PART E

ARCHAEOCYATHA AND PORIFERA

ARCHAEOCYATHA

By Vladimir J. Okulitch

CONTENTS

INTRODUCTION

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

MORPHOLOGY

GENERAL FEATURES

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

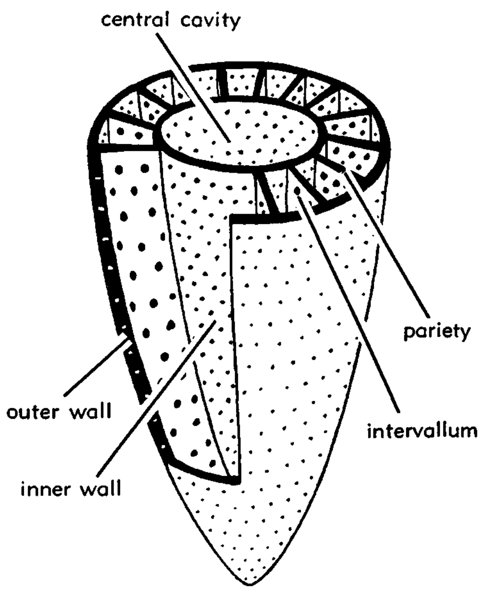

FIG. 1. Diagrammatic sketch of a typical archaeocyathid (*Ajacicyathus*) with porous outer and inner walls joined by radially disposed porous cross walls (parieties) (7).

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

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

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

OUTER WALL

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

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

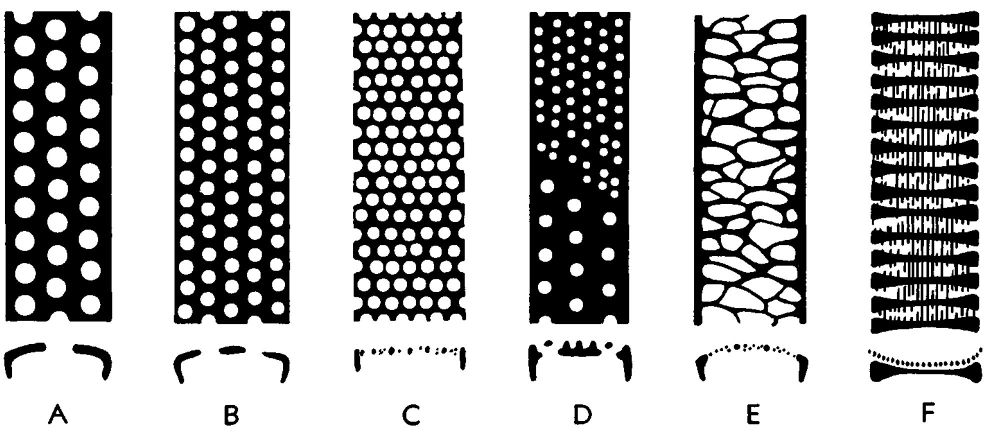

Fig. 2. Types of outer-wall pores in archaeocyathids (12).

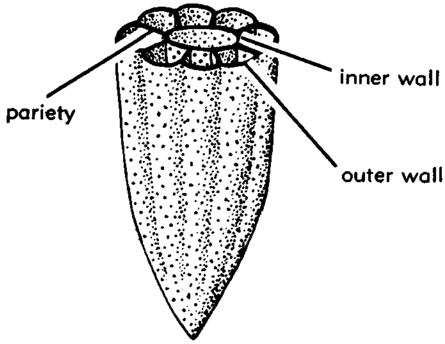

FIG. 3. Vertically fluted cup of *Archaeocyathellus,* showing relation of grooves to parieties (7).

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

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

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

INTERIOR STRUCTURES

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

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

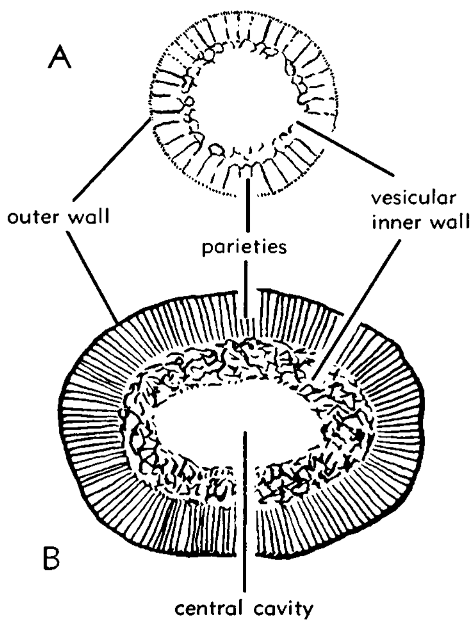

FIG. 4. Transverse sections showing parieties and vesiculose structure in position of the inner wall. *A, Ethmophyllum,* with moderately numerous particles and thin vesicular zone (13). *B, Tercyathus,* with abundant closely spaced parieties and thick vesicular zone (12).

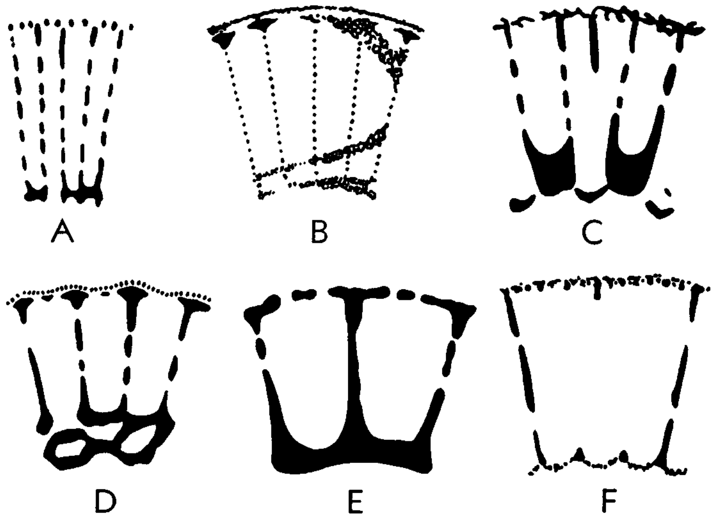

FIG. 5. Types of parieties and inner walls represented in transverse sections (12).

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

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

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

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

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

EXOTHECAL LAMELLAE

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

SINGLE-WALLED ARCHAEOCYATHIDS

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

SPITZES

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

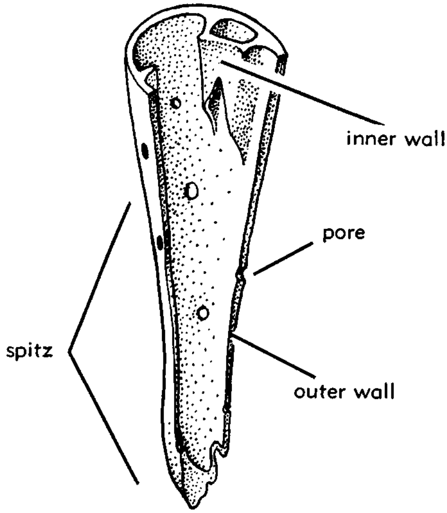

FIG. 6. Restoration of initial part of the skeleton of *Ajacicyathus nevadensis* with wall cut away to show inner cavity and lack of double walls at beginning of growth (7).

MORPHOLOGICAL TERMINOLOGY

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

Glossary of Morphological Terms

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

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

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

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

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

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

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

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

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

rima. Space between horizontal tabellae in intervallum.

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

synapticula. Rodlike structure extending between parieties.

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

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

taenia. Irregularly bent small plate in intervallum.

SYSTEMATIC POSITION

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

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

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

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

CLASSIFICATION

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

Divisions of Archaeocyatha

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

SYSTEMATIC DESCRIPTIONS

Phylum ARCHAEOCYATHA Vologdin, 1937

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

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

Class MONOCYATHEA Okulitch, 1943

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

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

Order MONOCYATHIDA Okulitch, 1935

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

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

Family MONOCYATHIDAE Bedford & Bedford, 1934

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

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

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

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

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

Family RHIZACYATHIDAE Bedford & Bedford, 1939

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

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

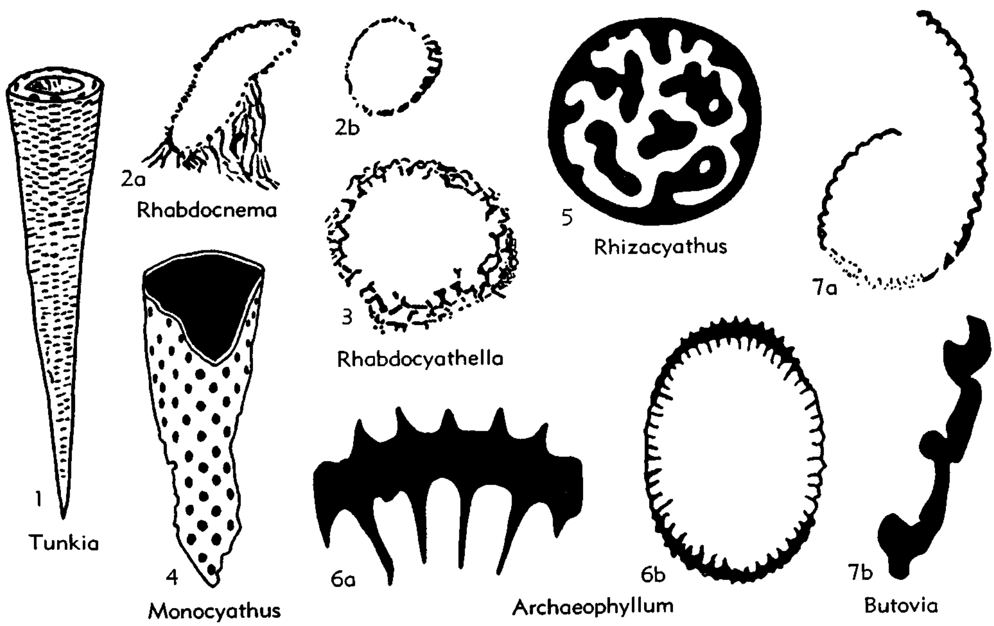

Fig. 7. Monocyathida, Archaeophyllida (p. E9-E10).

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

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

Order ARCHAEOPHYLLIDA Okulitch, 1943

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

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

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

Family ARCHAEOPHYLLIDAE Vologdin, 1931

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

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

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

Class ARCHAEOCYATHEA Okulitch, 1943

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

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

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

Order AJACICYATHIDA Bedford & Bedford, 1939

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

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

Family AJACICYATHIDAE Bedford & Bedford, 1939

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

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

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

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

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

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

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

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

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

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

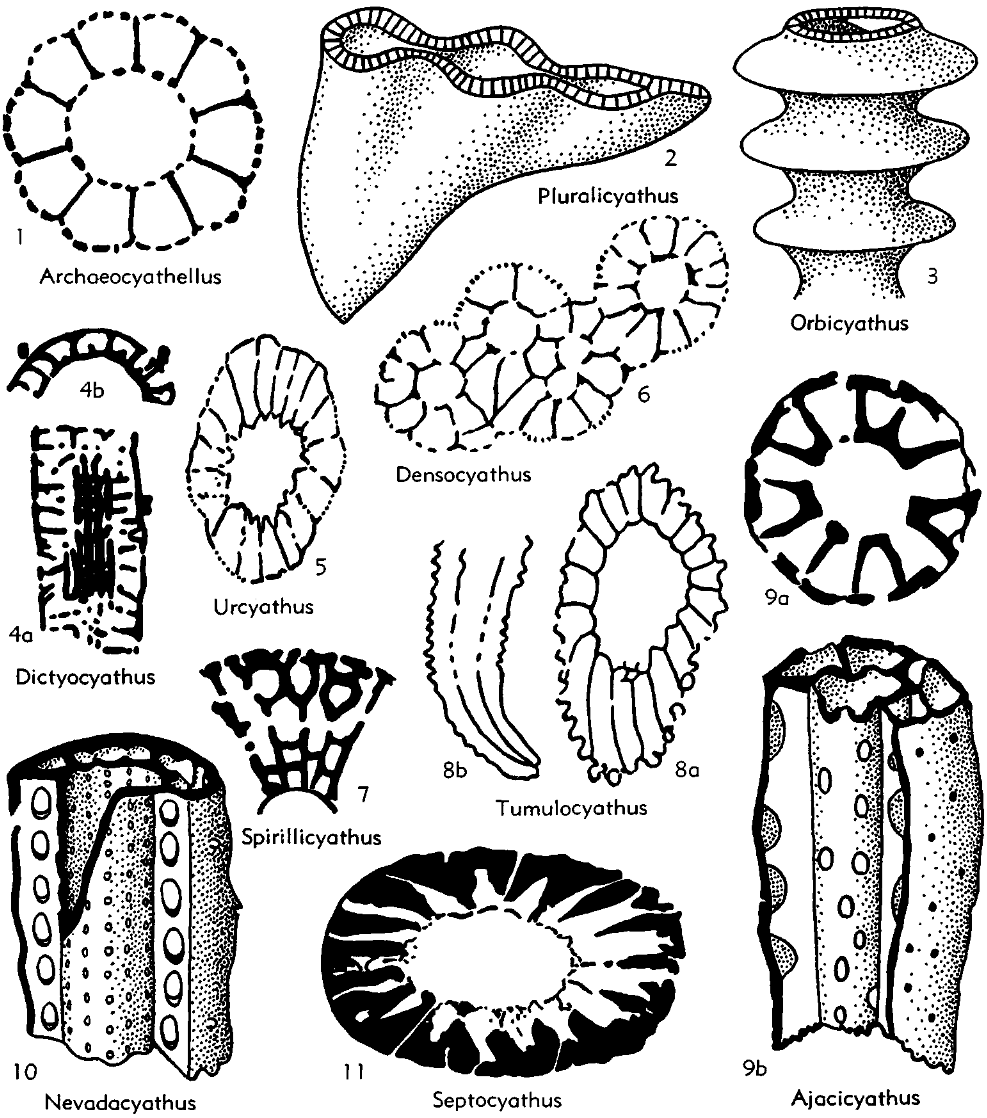

FIG. 8. Ajacicyathida: Ajacicyathidae, Dictyocyathidae (p. E10-E12).

Family DICTYOCYATHIDAE Taylor, 1910

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

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

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

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

Family BICYATHIDAE Vologdin, 1933

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

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

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

Family ETHMOPHYLLIDAE Okulitch, 1943

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

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

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

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

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

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

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

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

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

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

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

Family COSCINOCYATHIDAE Taylor, 1910

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

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

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

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

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

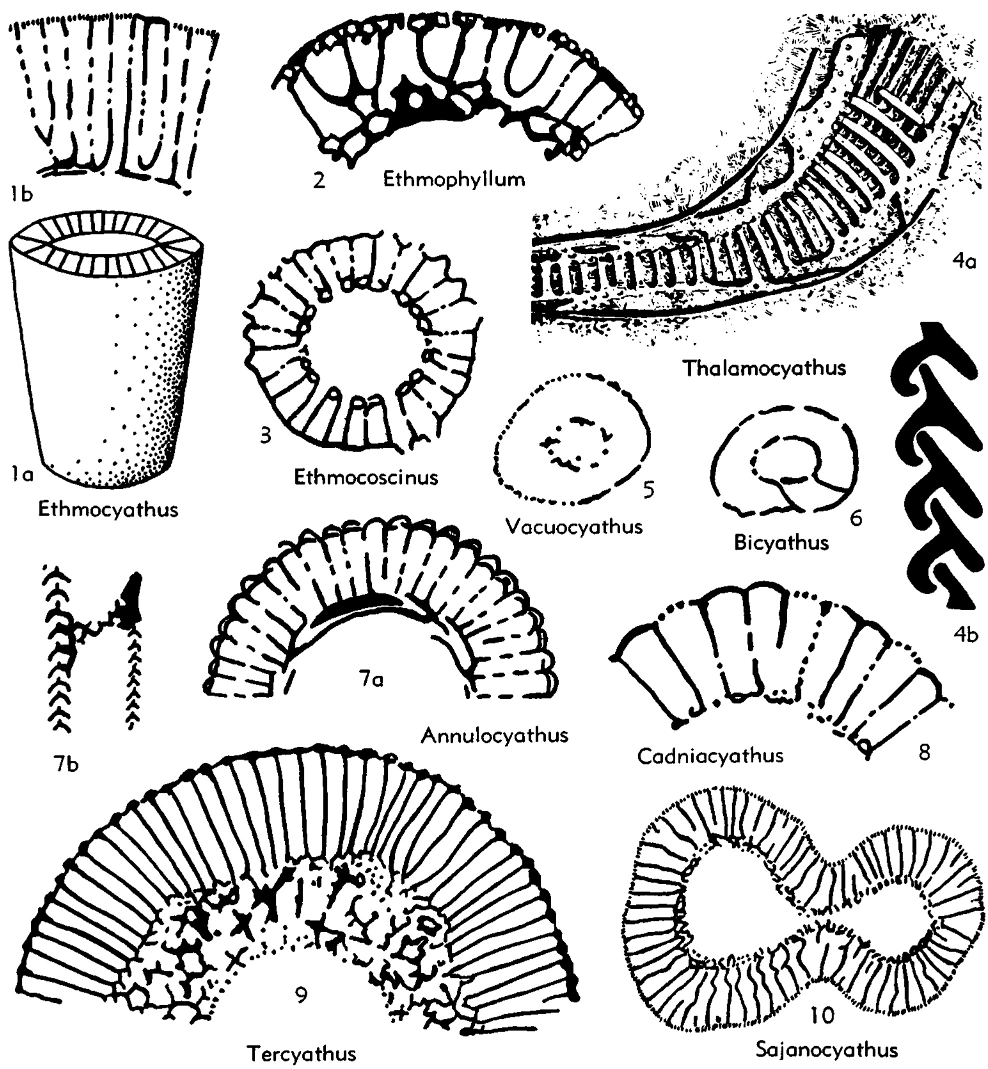

Fig. 9. Ajacicyathida: Bicyathidae, Ethmophyllidae (p. E12).

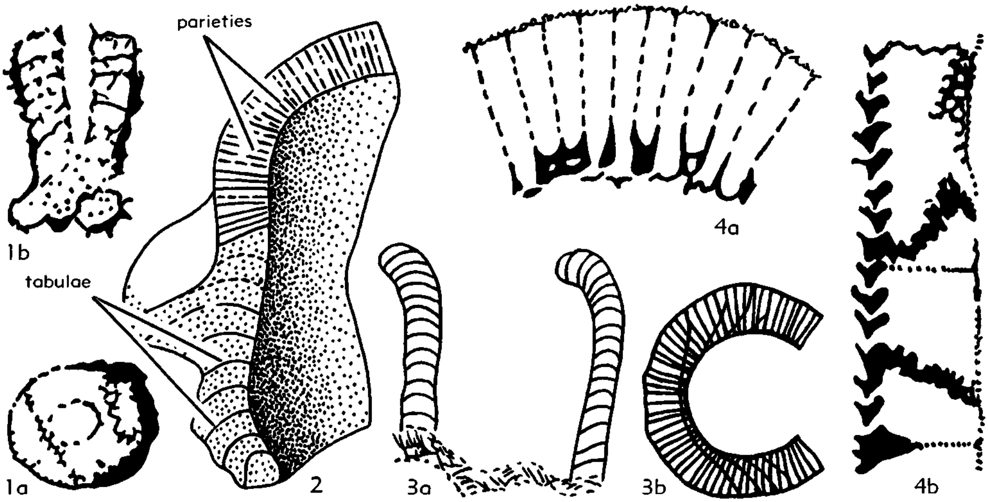

FIG. 10. Ajacicyathida: Coscinocyathidae (p. E13-E14).

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

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

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

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

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

Order METACYATHIDA Bedford & Bedford, 1936

[*nom. correct.* OK., herein (*ex* Metacyathina BEDF.-B., 1936)]

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

Family ARCHAEOCYATHIDAE Taylor, 1910

[=Spirocyathidae TAYLOR, 1910; Metacyathidae BEDF.-B., 1934; Flindersicyathidae BEDF.-B., 1937]

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

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

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

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

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

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

Metaldetes TAYLOR, 1910 [*M. cylindricus] [=*Metacyathus* BEDF.-B., 1934]. Growing from spitz of *Archaeopharetra* type; intervallum filled by parietal and trabecular tissue complicated by dissepiments in upper part of cup; parieties and taeniae generally porous. Differs from *Archaeocyathus* in more regular development of parieties (4). *L.Cam.*, N.Am.-Eu.-Asia-Austral.——FIG. 11,*6*. **M. cylindricus;* transv. sec., ×5 (8).

Protopharetra BORN., 1884 [*P. polymorpha; SD SIMON, 1939]. Cylindrical to irregular forms with intervallum filled by curved bars, taeniae, and flattened fibers that build a mass of vesicular tissue; inner wall indistinct; central cavity very narrow, in some filled by vesicles so that inner wall is undefinable; spitz of *Archaeopharetra* type. *L.Cam.-M.Cam.*, cosmop.——FIG. 11,*3*. **P. polymorpha;* transv. sec., ×5 (7).

Family PYCNOIDOCYATHIDAE Okulitch, 1950

[=Cambrocyathidae OK., 1937]

Walls connected by perforate radial parieties with abundant synapticulae; outer wall may be crenulate; irregular spitz of *Archaeophraretra* type. *L.Cam.-M.Cam.*

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

P. (Pycnoidocyathus).——FIG. 11,*5*. **P. (P.) synapticulosus,* Austral.; *5a,b,* part of transv. sec., ×0.75; *5b,* side view, ×0.5 (7).

P. (Archaeofungia) TAYLOR, 1910 [*A. ajax] [=*Metafungia* BEDF.-B., 1934; *Sibirecyathus* VOL., 1937]. Small cylindrical or conical forms without annulations, characterized by strong development of synapticulae; central cavity rather narrow (4). *L.Cam.-M.Cam.*, Austral.-Sib.-B.C.

Ardrossacyathus BEDF.-B., 1937 [*A. endotheca]. Outer wall irregular, parieties with dissepiments, inner wall porous; central cavity filled by endothecal tissue in form of curved irregular sheets. *L.Cam.*, Austral.——FIG. 11,*8*. **A. endotheca;* part of transv. sec., ×8 (6).

Dendrocyathus OK. & ROOTS, 1947 [*D. unexpectans (sic)]. Complex parieties branching dendritically in their course from inner to outer wall and connected by synapticulae or taeniae. *L.Cam.*, B.C.——FIG. 11,*1*. **D. unexpectans,* transv. sec., ×3 (7).

Echinocyathus TERM.-T., 1950 [*E. goundafensis]. Outer wall with tubercles and spines, parieties with synapticulae. *L.Cam.*, N.Afr.——FIG. 11, *2*. **E. goundafensis;* transv. sec., ×1 (10).

Loculicyathus VOL., 1931 [*Coscinocyathus irregularis TOLL., 1899] [=*Loculocyathus* VOL., 1937]. Delicate vesicular tissue in intervallum and central cavity. *L.Cam.-M.Cam.*, Sib.——FIG. 11,*7*. **L. irregularis;* oblique long. sec., ×3 (11).

Metethmophyllum OK., 1943 [*Ethmophyllum meeki WALC., 1891]. Complex inner wall of *Ethmophyllum* type, parieties with dissepiments or synapticulae (2). *L.Cam.*, N.Am.——FIG. 12, *5*. **M. meeki* (WALC.); transv. sec., ×2 (7).

Paranacyathus BEDF.-B., 1937 [*pro Paracyathus* BEDF.-B., 1936 (*non* EDW.-H., 1848)] [*Paracyathus parvus BEDF.-B., 1936] [=*Spirocyathella* VOL., 1940]. Small to medium conical cups, base without inner wall or parieties, filled by irregular trabecular tissue; radial parieties, inner wall, and central cavity become defined shortly above base; dissepiments may occur; pores small and irregular near base but large and regularly arranged higher up. *L.Cam.-M.Cam.*, Austral.-S. Urals.——FIG. 12, *6*. **P. parvus* (BEDF.-B.), *L.Cam.*, Austral.; *6a,b,* transv. secs. of upper and lower parts, ×8 (6).

Sigmocyathus BEDF.-B., 1936 [*Coscinocyathus didymoteichus TAYLOR, 1910] [=*Hemistillicidocyathus* TING, 1937]. Large turbinate cups with many straight parieties, without synapticulae or tabulae; inner wall or both walls with continuous annular sigmoidally curved plates; growth from an irregular base of trabeculae and vesicular tissue that fills central cavity and obliterates parieties. *L.Cam.*, cosmop.——FIG. 12,*4*. **S. didymoteichus* (TAYLOR); *4a,* part of transv. sec., ×4; *4b,* surface of pariety, ×8 (9).

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

Family METACOSCINIDAE Bedford & Bedford, 1936

Metacyathida distinguished by horizontal or arched tabulae; spitz of *Archaeopharetra* type. The family parallels the Coscinocyathidae among Ajacicyathida. *L.Cam.-M.Cam.*

Metacoscinus BEDF.-B., 1934 [*M. reteseptatum]. Upper part of cup with straight netlike parieties but lower part with irregular parieties and filled with vesicles; tabulae present. *L.Cam.*, Austral. ——FIG. 12,*3*. **M. reteseptatum; 3a,* transv. sec. of upper part showing parieties and tabula; *3b,* transv. sec. of lower part; *3c,* long. sec. of pariety; all ×4 (6).

Altaicyathus VOL., 1932 [*A. notabilis]. Differs from *Claruscyathus* in having vertical pillars beneath the tabulae. *M.Cam.*, Sib.-Mongolia.

Archaeosycon TAYLOR, 1910 [*Archaeocyathus bil-

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

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

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

Order ACANTHINOCYATHIDA Okulitch, 1935

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

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

Family ACANTHINOCYATHIDAE Bedford & Bedford, 1934

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

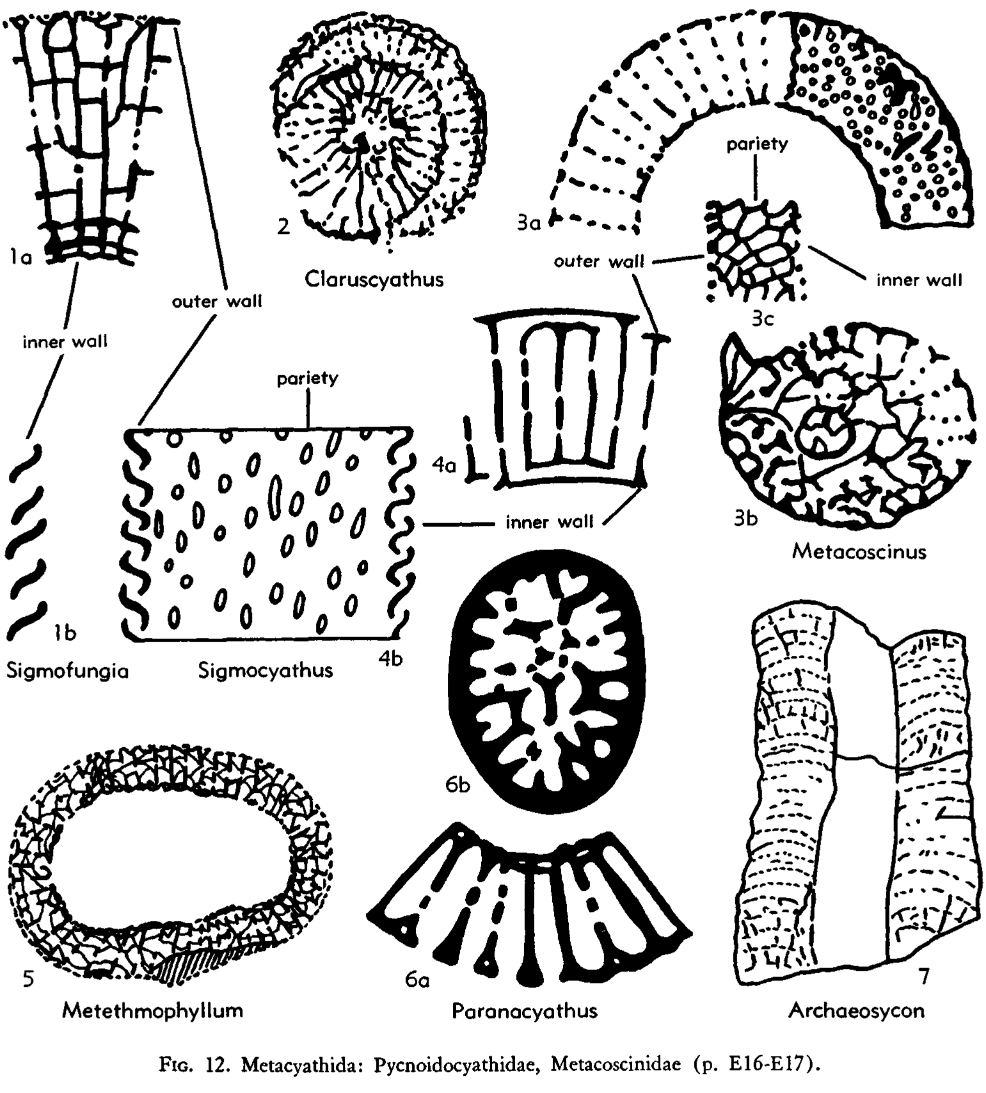

FIG. 12. Metacyathida: Pycnoidocyathidae, Metacoscinidae (p. E16-E17).

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

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

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

Order HETAIRACYATHIDA Okulitch, 1943

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

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

Family RADIOCYATHIDAE Okulitch, 1937

[=Hetairacyathidae BEDF.-B., 1934]

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

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

Order SYRINGOCNEMIDA Okulitch, 1935

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

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

Family SYRINGOCNEMATIDAE Taylor, 1910

[*nom. correct.* OK., herein (*ex* Syringocnemidae TAYLOR, 1910)]

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

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

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

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

Class ANTHOCYATHEA Okulitch, 1943

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

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

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

Order ANTHOMORPHIDA Okulitch, 1935

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

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

Family ANTHOMORPHIDAE Okulitch, 1935

Characters of order. *L.Cam.*

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

Order SOMPHOCYATHIDA Okulitch, 1943

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

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

Family SOMPHOCYATHIDAE Okulitch, 1935

Characters of order. *L.Cam.*

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

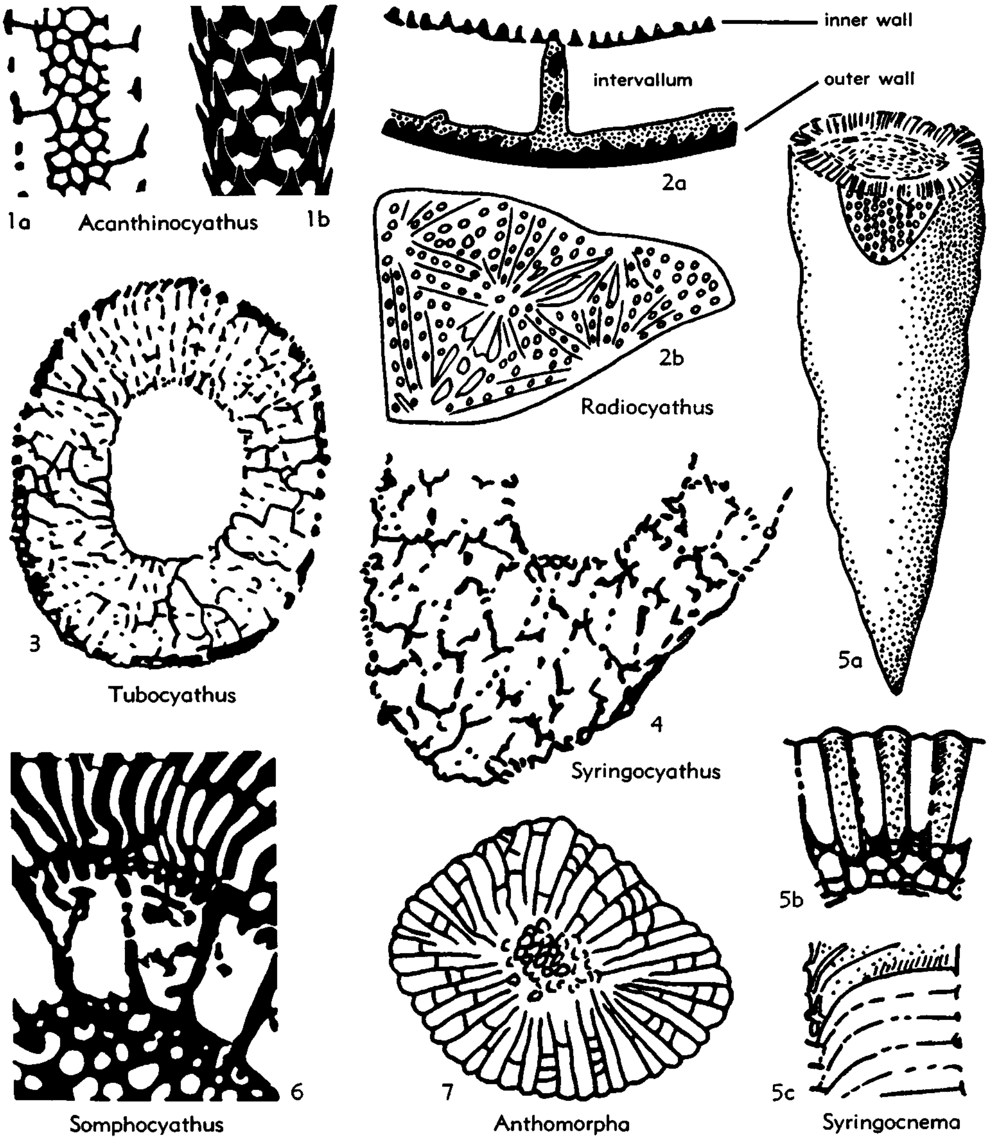

Fig. 13. Acanthocyathida, Hetairacyathida, Syringocnemida, Anthomorphida, Somphocyathida (p. E18-E19).

CLASSIFICATION UNCERTAIN

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

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

INVALID GENERA

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

REFERENCES

The publications cited in the following list consist only of those that are judged to be most helpful in furnishing additional information concerning Archaeocyatha and in offering a guide to more extensive literature. The index numbers enclosed in parentheses in the column at left are employed in the text for identification of the publications.

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(1) 1939, *Development and classification of Archaeos (Pleospongia):* Kyancutta Mus. Mem. 6, p. 67-82, pl. 1-11.

Okulitch, V. J.

(2) 1943, *North American Pleospongia:* Geol. Soc. America, Spec. Paper 48, p. 1-112, pl. 1-18, fig. 1-19.

Simon, W.

(3) 1939, *Archaeocyathacea. I. Kritische Sichtung der Superfamilie. II. Die Fauna im Kambrium der Sierra Morena:* Abh. Senckenberg. naturf. Gesell. 448, p. 1-87, pl. 1-5.

Taylor, T. G.

(4) 1910, *The Archaeocyathinae from the Cambrian of southern Australia:* Roy. Soc. South Australia, Mem. 2, p. 1-188, pl. 1-16.

Vologdin, A. G.

(5) 1940, *Subtype Archaeocyatha:* Atlas of leading forms of fossil faunas of U.S.S.R., State Office for Geol. Literature, vol. 1 (Cam.), p. 24-97, pl. 1-32, Moscow.

SOURCES OF ILLUSTRATIONS

The names of authors, but not individual publications, are cited by index numbers as shown in the following list. Because the figures consist of new drawings, they are understood as "after" the sources indicated.

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