SCLERACTINIA

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CONTENTS

GENERAL CHARACTERS

The order Scleractinia is the major division of the Zoantharia which includes nearly all post-Paleozoic fossil and Recent corals. It includes solitary and colonial forms with polyps less specialized than those of the Actiniaria and resembling more closely those of the Corallimorpharia, a highly specialized and probably closely parallel group. The Scleractinia are distinguished by a calcareous external skeleton consisting essentially of radial partitions or septa situated between the mesenteries and secreted by the ectodermal body layer within upward infoldings of the basal part of the polyp wall, together with a more or less developed external sheathing and variously developed attendant supporting structures. In ontogeny the septa are developed following the pattern of the mesenteries: after the establishment of the first 6 septa, others normally are inserted between those previously formed in successive groups of 6, 12, 24, and so on.

As in all other anthozoans, scleractinian corals are exclusively marine in habit. They are commonest in warm, clear, shallow waters of the tropical zone, but some are adjusted to shallow or deep, cold water and may be found in all latitudes. They have little or no tolerance for other than normal salinity.

The oldest known Scleractinia are a few shallow-water forms of primitive aspect from the Middle Triassic, and like the majority of other invertebrates, were essentially modernized by the beginning of Cenozoic time. Scleractinians obviously are allied so closely to the soft-bodied actiniarian and corallimorph anemones that either the 3 groups had a common origin, or as is more likely, the scleractinians were a late Paleozoic or early Mesozoic development from the same stock as the corallimorphs.

Morphological terminology applied to the scleractinian corals is explained in following sections on anatomy of the polyps and morphology of the skeleton, most special terms being called to notice by printing the name in boldface type where it first appears. In addition, an alphabetically arranged glossary of morphological terms used in description of Scleractinia, Rugosa, Heterocorallia, and Tabulata is given on pages F245 to F251.

For valuable criticism and suggestions relating especially to the organization of general discussion of the Scleractinia, it is appropriate to express acknowledgment and appreciation to Dr. H. DIGHTON THOMAS, of the British Museum (Natural History) and the *Treatise* Editor, Dr. RAYMOND C. MOORE.

ANATOMY OF POLYPS

Scleractinian polyps resemble those of the simpler types of actiniarians (Fig. 222). Alive, they are variously colored and assume different aspects as they are fully expanded or contracted. The expanded polyp shows 2 distinct regions: the smooth, cylindrical **column,** terminated above by the horizontal **oral disc,** below by the **basal disc.** In the

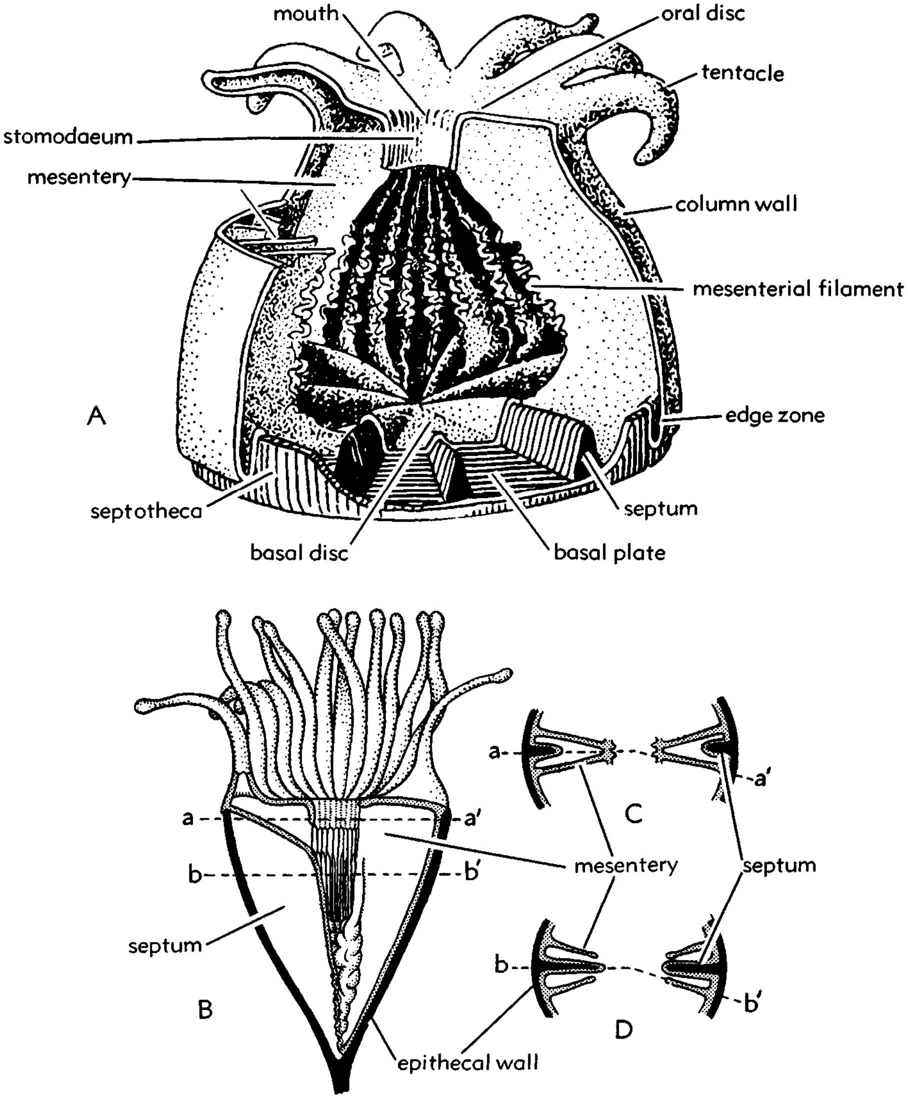

Fig. 222. Relations of polyp and skeleton in scleractinian corals. *A*, Young caryophylliid, with edge zone (mesenteries not shown between septa in foreground) (185). *B. Flabellum,* lacking edge zone. *C,D,* Transverse sections of *Flabellum* along line *a-a′* and *b-b′* (151).

center of the oral disc is the **mouth,** a hole leading to the polyp interior. The oral-disc region around the mouth is the **peristome,** peripherally bounded by one or more rings of **tentacles.** The **stomodaeum** is an esophagus-like connection between the mouth and the interior gastrovascular cavity. The latter is hollow and subdivided by 2 series of vertical radial partitions. One series is formed by the **mesenteries,** fleshy plates attached to the inner surface of the oral disc and column wall. Their upper parts may or may not be connected to the stomodaeum, and their lower edges commonly are free. The other series of partitions comprises the septal invaginations, which are inturnings of the basal disc occupied by the calcareous **septa,** and which alternate in position with the mesenteries or pairs of mesenteries.

BODY LAYERS

Microscopically the column wall, oral

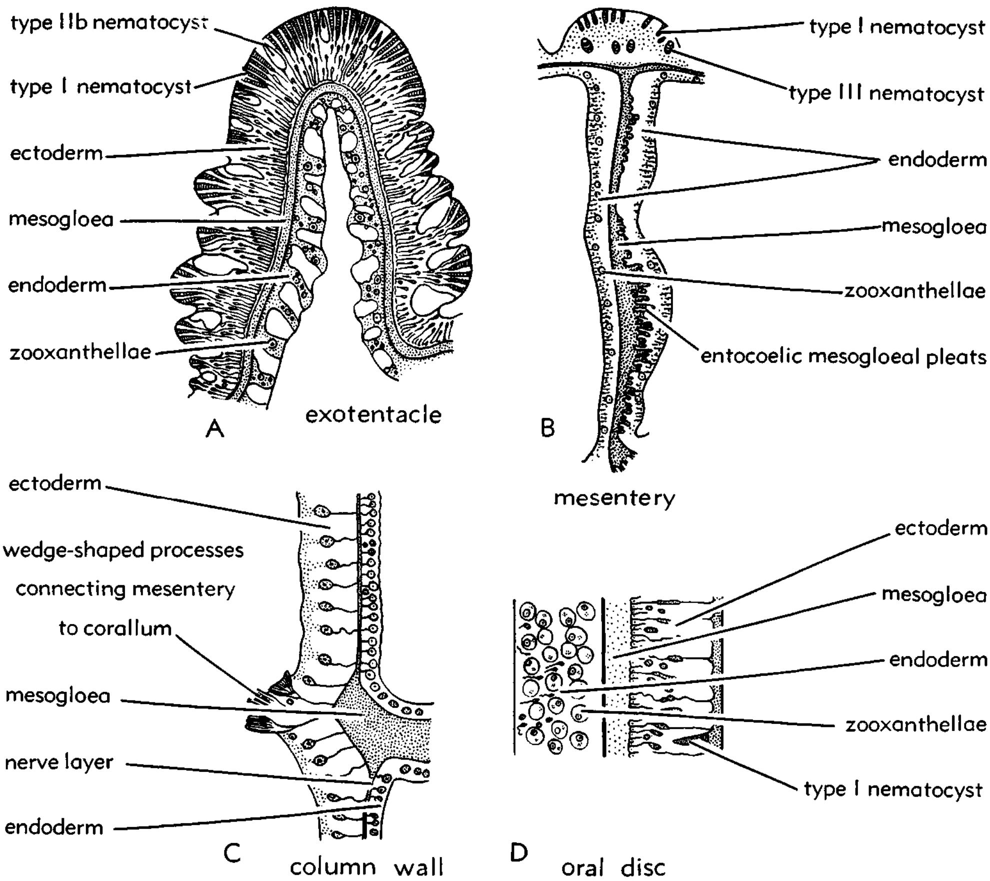

FIG. 223. Body layers of scleractinian polyps (83). *A,* Longitudinal section of exotentacle of *Favia doreyensis* M.EDW.-H., Maldives, ×90. *B,* Transverse section of mesentery of *Favia bertholleti* M.EDW.-H., Ceylon, ×42. *C,* Transverse section near upper part of column wall of *Favites pentagonus* (ESPER), Maldives, ×315. *D,* Transverse section of part of oral disc of *Favia hululensis* GARDINER, Maldives, ×37.

disc, tentacles, and basal disc (but not the mesenteries), are composed of 3 distinct layers of tissue: **ectoderm, mesogloea,** and **endoderm** (Fig. 223). The outer layer of ectoderm is externally ciliated and contains nuclei, granular and mucous vacuoles, and nematocyst capsules. The middle, supporting lamina of mesogloea is nearly homogeneous, noncellular, nucleated, and jelly-like. The inner layer of endoderm consists of glandular and muscular elements, and granular vacuoles. The endoderm of most reef-dwelling corals contains large numbers of symbiotic, unicellular, yellow-brown, dinoflagellate algae, termed **zooxanthellae.**

The ectoderm consists of 2 histologically distinct regions: (1) the exposed surface of the polyp: oral disc, tentacles, and outer areas known as **edge zone,** if they merely extend over the corallite wall, and **coenosarc,** if they are continuous between polyps of colonial coralla; and (2) the **calicoblast layer,** comprising whatever parts of the ectoderm that lie directly against the skeleton. The calicoblast layer, nonexistent in the larval stage, is differentiated after fixation of the larva from the ectoderm of the basal disc antecedent to development of the skeleton which it secretes.

MESENTERIES

NATURE AND KINDS

The radial partitions of the gastrovascular cavity, the mesenteries, are the most vital part of anthozoan polyps. With their filaments, they are the organs of digestion, absorption, and excretion, and are the site of development of the gonads; their arrangement and order of development are the distinguishing feature of the Anthozoa. Mesenteries are laminar in appearance and consist of 2 layers of endoderm between which is a sheet of mesogloea (Fig. 223). They are attached above to the under surface of the oral disc and along their outer margins to the inner surface of the hard parts by wedge-shaped mesogloeal processes. Those that extend to and join the inner surface of the stomodaeum are said to be **complete mesenteries;** those that do not reach the stomodaeum are **incomplete mesenteries.** A short distance below the stomodaeum the inner free margin of the mesentery may be drawn out into long ribbon-like prolongations **(mesenterial filaments)** which lie coiled in the gastrovascular cavity.

On each side of the mesogloea, as seen in the cross section of a mesentery, is a longitudinal layer of retractor muscle fiber. Invariably one of these muscle layers is better developed than the other and the mesogloea beneath it is extended as a series of longitudinal folds or **pleats** (Fig. 223). The position of these pleats is constant in all mesenteries of the same relative position and is useful in orientation of the polyp. Most of the mesenteries in a polyp are disposed radially with respect to an axis passing through the stomodaeum; they are arranged in **pairs** in which the mesogloeal pleats of each member face those of the other (Fig. 224). The space between the mesenteries of such a pair is an **entocoele,** and the space between neighboring pairs is an **exocoele.**

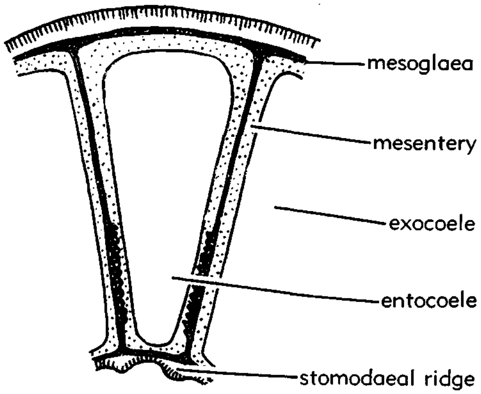

Fig. 224. Generalized transverse section of part of polyp, showing relations of normal mesenterial couple (151).

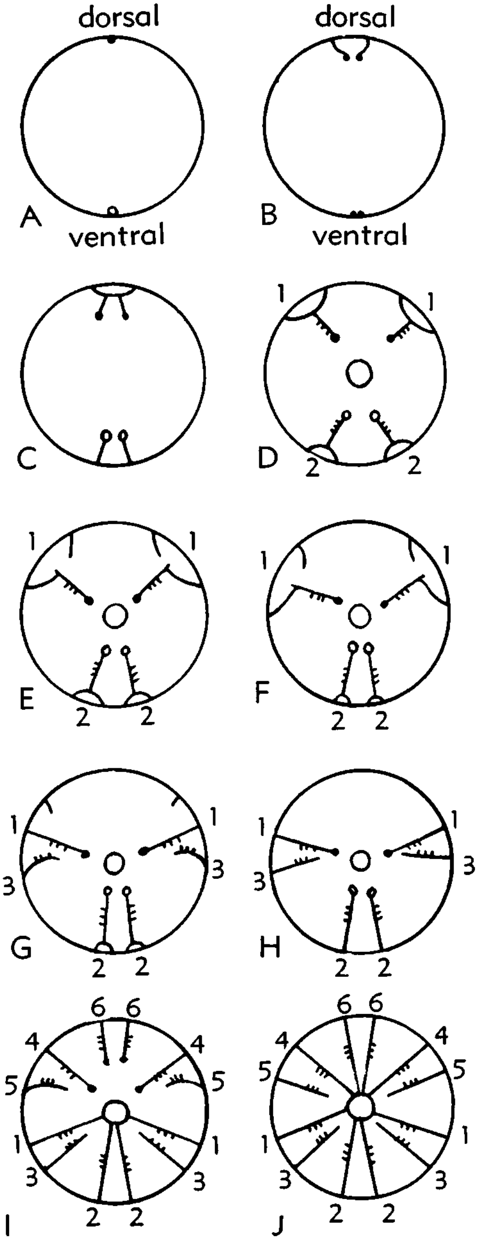

Fig. 225. Development of first cycle of mesenteries (protocnemes) in *Pocillopora* and *Seriatopora, 1,2, 4,6* (=orthocnemes); *3,5* (=sterigmatocnemes). Position of muscular pleats indicated by short lines perpendicular to mesenteries (76).

In all solitary **(monostomatous)** polyps and in each of the new polyps of colonial corals developed by budding outside the tentacular ring, the mesenteries of 2 oppos-

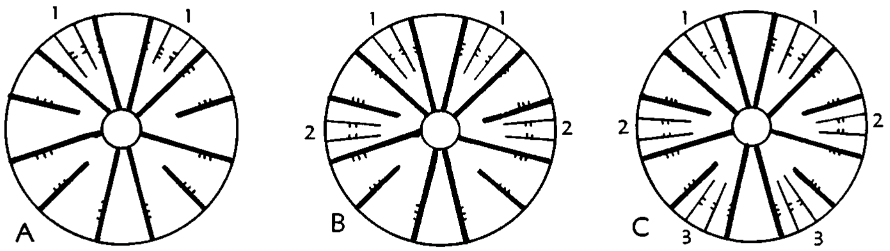

FIG. 226. Development of second cycle of mesenteries (metacnemes) in *Manicina; A,B,C,* successive stages. Second cycle of mesenteries (metacnemes) indicated in order of appearance by *1,2,3* (26).

ing pairs in a so-called dorsoventral plane have their pleating reversed; these are **directive pairs** or **directive mesenteries.** In some forms, the tentacles lying over these directive pairs and skeletal septa within are enlarged. Where colony-formation is by budding within the tentacular ring, the founder polyp has 2 directive pairs, but upon "division" of the polyp, the pairs are separated and the vast majority of the polyps in such a colony have no directive pairs, although theoretically each original pair is in some polyp somewhere in the colony. In such cases it is convenient to regard the polyps as lacking directive mesenteries.

DEVELOPMENT

Before the appearance of mouth opening or tentacles in the larva **(planula),** 2 opposing bulges consisting of longitudinal muscular sheets appear in the endoderm, and define a polarity designated as dorsoventral (Fig. 225*a*). These sheets, called **sterigmatocnemes,** are substrates on which the mesenteries develop. The dorsal bulge precedes the ventral and undergoes cleavage in which the 2 halves spread apart from each other (Fig. 225*b-d*). The ventral bulge does the same, but later on. Another sheet, termed **orthocneme,** develops on the surface of each sterigmatocneme, undergoes cleavage, and elongates toward the axis. These new sheets are predecessors of complete mesenteries.

After the mouth and stomodaeum have appeared (Fig. 225*d*), musculature and pleats appear on the orthocnemes, the ventral couple of which becomes the ventral pair of directive mesenteries, and the dorsal pair becomes the first pair of complete mesenteries. Thus far, development of the first 2 pairs of orthocnemes has been similar, the ventral pair being slightly retarded, but subsequently the sterigmatocnemes of the ventral pair retrogress and disappear (Fig. 225*e-h*). The laterodorsal part of the 2 dorsal sterigmatocnemes also disappears (Fig. 225 *f-h*), but thickening of the ventral part produces the third couple of mesenteries which form pairs with the dorsal orthocnemes (Fig. 225*g,h*). Repetition of this sequence in the dorsal sector (Fig. 225*i,j*) gives rise to another couple of mesenteries before the dorsal directive pair appears. When the first 6 mesenteric pairs (comprising 12 **protocnemes**) have developed (Fig. 225*j*) the embryonic period is terminated. Mesenteries developed subsequently are called **metacnemes.**

The sequence just described seems to represent the primitive order of appearance. In most groups of scleractinians development of orthocnemes in the dorsal sector is greatly accelerated, and they may be well formed before the appearance of the ventral directives.

The developmental order of the metacnemes (Fig. 226) follows the dorsoventral sequence established by the protocnemes. The second cycle of 6 metacnemic pairs appears after fixation of the planula, one pair at a time within the exocoeles of the protocnemic pairs. The first are introduced in the spaces between a dorsal directive and the first lateral protocnemes (Fig. 226*A*), the next between the first and second lateral pairs of protocnemes (Fig. 226*B*), and so on (Fig. 226*C*). The 12 pairs of third-cycle metacnemes arise in 2 series of 6 couples each (Fig. 227), the first in the exocoeles on the dorsal side of the second-cycle couples (Fig. 227*A*), and in the same order. After the appearance of the first series, the second series arises in the ventral exocoeles (Fig. 227*B,C*).

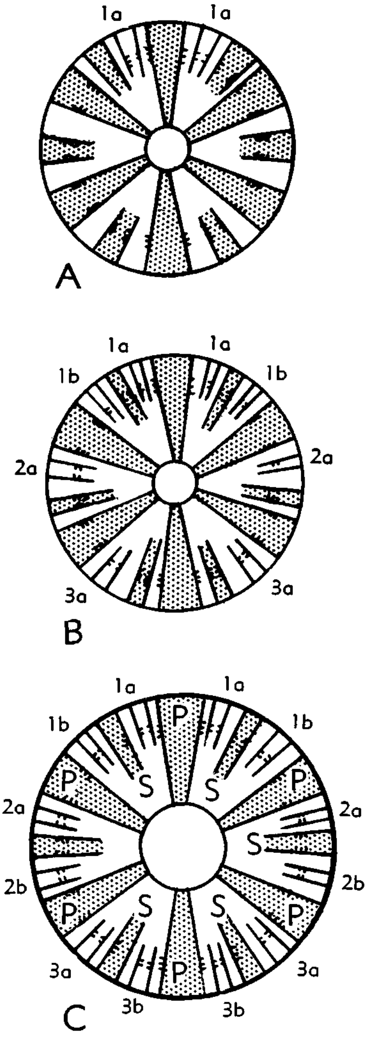

FIG. 227. Development of 3rd cycle of mesenteries (metacnemes) in *Manicina.* First cycle (protocnemes) *(P)* and 2nd cycle (metacnemes) *(S)* indicated by shading between mesentery pairs; order of appearance of 3rd-cycle metacnemes indicated by sequences *1a,2a,3a* (1st series) and *1b,2b,3b* (2nd series) (26).

The dorsoventral succession in each of 2 moieties of mesenterial insertion, which is characteristic for the Scleractinia, Corallimorpharia, and most of the Actiniaria, is basically bilateral, as in the Rugosa, not radial. But the sites of insertion and order contrast with the Rugosa, as inferred from the septal succession in the latter, where a dorsoventral (or ?ventrodorsal) succession occurred in each of 4 quadrants defined by the cardinal-counter and alar pairs of septa, after the establishment of the protocnemes and the 6 primary entocoelic septa; or, to put it differently, in the Scleractinia additions of metacnemes (and septa) occur in all 6 of the primary exocoeles, and in only 4 of the 6 primary exocoeles in the Rugosa.

STOMODAEUM

The stomodaeum connects the mouth with the gastrovascular cavity (Fig. 222). It is generally rather short and compressed laterally with respect to the directive mesenteries. The complete mesenteries are attached to its inner surface and over the points of attachment the ectoderm may be raised into vertical ridges (Fig. 224). In some groups, these stomodaeal ridges are lacking and the stomodaeum is smooth (Astrocoeniina, Agariciicae, Poriticae). Since free-swimming larvae lack stomodaeal ridges, their absence in adult forms may be a primitive character, or it may simply be correlated with size of the polyps. In polyps with directive couples of mesenteries, 2 vertical grooves in the stomodaeum face these couples.

TENTACLES

The tentacles arise from the oral disc as out-pushings of the mesenterial chambers below—**entotentacles** from entocoeles, and **exotentacles** from exocoeles. They are arranged in one or more rings around the mouth, from the edge of which they are separated by the peristome, or they may be spread over much of the entire oral disc. They are mostly simple, formed by a single tubular extension, but in *Siderastrea* the entotentacles are bifurcated near their tips. The tips of the tentacles are swollen or knobbed with concentrated nematocyst batteries, or obtuse with scattered batteries. In most corals, a longitudinal ectodermal musculature is capable of retracting the tentacle, but in some forms *(Stephanophyllia, Fungiacyathus, Euphyllia)*, the tentacles are nonretractile. In a few genera of the Agariciidae, the tentacles are very small or even rudimentary. The function of the tentacles is tactile and prehensile, to detect and seize food particles and move them toward the mouth.

NEMATOCYSTS

Stinging or adhesive structures, termed

nematocysts or cnidocils, are found in all scleractinian polyps. They are ectodermal, differing in shape and structure in different species or in different parts of the same polyp. Four main types are recognized, of which some have a stinging function, whereas others may be merely adhesive. The combination of nematocyst types found in scleractinian polyps is similar to that in the corallimorph anemones, and much less varied than in the Actiniaria.

EDGE ZONE AND COENOSARC

The **edge zone** is the part of a polyp that lies outside the wall of a solitary coral (Figs. 222, 228*A*). It is simply a horizontal outfold of the column wall overflowing the corallite wall, and contains a continuation of the gastrovascular cavity. In solitary corals, only edge zone is developed; in colonies the edge zone becomes coextensive between the polyps, constituting the **coenosarc** (Fig. 228*B*).

The calicoblast layer is present on the under surface of edge zone or coenosarc and lays down calcareous deposits called **costae,** which are essentially prolongations of the septa outside the column wall, and other extramural skeletal deposits such as dissepiments and stereome, which are collectively termed **coenosteum** when deposited by coenosarc. **Coenenchyme** is a term often applied to either coenosteum or coenosarc, or to both together; and properly speaking, it refers to the latter combination, a connotation unnecessary in scleractinian terminology.

Edge zone and coenosarc typically contain extensions of the mesenteries, hence the strict homology between intra- and extramural skeletal structures, but in some groups (acroporids, dendrophylliids), the extended mesenterial chambers are modified into a network of canaliculae. In corals with perforate skeletal wall *(Acropora, Porites)*, the interior of the coenosarc and the intramural gastrovascular cavity of the polyps are directly connected through the wall as well as over it. In corals with epitheca, the edge zone is narrow and extends down to the edge of the upgrowing epitheca *(Caryophyllia)*, or is absent *(Flabellum)*.

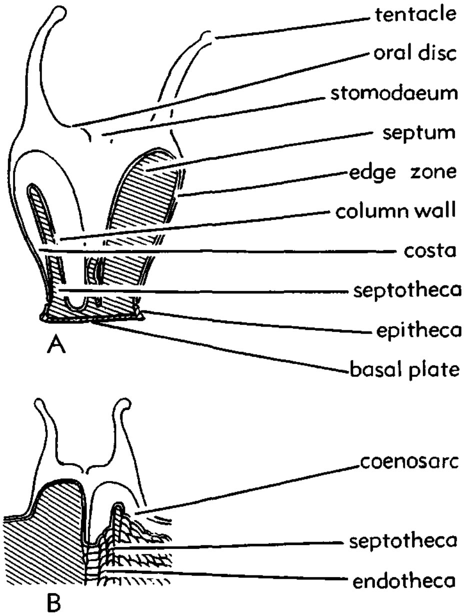

FIG. 228. Edge zone and coenosarc: diagrammatic vertical sections. *A*, Solitary caryophylliid (151). *B*, Colonial plocoid faviid (151).

MORPHOLOGY OF THE SKELETON

The scleractinian skeleton (Fig. 229) consists of a thin **basal plate** from which rise radiating vertical partitions called **septa,** and attendant structures. An upward continuation of the basal plate, marking the limit of the oral disc or edge zone, is termed **epitheca.** The column wall of the polyp is enclosed by a limiting calcareous deposit (**wall** or **theca**) consisting of different structures in different corals. **Costae** are extensions of the septa beyond the wall into the edge zone of coenosarc.

The entire skeleton deposited by a single polyp or by a colony of polyps is a **corallum.** Individual polyp skeletons in a colony are **corallites.** The upper or open end of a corallum or corallite is the **calice** (pl., **calices**), usually concave and deepest in the center, and occupied in life by the polyp. Extrathecal structures supporting the edge zone and coenosarc are collectively termed **coenosteum. Dissepiments** are thin, curved or tabular sheets in the spaces between septa or costae that support the lower surface of the soft parts and cut off the void left by upward growth (Fig. 230). **Endotheca** com-

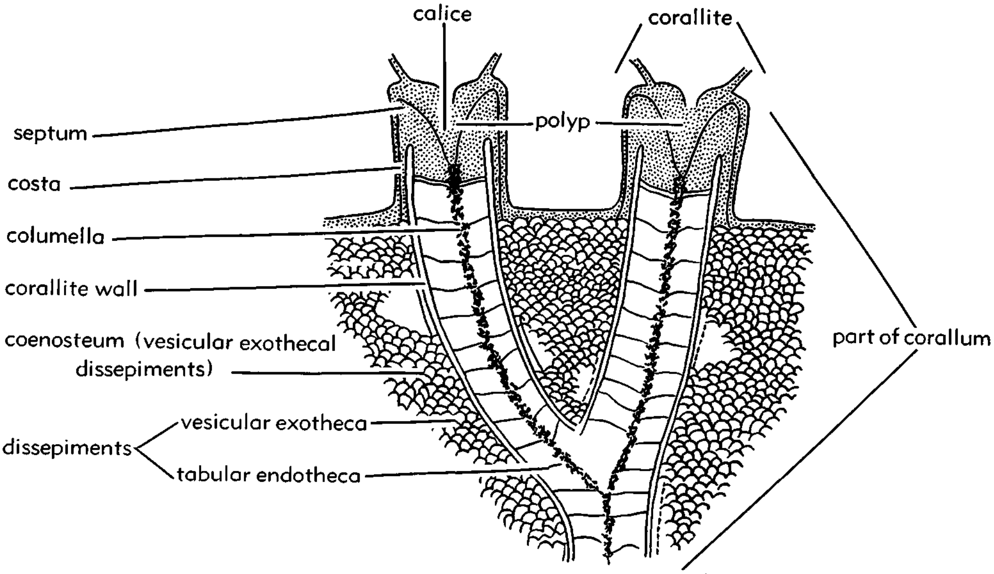

FIG. 229. General relations of polyp and corallum in *Galaxea* (98).

prises dissepiments inside the wall of a corallum or corallite, **exotheca** those outside the wall. A central axial structure, originating from various modifications of the inner ends of the septa, is the **columella.** Septa and thecal structures are commonly thickened secondarily by a deposit of **stereome,** similar in structure to epitheca.

COMPOSITION AND ORIGIN

The exact way in which the skeleton is deposited by the polyp is not thoroughly understood, but it has been supposed that it is carried out within certain specialized cells of the calicoblast layer of the body wall ectoderm (intraprotoplasmic), and that it constitutes an exoskeleton. The calcareous tissue of the exoskeleton consists of minute crystalline fibers or needles of aragonite ($CaCO_3$), about 2 microns in diameter and each an orthorhombic crystal, arranged normal to the secreting surface of the ectoderm. In the basal plate, dissepiments, and stereome, all of which are deposited from unfolded, even-surfaced ectoderm, the skeletal tissue appears as dense, fibrous sheets marked only by growth laminations (Fig. 230).

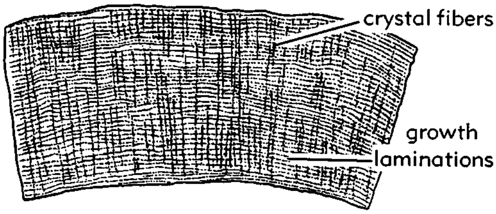

FIG. 230. Structure of scleractinian dissepiment. Vertical section of dissepiment of *Galaxea, ca.* ×50 (98).

When septa and structures derived from them are examined in thin section under considerable magnification (Fig. 231), they are seen to contain numerous dark spots or **"centers of calcification,"** from each of which fibrous crystals radiate toward those of neighboring centers. The centers of calcification and their clusters of fibers are termed **sclerodermites,** and are considered for practical purposes as the primary units of the septa. However, sclerodermites do not differ fundamentally from the fibrous sheets of the basal plate and its related structures. They are secreted in the upfoldings of the basal disc of the polyp by persistent areas of calcification in hollows, often very small and close together along the upper ectodermal surface of the upfold. The dark "centers of calcification" of the sclerodermites may be an optical effect or possibly patches of residual organic matter in the center toward which the fibrous crystals have grown. The remaining ectodermal surface of the upfold does not lack the ability to secrete crystalline

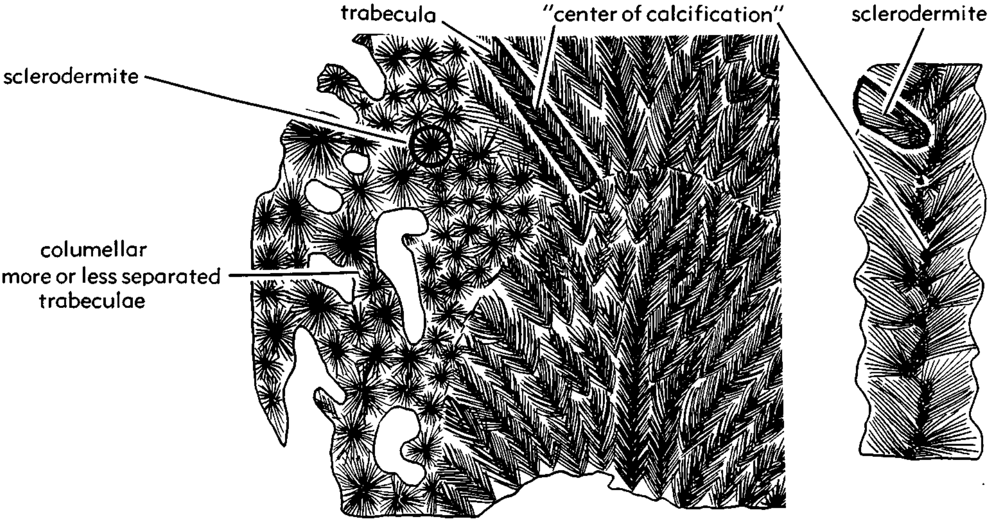

FIG. 231. Scleractinian septal structure. *A,* Radial section of septum and columella of *Galaxea, ca.* ×50 (98). *B,* Tangential section of septum of *Galaxea, ca.* ×50 (98).

fibers, sheets of which (stereome) may afterwards be laid over the sclerodermites, thickening and strengthening the septa.

SEPTA

GENERAL NATURE

Relative to the polyp, the septa lie in the ento- and exocoeles, their function being that of support and separation of the mesenteries. In development, they are the first skeletal structures to appear after the deposition of the basal plate. All other skeletal parts are subsequent to the septa and of secondary importance.

The sclerodermites are more or less persistent vertically in the plane of the upfold from the basal disc of the polyp, and develop spines or rods called **trabeculae** (Fig. 231). A septum is a palisade of trabeculae. Depending on the development of the sclerodermites along the crest of the upfold, the trabeculae vary widely in different scleractinian groups. They are **simple trabeculae,** if composed of series of single sclerodermites (Fig. 232), or **compound trabeculae,** if composed of bundles of sclerodermites (Fig. 233). Sclerodermites are rarely arranged in a uniformly continuous vertical series; commonly they incline outward from the axis of the trabecula and emerge from the septal plane as striae or granulations. They may emerge at the same level in adjacent trabeculae and fuse laterally in form ridges parallel to the upper or growing margin of the septum. Trabeculae are rarely parallel to one another, but are so arranged that they are increasingly inclined outward from an **axis of divergence** which may be vertical, inclined, or even horizontal (Fig. 234). The pattern thus produced constitutes a **fan system.** Septa may consist of more than one fan system lying in the septal plane (Fig. 232*B*). If the trabeculae are closely united without intervening spaces to form a continuous sheet (Fig. 232), the septum is **laminar** and in cross section the centers of calcification may be discrete or so close together as to form an apparently continuous dark line. If trabeculae are more or less loosely connected, they form a **fenestrate septum** (Fig. 223), in which **pores or perforations** appear more or less regularly between adjacent trabeculae. Such perforations may become filled secondarily. In a few primitive genera of stylophyllids and astrocoeniids, the trabeculae may be more or less completely isolated from each other in the septal plane as **trabecular spines** (Fig. 235). These spines may also be discontinuous vertically and interrupted by endotheca, as if septal secretion began anew after each period of growth. This structure is homologous with the acanthine septal type of some Rugosa.

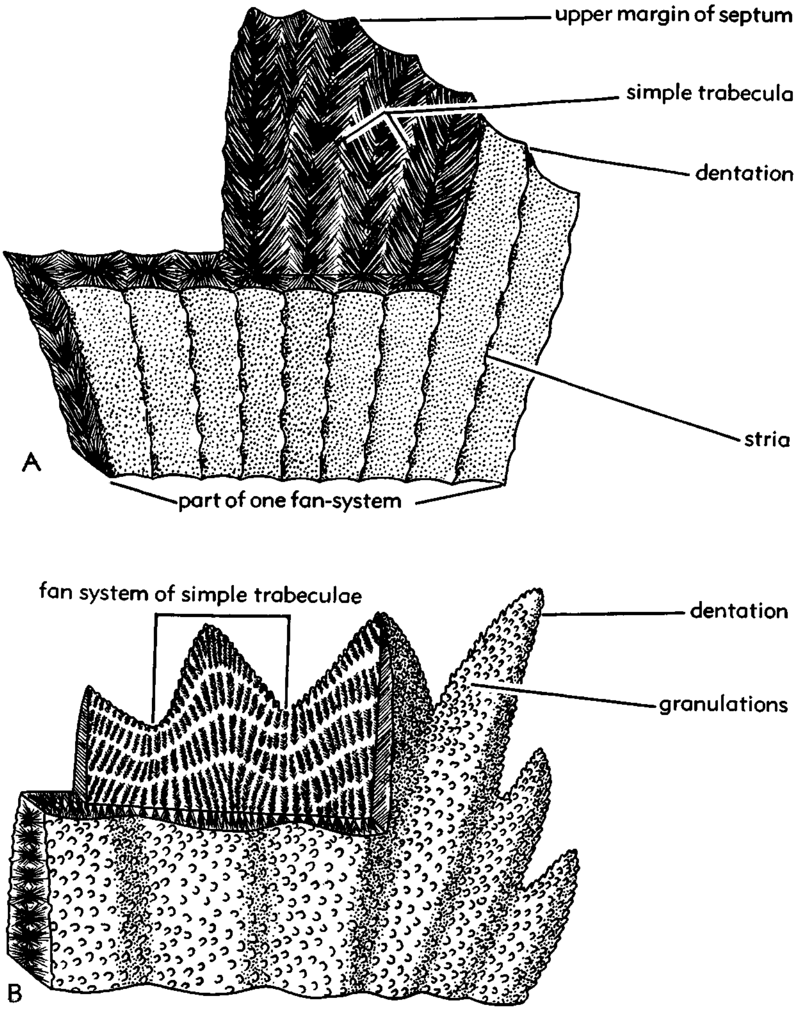

FIG. 232. Trabecular structure of scleractinian septa. *A*, Single fan system of simple trabeculae in laminar septum of *Galaxea* (98). *B*. Multiple fan systems of simple trabeculae in laminar septum of *Mussa* (98).

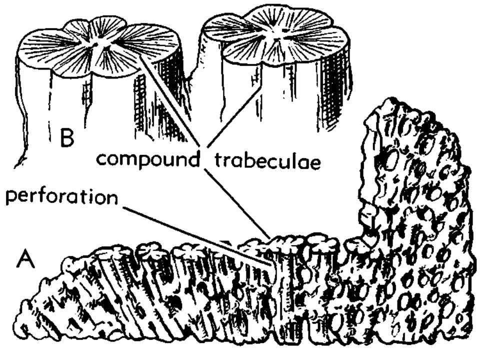

FIG. 233. Trabecular structure of scleractinian septum. *A*, Single fan system of compound trabeculae in fenestrate septum of *Cyclolites* (105). *B*, Compound trabeculae enlarged (105).

Septal teeth or **dentations** are formed along the upper margin of the septum if the trabecular axes project beyond the connective tissue or if the trabeculae are too far apart for intervening spaces to be filled (Fig. 236). They reflect the underlying structure of the septum. Granular or beadlike teeth are found in scleractinians having the septa composed mostly of simple trabeculae arranged in one fenestrate fan system (Astrocoeniidae, Calamophylliidae, Agariciidae, Thamnasteriidae, Microsolenidae). Nearly smooth, acute teeth occur (Montlivaltiidae, Faviidae) where the septa are composed of simple trabeculae in 1 or 2

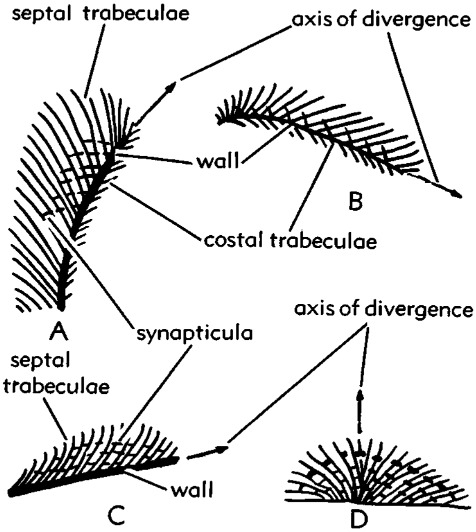

FIG. 234. Axis of trabecular divergence in fungiid genera *(A, Acrosmilia; B, Fungia; C, Cyclolitopsis; D, Cyclolites)* (151).

laminar fan systems. Dentations like the last but larger and tending to be irregularly lacerate or hirsute, are common in groups (Pectiniidae, Merulinidae) in which the septa are laminar but with compound trabeculae. In the stylophyllid corals of large size *(Oppelismilia)*, the compound trabeculae emerge as blunt, lobulate teeth. In the Fungiidae, trabeculae are compound, forming small beadlike dentations in the fenestrate primitive forms and early stages of advanced types, and large, hirsute, acute to lobulate teeth in later stages. Where the septa are formed by a number of small fan systems, as in the Mussidae, each system may form a single large, lobulate, conical, or triangular tooth. Even septa which apparently have quite smooth upper margins are very minutely dentate (Caryophylliidae).

The septal structure, as briefly outlined above, varies regularly from group to group within the Scleractinia. This variation of a fundamental structure forms the principal basis for the classification of the order into suborders, superfamilies, and families (Fig. 237).

ARRANGEMENT AND DEVELOPMENT

In general, the septal order of appearance and arrangement corresponds to that of the mesenteries, as is to be expected. Septa developed within mesenterial entocoeles are **entosepta,** those in the exocoeles are **exosepta.** The first-formed septa, called **protosepta,** are the 6 located in the entocoeles of the first cycle of mesenterial pairs. Unlike the protocnemes, however, the protosepta appear simultaneously rather than in succession in basal invaginations of the prosepta, the latter being high vertical endodermal ridges which appear on fixation of the polyp. Other cycles of septa, collectively termed **metasepta,** are subsequently introduced one after the other. If only one cycle of mesenteries (protocnemes) has developed when the 6 protosepta appear, the second cycle of septa appears in the exocoeles as exosepta. If 2 cycles of mesenteries (protocnemes and first-cycle metacnemes) have developed, both the protosepta and second-cycle metasepta appear nearly simultaneously and both are entoseptal. The first-cycle protosepta develop simultaneously, and the second-cycle ento- or exosepta apparently also originate simultaneously, but in some forms the order of appearance of the second cycle is arranged in a dorsoventral order following that of the metacnemes, emphasizing the basic bilaterality of the scleractinian polyp and corallum. This order of succession in sextants constitutes the most obvious difference between the Scleractinia and the Rugosa. In the latter, the metasepta develop in a dorsoventral (?ventrodorsal) direction in each of 4 quadrants of insertion.

The succession of septal cycles after the first 2 may be complicated by the first appearance of the second- or third-cycle exosepta in the positions ultimately occupied by the entosepta (Fig. 238). This **substitution**

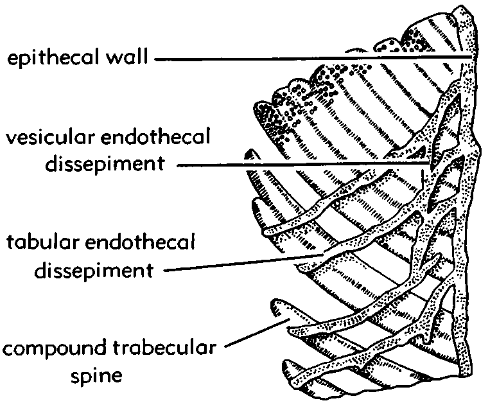

FIG. 235. Trabecular structure of scleractinian septum. Trabecular spines in *Oppelismilia,* ×2 (172).

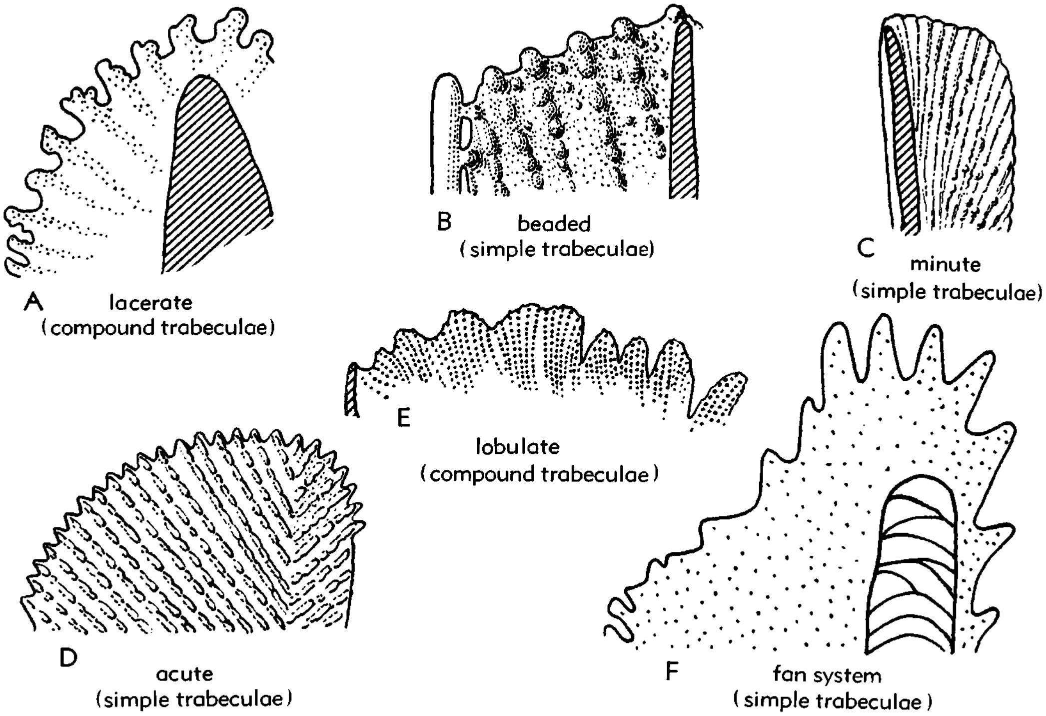

Fig. 236. Septal margins. *A*, Lacerate teeth (compound trabeculae), *Merulina*, ×8 (172). *B*, Beaded teeth (simple trabeculae), *Actinastrea*, ×12 (172). *C*, Minute teeth (simple trabeculae), *Caryophyllia*, ×8 (151). *D*, Acute teeth (simple trabeculae), *Montlivaltia*, ×4 (151). *E*. Lobulate teeth (compound trabeculae), *Oppelismilia*, ×8 (151). *F*, Fan system teeth (simple trabeculae), *Acanthophyllia*, ×1.5 (172).

of a permanent entoseptum for a temporary exoseptum is brought about by bifurcation of the outer (with respect to the axis of the corallum and polyp) end of the exoseptum as it grows upward, by coincident development of a mesenterial pair between the exoseptal branches, and by the growth of a new entoseptum within the entocoele formed by the new mesenteries. The 2 exosepta formed by branching of the original exoseptum may remain united proximally, fuse to the new entoseptum, or become free. This process

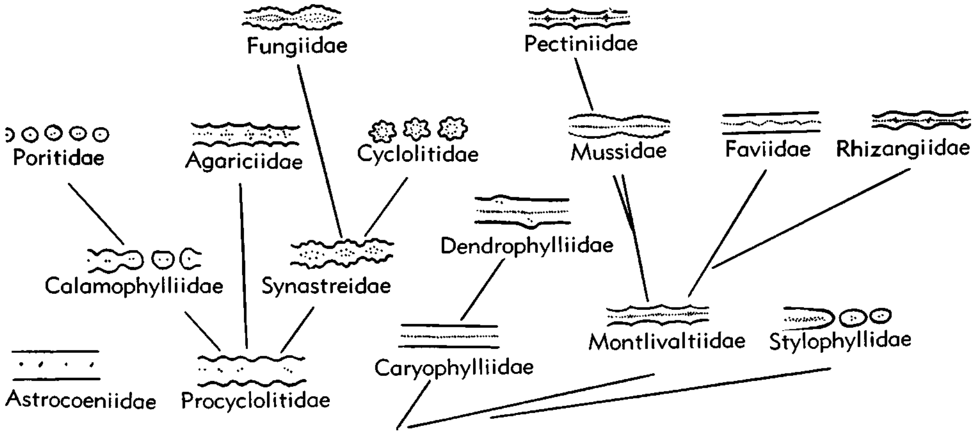

Fig. 237. Principal types of septal structure and probable relationships of important scleractinian groups. The figures, which are highly schematic and not to scale, represent horizontal sections of septa, and the fine dots indicate grouping of trabecular centers (151).

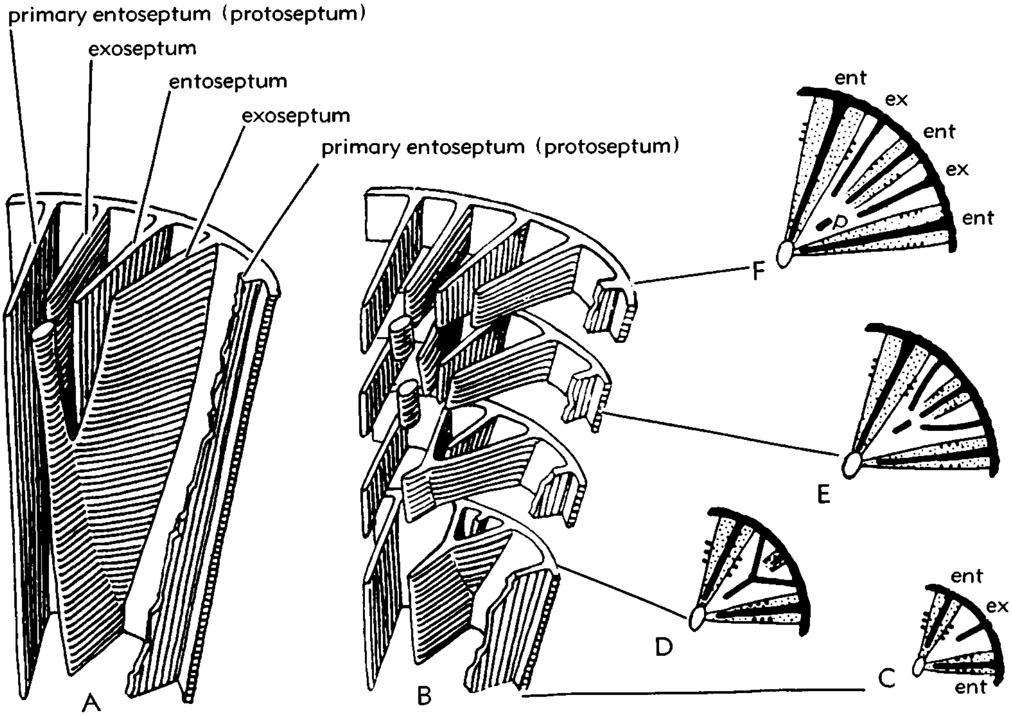

FIG. 238. Septal substitution and origin of pali. *A*, Sextant of solitary scleractinian (primary entoseptum to right is cut away). *B*, Same sextant with horizontal layers cut away. *C,D,E,F*, Sections of corallum and polyp at various levels (entocoeles indicated by stippling) (185).

may be repeated with the formation of new entosepta and doubling of the exosepta. In some groups (notably the dendrophylliids), the development of the exosepta is commonly much greater than that of the entosepta, so that, except for the first 1 or 2 cycles, they appear subordinate to the exosepta: **the Pourtalès plan** (Fig. 239). If septa of a higher cycle unite with those of a lower, it may be assumed that substitution has occurred, but if their inner ends are free, substitution may or may not have taken place, generally not. But in some genera no exosepta are ever formed, and in a few others even the first cycle is exocoelic.

The primary plan of the septa, like that of the mesenteries, is hexameral and seemingly radial (Fig. 240*A*). The 6 protosepta, appearing simultaneously, form the **first cycle.** The **second cycle** also consists of 6 septa inserted in spaces between the first. **The third cycle** includes 12 septa, the **fourth** 24, the **fifth** 48, and so on. Only very exceptionally are found other than traces of more than 8 cycles (768 septa, if complete). Septa of the second and third cycles commonly do not appear until all septa of the previous cycle have been formed. This general rule holds true for many scleractinians, but exceptions are common. Thus, in some forms, septa of equal size and apparent rank may be octameral or decameral in arrangement: 8/8/16/32, or 10/10/20. In such corals, certain mesenterial couples of the normal second cycle have attained a level of de-

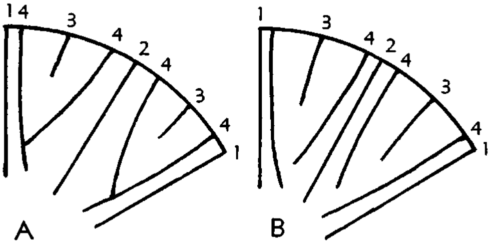

FIG. 239. Types of Pourtalès plan in dendrophylliid corals. Numbers indicate septal cycle: 1=protosepta; 2,3=substitute entosepta; 4=exosepta constituting fourth cycle. Greater development and curvature of fourth cycle exosepta is characteristic of the Pourtalès plan (151).

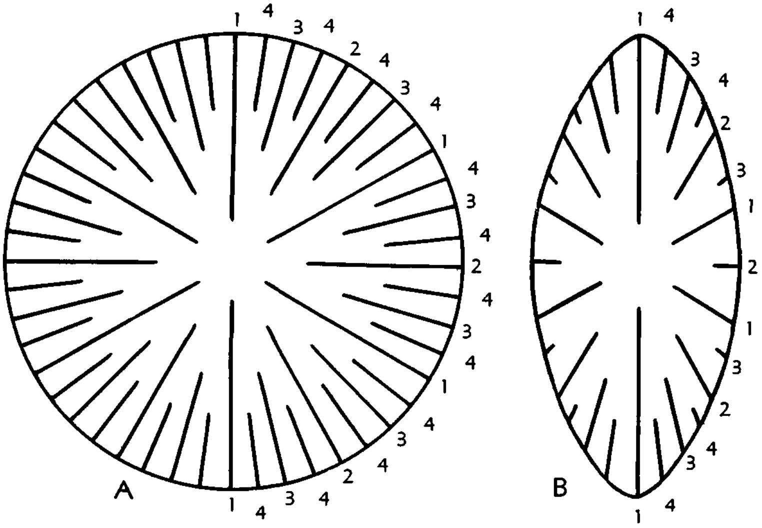

FIG. 240. Septal cycles in scleractinian corals. *A,* Normal cyclical order (numbers indicate cycles) (175). *B,* Cyclical order in calice elongated in plane of directive septa and mesenteries (higher cycles accelerated in end sextants; lower cycles retarded in lateral sextants) (175).

velopment equal to those of the first cycle, the complement of the second-cycle mesenteries, being filled by couples belonging to the third normal cycle.

The rule that septa of one cycle must be complete before those of the next cycle appear does not hold for septa of cycles higher than the third, especially in forms having an elongate calice (Fig. 240*B*). Higher-cycle septa tend to be accelerated and to appear in order from positions nearest the 2 opposing protosepta in the entocoeles of the directive mesenterial couples *(Flabellum, Notophyllia, Fungia)* and to be retarded in the transverse sextants.

SPECIAL STRUCTURES OF SEPTAL ORIGIN

PALI AND PALIFORM LOBES

Vertical lamellae or pillars along the inner edges of certain entosepta, especially in the Caryophylliidae (Figs. 238, 241), are called **pali.** They are structurally identical with the septa and secondary to them, and are the internal portions of exosepta which remain after substitution, as shown by their attachment basally to the united inner ends of exosepta. In forms of *Caryophyllia* with 48 septa (in 4 cycles), for example, the first 2 cycles (6/6) are entoseptal, the third (12) is originally exoseptal but by substitution be-

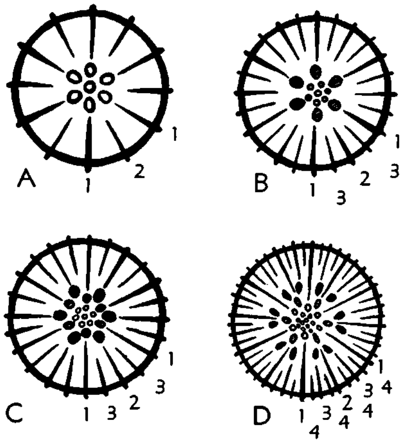

FIG. 241. Development of pali and paliform lobes in *Trochocyathus rawsoni* POURTALÈS, off South Africa (55). *A,* Early stage with central columellar tubercle (unshaded) resulting from fusion of ends of primary entosepta *(1),* surrounded by 6 paliform lobes (shaded) offset from entosepta. *B,* Later stage with a 2nd ring of 6 paliform lobes (shaded) before primary entosepta *(1)* [1st ring of paliform lobes (unshaded) now forming columellar tubercles]. *C,* Still later stage with 1st crown of 6 pali (black) resulting from substitution of 2nd cycle entosepta *(2)* for former 2nd cycle exosepta which have doubled and now form 3rd cycle *(3)*. *D,* Adult stage, with 2nd crown of 12 pali, in pairs of chevrons, resulting from substitution of 3rd cycle entosepta *(3)* for former 3rd cycle exosepta now doubled and forming the 4th cycle *(4)*.

comes entoseptal, the doubled exosepta forming the fourth and last cycle (24), and the inner or proximal ends of the third exoseptal cycle are left in the form of a circle or **crown** of pali adjacent and opposite to the inner edges of the permanent third-cycle entosepta. Thus, when pali are present, the number of crowns equals the number of cycles of exosepta less one.

Paliform lobes resemble pali, and are often difficult to differentiate in some genera. They are more or less detached trabecular offsets from the inner edges of some septa, appear in vertical succession, and apparently are not the result of septal substitution. Paliform lobes from the first 1 or 2 cycles of septa may mingle axially to form a columella (Fig. 241).

COLUMELLA

An axial structure found in many corals is termed **columella. A trabecular (parietal** or **spongy) columella** is formed by the intermingling of loose trabeculae, synapticulae, or paliform lobes from the inner septal margins of lower-cycle septa. It may be a weakly developed and loose, or a compact, spongy mass. A **fascicular columella** appears as a group of twisted vertical ribbons or rods similar to pali and paliform lobes in origin, that is, composed of remnant inner portions of exosepta, or offsets from the first 1 or 2 cycles. In some corals these elements may be solidly fused together as a single columnar rod, a **styliform columella,** free at its upper end with the entosepta secondarily fused to it by stereome. A **lamellar columella** is a plate, commonly free in its upper part, lying lengthwise in the longer axis of elongate calices. In calicular series resulting from intratentacular budding, a lamellar columella may be continuous or discontinuous between calicular centers. It originates by elongation of the dorsal directive protoseptum into the axis of the corallite. Later it may become separated and appear free. In no case does the columella originate independently of the septa, but in some forms its development may be accelerated and it may appear nearly at the same time as the protosepta.

SYNAPTICULAE

Rods or bars connecting opposed faces of adjacent septa and perforating mesenteries between them are termed **synapticulae** (Fig. 242). They first develop as large granulations formed by horizontal growth of strongly diverging trabecular elements, and may include 1 or 2 extra sclerodermites. **Simple synapticulae** are rods formed by 2 opposed granulations, as in *Siderastrea;* **compound synapticulae** are broad bars formed by the fusion of opposing ridges on 2 adjacent septa, parallel to the upper septal margin, as in *Fungia.* Synapticulae are found in nearly every scleractinian, especially in inner and outer parts of septa, and are particularly characteristic of forms with fenestrate septa (Fungiina).

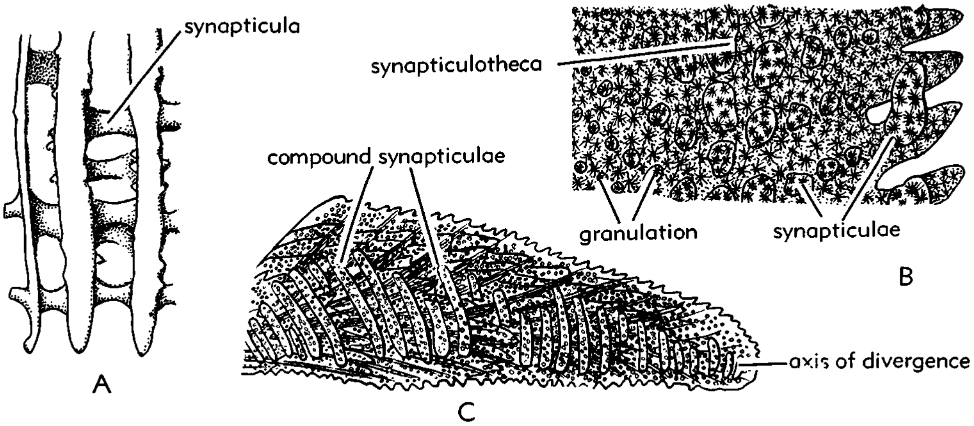

FIG. 242. Synapticulae. *A,* Simple synapticulae between septa of *Micrabacia* (30). *B,* Simple synapticulae in *Siderastrea:* longitudinal section parallel with septal plane (98). *C,* Compound synapticulae in *Fungia:* longitudinal section parallel with septal plane (98).

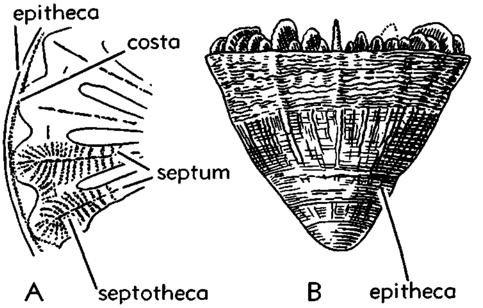

FIG. 243. Epitheca of *Trochocyathus hyatti* VAUGHAN, Paleoc.(Midway.), Ala. *A*, Schematic transverse section of mural region, ×8 (144). *B*, Lateral aspect of corallite, showing growth-wrinkled epitheca overlying costae, ×3 (144).

OTHER STRUCTURES

BASAL PLATE, EPITHECA, AND ROOTLETS

The first-formed part of the skeleton is the **basal plate,** which is deposited by the basal disc shortly after fixation of the larva, before the appearance of any septa. It is very thin, nearly transparent, firmly adherent to the substrate, and is commonly thickened by a later deposit of stereome.

As the polyp grows upward from the basal plate, the margin of the latter turns upward, forming a cup. This extension of the basal plate is the **epitheca,** secreted by the lower or outer edge of the calicoblast layer of the column wall where it is flexed upward, or at the lower margin of the edge zone where this is present. It is thin and externally marked only by growth lines. In corals lacking an edge zone, the epitheca unites the outer ends of the septa and keeps pace with their upward growth, forming the outer part of the epithecal wall. In forms with an edge zone, if this extends to the base, the epitheca may never be developed or it may lag considerably behind the septa and wall. If the edge zone extends only part way to the base, the epitheca extends from it to the base, closely covering the costae (Fig. 243).

Rootlets occur in a few genera, such as *Monomyces,* without an edge zone. Temporary extrusions of a tongue of edge zone over the margin of the calice toward the substrate may develop, depositing a layer of epitheca around themselves, then degenerating and leaving a hollow tube as an added element of stability. Such hollow rootlets are structurally distinct from the solid costal spines serving the same function, which are found in some genera provided with an edge zone.

DISSEPIMENTS

These are the partitions by which the polyp is cut off from the lower part of the corallum which it no longer occupies by reason of upward growth. Just how they are formed is not known exactly, but they seem to be responses to strains and shifts of the basal disc and column wall of the polyp resulting from secretion of vertical skeletal elements such as septa and walls. As skeletal deposition takes place along the tops of septa and wall, the soft parts are drawn upward, developing tensions sufficient to pull away the basal disc of the polyp from contact with the basal plate, either as a whole (whence tabular dissepiments) or as blister-like upward bulges (whence vesicular dissepiments). After the development of such bulges new skeletal tissue is deposited on the ectodermal surface. Dissepiments thus are successive, locally constructed basal discs.

Two types of dissepimental structures are **tabular** and **vesicular** (Fig. 235). The former are more or less flat plates extending across the whole corallite or confined to the axial part. Vesicular dissepiments appear as small, curved, overlapping plates inclined downward and inward from the corallite boundary or wall, and appear vesicular in section. Dissepiments developed between septa inside the corallite are **endothecal;** those outside the corallite, between costae or costal elements, are **exothecal** (Fig. 229).

STEREOME

The surfaces of the septa and other structures may be thickened secondarily by a closely adherent layer of variable thickness with smooth or lightly granular surface, the **stereome.** Structurally this is identical with the basal plate and dissepiments, and is especially common in corals having laminar septa, as the Faviina and Caryophylliina.

COENOSTEUM

In colonial corals, the corallites are united to each other by structures deposited by the coenosarc and referred to generally as **coenosteum.** Where the coenosarc contains extrathecal extensions of the mesenteries, the coenosteum is made up of costae, which

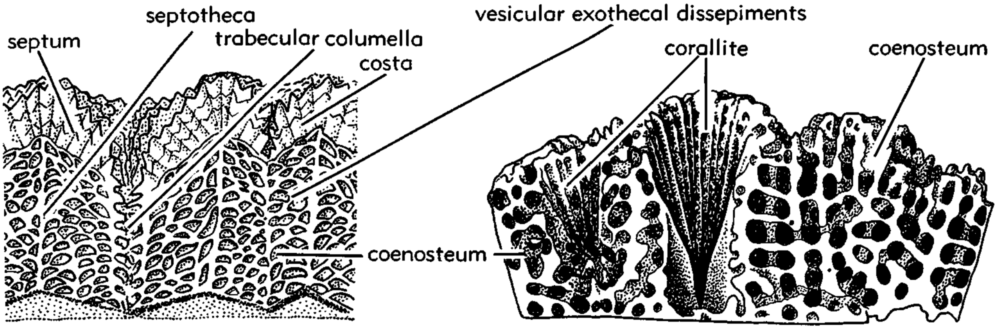

FIG. 244. Coenosteum. *A, Montastrea:* coenosteum composed of costae and vesicular exothecal dissepiments, in vertical section (98). *B, Astreopora:* porous coenosteum, in vertical section (57).

may be confluent between corallites, and tabular or vesicular exothecal dissepiments (Fig. 244). Where the extrathecal mesenteries are not developed, with consequent reduction or absence of costae, the coenosteum consists wholly of dissepimental tissue (Fig. 229). In such groups as the Poritidae, Acroporidae, and Dendrophylliidae, the lower part of the coenosarc is modified into a tangle of canaliculae with ramifying vertical and lateral connections. The coenosteum laid down around this soft tissue consists of sclerodermites united horizontally and vertically by rods in more or less distinct laminae (Fig. 244); or, if the canaliculae do not extend downward, as in the Pocilloporidae, the coenosteum is either a solid or vesicular granulated or spinulose deposit lacking sclerodermites.

Modifications of coenosteal structure parallel those of the septa, for increasing porosity of the septa is accompanied by porosity of

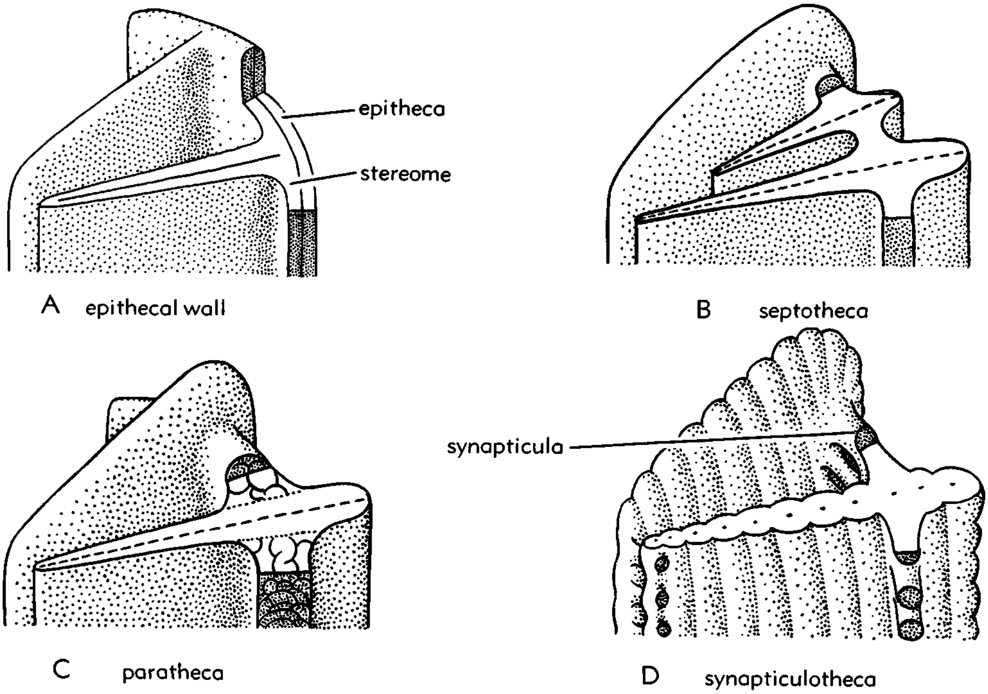

FIG. 245. Wall structures (198n). *A,* Epithecal wall. *B,* Septotheca. *C,* Paratheca. *D,* Synapticulotheca.

the coenosteum, and reduction of the extrathecal mesenterial continuations to canaliculae results in porous coenosteum.

WALL

The skeletal **wall** or **theca** encloses the column wall of the polyp, and unites and secures the outer ends of the septa. It is entirely secondary in origin and its function is assumed by different structures in different groups. In many primitive (*Pinacophyllum,* procyclolitids, stylophyllids), and a few neotenic (flabellids, guyniids) scleractinians, the epitheca encircles the outer ends of the septa, with an internal thickening of stereome (Fig. 245*A*). Such a wall is found in the earliest stages of nearly all corals, but generally is superseded during ontogeny by other types of mural structure. In forms with an edge zone, where the development of epitheca is limited or even prevented, another type of wall, the **septotheca,** is developed by thickening of the outer part of the septa along the axis of trabecular divergence, with or without additional sclerodermites (Fig. 245*B*). A septotheca is solid, forming a partition between the septa and costae. In some corals having well-developed dissepiments, these may push upwards so as to reinforce the septotheca, or even replace it as the wall (Fig. 245*C*). In the latter instance the wall is termed **paratheca.** Similar to septotheca but not solid, is a **synapticulotheca,** formed by one or more rings of simple or compound synapticulae along the axis of trabecular divergence (Fig. 245*D*). Such a wall enables direct communication through the wall as well as over it between the gastrovascular cavity and its extension into the edge zone or coenosarc.

REPRODUCTION

SEXUAL REPRODUCTION

Scleractinian polyps are hermaphroditic, unisexual, or sterile. In hermaphroditic forms, ovaria and spermaria are closely associated in the same polyp, commonly on the same mesentery. Dioecious forms are common, the ovaria usually bearing but one large egg at a time.

Viviparity is the rule. Before extrusion, the larvae are free in the gastrovascular cavity of the parent, and are ejected through the mouth singly or in batches up to a dozen or more at a time. The breeding season for many reef corals seems to have a roughly lunar periodicity, but some species have an almost continuous season, and still others have a prolonged annual season.

The young larva or **planula** (Fig. 246*A*) is spheroid, pyriform, or elongate-cylindrical, ranging in length from 1 to 3 mm., externally ciliated, and able to swim very shortly after extrusion. At first, the oral aperture is not visible, but soon appears as a minute opening at or near one end. Initially almost opaque, the planula later becomes more transparent, and the mesenterial attachments to the wall can be seen, generally with 6 orthocnemes developed (Fig. 246*B*).

Planulae may swim about sometimes for weeks, but settling on a substrate usually occurs within a few days. Fixation is by the aboral end, which flattens and broadens as the basal disc and column wall become differentiated. The first complete cycle of mesenteries appears within a few days after fixation when the entocoeles of the protocnemic mesenteries have been formed, and at about the same time the first cycle of septa is developed (Fig. 246*C*).

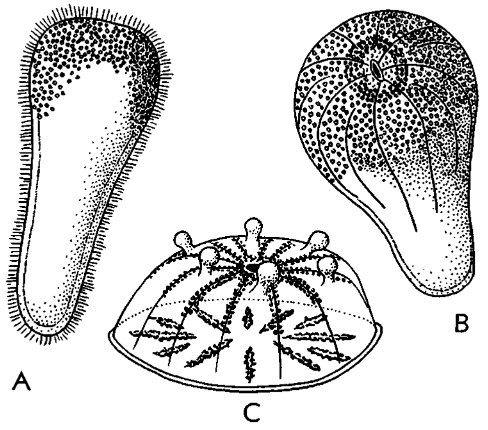

FIG. 246. Planulae and early stages of *Siderastrea radians, ca.* ×25 (28). *A,* Larva immediately on extrusion. *B,* Second-day larva just before settling, with six pairs of mesenteries (protocnemes). *C,* Polyp a few days after fixation. First two cycles of ento- and exosepta beginning to develop.

ASEXUAL REPRODUCTION AND COLONY FORMATION

To be discussed here are the various modes by which new polyps or stomodaea[1] may be produced from other polyps, either as separate, **solitary individuals,** or as members of **colonies** with or without organic continuity between parent and daughter polyps. The many modes by which this is accomplished and the different conditions to which they lead are one of the most remarkable aspects of the Scleractinia; they have great systematic importance because the form of the colonies is largely determined by them.

New stomodaea or polyps arise (1) by invagination, either of the oral disc inside the tentacular ring **(intratentacular budding),** or of the edge zone or coenosarc outside the tentacular ring **(extratentacular budding),** into the coelenteric cavity; (2) by union of the marginal filaments of the broader subsidiary mesenteries, with openings in the oral disc **(intratentacular),** or in the edge zone or coenosarc **(extratentacular),** and (3) by **transverse division** of the polyp. For practical purposes the first 2 generally have essentially the same result, and it is more convenient to recognize 3 main modes: (1) intratentacular budding ("fission"), (2) extratentacular budding ("budding"), and (3) transverse division.

INTRATENTACULAR BUDDING

The development of 2 or more mouths with stomodaea within the same tentacular ring, (a) with one or more couples of mesenteries between each pair of neighboring stomodaea **(indirect linkage),** or (b) with neighboring stomodaea connected by mesenterial strands **(direct linkage),** characterizes intratentacular budding. Indirect linkage of stomodaea, which concerns soft parts, is reflected in the hard parts by **trabecular linkage** between corallite centers (Fig. 247*A*); in direct linkage of stomodaea, corallite centers are joined by lamellar septal plates **(lamellar linkage)** (Fig. 247*B*).

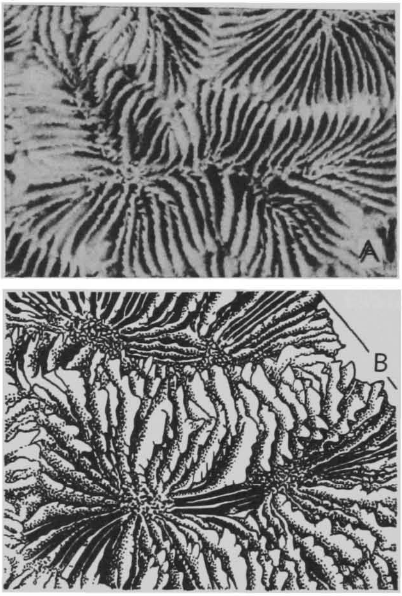

FIG. 247. Linkages after intratentacular budding. *A*, Trabecular linkage of centers in *Isophyllia* (88). *B*, Lamellar linkage in *Symphyllia* (88).

Modes of Intratentacular Budding

1. *Distomodaeal budding,* with 2 stomodaea developed within a common tentacular ring and 2 interstomodaeal couples of mesenteries between original and each new stomodaeum (Fig. 248*A*; 249,*2*).
2. *Tristomodaeal budding,* like distomodaeal budding except that 3 stomodaea occur in series or forming a triangle (Fig. 249,*1,3,6*).
3. *Triple stomodaeal budding,* like tristomodaeal budding except that the 3 stomodaea invariably form a triangle and only one interstomodaeal couple of mesenteries occurs between every 2 neighboring stomodaea.
4. *Polystomodaeal budding,* with more than 3 stomodaea developed within a common tentacular ring; includes 3 types, as follows.
   - a. *Intramural budding,* with stomodaea directly or indirectly linked in a single linear series; the polystomatous polyps may be continuous or discontinuous throughout a colony and exhibit lateral branching or terminal forking (Fig. 248*B*; 249,*4*).
   - b. *Circumoral budding,* with directly linked stomodaea arranged concentrically around central parent stomodaeum (Fig. 248*C*).
   - c. *Circummural budding,* with indirectly linked stomodaea arranged around discontinuous collines or monticules of corallum (Fig. 248*D*).

The several basic modes of budding indicated in the tabular outline just given may

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[1] A "polyp" includes a mouth and stomodaeum enclosed by a tentacular ring or rings, but in many scleractinian polyps intratentacular budding ends with 2 or more mouths and stomodaea enclosed within the same tentacular ring. It is not yet settled whether this latter condition (di- to polystomodaeal) constitutes one "polyp" or as many polyps as there are mouths and stomodaea within a common tentacular ring.

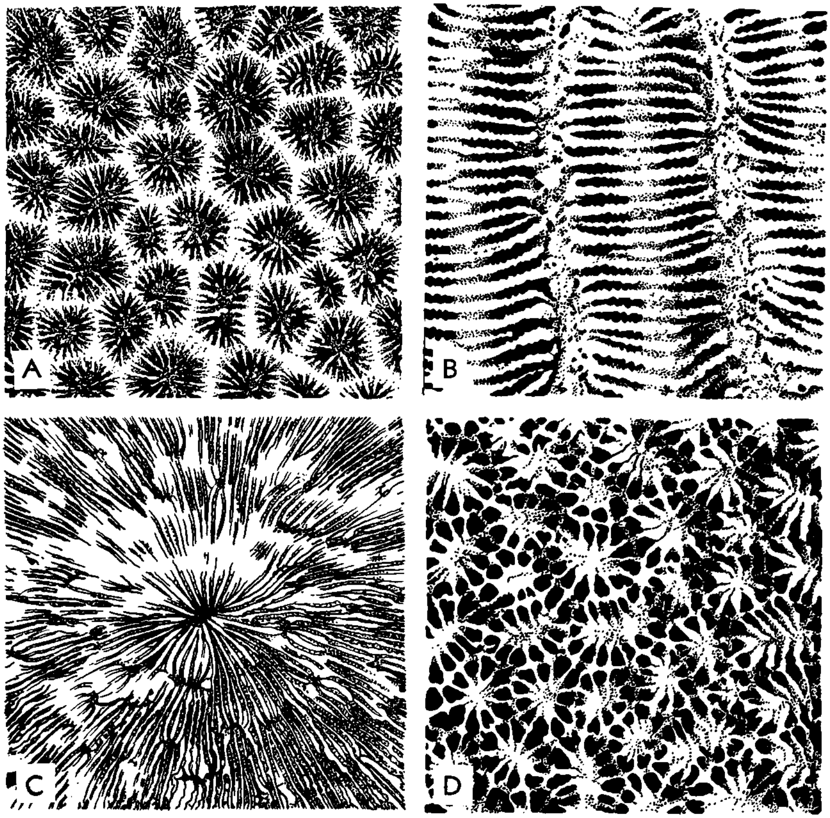


Fig. 248. Intratentacular budding. *A,* Distomodaeal budding in *Goniastrea retiformis* (Lamarck), Rec., Rotuma, ×3 (83). *B,* Intramural budding with indirect linkage in *Diploria strigosa* (Dana), Rec., W. Indies, ×3 (88). *C,* Circumoral budding in *Halomitra philippinensis* Studer, Rec., Jaluit, ×1 (165). *D,* Circummural budding in *Hydnophora microconos* (Lamarck), Rec., Maldives, ×3 (88).

be permanent or only temporary. After di- or tristomodaeal budding, the new stomodaea may remain within the same tentacular ring or they may become individualized as separate polyps, each with its own tentacular ring. In the latter case, the **monostomodaeal** condition is said to be permanent, and the corallites are **monocentric.** If the permanent condition is di- or tristomodaeal, the corallites are **di-** or **tricentric,** and when the polystomodaeal condition is permanent the corallum is **polycentric.** These conditions, and likewise conditions of linkage, are generally the same within the limits of a genus.

In many genera, the mode of colony formation changes as the colony grows: at first it may be circumoral, followed by intramural or di- or tristomodaeal budding. When polystomodaeal budding occurs, individualization of polyps or corallites rarely takes place.

EXTRATENTACULAR BUDDING

The presence of only one stomodaeum within a tentacular ring, combined with development of new stomodaea from edge zone or coenosarc outside the tentacular ring of the parent, characterizes extratentacular budding (Fig. 250). Significant also is the absence of interstomodaeal mesenterial couples or mesenterial strands between stomodaea of neighboring polyps, as well as the absence of polystomodaeal polyps or polycentric corallites.

Solitary corals normally lacking an edge zone, as *Culicia,* or with a very narrow edge zone, as *Rhizangia,* may develop reptoid colonies by the outpushing of a temporary tongue of edge zone on which a new extratentacular bud is formed. Such stoloniferous expansions may lay down a calcareous base, or degenerate and sever organic continuity.

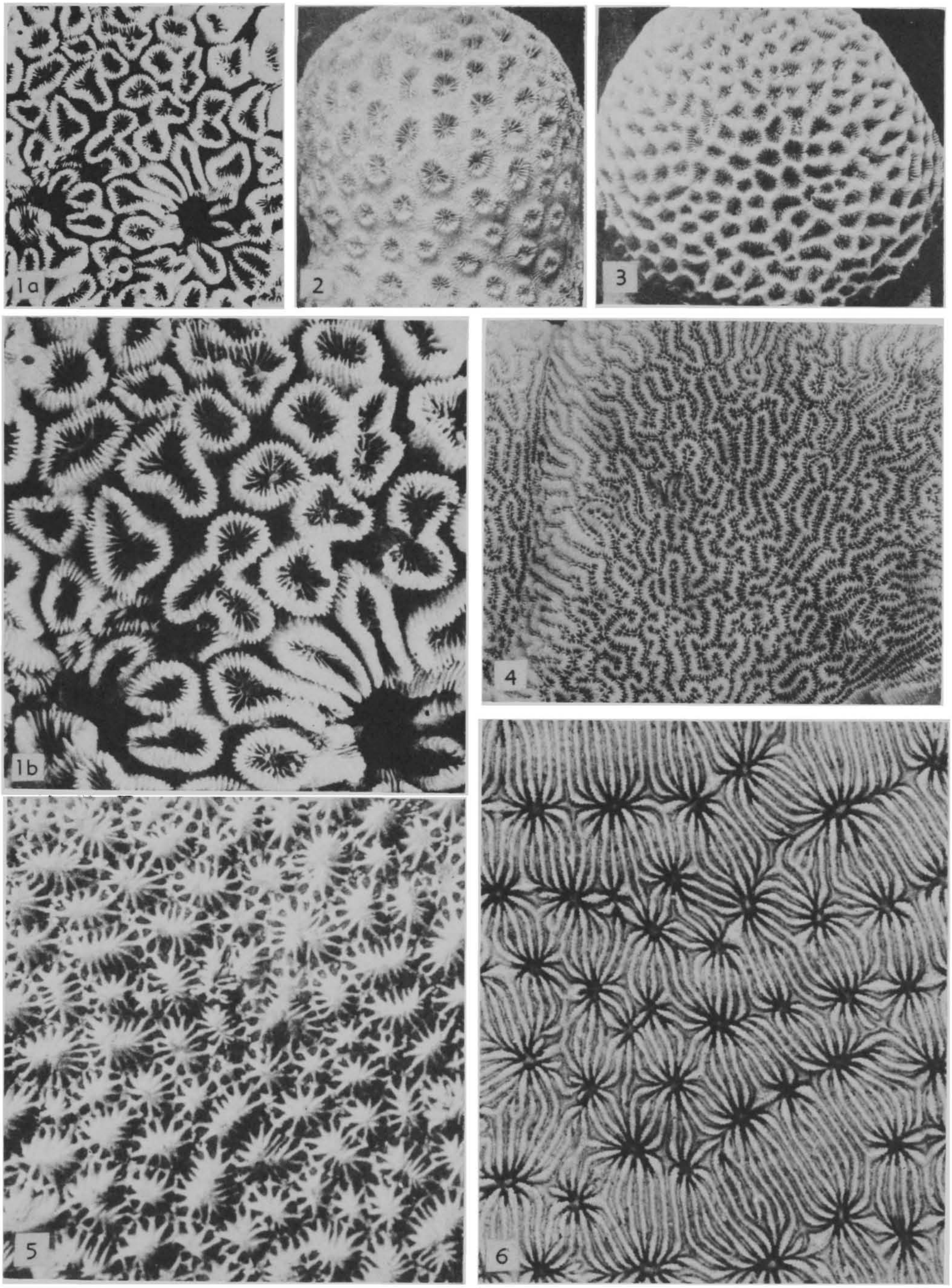


FIG. 249. Recent hermatypic scleractinian corals. *1, Caulastrea tumida,* Japan, showing phaceloid mono- to tristomodaeal intratentacular budding; *1a,b,* ×0.5, ×1 (YABE & SUGIYAMA). *2, Favia speciosa,* Fiji, showing plocoid mono- to distomodaeal intratentacular budding, ×0.5 (VAUGHAN). *3, Goniastrea pectinata,* Fiji, showing cerioid mono- to tristomodaeal intratentacular budding, ×0.5 (VAUGHAN). *4, Leptoria phrygia,* Bonin I., showing meandroid polystomodaeal intramural intratentacular budding, ×0.8 (WELLS). *5, Hydnophora microconos,* Murray I., Great Barrier Reef, showing hydnophoroid circummural intratentacular budding, ×2 (VAUGHAN). *6, Pavona crassa,* Ryukyu I., showing thamnasterioid mono- to tristomodaeal intratentacular budding, ×4 (WELLS).

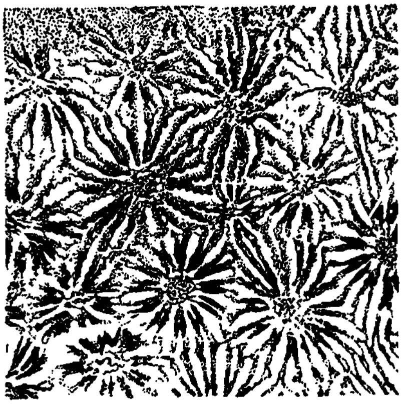


FIG. 250. Extratentacular budding in *Diploastrea heliopora* (LAMARCK), Rec., Minikoi, ×2 (83).

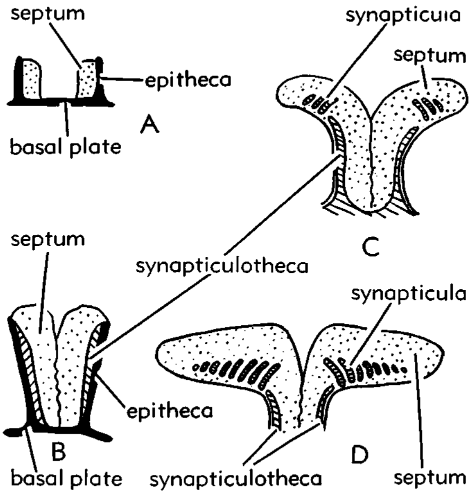


FIG. 251. Transverse division in *Fungia* (schematic vertical sections) (151). *A*, Early post-embryonic stage (anthocaulus) with epithecal wall. *B*, Later anthocaulus stage, with synapticulotheca developing inside epithecal wall. *C*, *Acrosmilia* stage. *D*, Detached anthocyathus.

TRANSVERSE DIVISION

Transverse fission with complete severance of connection has been observed in only a few scleractinians.

Fungia may reproduce by transverse division of a fixed conical solitary polyp and corallum, the **anthocaulus** or **anthoblast** (*Acrosmilia* stage of ontogeny) (Fig. 251). An anthocaulus is the result of sexual generation, an anthoblast, of extratentacular budding. **Anthocyathi** (neanic *Fungia* stage) are the buds separated from anthocauli or anthoblasts. This is a special form of transverse division, differing from the usual concept of fission in that the anthocaulus or anthoblast apparently never attains the adult *Fungia* condition and either dies or remains in the *Acrosmilia* stage and produces more anthocyathi (successive transverse division). Other genera related to *Fungia* show the same mode of division, but in some the anthocyathi do not break away from the anthocaulus and a fixed adult corallum results. Genera of extinct groups, such as the Cyclolitidae, may have had this mode of increase.

REGENERATION

Genera of the Fungiidae and a few others have remarkable ability to regenerate more or less complete adult coralla from fragments. The minimum amount of polyp and corallum necessary for successful regeneration is a segment between and including 2 adjacent entosepta of the first cycle, about one-sixth of most solitary scleractinians.

In several genera, such as *Dasmosmilia*, the conical corallite shows a strong tendency to split lengthwise into wedge-shaped fragments, either as a result of injury or an inherent structural weakness. Each fragment is able to produce one or more buds on its inner surface **(parricidal budding).**

MORPHOGENESIS OF CORALLUM

SOLITARY CORALLA

The form of the corallum depends on the character of the polyp, the relative growth rates of its parts, and in colonial forms, on the mode of asexual increase.

The basic corallum, as suggested by the earliest stages of living forms, is a disc formed by the horizontal basal plate fixed to the substratum (Fig. 252). In development, this is followed immediately by a narrow band of epitheca forming a shallow cup, after which the first septa appear. The adult corallum of some groups (Flabellidae, Guyniidae) is of this simple type, but in most it is followed by development of more advanced types of wall and the epitheca is to be regarded as an early post-embryonic structure of diminishing importance. Ability to form epitheca, however, is always retained by the edge zone and it frequently develops when the edge zone is retracted as upward growth proceeds. Some genera in which the corallum is wholly covered by the polyp, invariably lack all traces of epitheca (turbinolians).

The commonest form of the solitary corallum is conical or **turbinate,** with a basal angle of 60° to 80° (Fig. 252). If the angle is about 40°, the corallum is termed **trochoid,** and if the angle is only about 20° the corallum is said to be **ceratoid.** These essentially conical coralla result from differing rates of vertical and peripheral growth, vertical growth generally being faster than peripheral. If peripheral enlargement ceases in the adult stage, and vertical growth continues, the resulting corallum is elongate and **cylindrical** if regular, or **scolecoid** if irregular. In a few forms peripheral growth ceases at a very early stage and the corallum resembles a short, squat plug, or drum, the **tympanoid** form. **Cupolate** coralla, with flat base and highly convex oral surface, are the result of nearly equal rates of peripheral and vertical growth. **Discoid** coralla, with horizontal wall and flat or slightly concave or convex oral surface, develop if peripheral growth is much faster than vertical. **Patellate** coralla, which are broadly flattened conical in form, are the result of slight acceleration of peripheral over vertical growth. **Cuneiform** (wedge-shaped) and **flabellate** (fan-shaped) coralla develop if the calice is elongated in the direction of the directive entosepta. If the polyp continues to grow in the gerontic stage, the skeletal structures generally show a reduction in size from their maxima and the calices become smaller.

COLONIAL CORALLA

The form of a colonial corallum depends to a great extent on the mode of colony formation. It may be **reptoid** (creeping), with stolon-like expansions of edge zone from which new corallites are budded; **dendroid,** with spreading branches; **phaceloid** (bushy), with parallel or nearly parallel, laterally free corallites forming tufts; **plocoid** (Fig. 250), with more or less cylindrical corallites having distinct walls and united to each other by confluent or nonconfluent costae and dissepiments; **cerioid** (Fig. 248*A*), with closely appressed prismatic corallites united directly to each other by fused walls; **aphroid,** found only in a few amphiastreids, with septa withdrawn or separated from the wall by a zone of dissepiments; **thamnasterioid** (Fig. 249,*6*), with corallites lacking definite walls and with directly confluent septa or septocostae; **hydnophoroid** (Fig. 248*D*), with corallite centers arranged around protuberant **collines or monticules,** the result of circummural budding; or **meandroid** (Fig. 248*B*; 249,*4*), with corallites forming **linear series** or groups of series within the same walls. In meandroid coralla the exsert edges of the septa and walls may form a ridge or colline on each side of the series. Collines of adjacent series may be fused to form a single colline (Fig. 248*B*), or separated by a trough of coenosteum, an **ambulacrum.** Meandroid coralla with a single continuous slightly contorted or straight laterally free linear series are termed **flabellate.**

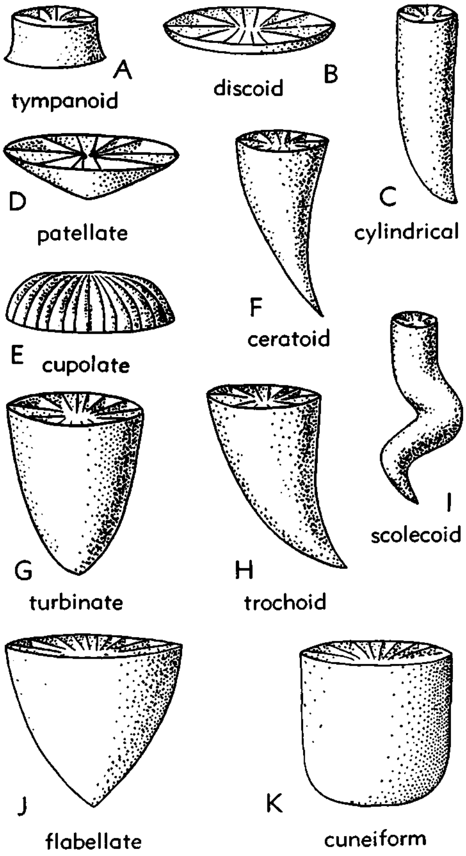


FIG. 252. Forms of solitary coralla.

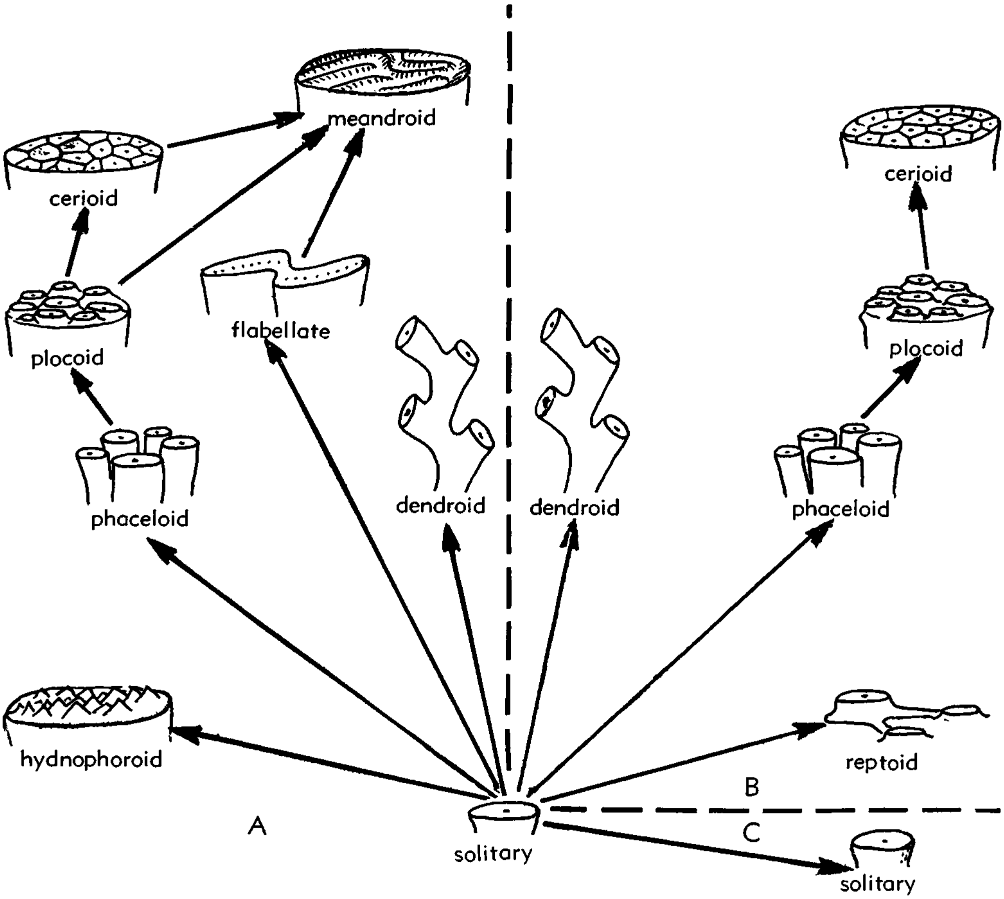


FIG. 253. Morphogenetic trends in colony formation (198mod.). *A,* Intratentacular budding; *B,* Extratentacular budding; *C,* Transverse division.

Cerioid, plocoid, thamnasterioid, hydnophoroid, and meandroid coralla are **massive** in habit if they form more or less thick masses or heads; **ramose** if branching; **foliaceous** if they form thin, expanding, overlapping sheets with a small basal attachment, like Savoy cabbages; and **incrusting** if they form thin sheets adherent to and following the substrate. Reptoid coralla result only from extratentacular budding; thamnasterioid, hydnophoroid, meandroid, and flabellate, only from intratentacular budding; and dendroid, phaceloid, cerioid, and plocoid from either mode.

Colonial coralla may also be produced by the fixation of a number of planulae of the same species in such close proximity that they subsequently fuse together.

MORPHOGENETIC TRENDS

Most scleractinian families show trends from solitary to various types of complex colonial coralla, especially if the principal mode of colony formation is by intratentacular budding, as partly summarized in Fig. 253. In addition to the trends there shown, it should be noted also that trends from solitary to thamnasterioid occur, and from plocoid and cerioid to thamnasterioid likewise. Thus, from a solitary progenitor some 13 colonial forms can arise by various modes of colony formation, 6 of these forms having 4 distinct habits apiece, a total of at least 31 principal growth forms of specific to generic value.

ECOLOGY

Scleractinian corals may be divided into two ecological groups: (1) **hermatypic** (reef) corals (Figs. 254-256), characterized by the presence of vast numbers of symbiotic, unicellular, dinoflagellates or zooxanthellae in their endodermal tissues, and (2) **ahermatypic** ("deep-sea") corals, which lack zooxanthellae and are less restricted environmentally than reef corals (Fig. 257). Seemingly, the hermatypic corals are closely dependent on their contained zooxanthellae for general well-being and vigorous growth, and their restricted habitat is largely controlled by the ecologic requirements of the symbionts.

CONTROLLING FACTORS

DEPTH

Hermatypic corals live between the surface and a maximum depth of about 90 m., but most of them occur in depths less than 50 m., and the most luxuriant growth is attained where the water is less than 20 m. deep. Ahermatypic corals live at all depths down to a maximum of nearly 6,000 m., but mostly between the surface and 500 m.

TEMPERATURE

A few hermatypic corals can live in temperatures as low as 15°C. but most are found in waters above 18°C. and they flourish best between 25° and 29°C.; the maximum endurable temperature is about 36°C. Ahermatypic corals live within a range from average reef temperatures to a minimum of about −1.1°C., but maximum development is found between 4.5° and 10°C.

SALINITY

The salinity tolerated by scleractinians lies between 27 and 40 parts per thousand, but they live best in salinities at or near the ocean normal of 36 ppm.

LIGHT

Strong sunlight is essential for vigorous growth of hermatypic corals, whereas ahermatypic corals live in partial to total darkness.

WATER MOVEMENT

Circulation of water is necessary, both to insure adequate supplies of nutrients (largely zooplankton) and oxygen, and to remove sediment. Corals rarely survive or live in areas where sedimentation is rapid.

The duration of the free-swimming planula stage of sexual increase is frequently a matter of days or weeks, and the transportation of planulae by currents is responsible for the wide distribution of many species, whereas shortness of the planula stage in other species accounts for their absence in some regions, even where the environment is suitable, as adjacent to Hawaii and Bermuda.

SUBSTRATUM

Coral planulae can settle only on a firm substratum such as bed rock, other corals, shells and skeletal parts of other sedentary organisms, loose blocks and smaller stable particles down to a few millimeters in size. In general, fine sand, silt, or mud bottoms are inimical to coral development unless there are scattered larger, clean particles and sedimentation is slow.

GROWTH RATE

The growth rate of corals differs in different areas and is greater in places where the annual average water temperatures are moderately higher. It also varies according to the structure of the skeleton, being slower in types with dense coralla, and faster in types with light, porous skeletons. In the tropical Indo-Pacific region, where ecologic conditions are more or less optimum, the annual growth increment of hermatypic corals, expressed in percentage gain in weight of coralla weighing 100 to 200 grams, ranges from as little as 20 per cent in solid coralla such as *Leptastrea,* to as much as 1,200 per cent in coralla with highly porous light skeletons, such as *Porites.* Annual increments in overall height range from 5 mm. (with 20 per cent weight increment) to 82 mm. (with 78 per cent weight increment).

FORM AND SIZE OF COLONIES

To some extent hermatypic corals, whether massive, foliaceous, ramose, or incrusting, owe their growth form to their situation on the reefs with respect to water movements.

The development of enormous colonies

consisting of millions of polyps and corallites, surpassing anything found amongst Paleozoic corals, is attributable to the development of (1) the porous, fast-growing skeletons of many forms and (2) the symbiosis of polyps and zooxanthellae.

PALEOECOLOGY

Certain ecologic factors controlling the distribution and development of corals, such as salinity, substratal requirements and sedimentation, certainly have been significant since the first appearance of the Scleractinia. Probably they were similarly operative on earlier occupants (rugose and tabulate corals) of the same ecologic niche. How long the single most important ecologic factor among the living hermatypic corals, the symbiosis with zooxanthellae, has existed, is uncertain, since it has no direct reflection in the skeletal structure and only an indirect effect on growth form. It is a characteristic and invariable condition only in a few families, and most families include both hermatypic and ahermatypic genera. The condition certainly was a gradual development, at first ecologically insignificant, but of increasing importance as zooxanthellae-coral symbiotic lineages became more and more mutually interdependent. Coral groups with established dinoflagellate symbiosis became further limited not only by factors controlling growth of the zooxanthellae, such as temperature and light intensity, which change with depth, but also of effects of resultant vastly increased colonial habit. In spite of these rather severe restrictions, which effectively limit hermatypic corals to the tropical surface temperature zone of the seas, this ecologic group has developed to an extent unknown in the Paleozoic corals and thus construction of true coral reefs became possible.

The earliest scleractinians, of Triassic age, were, by analogy with living forms, reef types. Symbiosis wtih zooxanthellae may have existed among Triassic corals, for they thrived best under conditions similar to those governing modern hermatypic forms, but presumably the relationship was not yet very significant and therefore development of vast reef structures was not possible. In the Jurassic, ahermatypic caryophylliids first appear in nonreef environments and a slow spread of corals into cooler, darker water began. In later Jurassic and Cretaceous time, ahermatypic corals representing other families are found less frequently in reef environments and more and more commonly in areas interpreted as marginal to the then tropical zone and beyond, and in areas of deeper and deeper water. Whereas modern ahermatypic corals at present equal or even surpass reef-builders in number of genera, less than a third of these are colonial in habit. The small colonies, many of which are delicately dendroid (an effect of sediment control in regions below wave base), can develop extensive banks and thickets only in a few places where food supplies are high, such as along the edge of the continental shelf off western Europe. Ahermatypic corals represent amongst the scleractinians the deployment away from the ancient, ancestral, and most fitted hermatypic environment, into all other possible environments so characteristic of the later history of successful organic groups.

STRATIGRAPHIC AND GEOGRAPHIC DISTRIBUTION

TRIASSIC

Scleractinian corals have not yet been found in rocks older than Middle Triassic. The oldest are found in lower Middle Triassic (Anisian-Muschelkalk) deposits of Germany, the southern Alps, Corsica, and Sicily; they include representatives of the Thamnasteriidae, Astrocoeniidae, Stylinidae, Procyclolitidae, and Montlivaltiidae, all of which seem to be hermatypic forms that lived on banks and in patches rather than forming true reefs. The late Middle Triassic (Ladinian) faunas of the same region are very similar.

The Late Triassic (Carnian, Norian, Rhaetian) witnessed world-wide extension of the earlier scleractinian faunas and considerable increase in their variety, including the first appearance of the Stylophyllidae in the Carnian. Species of the Montlivaltiidae, Procyclolitidae, Stylophyllidae, and Thamnasteriidae formed scattered reef patches during the Norian in southern and southeastern Europe, southeastern Asia, and

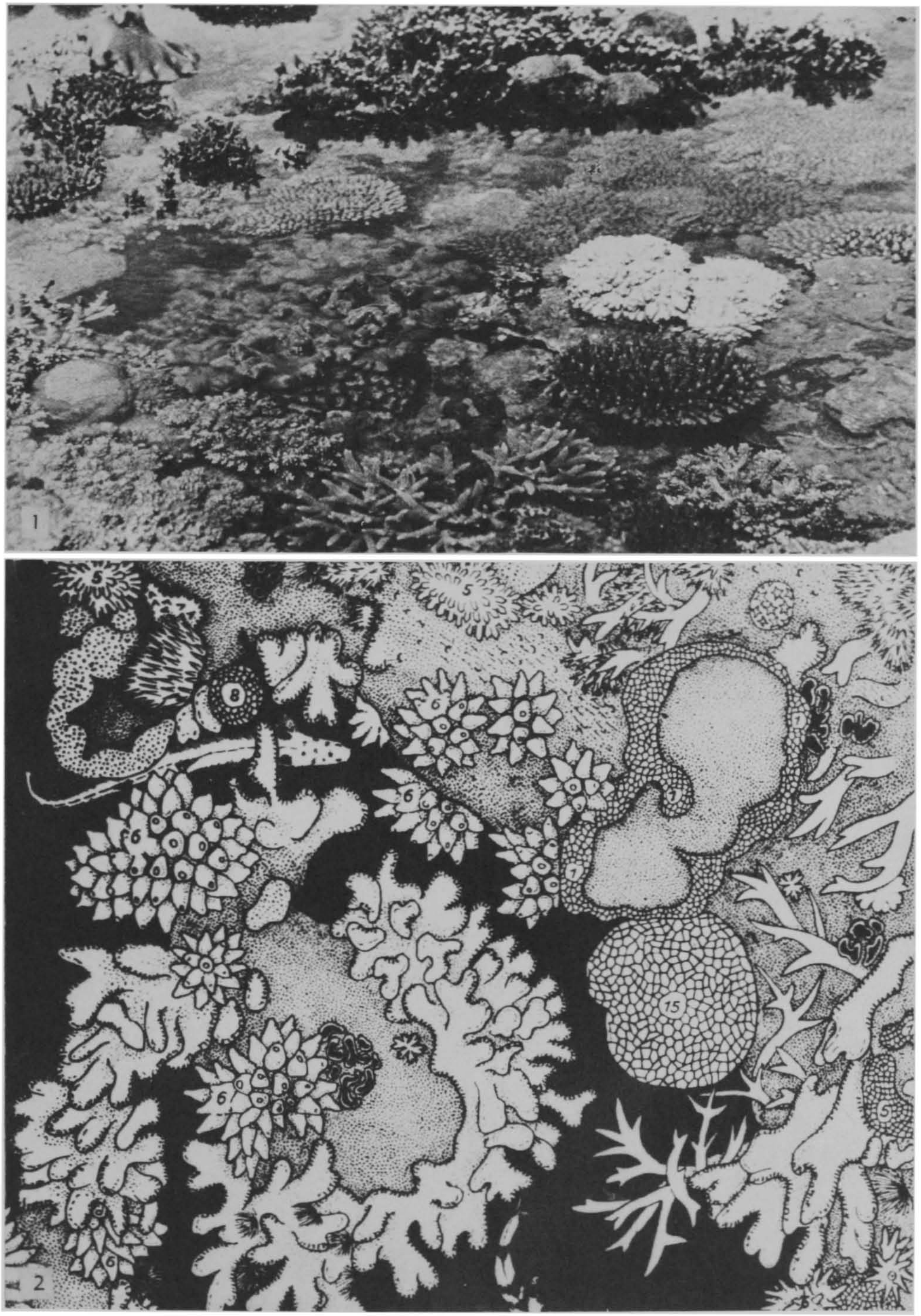


FIG. 254. Recent hermatypic scleractinian and alcyonarian corals. *1*, Calm-water reef tract at low tide, Low Isles, Great Barrier Reef, Australia (STEPHENSON). *2*, Map of coral colonies in area about 6 by 7 feet on part of Yonge Reef, Great Barrier Reef, Australia (MANTON).

Malaysia. These, with the exception of the Stylophyllidae, had already reached western North America in the Carnian.

The maximum range of the Late Triassic patch reefs and banks was from 60°N. to 10°S., greater than that of succeeding periods, but it is possible that hermatypic corals had not so close an adjustment to the tropical zone as they had later.

JURASSIC

The Early Jurassic (Liassic) corals were not greatly different from those of the Late Triassic. The families were practically the same; a few genera died out and a few new ones appeared. They were still of hermatypic type, but no important reefs are known. The Pinacophyllinae disappeared, and the Procyclolitidae lost most of their more primitive types as genera with more advanced septal structure developed. The Stylophyllidae culminated and became extinct by the Middle Jurassic. The most important addition was the appearance of the first caryophylliids in the Toarcian of northern Europe, marking the beginning of the distinction between reef and nonreef corals.

The Middle Jurassic (Aalenian-Bajocian-Bathonian) was a turning point in scleractinian evolution. From the Bajocian, diversification and multiplication of families and genera increased, with the center of this acceleration seemingly located in the western part of the Tethys. New groups were the Microsolenidae, Amphiastreidae, Calamophylliidae, and Synastreidae. In Bathonian time, conditions suitable for reef types extended eastward in the Tethys and southward along the eastern border of Africa. New Bathonian groups were the Stylininae, Parasmiliinae, and Rhipidogyridae. Few reefs were built, but patches and banks were common.

The Upper Jurassic was an epoch of extensive reef development, especially in the Tethys and its extensions into northern Europe, and as far east as Japan. Important new groups were the Actinacididae, Haplaraeidae, and Faviidae.

The early Late Jurassic (Callovian-Oxfordian) was much like the late Liassic in its lack of large faunas, but beginning in Lusitanian time corals are a most important element of the Tethyan faunas, even though they are almost absent in the Americas. Especially typical are the Rhipidogyridae, Amphiastreidae, *Enallhelia,* and *Tiaradendron.* The northernmost reef patches of this time are in England at 54°30′N., in Germany at 54°N., and in Japan at 38°N. Scattered occurrences of reef types are known as far north as 58° in Scotland. The most southerly are about 5°S. in eastern Africa. The reef-coral belt had about the same extent as today, but the zone as a whole was nearly 20° farther north.

CRETACEOUS

Little or no reef development is observed in earliest Cretaceous rocks and the corals of the Valanginian and Hauterivian are Jurassic in aspect; they are found mainly in Tunisia, Portugal, France, Italy, Carpathians, eastern Balkans, and the Crimea, where they lived on banks under conditions somewhat less than optimum.

In the Barremian and Aptian, another world-wide epoch of reef building began (Urgonian phase). Sizable reefs are known in France, Switzerland, Capri, Tunisia, Algeria, Catalonia, western Balkans, Bulgaria, Rumania, the Crimea, Kenya-Tanganyika, Japan, Venezuela, Mexico, and Texas. Coral banks existed as far south as Neuquen, Argentina (37°S.), and in Europe north to the Isle of Wight (50°45′N.). New families and subfamilies include the Cyclolitidae, Placosmiliinae, Montastreinae, Siderastreidae, Rhizangiidae, Micrabaciidae, and Desmophyllinae. The Rhipidogyridae died out, and the Thecocyathinae and Amphiastreidae declined.

Little reef development occurred during the Middle Cretaceous (Albian-Cenomanian), while ahermatypic corals living in the varied environments of neritic and bathyal zones became increasingly abundant. Albian deep- or cold-water coral faunas are known from France, Switzerland, England, Texas, and Antarctica (Graham Land), reef-coral faunas from Texas, northern Mexico, England, France, and central India. Cenomanian hermatypic faunas occur in Devon, France, northern Italy, Westphalia, Czechoslovakia, Bavaria, Albania, Greece, western Balkans, Belgium, Algeria, Egypt, Asia Minor, and southern India. They are similar to those of the Urgonian phase but few reefs are known. Cenomanian ahermatypic corals are widespread from Antarctica to England,

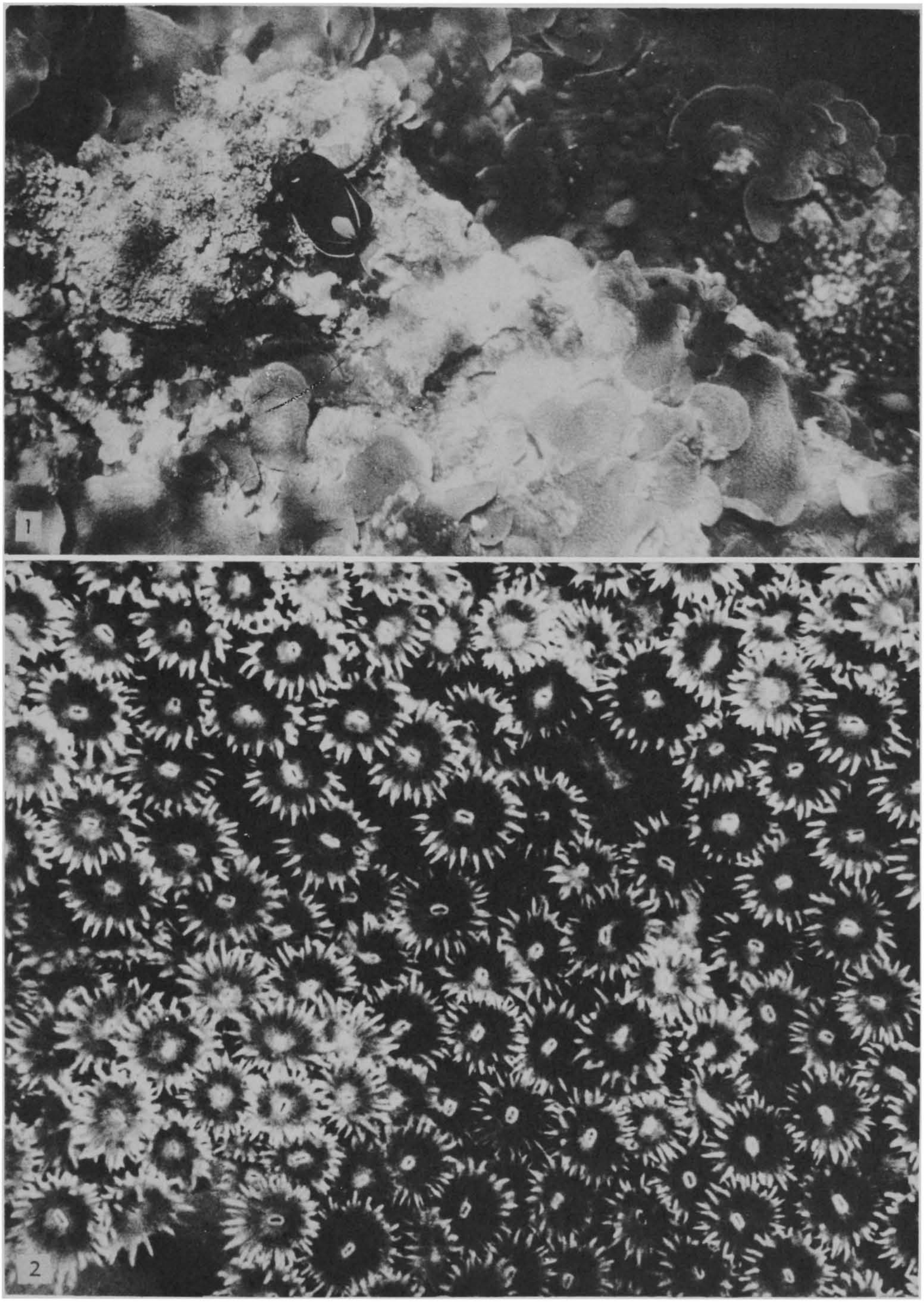


FIG. 255. *Turbinaria,* a typical hermatypic scleractinian coral. *1, T.* sp. *cf. T. veluta,* Bikini Atoll, showing typical form of colony with folia 10 to 20 cm. in width growing in quiet water about 1 fathom deep (WELLS). *1, T.* sp., Low Isles, Great Barrier Reef, Australia, showing part of a colony with polyps expanded, ×1 (YONGE).

Poland to Texas, and in Mexico, Madagascar, and India.

The Late Crotaceous was yet another time of reef building, but less so than the Late Jurassic or Early Cretaceous. The most important reefs are in Austria, Carinthia, southern France, Tunisia, Serbia, Switzerland, Czechoslovakia, Catalonia, and India. By the latest Cretaceous (Campanian-Maastrichtian) the Tethyan reef-coral fauna extended westward as far as the West Indies and Mexico and eastward to Malaysia, and the extent of the reef zone at this time was from about the equator to 50°N., although most of the reefs lie between 30° and 47°N.

By the Late Cretaceous, ahermatypic corals had secured a firm foothold in nearly every part of the littoral, neritic, and bathyal environments, and occur in Late Cretaceous beds of England, northern France, Catalonia, northern Germany, Scandinavia, Bavaria, Volga Basin, Poland, northern Africa, southeastern Africa, Arabia, India, United States, Chile, and Antarctica.

By the end of the Cretaceous, the modern aspect of both hermatypic and ahermatypic coral faunas became evident; this is marked by the appearance of early representatives of the Pocilloporidae, Poritidae, Turbinoliinae, and Dendrophylliidae, and disappearance of the Microsolenidae and Amphiastreidae.

TERTIARY

During the Paleocene and Eocene epochs, conditions favorable for extensive formation of reefs seemingly were absent everywhere, both hermatypic and ahermatypic types living sporadically in the Tethys, the coastal plains of the United States, the West Indies, and a few other spots. In the eastern Tethys, the Indian and Malaysian faunas began to become distinct from those of the central Tethys, as did those of the West Indies.

At the close of Eocene times most of the older elements of coral faunas had become extinct or were rapidly dying out; these include the Placosmiliinae, Montlivaltiinae, Haplaraeidae, Cyclolitidae, Actinacididae, Calamophylliidae, and Cyathophorinae. Dominant groups at this time were nearly the same as those of the present day: Eusmiliinae, Dichocoeniinae, Mussidae, Pocilloporidae, Poritidae, Acroporidae, Agariciidae, Siderastreidae, Fungiidae, and Faviidae. Ahermatypic groups, especially the Caryophylliidae, Dendrophylliidae, Flabellidae, and Rhizangiidae, were developing rapidly.

In the Oligocene, fringing reefs were built in the southeastern United States, West Indies, Mexico, northern South America, northern Italy, and India, and in the latest Oligocene in the East Indies and Japan. In Europe, reef-coral banks occurred in Bavaria, southeastern France, and the Balkans. During the late Oligocene, the European elements of the West Indian fauna began to die out, leaving Miocene faunas composed of essentially the same genera as those of today.

In Miocene time the final severance of connection between the Mediterranean and Indian Ocean areas eliminated the eastward route by which reef corals had migrated from the central Tethys to the East Indies, and from this epoch originate the 2 great modern reef-coral provinces, the Caribbean and Indo-Pacific.

During the later Tertiary, the Indo-Pacific coral faunas, already richer than those of the Caribbean, expanded greatly. Especially significant is the enormous development of the Pocilloporidae, Poritidae, and Acroporidae, which had been relatively unimportant in the early Tertiary, but now accounting for more than two-thirds of the present reef fauna.

The relic hermatypic fauna of the European Miocene consisted of a few genera related to both Indo-Pacific and Caribbean faunas, but few reefs were built and adverse conditions soon wiped out reef corals, leaving only a European Pliocene fauna of ahermatypic genera which is similar to that of the Mediterranean of the present day.

The contraction of the tropical zone in Pliocene time shifted the northern limit of reef coral growth southward to a maximum of 35°N., the southern boundary remaining nearly the same, and with little change of faunal composition.

Development of ahermatypic corals (Fig. 258) in the later Tertiary shows no sharp differentiation into faunal provinces. Because of their adaptability to extremes of temperature and depth, in strong contrast to reef corals, many genera and even species are cosmopolitan in distribution. Of the 11 families and subfamilies which include ahermatypic forms, all had appeared by the

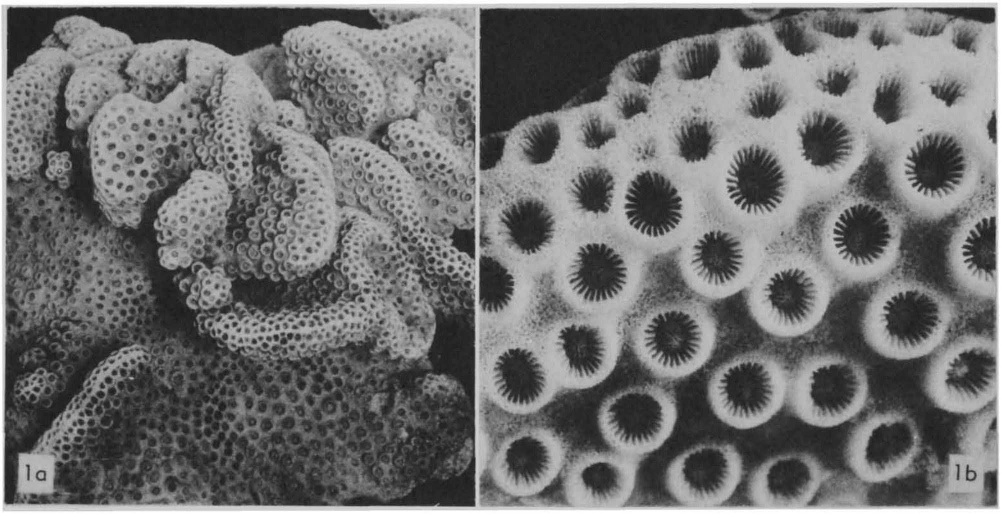


FIG. 256. *Turbinaria,* a typical hermatypic scleractinian coral. *1, T. peltata,* Formosa; *1a,* part of corallum, ×0.3; *1b,* calices, ×3 (YABE & SUGIYAMA).

Eocene. None is peculiar to any single environment, although the Rhizangiidae as a whole prefer rocky bottoms in the littoral and shallow neritic zones, whereas the Turbinoliinae, Anthemiphylliinae, and Micrabaciidae, which include only free-living solitary types, occur on sandy or silty bottoms at depths below wave base. Several families, such as the Micrabaciidae and Flabellidae, which were cosmopolitan in the early Tertiary, are now mostly confined to the Indo-Pacific-Antarctic region, whereas the Parasmiliinae are more abundant in the North Atlantic and West Indies. Several genera, such as *Conocyathus* and *Platytrochus,* which originated in the Tethyan or West Indian areas, now survive in the Australian area.

PLEISTOCENE AND RECENT

Pleistocene conditions had little noticeable effect on hermatypic corals, except possibly for a slight reduction in their numbers, and the faunal effect was an accentuation of porous types, such as the Poritidae and Acroporidae. Known Pleistocene coral faunas show almost no difference between those of the Pliocene and the present day.

In general, Recent hermatypic corals are found in the shallow waters of oceans and seas in the subtropical and tropical zones within an earth-encircling band from about 35°N. to 32°S. These are the extreme limits of reef-coral growth but reefs are only well developed within somewhat narrower limits, around oceanic islands away from influxes of quantities of terrigenous sediments, and in places along the eastern sides of continental masses.

Two large provincial areas of hermatypic corals are recognizable within the tropical zone: (1) *Caribbean* and (2) *Indo-Pacific.* The Caribbean province lies within the area bounded by the southeastern coast of the United States, eastern coast of Mexico and Central America, and northern coast of South America eastward to the Windward Islands, between latitudes 27°30′N. and 11° 30′N. In this area, however, corals do not occur everywhere, even where the water is sufficiently shallow. They are not found along the margin of the Gulf of Mexico from north of Cape Roxo around to Tampa, Fla., and are very sparse from the latter place southward to Cape Sable. Along the South American coast they are found only around a few islands off Colombia and Venezuela. They are most abundant in the West Indies away from large land masses, and in the Bahamas and Florida Keys, where fringing reefs are fairly well developed.

The Caribbean reef fauna consists of about 20 genera and 36 species of the Acroporidae, Faviidae, Mussidae, Poritidae, Eusmiliidae, Meandrininae, Dichocoeniinae,

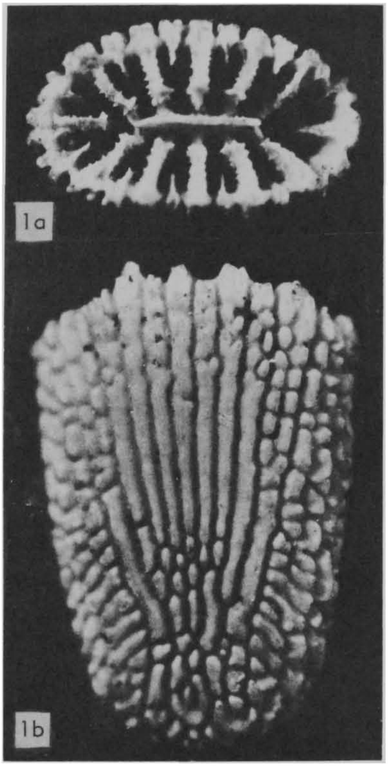


FIG. 258. *1, Sphenotrochus auritus* POURTALÈS, Plio., Venez.; *1a,b,* ×13 (WELLS).

Siderastreidae, Agariciidae, and Astrocoeniidae. Distinctive is the absence of any Pocilloporidae (except *Madracis*), and Fungiidae and the genera *Montipora, Astreopora, Goniopora, Alveopora, Hydnophora,* and *Pavona,* although all are known in the Caribbean middle Tertiary.

Outposts of the Caribbean fauna occur on the Bermuda reefs (32°N.), off the Brazilian coast between Alcantara (2°S.) and Rio de Janeiro (23°S.), and in the Gulf of Guinea, West Africa.

The Indo-Pacific province includes the Red Sea, Gulf of Aden, Persian Gulf, Gulf of Oman, Indian Ocean south to 26°S., the Australasian region, China Sea, Tropical Pacific, Bay of Panama, and the lower part of the Gulf of California. Nowhere in this vast area are any strongly marked faunal differences found, with exception of the Panamanian region which is depauperate rather than different. Coral growth in general is far more luxuriant and vigorous than that of the Caribbean, and in favorable places the annual growth rate is several times that of Caribbean species. The total number of species within the entire area is not less than 500, representing about 80 genera and subgenera, and the number of species living on a single reef tract ranges from 50 to as many as 200. As a whole, contrasting with the Caribbean, the fauna is notable for the protean development of the Acroporidae, of which the genera *Acropora, Astreopora,* and *Montipora* have at least 250 species, compared with 3 only of *Acropora* in the Caribbean; the Poritidae, with about 50 species of *Porites, Goniopora,* and *Alveopora,* compared with 3 only of Caribbean *Porites;* and the Seriatoporidae, with some 25 species of *Pocillopora, Stylophora,* and *Seriatopora,* all unrepresented in the Caribbean. A few genera have only local distribution and subprovincial areas can be broadly outlined.

The Indo-Pacific hermatypic coral fauna shows more differentiation bathymetrically than geographically. This variation as yet is only partially studied in a few localities, but 2 broad ecologic associations are evident: (1) surface reefs to a depth of 15 to 20 m., limited downward by normal wave base, and (2) quiet waters of lagoons and seaward slopes of reefs below wave base to the extreme lower limit of hermatypic coral growth, about 90 m. A number of forms are confined to the second association, but they are very widely distributed; examples are *Anacropora, Leptoseris, Cycloseris, Madracis,* and delicately branching and thinly foliaceous species of common surface-reef genera.

The ahermatypic corals are not readily separable into distinct faunal provinces, partly because of their commonly wide, seemingly erratic distribution, and partly because of lack of adequate information concerning certain areas. In general, their distribution varies with depth: the deeper the normal habitat of a species the greater is its geographic range, and forms occurring below about 500 m. are mostly cosmopolitan. Most species occur within definite bathymetric zones; also, more species occur in tropical than in temperate or cold seas. Corals inhabiting the littoral and shallower parts of the neritic zones along the coasts of great land masses generally are sparse both in variety and individuals, and in the tropics

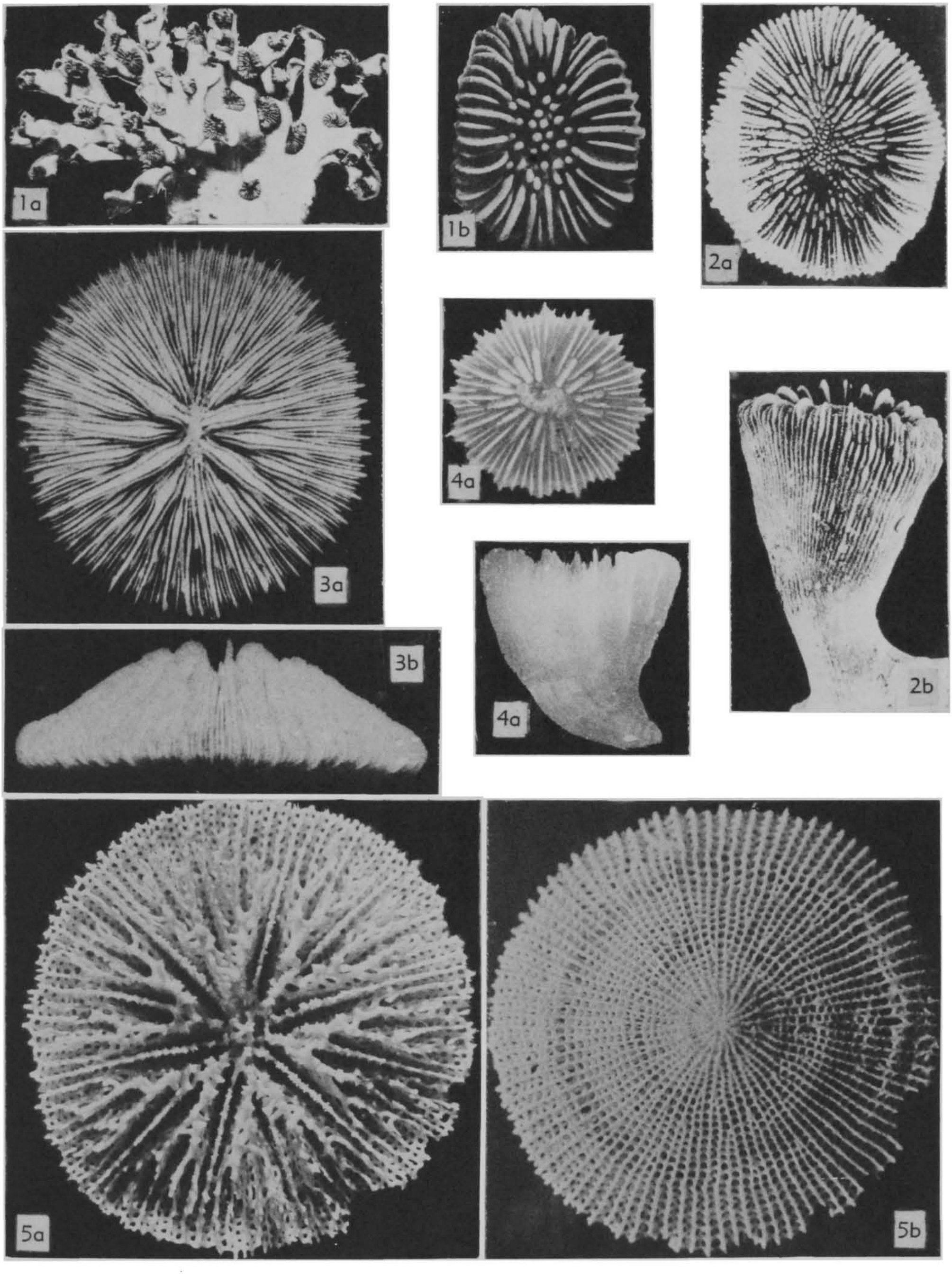


FIG. 257. Recent ahermatypic scleractinian corals. *1, Cyathelia axillaris,* Amboina; *1a,* corallum, ×0.5; *1b,* calice, ×3.5 (BEDOT). *2, Paracyathus stearnsi,* off Calif., depth 110 m.; *2a,b,* ×2 (DURHAM & BARNARD). *3, Cycloseris vaughani,* Hawaii; *3a,b,* ×1, ×1.2 (BOSCHMA). *4, Caryophyllia clavus,* off Azores, depth 1,900 m.; *4a,b,* ×1 (GRAVIER). *5, Stephanophyllia formosissima,* Kii I., E.Indies; *5a,b,* ×1 (WELLS).

away from large land masses these zones are even more thinly populated by ahermatypic corals.

The greatest development of ahermatypic corals occurs near and down the edges of the continental shelves and the equivalent bathymetric zone around oceanic islands in depths from 175 to about 800 m., below the light floor of the ocean, in temperatures of 4° to 21°C. The family and subfamily groups consisting wholly of or including these corals are shown in the following tabulation.

Bathymetric Distribution of Ahermatypic Corals

- Littoral-neritic
  - Rhizangiidae
- Littoral-bathyal
  - Oculinidae
  - Dendrophylliidae
- Littoral-abyssal
  - Caryophylliinae
  - Desmophyllinae
  - Flabellidae
- Neritic-bathyal
  - Anthemiphylliidae
  - Parasmiliinae
  - Guyniidae
- Neritic-abyssal
  - Fungiidae
  - Micrabaciidae
  - Turbinoliinae

EVOLUTION

GENERAL DISCUSSION

The major source of information on the evolution of scleractinian corals, in the absence of information on the polyps of extinct forms, is the structure of the septa (Fig. 237). The latter are the most important skeletal structures and differ from suborder to suborder, family to family, in progressive and orderly fashion. Wall structures are of some value, but since the same type of wall may appear in analogous genera of widely separated families, or 2 different types may appear in the same corallum or even in the same corallite, they are of secondary significance (Fig. 259). Structures independent of the septa, such as dissepiments, epitheca, and basal plate, are of little value. Evolution within small, compact groups, such as the Rhipidogyridae, is best shown by morphogenetic trends (Fig. 260).

A large question in the evolution of anthozoan corals is the relation of scleractinians to rugosans: whether the scleractinians were filiated from the rugosans or whether they were independently derived from skeletonless anemone stocks—the scleractinians from the same stock that led to the living corallimorphs and actiniarians and the rugosans from earlier stocks leading to the zoanthids. Chronologically and to some extent ecologically, the scleractinians succeeded the rugose corals and many have wished to view them as redivived rugosans (Fig. 261). If this were so, it would seem that the ancestral stock should be found among the Late Paleozoic rugose corals, perhaps in the Permian calophyllids (plerophyllids), the specialized end-forms of a long-lived line of conservative solitary forms. To derive the Scleractinia from these it would have to be assumed that there was (1) a change in septal structure from laminar to subfenestrate, (2) a change in the pattern of mesenterial and septal insertion, and (3) a possible change in skeletal substance from calcite to aragonite. Further, this involves acceptance of a monophyletic derivation by sudden mutation on the ordinal level (typostrophism) affecting some early ontogenetic stage (proterogenesis) of the Late Permian ancestor. The Scleractinia, however, like the Rugosa, are seemingly not a monophyletic group. At the earliest recorded appearance of both orders, each already included widely divergent groups at the subordinal level, such as the columnariids in the Rugosa and the astrocoeniids in the Scleractinia. Supposed survival of aspects of the rugosan mode of septal insertion in scleractinians, indicative of transitional characters, seems more apparent than real. In the absence of any known corals in latest Permian and Early Triassic or other evidence clearly linking the known early scleractinians with Paleozoic forms, no definite conclusion as to origin is now warranted. At present it seems most probable that the Rugosa and Scleractinia were developed at different times from different lines or stocks of the ancient anemones.

ASTROCOENIINA

The isolated suborder Astrocoeniina, of exclusively colonial habit, is first known from the Middle Triassic, where it is represented by the Pinacophyllinae. This little group, with spinelike septal trabeculae, was either an early offshoot from the astrocoeniid line, or represented the primitive type of the suborder, but a considerable previous history

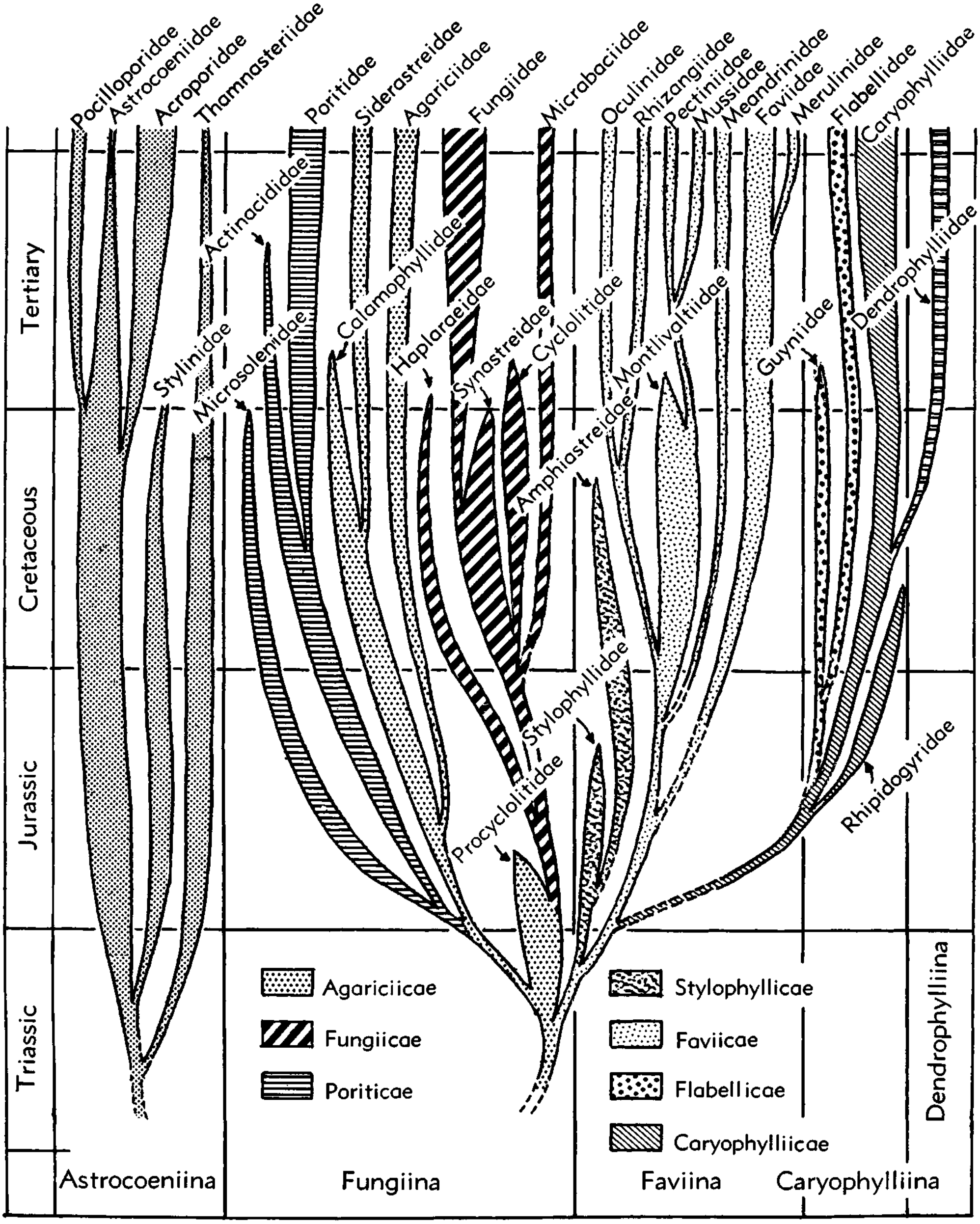


Fig. 259. Evolutionary pattern of the scleractinian suborders and families (198 mod.). [The author chooses to recognize superfamily *Faviicae* in preference to *Oculinicae,* which has priority, despite Copenhagen Decisions (1953).—Ed.]

must be inferred, for no solitary astrocoeniids are yet known. The Astrocoeniinae, with more compact septa and closely united corallites, appeared in the Late Triassic, and within a relatively short time were worldwide in distribution. No marked change is apparent until the late Middle Cretaceous when the development of a more or less solid coenosteum between the corallites, the result of expansion of coenosarc, led to the Pocilloporidae. The Acroporidae came in the Late Cretaceous and were the result of

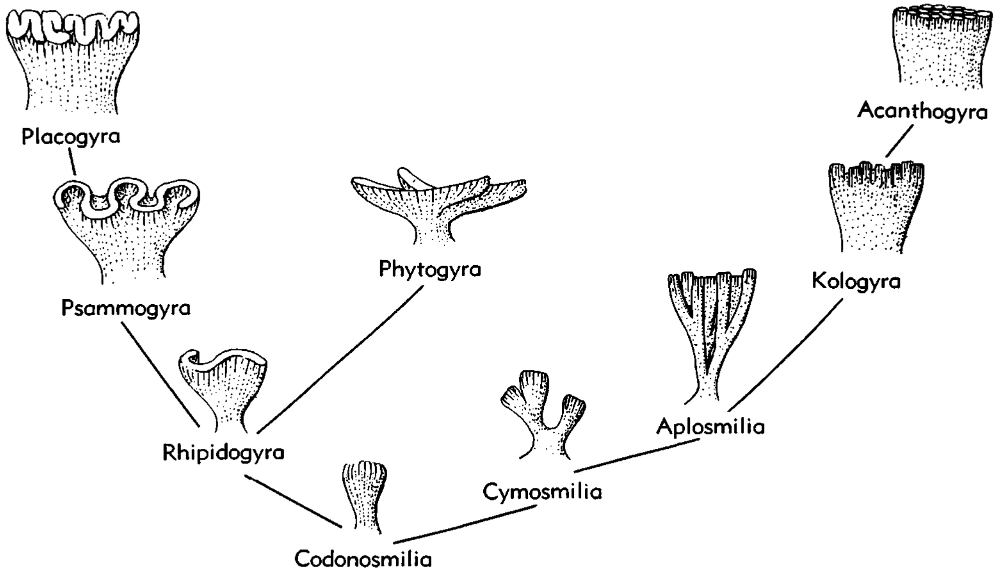


Fig. 260. Evolution in the Rhipidogyridae, a middle Mesozoic family (198mod.).

great compaction of the first-cycle septal trabeculae to form thin, laminar, smooth-margined but commonly reduced septa, accompanied by development of porous, canaliculate coenosteum. This group, on the basis of their light, very rapidly growing skeleton, and enormous numbers of small polyps forming huge colonies, is perhaps the most successful of all scleractinians.

The main astrocoeniid line weakened in the Tertiary, and there are now only 3 or 4 living species of *Astrocoenia,* its recent derivative *Stylocoeniella,* and *Stephanocoenia.*

The Thamnasteriidae, which very early were derived from astrocoeniids by development of the intratentacular mode of colony formation and septa supported by synapticulae, appeared in the Middle Triassic and persisted with little modification or diversification until the close of the Cretaceous. Late in the Cretaceous, however, canalicular modification of the extratentacular extensions of the mesenteries, similar to that which took place in the poritids, gave rise to *Ahrdorffia* and a few Tertiary and living forms such as *Psammocora,* without achieving any great success.

The Stylinidae, a distinct family of uncertain relations, were colonial corals with small corallites and relatively few, smooth-margined septa, suggesting an astrocoeniid connection. The structure of the earliest and most primitive of the Cyathophorinae, *Cassianastraea* of the Middle Triassic, further strengthens such a supposition. The Stylininae appeared in the Late Triassic, the Euheliinae in the Middle Jurassic, and the whole group was practically extinct and without issue by the end of the Mesozoic.

FUNGIINA

The suborder Fungiina consists of 3 superfamily groupings, Agariciicae, Fungiicae, and Poriticae, derived from the Procyclolitidae, an early Mesozoic central agariciid family. One of the earliest members of this family, *Triadophyllum* of the Middle Triassic, is a prototypic form with rather simply constructed septa in which each trabecula consists of a single vertical series of sclerodermites scarcely diverging from the vertical plane and closely placed side by side to form a continuous laminar sheet. Progressively, however, in later members of the family, the trabeculae were less closely united laterally in the septal plane and the sclerodermites were inclined more and more away from the plane, appearing on the face as granulations or ridges, so as to make fenestrate septa. The earlier stages of Late Triassic genera, such as *Margarophyl-*

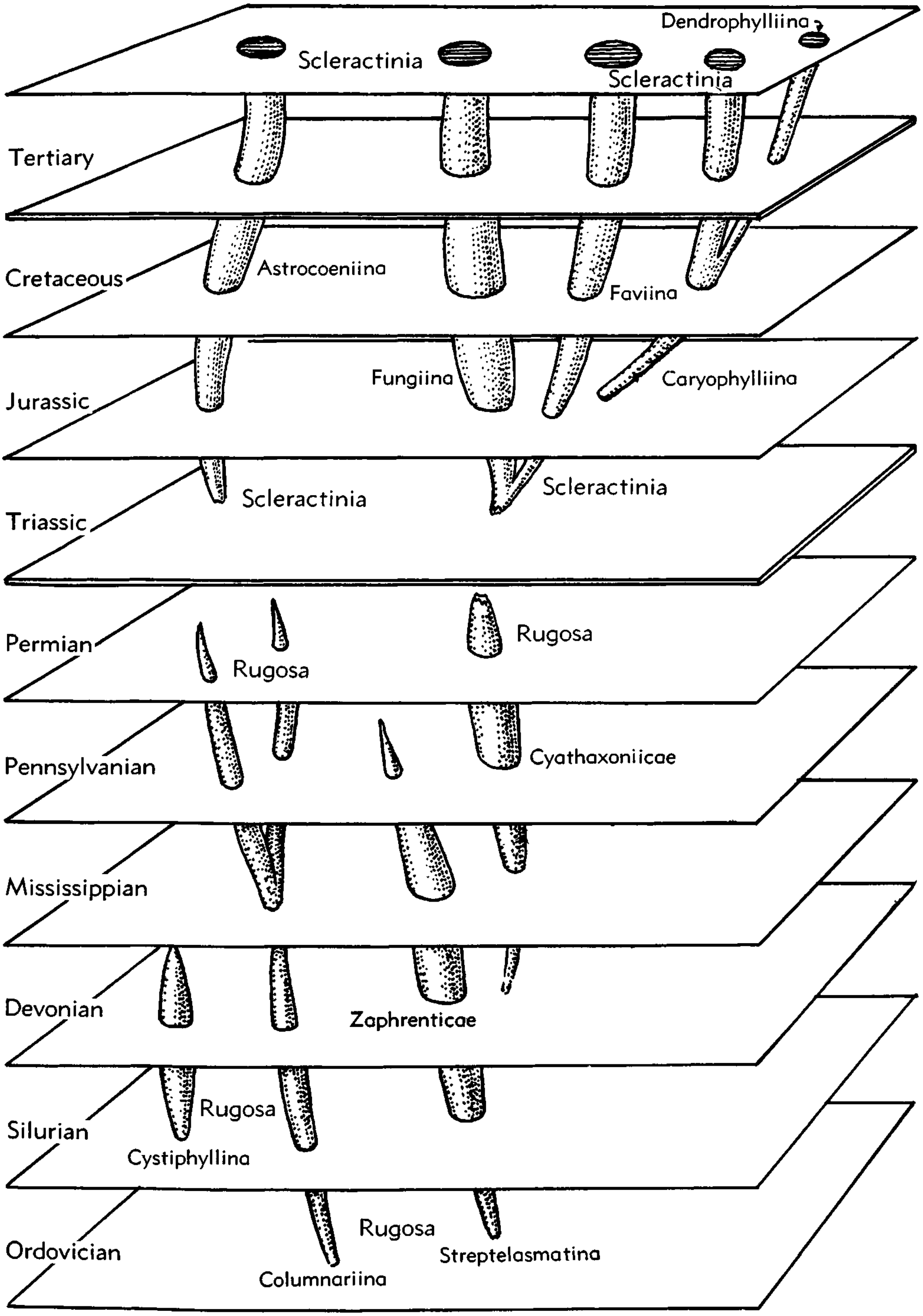


Fig. 261. Chronologic distribution of major groups of scleractinian and rugose corals (198mod.).

lia and Conophyllia, have the laminar *Triadophyllum*-type of septum and more fenestrate septa in later stages.

Early in the Jurassic, the procyclolitids diverged along 2 lines. In one, the septa were composed of mostly simple trabeculae, tending to become increasingly fenestrate and perforate. In the earliest family (Calamophylliidae) of this line, the septa have only scattered perforations. The Agariciidae, first known in the Middle Cretaceous *(Trochoseris)*, originated from calamophylliids with very compact septa, resulting from such close growth of the trabeculae that they were staggered in the septal plane. From the Early Jurassic calamophylliids developed the Microsolenidae with highly perforate, confluent septa. In the Middle Jurassic, mesenterial continuations beyond the tentacular ring began to break down *(Actinaraea)* into canaliculate gastro-vascular prolongations, resulting in the disappearance of definite septocostae outside the calice (Actinacididae). From the actinacidids in Late Cretaceous time came the modern, highly successful Poritidae, in which the extracalicular coenosteum diminished as the corallites became smaller and more numerous, and the number of septal trabeculae and septa diminished. Late Jurassic offshoots from the calamophylliids were the Siderastreidae, in which extratentacular mesenteries nearly disappeared as common synapticular walls developed between corallites, and compound trabeculae developed, coarsening the septa.

From the other procyclolitid line arose the Fungiicae of probable *Thecoseris* ancestry, in which the number of vertical series of sclerodermites in each trabecula increased from 1 or 2 to 4, 8, or even more, resulting in compound trabeculae whose emergent edges appeared as spinose or granulose teeth instead of the small, nearly smooth, bead-like teeth of the Agariciidae and Poriticae. The earliest in this line of development were the Synastreidae of the Middle Jurassic-Cretaceous, with nearly imperforate septa. Early offshoots in the Middle Jurassic were the Haplaraeidae with large, irregularly spaced septal perforations. A later one comprised the Cyclolitidae, Cretaceous-Early Tertiary ecologic predecessors of the Fungiidae, with regular septal perforations and broad flat-based coralla adapted for lying loose on soft or shifting substrates.

In the Middle Cretaceous, the axis of trabecular divergence, which had remained essentially vertical in the cyclolitids, became inclined towards the horizontal in some synastreids, resulting in coralla shaped like those of the cyclolitids but lacking epitheca. The septal structure in earlier forms was more or less perforate (as it still is in early developmental stages of modern fungiids) but later it became more compact. These were the earliest Fungiidae *(Cycloseris)*. Reduction of the solid septotheca to a more or less perforate synapticulotheca gave direct connection between oral and aboral surfaces, allowing development early in the Tertiary of large coralla characteristic of *Fungia* and its derivatives. Living fungiids pass through a very brief procyclolitid stage with epithecal wall, followed by a trochoid acrosmiliid stage and a short cycloserid stage during the anthocaulus and anthocyathus periods of ontogeny.

FAVIINA

The suborder Faviina had its origin in Triassic procyclolitids from which there are 2 possible lines of development: (1) through the Stylophyllidae to the Montlivaltiidae, or (2) directly through the Montlivaltiidae from which the stylophyllids may have been early derivatives. The Stylophyllidae first appeared in the Middle Triassic and were marked by septa having compound trabeculae different from those of the fungiids, by retention of the simple epithecal type of wall, and by more or less nonexsert septa with trabeculae either completely united vertically or discontinuous and appearing as more or less free spines, but never uniting as a fenestrate sheet. Later forms showed a trend towards the laminar septum. Abundant and widely distributed in the Late Triassic and Liassic, they declined and disappeared by Middle Jurassic time. The family Amphiastreidae, with septa similar to those of advanced stylophyllids and a tendency towards the aphroid condition in the corallites, are provisionally associated here. Many genera showed a greater development of one or more adjoining (dorsal?) septa, leading to the development of a lamellar columella in some later forms. The group as a whole was not a success—edge zone was never developed—and after attaining wide distribution in Late Jurassic and Early Cretaceous time, disappeared before the end of the Cretaceous.

The earliest montlivaltiids, of Late Triassic age, are not easily distinguished from procyclolitids with compact septa, but they soon developed an edge zone leading to septothecal or parathecal walls. The characteristic laminar septa of the faviids, with sharp, conical dentations, resulted from closely spaced trabeculae with sclerodermites laterally diverging only slightly from the septal plane. By Mid-Jurassic, the Montlivaltiidae were highly developed.

Some of the earliest derivatives of the montlivaltiids, the Faviidae, appearing in the Late Jurassic and increasing steadily to the present day, owe much of their success to broadening of the edge zone with consequent reduction of epitheca, and thorough exploitation of various modes of colony formation. The earlier forms were intratentacular in mode of colony formation (Faviinae), but early in the Cretaceous the extratentacular mode became dominant in the Montastreinae, which are artificially separated from the Faviinae solely on this distinction. The Faviidae will eventually be more properly reorganized on the basis of subfamilial lineages. Late in the Tertiary, the Merulinidae appeared, characterized by small compound trabeculae produced by very irregular divergence of the sclerodermites. The Trachyphylliinae and Agathiphylliinae are minor offshoots from the Faviidae.

The Mussidae, first definitely known early in Tertiary time, show the culmination of septal development in the main montlivaltiid line, with large polyps, and septa formed by a number of fan systems of trabeculae, each system forming a large dentation. An early Tertiary group was the Pectiniidae, with irregular, ragged, reduced dentations.

The Rhizangiidae are first known in the Early Cretaceous and are now widely distributed in the littoral and neritic zones. The earliest form, *Arctangia,* like the progenitors of other faviid groups, was small and solitary, with irregular septal dentations resulting from irregular divergence of sclerodermites, probably developed from some early montlivaltiid. In many later rhizangiid genera the entosepta are nearly smooth-margined, but the exosepta retain the more primitive, coarse teeth.

The Anthemiphylliidae as yet have no paleontological history, but the septal structure suggests a rhizangiid ancestry.

The Meandrinidae, which are distinguished by the minutely dentate septal margins, were seemingly derived from montlivaltiids late in the Jurassic. The group includes 2 short, but well-defined lineages of hermatypic corals with lamellar columella dating from the Cretaceous. The *Pachygyra* lineage lasted only into the Eocene; the *Meandrina* lineage still survives. The Dichocoeniinae are a very small group dating from the Late Cretaceous, distinguished by development of a heavy coenosteum.

CARYOPHYLLIINA

The earliest Caryophylliina, the most successful of all scleractinian groups in adaptation to extremes of environment and prolific in generic differentiation, are 2 genera which constitute the Thecocyathinae. *Thecocyathus,* of the Early Jurassic, had an epithecal wall. By the Middle Jurassic, *Discocyathus* had developed an edge zone and the beginnings of a septotheca. The first Caryophylliinae came in the Middle Jurassic, living in a neritic, nonreef environment. By the commencement of the Tertiary, some genera had become adjusted to the littoral zone, and on the other hand, penetration of the deep waters of the bathyal zone had begun.

The Turbinoliinae, first known in the Late Cretaceous, are a curious group of handsome little corals especially adapted to substrates affording few or very small sites for larval fixation. Except in the very earliest ontogenetic stages, these exclusively solitary corals are unattached, the edge zone completely covering the exterior of the corallum which lies loose on the bottom or partly imbedded in it.

Earlier in the Cretaceous appeared the small group of the Desmophyllinae, caryophyllians in which septal substitution was scarcely developed, with little or no development of columella and pali. The Parasmiliinae came later in the Jurassic from caryophyllians in which the relatively great vertical extent of the corallum provoked the development of dissepiments. The hermatypic Eusmiliinae are parasmilian derivatives.

Septal substitution had diminished in an even earlier offset from the caryophyllians during the Middle Jurassic, the Rhipidogyridae, a compact lineage extinct by the Early Cretaceous.

The ahermatypic Flabellidae, dating from the Cretaceous, contain a few neotenic forms which seem to have been derived from caryophyllians by arrested development of the edge zone, resulting in a wholly epithecal wall. The somewhat similar Guyniidae, first appearing in the Middle Jurassic, may represent a still earlier neotenic caryophyllian offshoot.

DENDROPHYLLIINA

The dendrophylliids were the last of the scleractinian suborders to evolve. About the middle of the Cretaceous, the sclerodermites of the septa of some caryophyllians became very irregular in development, diverging strongly sideward from the plane of the normally compact, laminar septum, especially in the vicinity of the wall with locally opening perforations. This brought about a thickening of the outer parts of the septa, and the septotheca gave way to an irregularly porous synapticulotheca. In this new group, the Dendrophylliidae, the substitution of entosepta for exosepta, a common occurrence in scleractinians, became very marked, and the Pourtalès plan of septal arrangement is characteristic of the suborder.

SUMMARY OF MAIN EVOLUTIONARY TRENDS

(1) *Increase or decrease in compactness of septa.* Increase in compactness of some procyclolitids led to the laminar septa of the Faviina and Caryophylliina. Irregular development of sclerodermites in the latter led in turn to the porous septa of the Dendrophylliina. Decrease in compactness in other procyclolitids led to the fenestrate septa of the Fungiina. A trend from simple to compound trabeculae can be observed in some family groups, and from many to few septa in others.

(2) *Suppression of primitive epithecal wall.* The development of an edge zone with septotheca, paratheca, or synapticulotheca, and coenosteal structures, accompanied by suppression of the primitive epithecal wall, is regularly observed in the Fungiina, Faviina, and Caryophylliina. Reduction of extramesenterial extensions to canalicular mazes, with modification of coenosteal structure, is found especially in some lines of the Astrocoeniina and Fungiina.

(3) *Development of colonial habit.* This is particularly notable in hermatypic corals, which display many modes of colony formation, many of which are significant by making possible large, efficient colonies.

Broadly speaking, the classification used here is based on the following features, in order of decreasing taxonomic importance:

(1) Structure of septa and ancillary structures such as wall, synapticulae, and costae; and nature of polyps: *suborders, superfamilies,* and some *families.*

(2) Primary mode of colony formation, and relative development and structure of extrathecal structures: *families.*

(3) Secondary modes of colony formation, involving shape of colonial coralla and lineages of trends, habit of colonial coralla, shape of solitary coralla, secondary septal structures such as pali and columella, relative development and form of dissepiments: some *families, subfamilies, genera,* and *subgenera.*

(4) Dimensions of corallites, number, arrangement and structural details of septa and costae, habit of colonial coralla and shape of solitary coralla, and features of the coenosteum: *species* and *subspecies, varieties, formae,* etc.

CLASSIFICATION

A tabular summary of suprageneric divisions recognized in the order Scleractinia, showing stratigraphic range of each as now known and including record of the number of genera and subgenera recognized in each taxonomic unit, follows. The presence of 10 genera in a family, for example, is indicated by "(10)" and occurrence of 6 genera and 2 subgenera in a family or other taxonomic division is shown as "(6; 2)."

Suprageneric Divisions of Scleractinia

Scleractinia *(order)* (450; 57). *M.Trias.-Rec.*
  Astrocoeniina *(suborder)* (46; 14). *M.Trias.-Rec.*

- Astrocoeniidae (13). *M.Trias.-Rec.*
  - Pinacophyllinae (2). *M.Trias.-U.Trias.*
  - Astrocoeniinae (11). *U.Trias.-Rec.*
- Thamnasteriidae (4; 5). *M.Trias.-Rec.*
- Pocilloporidae (4). *U.Cret.-Rec.*
- Acroporidae (6; 2) *U.Cret.-Rec.*
- Stylinidae (19; 7). *M.Trias.-Eoc.*
  - Cyathophorinae (6; 3). *M.Trias.-Eoc.*
  - Stylininae (8; 4). *U.Trias.-Cret.*
  - Euheliinae (5). *M.Jur.-L.Cret.*
- Fungiina *(suborder)* (108; 12). *M.Trias.-Rec.*
  - Agariciicae *(superfamily)* (51; 10). *M.Trias.-Rec.*
    - Procyclolitidae (10). *M.Trias.-M.Jur.*
    - Calamophylliidae (23). *M.Jur.-Cret.*
    - Agariciidae (12; 5). *M.Cret.-Rec.*
    - Siderastreidae (6; 5). *Cret.-Rec.*
  - Fungiicae *(superfamily)* (35). *M.Jur.-Rec.*
    - Synastreidae (7). *M.Jur.-Rec.*
    - Cyclolitidae (5). *Cret.-Eoc.*
    - Haplaraeidae (9). *U.Jur.-Eoc., ?Oligo.-?Mio.*
    - Fungiidae (11). *M.Cret.-Rec.*
    - Micrabaciidae (3). *Cret.-Rec.*
  - Poriticae *(superfamily)* (22; 2). *Jur.-Rec.*
    - Microsolenidae (14). *Jur.-Cret.*
    - Actinacididae (4). *U.Jur.-Oligo.*
    - Poritidae (4; 2). *M.Cret.-Rec.*
- Faviina *(suborder)* (178; 13). *M.Trias.-Rec.*
  - Stylophyllicae *(superfamily)* (28). *M.Trias.-Cret.*
    - Stylophyllidae (7). *M.Trias.-L.Jur.*
    - Amphiastreidae (21). *M.Jur.-Cret.*
  - Faviicae *(superfamily)* (150; 11). *M.Trias.-Rec.*
    - Montlivaltiidae (20). *M.Trias.-Eoc.*
      - Montlivaltiinae (15). *M.Trias.-Cret.*
      - Placosmiliinae (5). *U.Jur.-Eoc.*
    - Faviidae (58, 4). *M.Jur.-Rec.*
      - Faviinae (30; 2). *U.Jur.-Rec.*
      - Montastreinae (19, 2). *M.Jur.-Rec.*
      - Agathiphylliinae (4). *Eoc.-Mio.*
      - Trachyphylliinae (5). *Oligo.-Rec.*
    - Rhizangiidae (14; 3). *L.Cret.-Rec.*
    - Oculinidae (15; 2). *Cret.-Rec.*
      - Oculininae (11; 2). *Cret.-Rec.*
      - Galaxeinae (4). *Mio.-Rec.*
    - Meandrinidae (14; 2). *Cret.-Rec.*
      - Meandrininae (9). *Cret.-Rec.*
      - Dichocoeniinae (5; 2). *U.Cret.-Rec.*
    - Merulinidae (4). *Rec.*
    - Mussidae (17; 2). *?U.Jur., Eoc.-Rec.*
    - Pectiniidae (6). *Oligo.-Rec.*
    - Anthemiphylliidae (2). *Rec.*
- Caryophylliina *(suborder)* (93; 18). *Jur.-Rec.*
  - Caryophylliicae *(superfamily)* (79; 19). *Jur.-Rec.*
    - Caryophylliidae (73; 19). *Jur.-Rec.*
      - Thecocyathinae (2). *Jur.-M.Cret.*
      - Caryophylliinae (27; 12). *U.Jur.-Rec.*
      - Turbinoliinae (16; 6). *U.Cret.-Rec.*
      - Desmophyllinae (8). *Cret.-Rec.*
      - Parasmiliinae (14). *U.Jur.-Rec.*
      - Eusmiliinae (6). *Eoc.-Rec.*
    - Rhipidogyridae (9). *M.Jur.-L.Cret.*
  - Flabellicae *(superfamily)* (12). *M.Jur.-Rec.*
    - Flabellidae (6). *Cret.-Rec.*
    - Guyniidae (6). *M.Jur.-Eoc.*
- Dendrophylliina *(suborder)* (24; 2). *U.Cret.-Rec.*
  - Dendrophylliidae (24; 2). *U.Cret.-Rec.*

SYSTEMATIC DESCRIPTIONS

Order SCLERACTINIA Bourne, 1900

[Zoantharia aporosa et perforata M.Edw.-H., 1851; Madreporaria M.Edw.-H., 1857 *(partim)*; Hexacorallia Haeckel, 1866 *(partim)*; Hexacorallidae Delage & Hérouard, 1901; Cyclocorallia Schindewolf, 1942]

Solitary or colonial Zoantharia with calcareous external skeleton secreted by the ectodermal body layer, consisting essentially of radial partitions or septa, which are intermesenterial in position and formed within upward infoldings of basal part of polyp column wall, and attendant supporting structures: basal plate, epitheca, dissepiments, synapticulae, and mural structures. Septa developed in ontogeny following pattern of mesenteries: additional septa after first 6 being inserted in all 6 primary mesenterial exocoeles in successive cycles of 6, 12, 24, 48, and so on, in dorsoventral order. *M. Trias.-Rec.*

The classification followed here is a modification of that proposed by Vaughan & Wells (1943), and the 5 suborders are separable by characters stated in the following key.

Key for Recognition of Scleractinian Suborders

1. Septa composed of relatively few (up to 8) simple trabeculae; mostly colonial, with small corallites (diam. 1 to 3 mm.); polyps rarely with more than 2 cycles of tentacles, and lacking stomodaeal ridges .... ASTROCOENIINA
2. Septa composed of numerous trabeculae; solitary or colonial, with corallites generally larger in diameter than 2 mm.; polyps commonly with more than 2 cycles of tentacles, and stomodaea generally ridged.
   A. Synapticulae present
      i. Septa basically fenestrate, more or less perforate .... FUNGIINA

- ii. Septa basically laminar, irregularly perforate .... DENDROPHYLLIINA
- B. Synapticulae rarely present
  - i. Septal margins dentate .... FAVIINA
  - ii. Septal margins smooth .... CARYOPHYLLIINA

Suborder ASTROCOENIINA Vaughan & Wells, 1943

[*nom. transl.* WELLS, herein (*ex* Astrocoeniida VAUGHAN & WELLS, 1943)]

Colonial, rarely solitary: corallites small. Septa formed by relatively few (up to 6 or 8) simple or compound trabeculae, appearing as simple spines to solid laminae, inclined in series from wall rather than in divergent fan systems, dentate to practically smooth marginally; sclerodermites regularly continuous or irregularly divergent along trabecular axes. Polyps small, with smooth stomodaea, rarely with more than 12 tentacles arranged in a single ring. *M.Trias.-Rec.*

Family ASTROCOENIIDAE Koby, 1890

Colonial; hermatypic; phaceloid to cerioid by extratentacular budding. Corallite walls septothecal (except *Pinacophyllum*). Septa exsert (except *Pinacophyllum*), composed of one series of simple trabecular spines projecting inward and upward from the wall, those of lower cycles fusing in the septal plane to form nearly smooth- or beaded-margined laminae. Columella absent or styliform and continuous. Endothecal dissepiments tabular; exothecal dissepiments tabular when developed. *M.Trias.-Rec.*

Subfamily PINACOPHYLLINAE Vaughan & Wells, 1943

Primitive astrocoeniids with septa formed by distinct trabecular spines; columella absent. *M.Trias.-U.Trias.*

Pinacophyllum FRECH, 1890 [**Amplexus? parallelus* FRECH, 1889; SD DIENER, 1921]. Small phaceloid colonies. Corallites with wall of epitheca internally thickened by stereome. Septa not exsert. *U.Trias.*, Eu.——FIG. 262,2. **P. parallelum* FRECH, U.Trias. (Nor.), Aus.; *2a,b*, ×1, ×2 (50);*2c*, ×10, long. sec. (151).

Koilocoenia DUNCAN, 1884 [**Phyllocoenia decipiens* LAUBE, 1865] [=*Coelocoenia (nom. van.), ?Cyathocoenia* VOLZ, 1896 (*non* DUNCAN, 1867)]. Small, plocoid to cerioid colonies. Corallite walls septothecal, costae nonconfluent. Septa exsert. *M. Trias.-U.Trias.*, Eu.——FIG. 262,4. **K. decipiens* (LAUBE), U.Trias., Aus.; *4a*, ×2 (155); *4b*, transv. sec., ×5 (155); *4c*, long. sec., ×7 (151).

Subfamily ASTROCOENIINAE Koby, 1890

[*nom. transl.* FELIX, 1898 (*ex* Astrocoeniidae KOBY, 1890)]

Astrocoeniids with septa of lower cycles laminar. Columella generally present, continuous. *U.Trias.-Rec.*

Actinastrea ORB., 1849 [**Actinastrea goldfussi* (=*Astrea geminata* GOLDFUSS, 1826 *(partim)*)] [=*Aplosastrea (partim), Enallocoenia* ORB., 1849; *Cyathocoenia* DUNCAN, 1867 (*non* VOLZ, 1896); *Stelidioseris* TOMES, 1893; *?Toechastraea* VOLZ, 1896; *Praestephanocoenia* OPPENHEIM, 1930; *Platastrocoenia* GREGORY, 1930; *Araiocoenia* ALLOITEAU, 1948; *?Septastraeopsis* ALLOITEAU, 1954; *Astrocoenia auctt.* (*non.* M.EDW.-H., 1848). Cerioid; ramose, massive, or incrusting; by extratentacular budding. Columella generally well developed, styliform. *U.Trias.-Rec.*, cosmop.——FIG. 262,*6a,b*. *A. ramosa* (M.EDW.-H.), U.Cret.(Turon.), Gosau, Aus.; long. transv. secs., ×25 (42).——FIG. 262, *6c*. *A. matheyi* (KOBY), U.Jur.(Sequan.), Switz.; lateral aspect of septum, ×2 (71).——FIG. 262,*6d*. *A. guadalupae* (ROEMER), L.Cret.(Alb.), Tex.; ×5 (157).

Stylocoeniella YABE & SUGIYAMA, 1935 [**Stylocoenia hanzawai* YABE-S., 1933 (=*Stylophora armata* EHR., 1834)]. Like *Actinastrea* but with striate, columniform projections arising at junctions of adjacent calices. *Eoc.-Rec.*, USA-W.Indies-IndoPac.——FIG. 262,*7a,b*. **S. armata* (EHR.), Rec., Bikini, Marshall I.; *7a*, ×2; *7b*, ×5 (163).

Platycoenia VAUGHAN, 1900 [**P. jacksonensis*]. Like *Actinastrea* but plocoid with echinulate coenosteum. *Eoc.-Mio.*, USA-Eu.

Isastrocoenia GREGORY, 1900 [**I. kachensis*]. Like *Actinastrea* but subplocoid with some intratentacular budding. Columella absent or very weak. *M. Jur.*, India-E.Afr.——FIG. 262,*3*. **I. kachensis*, M.Jur.(Bath.), Cutch; transv. sec., ×6 (65).

Columactinastraea ALLOITEAU, 1952 [**C. rennensis*] [=*Stephanastraea* FROMENTEL, 1886 (*non* ÉTALLON, 1862)]. Like *Actinastrea* but with pali before first 2 septal cycles in one crown. *Cret.*, Eu.

?Stephanastrea ÉTALLON, 1862 [**S. ramulifera*]. Like *Columactinastraea* but with pali in 2 crowns. *U.Jur.-Cret.*, Eu.

Stylocoenia M.EDW.-H., 1849 [**Astrea emarciata* LAMARCK, 1816] [=*Aplosastrea (partim), Triphyllocoenia* ORB., 1849]. Like *Stylocoeniella* but much lighter corallum and thin laminar septa with acute dentations. *Eoc.-Mio.*, Eu.-W.Indies.——FIG. 262,*8*. **S. emarciata* (LAM.), M.Eoc. (Lut.), Paris Basin, Fr.; *8a*, ×1; *8b*, ×5 (95).

Astrocoenia M.EDW.-H., 1848 [**Astrea numisma* DEFRANCE, 1826] [=*Goniocoenia* ORB., 1849]. Like *Stylocoenia* but lacking intercorallite pillars or styliform columella. *Eoc.-Mio.*, Eu.

Lithostrotionoides ALLOITEAU, 1952 [**L. tessieri*] Like *Astrocoenia* but walls very thin and zigzag in cross section; columella sublamellar. *U.Cret. (Maastr.)*, Senegal.

Stephanocoenia M.Edw.-H., 1848 [**Astrea intersepta* Lamarck, 1816 (*non Madrepora intersepta* Esper, 1719) (=**S. michelini* M.Edw.-H., 1848] [*Antillastraea* Duncan, 1884]. Plocoid to subcerioid, massive. Costae short. Septa with minutely dentate margins, one crown of 12 pali before first 2 septal cycles. Columella styliform. *Cret.-Rec.*, Eu.-USA-W.Indies.——Fig. 262,*1*. **S. michelini* M.Edw.-H., Rec., W.Indies, ×5 (95).

Columastrea Orb., 1849 [**Astrea striata* Goldf., 1827] [=*Columellastrea* Orb., 1850; *Columnastrea* M.Edw.-H., 1851, *?Psammocoenia* M.Edw.-H., 1857; *Haldonia* Duncan, 1879; *?Stylinopsis* Chevalier, 1954]. Like *Stephanocoenia*, but with one crown of 6 pali before second cycle. *U.Jur.-U.Cret.*, Eu.-USA.——Fig. 262,*5*. *C. striata* (M.Edw.-H.), U.Cret.(Turon.), Gosau, Aus.; transv. sec., ×12 (42).

Family THAMNASTERIIDAE Vaughan & Wells, 1943

Colonial, hermatypic; massive, ramose, or incrusting, growth by intratentacular mono- to tristomodaeal budding. Corallite walls absent or weakly defined by synapticular rings.

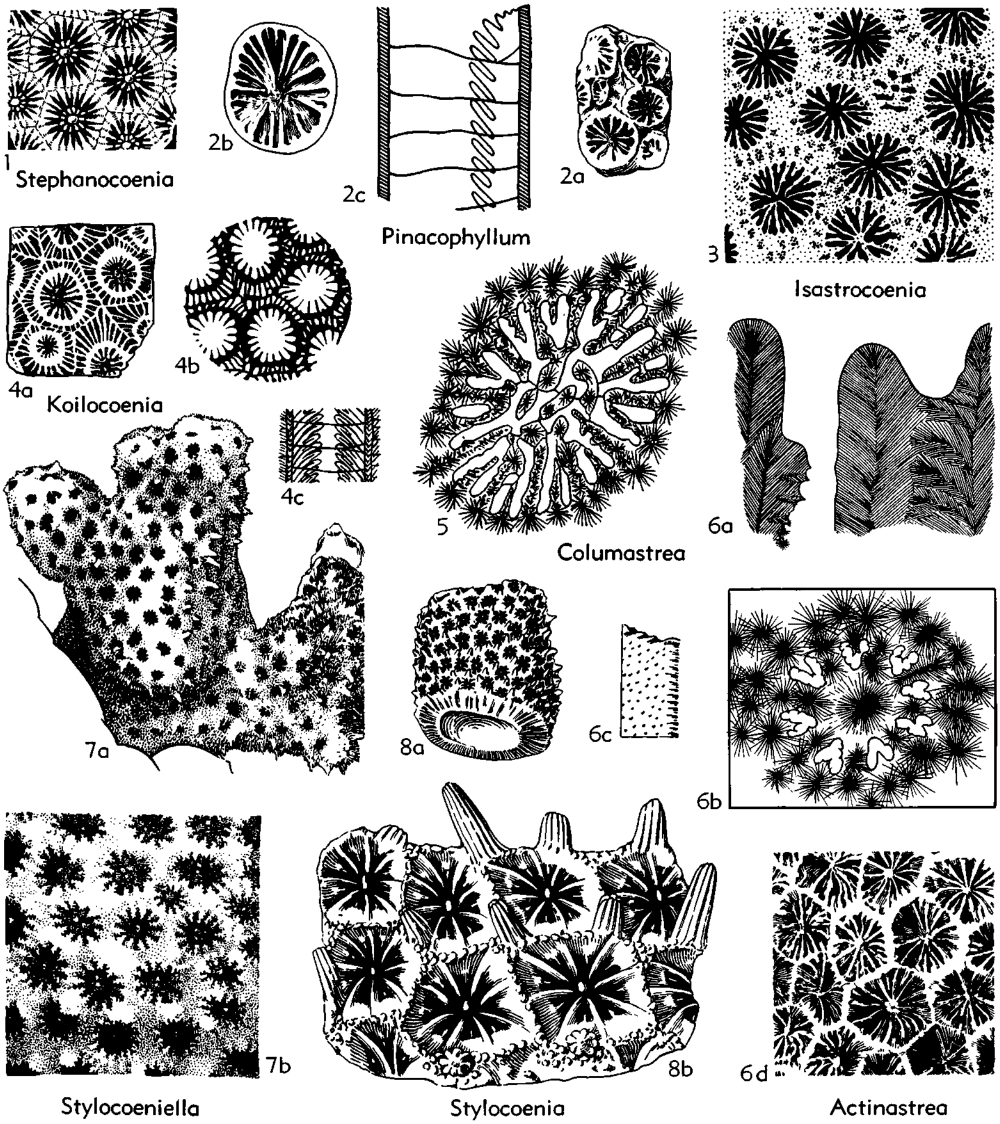


Fig. 262. Astrocoeniina: Astrocoeniidae (p. F370-F371).

Septa confluent between centers, similar in structure to those of the astrocoeniids, mostly of simple trabeculae with sclerodermites diverging laterally and producing granulations or continuous ridges, more or less porous, with beaded margins. Columella styliform or absent. Dissepiments tabular. *M.Trias.-Rec.*

Thamnasteria Lesauvage, 1823 [**T. lamourouxi* (=*Astrea dendroidea* Lamarck, 1821)] [=*Thamnastraea* Lesauvage, 1832; *Centrastrea, Dactylastrea, Dactylocoenia, Dendrastrea* Orb., 1849; *Morphastrea* Orb., 1850; *Holocoenia* M.Edw.-H., 1861; ?*Thamnoseris* Fromentel, 1861; *Stylomaeandra* From., 1873; *Mesomorpha* Pratz, 1883; *Astraeofungia* Alloiteau, 1952]. Massive, ramose, or incrusting colonies. Corallite centers closely united by confluent, short, septocostae. Columella styliform. Septa with rows of granulations or discontinuous ridges parallel to margins. *M.Trias.-M.Cret.,* Eu.-Asia-Afr.-N.Am.-S.Am.

T. (Thamnasteria). *M.Trias.-M.Cret.,* cosmop.——Fig. 263,*1*. *T. (T.) rectilamellosa* (Winkler), U.Trias.(Nor.), Gosau, Aus.; *1a,* ×1; *1b,* transv. sec., ×5 (50).

T. (Astraeomorpha) Reuss, 1854 [**A. crassisepta*]. Septal ridges strong and continuous. *U.Trias.,* Eu.

Stereocaenia Alloiteau, 1952 [**Holocoenia collinaria* Fromentel, 1867]. Like *Thamnasteria* but septa thickened by development of irregular multiple series of large trabeculae. *L.Cret.,* Eu.——Fig. 263,*2*. **S. collinaria* (From.), L.Cret. (Neocom.), Yonne, Fr.; transv. sec., ×35 (172).

Ahrdorffia Trauth, 1911 [**Porites stellulata* Reuss, 1854]. Nodular or ramose. Corallites small, separated by ramifying, uniting septocostae. Columella a single trabecular pillar. *U.Cret.,* Eu.——Fig. 263,*5*. **A. stellulata* (Reuss), U.Cret.(Turon.), Gosau, Aus.; ×10 (112).

Psammocora Dana, 1846 [**Pavona obtusangula* Lamarck, 1816; SD M.Edw.-H., 1850]. Massive, foliaceous, ramose, columnar, or incrusting. Corallites small, structures as in *Ahrdorffia.* Collines low and rounded, enclosing several centers or series of centers. *Mio.-Rec.,* W.Indies-IndoPac.

P. (Psammocora), *Mio.-Rec.,* W.Indies-IndoPac.——Fig. 263,*3a*. *P. (P.) folium* Umbgrove, Rec., Indon.; ×5 (138).——Fig. 263,*3b*. *P. (P.) nierstraszi* Horst, Rec., Indon.; ×5 (141).

P. (Stephanaria) Verrill, 1867 [*pro Stephanocora* Verrill, 1866 (*non* Ehr., 1834)] [**Stephanocora stellata* Verrill, 1866]. Intercorallite areas very narrow and low, the collines enclosing one center or series, or absent. *Rec.,* IndoPac.

P. (Plesioseris) Duncan, 1884 [**Maeandroseris australiae* Rousseau, 1854]. Centers or series separated by high, acute, collines. *Rec.,* IndoPac.

Family POCILLOPORIDAE Gray, 1842

Plocoid, generally ramose, mostly hermatypic, colony formation by extratentacular budding. Septa rarely more than 2 cycles, reduced to narrow laminae or striae, even to spines. Columella styliform, vertically discontinuous. Coenosteum solid or vesicular. *U.Cret.-Rec.*

Stylophora Schweigger, 1819 [**Madrepora pistillata* Esper, 1797; SD M.Edw.-H., 1850] [=*Sideropora* Blainv., 1830; *Anthopora* Gray, 1835; *Enallastrea* Orb., 1849; *Phyllopora* T.-Woods, 1879; *Stylomadrepora* Oppenheim, 1923; *Palauastrea* Yabe & Sugiyama, 1941; *Stylacropora* Kühn, 1948]. Ramose to submassive. Corallites tending to spiral irregularly around branches, set in solid, spinose coenosteum. Septa of first cycle uniting with styliform columella. *Eoc.-Rec.,* Eu.-N.Am.-S.Am.-IndoPac.——Fig. 263,*8*. *S. mordax* Dana, Rec., Fanning I., Pac.; *8a,* ×0.5; *8b,* ×10 (148).

Seriatopora Lamarck, 1816 [**S. subulata;* SD M.Edw.-H., 1850]. Like *Stylophora* but corallites arranged in longitudinal series along branches. *Mio.-Rec.,* IndoPac.——Fig. 263,*7*. *S. hystrix* Dana, Rec., Fiji; ×0.5 (148).

Pocillopora Lamarck, 1818 [**P. acuta;* SD M.Edw.-H., 1850]. Ramose, rarely massive or incrusting. Calices commonly borne on short protuberances (verrucae) from the branches. Septa rudimentary, represented by striae or spines. Endothecal dissepiments solid or tabular. Columella a low boss. *Eoc.-Rec.,* W.Indies-IndoPac.——Fig. 263,*6a*. *P. elegans* Dana, Rec., Banda, E.Indies; ×0.5 (129).——Fig. 263,*6b*. *P. eydouxi* M.Edw.-H., Rec., Torres Strait, Austral.; ×10 (148).

Madracis M.Edw-H., 1849 [**M. asperula*] [=*Axhelia* M.Edw.-H., 1849; *Axohelia* M.Edw.-H., 1857; *Reussia* Duchaissing & Michelotti, 1860; *Pentalophora* Saville-Kent, 1871; ?*Stylopsammia* Oppenheim, 1930]. Ramose to submassive. Septa well developed with smooth margins, higher cycles reduced to spines, arranged in groups of 8 or 10. Columella styliform, prominent. *U.Cret.-Rec.,* ?Eu.-IndoPac.-N.Am.-W.Indies.——Fig. 263,*4a*. **M. asperula,* Rec., 15 m. depth, Porto Rico; ×10 (195).——Fig. 263,*4b*. *M. mirabilis* Duch. & Mich., Rec., Porto Rico; ×1 (195).

Family ACROPORIDAE Verrill, 1902

Massive or ramose colonies by extratentacular budding; hermatypic. Corallites small, synapticulothecate, pseudocostate, slightly differentiated from coenosteum. Septa nonexsert, in 2 cycles, formed by simple spiniform trabeculae projecting inward and upward from vertical mural trabeculae, commonly fusing to form laminae. Columella absent or trabecular and weak. Dissepiments thin and tabular when developed. Coenosteum extensive, light reticulate, flaky, generally spinose or striate on surface. *U.Cret.-Rec.*

Acropora OKEN, 1815 [**Millepora muricata* LINNÉ, 1758; SD VERRILL, 1902] [=*Madrepora auctt.* (*non* LINNÉ, 1758), *Heteropora* EHR., 1834; *Isopora* STUDER, 1878; *Conocyathus, Distichocyathus, Eumadrepora, Lepidocyathus, Odontocyathus, Polystachys, Rhabdocyathus, Trachylopora, Tylopora*

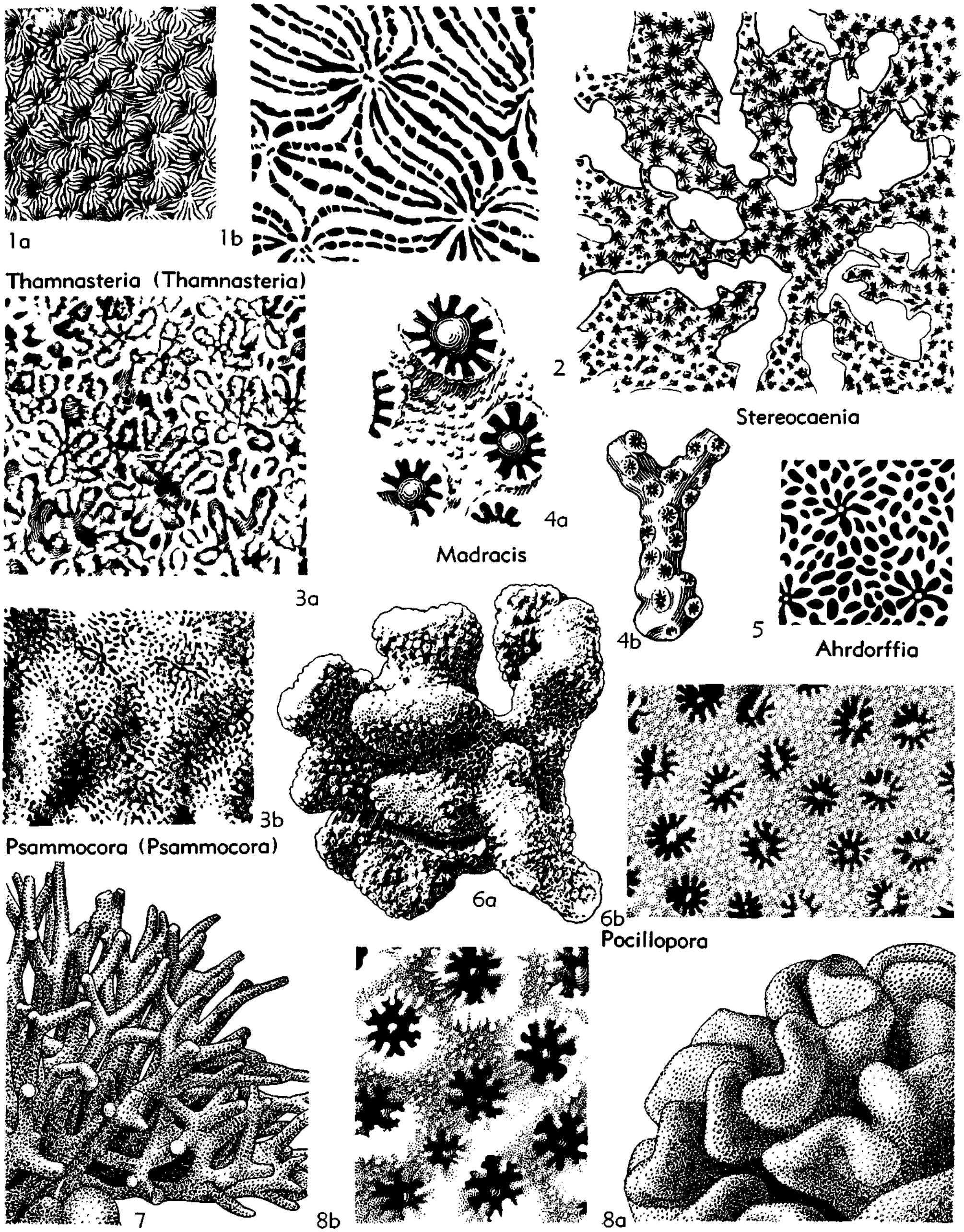


FIG. 263. Astrocoeniina: Thamnasteriidae, Pocilloporidae (p. F372).

Brook, 1893]. Ramose, rarely massive or incrusting; branches with an axial or leading corallite larger than the more numerous radial corallites budded from it, united by light, reticulate, spinose or pseudocostate coenosteum. Columella and dissepiments absent. *Eoc.-Rec.,* Eu.-W.Indies-N.Am.-IndoPac. The most important and protean genus of hermatypic corals, with more than 200 living species representing about 40 per cent of living scleractinians; not yet satisfactorily divided subgenerically.——Fig. 264,*2a. A. formosa* (Dana), Rec., Formosa; ×0.2.——**Fig. 264,*2b. A. tubicinaria*** (Dana), Bikini, Marshall I.; ×4.

Dendracis M.Edw.-H., 1849 [**Madrepora gervillei* Defrance, 1823]. Like *Acropora* but without persistent axial corallite, with coenosteum solid below. *Eoc.-Mio.,* Eu.-Afr.-E.Indies-W.Indies.——Fig. 264,*3. D. mammillosa* Reuss, M.Olig.(Rupel.), Mte.Grumi, Italy; ×2 (116).

Astreopora Blainv., 1830 [**Astrea myriophthalma* Lamarck; SD M.Edw.-H., 1850] [=*Phyllopora* Ehr., 1834; *Araeacis* M.Edw.-H., 1849; *Polysolenia* Reuss, 1867; *Astraeacis* Quenst., 1880; *Octotremacis* Gregory, 1899; *Annulopora, Palaestraeopora* Kühn & Andrusov, 1937]. Massive or subramose; no axial corallites. Coenosteum reticular, formed by outwardly inclined trabeculae, with spinose surface. Dissepiments tabular. Corallite walls solid. *U.Cret.-Rec.,* Eu.-W.Indies-IndoPac.

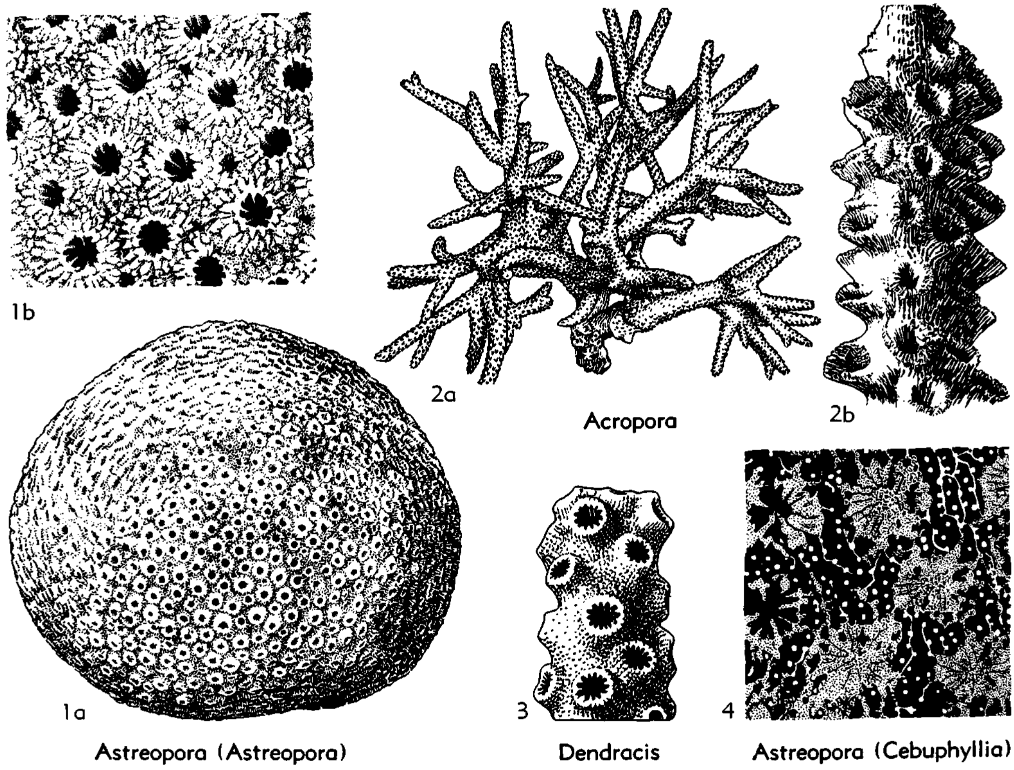
A. (Astreopora). *U.Cret.-Rec.*——Fig. 264,*1. A. listeri* Bernard, Rec., Bikini, Marshall I.; *1a,* ×0.4; *1b,* ×2.

A. (Cebuphyllia) Yabe & Sugiyama, 1941 [**C. chitanii*]. Like *A. (Astreopora),* but with well-developed trabecular columella and thick septa. *?Plio.,* Philip.——Fig. 264,*4.* **A. (C.) chitanii,* transv. sec., ×3 (200).

?Gravieropsammia Filliozat, 1910 [**G. cornucopiae*]. Solitary, free, ceratoid. Corallite wall imperforate, with interseptal costae; a solitary *Astreopora* (?). *M.Eoc.,* Fr.

Montipora Quoy & Gaimard in Blainv., 1830 [**M. verrucosa* (*non Madrepora verrucosa* Lamarck, 1816); SD M.Edw.-H., 1850 (=*Manopora foveolata* Dana, 1846)] [=*Manopora* Dana, 1846]. Submassive, foliaceous, ramose or incrusting; no axial corallite. Corallite walls porous. Columella feeble or absent. Coenosteum reticular with strong vertical trabeculae, thin horizontal connections, surface spinulose or hirsute. No dissepiments. *Eoc.-Rec.,* IndoPac.——Fig. 265,*1a. M. foliosa* (Pallas), Rec., Cocos Keeling; ×0.1 (148).——Fig. 265,*1b. M. turgescens* Bernard, Rec., Bikini, Marshall I.; ×12.

Anacropora Ridley, 1884 [**A. forbesi*]. Like *Monti-*



Acropora

Astreopora (Astreopora)

Dendracis

Astreopora (Cebuphyllia)

Fig. 264. Astrocoeniina: Acroporidae (p. F373-F374).

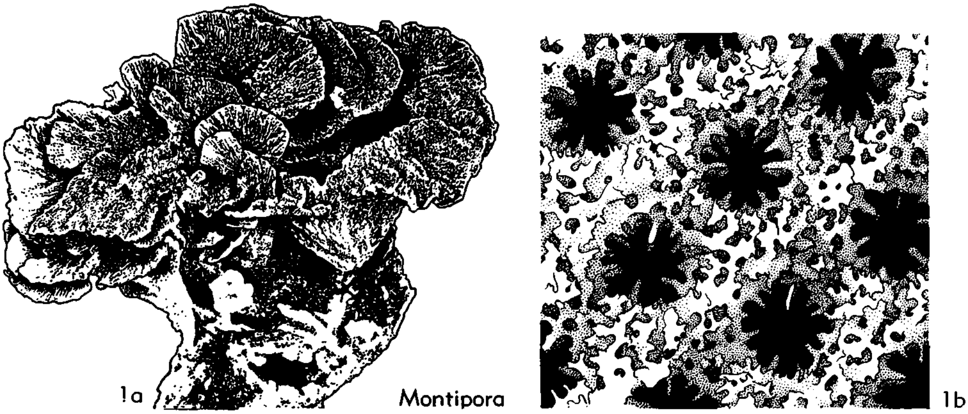


FIG. 265. Astrocoeniina: Acroporidae (p. F374).

pora but invariably ramose, with dense coenosteum. *Rec.*, IndoPac.

Family STYLINIDAE d'Orbigny, 1851

Colonial, hermatypic; colony formation by intra- and extratentacular budding. Septotheca present, generally thickened by stereome. Septa composed of a single fan system of simple trabeculae, upper margins smooth to beaded, laterally smooth or finely granulated. Endothecal dissepiments tabular when developed, rarely vesicular. *M.Trias.-Eoc.*

Subfamily CYATHOPHORINAE Vaughan & Wells, 1943

Ramose or plocoid, rarely cerioid; colony formation by extratentacular budding. Septa rarely more than 2 cycles, slightly exsert. No columella. Endothecal dissepiments thin and tabular, or absent. Coenosteum vesicular or tabular, surface spinose. *M.Trias.-Eoc.*

Cassianastraea Volz, 1897 [**Stylina reussi* Laube, 1865]. Small clumps consisting of ramose branches with crowded corallites lacking costae, united by some vesicular coenosteum. No endothecal dissepiments or columella. *U.Trias.*, Aus.——Fig. 266,*1*. **C. reussi* (Laube), Carn., Aus.; *1a*, ×2; *1b*, transv. sec., ×4 (155).

Procyathophora Weissermel, 1928 [**Cyathophora fürstenbergensis* Eck, 1880]. Massive, plocoid; corallites noncostate, united by spinose tabular coenosteum. Septa rudimentary. Endothecal dissepiments tabular. *M. Trias.*, Ger.——Fig. 266,*11*. **P. fürstenbergensis*, Baden; *11a-c*, surf., transv. and long. secs., ×2 (156).

Cyathophora Michelin, 1843 [**C. richardi* (=*Astrea bourgeti* Defrance, 1826)] [=*Pentacoenia* Orb., 1850; *Depaphyllum, Bathycoenia, Scyphocoenia* Tomes, 1883; *Orbignycaenia* Alloiteau, 1948]. Massive, plocoid. Costate corallites united by more or less costate tabular coenosteum. Septa well developed but rarely extending to corallite axis. No columella. Endothecal dissepiments tabular. *Jur.-Cret.*, Eu.-N.Am.-S.Am.

C. (Cyathophora). *Jur.-Cret.*——Fig. 266,*2*. *C. haysensis* Wells, L.Cret.(U.Apt.), Tex.; *2a,b*, long. and transv. secs., ×2 (157).

C. (Holocystis) Lonsdale, 1849 [**H. elegans*] [=*Tetracoenia* Orb., 1850; *Cyathocoenia* Fromentel, 1884 (*non* Duncan, 1867)]. Like *C. (Cyathophora)*, but with vesicular coenosteum and tetramerally arranged septa. *L.Cret.*, Eu.

C. (Cyathophoropsis) Alloiteau, 1947 [**C. hupei*]. Reputed to differ from *C. (Cyathophora)* by having intercalicular pillars as in *Stylocoenia* and *Stylocoeniella*. *L.Cret.(Gargas.)*, Sp.

Heterocoenia M.Edw-H., 1848]**Lithodendron exiguum* Michelin, 1847] [=*Crinopora, Cyclocoenia* Orb., 1849; *Baryhelia* M.Edw.-H., 1857; *Hexasmilia* Fromentel, 1873; *Trinacis, Bacillastraea* Quenst., 1881; *?Pachycaenia, Heterocaeniopsis* Alloiteau, 1952]. Plocoid; massive, foliaceous, or ramose; corallites noncostate, united by extensive vesicular or nearly dense coenosteum. Septa rarely more than 2 cycles, trimerally arranged; some may be reduced to rudimentary spines. Columella absent or weakly developed (*Heterocaeniopsis*). *Cret.*, Eu.-N.Am.-Japan.——Fig. 266,*6*. *H. provincialis* (Mich.), U.Cret.(Turon.), Fr.; *6a*, ×1; *6b*, nat. long. sec., ×1.5 (181).

Miyakosmilia Eguchi, 1936 [**M. densa*]. Like *Heterocoenia*, but corallites with low costae. *L. Cret.*, Japan.

Ewaldocoenia Oppenheim, 1921 [**E. hawelkai*]. Like *Heterocoenia*, but cerioid. *U.Eoc.*, Eu.

Subfamily STYLININAE d'Orbigny, 1851

[*nom. transl.* Verrill, 1864 (*ex* Stylinidae Orb., 1851)]

Phaceloid, plocoid, meandroid, or rarely hydnophoroid; colony formation by extra-or intratentacular budding. Septa exsert. Columella styliform, lamellar, or absent. Endothecal dissepiments subtabular or vesicular. Coenosteum, where developed, subtabular or vesicular. *U.Trias.-Cret.*

Aplophyllia Orb., 1849 [**Lithodendron dichotomum* Michelin, 1843 (*non* Goldf., 1827) (=**A. orbignyi* M.Edw.-H., 1851]. Phaceloid clumps by extratentacular budding. Costae distinct only near calicular margins, covered below by dense granular stereome. Columella feeble, trabecular. No coenosteum. *M.Jur.-U.Jur.,* Eu.

Stylosmilia M.Edw.H., 1848 [**S. michelini*]. Like *Aplophyllia* but with strong styliform columella. *M.Jur.-L.Cret.,* Eu.-S.Am.——Fig. 266,*7b-d.* **S. michelini,* U.Jur.(Raur.), Switz.; *7b-d,* ×2 (71).——Fig. 266,*7a. S. suevica* Becker, U.Jur. (Kimm.), Ger.; ×1 (7).

Stylina Lamarck, 1816 [**S. echinulata*] [=*Fascicularia* Lam., 1816; *Branchastrea* Blainv., 1830; *Gemmastrea* Blainv., 1834; *Stylopora* M'Coy, 1848; *?Adelocoenia, Conocoenia, ?Convexastrea, Cryptocoenia, ?Decacoenia, ?Dendrocoenia, Lobocoenia, ?Tremacoenia* Orb., 1849; *Acanthocoenia, ?Octocoenia, Pseudocoenia* Orb., 1850; *Platysmilia* Toula, 1889; *Dendroseris* Gregory, 1929]. Plocoid; massive or ramose; corallites protuberant, united by costate, subtabular coenosteum. Columella styliform or absent. Septa variously arranged (hexamerally, octamerally, etc.). *U.Trias.-L.Cret.,* Eu.-AsiaM.-Afr.-N.Am.-S.Am.

S. (Stylina). *U.Trias.-L.Cret.*——Fig. 266,*8. S. girodi* Étallon, U.Jur.(Raur.), Switz.; calices, ×1 (71).

S. (Heliocoenia) Étallon, 1859 [**H. variabilis*] [=*Dendrohelia* Étallon, 1860; *Pleurostylina, Psammohelia, ?Stylohelia* Fromentel, 1861]. Like *S. (Stylina)* but coenosteum noncostate, surface granulate. *U.Jur.-L.Cret.,* Eu.——Fig. 266,*9. S. (Heliocoenia) corallina* Koby, U.Jur. (Raur.), Switz.; long. sec., ×3 (71).

Elasmocoenia M.Edw.-H., 1851 [**Oculina explanata* Michelin, 1845; SD Wells, 1936]. Thick laminae produced by marginal extratentacular and some intratentacular budding. Corallites strongly costate, united by extensive vesicular exothecal dissepiments. No columella. *M.Cret.-U.Cret.,* Eu.

Myriophyllia Orb., 1849 [**Meandrina rastellina* Michelin, 1843] [=*Eugyra* Fromentel, 1857; *Ktenodema* Schafhäutl, 1877; *??Diplothecophyllia* Alloiteau, 1952]. Meandroid colonies produced by intratentacular polystomodaeal budding; series united directly by walls. Septa short. Columella lamellar, continuous, discontinuous, or absent. *U.Jur.-L.Cret.,* Eu.-Afr.-N.Am.-S.Am.——Fig. 266,*5. M. angustata* (Orb.), U.Jur.(Lusit.), Port.; ×1 (73).

Diplogyra Eguchi, 1936 [**D. lamellosa*]. Like *Myriophyllia* but with series separated by ambulacra. *L.Cret.,* Japan.

Felixigyra Prever, 1909 [**F. deangelisi*] [=*Eohydnophora* Yabe & Eguchi, 1936]. Hydnophoroid; series continuous; collines short, discontinuous. Columella weak, usually not developed. *L.Cret.-M.Cret.,* Eurasia-Tex.

?**Haimesastraea** Vaughan, 1900 [**H. conferta*]. Plocoid; massive or ramose colonies produced by extratentacular budding; corallites small, united by dense, costate coenosteum. Septa marked by strong lateral divergence of trabeculae from septal plane, alternately or oppositely, producing thin ridges or carinae parallel to margins. Columella trabecular. *L.Eoc.-M.Eoc.,* N.Am.-S.Am.

H. (Haimesastraea). *L.Eoc.-M.Eoc.*——Fig. 266, *10.* **H. conferta,* L.Eoc. (Wilcox.), Ala.; *10a,* ×0.5; *10b,* ×5 (144).

H. (Peruviastrea) Vaughan, 1922 [**P. peruviana*]. Like *H. (Haimesastraea)* but columella compressed, substyliform. *M.Eoc.,* Peru.

Subfamily EUHELIINAE de Fromentel, 1861

Dendroid colonies formed by extratentacular budding, generally in one plane. Coenosteum dense, surface nearly smooth or finely granulated. Hermatypic. *M.Jur.-L. Cret.*

Euhelia M.Edw.-H., 1850 [**Oculina gemmata* Michelin, 1843]. Colonies small; buds produced simultaneously on opposite sides of branches in pairs. Costae concealed below by stereome. Columella absent or weak. *M.Jur.-U.Jur.* Eu.

Tiaradendron Quenst., 1857 [**Lobophyllia germinans* Quenst., 1852]. Larger than *Euhelia,* with calices tending to alternate, and with 2 opposing septa (?directives) larger and lying in the plane of the branch. *U.Jur.,* Eu.-Afr.——Fig. 266,*4.* **T. germinans,* U.Jur.(Kimm.), Württ., Ger.; ×0.6 (110).

?**Pseudogatheria** Euchi, 1951 [**P. hiraigaensis*]. Fasciculate tufts produced by irregular budding at right angles. Columella formed by 2 to 3 trabecular papillae. *L.Cret.,* Japan.

Enallhelia M.Edw.-H., 1849 [**Lithodendron compressum* Goldf., 1829; SD M.Edw.-H., 1850]. Branches generally anastamosing with tendency to lie in one plane; calices alternately produced. Costae short, becoming covered by granular stereome. Columella styliform, well developed. *M.Jur.-L.Cret.,* Eurasia-S.Am.——Fig. 266,*3. E. tubulosa* Becker, U.Jur.(Kimm.), Württ., Ger.; *3a,* ×0.6; *3b,* ×3.

Stylangia Fromentel, 1857 [**S. neocomiensis*] [=*Prohelia* From., 1857]. Like *Enallhelia* but calices produced from only one side of branches. *L.Cret.,* Eu.-N.Am.-S.Am.

Suborder FUNGIINA Verrill, 1865

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

Solitary and colonial. Septa fenestrate, formed by simple or compound trabeculae united by simple or compound synapticulae, margins beaded or dentate. *M.Trias.-Rec.*

Superfamily AGARICIICAE Gray, 1847

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

Solitary and colonial. Septa fundamentally fenestrate, irregularly porous, formed by one (rarely more) fan system of mostly simple trabeculae, united by simple synapticulae, margins beaded, commonly laminar in later stages. *M.Trias.-Rec.*

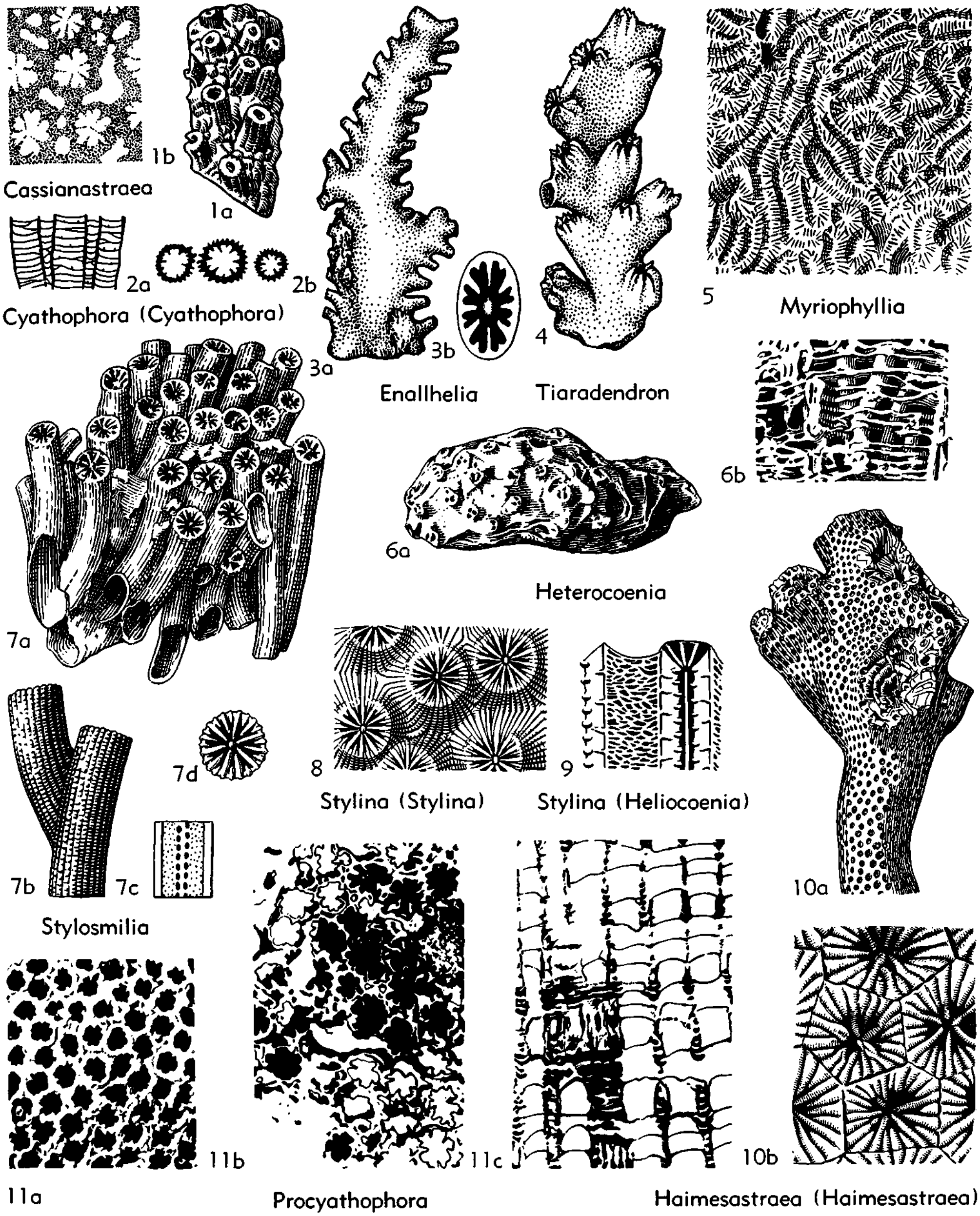


FIG. 266. Astrocoeniina: Stylinidae (p. F375-F376).

Family PROCYCLOLITIDAE Vaughan & Wells, 1943

Solitary and colonial; hermatypic. Corallite wall epithecal. Septa primarily formed by one fan system of simple trabeculae; compound trabeculae in advanced forms; fenestrate structure not strongly developed. Synapticulae simple, uncommon. Endothecal dissepiments well developed. Columella trabecular or absent, rarely otherwise. *M.Trias.-M.Jur.*

Triadophyllum Weissermel, 1925 [**T. posthumum*]. Solitary, trochoid, free in ephebic stage. Septa few, slightly exsert, margins beaded, laterally striate or spinose. No columella. *M.Trias.*, Eu.——Fig. 267,*1*. **T. posthumum*, Anis., Ger.; *1a,b*, ×1 (156).

Gigantostylis Frech, 1890 [**G. epigonus*]. Like *Triadophyllum* but one septum forms an elongate styliform columella. *U.Trias.*, Aus.——Fig. 267,*6*. **G. epigonus*, Nor., Aus.; *6a,b*, ×1 (50).

Margarophyllia Volz, 1896 [**Montlivaltia capitata* Münster, 1841]. Solitary, subcylindrical, fixed. Septa faintly fenestrate in later stages. *U.Trias.*, Eu.——Fig. 267,*4*. *M. crenata* (Münster), Carn., Aus.; *4a*, ×1; *4b*, transv. sec., ×10 (155).

Margarosmilia Volz, 1896 [**Cyathophyllum confluens* Münster, 1841; SD Diener, 1921]. Like *Margarophyllia* but small phaceloid colonies formed by intratentacular budding. *M.Trias.-U.Trias.*, Eu. ——Fig. 267,*3a*. *M. septanectens* (Loretz), M. Trias.(Ladin.), Aus.; transv. sec., ×15 (204).——Fig. 267,*3b*. *M. zieteni* (Klipstein), M.Trias. (Ladin.), Aus.; ×1 (155).

Craspedophyllia Volz, 1896 [**C. cristata* (=*Omphalophyllia boletiformis* Laube, 1865, *non Montlivaltia boletiformis* Münster, 1841); SD Vaughan, 1905]. Like *Margarophyllia* but with septal structure as in *Triadophyllum*. Columella trabecular. *U.Trias.*, Eu.

Conophyllia Orb., 1849 [**Montlivaltia granulosa* Münster, 1841] [=*Omphalophyllia* Laube, 1865]. Like *Craspedophyllia* in early stages but septa developing more distinct fenestrate structure. *M.Trias.-U.Trias.*, Eurasia.——Fig. 267,*5*. *C. boletiformis* (Münster), M.Trias.(Ladin.), Aus.; *5a,b*, transv. and long. secs., ×2 (155).

Procyclolites Frech, 1890 [**P. triadicus*] [=*Myriophyllia* Volz, 1896 (*non* Orb., 1849)]. Solitary or with some polystomodaeal intratentacular budding, fixed, subcylindrical to subturbinate. Septa laminar and imperforate with tendency toward porous fenestrate condition with simple (Trias. species) and compound (Trias.-Jur. species) trabeculae, commonly with strong lateral ridges. *U.Trias.-L.Jur.*, Eurasia.——Fig. 267,*2*. **P. triadicus*, U.Trias. (Nor.), Aus.; *2a*, corallum, ×1; *2b*, long. sec., ×2 (50).

Thecoseris Fromentel & Ferry, 1869 [**T. patellata;* SD From., 1870]. Like *Procyclolites* but compound trabeculae well developed; septa porous, united by simple trabeculae. *L.Jur.-M.Jur.*, Eu.

Tricycloseris Tomes, 1878 [**T. anningi*]. Like *Thecoseris* but small thamnasterioid colonies formed by incomplete mono- to tristomodaeal intratentacular budding. *L.Jur.*, Eng.

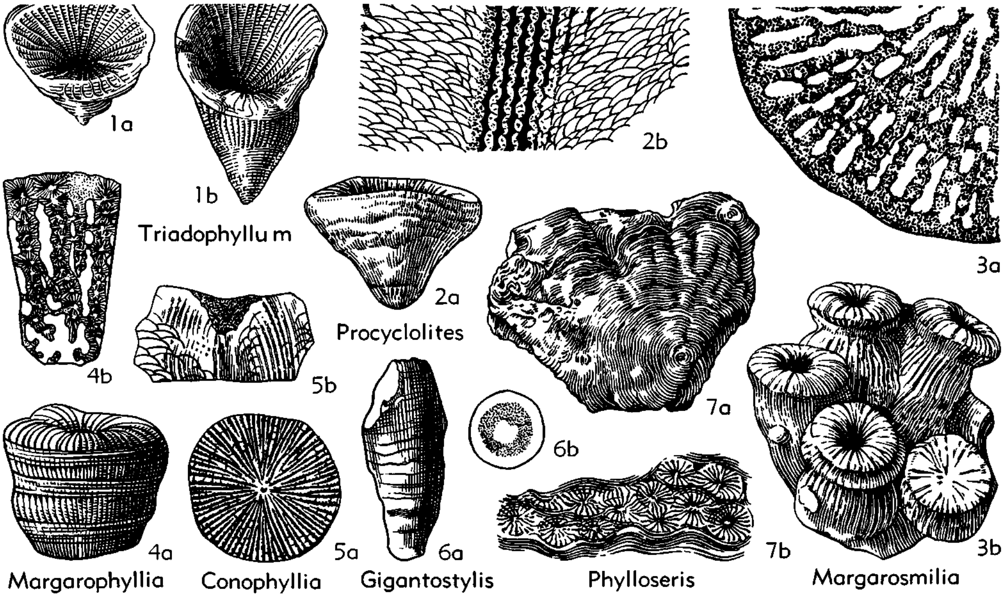


Fig. 267. Fungiina (Agariciicae): Procyclolitidae (p. F378-F379).

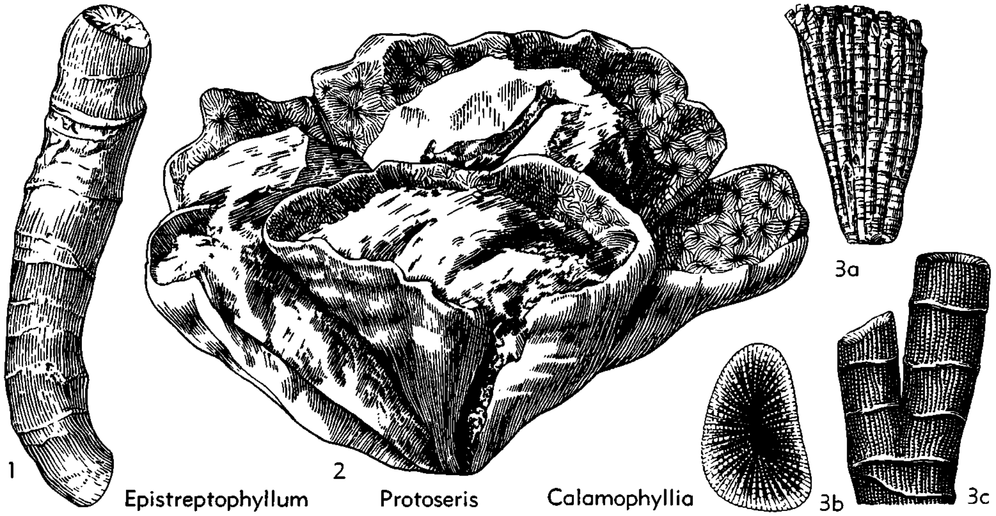


Fig. 268. Fungiina (Agariciicae): Calamophylliidae (p. F379-380).

Phylloseris Tomes, 1882 [**P. rugosa*]. Structures as in *Thecoseris* and *Procyclolites* but corallites smaller, forming foliaceous colonies by ?extratentacular budding. *M.Jur.*, Eng.——Fig 267,7. **P. rugosa*, Baj., Eng.; *7a*, ×0.6; *7b*, ×2 (131).

Family CALAMOPHYLLIIDAE Vaughan & Wells, 1943

Solitary and colonial; hermatypic. Colony formation mostly by intratentacular budding, linkages generally lamellar. Wall synapticulothecal, tending to be thickened secondarily and solid, costate. Septa fenestrate, formed by one fan system of simple trabeculae, axis of divergence vertical or slightly inclined and coinciding with the wall, more or less perforate internally, upper margins beaded, laterally granulated or ridged. Synapticulae sparse except near walls. Endothecal dissepiments thin or absent. Exothecal dissepiments and coenosteum present in some forms. Columella trabecular, feeble or well developed. *M.Jur.-Cret.*

Cyclastraea Alloiteau, 1952 [**Cyclolites spinosa* Fromentel, 1864]. Solitary, cupolate, with basal epitheca. Septa imperforate with strong dentations and vertical carinae. *M.Cret.(Cenom.)*, Fr.

Epistreptophyllum Milaschewitsch, 1875 [**E. commune;* SD Wells, 1936] [=*Phegmatoseris* Milaschewitsch, 1876; *Phragmatoseris* Duncan, 1884; *Lithoseris* Koby, 1886; *Frechia, Metethmos, Protethmos* Gregory, 1900; *Calamosmilia* Koby, 1904]. Solitary, turbinate to cylindrical. Epitheca more or less developed. Dissepiments present. *M. Jur.-M.Cret.*, Eurasia-N.Am.——Fig. 268,*1*. *E. typum* (Koby), U.Jur.(Sequan.), Port.; ×1 (73).

Gonioseris Duncan, 1872 [**G. angulata*]. Solitary, free, hexagonal-pyramido-cupolate with flat base. Basal costae prominent, parallel, extending inward at right angles from sides of each basal segment. *M.Jur.*, Eng.

?**Antilloseris** Vaughan, 1905 [**Turbinoseris eocaenica* Duncan, 1873]. Solitary, turbinate, subceratoid or subpatellate, generally compressed. No columella or dissepiments. *Eoc.*, W.Indies-N.Am.

Dermosmilia Koby, 1884 [**D. divergens;* SD Wells, 1936[[=*Calamophylliopsis* Alloiteau, 1952]. Dendroid colonies produced by complete monostomodaeal intratentacular budding, corallites united basally. *U.Jur.-L.Cret.*, Eu.——Fig. 269,2. *D. crassa* (Étallon), U.Jur.(Raur.), Switz.; ×0.3 (71).

Sematethmos Gregory, 1900 [**S. sinuosa*]. Low colonies formed by circumoral budding with 1 or 2 concentric series of centers. *M.Jur.-U.Jur.*, Eurasia.

Protoseris M.Edw.-H., 1851 [**P. waltoni*] [=*Illinodendron* Quenst., 1880]. Colony formation at first circumoral followed by polystomodaeal budding, several series of centers formed between walls with common forking and formation of collines, resulting in foliaceous or contorted fronds. *U.Jur.*, Eu.——Fig. 268,*2*. **P. waltoni*, Coral., Eng.; ×0.6 (94).

?**Synhelia** M.Edw-H., 1849 [**Lithodendron gibbosum* Goldf., 1829]. Slender ramose, like *Oculina* in form, corallites superficial, with confluent septocostae. Structures apparently calamophylliid but secondarily thickened by heavy stereome. *Cret.*, Eu.

Viminohelia Geyer, 1954 [**V. seminuda*]. Like *Synhelia* but espalier-like in form, with calices on one side of corallum. *U.Jur.*, Eu.

Calamophyllia Blainv., 1830 [**C. striata;* SD M. Edw.-H., 1850] [=*Rhabdophyllia* M.Edw.-H., 1851; *Calamoseris* Alloiteau, 1952]. Phaceloid clumps produced by complete polystomodaeal budding, centers permanently monocentric. *M.Jur.-Cret.,* Eurasia-Afr.-N.Am.-W.Indies.——Fig. 268,*3*. *C. stokesii* M.Edw.-H., U.Jur.(Raur.), Eng.; *3a,* ×0.3; *3b,* ×2; *3c,* ×1 (94).

Latomeandra M.Edw.-H., 1849 [**Lithodendron plicatum* Goldf., 1827] [=*Latimaeandra* M.Edw.-H., 1857; *Chorisastrea* Fromentel, 1861; *Thorisastrea* Étallon, 1864; *Jugodendron, Plicodendron,* Quenst., 1880]. Like *Calamophyllia* but corallites mostly di- or tricentric. *M.Jur.-L.Cret.,* Eu.——Fig. 269,*6*. **L. plicatum,* U.Jur.(Kimm.), Ger.; ×1 (7).

Gyrodendron Quenst., 1880 [**G. lobatum;* SD Wells, 1936]. Like *Latomeandra* but polycentric condition mostly permanent, corallum fasciculate, formed by clusters of polycentric corallites. *U.Jur.,* Eu.——Fig. 269,*4*. **G. lobatum,* Kimm., Ger.; ×1 (7).

Comophyllia Orb., 1849 [**C. elegans*] [=*Dimorphophyllia* Becker, 1875; *Archaeoseris* Gregory, 1900]. Circumoral followed by intramural budding, with irregularly radiating collines between groups of serial centers. *U.Jur.,* Eu.——Fig. 269,*3*. *C. polymorpha* (Koby), U.Jur.(Raur.), Port.; ×1 (73)

Rabdastrea Étallon, 1859 [**R. jurensis;* SD Wells, 1936]. Submassive subplocoid colonies, with mono- to tricentric corallites closely united nearly to the calices by costae and exothecal dissepiments. *U.Jur.,* Eu.

Baryphyllia Fromentel, 1857 [**Barysmilia gregaria* Orb., 1850; SD Wells, 1936]. Like *Rabdastrea* but corallites monocentric. *Cret.,* Eu.

Ovalastrea Orb., 1849 [**Astrea caryophylloides* Goldf., 1827] [=*Ebrayia* Ferry, 1870; *Favoidioseris* Wells, 1933; *Favioseris* Wells, 1934; *Ambiguastraea* Alloiteau, 1952]. Plocoid colonies by mono- to tristomodaeal budding, corallites mono- to tricentric, united by costae and exothecal dissepiments. *M.Jur.-Cret.,* Eurasia-Afr.-N.Am.-W.Indies.——Fig. 270,*2a*. *O. bihinensis* (Gregory), U.Jur.(Kimm.), Br.Somali.; transv. sec., ×2 (130).——Fig. 270,*2b*. **O. caryophylloides,* U.Jur.(Kimm.), Ger.; ×1 (130).

Isastrea M.Edw-H., 1851 [**Astrea helianthoides* Goldf., 1827; SD Quenst., 1857] [=*Desmastraea* Fromentel, 1865; *Placastrea* Stoliczka, 1873; *Platastrea* Tomes, 1886]. Laminar to massive cerioid colonies; corallite walls septothecal to parathecal, but commonly partly absent with septa confluent; corallites mono- or dicentric. *M.Jur.-Cret.,* Eu.-Afr.-N.Am.——Fig. 269,*1a*. *I. limitata* (Lamx.), M.Jur.(Bath.), Eng.; ×2 (94).——Fig. 269,*1b*. *I. bonanomii* (Koby), U.Jur.(Raur.), Switz.; lat. aspect of septum, ×4 (71).

Periseris Ferry, 1870 [**Agaricia elegantula* Orb., 1850] [=*?Fungiastraea* Alloiteau, 1952]. Like *Isastrea* but thamnasterioid, corallite walls absent at surface, parathecal below; calices superficial. Septa laterally carinate. *M.Jur.-Cret.,* Eu.-N.Am.-S.Am.——Fig. 269,*5*. *P. irregularis* (Felix), L. Cret.(Apt.), Tex.; transv. sec., ×2 (157).

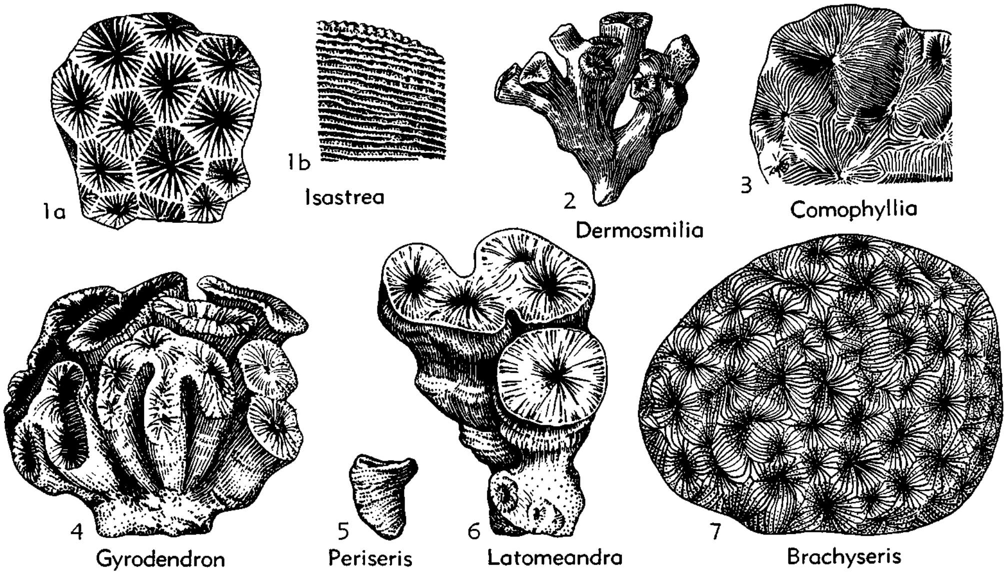


Fig. 269. Fungiina (Agariciicae): Calamophylliidae (p. F379-F381).

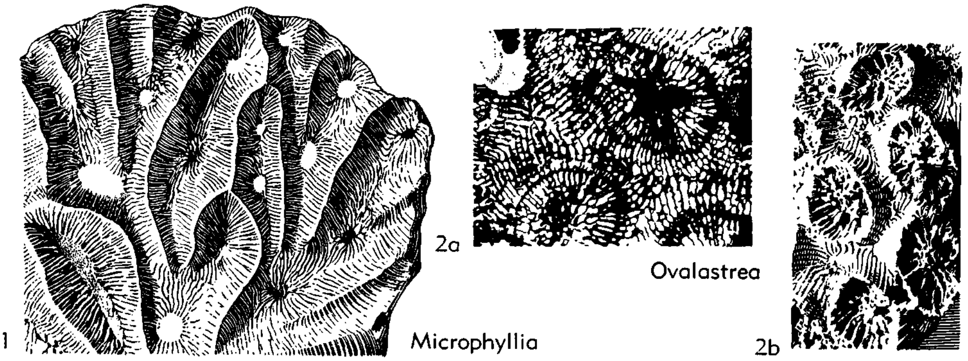


FIG. 270. Fungiina (Agariciicae): Calamophyllidae (p. F380-F381).

Ferrya FROMENTEL in FERRY, 1870 [**F. burgundiae*]. Like *Ovalastrea* but meandroid, the calicular series separated by broad ambulacra. *M.Jur.*, Eu.

Stibastrea ÉTALLON, 1859 [**S. edwardsi*]. Meandroid, derived from *Latomeandra* by incomplete separation of corallites with intramural budding. Ambulacra narrow, costate. *U.Jur.*, Eu.

Stiboria ÉTALLON, 1862 [**S. suprajurensis*]. Like *Stibastrea* but ambulacra granulated, noncostate. *U.Jur.*, Eu.

Microphyllia ORB., 1849 [**Meandrina soemmeringii* MÜNSTER in GOLDF., 1829] [=*Axophyllia* ORB., 1849; *Comastrea* FROMENTEL, 1862; *?Koilomorpha* ALLOITEAU, 1952]. Like *Stibastrea* but lacking ambulacra; collines subacute; series in single rows of centers in the valleys, or less commonly several rows or groups. *U.Jur.*, Eurasia-Afr.-S.Am.——FIG. 270,*1*. **M. soemmeringii,* U.Jur.(Kimm.), Ger.; ×1 (7).

Brachyseris ALLOITEAU, 1947 [**Latimeandra morchella* REUSS, 1854]. Like *Microphyllia,* but series short (1 to 3 centers), surrounded by acute collines; centers with trabecular linkage. *Cret.*, Eu. ——FIG. 269,*7*. **B. morchella,* U.Cret.(Turon.), Gosau, Aus.; ×1 (112).

Family AGARICIIDAE Gray, 1847

Solitary and colonial; hermatypic. Colony formation mainly by intratentacular budding. Wall synapticulothecal, usually becoming solid, or absent. Septa formed by one fan system of simple trabeculae, rarely porous, margins beaded, directly confluent between centers, united by some compound synapticulae. Endothecal dissepiments mostly absent. Columella trabecular or absent. *M.Cret.-Rec.*

Trochoseris M.EDW.-H., 1849 [**Anthophyllum distortum* MICHELIN, 1844] [=*Gyroseris* REUSS, 1854; *Palaeoseris* DUNCAN, 1870; *Trochoseropsis* SÖHLE, 1897]. Solitary, turbinate or trochoid, fixed. Columella papillose or weak. *M.Cret.-Oligo.*, Eurasia-W.Indies.

Vaughanoseris WELLS, 1934 [**V. catadupensis*]. Solitary, discoid-patellate, free. Well-developed trabecular columella. *U.Cret.*, W.Indies.——FIG. 272,*1*. **V. catadupensis,* Camp., Jamaica; *1a-c,* ×0.5 (198).

Elliptoseris DUNCAN, 1880. [**E aperta*]. Like *Trochoseris* but lacking columella. *Eoc.*, India.

Brachyphyllia REUSS, 1854 [**B. dormitzeri;* SD REUSS, 1864]. Small subplocoid colonies formed by extratentacular budding. *U.Cret.*, Eu.——FIG. 271,*2*. *B. depressa* REUSS, Turon., Gosau, Aus.; *2a,b,* ×1 (112).

Cyathoseris M.EDW.-H., 1849 [**Pavonia infundibuliformis* BLAINV., 1830] [=*Dimorphophyllia* REUSS, 1864; *?Spinellia* D'ACHIARDI, 1867; *Pterastrea* DUNCAN, 1880; *Pratzia* DUNCAN, 1884; *Mycetoseris* REIS, 1889; *Axoseris* OPPENHEIM, 1901; *Kühnophyllia* WELLS, 1937]. Like *Trochoseris* but expanding colonies formed by circumoral, followed by marginal or intramural budding with terminal forking. Collines more or less radiating. *U.Cret.-Mio.*, Eurasia.——FIG. 271,*1a,b*. *C. irradians* (REUSS), M.Oligo.(Rupel.), Italy; *1a,* ×0.6; *1b,* ×3 (116).——FIG. 271,*1c*. *C. centrifuga* (REUSS), M.Oligo.(Rupel.), Italy; ×0.6 (116).——FIG. 271, *1d,e*. *C. applanata* REUSS, M.Oligo.(Rupel.), Italy; ×0.6 (116).——FIG. 271,*1f*. *C. oxylopha* (REUSS), M.Oligo.(Rupel.), Italy; ×0.6 (116).

Hydnophorabacia D'ACHIARDI, 1875 [**H. variabilis*]. Hydnophoroid; colony formation by circummural budding. *Eoc.*, Eu.

Agaricia LAMARCK, 1801 [**Madrepora undata* ELLIS & SOLANDER, 1786; SD M.EDW.-H., 1850] [=*Undaria* OKEN, 1815; *Mycedia* DANA, 1846]. Colony formation by circumoral budding followed by marginal budding, forming foliaceous unifacial or bifacial fronds or submassive coralla. Collines discontinuous, enclosing several centers. Corallite walls well developed, calices inclined slightly toward margin. *Mio.-Rec.*, W.Indies.——FIG. 273,*2*. *A. agaricites* (PALLAS), Rec., Fla.; ×1 (151).

Heterogyra REUSS, 1868 [**H. lobata*]. Colony for-

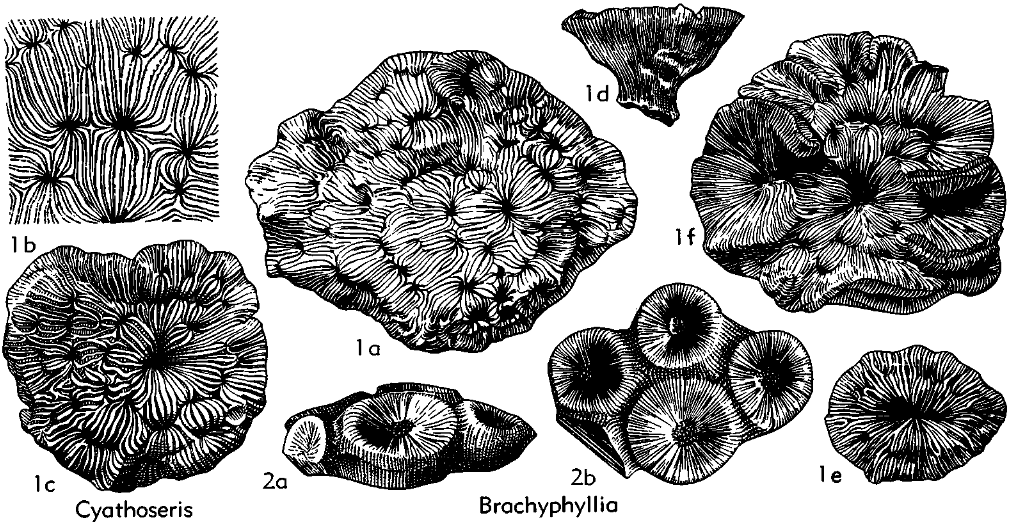


FIG. 271. Fungiina (Agariciicae): Agariciidae (p. F381).

mation by intramural budding with lateral branching and terminal forking; series generally discontinuous, laterally free or closely united with acute collines. _Oligo.,_ Eu.——FIG. 273,_1_. *_H. lobata,_ Rupel., Italy; _1a,b,_ ×0.6 (116).

Pavona LAMARCK, 1801 [*_Madrepora cristata_ ELLIS & SOLANDER, 1786 (=_M. cactus_ FORSKÅL, 1775); SD VAUGHAN, 1918] [=_Pavonia_ LAM., 1816; _Lophoseris_ M.EDW.-H., 1849; _Pseudastraea_ REUSS, 1864; _Reussastraea_ D'ACHIARDI, 1875; _Heteroseris_ FERRY, 1870]. Massive to foliaceous with bifacial fronds. Corallite walls absent. Collines radiating, discontinuous. _Oligo.-Rec.,_ Eu.-W.Indies-IndoPac.

P. (Pavona). _Oligo.-Rec._——FIG. 273,_3_. _P. frondifera_ LAM., Rec., Jaluit, Marshall I.; _3a,_ ×0.6; _3b,_ ×4.

P. (Polyastra) EHR., 1834 [*_Polyastra venosa_] [=_Tichoseris_ QUELCH, 1884; _Asteroseris_ VERRILL, 1902; (_non_ FROMENTEL, 1867)]. Like _Pavona_ but centers in short or submeandrine series, bounded by well-developed, acute walls. Corallum massive or incrusting. _Rec.,_ IndoPac.

P. (Pseudocolumnastraea) YABE & SUGIYAMA, 1933 [*_Pseudocolumnastraea yamanarii_]. Like _Pavona_ but corallites bounded by distinct walls, appearing plocoid; no collines. _Rec.,_ IndoPac.

Leptoseris M.EDW.-H., 1849 [*_L. fragilis_] [=_Haloseris, Helioseris_ M.EDW.-H., 1849; _Domoseris, Cylloseris_ QUELCH, 1886; _Folioseris_ REHBERG, 1892; _Agariciella_ MA, 1937]. Circumoral followed by marginal budding, forming thin, unifacial folia, crateriform to digitate. Centers superficial, protuberant in some species; collines poorly developed. _Oligo.-Rec.,_ W.Indies-IndoPac.——FIG. 274,_1_. _L. hawaiiensis_ VAUGHAN, Rec., depth 45 m., Hawaii; _1a,b,_ ×0.6 (146).

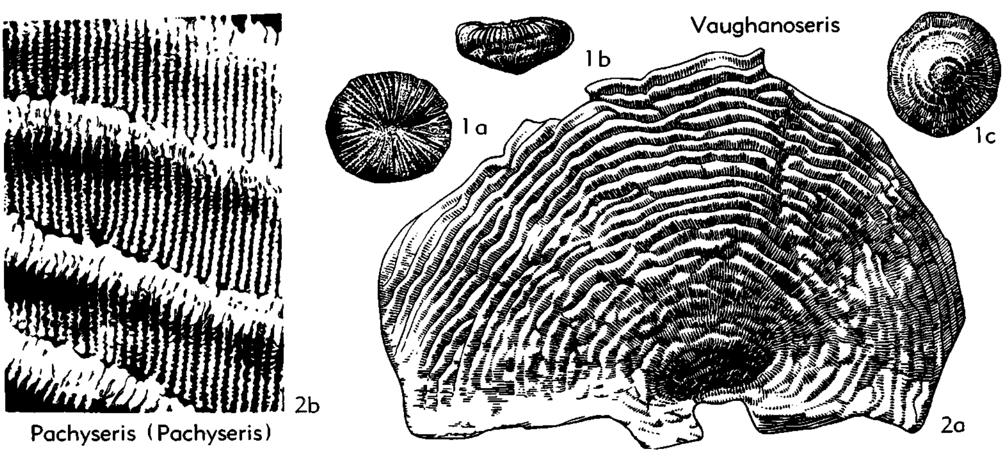


FIG. 272. Fungiina (Agariciicae): Agariciidae (p. F381-F383).

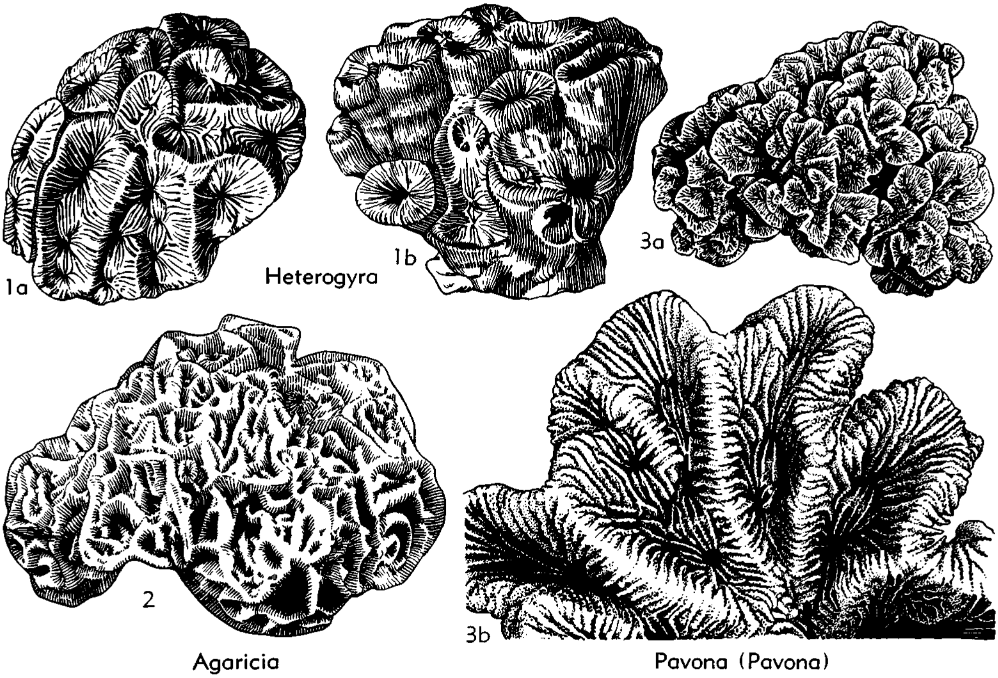


FIG. 273. Fungiina (Agariciicae): Agariciidae (p. F381-F382).

Coeloseris VAUGHAN, 1918 [**C. mayeri*]. Corallum cerioid; colony formation by monostomodaeal budding. Columella absent, axial space open. *Rec.,* IndoPac.——FIG. 275,*1*. **C. mayeri,* Rec., Torres Strait, Austral.; *1a,* ×2; *1b,* transv. sec., ×10 (148).

Pachyseris M.EDW.-H., 1849 [**Agaricia rugosa* LAMARCK, 1801]. Foliaceous, unifacial or bifacial. Centers in concentric rows between long collines parallel to margin, indistinct, linked by columellar laminae or trabeculae. Walls well developed in collines. *Mio.-Rec.,* IndoPac.

P. (Pachyseris), *Mio.-Rec.*——FIG. 272,*2*. *P. (P.) speciosa* DANA, Rec., E.Indies; *2a,* ×0.6; *2b,* ×5 (148).

P. (Pavonaraea) UMBGROVE, 1946 [**Pavonaraea irregularis*]. Like *Pachyseris* but centers distinct. *Plio.,* Java.——FIG. 275,*2*. **P. (P.) irregularis;* ×0.5 (140).

Family SIDERASTREIDAE Vaughan & Wells, 1943

Colonial, rarely solitary; hermatypic. Colony formation by intra- or extratentacular budding. Synapticulothecate. Septa composed of one fan system of small, simple or compound trabeculae, laterally strongly granulated, more or less porous, margins beaded or dentate, laterally united by simple synapticulae. Columella composed of one or more papillary trabeculae. Endothecal dissepiments present. *Cret.-Rec.*

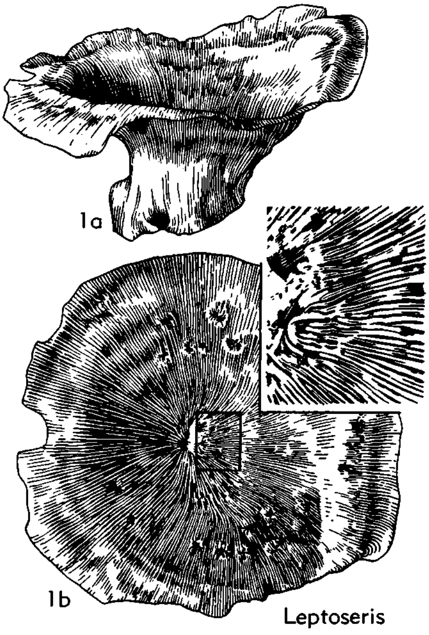


FIG. 274. Fungiina (Agariciicae): Agariciidae (p. F382).

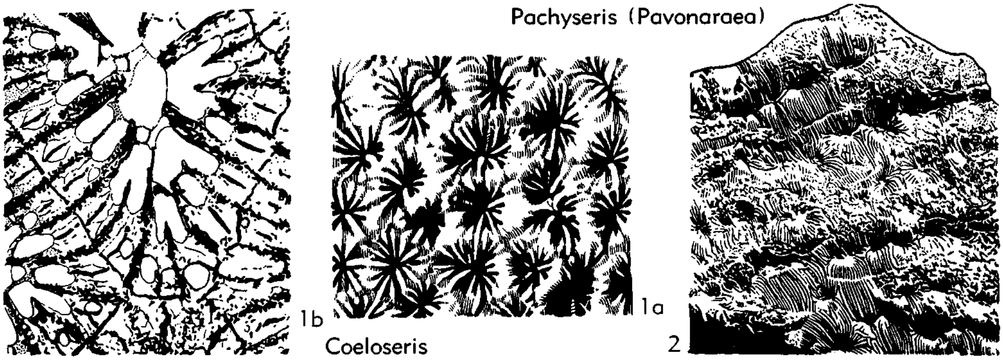


FIG. 275. Fungiina (Agariciicae): Agariciidae (p. F383).

Siderastrea Blainv., 1830 [**Madrepora radians* Pallas, 1766] [=*Siderina* Dana, 1846]. Massive, ramose or incrusting, cerioid colonies formed by extratentacular budding. Corallite walls well defined, formed by several synapticular rings. *Cret.-Rec.,* Eu.-Afr.-N.Am.-S.Am.-W.Indies-Red Sea-W. Ind.O.

S. (Siderastrea), *Cret.-Rec.*——Fig. 276,*1a. S. (S.) radians* (Pallas), Rec., Fla.; ×1 (151).——Fig. 276,*1b. S. (S.) italica* (Defrance), Mio.,

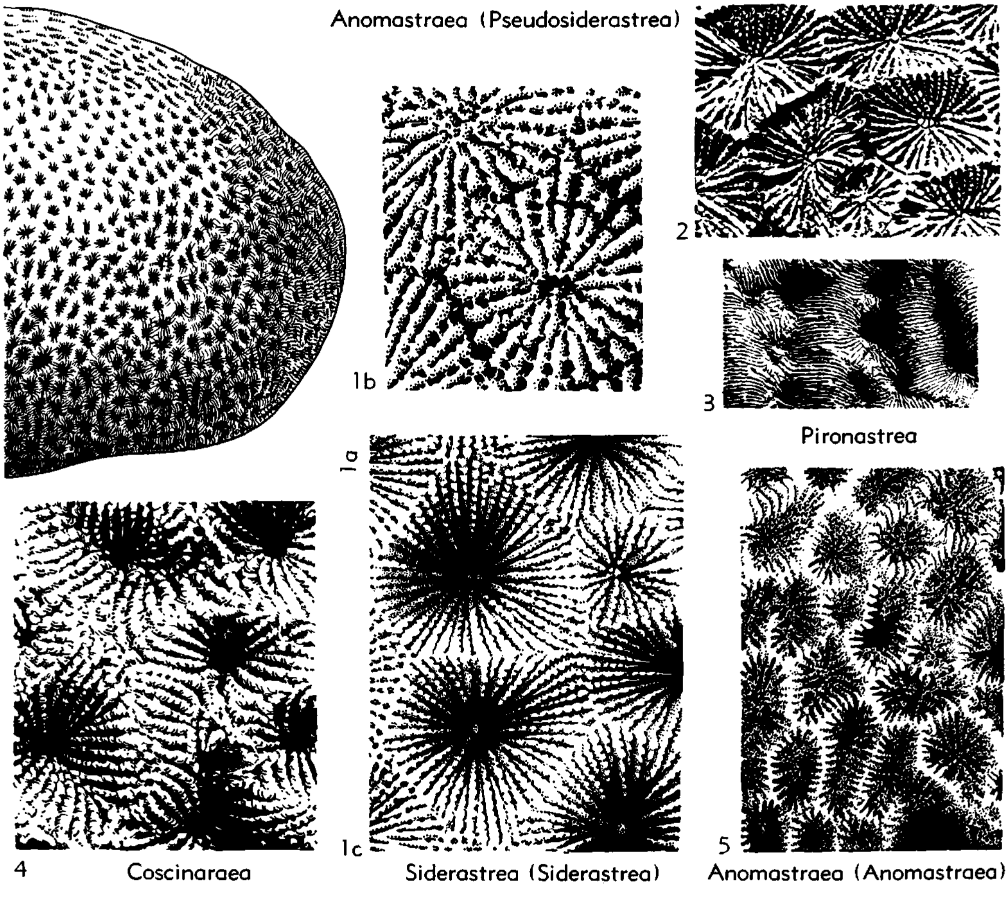


FIG. 276. Fungiina (Agariciidae): Siderastreidae (p. F384-F385).

Poland; transv. sec., ×8 (190).——FIG. 276,*1c*. *S. (S.) siderea* (ELLIS & SOLANDER), Rec., Bahamas; ×6 (149).

S. (Siderofungia) REIS, 1889 [**Columnastraea bella* REUSS, 1869]. Like *S. (Siderastrea)* but corallite walls indistinct; septa confluent, corallum thamnasterioid. *Cret.-Oligo.*, Eurasia-N.Am.

S. (Stephanomorpha) VAUGHAN, 1900 [**Stephanomorpha monticuliformis*]. Like *E. (Siderastrea)* but inner ring of mural synapticulae strongly developed, giving corallum a plocoid aspect. *Eoc.*, N.Am.

Sideroseris WELLS, 1945 [**S. durhami*]. Like *S. (Siderastrea)* but solitary, *Eoc.*, Barbados.

Pironastrea D'ACHIARDI, 1875 [**P. discoides*]. Like *S. (Siderastrea)* but intratentacular circumoral budding forms explanate corallum with centers in concentric rings separated by low concentric collines. *Eoc.-Oligo.*, Eu.-W.Indies.——FIG. 276,*3*. *P. anguillensis* VAUGHAN, Oligo., W.Indies; ×2 (149).

Maeandroseris ROUSSEAU, 1854 [**M. bottae;* SD WELLS, 1936]. Like *Pironastrea* but circumoral followed by intramural budding forms irregularly radiating series separated by collines. *Pleisto.*, Red Sea.

Anomastraea VON MARENZELLER, 1901 [**A. irregularis*] [=?*Thalamocaeniopsis* ALLOITEAU, 1954]. Like *S. (Siderastrea)* but colony formation by intratentacular budding. Corallite wall nearly solid, formed by a single synapticular ring. Septa partly perforate, nonexsert. *?L.Cret.*, N.Afr. (*Thalamocaeniopsis*). *Rec.*, W.Ind.O.-W.Pac.

A. (Anomastraea).——FIG. 276,*5*. **A. (A.) irregularis*, Pt.St.Johns, Pondoland; ×4 (176).

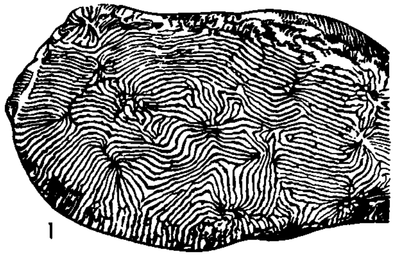
A. (Pseudosiderastrea) YABE & SUGIYAMA, 1935 [**Pseudosiderastrea tayamai*]. Like *A. (Anomastraea)* but colony formation by extratentacular budding; septa nearly imperforate. W.Pac.——FIG. 276,*2*. **A. (P.) tayamai*, Aru I., ×4 (200).

Coscinaraea M.EDW.-H., 1848 [**C. bottae* (=*Astrea monile* FORSKÅL, 1775)] [=*Coscinastrea* M.EDW.-H., 1848]. Massive, subspherical, columniform, or incrusting colonies by intratentacular mono- to tristomodaeal budding. Synapticulotheca formed by several rings of synapticulae forming low collines. Septa perforate, formed mostly by compound trabeculae. *Pleisto.-Rec.*, IndoPac.——FIG. 276,*4*. **C. monile* (FORSKÅL), Rec., E.Afr.; ×4 (195).

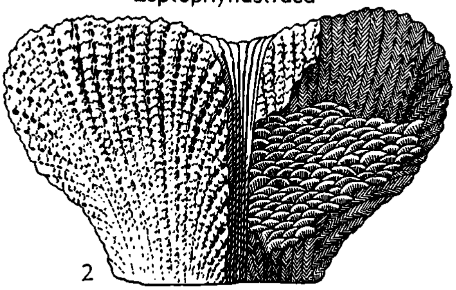
Superfamily FUNGIICAE Dana, 1846

[*nom. correct.* WELLS, herein (*ex* Fungioidae VAUGHAN & WELLS, 1943, *nom. transl. ex* Fungiidae DANA, 1846)]

Solitary and colonial; colony formation commonly by intratentacular budding. Corallite wall synapticulothecal, secondarily septothecal. Septa formed by compound trabeculae, united by mostly compound synapticulae, irregularly porous in early genera, more regularly porous in later ones, strongly dentate on margins. *M.Jur.-Rec.*



Leptophyllastraea



Acrosmilia

FIG. 277. Fungiina (Fungiicae): Synastreidae (p. F385).

Family SYNASTREIDAE Alloiteau, 1952

[=Leptophylliidae VAUGHAN, 1905]

Solitary and colonial; hermatypic. Synapticulothecate, wall more or less perforate near calice, solid basally, costate. Septa exsert, axis of divergence coinciding with wall, vertical or inclined outward; perforate inwardly and near upper margins, strongly beaded marginally. Endothecal dissepiments well developed. Columella trabecular. *M.Jur.-Rec.*

Acrosmilia ORB., 1849 [**Turbinolia cernua* MICHELIN, 1846 (*non* GOLDF., 1826) (=*Trochosmilia crassa* M.EDW.-H., 1850] [=*Polyphyllia* ORB., 1849 (*non* QUOY & GAIMARD, 1830); *Leptophyllia* REUSS, 1854; *Placoseris* FROMENTEL, 1863; *Turbinoseris* DUNCAN, 1870; *Septophyllia* QUENST., 1881; *?Carantoseris, ?Proleptophyllia* ALLOITEAU, 1952]. Solitary, turbinate, with weak columella. *M.Jur.-Cret.*, Eu.-N.Am.——FIG. 277,*2*. *A. clavata* (REUSS), U.Cret.(Turon.), Aus.(Gosau); vert. sec., ×2 (105).

Leptophyllastraea OPPENHEIM, 1930 [**L. irregularis*]. Like *Acrosmilia* but small colonies produced by irregular mono- to tristomodaeal budding, corallites remaining closely united. *U.Cret.*, Eu.——FIG. 277,*1*. **L. irregularis*, U.Cret.(Turon.), Aus. (Gosau); calicular surface, ×1 (100).

Felixastraea OPPENHEIM, 1930 [**Cyathoseris zitteli* FELIX, 1903]. Like *Acrosmilia* but thamnasterioid, colony formation by polystomodaeal intramural budding with terminal forking; centers with lamellar linkages. Series free laterally near summits,

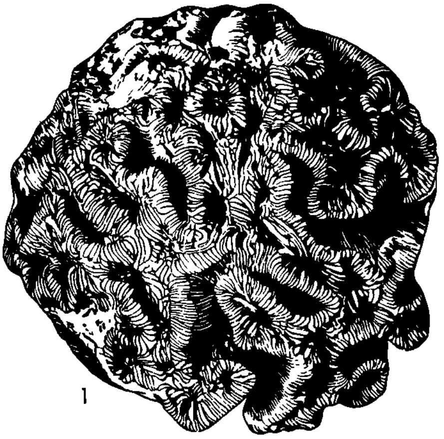


Fig. 278. Fungiina (Fungiicae): Synastreidae (p. F385).

with narrow ambulacra. *U.Cret.*, Eu.——Fig. 278,*1.* **F. zitteli,* U.Cret.(Turon.), Aus.(Gosau); ×1 (100).

Edwardsoseris Alloiteau, 1946 [**Latomeandra corrugata* M.Edw.-H., 1849] [=*Kobymeandra* Alloiteau, 1954]. Like *Felixastraea* but lacking ambulacra. *M.Jur.-Cret.,* Eu.——Fig. 279,*1.* **E. corrugata,* M.Jur., Switz.; *1a,b,* ×0.7; *1c,* lat. aspect of septum, ×4 (71).

Synastrea M.Edw.-H., 1848 [**Astrea agaricites* Goldf., 1826] [=*Thamnastrea auctt.* (*non Thamnastraea* Lesauvage, 1832, =*Thamnasteria* Lesauvage, 1823); *Adelastrea* Reuss, 1854; *Mesoseris* Ferry, 1870; *Aphragmastraea* Solomko, 1888]. Thamnasterioid, colony formation by incomplete polystomodaeal budding, corallites united to summits; calices flush. *M.Jur.-Cret.,* Eu.-N.Am.-W. Indies.——Fig. 279,*4a. S. raristella* (Reuss), U. Cret.(Turon.), Aus.(Gosau); ×0.5 (112).——Fig. 279,*4b. S. arachnoides* (Parkinson), U.Jur. (Raur.), Switz.; lat. aspect of septum, ×4 (71).

Dimorphoseris Duncan, 1872 [**D. oolitica*] [=*Kobya* Gregory, 1900]. Thamnasterioid, colony formation by circumoral budding; homeomorphic with *Dimorphastrea,* etc. *M.Jur.-Cret.,* Eurasia.——Fig. 279,*3. D. waehneri* (Felix), U. Cret.(Turon.), Aus.(Gosau); ×1 (100).

Crateroseris Tomes, 1883 [**C. fungiformis*]. Like *Dimorphoseris* but calices protuberant as bosses (bourrelets); homeomorphic with *Polyphylloseris. U.Jur.,* Eu.——Fig. 279,*2.* **C. fungiformis,* Sequan., Eng.; ×0.5 (194).

Family CYCLOLITIDAE d'Orbigny, 1851

Solitary and colonial, free in ephebic stage, subdiscoid, patellate, or cupolate; hermatypic. Colony formation by circumoral or circummural intratentacular budding. Corallite wall synapticulothecate, epithecate. Septa as in Synastreidae, perforations generally filled secondarily, axis of trabecular divergence inclined outwards. Endothecal dissepiments and columella weak or absent. Homeomorphic with Fungiidae. *Cret.-Eoc.*

Cyclolites Lamarck, 1801 [**C. ellipticus*] [=?*Porpites* Schloth., 1820; *Cyclolithas* Ehr., 1834; *Funginella* Orb., 1849; *Orbitolina* Orb., 1850; *Episeris* Fromentel, 1861; *Zittelofungia* Duncan, 1884; ?*Cunnolites* Gagnebin, 1772, *Plesiocunnolites* Alloiteau, 1952]. Solitary, cupolate; septa mostly perforate, axis of divergence nearly vertical. *Cret.-Eoc.,* Eurasia-N.Afr.-W.Indies.——Fig. 280, *4a. C.* sp. restored long. sec., ×2 (105).——Fig. 280,*4b,c.* **C. ellipticus,* U.Cret.(Turon.), Aus. (Gosau); ×0.5 (112).

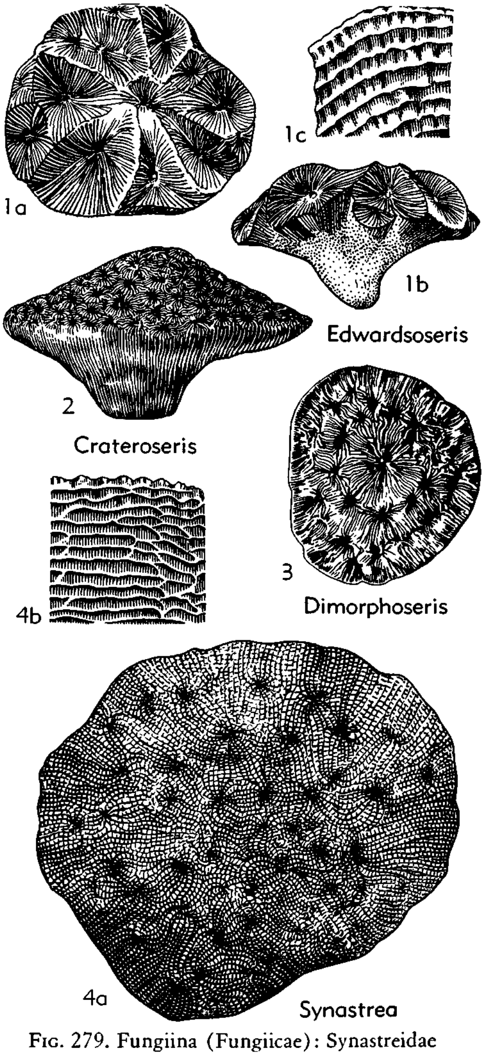


Fig. 279. Fungiina (Fungiicae): Synastreidae (p. F386).

Cyclolitopsis Reuss, 1873 [*_Cyclolites patera_ d'Achiardi, 1867]. Solitary, patellate, fixed basally in early stages. Septa nearly imperforate, axis of divergence outwardly inclined. *Eoc.*, Eu.

Paracycloseris Wells, 1934 [*_P. elizabethae_]. Like *Cyclolites* but discoid or patellate, with well-developed columella. *U.Cret.*, W.Indies-Mex.——Fig. 280,*2*. *_P. elizabethae_ Campan., Jamaica; *2a,b*, ×1 (198).

Aspidastraea Kühn, 1933 [*_A. orientalis_]. Like *Cyclolites* but small colonies formed by circumoral budding. Homeomorphic with *Halomitra* and *Genabacia*. *U.Cret.*, SW.Asia.——Fig. 280,*3*. *_A. orientalis_, Senon., Iran; ×1 (78).

Aspidiscus König, 1825 [*_A. shawi_ (=*Cyclolites cristata* Lamarck, 1801)] [=*Cyclophyllia* M.Edw.-H., 1848; *Helladastraea* Avnimelech, 1947]. Small, cupolate, hydnophoroid colonies produced by circummural budding. *M.Cret.*, Eu.-AsiaM.-N. Afr.——Fig. 280,*7*. *A. felixi* Renz, Cenom., Greece; *7a*, lat. aspect, ×1; *7b*, transv. sec., ×2 (188).

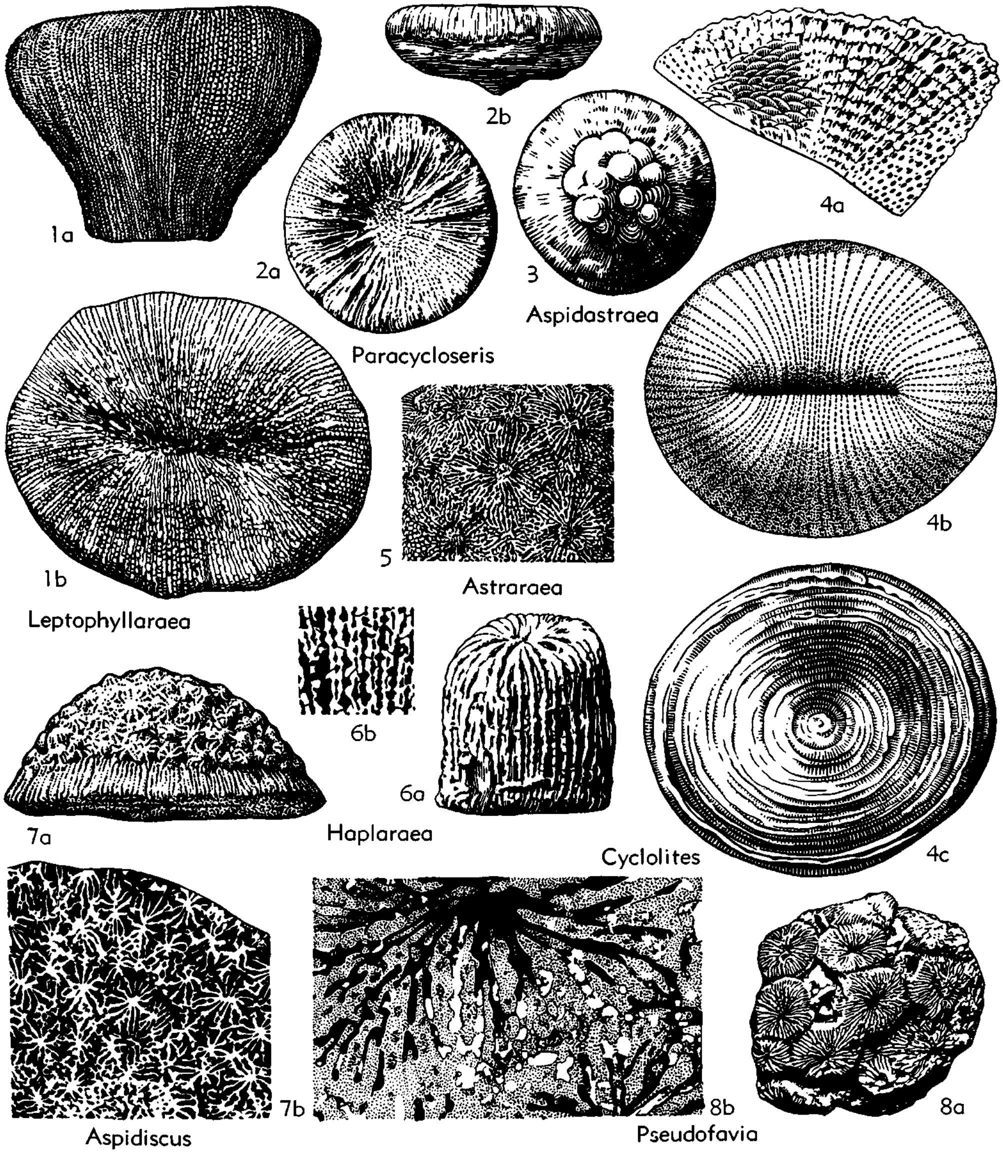


Fig. 280. Fungiina (Fungiicae): Cyclolitidae, Haplaraeidae (p. F386-F388).

Family HAPLARAEIDAE Vaughan & Wells, 1943

Solitary and colonial; hermatypic. Colony formation by intra- and extratentacular budding. Wall synapticulothecate, porous, poorly defined, costate. Septa exsert, formed by one fan system of compound trabeculae, vertical axis of divergence, irregularly porous and thick. Dissepiments thin. Columella trabecular and weak, or absent. *U.Jur.-Eoc., ?Oligo.-?Mio.*

Haplaraea MILASCHEWITSCH, 1876 [**H. elegans*]. Solitary, cylindrical, fixed, epitheca thin. *U.Jur.-Cret.,* Eu.——FIG. 280,*6*. *H. pratzi* FELIX, U.Cret.(Turon.), Aus.(Gosau); *6a,* ×1; *6b,* transv. septal sec., ×2 (42).

Leptophyllaraea ALLOITEAU, 1952 [**Leptophyllia granulata* FROMENTEL, 1863]. Like *Haplaraea* but turbinate and lacking epitheca. *M.Cret.-U.Cret.,* Eu.——FIG. 280,*1*. *L. conclavina* (OPPENHEIM), U.Cret.(Turon.), Aus.(Gosau); *1a,b,* ×1 (100).

Physoseris VAUGHAN, 1905 [**Trochoseris insignis* DUNCAN, 1873]. Like *Haplaraea* but lacking epitheca and with lower part of wall paratheca1. *Eoc.,* W.Indies.

Diplaraea MILASCHEWITSCH, 1876 [**D. arbuscula*]. Like *Haplaraea* but phaceloid colonies formed by intratentacular budding, corallites monocentric. *U.Jur.-L.Cret,* Eu.-S.Am.

Pseudofavia OPPENHEIM, 1930 [*pro Parastraea* REUSS, 1854 (*non* M.EDW.-H., 1848)] [**Parastraea grandiflora* REUSS, 1854] [=*Cretastraea* KÜHN, 1930]. Like *Haplaraea* but massive plocoid heads formed by extratentacular budding. Corallites closely united by short costae. *U.Cret.,* Eu.——FIG. 280, *8*. **P. grandiflora* (Turon.), Aus.(Gosau); *8a,* ×0.5; *8b,* transv. sec., ×2.5 (100).

Trechmannaria WELLS, 1935 [**T. montanaroae*] [=?*Stiboriopsis* VAUGHAN, 1899]. Like *Pseudofavia* but colony formation by intratentacular polystomodaeal budding, with short meandrine series; centers linked by porous lamellae. *U.Cret.,* W. Indies.

Summiktaraea ALLOITEAU, 1952 [**Meandrastrea reticulata* ORB., 1850]. Like *Trechmannaria* but series long and contorted. *U.Cret.,* Eu.

Astraraea FELIX, 1900 [**Thamnastrea media* SOWERBY, 1832; SD WELLS, 1936]. Like *Pseudofavia* but corallites much smaller, colony formation by intratentacular mono- to tristomodaeal budding; corallites permanently monocentric. *U.Cret.,* Eu.——FIG. 280,*5*. *A. columellata* OPPENHEIM, Turon., Aus.(Gosau); ×1 (100).

?**Confusastraraea** GERTH, 1933 [**Confusastraea obsoleta* GERTH, 1921] [=?*Polyaraea* FRITSCH, 1878]. Small plocoid colonies formed by intratentacular budding, with large corallites; septa very porous. *?Eoc., Mio.,* E.Indies.

Family FUNGIIDAE Dana, 1846

Solitary and colonial, fixed or free, mostly hermatypic. Solitary corallites discoidal or elongate-oval, aboral surface flat or concave. Colonies discoidal or elongate-oval, free or foliaceous and fixed; colony formation by incomplete intratentacular polystomodaeal budding. Wall synapticulothecate, commonly secondarily septothecal or thickened. Septa numerous, fenestrate in early stages, perforate or solid, composed of a single fan system of compound trabeculae producing simple or compound marginal dentations, laterally united by stout compound synapticulae (Fig. 242*C*). Axis of trabecular divergence horizontal in ephebic stage. Costae continuous or broken up into spinose projections. Columella trabecular, feeble. Dissepiments absent; epitheca only in early anthoblast stage. Homeomorphic with Cyclolitidae. *M.Cret.-Rec.,* Eurasia-IndoPac.

Cycloseris M.EDW.-H., 1849 [**Fungia cyclolites* LAMARCK, 1801] [=*Diaseris* M.EDW.-H., 1849; *Actinoseris* ORB., 1849; *Asteroseris* FROMENTEL, 1867; *Microseris* FROM., 1870; *Javanoseris* GERTH, 1922; ?*Funginellastraea* ALLOITEAU, 1952]. Solitary, small discoid to cupolate. Wall imperforate, with well-defined costae. Lower-cycle septa imperforate with acute dentations; higher cycles more or less perforate; cyclolitid in structure. *M.Cret.-Rec.,* Eurasia-IndoPac., depth range, 0-411 m.——FIG. 281,*1*. *C. fragilis* ALCOCK, Rec,. Sulu I., 37 m.; ×0.5 (175).

?**Discotrochus** M.EDW.-H., 1848 [**D. orbignyanus*]. Like *Cycloseris* but smaller, with relatively few septa (4 cycles), beaded on margins; ahermatypic. *Eoc.,* USA; *Oligo.-Mio.,* ?Russia, ?Italy.——FIG. 281,*2*. **D. orbignyanus,* M.Eoc.(Claib.), USA; *2a-c,* ×2 (151); *2d,* nat. long. sec., ×3 (144).

Lithophyllon REHBERG, 1892 [**L. undulatum* (=*Leptoseris edwardsi* ROUSSEAU, 1850)]. Like *Cycloseris* in structure but forming fixed, unifacial, foliaceous colonies by marginal budding. *Oligo.-Rec.,* Eu.-IndoPac.

Fungia LAMARCK, 1801 [*pro Fungites* CUVIER, 1798 (*non* GLEDITSCH, 1765)] [**Madrepora fungites* LINNÉ, 1758; SD LEUCKART, 1841] [=*Haliglossa* EHR., 1834 *(partim); Ctenactis, Lobactis, Pleuractis* VERRILL, 1864]. Solitary, discoid, or elongate-oval, flat or convex, free. Wall perforate in ephebic stage. Costae mostly reduced to rows of spines. Septa imperforate except highest cycles, strongly dentate. Contains 6 species groups: (1) *F. echinata* group, with triangular septal dentations, costal spines tall and spinose; (2) *F. scutaria* group, with rounded septal dentations and horizontal lateral ridges, costal spines small, beaded; (3) *F. repanda* group, with subtriangular septal dentations and irregular lateral ridges, costal spines beaded, commonly branching; (4) *F. danai* group, with triangular spinulose septal dentations, costal spines club-shaped, finely spinulose; (5) *F. actiniformis* group, with lobulate, finely spinulose septal teeth, costal spines short, minutely spinulose; (6) *F. fungites* group with triangular, acute, nearly smooth septal teeth, costal spines tall, nearly smooth. *Mio.-Rec.,* IndoPac.——Fig. 281,*4*. *F. scutaria* Lam., Rec., Hawaii; *4a,b,* ×0.5 (146).

Herpolitha Eschscholtz, 1826 [**Madrepora limax* Esper, 1797; SD M.Edw.-H., 1850] [=*Herpetolithus* Leuckart, 1841; *Herpetolitha* M.Edw.-H., 1860]. Colonial, elongate-oval, convex, free. Colony formation by linear polystomodaeal budding forming a deep axial furrow with a few lateral circumoral centers. Septal and costal structure as in *Fungites scutaria* group. *Rec.,* IndoPac.——Fig. 281,*6*. **H. limax* (Esper), Jaluit, Marshall I.; ×0.4 (198).

Polyphyllia Quoy & Gaimard, 1830 [**P. pelvis* (=*Fungia talpina* Lamarck, 1816)] [=*Lithactina* Lesson, 1832; *Cryptabacia* M.Edw.-H., 1849]. Similar to *Herpolitha* in early stages but secondary centers numerous and nearly equal in size to those of axial furrow. Structures as in *Fungites scutaria* group. *Rec.,* Pac.——Fig. 281,*5*. **P. talpina* (Lam.), E.Indies; ×0.2 (128).

Halomitra Dana, 1846 [**Madrepora pileus* Linné, 1758]. Subcircular, convex, free, lacking axial furrow. Colony formation by circumoral followed by marginal budding. Structures as in *Fungia fungites* group. *Rec.,* IndoPac.——Fig. 282,*1*. **H. pileus,* E.Indies; ×0.2 (193). (Also Fig. 248*C*.)

Parahalomitra Wells, 1937 [*pro Doederleinia* Gardinier, 1909 (*non* Steindachner, 1883)] [**Halomitra irregularis* Gardiner, 1898] [=*?Sandalolitha* Quelch, 1884]. Like *Halomitra* but structures as in *Fungia repanda* group. *Rec.,* IndoPac.

Podabacia M.Edw.-H., 1849 [**Agaricia cyathoides* Valenciennes in M.Edw.-H., 1849 (=*Madrepora crustacea* Pallas, 1766)]. Like *Parahalomitra* and

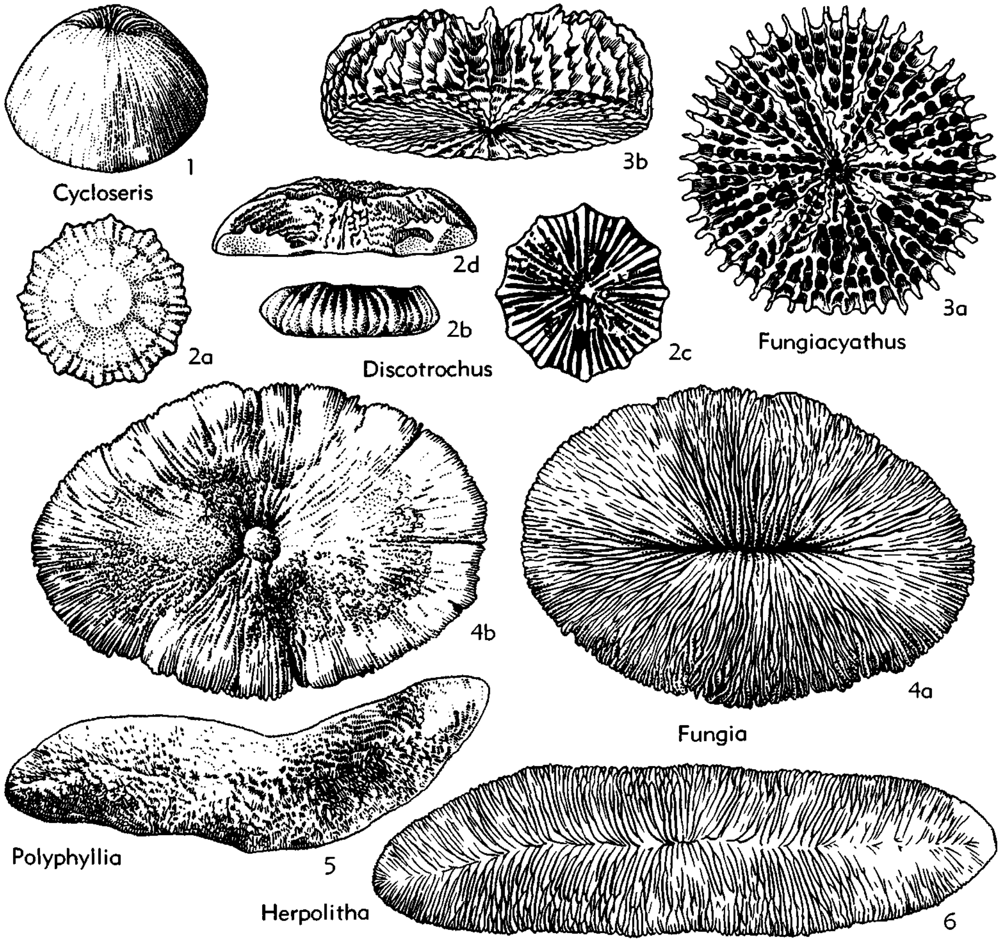


Fig. 281. Fungiina (Fungiicae): Fungiidae (p. F388-F390).

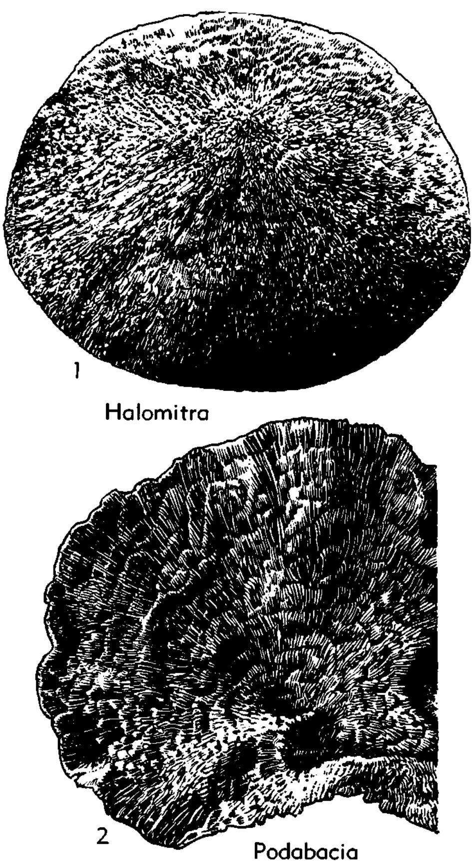


Fig. 282. Fungiina (Fungiicae): Fungiidae (p. F389-F390).

Fungia repanda group in structure but corallum chaliciform, fixed. *Rec.*, IndoPac.——Fig. 282,*2*. **P. crustacea* (Pallas), S.Philip.; ×0.3 (40).

Zoopilus Dana, 1846 [**Z. echinatus*]. Like *Halomitra* but secondary circumoral centers few and distant, and structures as in *Fungia echinata* group. *Rec.*, Pac.

?**Fungiacyathus** Sars, 1872 [**F. fragilis* (=*Fungia symmetrica* Pourtalès, 1871)] [=*Bathyactis* Moseley, 1881]. Solitary, discoidal or cupolate, free; ahermatypic. Costae thin, acute, spinose. Septa thin, dentations irregular and acute, laterally braced by thin, perforate plates (synapticulae?) extending upward and outward from the horizontal septotheca and by thin septal striae. *Tert.-Rec.*, cosmop., depth range 58-5,868 m.——Fig. 281,*3*. **F. symmetrica*, Rec., off Tristan da Cunha, 3,700 m.; *3a,b*, ×2 (97).

Family MICRABACIIDAE Vaughan, 1905

Solitary, cupolate, free; ahermatypic. No corallite wall, the costae alternating in position with the septa, beaded or smooth, fixed to septa by regularly spaced simple synapticulae. Septa composed of one fan system of simple trabeculae, perforate, margins dentate. Dissepiments absent. Columella trabecular. *Cret.-Rec.*

Micrabacia M.Edw.-H., 1849 [**Fungia coronula* Goldf., 1827] [=*Discopsammia* Orb., 1849; *Stephanoseris* Fromentel, 1863 (*non* M.Edw.-H., 1851); *Cyclabacia* Bölsche, 1866; *Diafungia* Duncan, 1884]. Small, up to 15 mm. in diameter. Septal margins nearly vertical peripherally, with small, transverse dentations. *Cret.-Rec.*, cosmop., depth range 91-328 m.——Fig. 283,*1a-c*. *M. mineolensis* Stephenson, U.Cret., Tex.; *1a-c*, ×4 (191).——Fig. 283,*1d*. *M. rotatilis* Stephenson, U.Cret., Md.; nat. long. sec., ×4 (191).

Stephanophyllia Michelin, 1841 [**Fungia elegans* Bronn, 1837; SD M.Edw.-H., 1850] [=*Letepsammia, Stephanopsammia* Yabe & Eguchi, 1932]. Larger than *Micrabacia,* with septal margins forming peripheral shelf. *Eoc.-Rec.*, Eurasia-W.Pac., depth range 73-814 m.——Fig. 283,*3*. *S. imperialis* Mich., Mio.(Vindob.), Baden; *3a,b*, ×1 (113). (Also Fig. 257,*5*.)

Leptopenus Moseley, 1881 [**L. discus;* SD Wells, 1936]. Like *Stephanophyllia* but with very porous, delicate structures. Costae smooth, acute; septal dentations reduced to a few long spines. *Rec.*, S. Atl.-S.IndoPac., depth range 682-4,115 m.——Fig. 283,*2*. *L. hypocoelus* Moseley, 4,000 m., off Chile; *2a,b*, ×2 (97).

Superfamily PORITICAE Gray, 1842

[*nom. correct.* Wells, herein (*ex* Poritoidae Vaughan & Wells, 1943, *nom. transl. ex* Poritidae Gray, 1842)]

Colonial, rarely solitary. Septa formed by simple trabeculae; sclerodermites diverging at more or less regular intervals and fusing in plane of septum, forming a fenestrate, porous meshwork united laterally by simple synapticulae. *Jur.-Rec.*

Family MICROSOLENIDAE Koby, 1890

Solitary and colonial; hermatypic. Colony formation by intra- and extratentacular budding. Corallite walls absent or marked by synapticular rings. Septa thin, formed by one fan system of simple trabeculae, fenestrate, with abundant, regularly arranged perforations. Synapticulae simple, abundant between septa. Dissepiments feebly developed. Columella trabecular, feeble. *Jur.-Cret.*

Chomatoseris Thomas, 1936 [*pro* **Orbulites* Schweigger, 1819 (*non* Lamarck, 1801)] [**Madrepora porpites* Smith, 1816] [=*Anabacia auctt.* (*non* M.Edw.-H., 1849)]. Solitary, cupolate,

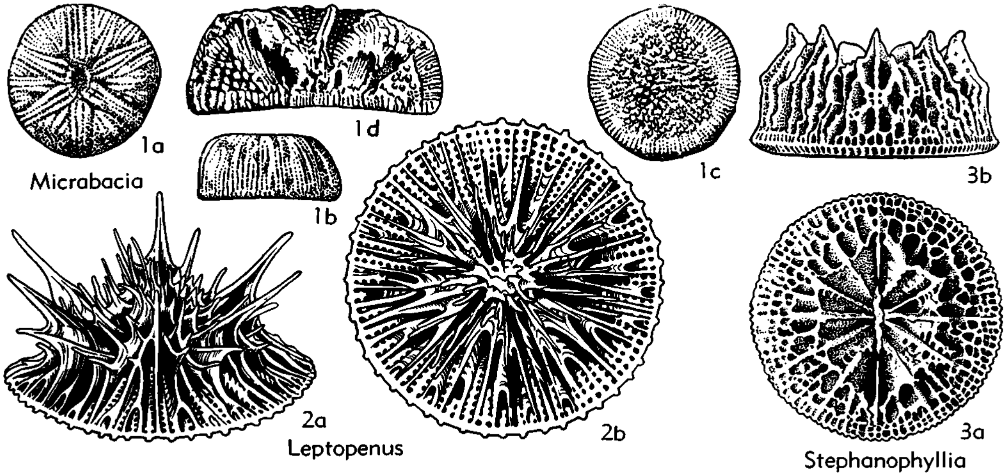


FIG. 283. Fungiina (Fungiicae): Micrabaciidae (p. F390).

free. *L.Jur.-M.Jur.*, Eurasia.——FIG. 285,*3*. *C. complanata* (DEFRANCE), M.Jur.(Bath.), Fr.; transv. sec., ×5 (199).

Semeloseris THOMAS, 1935 [**Tricycloseris limax* TOMES, 1883]. Like *Chomatoseris* but small subthamnasterioid colonies with several centers produced by polystomodaeal budding. *M.Jur.*, Eng.

Genabacia M.EDW.-H., 1849 [**Fungia stellatifera* D'ARCHIAC, 1843]. Like *Chomatoseris* but small colonies produced by circumoral budding, with 1 or 2 rings of secondary centers. Homeomorphic with *Aspidastraea*. *M.Jur.*, Eu.——FIG. 284,*3*. **G. stellatifera*, Bath., Fr.; *3a,b*, ×1 (186).

Trocharea ÉTALLON, 1864 [**T. actiniformis*] [=*Trochoplegma* GREGORY, 1900; *Trochophlegma* VAUGHAN, 1905; *Paracyclolites* WELLS, 1933]. Solitary, patellate to trochoid, or subcylindrical, fixed. *M.Jur.-Cret.*, Eurasia-N.Am.——FIG. 284,*1*. *T. bakerae* WELLS, M.Cret(Cenom.), Tex.; *1a,b*, ×1; *1c*, ×2 (158).

Mycetaraea PRATZ, 1882 [**Thamnastraea? dimorpha* BÖLSCHE, 1866]. Small, thamnasterioid colonies formed by intratentacular mono- to tristomodaeal budding, corallites permanently di- or tricentric. *U.Jur.*, Eu.

Disaraea FROMENTEL, 1861 [**D. cotteaui;* SD WELLS, 1936]. Phaceloid colonies formed by extratentacular budding; corallites cylindrical with stout epitheca. *U.Jur.*, Eu.

Dermoseris KOBY, 1887 [**D. schardti;* SD WELLS,

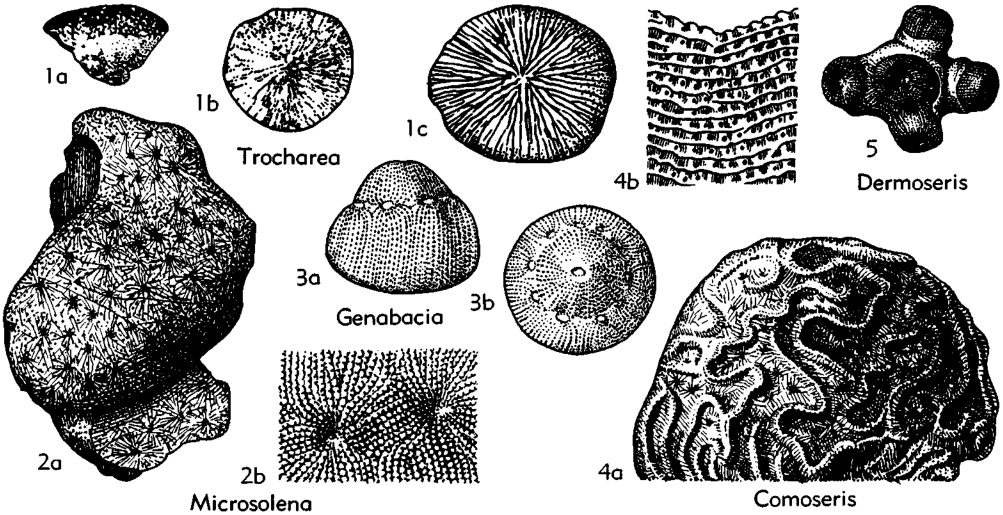


FIG. 284. Fungiina (Poriticae): Microsolenidae (p. F391-F392).

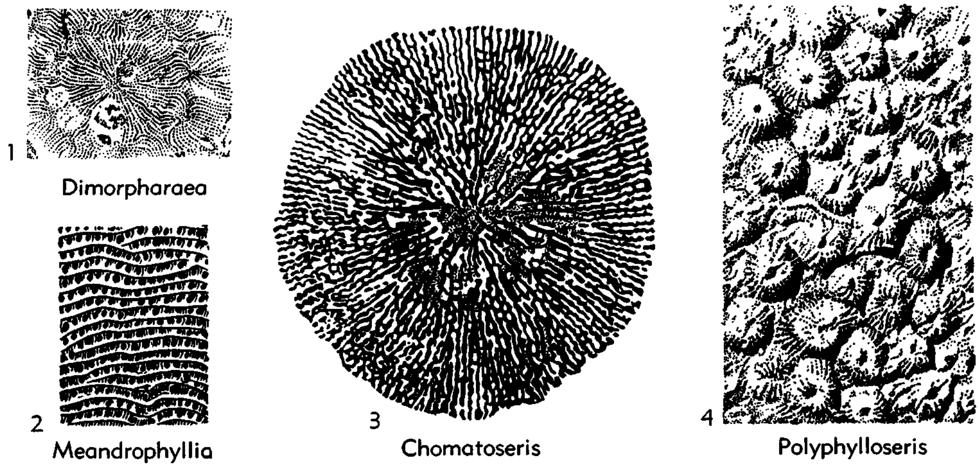


FIG. 285. Fungiina (Poriticae): Microsolenidae (p. F390-F392).

1936]. Like *Disaraea* but colony formation by intratentacular budding, corallites permanently monocentric. *U.Jur.,* Eu.——FIG. 284,*5*. *D. corymbosa* KOBY, Sequan., Port.; ×1 (73).

Dactylaraea ORB., 1849 [**D. truncata*]. Phaceloid tufts of small epithecate branches each with 1 to 3 centers formed by intratentacular polystomodaeal budding. *U.Jur.,* Eu.

Microsolena LAMOUROUX, 1821 [**M. porosa*] [=?*Turbinolopsis* LAMX., 1821; *Turbinastrea* BLAINV., 1830; *Trochopsis* EHR., 1834; *Polyphyllastrea* ORB., 1849; *Microsaraea* KOBY, 1890; *Camptodocis* DIETRICH, 1926]. Thamnasterioid, massive or explanate colonies formed by intratentacular marginal budding. Calices superficial. *M.Jur.-Cret.,* Eurasia-Afr.-N.Am.-S.Am.——FIG. 284,*2*. *M. fromenteli* KOBY, U.Jur.(Raur.), Switz.; *2a,* ×0.5; *2b,* ×2 (71).

Dimorpharaea FROMENTEL, 1861 [**Microsolena koechlini* M.EDW.-H., 1860; SD GREGORY, 1900] [=?*Anomophyllum* ROEMER, 1836]. Like *Microsolena* but colony formation by circumoral with some marginal budding. Homeomorphic with *Dimorphoseris* and *Dimorphastrea. M.Jur.-Cret.,* Eurasia-Afr.-N.Am.——FIG. 285,*1*. *D. manchacaensis* WELLS, M.Cret.(Cenom.), Tex.; transv. sec., ×2 (158).

Polyphylloseris FROMENTEL, 1857 [**Polyphyllastrea convexa* ORB., 1849; SD WELLS, 1936] [=*Mastophyllia* FELIX, 1891]. Like *Microsolena* but calices elevated on bosses or bourrelets. *U.Jur.-Cret.,* Eurasia-N.Am.——FIG. 285,*4*. *P. simondsi* WELLS, L.Cret.(Apt.), Tex.; ×1 (157).

Meandrophyllia ORB., 1849 [**Meandrina lotharinga* MICHELIN, 1843] [=*Meandraraea* ÉTALLON, 1859; *Latimaeandraraea* FROMENTEL, 1861; *Michelinaraea* ALLOITEAU, 1952]. Massive or columniform colonies formed by intratentacular intramural budding; collines continuous; valleys discontinuous. *M.Jur.-Cret.,* Eurasia-Afr.-N.Am.-S.Am.——FIG. 285,*2*. *M. gressleyi* (ÉTAL.), U. Jur.(Raur.), Switz.; lat. aspect of septa, ×4 (71).

Comoseris ORB., 1849 [**Pavonia maeandrinoides* MICHELIN, 1843] [=*Oroseris* M.EDW.-H., 1851; *Commoseris* FROMENTEL, 1865]. Like *Meandrophyllia* but commonly foliaceous, with several series of centers between collines. *M.Jur.-U.Jur.,* Eu.——FIG. 284,*4*. **C. maeandrinoides,* U.Jur.(Sequan.), Port.; *4a,* ×1 (73); Switz.; lat. aspect of septum, *4b,* ×5 (71).

Gosaviaraea OPPENHEIM, 1930 [**G. camerina*]. Like *Microsolena* but septa irregularly porous with some distal bifurcation. *U.Cret.,* Eu.

Family ACTINACIDIDAE Vaughan & Wells, 1943

Colonial; hermatypic. Colony formation by intra- and extratentacular budding. Synapticulothecate. Septa relatively few, formed by one fan system of 3 to 5 nearly vertical simple trabeculae, pores common, laterally united by simple synapticulae, innermost trabeculae commonly differentiated as paliform lobes. Distinct septocostae scarcely distinguishable, or absent where distal ends of septa bifurcate and become lost in coenosteum formed by discontinuous vertical trabeculae united horizontally by simple trabeculae. Columella absent or formed by one or more trabecular pillars. Endothecal dissepiments thin and subtabular. *U.Jur.-Oligo.*

Actinaraea ORB., 1849 [**Agaricia granulata* MÜNSTER in GOLDF., 1833]. Colony formation by intratentacular budding. Calicular margins definite. Septocostae present but somewhat vague. No palar trabeculae. *U.Jur.,* Eu.——FIG. 286,*3*. **A. granulata,* U.Jur.(Kimm.), Ger.; ×3 (7).

Dendraraea Orb., 1849 [**Alveopora racemosa* Michelin, 1843] [=*Thamnaraea* Étallon, 1864; *Spongitamnia* Gregorio, 1884]. Colony formation by intratentacular budding, producing ramose or submassive colonies. Structures similar to *Actinaraea* but septocostae much reduced and coenosteum distinctly layered. *M.Jur.-L.Cret.,* Eurasia-S.Am.

Elephantaria Oppenheim, 1930 [**E. lindstroemi*]. Submassive colonies produced by extratentacular budding. Septocostae very reduced. Columellar trabeculae developed. *U.Cret.,* Eu.-W.Indies.——Fig. 286,*2*. **E. lindstroemi,* U.Cret.(Turon.), Aus.(Gosau); transv. sec., ×5 (100).

Actinacis Orb., 1849 [**A. martiniana*] [=*Neostroma* Tornquist, 1901]. Submassive to ramose; colony formation by extratentacular budding. Septa commonly in 3 cycles with one crown of 6 to 8 palar trabeculae. One columellar trabecula. *M.Cret.-Oligo.,* Eurasia-N.Am.-S.Am.-W.Indies-Afr.——Fig. 286,*1a*. *A.* sp., U.Cret.(Coni.), Corbières, Fr.; long sec., ×30 (5).——Fig. 286,*1b*. **A. martiniana,* U.Cret.(Turon.), Aus.(Gosau); transv. sec., ×10 (151).——Fig. 286,*1c*. *A. elegans* Reuss, U.Cret.(Turon.), Aus.(Gosau); ×1 (100).

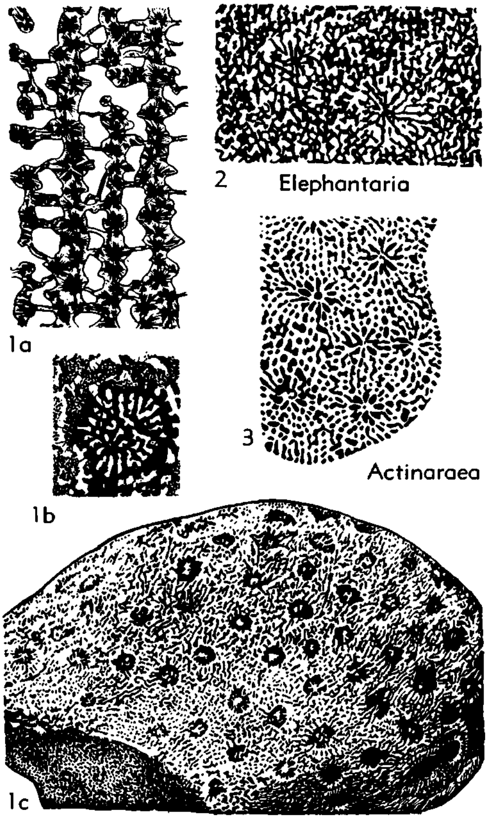


Fig. 286. Fungiina (Poriticae): Actinacididae (p. F392-F393).

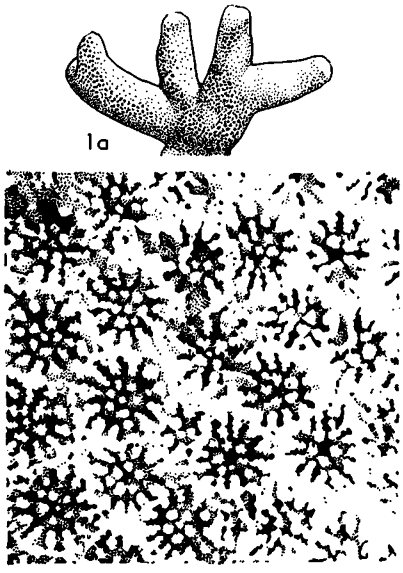


Fig. 287. Fungiina (Poriticae): Poritidae (p. F393).

Family PORITIDAE Gray, 1842

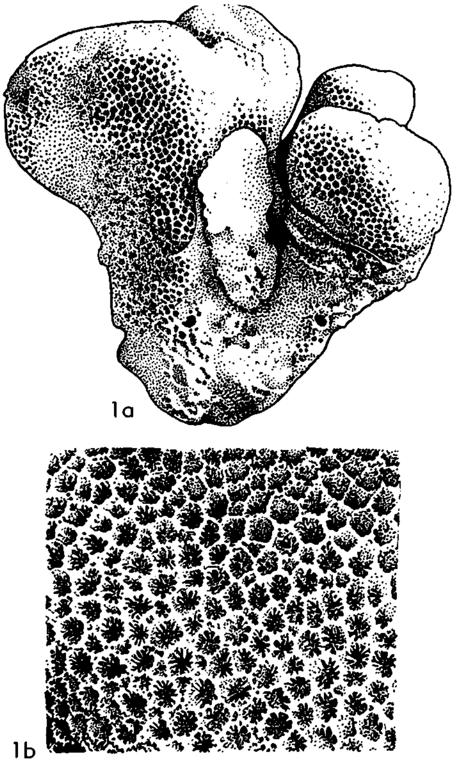
Colonial, hermatypic. Colony formation by extratentacular budding. Corallites mostly united closely without coenosteum, limited by one or more synapticular rings. Septa (except *Alveopora*) formed by 3 to 8 nearly vertical trabeculae, loosely united, with more or less regular perforations. Innermost trabeculae of certain septa differentiated as pali. A single columellar trabecula. *M.Cret.-Rec.*

Goniopora Blainv., 1830 [**G. pedunculata*] [=*Goniaraea* Orb., 1849; *Litharaea, Rhodaraea* M.Edw.-H., 1849; *Tichopora* Quelch, 1886]. Massive, columniform, or ramose, rarely incrusting. Septa generally in 3 cycles, formed by 4 to 8 trabeculae. *M.Cret.-Rec.,* Eu.-Pac.——Fig. 289,*3* (131). *G. duofaciata* Thiel, Rec., Philip.; ×5 (128).

Porites Link, 1807 [**P. polymorphus* (=*Madrepora porites* Pallas, 1766, *partim*)] [=*?Stylaraea* M. Edw.-H., 1851; *Cosmoporites, Neoporites* Duchaissing & Michelotti, 1860]. Massive, ramose, or incrusting. Corallites smaller (to 2 mm.) than *Goniopora,* with only 2 septal cycles. Septa formed by 3 to 4 trabeculae. One of the most important hermatypic coral genera, second only to *Acropora. Eoc.-Rec.,* cosmop.

P. (Porites), *Eoc.-Rec.*——Fig. 287,*1*. **P. (P.) porites,* Rec., W.Indies; *1a,* ×0.3; *1b,* ×10 (151).

P. (Synaraea) Verrill, 1864 [**Porites erosa* Dana, 1846; SD Vaughan, 1919] [=*Napopora* Quelch, 1884]. Like *P. (Porites)* but calices superficial,



Alveopora

FIG. 288. Fungiina (Poriticae): Poritidae (p. F393-F394).

separated by finely porous coenosteum, commonly raised in ridges. *Oligo.-Rec.*, W.Indies-IndoPac.——FIG. 289,*2*. *P. (S.) horizontalata* HOFFMEISTER, Rec., Bikini, Marshall I.; ×5 (198).

Dictyaraea REUSS, 1867 [**D. micrantha;* SD GREGORY, 1925]. Ramose with slender branches, cerioid. Septa on plan of *Porites* but generally very irregular and much thickened secondarily with obliteration of basic plan. *Mio.-Plio.*, W.Pac.——FIG. 289, *1*. **D. micrantha*, Mio., Java; *1a*, ×1; *1b*, ×5 (115).

Alveopora BLAINV., 1830 [**Madrepora daedalea* FORSKÅL, 1775; SD WELLS, 1936] [=*Porastrea* M.EDW.-H., 1848; *Favositipora* SAVILLE-KENT, 1870; *?Diechoraea* T. WOODS, 1879]. Massive or ramose. Septa in 1 to 3 cycles, represented by nearly horizontal spines projecting inward from mural trabeculae. *Eoc.-Rec.*, Eu.-IndoPac.——FIG. 288,*1*. *A. verrilliana* DANA, Rec., Japan; *1a*, ×0.4; *1b*, ×2 (198).

Suborder FAVIINA Vaughan & Wells, 1943

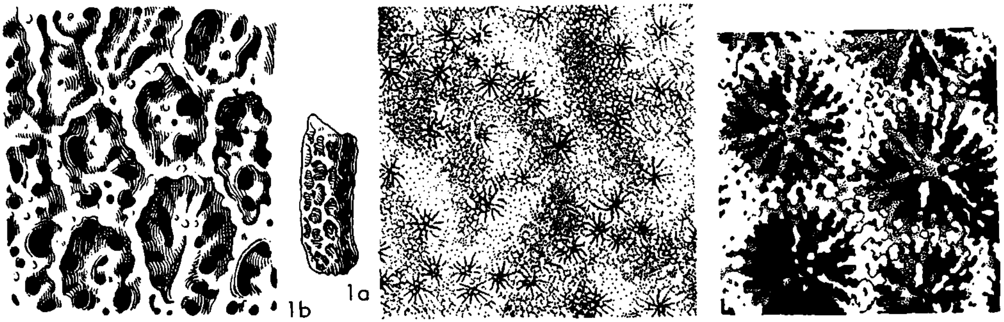
[*nom. correct.* WELLS, herein (*ex* Faviida VAUGHAN & WELLS, 1943)]

Solitary and colonial. Corallite wall epithecal, septothecal, or parathecal. Septa formed by one or more fan systems of simple or compound trabeculae, ranging from isolated spines to imperforate laminae, margins more or less regularly dentate. Dissepiments well developed. Synapticulae very rare. *M. Trias.-Rec.*

Superfamily STYLOPHYLLICAE Volz, 1896

[*nom. transl.* WELLS, herein (*ex* Stylophyllidae, VOLZ, 1896)]

Solitary and colonial; colony formation by extratentacular (parricidal or intracalicular) or intratentacular budding. Wall epithecal, secondarily thickened internally. Septa essentially laminar, ranging from isolated trabecular spines to solid laminae, commonly discontinuous vertically. Columella absent or represented by elongated septum. Endothecal dissepiments generally bizonal: peripherally vesicular, and centrally tabular. *M. Trias.-Cret.*



Dictyaraea

Porites (Synaraea) 2

Goniopora 3

FIG. 289. Fungiina (Poriticae): Poritidae (p. F393-F394).

Family STYLOPHYLLIDAE Volz, 1896

Solitary and colonial, hermatypic. Septa scarcely exsert, formed by simple or compound trabecular spines inclined inward from periphery, isolated or laterally united as vertically discontinuous laminae, interrupted by dissepiments. No columella. *M. Trias.-L.Jur.*

Stylophyllum Reuss, 1854 [**S. polyacanthum*]. Solitary, or small phaceloid or cerioid colonies formed by extratentacular intracalicular budding. Corallites free laterally. Septal spines rarely fused into laminae. Endothecal dissepiments tabular. *U.Trias.,* Eu.——Fig. 290,*2a,b.* **S. polyacanthum,* U.Trias.(Nor.), Aus.; transv. and long. secs., ×1 (112).——Fig. 290,*2c,d. S. paradoxum* Frech, U.Trias.(Nor.), Aus.; ×1 (50).

Oppelismilia Duncan, 1867 [**O. gemmans*] [=?*Epismilia* Fromentel, 1861; *Stylophyllopsis* Frech, 1890; *Molluḳḳia* Jaworski, 1915; ?*Epismiliopsis, Plesiophyllum* Alloiteau, 1952]. Like *Stylophyllum* but the trabecular septal spines tend to fuse and form subcompact septal laminae. *U. Trias.-Jur.,* Eurasia-E.Indies-N.Am.-S.Am.——Fig. 290,*1a,b. O. rudis* (Emmrich), U.Trias. (Rhaet.), Aus.; ×1 (50).——Fig. 290,*1c. O. rugosa* (Duncan & Wright), L.Jur., Eng.; transv. sec., ×5 (192).——Fig. 290,*1d. O. mucronata* (Duncan), U.Jur., Eng.; septal margin, ×3 (192).

Coccophyllum Reuss, 1865 [**C. sturi*]. Like *Stylophyllum* but cerioid. Endothecal dissepiments mostly tabular. *U.Trias.,* Eu.——Fig. 290,*3.* **C. sturi,* U.Trias.(Nor.), Aus.; *3a,b,* surface and long secs., ×1 (50).

Maeandrostylis Frech, 1890 [**Stylophyllum (M.) irregulare*]. Like *Oppelismilia* but small corallites forming small, submassive colonies by intratentacular intramural budding, in short series. *U. Trias.,* Eu.

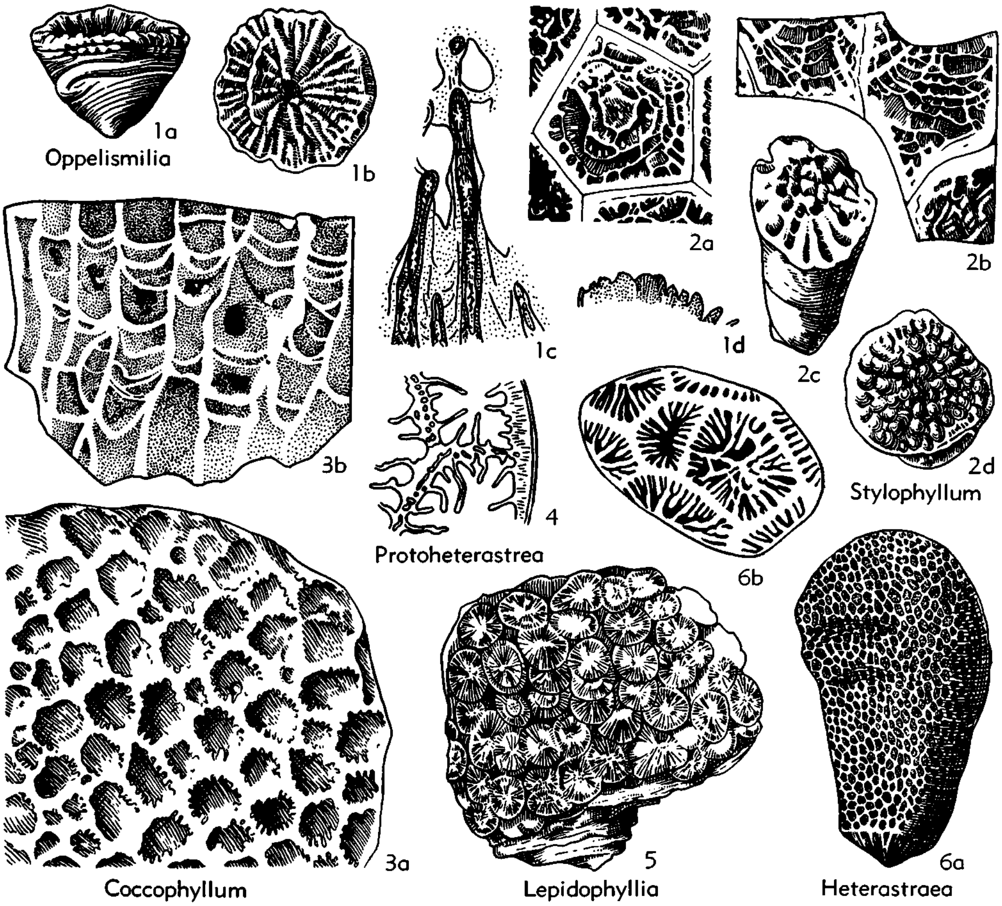


Fig. 290. Faviina (Stylophyllicae): Stylophyllidae (p. F395-F396).

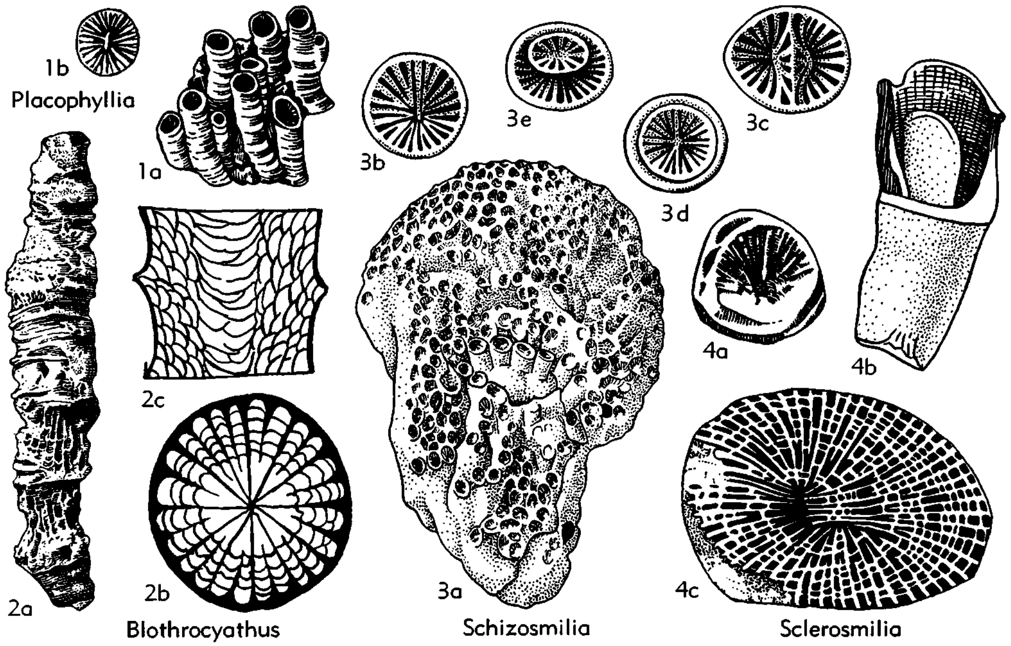


Fig. 291. Faviina (Stylophyllicae): Amphiastreidae (p. F396-F398).

Lepidophyllia Duncan, 1868 [**L. hebridensis;* SD Wells, 1936]. Like *Oppelismilia* but phaceloid; massive, subglobose colonies with small corallites, formed by extratentacular budding. *L.Jur.*, Br.I.-S.Am.——Fig. 290,*5*. **L. hebridensis,* L.Jur. (Sinem.), Hebrides; ×0.5 (30).

Protoheterastrea Wells, 1937 [*pro Hexastraea* Volz, 1896 (*non* Sismonda, 1871)] [**Hexastraea leonhardi* Volz, 1896]. Small, dendroid or phaceloid colonies by intratentacular budding; corallites monocentric. Septa composed of inwardly inclined spines commonly fusing in subcompact laminae. Endothecal dissepiments mostly tabular, but may be vesicular peripherally. *M.Trias.*, Eu.——Fig. 290,*4*. *P. fritschi* (Volz), Aus.; transv. sec., ×10 (155).

Heterastraea Tomes, 1888 [**Isastrea tomesi* Duncan, 1868; SD Vaughan & Wells, 1943]. Like *Protoheterastrea* but cerioid, with some di- or tristomodaeal budding. *U.Trias.-L.Jur.*, Eu.——Fig. 290,*6*. *H. haimei* (Duncan), L.Jur.(Hett.), Eng.; *6a*, ×0.5; *6b*, ×3 (30).

Family AMPHIASTREIDAE Ogilvie, 1896

Solitary and colonial, hermatypic. Septa nonexsert, formed by one scarcely diverging system of relatively few trabeculae, laminar, with nearly smooth or beaded margins, commonly interrupted vertically. Columella absent, but one larger septum generally projects into the axial space. In early forms, an outer endothecal zone of dissepiments is absent or weakly developed. In central members of the family, outer ends of septa may be withdrawn from the corallite wall (aphroid condition). In later types, bilaterality produced by columellar septum or septal group is lost. *M.Jur.-Cret.*

Ceratocoenia Tomes, 1884 [**C. elongata*]. Solitary, elongate, ceratoid or cylindrical. Septa few, radial, laminar. Endothecal dissepiments tabular. *M.Jur.*, Eu.——Fig. 292,*5*. **C. elongata,* M.Jur.(Bath.), Fr., ×0.5 (194).

Discocoenia Tomes, 1884 [**D. bononiensis*]. Like *Ceratocoenia* but patellate. *M.Jur.*, Eu.

Budaia Wells, 1933 [**B. travisensis*]. Like *Ceratocoenia* but with 2 endothecal zones, an outer vesicular and an inner tabular. *L.Cret.-M.Cret.*, N.Am.-S.Am.——Fig. 292,*3*. **B. travisensis,* M.Cret. (Cenom.), Tex.; *3a,b*, ×1 (158).

Aulastraeopora Prever, 1909 [**A. deangelisi;* SD Wells, 1936]. Like *Budaia* but phaceloid or cerioid. *M.Cret.*, Eu.

Cheilosmilia Koby, 1888 [**C. microstoma*]. Solitary, elongate, ceratoid. Septa rudimentary. *U.Jur.*, Eu.——Fig. 292,*4*. **C. microstoma,* U.Jur.(Raur.), Switz., *4a,b*, ×0.5 (71).

Sclerosmilia Koby, 1888 [**S. rugosa;* SD Wells, 1936] [=*Lingulosmilia* Koby, 1888; *Opisthophyllum* Ogilvie, 1897]. Solitary, elongate, cylindrical. Major septum well developed. *U.Jur.*, Eu.——Fig.

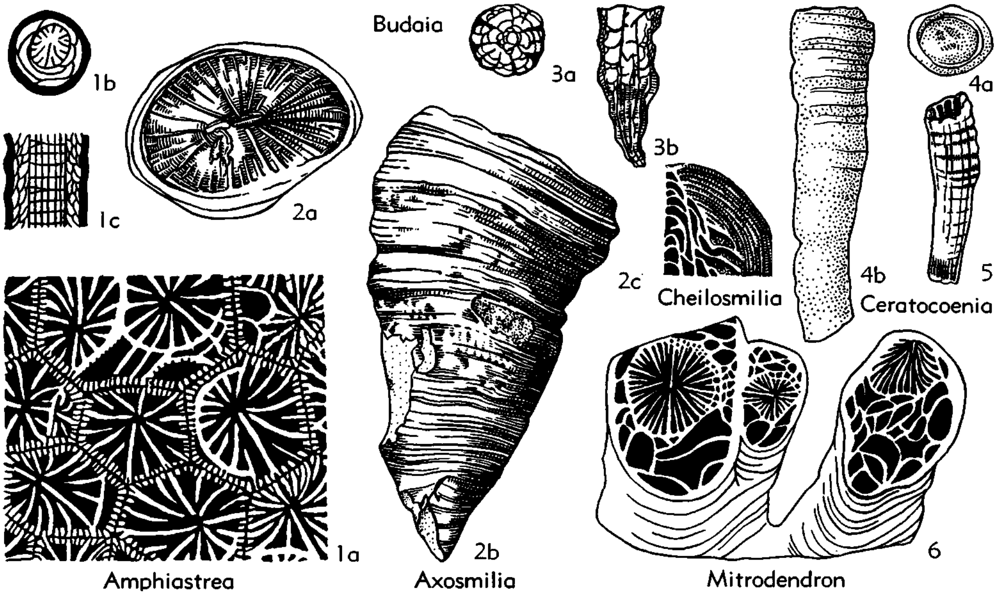


Fig. 292. Faviina (Stylophyllicae): Amphiastreidae (p. F396-F398).

291,*4a,b*. *S. excavata* (Koby), U.Jur.(Sequan.), Switz.; ×1 (71).——Fig. 291,*4c*. *S. vesiculare* (Ogilvie), U.Jur.(Portl.), Czech.; ×1 (99).

Donacosmilia Fromentel, 1861 [**D. corallina;* SD Wells, 1936] [=*?Pleurophyllia* From., 1861; *Pseudothecosmilia* Koby, 1888; *?Pseudostylina* Alloiteau, 1939; *?Pseudopisthophyllum* Geyer, 1955]. Like *Sclerosmilia* but forming phaceloid colonies *U.Jur.,* Eu.-AsiaM.

Schizosmilia Koby, 1888 [**S. excelsa;* SD Wells, 1936]. Like *Donacosmilia* but budding apparently intratentacular. *U.Jur.,* Eu.——Fig. 291,*3*. **S. excelsa,* U.Jur.(Sequan.), Switz.; *3a,* ×0.5; *3b-e,* ×3 (71).

Polymorphastraea Koby, 1907 [**P. variabilis*]. Solitary, ceratoid, but producing 4 smaller corallites parricidally in calice; structures as in *Sclerosmilia. M.Jur.,* Eu.

Mitrodendron Quenst., 1880 [**Lithodendron mitratum* Quenst., 1858] [=*Aulastraea* Ogilvie, 1897; *Amphiaulastrea* Geyer, 1955]. Columniform, composed of corallite groups enclosed by common epitheca as result of incomplete separation after intensive budding. Broad outer zone of vesicular endothecal dissepiments. *U.Jur.,* Eu.——Fig. 292, *6*. *M. schaferi* (Ogilvie), U.Jur.(Portl.), Czech.; ×1 (99).

Amphiastrea Étallon, 1859 [**A. basaltiformis*] [=*Diplocoenia* Duncan, 1867; *Diplothecastraea* Duncan, 1884; *Connectastrea* Koby, 1904; *Metaulastraea* Dietrich, 1926]. Like *Donacosmilia* and *Sclerosmilia* but massive, cerioid. Outer vesicular endothecal zone narrow. *M.Jur.-M.Cret.,* Eurasia-Afr.-N.Am.——Fig. 292,*1a*. *A. gracilis* Koby, U.Jur.(Portl.), Czech., transv. sec., ×4 (99).——Fig. 292,*1b,c*. *A. waltheri* de Angelis, L.Cret.(Apt.), Italy; transv. and long. secs., ×2 (173).

Oyonnaxastraea Alloiteau, 1952 [**O. schlumbergeri*]. Like *Amphiastrea* but wall thickened and major septum axially swollen. *U.Jur.,* Eu.

Latusastrea Orb., 1849 [**Explanaria alveolaris* Goldf., 1831] [=*Pleurocoenia* Orb., 1849; *Thecidiosmilia* Koby, 1888]. Colonial, foliaceous or incrusting; plocoid. Calices opening towards growing margin like pockets. *U.Jur.-L.Cret.,* Eu.——Fig. 293,*1*. **L. alveolaris,* U.Jur.(Kimm.), Ger.; ×1 (7).

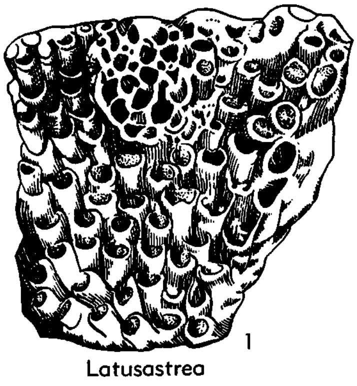


Fig. 293. Faviina (Stylophyllicae): Amphiastreidae (p. F397).

?**Thamnosmilia** TOMES, 1886 [**T. annulata*]. Dendroid, formed by lateral budding as in *Donacosmilia.* Columella trabecular. *M.Jur.*, Eng.

?**Lochmaeosmilia** WELLS, 1943 [*pro Eunomia* LAMX., 1821 (*non* RAFINESQUE, 1815; *nec* HÜBNER, 1818)] [**Stylosmilia trapeziformis* GREGORY, 1900]. Phaceloid, corallites very small, elongate, cylindrical or subprismatic. Endothecal dissepiments tabular (possibly a stylinid). *M.Jur.-U.Cret.*, Eurasia-Afr.

Selenegyra OGILVIE, 1897 [**S. geikiei*]. Phaceloid, colony formation as in *Schizosmilia;* corallites lunate or crescentiform in cross section. *U.Jur.*, Eu.

Axosmilia M.EDW.-H., 1848 [**Caryophyllia extinctorum* MICHELIN, 1840] [=*Pleurosmilia* FROMENTEL, 1856; *Blastosmilia* ÉTALLON, 1859; *Trismilia* FROM., 1861; *Axiphyllum* QUENST., 1880]. Solitary, turbinate, or subcylindrical. Lamellar columella formed by enlarged major septum. Endothecal dissepiments vesicular. *M.Jur.-M.Cret.*, Eu.-Afr.-N.Am.——FIG. 292,*2a,b*. *A. cuneata* (KOBY), U.Jur.(Sequan.), Port.; ×1 (71).——FIG. 292,*2c*. *A. pumila* (KOBY), U.Jur. (Sequan.), Switz.; septum and wall, ×1 (71).

Columnaphyllia GEYER, 1955 [**C. tithonica*]. Like *Axosmilia* but forming phaceloid colonies. *U.Jur.*, Eu.

Blothrocyathus WELLS, 1932 [**B. harrisi*]. Solitary, cylindrical, with relatively few septa, no columella; 2 zones of endothecal dissepiments. *L.Cret.*, N.Am. ——FIG. 291,*2*. **B. harrisi,* L.Cret.(Apt.), Tex.; *2a,* ×0.25, *2b,c,* transv. and long. secs., ×0.5 (157).

?**Plesiosmilia** MILASCHEWITSCH, 1876 [**P. turbinata;* SD WELLS, 1936]. Like *Axosmilia* but septa slightly exsert; wall parathecal. *U.Jur.*, Eu.

Placophyllia ORB., 1849 [**Lithodendron dianthus* GOLDF., 1827]. Like *Plesiosmilia* but forming small phaceloid colonies. *M.Jur.-U.Jur.*, Eu.——FIG. 291, *1*. *P. rugosa* BECKER, U.Jur.(Kimm.), Ger.; *1a,* ×0.5; *1b,* ×2 (7).

Superfamily FAVIICAE Gregory, 1900[1]

[*nom. transl.* WELLS, herein (*ex* Faviidae GREGORY, 1900)]

Solitary and colonial. Wall septothecal or parathecal. Septa laminar with very rare perforations, margins dentate. *M.Trias.-Rec.*

Family MONTLIVALTIIDAE Dietrich, 1926

Solitary and colonial, hermatypic. Colony formation by various plans of complete and incomplete intratentacular budding, lamellar linkages between corallite centers. Epitheca well developed. Septa exsert, formed by one fan system of large, mostly simple trabeculae, with regular conical dentations and lateral striae or granulations. Endothecal dissepiments abundant. *M.Trias.-Eoc.*

Subfamily MONTLIVALTIINAE Dietrich, 1926

[*nom. transl.* VAUGHAN & WELLS, 1943 (*ex.* Montlivaltiidae DIETRICH, 1926)]

Montlivaltiids with columella absent or trabecular. *M.Trias.-Cret.*

Montlivaltia LAMOUROUX, 1821 [**M. caryophyllata*] [=*Thecophyllia* M.EDW.-H., 1848; *Amblophyllia, Lasmophyllia, Perismilia* ORB., 1849; *?Cyathophyllia* FROMENTEL, 1865; *Coenotheca* QUENST., 1881; *Montlivaltiopsis, ?Paramontlivaltia, Stereophyllia, Trochophyllia* ALLOITEAU, 1952]. Solitary, cupolate, trochoid to subcylindrical, usually free in ephebic stage. Columella generally weak. *M.Trias.-Cret.*, cosmop.——FIG. 294,*2a,b*. *M. nattheimensis* MILASCHEWITZ, U.Jur.(Kimm.), Ger.; ×0.5 (7). ——FIG. 294,*2c*. *M. matheyi* KOBY, U.Jur.(Raur.), Fr.; lat. aspect of septum and wall, ×0.5 (71).

?**Ellipsosmilia** ORB., 1849 [**Montlivaltia? cornucopia* M.EDW.-H., 1849] [=*Veliphyllum* QUENST., 1880]. Like *Montlivaltia* but trabeculae inclined only inwards with no line of divergence and with irregular septal dentation (?may be a stylophyllid). *Cret.*, Eu.

Dimorphosmilia TOMES, 1902 [**D. eboracensis*]. Thamnasterioid; formed by circumoral followed by intramural budding. Radiating collines. *M.Jur.*, Eu.

Dimorphastrea ORB., 1850 [**D. grandiflora;* SD GREGORY, 1900] [=*Dimorphocoenia* FROMENTEL, 1857]. Like *Dimorphosmilia* but colony formation by circumoral budding only; no collines. *U.Jur.-M.Cret.*, Eurasia-Afr.——FIG. 294,*5*. *D. crassisepta* ORB., L.Cret.(Urgon.), Fr.; ×2 (72).

Thecosmilia M.EDW.-H., 1848 [**Lithodendron trichotomum* GOLDF., 1826] [=*Hymenophyllia* M.EDW.-H., 1851; *Bavarosmilia* KÜHN, 1942]. Phaceloid colonies formed by polystomodaeal budding, mono- to tristomodaeal conditions permanent. Polyphyletic. *M.Trias.-Cret.*, cosmop.——FIG. 294,*7a*. *T. annularis* (FLEMING), U.Jur., Eng.; ×0.5 (94).——FIG. 294,*7b*. *T. costata* FROMENTEL, U.Jur.(Raur.), Switz.; lat. aspect of septum and wall, ×2 (71).

Palaeastraea KÜHN, 1936 [**Phyllocoenia grandissima* FRECH, 1890] [=*Thigmastrea* WELLS, 1937]. Massive, plocoid, corallites mono- to tricentric, derived from Triassic Thecosmilias by incomplete separation of corallites. *M.Trias.-U.Trias.*, Eu.-N. Am.——FIG. 294,*1*. **P. grandissima,* U.Trias. (Nor.), Aus., transv. sec., ×1 (50).

Elysastraea LAUBE, 1864 [*pro Clausastrea* ORB., 1949 (*non* M.EDW.-H. 1849)] [**E. fischeri*]. Like *Palaeastraea* but cerioid. *M.Trias.-L.Jur.*, Eurasia-N.Am.

Margarastraea FRECH, 1896 [**Isastrea (Margarastraea) klipsteini*]. Like *Elysastraea* but meandroid.

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[1] The name Faviicae, which is accepted by the author for this superfamily, is not authorized by the International Rules, since it is based on a family group other than the first-published such taxon included in the assemblage (Oculinidae GRAY, 1847, or Meandrinidae GRAY, 1847). Accordingly, the author has been urged to submit an application to ICZN for validation of Faviicae by action under plenary powers.—EDITOR.

Series discontinuous, united directly by fused walls; collines acute. *U.Trias.*, Eu.

Phyllogyra Tomes, 1882 [**Symphyllia etheridgei* Duncan, 1874; SD Wells, 1936]. Meandroid, derived from Middle Jurassic Thecosmilias by polystomodaeal budding, commonly linear. Series discontinuous, closely joined by costae and exothecal dissepiments; collines rounded. *M.Jur.*, Eng.

Complexastrea Orb., 1849 [**C. subburgundiae* (=*Astrea rustica* Defrance, 1826] [=*Confusastrea* Orb., 1849]. Massive, plocoid, derived from Middle Jurassic Thecosmilias. Corallites monocentric, with parathecal wall. *M.Jur.-M.Cret.*, Eu.——Fig. 294,*4a*. **C. rustica,* U.Jur.(Raur.), Switz.; lat. aspect of septum and wall, ×2 (71).——Fig. 294,*4b*. *C. magnifica* (Tomes), M.Jur.(Bath.), Eng.; ×0.5 (131).

Meandrastrea Orb., 1849 [**Astrea pseudomeandrina* Michelin, 1841]. Massive, submeandroid colonies formed by polystomodaeal budding; series short, some corallites monocentric. *U.Cret.*, Eu.

Latiphyllia Fromentel, 1861 [**Lobophyllia requienii* Michelin, 1841; SD Wells, 1936] [=*Glyphephyllia* From., 1873]. Flabello-meandroid, colony formation by polystomodaeal linear budding; series free laterally. *U.Jur.-Cret.*, Eurasia-Madag.——Fig. 294,*6*. *L. suevica* (Quenst.), U. Jur.(Kimm.), Ger.; ×0.5 (7).

Fromentellia Ferry, 1863 [**F. fabryana;* SD Wells, 1936]. Like *Latiphyllia* but series closely united to summits by costae and exothecal dissepiments, separated by ambulacra. *M.Jur.-U.Jur.*, Eu.

Lasmosmilia Orb., 1849 [**Lobophyllia lobata* Michelin, 1846 (=*L. lobata* Blainv., 1830)]. Massive, plocoid, corallites united nearly to summits by costae and exothecal dissepiments. *M.Cret.-U.Cret.*, Eu.

Mycetophyllopsis Oppenheim, 1930 [**Mycetophyllia antiqua* Reuss, 1854]. Meandroid, series directly united over low common paratheca. *U.Cret.*, Eu. ——Fig. 294,*3*. **M. antiqua,* U.Cret.(Turon.), Aus.(Gosau); ×0.5 (112).

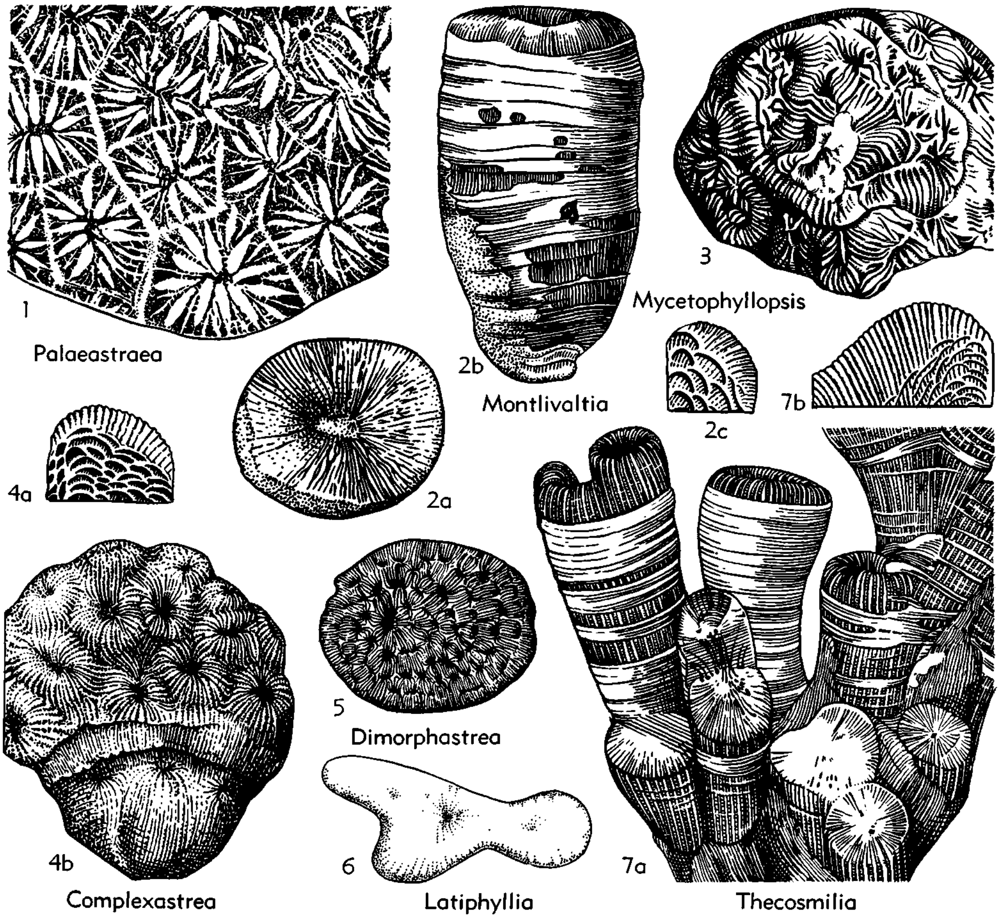


Fig. 294. Faviina (Faviicae): Montlivaltiidae (p. F398-F399).

Subfamily PLACOSMILIINAE Alloiteau, 1952

Montlivaltiids with well-developed lamellar columella. *U.Jur.-Eoc.*

Peplosmilia M.Edw.-H., 1850 [**P. austeni*] [=*Plesiosmilia* Koby, 1884 (*non* Sismonda, 1871)]. Solitary, subcylindrical, fixed. *U.Jur.-M.Cret.*, Eu.——Fig. 296,*3*. **P. austeni*, M.Cret. (Cenom.), Eng.; *3a,b*, ×0.5 (94).

Elasmophyllia d'Achiardi, 1875 [**E. gigantea*]. Phaceloid; colony formation by polystomodaeal budding, corallites mono- to tricentric. *Cret.-Eoc.*, Eu.-N.Am.-S.Am.——Fig. 295,*2*. *E. deformis* (Reuss), U.Cret.(Turon.), Aus.(Gosau); *2a,b*, ×1 (100).

Placosmilia M.Edw.-H., 1848 [**Turbinolia cymbula* Michelin, 1846; SD M.Edw.-H., 1850] [=*Lasmogyra* Orb., 1849; *Epigyra* Ferry, 1870; *Firia* Gregorio, 1894]. Flabellate, with a linear contorted series. *U.Cret.-Eoc.*, Eu.——Fig. 298,*2*. *P. tortuosa* (Felix), U.Cret(Turon.), Aus.(Gosau); transv. sec., ×1 (42).

Astrogyra Felix, 1900 [**Gyrosmilia edwardsi* Reuss, 1854]. Like *Lasmogyra* but with forked series united nearly to summits by costae and exothecal dissepiments; narrow ambulacra. *U.Cret.*, Eu.——Fig. 295,*4*. **A. edwardsi*, U.Cret.(Turon.), Aus.(Gosau); ×05 (100).

Taxogyra Wells, 1937 [*pro Heterophyllia* Orb., 1849 (*non* M'Coy, 1849)] [**Meandrina macroreina* Michelin, 1847]. Like *Astrogyra* but lacking ambulacra; series closely united to summits. *U.Cret.*, Eu.

Family FAVIIDAE Gregory, 1900

Solitary and colonial, mostly hermatypic. Colony formation by extratentacular or various plans of intratentacular budding. Septothecate or parathecate, rarely partially synapticulothecate. Septa exsert, laminar, formed by 1 or 2 fan systems of simple (compound in some later forms) trabeculae, more or less regularly dentate marginally. Paliform lobes formed by inner fan system commonly developed. Columella trabecular or laminar, rarely styliform or absent. *M.Jur.-Rec.*

Subfamily FAVIINAE Gregory, 1900

[*nom. transl.* Vaughan & Wells, 1943 (*ex* Faviidae Gregory, 1900)]

Solitary and colonial faviids, hermatypic. Colony formation by intratentacular budding (rare extratentacular budding). Septa formed by one fan system of simple trabeculae, commonly with small inner fan system. *U.Jur.-Rec.*

?Cladophyllia M.Edw.-H., 1851 [**Lithodendron*

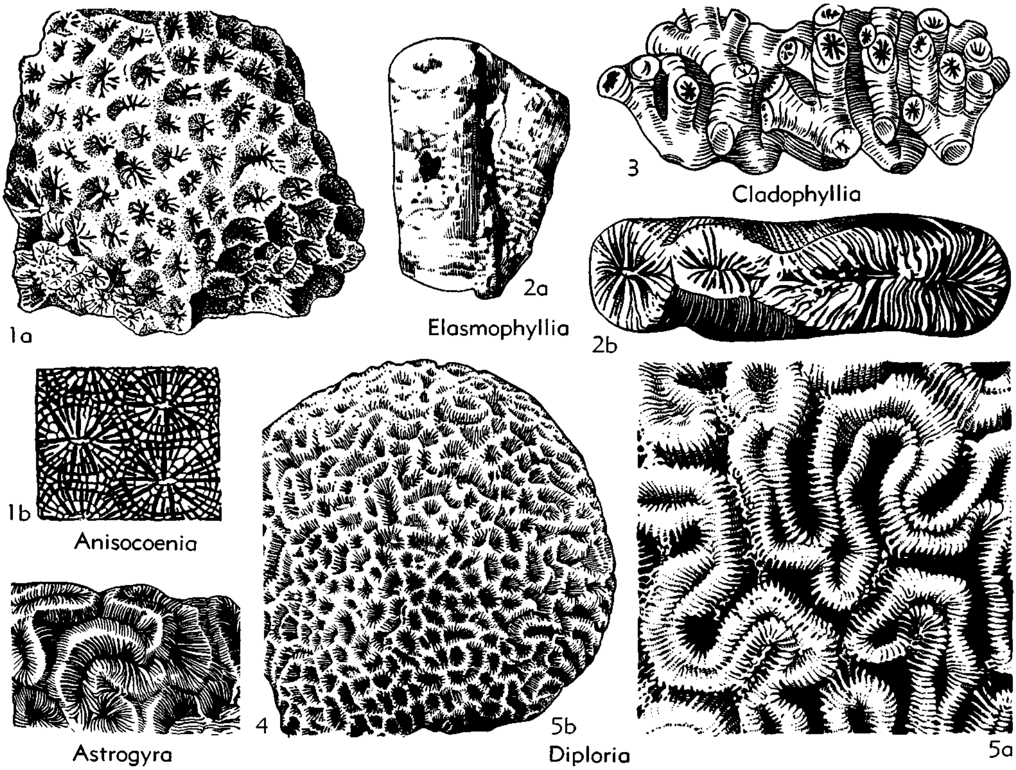


Fig. 295. Faviina (Faviicae): Montlivaltiidae, Faviidae (p. F400-F402).

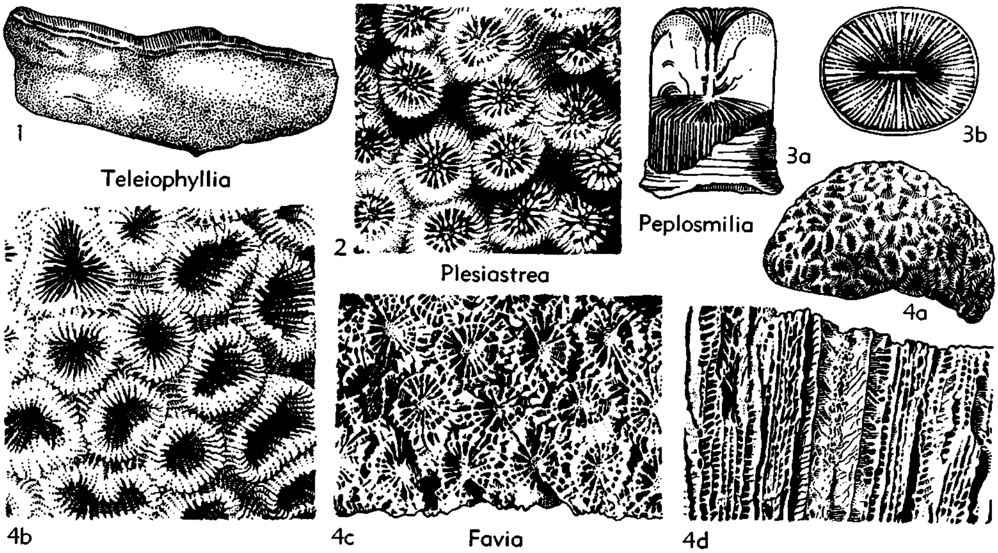


Fig. 296. Faviina (Faviicae): Montlivaltiidae, Faviidae (p. F402).

dichotomum Goldf., 1829; SD Wells, 1933]. Phaceloid tufts. Corallite walls epithecal; columella feeble, trabecular. *U.Jur.-M.Cret.,* Eu.-N.Am.-S. Am.——Fig. 295,*3*. *C. babeana* (Orb.), M.Jur. (Bath.), Eng.; ×1 (94).

Indosmilia Gerth, 1933 [**I. rembangensis*]. Solitary, trochoid, lacking columella. *Oligo.-Mio.,* Eu.-E.Indies.

Petrophylliella Felix, 1925 [*pro Petrophyllia* Felix, 1885 (*non* Conrad, 1855)] [**Caryophyllia grumi* Catullo, 1847]. Solitary, ceratoid, with well-developed trabecular columella. *Oligo.,* Eu.——Fig. 300,*5*. **P. grumi,* M.Oligo., Italy; *5a,* ×0.5; *5b,* ×1 (116).

Grumiphyllia Wells, 1937 [*pro Grumia* Oppenheim, 1899 (*non* Alphéraky, 1892)] [**Grumia diploctenium* Oppenheim, 1899]. Solitary (or ?colonial), flabellate, lacking columella. Homeomorphic with *Diploctenium*. *Oligo.,* Eu.

Laterophyllia Kühn, 1933 [=*L. turriformis*]. Forming tall colonies by budding from edge zone, buds so produced in turn budding intratentacularly to form short straight series. Columella lamellar. *Mio.,* Asia.

Caulastrea Dana, 1846 [**C. furcata*] [=*Dasyphyllia* M.Edw.-H., 1848; *Cricotheca* Quenst., 1881]. Phaceloid colonies produced by mono- to tristomodaeal budding, permanent condition mono- to tricentric. Columella feeble. *Eoc.-Rec.,* Eu.-Asia-IndoPac.——Fig. 297,*1*. **C. furcata,* Rec., Fiji; ×0.5 (88).

Desmocladia Reuss, 1874 [**D. septifera*]. Like *Caulastrea* but with short series partially united by some exothecal dissepiments. *Oligo.,* Eurasia.

Astraeosmilia Ortmann, 1892 [**A. connata*]. Like *Caulastrea* but subplocoid. *Rec.,* E.Afr.

Bikiniastrea Wells, 1954 [**B. laddi*]. Like *Caulastrea* but distomodaeal budding; corallum subdendroid, the corallites anastomosing, with some coenosteum. Corallite wall parathecal. *Rec.,* Pac.

Barabattoia Yabe & Sugiyama, 1941 [**B. mirabilis*]. Subplocoid, with corallites free at summits; colony formation by intra- and extratentacular budding. Intermediate between *Bikiniastrea* and *Plesiastrea*. *Rec.,* Pac.

Plesiastrea M.Edw.-H., 1848 [*pro Astrea* Lamarck, 1801 (*non* Brown, 1789; *nec* Bolten, 1798)] [**Astrea versipora* Lam., 1816] [=*Heliastrea* M. Edw.-H., 1857; ?*Plesiastreopsis* Chevalier, 1954]. Plocoid, corallites closely united nearly to summits; colony formation mostly by extratentacular budding. *Mio.-Rec.,* Eu.-IndoPac.——Fig. 296,*2*. **P. versipora,* Rec., Austral.(Torres Strait); ×2 (148).

Fig. 297. Faviina (Faviicae): Faviidae (p. F401).

Favia OKEN, 1815 [**Madrepora fragum* ESPER, 1795; SD M.EDW.-H., 1848] [=*Dipsastraea* BLAINV., 1830; *Fissicella* DANA, 1846; *Parastrea, Phymastrea* M.EDW.-H., 1848; *Ellipsocoenia, Thalamocoenia* ORB., 1850; *Stegiastrea* MENEGHINI, 1857; *Clypeofavia* ANGELIS, 1895; *?Pseudaulina* ALLOITEAU, 1954]. Plocoid, massive, foliaceous, or incrusting colonies formed by mono- to tristomodaeal budding, corallites permanently monocentric. Vesicular endo- and exothecal dissepiments. Columella trabecular, spongy. *Cret.-Rec.,* cosmop.——FIG. 296,*4a*. **F. fragum,* Rec., Fla.; ×0.5 (199).——FIG. 296,*4b-d*. *F. speciosa* (DANA), Rec., E.Indies; Cocos-Keeling; ×1 (148). (Also Fig. 249,*2*.)

Barbadiastrea WELLS, 1945 [**B. favioides*]. Like *Favia* but with lamellar columella. *Eoc.,* W.Indies.

Nefocoenia OPPENHEIM, 1930 [*pro Phyllastraea* FROMENTEL, 1877 (*non* DANA, 1846)] [**Areacis lobata* REUSS, 1854] [=*Proplesiastraea* OPPENHEIM, 1930]. Like *Favia* but with spinose coenosteum and short, thin, lamellar columella. *U.Cret.,* Eu.——FIG. 298,*3*. **N. lobata,* U.Cret.(Turon.), Aus.(Gosau); transv. sec., ×8 (42).

Diploria M.EDW.-H., 1848 [**Meandrina cerebriformis* LAMARCK, 1816 (=*Madrepora labyrinthiformis* LINNÉ, 1758)] [=*Maeandrella* OPPENHEIM, 1930 (*non* PERNA, 1903)]. Like *Favia* but meandroid; colony formation by polystomodaeal intramural budding with lateral branching and terminal forking; series long with thick collines, separated by ambulacra in some species. Columella continuous, trabecular. *U.Cret.-Rec.,* Eu.-N.Am.-W.Indies.——FIG. 295,*5a*. **D. labyrinthiformis,* Rec., Fla.; ×1 (151).——FIG. 295,*5b*. *D. strigosa* (DANA), Rec., Fla.; ×0.5 (151). (Also Fig. 248*B*.)

Favites LINK, 1807 [**F. astrinus* (=*Madrepora abdita* ELLIS & SOLANDER, 1786; SD VAUGHAN, 1901)] [=*Astrophyllia* EHR., 1834; *Cellastraea* BLAINV., 1834; *Aphrastrea, Prionastrea* M.EDW.-H., 1848; *Clausastrea* M.EDW.-H., 1849; *Plerastrea* M. EDW.-H., 1851; *Metastraea* M.EDW.-H., 1857; *Dyctioastraea, Halysiastraea* SISMONDA, 1871; *Ellasmoastraea, Plesiophyllia* MICHELOTTI in SISMONDA, 1871; *?Narcissastraea* PRATZ, 1883; *Allastraea* GREGORY, 1900]. Like *Favia* but cerioid. *Eoc.-Rec.,* Eu.-W.Indies-IndoPac.——FIG. 299,*2a,b*. **F. abdita,* Rec., Fiji; *2a,* ×1; *2b,* ×2 (148)——FIG. 299,*2c*. *F. affinis* KLUNZINGER, Rec., Red Sea; lat. aspect of septum, ×3 (151).

Oulophyllia M.EDW.-H., 1848 [**Meandrina crispa* LAMARCK, 1816] [=*Ulophyllia* M.EDW.-H., 1857]. Like *Favites* but meandroid; colony formation by intramural polystomodaeal budding. Series short, discontinuous, separated by simple, acute, parathecal collines. Centers linked by trabeculae. *M.Oligo.-Rec.,* Eu.-IndoPac.——FIG. 300,*6*. *O. aspera* QUELCH, Rec., Pac.; ×1 (88).

Goniastrea M.EDW.-H., 1848 [**Astrea retiformis* LAMARCK, 1816] [=*?Coelastrea* VERRILL, 1866]. Cerioid or submeandroid; colony formation by mono- to tristomodaeal budding, corallites permanently monocentric. Septa with scarcely dentate paliform lobes. Columella feeble. *Eoc.-Rec.,* N.Am.-W.Indies-IndoPac.——FIG. 298,*6*. *G. pectinata* (EHR.), Rec., Austral.(Torres Strait); ×2 (148). (Also Figs. 248*A*, 249,*3*.)

Anisocoenia REUSS, 1867 [**A. crassisepta*] [=*Favoidea* REUSS, 1867]. Like *Goniastrea* but lacking columella and with reduced paliform lobes. *Mio.,* E.Indies.——FIG. 295,*1*. **A. crassisepta,* Mio., Java; *1a,* ×1; *1b,* ×2 (115).

Lamellastraea DUNCAN, 1867 [**L. smythi*]. Like *Goniastrea* but with short, solid, lamellar columella. *Oligo.,* W.Indies.——FIG. 298,*1*. **L. smythi,* M.Oligo., Antigua; ×2.5 (198).

Ogilviastraea OPPENHEIM, 1930 [*pro Placohelia* FELIX, 1903 (*non* POČTA, 1887)] [**Placohelia bigemmis* FELIX, 1903]. Small subplocoid colonies formed by mono- or distomodaeal budding, permanent condition monocentric. Coenosteum extensive, solid. Columella elongate, commonly appearing lamellar. *U.Cret.,* Eu.——FIG. 300,*3*. **O. bigemmis,* U.Cret.(Turon.), Aus.(Gosau); *3a,* ×1; *3b,* ×3 (42).

?**Diplocoenia** FROMENTEL, 1857 [**D. mirabilis*]. Cerioid or subplocoid; colony formation by mono- or distomodaeal budding, permanent condition monocentric. Endothecal dissepiments vesicular, forming false "inner wall." Columella substyliform, fixed to several larger septa. *U.Jur.-L.Cret.,* Eu.-Afr.

Platygyra EHR., 1834 [**P. lamellina;* SD BRUEGGEMANN, 1879] [=*Coeloria, Astroria* M.EDW.-H., 1848; *Brachymeandrina* DUNCAN, 1884; *Miria* GREGORIO, 1894]. Meandroid; colony formation by linear intramural polystomodaeal budding with lateral branching and terminal forking. Collines narrow, septothecal. Larger septa commonly with small internal paliform lobes. Columella continuous, trabecular. *Eoc.-Rec.,* Eu.-IndoPac.——FIG. 298,*4*. **P. lamellina,* Rec., Austral.(Torres Strait); *4a,* ×1; *4b,* ×4, lat. aspect of septum; *4c,* ×4 (148).

Leptoria M.EDW.-H., 1848 [**Meandrina phrygia* LAMARCK, 1816 (=*Madrepora phrygia* ELLIS & SOLANDER, 1786)] [=*Cycloria* REUSS, 1854]. Meandroid; colony formation by intramural polystomodaeal budding. Collines simple, thin, septothecal. Columella thin, lamellar, continuous or not. *U.Cret.-Rec.,* Eu.-IndoPac.

L. (Leptoria). *U.Cret.-Rec.*——FIG. 299,*3*. *L. (L.) gracilis* (DANA), Rec., Fiji; *3a,* ×1; *3b,* ×3 (148). (Also Fig. 249,*4*.)

L. (Dictuophyllia) BLAINV., 1830 [**Meandrina reticulata* GOLDF., 1827] [=*?Anisoria* VIDAL, 1917]. Like *L. (Leptoria)* but collines separated by costate ambulacra. *U.Cret.-Oligo.,* Eu.-W. Indies-N.Am.——FIG. 298,*5*. *L. (D.) crassolamellosa* (M.EDW.-H.), U.Cret.(Turon.), Aus. (Gosau); ×0.5 (112).

Hydnophora FISCHER, 1807 [**H. demidovii*

(=*Madrepora exesa* Pallas, 1766)] [=*Monticularia* Lamarck, 1816; *Actinhelia, Monticulastraea* Duncan, 1880; *Monticulina* Saville-Kent, 1893; *Hydnophorella* Delage & Hérouard, 1901; *Staminocoenia* Gregory, 1930; *Hydnophoraraea* Oppenheim, 1930]. Hydnophoroid; colony formation by circummural polystomodaeal budding. Collines discontinuous, short, conical. Columella trabecular to lamellar, discontinuous. *Cret.-Rec.,* Eurasia-W. Indies-S.Am.-IndoPac.——Fig. 300,*1*. *H. microconos* (Lam.), Rec., Austral.(Torres Strait); *1a,* ×1; *1b,* ×3 (148). (Also Figs. 248*D*, 249,*5*.)

Thysanus Duncan, 1863 [**T. excentricus*]. Flabellate; colony formation by intramural budding proceeding away from parent center in one direction. Larger septa with small internal lobes. Columella trabecular below, sublamellar and interrupted above. *Mio.-Plio.,* W.Indies-N.Am.——Fig. 300,2. **T. excentricus,* Mio., Jamaica; *2a,b,* ×1 (195).

Teleiophyllia Duncan, 1864 [**T. grandis*]. Like *Thysanus* but budding proceeds in both directions from parent center. *Mio.,* W.Indies.——Fig. 296,*1*. **T. grandis,* Dominican Republic; ×0.5 (29).

Manicina Ehr., 1834 [**Madrepora areolata* Linné, 1758; SD M.Edw.-H., 1850] [=*Podasteria* Ehr., 1834]. Like *Teleiophyllia* but with forking and branching of series and development of ambulacra. *Mio.-Rec.,* W.Indies-Fla.——Fig. 299,*1*. **M. areolata,* Rec., Fla.; ×0.75 (201).

Colpophyllia M.Edw.-H., 1848 [**Meandrina gyrosa* Lamarck, 1816 (=*Madrepora gyrosa* Ellis & Solander, 1786, =*Madrepora natans* Müller, 1775)] [=*Hydnophyllia* Reis, 1889]. Meandroid; colony formation by intramural budding with terminal forking. Collines discontinuous, rarely with ambulacra. Series commonly discontinuous, linkages lamellar. Septa with very small or no internal lobes. *Eoc.-Rec.,* Eu.-W.Indies.——Fig. 300,*4*. *C. amaranthus* (Müller), Rec., Barbados; ×1 (88).

Montigyra Matthai, 1928 [**M. kenti*]. Subhydnophoroid; colony formation by intramural and circummural budding. Collines discontinuous; series continuous with lamellar linkages. *Rec.,* Ind.O.

Subfamily MONTASTREINAE Vaughan & Wells, 1943

Colonial, hermatypic faviids. Colony for-

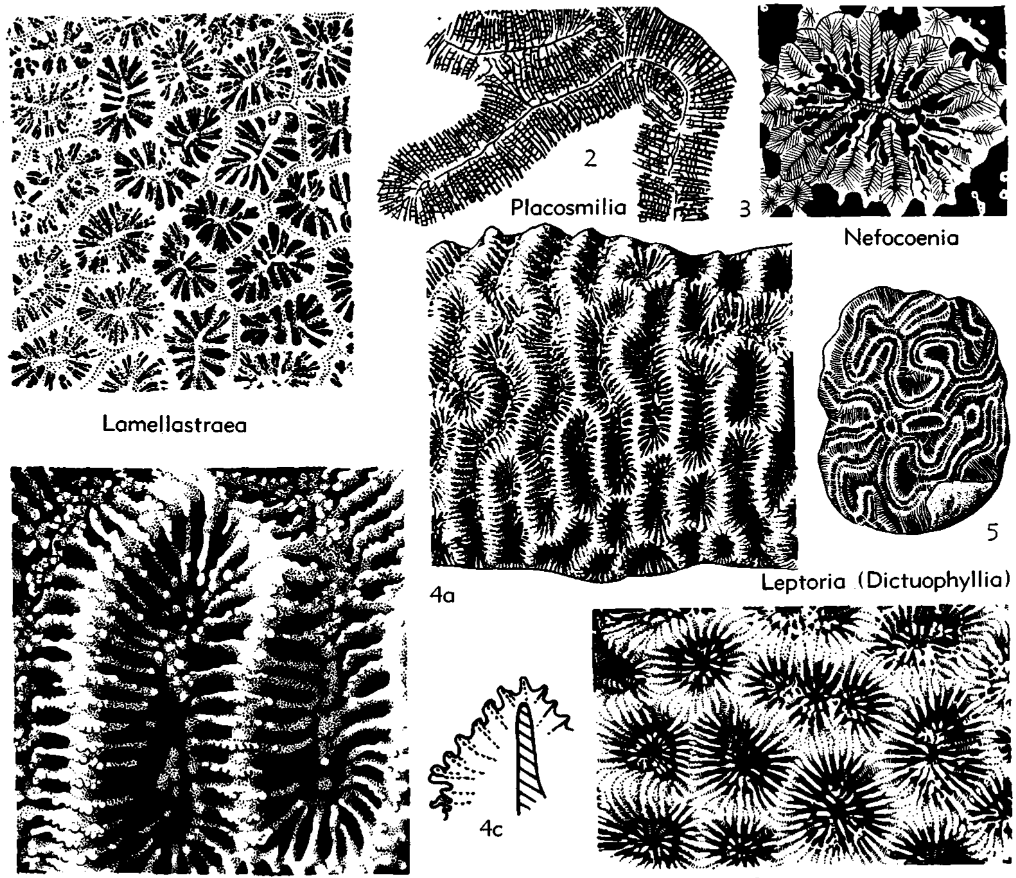


Fig. 298. Faviina (Faviicae): Montlivaltiidae, Faviidae (p. F400-F403).

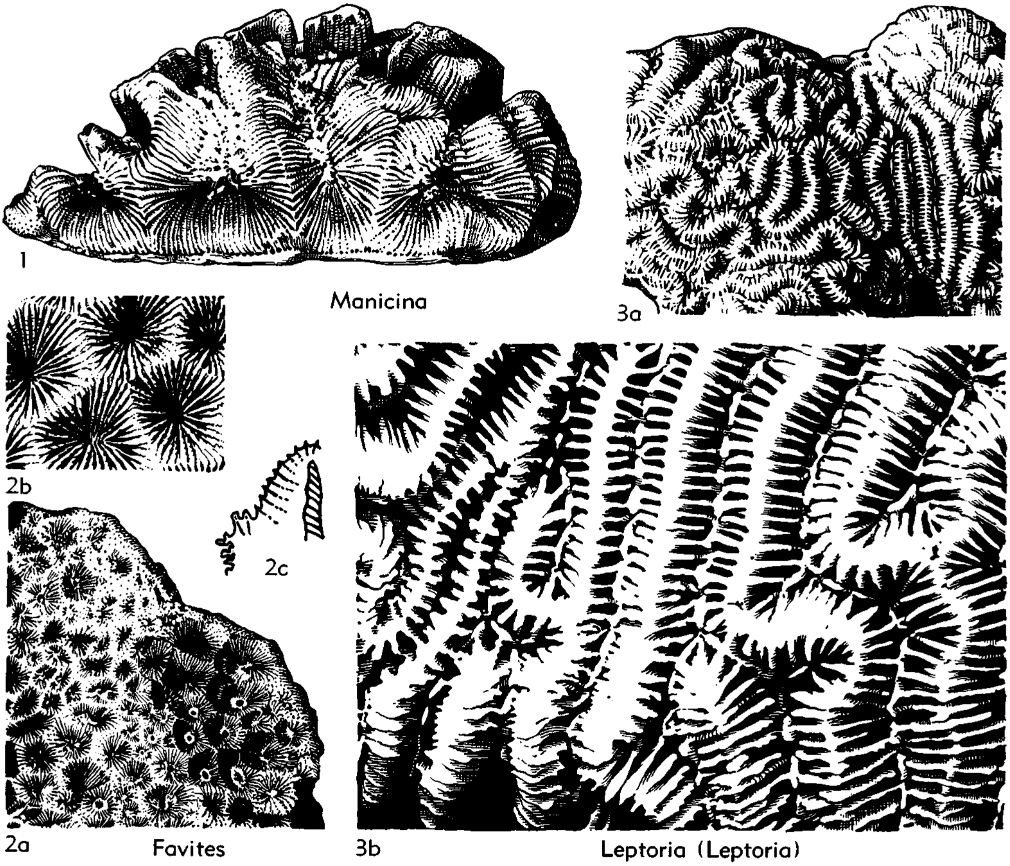


Fig. 299. Faviina (Faviicae): Faviidae (p. F402).

mation by extratentacular budding (with a few exceptions). Septa formed by one fan system of mostly simple trabeculae. *M.Jur.-Rec.*

Goniocora M.Edw.-H., 1851 [**Lithodendron sociale* Roemer, 1836] [=?*Thamnocoenia* Tomes, 1885]. Phaceloid. Columella styliform. No paliform lobes. *M.Jur.-U.Jur.*, Eu.——Fig. 301,*4*. **G. socialis*, U. Jur.(Raur.), Eng.; *4a*, ×1.5; *4b*, ×3 (94).

Rhabdocora Fromentel, 1873 [**R. cretacea*]. Like *Goniocora* but with strong lamellar columella. *M. Cret.-U.Cret.*, Eu.

Cladocora Ehr., 1834 [**Madrepora caespitosa* Linné, 1767; SD M.Edw.-H., 1850] [=*Procladocora* Alloiteau, 1952]. Phaceloid. Paliform lobes opposite all but last cycle of septa, merging with papillose columella. *U.Cret.-Rec.*, Eu.-Medit.-Atl.-W.Indies-N.Am.-E.Pac.

C. (Cladocora). *U.Cret.-Rec.*——Fig 302,*1*. *C. arbuscula* (Lesueur), Rec., Fla.; *1a*, ×0.75; *1b*, ×5 (198).

C. (Dendrocora) Duncan, 1876 [**D. fissipara*]. Like *Cladocora* but colony formation mostly by intratentacular budding. *Rec.*, W.Afr.

Stylocora Reuss, 1871 [**S. exilis*]. Like *Cladocora* but columella styliform; paliform lobes reduced. *Mio.*, Eu.

Pleurocora M.Edw.-H., 1848 [**Lithodendron gemmans* Michelin, 1847] [=*Stylocora* Fromentel, 1873 (*non* Reuss, 1871); ?*Phyllohelia* Alloiteau, 1952]. Like *Cladocora* but subplocoid, subdendroid, or explanate, with coenosteum between corallites formed by costae and exothecal dissepiments. *M.Cret.-U.Cret.*, Eu.-N.Am.——Fig. 301,*1*. *P. angelisi* Felix, U.Cret.(Turon.), Carp., ×2 (177).

Psammiophora Fromentel, 1870 [**P. cenomana*]. Corallum compressed, thin lamina with calices on both sides. Corallites protuberant, united by smooth coenosteum. Paliform lobes and papillose columella. *M.Cret.-U.Cret.*, Eu.

Montastrea Blainv., 1830 [**Astrea guettardi* Defrance, 1826; SD Smith & Lang, 1935] [=?*Astroites* Walch, 1775; *Orbicella* Dana, 1846; *Phyllocoenia* M.Edw.-H., 1848; *Actinocoenia* Orb., 1849; *Cellulastraea* Blanckenhorn, 1890; *Hydnophoropsis* Söhle, 1899; *Phyllocoeniella* Felix, 1926; *Prodiploastrea* Wells, 1934; *Neocoenia* Hackemesser, 1936; *Aquitanastrea, Heliastreopsis, Phyllocaeniopsis, ?Provinciastrea* Chevalier, 1954]. Massive, incrusting, or subfoliaceous, plocoid colonies. Septothecate. Septal margins regularly dentate. Columella trabecular. *U.Jur.-Rec.,* Eu.-W. Indies-W.Afr.-Brazil-N.Am.——Fig. 301,*5a.* **M. annularis* (Ellis & Solander), Rec., P.R., ×3 (195).——Fig. 301,*5b. M. corollaris* (Reuss), U. Cret.(Turon.), Aus.(Gosau); transv. sec., ×5 (42).

Diploastrea Matthai, 1914 [**Astrea heliopora* Lamarck, 1816] [=*?Thegioastraea* Sismonda, 1871]. Plocoid colonies. Walls mostly septothecate, but partially synapticulothecate and porous at level of calices. Septa formed by compound trabeculae (especially in later forms); dentations relatively large; columella well developed. *Cret.-Rec.,* Eu.-W.Indies-N.Am.-S.Am.-IndoPac.——Fig. 302,*4a. D. harrisi* Wells, L.Cret.(Apt.), Tex.; transv. sec., ×3 (157).——Fig. 302,*4b,c.* **D. heliopora,* Rec., Fr.Somali.; *4b,* ×1; *4c,* ×3 (195).

?**Oulastrea** M.Edw.-H., 1848 [**Astrea crispata* Lamarck, 1816] [=*Ulastrea* M.Edw.-H., 1857]. Like *Montastrea* and *Diploastrea* but wall more porous and septal structures smaller. Paliform lobes opposite larger septa, merging with papillose columella (may be an agariciid). *Rec.,* IndoPac.——Fig. 301,*2.* **O. crispata,* Rec., Japan; *2a,* ×1; *2b,* ×3 (164).

Antiguastrea Vaughan, 1919 [*pro Heterastraea* Reis, 1889 (*non* Tomes, 1888)] [**Astraea cellulosa* Duncan, 1863]. Like *Montastrea* but subcerioid, and with thin lamellar columella. *U.Cret.-Oligo.,* Eu.-N.Am.-W.Indies-S.Am.——Fig. 303,*3.* **A. cellulosa,* U.Oligo., USA; ×2 (149).

Placocoenia Orb., 1849 [**Astrea macrophthalma* Goldf., 1829]. Like *Antiguastrea* but plocoid, with short, stout, lamellar columella. *Cret.,* Eu.-N.Am.——Fig. 302,*2. P. orbignyana* Reuss, U. Cret.(Turon.), Aus.(Gosau); transv. sec., ×4 (42).

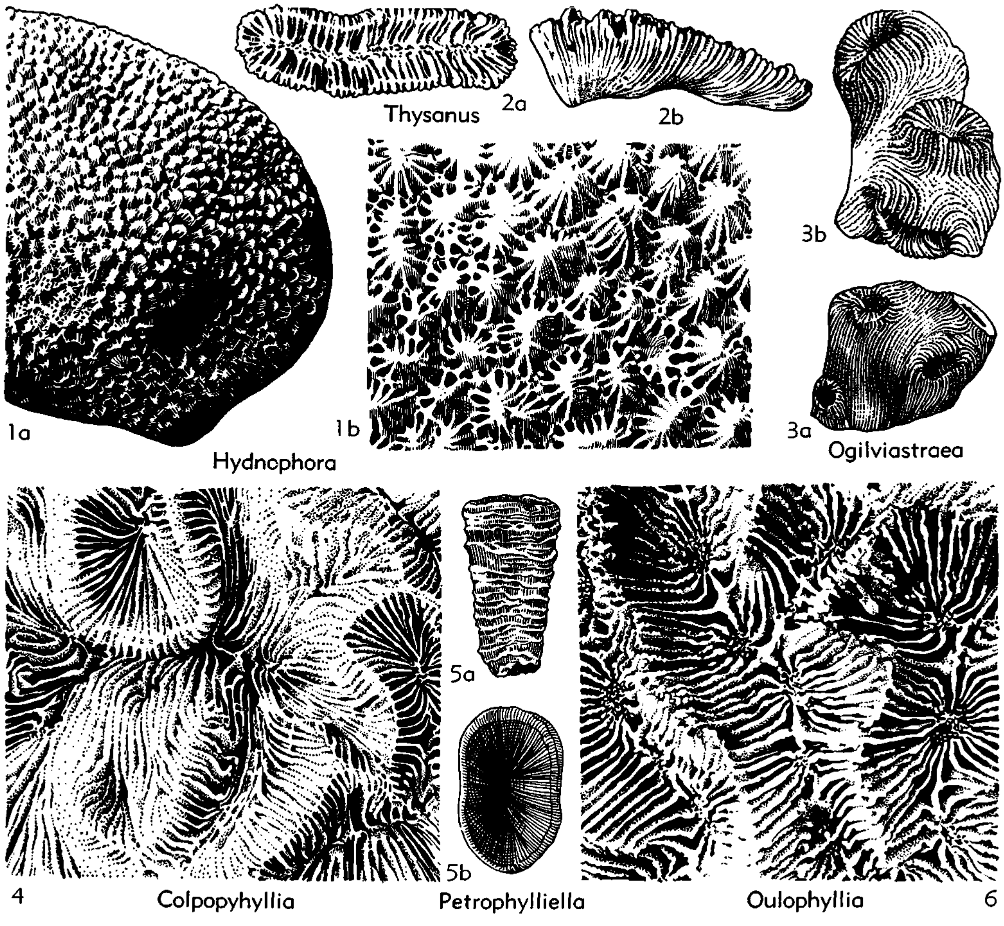


Fig. 300. Faviina (Faviicae): Faviidae (p. F401-F404).

Leptastrea M.Edw.-H., 1848 [**L. roissyana;* SD M. Edw.-H., 1850] [=*Baryastrea* M.Edw.-H., 1848]. Like *Montastrea* but subcerioid, with dense coenosteum. Columella generally papillose. Septa minutely dentate. *M.Oligo.-Rec.,* IndoPac.——Fig. 303,*4a. L. bottae* M.Edw.-H., Austral.(Torres Strait); ×4 (194).

Solenastrea M.Edw.-H., 1848 [**Astrea turonensis* Michelin, 1847; SD M.Edw.-H., 1850] [=*D'Achiardia* Duncan, 1884]. Like *Montastrea* but coenosteum vesicular, nearly devoid of costae, with blistered surface. Paliform lobes opposite first 2 septal cycles. *Oligo.-Rec.,* Eurasia-W.Indies-N. Am.——Fig. 303,*4b. S. bournoni* M.Edw.-H., Rec., W.Indies; ×4 (195).

Cyphastrea M.Edw.-H., 1848 [**Astrea microphthalma* Lamarck, 1816] [=*Chypastraea* Sismonda, 1871; *Quelchia* Duncan, 1886]. Like *Montastrea* but costae rarely extending over coenosteum, the surface of which is spinose. Columella trabecular, spongy. *Oligo.-Rec.,* W.Indies-Indo-Pac.——Fig. 301,*3. *C. microphthalma,* Rec., Cocos-Keeling; ×4 (148).

Multicolumnastraea Vaughan, 1899 [**Heliastraea cyathiformis* Duncan, 1865]. Like *Cyphastrea* but columella formed by 3 or 4 trabecular pillars. *U. Cret.,* W.Indies-Mex.——Fig. 302,*3. *M. cyathiformis,* U.Cret.(Camp.), Jamaica; transv. sec., ×5 (151).

Agathelia Reuss, 1854 [**A. asperella*]. Like *Cyphastrea* but much intratentacular budding; coenosteum dense with minutely granulated surface. *M.Cret.-U.Cret.,* Eu.-Tex.——Fig. 303,*2. *A. asperella,* U. Cret.(Turon.), Aus.(Gosau); *2a,* ×1 (112); *2b,* trans. sec., ×5; *2c,* long. sec., ×5 (42).

Placophora Fromentel, 1879 [**P. neocomiensis*]. Like *Cyphastrea* but with short, lamellar columella. *L.Cret.,* Eu.

Tarbellastraea Alloiteau, 1950 [**Astrea ellisiana* Defrance, 1826]. Like *Cyphastrea* but with parathecal wall and lamellar or sublamellar columella. *Mio.,* Eu.

Echinopora Lamarck, 1816 [**Madrepora lamellosa* Esper, 1797] [=*Echinastrea* Blainv., 1830; *Stephanocora* Ehr., 1834; *Acanthopora* Verrill, 1864 (*non* Orb., 1849); *Acanthelia* Wells, 1937]. Submassive to foliaceous or ramose. Coenosteum dense or vesicular; costae reduced to spines. Corallite walls defined but may be perforate near level of calices. Columella spongy. *Mio.-Rec.,* IndoPac. ——Fig. 303,*1. *E. lamellosa,* Rec., Banda; ×2 (128).

Subfamily AGATHIPHYLLIINAE Vaughan & Wells, 1943

Solitary and colonial, hermatypic. Colony formation by extratentacular budding. Corallite wall synapticulothecate near calices, septothecate or parathecate below. Septa of lower cycles composed of 2 fan systems of

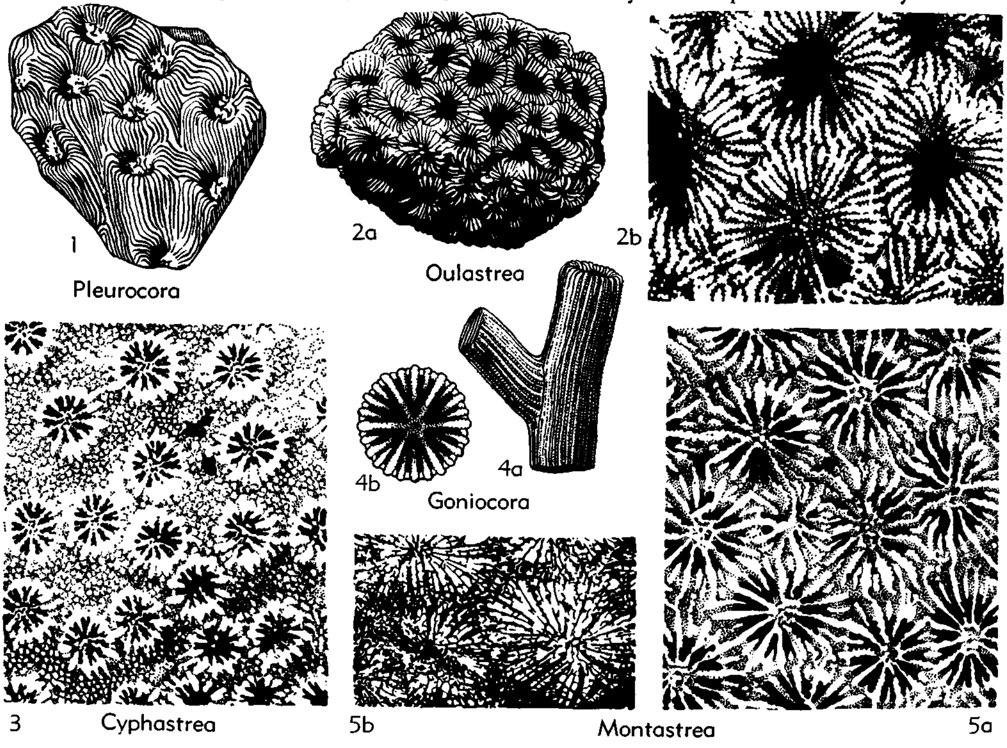


Fig. 301. Faviina (Faviicae): Faviidae (p. F404-F406).

mostly compound trabeculae, the inner fan system forming prominent internal septal lobes; higher cycles of one fan system and more or less perforate internally. *Eoc.-Mio.*

Pattalophyllia d'Achiardi, 1867 [_*Turbinolia subinflata_ Catullo, 1856 (=*Caryophyllia pseudocalvimonti* Catullo, 1856)]. Solitary, turbinate, fixed by small base. Wall septothecal and synapticulothecal. Columella trabecular, well developed. *Eoc.-Oligo.*, Eu.

?Ceratophyllia Fritsch, 1878 [_*C. flabelloides;_ SD Felix, 1925]. Like *Pattalophyllia* but ceratoid, and lacking columella. *Eoc.*, E.Indies.

Cricocyathus Quenst., 1881 [*pro Leptaxis* Reuss, 1868 (*non* Lowe, 1852)] [_*Cyathophyllia annulata_ Reuss, 1868] [=*Stephanosmilia* Reuss, 1874 (*non* Fromentel, 1862)]. Like *Pattalophyllia* but with broad base and synapticuloparathecal wall. *Eoc.-Mio.*, Eu.——Fig. 304,*1*. _*C. annulata,_ M.Oligo. (Rupel.), Italy; *1a*, ×0.6; *1b*, ×1 (116).

Agathiphyllia Reuss, 1864 [_*A. explanata;_ SD Vaughan, 1919] [=*Cyathomorpha* Reuss, 1868]. Like *Cricocyathus* but forming submassive plocoid colonies by budding from edge zone. *Oligo.*, Eu.-W.Indies-S.Am.-N.Am.——Fig. 304,*2c*. _*A. explanata_ Reuss, M.Oligo.(Rupel.), Italy; lat. aspect of minor septum, ×3 (116).——Fig. 304, *2a,b*. *A. umbellata* Reuss, M.Oligo.(Rupel.), Italy; *2a*, ×0.6; *2b*, ×1 (116).

Subfamily TRACHYPHYLLIINAE Wells, nov.

Solitary and colonial, hermatypic. Colony formation by intratentacular polystomodaeal intramural budding. Wall septothecal to parathecal. Septa formed by 2 fan systems of simple trabeculae; inner fan system forming prominent lobes. *Oligo.-Rec.*

Antillophyllia Vaughan, 1932 [_*Antillia lonsdaleii_ Duncan, 1864]. Solitary, free in ephebic stage, trochoid, compressed or bilobate in cross section. Columella trabecular, spongy. *Oligo.-Mio.*, W. Indies.——Fig. 305,*3*. *A. sawkinsi* (Vaughan), Mio., Trinidad; *3a,b*, ×1 (150).

Indophyllia Gerth, 1921 [_*I. cylindrica_]. Like *Antillophyllia* but discoid to subcylindrical. *Oligo.-Mio.*, E.Indies.——Fig. 305,*1*. _*I. cylindrica,_ Mio., Borneo; *1a*, basal aspect ×1; *1b*, nat. long. sec., ×1.33 (57).

Trachyphyllia M.Edw.-H., 1848 [_*Turbinolia geoffroyi_ Audouin, 1826; SD M.Edw.-H., 1850]. Like *Antillophyllia* but colonial, flabello-meandroid. Series short, free laterally. Trabecular linkages between centers. *Mio.-Rec.*, IndoPac.——Fig. 305,*2*. _*T. geoffroyi,_ Rec., Austral.; *2a*, ×0.5; *2b*, lat. aspect of septum, ×2 (88).

Callogyra Verrill, 1902 [_*C. formosa_]. Like *Trachyphyllia* but series united laterally to summits. *Rec.*, Pac.

?Moseleya Quelch, 1884 [_*M. latistellata_]. Cerioid,

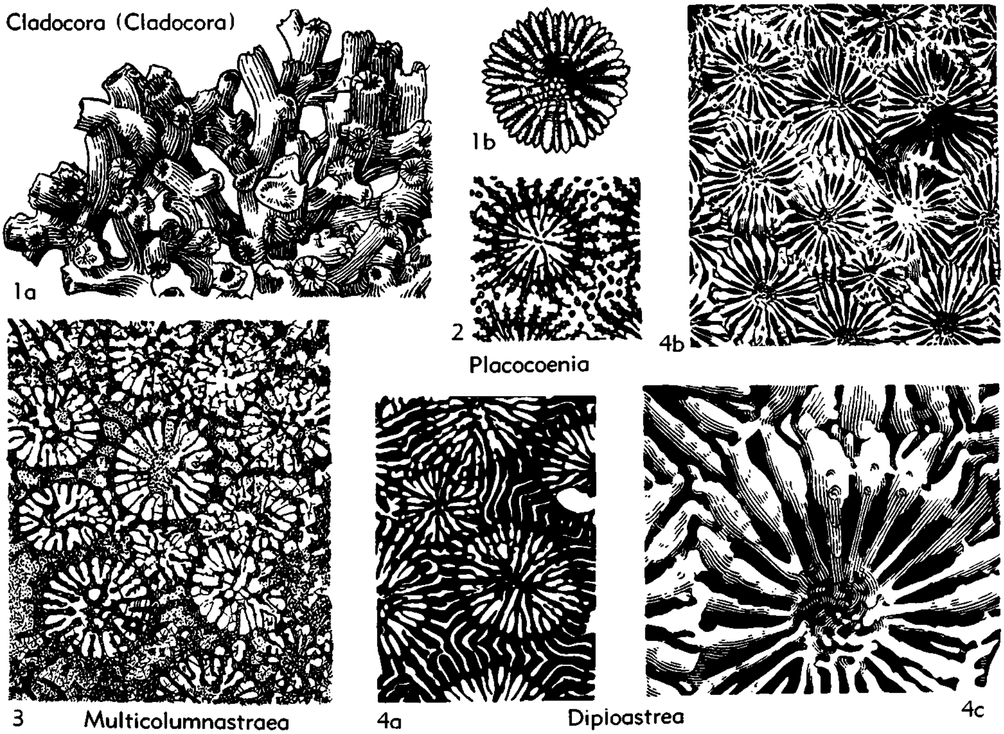


Fig. 302. Faviina (Faviicae): Faviidae (p. F404-F406).

colony formation by extra- and intratentacular budding (stomodaeal diversion and oral disc invagination). Parathecate. Columella trabecular, small and spongy. *Rec.*, N.Austral., Great Barrier Reef.——Fig. 305,*4*. **M. latistellata;* ×0.5 (109).

Family RHIZANGIIDAE d'Orbigny, 1851

[=Astrangiidae Verrill, 1869]

Colonial, ahermatypic. Colony formation by extratentacular budding from edge zone or stolon-like expansions of edge zone, polyps remaining organically connected or not, colonies commonly consisting of scattered corallites with no apparent connection, or united basally by coenosteum, or they form compact masses. Corallites small and low. Septa composed of one fan system of simple or compound trabeculae; irregular divergence of sclerodermites producing scattered lateral granulations and more or less irregular marginal dentations. Columella trabecular, rarely solid or absent. Endothecal dissepiments thin. *L.Cret.-Rec.*

Arctangia Wells, 1937 [**Thecocyathus nathorsti* Lindström, 1900]. Solitary, subturbinate, fixed by small base. Septa dentate; columella papillary. *L. Cret.*, Arct.——Fig. 306,*3*. **A. nathorsti,* L.Cret. (Neocom.), King Charles I., Arct.; *3a,* ×1; *3b,c,* ×4 (183).

Rhizangia M.Edw.-H., 1848 [**Astrea brevissima* Deshayes, 1834]. Tympanoid, reptoid; all septa dentate; columella a single tubercle. *U.Cret.-Mio.*, Eu.——Fig. 307,*1*. *R. michelini* Reuss, U.Cret. (Turon.), Aus.(Gosau); *1a,* ×1; *1b,* ×2 (42).

Culicia Dana, 1846 [**C. stellata;* SD Wells, 1936] [=*Angia* M.Edw.-H., 1848; *Cylicia* M.Edw.-H., 1857]. Tympanoid, reptoid, basal connections temporary. First-cycle septa generally weakly dentate or lobate. Columella weak. *Pleisto.-Rec.*, IndoPac., depth range 0-366 m.——Fig. 307,*3*. *C.* sp., Rec., Austral., 55 m.; ×2 (180).

Cryptangia M.Edw.-H., 1848 [**C. woodii*]. Corallites subtrochoid, immersed in mass of bryozoan. Septa dentate; columella papillary. *Mio.-Plio.*, Eu.——Fig. 306,*4*. **C. woodii,* Plio., Eng.(Norf.); ×3 (120).

Astrangia M.Edw.-H., 1848 [**A. michelini;* SD M.

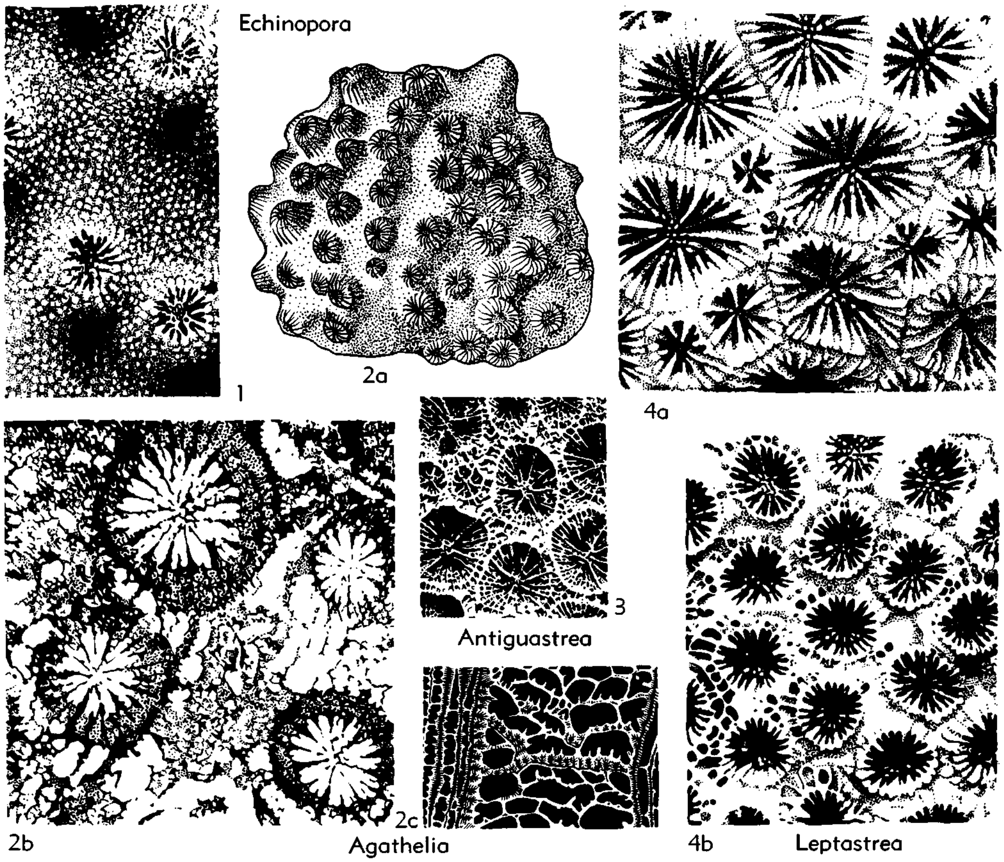


Fig. 303. Faviina (Faviicae): Faviidae (p. F406-F407).

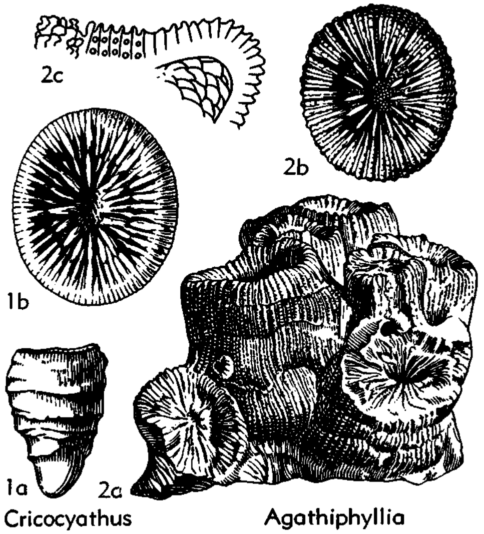


FIG. 304. Faviina (Faviicae): Faviidae (p. F407).

Edw.-H., 1850] [=*Stellangia* Duchaissing & Michelotti, 1860; *Gombertangia* Oppenheim, 1899]. Incrusting, subplocoid, corallites united basally by thin coenosteum. Septa dentate; columella papillary. *M.Cret.-Rec.,* Eu.-N.Am.-S.Am.-W. Indies-Austral., shallow water.

A. (Astrangia). *Eoc.-Rec.*——FIG. 306,*5*. *A. rathbuni* Vaughan, Rec., Braz.; ×2 (195).

A. (Coenangia) Verrill, 1869 [**Coenangia conferta;* SD Vaughan & Wells, 1943]. Like *A. (Astrangia)* but cerioid. *M.Cret.-Rec.,* N.Am.-C. Am., shallow water.——FIG. 306,*2*. **A. (C.) conferta,* Rec., GulfCalif.; ×1 (36).

A. (Hoplangia) Gosse, 1860 [**H. durotrix*]. Like *A. (Astrangia)* but septal margins nearly smooth. *Rec.,* Eu.

Oulangia M.Edw.-H., 1848 [**O. stokesiana;* SD M. Edw.-H., 1850] [=*Ulangia* M.Edw.-H., 1857]. Small reptoid colonies, the corallites united by thin coenosteum. Septa of first 2 or 3 cycles obscurely dentate and exsert. Columellar papillae merging with inner septal dentations. *Pleisto.-Rec.,* IndoPac., shallow water.——FIG. 307,*2*. **O. stokesiana,* Rec., Philip.; *2a,* ×1; *2b,* ×2.5 (93).

Phyllangia M.Edw.-H., 1848 [**P. americana;* SD M.Edw.-H., 1850] [=*Syndepas* Lyman, 1857]. Incrusting, habit like *Oulangia* but with more extensive coenosteum. Lower-cycle septa obscurely dentate; columella weak. *Mio.-Rec.,* Eu.-W.Afr.-N.Am.-S.Am., depth range 0-100 m.——FIG. 307,*5*. **P. americana,* Rec., W.Indies; ×1 (198).

Colangia Pourtalès, 1871 [**C. immersa*]. Rounded, incrusting, plocoid; corallites united basally by heavy coenosteum. Lower-cycle septa obscurely dentate, highly exsert; paliform lobes before third cycle. Columella a thin, interrupted lamella, trabecular below. *Rec.,* W.Indies.

Cladangia M.Edw.-H., 1851 [**Astrea semispherica* Defrance, 1826]. Like *Astrangia* but massive or subramose, plocoid; corallites united by striate or

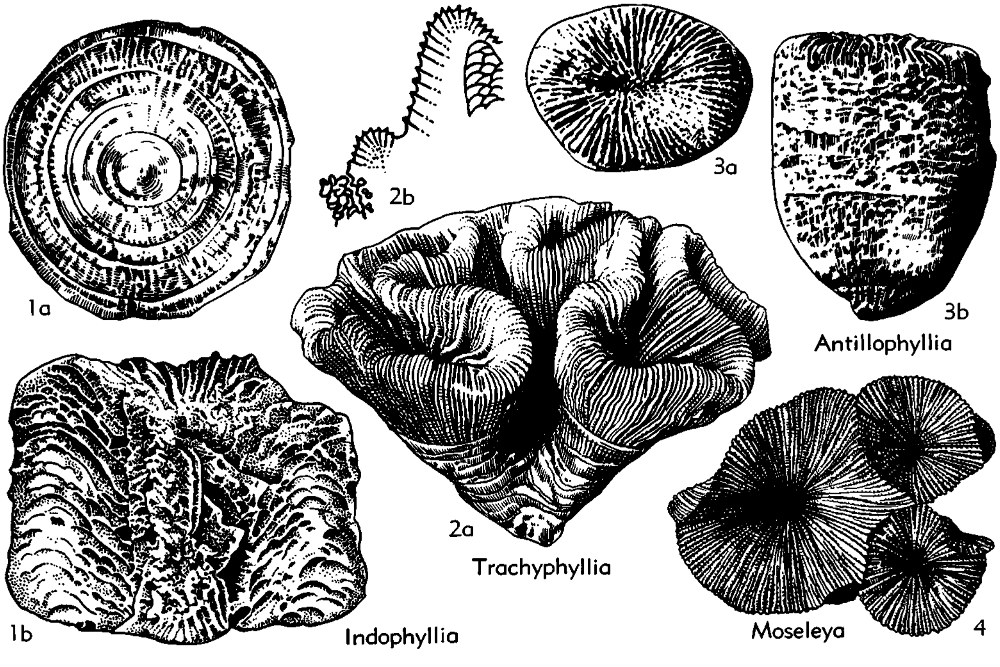


FIG. 305. Faviina (Faviicae): Faviidae (p. F408).

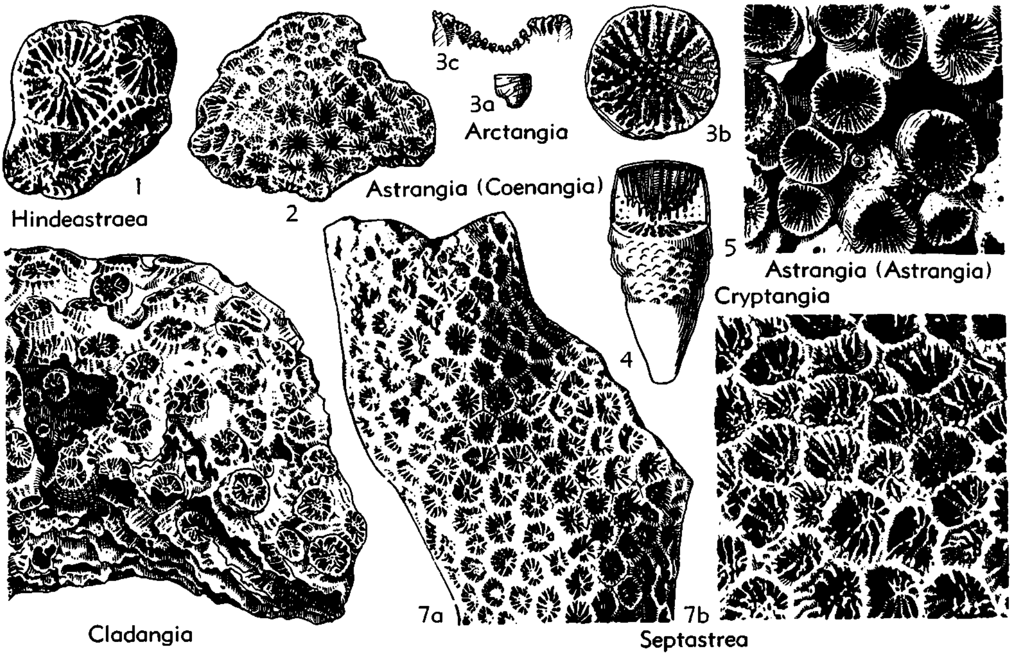


FIG. 306. Faviina (Faviicae): Faviidae (p. F409-F410).

spinose coenosteum. *Eoc.-Rec.,* Eurasia.——FIG. 306,*6*. *C. exusta* LÜTKEN, Rec., India; ×1 (184).

Reussangia WELLS, 1937 [*pro Stylangia* REUSS, 1874 (*non* FROMENTEL, 1857)] [=**Stylangia elegans* REUSS, 1874]. Like *Cladangia* but columella a single tubercle as in *Rhizangia*. Coenosteum costate. *Eoc.-Oligo.,* Eu.-C.Am.——FIG. 307,*4*. **R. elegans,* M.Eoc.(Lut.), Italy; *4a,* ×1; *4b,* ×2 (116).

Hindeastraea WHITE, 1888 [**H. discoidea*]. Ramose colonies formed by extratentacular budding; cerioid or subplocoid. Septa dentate; columella feeble, trabecular. *U.Cret.,* Tex.——FIG. 306,*1*. **H. discoidea,* Navarro, Tex.; ×2 (180).

Septastrea ORB., 1849 [**S. subramosa (nom. nud.)* (=*S. forbesi* M.EDW.-H., 1849; =*Astrea marylandica* CONRAD, 1841)] [=?*Hexastraea* SISMONDA, 1871; *Glyphastraea* DUNCAN, 1887]. Like *A. (Coenangia)* but forming large, ramose colonies. Corallites rarely with more than 2 cycles of septa. Columella generally appearing solid. *Mio.-Plio.,* Eu.-N.Am.-C.Am.——FIG. 306,*7*. *S. crassa* (TUOMEY & HOLMES), Plio., N.Car.; *7a,* ×1; *7b,* ×2 (151).

Platyhelia TENISON-WOODS, 1880 [**P. distans*]. Like *Septastrea* but with more than 2 cycles of septa and paliform lobes or lobate dentations before 1st 2 or 3 cycles; columella papillary. *U.Oligo.-Mio.,* N.Z.

?**Podoseris** DUNCAN, 1869 [**P. mammiliformis;* SD DUNCAN, 1889]. Solitary, tympanoid. Septa dentate, exsert; columella papillose. *M.Cret.,* Eng.

Family OCULINIDAE Gray, 1847

Colonial; colony formation by extratentacular (or rarely intratentacular) budding. Corallites externally thickened by extensive, noncostate, granulated or smooth, dense (rarely vesicular) coenosteum. Septa exsert, formed by one fan system of simple trabeculae, margins minutely dentate, laterally granulose or spinose. Pali generally developed. Columella papillose, trabecular, or absent. Endothecal dissepiments, when developed, subtabular, thin, or replaced by stereome. *Cret.-Rec.*

Subfamily OCULININAE Gray, 1847

[*nom. transl.* VAUGHAN & WELLS, 1943 (*ex.* Oculinidae GRAY, 1847)]

Mostly ahermatypic oculinids forming dendroid colonies; corallites united basally by dense coenosteum. *Cret.-Rec.*

Oculina LAMARCK, 1816 [**O. virginea* (*non Madrepora virginea* LINNÉ, 1758; *nec* ELLIS & SOLANDER, 1786) (=*O. diffusa* LAM., 1816; SD M.EDW.-H., 1850)] [=*Dentipora* BLAINV., 1830; *Trymhelia* M.EDW.-H., 1849; *Trymohelia* M.EDW.-H., 1857; *Coelohelia* VAUGHAN, 1900]. Ramose colonies formed by alternate budding, corallites tending to spiral around branches; ahermatypic and hermatypic. Coenosteum dense, striated. Pali before first

2 cycles in an irregular crown. Columella papillose. *Cret.-Rec.*, Eu.-W.Indies-N.Am.-Austral., depth range 0-91 m.

O. (Oculina). *Cret.-Rec.*——Fig. 308,*4*. **O. (O.) diffusa*, Rec., Fla.; ×3 (151).

O. (Schizoculina) Wells, 1937 [**O. fissipara* M. Edw.-H., 1850]. Like *O. (Oculina)* but colony formation mostly by intratentacular monostomodaeal budding. *Rec.*, W.Afr.

Archohelia Vaughan, 1919 [**A. limonensis*]. Like *Oculina* but with persistent axial corallite as in *Acropora*. *M.Cret.-Plio.*, N.Am.-C.Am.-W.Indies. ——Fig. 309,*2*. *A. vicksburgensis* (Conrad), Oligo., Miss.; *2a*, ×0.5; *2b*, ×1.5 (144).

Sclerhelia M.Edw.-H., 1850 [**Madrepora hirtella* Pallas, 1766] [=*Sclerohelia* M.Edw.-H., 1857]. Like *Oculina* but pali in one crown opposite 2nd cycle; columella papillose. *Rec.*, S.Atl.-IndoPac., depth range 110-400 m.——Fig. 309,*1*. *S. formosa* (Alcock), Maldive I., 400 m.; *1a*, ×0.5; *1b*, ×4 (171).

Bathelia Moseley, 1881 [**B. candida*]. Regular and alternate budding from edge zone near calices. Septa apparently entire marginally. Pali in one crown opposite 3rd cycle. Columella of curled laths. *Rec.*, S.Atl., depth range 1,097 m.——Fig. 308,*1*. **B. candida*, 1,097 m.; *1a*, ×0.35; *1b*, ×1.5 (97).

Haplohelia Reuss, 1864 [**H. gracilis*]. Budding from calicular margin, singly and usually from same side. Pali in 2 crowns opposite 1st 2 cycles. Columella papillose. *Oligo.*, Ger.——Fig 310,*2*. **H. gracilis; 2a*, ×1; *2b*, ×3 (114).

Cyathelia M.Edw.-H., 1849 [**Madrepora axillaris* Ellis & Solander, 1786] [=*Cyathohelia* M.Edw.-H., 1857]. Regular alternate budding. Pali opposite 1st 3 cycles in 2 crowns. Columella of twisted trabecular rods. *Rec.*, IndoPac., depth range 119-1,509 m.——Fig. 308,*2*. **C. axillaris* (Ellis-S.), Amboina; *2a*, ×0.5; *2b*, ×6 (174).

Astrhelia M.Edw.-H., 1849 [**Madrepora palmata* Goldf., 1829] [=*Astrelia* Orb., 1849; *Astrohelia* M.Edw.-H., 1857]. Subramose with stout anastomosing branches. Corallites united by dense, smooth coenosteum, slightly protuberant. Septal dentations lacerate; pali absent; columella trabecular. *Mio.*, N.Am.——Fig. 310,*1*. **A. palmata* (Goldf.), Md.; *1a*, ×0.5; *1b*, ×1.25 (195).

Diplhelia M.Edw.-H., 1850 [**Oculina raristella* Defrance, 1825] [=*Diplohelia* M.Edw.-H., 1857]. Dendroid with coalescing branches. Paliform lobes opposite 1st 2 cycles of dentate septa.

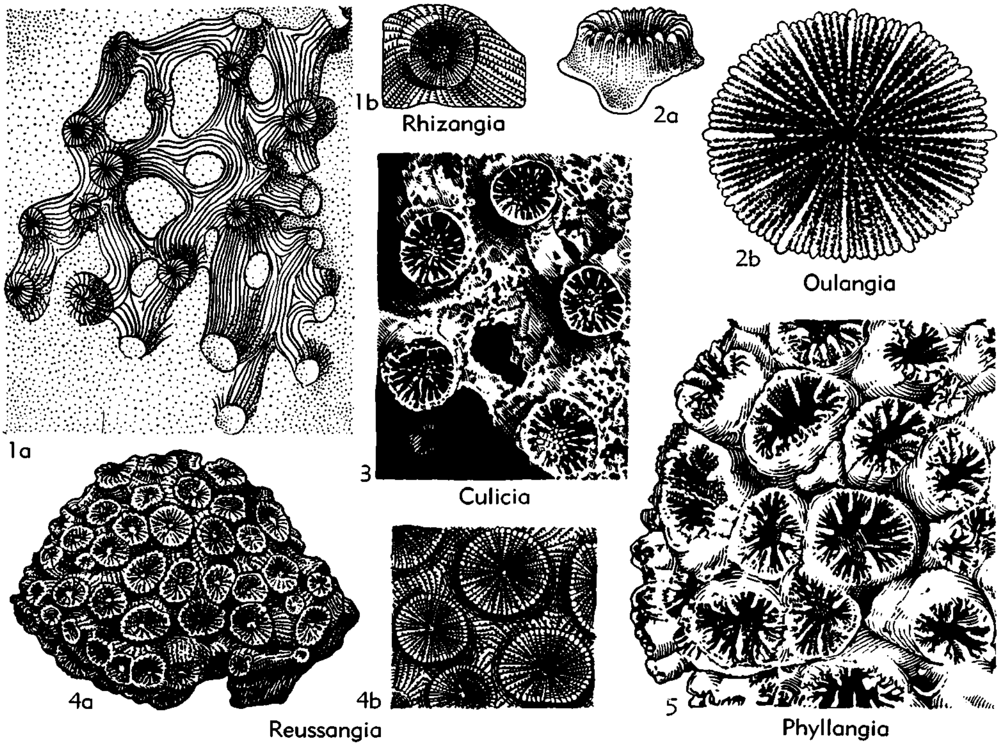


Fig. 307. Faviina (Faviicae): Rhizangiidae (p. F409-F410).

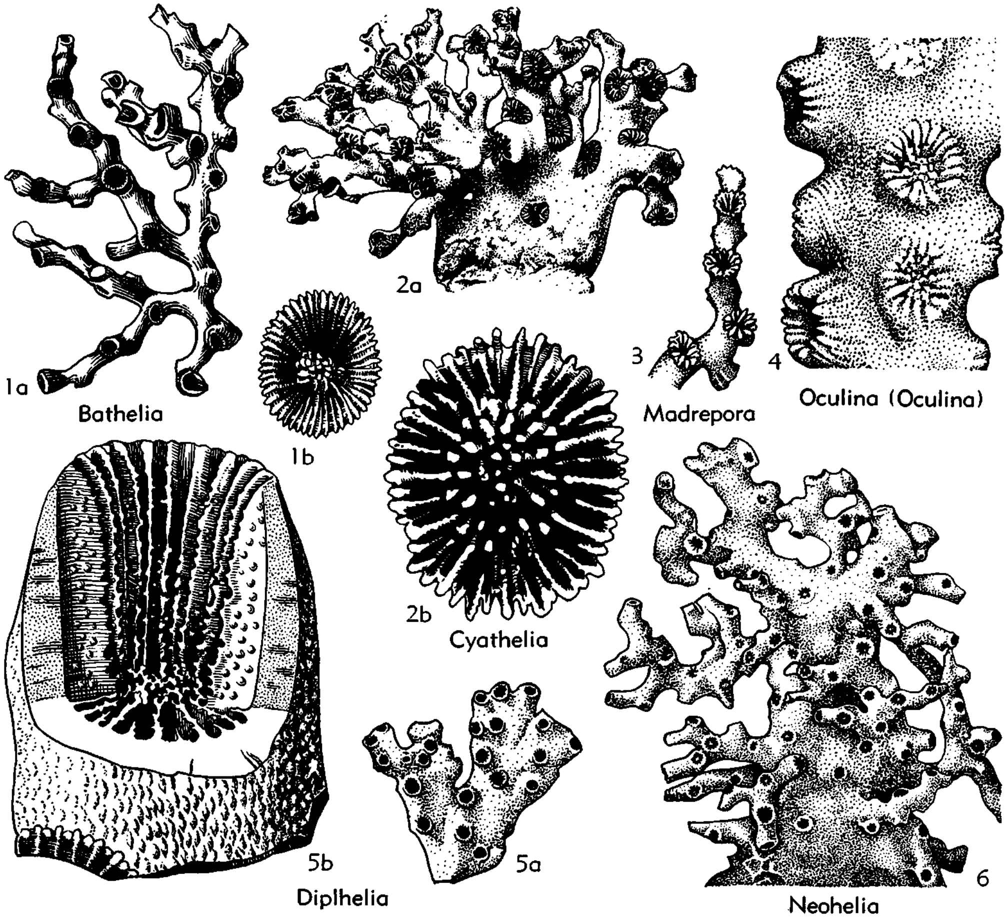


FIG. 308. Faviina (Faviicae): Oculinidae (p. F411-F413).

Eoc., Eu.——FIG. 308,*5*. *D. papillosa* M.EDW.-H., L.Eoc.(Lond.), Isle of Wight; *5a*, ×0.5; *5b*, ×6 (94).

Madrepora LINNÉ, 1758 [**M. oculata;* SD VERRILL, 1902] [=*Amphelia* M.EDW.-H., 1849; *Amphihelia* M.EDW.-H., 1857]. Dendroid colonies with more or less regular, alternate budding. Coenosteum dense, corallites filled internally by stereome. Pali absent. Columella spongy or absent. *Eoc.-Rec.*, cosmop., depth range 183-1,554 m.——FIG. 308,*3*. *M. galapagensis* VAUGHAN, Rec., Galapagos I., 575 m.; ×1 (195).

Diblasus LONSDALE, 1850 [**D. grevensis*]. Like *Madrepora* but colony formation irregular, mostly by basal budding, branches irregularly dividing. Corallites with little or no internal stereome. *U. Cret.*, Eu.

Neohelia MOSELEY, 1881 [**N. porcellana*]. Subdendroid, with dense coenosteum. Septa nonexsert, apparently nondentate. Columella absent. *Rec.*, Pac., depth range 91-115 m.——FIG. 308,*6*. **N. porcellana*, New Hebrides; ×1 (97).

Subfamily GALAXEINAE Vaughan & Wells, 1943

Hermatypic oculinids, ramose or plocoid. Corallites united by vesicular coenosteum. Septa highly exsert. *Mio.-Rec.*

Galaxea OKEN, 1815 [**Madrepora fascicularis* LINNÉ, 1767; SD VAUGHAN, 1918]. Massive, plocoid colonies formed by budding from broad edge zone of coenosarc. Corallites costate, cornute to cylindrical, united basally by extensive, vesicular, spinose, noncostate coenosteum. Columella absent or weak. Endothecal dissepiments weak and thin. *Mio.-Rec.*, N.Am.-IndoPac.——FIG. 311,*2*. **G. fascicularis* (LINNÉ), Rec., Austral.(Torres Strait); *2a*, ×2 (194); *2b*, Amboina, long. sec., ×2 (174).

Simplastrea UMBGROVE, 1939 [**S. vesicularis*]. Like *Galaxea* but corallites united to calicular margins by coenosteum. Columella trabecular. *Rec.*, E.

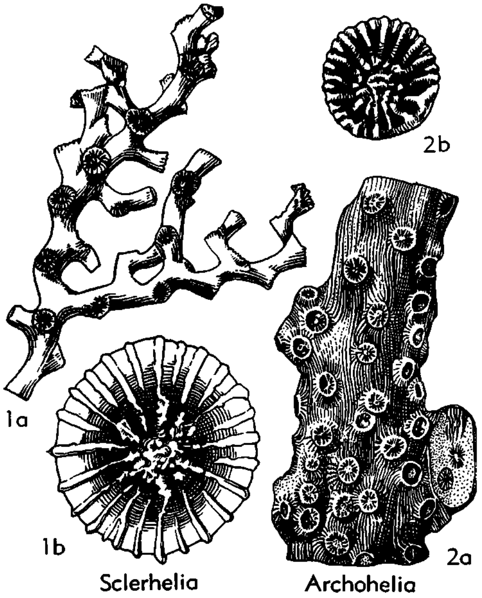


Fig. 309. Faviina (Faviicae): Oculinidae (p. F411).

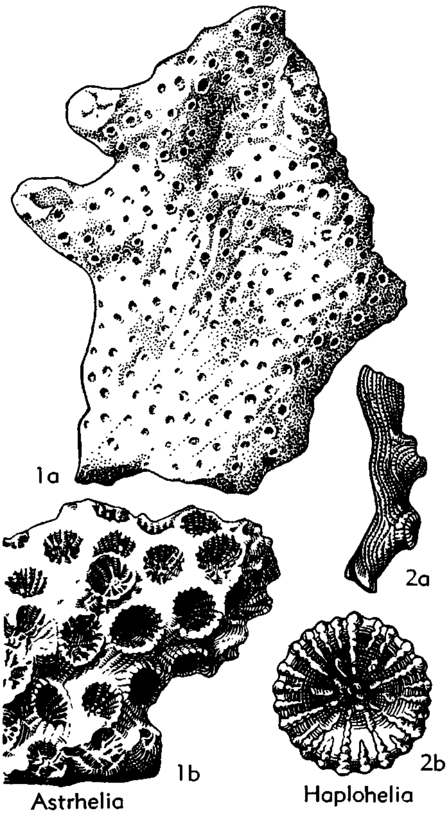


Fig. 310. Faviina (Faviicae): Oculinidae (p. F412).

Indies.——Fig. 311,*1*. **S. vesicularis,* Batavia Bay; ×2 (138).

Acrhelia M.Edw.-H., 1849 [**Oculina horrescens* Dana, 1846] [=*Acrohelia* M.Edw.-H., 1857]. Ramose, with corallites tending to spiral around branches. Calices protuberant with very exsert septa. Costae rudimentary. Coenosteum mostly solid, vesicular in lower parts of corallum. *Rec.,* Pac.——Fig. 312,*1*. **A. horrescens* (Dana), Austral.(Torres Strait); ×1 (148).

Bantamia Yabe & Eguchi, 1943 [**B. gerthii*]. Like *Acrhelia* but columella developed. *Mio.,* Java.

Family MEANDRINIDAE Gray, 1847

Solitary and colonial; colony formation by intratentacular budding. Wall septothecal or rarely parathecal, costate. Septa formed by one fan system of simple trabeculae, exsert, margins minutely dentate. Columella lamellar or trabecular. Endothecal dissepiments

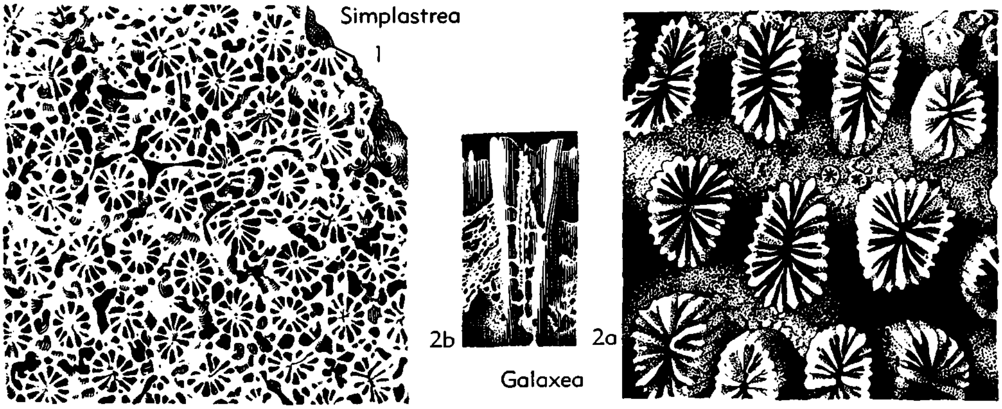


Fig. 311. Faviina (Faviicae): Oculinidae (p. F413-F414).

Fig. 312. Faviina (Faviicae): Oculinidae (p. F414)

well developed; exothecal dissepiments in some forms. *Cret.-Rec.*

Subfamily MEANDRININAE Gray, 1847

[*nom. transl.* Vaughan & Wells, 1943 (*ex* Meandrinidae Gray, 1847)]

Solitary and colonial, apparently most hermatypic. Colony formation by intratentacular polystomodaeal intramural budding. Septothecate or parathecate, costate. Septa laminar, exsert, with very small simple trabeculae. Columella a thin lamella, generally continuous, deep in calice or series. *Cret.-Rec.*

Aulosmilia Alloiteau, 1952 [**Trochosmilia archiaci* Fromentel, 1862] [=*Placosmilia auctt.* (*non* M. Edw.-H., 1848); *Phragmosmilia* Alloiteau, 1952]. Solitary, compressed or flabellate, with simple costae. *M.Cret.-Eoc.*, Eu.-N.Am.-W.Indies.——Fig. 313,*4*. *A. cuneiformis* (M.Edw.-H.), U.Cret. (Turon.), Aus.(Gosau); *4a*, ×0.5 (112); *4b*, transv. sec., ×0.5; *4c,d*, long. secs., ×1, ×6 (42).

Flabellosmilia Oppenheim, 1930 [**Flabellum bisinuatum* Reuss, 1854; SD Vaughan & Wells, 1943]. Solitary, flabellate, with alate opposing end costae. *U.Cret.*, Eu.——Fig. 314,*1*. *F. subcarinata* (Reuss), Turon., Aus.(Gosau); *1a*, ×1; *1b*, transv. sec., ×2 (100).

Nefophyllia Wells, 1937 [*pro Platysmilia* Felix, 1899 (*non* Toula, 1889)] [**Placosmilia angusta* Reuss, 1854]. Phaceloid colonies formed by extratentacular budding. *U.Cret.*, Eu.——Fig. 313,*5*. *N. multicincta* (Reuss), Turon, Aus.(Gosau); ×0.5 (100).

Phyllosmilia Fromentel, 1862 [**Turbinolia basochesi* Defrance, 1828]. Colonial, flabellate, with continuous end costae, others dividing. *U.Cret.-Eoc.*, Eu.——Fig. 313,*2*. *P. transiens* Felix, U. Cret.(Turon.), Aus.(Gosau); *2a,b*, ×0.5 (42).

Diploctenium Goldf., 1827 [**D. cordatum;* SD Wells, 1936]. Like *Phyllosmilia* but series curved

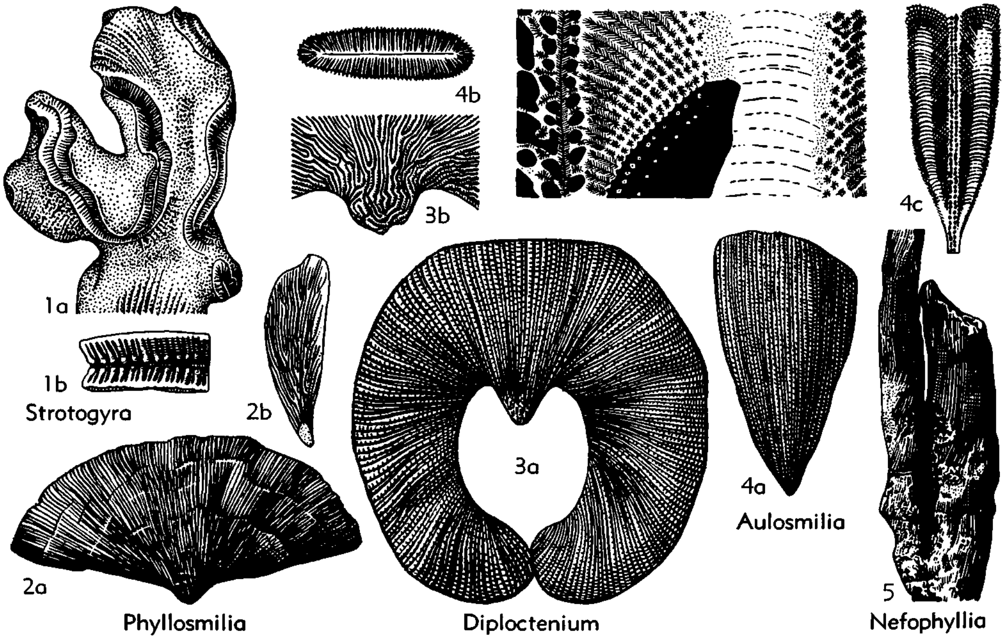


Fig. 313. Faviina (Faviicae): Meandrinidae (p. F414-F415).

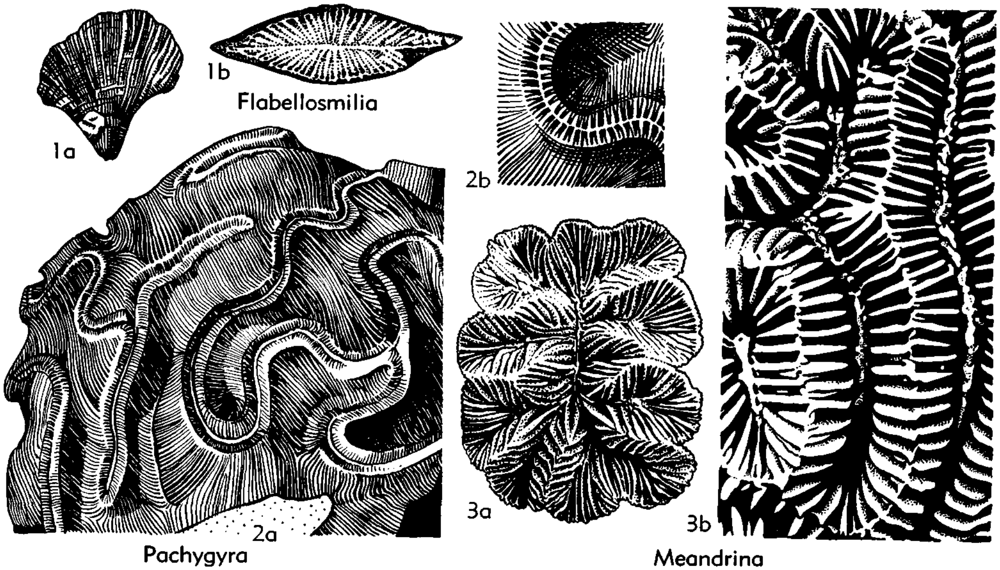


FIG. 314. Faviina (Faviicae): Meandrinidae (p. F415).

toward base, not horizontal. *M.Cret.-U.Cret.,* Eu.-N.Afr.-W.Indies.——FIG. 313,*3*. *D. haidingeri* REUSS, U.Cret.(Turon.), Aus.(Gosau); *3a,* ×0.5 (112); *3b,* detail of base, ×1 (100).

Strotogyra WELLS, 1937 [**Rhipidogyra undulata* REUSS, 1854]. Like *Phyllosmilia* and *Diploctenium* but corallum contorted, formed by one continuous, laterally free, series. *U.Cret.-Eoc.,* Eu.——FIG. 313, *1*. *S. savii* (D'ACHIARDI), M.Eoc.(Lut.), Italy; *1a,* ×1; *1b,* ×2 (116).

Pachygyra M.EDW.-H., 1848 [**Lobophyllia labyrinthica* MICHELIN, 1846]. Meandroid, massive, formed by one or a series united to summits by costae and exothecal dissepiments which form ambulacra. Columella discontinuous. *U.Cret.-Eoc.,* Eu.——FIG. 314,*2*. *P. princeps* REUSS, U.Cret.(Turon.), Aus.(Gosau); *2a,* ×0.5; *2b,* ×1 (112).

Meandrina LAMARCK, 1801 [**M. pectinata* (=*Madrepora maeandrites* LINNÉ, 1758)] [=*Maeandra* OKEN, 1815; *Placocyathus* M.EDW.-H., 1848; *Ctenophyllia* DANA, 1846; *Sphenophyllia* MOSELEY, 1881; *?Thecophyllia* DAINELLI, 1915 (*non* M.EDW.-H., 1848)]. Meandroid; valleys continuous or discontinuous, the series united directly by septothecae without ambulacra. Columella generally discontinuous. *?Eoc., Rec.,* Eu.-W.Indies-Braz.——FIG. 314,*3a*. *M. braziliensis* (M.EDW.-H.), Rec., Braz.; ×0.5 (88).——FIG 314,*3b*. **M. maeandrites* (LINNÉ), Rec., Bahamas; ×1 (88).

Ctenella MATTHAI, 1928 [**C. chagius*]. Like *Meandrina* but columella continuous. *?Rec.,* Ind.O.

Subfamily DICHOCOENIINAE Vaughan & Wells, 1943

Meandroid, colonial, hermatypic meandrinids with trabecular columella and well-developed, heavy coenosteum between corallites. *U.Cret.-Rec.*

Barysmilia M.EDW.-H., 1848 [**Dendrophyllia brevicaulis* MICHELIN, 1841] [=*Stenosmilia* FROMENTEL, 1870; *?Axophyllia* DAINELLI, 1915 (*non* ORB., 1849)]. Massive, plocoid heads formed by intratentacular polystomodaeal budding, permanent conditions mono- to tricentric. Corallites protuberant, united by costate and vesicular to solid coenosteum. Columella trabecular, commonly appearing lamellar at surface. *U.Cret.-Eoc.,* Eu.

Dichocoenia M.EDW.-H., 1848 [**D. stokesi*]. Like *Barysmilia* but with some meandroid series, noncostate ambulacra, and granulose coenosteum. *U. Cret.-Rec.,* W.Indies-N.Am.

D. (Dichocoenia). *U.Cret.-Rec.*——FIG. 315,*1a*. *D. trechmanni* WELLS, U.Cret.(Camp.), Jamaica; long. sec., ×1 (151).——FIG. 315,*1b*. **D. stokesi,* Rec., Bahamas; ×1 (195).

D. (Psilogyra) FELIX, 1903 [**Psilogyra telleri*]. Like *D. (Dichocoenia)* but without columella. *U.Cret.,* Eu.——FIG. 316,*1*. **D. (P.) telleri,* Turon., Aus.(Gosau); ×1 (100).

Dendrogyra EHR., 1834 [**D. cylindrus;* SD M.EDW.-H., 1850] [=*Gyrophyllia* ORB., 1849; *Meandroria* ALLOITEAU, 1952]. Corallite series long, united directly by thickened septothecae. Columella trabecular and solid, a discontinuous lamella, or substyliform. *Eoc.-Rec.,* Eu.-W.Indies-N.Am.——FIG. 315,*2*. **D. cylindrus,* Rec., Bahamas; *2a,* ×0.08; *2b,* ×3 (88).

Orbignygyra ALLOITEAU, 1952 [**Diploria neptuni*

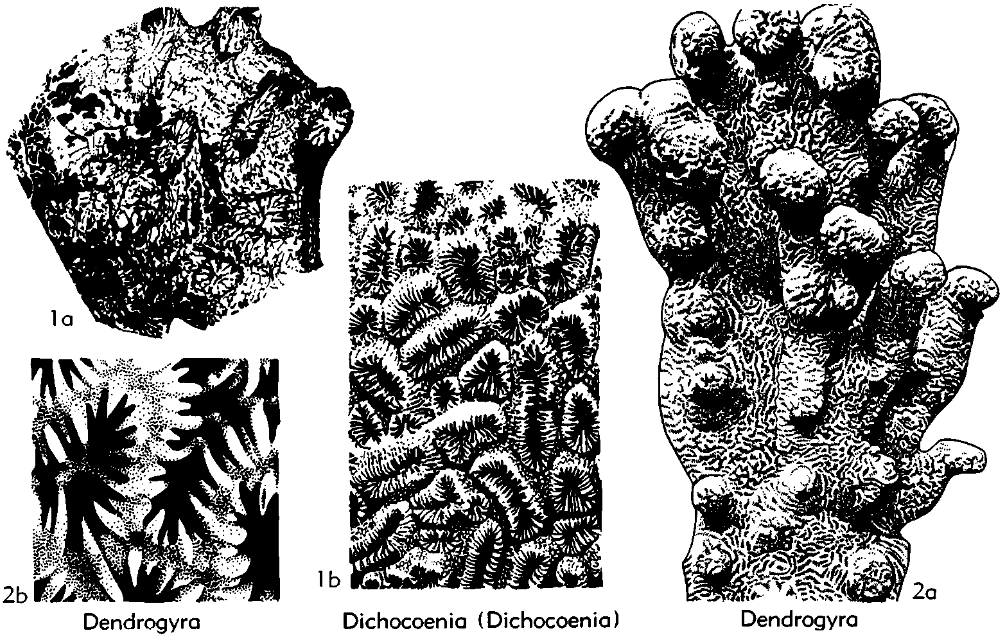


FIG. 315. Faviina (Faviicae): Meandrinidae (p. F416).

ORB., 1850]. Like *Dendrogyra* but series separated by ambulacra. *U.Cret.*, Eu.

Scalariogyra GERTH, 1923 [**S. escharoides*]. Like *Dendrogyra* but inner ends of septa with strong internal swellings or paliform lobes. *Oligo.*, Borneo.

Family MERULINIDAE Verrill, 1866

Colonial, hermatypic. Colony formation by intratentacular polystomodaeal budding; centers linked by trabeculae. Septa of one fan system of compound trabeculae, regularly dentate at first, later with scattered, spinose, ragged, very irregular dentations. Columella feeble or absent. Dissepiments sparse. *Rec.*

FIG. 316. Faviina (Faviicae): Meandrinidae (p. F416).

Boninastraea YABE & SUGIYAMA, 1935 [**B. boninensis*]. Cerioid; colony formation by polystomodaeal budding, permanent condition of corallites di- to tricentric. No columella. *Rec.*, Pac.——FIG. 317,*3*. **B. boninensis*, Ogasawara I.; *3a*, ×0.5 (164); *3b*, septum, ×2 (151).

Merulina EHR., 1834 [**Madrepora ampliata* ELLIS & SOLANDER, 1786]. Foliaceous, thin, meandroid; colony formation by intramural budding, series relatively straight, spreading fanwise by lateral branching and terminal forking. Columella trabecular, generally fused into a continuous mass. *Rec.*, IndoPac.——FIG. 317,*2a,b*. *M. studeri* BEDOT, Amboina; ×0.25, ×2 (174).——FIG. 317,*2c*. **M. ampliata*, Pac.; septum, ×2 (151).

Clavarina VERRILL, 1864 [**Merulina scrabicula* DANA, 1846] Like *Merulina* but ramose, the series discontinuous with circumscribed corallites. Columella rudimentary. *Rec.*, Pac.

Scapophyllia M.EDW.-H., 1848 [**S. cylindrica*]. Like *Merulina* but massive-columniform, corallite series sinuous, continuous. *Rec.*, W.Pac.——FIG. 317,*1*. **S. cylindrica*, Philip.; septum, ×2 (151).

Family MUSSIDAE Ortmann, 1890

Solitary and colonial, hermatypic. Colony formation by intratentacular budding; centers linked by lamellae or trabeculae. Septothecate or parathecate. Septa entocoelic, formed by several fan systems of large, simple trabeculae, each fan system producing a lobulate dentation. Endothecal dissepiments well developed. Columella trabecular. *?U.Jur., Eoc.-Rec.*

?Palaeomussa Alloiteau, 1952 [**Montlivaltia minor* Fromentel, 1864]. Small, solitary, turbinate, with trabecular columella. Septa composed of a few (4 or 5) irregular fan systems. *U.Jur.*, Eu.

Circophyllia M.Edw.-H., 1848 [**Anthophyllum truncatum* Goldf., 1826] [=*Felixopsammia* Filliozat, 1910]. Solitary, turbinate or trochoid, fixed or free. Septothecate, costate. Septa with one broad peripheral fan system and several smaller inner ones. *Eoc.*, Eu.——Fig. 318,*6*. **C. truncatum* (Goldf.), M.Eoc.(Lut.), Fr.; lat. aspects of septum ×1 (151).

?Trochosmilia M.Edw.-H., 1848 [**Turbinolia cornicula* Michelin, 1846; SD Gregory, 1900] [=*?Feddenia* Duncan, 1880]. Solitary, turbinate or trochoid, nonepithecate, septothecate. Septa vertically discontinuous, formed by isolated trabeculae and trabecular bundles, thickened by stereome, with large dentations. Exo- and endothecal dissepiments developed. *Eoc.*, Eurasia.

Mussismilia Ortmann, 1890 [**Mussa harttii* Verrill, 1867] [=*Protomussa* Matthai, 1928]. Phaceloid; colony formation by di- or tristomodaeal budding. Parathecate. Septal dentations small, more or less uniform but ragged. *Rec.*, Braz.——Fig. 318,*2a*. **M. harttii;* long. sec., ×1 (151).——Fig. 318,*2b*. *M. braziliensis* (Verrill); long. sec., ×1 (151).

Syzygophyllia Reuss, 1860 [**S. brevis*]. Solitary or in small phaceloid clumps produced by distomodaeal budding. Centers with lamellar linkage. *Mio*, Eu.——Fig. 319,*3*. **S. brevis,* Vindob., Czech.; *3a,* ×1; *3b,* long. sec., ×1 (189).

Homophyllia Brueggemann, 1877 [**Caryophyllia australis* M.Edw.-H., 1849]. Solitary, broadly turbinate; or with 1 or 2 secondary centers with lamellar linkage. Septal dentations numerous, generally triangular. *U.Oligo.-Rec.*, Austral.

Acanthastrea M.Edw.-H., 1848 [**A. spinosa* (=*A. hirsuta* M.Edw.-H., 1848; =*Astraea echinata* Dana, 1846)]. Low, cerioid (rarely plocoid) colonies with monocentric corallites formed mostly by marginal budding. *Mio.-Rec.*, IndoPac.——Fig. 318,*8*. **A. echinata* (Dana), Rec., Fiji; *8a,* ×2; *8b,* long. sec., ×2; *8c,* septum, ×1 (148).

Acanthophyllia Wells, 1937 [**Caryophyllia deshayesiana* Michelin, 1850] [=*?Apostrophyllum* Thomas, 1935]. Solitary, turbinate, free or fixed by small base. Parathecate with spinose costae. Septal dentations large and lobulate. Columella spongy. *?Oligo.*, *Mio.-Rec.*, Eu.-IndoPac.——Fig. 319,*1a,b*. *A. ampla* (Reuss), Mio.(Vindob.), Rumania; ×0.5 (117).——Fig. 319,*1c*. **A. deshayesiana,* Rec., Philip.; long. sec., ×1 (151).

Antillia Duncan, 1863 [**A. dentata;* SD Fromentel, 1867] [=*Smilophyllia* From. & Ferry, 1865]. Like *Acanthophyllia* but septothecate and septa with larger peripheral fan system. *Eoc.-Mio.*, W.Indies.——Fig. 318,*4a,b*. *A. dentata,* Mio., Dominican Rep.; ×0.7 (29).——Fig. 318,*4c*. *A. gregorii* Vaughan, Mio., Dominican Rep.; long. sec., ×1 (151).

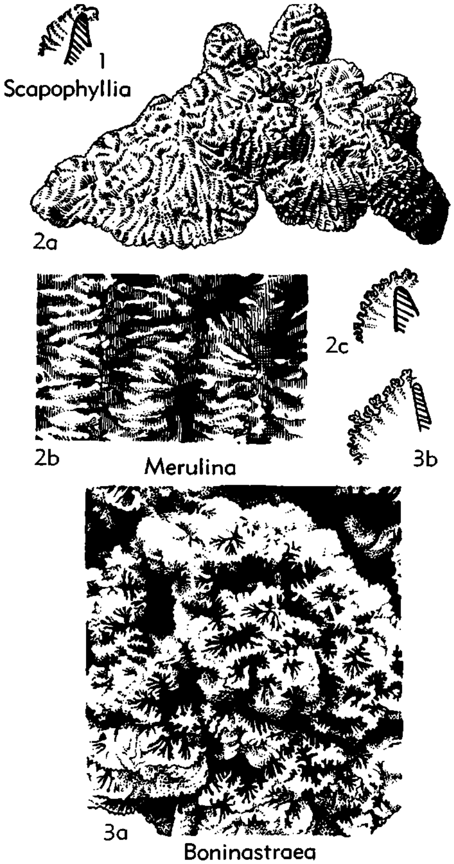


Fig. 317. Faviina (Faviicae): Merulinidae (p. F416-F417).

Cyclomussa Wells, 1941 [**C. concinna*]. Solitary, cupolate to low cylindrical, free, with nearly flat base and highly exsert septa. Septo- and parathecate. *Oligo.*, Peru.——Fig. 319,*2*. **C. concinna; 2a-c,* basal, lat., oral aspects, ×1; *2d,* long. sec., ×1 (198).

Leptomussa d'Achiardi, 1867 [**L. variabilis*]. Solitary, fixed, ceratoid, septothecate. Septa with large fan systems, each bearing dentations. Columella absent. *Oligo.*, Italy.——Fig. 318,*7*. **L. variabilis,* Oligo., Italy, long. sec. of septum, ×1 (116).

Lobophyllia Blainv., 1830 [**Madrepora corymbosa* Forskål, 1775; SD Matthai, 1928] [=*Cynarina* Brueggemann, 1877; *Rhodocyathus* Bourne, 1905; *Protolobophyllia* Yabe & Sugiyama, 1935]. Meandroid-phaceloid clumps formed by intramural polystomodaeal budding, series laterally free. Centers with lamellar linkage. *Rec.*, IndoPac.

L. (Lobophyllia). *Rec.*——Fig. 318,*3*. *L. echinata* (Dana), Amboina; ×0.4 (174).

L. (Palauphyllia) Yabe, Sugiyama & Eguchi, 1936

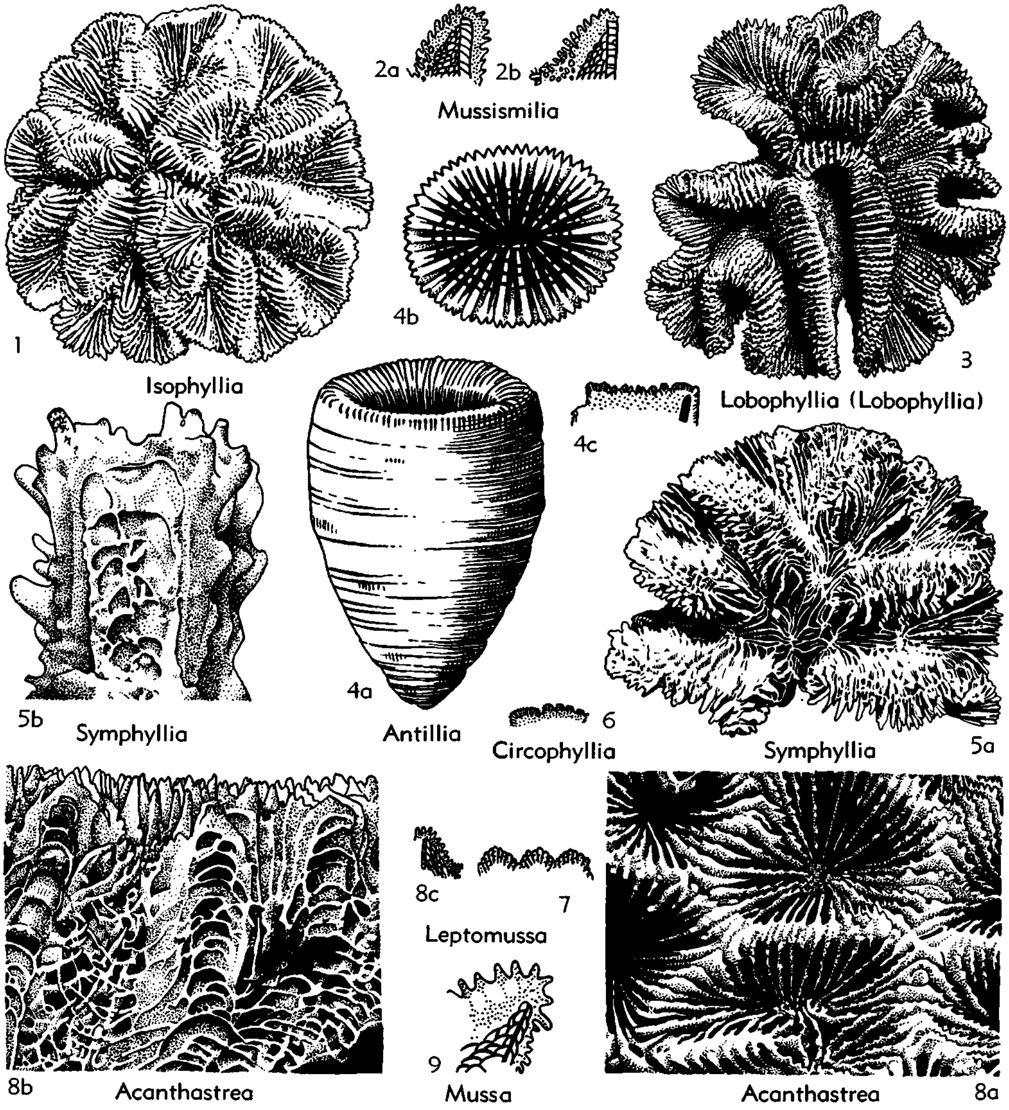


Fig. 318. Faviina (Faviicae): Mussidae (p. F417-F419).

[**L. (P.) hataii*]. Like *L. (Lobophyllia)* but circumoral followed by marginal budding forms broad valleys enclosing more than one series of centers. Pac.

Symphyllia M.Edw.-H., 1848 [**Meandrina sinuosa* Quoy & Gaimard, 1833 (*non Madrepora sinuosa* Ellis & Solander, 1786) (=*Mussa nobilis* Dana, 1846)] [=*Sclerophyllia* Klunzinger, 1879]. Like *Lobophyllia* but series directly united by walls to summits; no ambulacra. *Rec.*, IndoPac.——Fig. 318,*5*. *S. indica* M.Edw.-H., Amboina; *5a*, ×0.5; *5b*, ×2 (174).

Mussa Oken, 1815 [**Madrepora angulosa* Pallas, 1766; SD Vaughan, 1918] [=*Lithodendron* Schweigger, 1819; *Scolymia* Haime, 1852; *Lithophyllia* M.Edw.-H., 1857]. Like *Lobophyllia* but corallites rarely permanently polycentric and centers with trabecular linkages. *Plio.-Rec.*, W.Indies.——Fig. 318,*9*. **M. angulosa* (Pallas), Rec., W. Indies, ×1 (116). Also, see Fig. 232*B*.

Isophyllia M.Edw.-H., 1851 [**Madrepora sinuosa* Ellis & Solander, 1786; SD Matthai, 1928 (=*Oulophyllia? spinosa* M.Edw.-H., 1849)]. Colony formation by circumoral followed by intramural budding, the series later discontinuous, closely united laterally. Trabecular linkages. *Rec.*, W.Indies.——Fig. 318,*1*. **I. sinuosaa* Ellis-S., Bermuda; ×0.5 (88).

Isophyllastraea Matthai, 1928 [**Astraea rigida* Dana, 1846]. Like *Isophyllia* but circumoral budding is followed by separation of buds to form mono- to tricentric corallites. *Rec.,* W.Indies.

Mycetophyllia M.Edw.-H., 1848 [**M. lamarckiana*]. Like *Isophyllia* but several series of centers enclosed between collines. Lamellar linkages. *Mio.-Rec.,* W.Indies.——Fig. 319,*4*. **M. lamarckiana,* Rec., W.Indies; ×1 (88).

Family PECTINIIDAE Vaughan & Wells, 1943

Solitary and colonial, hermatypic. Colony formation by intratentacular polystomodaeal budding; polyps and corallites organically united throughout; linkages by interstomodaeal mesenteries and thin lamellae. Corallum fixed, explanate to foliaceous, rarely submassive, with light structures. Corallites lacking definite walls; coenosteum abundant to practically absent. Septa irregularly dentate, formed by one fan system of compound trabeculae which may produce spinose dentations of mussoid or merulinid type, or dentations may be almost completely reduced. Columella trabecular, feeble or absent. *Oligo.-Rec.*

Fungophyllia Gerth, 1923 [**F. monstrosa;* SD Vaughan & Wells, 1943]. Solitary, with expanded calice whose oral surface is nearly flat. Dentations mussoid. *Oligo.-Mio.,* E.Indies-W.Pac.-W.Indies.——Fig. 321,*1*. **F. monstrosa,* Mio., Borneo; *1a,b,* ×0.5 (58).

Echinophyllia Klunzinger, 1879 [**Madrepora aspera* Ellis & Solander, 1786; SD Wells, 1936] [=*Oxyphyllia* Yabe & Eguchi, 1935]. Colonial; colony formation in earlier stages by circumoral budding, followed by irregular polystomodaeal budding, forming spreading explanate coralla. Calices parallel to plane of frond, united by vesicular coenosteum and confluent septocostae. *Mio.-Rec.,* Eu.-IndoPac.——Fig. 320,*2*. **E. aspera,* Rec., Japan; ×1 (164).

Oxypora Saville-Kent, 1871 [*pro Trachypora* Verrill, 1864 (*non* M.Edw.-H., 1851)] [*Trachypora lacera* Verrill, 1864; SD Wells, 1936]. Like *Echinophyllia* but folia very thin, nonvesicular, perforated at points of insertion of new septa. Calices superficial. Septa with simple to trifurcate dentations. *Rec.,* Pac.——Fig. 320,*1*. **O. lacera,* Palau I.; *1a,b,* ×1 (164).

Mycedium Oken, 1815 [**Madrepora elephantotus* Pallas, 1766; SD Verrill, 1902] [=*Phyllastraea* Dana, 1846]. Like *Echinophyllia* but forming contorted folia with protuberant, nariform, outwardly inclined calices. *Rec.,* Pac.——Fig. 320,*3a*. *M. tenuicostatum* Verrill, Singapore; ×1 (152).——Fig. 320,*3b*. *M. tubifex* (Dana), Mergui I.; ×1 (85).

Physophyllia Duncan, 1884 [**P. ayleni* Wells,

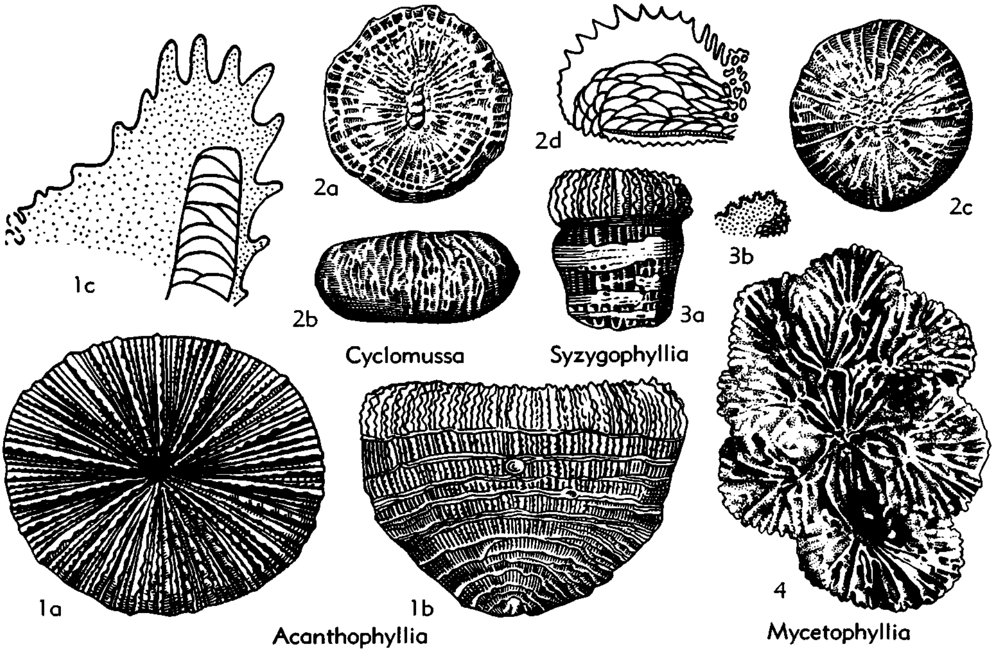


Fig. 319. Faviina (Faviicae): Mussidae (p. F417-F419).

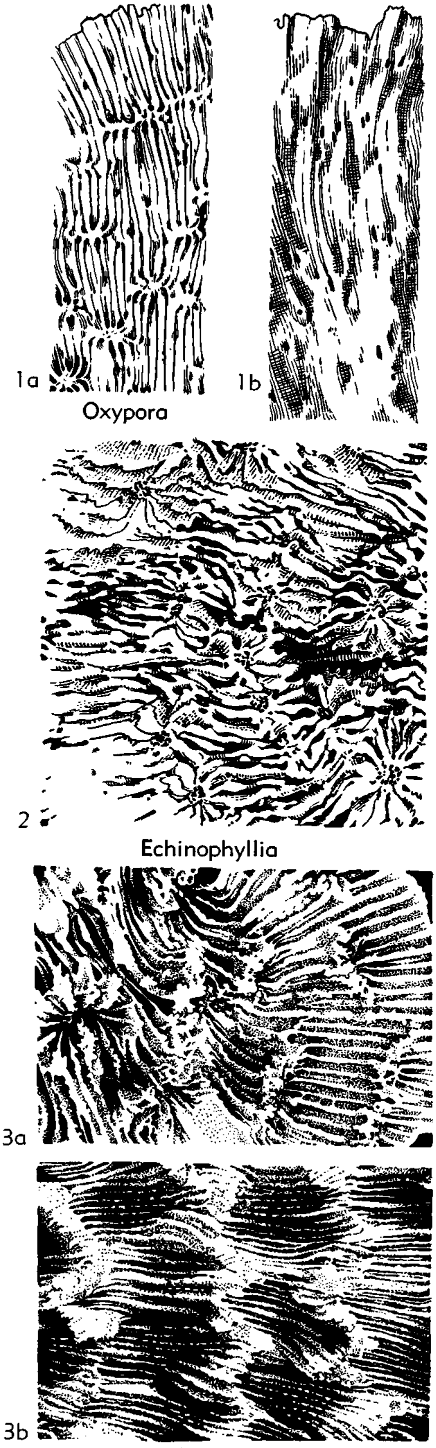


Fig 320. Faviina (Faviicae): Pectiniidae (p. F419-F421).

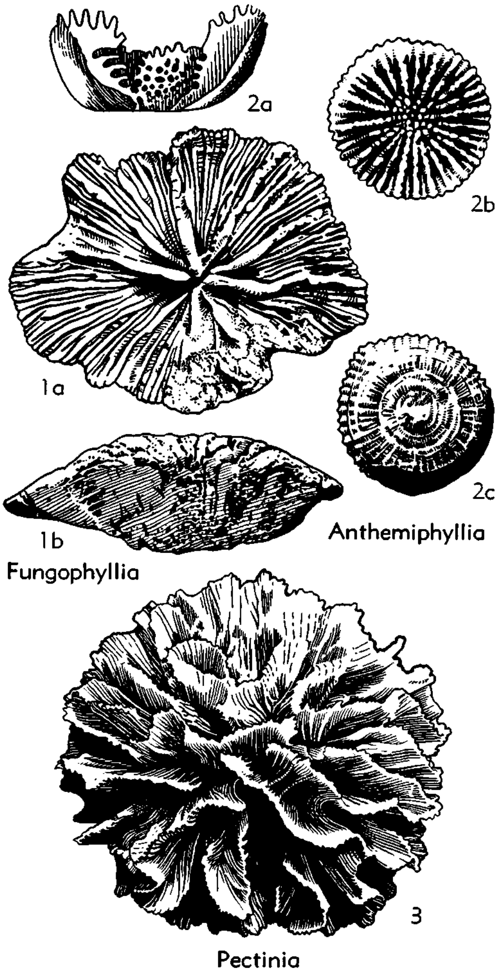


Fig. 321. Faviina (Faviicae): Pectiniidae, Anthemiphylliidae (p. F419-F421).

1934; SD Wells, 1934]. Like *Echinophyllia* but abundant vesicular coenosteum rising between centers forming low collines. Septal dentations small, spinose, distant. *Rec.,* Pac.

Pectinia Oken, 1815 [**Madrepora lactuca* Pallas, 1766; SD Vaughan, 1901] [=**Tridacophyllia* Blainv., 1830; *?Trydacnophyllia* Prever, 1921]. Colony formation by circumoral followed by intramural budding, with submeandrine series separated by high, thin, acute collines bearing secondary centers. *Rec.,* IndoPac.——Fig. 321,*3*. **P. lactuca,* Amboina; ×0.3 (174).

Family ANTHEMIPHYLLIIDAE
Vaughan, 1907

Solitary, free, patellate; ahermatypic. Septothecate, costate. Septa exsert, formed by one fan system of simple trabeculae produc-

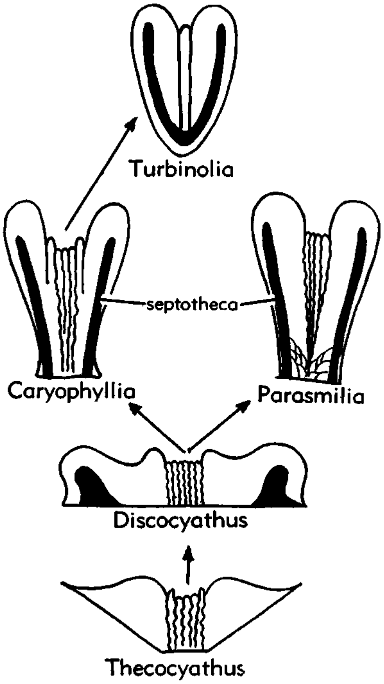


FIG. 321A. Structure of Carophylliicae shown by diagrammatic longitudinal sections (198n).

ing strong dentations. Columella trabecular or absent. Dissepiments absent. *Rec.*

Anthemiphyllia POURTALÈS, 1878 [**A. patera*]. Patellate, with smooth or granulated costae distinct to center of base. Columella trabecular, papillose on surface. *Rec.*, W.Indies-Pac., depth range 183-732 m.——FIG. 321,*2a*. **A. patera,* off Havana, 450-732 m.; long. sec., ×3 (187).——FIG. 321,*2b,c*. *A. hawaiiensis* VAUGHAN, Hawaii; ×3 (146).

Bathytrochus GRAVIER, 1915 [**B. hexagonus*]. Like *Anthemiphyllia* but lacking columella. *Rec.*, Atl., depth range 4,023 m.

Suborder CARYOPHYLLIINA Vaughan & Wells, 1943

[*nom. correct.* WELLS, herein (*pro* Caryophylliida VAUGHAN & WELLS, 1943)]

Solitary and colonial. Septa laminar, with smooth or nearly smooth margins, composed of one fan system of small, simple trabeculae. *Jur.-Rec.*

Superfamily CARYOPHYLLIICAE Gray, 1847

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

Caryophylliina with septothecal wall; rarely parathecal (epithecal in *Thecocyathus*). *Jur.-Rec.*

Family CARYOPHYLLIIDAE Gray, 1847

Solitary and colonial. Colony formation by extratentacular (rarely intratentacular) budding, forming phaceloid or dendroid colonies. Costae commonly covered by stereome or epitheca. Septa exsert. Columella formed by curled trabecular laths, solid, spongy or absent. Pali or paliform lobes common. Endothecal dissepiments developed in some groups (Fig. 321*A*) (199). *Jur.-Rec.*

Subfamily THECOCYATHINAE Vaughan & Wells, 1943

Solitary, discoidal or turbinate, free; ahermatypic. Wall epithecal or partly septothecal. *Jur.-M.Cret.*

Thecocyathus M.EDW.-H., 1848 [**Cyathophyllum tintinnabulum* GOLDF., 1826; SD M.EDW.-H., 1850]. Turbinate, wall epithecal, some internal stereome. Septa slightly exsert; pali opposite all but last cycle. Columella papillose. *Jur.*, Eu.——FIG. 322,*2*. *T. mactrus* (GOLDF.), L.Jur.(Toarc.), Fr.; *2a-c*, ×1.3 (53).

Discocyathus M.EDW.-H., 1848 [**Cyclolites eudesii* MICHELIN, 1840] [=*Brachycyathus* M.EDW.-H., 1848; *Cyclocyathus* M.EDW.-H., 1850]. Discoid; septotheca developed vertically near periphery of epithecal base, with granulated costae. Pali opposite 3rd septal cycle. Columella of several pillars, commonly fused to form lamella. *M.Jur.-M.Cret.*, Eurasia.——FIG. 322,*1*. **D. eudesii* (MICH.), M. Jur.(Baj.), Fr.; *1a-c*, ×1.3 (53).

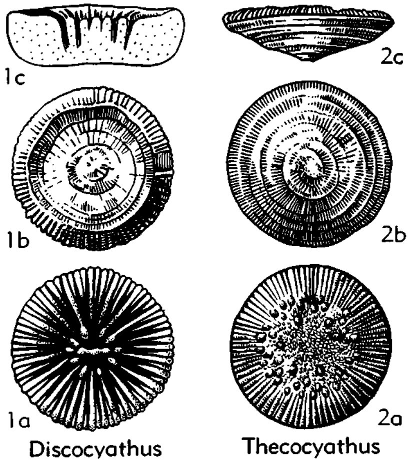


FIG. 322. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F421).

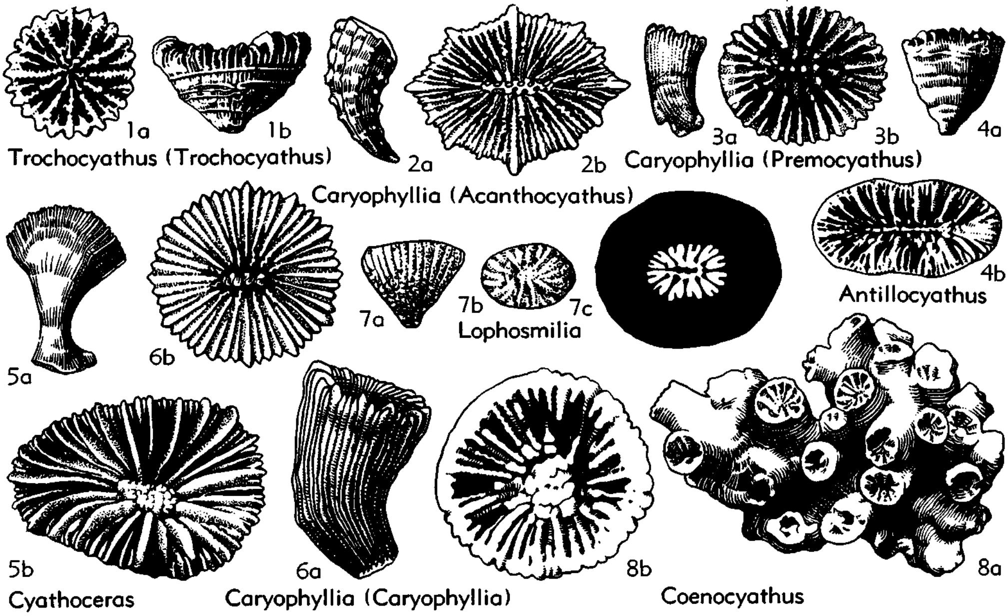


Fig. 323. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F422-F423).

Subfamily CARYOPHYLLIINAE Gray, 1847

[*nom. transl.* M.Edw.-H., 1857 (*ex* Caryophyllidae Gray, 1847)]

Mostly solitary, fixed or free; ahermatypic. Phaceloid or dendroid colonies formed by extratentacular budding from edge zone. Septothecate, with strong costae. Endothecal dissepiments rare. *U.Jur.-Rec.*

Caryophyllia Lamarck, 1801 [**Madrepora cyathus* Ellis & Solander, 1786; SD Broderip, 1828] [=*Anthophyllea* Link, 1807; *Anthophyllum* Schweigger, 1819; *Cyathina* Ehr., 1834; *Amblocyathus* Orb., 1849; *Paterocyathus* Duchassaing & Michelotti, 1860; *Ceratocyathus* Seguenza, 1863; *Blastocyathus* Reuss, 1864; *Goniocyathus* Yabe & Eguchi, 1932]. Solitary, turbinate to subcylindrical, fixed or free. Pali opposite third cycle in one crown (or before 2nd group of septa where hexameral symmetry is lost). Columella fascicular, formed by twisted trabecular laths. *U.Jur.-Rec.*, cosmop., depth range 0-2,743 m.

C. (Caryophyllia). *U.Jur.-Rec.*——Fig. 323,*6*. *C. (C.) bukowskii* Jüssen, Plio., Rhodes; *6a*, ×1; *6b*, ×1.5 (182).

C. (Acanthocyathus) M.Edw.-H., 1848 [**A. grayi;* SD M.Edw.-H., 1850]. Like *C. (Caryophyllia)* but with large costal spines, best developed on costae in plane of longer calicular axis. *Mio.-Rec.*, Eu.-IndoPac., depth range 68-732 m.——Fig. 323,*2*. *C. (A.) transylvanica* Reuss, Mio., Rumania; *2a*, ×1; *2b*, ×2 (117).

C. (Premocyathus) Yabe & Eguchi, 1942 [**Premocyathus compressus*]. Like *C. (Caryophyllia)* but compressed, with end costa of convex side expanded. *Plio.-Rec.*, Pac., depth range 34-658 m.——Fig. 323,*3*. **C. (P.) compressa*, Rec., Philip.; *3a*, ×1; *3b*, ×3 (165).

Antillocyathus Wells, 1937 [**Placocyathus maoensis* Vaughan, 1925]. Like *C. (Caryophyllia)* but with more compressed calice and sublamellar columella. *Mio.*, W.Indies.——Fig. 323,*4*. **A. maoensis* (Vaughan), Mio., Dominican Rep.; *4a*, ×1; *4b*, ×2 (150).

Coenocyathus M.Edw.-H., 1848 [**C. cylindricus;* SD M.Edw.-H., 1850] [=*Bathangia* Keferstein, 1859]. Like *C. (Caryophyllia)* but small subphaceloid colonies formed by extratentacular budding. *Oligo.-Rec.*, Eu.-W.Indies-Calif., depth range 0-732 m.——Fig. 323,*8*. *C. bowersi* Vaughan, Rec., Calif.; *8a*, ×1; *8b*, ×4 (195).

Dendrocyathus Alloiteau, 1952 [**Dactylosmilia cenomana* Orb., 1850]. Like *Coenocyathus* but with small lamellar columella. *M.Cret.*, Eu.

Cyathoceras Moseley, 1881 [**C. cornu;* SD Faustino, 1927]. Like *C. (Caryophyllia)* but lacking pali or paliform lobes. *Mio.-Rec.*, Eu.-W.Indies-S. Atl.-IndoPac., depth range 300-1,372 m.——Fig. 323,*5*. *C. diomedeae* Vaughan, Rec., Hawaii, 300-330 m.; *5a*, ×0.5; *5b*, ×1 (146).

Oxysmilia Duchassaing, 1870 [**Lophosmilia rotundifolia* M.Edw.-H., 1849]. Like *Cyathoceras* but columella fused in solid elongate mass. *Rec.*, W. Indies, depth range 73-293 m.

Lophosmilia M.Edw.-H., 1848 [**Caryophyllia cenomana* Michelin, 1845] [=*Actinosmilia* Orb., 1849; *Thalassiotrochus* M.Edw.-H., 1861; *Cenomanosmilia* Alloiteau, 1949]. Like *Oxysmilia* but columella a thin, lamellar sheet deep in calice.

M.Cret.-Rec., Eu.-N.Am.-S.Am.-Pac., depth range 183-366 m.——Fig. 323,*7*. **L. texana* (Vaughan), U.Cret.(Cenom.), Tex.; *7a,b,* ×1; *7c,* transv. sec., septotheca thickened by stereome, ×4 (158).

Bathycyathus M.Edw.-H., 1848 [**B. chilensis;* SD Wells, 1936] [=*Steriphonotrochus* Vaughan, 1900]. Like *C. (Caryophyllia)* but pali not distinct from columellar laths. *Cret.-Rec.,* Eu.-N.Am.-W. Indies-N.Atl.-SE.Pac., depth range 55-165 m.

?**Nomlandia** Durham & Barnard, 1952 [**N. californica*]. Said to be like *Bathycyathus* but discoidal and lacking wall. *Rec.,* 90 m., Calif.

Trochocyathus M.Edw.-H., 1848 [**Turbinolia mitrata* Goldf., 1827; SD M.Edw.-H., 1850]. Solitary, turbinate to ceratoid, fixed or free. Pali opposite all but last cycle in 2 crowns. Columella fascicular, spongy, or crispate *M.Jur.-Rec.,* cosmop., depth range 32-1,573 m.

T. (Trochocyathus). *M.Jur.-Rec.*——Fig. 323,*1*. *T. (T.) uber* Vaughan & Popenoe, L.Eoc.(Midway.), Tex.; *1a,b,* ×4 (196).

T. (Aplocyathus) Orb., 1849 [**Turbinolia armata* Michelotti, 1838]. Like *T. (Trochocyathus)* but bowl-shaped, with strong basal costal spines. *Eoc.-Rec.,* Eu.-N.Am.-S.Am.-E.Pac., depth range 27-366 m.——Fig. 325,*1*. **T. (A.) armata,* Mio., Italy; *1a,* basal aspect, ×1; *1b,* lat., ×1 (92).

T. (Platycyathus) Fromentel, 1863 [**Trochocyathus terquemi* M.Edw.-H., 1857; SD Wells, 1933] [=?*Ecmesus* Philippi, 1841; *Hemicyathus* Seguenza, 1864; ?*Blanfordia* Duncan, 1880; *Blanfordiola* Strand, 1928]. Like *T. (Trochocyathus)* but thin, discoidal, free. *Cret.-Rec.,* Eu.-N. Am.-Pac., depth range 366-549 m.——Fig. 324, *2*. *T. (P.) lunulitiformis* (Conrad), U.Eoc.(Jackson.), Miss.; *2a,b,* ×2 (144).

Tethocyathus Kühn, 1933 [**Thecocyathus microphyllus* Reuss, 1871] [=*Thecocyathus auctt.* (*non* M.Edw.-H., 1848)]. Like *Trochocyathus* but edge zone narrow; epitheca extensive. *Eoc.-Rec.,* Eu.-Iran-N.Am.-W.Indies-Ind.O.-E.Indies, depth range 13-732 m.——Fig. 324,*1*. *T. cylindraceus* (Pourtalès), Rec., W.Indies; *1a,b,* ×1.5 (104).

Stylocyathus Orb., 1849 [**S. dentalinus*]. Like *Trochocyathus* but pali in one irregular crown opposite first 2 cycles. Columella trabecular, appearing substyliform. *M.Cret.,* Eu.

Axocyathus Alloiteau, 1952 [**Ceratotrochus exiguis* Fromentel, 1861]. Like *Stylocyathus* but with paratheca. Columella fascicular, appearing papillose on surface. *U.Cret.,* Eu.

Deltocyathus M.Edw.-H., 1848 [**Turbinolia italicus* Michelotti, 1838]. Solitary, discoid to patellate, free. Palpi opposite but all last cycle, forming deltas. Columella papillose on surface. *Eoc.-Rec.,* cosmop., depth range 13-4,480 m.

D. (Deltocyathus). *Eoc.-Rec.*——Fig. 324,*6*. **D. (D.) italicus* (Michelotti), Mio.(Vindob.), Aus.; *6a,b,* ×1 (117).

D. (Levipalifer) Vaughan, 1900 [**Levipalifer orientalis* (=*D. (L.) vaughani* Yabe & Eguchi, 1937 (*non D. orientalis* Duncan, 1876)]. Like *D. (Deltocyathus)* but with pali before all cycles. *Rec.,* IndoPac., depth range 80-549 m.——Fig.

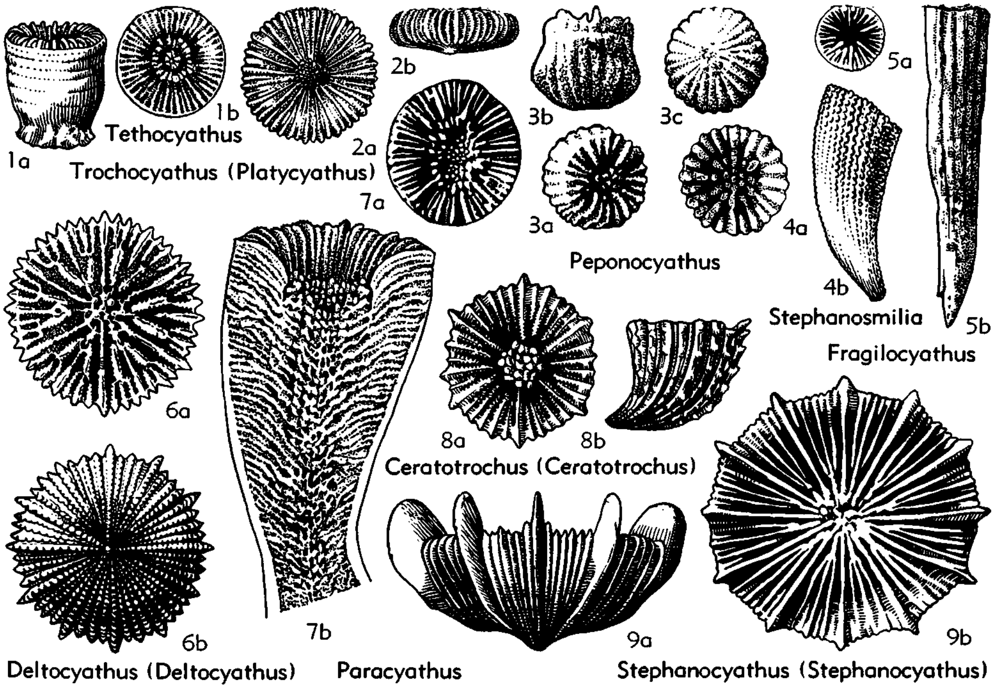


Fig. 324. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F423-F426).

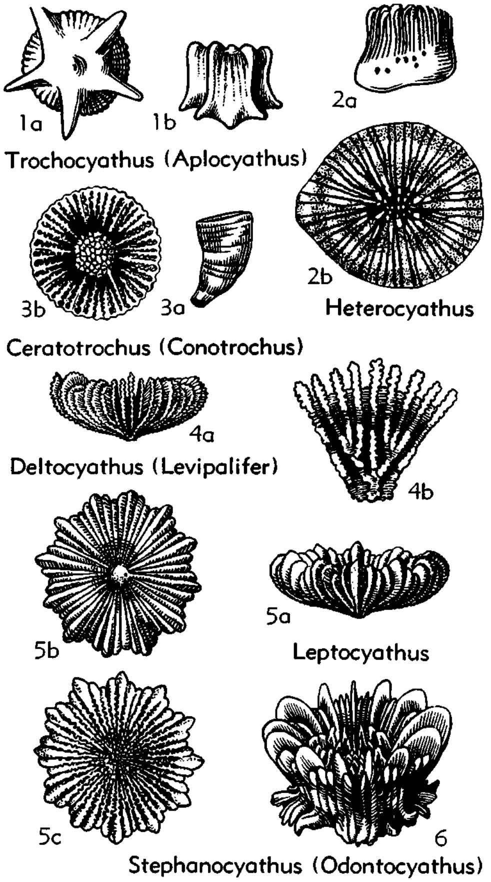


Fig. 325. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F423-F424).

325,*4*. **D. (L.) vaughani*, Japan; *4a*, ×1; *4b*, ×1.5 (195).

Paracyathus M.Edw.-H., 1848 [**P. procumbens;* SD M.Edw.-H., 1850]. Solitary, turbinate, fixed. Pali opposite all but last cycle, merging with columellar papillae. *Eoc.-Rec.*, cosmop., depth range 13-1,472 m.——Fig. 324,*7b*. **P. procumbens*, M.Eoc.(Lut.), Fr.; long. sec., ×2 (93).——Fig. 324,*7a*. *Paracyathus* sp., Fla.; ×2 (151).

Polycyathus Duncan, 1876 [**P. atlanticus*] [=*Agelecyathus* Duncan, 1876]. Like *Paracyathus* but low colonies formed by extratentacular budding from edge zone. *Rec.*, S.Atl.-RedSea-Persian Gulf, depth range 20-73 m.

Deltocyathoides Yabe & Eguchi, 1932 [**D. japonicum*]. Like *Paracyathus* but patellate or subturbinate; free. *Rec.*, Japan, depth range 91-229 m.

Leptocyathus M.Edw.-H., 1850 [**L. elegans*]. Solitary, discoidal, free. Pali opposite all cycles, merging with columellar papillae. *M.Cret.-Eoc.*, Eng. ——Fig. 325,*5*. **L. elegans*, L.Eoc.(Lond.), Eng.; *5a-c*, ×1.5 (94).

Heterocyathus M.Edw.-H., 1848 [**H. aequicostatus;* SD M.Edw.-H., 1850] [=*Stephanoseris* M.Edw.-H., 1851; *Brachytrochus* Duncan, 1876 (*non* Reuss, 1864); *Brachytrossatus* Strand, 1928]. Solitary, fixed in neanic stage to small univalve later completely covered by corallite base except for openings communicating with habitation of commensal sipunculid. Costae extending over base as granulations. Pali opposite all cycles; papillose columella. *Plio.-Rec.*, IndoPac., depth range 11-549 m. ——Fig. 325,*2*. *H. rousseanus* M.Edw.-H., Rec., Zanzibar; *2a*, ×1; *2b*, ×2 (93).

Ceratotrochus M.Edw.-H., 1848 [**Turbinolia multiserialis* Michelotti, 1838; SD M.Edw.-H., 1850] [=*Crispatotrochus* T.-Woods, 1878]. Solitary, trochoid, fixed or free. Pali absent. Columella large and papillose. *M.Cret.-Rec.*, cosmop., depth range 27-732 m.

C. (Ceratotrochus). *M.Cret.-Rec.*——Fig. 324,*8*. *C. (C.) multispinosus* M.Edw.-H., Mio.(Vindob.), Aus.; *8a,b*, ×1 (117).

C. (Conotrochus) Seguenza, 1864 [**C. typus*] [=*Pleurocyathus* Moseley, 1881 (*non* Keferstein, 1859); *Phloeocyathus* Alcock, 1902]. Like *C. (Ceratotrochus)* but epithecate, with septa almost nonexsert. *Eoc.-Rec.*, Eu.-N.Atl.-E.Indies, depth range 137-1,005 m.——Fig. 325,*3*. **C. (C.) typus*. Mio.(Vindob.), Aus.; *3a*, ×1; *3b*, ×2 (117).

Lochmaeotrochus Alcock, 1902 [**L. oculeus*]. Like *C. (Conotrochus)* but forming small phaceloid or subdendroid colonies. *Rec.*, E.Indies, depth range 366-530 m.

Stephanosmilia Fromentel, 1862 [**S. perlata*]. Like *Conotrochus* but small columella and with pali in 2 crowns opposite first 2 cycles. *L.Cret.*, Eu.——Fig. 324,*4*. **S. perlata*, L.Cret.(Apt.), Fr.; *4a,b*, ×3 (52).

Stephanocyathus Seguenza, 1864 [**S. elegans;* SD Wells, 1936] [=*Sabinotrochus* Duncan, 1873; *Stephanotrochus* Moseley, 1881]. Solitary, patellate, free, with strong costae. Pali opposite 1 or 2 cycles or absent. Columella trabecular, papillose on surface. *Eoc.-Rec.*, cosmop., depth range 141-2,195 m.

S. (Stephanocyathus). *Eoc.-Rec.*——Fig. 324,*9*. *S. (S.) diadema nobilis* (Moseley), Rec., off Azores; *9a,b*, ×1 (64).

S. (Odontocyathus) Moseley, 1881 [**Platytrochus coronatus* Pourtalès, 1868]. Like *S. (Stephanocyathus)* but with basal part of lower cycles of costae produced into stout spines. *Mio.-Rec.*, W. Indies-Atl.-Pac., depth range 366-1,575 m.——Fig. 325,*6*. **S. (O.) coronatus* (Pourtalès), Rec., VirginI., 750 m.; ×1 (97).

Vaughanella Gravier, 1915 [**V. concinna*]. Like *Stephanocyathus* but corallum turbinate or subtrochoid. *Rec.*, N.Atl., depth range 1,097-1,829 m.

Fragilocyathus Yabe & Eguchi, 1932 [**F. conotrochoides* (=*Flabellum matricidum* Saville-Kent, 1871)]. Ceratoid, free. Wall finely costate. Longitudinal parricidal budding. No columella or pali. *Rec.,* Japan, depth range 84-289 m.——Fig. 324,*5.* **F. matricidum* (Saville-Kent); *5a,b,* ×0.67 (199).

Aulocyathus Marenzeller, 1904 [**A. juvenescens*]. Like *Fragilocyathus* but with trabecular columella. *Rec.,* E.Afr., depth range 366-430 m.

Stylotrochus Fromentel, 1861 [**S. arcuatus*]. Ceratoid, free. Pali irregular; columella sublamellar. *U.Cret.,* Eu.

Subfamily TURBINOLIINAE Milne-Edwards & Haime, 1848

Solitary, free, trochoid, cuneiform, or conical, completely invested by polyp; intercostal grooves deeply incised from calicular margin to points of origin of costae; ahermatypic. *U.Cret.-Rec.*

Bothrophoria Felix, 1909 [**B. ornata*]. Trochoid, slightly compressed. Wall regularly perforated between costae. No pali; columella spongy. *U.Cret.,* Antarct.——Fig. 329,*1. B. ornata,* Senon., Antarct.; *1a,b,* ×2 (177).

Conocyathus Orb., [**C. sulcata*] [=*Stylocyathus* Reuss, 1855 (*non* Orb., 1849); *Pleurocyathus* Keferstein, 1859]. Like *Bothrophoria* but not compressed, and with paliform lobes forming one crown opposite second cycle. *Eoc.-Rec.,* Eu.-Afr.-IndoPac., depth range 73 m.——Fig. 326,*1. C. zelandiae* Duncan, Rec., Persian Gulf; *1a,b,* ×5 (178).

Trematotrochus T.-Woods, 1879 [**Conocyathus fenestratus* T.-Woods, 1878]. Like *Conocyathus* but septa and costae with hispid granulations; paliform lobes reduced or even absent. *U.Oligo.-Rec.,* Austral.-N.Z., depth range 27-457 m.——Fig. 327,*2. T. hedleyi* Dennant, Rec., off Pt. Jackson, 457 m.; *2a,b,* ×5 (21).

Turbinolia Lamarck, 1816 [**T. sulcata;* SD M.Edw.-H., 1850] [=*Diplactis, Heteractis* Chalmas, 1895]. Trochoid-conical; wall perforated or externally pitted between costae. Interseptal costae in some species. Styliform or slightly compressed columella formed by fusion of primary septa. *Eoc.-Oligo.,* Eu.-W.Afr.-N.Am.-S.Am.

T (Turbinolia). *Eoc.-Oligo.*——Fig. 326,*2a.* **T. (T.) sulcata* Lam., M.Eoc.(Auvers.), Eng.; ×5 (94).——Fig. 326,*2b. T. (T.) dixoni* M.Edw.-H., M.Eoc.(Auvers.), Eng.; ×5 (94).

T. (Batotrochus) Wells, 1937 [**Turbinolia corbicula* Pourtalès, 1879]. Like *T. (Turbinolia)* but septa and costae with thick-set spinose granulations. *Rec.,* Fla., depth range 183-567 m.

Notocyathus T.-Woods, 1880 [**Caryophyllia viola* Duncan, 1864; SD Felix, 1927] [=*Nototrochus* Duncan, 1884; *Citharocyathus* Alcock, 1902]. Trochoid-conical to cuneiform; wall imperforate. Paliform lobes opposite all but last cycle, commonly forming deltas opposite second and third. Columella papillose to pseudolamellar. *U.Eoc-Rec.,* W.Pac.-Austral.

N. (Notocyathus). *U.Oligo.-Rec.,* depth range 68-583 m.——Fig. 329,*6. N. (N.) conicus* (Alcock), Rec., Sulu Sea, 550 m.; *6a,b,* ×5 (4).

N. (Paradeltocyathus) Yabe & Eguchi, 1937 [**Deltocyathus orientalis* Duncan, 1876]. Like *N. (Notocyathus)* but with bowl-shaped corallum. *U.Eoc.-Rec.,* IndoPac.-N.Atl., depth range 55-835 m.

Sphenotrochus M.Edw.-H., 1848 [**Turbinolia crispa* Lamarck, 1816; SD M.Edw.-H., 1850]. Cuneiform, with strong crispate costae or costae more or less reduced to granulations. Columella pseudolamellar. Pali absent. *Eoc.-Rec.,* cosmop.

S. (Sphenotrochus). *Eoc.-Rec.,* depth range 21-274 m.——Fig. 327,*4. S. (S.) intermedius* (Münster), Plio., Eng.; *4a,b,* ×5 (94). (Also Fig. 248.)

S. (Eusthenotrochus) Wells, 1935 [**S. (E.) moseri* (=*S. gilchristi* Gardiner, 1904)]. Like *S. (Sphenotrochus)* but costae wholly reduced to crispate granulations. *Eoc.-Rec.,* Eu.-W.Indies-Ind. O., depth range 78-142 m.——Fig. 326,*3.* **S. (E.) gilchristi,* Rec., southeast Africa, 125 m.; *3a,b,* ×1 (198).

Idiotrochus Wells, 1936 [**Sphenotrochus emarciatus* Duncan, 1865]. Like *S. (Sphenotrochus)* but the costae alternate in position with septa, and with pali in one crown opposite first 2 cycles. *Oligo.-Rec.,* W.Pac.-Austral.——Fig. 329,*4.* **I. emarciatus,* L.Mio.(Balcomb.), SAustral.; *4a,b,* ×5 (198).

Dunocyathus T.-Woods, 1878 [**D. parasiticus* T.-Woods, 1878 (=*Deltocyathus rotaeformis* T.-Woods, 1878)]. Like *Idiotrochus* but patellate to discoidal or turbinate with base overgrown by

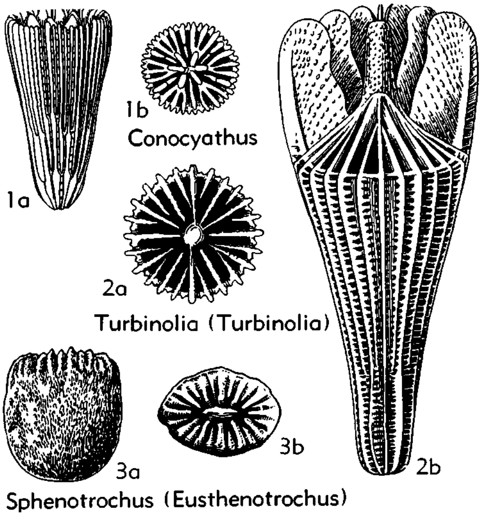


Fig. 326. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F425).

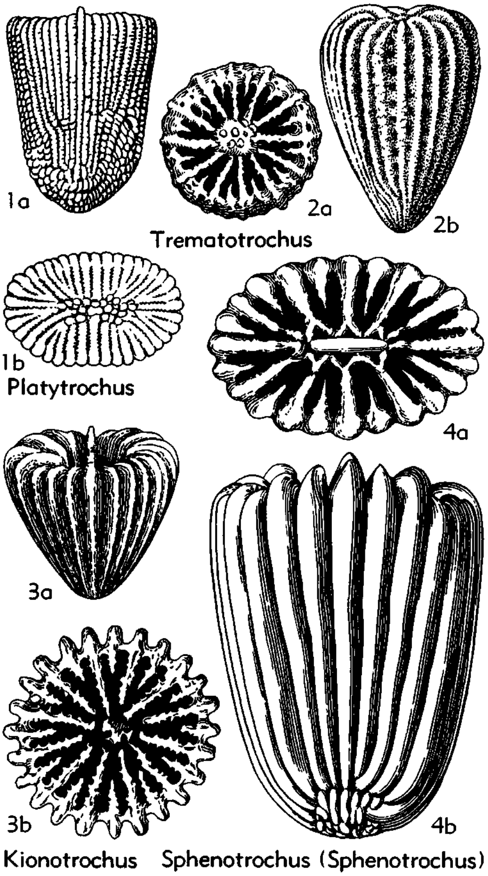


FIG. 327. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F425-F426).

bryozoan *(Bipora)*. *Rec.*, Austral., depth range, 82-457 m.

Platytrochus M.EDW.-H., 1848 [**Turbinolia stokesi* LEA, 1833; SD M.EDW.-H., 1850]. Like *Sphenotrochus* but with spongy columella, and generally with alate, thickened end costae. *U.Cret.-Rec.*, N. Am.-Austral., depth range 27-130 m.——FIG. 327, *1*. *P. claibornensis* GREGORIO, M.Eoc.(Claib.), Ala.; *1a,b*, ×5 (144).

Koilotrochus T.-WOODS, 1878 [**Smilotrochus? vacuus*] [=*Aldrichia* VAUGHAN, 1900 (*non* COQUILLET, 1894); *Aldrichiella* VAUGHAN, 1903]. Like *Platytrochus* but elongate-cornutiform, with normal end costae. *Eoc.-Mio.*, N.Am.-Austral.——FIG. 329,*5*. *K. elegans* (VAUGHAN), U.Eoc.(Jackson.), Miss.; *5a*, ×5; *5b*, ×10 (144).

Dominicotrochus WELLS, 1937 [**Smilotrochus? dominicensis* VAUGHAN, 1925]. Like *Platytrochus* but lacking columella. *Mio.*, W.Indies.

Kionotrochus DENNANT, 1906 [**K. suteri*]. Subtrochoid, bowl-shaped, or patellate. Costae broad and spinose. Columella commonly solid. Pali absent. *Rec.*, Eu.-Pac., depth range 68-470 m.——FIG. 327,*3*. **K. suteri*, Rec., N.Z.; *3a,b*, ×5 (21).

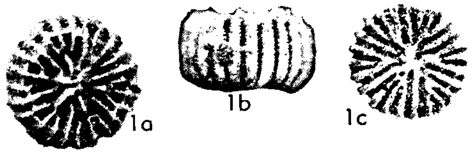


FIG. 328. Caryophylliina (Caryophylliicae): *Cylindrophyllia*.

Cylindrophyllia YABE & EGUCHI, 1937 [**C. minima*]. Tympanoid, generally with 3 cycles of septa and single crown of 6 thin pali before 2nd cycle; columella papillary. *Oligo.-Rec.*, Eu.-Pac., depth range 260 m.——FIG. 328,*1*. **C. minima*, M.Oligo. (Waitakian), N.Z.; *1a-c*, calicular, lateral, and basal views, ×6.7 (198).

Peponocyathus GRAVIER, 1915 [**P. variabilis*]. Globular or bottle-shaped; pali opposite all but last cycle of septa in 2 crowns; columella papillary. *Oligo.-Rec.*, Atl.-W.Indies-E.Pac.-Austral., depth range 110-1,097 m.——FIG. 324,*3*. **P. variabilis*, Rec., Azores, 350-850 m.; *3a-c*, ×5 (64).

Tropidocyathus M.EDW.-H., 1848 [**Flabellum lessoni* MICHELOTTI, 1842] [=*Cyathotrochus* BOURNE, 1905]. Like *Platytrochus* but larger, with strong alate costal extensions, and with pali opposite all but last cycle. *Mio.-Rec.*, IndoPac., depth range 11-480 m.——FIG. 329,*2*. **T. lessoni*, Rec., E. Indies; *2a,b*, ×2 (171).

Holcotrochus DENNANT, 1902 [**H. scriptus*]. Cuneiform, with very broad, spinose or hispid costae. Septa thick, few, equal. Columella trabecular. *Mio.-Rec.*, Austral., depth range 10-41 m.——FIG. 329,*3*. **H. scriptus*, L.Mio.(Balcomb.), S.Austral.; *3a,b*, ×5 (21).

Subfamily DESMOPHYLLINAE Vaughan & Wells, 1943

Solitary and colonial; ahermatypic. Colony formation by intra- and extratentacular budding. Endothecal dissepiments deep and sparse. Coenosteum dense where developed. Columella, pali, and epitheca absent. *Cret.-Rec.*

Desmophyllum EHR., 1834 [**D. dianthus* (*non Madrepora dianthus* ESPER, 1797) (=*D. cristagalli* M.EDW.-H., 1848; SD M.EDW.-H., 1850)] [=*Coelosmilia* M.EDW.-H., 1850; *Psammosmilia* FROMENTEL, 1867; *Thalamophyllia* DUCHASSAING, 1870; *Javania* DUNCAN, 1876]. Solitary, trochoid, fixed. Costae well developed near calice, obsolete or covered by stereome basally. Some sparse endothecal dissepiments. *M.Cret.-Rec.*, cosmop., depth range 0-2,286 m.——FIG. 330,*4*. **D. cristagalli*, Rec., off Cape Breton; ×0.5 (93).

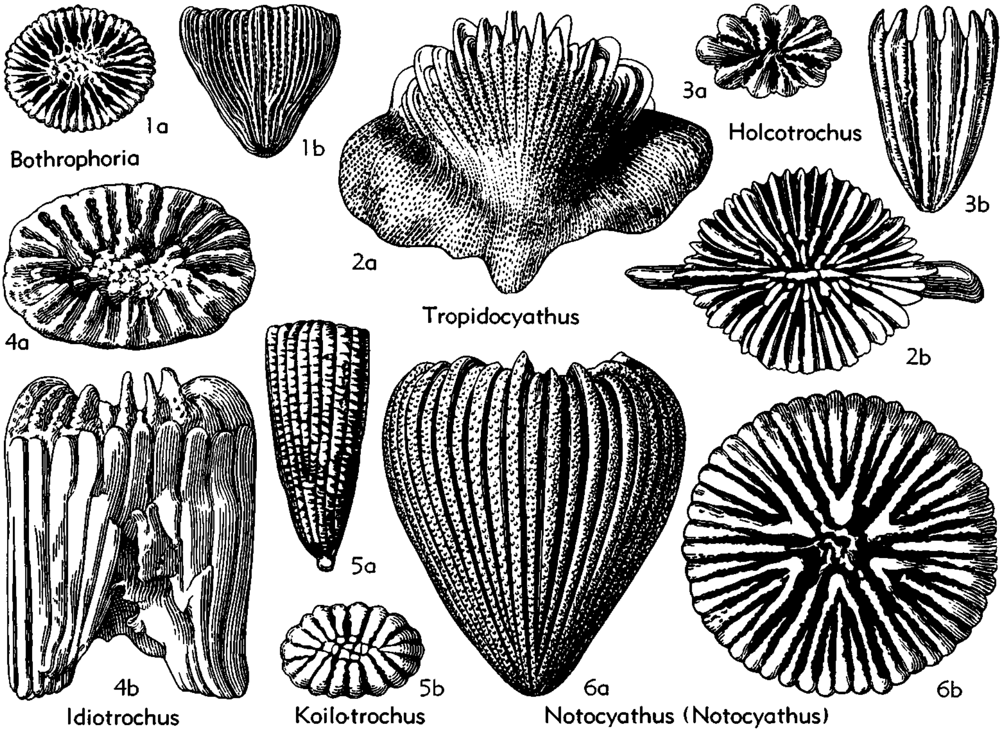


FIG. 329. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F425-F426).

Gemmulatrotrochus DUNCAN, 1878 [**G. simplex*] [=*Microcyathus* DÖDERLEIN, 1913 (*non* HINDE, 1896)]. Like *Desmophyllum* but forming small clumps mostly by extratentacular budding. *Rec.*, Medit.-Eng.Channel, shallow water.

Dactylotrochus WELLS, 1954 [**Tridacophyllia cervicornis* MOSELEY, 1881]. Like *Desmophyllum* but with slender, finger-like extensions of wall and septa flaring outwards from calicular margin. *Rec.*, Pac., depth range 75-135 m.

Lophelia M.EDW.-H., 1849 [**Madrepora prolifera* PALLAS, 1766; SD M.EDW.-H., 1850] [=*Lophohelia* M.EDW.-H., 1857; *Scolangia* T.-WOODS, 1880]. Like *Desmophyllum* but forming large dendroid

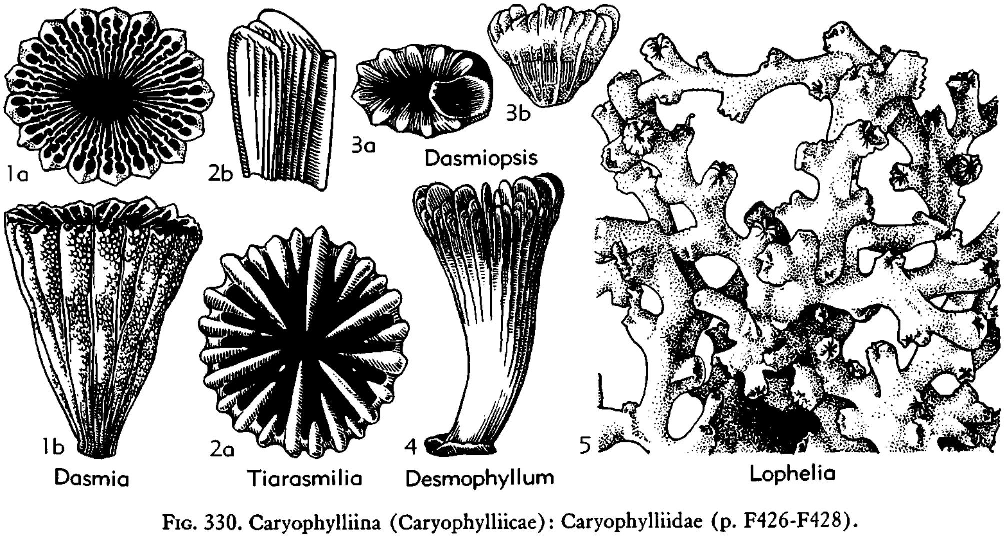


FIG. 330. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F426-F428).

colonies by unequal intratentacular monostomatous budding. Coenosteum dense. Costae feebly developed. Sparse tabular endothecal dissepiments. *Oligo.-Rec.*, N.Atl.-Medit.-N.Z., depth range 64-1,975 m.——FIG. 330,*5*. **L. prolifera*, Rec., off S. Car., 500-800 m.; ×0.5 (151).

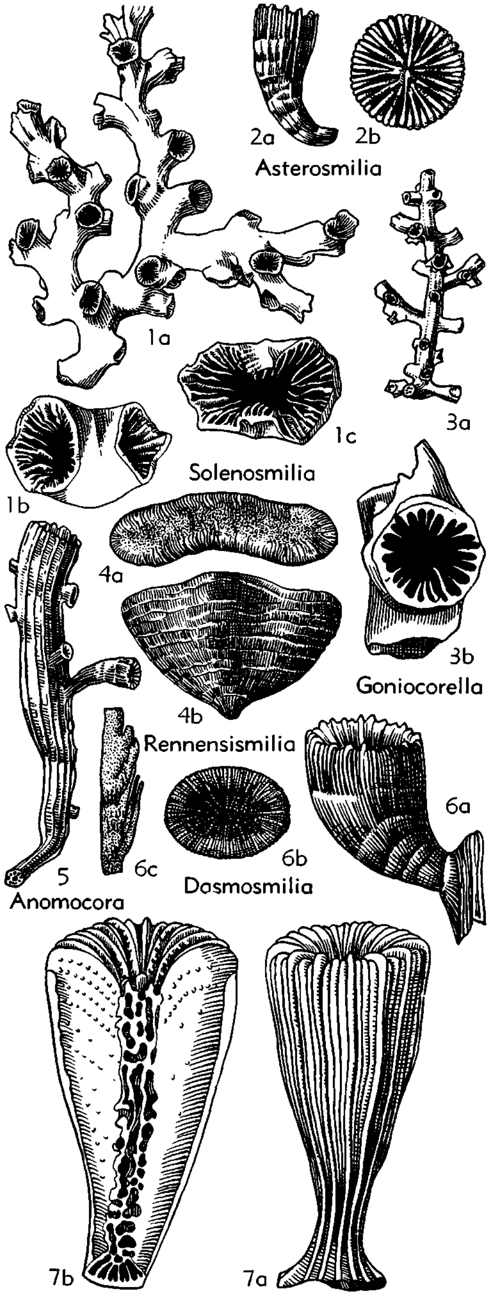


FIG. 331. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F428-F429).

Tiarasmilia Wells, 1932 [**T. casteri*]. Like *Desmophyllum* but septa with strong vertical striations or lateral ridges. *L.Cret.*, Tex.——FIG. 330,*2*. **T. casteri*, L.Cret.(U.Apt.), Tex.; *2a*, calice, *2b*, cutaway diagram of 3 septa, ×2 (157).

Stelloria Orb., 1849 [**S. elegans* (=*Anthophyllum sulcatum* Michelotti, 1845; SD Wells, 1936)]. Low and turbinate, fixed by broad base. Costae apparently very low or obsolete. Septa with strong vertical striations or carinae projecting nearly halfway to adjacent septa. *M.Cret.*, Eu.

Dasmia M.Edw.-H., 1848 [**D. sowerbyi*]. Solitary, free in ephebic stage. Septa of first cycle normal; those of higher cycles divided vertically without corresponding costae. *L.Eoc.*, Eng.——FIG. 330,*1*. **D. sowerbyi*, Lond., Eng.; *1a,b*, ×3 (94).

Dasmiopsis Oppenheim, 1930 [**Trochocyathus lamellicostatus* Reuss, 1854]. Solitary, cornute, free. Costae of first 2 cycles normal; those of higher cycles bent toward those of lower cycles and covered by stereome, giving appearance of only 12 costae. *U.Cret.*, Aus.——FIG. 330,*3*. **D. lamellicostatus* (Reuss), Turon., Aus.(Gosau); *3a,b*, ×1 (100).

Subfamily PARASMILIINAE Vaughan & Wells, 1943

Solitary and colonial, ahermatypic. Colony formation by intra- and extratentacular budding. Coenosteum, epitheca, and stereome rarely developed. Endothecal dissepiments sparse. Columella trabecular or absent. *U. Jur.-Rec.*

Parasmilia M.Edw.-H., 1848 [**Madrepora centralis* Mantell, 1822] [=*Cylicosmilia* M.Edw.-H., 1848; *Cyclosmilia* Orb., 1849; *Monocarya* Lonsdale, 1850; *?Plesioparasmilia, Strobilosmilia* Alloiteau, 1952]. Solitary, trochoid, fixed. Columella spongy. Endothecal dissepiments developed but deep in corallum. *L.Cret.-Rec.*, cosmop., depth range 313-366 m.——FIG. 331,*7*. **P. centralis*, U. Cret.(Senon.), Eng.; *7a,b*, corallum and long. sec. (endotheca not shown), ×2 (94).

Edwardsosmilia Alloiteau, 1949 [**Trochosmilia faujasi* M.Edw.-H., 1849]. Like *Parasmilia* but columella compressed; costae obsolete basally. *U. Cret.*, Eu.

Smilotrochus M.Edw.-H., 1851 [**Trochosmilia tuberosa* M.Edw.-H., 1850] [=*Blagrovia* Duncan, 1880]. Like *Parasmilia* but columella absent. *M. Cret.-Eoc.*, Eurasia.

Rennensismilia Alloiteau, 1952 [**Turbinolia didyma* Goldf., 1826]. Like *Smilotrochus* but compressed, with endothecal dissepiments well developed peripherally. Includes many species attributed to *Trochosmilia*. *U.Cret.*, Eu.——FIG. 331,*4*. *R. didymophila* (Felix), U.Cret.(Turon.), Aus. (Gosau); *4a,b*, ×0.5 (42).

Meandrosmilia ALLOITEAU, 1952 [**Trochosmilia flabellum* FROMENTEL, 1863]. Like *Rennensismilia* but larger, flabellate in shape. *U.Cret.,* Eu.

Coenosmilia POURTALÈS, 1874. [**C. arbuscula*]. Like *Parasmilia* but producing small phaceloid colonies by extratentacular budding from edge zone below calice. *Rec.,* W.Indies, depth range 183 m.

Dungulia OPPENHEIM, 1930 [**Coelosmilia milneri* GREGORY, 1898] [=*Coelosmilia auctt.* (*non* M. EDW.-H., 1850)]. Like *Parasmilia* but columella and endothecal dissepiments feebly developed, with relatively few septa. *U.Jur., ?Rec.,* Eurasia-Afr.-N.Am.

Caryosmilia WANNER, 1902 [**C. granosa*]. Like *Dungulia* but with paliform lobes opposite third cycle. *U.Cret.,* N.Afr.

Anomocora STUDER, 1878 [**Coelosmilia fecunda* POURTALÈS, 1871] [=*Blastosmilia* DUNCAN, 1878 (*non* ÉTALLON, 1859); *Pourtalosmilia* DUNCAN, 1884]. Like *Dungulia* but with tendency toward budding from edge zone with loss of organic connection. *Rec.,* W.Indies-Atl.-Ind.O., depth range 91-576 m.——FIG. 331,*5*. **A. fecunda,* Fla., 125-275 m.; ×1 (104).

Solenosmilia DUNCAN, 1873 [**S. variabilis*]. Dendroid or subphaceloid colonies produced by intratentacular budding. Corallites cylindrical with some granular stereome. Septa relatively few; columella very weak; endothecal dissepiments tabular. *Rec.,* Atl.-IndoPac., depth range 457-1,280 m.——FIG. 331,*1*. *S. jeffreyi* ALCOCK, off Travancore, 840 m.; *1a,* ×0.5; *1b,c,* ×2 (171).

Dendrosmilia M.EDW.-H., 1848 [**D. duvaliana*]. Like *Solenosmilia* but colony formation by extratentacular budding, regular and alternate. *Eoc.-Oligo.,* Eu.

Asterosmilia DUNCAN, 1867 [**Trochocyathus abnormalis* DUNCAN, 1865; SD VAUGHAN, 1919]. Solitary, trochoid-ceratoid, generally free. Paliform lobes opposite next to last 1 or 2 cycles. Columella lamellar at surface, trabecular below. *Oligo.-Rec.,* W.Indies, depth range 137-183 m.——FIG. 331,*2*. *A. prolifera* POURTALÈS, Rec., W.Indies; *2a,* ×1; *2b,* ×1.5 (104).

Dasmosmilia POURTALÈS, 1880 [**Trochosmilia lymani* POURTALÈS, 1871; SD WELLS, 1933]. Turbinate or trochoid, commonly increasing by parricidal budding. Paliform lobes before all but last cycle. Columella formed by mingling of inner lobes. *U.Cret.-Rec.,* N.Am.-W.Indies-RedSea, depth range 110-448 m.——FIG. 331,*6*. **D. lymani,* Rec., Fla., 125-275 m.; *6a,b,* lat. and calicular aspects, ×1; *6c,* septum with paliform lobes, ×1 (104).

Goniocorella YABE & EGUCHI, 1932 [**Pourtalosmilia dumosa* ALCOCK, 1902]. Dendroid; colony formation by extratentacular budding at right angles. Corallites cylindrical, faintly costate. Columella absent; endothecal dissepiments tabular and sparse. *Rec.,* W.Pac., depth range 100-457 m.——FIG. 331,*3*. **G. dumosa,* E.Indies, 450-457 m.; *3a,* ×0.5; *3b,* ×4 (4).

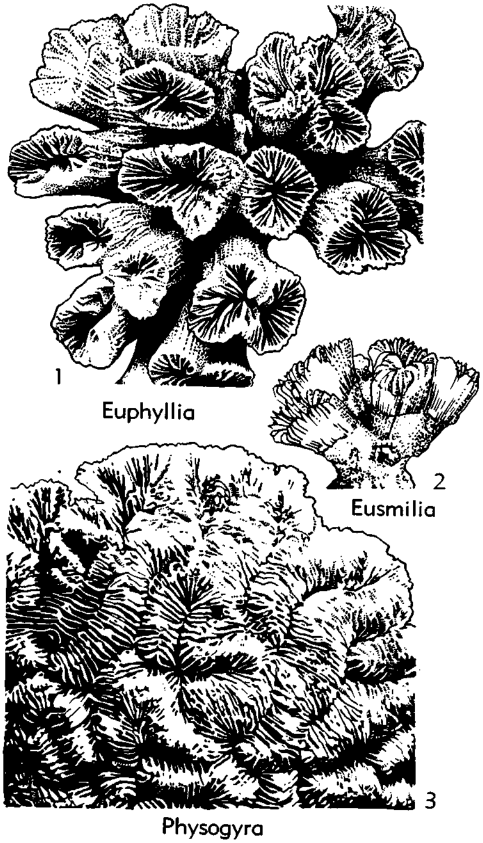


FIG. 332. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F429-F430).

Subfamily EUSMILIINAE Milne-Edwards & Haime, 1857

Colonial caryophylliids, hermatypic. Colony formation by intratentacular intramural di- to polystomodaeal budding. Corallite walls septothecal or parathecal. Costae low, distant. Septa exsert, mostly entocoelic. Columella trabecular, lamellar, or absent. Endothecal dissepiments vesicular. *Eoc.-Rec.*

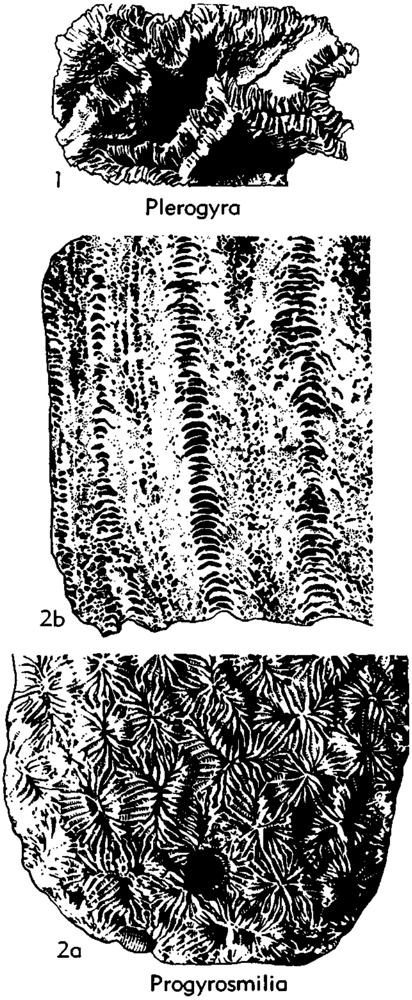
Euphyllia DANA, 1846 [**Caryophyllia glabrescens* CHAMISSO & EYSENHARDT, 1821; SD VAUGHAN, 1918] [=*Leptosmilia* M.EDW.-H., 1848; *Plocophyllia* REUSS, 1868]. Phaceloflabellate, with laterally free series. Walls septothecal. Columella absent. *Eoc.-Rec.,* Eurasia-IndoPac.——FIG. 332,*1*. **E. glabrescens,* Rec., Fiji; ×0.25 (148).

Plerogyra M.EDW.-H., 1848 [**P. laxa* M.EDW.-H., 1849; SD M.EDW.-H., 1850 (=*Euphyllia sinuosa* DANA, 1846)]. Like *Euphyllia* but series united basally and more or less laterally by cellular coenosteum; walls parathecal. *Rec.*, IndoPac.——Fig. 333, *1. P. sinuosa,* E.Indies; ×0.25 (88).

Physogyra Quelch, 1884 [**P. aperta* (=*Plerogyra lichtensteini* M.Edw.-H., 1851)]. Like *Plerogyra* but series closely united by walls; endothecal dissepiments highly vesicular. *Rec.*, IndoPac.——Fig. 332,*3. P. somaliensis* Vaughan, Fr.Somali.; ×0.5 (195).

Gyrosmilia M.Edw.-H., 1851 [**Manicina interrupta* Ehr., 1834]. Like *Physogyra* but with proportionally more septa and mostly septothecal walls. *Rec.*, RedSea.

Progyrosmilia Wells, 1937 [*pro Coelocoenia* Gerth, 1923 (*non* Volz, 1896)] [**Coelocoenia torulosa* Gerth, 1923]. Like *Gyrosmilia* but with shorter series separated by costate ambulacra. *Mio.*, E.Indies.——Fig. 333,*2. *P. torulosa,* Borneo; *2a,* ×1; *2b,* long. sec., ×1.75 (58).



Plerogyra

Progyrosmilia

Fig. 333. Caryophylliina (Caryophylliicae): Caryophylliidae (p. F429-F430).

Eusmilia M.Edw.-H., 1848 [**Madrepora fastigiata* Pallas, 1766]. Like *Euphyllia* but corallites smaller, mono- to tristomatous, with septa more exsert and spinose costae. *Oligo.-Rec.*, W.Indies-N. Am.——Fig. 332,*2. *E. fastigiata,* Rec., Fla.; ×0.5 (151).

Family RHIPIDOGYRIDAE Koby, 1904

Solitary and colonial, fixed; hermatypic. Colony formation by intratentacular budding (except *Cymosmilia*). Corallites united or externally thickened by solid coenosteum with granulated surface, concealing costae except near calices. Septa relatively few, exsert, thick, nondentate. Columella lamellar, thin, continuous, deep. Endothecal dissepiments thin and sparse. Epitheca absent. *M. Jur.-L.Cret.* (Fig. 260).

APLOSMILIA GROUP

Colony formation (except *Cymosmilia*) by complete mono- or distomodaeal budding.

?**Codonosmilia** Koby, 1888 [**C. elegans*]. Solitary or forming low colonies by monostomodaeal budding. Presence of columella in this genus not yet established. *M.Jur.-U.Jur.*, Eurasia.——Fig. 334,*4. *C. elegans,* U.Jur.(Bath.), Fr.; *4a,b,* ×1 (71).

Cymosmilia Koby, 1894 [**C. conferta*]. Low colonies produced by extratentacular budding from edge zone. *U.Jur.*, Eu.——Fig. 334,*3. C. conferta,* U.Jur.(Raur.), Fr.; *3a,* ×0.5; *3b,* ×1 (71).

Aplosmilia Orb., 1849 [**Lobophyllia semisulcata* Michelotti, 1843]. Phaceloid colonies formed by complete mono- or distomodaeal budding. *U.Jur.-L.Cret.*, Eu.-AsiaM.——Fig. 334,*6a. A. rugosa* Koby, U.Jur.(Raur.), Switz.; ×0.25 (71).——Fig. 334,*6b,c. *A. semisulcata,* U.Jur.(Sequan.), Fr.; long. secs. parallel to and across columella, ×1.5 (71).

Kologyra Wells, 1937 [**Pachygyra tuberosa* Orb., 1850]. Like *Aplosmilia* but subplocoid with incomplete separation of corallites which may form short series. *U.Jur.*, Eu.

Acanthogyra Ogilvie, 1897 [**A. columnaris*]. Like *Aplosmilia* but cerioid. *U.Jur.*, Eurasia.——Fig. 335,*1. A. multiformis* Ogilvie, Portl., Czech., transv. sec., ×1 (99).

RHIPIDOGYRA GROUP

Colony formation by incomplete, linear, polystomodaeal budding.

Rhipidogyra M.Edw.-H., 1848 [**Lobophyllia flabellum* Michelin, 1843; SD M.Edw.-H., 1850] [=*Stylogyra* Orb., 1849; *Stenogyra* Fromentel,

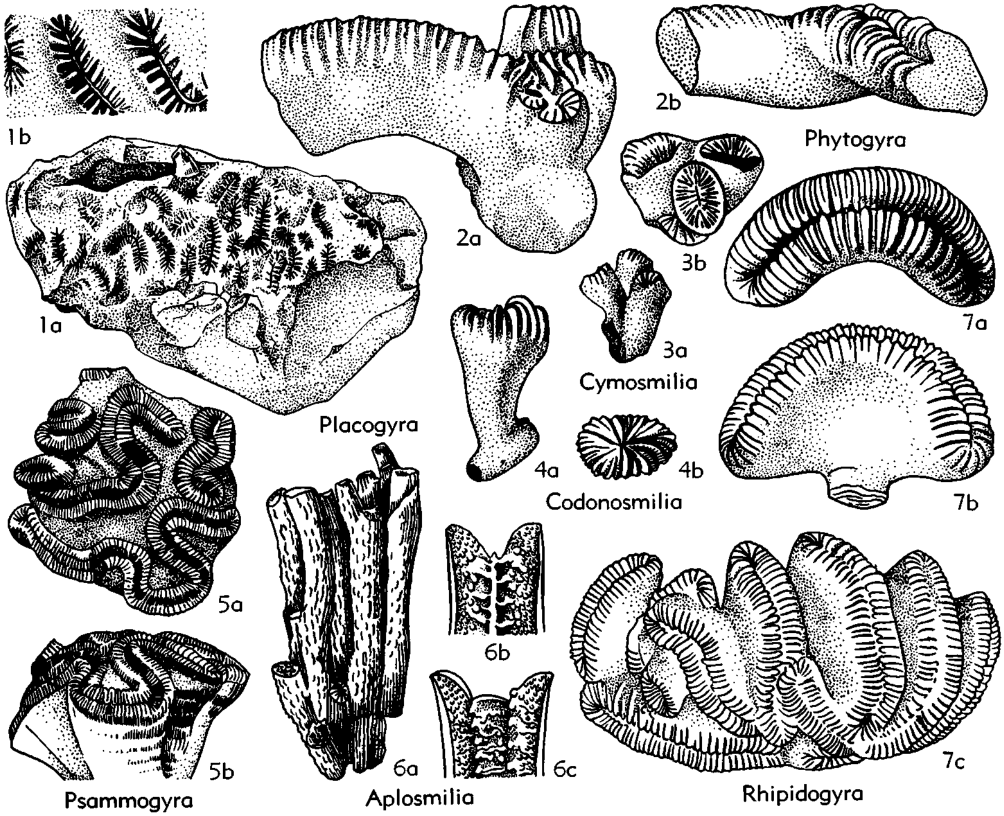


FIG. 334. Caryophylliina (Caryophylliicae): Rhipidogyridae (p. F430-F431).

1861; *Sclerogyra* FERRY, 1870; *Rhypidomontivoltia* GREGORIO, 1884; *Fromentelligyra* ALLOITEAU, 1952; *?Rhipidosmilia* GEYER, 1955]. Flabelliform, corallites in laterally free linear series, commonly contorted. *U.Jur.*, Eu.——FIG. 334,*7a,b*. *R. jaccardi* KOBY, Raur., Fr.; ×0.5 (71).——FIG. 334, *7c*. *R. percrassa* ÉTALLON, Raur., Switz.; ×0.4 (71).

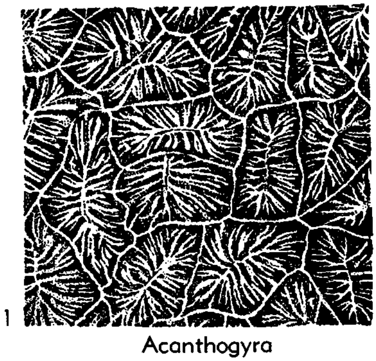


FIG. 335. Caryophylliina (Caryophylliicae): Rhipidogyridae (p. F430).

Phytogyra ORB., 1849 [**P. magnifica*]. Like *Rhipidogyra* but with low horizontal branches with terminal forking. *U.Jur.*, Eu.——FIG. 334,*2*. **P. magnifica*, Raur., Switz.; *2a,b*, ×0.5 (71).

Psammogyra FROMENTEL, 1862 [**Pachygyra cottaldina* ORB., 1850]. Massive, consisting of a single much-contorted meandrine series united laterally by coenosteum. *U.Jur.*, Eu.——FIG. 334,*5*. *P. caudata* ÉTALLON, Sequan., Switz.; *5a,b*, ×0.5 (71).

Placogyra KOBY, 1904 [**P. felixi*]. Several contorted series joined directly by their walls. *U.Jur.*, Eu.——FIG. 334,*1*. **P. felixi*, Lusit., Port.; *1a*, ×0.5; *1b*, ×1 (73).

Superfamily FLABELLICAE
Bourne, 1905

[*nom. correct.* WELLS, herein (*ex* Flabelloidae VAUGHAN & WELLS, 1943, *nom. transl.* Flabellidae BOURNE, 1905)]

Caryophylliina with epithecal wall. *M. Jur.-Rec.*

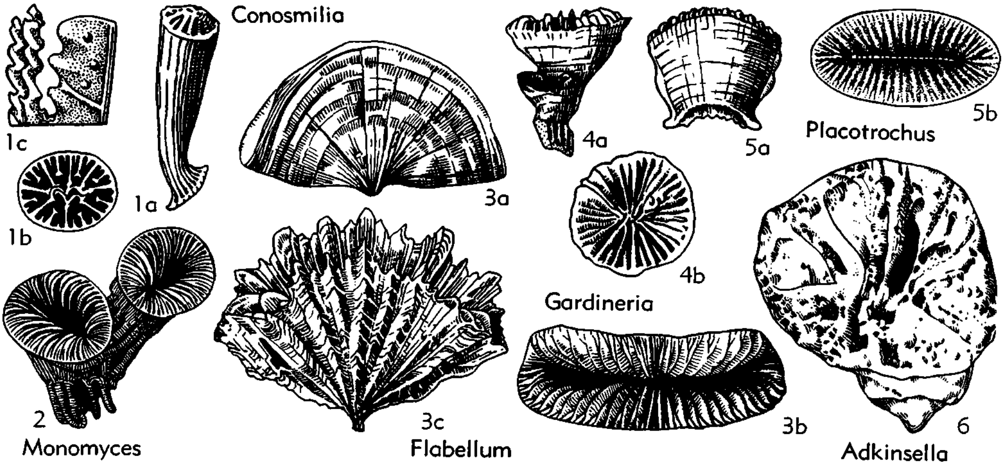


Fig. 336. Caryophylliina (Flabellicae): Flabellidae (p. F432).

Family FLABELLIDAE Bourne, 1905

Solitary, fixed or free; ahermatypic; neotenic. Wall epithecal, thickened internally by stereome. Septa nonexsert, formed by one fan system of simple trabeculae, with smooth margins, and laterally smooth or granulated. Pali and dissepiments absent. Columella present or absent. *Cret.-Rec.*

Flabellum Lesson, 1831 [**F. pavoninum*] [=*Phyllodes* Philippi, 1841; *Blastotrochus* M.Edw.-H., 1848; *?Ulocyathus* Sars, 1856; *Vasillum* T.-Woods, 1879; *Lithomyces* Phillipi, 1887; *Placotrochides* Alcock, 1902]. Cuneiform to compressed turbinate, free. Septa numerous. Columella absent or very feeble. *Eoc.-Rec.,* cosmop., depth range 3-3,183 m.——Fig. 336,*3a,b*. **F. pavoninum,* Rec., Hawaii, 375 m.; ×0.5 (146).——Fig. 336,*3c*. *F. alabastrum* Moseley, Rec., off Azores, 1,750 m.; ×0.5 (97).

Placotrochus M.Edw.-H., 1848 [**P. laevis*] [=*Microtrochus* Tenison-Woods, 1880]. Like *Flabellum* but with thin, irregular, lamellar columella. *Eoc.-Rec.,* IndoPac., depth range 265 m. ——Fig. 336,*5*. **P. laevis,* Rec., Philip.; *5a,* ×1; *5b,* ×1.4 (93).

Monomyces Ehr., 1834 [**M. anthophyllum;* SD M. Edw.-H., 1850] [=*Rhizotrochus* M.Edw.-H., 1848; *Coelocyathus* Sars, 1856; *Heterotrochus* M. Edw.-H., 1857; *Biflabellum* Döderlein, 1913]. Turbinate, cornute or compressed, fixed, with basal or lateral rootlets. Columella absent. *U.Cret.-Rec.,* Eu.-Medit.-IndoPac., depth range 27-1,047 m.——Fig. 336,*2*. *M. typus* (M.Edw.-H.), Rec. Singapore; ×0.5 (93).

Gardineria Vaughan, 1907 [*pro Haplophyllia* Pourtalès, 1868 (*non Aplophyllia* Orb., 1849; *nec Haplophyllia* Fromentel, 1865)] [**G. hawaiiensis*] [=*Duncania* Pourtalès, 1874 (*non* Kon., 1872)]. Turbinate, fixed, commonly with basal rootlets. Wall internally thickened by stereome. Relatively few septa. Columella trabecular, well developed. *Rec.,* W.Indies-S.Atl.-Pac., depth range 91-592 m.——Fig. 336,*4*. **G. hawaiiensis,* Hawaii, 525-575 m.; *4a,b,* ×0.5 (146).

Conosmilia Duncan, 1865 [**C. elegans*]. Trochoid-ceratoid, fixed. Columella formed by 1 or 2 crispate laths. *U.Eoc.-Mio.,* Austral.——Fig. 336,*1*. *C. anomala* Duncan, L.Mio.(Balcomb.); *1a,* ×1; *1b,* ×2; *1c,* septum and columella, ×6 (22).

Adkinsella Wells, 1933 [**A. edwardsensis*]. Like *Gardineria* but lacking columella. *L.Cret.,* Tex.——Fig. 110,*6*. **A. edwardsensis,* Alb., Tex.; ×1 (158).

Family GUYNIIDAE Hickson, 1910

Solitary, fixed or free, ceratoid to scolecoid; ahermatypic. Wall epithecal, with 1 or 2 series of pores between each septal pair, later filled by thin deposit. Septa nonexsert, relatively few, margins smooth, laterally smooth or finely granulated. Pali present or absent. Columella of trabecular laths, spongy, or absent. Endothecal dissepiments sparse or absent. *M.Jur.-Rec.*

Onchotrochus Duncan, 1870 [**O. serpentinus*]. Scolecoid, lacking columella and pali. *M.Cret.-U. Cret.,* Eu.——Fig. 337,*4*. **O. serpentinus,* U.Cret. (Senon.), Eng.; *4a,* ×1; *4b,* ×5 (30).

Guynia Duncan, 1873 [**G. annulata*] [=*Gwynia* Pourtalès, 1874; *Bistylia* T.-Woods, 1878; *Pyrophyllia* Hickson, 1910]. Ceratoid, free or laterally attached. Wall imbricated. Columella a single crispate trabecular lath. Pali absent. *U.Eoc.-Rec.,* W.Indies-Medit.-PersianGulf-Austral., depth range 170-658 m.——FIG. 337,*3*. *G. inflata* (HICKSON), Gulf of Oman, 300 m.; *3a,* ×5; *3b,* ×6 (179).

Microsmilia KOBY, 1888 [**Anthophyllum erguelense* THURMANN, 1851; SD VAUGHAN, 1905]. Ceratoid, fixed. Longitudinal parricidal budding. Columella formed by several twisted trabecular laths. *U.Jur.,* Switz.——FIG. 337,*5*. **M. erguelensis,* Oxf.; *5a,* ×1; *5b-d,* 3 regenerated corallites, ×1; *5e,* long. sec., ×3; *5f,* wall, ×5 (71).

Stenocyathus POURTALÈS, 1871 [**Coenocyathus vermiformis* POURTALÈS, 1868]. Ceratoid, with imbricated wall. Columella formed by 1 or 2 crispate trabecular laths. Pali crispate, in one crown of 6. *U.Cret.-Rec.,* W.Indies-Medit.-Atl.-N.Am.-Austral., depth range 155-1,097 m.——FIG. 337,*2*. **S. vermiformis,* Rec., off Azores, 1,150 m.; *2a,b,* ×3 (64).

Cyathosmilia T.-WOODS, 1878 [**C. laticostata*]. Ceratoid, fixed. Pali in 2 crowns opposite first 2 cycles. Columella weak. *U.Eoc.-L.Oligo.,* Austral.

Schizocyathus POURTALÈS, 1874 [**S. fissilis*]. Ceratoid, fixed. Longitudinal parricidal budding. One crown of pali opposite second cycle. Columella absent. *Eoc.-Rec.,* Atl.-W.Indies-Austral., depth range 102-1,445 m.——FIG. 337,*1*. **S. fissilis,* Rec., off Canary I., 625-900 m.; corallum split lengthwise, regenerated, ×3 (64).

Suborder DENDROPHYLLIINA Vaughan & Wells, 1943

[*nom. correct.* WELLS, herein (*ex* Dendrophylliida VAUGHAN & WELLS, 1943)]

Solitary and colonial. Wall synapticulothecal, irregularly porous. Septa primarily laminar as in Caryophylliina but generally secondarily thickened, more or less porous, with smooth or slightly dentate margins. *U. Cret.-Rec.*

Family DENDROPHYLLIIDAE Gray, 1847

Solitary and colonial, mostly ahermatypic. Colony formation by intra- and extratentacular budding. Wall formed by trabecular outer ends of septa and simple but very irregular synapticulae, irregularly porous, usually thick, irregularly costate or covered by reduced costal granulations. Porous, layered coenosteum in some colonial forms. Septa composed of one fan system of simple trabeculae, but trabeculae tend to be very irregular, commonly not united closely in plane of septum and vertically discontinuous with sclerodermites bending outward from septal plane, especially at periphery and near columella. Septa strongly granulated laterally, mostly smooth marginally except peripherally and centrally where irregular dentations occur, or wholly weakly dentate. Septa inserted following POURTALÈS plan (Fig. 239), at least in early stages. Columella trabecular and spongy, or absent. Endothecal dissepiments thin and poorly developed. *U.Cret.-Rec.*

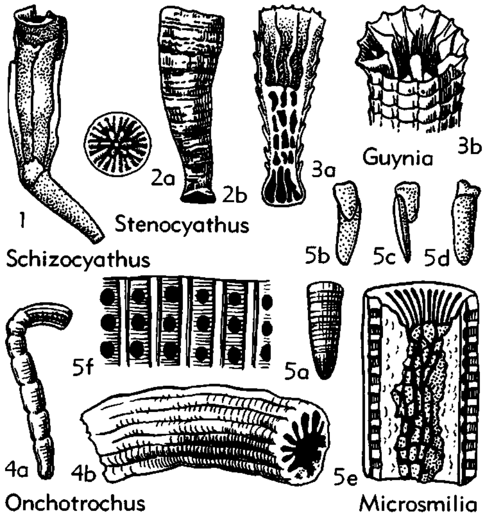


FIG. 337. Caryophylliina (Flabellicae): Guyniidae (p. F432-F433).

Palaeopsammia WANNER, 1902 [**P. multiformis*]. Solitary, ceratoid to patellate, free in ephebic stage, externally epithecate. Costae corresponding to septa. POURTALÈS plan not apparent. Columella spongy. *U.Cret.,* N.Afr.——FIG. 338,*3*. **P. multiformis,* Dan., Libyan Desert; *3a,* ×1; *3b,* ×2 (197).

Areopsammia DIETRICH, 1917 [**A. maestrichtensis* (=*Cyclolites alacca* MORREN, 1828)] [=*Porosmilia* UMBGROVE, 1925 (*non* FROMENTEL, 1860)]. Solitary, turbinate, nonepithecate. Costae distinct only near calice, reduced basally to granulations. POURTALÈS plan not apparent. Columella weak. *U.Cret.,* Eu.

Wadeopsammia WELLS, 1933 [**Trochosmilia nodosa* WADE, 1926]. Solitary, small, turbinate, free, base with tube of commensal sipunculid. Wall thin; costae reduced to granulations. Septa arranged following POURTALÈS plan. Columella large and solid. *U.Cret.,* N.Am.——FIG. 338,*6*. **W. nodosa,* Navarro, Tex.; ×2 (158).

Balanophyllia WOOD., 1884 [**B. calyculus*] [=*Ostеodes* CONRAD, 1855; *Leptopsammia* M.EDW.-H., 1848; *?Clonotrochus* SCHAFHÄUTL, 1863; *Rhodopsammia* SEMPER, 1872]. Solitary, trochoid, fixed by broad or pedunculate base. Costae well developed,

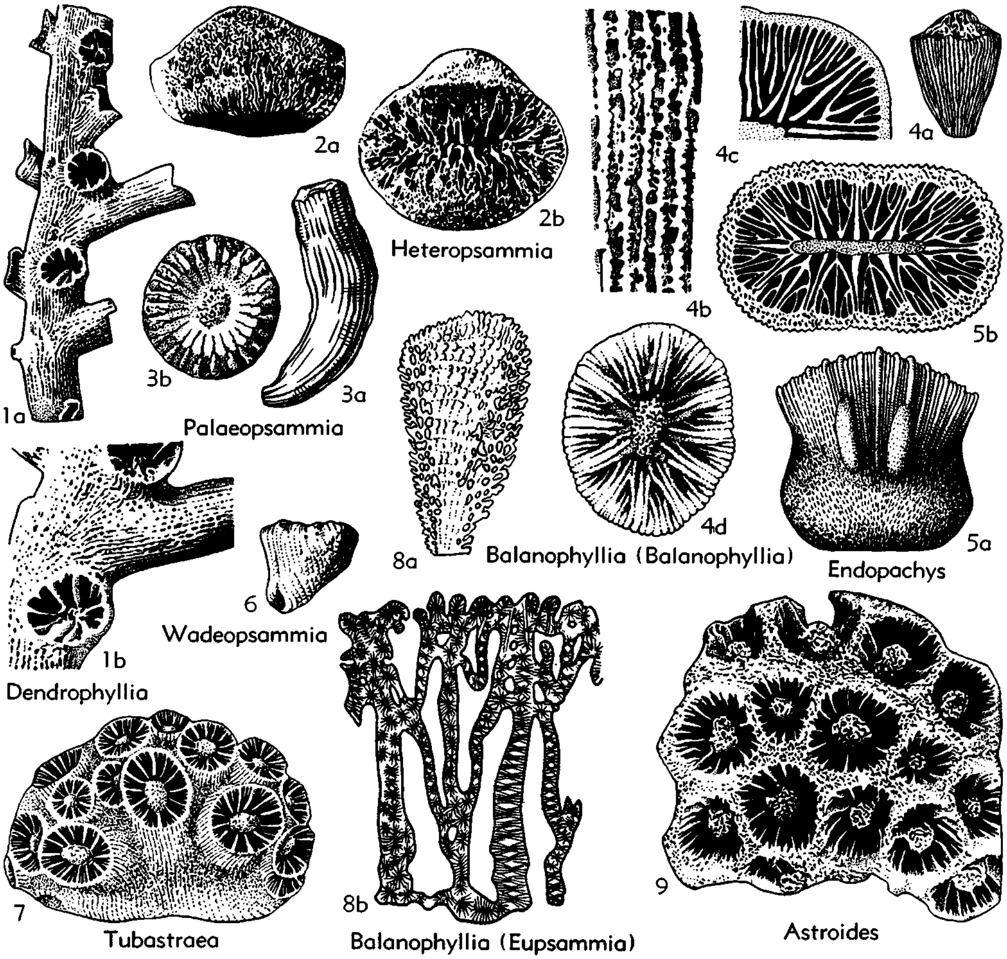


Fig. 338. Dendrophylliina: Dendrophylliidae (p. F433-F436).

corresponding to septa. Septa following Pourtalès plan. Columella well developed, spongy. *Eoc.-Rec.*, cosmop.

B. (Balanophyllia). *Eoc.-Rec.*, depth range 0-1,100 m.——Fig. 338,*4a,b*. *B. (B.) irrorata* (Conrad), M.Eoc.(Claib.), Tex.; *4a*, ×1; *4b*, costae, ×5 (144).——Fig. 338,*4c*. *B. (B.) inauris* Vaughan, L.Eoc., N.J., transv. sec., ×3 (144).——Fig. 338, *4d*. *B. (B.) italica* Michelotti, Rec., Italy; calice, ×2 (25).

B. (Eupsammia) M.Edw.-H., 1848 [**Madrepora trochiformis* Pallas, 1766; SD M.Edw.-H., 1850]. Like *B. (Balanophyllia)*, but free in ephebic stage. *U.Cret.-Rec.*, Eu.-IndoPac.-N.Am., depth range *ca.* 55 m.——Fig. 338,*8*. **B. (E.) trochiformis*, M.Eoc.(Lut.), Paris Basin; *8a*, lat. aspect of septum, ×0.7; *8b*, transv. sec., ×5 (98).

Endopachys Lonsdale, 1845 [**Turbinolia maclurii* Lea, 1833; SD M.Edw.-H., 1850] [=*Rhectopsammia* Vaughan, 1900]. Like *B. (Balanophyllia)* but cuneiform, free, with alate costal extensions extending outward along longer axis near base. Costae generally distinct around calice. *Eoc.-Rec.*, N.Am.-IndoPac., depth range 37-604 m.——Fig. 338,*5*. **E. maclurii*, M.Eoc.(Claib.), USA; *5a*, ×1.5; *5b*, ×2 (93).

Notophyllia Dennant, 1899 [**N. semivestita*]. Like *Endopachys* but more elongate, costal extensions reduced, septa appearing normal. Columella elongate, semi-solid, even laminar. Costae represented by granulations. *Mio.-Rec.*, Austral., depth range 37-457 m.——Fig. 339,*8*. *N. etheridgei* Hoffmeister, Rec., S.Austral., 37-40 m.; *8a,b*, ×2 (180).

Rhizopsammia Verrill, 1869 [**R. pulchra*]. Like *B. (Balanophyllia)* but forming small colonies by extratentacular stoloniferous budding as in *Culicia,* the corallites generally losing organic connection. *Rec.,* IndoPac., depth range 0-113 m.

Cladopsammia Lacaze-Duthiers, 1897 [**C. rolandi*]. Like *B.* *(Balanophyllia)* but in small phaceloid colonies formed by extratentacular budding. *Rec.,* Medit., depth range 18 m.

Dendrophyllia Blainv., 1830 [**Madrepora ramea* Linné, 1758; SD M.Edw.-H., 1850] [=*Brasseyia* Wright, 1882]. Like *B. (Balanophyllia)* but forming dendroid colonies by extratentacular budding from edge zone. *Eoc.-Rec.,* cosmop., depth range 0-1,372 m.——Fig. 338,*1. D. micrantha* (Ehr.), Rec., Philip.; *1a,* ×1; *1b,* ×2 (40).

Lobopsammia M.Edw.-H., 1848 [**Lithodendron cariosum* Goldf., 1827; SD M.Edw.-H., 1850] [=*Placopsammia* Reuss, 1859]. Like *Dendrophyllia* but colonies small, formed by mono- or distomodaeal intratentacular budding, corallites permanently monocentric. *Eoc.-Oligo.,* Eu.——Fig. 339,*7.* **L. cariosa,* M.Eoc.(Lut.), Fr.; ×1 (92).

Reussopsammia Wells, 1937 [**Stereopsammia granulosa* Reuss, 1864]. Like *Lobopsammia* but columella very feeble or absent; Pourtalès plan not apparent. *Oligo.,* Ger.——Fig. 339,*3.* **R. granulosa; 3a,* ×1; *3b,* ×2; *3c,* ×4 (114).

Stichopsammia Felix, 1885 [**S. gyrosa;* SD Felix, 1925]. Like *Lobopsammia* but polycentric condition permanent, forming flabellate series. *Oligo.,* Eu.

Endopsammia M.Edw.-H., 1848 [**E. philippinensis*]. Solitary, subcylindrical, fixed by broad base. Wall thin, costate. Septa thin, following Pourtalès plan only in early stages. Columella weak. *Rec.,* Medit.-S.Atl.-IndoPac., depth range 5-91 m.——Fig. 339,*2. E. microcardia* (Döderlein), Naples; ×2 (25).

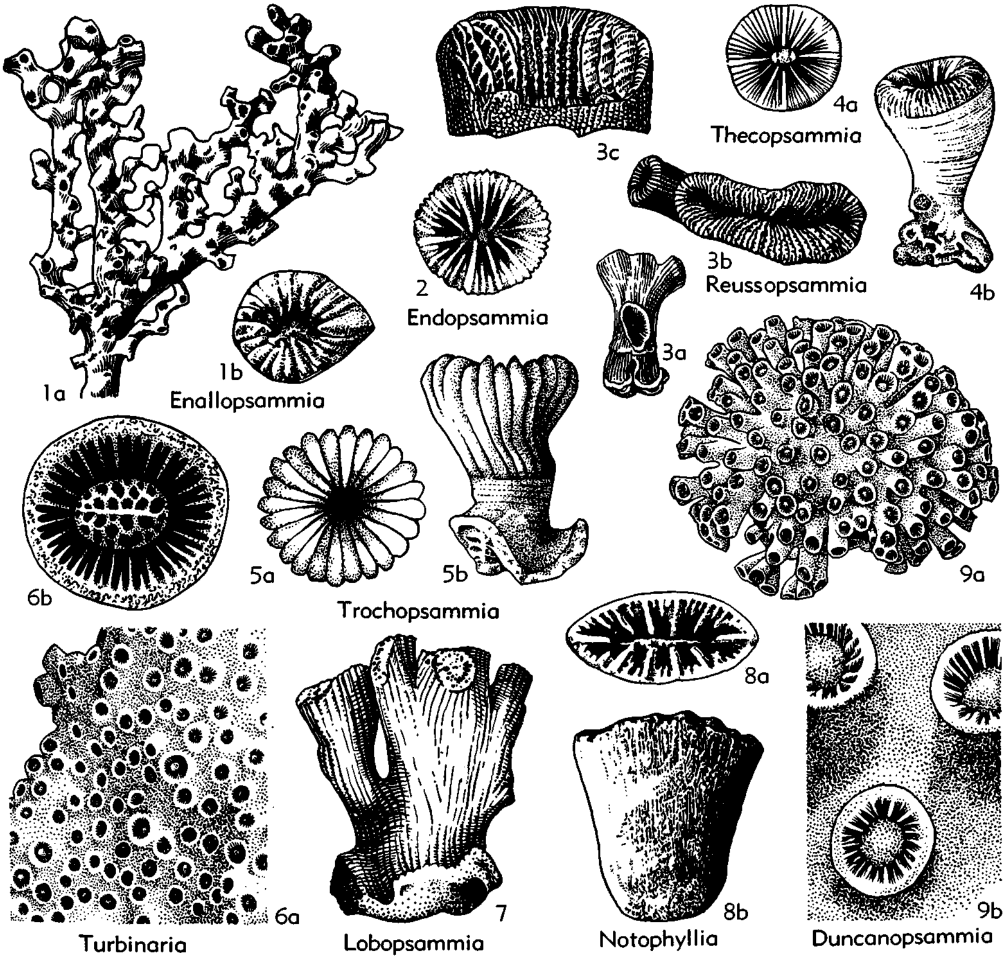


Fig. 339. Dendrophylliina: Dendrophylliidae (p. F434-F436).

Tubastraea Lesson, 1834 [*T. coccinea (=Lobophyllia aurea* Quoy & Gaimard, 1833)] [=*Coenopsammia* M.Edw.-H., 1848; *Astropsammia, Pachypsammia* Verrill, 1869]. Like *Endopsammia* but in small plocoid clumps formed by extratentacular budding from edge zone; corallites generally united by feeble costae and some coenosteum. Columella mostly feeble. *Rec.*, cosmop., depth range 0-1,463 m.——Fig. 338,*7*. *T. tenuilamellosa* (M.Edw.-H.), Panama; ×1 (93).

Astroides Quoy & Gaimard, 1827 [**A. luteus* (=*Madrepora calycularis* Pallas, 1766)] [=*Astreoides* Blainv., 1830; *Astroitis* Dana, 1846]. Like *Endopsammia* but extratentacular budding from proliferations of edge zone produces small, submassive colonies. Corallites united by noncostate coenosteum; costae reduced to granulations. Columella large, spongy. *Rec.*, Medit., depth range 0-73 m.——Fig. 338,*9*. *A. calycularis*, Naples; ×2 (25).

Stereopsammia M.Edw.-H., 1850 [**S. humilis*] [=?*Bosnopsammia* Oppenheim, 1908]. Like *Tubastraea* but much smaller, and columella very weak or absent. *Eoc.*, Eu.

Trochopsammia Pourtalès, 1878 [**T. infundibulum*]. Solitary, turbinate, fixed, with some epitheca. Costae thick, spongy, equal over thin wall. Septa showing no trace of Pourtalès plan. Columella absent. *Rec.*, W.Indies, depth range 403-1,490 m.——Fig. 339,*5*. **T. infundibulum*, Fla., 1,100 m.; *5a,b*, ×2 (151).

Enallopsammia Michelotti, 1871 [**Coenopsammia scillae* Seguenza, 1864] [=*Anisopsammia* von Marenzeller, 1904]. Dendroid colonies formed by extratentacular budding, the calices generally on one side of branches which tend to anastomose in one plane. Septa following Pourtalès plan only in early stages. Columella weak. *Mio.-Rec.*, Eu.-W. Indies-IndoPac., depth range 293-1,966 m.——Fig. 339,*1*. *E. rostrata* (Pourtalès), Rec., Morocco, 1,966 m.; *1a*, ×0.4; *1b*, ×2 (64).

Thecopsammia Pourtalès, 1868 [**T. socialis*]. Solitary, turbinate, fixed, costae reduced to spinose granulations. Epitheca stout, extending halfway to calice. Septa following Pourtalès plan only in early stages. Columella weak. *Rec.*, W.Indies-N. Atl.-Pac., depth range 0-1,097 m.——Fig. 339,*4*. **T. socialis*, Fla., 375-500 m.; *4a,b*, ×1 (187).

Bathypsammia von Marenzeller, 1906 [**Thecopsammia tintinnabulum* Pourtalès, 1868]. Like *Thecopsammia* but Pourtalès plan apparent; columella well developed. *Rec.*, W.Atl., depth range 220-329 m.

Psammoseris M.Edw.-H., 1851 [**Heterocyathus hemisphericus* Gray, 1850] [=*Spongiocyathus* Folkeson, 1919]. Solitary, subdiscoidal, free, base with tube of commensal sipunculid. Costae thick and spongy, distinct to center of base. Septa thick and spongy. Columella well developed. *Rec.*, E. Indies, depth range 11-44 m.

Heteropsammia M.Edw.-H., 1848 [**H. michelini*]. Solitary, or colonial with 2 or 3 calices resulting from mono- or distomodaeal intratentacular budding, free, base enclosing tube of commensal sipunculid with several lateral opening through corallum. Wall thick and spongy; costae reduced to multiple rows of crispate granulations, becoming labyrinthine over base. Septa following Pourtalès plan, lower cycles thick and spongy. Columella well developed. *Pleisto.-Rec.*, IndoPac., depth range 11-192 m.——Fig. 338,*2*. **H. michelini*, Pleisto., Formosa; *2a,b*, ×2 (199).

Duncanopsammia Wells, 1936 [**Dendrophyllia axifuga* M.Edw.-H., 1848]. Broad, pedunculate, subdendroid, hermatypic colonies formed by extratentacular budding from lower margins of corallites. Corallites basally united by coenosteum; costae reduced to rows of crispate granulations extending over coenosteum. Septa following Pourtalès plan. Columella spongy, deep in calices. *Mio.-Rec.*, Austral.——Fig. 339,*9*. **D. axifuga*, Rec., 5.5 m.; *9a*, ×0.25; *9b*, ×2 (198).

Turbinaria Oken, 1815 [**Madrepora crater* Pallas, 1766] [=*Explanaria* Lamarck, 1816; *Gemmipora* Blainv., 1830; *Turbinacis* Quenst., 1880]. Hermatypic; large explanate or crateriform, contorted foliaceous colonies; corallites united nearly to summits by extensive coenosteum. Pourtalès plan apparent only in early stages. Columella well developed. *Oligo.-Rec.*, Eu.-IndoPac.——Fig. 339,*6*. *T. peltata* (Esper), Rec., E.Indies; *6a*, ×0.5; *6b*, ×6 (40). (Also Figs 255, 256.)

GENERA OF UNCERTAIN SYSTEMATIC POSITION

Andemantastraea Alloiteau, 1951 [**Synastraea consobrina* Orb., 1850]. *M.Jur.*, Fr.

Carcicocaenia Alloiteau, 1954 [**C. pfenderae*]. *M.Cret.*, Fr.

Cenomanina Alloiteau, 1952 [**Rhabdocora exiguis* Fromentel, 1873]. *M.Cret.*, Fr.

Ceratosmilia Alloiteau, 1952 [**C. arnaudi*]. Horizon and locality not indicated.

Corbariastraea Alloiteau, 1952 [**C. rennensis*]. *U.Cret.*, Fr.

Cyclophyllopsis Alloiteau, 1952 [**Cyclolites aptiensis* Fromentel, 1870]. *L.Cret.*, Fr.

Dactylosmilia Orb., 1849 [**D. carantonensis*]. *M. Cret.*, Fr.

Epitrochus Fromentel, 1861 [**E. primus*]. *M.Cret.*, Fr.

Eusmiliopsis Alloiteau, 1952 [**Amblophyllia cretacea* Orb., 1849]. *M.Cret.*, Fr.

Ficariastraea Alloiteau, 1952 [**Phyllastraea hippuritiformis* Fromentel, 1857]. *U.Cret.*, Fr.

Glenaraea Počta, 1887 [**G. cretacea*]. *M.Cret.*, Czech.

Lamellofungia Alloiteau, 1952 [**L. rennensis*]. *U.Cret.*, Fr.

Morchellastraea Alloiteau, 1941 [**Astrea coniformis* Michelin, 1843]. *U.Cret.*, Fr.

Pleuropodia Dennant, 1903 [**P. otwayensis*]. *Mio.*, S.Austral.

Pseudoseris Alloiteau, 1952 [**P. senessi*]. *U.Cret.*, Fr.

Siniastraea Avnimelech, 1947 [**Aspidiscus labyrinthica* Hoppe, 1922]. *U.Jur.*, Sinai.

Subtilicyathus Zuffardi-Comerci, 1924 [**S. zanoni*]. *Mio.*, Libya.

Trigerastraea Alloiteau, 1952 [**Isastraea trigeri* Fromentel, 1857]. *M.Cret.*, Fr.

Tubicora Latham, 1929 [**T. somaliensis* (=*Calamophyllia aylmeri* Gregory, 1900)]. *Eoc.*, Somali.

Turbinacis Gregory, 1900 [**T. erythraensis*] [*non Turbinacis* Quenst., 1880]. Oligo., Somali.

Valloria Vidal, 1874 [**V. egozcuei*]. *U.Cret.*, Sp.

UNRECOGNIZABLE GENERA

Allocoenia Étallon, 1859 [**A. furcata*]. *M.Jur.*, Fr.

Anabacia M.Edw.-H., 1849 [**A. parkinsoni* (=*Madrepora porpita* Parkinson, 1808)]. ?Age, ?loc.

Archicoeniopsammia Kolosvary, 1949 [**A. hungarica*]. *Eoc.*, Hung.

Brevismilia Bölsche, 1866 [**Anthophyllum conicum* F. A. Roemer, 1836]. *L.Cret.*, Ger. (Brunswick).

Coenastraea Étallon, 1859 [**C. martis*]. *M.Jur.*, Fr.

Corofolius Gregorio, 1930 [**C. mirus*]. *Trias.*, Sicily.

Digitium Gregorio, 1930 [**D. taxum*]. *Trias.*, Sicily.

Discoseris Gümbel, 1861 [**D. rhaetica*]. *U.Trias.*, Bavaria.

Isocora Étallon, 1864 [**I. thurmanni*]. *M.Jur.*, Switz.

Kraterostrobilos Crickmay, 1930 [**K. bathys*]. *L. Jur.*, B.C.

Lepiconus Stoppani, 1857 [**L. bassii*]. *U.Trias.*, Italy.

Mirmidia Gregorio, 1884 [**Meandrina? (Mirmidia) serafina*]. *U.Jur.*, Sicily.

Stylastraea Fromentel, 1860 [**S. sinemuriensis*]. [*non Stylastraea* Lonsdale, 1845]. *L.Jur.*, Fr.

Pyxidophyllum Stoppani, 1861 [**P. edwardsii*]. *U.Trias.*, Italy.

Petrophyllia Conrad, 1855 [**P. arkansasensis*]. *Tert.*, Ark.

Trochosmilietta Kolosvary, 1949 [**Trochosmilia comonensis* d'Achiardi, 1875]. *M.Eoc.*, Italy.

INVALID GENERIC NAMES

The following names were proposed by Alloiteau (1952), without description, illustration, or indication of valid type species: *Clavismilia, Columnocoenia, Cylindrocyathus, Delphinastraea, Dermosmiliopsis, Diplothecophyllia, Ellipsoidastraea, Hemiporites, Metasmilia, Palaeosmilia* (*non* M.Edw.-H., 1848), *Parasmiliopsis, Phyllotrochus, Placocaeniopsis, Polyastropsis, Polystephanastraea, Saltastraea, Thecoseriopsis,* and *Uxacalcaraea.*

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TABULATA

By Dorothy Hill and Erwin C. Stumm

CONTENTS

MORPHOLOGY

The Tabulata are an extinct, almost invariably Paleozoic order of corals characterized by their exclusively colonial mode of growth and secretion of a calcareous exoskeleton of slender tubes crossed by many transverse partitions called tabulae. Relative prominence of these tabulae and inconspicuousness or even absence of radially disposed longitudinal partitions (septa) are features which suggested the name of the group.

Morphological terms applied to tabulate corals are distinguished in introductory parts of the text devoted to this group by printing in boldface type. In addition, they are included in an alphabetically arranged glossary of morphological terms used in describing Rugosa, Heterocorallia, Scleractinia, and Tabulata (p. F245-F251).

FORM OF CORALLA

The form of the complete colonial exoskeleton **(corallum)** varies widely, depending mainly on the shape and arrangement of the exoskeletons **(corallites)** built by the constituent individual polyps. Thus, the corallum may be a laminar expansion, a domed, hemispherical (Fig. 340,*6*), spherical, nodular, or irregular body, or it may be slenderly or coarsely branching, the branches being cylindrical (ramose, Fig. 340,*3*) or flattened (foliose, Fig. 352,*4a*) and either free or joining to form a network; some colonies develop only as thin incrustations attached to foreign objects. Maximum dimensions of coralla range from a few millimeters to 2 m. or more; the diameter of corallites ranges from approximately 0.2 to 20 mm.

In the families Chaetetidae, Syringophyllidae, Heliolitidae, and Favositidae, all the corallites of the corallum are commonly in contact throughout their length; if the corallite walls are prismatic by reason of mutual pressure, the corallum is said to be cerioid (Fig. 340,*7*); if opposite walls fail to develop in rows of corallites it is meandroid (Fig. 340,*5*); if dividing walls are absent and a common tissue (coenenchyme) unites the corallites, the corallum is coenenchymal (Fig. 340,*6*). Corallites in these coralla may be erect or curved but opening at right angles to their axes; or reclined, opening obliquely. Reclined corallites are generally alveolitoid (Fig. 340,*1*) with a vaulted upper wall and a lower wall parallel to the surface of adherence.

Cateniform coralla have their corallites united laterally in palisades generally one corallite thick, the palisades forming a network (Fig. 341,*9*). These characterize the Halysitidae.

The Auloporidae have a number of types of corallum, of which the fasciculate is commonest, the corallites being cylindrical, parallel, and distant, but united by connecting tubules (Fig. 341,*7*); in a second type, coenenchymal expansions alternate with fasciculate zones (Fig. 340,*4*). In this family, too, the proximal part of a corallum may be an attached (reptant) ring or reticulum (Fig. 340,*2*) and distal parts may consist of cylindrical or trumpet-shaped corallites which are either fasciculate or with erect or reptant branches arranged like umbrella ribs in whorls (umbelliferous) (Fig. 341,*8*) or zigzag (Fig. 341,*6*).

STRUCTURAL ELEMENTS

CALICE, EPITHECA, AND WALL

The distal surface of each corallite is the **calice** (Fig. 341,*2*). In all fasciculate and in some cerioid coralla, each corallite is enclosed laterally in a sheath (**epitheca,** Fig. 341,*2*) of ?granular $CaCO_3$; in many cerioid, meandroid, and coenenchymal coralla, a common epitheca covers all but the calical surface of the corallum. The epitheca typically is without the longitudinal ridges and furrows of the Rugosa, but growth rings are common; some Palaeacinae have superficial epithecal scales, as in some Rugosa; *Michelinia* has radiciform processes consisting of rootlike epithecal outgrowths.

The **corallite wall** (on which lies the epitheca in corallites of fasciculate coralla) is not a simple structure; in some corals it is formed by the peripheral edges of the septa expanding to contiguity; in others, the space between the peripheral edges of the septa is bridged by calcareous tissue consisting of "fibers" (needle-like crystals) directed inwards towards the axes of the corallite; this tissue may show growth lamellation across the fibers.

TRANSVERSE STRUCTURES

Corallites in coralla without coenenchyme have only one type of skeletal element transverse to their length, the **tabulae** —floors which generally are subhorizontal (Fig. 342,*1b;* 345,*4*) but in some are shallow domes or saucers, or in others, funnel-shaped (infundibuliform, Fig. 341,*1*). Each tabula is typically complete, i.e., made of one plate only (Fig. 345,*4*), but in some the tabulae may be incomplete, composed of several small plates (**tabellae,** as in *Michelinia,* Fig. 341,*3*). The **tabularium** is the area in which tabulae are developed and it may occupy the whole corallite.

In some cerioid forms, a **marginarium** may develop between the tabularium and the periphery of each corallite, generally as a dense zone of skeletal tissue without loculi forming a stereozone (Fig. 342,*2*); this is generally a septal stereozone formed by thickening of the peripheral parts of the septa to such extent that they become contiguous, but in some it may be formed in part by the thickening of wall segments between peripheral ends of the septa.

The coenenchyme of coenenchymal coralla is a common marginarium. In coenenchyme, transverse skeletal elements of various types may be found: **dissepiments,** which are small domed plates usually not inclined (as in *Propora,* Fig. 342,*1*); **sola,** which are small horizontal or shallowly saucered plates crossing coenenchymal tubules, as in *Heliolites* (Fig. 342,*3*); or extensions of the tabulae, as in *Calapoecia* (Fig. 346,*5*) and *Sarcinula* (Fig. 346,*6b*).

LONGITUDINAL STRUCTURES

Among skeletal elements oriented in the direction of growth of the corallite (longitudinal skeletal elements), the **septa** are most important and are radially arranged in the outer parts of the tabularium; they are short (extending but a little toward the axis from the periphery) and being equal are presumably of one order; in many they are 12 in number. Studies are required on their order of insertion, though one may not find orderly insertion in offsets owing to the manner of increase. Each septum is typically acanthine (spinose), i.e., each consists of a vertical series of thorns (trabeculae, Fig. 342,*3*) with acutely or obtusely pointed apices, in some separate throughout their length, in others contiguous at their bases at the periphery; in a few genera the septal trabeculae are contiguous throughout their lengths, forming a laminar septum. The trabeculae are generally in single series, the axis of each in the mid-plane of the septum, but in some (Fig. 343,*1*) the axes may diverge from the mid-plane; they are directed toward the axis of the corallite, typically upward but in some horizontally and rarely (*Proheliolites,* Fig. 348,*6*) downward. In some Favositinae (*Emmonsia*), certain of the trabeculae may expand laterally to form eavelike plates (**squamulae,** Fig. 343,*3*) projecting horizontally toward the axis of the corallite.

Axial structures are exceptional in Tabulata, and where formed, consist merely of vertical, separate trabeculae based on the tabulae. The longitudinal skeletal elements of the coenenchyme are trabeculae, generally separate (Fig. 342,*1*), though in some they are contiguous in linear series to form laminae, of which some may be continuations of the septa, while others may form walls enclosing prismatic or cylindrical spaces or tubules (Fig. 342,*3*). The trabeculae are typically vertical (parallel to the direction of growth of the corallum) and may be thin or stout. In the Palaeacinae, the coenenchyme consists of trabeculae contiguous throughout, except for irregular canal-like spaces which may connect neighboring tabularia or open at the surface.

The coenenchyme indicates the presence of a coenosarc or common soft tissue; but direct communication between the polyps of neighboring corallites seems to have been possible also by means other than the coenosarc. Thus, in the Syringoporinae, connecting tubules (Fig. 341,*7*) join neighboring corallites and may pierce both walls. In the Favositidae and in cerioid Syringoporinae (*Roemeria*), regular or irregular systems of circular or oval **mural pores** (holes through the common walls) are found (Fig. 343,*2*). In Micheliniinae and Palaeacinae, the walls may be perforate (Fig. 343,*4*) in the same irregular manner as in the perforate Scleractinia and the calostylid Rugosa.

MICROSTRUCTURE OF SKELETON

Each of the skeletal elements (septum, tabula, dissepiment, solum or wall segment) consists of needle-like crystals (fibers) of $CaCO_3$, though whether originally of aragonite or calcite is not known. In the transverse skeletal elements these are arranged at right angles to the upper and lower surfaces of the plate, but in the septa they are directed upward and outward from the axes of the constituent trabeculae. In all elements, skeletal thickening is effected by a lengthening of the fibers from their upper ends, and growth lamellation is at right angles to the fibers; in some types of recrystallization during fossilization, the fibrosity disappears and lamellation is emphasized.

The relation of the entire exoskeleton to the soft parts must have been similar to that in Scleractinia. No fossil impressions of the soft parts of Tabulata are known. As in Rugosa, the fibers of Tabulata were formed by spherulitic crystallization, presumably in a gel exuded from the basal ectoderm. Crystallization in the transverse skeletal elements is by planar control, and in the

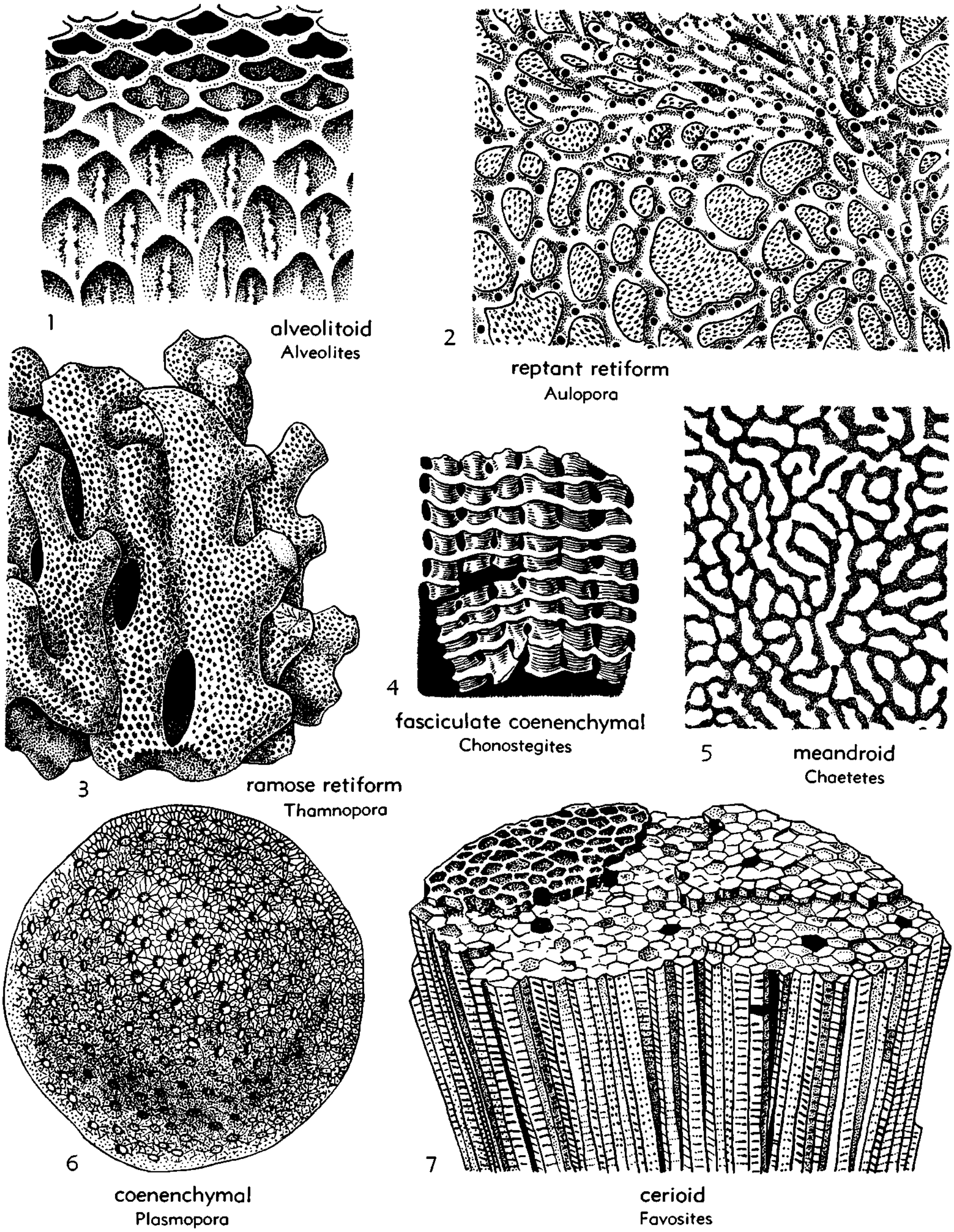

Fig. 340. Types of tabulate coralla. *1, Alveolites suborbicularis* Lamarck, M.Dev., Ger.; part of surface showing form of nearly recumbent (alveolitoid) corallites with large septal spine in middle of lower wall, enlarged (55). *2, Aulopora serpens* Goldf., M.Dev., Ger.; upper surface of corallum showing circular calices of branching tubes (reptant on another coral), ×1 (55). *3, Thamnopora reticulata* Blainv., M.Dev., Ger.; surface of corallum, ×1 (55). *4, Chonostegites clappi* M.Edw.-H., M.Dev., Ohio; side of weathered corallum showing regularly spaced flat coenenchymal extensions connecting the cylindrical corallites, ×1 (70). *5, Chaetetes septosus* Fleming, L.Carb., Belg.; transv. sec. ×8 (76). *6, Plasmopora petalliformis* (Lonsdale), M.Sil., Eu.; surface of corallum, ×1 (68). *7, Favosites gothlandicus* Lamarck, Sil. Gotl.; corallum broken along walls of prismatic tubes, ×1 (55).

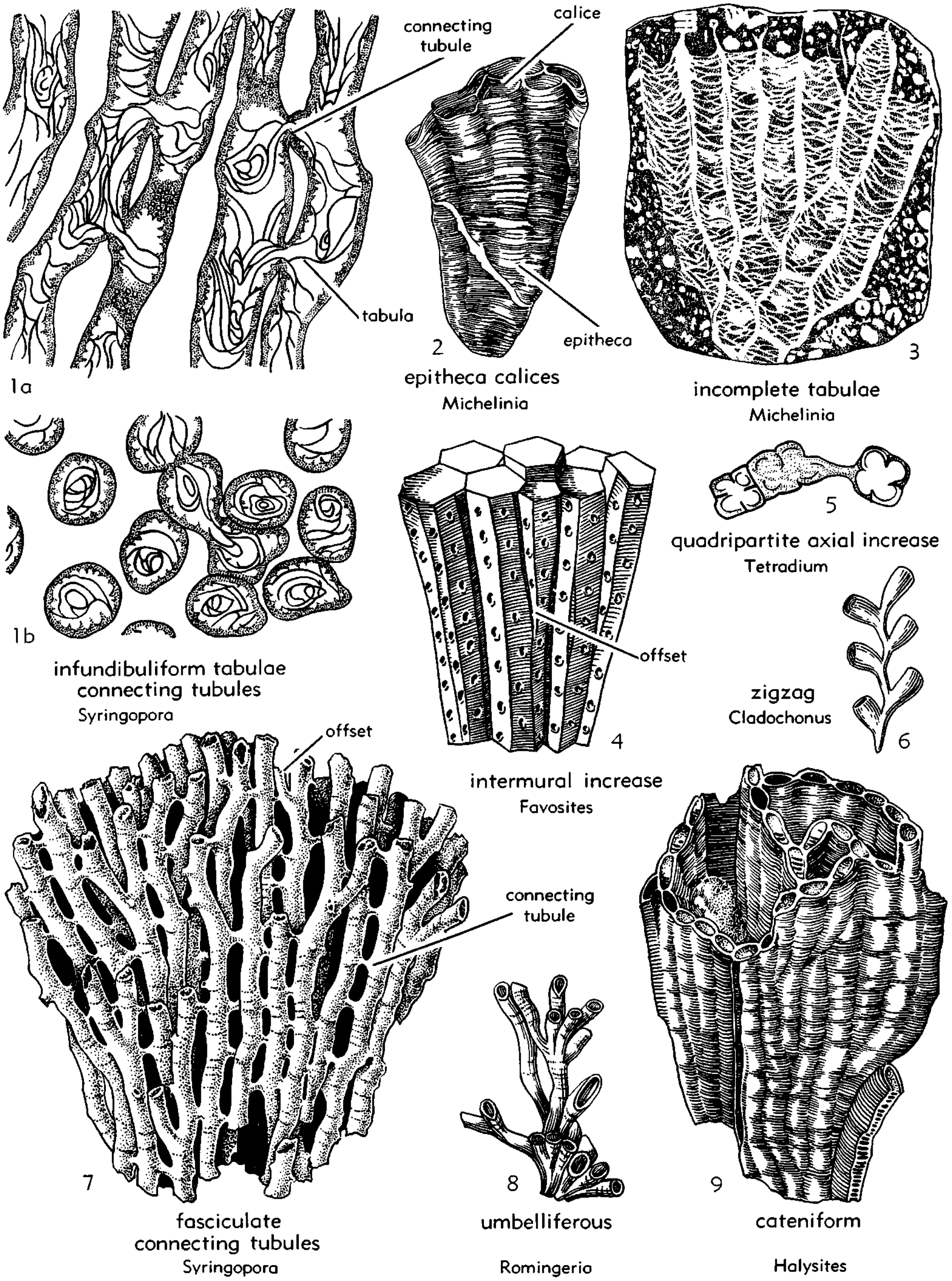

Fig. 341. Types of coralla, increase and tabulae in tabulate corals. *1, Syringopora reticulata* Goldf., L.Carb., Eng.; long. and transv. secs., showing infundibuliform tabulae and connecting tubules between corallites, ×5 (70). *2,3, Michelinia tenuisepta* (Phillips), L.Carb., Belg.; *2*, side of corallum, ×1 (68); *3*, long. sec., ×1 (68). *4, Thamnopora polymorpha* (Goldf.), M.Dev., Ger.; part of corallum broken along walls of prismatic tubes, showing prominent mural pores, enlarged (55). *5, Tetradium oklahomense* Bassler, M. Ord., Okla.; transv. sec. of 3 corallites, ×12 (45). *6, Cladochonus brevicollis* (M'Coy), L.Carb., Eng.; side of corallum, ×1 (66). *7, Syringopora ramulosa* Goldf., L.Carb., Belg.; side of corallum, ×1 (55). *8, Romingeria umbellifera* (Bill.), M.Dev., Ont.; side of corallum, ×1 (70). *9, Halysites labyrinthicus* (Goldf.), M.Sil., Can.; corallum, ×1 (55).

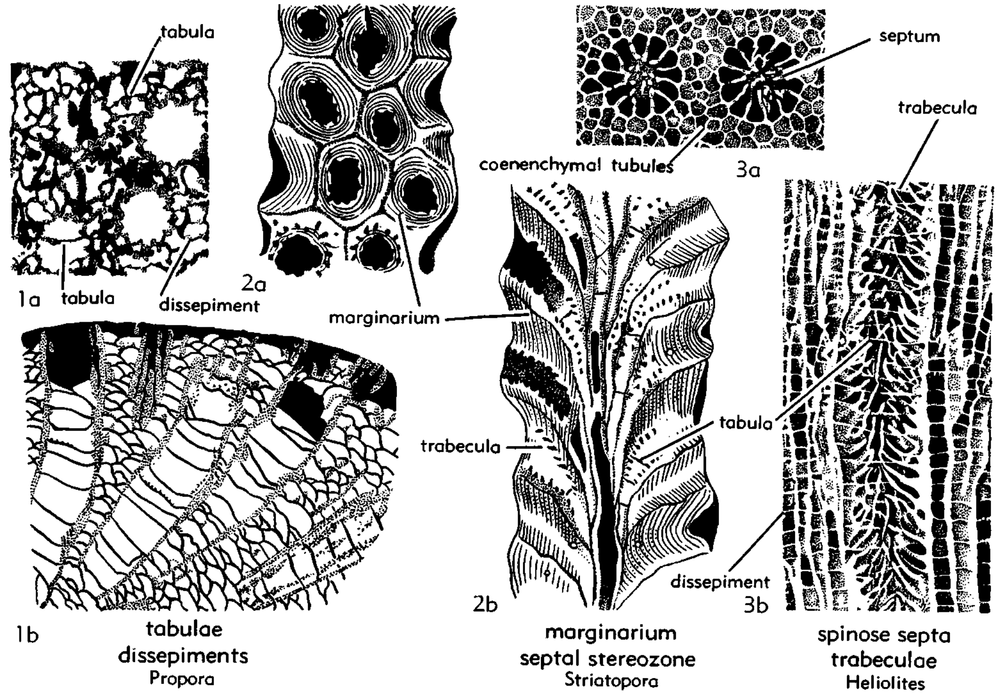

FIG. 342. Morphological features of tabulate corals. *1, Propora speciosa* (BILLINGS), Sil., Eu.; *1a,b,* transv. and long. secs., ×4 (65). *2, Striatopora ornata* (ROMINGER), M.Dev., N.Y.; *2a,b,* surface and long. sec., ×7 (70). *3, Heliolites barrandei* PENECKE, U.Sil.-L.Dev., Eu.; *3a,b,* transv. and long. secs., ×12 (65).

septa by puntal control from a series of points along the crests of invaginations in the base of the polyp, a trabecula being formed from each point.

INCREASE OF CORALLA

The growth or increase of coralla may have started from one corallite only, or possibly from a group of corallites secreted by simultaneously settling planulae (the free-swimming larval stages). New corallites formed during increase are **offsets.**

Three chief types of increase are distinguishable:

(1) **Axial,** in which one or more new dividing walls grow across the axis of a corallite so that small offsets form in the place of the one corallite, whose peripheral tissues continue to grow as part of the offsets; where 2 offsets are so formed the increase is bipartite, and this may be equal or unequal; where 4 offsets are formed, the increase is quadripartite (Fig. 341,*5*).

(2) **Peripheral** (or coenenchymal), where offsets arise in the coenenchyme.

(3) **Lateral** (in fasciculate coralla, Fig. 341, *7*) or **intermural** (in cerioid coralla, Fig. 341,*4*), where the offsets arise laterally, the initial portion becoming surrounded by the growing wall of the older corallite.

CLASSIFICATION

The order has had many changes in its systematics. MILNE-EDWARDS & HAIME included among Tabulata several genera which subsequently have been assigned to other orders, subclasses, or phyla, as for example, *Pocillopora* and *Seriatopora* (scleractinians); *Millepora* (hydrocoralline); *Labechia* (stromatoporoid); *Heliopora* (octocorallian) and *Fistulipora, Stenopora* (polyzoans), etc. As the real affinities of these misfits were discovered, it came to be thought that there was no such zoological entity as the Tabulata, and the remaining genera were distributed among the other Anthozoa, chiefly in the Scleractinia and Octocorallia, but sometimes in specially named orders; the earlier moves were reviewed by NICHOLSON (29); later essays are those of SARDESON (32), GERTH (12), OKULITCH (30), and TERMIER & TERMIER (36). WEISSERMEL (37), in reviewing OKULITCH's conclusions, gave sound reasons for concluding that the Tabulata as now understood and herein defined are a natural unit.

The 6 families forming the order are clearly distinguishable from the Rugosa, Scleractinia, and Octocorallia, and should retain MILNE-EDWARDS & HAIME's name Tabulata. They differ from the Octocorallia (except *Heliopora*) and resemble the Rugosa and Scleractinia in having skeletons of fibrous $CaCO_3$ (not spicular, as in Octocorallia), arranged in trabeculae in the septa and in sheets in the transverse plates. They differ from both Rugosa and Scleractinia in having septa of one series only, while in many the number of septa is 12. They are invariably compound, the corallites are almost universally slender, and they tend to communicate with one another by mural pores, connecting tubules, irregularly perforate wall tissue, or coenenchyme.

Subdivision of the Tabulata is relatively simple, the 6 families recognized having distinctive features. Thus, the most primitive (Chaetetidae) are aseptate and without mural pores; the Favositidae are septate, with mural pores, a few of its members having 12 septa; the Heliolitidae all have 12 septa and are coenenchymal; the Halysitidae have a characteristic cateniform growth and 12 septa; the Auloporidae commonly have funnel-shaped tabulae and connecting tubes which become mural pores in cerioid forms; the Syringophyllidae have mural pores but develop a characteristic coenenchyme.

The aseptate aporose condition of the Chaetetidae might perhaps be thought discrepant from the other Tabulata, but in Devonian forms in which the wall is thickened, the tissue is found to be fibrous as in the other corals.

A tabular summary of suprageneric divisions recognized in the Tabulata, showing stratigraphic range of each as now known and including record of the number of genera (figures enclosed by parentheses) in each taxonomic unit, follows.

Suprageneric Divisions of Tabulata

Tabulata *(order)*, exclusively colonial, corallites mostly small, characterized by presence of tabulae but septa weak or absent (108). *Ord.-Perm., ?Trias.-?Eoc.*
- Chaetetidae *(family)* (8). *M.Ord.-Perm., ?Trias.-?Eoc.*
  - Lichenariinae *(subfamily)* (1). *M.Ord.*
  - Tetradiinae (2). *M.Ord.-U.Ord.*
  - Chaetetinae (5). *Ord.-Perm., ?Trias.-?Eoc.*
- Syringophyllidae (7). *M.Ord.-L.Sil.*
  - Billingsariinae (4). *M.Ord.-U.Ord.*
  - Syringophyllinae (3). *M.Ord.-L.Sil.*
- Heliolitidae (18). *M.Ord.-U.Dev.*
  - Coccoseridinae (5). *M.Ord.-L.Sil.*
  - Palaeoporitinae (3). *M.Ord.-U.Ord.*
  - Plasmoporinae (5). *M.Ord.-U.Sil.*
  - Proheliolitinae (1). *U.Ord.-L.Sil.*
  - Heliolitinae (4). *L.Sil.-U.Dev.*
- Favositidae (40). *U.Ord.-Perm., ?Trias.*
  - Favositinae (16). *U.Ord.-U.Dev.*
  - Theciinae (2). *Sil.*
  - Pachyporinae (7). *Sil.-Perm.*
  - Alveolitinae (3). *Sil.-Dev.*
  - Micheliniinae (4). *Dev.-Perm.*
  - Palaeacinae (8). *L.Dev.-Perm.*
- Halysitidae (3). *Ord.-Sil.*
- Auloporidae (24). *Sil.-Perm.*
  - Auloporinae (15). *Sil.-Perm.*
  - Syringoporinae (9). *Sil.-Perm.*
- Incertae sedis (8). *Sil.-Carb.*

STRATIGRAPHIC DISTRIBUTION

GENERAL SUMMARY

The Tabulata are first known in the Chazyan, early Middle Ordovician strata of the shallow seas associated with the Appalachian geosyncline of eastern North America, but by Trentonian time, they were cosmopolitan. They apparently preceded the Rugosa, first known in Blackriveran strata. In numbers of individuals they exceeded the Rugosa throughout the Ordovician and Silurian, but were about equal in the Devonian until late in Givetian time, when their numbers markedly decreased; by early Carboniferous times they were subordinate to the Rugosa, and retained this relative unimportance until the extinction of the Rugosa at the end of the Paleozoic Era. In families, genera, and species, they outnumbered the Rugosa only in the Ordovician. Probably only one family of tabulate corals survived the Paleozoic, being represented by uncommon examples until its extinction in the

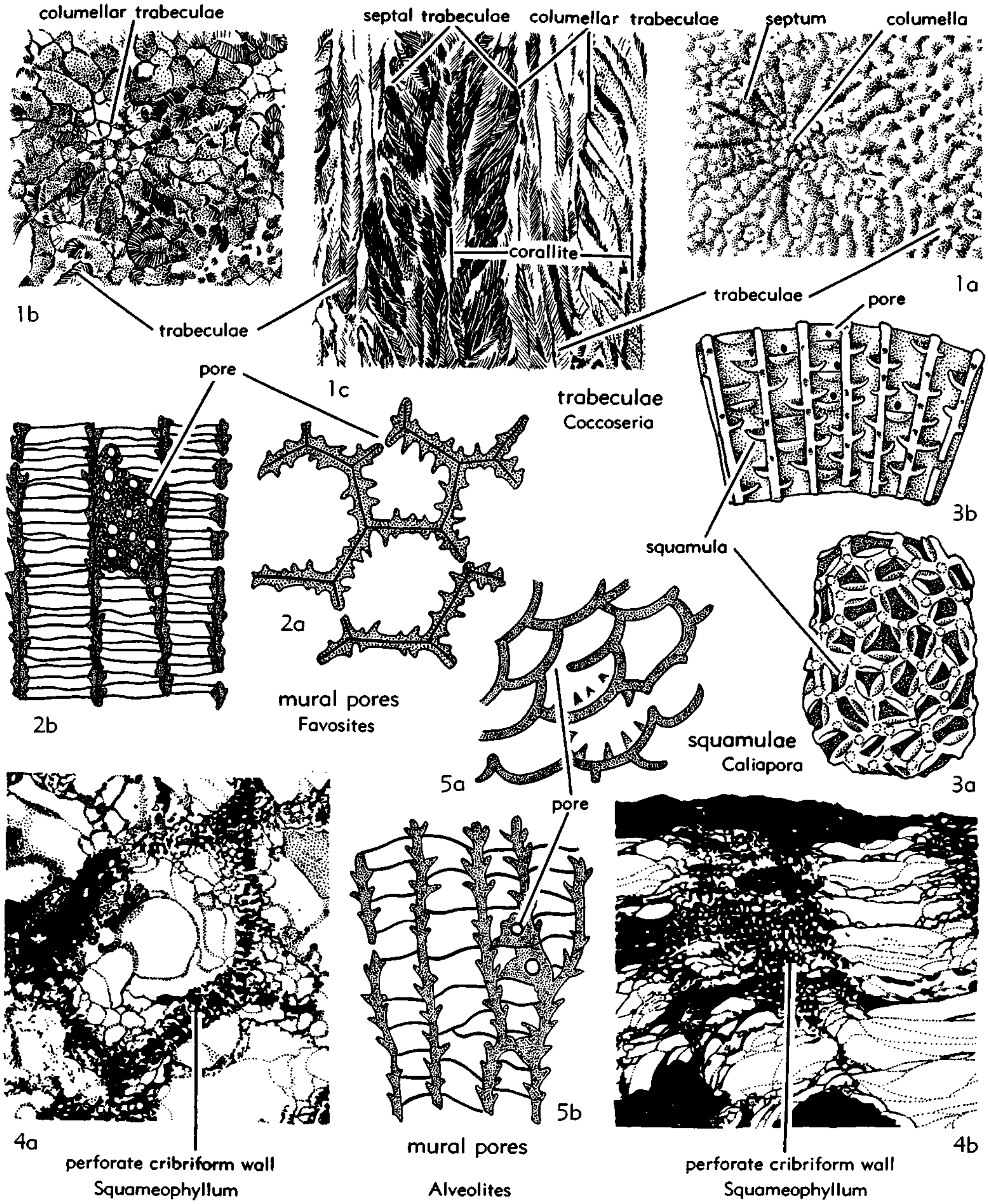

Fig. 343. Morphological features of tabulate corals. *1, Coccoseris ungerni* Eichw., U.Ord., Est.; *1a,* part of distal surface; *1b,c,* transv. and long secs.; all ×10 (65). *2, Favosites* sp., Dev., Queensl.; *2a,* transv. sec. in plane which happens to coincide with position of some mural pores, also showing short spinelike septa; *2b,* long. sec. showing closely spaced tabulae and mural pores in walls both parallel and normal to plane of the section, ×6 (70). *3, Caliapora battersbyi* (M.Edw.-H.), M.Dev., Eu.; *3a,b,* transv. and long. secs. showing shelflike projections from the wall which are termed squamulae, ×6 (74). *4, Squameophyllum antiquum* (M'Coy), L.Carb., Ire.; *4a,b,* transv. and long. secs. showing perforate walls and irregular tabulae, enlarged (76). *5, Alveolites labechei* M.Edw.-H., Sil., Eu.; *5a,b,* transv. and long. secs. showing spinose septa and mural pores, ×10 (70).

Eocene. Bursts of fecundity and evolutional activity are less notable in the Tabulata than in the Rugosa.

RELATIVE IMPORTANCE OF FAMILIES IN SUCCESSIVE EPOCHS

ORDOVICIAN

The families appearing in the Chazyan of North America were the Chaetetidae (*Tetradium, Lichenaria*), Syringophyllidae (*Billingsaria*), and Auloporidae (*Eofletcheria*), the chaetetids being perhaps commonest. During Blackriveran (zone of *Nemagraptus gracilis*) time, these Tabulata seem still confined to the strata of the Appalachian seas of North America, with the exception of *Tetradium* in possible Blackriveran equivalents on Bear Island south of Spitzbergen. But by Trentonian time (zones of *Climacograptus peltifer* to *C. linearis,* inclusive) they occurred also in the Caledonian seas of northern Europe and the Himalayan seas of central Asia, and the first Heliolitidae (*Protaraea, Propora*) and Halysitidae (*Halysites*) had entered. The Favositidae are not certainly known until *Palaeofavosites* appeared in the Upper Ordovician, in equivalents of the zone of *Dicellograptus anceps*. In the Upper Ordovician too, the Heliolitidae replaced the Chaetetidae as the dominant family of Tabulata, many genera, particularly of Coccoseridinae, Palaeoporitinae, and Plasmoporinae appearing. The Syringophyllidae were practically extinct by the end of the Ordovician.

SILURIAN

During the Silurian the Chaetetidae were quite unimportant, being represented by a few Chaetetinae only, and the dominant family was perhaps the Favositidae. The ramose Pachyporinae and reclined Alveolitinae were less numerous than the hemispherical or spherical Favositinae, of which *Favosites* itself was the most important, with its pores in the faces rather than the angles of the walls, as in the mainly Ordovician *Palaeofavosites*. In the still important Heliolitidae, the Plasmoporinae and Heliolitinae took the place of the Coccoseridinae, Palaeoporitinae, and Proheliolitinae. The Halysitidae were only slightly more important than the Auloporidae, but whereas the latter continued throughout the Paleozoic, the former became extinct at the end of the Silurian or within the Gedinnian.

DEVONIAN

Devonian faunas are characterizd by only 4 of the families of Tabulata. The Favositidae remained dominant, though they waned in the Upper Devonian. The Heliolitidae were represented by only 2 subfamilies, the Heliolitinae and Plasmoporinae, which continued from the Silurian; the last heliolitid, *Heliolites* itself, became extinct in the early Late Devonian. The Auloporidae and Chaetetidae retained minor importance. Of the Favositidae, the Favositinae and Pachyporinae were very important until late in the Devonian, ramose *Favosites* and the Pachyporinae outnumbering the hemispherical coralla. Many of the Favositinae developed squamulae in the late Early and Middle Devonian. By Late Devonian time, the hemispherical Favositinae were practically absent, and the Alveolitinae and Pachyporinae were the dominant types, the former becoming extinct before the end of the period. The Micheliniinae and Palaeacinae entered in the Early Devonian with *Pleurodictyum* and *Cleistopora,* respectively, but except in the Early Devonian, when *Pleurodictyum* was common, these 2 subfamilies were unimportant.

CARBONIFEROUS AND PERMIAN

In Early Carboniferous time, only the Auloporidae, Chaetetidae, and Favositidae remained, in that order of importance. Few genera and species were involved, but the number of individuals of *Syringopora* and *Chaetetes* was sometimes great. The Favositinae were poorly represented by small squamulate forms and the Micheliniinae were relatively important in numbers of individuals; the Palaeacinae showed considerable variability and a number of these perforate genera have been distinguished; the Pachyporinae were very rare.

The Moscovian, Artinskian, and later Paleozoic faunas are similar to those of the Lower Carboniferous, though there was a slight increase in the evolutional activity of the Auloporidae and Pachyporinae and a decrease in that of the Chaetetidae, the Micheliniinae, and the Palaeacinae.

POST-PALEOZOIC

Most post-Paleozoic species referred to the Tabulata have been removed subsequently; of a number of Mesozoic and Eocene species now recorded under the Chaetetidae, some may be coralline algae, while Triassic species referred to the Favositidae deserve further research.

ECOLOGY

The Tabulata frequently acted as framework organisms in the reefs of the Paleozoic, and in this role were sometimes more important than either the Rugosa or the Stromatoporoidea. But they also occurred in other than reef habitats; thus *Pleurodictyum* is particularly characteristic of the Siegen facies of the Lower Devonian. In general, it may be said that the largest coralla characterize the reef facies and that in deeper- and colder-water facies one finds small or slenderly branched coralla. Like the Rugosa, they are usually found in beds with a considerable lime content and are rare or absent in noncalcareous sandstones and mudstones and in greywackes.

ONTOGENY

Since members of the order are invariably compound, ontogenetic studies have been practically confined to elucidating the position of development of new corallites, and because *Pleurodictyum* has perhaps the largest corallites known in the Tabulata, it has been most studied. The order of insertion of septa in Tabulata is a neglected field of research, just as neglected as in the young corallites of compound Rugosa; one would like to know whether the apparently single order of septa was inserted pinnately in 4 positions, as in the Rugosa, or not, with or without masking by skipping of stages in offsets.

EVOLUTIONARY TRENDS

(1) The production of a marginarium was perhaps the most important of the evolutionary trends in Tabulata, as in Rugosa. There are 2 classes:

(A) In cerioid coralla, where the septa of neighboring corallites are divided by a plane of divergence of their trabeculae, the only marginarium found is the septal stereozone (e.g., *Striatopora*); a dissepimentarium is unknown. Since minor septa are not developed, the width of the septal stereozone does not depend on the length of the minor septa, as in Rugosa.

(B) In coralla where the dividing walls between corallites disappear, the marginarium is a common one, the coenenchyme; different types of coenenchyme develop:

(i) A compact coenenchyme where the common tissue consists (a) of vertical, very short, tightly packed trabeculae only (Coccoseridinae), or (b) of lamellar sclerenchyme in which the original fibrosity is lost in emphasis of the growth lamellation (*Thamnopora lamellicornis,* Fig. 351,*3c-e*).

(ii) A proporoid coenenchyme, where isolated trabeculae, stout or thin, are based on slightly domed dissepiments.

(iii) A heliolitoid coenenchyme in which the trabeculae are organized into vertical walls forming tubules which are crossed by small transverse plates or sola.

(iv) A halysitoid coenenchyme; very narrow vertical tubular spaces crossed by small transverse plates and without vertical skeletal elements may develop between neighboring corallites of cateniform coralla.

(v) A calapoecioid coenenchyme formed by extensions from the tabulae and septa which intersect to enclose horizontal tubular spaces.

(vi) A palaeacoid coenenchyme, i.e., a trabeculate but irregularly tunneled and perforate coenenchyme, as in *Palaeacis*.

(2) The development of intercorallite communication, apart from the coenenchyme, is a trend distinctive of the Tabulata; one finds:

(A) Mural pores (Favositidae, Billingssariinae).

(B) Connecting tubes between the cylindrical corallites of fasciculate Syringoporinae, which in the cerioid *Roemeria* become mural pores.

(C) Irregular perforation of the walls and septa, common in Scleractinia and calostylid Rugosa, and present in the Palaeacinae and Palaeoporitinae.

(3) The development of corallites of reclined, not vertical habit is seen in the Alveolitinae; the upper wall of the reclined corallites becomes vaulted.

Several other trends occur, but less commonly, and some of these which are minor in the Tabulata are common in the Rugosa. Thus, the common Rugosa trend to replacement of tabulae by tabellae is seen in Tabulata only in the Micheliniinae, one of the later subfamilies of Favositidae. The trend to complication of the arrangement of trabeculae within the septa may occur exceptionally in the Tabulata, as in some early Coccoseridinae where the individual trabeculae of each septum diverge from the medial plane; the development of squamulae in Favositinae in the Devonian (*Emmonsia*) and Lower Carboniferous may be due to a specialization of this trend. Laminar septa, where the axes of the trabeculae are so closely spaced in the septum that one cannot distinguish the fibers of the different trabeculae, are rare in Tabulata, but are quite common in Rugosa. The production of an axial structure is also very rare in Tabulata, though common in late Rugosa and in Scleractinia; its early appearance with vertical axial trabeculae in *Billingsaria* and a few Heliolitidae was abortive. The appearance of alternation in size of septa in the early syringophyllid *Nyctopora* seems not to have been due to the trend to develop more than one order of septa which distinguishes both Rugosa and Scleractinia; nor is there any clear trend to the predominance of 6 protosepta in Tabulata, characteristic in Scleractinia and appearing in late Rugosa, though a 12-equiseptate condition is found in many.

SYSTEMATIC DESCRIPTIONS

Order TABULATA Milne-Edwards & Haime, 1850

[as Zoantharia Tabulata (suborder) M.Edw.-H., 1850] [=Aseptata Grabau, 1913; Trichokorallen, Chätokorallen Weissermel, 1927; Chaetokorallen Weissermel, 1937; Trichocorallia Weissermel, 1939] [Includes Tubulosa (section) M. Edw.-H., 1851; Schizocoralla (subclass), Heliolitina (order) Okulitch, 1936; Heliolitida (section) Jones & Hill, 1940; Multisolenida (order) Fritz, 1950]

Corallum compound, with very slender corallites; septa short, equal, in many genera 12 in number, each typically a vertical series of spines; walls with pores in many; tabulae complete or funnel-shaped in some; extratabularial tissue a coenenchyme in many. *Ord.-Perm., ?Trias.-?Eoc.*

Family CHAETETIDAE Milne-Edwards & Haime, 1850

[*nom. transl.* Nicholson, 1877 (*ex* Chaetetinae M.Edw.-H., 1850)] [=Chaetetiniens de Fromentel, 1861 (invalid vernacular name); Chaetetiden Roemer, 1883; Chaetidae Počta, 1902; Tetradina, Chaetetina (orders) Okulitch, 1936]

Massive coralla composed of extremely slender aseptate corallites with imperforate walls and complete tabulae. *M.Ord.-Perm., ?Trias.-?Eoc.*

Subfamily LICHENARIINAE Okulitch, 1936

[*nom. transl. et correct.* Hill, 1951 (*ex* Lichenaridae Okulitch, 1936)]

Increase unequal, offsets arising near the margins of the corallites. *M.Ord.*

Lichenaria Winchell & Schuchert, 1895 [**L. typa*] [=*Lamottia* Raymond, 1924]. Corallites erect, prismatic (18a). *M.Ord.*, N.Am.-Scot.——Fig. 344,*1*. **L. typa*, N.Am.; *1a*, surface, ×1; *1b*, calices on weathered surface, ×6; *1c,d*, transv. and long. secs., ×4 (45).

Subfamily TETRADIINAE Nicholson, 1879

[*nom. transl.* Hill, 1951 (*ex* Tetradiidae Nich., 1879)] [=Palcoalveolitidae, Tetradidae Okulitch, 1935; Tetradina (order) Ok., 1936]

Increase quadripartite, incomplete in many. *M.Ord.-U.Ord.*

Tetradium Dana, 1848 [*non* Schmidt, 1874] [**T. fibratum* Safford, 1856; SD Safford, 1856] [=*Prismostylus* Okulitch, 1935; *Prismatostylus* Lang-S.-T., 1940 *(nom. van.)*]. Corallites erect, cylindrical or prismatic (18a). *M.Ord.-U.Ord.*, N. Am.-Eu.-N.S.W.-Tasm.——Fig. 344,*2*. **T. fibratum, M.Ord.*, N.Am.; *2a,b,d*, transv. secs., ×2, ×4, ×6; *2c*, long. sec., ×4 (45). Other species, Fig. 341,*5*.

Paleoalveolites Okulitch, 1935 [**Tetradium carterense* Bassler, 1932] [=*Kentlandia* Shrock, 1937; *Palaeoalveolites* Lang-S.-T., 1940 *(nom. van.)*]. Ramose; axial corallites prismatic and erect, peripheral corallites inclined, with upper walls vaulted (18a). *M.Ord.*, N.Am.——Fig. 344,*3*. **P. carterensis* (Bassler); *3a,b*, transv. secs., ×4, ×8; *3c*, long. sec., ×4 (45).

Subfamily CHAETETINAE Milne-Edwards & Haime, 1850

Increase bipartite, may be incomplete giving meandroid coralla. *Ord.-Perm., ?Trias.-?Eoc.*

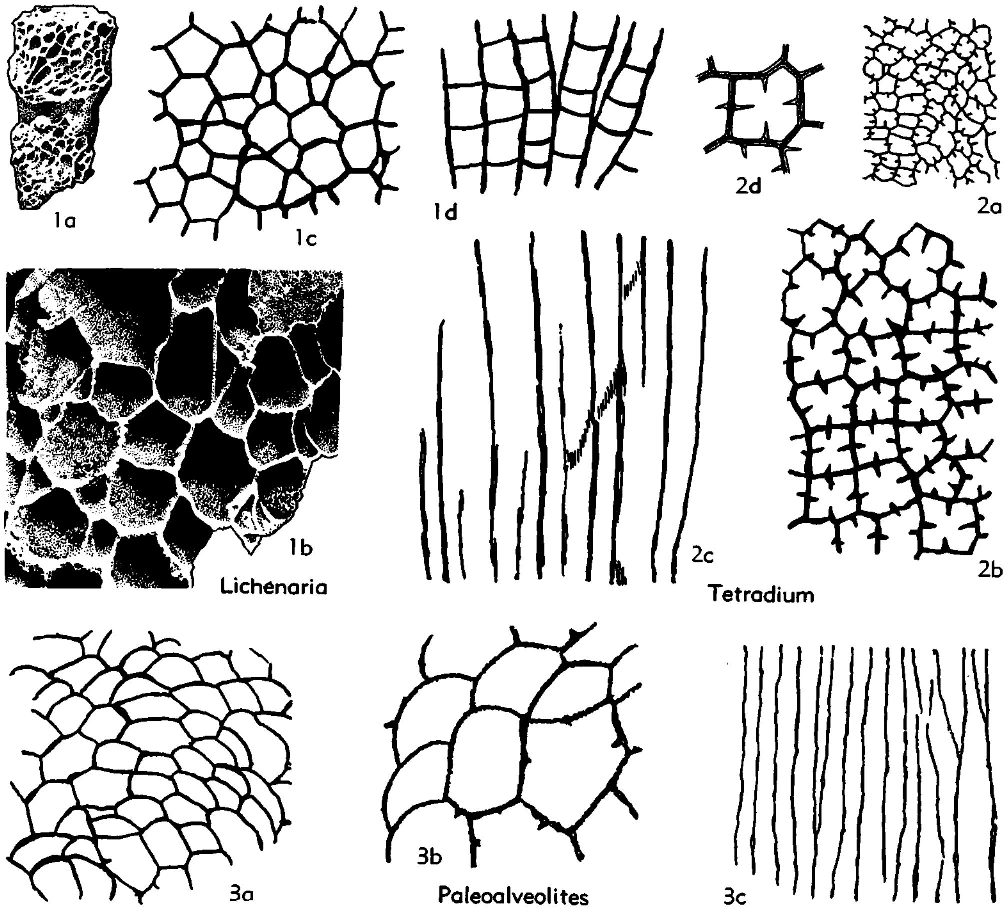

Fig. 344. Chaetetidae (p. F454).

Chaetetes Fischer in Eichwald, 1829 [**C. cylindraceus;* SD Oakley, 1936] [=?*Chaetetopsis* Neumayr, 1890; *Chaetetipora* Struve, 1898; ?*Carnegiea* Girty, 1913 (*pro Carnegia* Girty, 1907, *non* Holland, 1896); *Chaetetides* Strand, 1928; *Boswellia, ?Chaetetella, ?Chaetetiporella, ?Moscovia, ?Spongiothecopora* Sokolov, 1939; ?*Septachaetetes* Rios & Almela, 1944; ?*Fistulimurina* Sokolov, 1947]. Massive or incrusting (18a). *Ord.-Perm.,* cosmop.; ?*Trias.-?Eoc.,* Eu.——Fig. 340,*5;* 345,*1. C. ?septosus* Fleming, L. Carb. (Visé.), Eu.; 340,*5,* transv. sec., ×6 (76); 345,*1a,b,* transv. and long. secs., ×4 (58n).

Dania M.Edw.-H., 1849 [**D. huronica*]. Like *Chaetetes* but with tabulae on same level in contiguous corallites and unequally spaced (28). *Sil.,* N.Am.——Fig. 345,*2.* **D. huronica; 2a,* weathered top surface, showing form of corallites in transv. sec., ×4; *2b,* weathered side of corallum, showing accordant tabulae, ×1 (68).

Hattonia Jones, 1927 [**H. etheridgei*]. Like *Chaetetes* but with 1 to 3 tabulae occurring in groups which are regularly spaced and on the same level in contiguous corallites. *M.Sil.,* N.S.W.-USSR.——Fig. 345,*3.* **H. etheridgei,* N.S.W.; *3a,b,* transv. and long. secs., ×4 (60).

Litophyllum Etheridge, 1899 [**Amplexopora konincki* Etheridge & Foord, 1884]. Like *Chaetetes* but with walls a little thickened so that tabularium is rounded rather than polygonal. *Up.M.Dev.,* E.Austral.——Fig. 345,*4.* **L. konincki* (Eth.-F.), Queensl.; sec., ×4 (58n).

Pachytheca Schlüter, 1885 [*non* Hooker, 1861; *nec* Canu, 1913] [**P. stellimicans*]. Like *Litophyllum* but with walls so thickened as almost to fill the corallite (33). *M.Dev.,* Ger.——Fig 345,*5.* **P. stellimicans,* Eifel; *5a,b,* transv. and long. secs., ×9 (74).

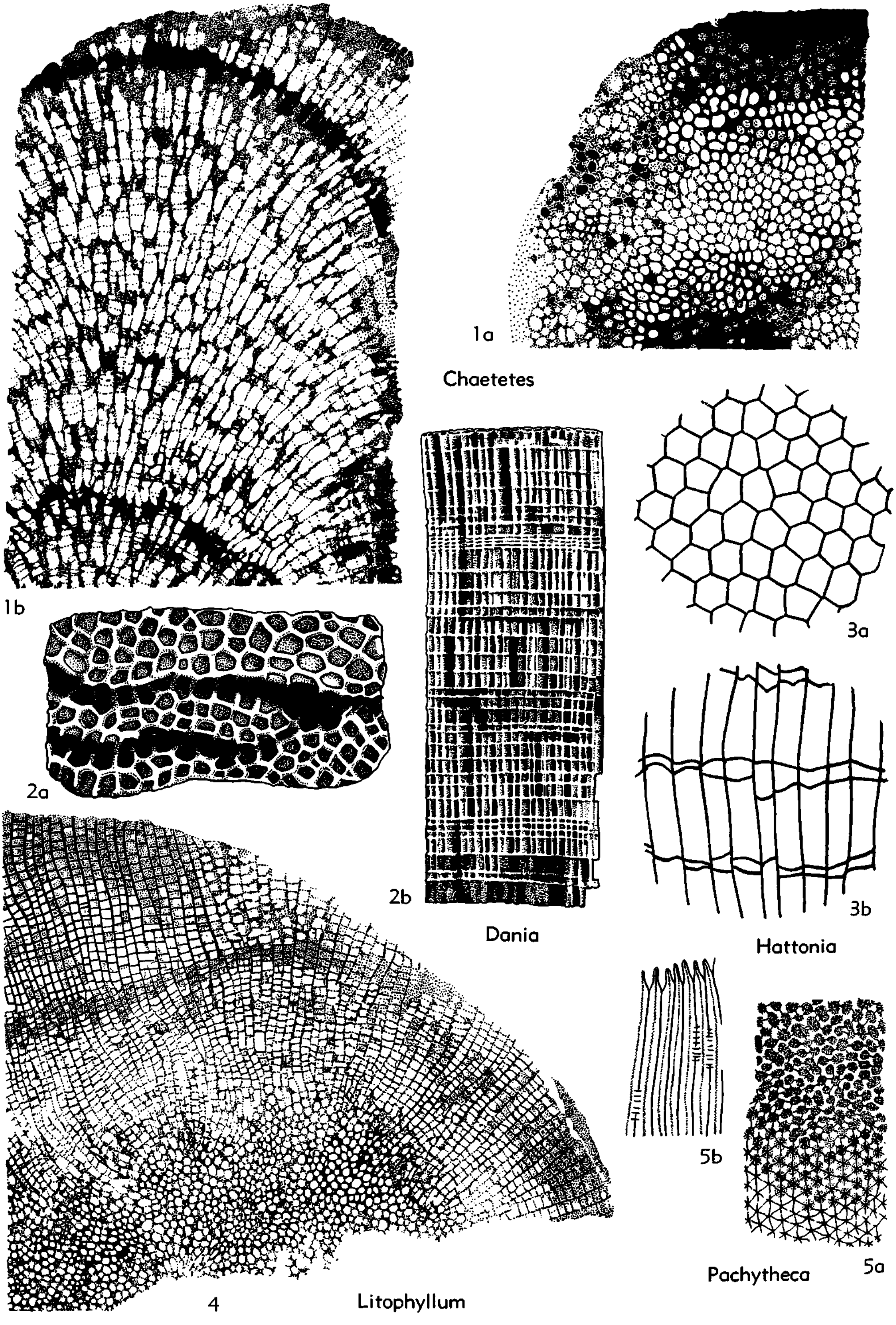

Fig. 345. Chaetetidae (p. F455).

Family SYRINGOPHYLLIDAE Počta, 1902

[*ex Syringophyllum* Milne-Edwards & Haime, 1850 (=*Sarcinula* Lamarck, 1816, subj.)] [=Syringophylliden Roemer, 1883 (invalid vernacular name); Lyoporidae Kiär, 1930; Billingsaridae Okulitch, 1936; Calapoeciidae Hill, 1951; Columnoporidae Lecompte, 1952]

Massive; septa short, thick, spinose, and typically equal in number in any species; mural pores interseptal and arranged in horizontal rows, each just above a tabula; coenenchyme formed by extensions from the tabulae and septa which intersect to enclose horizontal tabular spaces (18a). *M.Ord.-L.Sil.*

Subfamily BILLINGSARIINAE Okulitch, 1936

[*nom. transl. et correct.* Hill, 1955 (*ex* Billingsaridae Okulitch, 1936)] [=Nyctoporinae Hill, 1951]

Coenenchyme absent, septa 16, may alternate in size (18a). *M.Ord.-U.Ord.*

Billingsaria Okulitch, 1936 [**Columnaria parva* Billings, 1859]. Septal trabeculae dilated wedgewise to form a thick wall; vertical trabeculae may

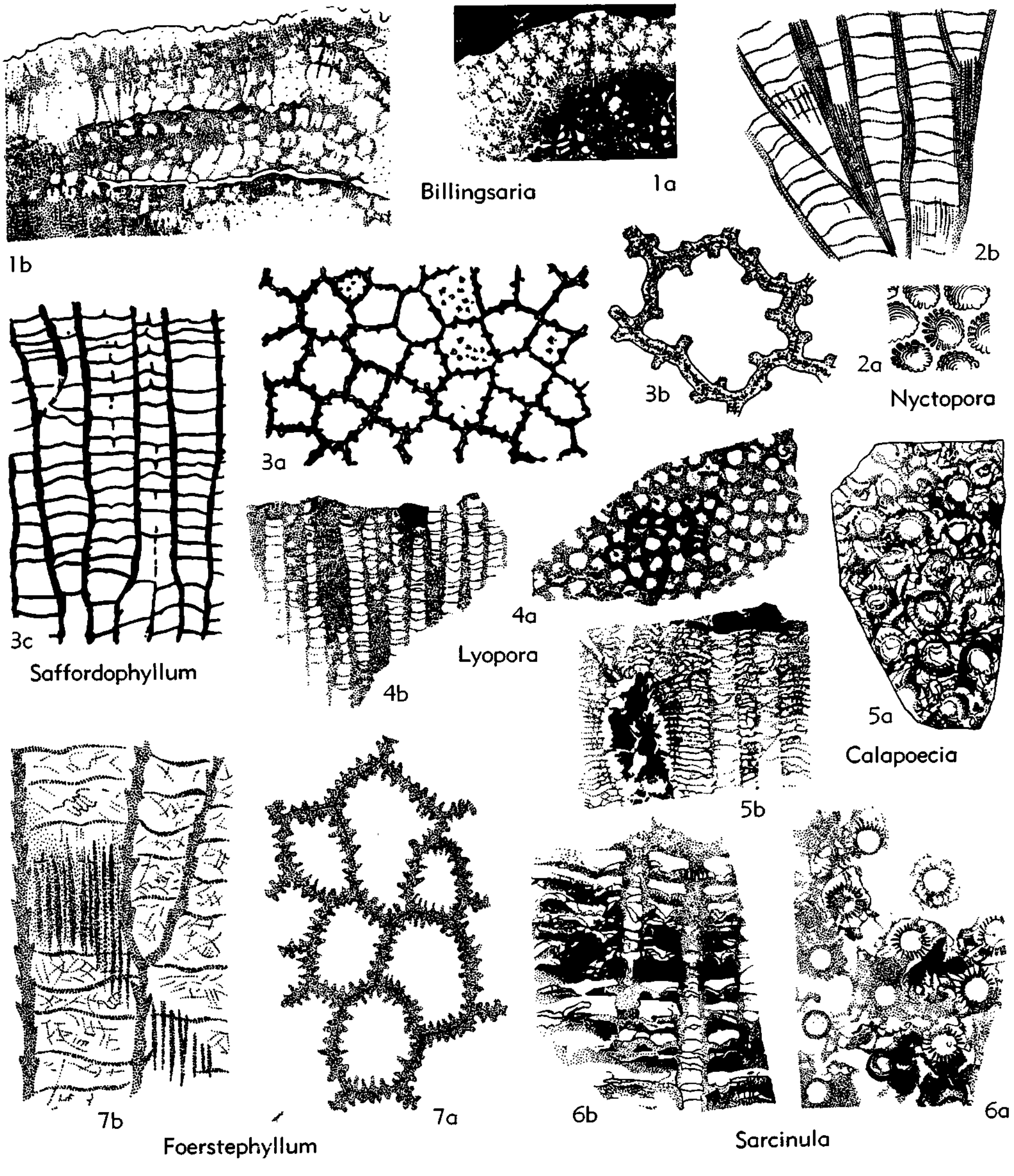

Fig. 346. Syringophyllidae (p. F457-F458).

develop at axis (18a). _M.Ord._, N.Am.-Austral.——Fig. 346,_1_. *_B. parva_ (Bill.), N.Am.; _1a,b,_ transv. and long. secs., ×4 (72).

Nyctopora Nicholson, 1879 [*_N. billingsi_ (_pro Columnaria goldfussi_ Nich., 1875, _non_ Bill., 1858)]. Walls and septa thin (18a). _M.Ord.-U.Ord._, N.Am.-Eu.-Austral.; _M.Ord._, Spiti.——Fig. 346,_2_. *_N. billingsi,_ M.Ord., N.Am.; _2a,_ top surface showing calices, ×5; _2b,_ long. sec., ×5 (70).

Saffordophyllum Bassler, 1950 [*_S. deckeri_ (_pro Lichenaria carterensis_ Decker, 1931, _non Columnaria carterensis_ Safford, 1869)]. Septa very short, equal, 8, each proceeding from an inward undulation of the wall; tabulae close (4). _M.Ord._, N.Am.——Fig. 346,_3_. *_S. deckeri; 3a,b,_ transv. secs., ×4, ×10; _3c,_ long. sec., ×4 (45).

?**Foerstephyllum** Bassler, 1950 [*_Columnaria? halli_ Nicholson, 1879]. Septa numerous, short, thick, of one order only (4). _M.Ord.-U.Ord._, N.Am.——Fig. 346,_7_. _F. halli_ (Nich.), M.Ord., N.Am.; _7a,b,_ transv. and long. secs., ×4 (70).

Subfamily SYRINGOPHYLLINAE Počta, 1902

[_nom. transl._ Hill, 1955 (_ex_ Syringophyllidae Počta, 1902)] [=Lyoporidae Kiär, 1930; Calapoeciinae Hill, 1951; Columnoporidae Lecompte, 1952]

Cerioid or with coenenchyme; septa 20 to 24, equal (18a). _M.Ord.-L.Sil._

Lyopora Nicholson & Etheridge, 1878 [*_Palaeopora? favosa_ M'Coy, 1850] [=_Liopora_ Lang-S.-T., 1940 _(nom. van.)_ (_non_ Girty, 1915)]. Cerioid, without coenenchyme (18a). _M.Ord._, Eu.-N.Am. Fig. 346,_4_. *_L. favosa_ (M'Coy), Eu.; _4a,b,_ transv. and long. secs., ×1 (47).

Calapoecia Billings, 1865 [*_C. anticostiensis;_ SD Lindström, 1883] [=_Columnopora_ Nicholson, 1874; _Houghtonia_ Rominger, 1876]. Coenenchyme more or less well developed (18a). _M.Ord.-L.Sil._, N.Am.-Scand.——Fig. 346,_5_. *_C. canadensis_ Bill. _anticostiensis,_ U.Ord., N.Am.; _5a,b,_ transv. and long. secs., ×1 (47).

Sarcinula Lamarck, 1816 [*_Madrepora organum_ Linné, 1758 _(partim);_ SD Dana, 1846] [=_Syringophyllum_ M.Edw.-H., 1850 (_non_ Ulr. in Miller, 1889, _nec_ Grabau & Yoh, 1929)]. Corallum alternatingly fasciculate and with wide coenenchymal platforms (18a). _M.Ord.-L.Sil._, N.Eu.——Fig. 346,_6_. *_S. organum_ (Linné), M.Ord.-L.Sil., N.Eu.; _6a,b,_ transv. and long. secs., ×1 (47).

Family HELIOLITIDAE Lindström, 1876

[_pro_ Palaeoporidae M'Coy, 1851, _ex Palaeopora_ M'Coy, 1849 (=_Heliolites_ Dana, 1846, obj.); _pro_ Heliolithidae Lind., 1873, _ex Heliolithes_ Lind., 1873 (=_Heliolites_ Dana, 1846, obj.)] [=Palaeoporidae M'Coy, 1851; Heliolithidae Lind., 1873; Heliolitiens Dollfuss, 1875 (invalid vernacular name); Heliolithinae Wentzel, 1895; Heliolithoidea (order) Frech, 1897; Heliolitina (order) Okulitch, 1936; Heliolitacea (suborder) Wedekind, 1937; Heliolitida (section) Jones & Hill, 1940)]

Massive coralla with slender tabularia separated by coenenchyme; each tabularium with 12 equal spinose septa and with complete tabulae (18a). _M.Ord.-U.Dev._

Subfamily COCCOSERIDINAE Kiär, 1899

[_nom. correct._ Hill & Stumm, herein (_pro_ Coccoserinae Kiär, 1899)] [=Pycnolithinae, Coccoseridae Lindström, 1899; Protaraeinae Kiär, 1904; Protaraeidae Lecompte, 1952]

Incrusting, discoid, nodular or branching; coenenchyme tubular; trabeculae greatly thickened; septal trabeculae curving upwards and inwards to become vertical in axial parts of tabularia; coenenchymal trabeculae vertical, spaced so as to form vertical tubules (18a). _M.Ord.-L.Sil._

Protaraea M.Edw.-H., 1851 [*_Porites? vetustus_ Hall, 1847; SD Miller, 1889] [=_Diplastraea_ Eichw., 1854; _Tumularia_ Robinson, 1916 (_pro Stylaraea_ Seebach, 1866, _non_ M.Edw.-H., 1851)]. Trabeculae very stout, coenenchyme narrow or absent (18a). _M.Ord.-L.Sil._, N.Am.-Eu.-Tasm.——Fig. 347,_1_. *_P. vetusta_ (Hall) M.Ord., N.Am.; _1a,_ side view of corallum, ×1; _1b,_ calices, ×10 (68).

Coccoseris Eichwald, 1855 [*_C. ungerni_ (=_Lophoseris ungerni_ Eichw., 1855); SD Lang-S.-T., 1940). Coenenchyme wide, trabeculae so stout that all spaces are filled (18a). _U.Ord.-L.Sil._, Eu.——Fig. 347,_2_. *_C. ungerni,_ U.Ord., Est.; _2a,_ part of surface, ×1; _2b,c,_ transv. and long. secs., ×10 (65).

Acidolites Lang-S.-T., 1940 [_pro Acantholithus_ Lindström, 1899 (_non_ Stimpson, 1858)] [*_Acantholithus lateseptatus_ Lind., 1899]. Coenenchyme wide, trabeculae relatively slender, leaving spaces crossed by dissepiments (18a). _U.Ord.-L.Sil._, Eu.-Tasm.——Fig. 347,_3_. *_A. lateseptatus_ (Lind.), ?L.Sil., Gotl.; _3a,_ part of surface, ×1; _3b-d,_ transv. and long. secs., ×8 (65).

Pycnolithus Lindström, 1899 [*_P. bifidus_]. Discoid; coenenchymal trabeculae so thick as to fill all spaces; septa very short, leaving open tabularia crossed by tabulae (26). _L.Sil._, Gotl.——Fig. 347,_4_. *_P. bifidus,_ L.Sil., Gotl.; _4a,c,_ transv. and long. secs., ×4; _4b,_ part of surface showing calices, ×4 (65).

Urceopora Eichwald, 1855, **Stylidium** Eich., 1855 (_non_ Dall in Bartsch, 1907) are possibly coccoseridines but thin sections are required.

Subfamily PALAEOPORITINAE Kiär, 1899

Like Coccoseridinae, but septa and walls of tabularia and coenenchymal tubules perforate (22). _M.Ord.-U.Ord._

Trochiscolithus Kiär, 1904 [*_T. micraster_]. Branching, axis of branch with slender trabeculae forming partially perforate septa and walls; outer parts of branch with all spaces filled by dilatation of the trabeculae (18a). _M.Ord.-U.Ord._, Eu.——Fig. 347, _5_. *_T. micraster,_ Ord., Norway; _5a,_ transv. sec., ×4; _5b,_ part of surface, ×10 (62).

Protrochiscolithus Troedsson, 1928 [**P. ḳiaeri*]. Coenenchyme narrow; trabeculae slender, forming partially perforate septa and walls, and leaving tabularial and coenenchymal spaces (18a). *U.Ord.*, Arct.N.Am.——Fig. 347,7. **P. ḳiaeri; 7a,* part of surface, ×1; *7b,c,* transv. and long secs., ×10 (79).

Palaeoporites Kiär, 1899 [**P. estonicus*]. Nodular;

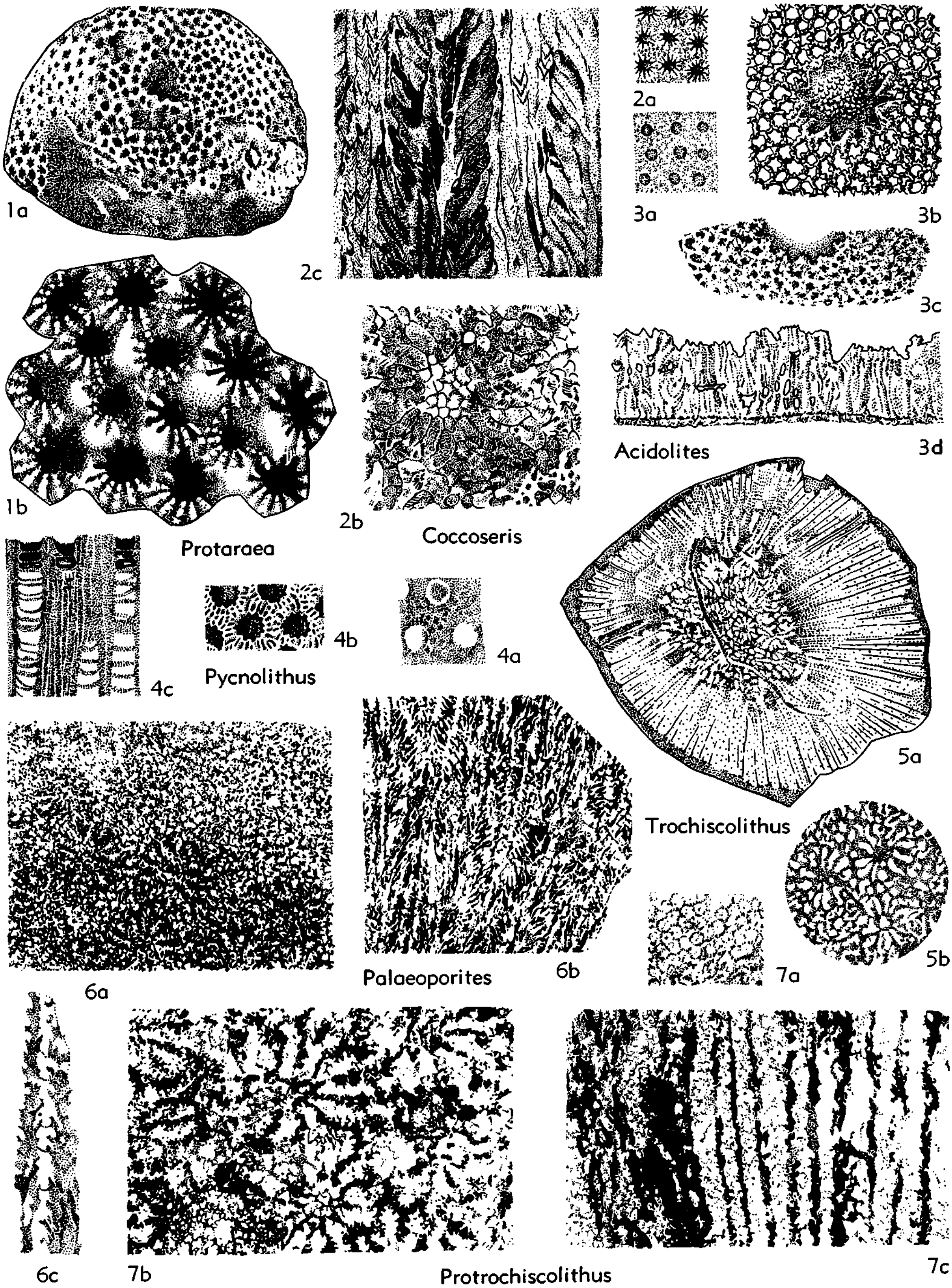

Fig. 347. Heliolitidae (p. F458-F460).

coenenchyme wide; trabeculae moderately thick, leaving spaces in tabularia and coenenchyme, and forming perforate walls and septa; septal trabeculae curving outwards from median plane of septum (22). *L.Sil.* (F₂), Balt.——Fig. 347,*6*. **P. estonicus; 6a,b,* transv. and long. secs., ×4; *6c,* detail of oblique sec. showing septal trabeculae, ×10 (62).

Subfamily PLASMOPORINAE Wentzel, 1895

[*nom. transl.* Kiär, 1899 (*ex* Plasmoporidae Wentzel, 1895)] [=Plasmoporinae Lindström, 1899 (tribe); Proplasmoporinae Kiär, 1904 (invalid); Proporinae Hill, 1951]

Coenenchyme of domed plates and isolated trabeculae or with trabeculae uniting to form discontinuously walled tubuli. *M. Ord.-U.Sil.*

Propora M.Edw.-H., 1849 [**Porites tubulatus* Lonsdale, 1839 *(partim)*] [=*Lyellia* M.Edw.-H., 1851; *Pinacopora* Nicholson & Etheridge, 1878; *?Nicholsonia* Kiär, 1899 (*non* Davis, 1885; *nec* Schlüter, 1885; *nec* Počta, 1902; *nec* others); *Cavella* Stechow, 1922 (*pro Calvinia* Savage, 1913, *non* Nutting, 1900); *Koreanopora* Ozaki, 1934]. Coenenchyme of domed plates and isolated trabeculae not more thickened in surface zones than in inner or axial zones of the corallum (18a). *M.Ord.-U.Sil.,* cosmop.——Fig. 348,*1*. **P. tubulata* (Lonsdale), Sil., Eu.; *1a,* part of surface, ×4; *1b,c,* transv. and long. secs., ×4 (65).

Plasmoporella Kiär, 1897 [**P. convexotabulata* forma *typica* Kiär, 1899] [=*Camptolithus* Lindström, 1899]. Like *Propora* but with tabulae domed and complete or incomplete; trabeculae slender (18a). *U.Ord.-M.Sil.,* Eu.-N.Am.-Tasm.-Asia.——Fig. 348,*2*. **P. convexotabulata,* U.Ord., Norway; *2a,b,* transv. and long. secs., ×4 (62).

Diploëpora Quenst., 1879 [**Heliolites grayi* M. Edw.-H., 1851]. Branching; axially like *Propora* but with surface zones of corallum with great trabecular thickening (22). *M.Sil.,* Eu.-E.Austral. ——Fig. 348,*3*. **D. grayi* (M.Edw.-H.), Eu.; long. sec., ×4 (62).

Plasmopora M.Edw.-H., 1849 [**Porites petalliformis* Lonsdale, 1839]. Coenenchyme tubular, with an aureole around each tabularium of 12 tubules whose radial walls are continuous with the septa (22). *L.Sil.-M.Dev.,* Eu.-N.Am.-E.Austral.-Asia. ——Fig. 340,*6;* 348,*5*. **P. petalliformis* (Lonsd.), M.Sil., Eu.; 340,*6,* surface of corallum, ×1 (68); 348,*5a,* part of surface, ×1; 348,*5b,c,* transv. and long. secs., ×4 (65).

?Cyrtophyllum Lindström, 1882 [**C. densum*]. Coenenchyme tubular, all tubules with discontinuous walls, more than 12 in aureole. *L.Sil.,* Sib. ——Fig. 348,*4*. **C. densum; 4a,b,* transv. and long. secs., ×1.5 (65).

Subfamily PROHELIOLITINAE Kiär, 1899

Tabularia in contact and polygonal or separated in part of their circumference by 1, 2, or 3 small coenenchymal tubuli, each of which may widen to form a normal tabularium; with 12 septa, each composed of a single series of downwardly directed separate spines (18a). *U.Ord.-L.Sil.*

Proheliolites Kiär, 1897 [*Heliolites dubius* Schmidt, 1858].——Fig. 348,*6*. **P. dubius* (Schmidt), Eu., *6a,b,* transv. and long. secs., ×4 (62).

Subfamily HELIOLITINAE Lindström, 1876

[*nom. transl.* Kiär, 1899 (*ex* Heliolitidae Lind., 1876)] [=Palaeoporidae M'Coy, 1851; Heliolithinae Wentzel, 1895]

Coenenchyme of tubuli with complete thin walls, with more than 12 tubuli bounding each tabularium. *L.Sil.-U.Dev.*

Heliolites Dana, 1846 [**Astraea porosa* Goldf., 1826] [=*Palaeopora* M'Coy, 1849 (obj.); *?Lonsdalia* Orb., 1849 (*non Lonsdaleia* M'Coy, 1849); *Geoporites* Orb., 1850 (obj.); *Heliolithes* Lindström, 1873 (obj.); *Pachycanalicula* Wentzel, 1895; *Helioplasma* Kettnerova, 1933]. Tabularia polygonal or circular in transverse section, septa spinose (26). *L.Sil.-Up.M.Dev.,* cosmop.——Fig. 348,*7*. **H. porosa* (Goldf.), M.Dev., cosmop.; *7a,b,* transv. and long. secs., ×5 (65). Other species, Fig. 342,*3*.

Stelliporella Wentzel, 1895 [**S. lamellata*]. Tabularia stellate in transverse section, septa laminar, interfingering at the axis; walls thin (26). *Sil.,* Eu.——Fig. 348,*8*. **S. lamellata,* Czech.; *8a,b,* transv. and long. secs., ×4 (81).

Cosmiolithus Lindström, 1899 [**C. ornatus;* SD Lang.-S.-T., 1940]. Like *Stelliporella* but with thickened walls and septa, and with coenenchymal tubuli of 2 sizes, the smaller around the larger (26). *Sil.,* Gotl.——Fig. 348,*9*. **C. ornatus; 9a,* transv. sec., ×4; *9b,* long. sec., ×8 (65).

Paeckelmannopora Weissermel, 1939 [**P. macrophthalma*]. Tabularial walls thin, in 12 longitudinal waves, without septal spines; coenenchymal tubules small, thin-walled, irregular and unequal. *L.Dev.,* AsiaM.——Fig. 348,*10*. **P. macrophthalma; 10a,b,* transv. and long. secs., ×4 (80).

Family FAVOSITIDAE Dana, 1846

[=Favositacea Wedekind, 1937] [Includes Multisolenida Fritz, 1950]

Massive, typically without coenenchyme; corallites slender, with mural pores; septa short, equal, spinose, variable in number; tabulae complete (18a). *U.Ord.-Perm., ?Trias.*

Subfamily FAVOSITINAE Dana, 1846

[=Multisolenida (order), Multisolenidae (=Multisoleniidae, *nom. correct.*, herein) Fritz, 1950; Emmonsiinae, Scolioporinae Lecompte, 1952]

Corallites prismatic, thin-walled, perforated by mural pores only (18a). *U.Ord.-U. Dev.*

Palaeofavosites Twenhofel, 1914 [**Favosites asper* Orb., 1850]. Mural pores predominantly at angles of walls (18a). *U.Ord.-U.Sil.,* Eu.-N.Am.——Fig. 349,*1*. **P. asper* (Orb.), Sil., Eu.; *1a,b,* transv. and long. sec., ×4 (60).

Favosites Lamarck, 1816 [**F. gothlandicus;* SD M.Edw-H., 1850] [=*Calamopora* Goldf., 1829; *Astrocerium* Hall, 1851; *?Brignus* Gregorio, 1930; *?Sapporipora* Ozaki, 1934; *Eufavosites* Rushkin, 1936]. Mural pores predominantly near middle of walls (18a). *U.Ord.-M.Dev.,* cosmop.; *?Trias.,* Sicily.——Fig. 340,*7;* 349,*3*. **F. gothlandicus,* Sil.-L.Dev., cosmop.; 340,*7,* corallum,

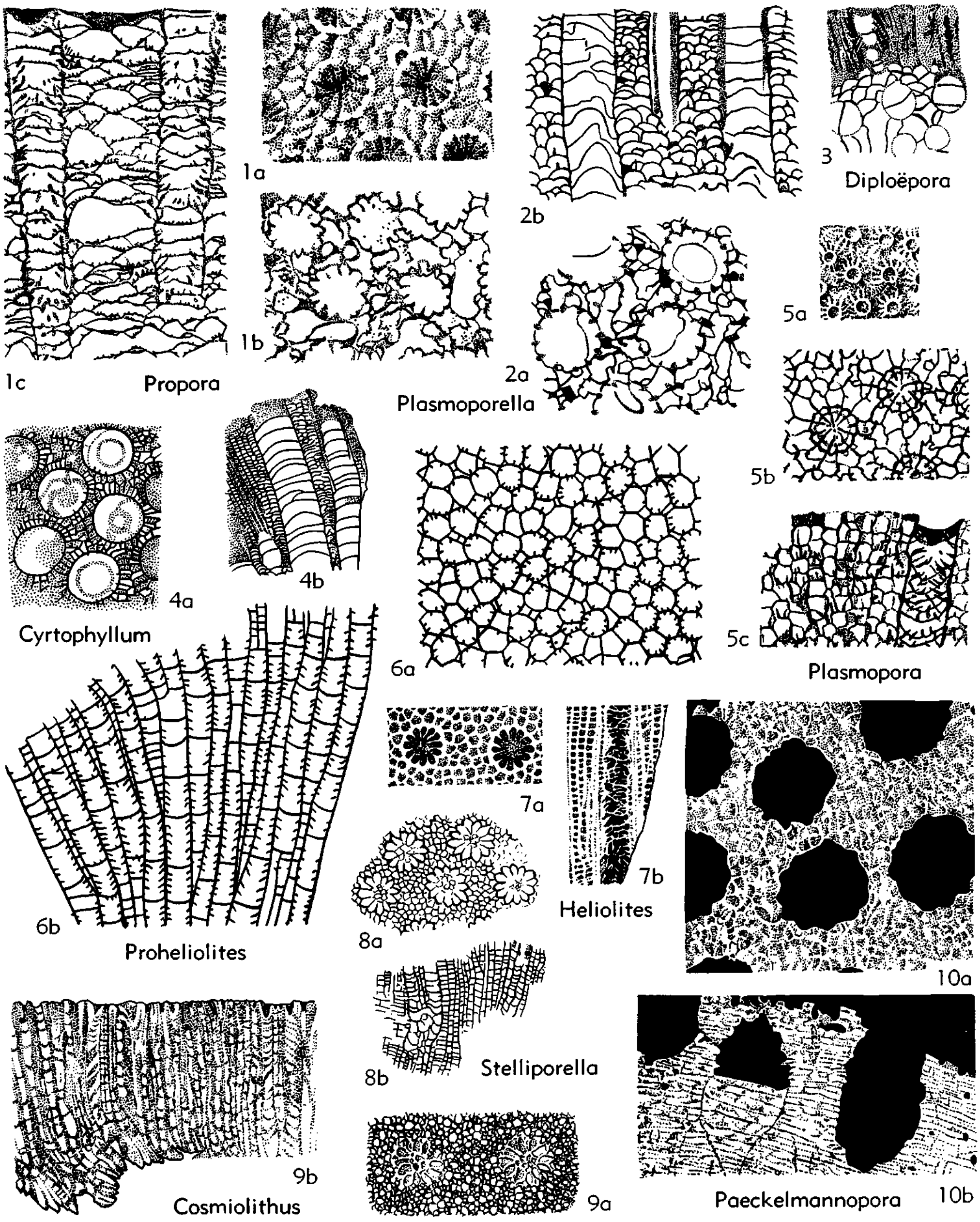

Fig. 348. Heliolitidae (p. F460).

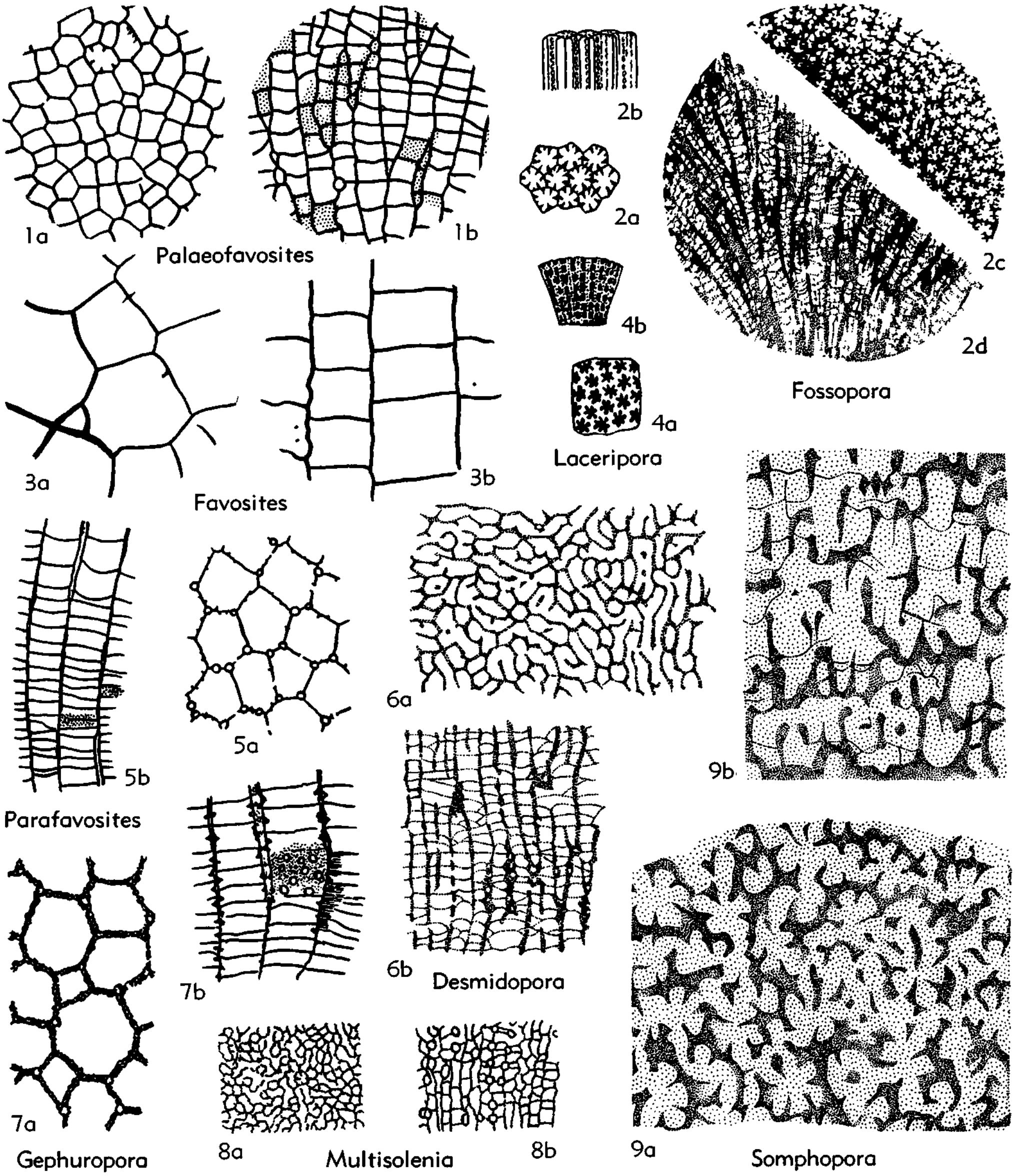

Fig. 349. Favositidae (p. F461-F464).

×1; 349,_3a,b,_ transv. and long. secs., ×4 (60). Other species, Fig. 340,_7;_ 341,_4_.

Parafavosites Orlov, 1930 [*_P. ferganensis;_ SD Lang-S.-T., 1940] [=_Paralleloporella_ Strand, 1934 (_pro Parallelopora_ Holtedahl, 1914, _non_ Bargatzky, 1881)]. Like _Favosites_ but with vertical aseptate and atabulate tubules expanding the walls either in the angles or faces (3). _Sil.,_ Arct. Can.-Asia.——Fig. 349,_5._ *_P. ferganensis,_ U.Sil., Ferghana; _5a,b,_ transv. and long. secs., ×4 (45).

Gephuropora Etheridge, 1920 [*_Favosites (?Columnopora) duni_ Eth., 1920]. Like _Parafavosites_ but tubules may be tabulate (3). _L.M.Dev.,_ E. Austral.-Belg.——Fig. 349,_7._ *_G. duni_ (Eth.); _7a,b,_ transv. and long. secs., ×4 (45).

Fossopora Etheridge, 1903 [*_F. wellingtonensis_] [=_?Boreaster_ Lambe, 1906; _Fossipora_ Lang-S.-T., 1940]. Mural pores oval, one vertical series on each face; septa 6, long, laminar peripherally, spinose axially (8). _Sil._ or _Dev.,_ N.S.W.; _Sil.,_ Arct.

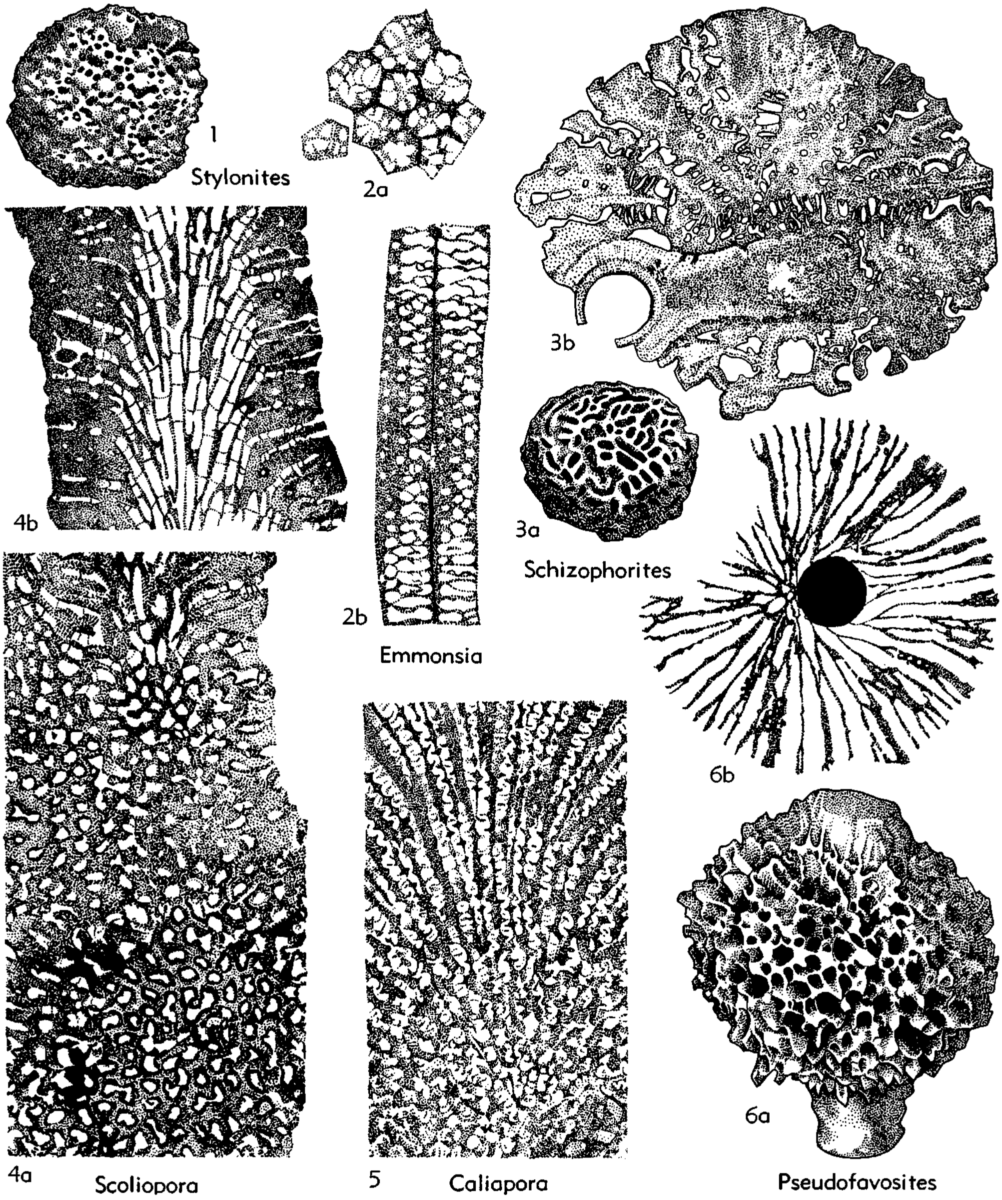

Fig. 350. Favositidae (p. F464).

Can.——Fig. 349,*2c,d*. **F. wellingtonensis*, Sil. or Dev., N.S.W.; *2c,d*, transv. and long. secs., ×4 (49).——Fig. 349,*2a,b*. *F. lowi* (Lambe) (type species of *Boreaster*), Sil., Arct.Can.; *2a,b*, transv. and long. secs., ×4 (45).

Somphopora Lindström, 1883 [**S. daedalea*]. Mural pores numerous, septa 6, spinose (8). *Sil.*, China.——Fig. 349,*9*. **S. daedalea*, Szechuan; *9a,b*, transv. and long. secs., ×4 (65).

Laceripora Eichwald, 1854 [**L. cribrosa*] [=*Laceropora* Lang-S.-T., 1940 (*nom. van.*)]. Mural pores very numerous, septa laminar, not more than 6; tabulae on same level in contiguous corallites throughout corallum (8). *?Sil.*, Est.——Fig. 349,*4*. **L. cribrosa; 4a,b*, transv. and long. secs., ×4 (48).

Desmidopora Nicholson, 1886 [**D. alveolaris*] [=*?Nodulipora* Lindström, 1873]. Meandroid; increase bipartite; mural pores at angles of wall as well as mid-wall (11). *Sil.*, Eng.——Fig. 349,*6*.

*_D. alveolaris,_ Wenlock., Eng.; _6a,b,_ transv. and long. secs., ×4 (70).

Multisolenia Fritz, 1937 [*_M. tortuosa_] [=_Polysolenia_ Weissermel, 1939 (_non_ Ehr., 1860; _nec_ Reuss, 1866)]. Like _Desmidopora,_ but with walls waved near the angles, so that rounded projections, circular in vertical section, alternate in neighboring corallites (11). _Sil.,_ Can.-USSR.——Fig. 349, _8._ *_M. tortuosa,_ Lockport., Can.; _8a,b,_ transv. and long. secs., ×4 (52).

Scoliopora Lang-S.-T., 1940 [_pro Plagiopora_ Gürich, 1896 (_non_ MacGill., 1895)]. [*_Alveolites denticulatus_ M.Edw.-H., 1851]. Branching or lamellar, increase bipartite; calices elongated transversely, opening normal to surface; walls thickened distally, mural pores numerous, septal spines few, tabulae close in peripheral regions (25). _M.Dev.,_ Eu.-E.Austral.; _U.Dev.,_ Eu.——Fig. 350,_4._ *_S. denticulata_ (M.Edw.-H.), M.Dev.-U.Dev., Eu.; _4a,b,_ ×4 (64).

Emmonsia M.Edw.-H., 1851 [*_Favosites emmonsii_ Rominger, 1876 (=_F. hemispherica_ Yandell & Shumard, M.Edw.-H. _partim_); SD Roemer, 1883]. Massive or tuberose; corallites prismatic, squamulae project toward axis over the mural pores; tabulae thin, dependent from inner ends of squamulae. _L.Dev.-M.Dev.,_ N.Am.——Fig. 350,_2._ *_E. emmonsii_ (Rom.), Onond., N.Y.; _2a,b,_ transv. and long. secs., ×4 (58n).

Caliapora Schlüter, 1889 [*_Alveolites battersbyi_ M.Edw.-H., 1851]. Like _Emmonsia_ but squamulae with concave upper surfaces (25). _M.Dev.,_ Eu., Austral.(Vict.).——Fig. 343,_3;_ 350,_5._ *_C. battersbyi,_ Givet., NW.Eu.; 343,_3a,b,_ transv. and long. secs., ×6; 350,_5,_ long. sec., ×4 (64).

Schizophorites Gerth, 1921 [*_S. dubiosus_]. Small, adherent, spherical; corallites with rectangular calices, thick walls, large ragged septal spines; sparse mural pores and numerous thin tabulae (13). _Perm.,_ Timor.——Fig. 350,_3._ *_S. dubiosus; 3a,_ surface, ×1; _3b,_ long. sec., ×4 (54).

Pseudofavosites Gerth, 1921 [*_P. stylifer_]. Massive or incrusting; corallites as in _Favosites_ but with angles of walls produced distally into processes, and apparently without tabulae (13). _Perm.,_ Timor.——Fig. 350,_6._ *_P. stylifer; 6a,_ surface, ×1; _6b,_ long. sec., ×1 (54).

Stylonites Gerth, 1921 [_non_ Fries, 1848] [*_S. porosus_]. Spherical, with distal processes from angles of walls, corallites with a columella and 8 spinose septa (13). _Perm.,_ Timor.——Fig. 350,_1._ *_S. porosus;_ surface, ×1 (54).

?Plasmadictyon Wilson, 1926 [*_P. irregulare_]. _U. Ord.,_ W.Can.

Subfamily THECIINAE Milne-Edwards & Haime, 1850

[_nom. transl. et correct._ Hill & Stumm, herein (_ex_ Thecidae M.Edw.-H., 1850)]

Corallites very slender, prismatic; septa typically 12, equal; with or without trabeculate coenenchyme; mural pores may be long tunnels. _Sil._

Thecia M.Edw.-H., 1849 [*_Porites expatiatus_ Lonsdale, 1839 (=*_Agaricia swinderniana_ Goldf., 1829] [=_Angopora_ Jones, 1936 (_pro Laminopora_ Jones, 1930, _non_ Michelin, 1842)]. Septa laminar, thick and in contact peripherally but free and spinose axially; peripheral trabeculae vertical; mural pores few (1). _Sil.,_ Eu.-N.Am.——Fig. 351, _1a,b._ *_T. swinderniana_ (Goldf.), Wenlock., Eng.; _1a,b,_ transv. and long. secs., ×4 (58n).——Fig. 351,_1c,d._ _T. hisingeri_ (Jones) (type species of _Angopora_), Sil., Gotl.; _1c,d,_ transv. and long. secs., ×4 (60).

Romingerella Amsden, 1949 [*_Thecia major_ Rominger, 1876]. Like _Thecia_ but trabeculae diverging from planes of contact of corallites (1). _Sil.,_ N.Am.——Fig. 351,_2._ *_R. major_ (Rom.), Brownsport, Tenn.; _2a,_ surface, ×5; _2b,_ transv. sec., ×4 (43).

Subfamily PACHYPORINAE Gerth, 1921

[_nom transl._ Hill & Stumm, herein (_ex_ Pachyporidae Gerth, 1921, _ex Pachypora_ Lindström, 1873, =_Thamnopora_ Steininger, 1831 subj.)] [=?Trachyporinae Waagen & Wentzel, 1886; ?Trachyporidae Sardeson, 1896; Thamnoporinae Hill, 1954]

Tuberose or branching; walls of corallites thickened, with tunnel-like mural pores; calices opening normal to surface; septa spinose, tabulae thin, complete. _Sil.-Perm._

Thamnopora Steininger, 1831 [_non_ Hall, 1883] [*_T. madreporacea_ (=*_Alveolites cervicornis_ Blainv., 1830); SD Lang-S.-T., 1940] [=_Pachypora_ Lindström, 1873]. Massive, tuberose or ramose; walls thickened, increasing distally; septal spines poorly developed, mural pores numerous, tabulae thin (25). _Sil.-Perm.,_ cosmop.——Fig. 351, _3a,b._ *_T. cervicornis_ (Blainv.), M.Dev. (Givet.), Eu.; _3a,b,_ transv. and long. secs., ×4 (64).——Fig. 351,_3c-e._ _T. lamellicornis_ (Lind.) (type species of _Pachypora_), Sil., Gotl.; _3c,_ surface, ×1; _3d,e,_ transv. and long. secs., ×4 (65).

Striatopora Hall, 1851 [*_S. flexuosa_] [=_Cyathopora_ Owen, 1844 (_nom. null. pro Cyathophora_ Michelin, 1843); _?Thamnoptychia_ Hall, 1876]. Ramose; walls thickened distally only; septa 12, with numerous trabeculae. _Sil.,_ cosmop.; _Dev.-Perm.,_ N.Am.——Fig. 352,_5._ *_S. flexuosa;_ M.Sil., N.Y.; _5a,b,_ transv. and long. secs., ×4 (58n). Other species, Fig. 342,_2._

Acaciapora Moore & Jeffords, 1945 [*_Michelinia subcylindrica_ Mather, 1915]. Like _Thamnopora_ but with squamulae. _Penn.,_ Tex.-Okla.——Fig. 352,_2._ *_A. subcylindrica_ (Mather), Tex.; _2a,_ surface, ×1; _2b,c,_ transv. and long. secs., ×4 (69).

Heterocoenites Gerth, 1921 [*_H. variabilis;_ SD Lang.-S.-T., 1940]. Like ramose _Thamnopora_ but with greatest thickening at axes of the branches (13). _Perm.,_ Timor.——Fig. 352,_3._ *_H. variabilis; 3a,_ surface, ×1; _3b,_ long. sec., ×2 (54).

?**Trachypora** M.Edw-H., 1851 [*non* Verrill, 1864] [**T. davidsoni*]. *U.Dev.*, Eu.

?**Taouzia** Termier, 1948 [**T. chouberti*] (36). *M. Dev.*, Morocco.

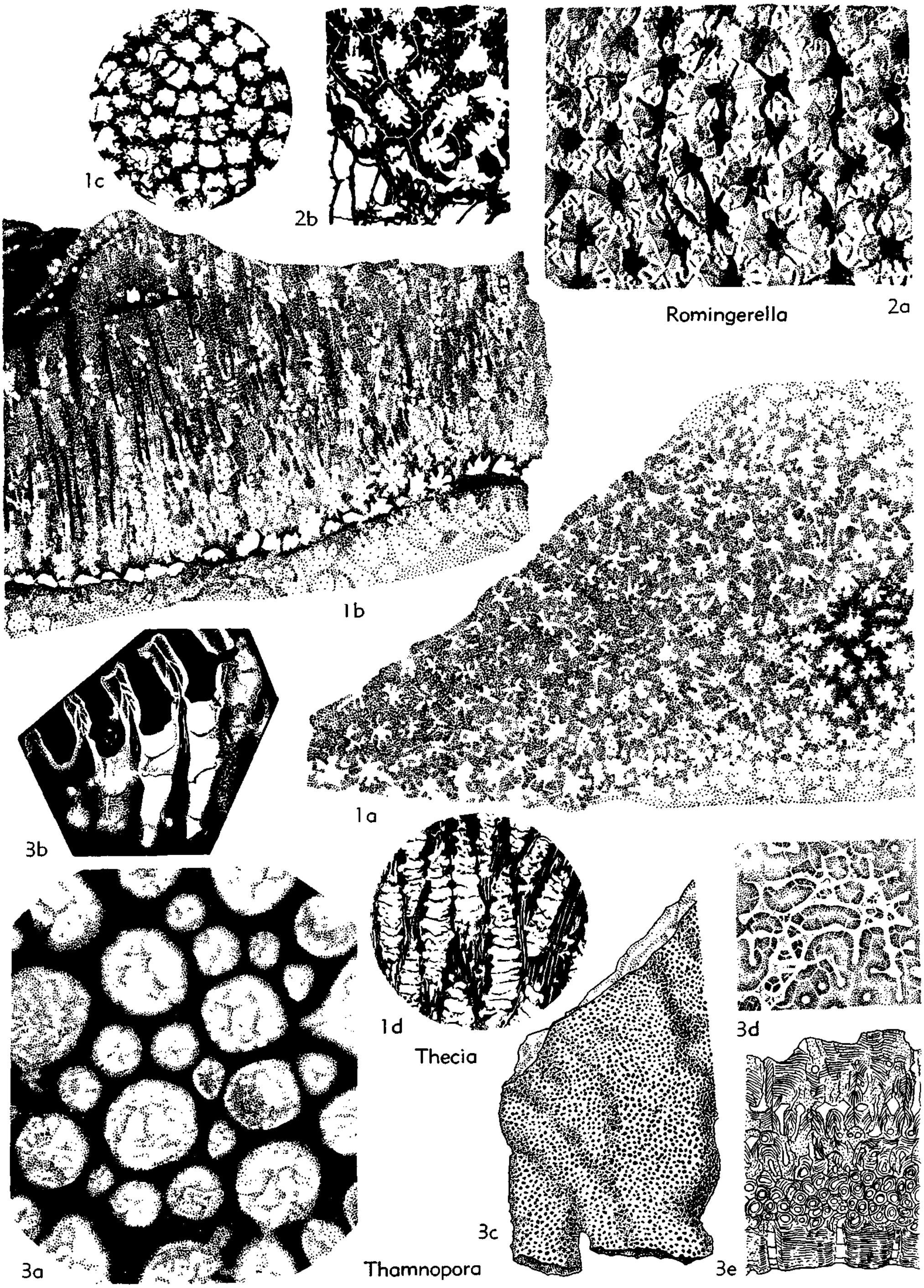

Fig. 351. Favositidae (p. F464).

Subfamily ALVEOLITINAE Duncan, 1872

[*nom. transl.* Waagen & Wentzel, 1886 (*ex* Alveolitidae Duncan, 1872)] [=Coenitidae Sardeson, 1896]

Massive, lamellar or branching; corallites inclined, calices opening obliquely, corallites not prismatic but with upper wall vaulted. *Sil.-Dev.*

Alveolites Lamarck, 1801 [*non* Defrance, 1816] [**A. suborbicularis;* SD Nicholson & Etheridge, 1877] [=*Billingsia* de Koninck, 1876 (*non* Walcott, 1886; *nec* Ford, 1886); *?Platyaxum* Davis, 1887]. Massive, incrusting or ramose; lower or adherent wall parallel to outer (upper) surfaces of earlier corallites; commonly one larger septal spine in the middle of the lower wall; mural pores large, at bases of upper walls (25). *Sil.-Dev.*, cosmop.——Fig. 352,*7*. **A. suborbicularis* M.Dev.-U.Dev., Eu.-Asia-Austral.; *7a,b,* transv. and long. secs., ×4 (64). Other species, Fig. 340,*1*.

Planalveolites Lang & Smith, 1939 [**Alveolites fougti* M.Edw.-H., 1851]. Like *Alveolites* but thin and flat, the large almost horizontal corallites with very oblique calices, with lower wall produced beyond the upper (1). *Sil.*, Eu.-N.Am.——Fig. 352,*1*. **P. fougti* (M.Edw.-H.), U.Sil., Gotl.; weathered surface, ×1 (68).

Coenites Eichwald, 1829 [**C. juniperinus;* SD Miller, 1897 (*species inquirenda*)] [=*Limaria* Steininger, 1831 (*non* Link, 1807, *nec* Rafinesque, 1815); *Cladopora* Hall, 1851; *?Dictyostroma* Nicholson, 1875 (=*Dictyostoma* Spencer, 1883); *?Milleria* Davis, 1887 (*non* Hartman, 1830, *nec* Herrich-Schaeffer, 1859, *nec* Hering, 1922); *?Vetofistula* Etheridge, 1917]. Foliar, ramose or massive; corallites short, inclined with crescentic calices; walls thickened except proximally; tabulae few, mural pores rare, septa may be represented by 3 processes in the calice (25). *Sil.-Dev.*, Eu.-E.Austral.-N.Am.——Fig. 352, *4*. *C. escharoides* (Steininger), M.Dev. (Couvin.), NW.Eu.; *4a,* surface, ×1; *4b,* long. sec., ×4 (64).

Subfamily MICHELINIINAE Waagen & Wentzel, 1886

[=Beaumontidae Chapman, 1893; Michelinidae Gerth, 1921; Pleurodictyidae Sardeson, 1896; Michelininae Počta, 1902]

Discoid or hemispherical, with large corallites, large mural pores, septal spines or ridges, and with or without tabulae. *Dev.-Perm.*

Pleurodictyum Goldfuss, 1829 [**P. problematicum*] [=*?Procteria* Davis, 1887 (*non* Werner, 1924); *?Dendrozoum* Fuchs, 1915]. Discoid or hemispherical; corallites large, thick-walled, with irregularly distributed tunnel-like mural pores, septal spines, and few or very thin complete tabulae; may grow around a worm tube. *L.Dev.*, cosmop.——Fig. 352,*6a,b*. **P. problematicum*, Ger.; *6a,* mold, ×1 (55); *6b,* calice enlarged (67).——Fig. 352,*6c,d*. *P. michelinoidea* (Davis) (type species of *Procteria*); *6c,* surface, ×1; *6d,* long. sec., ×2 (78).

Antholites Davis, 1887 [**A. speciosus*]. Like *Pleurodictyum* but incrusting, with pores arranged in regular vertical series, with septal ridges rather than spines, and without tabulae (7). *M.Dev.*, N.Am.——Fig. 353,*1*. **A. speciosus*, Hamilton, Ohio; *1a,* top surface, ×1; *1b,* side, ×2 (78).

Michelinia de Koninck, 1841 [*non* Dujardin & Hupé, 1862] [**Calamopora tenuisepta* Phillips, 1836 (=*Michelinia tenuisepta* Kon., 1841); SD M.Edw.-H., 1850] [=*?Conopoterium* Winchell, 1865; *Eumichelinia, Protomichelinia, Michelinopora* Yabe & Hayasaka, 1915]. Like *Pleurodictyum* but with numerous, incomplete, convex tabulae; may be thin-walled. *U.Dev.-Perm.*, cosmop.——Fig. 341,*2,3;* 353,*2a,b*. **M. tenuisepta* (Phillips), L.Carb., Eu.; 341,*2,* side of corallum, ×1 (63); 341,*3,* long. sec., ×1 (63); 353,*2a,b,* top and side views, ×0.7 (63).——Fig. 353,*2c,d*. *M. effusa* (Winchell) (type species of *Conopoterium*), L. Carb., Mich.; *2c,* surface, ×1; *2d,* long. sec., ×2 (82).

Beaumontia M.Edw.-H., 1851 [*non* Eudes-Deslongchamps, 1856, *nec* David, 1928] [**Columnaria laxa* M'Coy, 1849; SD Lang-S.-T., 1940] [=*?Rhizopora* Kon., 1871]. Like *Michelinia,* but corallum phaceloid in part. *L.Carb.*, Eng.——Fig. 353,*5*. **B. laxa* (M'Coy); *5,* side of weathered corallum, ×1 (66).

Subfamily PALAEACINAE Počta, 1902

[*nom. transl.* Hill & Stumm, herein (*ex* Palaeacidae Počta, 1902)] [=Palaeaciden C.F.Roemer, 1883 (invalid vernacular name); =Leptoporidae Miller, 1892 (invalid); Trachypsammidae Gerth, 1921;[1] Cleistoporidae Easton, 1944; Trachypsammiidae,[1] Vaughaniidae Lecompte, 1952]

Discoid or cuneiform; walls and septa perforate and retiform; tabulae thin, few, distant. *L.Dev.-Perm.*

Cleistopora Nicholson, 1888 [**Michelinia geometrica* M.Edw.-H., 1851]. Small, discoid, adherent; corallites with dense walls pierced by mural pores, short, lined by a reticulate development from the perforate septa, and crossed by thin, distant tabulae (76). *L.Dev.*, Fr.——Fig. 353,*3*. **C. geometrica* (M.Edw.-H.), Fr.; *3a,* surface, ×1; *3b,* long. sec., ×4 (76).

Araeopora Nicholson & Etheridge, 1879 [**A. australis*]. Massive, with very slender tall, prismatic corallites, septa and walls cribriform, tabulae few, thin. *?Dev.*, N.Queensl.——Fig. 353,*4*. **A. australis, 4a,b,* transv. and long. secs., ×4 (71).

Squameophyllum Smyth, 1933 [**S. spumans*] [=*Leptopora* Winchell, 1863 (*non* Orb., 1849); *Ethmoplax* Smyth, 1939 (*pro Stratophyllum* Smyth, 1933, *non Stratiphyllum* Scheffen, 1933; *nec* Lang-S.-T., 1940); *?Helioalcyon* Termier,

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[1] Although included by Hill & Stumm in the Tabulata, the Trachypsammiidae are classed as Octocorallia by Bayer and Montanaro-Gallitelli (see p. F182, F190).

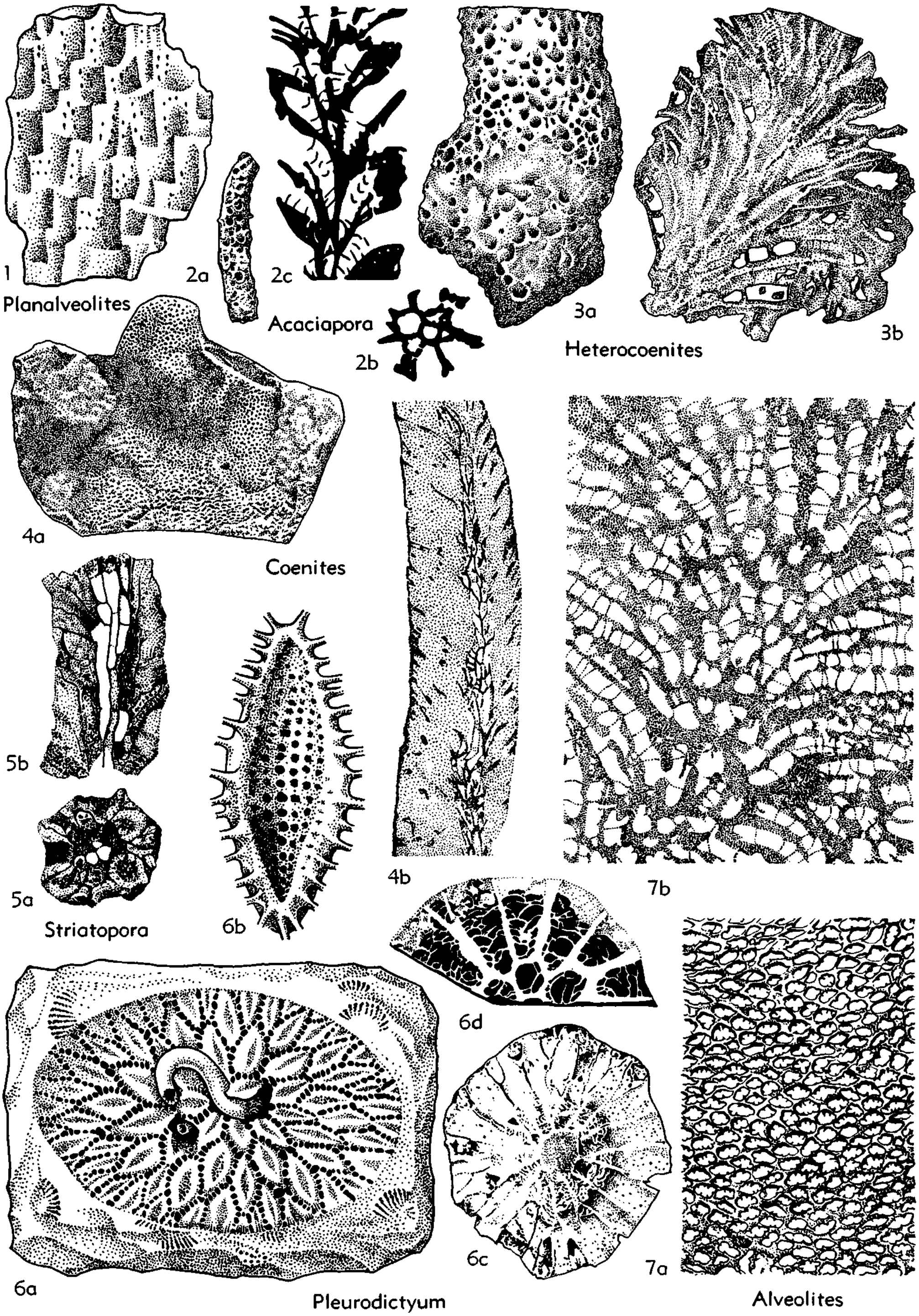

FIG. 352. Favositidae (p. F464-F466).

1945]. Like *Cleistopora* but with epithecal scales and with both walls and septa cribriform; where tabulae develop, the septa are discontinuous from one to the next, being developed only on their upper surfaces. *L.Carb.,* Eu.-N.Am.——FIG. 353, *6a,b.* **S. spumans,* Tournais., Belg.; *6a,* surface, ×1; *6b,* sec., ×4 (76).——FIG. 353,*6c-e. S. tenue* (SMYTH) (type species *Stratophyllum*), L.Carb., Belg.; *6c,d,* upper and lower surfaces, ×1; *6e,* sec., ×4 (76). Other species, FIG. 343,*4*.

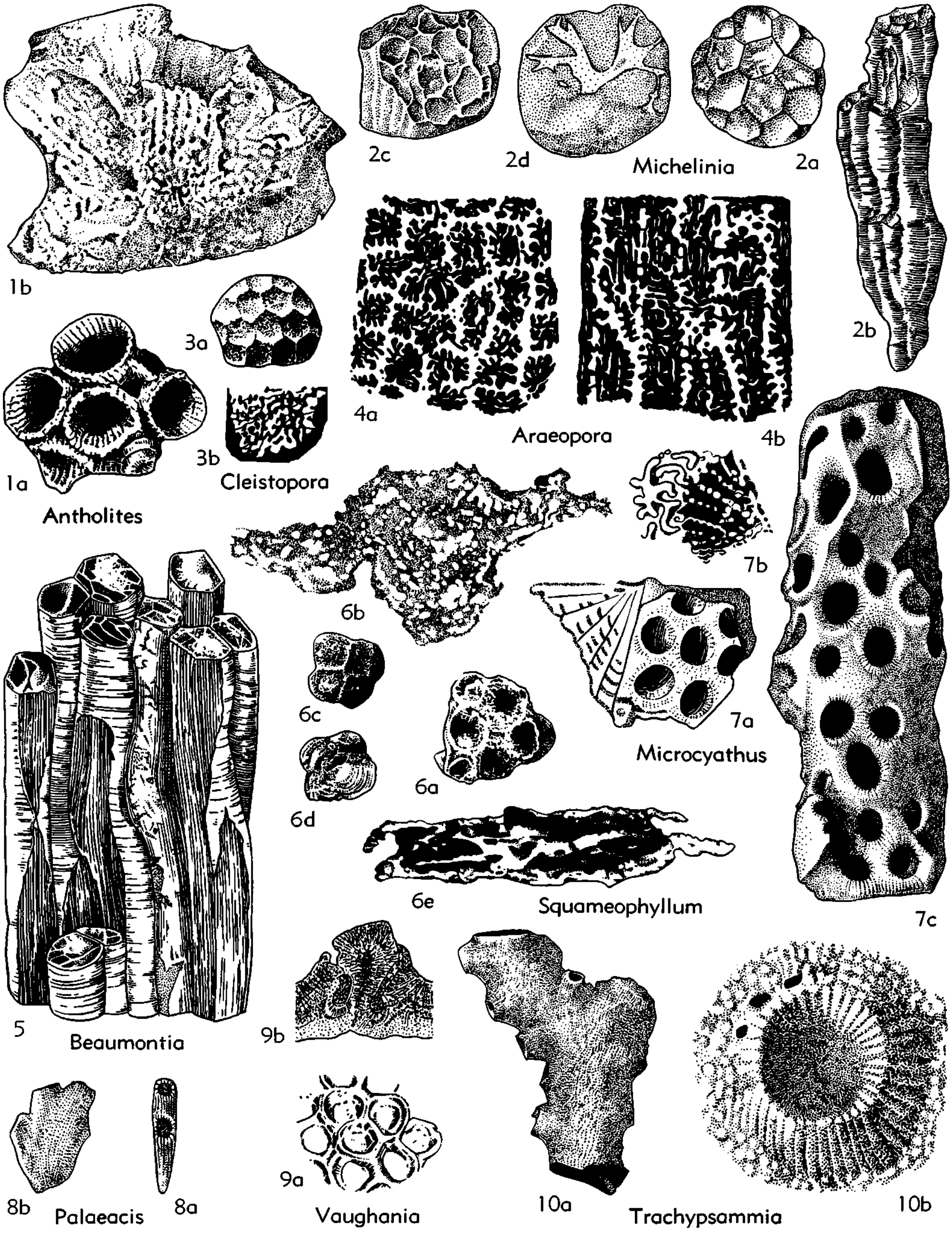

FIG. 353. Favositidae (p. F466-F469).

Vaughania GARWOOD, 1913 [**V. cleistoporoides*]. Discoid, free; atabulate; walls and floor of dense fibrous tissue in which neither septa, septal loculi, nor tabulae can be distinguished; each corallite with a ring canal around the base where the wall joins the floor; ring canals of neighboring corallites connected by mural pores. *L.Carb.*, Eng.——FIG. 353,*9*. **V. cleistoporoides*, NW.Eng.; *9a*, surface, ×1; *9b*, long. sec., ×10 (53).

Microcyathus HINDE, 1896 [*non* DÖDERLEIN, 1913] [**Hydnopora? cyclostoma* PHILLIPS, 1836] [=*?Dictyopora* GERTH, 1921 (*non* STEININGER, 1849, *nec* MACGILL., 1869)]. Adherent, discoid with calices on upper surface; coenenchyme trabeculate, ridged, and irregularly canaliculate; calices lined with nontrabeculate aperforate fibrous tissue (73). *L.Carb.*, Eu.-N.Am.; *?Perm.*, Timor.——FIG. 353,*7a,b*. **M. cyclostoma* (PHILLIPS), L.Carb., Eng.(Yorks.); *7a*, surface, ×1; *7b*, sec., enlarged (73).——FIG. 353,*7c*. *M. incrustans* (GERTH) (type species of *Dictyopora*), Perm., Timor; surface, ×1.5 (54).

Palaeacis HAIME in M.EDW., 1857 [**P. cuneiformis*] [=*Sphenopoterium* MEEK & WORTHEN, 1860]. Wedge-shaped, adherent in young stages; with round calices along narrow sides; flat sides of trabeculate, ridged, and irregularly canaliculate coenenchyme; calices lined with atrabeculate fibrous tissue pierced by perpendicular pores; septa cribriform; atabulate (59). *L.Carb.*, Eu.-N.Am.-Austral.; *Penn.*, N.Am.——FIG. 353,*8*. **P. cuneiformis*, L.Carb., N.Am.; *8a,b*, top and side views, ×1 (59).

Trachypsammia[1] GERTH, 1921 [**T. dendroides*]. Like *Palaeacis* but with tall, somewhat flattened branches, calices on the outer edges (13). *Perm.*, Timor.——FIG. 353,*10*. **T. dendroides*, *10a*, surface, ×1; *10b*, calice, ×4 (54).

?**Yavorskia** FOMICHEV, 1931 [**Y. barsasensis*]. *L. Carb.*, Sib.(Kouznetzk).

?**Oculinella** YAKOVLEV, 1939 [**O. gerthi*]. *L.Perm. (Artinsk.)*, USSR.

Family HALYSITIDAE Milne-Edwards & Haime, 1850

[*nom. transl.* DUNCAN, 1872 (*ex* Halysitinae M.EDW.-H., 1850)] [=Halysitiniens DE FROMENTEL, 1861 (invalid vernacular name); Halisitinae DE KONINCK, 1872]

Phaceloid coralla, composed of cylindrical, oval, or subpolygonal corallites united with one another along 2 or 3 sides producing anastomosing chainlike networks. Walls of corallites imperforate. Microcorallites present between corallites in some forms. Tabulae horizontal or arched, more closely set in microcorallites. Some forms have 12 vertical rows of septal spines in corallites. *Ord.-Sil.*

Halysites FISCHER, 1828 [*nom. conserv.* (ICZN pend.) *pro Alyssites* FISCHER, 1813] [**Tubipora catenularia* LINNÉ, 1767]. Corallites long, cylindrical or oval, united along entire length in manner forming uniserial (rarely biserial or triserial) palisades which interconnect so that transverse sections appear as an anastomosing network of chains. Adjacent normal corallites in a series are separated by a rounded or subpolygonal microcorallite, both types of corallites having imperforate walls. Septa absent or represented by 12 vertical rows of spines; tabulae horizontal or gently arched, more closely set in microcorallites (23, 29). *Ord.-Sil.*, N.Am.-Eu.-Asia-Afr.-Austral.——FIG. 354,*1*. **H. catenularia* (LINNÉ), M.Sil., Gotl., Eng.; *1a*, exterior, ×1; *1b,c*, transv. and long. secs., ×5 (*1a*, 75; *1b,c*, 70). Other species, FIG. 341,*9*.

Catenipora LAMARCK, 1816 [**C. escharoides;* SD THOMAS & SMITH, 1954]. Differs from *Halysites* in lacking microcorallites. *Ord.-Sil.*, cosmop.

Labyrinthites LAMBE, 1906 [**L. chidlensis*]. Massive; corallites slender, subpolygonal, connected along entire length with one or more neighbors, giving rise to meandering series of tubes. *Differs* from *Halysites* in form of normal corallites and absence of microcorallites. Septa apparently absent; tabulae numerous, horizontal (24). *?Ord., Sil.*, N.Am.——FIG. 354,*2*. **L. chidlensis*, ?U.Ord., Arct.N.Am.; transv. sec., ×30 (24).

Arcturia WILSON, 1931 [**A. complexa*]. Like *Labyrinthites* but corallites connect by vertical series of horizontal tubes instead of along entire side (38). *?Ord., Sil.*, N.Am.——FIG. 354,*3*. **A. complexa*, drift, *ex* Ord. or Sil., Can.; *3a*, distal surface, ×4; *3b*, side, ×4 (83).

Family AULOPORIDAE Milne-Edwards & Haime, 1851

[=Pyrgiens DE FROMENTEL, 1961 (invalid vernacular name); Moniloporidae GRABAU, 1899; Cladochonidae HILL, 1942; Chonostegitidae LECOMPTE, 1952]

Coralla compound, erect or repent and incrusting; corallites tubular, cylindrical or trumpet-shaped, increasing by lateral gemmation, in some forms connected by transverse stolons; walls solid, covered by transversely wrinkled epitheca. Septa represented by peripheral ridges or vertical rows of spines, lacking in some forms. Tabulae horizontal or distally concave, closely or widely spaced, broken up into tabellae in some forms, rare or absent in others. *?Sil., Dev.-Perm.*

Subfamily AULOPORINAE Milne-Edwards & Haime, 1851

[*nom. transl.* HILL & STUMM, herein (*ex* Auloporidae M.EDW.-H., 1851)]

Small repent or erect coralla, typically with trumpet-shaped corallites that increase by lateral gemmation producing uniserial, biserial, multiserial, ramose, or web-shaped growth patterns; transverse stolons absent.

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[1] Trachypsammia is classed as an octocoral by MONTANARO-GALLITELLI (see p. F192).

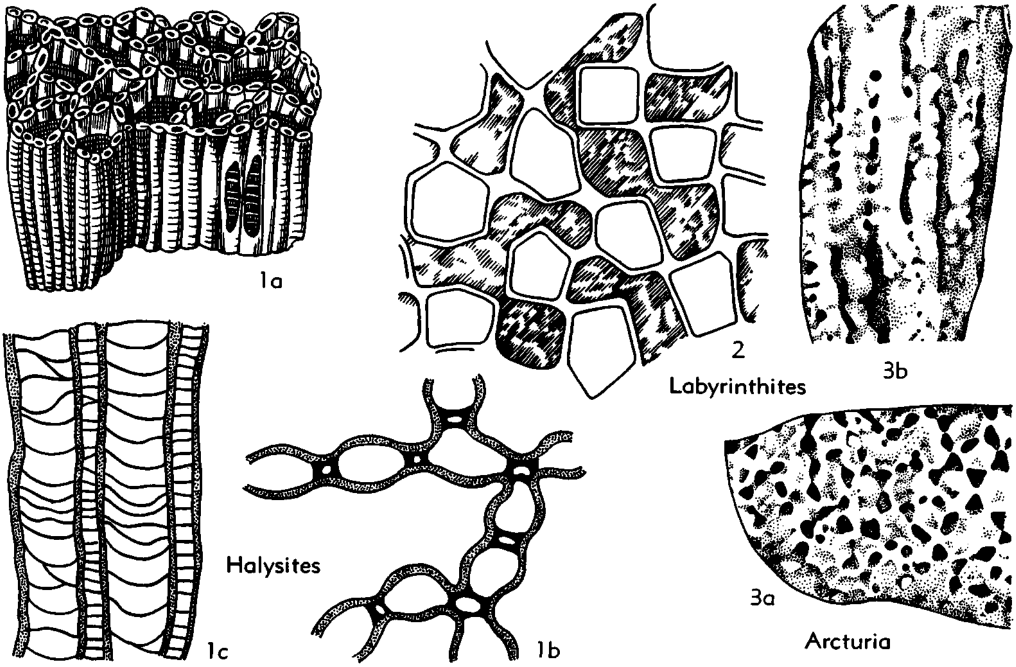

Fig. 354. Halysitidae (p. F469).

Septa represented by peripheral ridges or rows of spinules, absent in some forms. Tabulae widely spaced or lacking. *?Sil.-Dev.-Perm.*

Auloporella Grubbs, 1939 [**A. typa*]. Like *Aulopora* but has secondary inner chambers, producing a double wall; young corallites retain communication with parent chambers. Tabulae and septa apparently lacking (16). *Sil.*, N.Am.——Fig. 355, *6*. **A. typa,* M.Sil., Ill.; *6a,* long. sec., ×2.5; *6b,* side, ×2.5 (56).

Aulozoa Grubbs, 1939 [**A. constricta*]. Corallum attached, composed of tortuous constricted tubes of nearly uniform diameter; 1 to 6 new tubes may be added within a short space of gemmation at any position about parent, all tubes having the same general direction of growth, tending to bend slightly upward near the apertural end; young tubes communicating with parent through a small subcircular opening at their points of origin. Apertures circular; tabulae apparently lacking; septa rudimentary (16). *Sil.*, N.Am.——Fig. 355,*3*. **A. constricta,* M.Sil., Ill.; side, ×3 (56).

Romingeria Nicholson, 1879 [*pro Quenstedtia* Rominger, 1876 (*non* Morris & Lycett, 1854)] [**Aulopora umbellifera* Billings, 1859]. Resembling *Aulopora* but only attached basally; corallites cylindrical, annulated, multiplying by lateral gemmation, and typically producing new tubes in umbellate whorls or verticels at short intervals. Tabulae complete, remote, apparently not distinctly infundibuliform; septa represented by vertical rows of spinules (23, 29, 31). *Sil.-Dev.,* N. Am.——Fig. 341,*8; 355,12*. **A. umbellifera* (Bill.), M.Dev., Ont.; 341,*8,* side, ×1 (46); 355, *12a,b,* proximal and side views, ×1 (46).

Bainbridgia Ball & Grove, 1940 [**B. typicalis*]. Corallum flattened cylindrical; corallites short, uniformly spaced, rising from opposite sides in regular alternating succession. Faint septal ridges in some corallites; tabulae absent (2). *Sil.,* N.Am. ——Fig. 355,*11*. **B. typicalis,* M.Sil., Mo.; *11a,* side, ×6; *11b,* long. sec., ×6 (44).

Diorychopora Davis, 1887 [**D. tenuis*]. Similar to *Aulopora* except with much smaller corallites arranged in biserial pattern. *Sil.,* N.Am.——Fig. 356, *5*. **D. tenuis; 5a,* side, ×1; *5b,* long. sec., ×1 (78n).

Aulocaulis Fenton & Fenton, 1937 [**Aulopora expansa* Fenton-F., 1924]. Growth prostrate as in *Aulopora;* corallites thin-walled, smooth or indistinctly wrinkled, narrowly tubular from base to calice, then expanding abruptly to form circular, vertically directed calices with diameters 1.5 to 4 times that of tubular portions. Tabulae few or absent; septal ridges in calices. An indistinct dorsal ridge on most or all corallites of some species (10). *Dev.,* N.Am.——Fig. 355,*2*. **A. expansa,* U.Dev., Iowa; ×1 (50).

Aulocystis SCHLÜTER, 1885 [**A. cornigera*] [=*Drymopora* DAVIS, 1887; *Ceratopora* GRABAU, 1899]. Like *Aulopora* in external form, increasing by lateral gemmation, erect or prostrate, rarely attached above the base; corallites subcylindrical to trumpet-shaped. Septa represented by ridges or rows of spinous trabeculae projecting from inner walls. Calices deep, funnel-shaped, thin-walled, continued downwards in a narrowing tube, formed by thickening of walls through addition internally of coarse, steeply inclined cysts (7, 14, 33). *Dev.*, N.Am.-Eu.-Asia-Austral.——FIG. 355,*5*. **A. cornigera*, M.Dev., Ger.; *5a*, typical corallum, ×1; *5b*, distal view of weathered corallite, ×3; *5c*, long. sec. showing cysts, ×3 (74).

Chonostegites M.EDW.-H., 1851 [**C. clappi*]

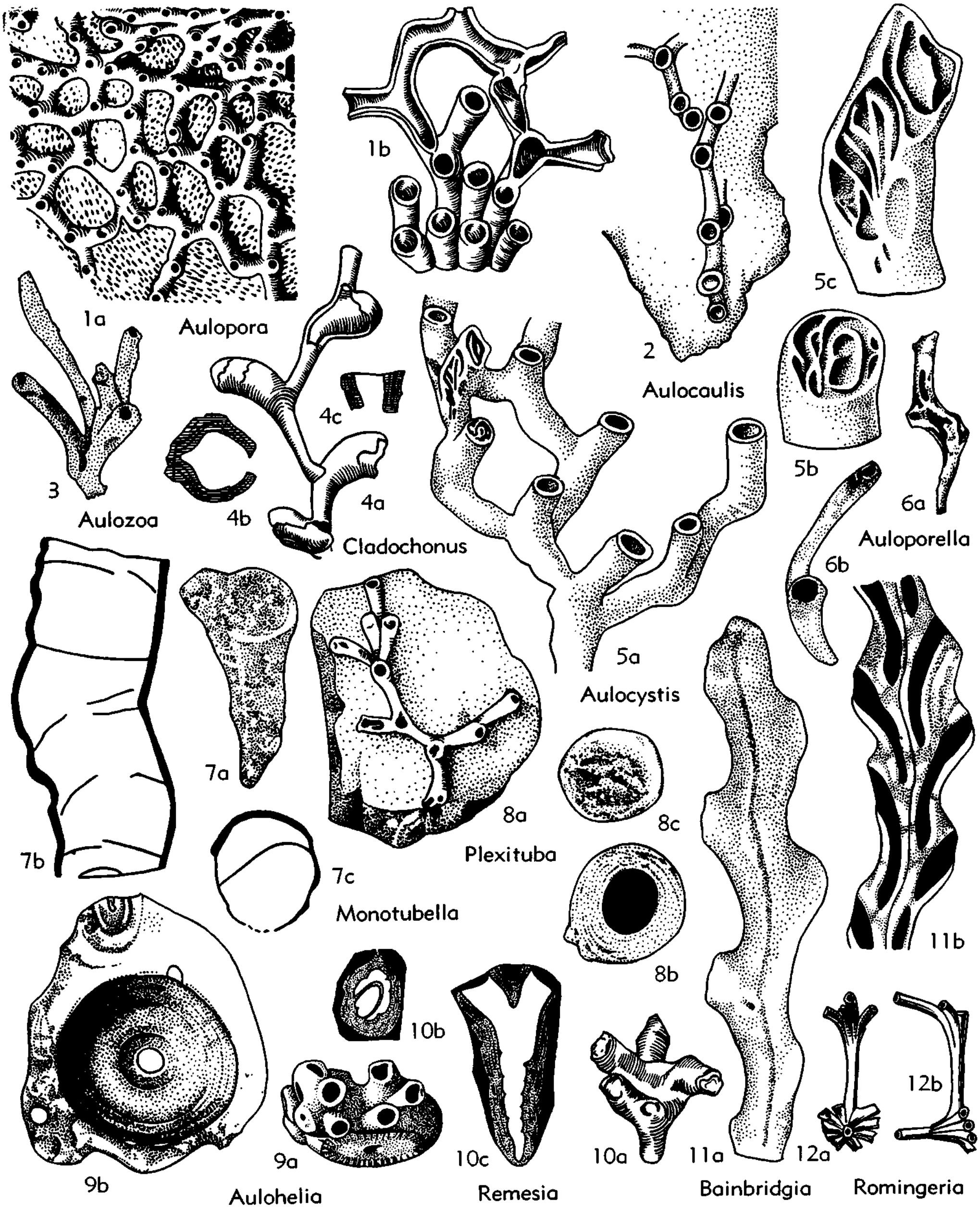

FIG. 355. Auloporidae (p. F470-F472).

[=*Haimophyllum* Billings, 1859]. Coralla fasciculate, with cylindrical corallites connected at regular intervals by disc-shaped expansions. Septa represented by peripheral ridges or spines; tabulae numerous, closely set, broken up into tabellae in some (5, 9). *Dev.*, N.Am.——Fig. 340,*4;* 356,*3*. **C. clappi* M.Dev. (drift), Ohio; 340,*4*, side, ×1; 356,*3a*, side, ×1; 356,*3b*, distal surf., ×1; 356,*3c*, long. sec., ×2 (50).

Remesia Kettner, 1937 [**R. tubulosa*]. Tubular subcylindrical corallites budding irregularly to form a dendritic colony; walls thick, composed of concentric layers of sclerenchyme, with rudimentary septal spines on inner surface. Calices circular, not enlarged. Tabulae very rare, or absent (21). *Dev.*, Eu.——Fig. 355,*10*. **R. tubulosa*, M.Dev., Czech.; *10a*, side, ×1; *10b,c*, transv. and long. secs., ×3 (61).

Aulopora Goldfuss, 1829 [**A. serpens* (*non Tubipora serpens* Linné, 1758, =*Aulopora repens* M.Edw.-H., 1851); SD M.Edw.-H., 1850]. Repent network of trumpet-shaped corallites with circular, obliquely set calices; shape of coralla ranging from a loose, subhexagonal network to biserial or multiserial rows of laterally contiguous corallites. Small septal spines or faint septal ridges in some species; tabulae widely spaced, horizontal, arched or inclined, rudimentary or absent (10, 29). *Dev.*, N.Am.-Eu.-Asia-Austral.-Afr.——Fig. 340,*2;* 355,*1*. **A. serpens*, M.Dev.; 340,*2*, corallum, ×1 (55); 355,*1a*, Ger.; corallum incrusting on *Alveolites*, ×1; *1b*, part enlarged (55).

Plexituba Stainbrook, 1946 [**P. contexta*]. Like *Aulopora* but with greatly thickened walls composed of fine, concentric lamellae and having internal cysts similar to those of *Aulocystis*. Septal ridges or spines and tabulae absent (34). *Dev.*, N.Am.——Fig. 355,*8*. **P. contexta*, U.Dev., Iowa; *8a*, side, ×1; *8b,c*, transv. secs. showing wall lamellae and edges of cysts, ×5 (77).

Cladochonus M'Coy, 1847 [**C. tenuicollis;* SD M.Edw.-H., 1850] [=*Pyrgia* M.Edw.-H., 1851; *Monilopora* Nicholson & Etheridge, 1879]. Proximal corallites in reptant ring from which free branches arise; individual corallites trumpet- or pipe-shaped, in contact only at points of origin, each giving rise to another by lateral increase through wall of the expanded calice; each with a thick peripheral stereozone of laminar or reticulate sclerenchyme. Septal spines and tabulae lacking in the narrow lumen, but septal ridges may appear in the calices (19). *Dev.-Perm.*, N.Am.-Eu. - Asia - E.Indies - Austral.——Fig. 355,*4*. **C. tenuicollis*, L.Carb., N.S.W.; *4a*, side, ×1; *4b,c*, transv. and long. secs., ×2 (58). Other species, Fig. 341,*6*.

Monotubella Yakovlev, 1939 [**M. permiensis;* SD herein]. Small simple coralla or rarely with one lateral bud; cylindrical or trumpet-shaped, erect, attached by basal extremity. Calices bell-shaped. Interiors with widely spaced, horizontal tabulae; traces of rudimentary septa in some (40). *Perm.*, Asia.——Fig. 355,*7*. **M. permiensis*, L.Perm., USSR; *7a*, side, ×2.5; *7b,c*, transv. and long. secs., much enlarged (85).

Aulohelia Gerth, 1921 [**A. irregularis;* SD Lang-S.-T., 1940]. Typically incrusting crinoid stems. Calices tubular, with thin septal ridges. Interiors almost completely filled with sclerenchyme, leaving narrow axial canals connecting adjacent corallites. Tabulae apparently absent (13). *Perm.*, Timor.——Fig. 355,*9*. **A. irregularis; 9a*, corallum attached to crinoid columnal, ×1; *9b*, sec. showing parts of axial canals, ×2 (54).

Pseudoromingeria Yabe & Sugiyama, 1941 [**P. kotoi*]. Coralla fasciculate, composed of many subcylindrical, irregularly twisted corallites multiplying by lateral gemmation. Septa represented by vertical rows of short, blunt spines; tabulae distally concave, crowded in some corallites, widely spaced in others (39). *Perm.*, China.——Fig. 356, *1*. **P. kotoi; 1a*, sec. showing fasciculate growth, ×1; *1b,c*, transv. and long. secs., ×5 (84).

Subfamily SYRINGOPORINAE Nicholson, 1879

[=Syringoporiens, Thecostegitiniens de Fromentel, 1861 (invalid vernacular names); Syringolitinae Waagen & Wentzel, 1886 (=Syringolitidae, *nom. transl.* Lecompte, 1952)]

Large, erect dendroid or fasciculate coralla composed of cylindrical corallites connected by transverse stolons. Septa represented by peripheral ridges or vertical rows of spines, lacking in some forms. Tabulae typically closely set, numerous, horizontal, infundibuliform, or broken up into tabellae. *Sil.-Perm.*

Syringopora Goldfuss, 1826 [**S. ramulosa;* SD M.Edw.-H., 1850] [=*Harmodites* Fischer, 1828; ?*Kazania* Stuckenberg, 1895; *Kueichowpora* Chi, 1933]. Closely or loosely set cylindrical corallites connected in most species by hollow, transverse stolons. Septa lacking or represented by 12 vertical rows of small spinules; tabulae closely set, deeply depressed axially, coalesced in some species to form a continuous axial tube (6, 29). *Sil.-Penn.*, N.Am.-Eu.-Asia-Austral.-Afr.——Fig. 341,*7;* 356, *2*. **S. ramulosa*, L.Carb., Eng.; 341,*7*, side of corallum, ×1 (68); 356,*2a*, side, ×1; 356,*2b*, distal surf., ×4; 356,*2c*, long. sec., ×4 (68). Other species, Fig. 341,*1*.

Reuschia Kiär, 1930 [**R. aperta*]. Phaceloid colonies composed of small, thick-walled cylindrical corallites. Walls indented on inner side to form 10 to 12 short, thick septal ridges; tabulae apparently absent (22). *U.Ord.*, Eu.——Fig. 357,*5*. **R. aperta* Norway; *5a,b*, transv. and long. secs. showing thick walls with septal ridges and tubular axial area (lectotype), ×2 (63).

Eofletcheria Bassler, 1950 [**Columnaria incerta*

Billings, 1859]. Small, phaceloid, thick-walled colonies with poorly developed, intermittently spaced, complete or incomplete tabulae and no septa. Corallites connected by short, horizontal, syringoporoid tubules (4). _M.Ord._, N.Am.——Fig. 357,_2_. *_E. incerta_ (Bill.), Chazy., Que.; _2a,b_, long. and transv. secs. showing tubula, tabulae and thick walls, ×10 (72).

Syringolites Hinde, 1879 [*_S. huronensis_]. _Sil._, Mich.

Cannapora Hall, 1852 [*_C. junciformis_]. Like _Syringopora_ but with closely set corallites connected by stolons at distinct intervals. Interiors of corallites with 12 vertical rows of long septal spines; tabulae horizontal, closely or widely spaced (23, 31). _Sil._, N.Am.——Fig. 356,_6_. *_C. junciformis_, M.Sil., N.Y.; _6a_, side, ×1; _6b_, distal surf., ×2 (56).

Thecostegites M.Edw.-H., 1849 [*_Harmodites bouchardi_ Michelin, 1846]. Differs from _Syringo-_

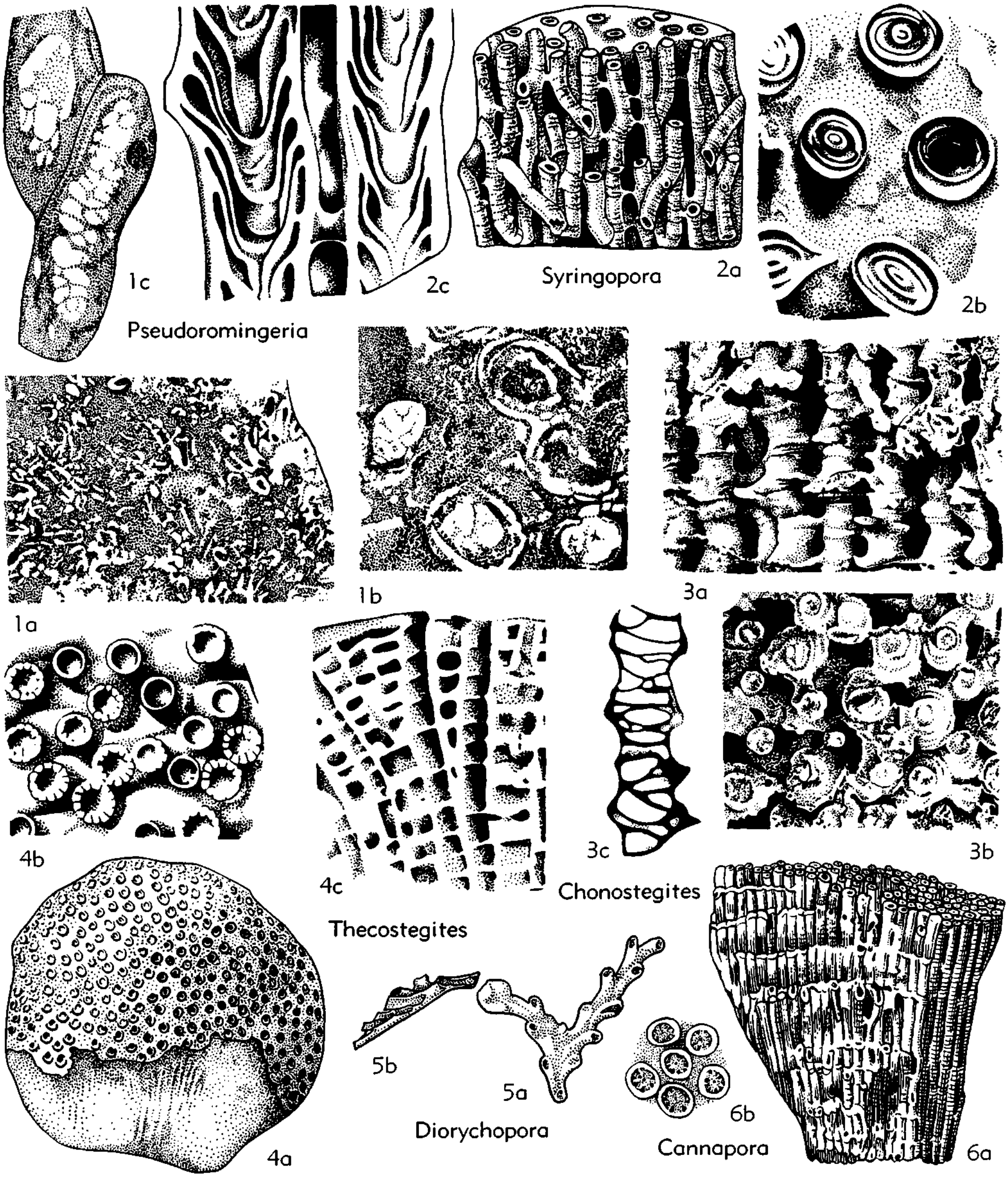

Fig. 356. Auloporidae (p. F470-F474).

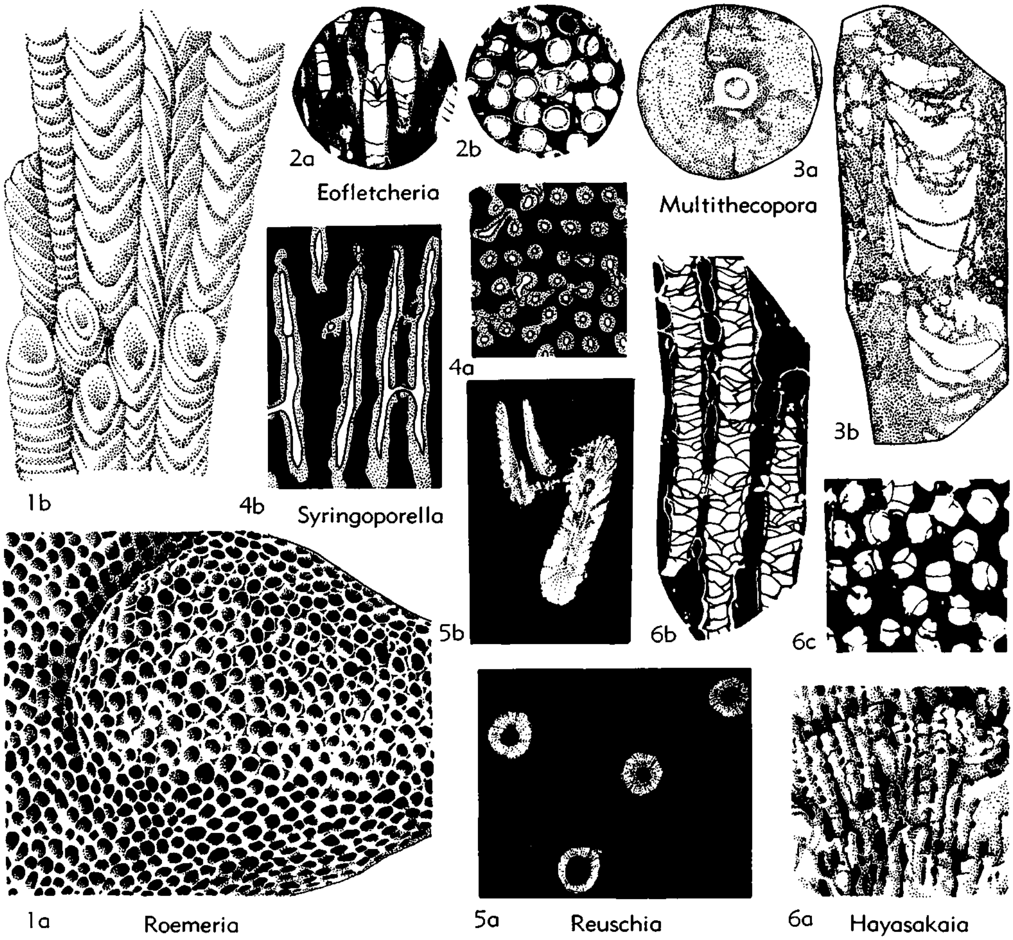

FIG. 357. Auloporidae (p. F472-F474).

pora in having vertical septal ridges and closely set horizontal tabulae (28). *Dev.*, N.Am.-Eu.——FIG. 356,*4*. **T. bouchardi* (MICH.), M.Dev., Fr.; *4a*, corallum, ×1; *4b*, distal surf., ×3; *4c*, long. sec., ×3 (68).

Roemeria M.EDW.-H., 1851 [**Calamopora infundibulifera* GOLDFUSS, 1829]. Subcerioid to subphaceloid, with peripheral septal spines and complete, funnel-shaped tabulae. Neighboring corallites connected by short syringoporoid tubules, or by pores where corallites adjoin (1). *Dev.*, Eu.-Austral.——FIG. 357,*1*. *R. infundibulifera* (GOLDF.), M.Dev., Ger. (Eifel); *1a*, distal view (holotype), ×1; *1b*, long. sec. showing tabulae, ×3 (55).

Syringoporella KETTNER, 1937 [**Syringopora moravica* ROEMER, 1883]. Externally like *Syringopora* but with much smaller, very thick-walled corallites; connecting stolons short, commonly barrel-shaped, constricted at junctions with corallites. No septal spines or ridges; tabulae horizontal, very remote, lacking in some corallites (21). *Dev.*, Eu.——FIG. 357,*4*. **S. moravica* (ROEMER), M.Dev., Czech.; *4a,b*, transv. and long. secs., ×3 (61).

Multithecopora YOH, 1927 [**M. penchiensis*]. Like *Syringopora* but corallites with greatly thickened walls, composed of concentric layers of sclerenchyme, occupying four-fifths of the interior. Septa lacking; tabulae thin, closely set, distally concave (41). *U.Carb.*, China.——FIG. 357,*3*. **M. penchiensis*, *3a,b*, transv. and long. secs., ×15 (86).

Hayasakaia LANG-S.-T., 1940 [*pro Tetrapora* YABE & HAYASAKA, 1915 (*non* QUENST., 1857)] [**Tetrapora elegantula* YABE-H., 1915]. Differs from *Syringopora* in having quadrate corallites connected by closely set short stolons arranged in vertical rows on flattened sides. Tabulae close-spaced, horizontal or convex; no septal spines (20, 41). *Perm.*, China.——FIG. 357,*6*. **H. elegantula* (YABE-H.); *6a*, side, ×1; *6b,c*, long. and transv. secs., ×2 (87).

Order TABULATA Incertae Sedis

Asteriophyllum PORFIRIEV, 1937 [**A. aenigmaticum*]. *Dev.*, E.Urals (not seen).

Čelechopora PRADÁČOVÁ, 1938 [**C. robustus*]. *Dev.* Czech.

Cylindripora EICHWALD, 1829 [*non* YABE & HAYASAKA, 1915] [**C. serpuloides*] [=*Cylindropora* LANG-S.-T., 1940]. Drift, *ex Sil.*, Est. (possibly bryozoan).

Dendropora MICHELIN, 1846 [**D. explicita*]. *?Dev.*, Fr. (possibly bryozoan).

Dictyopora STEININGER, 1849 [*non* MACGILLIVRAY, 1869; *nec* GERTH, 1921] [**D. reticulata*]. *Dev.*, Ger. (possibly bryozoan).

Donetzites DAMPEL, 1940 [**D. milliporides*]. *Carb.*, Donetz (not seen).

Latepora RAFINESQUE, 1819 [**L. alba*]. *Dev.*, N. Am. May be conspecific with *Michelinia convexa* ORB., 1850 (types missing).

Linipora TROOST, 1840 [**L. rotunda*] [=*Linopora* LANG-S.-T., 1940 *(nom. van)*]. *Sil.*(Brownsport), Tenn. (not recognizable).

Protopora GREENE, 1904 [**(Romingeria cystoides)* GRABAU in GREENE, 1901]. *L.Carb.*, N.Am.

Salpingium SMYTH, 1928 [**S. palinorsum*]. *L.Carb.*, Ire.

Tetraporella SOKOLOV, 1947 [**Labyrinthites? monticuliporoides* TROEDSSON, 1928]. *U.Ord.*, Greenl.

Troedssonites SOKOLOV, 1947 [**Syringopora conspirata* TROEDSSON, 1928]. *U.Ord.*, Greenl.

Vaughanites PAUL, 1937 [*non* WOODRING, 1928] [**Syringopora favositoides* VAUGHAN, 1915]. *L. Carb.*, Eu.

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ZOANTHARIA INCERTAE SEDIS

By Dorothy Hill

ZOANTHARIA INCERTAE SEDIS

The following generic names which have been applied to Zoantharia cannot be assigned satisfactorily to any division of the subclass, and some of them may not be zoantharians or Anthozoa.

Cylicopora Steininger, 1849 [**C. fasciculata*]. *M. Dev.*, Ger. (not seen).

Discophyllum Hall, 1847 [**D. peltatum*]. *Ord.*, N.Y. (probably plant).

Favositella Mansuy, 1912 [*non* Eth.-F., 1884] [**F. columnaris*]. *U.Dev.*, Yunnan (may not be coral).

Kazania Stuckenberg, 1895 [**K. elegantissima;* SD Lang-S.-T., 1940]. *U.Carb.* Urals (may not be coral).

Khmeria Mansuy, 1914 [**K. problematica*]. *Perm.*. Indo-China (an operculate coelenterate, probably not a rugose coral).

Lamellopora Owen, 1844 [**L. infundibularia*] [=*Lamellipora* Lang-S.-T., 1940]. *M.Sil.*, N.Am. (may be stromatoporoid).

Mezenia Stuckenberg, 1895 [*non* Simon, 1897] [**M. rozeni*]. *Carb.*, Timan (probably not coral).

Mortieria de Koninck, 1841 [**M. vertebralis*]. *L. Carb.*, Eu. (possibly sponge).

Patinula Eichwald, 1829 [**P. lithuana*] (may not be coral).

Siphonaxis Dybowski, 1873 [**S. tubiferus*]. Drift (undeterminable).

Spongarium Lonsdale, 1839 [*non* M'Coy, 1851] [**S. edwardsii*]. *Sil.*, Eng. (may not be coral).

Sycidium Sandberger, 1849 [*non* Haeckel, 1870] [**S. reticulatum*]. *M.Dev.*, Ger. (probably plant).

CTENOPHORA

By John W. Wells and Dorothy Hill

The Ctenophora are an assemblage of marine coelenterates which lack nematocysts and in various ways differ sufficiently from other assemblages to warrant classification as an independent subphylum. Fossil ctenophores are very doubtful or lacking.

Subphylum CTENOPHORA Eschscholtz, 1829

[=Ciliobranches, Ciliogrades de Blainville, 1830; Acalephes cténophores Milne-Edwards & Haime, 1850; Ctenarea Delage & Hérouard, 1901; Ctenophoraria Poche, 1911; Acnidaria Pax, 1924]

Ctenophores ("comb-jellies") are transparent, pelagic, mobile, marine, coelenterated animals, mostly globular in shape (Fig. 358). They are characterized by body layers of endoderm, mesogloea, and ectoderm, possession of biradial symmetry, a gastrovascular cavity and stomodaeum, and position of the gonads. From the Cnidaria they are differentiated by the presence of colloblasts (lasso cells) instead of nematocysts, by locomotion almost wholly by means of ciliary movement concentrated in 8 longitudinal bands, enormous thickening of the mesogloea, presence of a statocyst or sensitive organ at the aboral end, and solid tentacles with axial mesogloea. *Rec.*

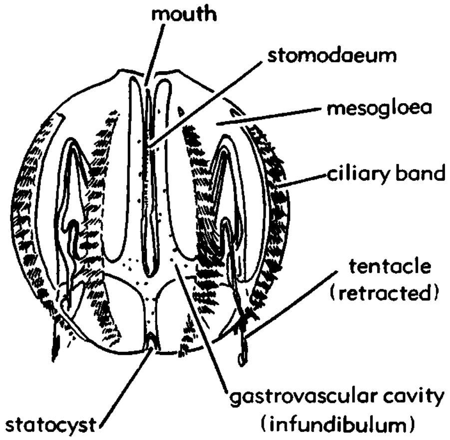

Fig. 358. Morphology of Ctenophora illustrated by *Pleurobrachia rhododactyla,* Rec., Atl., ×1 (Agassiz).

No fossil ctenophores are known certainly, their preservation being most improbable, although 2 genera have been suggested as belonging here:

Rangea Gürich, 1930 [**R. schneiderhohni*]. Said to resemble *Beroë. L.Paleoz. (Otavi fm., Kuibis quartzite),* S.Afr.

Xenusion Pompeckj, 1927 [**X. auerswaldae*]. *Cam.* (drift), Ger.

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