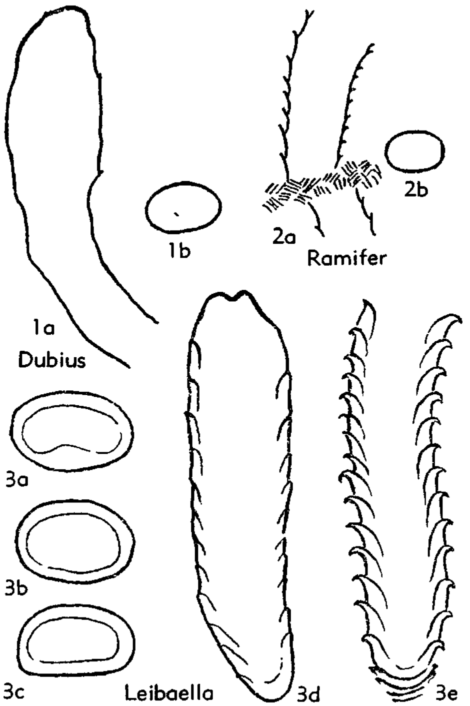


FIG. 105. Leibaellidae (p. *E*137).

lum, Bephyllum, Cephyllum all of RADUGIN, 1964, p. 146, 1966 (unseen); type new species of these genera named and figured as *C. mani, S. cerskii, A. lomonsovi, B. lermontovae,* and *C. costatum* but not described by RADUGIN, 1964, p. 146, and all were considered synonyms of *C. kelleri* by YANKAUSKAS, 1969, p. 143; there is a senior homonym in the animal kingdom for *Aphyllum; Manaella* YANKAUSKAS, 1964 (unseen), 1965, p. 439, only species named and figured, not described, *M. basaika* YANKAUSKAS, 1964]. Cups one-walled, third type. *L.Cam.(Aldan.),* USSR(E.Sayan).——FIG. 106,*1*. **C. kelleri,* R.Mana, E.Sayan; *1a-f,* transv. and long. secs., ×16 (Yankauskas, 1969).

Crispus YANKAUSKAS, 1965, p. 439 [**C. subdimidiatus;* M; genus diagnosed; single species illustrated only; type-species described by YANKAUSKAS, 1969, p. 145]. One-walled cups, the wall chambered or ring-chambered, formed of peripteratae of third type (see Fig. 104), upper edges of the peripteratae on the one side rounded, on the other, sharply pointed. *L.Cam.(Aldan.),* USSR (E.Sayan).——FIG. 106,*3*. **C. subdimidiatus,* R. Mana, E.Sayan; *3a,* sec. through initial and early stages; *3b,c,* oblique sec., *3d,* oblique long. sec., all ×16 (Yankauskas, 1969).

Longaevus YANKAUSKAS, 1965, p. 439 [**L. vitalis,* M; genus diagnosed; single species illustrated only; species described by YANKAUSKAS, 1969, p. 144]. Slenderly conical cups, oval in transverse section, with simple, camerate wall; peripteratae asymmetrically positioned, their axial edges on the one side free, on the other side conjunct. *L.Cam. (Aldan.),* USSR(E.Sayan).——FIG. 106,*2*. **L. vitalis,* R.Mana, E.Sayan; holotype, oblique sec. of orifice region, ×16 (Yankauskas, 1969).

Superfamily AKADEMIOPHYLLACEA Radugin, 1964

[*nom. transl.* HILL, herein (*ex* Akademiophyllidae RADUGIN, 1964, p. 145)] [=Pterocyathacea YANKAUSKAS, 1969, p. 146]

Conical or cylindrical cups, two-walled;

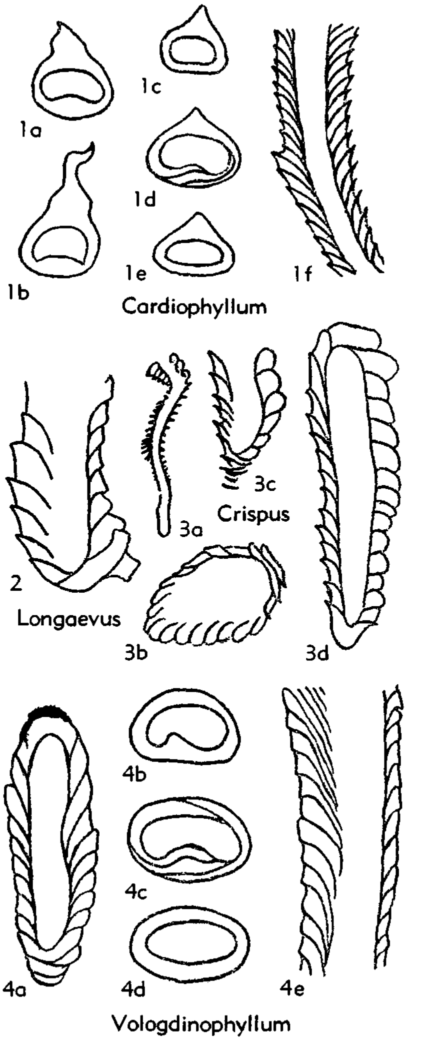


FIG. 106. Vologdinophyllidae (p. *E*138).

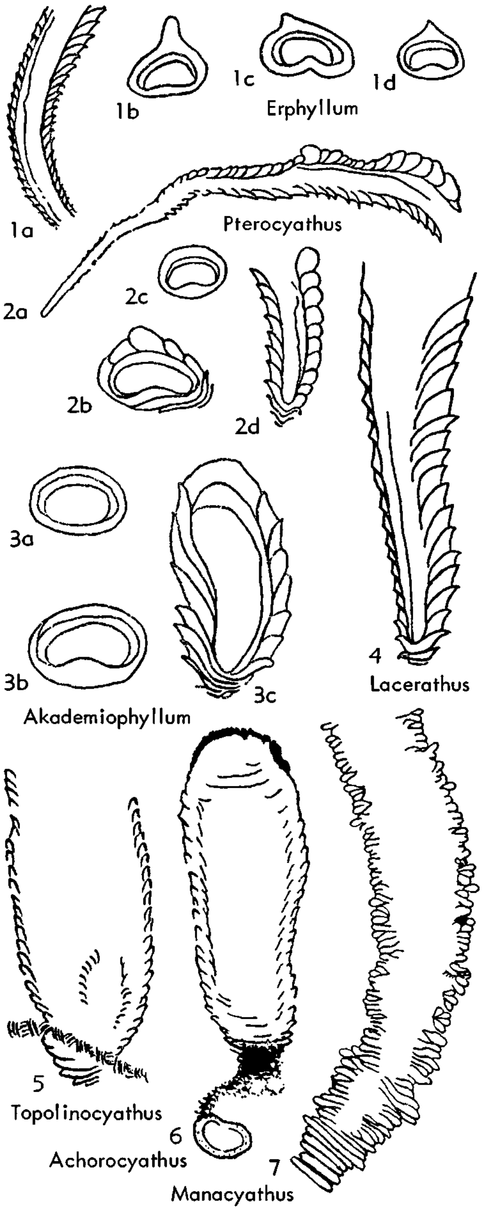


FIG. 107. Akademiophyllidae *(1-4)*; Achorocyathidae *(5-6)*; Manacyathidae *(7)* (p. *E*140-*E*141).

outer wall peripterate, inner wall monolithic or striate. *L.Cam.(Aldan.)*.

Family AKADEMIOPHYLLIDAE Radugin, 1964

[Akademiophyllidae RADUGIN, 1964, p. 145] [=Pterocyathidae YANKAUSKAS, 1965, p. 440]

Cup two-walled; outer wall chambered or ring-chambered, peripteratae of third type (see Fig. 104); inner wall monolithic. *L. Cam.(Aldan.)*.

Akademiophyllum RADUGIN, 1964, p. 145 [**A. conuforme*, OD]. Cup two-walled; outer wall peripterate, chambered or ring-chambered, peripteratae of third type (see Fig. 104); inner wall monolithic, trough-formed. *L.Cam.(Aldan.)*, USSR(R.Mana, E.Sayan).——FIG. 107,*3*. **A. cornuforme; 3a,b*, transv. secs., *3c*, long. sec., all ×13 (Yankauskas, 1969).

Erphyllum RADUGIN, 1964, p. 146 [**E. bephylleforme;* OD (figured only; described by YANKAUSKAS, 1969, p. 148)] [=*Archaeobullathus* YANKAUSKAS, 1965; p. 440 (type, *A. cereiformis* YANKAUSKAS, 1965, p. 438; M; figured only, but genus diagnosed); *Archaeobullatus* VOLOGDIN, 1966, p. 16, *nom. null.*]. Like *Akademiophyllum*, but cup heart-shaped in transverse section. *L. Cam.(Aldan.)*, USSR(R.Mana, E.Sayan).——FIG. 107,*1*. **E. bephylleforme*, R.Mana, E.Sayan; *1a*, long. sec., *1b,c,d*, transv. secs., all ×13 (Yankauskas, 1969).

Lacerathus YANKAUSKAS, 1965, p. 440 [**L. cuneatus;* M; genus diagnosed, single species illustrated only; species described YANKAUSKAS, 1969, p. 149] [=*Laceratus* YANKAUSKAS, 1964, p. 438; 1969, p. 149, *nom. null.*]. Outer wall peripterate, chambered, asymmetry of peripteratae as in *Longaevus;* inner wall monolithic, trough-formed. *L.Cam.(Aldan.)*, USSR(E.Sayan).——FIG. 107,*4*. **L. cuneatus*, R.Mana, E.Sayan; oblique long. sec., ×20 (Yankauskas, 1969).

Pterocyathus YANKAUSKAS, 1965, p. 440 [**P. glaucus;* M; genus diagnosed, single species illustrated only; species described YANKAUSKAS, 1969, p. 150, as *P. glausus (nom. null.)*]. Two-walled cups; outer wall peripterate, chambered or ring-chambered; inner wall monolithic; upper edge of peripteratae on "ventral" side acute, on "spinal" side rounded. *L.Cam.(Aldan.)*, USSR(Altay-Sayan).——FIG. 107,*2*. **P. glaucus*, R.Mana, E. Sayan; *2a*, long. sec., ×13; *2b,c*, transv. sec., ×13; *2d*, oblique long. sec., ×10 (Yankauskas, 1969).

Family ACHOROCYATHIDAE Yankauskas, 1965

[Achorocyathidae YANKAUSKAS, 1965, p. 440]

Cups two-walled, large (1.5 to 2 mm. diameter), straight, slenderly conical with rounded, rarely oval transverse section; outer wall subcamerate, composed of peripteratae of the fifth type (see Fig. 104); inner wall striate. Porosity rarely observed. *L.Cam.(Aldan.)*.

Achorocyathus YANKAUSKAS, 1965, p. 440 [**A. perbellus,* M; genus diagnosed, single species illustrated only; species described YANKAUSKAS, 1969, p. 152]. Cups long, straight, conical two-walled; outer wall peripterate, subcamerate, composed of peripteratae of fifth type; inner wall striate, developed for entire length of adult stages. Gyrate peripteratae have uneven lower edges, causing short transverse chink-like openings performing role of pores. *L.Cam.(Aldan.),* USSR(E.Sayan).——FIG. 107,*6*. **A. perbellus,* R.Mana, E.Sayan; oblique long. sec., ×13 (Yankauskas, 1969).

Topolinocyathus YANKAUSKAS, 1965, p. 440 [**T. popovi;* M; genus diagnosed, single species illustrated only; species described YANKAUSKAS, 1969, p. 153]. Outer wall as in *Achorocyathus;* inner wall striate, barrel-shaped. *L.Cam.(Aldan.),* USSR (E.Sayan).——FIG. 107,*5*. **T. popovi,* R.Mana, E.Sayan; holotype, oblique sec., ×13 (Yankauskas, 1969).

Class UNCERTAIN

Order ARCHAEOPHYLLIDA Okulitch, 1943

[*nom. correct.* OKULITCH, 1955, p. *E*10 (*pro* Archaeophyllina OKULITCH, 1943, p. 46)] [=Archaeophylloidea RADUGIN, 1964, p. 147]

Family ARCHAEOPHYLLIDAE Vologdin, 1931

[Archaeophyllidae VOLOGDIN, 1931, p. 60]

Archaeophyllum SIMON, 1939, p. 21 [**A. edelsteini;* OD SIMON, 1939, p. 21]. *?L.Cam.(up.Atdaban.),* USSR(Kameshki, Kuznetsk Alatau).

Butovia VOLOGDIN, 1931, p. 63 [**B. serrata;* M]. *?L.Cam.(up.Atdaban.),* USSR(Kameshki, Kuznetsk Alatau).

Order UNCERTAIN

Family MANACYATHIDAE Yankauskas, 1969

[Manacyathidae YANKAUSKAUS, 1969, p. 154]

One-walled, radially symmetrical, conical or cylindrical cups, the wall composed of connecting peripteratae of the sixth type (see Fig. 104). *L.Cam.(Aldan.).*

Manacyathus YANKAUSKAS, 1969, p. 154 [**M. mikroporosus;* OD]. Cups radially symmetrical, one-walled; wall composed of a system of peripteratae each doubled back on itself (sixth type) forming an annular riffle. Some skeletal elements microporous. *L.Cam.(Aldan.),* USSR(E.Sayan).——FIG. 107,*7*. **M. mikroporosus,* R.Mana, E. Sayan; holotype, part of long. sec., ×13 (Yankauskas, 1969).

Class RADIOCYATHA Debrenne, H. Termier, & G. Termier, 1971

[Radiocyatha DEBRENNE, H. TERMIER, & G. TERMIER, 1971, p. 120]

DEBRENNE, *et al.,* 1971, p. 124, drew attention to morphological similarities of this class to Archaeocyatha and Echinodermata. *L.Cam.(up.Atdaban.-low.Botom.).*

Order HETAIRACYATHIDA R. Bedford & J. Bedford, 1937

[*nom. correct.* OKULITCH, 1955, p. *E*18 *pro* Hetairacyathina R. BEDFORD & J. BEDFORD, 1937, p. 27 (*nom. subst. pro* Heterocyathina OKULITCH, 1935, p. 90, based on invalid generic name)]

Family HETAIRACYATHIDAE R. Bedford & J. Bedford, 1934

[*nom. subst.* R. BEDFORD & J. BEDFORD, 1937, p. 27 (*pro* Heterocyathidae R. BEDFORD & W. R. BEDFORD, 1934, p. 6)]

Radiocyathus OKULITCH, 1937 (April), p. 252 [*nom. subst.* OKULITCH, 1937, p. 252, *pro Heterocyathus* R. BEDFORD & W. R. BEDFORD, 1934, p. 6 (type, *H. minor;* SD BEDFORD & W. R. BEDFORD, 1936, p. 20), *non Heterocyathus* EDWARDS & HAIME, 1848, p. 323 (type, *H. aequicostatus;* SD EDWARDS & HAIME, 1850, p. xv)] [**Heterocyathus minor* R. BEDFORD & W. R. BEDFORD, 1934, p. 7; OD] [=*Hetairacyathus* R. BEDFORD & J. BEDFORD, 1937 (Sept.), p. 27, *nom. subst. pro Heterocyathus* R. BEDFORD & W. R. BEDFORD, 1934, p. 6, *non Heterocyathus* EDWARDS & HAIME, 1848, p. 323 (type, *H. aequicostatus;* SD EDWARDS & HAIME, 1850, p. xv)]. *L.Cam.(up.Atdaban.* or *low.Botom.),* S.Australia(Ajax Mine, Beltana).

Class UNCERTAIN, PROBABLY NOT ARCHAEOCYATHA

Order UNCERTAIN

Family MATTHEWCYATHIDAE Okulitch, 1943

[Matthewcyathidae OKULITCH, 1943, p. 48]

Matthewcyathus OKULITCH, 1940, p. 84 [**Archaeocyathus pavonoides* MATTHEW, 1886, p. 29; OD]. *M.Cam.,* Can.(N.B.).

Family KOROVINELLIDAE Khalfina, 1960

[Korovinellidae KHALFINA, 1960, p. 80]

Members of this family, together with *Praeactinostroma* and *Cambrostroma* were considered to be the earliest stromatoporoids by YAWORSKY (1932, p. 613), ZHURAVLEVA (1955, p. 17; 1960, p. 312), KHALFINA (1960, p. 79), VLASOV (1961, p. 22; 1967, p. 120), KHALFINA & YAVORSKIY (1967, p. 133) and VOLOGDIN (1940b, p. 102; 1966, p. 7), but NESTOR (1966, p. 3) considered them to be archaeocyathans of the Order Archaeosyconida. Herein they are considered probably not archaeocyathans. *L.Cam.(up. Botom.).*

Altaicyathus VOLOGDIN, 1932, p. 27 [**A. notabilis;* M] [=*Korovinella* RADUGIN (MS in KHALFINA), 1960, p. 81 (type, *Clathrodictyon sajanicum* YAWORSKY, 1932, p. 614; OD)]. *L.Cam.(up. Botom.),* USSR(Sayano-Altay).

Family UNCERTAIN

Atikokania WALCOTT, 1912, p. 6 [**A. lawsoni;* OD]. *?Precam.(Steeprock Series),* Can.

Cambrostroma VLASOV, 1961, p. 29 [**C. rossicum;* OD]. *L.Cam.(up.Botom.),* USSR(Sayano-Altay).

Miassocyathus FOMIN, 1963, p. 17 [**M. lobanovae;* OD]. *M.Dev.,* USSR(S.Urals).

Misracyathus VOLOGDIN, 1959, p. 82 [**M. vindhianus;* M]. *U.Proteroz.(Vindhyan),* India.

Orlinocyathus KRASNOPEEVA in VOLOGDIN, 1957, p. 212 [**O. olgae;* M]. *U.Cam.,* USSR(Salair). Probably a sponge of the family Archaeoscyphidae RAUFF.

Praeactinostroma KHALFINA, 1960, p. 81 [**Actinostroma vologdini* YAWORSKY, 1932, p. 613; OD]. *L.Cam.(up.Botom.),* USSR(Sayano-Altay).

Spongiosicyathus ZHURAVLEVA, 1968, p. 174 [**Dictyocyathus translucidus* ZHURAVLEVA, 1960, p. 275; OD]. Solitary or colonial, cups in form like a round loaf, or commonly conical; skeletal walls absent; intervallum a framework of regularly spaced spicules arranged at right angles in three planes—radial longitudinal, radial horizontal and tangential; adherent outgrowths form shapeless carbonate mass. *L.Cam.(up.Tommot.-low.Botom.),* USSR(Sib.Platf.).

REFERENCES

Bayfield, H. W.

(1) 1845, *On the junction of the transition and primary rocks of Canada and Labrador:* Geol. Soc. London, Quart. Jour., v. 1, p. 450-459.

Bedford, R., & Bedford, J.

(2) 1936, *Further notes on Cyathospongia (Archaeocyathi) and other organisms from the Lower Cambrian of Beltana, South Australia:* Kyancutta Museum, Mem., no. 3, p. 21-26, pl. 21-26 (fig. 88-105).

(3) 1937, *Further notes on Archaeos (Pleospongia) from the Lower Cambrian of South Australia:* Same, Mem., no. 4, p. 27-38, pl. 27-41 (fig. 106-159).

(4) 1939, *Development and classification of Archaeos (Pleospongia):* Same, Mem., no. 6, p. 67-82, pl. 42-52 (fig. 160-212).

———, & Bedford, W. R.

(5) 1934, *New species of Archaeocyathinae and other organisms from the Lower Cambrian of Beltana, South Australia:* Kyancutta Museum, Mem., no. 1, p. 1-7, pl. 1-6 (fig. 1-36).

(6) 1936, *Further notes on Archaeocyathi (Cyathospongia) and other organisms from the Lower Cambrian of Beltana, South Australia:* Same, Mem., no. 2, p. 9-20, pl. 7-20 (fig. 37-87).

Belyaeva, G. V.

(7) 1969, *Novye Arkheotsiaty khrebta Dzhagdy (Dallniy Vostok);* in I. T. Zhuravleva, (ed.), Biostratigrafiya i paleontologiya nizhnego kembriya Sibiri i Dal'nego Vostoka, p. 86-98, pl. 34-38, Nauka (Moskya). [*New Archaeocyatha from the Dzagdu Range (Far East).*]

Billings, Elkanah

(8) 1861, *New species of Lower Silurian fossils: on some new or little known species of Lower Silurian fossils from the Potsdam Group (Primordial zone):* 24 p., 25 text-fig., Geol. Survey Canada (Montreal).

(9) 1865, *On some new or little-known species of Lower Silurian fossils from the Potsdam group (Primordial zone):* [a reprint, with alterations and additions, of BILLINGS, 1861], in Palaeozoic fossils, v. 1, p. 1-18, 22 text-fig., Geological Survey Canada (Montreal).

Bornemann, J. G.

(10) 1884, [*Bericht über die Fortsetzung seiner Untersuchungen cambrischer Archaeocyathus-Formen und verwandter Organismen von der Insel Sardinien*]*:* Deutsch. Geol. Gesell., Zeitschr., v. 36, p. 702-706.

(11) 1886, *Die Versteinerungen des Cambrischen Schichtensystems der Insel Sardinien nebst vergleichenden Untersuchungen über analoge Vorkommisse aus andern Ländern.* Erste Abt. iii. *Archaeocyathinae:* Nova Acta Acad. Caesar. Leopoldina Carol., v. 51, pt. 1, p. 28-78, pl. 5-33.

(12) 1891, *Zweite Abt. Nachschrift, iii. Archaeocyathinae:* Same, v. 56, pt. 1, p. 495 (71)-500 (76), 2 pl.

Boucart, J., & le Villain, G.

(13) 1931, *La faune des calcaires cambriens de Sidi Mouça d'Aglou (Anti-Atlas Marocain):* Serv. Mines Carte Géol. Maroc., Notes & Mém. v. 15, p. 1-65, 10 pl.

Boyarinov, A. S.

(14) 1962, *O rodakh Szecyathus Vol. i Lucyathus Vol.:* in Materialy po geologii zapadnoi Sibiri, no. 63, p. 14-15, 1 text-fig., Tomsk Univ. (Tomsk). [*On the genera Szecyathus Vol. and Lucyathus Vol.*]

Broili, Ferdinand

(15) 1915, *Archaeocyathinae:* in K. von Zittel, Grundzüge der Paläontologie, 4th edit., p. 121, Oldenbourg (München, Berlin).

Brook, George

(16) 1893, *The genus Madrepora:* Cat. Madreporian Corals, British Museum (Nat. History), v. 1, vii+212 p., 35 pl. (London).

Chernysheva, S. V.

(16a) 1960, *Tollicyathus—novyy rod arkheotsiat:* Sibir. Nauchno-Issledov. Inst. Geologii, Geofiziki i Mineral'nogo Syr'ya (SNIIG-GIMS), Minister. geol. i okhrany nedr SSSR, Trudy, v. 8, p. 77-78, pl. 4. [*Tollicyathus—a new genus of Archaeocyatha.*]

Datsenko, V. A., Zhuravleva, I. T., Lazarenko, N. P., Popov, Yu. N., & Chernysheva, N. E.

(17) 1968, *Biostratigrafiya i fauna kembriyskikh otlozheniy severo-zapada Sibirskoy platformy:* Nauchno-Issledov. Inst. Geol. Arktiki, Trudy, v. 155, 213 p., 23 pl.; Atlas, 13 tables, 47 text-fig., Nedra (Leningrad). [*Biostratigraphy and fauna of the Cambrian deposits of the northwest Siberian Platform.*]

David, T. W. E., & Priestley, R. E.

(18) 1914, *Glaciology, physiography, stratigraphy and tectonic geology of South Victoria Land:* Rept. British Antarctic Exped. 1907-09, Geology, p. 1-319, Heinemann (London).

Dawson, J. W.

(19) 1865, *On the structure of certain organic remains in the Laurentian limestones of Canada:* Geol. Soc. London, Quart. Jour., v. 21, p. 51-59, pl. 6-7.

Debrenne, Françoise

(20) 1959a, *Sur quelques Archaeocyatha du Jebel Taïssa (Anti-Atlas occidental):* Serv. Mines Carte Géol. Maroc, Notes & Mém., no. 143, v. 16, p. 59-67, text-fig. 1-2, pl. 1-3.

(21) 1959b, *Un nouveau genre d'Archaeocyatha du Cambrien marocain:* Soc. Géol. France, Comptes Rendus somm. Séanc., 1959, no. 1, p. 14-15, 1 text-fig.

(21a) 1960, *Deux nouveaux genres d'Archaeocyathidés du Cambrien marocain (Geniculicyathus, Volvacyathus):* Same, Comptes Rendus somm. Séanc., 1960, no. 5, p. 118, 2 text-fig.

(22) 1961, *Nouvelles données sur la faune d'Archaeocyatha du Jebel Taïssa:* Serv. Mines Carte Géol. Maroc, Notes & Mém., no. 152, v. 20, p. 7-26, pl. 1-6.

(23) 1963, in Debrenne, F., & Lotze, F., *Archaeocyatha d'Espagne:* Akad. Wiss. Lit. [Mainz], Abhandl., math-naturw. Kl., 1963, no. 2, p. 17-38, 2 text-fig., 5 pl.

(24) 1964, *Archaeocyatha. Contribution a l'étude des faunes cambriennes du Maroc, de Sardaigne et de France:* Serv. Mines Carte Géol. Maroc, Notes & Mém., no. 179, v. 1, Texte, 265 p., 69 text-fig., 29 tables; v. 2, Planches, 52 pl.

(25) 1965, *Halysicyathus, nouveau genre d'Archeocyathe du Cambrien marocain:* Soc. Géol. France, Comptes Rendus somm. Séanc., 1965, pt. 4, p. 143-144, text-fig. 1-2.

(26) 1969a, *Lower Cambrian Archaeocyatha from the Ajax Mine, Beltana, South Australia:* British Museum Nat. History, Bull., ser. geol., v. 17, no. 7, p. 295-376, 15 text-fig., 18 pl.

(26a) 1969b, *Archaeocyatha. Questions de nomenclature:* Soc. Géol. France, Comptes Rendus somm. Séanc. 3 Nov. 1969, p. 262-263.

(26b) 1970a, *Coscinocyathus Bornemann, 1884 (Archaeocyatha):* Proposed designation of a type-species under the plenary powers. Z.N.(S) 1924: Bull. Zool. Nomencl., v. 27, p. 207-208.

(27) 1970b, *A revision of Australian genera of Archaeocyatha:* Royal Soc. S. Australia, Trans., v. 94, p. 21-49, 2 pl.

———, & Debrenne, M.

(27a) 1965, *Etudes préliminaires des faunes d'Archéocyathes des calcaires l'Oued Tamanar (Aguerd-Tamezra, Maroc):* Soc. Géol. France, Comptes Rendus somm. Seanc., 1965, no. 5, p. 159-160, 1 text-fig.

———, Termier, H., & Termier, G.

(27b) 1970, *Radiocyatha. Une nouvelle classe d'organismes primitifs du Cambrien inférieur:* Soc. Géol. France, Bull., v. 12, no. 1, p. 120-125, pl. 4-6.

———, & Zamarreno, I.

(27c) 1970, *Sur la découverte d'Archeocyathes dans le Cambrien du NW de l'Espagne:* Breviora geologica asturica, v. 14, no. 1, p. 1-11, text-fig. 1-7.

Duncan, P. M.

(28) 1876, *Notices of some deep-sea and littoral corals from the Atlantic Ocean, Caribbean, Indian, New Zealand, Persian Gulf and*

Japanese . . . seas: Zool. Soc. London, Proc., p. 428-442, 4 pl.

Etheridge, Robert, Jr.

(29) 1890, *On some Australian species of the family Archaeocyathinae:* Royal Soc. S. Australia, Trans., v. 13, p. 10-22.

Fomin, Yu. M.

(30) 1963, *O nakhodke arkheotsiatopodovnykh organizmov v srednedevonskikh otlozheniyakh vostochnogo sklona yuzhnogo Urala:* Paleont. Zhurnal, 1963, no. 2, p. 17-19, text-fig. 1-2. [*On the discovery of Archaeocyatha-like organisms in Middle Devonian deposits of the eastern slopes of the southern Urals.*]

Fonin, V. D.

(31) 1960, *O novom semeystve kembriyskikh metatsiatid—Prismocyathidae Fonin, fam. n.:* Akad. Nauk SSSR, Doklady, v. 135, no. 3, p. 725-727, text-fig. 1 (opp. p. 702). [*On a new family of Cambrian metacyathids—Prismocyathidae Fonin, fam. n.*]

(32) 1961, *O nekotorykh voprosakh morfologii tenial'nykh arkheotsiat* (avtoreferat): Moskov. Obshch. Ispyt. Prirody, Byull., ser. geol., 1961, no. 3, p. 149-150. [*On some problems in the morphology of tenial Archaeocyatha* (abstract).]

(33) 1963, *K poznaniyu tenial'nykh arkheotsiat Altae-Sayanskoy skladchatoy oblasti:* Paleont. Zhurnal, 1963, no. 4, p. 14-29, 8 text-fig., pl. 3. [*Contribution to knowledge of taenioid Archaeocyatha from the Altay-Sayan fold area.*]

Ford, S. W.

(34) 1873a, *On some new species of fossils from the Primordial or Potsdam group of Rensselaer Co., N.Y. (Lower Potsdam):* Am. Jour. Sci. Arts, ser. 3, v. 5, p. 211-215, text-fig. 1-3.

(35) 1873b, *Remarks on the distribution of fossils in the Lower Potsdam rocks at Troy, N.Y., with a description of four new species:* Same, ser. 3, v. 6, p. 134-140, text-fig. 1-2.

(36) 1878, *Descriptions of two new species of Primordial fossils:* Same, ser. 3, v. 15, p. 124-127, text-fig. 1.

Frederiks [Fredericks], Georgiy

(37) 1925, *Upper Paleozoicum of the Ussuriland. II. Permian Brachiopoda of Cape Kalouzin:* Materialy po geologii i poleznym iskopaemym Dal'nyago Vostoka (Rec. Geol. Comm. Russian Far East), no. 40, p. 1-28, pl. 1-4 (in Russian) [not seen].

Gekker [Hecker], R. F.

(38) 1928, *O pervoy nakhodke arkheotsiat v Sibiri:* Geol. Vestnik, v. 6, no. 1, p. 43-46 (unseen; quoted by ZHURAVLEVA, 1960, p. 328). [*On the first discovery of Archaeocyatha in Siberia.*]

Gordon, W. T.

(38a) 1920, *Scottish National Antarctic Expedition 1902-04. Cambrian organic remains from a dredging in the Weddell Sea:* Royal Soc. Edinburgh, Trans., v. 52, p. 681-714, pl. 1-7.

Greggs, R. G.

(39) 1959, *Archaeocyatha from the Colville and Salmo areas of Washington and British Columbia:* Jour. Paleontology, v. 33, p. 63-75, pl. 11-14.

Handfield, R. C.

(40) 1967, *A new Lower Cambrian Archaeocyatha?:* Jour. Paleontology, v. 41, no. 1, p. 209-212, 1 text-fig., pl. 23.

(41) 1971, *Archaeocyatha of the Mackenzie and Cassiar Mountains, Northwestern Canada:* Geol. Survey Canada, Bull. 201, 119 p., pl.

———, & Hansman, R. H.

(42) 1967, *The genus Tunkia Bedford & Bedford:* Jour. Paleontology, v. 41, no. 4, p. 1002-1003, text-fig. 1.

Hill, Dorothy

(43) 1964a, *The phylum Archaeocyatha:* Biol. Reviews, v. 39, p. 232-258, 6 text-fig., 1 pl.

(43a) 1964b, *Archaeocyatha from the Shackleton Limestone of the Ross System, Nimrod Glacier area, Antarctica:* Royal Soc. New Zealand, Trans. (Geol.), v. 2, no. 9, p. 137-146, pl. 1-2.

(43b) 1964c, *Archaeocyatha from loose material at Plunket Point at the head of Beardmore Glacier:* in Antarctic Geology, SCAR Proc. 1963, XI. Palaeontology, p. 609-619, 2 text-fig.

(44) 1965, *Archaeocyatha from Antarctica and a review of the phylum:* Trans-Antarctic Expedition 1955-1958, Sci. Rept., no. 10 (Geol. no. 3), 151 p., 25 text-fig., 12 pl., Trans-Antarct. Exped. Comm. (London).

(45) 1967, *Phylum Archaeocyatha Vologdin 1937:* in The fossil record, W. B. Harland, *et al.* (ed.), p. 341-345, Geol. Soc. London (London).

Hinde, G. J.

(46) 1889, *On Archaeocyathus Billings, and on other genera, allied to or associated with it, from the Cambrian strata of North America, Spain, Sardinia and Scotland:* Geol. Soc. London, Quart. Jour., v. 45, p. 125-148, pl. 5.

Khabakov, A. V.

(47) 1967, *Paleontologicheski okharakterizovannye kembriyskie otlozheniya na yuge yuzhnogo Urala:* in Materialy po paleogeografii i litologii, Vses. Nauchno-Issledov. Geol. Inst., Trudy, v. 110, p. 36-52, 3 text-fig. [*Paleontological descriptions for the Cambrian deposits in the south of the southern Urals.*]

Khalfin, L. L. (ed.)

(48) 1960, *Biostratigrafiya paleozoya Sayano-Altayskoy gornoy oblasti, tom 1, nizhniy paleozoy:* Sibir. Nauchno-Issledov. Inst. Geol. Geofiz. Mineral. Syr'ya, Trudy, no. 19, 498 p., text-fig., pl. Cm 1-33, 01-20 tables. [*Biostratigraphy of the Paleozoic of the Sayano-Altay mountain region, volume 1, Lower Paleozoic.*]

Khalfina, V. K.

(49) 1960, *Stromatoporoidei iz kembriyskikh otlozheniy Sibiri:* in Materialy po paleontologiya i stratigrafiya Zapadnaya Sibiri, Sibir. Nauchno-Issledov. Inst. Geol. Geofiz. Mineral. Syr'ya, Trudy, v. 8, p. 79-83. [*Stromatoporoids of the Cambrian deposits of Siberia.*]

———, & Yavorskiy [Yaworsky], V. I.

(50) 1967, *O drevneyshikh stromatoporoideyakh:* Paleont. Zhurnal, 1967, no. 3, p. 133-136. [*On the most ancient stromatoporoids.*]

Khomentovskiy, V. V., Zhuravleva, I. T., Repina, L. N., & Rozanov, A. Yu.

(51) 1962, *Nizhniy kembriy gornogo Altaya:* Akad. Nauk SSSR, Izvestiya, ser. geol., 1962, no. 3, p. 55-71. [*Lower Cambrian of the Altay Mountains.*]

Konyushkov, K. N.

(52) 1967, *Novye dannye po arkheotsiatam gor Agyrek severo-vostochnogo Kazakhstana:* in Biostratigraficheskiy sbornik, vyp. 3, Vses. Nauchno-Issledov. Geol. Inst., Trudy, n. ser., no. 129, p. 104-113, 1 text-fig., pl. 1. [*New data on the Archaeocyatha of Mt. Agyrek in northeastern Kazahkstan.*]

Krasnopeeva, P. S.

(53) 1937, *Vodorosli i arkheotsiaty drevneyskikh tolshch Potekhinskogo rayona Khakassii:* in Materialy po geologii Krasnoyarskogo kraya, vyp. 3, Zapadno-Sibirskogo Geologicheskogo Tresta, p. 1-50, 20 pl. (unseen). [*Algae and Archaeocyatha of the most ancient thickness of the Potekhino district of Khakassia.*]

(54) 1953a [Title unknown]: Tomsk Gosud. Univ., Trudy, v. 124, ser. geol., p. 36 (*fide* ZHURAVLEVA, 1960b, p. 192-193).

(55) 1953b, *Osobennosti kameshkovskogo kompleksa arkheosiat v fatsii effuzivno-osadochnykh otlozheniy na primere arkheotsiat zapadnoi chasti Tuvy:* Same, Trudy, v. 124, ser. geol., p. 51-62, pl. 1-4. [*Features of the Kameshkian complex of Archaeocyatha in the facies of effusive-sedimentary deposits exemplified by the Archaeocyatha of the western part of Tuva.*]

(56) 1954, *Novye dannye k stratigrafii arkheotsiat Zapadnoy Sibiri:* Akad. Nauk SSSR, Doklady, v. 99, no. 4, p. 601-604. [*New data on the stratigraphy of the Archaeocyatha of Western Siberia.*]

(57) 1955, *Tip Archaeocyathi, Arkheotsiati:* in Atlas rukovodyashchikh form iskopaemykh fauny i flory Zapadnoy Sibiri, L. L. Khalfina (ed.), v. 1, p. 74-102, text-fig. 117-156, pl. 1-10, Gosgeoltekhizdat (Moskva). [*Phylum Archaeocyatha, Arkheotsiati.*]

(58) 1959, *Arkheotsiaty gor Agyrek Pavlodarskoy oblasti Kazakhskoy SSR:* Akad. Nauk Kazakh. SSSR, Izvestiya, ser. geol., 1959, no. 3 (36), p. 3-10, 3 text-fig., pl. 1-2. [*Archaeocyatha of Mt. Agyrek, Pavlodarsk region of Kazakh SSR.*]

(59) 1960, *K voprosu o sistematicheskom polozhenii arkheotsiat:* Tomsk. Univ., Trudy, v. 146, ser. geol., p. 37-44, pl. 1-6. [*On the problem of the systematic position of the Archaeocyatha.*]

(60) 1961, *Novye arkheotsiaty iz obruchevskogo gorizonta Altae-Sayanskoy oblasti:* Sibir. Nauchno-Issledov. Inst. Geol. Geofiz. Mineral. Syr'ya, Trudy, no. 5, p. 247-253, text-fig. 1, pl. 1-4. [*New Archaeocyatha from the Obruchevian horizon of the Altay-Sayan region.*]

(61) 1969, *Osnovnye osobennosti morfologii arkheotsiat:* in I. T. Zhuravleva (ed.), 1969, Biostratigrafiya i paleontologiya nizhnego kembriya Sibiri i Dal'nego Vostoko, p. 60-65, Nauka (Moskva). [*Principle features of the morphology of Archaeocyatha.*]

Maslov, A. B.

(62) 1957, *O novom predstavitele semeystva Ethmophyllidae Okulitch, 1943 iz kembriya Chitinskoy oblasti s sokhranivshimsya vnutrennim organom:* Akad. Nauk SSSR, Doklady, v. 117, p. 307-309. [*On new representatives of the family Ethmophyllidae Okulitch, 1943, in the Cambrian of the Chita region with internal organs preserved.*]

(63) 1958, *O sluchae fakul'tativnogo parazitizma u arkheotsiat:* Same, Doklady, v. 122, no. 4, p. 699-701. [*On a case of facultative parasitism in the Archaeocyatha.*]

(64) 1960, *Novyy vid roda Rabdocnema Okulitch 1943 s pelta v verkhney chasti kubka:* Same, Doklady, v. 130, no. 5, p. 1117-1119. [*A new species of the genus Rhabdocnema Okulitch 1943 with pelta at the upper part of the cups.*]

(65) 1961, *O novykh naklodkakh arkheotsiat s peltami v verkhney chasti kubkov:* Moskov. Obshch. Ispyt. Prirody, Byull., v. 36, no. 6, p. 121-122. [*On new discoveries of Archaeocyatha with peltas at the upper part of the cups.*]

Matthew, G. F.

(66) 1886, *IV. Illustrations of the fauna of the St. John group continued, no. III—Descrip-*

tions of new genera and species (including a description of a new species of Solenopleura by J. W. Whiteaves): Royal Soc. Canada, Trans., 1885, v. 3, sec. 4, p. 29-84, pl. 5-7.

Meek, F. B.

(67) 1868, *Preliminary notice of a remarkable new genus of corals, probably typical of a new family:* Am. Jour. Sci., ser. 2, v. 45, p. 62-64.

Meshkova, N. P.

(67a) 1969, *Khiolity i Khiolitel'minty nizhnego kembriya Sibirskoy platformy i ikh biostratigraficheskoe znachenie:* Avtoreferat dissertatsii na soiskani uchenoy stepani kandidata geologo-mineralogicheskikh nauk. Novosibirskii gosudarst. univ. uchenyy sovet po geol.-mineral. naukam, no. 128. Paleont. i strat. [Author's abstract of dissertation submitted for the candidate's degree in geologo-mineralogical science. Novosibirsk State Univ. Teaching Council for Geol.-mineral. Sciences, no. 128, Paleontology and stratigraphy.] [*Hyolithids and hyolitelminths of the Lower Cambrian of the Siberian Platform and their significance.*]

Milne-Edwards, Henri, & Haime, Jules

(68) 1848, *Recherches sur les polypiers, Mem. 2, Monographie des turbinolides:* Ann. Sci. Nat., ser. 3, v. 9, p. 211-344, pl. 7-10.

(69) 1850, *A monograph of the British fossil corals, Pt. 1, Introduction: Corals from the Tertiary and Cretaceous formations:* Palaeontograph. Soc., Mon., lxxxv+71 p., 11 pl.

Missarzhevskiy, V. V.

(70) 1961, *Rannekembriyskie arkheotsiaty basseyna reki Shivelig-Khem:* Paleont. Zhurnal, 1961, no. 4, p. 19-23, 1 text-fig., 1 pl. [*Early Cambrian Archaeocyatha from the basin of the River Shevilig-Khem.*]

———, & Rozanov, A. Yu.

(71) 1962, *K morfologii naruzhnykh stenok pravil'nykh arkheotsiat:* Paleont. Zhurnal, 1962, no. 2, p. 34-44, text-fig. 1-6, pl. 3. [*On the morphology of the outer wall of the regular Archaeocyatha.*]

Myagkova [Miagkova], E. I.

(72) 1955a, *K kharakteristike klassa Aphrosalpingoida Miagkova, 1955:* Akad. Nauk SSSR, Doklady, v. 104, no. 3, p. 478-481, 2 text-fig. [*On the characteristics of the class Aphrosalpingoida Myagkova, 1955.*]

(73) 1955b, *Novye predstaviteli typa Archaeocyatha:* Same, Doklady, v. 104, no. 4, p. 638-641, 2 text-fig. [*New representatives of the phylum Archaeocyatha.*]

Nestor, Kh. E.

(74) 1966, *O drevneyshikh stromatoporoideyakh:* Paleont. Zhurnal, 1966, no. 2, p. 3-12. [*On the most ancient stromatoporoids.*]

Nitecki, M. H.

(74a) 1967, *Bibliographic index of North American archaeocyathids:* Fieldiana, Geology, v. 17, no. 2, p. 105-220.

Öpik, A. A.

(75) 1956, *Cambrian geology of the Northern Territory:* El Sistema Cambrica, v. 2, p. 25-54, 2 text-fig., Internatl. Geol. Congress, Rept. 20th Sess. (Mexico City). [Reprinted, 1957, as Australia Bur. Mineral Res., Bull., no. 49, p. 25-54, 2 text-fig.]

(76) 1961, *The geology and palaeontology of the headwaters of the Burke River, Queensland:* Australia Bur. Mineral Res., Bull., v. 53, p. 1-249, 59 text-fig., 24 pl.

(76a) 1967, *The Ordian Stage of the Cambrian and its Australian Metadoxididae:* Same, Bull., v. 92, p. 135-170, pl. 19-20.

Okulitch, V. J.

(77) 1935, *Cyathospongia—a new class of Porifera to include the Archaeocyathinae:* Royal Soc. Canada, Trans., ser. 3, sec. 4, v. 29, p. 75-106, 2 text-fig., pl. 1-2.

(78) 1937, *Some changes in nomenclature of Archaeocyathi (Cyathospongia):* Jour. Paleontology, v. 11, no. 3, p. 251-252.

(79) 1940, *Revision of type Pleospongia from eastern Canada:* Royal Soc. Canada, Trans., ser. 3, sec. 4, v. 34, p. 75-87, 3 pl.

(80) 1943, *North American Pleospongia:* Geol. Soc. America, Spec. Paper, v. 48, 112 p., 19 text-fig., 18 pl.

(81) 1946, *Exothecal lamellae of Pleospongia:* Royal Soc. Canada, Trans., ser. 3, sec. 4, v. 40, p. 73-86, 7 pl.

(82) 1950a, *Vacuocyathus a new name for Coelocyathus Vologdin, 1933:* Jour. Paleontology, v. 24, p. 392-393.

(83) 1950b, *Nomenclatural notes on pleosponge genera Archaeocyathus, Spirocyathus, Flindersicyathus, Pycnoidocyathus and Cambrocyathus:* Same, v. 24, p. 393-395.

(84) 1950c, *Pluralicyathus, new name for Polycyathus Vologdin, 1928 not Duncan, 1876:* Same, v. 24, p. 503.

(85) 1955a, *Archaeocyatha:* in Treatise of invertebrate paleontology, Part E, R. C. Moore (ed.), p. *E*1-*E*20, text-fig. 1-13, Geol. Soc. America & Univ. Kansas (New York, Lawrence, Kansas).

(85a) 1955b, *Archaeocyatha from the M'Dame area of northern British Columbia:* Royal Soc. Canada, Trans., ser. 3, sec. 4, v. 49, p. 47-64, pl. 1-3.

———, & Roots, E. F.

(86) 1947, *Lower Cambrian fossils from the Aiken Lake area, British Columbia:* Royal

Soc. Canada, Trans., ser. 3, sec. 4, v. 41, p. 37-46, pl. 1.

Okuneva, O. G.

(87) 1967, *Novyy podrod monotsiatid iz nizhnego kembriya Primor'ya:* Paleont. Zhurnal, 1967, no. 1, p. 132-135, text-fig. 1-2. [*A new subgenus of monocyathids in the Lower Cambrian of Primorye.*]

(88) 1969, *K biostratigrafii nizhnego kembriya Primor'ya (Spasskiy i Chernigovskiy rayony);* in I. T. Zhuravleva (ed.), Biostratigrafiya i paleontologiya nizhnego kembriya Sibiri i Dal'nego Vostoka: p. 66-85, pl. 30-33, Nauka (Moskva). [*On the biostratigraphy of the Lower Cambrian of Primorye (in the vicinity of Spasskoye and Chernigovka).*]

Radugin, K. V.

(89) 1962, *O rannikh formakh arkheotsiat:* in Materialy po geologii Zapadnoy Sibiri, no. 63, p. 7-10, 1 text-fig., State Univ. (Tomsk). [*On early forms of Archaeocyatha.*]

(90) 1964, *O novoy gruppe drevneyshikh zhivotnykh:* Akad. Nauk SSSR, Sibir. Otdel., Geol. & Geofiz. 1964, no. 1, p. 145-149, 2 text-fig. [*On a new group of most ancient animals.*]

(91) 1966, *Problema pozdnego proterozoya:* in Materialy k izucheniyu geologii pozdnego dokembriya Sibiri, ch. I. Primit'ivnye arkheotsiaty pozdnego proterozoya, 149 p., 61 pl., Tomsk Univ. (Tomsk). [*Problems of the late Proterozoic:* in Materials for the study of the geology of the late Precambrian of Siberia, Part 1. Primitive Archaeocyatha of the late Proterozoic.]

Raymond, P. E.

(91a) 1931, *The systematic position of the Archaeocyathinae:* Harvard Univ., Museum Comp. Zoology, Bull., v. 55, p. 172-177.

Reid, R. E. H.

(91b) 1968, *Tremacystia, Barroisia, and the status of Sphinctozoida (Thalamida) as Porifera:* Univ. Kansas, Paleont. Contrib., Paper 34, p. 1-10, text-fig. 1-5.

Repina, L. N., Khomentovskiy, V. V., Zhuravleva, I. T., & Rozanov, A. Yu.

(92) 1964, *Biostratigrafiya nizhnego kembriya Sayano-Altayskoy skladchatoy oblasti:* 365 p., 48 pl., Nauka (Moskva). [*Biostratigraphy of the Lower Cambrian of the Sayano-Altay folded region.*]

Richter, Rudolf, & Richter, Emma

(92a) 1948, *Studien im Paläozoikum der Mittelmeer-Länder. 8. Zur Frage des Unter-Kambriums in Nordost-Spanien:* Senckenbergiana, v. 29, p. 23-29, 16 text-fig., 1 pl.

Rincón, A. P.

(92b) 1971, *Pachecocyathus, nuevo género do Archaeocyathidos del Cambrico español:* Estud. Geol., v. 27, p. 81-83.

Roemer, F. A.

(93) 1878, *Über Archaeocyathus marianus n. sp.:* Deutsch. Geol. Gesell., Zeitschr., v. 30, p. 369-370.

(93a) 1880, *Lethaea Palaeozoica:* v. 1, p. 298-303, 50 text-fig., 1 pl. (Stuttgart).

Rozanov, A. Yu.

(94) 1960a, *Novye dannye ob arkheotsiatakh Gornoy Shorii:* Akad. Nauk SSSR, Doklady, v. 131, no. 3, p. 663-666. [*New data on the Archaeocyatha of the Shoria Mts.*]

(95) 1960b, *O novykh predstavitelyakh arkheotsiat semeystva Dokidocyathidae:* Paleont. Zhurnal, 1960, no. 3, p. 43-47, pl. 1, text-fig. 1-2. [*On new representatives of the archaeocyathan family Dokidocyathidae.*]

(96) 1963, *Nekotorye voprosy evolyutsii pravil'nykh arkheotsiat:* Same, 1963, no. 1, p. 3-12, 5 text-fig. [English transl. in Internatl. Geology Rev. Washington, v. 6, no. 10, p. 1814-1821.] [*Some problems in the evolution of the regular Archaeocyatha.*]

(96a) 1967, *The Cambrian lower boundary problem:* Geol. Mag., v. 104, p. 415-434.

(97) 1969, *Nekotorye voprosy sistematiki arkheotsiat:* in I. T. Zhuravleva (ed.), Biostratigrafiya i paleontologiya nizhnego kembriya Sibiri i Dal'nego Vostoka, p. 106-113, pl. 42, Nauka (Moskva). [*Some problems in the systematics of the Archaeocyatha.*]

———, & Missarzhevskiy, V. V.

(98) 1966, *Biostratigrafiya i fauna nizhnikh gorizontov kembriya:* Akad. Nauk SSSR, Geol. Inst., Trudy, v. 148, 126 p., 68 text-fig., 13 pl. [*Biostratigraphy and fauna of the lower horizons of the Cambrian.*]

———, ———, Volkova, N. A., Voronova, L. G., Krylov, I. N., Keller, B. M., Korolyuk, I. K., Lendzion, K., Mikhnysk, R., Pykhova, N. G., & Sidorov, A. D.

(99) 1969, *Tommotskiy yarus i problema nizhney granitsy kembriya:* Akad. Nauk SSSR, Geol. Inst., Trudy, v. 206, 380 p., 79 text-fig., 55 pl., Nauka (Moskva). [*Tommotian Stage and the problem of the lower limit of the Cambrian.*]

Schlüter, Clemens

(100) 1886, *Archaeocyathus im russichen Silur?:* Deutsch. Geol. Gesell., Zeitschr., v. 38, p. 899-909.

Seilacher, Adolf

(101) 1962, *Die Sphinctozoa, eine Gruppe fossiler Kalkschwämme:* Akad. Wiss. Lit. [Mainz], Abhandl., math.-naturwiss. Kl., 1961, pt. 10, p. 720-790, pl. 1-9.

Simon, Wilhelm

(102) 1939, *Archaeocyathacea. I. Kritische Sichtung der Superfamilie. II. Die Fauna im Kambrium der Sierra Morena (Spanien):* Senckenberg. Naturforsch. Gesellsch., Abhandl., no. 448, p. 1-87, text-fig. 1-5, pl. 1-5.

(103) 1941, *Archaeocyathacea. III. Ergänzungen zur Taxonomie aus neueren Arbeiten:* Senckenbergiana, v. 23, no. 1-3, pl. 1-19.

Steinmann, G.

(103a) 1882, *Pharetronen-Studien:* Neues Jahrb. Mineralogie, Geologie u. Paläontologie, Abhandl., v. 2, p. 139-191.

Taylor, T. G.

(104) 1908, *Preliminary note on Archaeocyathinae from the Cambrian "coral reefs" of South Australia:* Australasian Assoc. Advanc. Sci., Rept., v. 11, p. 423-437, 2 pl., 8 text-fig.

(105) 1910, *The Archaeocyathinae from the Cambrian of South Australia with an account of the morphology and affinities of the whole class:* Royal Soc. S. Australia, Mem., v. 2, pt. 2, p. 55-188, pl. 1-16, 51 text-fig.

Termier, H., & Termier, G.

(106) 1950, *Paléontologie Marocaine:* v. 2, pt. 1, p. 41-54, pl. 3-9, Hermann & Cie (Paris).

Ting, T. H.

(107) 1937, *Revision der Archaeocyathinen:* Neues Jahrb. Geologie, Mineralogie, Paläontologie, v. 78, abt. B., p. 327-379, 12 text-fig., pl. 9-14.

Toll, E. von

(108) 1899, *Beiträge zur Kenntniss des sibirischen Cambrium. I:* Acad. Sci. St. Pétersbourg, Mém., sér. 8, Cl. Phys.-Math., v. 8, no. 10, p. 1-57, pl. 1-8.

Vlasov, A. N.

(109) 1961, *Kembriyskie stromatoporoidei:* Paleont. Zhurnal, 1961, no. 3, p. 22-32, pl. 1. [*Cambrian stromatoporoids.*]

(110) 1967, *O rode Altaicyathus Vologdin:* Same, 1967, no. 1, p. 120. [*On the genus Altaicyathus Vologdin.*]

Vologdin, A. G.

(111) 1928, *O novykh svoeobraznykh formakh arkheotsiat iz kembriya Sibiri:* Ezheg. Russk. Paleont. Obshch., v. 7, p. 25-46. [*On new and unusual forms of Archaeocyatha of the Cambrian of Siberia.*]

(112) 1931, *Arkheotsiaty Sibiri, vyp. 1, Fauna i flora izvestnyakov rayona d. Kameshki i ul. Bey-buluk Minusinsko-Khakasskogo kraya i okamenelosti izvestnyakov s.r. nizhney Tersi Kuznetskogo okruga:* 119 p., 44 text-fig., 24 pl., Geol. Izdatel. Glav. Geol.-razved. Uprav. (Moskva, Leningrad). [*Archaeocyatha of Siberia, fasc. I. Fauna and flora of the limestone areas of Kameshki and Bey-Buluk in the Minusinsk-Khakassiya regions and fossils of the limestones of the Lower Tersi R. of the Kuznetsk district.*]

(113) 1932, *Arkheotsiaty Sibiri, vyp. 2, Fauna kembriyskikh izvestnyakov Altaya:* 106 p., 46 text-fig., 14 pl., Gosudarst. Nauchno-tekhnich. Geol.-razved. Izdatel. [N.K.I.P.] (Moskva, Leningrad). [*Archaeocyatha of Siberia, no. 2, Fauna of the Cambrian limestones of the Altay.*]

(114) 1934, *Ob arkheotsiatakh iz basseyna reki Laby severnogo Kavkaza:* Akad. Nauk SSSR, Doklady, v. 4, p. 499-505, text-fig. 1-4. [*On the Archaeocyatha of the basin of the River Laba of the northern Caucasus.*]

(115) 1937a, *Arkheotsiaty i vodorosli yuzhnogo sklona Anabarskogo massiva:* Arktich. Inst., Trudy, v. 91, p. 9-66, pl. 1-12. [*Archaeocyatha and algae of the southern slopes of the Anabar massif.*]

(116) 1937b, *Arkheotsiaty i rezul'taty ikh izucheniya v SSSR:* Problemy paleontologii, v. 2-3, p. 453-500, 24 text-fig., pl. 1-4, Paleontologicheskaya Laboratoriya, Moskovskogo Gosudarstvennogo Universiteta (Moskva). [*Archaeocyatha and the results of their study in the USSR.*]

(117) 1939, *Arkheotsiaty i vodorosli srednego kembriya yuzhnogo Urala:* Problemy paleontologii, v. 5, 209-276, pl. 1-12, Paleontologicheskaya Laboratoriya, Moskovskogo Gosudarstvennogo Universiteta (Moskva). [*Archaeocyatha and algae of the Middle Cambrian of the southern Urals.*]

(118) 1940a, *Arkheotsiaty i vodorosli kembriyskikh izvestnyakov Mongolii i Tuvy, Chast' 1:* Akad. Nauk SSSR, Mongol. Kom., Trudy, no. 34, 268 p., 83 text-fig., 54 pl., 1 map. [*Archaeocyatha and algae of the Cambrian limestones of Mongolia and Tuva, Part 1.*]

(119) 1940b, *Atlas rukovodyashchikh form iskopaemykh faun SSSR. (1) Kembriy:* (A. G. Vologdin, ed.), 193 p., 49 pl., Gosgeolizdat (Moskva, Leningrad). [*Atlas of characteristic forms of the fossil faunas of the USSR. (1) Cambrian.*]

(120) 1948, *K stroeniyu tela pravil'nykh arkheotsiat:* Akad. Nauk SSSR, Izvestiya, ser. biol., no. 1, p. 93-99. [*On the structure of the soft parts of the regular Archaeocyatha.*]

(121) 1955, *O kol'chatykh bezdnishchevykh arkheotsiatakh kembriya severnoy Azii:* Same, Doklady, v. 103, no. 1, p. 141-143, 3 text-fig. [*On the annulate, atabulate Archaeocyatha of the Cambrian of northern Asia.*]

(122) 1956, *K klassifikatsii tipa Archaeocyatha:* Same, Doklady, v. 111, no. 4, p. 877-880. [*On the classification of the phylum Archaeocyatha.*]

(123) 1957a, *Arkheotsiaty i ikh stratigraficheskoe znachenie:* Acta Palaeont. Sinica, v. 5, p.

173-222, pl. 1-22. [*Archaeocyatha and their stratigraphic significance.*]

(124) 1957b, *K stroeniyu vnutrennego organa arkheotsiat:* Akad. Nauk SSSR, Doklady, v. 114, no. 5, p. 1105-1108. [*On the structure of the internal organs of Archaeocyatha.*]

(125) 1957c, *O neskol'kikh vidakh planktonnykh i benticheskikh arkheotsiat:* Same, Doklady, v. 116, no. 3, 493-496, 4 text-fig. [*On some species of planktonic and benthonic Archaeocyatha.*]

(126) 1957d, *Ob ontogeneze arkheotsiat:* Same, Doklady, v. 117, no. 4, p. 697-700, 1 text-fig. [*On the ontogeny of Archaeocyatha.*]

(127) 1959a, *Tersiidy kembriyskikh otlozheniy Chitinskoy oblasti:* Same, Doklady, v. 124, no. 5, p. 1133-1136, 2 text-fig. [*Tersiids of the Cambrian deposits of Chita province.*]

(128) 1959b, *Verkhne-kembriyskiy arkheotsiato-korallovyy tsenoz, khr. Tannu-ola, Tuva:* Same, Doklady, v. 129, no. 3, p. 670-673, 4 text-fig. [*Upper Cambrian archaeocyathan-coral coenose, Tannu-ola Range, Tuva.*]

(129) 1959c, *K onto-filogenezu Arkheotsiat:* Inst. Morfol. zhivotn., A. N. Severtsova, Trudy, 1959, v. 27, p. 79-89, 11 text-fig. [*On the onto-phylogenesis of the Archaeocyatha.*]

(130) 1960, *O rode Ajacicyathus Bedford et Bedford, 1939 i sem. Ajacicyathidae Bedford et Bedford, 1939:* Akad. Nauk SSSR, Doklady, v. 130, no. 2, p. 421-424, 1 text-fig. [*On the genus Ajacicyathus Bedford et Bedford, 1939 and the fam. Ajacicyathidae Bedford et Bedford, 1939.*]

(131) 1961, *Arkheotsiaty i ikh stratgraficheskoe znachenie:* Mezhdunar. geol. Kongr. XX sessiya, Simpozium po kembriyu, v. 3, p. 173-177 (unseen; *fide* VOLOGDIN, 1966, p. 16). [*Archaeocyatha and their stratigraphical significance.*]

(132) 1962a, *Novyy rod odnostennykh arkheotsiat s lozhnym intervallyumom:* Akad. Nauk SSSR, Doklady, v. 145, no. 2, p. 419-421, text-fig. 1. [*A new genus of one-walled Archaeocyatha with pseudo-intervallum.*]

(133) 1962b, *K anatomii arkheotsiat:* Paleont. Zhurnal, 1962, no. 2, p. 9-20, 5 text-fig., pl. 1-2. [*On the anatomy of the Archaeocyatha.*]

(134) 1962c, *Arkheotsiaty i vodorosli kembriya Baykal'skogo nagor'ya:* Akad. Nauk SSSR, Paleont. Inst., Trudy, v. 93, 118 p., 21 pl. (Moskva). [*Archaeocyatha and algae of the Cambrian of the Baykal uplands.*]

(135) 1962d, *Tip Archaeocyatha. Arkheotsiati:* in Osnovy paleontologii, Yu. A. Orlov (ed.), Gubki, arkheotsiaty, kishechnopolostnye, chervi, p. 89-142, text-fig. 1-128, pl. 1-9, Akad. Nauk SSSR (Moskva). [*Phylum Archaeocyatha. Arkheotsiati.*]

(136) 1963, *Pozdnesrednekembriyskie arkheotsiaty basseyna reki Amgi (Sibirskaya platforma):* Akad. Nauk SSSR, Doklady, v. 151, no. 4, p. 946-949, text-fig. 1-3. [*Late Middle Cambrian Archaeocyatha of the basin of the River Amga (Siberian platform).*]

(137) 1964a, *Kribritsiaty—novyy klass arkheotsiat:* Same, Doklady, v. 157, no. 6, p. 1391-1394, text-fig. 1. [*Cribricyatha—a new class of Archaeocyatha.*]

(138) 1964b, *O slozhnoperegorodochnykh arkheotsiatakh verkhnemonokskoy svity kembriya zapadnogo Sayana:* Same, Doklady, v. 159, no. 2, p. 357-360, text-fig. 1-2. [*On complexly septate Archaeocyatha in the Upper Monok Suite of the Cambrian of western Sayan.*]

(139) 1966, *Kribritsiaty kembriya SSSR:* Same, Paleont. Inst., Trudy, v. 109, 64 p., text-fig. 1-30, pl. 1-3. [*Cribricyatha of the Cambrian of the USSR.*]

———, & Fonin, V. D.

(140) 1966, *Novye odnostennye tenial'nye arkheotsiaty Priargun'ya:* Akad. Nauk SSSR, Doklady, v. 167, p. 187-190, text-fig. 1. [*New one-walled tenial Archaeocyatha of Priargunye.*]

———, & Yazmir, M. M.

(141) 1967, *Novoe semeystvo arkheotsiat s shestigrannymi lokulyami v intervallyume:* Akad. Nauk SSSR, Doklady, v. 175, no. 6, p. 1375-1377, 1 text-fig., 1 pl. (fig. 2) opp. p. 1357. [*New family of Archaeocyatha with hexagonal loculi in the intervallum.*]

Voronin, Yu. I.

(142) 1962, *Novye arkheotsiaty (Ayatsitsiat'idy) iz kembriya Tuvy:* Paleont. Zhurnal, 1962, no. 3, p. 24-28, pl. 4. [*New Archaeocyatha (Ajacicyathidae) from the Cambrian of Tuva.*]

(143) 1964, *O nekotorykh septal'nykh arkheotsiatakh kembriya Chitinskoy oblasti:* Same, 1964, no. 2, p. 11-21, 2 text-fig., pl. 1. [*On some septate Archaeocyatha from the Cambrian of Chita province.*]

(144) 1969, *Sistematicheskoe polozhenie roda Cadniacyathus Bedford, R. et J., 1937 i roda Inessocyathus Debrenne, 1964:* in I. T. Zhuravleva (ed.), 1969, Biostratigrafiya i paleontologiya nizhnego kembriya Sibiri i Dal'nego Vostoka, p. 99-105, 3 text-fig., pl. 39, Nauka (Moskva). [*Systematic position of the genus Cadniacyathus Bedford, R. et J., 1937 and of the genus Inessocyathus Debrenne, 1964.*]

Walcott, C. D.

(145) 1886, *Second contribution to the studies on the Cambrian faunas of North America:*

U.S. Geol. Survey, Bull., no. 30, 369 p., 33 pl.

(146) 1889 [1890?], *Descriptive notes of new genera and species from the Lower Cambrian or Olenellus Zone of North America:* U.S. Natl. Museum, Proc., v. 12, p. 33-46.

(147) 1912, *Notes on fossils from limestone of Steeprock Lake, Ontario:* Geol. Survey Canada, Mem., no. 28, 11 p. (appendix).

Walter, M. R.

(147a) 1967, *Archaeocyatha and the biostratigraphy of the Lower Cambrian Hawker Group, South Australia:* Geol. Soc. Australia, Jour., v. 14, p. 139-152, pl. 7-8.

Webers, G. F.

(148) 1966, *Upper Cambrian archaeocyathid from Antarctica:* Geol. Soc. America, Spec. Paper, v. 87, p. 183 [abstr. 1965].

Yakovlev, V. N.

(149) 1956, *O nekotorykh nepodcherknutykh osobennostyakh Archaeolynthus Taylor i ego vozmozhnoy rodstvennoy svyazi s iglokozhimi:* Akad. Nauk SSSR, Doklady, v. 109, no. 4, p. 855-857, text-fig. 1. [*On some not understood peculiarities in the structure of Archaeolynthus Taylor and its possible relationships with the Echinodermata.*]

(149a) 1959, *Chankacyathus strachovi gen. et sp. nov.—pervyy predstavitelnogo semeystva nizhnekembriyskikh arkheotsiat:* Soobshcheniya DVF SO AN SSSR, vyp. 10 [not seen, quoted by OKUNEVA, 1969, p. 85.] [*Chankacyathus strachovi new genus and species—first representative of a new family of lower Cambrian Archaeocyatha.*]

Yankauskas, T. V.

(150) 1964, *O nekotorykh problematicheskikh organicheskikh ostatkakh iz nezhnego kembriya Vostochnego Sayana:* Materialy po geologii i poleznym iskopaemym so dnr rozhdeniya M. A. Usova, p. 56-59, State Univ., Tomsk (unseen). [*On some problematical organic remains from the Lower Cambrian of Eastern Sayan.*]

(151) 1965, *Pterotsiatidy-Novyy otryad kribritsiat:* Akad. Nauk SSSR, Doklady, v. 162, no. 2, p. 438-440, text-fig. 1. [*Pterocyathida—a new order of Cribricyathida.*]

(152) 1969, *Pterotsiatidy nizhnego kembriya Krasnoyarskogo kryazha (vostochnyy Sayan),* in I. T. Zhuravleva (ed.), Biostratigrafiya i paleontologiya nizhnego kembriya Sibiri i Dal'nego Vostoka, p. 114-157, text-fig. 1-29, pl. 43-50, Nauka (Moskva). [*Pterocyathida of the Lower Cambrian of the Krasnoyarsk block (eastern Sayan).*]

———, & Zhuravleva, I. T.

(153) 1969, *Opornyy razrez nizhnego kembriya zapadnogo Sayana:* Akad. Nauk SSSR, Geol. & Geofiz., 1969, no. 4, p. 3-10. [*Key section of the Lower Cambrian of western Sayan.*]

Yaroshevich, V. M.

(154) 1957, *Novye predstaviteli arkheotsiat kembriya vostochnogo sklona Kuznetskogo Ala-Tau:* Akad. Nauk SSSR, Doklady, v. 116, no. 6, p. 1015-1017, 1 pl. [*New representatives of Archaeocyatha in the Cambrian of the eastern slopes of the Kuznetsk Ala-Tau.*]

Yavorskiy [Yaworsky], V. I.

(155) 1940, *Poryadok Stromatopory:* in Atlas rukovodyashchikh form iskopaemykh faun SSSR, Tom. 1, Kembriy, A. G. Vologdin (ed.), p. 100-103, pl. 1, Gosgeoltekhizdat, (Moskva). [*Order Stromatoporoidea.*]

Yaworsky, B.

(156) 1932, *Ein Stromatoporenfund im Cambrium:* Zentralblatt, Mineralogie, Geologie, Paläontologie, Abt. B, 1932, no. 12, p. 613-616.

Zelenov, K. K.

(157) 1957, *Litologiya kembriyskikh otlozheniy severnogo sklona Aldanskogo massiva:* Akad. Nauk SSSR, Geol. Inst., Trudy, no. 8, p. 1-123. [*Lithology of the Cambrian deposits of the northern slopes of the Aldan massif.*]

Zhuravleva, I. T.

(158) 1949, *Nekotorye dannye o stroenii kubka u predstaviteley roda Rhabdocyathus Toll:* Akad. Nauk SSSR, Doklady, v. 67, no. 3, p. 547-550, text-fig. 1-2. [*Some data on the structure of the cup in representatives of the genus Rhabdocyathus Toll.*]

(159) 1950, *Arkheotsiati kembriya vostochnogo sklona Kuznetskogo Ala-Tau:* Dissertatsiya na soiskanie uchenoy stepeni kandidata biologicheskikh nauk Nauchnyy rukovoditel'-professor doktor biologicheskikh nauk E. D. Soshkina. Avtoreferat, p. 1-13, Akad. Nauk SSSR, Paleont. Inst. (Moskva). [*Archaeocyatha of the Cambrian of the eastern slopes of the Kuznetsk Ala-Tau.*]

(160) 1951a, *Ob individual'nom razvitii kubkov pravil'nykh arkheotsiat i "arkheotsiatovykh lichinkakh":* Akad. Nauk SSSR, Doklady, v. 80, no. 1, p. 97-100, text-fig. 1-3. [*On individual development of the cup of the regular Archaeocyatha and "archaeocyathan larvae."*]

(161) 1951b, *O novum rode arkheotsiat s grebenchatymi dnishchami v kembriyskikh izvestnyakakh Sibiri:* Same, Doklady, v. 81, no. 1, p. 77-80, text-fig. 1-3. [*On a new genus of Archaeocyatha with pectinate tabulae from the Cambrian limestones of Siberia.*]

(162) 1955a, *Arkheotsiaty kembriya vostochnogo sklona Kuznetskogo Ala-Tau:* Same, Paleont. Inst., Trudy, v. 56, p. 5-56, text-fig. 1-6, pl. 1-6. [*Archaeocyatha of the Cam-*

brian of the eastern slopes of the Kuznetsk Ala-Tau.]

(163) 1955b, *K poznaniyu arkheotsiat Sibiri:* Same, Doklady, v. 104, no. 4, p. 626-629, 2 text-fig. [*Contribution to our knowledge of the Archaeocyatha of Siberia.*]

(164) 1957, *Arkheotsiaty, ikh razvitie i stratigraficheskoe znachenie*: Moskov. Obshch. Ispyt. Prirody, Byull., ser. geol., v. 32, no. 3, p. 174-175. [*Archaeocyatha, their development and stratigraphic significance.*]

(165) 1959a, *Arkheotsiaty bazaikhskogo gorizonta R. Kii:* Akad. Nauk SSSR, Doklady, v. 124, no. 2, p. 424-427, 1 text-fig., 1 pl. [*Archaeocyatha of the Bazaikhian horizon of the R. Kiya.*]

(166) 1959b, *O polozhenii arkheotsiat v filogeneticheskoy sisteme:* Paleont. Zhurnal, 1959, no. 4, p. 30-40, text-fig. 1-6, pl. 1. [*On the position of the Archaeocyatha in a phylogenetic system.*]

(167) 1960a, *Novye dannye ob arkheotsiatakh sanashtykgol'skogo gorizonta:* Akad. Nauk SSSR, Geol. Geofiz. Novosibirsk, 1960, no. 2, p. 42-46, text-fig. 1a-k. [*Recent data on the Archaeocyatha of the Sanashtykgolian horizon.*]

(168) 1960b, *Arkheotsiaty Sibirskoy platformy:* 344 p., 147 text-fig., 33 pl., 26 tables, Akad. Nauk SSSR (Moskva). [A monograph of Akad. Nauk SSSR, Sibirskoe otdelenie, Institut. Geologii i Geofiziki, Paleont. Institut.] [*Archaeocyatha of the Siberian platform.*]

(169) 1961, *Monograficheskoe opisanie nekotorykh arkheotsiat sretenskogo razreza:* in article by D. I. Musatov, V. N. Nemirovskiy, E. V. Shirokoviy, & I. T. Zhuravleva, "Sretenskiy razrez v Vostochnogo Sayana," Materialy po geologii polezn. iskop. Krasnoyarskogo kraya, no. 2, p. 17-33, Zapadno-Sibirskogo geologicheskogo tresta (city not known) [unseen].

(170) 1963a, *Novye dannye ob arkheotsiatakh vostochnogo sklona yuzhnogo Urala:* Paleont. Zhurnal, 1963, no. 4, p. 116-118, 2 text-fig. [*New data on the Archaeocyatha of the eastern slopes of the southern Urals.*]

(171) 1963b, *Arkheotsiaty Sibiri. Odnostennye Arkheotsiaty (Otryady Monocyathida i Rhizacyathida):* 140 p., 12 pl., Akad. Nauk SSSR (Moskva). [*Archaeocyatha of Siberia: One-walled Archaeocyatha (orders Monocyathida and Rhizacyathida).*]

(172) 1965, *Arkheotsiaty verkhnego podotdela nizhnego kembriya severa Baykal'skogo nagor'ya (solontsovskiy i obruchevskiy gorizonty):* in Stratigrafiya i paleontologiya paleozoya Aziatskoy chasti SSSR, p. 3-12, text-fig. A-E, pl. 1-2, Nauka (Moskva). [*Archaeocyatha of the upper subdivision of the Lower Cambrian of the northern Baykal highlands (Solontsovian and Obruchevian horizons).*]

(173) 1966, *Rannekembriyskie organogennye postroyki na territorii Sibirskoy platformy,* in Organizm i sreda v geologicheskom proshlom: p. 61-84, Nauka (Moskva). [*Early Cambrian organogenic structures in the territories of the Siberian platform.*] [A book of the Akad. Nauk SSSR, Paleontologicheskiy Institut.]

(174) 1968a, *Biogeografiya i geokhronologiya rannego kembriya po arkheotsiatam:* XXIII Sessiya Mezhdunarodnogo geologicheskogo kongressa, 1968, Doklady Sovetskikh geologov, 3. Problemy Paleontologii, p. 33-44. [*Biogeography and geochronology of the early Cambrian based on the Archaeocyatha.*]

(175) 1968b, *Arkheotsiaty nezhnego kembriya severo-zapadna Sibirskoy platformy:* in V. A. Datzenko, I. T. Zhuravleva, N. P. Lazarenko, Yu. N. Popov, & N. E. Chernysheva, Biostratigrafiya i fauna kembriyskikh otlozheniy severo-zapadna Sibirskoy platformy, Nauchno-Issledov. Inst. Geol. Arktiki, Trudy, v. 155, p. 118-176, pl. 1-14, Nedra (Leningrad). [*Archaeocyatha of the Lower Cambrian of the northwest Siberian platform.*]

(176) 1969, *Biostratigrafiya i paleontologiya nizhnego kembriya Sibiri i Dal'nego Vostoka:* I. T. Zhuravleva (ed.), 228 p., 60 pl., Nauka (Moskva). [*Biostratigraphy and paleontology of the Lower Cambrian of Siberia and the Far East.*]

(177) 1970a, *Porifera, Sphinctozoa, Archaeocyathi—their connections:* in W. G. Fry (ed.), The biology of the Porifera, Symposium Zool. Soc. London, no. 25, p. 41-59 (London).

(178) 1970b, *Marine faunas and Lower Cambrian stratigraphy:* Am. Jour. Sci., v. 269, p. 417-445.

———, Konyushkov, K. N., & Rozanov, A. Yu.

(179) 1964, *Arkheotsiaty Sibiri. Dvustennye arkheotsiaty:* 132 p., 16 pl., Akad. Nauk SSSR (Moskva). [*Archaeocyatha of Siberia. Two-walled Archaeocyatha.*]

———, Korshunov, V. I., & Rozanov, A. Yu.

(180) 1969, *Atdabanskiy yarus i ego obosnovanie po arkheotsiatam v stratotipicheskom razreze:* in I. T. Zhuravleva (ed.), Biostratigrafiya i paleontologiya nizhnego kembriya Sibiri i Dal'nego Vostoka, p. 5-59, pl. 1-25, Nauka (Moskva). [*The Atdaban stage and its significance based on the Archaeocyatha of the stratotypical section.*]

———, Krasnopeeva, P. S., & Chernysheva, S. V.

(181) 1960, *Tip Archaeocyathi. Arkheotsiati:* in Biostratigrafiya paleozoya Sayano-Altayskoy gornoy oblasti, L. L. Khalfin (ed.), Sib. Nauchno-Issled. Inst. Geol. Geofiz. Miner. Syr'ya, Trudy, v. 19, p. 97-140, text-fig. 19-38, pl. 1-12. [*Phylum Archaeocyatha. Arkheotsiati.*]

———, Zadorozhnaya, N. M., Osadchaya, D. V., Pokrovskaya, N. V., Rodionova, N. M., & Fonin, V. D.

(182) 1967, *Fauna nizhnego kembriya Tuvy (opornyy razrez r. Shivelig-Khem):* 181 p., 39 text-fig., 70 pl., Nauka (Moskva). [*Fauna of the Lower Cambrian of Tuva (key section, River Shivelig-Khem).*]

———, & Zelenov, K. K.

(183) 1955, *Biogermy pestrotsvetnoy svity reki Leny:* Akad. Nauk SSSR, Paleont. Inst., Trudy, v. 66, p. 57-77, text-fig. 1-8, pl. 1-2. [*Bioherms of the variegated suite of the River Lena.*]

Ziegler, Bernhard, & Rietschel, Siegfried

(184) 1970, *Phylogenetic relationships of fossil calcisponges:* in W. G. Fry (ed.), The biology of the Porifera, Symposium Zool. Soc. London, no. 25, p. 23-40 (London).

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