MESOZOIC AND CENOZOIC HEXACTINELLID SPONGES: LYSSACINOSA AND HEXACTINOSA

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Subclass HEXASTEROPHORA Schulze, 1887

[*nom. transl.* REID, 1958a, p. xliv, *ex* tribe Hexasterophora SCHULZE, 1887b, p. 36]

Hexactinellida with microscleres that include hexasters but not spicules with umbellate ray terminations (such as paraclavules, hemidiscs, amphidiscs, staurodiscs, or hexadiscs); when microscleres are absent, with megascleric features restricted to hexaster-bearing sponges among modern forms; parenchymal skeleton of lyssacine or dictyonine types. Parenchymal megascleres of lyssacines range from hexactine to rhabdodiactine, and all loose, or have secondary fusion in parts ranging from only basal part to entire body; dermalia *s.s.* (autodermalia) supplemented by hypodermalia in some lyssacines, but not in other lyssacines or in dictyonines; lyssacines directly attached with a rigid, basidictyonal skeleton or by prostalia (basalia), which are sometimes pentactines and rhabdodiactines; dictyonines fixed by encrusting base or imbedded root processes, with a rigid, basal skeleton, formed by accretion of dictyonalia or by outgrowth of siliceous filaments from the parenchymal framework; hexasters in all modern genera but one (*Cyrtaulon* SCHULZE), additional sceptrule and uncinate microscleres in one dictyonine order (Hexactinosa). *Ordovician–Holocene.*

This taxon was proposed as tribe Hexasterophora of suborder Lyssacina ZITTEL (SCHULZE, 1887b) but was later expanded and raised in rank to include all hexaster-bearing sponges (SCHULZE, 1899).

The three included orders (Lyssacinosa, Hexactinosa, Lychniscosa) are considered here to be of common origin because of their possession of hexasters. Those occurring in lyssacines (Lyssacinosa) and dictyonines (Hexactinosa, Lychniscosa) have essentially the same range of types except in special forms. How the orders are related is unknown, and none is at first represented by especially primitive examples. Some lyssacines resemble Paleozoic Dictyospongiidae, but so-called hexasters of some dictyospongiids are not typical examples of such microscleres and can be compared with acanthophore spicules of some Amphidiscophora. The dictyospongiid paraclavule is also a possible prototype of amphidiscs if these developed via hemidiscs. There is also a fairly marked resemblance between the simplest types of dictyonine skeletons (in e.g., *Farrea* BOWERBANK, *Calyptrella* SCHRAMMEN) and the netted patterns seen in some older forms, for example, *Microstaura* FINKS; but none of these has features that anticipate the production of dictyonal strands of lychniscs.

Most fossils referred to this subclass have been identified as Hexasterophora by possession of dictyonine skeletons, which are not known in Amphidiscophora. Fossils may be considered as lyssacine Hexasterophora (Lyssacinosa) if they have parenchymal frameworks similar to those seen in various modern forms, or either paratropal megascleres or octasters, both confined to the family Rossellidae.

Order LYSSACINOSA Zittel, 1877

[Lyssacinosa ZITTEL, 1877b, p. 22; *emend.*, SCHRAMMEN, 1924a, p. 18; IJIMA, 1927, p. 319]

Hexasterophorans with parenchymal skeleton of megascleres that are typically separate but sometimes secondarily united; spicules range from hexactines to rhabdodiactines,

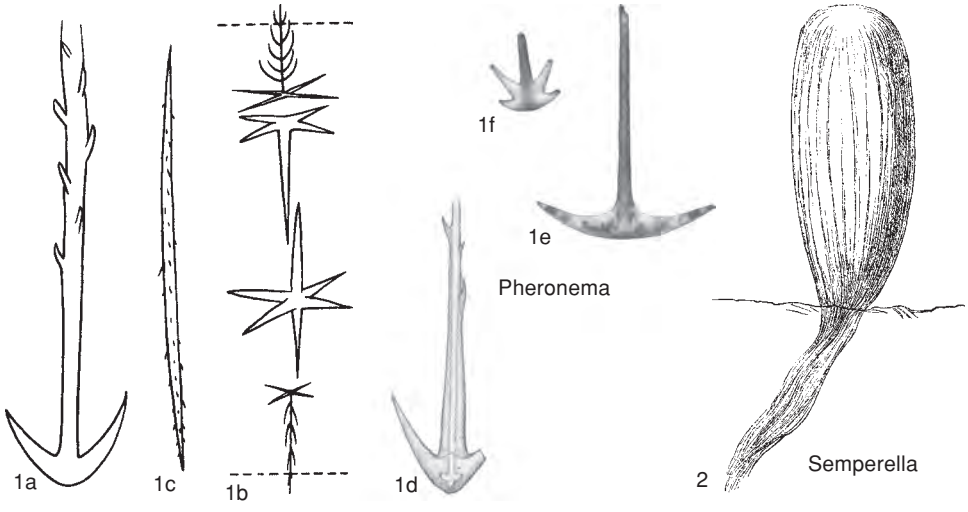


FIG. 296. Pheronematidae (p. 450).

always including latter and sometimes wholly of those spicules. *Ordovician–Holocene.*

Family PHERONEMATIDAE Gray, 1872

[*nom. correct.* IJIMA, 1927, p. 5, *pro* Pheronemadae GRAY, 1872a, p. 450]

Characteristic parenchymal megascleres are hexactines or pentactines, not accompanied by rhabdodiactines except as small intermedia; often with uncinates, prostal sceptres, or both; basalia anchorate monactines with two opposite teeth only, and dispersed or in groups but not forming an anchor rope; no acanthophores. [Range based on occurrences of isolated basalia, presumed not to be of Dictyospongiidae, which are not known after Permian.] *?Upper Jurassic, Cretaceous–Holocene.*

Pheronema LEIDY, 1868, p. 10 [**P. annae;* M]. Thick-walled cup or bowl, paragaster deep or shallow; basalia long, threadlike, usually in tuft. [Questionable Jurassic and Tertiary records are based on anchorate monactines, which need not be of this genus.] *?Upper Jurassic, Paleogene (?middle Eocene), Holocene:* New Zealand, *?Upper Jurassic, ?middle Eocene;* cosmopolitan, *Holocene.*——FIG. 296,*1a–c.***P. annae,* Holocene, West Indies; *a,* proximal end of root tuft spicule, ×120; *b,* spicules of body wall placed as in living sponge, outer surface above and gastral surface below, ×50; *c,* uncinate spicule, ×120 (de Laubenfels, 1955).——FIG. 296,*1d–f. P.* sp.; *d,* anchor spicule ascribed to *Pheronema,* ?middle Eocene, Otago, New Zealand, ×200 (Hinde & Holmes, 1892); *e–f,* basal anchor of pheronematid type, left hand spicule, Weiss Jura, Upper Jurassic, Gerstetten, Germany, ×50 (Schrammen, 1937).

Semperella GRAY, 1868, p. 376 [**Hyalonema schultzei* SEMPER, 1868a, p. 373; OD]. Similar to *Pheronema* but club shaped, not hollow, with oscules in longitudinal grooves on sides. *Cretaceous–Holocene:* cosmopolitan (de Laubenfels, 1955).——FIG. 296,*2.* **S. schultzei* (SEMPER), Holocene, Philippine Islands; side view of tubular sponge with convex lid and long root tuft, skeleton of threadlike, siliceous spicules, scale unknown (Gray, 1868).

Family EUPLECTELLIDAE Gray, 1867

[*nom. correct.* SCHULZE, 1887b, p. 37, *pro* Euplectelliadae GRAY, 1867, p. 527] [=Hertwigiidae TOPSENT, 1892, p. 25; Alcyoncellidae DE LAUBENFELS, 1936, p. 188; Placoplegmatidae DE LAUBENFELS, 1936, p. 187, *partim*]

With hexactinal dermalia and no differentiated hypodermalia or hypogastralia; choanosomal megascleres monactines and diactines; lophophytus or basiphytus; lophophytus basalia typically anisodiactinal rhabdodiactines with a terminal umbel, sometimes varied as monactines; basal dictyonalia present; often (if not always) thin-walled sponges with accessory, parietal oscula; some with sieve plates; parenchymal skeleton loose or fused rigidly for varying distance from base or all rigid; dermalia typically swordlike with proximal ray larger than others; gastralia similar or pentactinal. [These sponges have dermalia and gastralia

of one category only, consisting of hexactines.] *Lower Triassic–Holocene.*

Subfamily EUPLECTELLINAE new subfamily

[Euplectellinae Reid, herein] [type genus, *Euplectella* Owen, 1841, p. 3]

Tubular sponges with terminal sieve plate and with regularly arranged gaps in wall; attached by root tuft; basalia anisodiactinal rhabdodiactines with terminal umbel; shorter of two rays distal or comparable monactines; no basalidictyonalia. *Holocene.*

Euplectella Owen, 1841, p. 3 [**E. aspergillian;* OD]. Thin-walled, tubular or saccular, with terminal sieve plate and numerous parietal oscula; external surface smooth or ridged transversely; principalia mainly hexactines, pentactines, stauractines, with four rays paratangential and grouped to form longitudinal and transverse bundles; other bundles of spicule rays may take diagonal directions; other megasclere types include tauactines, rhabdodiactines, and others; dermalia swordlike hexactines; gastralia subhexactines or pentactines; hexasters, floricomes, graphicones, and oxyhexasters or oxyasters. Parenchymal skeleton loose or rigid in lower part or throughout, including sieve plate. [Supposed Miocene occurrence was recorded by de Laubenfels, 1955, who provided no evident authority for citation.] *Holocene:* cosmopolitan.——Fig. 297,*2. *E. aspergillian,* Philippine Islands, near Zebu; side view showing upper sieve plate, ridged main body, and root tuft, ×0.5 (Schulze, 1887b).

Subfamily TAEGERINAE Schulze, 1887

[Taegerinae Schulze, 1887a, p. 94] [=Corbitellinae Ijima, 1902, p. 30]

Root tuft and basalia absent; attached by encrusting basal mass, with basalidictionalia or by rigid, rootlike processes. [Type genus *?Taegeria* Schulze, 1887b, is probably not separable from *Regadrella* Schmidt, but this does not affect the nomenclature.] *Lower Triassic–Holocene.*

Regadrella Schmidt, 1880, p. 61 [**R. phoenix;* OD] [=*?Taegeria* Schulze, 1887b, p. 41 (type, *T. pulchra,* OD)]. Tubular or saccular, with numerous parietal oscula and a sieve plate; principalia rhabdodiactines interwoven diagonally; accessory, parenchymal megascleres smaller diactines and hexactines; parenchymal skeleton rigid in lower part or throughout; outer surface smooth or with irregular ridging or outgrowths; dermalia swordlike hexasters; gastralia pentactines, or with rudimentary distal ray; hexasters, floricomes, graphicomes, and oxyasters, oxyhexasters and oxystauraster. *Cretaceous (Cenomanian)–Holocene:* Europe, *Cenomanian, Coniacian–Maastrichtian;* southern England, *Cenomanian;* northwestern Germany, *Coniacian–Maastrichtian;* Spain, *Miocene;* cosmopolitan, *Holocene.*——Fig. 298,*1a–d. *R. phoenix,* Holocene, Gulf of Mexico; *a,* side view of upper part of wall and sieve plate, ×1; *b,* swordlike, dermal hexact, ×5; *c,* discohexaster, ×200; *d,* floricome, ×200 (Schulze, 1887a).

Arhoussia du Dresnay, Termier, & Termier, 1978, p. 277 [**A. calyx;* OD]. Goblet-shaped, rigid sponges with radial canals that are often bifurcated and with their exhalant ostia arranged in longitudinal folds in gastral wall; skeletal net of two parts, lower consolidated base with regular, dictyid structure with horizontal, undulating plates formed by rays of hexactines that limit mesh openings; plates separated and united by vertical rays of hexactines; upper part of sponge with large hexactines regularly spaced in skeleton with little coherence, largest spicules near folds of gastral wall, associated with intermediate-sized hexactines forming spicular network similar to that in adult lyssacid sponges; large diactines occur but rarely in wall interior; canals armored by second-order hexactines that may have reduced rays and appear similar to stauractines. [Placement in the family is uncertain.] *Jurassic (Sinemurian):* Morocco.——Fig. 298,*4a–c. *A. calyx,* reef limestone, Jebel bous Arhous Srhir; *a,* transverse section through base with regular, dictyonal skeleton, ×4; *b,* photomicrograph of regular skeletal net, ×20; *c,* photomicrograph of regular, dictyonal, skeletal net, ×60 (du Dresnay, Termier, & Termier, 1978; courtesy of *Geobios*).

Cypellospongia Rigby & Gosney, 1983, p. 790 [**C. fimbriartis;* OD]. Thick walled, goblet shaped, with lower, tubular, somewhat anastomosing, stalklike part; walls pierced by circular, parietal gaps and by at least two additional canal series with full diplorhysis, although with somewhat irregular development; skeleton of hexactine-based spicules solidly fused at contact points and with synapticulae; hexactine-based origin of most spicules obscure due to extensive synapticulae and irregular, noncubic orientation of skeleton; small hexactines in thin dermal layer and hexactine origin of larger, main spicules locally evident where axial canals preserved; microscleres not preserved. *Lower Triassic:* USA (Utah, Nevada).——Fig. 299,*1a–b. *C. fimbriartis,* Scythian, Thaynes Limestone, Spanish Fork Canyon, Utah; *a,* side view of goblet-shaped holotype with common, parietal gaps in dermal layer, BYU 1992, ×0.5; *b,* gastral surface with parietal gaps and irregular, hexactine-based, skeletal structure, BYU 1993, ×10 (Rigby & Gosney, 1983).

Guemeuria du Dresnay, Termier, & Termier, 1978, p. 279 [**G. elegans;* OD]. Conicocylindrical sponges with relatively thin wall around deep spongocoel; walls pierced by numerous radial canals; skeletal structure coherent, formed of regular meshes with spicule rays radial or concentric to wall; details of principal spicules not known, but gastralia or prostalia are parallel monaxons, arranged palisade-like, probably on exterior. *Lower Jurassic:* Morocco.——Fig. 300,*1a–b. *G. elegans,* red

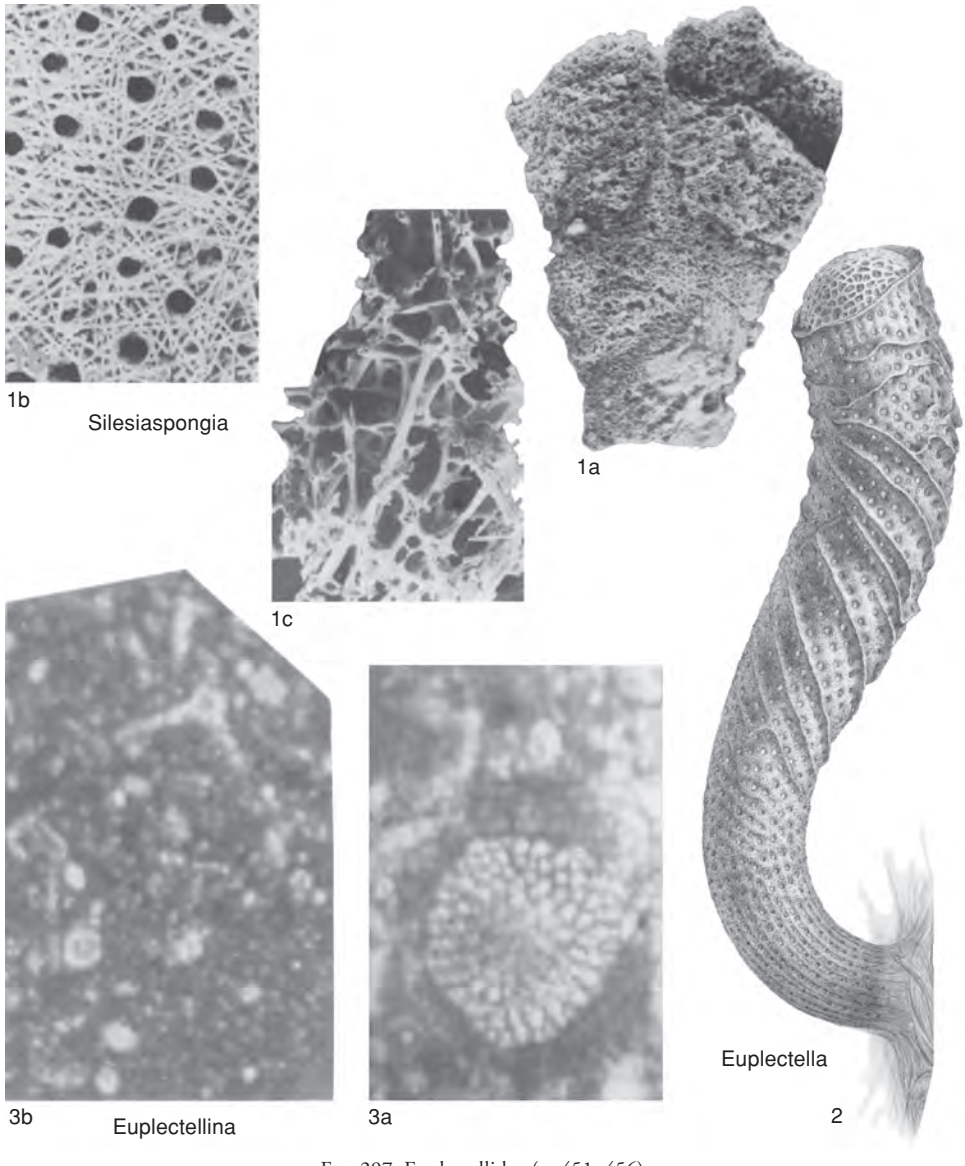


FIG. 297. Euplectellidae (p. 451–456).

ammonitic limestone, Sinemurian, Haut Oued Chouf Guemeur; *a,* segment through fragment showing dark canals and light skeletal net, ×8; *b,* photomicrograph of fragment with coherent, dictyonine net, ×25 (du Dresnay, Termier, & Termier, 1978; courtesy of *Geobios*).

Proeuplectella MORET, 1926b, p. 209 [**P. fragilis* MORET, 1926b, p. 210; M; ?=*Prohexactinella cenomanse* MORET, 1926b, p. 216, obj.] [?=*Prohexactinella* MORET, 1926b, p. 216 (type, *P. cenomanse,* OD)]. Incompletely known; based on fragment with fused reticulation of hexactines and diactines; parietal oscula not recognized, but with pitlike features present on gastral side. [Closest resemblance is to *Regadrella* or to *Prohexactinella.*] *Cretaceous (Cenomanian):* France.——FIG. 298,*3a–e. *P. fragilis,* Coulonges-les-Sablons; *a,* fragment with fused reticulation of hexactines and diactines, ×10; *b–e,* drawing of characteristic spicules including hexactines, spicules with barbs, oxea or diactine, and spicules fused into regular structure, scale not given but approximately ×60 (Moret, 1926b; courtesy of Société Géologique de France).

Purisiphonia BOWERBANK, 1869, p. 342 [**P. clarkei;* OD]. Similar to *Regadrella* but fairly thick walled with parietal perforations in form of radial canals;

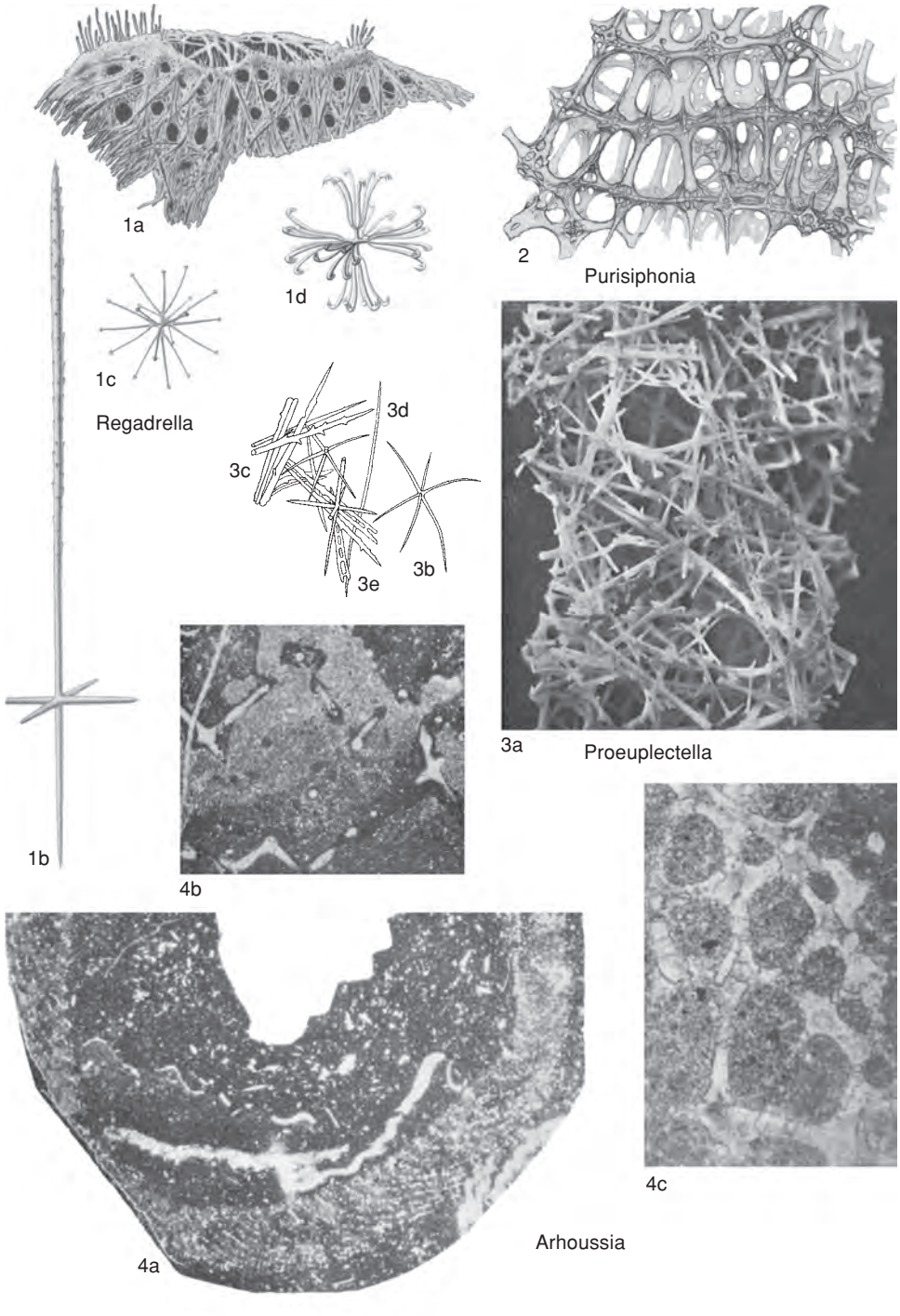


FIG. 298. Euplectellidae (p. 451–455).

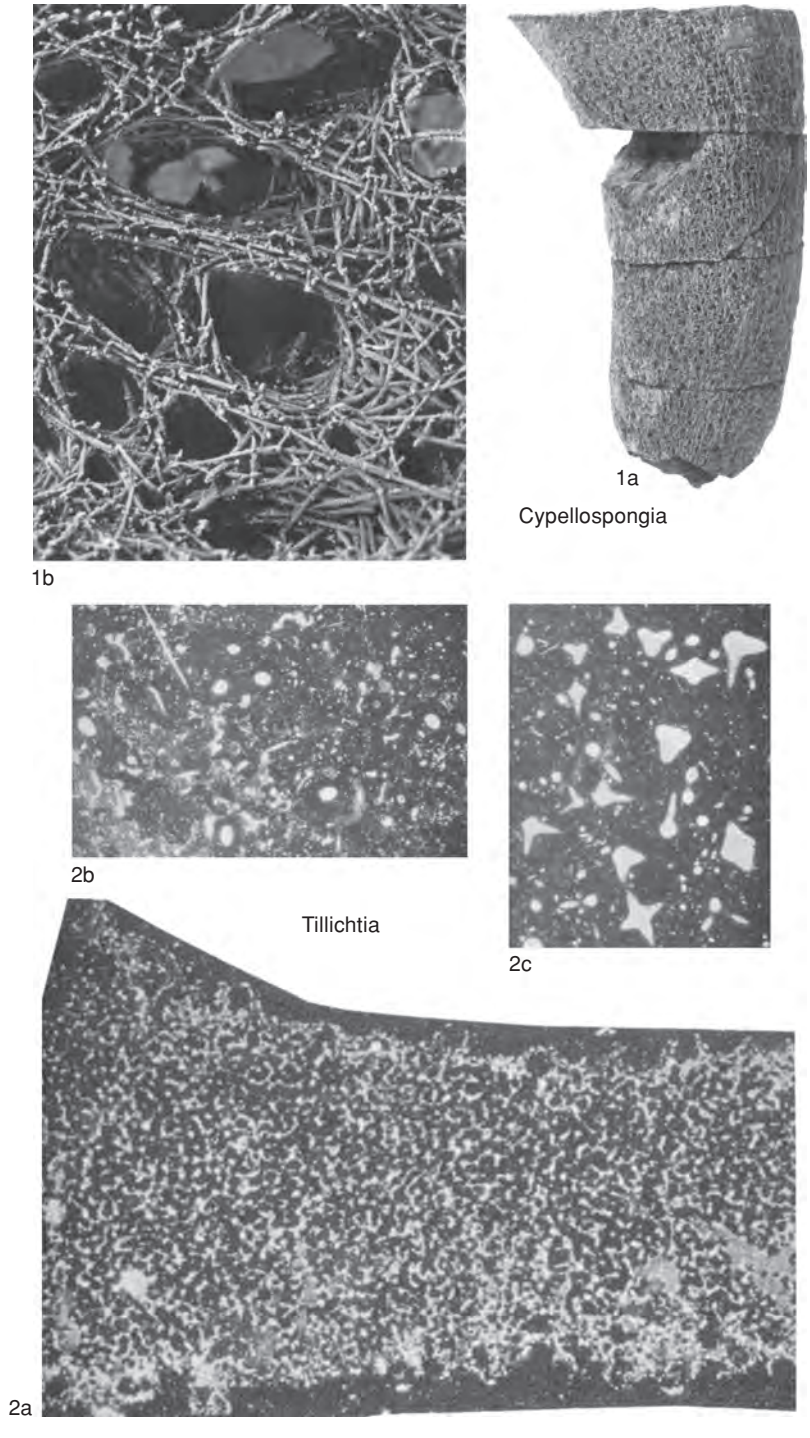


FIG. 299. Euplectellidae (p. 451–456).

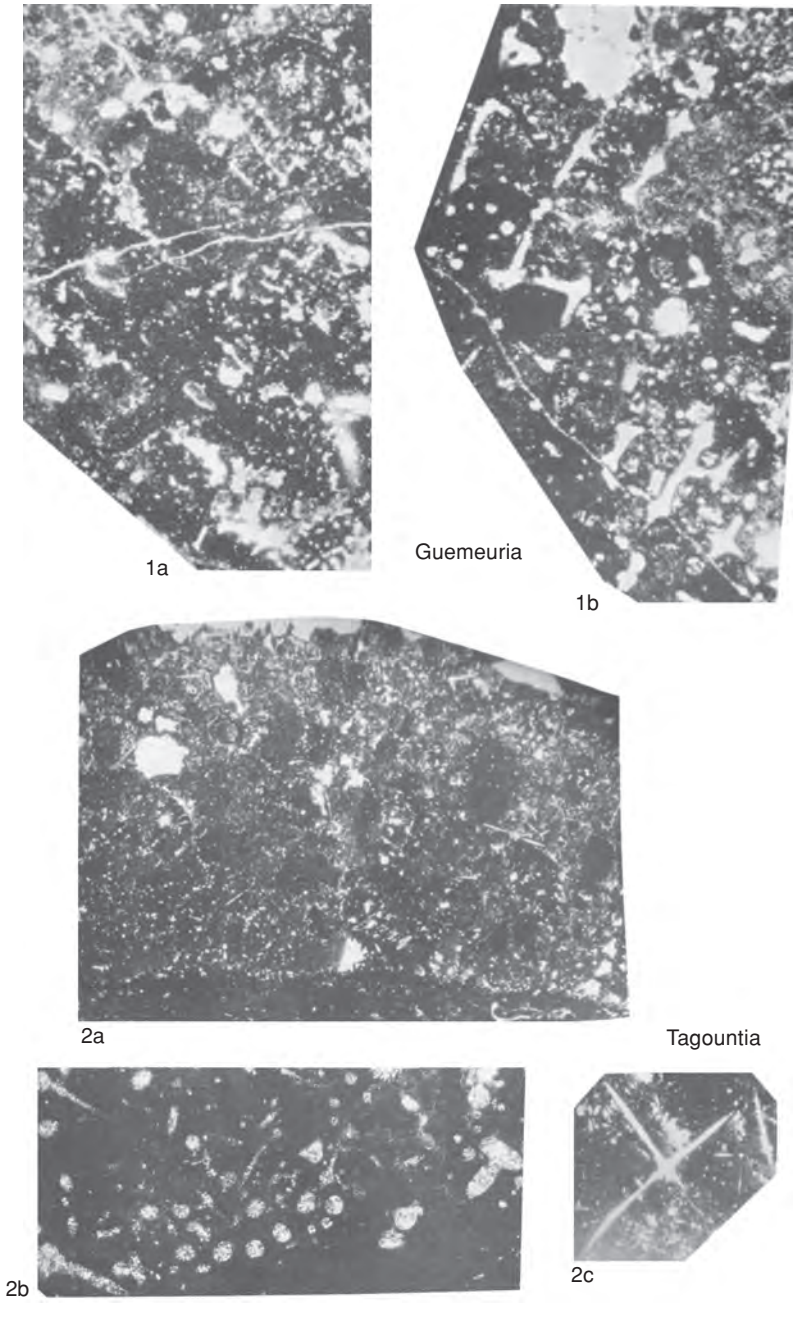


FIG. 300. Euplectellidae (p. 451–456).

sieve plate not known; cup or funnel-like, attached by root processes; other details unknown. *?Lower Cretaceous, Cretaceous (Coniacian–Maastrichtian):* Australia, *?Lower Cretaceous;* northern Germany, *Coniacian–Maastrichtian.*——FIG. 298,*2*. **P. clarkei,* ?Lower Cretaceous, Wollumbilla, Queensland, Australia; part of rigid skeleton showing irregular, siliceous fibers and *in situ,* interstitial hexactine, ×50 (Bowerbank, 1869).

Tagountia DU DRESNAY, TERMIER, & TERMIER, 1978, p. 279 [**T. flexuosa*; OD]. Sponges with thin, flexible walls and coarse, radial canals; relatively rare, large

stauractines occurring in irregular skeleton of largely intermediate-sized, hexactine-based spicules not organized into regular mesh; diactines may also occur; spongocoel wall and canal surfaces lined with unfused spicules like hexactines of main wall, but may have one or more rays aborted and appear as pentactines or triactines. *Lower Jurassic:* Morocco.——Fig. 300,*2a–c. *T. flexuosa,* limestone layers, Sinemurian, Petit Tagount; *a,* transverse section through wall with darker, irregular to oval canal sections, and light gray spicules, ×2; *b,* section including more densely spiculed gastral layer; *c,* stauractine and rays of other smaller spicules, ×25 (du Dresnay, Termier, & Termier, 1978; courtesy of *Geobios*).

Tillichtia du Dresnay, Termier, & Termier, 1978, p. 276 [**T. aedificator;* OD]. Cup-shaped sponges with thick walls pierced by numerous radial, branched, parietal canals; principal spicules generally separated from one another in a barely perceptible net with very fine mesh; main spicules robust hexactines with thick centers and elongate, vertical rays; intermediate spicules diactines and stauractines that are more or less parallel to sponge surface and perpendicular to principal spicules; outer net very fine textured and irregular, with openings corresponding to inhalant canals, and ankylosed as in living lyssacid sponges; prostalia of monaxons occur in scattered tufts. [Position in the family is questionable.] *Jurassic (Sinemurian):* Morocco.——Fig. 299,*2a–c. *T. aedificator,* gray-blue limestone, Foum Tillischt; *a,* uniform, skeletal net with crude layers arcuate toward right, growing direction, scale not given, approximately ×5; *b,* section through parenchymalia net showing regular positions of main spicules, with subcircular sections and smaller spicules, ×5; *c,* section through hexactines showing spacing and orientation, ×20 (du Dresnay, Termier, & Termier, 1978; courtesy of *Geobios*).

Subfamily UNCERTAIN

Euplectellina Termier, Termier, & Thibieroz, 1990, p. 7 [**E. cevenola;* OD]. Sievelike, oscular structure and abundant, isolated diactines and rhabdodiactines derived from triactines, pentactines, and stauractines with two rays reduced; organic axes commonly small, but locally large, microscleres including small hexasters, clavules, and scopules; basalia unknown. [The genus is not well defined and based of fragments from various areas.] *Lower Jurassic:* France.——Fig. 297,*3a–b. *E. cevenola,* Liassic carbonates, Hetangian–Sinemurian, Cevennes; *a,* oscular sieve; *b,* thin section with diverse sections of hexactine-based megascleres, ×35 (Termier, Termier, & Thibieroz, 1990).

Silesiaspongia Pisera & Bodzioch, 1991, p. 198 [**S. rimosa;* OD]. Cup-shaped, lyssacinosan sponges with thin walls that are often plicated, and skeleton of irregularly oriented, fused hexactines and hexactine-derived spicules, particularly diactines; distinct, outer layer of long, tangential diactines does not cover openings of numerous radial canals that pierce the wall; parietal gaps absent. *Middle Triassic:* Poland.——Fig. 297,*1a–c. *S. rimosa,* Karchowice Beds, Anisian, Szymiszów; *a,* side view of steeply obconical holotype with ostia of radial canals, ZPAL PfV/21, ×1; *b,* photomicrograph of outer layer with long, diagonal, tangential diactines and canal openings, ZPAL PfV/1, ×10; *c,* fragment of endosomal skeleton of fused, hexactine-based elements, ZPAL PfV/2, ×25 (Pisera & Bodzioch, 1991).

Family ASEMEMATIDAE Schulze, 1887

[Asememadae Schulze, 1887a, p. 113]

With pentactine hypodermalia and hypogastralia, and pinnular autodermalia and autogastralia, which may be hexactines or pentactines; principalia mainly rhabdodiactines and hexacts; base encrusting with basidictyonalia; no paratropal hypodermalia or octasters. *Paleogene (?middle Eocene), Holocene.*

Subfamily ASEMEMATINAE Schulze, 1887

[Asememadae Schulze, 1887a, p. 113]

Thin walled, funnel-like to tubular, not stalked. [Not represented as fossils.] *Holocene.*

Subfamily CAULOPHACINAE Schulze, 1887

[Caulophacinae Schulze, 1887a, p. 124]

Fungiform sponges, with long, tubular stalks; parenchymal megascleres united in varying lengths of stalk. *Paleogene (?middle Eocene)–Holocene.*

Caulophacus Schulze, 1887b, p. 46 [**C. elegans;* OD]. Fungiform with long stalk; upper convex surface of main body gastral; lower surface dermal and convex to concave; autodermalia pinular hexactines; autogastralia hexactines or pentactines; pinular distal rays short in autodermalia but long in autogastralia; two sorts of discohexasters, to which oxyhexasters may be added. [Supposed Tertiary record based on isolated, pinnular hexactines.] *Paleogene (?middle Eocene), Holocene:* New Zealand, *?middle Eocene.*——Fig. 301,*1. C.* sp., ?middle Eocene, Otago, New Zealand; pinular hexactine, ×200 (Hinde & Holmes, 1892).

Family ROSSELLIDAE Schulze, 1885

[Rossellidae Schulze, 1885, p. 447] [=Asconematidae Gray, 1872a, p. 458; Crateromorphidae Gray, 1872b, p. 137; Caulophacidae Ijima, 1903, p. 78; Lanuginellidae de Laubenfels, 1955, p. 68, *nom. transl. ex* Lanuginellinae Schulze, 1897, p. 532]

With hexactinal hypodermalia and nonpinular autodermalia and autogastralia;

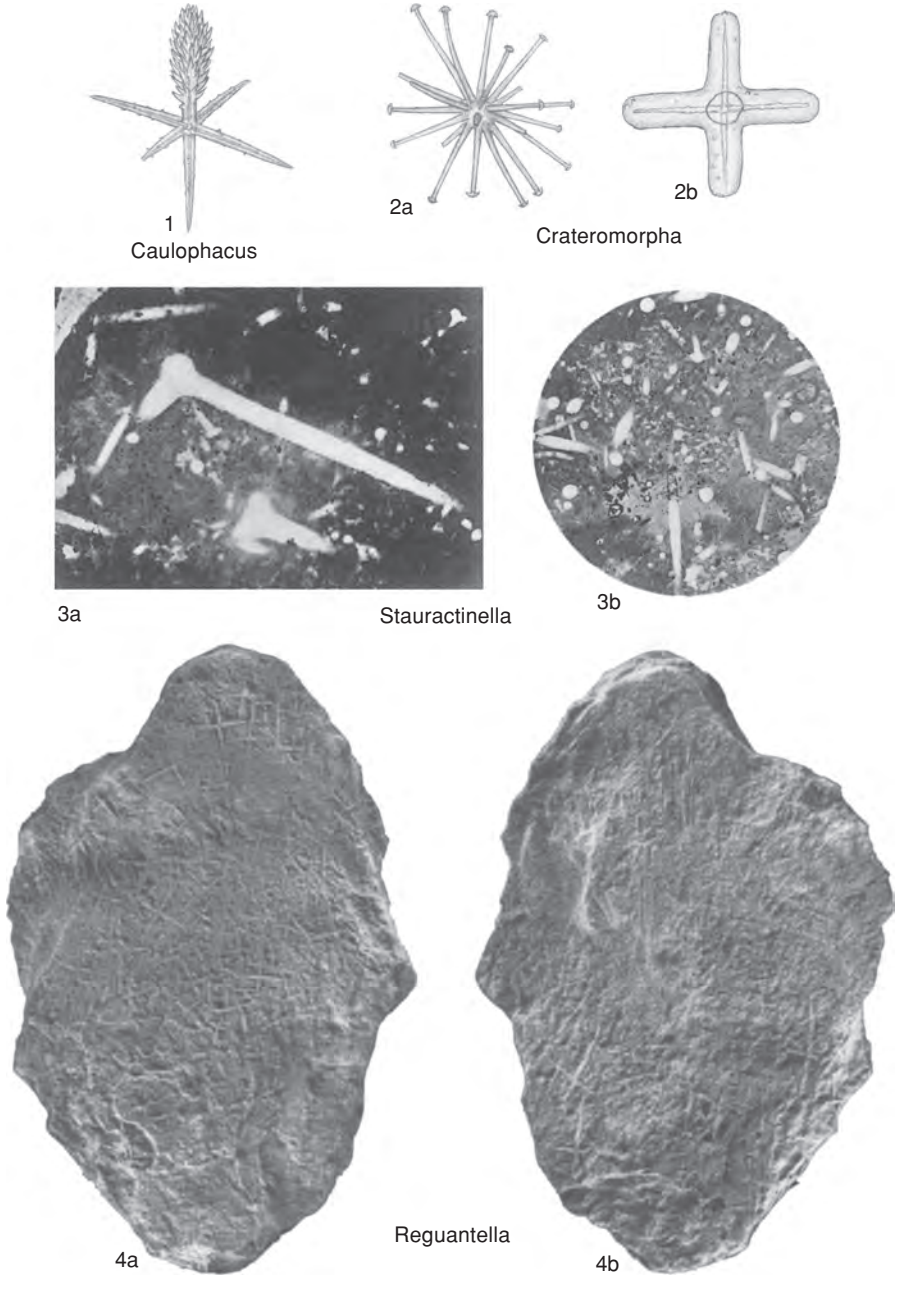


FIG. 301. Asememtidae, Rossellidae, Stauractinellidae, and Leucopsacasidae (p. 456–458).

latter most commonly stauractines or pentactines with (unspecialized) ray proximal; hexactines or rhabdodiactines may also occur; parenchymal megascleres hexactines and rhabdodiactines or latter only; attached by encrusting base or by protruded basalia that are uncinate or anchorate pentactines; hypodermal pentacts may be paratropal, protruded as prostalia, or both. Hexasters, oxyhexasters, additional plumicones, or discohexasters, or both, or with discohexasters replaced or accompanied by octasters.

[Cretaceous existence known from loose, paratropal pentactines, exclusive to this family, although no genus is recognized.] *?Paleogene–?Neogene, Holocene.*

Subfamily ROSSELLINAE Schulze, 1885

[*nom. transl.* Reid, herein, *ex* Rossellidae Schulze, 1885, p. 451]

Plumocones and octasters absent. *?Paleogene–?Neogene, Holocene.*

Crateromorpha Gray, 1872c, p. 110 [**C. meyeri;* OD]. Cup- or bowl-like with stalk, often large; exterior of main body smooth to strongly perforate with moderate, inhalant ostia; paragastralia in tracts between moderately large, open, exhalant canals; hypodermalia pentactines and may be supplemented by tangential bundles of small rhabdodiactines; hypodermalia not paratropal; autodermalia and autogastralia simple pentacts or stauractines; principalia rhabdodiactines and hexactines, or only former; oxyhexasters and discohexasters; stalk not tubular but with anastomosing, exhalant canals running lengthwise; stalk skeleton rigid. [Doubtful Paleogene records based on hexactines and hexasters similar to those from the stalk.] *?Paleogene–?Neogene, Holocene:* New Zealand, *?Paleogene–?Neogene.*——Fig. 301,*2a–b. C.* sp., ?Eocene, Otago, New Zealand; *a,* spherical discohexasters attributed to *Crateromorpha* sp., ×200; *b,* thick-rayed hexactine attributed to *Crateromorpha* sp., ×100 (Hinde & Holmes, 1892).

Family STAURACTINELLIDAE de Laubenfels, 1955

[Stauractinellidae de Laubenfels, 1955, p. 68]

Globular sponges in which spicules are a mass of hexacts, but stauracts and other types not present (hence genus and family misnamed). *Jurassic (Oxfordian)–Neogene*.

Stauractinella Zittel, 1877b, p. 60 [**S. jurassica;* OD]. Globular with (deep) paragaster; spicules large hexactines with proximal ray that is bigger than the others; other details unknown. [Possible euplectellid because spicules resemble euplectellid dermalia (Schrammen, 1936); stauractines absent.] *Jurassic (Oxfordian), Paleogene–Neogene:* Germany, Iran, *Oxfordian.*——Fig. 301,*3a–b. *S. jurassica,* Weiss Jura, Oxfordian, Unterdigisheim, Germany; thin sections with irregularly oriented hexactines with at least one large ray, ×5 (Kolb, 1910–1911).

Family LEUCOPSACIDAE Ijima, 1903

[Leucopsacidae Ijima, 1903, p. 29]

Thick-walled, ovoid to cuplike sponges with basal stalks of anchorate spicules; choanosomal spicules hexactines with rare diactines, outer skeletons with large, dermal pentactines, microsceleres commonly with discoidal, outer ends or sigmatoclones. *Paleogene (Eocene).*

Reguantella Pisera & Busquets, 2002, p. 326 [**R. cavernosa;* OD]. Ovoid, leucopsacasiid sponges without atrial cavity, with choanosomal skeleton mostly of diactines, locally bundled, supplemented by small pentactines and possible hexactines; interior of sponge cavernous; dermal surface with large, thick pentactines of several sizes with irregular distribution, tangential rays more or less parallel to each other, but not in regular meshwork, with unpaired ray directed inwardly. [This is the first described fossil representative of the family.] *Paleogene (Eocene):* Spain.——Fig. 301,*4a–b. *R. cavernosa,* La Guixa Member of Vic marls Formation, Bartonian, Munter, Catalonia; *a,* side view of holotype showing prominent dermal pentactines; *b,* opposite side showing diactines of the choanosomal skeleton, ZPAL Pf.X/22, ×1 (Pisera & Busquets, 2002).

Family UNCERTAIN

Calycomorpha Bodzioch, 1993, p. 240 [**C. triasina;* OD]. Small, stalked, gobletlike, thin-walled lyssacinosan with long, diactine spicules that project more or less horizontally into spongocoel from gastral part of wall; principal skeleton of fused hexactines and diactines. *Triassic:* Poland.——Fig. 302,*4a–b. *C. triasina,* Górazdze beds, lower Muschelkalk, Anisian, eastern upper Silesia; *a,* longitudinal section of small, gobletlike holotype with thick stem, ×2; *b,* upper part of holotype with diactine spicules projecting from gastral surface into matrix-filling spongocoel, ×4 (Bodzioch, 1993).

Gomphites Carter, 1871, p. 127 [**G. parfitte;* SD de Laubenfels, 1955, p. 40]. Based on loose pentactines, probably dermalia or gastralia resembling spicules of *Terpios* with heads bearing several lateral protrusions (de Laubenfels, 1955, p. 40). *Lower Cretaceous:* Europe.——Fig. 302,*1a–b. *G. parfitte,* Upper Greensand, Exeter, England; *a,* pentactine, dotted lines restored; *b,* pentactine with arched rays, dotted where restored, ×50 (Carter, 1871).

Krainerella Krainer & Mostler, 1992, p. 137 [**K. ingridae;* OD]. Isolated, delicate, long amphidiscs with a thin, delicate rhabd and similar-sized, umbrella-like umbels at both ends; both umbels have eight recurved rays, but rays of one thinner than those of other; long rhabd distinctly tapered in middle. *Middle Triassic:* Austria.——Fig. 302,*3. *K. ingridae,* Rote Knollenkalke, Ladinian, Kärnter, Karawanken; side view of typical spicule, ×50 (Krainer & Mostler, 1992).

Opeamorphus de Laubenfels, 1955, p. 78, *nom. nov. pro Acestra* C. F. Roemer, 1861, p. 55, *non* Dallas, 1852 [**Acestra subularis* C. F. Roemer, 1861, p. 55; OD]. Awl-shaped spicules, probably in root-tuft clusters. *Ordovician–Carboniferous:* Europe.

?Pyritonema M'Coy, 1850, p. 273 [**P. fasciculatus;* SD de Laubenfels, 1955, p. 78]. Name applied to

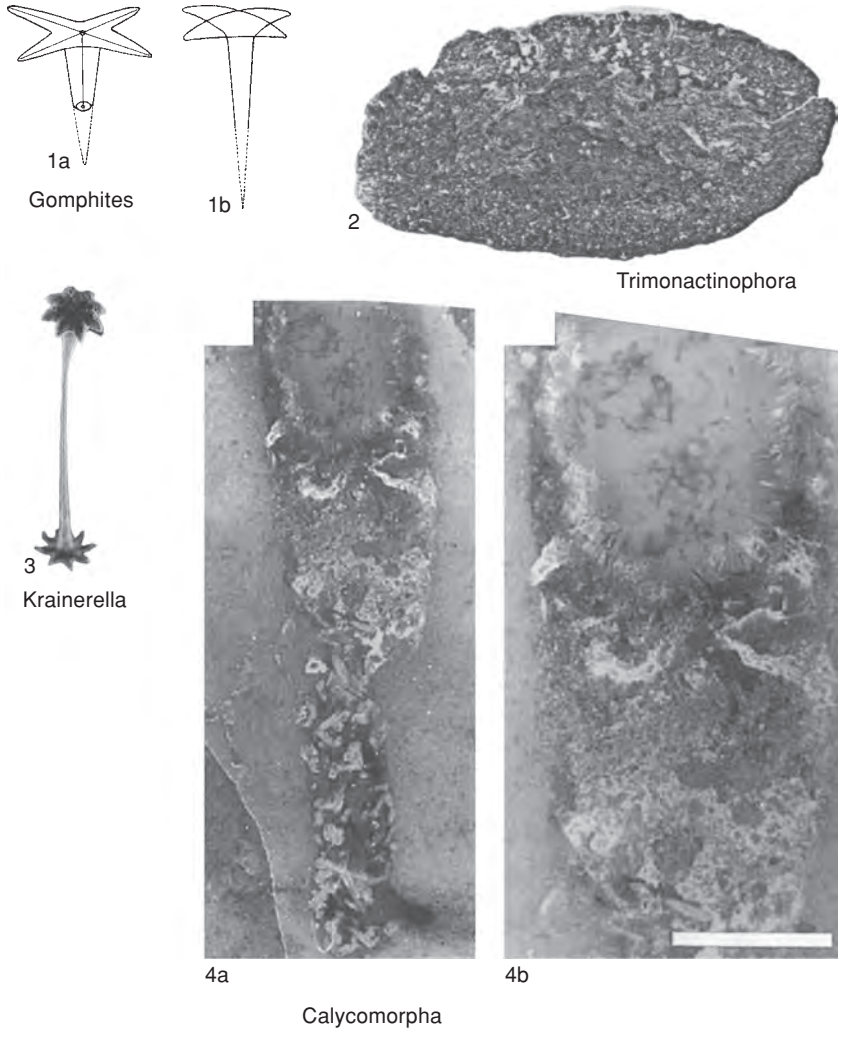


FIG. 302. Uncertain (p. 458–459).

masses of parallel, hairlike spicules that seemingly comprise root tufts of lyssakid sponges; possibly useful but not valid as a distinct genus. [No known suitable figures.] *Silurian:* England.

Trimonactinophora WU & XIAO, 1989, p. 17 [**T. triassica;* OD]. Sponges ranging from short pillars to open conical or tongue shaped; skeleton of hexactines and many monactines and triactines, with some stauractines, two sizes of spicules irregularly distributed, without strands; canals of moderately uniform width but irregularly distributed. *Triassic:* China.——FIG. 302,*2. *T. triassica,* upper member Hanwang Formation, Carnian, Mianzhu County, Sichuan; horizontal section of holotype, 256-536 CCG, ×1 (Wu & Xiao, 1989).

Order HEXACTINOSA Schrammen, 1903

[*nom. transl.* DE LAUBENFELS, 1936, p. 185, *ex* tribus Hexactinosa SCHRAMMEN, 1903, p. 4, *sensu* SCHRAMMEN, 1912, p. 190]

Dictyonine Hexasterophora without lychniscs at any stage of their ontogeny, and not considered to be derived from any genus with lychniscs; primary skeletal framework composed typically of dictyonal hexactines united to form linear, dictyonal strands, sometimes in single layer only, but usually

spread through three-dimensional meshwork one to many meshes thick without layered arrangement; further dictyonalia, not arranged to form dictyonal strands, may be added as a secondary development; in some forms, doubtfully included (Aulocalycidae), all dictyonalia are united without order; cortical meshwork absent, or present and formed by secondary accretion or by thickening or structural modifications of outermost, primary meshwork; skeletal canalization absent, restricted to secondary meshwork, or intracortical to fully developed in primary meshwork, in the last instance with separate systems of inhalant and exhalant skeletal canals (epirhyses, aporhyses) or with a single system only; superficial meshwork sometimes present, most often formed from adventitious, dictyonal hexactines, but sometimes partly or wholly from connected dermalia or gastralia, or from siliceous filaments that grew out from dictyonalia, dermalia, or gastralia; dermalia and gastralia usually pentactines, less commonly hexactines or stauractines, rarely rhabdodiactines (gastralia only); basal skeleton formed from dictyonal hexactines; most living examples with hexasters, uncinates, and sceptrules. [Usage of SCHRAMMEN, 1912 restricts this taxon to dictyonine genera, excluding lyssacine sponges that were initially (SCHRAMMEN, 1903) included. Order cryptogenic, represented initially by advanced genera (*Cribrospongia* D'ORBIGNY, *Casearia* QUENSTEDT); presumably derived from a primitive lyssacine with hexasters, perhaps similar to *Microstaura* FINKS if the latter had appropriate microscleres.] *Upper Ordovician–Holocene.*

Family EURYPLEGMATIDAE de Laubenfels, 1955

[Euryplegmatidae DE LAUBENFELS, 1955, p. 78]

Sponges in which hexactines of main skeleton less intensely fused than in most of order; included here because diactinal spicules, such as characterize lyssakid forms, absent. *?Cretaceous, Holocene.*

Euryplegma SCHULZE, 1887b, p. 80 [**E. auriculare;* OD]. Ear-shaped, thin-walled sponges with long, oval-shaped inhalant openings on convex, outer side and small, irregular, round exhalant openings on concave, inner side; skeletal net irregularly dictyonine, of similar thin rays with small, conical spines on their outer surfaces; net without thickened ray junctions or buttresses; parenchymal spicules include small, rough oxyhexactines and discohexasters. *?Cretaceous, Holocene:* cosmopolitan.

Family FARREIDAE Gray, 1872

[*nom. correct.* SCHULZE, 1887b, p. 69, *pro* Farreadae GRAY, 1872a, p. 457] [=Euretidae ZITTEL, 1877b, p. 35, *partim*]

Skeletal framework consisting of a single layer of meshwork, in which meshes are typically quadratic, or of a primary layer on which further layered or irregular meshwork is superimposed in older parts or up to growing margins; modern forms also distinguished by occurrence of clavules, sometimes accompanied by sarules or lonchioles but never scopules; thin-walled sponges with a simple chamber system, radial canals absent although small, pitlike, subdermal or subgastral spaces may be present; skeletal pores (ostia, postica) sometimes present if secondary meshwork is developed. [This is a small group of somewhat dissimilar genera, mainly from modern species, with a type of rigid skeleton appropriate in a prototype stock of the order; but they appear after most other families, and with characteristic sceptrules (clavules), which are unknown in the others.] *Cretaceous (Turonian)–Holocene.*

Farrea BOWERBANK, 1862, p. 1,118, *s.l.* [**F. occa;* OD]. Branched-tubular or plexiform; habits ranging from erect tubes with short to rudimentary lateral branches, arranged alternately or spirally, to irregular masses of tubes that divide and anastomose repeatedly; free tubes open at ends; base encrusting; sceptrules clavules only (s.-g. *Aulodictyon* KENT, 1870), clavules and sarules (s.-g. *Claviscopulia* SCHULZE, 1899) or unknown (*Farrea s.s.*). [Treated by zoologists as comprising forms referred here to s.-g. *Aulodictyon,* with *Farrea* and *Claviscopulia* as separate genera, but modern type species was based on material without sceptrules; usage here unites that which cannot be distinguished when loose spicules are absent, as in fossils.] *Cretaceous (Turonian)–Holocene:* southern England, *Turonian;* Northern Ireland, *Santonian;* ?Washington, *?Oli-*

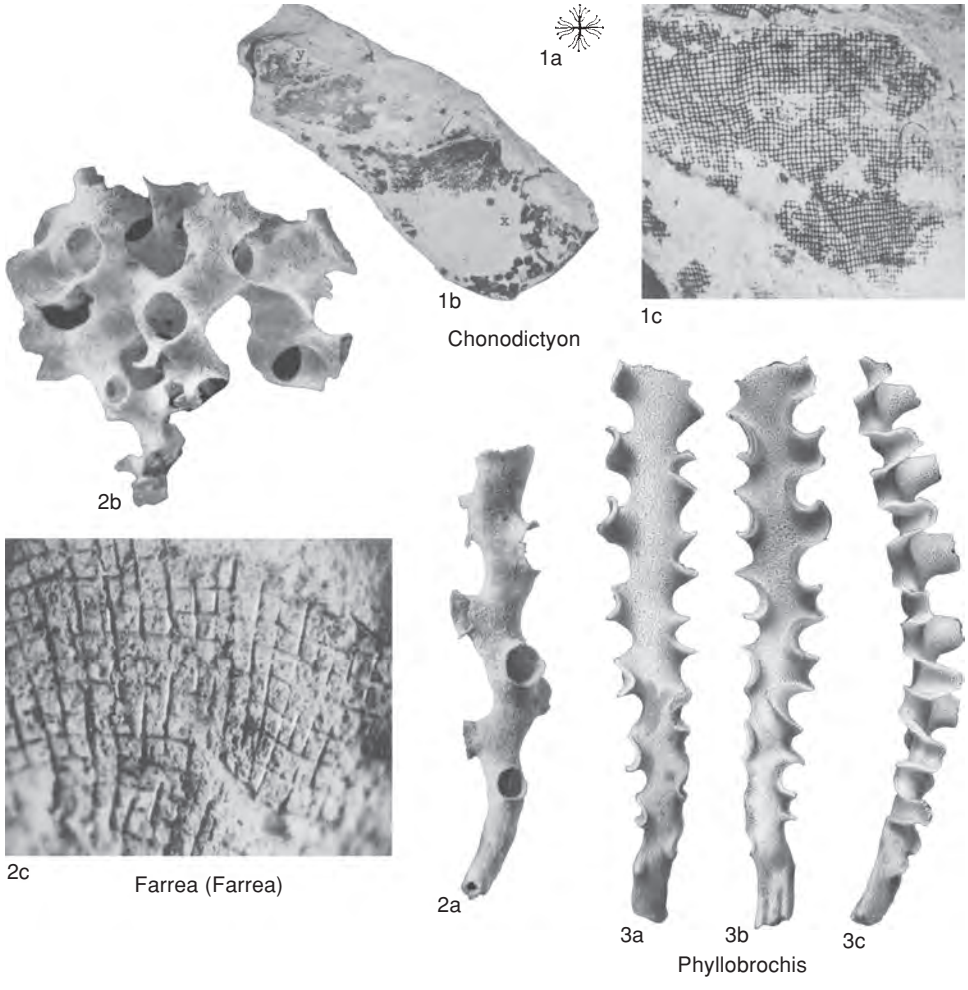


FIG. 303. Farreidae (p. 460–463).

gocene; USA (California), *Miocene;* cosmopolitan, *Holocene.*

F. (**Farrea**). Name applied here to fossil species, whose loose spicules are unknown. [Not *Farrea* species of SCHRAMMEN (1912) and MORET (1926b), in which the skeleton is euretid.] *Cretaceous (Turonian)–Holocene:* southern England, *Turonian;* Northern Ireland, *Santonian;* cosmopolitan, *Holocene.*——FIG. 303,*2a–b. *F. (F.) occa,* Holocene, Indian Ocean, off east end of Timor; *a,* side view with branched, tubular form with thin walls, ×0.5; *b,* somewhat smaller, more complexly branched specimen showing range of species, ×1 (Ijima, 1927).——FIG. 303,*2c. F. (F.)* cf. *oakleyi* REID, chalk, Senonian, Rickmansworth Station, Hertfordhire, England; plan view of dermal skeletal meshwork mold, ×8 (Reid, 1959; courtesy of The Palaeontographical Society, London).

Chonodictyon REID, 1959, p. 9 [**Farrea infundibuliformis* CARTER, 1873, p. 360; OD]. Body funnel-like; hexasters floricomes; other loose spiculation unknown. *Cretaceous (?Campanian), Holocene:* northern England, *?Campanian;* Caribbean Sea, *Holocene.*——FIG. 303,*1a. *C. infundibuliformis* (CARTER), Holocene, Caribbean Sea; isolated microsclere floricome spicule, magnification unknown (Reid, 1959; courtesy of Palaeontographical Society, London).——FIG. 303,*1b–c. C. ? sowerbyensis* REID, Chalk, Senonian, Sewerby, Yorkshire, England; *b,* side view of chalk nodule with dark, skeletal mesh, GSM Za3575, ×0.5; *c,* skeleton from same in plan view, ×2 (Reid, 1959; courtesy of Palaeontographical Society, London).

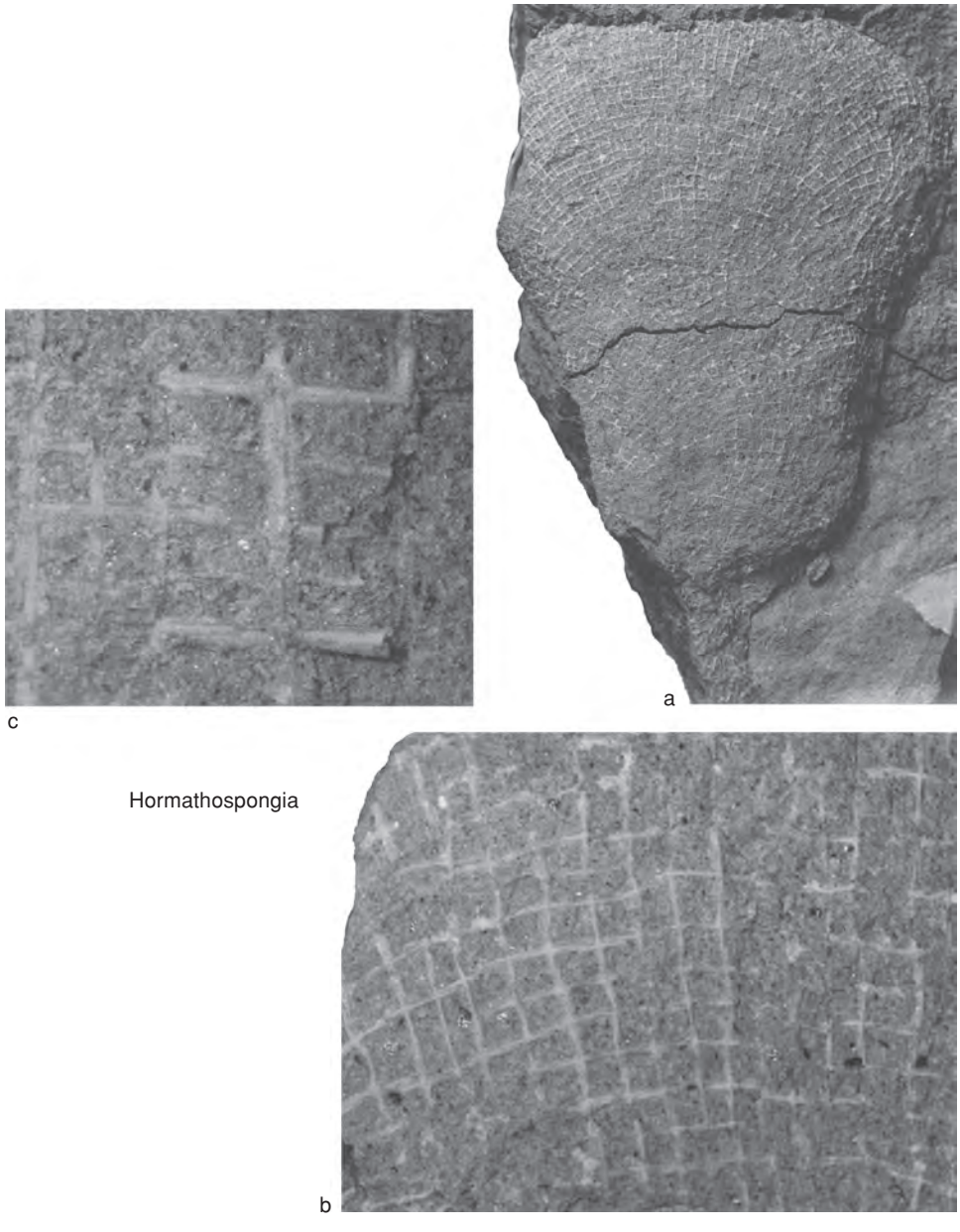


FIG. 304. Farreidae (p. 462–463).

Hormathospongia RIGBY, EMBREE, & MURPHY, 1996, p. 716 [**H. dictyota;* OD]. Hexactinellid sponges of thin-walled, annulate to beaded-appearing, linear series of attached, upwardly expanding pendant-, bell-, or teardrop-shaped chambers or sections; chamber walls a single layer of rectangularly arranged, reticulate mesh of stauractines fused into dictyonal framework by encasement of overlapping, spicule ray tips. *Cretaceous (Santonian):* USA (California).——FIG. 304*a–c.* **H. dictyota,* Forbes Formation, Colusa County; *a,* holotype with upwardly arching, dictyonine, skeletal net, ×2; *b,* enlarge-

ment of upper left part of overlapping spicule rays (not showing) in center and disappearance of lateral rays toward left in converging net, ×10; *c,* photomicrograph showing spicule rays encased in silica to form beams and smaller spicules in second-order quadrules, USNM 480458, ×20 (Rigby, Embree, & Murphy, 1996).

Phyllobrochis Reid, 1958a, p. iv [**Farrea laminaris* Topsent, 1904, p. 43; OD]. Tall, thin, curved, bladelike sponge with sinuously folded, lateral margins where folds on two margins alternate; skeleton dictyonal, with spiculation similar to *Farrea. Holocene:* Atlantic Ocean.——Fig. 303,*3a–c.* **P. laminaris* (Topsent), Azores; *a,* side view of convex surface of holotype; *b,* side view of concave surface; *c,* side view showing alternating position of folds on sponge margins, ×1 (Topsent, 1904).

Family EURETIDAE Zittel, 1877

[Euretidae Zittel, 1877b, p. 35, *partim*] [=Monakidae Marshall, 1876, p. 121; Coscinoporidae Zittel, 1877b, p. 36, *partim;* Maeandrospongidae Zittel, 1877b, p. 38, *partim;* Chonelasmatidae Scrammen, 1912, p. 190; Pleurothyrisidae Schrammen, 1912, p. 192; Myliusiidae de Laubenfels, 1955, p. 82, *partim;* Wapkiosidae de Laubenfels, 1955, p. 85]

Primary skeletal meshwork three dimensional and not constructed in layers, with subparallel, dictyonal strands in longitudinal or radial orientation ending at dermal surface or some at each surface; some with secondary meshwork in which dictyonal strands are absent, other than in primary meshes; skeletal canalization normally absent or limited to skeletal pores (ostia, postica) or shallow, radial canals (epirhyses, aporhyses) that open into underlying meshes; some with true radial canals but not in regular series; amararhyses in one genus; modified primary meshwork or added secondary meshwork may form dictyonal cortex at one or both surfaces. Modern forms normally with scopules, rarely sarules or no sceptrules, never clavules. [Only Mesozoic and Cenozoic forms are discussed here. Older forms are treated in the section on Paleozoic hexactinosans, p. 437 herein.] *Triassic (Carnian)–Holocene.*

Subfamily EURETINAE Zittel, 1877

[*nom. transl.* Reid, 1958, p. 19, *ex* Euretidae Zittel, 1877b, p. 35] [=Euretidae Zittel, 1877b, p. 35, *partim;* Calycospongiidae Wu, 1990, p. 350 (358)]

Typically thin-walled Euretidae of branched-tubular or plexiform habitus, or with a tubular, funnel-, or scabbardlike axis emitting lateral tubes or other appendages; axial funnel not regularly ribbed longitudinally when present; ostia and postica typically without order; no amararhyses; modern examples with scopules in most instances, sarules in one genus, no sceptrules in others; dermalia and gastralia usually pentactines, but sometimes hexactines. [The subfamily includes forms apparently comprising one main line of euretid evolution, not similar to Craticulariidae (*cf.* Chonelasmatinae below); Polythyridinae and Pseudobecksiinae are probably derivatives.] *Triassic (Carnian)–Holocene.*

Eurete Semper, 1868b, p. 29 [**E. simplicissimum;* OD] [=*Botryosella* Schrammen, 1912, p. 259 (type, *B. labyrinthica,* M); *?Hapalopegma* Schrammen, 1912, p. 258 (type, *H. fragilis,* SD de Laubenfels, 1955, p. 84); *Pararete* Ijima, 1927, p. 193, *partim* (type, *Farreopsis farreopsis* Carter, 1877, p. 122, not Schulze, 1887b, p. 70, SD Mehl, 1992, p. 68)]. Branched tube or divided and anastomosed tubes; skeletal framework without canalar features, with skeletal pores only or with shallow canals at either surface; cortex or none at either surface; scopules in living species. *?Middle Jurassic, Upper Jurassic–Holocene:* cosmopolitan.

- **E. (Eurete).** Habitus variable from an erect tube with lateral branches to complex of divided and anastomosed tubes that do not form regular column; scopules and pentactine dermalia and gastralia in modern examples. [Living *E. (Eurete)* is distinguished by restriction of hexasters to oxyhexasters.] *?Middle Jurassic; Lower Cretaceous–Holocene:* cosmopolitan.——Fig. 305,*6a. E. (E.) semperi* Schulze, Holocene, East Indies; side view of anastomosing tubules with thin walls, ×1 (de Laubenfels, 1955).——Fig. 305,*6b. E. (E.) schmidti* Schulze, Holocene, western Pacific; part of skeleton showing both dictyid megascleres and microscleres, ×40 (de Laubenfels, 1955).
- **E. (Aulodomus)** Schrammen, 1937, p. 54 (Schrammen, 1936, p. 182, *nom. nud.*) [**A. farreides;* OD]. Divided and anastomosed tubes forming a columnar growth, with lateral oscula at end of tubes projecting outwardly or in walls of ascending tubes; irregular cortical meshwork and skeletal pores present or absent. *Upper Jurassic–Upper Cretaceous:* Germany.——Fig. 305,*2a.* **E. (A.) farreides,* Weiss Jura, Upper Jurassic, Streitberg; surface of exterior with reticulate, skeletal structure, ×10 (Schrammen, 1936). ——Fig. 305,*2b. E. (A.) prolatum* Reid, Chalk Marl, Cenomanian, Berkshire, England; holotype showing anastomosed, tubular growth form, GSM 96775, ×0.5 (Reid, 1959;

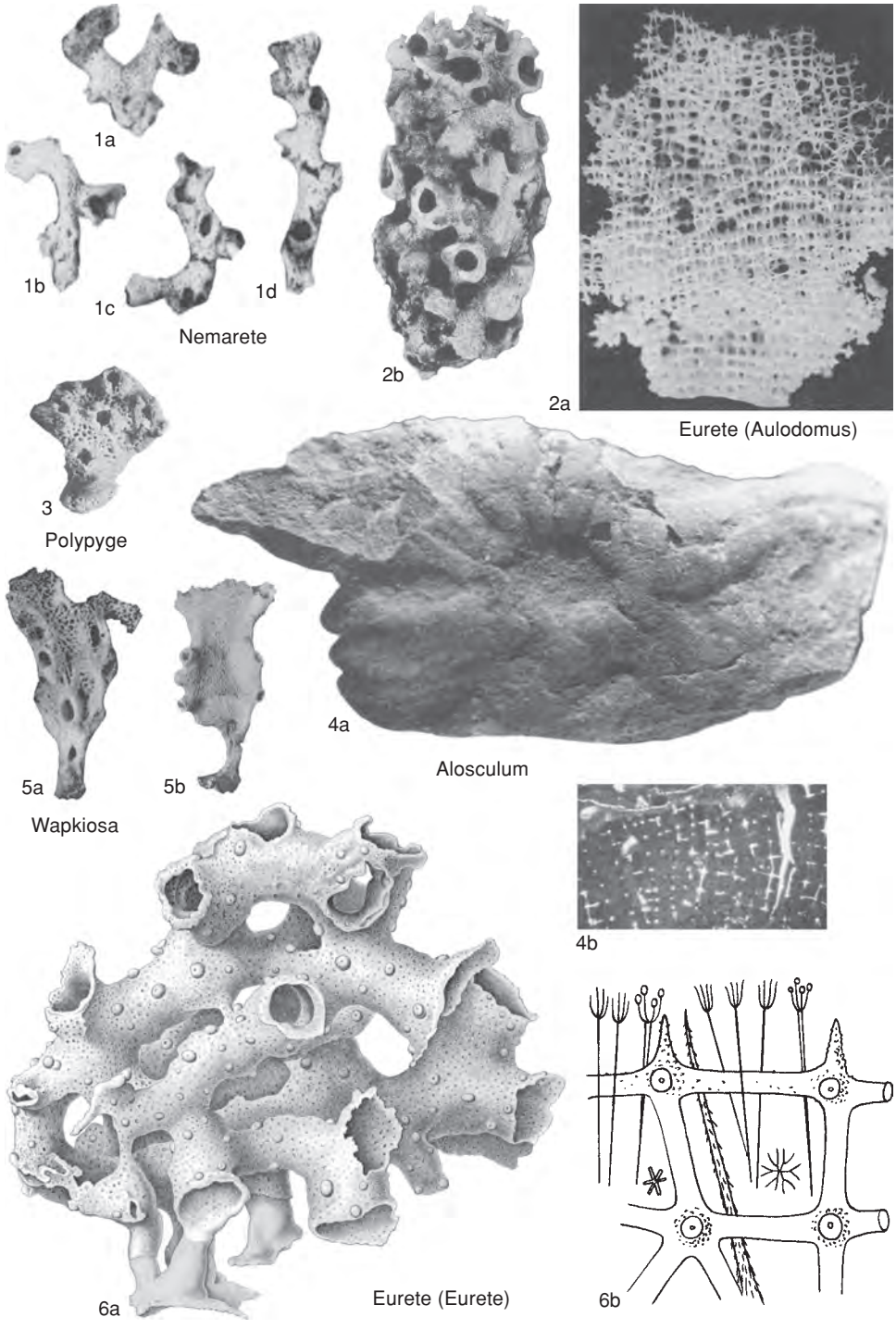


FIG. 305. Euretidae (p. 463–471).

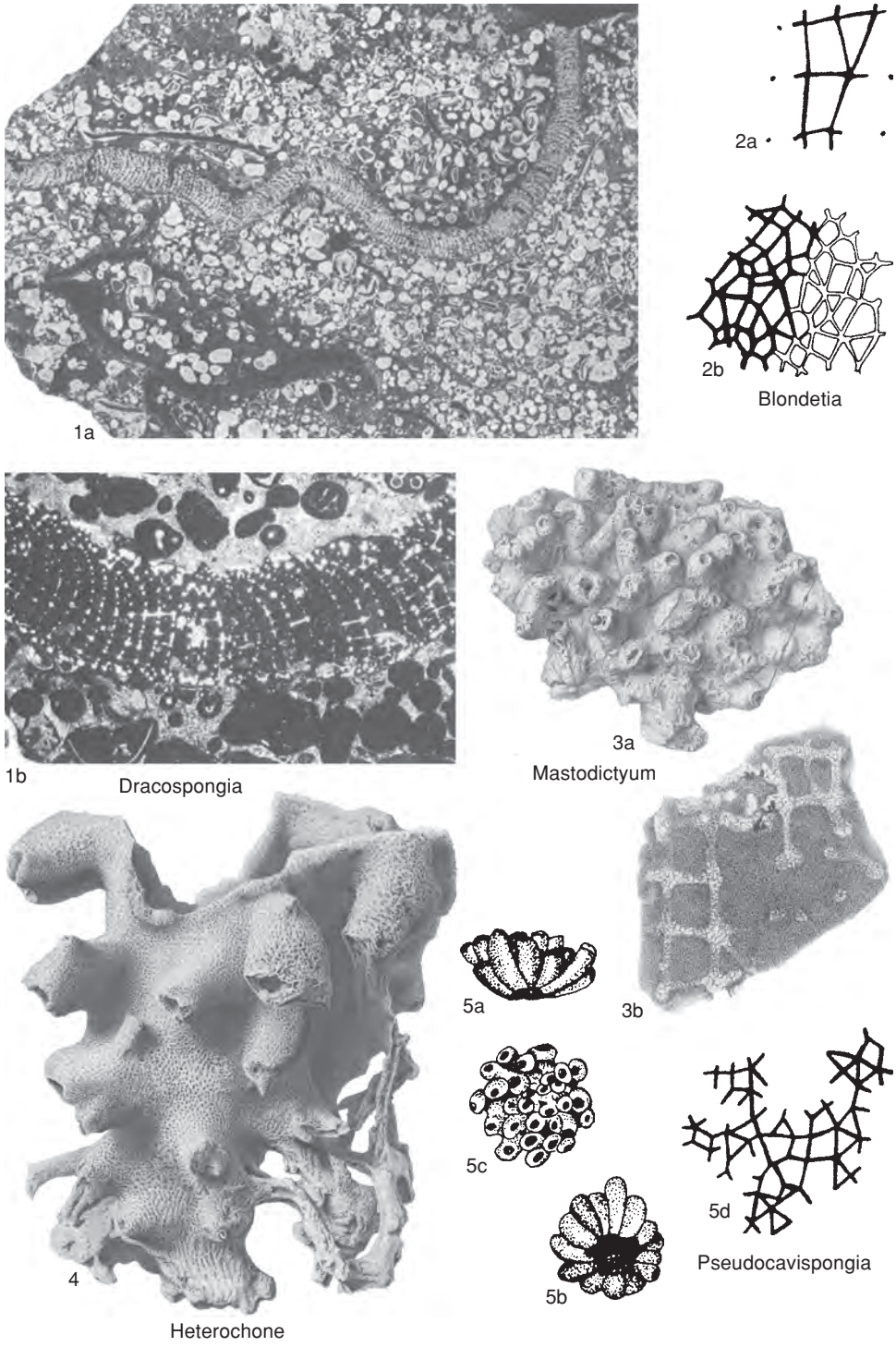


FIG. 306. Euretidae (p. 463–469).

courtesy of The Palaeontographical Society, London).

Alosculum Wu, 1990, p. 351 [359] [**A. heptapetalum;* OD] [?=*Radioplica* Wu, 1990, p. 351 [359] (type, *R. stephana,* M)]. Trochoid sponge with few large, vertical ridges formed by folded wall; ridges regularly radiating from axial part of sponge; rectangular, dictyonine skeleton evident in both vertical and transverse sections in walls. *Upper Triassic (Carnian):* China.——Fig. 305,*4a–b. *A. heptapetalum,* Hanwang Formation, northwestern Sichuan; *a,* view from below sponge with prominent, radial ridges in thick walls around indented base, ×1; *b,* photomicrograph of section showing dictyonine, skeletal structure, ×10 (Wu, 1990).

Blondetia Hérenger, 1944, p. 105 [**B. demolyi;* OD]. Large, cup-shaped, commonly laterally flattened hexactinosan without visible pores in very thin walls with main dictyonal skeleton of large, regular hexactines in cubic mesh and with a dermal layer of very small hexactines forming an octahedral-based mesh; hexactines of endosomal skeleton with thin, long, vertical rays parallel axis of sponge, and with thicker, lateral rays that produce horizontal, transverse streaks on weathered surface when fine, surficial skeletal net is missing. *Upper Cretaceous (Coniacian–Maastrichtian):* France.——Fig. 306,*2a–b. *B. demolyi,* Gisement de la Chartreuse, Entremont-le-Vieux, southeastern France; *a,* dictyonine hexactines of main skeleton in basic cubic mesh, with plain nodes and long, vertical rays, approximately ×1; *b,* segment of finer-textured, dermal skeleton, approximately ×1 (Hérenger, 1944).

Dracospongia Rigby, Wu, & Fan, 1998, p. 129 [**D. undulata;* OD]. Thin, undulate platelike to broadly obconical sponges with marked regularity in fine-textured, advanced, euretoid, skeletal structure; primary strands continuing full length or diameter at midwall or midplate, other strands diverging laterally to both dermal and gastral surfaces; transverse lamellae formed by beams from strands; plates lacking canals; well-defined, dermal and gastral layers of swollen dictyonalia, with additional dictyonalia in dermal layer. *Triassic (Carnian):* China (Sichuan).——Fig. 306,*1a–b. *D. undulata,* Hanwang Formation, Jushui; *a,* enlarged vertical section of annulate, platelike holotype in which primary strands diverge laterally and transverse lamellae of horizontal beams form arcuate elements in direction of growth, ×2; *b,* photomicrograph of holotype section showing undulate nature of sponge with thickened dermal layer, below, and gastral layer, above, with arcuate transverse lamellae curved in direction of growth, IGASB R6-20(064), ×10 (Rigby, Wu, & Fan, 1998).

Heterochone Ijima, 1927, p. 284 [**Chonelasma calyx* Schulze, 1887a, p. 326; OD]. Axial funnel with short, lateral tubes that are widely open at ends unless infilled by secondary tissue (or meshwork); exterior of skeletal framework with cortical meshwork and numerous ostia, latter arranged without order; no cortex and few or no postica on gastral side; dictyonal strands begin on gastral side and end in cortical meshwork of dermal side; plan views of latter may have irregular, strandlike series of diagonally interwoven beams; ostia open inwardly into simple meshes under cortex, or into vague epirhyses that may also open on gastral side; gastral surface sometimes with scattered, vague aporhyses that may extend outwardly to cortex; scopules present, dermalia and gastralia pinular hexactines in living examples. [*Chonelasma* Schulze, 1887a, *partim; Chonelasma sensu* Schrammen, 1912; not sharply separable from *Verrucocoelia* Étallon in material lacking dermalia and gastralia.] *?Cretaceous, Holocene:* Germany, Atlantic and Pacific Oceans.——Fig. 306,*4. *H. calyx* (Schulze), Holocene, Enoshima, Japan; side view of dried specimen showing growth form, ×0.5 (Schulze, 1887a).

Linonema de Laubenfels, 1955, p. 83, *nom. nom. pro Linosoma* Schrammen, 1937, p. 55, *non* Eichelbaum, 1909 [**Linosoma calyx* Schrammen, 1937, p. 55; OD]. Narrow, obconical to tubular sponge with deep, open spongocoel and moderately thick walls; dermal surface nodular outgrowths separated by furrows; inhalant ostia vertical, elongate-oval, or slitlike; gastral surface smooth and with similarly shaped, exhalant ostia; curved canals extend into wall from both surfaces but do not pierce it; skeletal net moderately regular dictyonine with rectangular meshes; strands generally parallel gastral surface but curve outward near dermal surface. [Placement in the family is uncertain.] *Upper Jurassic*: Germany.——Fig. 307,*1a–b. *L. calyx* (Schrammen), Oxfordian, marly limestone and Kimmeridgian marls, Hochwang and Bärenthal; *a,* side view of steeply obconical sponge with lobate outgrowths, ZPAL Pf.VIII/216, ×0.5; *b,* vertical section showing broad, deep spongocoel and moderately thick walls with radial canals, ZPAL Pf. VII23, ×0.5 (Pisera, 1997; courtesy of *Palaeontologica Polonica*).

Lopanella Počta, 1883, p. 27 [**L. depressa* Počta, 1883, p. 28; OD]. Thick-walled, basin- or bowl-shaped sponges with thick, short, basal stalk; entire gastral and upper dermal surfaces lacking ostia, although small, round to oval pores occur in irregular skeleton, which is composed of small, thick-rayed hexactines in dictyonine skeletal net. [Included in the subfamily with some question.] *Upper Cretaceous:* Czech Republic, Slovakia.——Fig. 308,*1a–b. *L. depressa,* Korytzaner Schichten, Kamajk; *a,* side view of young, thick-walled, obconical sponge, ×1; *b,* fragment of the thick-rayed, dictyonine, skeletal net, ×40 (Počta, 1883).

Mastodictyum Sollas, 1883, p. 544 [**M. whidborni;* M]. Imperfectly known, based on specimen in

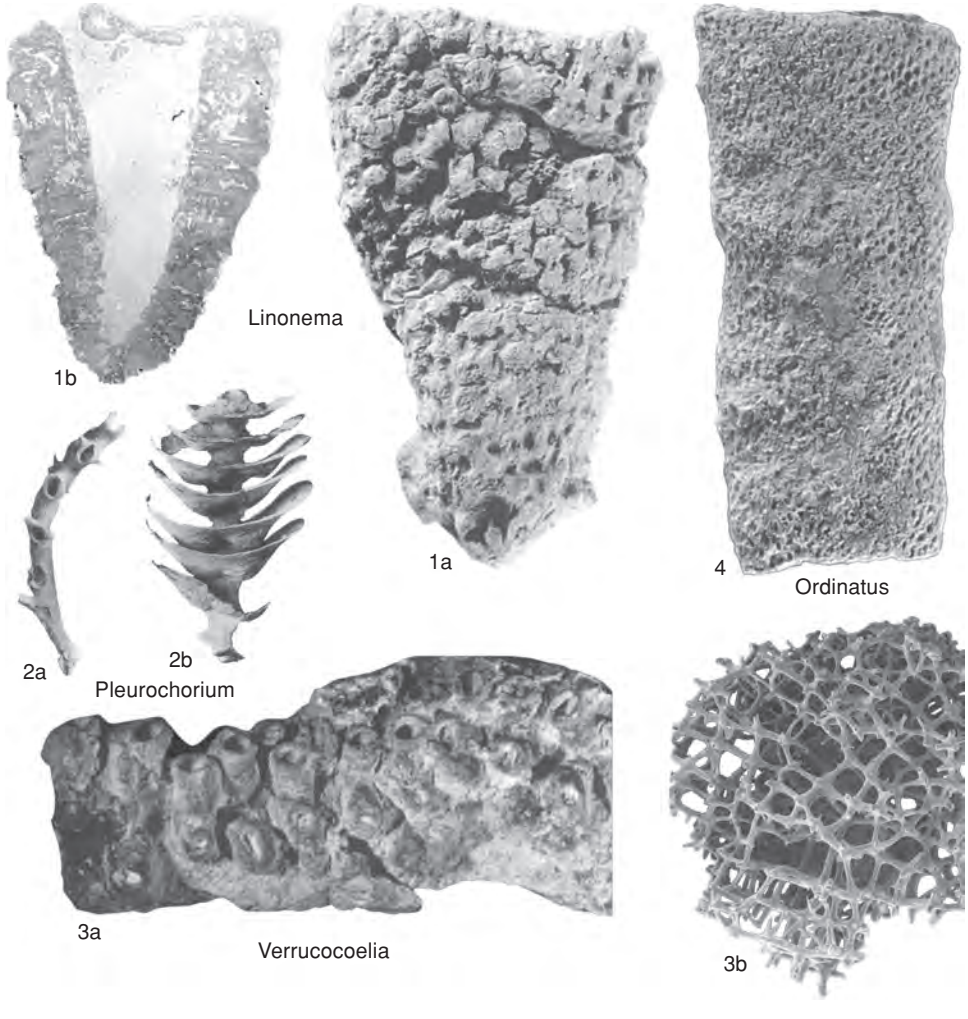


FIG. 307. Euretidae (p. 466–471).

which short, nipplelike outgrowths arise from an allegedly basal plate; ostia present, arranged without order. [Possibly a form of *Verrucocoelia* ÉTALLON.] *Middle Jurassic:* England.——FIG. 306,*3a–b.* **M. whidborni,* Inferior Oolite, Burton Bradstock; *a,* upper surface of nearly complete sponge with lobate outgrowths, ×0.5; *b,* part of sponge wall showing skeletal structure, ×50 (Hinde, 1893b).

Myliusia GRAY, 1859, p. 439 [**M. callocyathus;* OD]. Axial tube or funnel with short, open, lateral outgrowths whose margins become united, producing reticulate, external surface; no cortical or canalar features; skeletal net dictyonine with hexactine, oxyhexaster, and discohexaster microscleres but no sceptrules in living example. *Upper Cretaceous–Holocene:* Spain, *Upper Cretaceous, Miocene;* East Indies, West Indies, *Holocene.*——FIG. 308,*3a–c.* **M. callocyathus,* Holocene, Little Ki Island, western Pacific Ocean; *a,* side view of specimen with two oscula, ×1; *b,* oxyhexaster with S-shaped rays; *c,* discohexaster with S-shaped, terminal rays, ×150 (Schulze, 1887a).

Nemarete REID, 1961, p. 37 [**N. mirabilis;* OD]. Branched tube or branched and anastomosed tubes;

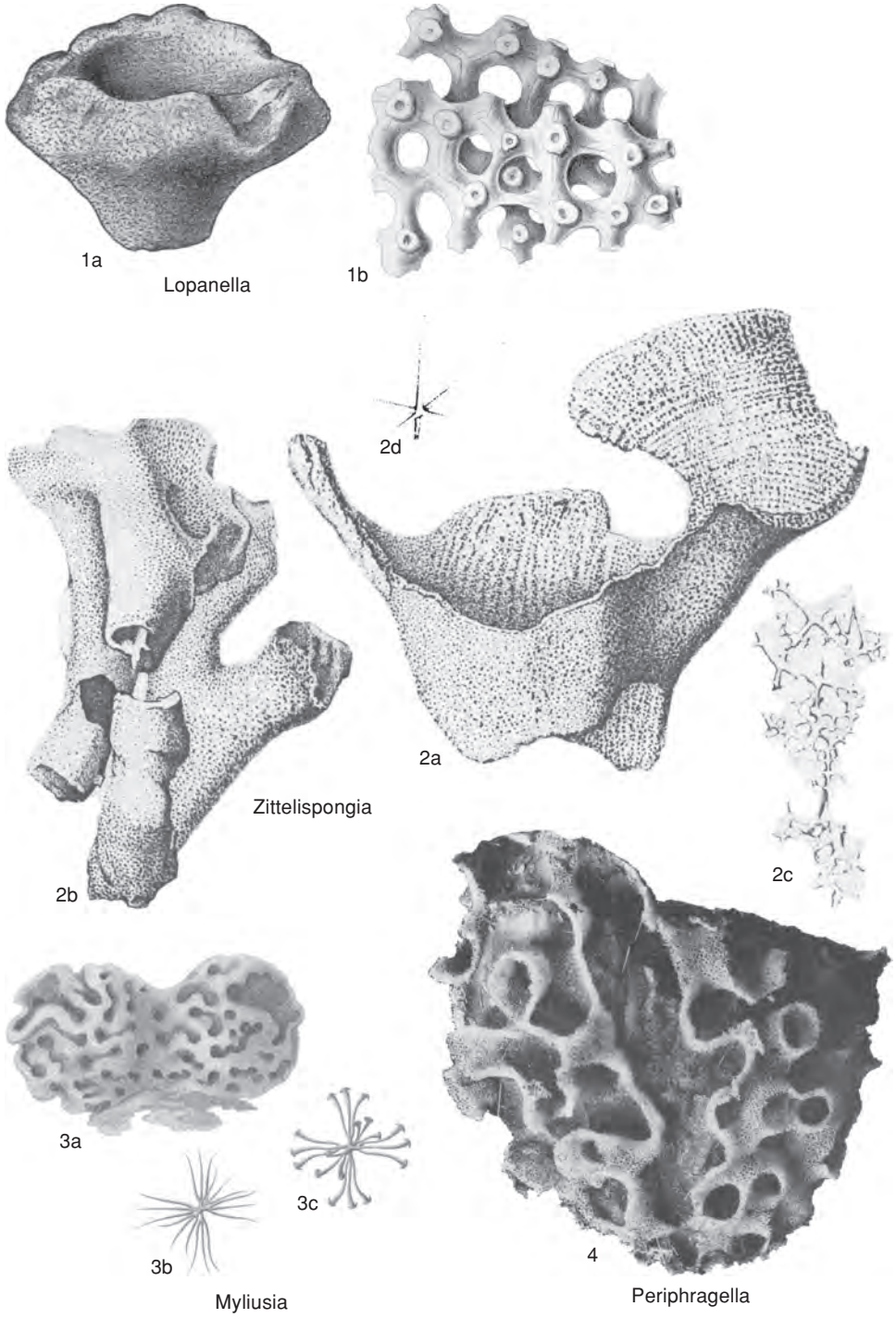


FIG. 308. Euretidae (p. 466–471).

skeletal framework with pores on dermal side; free rays of gastral, skeletal surface emitting siliceous filaments that ramify in plane of surface. *Cretaceous (Cenomanian):* England.——Fig. 305,*1a–d. *N. mirabilis,* Chalk Marl, Childrey, Berkshire; side view of four fragments of small holotype, GSM 94955, ×1 (Reid, 1961; courtesy of The Palaeontographical Society, London).

Ordinatus de Laubenfels, 1955, p. 83 *nom. nov. pro Eutactus* Schrammen, 1937, p. 38, *non* Gemminger & Harold, 1873 [**Scyphia texturata* Goldfuss, 1826, p. 6; OD]. Cylindrical to narrow, vaselike with sides full of pores; dermal surface with only slightly thickened, dictyonal skeleton, interior dictyonal skeleton regular with rectangular to square meshes, dictyonal strands diverging toward dermal surface. *Jurassic:* Germany.——Fig. 307,*4. *O. texturatus* (Goldfuss), Kimmeridgian marls, Upper Jurassic, Erkenbrectsweiler; side view of fragment with cylindrical form and distribution of ostia, ×1 (Pisera, 1997; courtesy Palaeontologica Polonica).

Periphragella Marshall, 1875, p. 177 [**P. elisae;* OD] [=*Proeurete* Schrammen, 1902, p. 21 (type, *P. plicata* Schrammen, 1902, p. 22, M, =*Periphragella plicata* (Schrammen), Schrammen, 1912, p. 214)]. Axial funnel emitting divided and anastomosed lateral tubes, similar to those of a plexiform *Eurete;* framework with pores on dermal side or no canalar features; scopules, pentactinal dermalia, and gastralia in living species. [This genus in not separable sharply from *Verrucocoelia* Étallon.] *Lower Cretaceous–Holocene:* cosmopolitan.——Fig. 308,*4. P. plicata* (Schrammen), Quadratenkreide, Campanian, Misburg, Germany; side view of plicate sponge, ×1 (Schrammen, 1902).

Plecteurete Herrmann-Degen, 1980, p. 14 [**P. megasiphon;* OD]. Sponge constructed of very regularly branched and anastomosed tubes that have a zigzag structure in space and spirally overlie one another at each bend at 90 degrees; these branches determine relationships between individual, identical, structured tubes, so that a plexus of unusual regularity develops; skeleton is euretoid and constructed of smooth hexactines; with or without a dictyonal cortex; dermal layer with characteristic, irregularly distributed epirhyses; more extensive canal system not developed. *Paleogene (Thanetian):* Egypt.——Fig. 309,*1. *P. megasiphon,* Chalk member, Tarawan Formation, Bulaq Oasis, between Kharga and Baris, southwestern Egypt; sponge with characteristic, intertwining, anastomosing, tubular structure, ×1 (Herrmann-Degen, 1980).

Plectospyris Sollas, 1883, p. 545 [**P. elegans;* SD de Laubenfels, 1955, p. 84]. Poorly known, based on incomplete specimens with groups of laterally anastomosing tubes; ostia present, arranged without order; postica apparently in longitudinal grooves. *Middle Jurassic:* England.——Fig. 309,*2a–b. *P. elegans,* Inferior Oolite, Burton Bradstock; *a,* view from above of branched sponge fragment, with oscula in some branches, ×1; *b,* enlarged part of sponge wall with dictyonine structure, ×50 (Hinde, 1893b).

Pleurochorium Schrammen, 1912, p. 251 [**P. schulzei;* OD]. Erect, tubular axis bears leaflike appendages or hat-brim-like flanges, developed above or across parietal oscula; no skeletal pores or cortex; scopules in living species. *Cretaceous–Holocene:* Germany, East Indies, Indian Ocean.——Fig. 307,*2a–b. *P. schulzei,* Quadratenkreide, Cenomanian, Oberg, Germany; *a,* side view of type with brimlike flanges out from erect axis; *b,* erect central branch with oscula between bases of flange remnants, ×1 (Schrammen, 1912).

Polypyge Schrammen, 1937, p. 61 (Schrammen, 1936, p. 183, *nom. nud.*) [**P. pusilla;* OD] [=*Polysyge* de Laubenfels, 1955, p. 86, *nom. null.*]. Very small, figlike sponges with flattened summit and base; upper surface with low rims around several oscula of deep spongocoels; smaller, irregularly space ostia of inhalant canals occurring between oscula and on exterior; spongocoel walls with larger, exhalant ostia; dictyonal skeletal network of closely and irregularly spaced hexatines; markedly thickened spicules producing differentiated dermal layer. *Jurassic:* Germany.——Fig. 305,*3. *P. pusilla,* Weiss Jura, Upper Jurassic, Streitberg; upper surface with rimmed oscula and smaller, inhalant ostia on holotype, ×4 (Schrammen, 1937).

Pseudocavispongia Hérenger, 1944, p. 86 [**P. stellata;* OD]. Very small sponges formed of several upwardly curved tubes opening as in corolla of a flower, coming from common base that may be concave; tubes with very thin walls whose principal dictyonine skeletons appear composed of small hexactines with plain nodes; young sponge with few tubes, but with additional tubes subsequently inserted around initial, central tube and between earlier formed tubes. *Lower Cretaceous (Valanginian):* France.——Fig. 306,*5a–d. *P. stellata,* lower Valanginian, Chateauneuf-de-Chabre by Laragne, southeastern France; *a,* side view of small sponge with upwardly curved tubes; *b,* diagonal lower view showing concave base and radially diverging, small, curved tubes; *c,* view from above of oscular tips of tubular branches, ×1; *d,* fragment of dictyonal skeleton, ×20 (Hérenger, 1944).

Radioplica Wu, 1990, p. 351 [**R. stephana* Wu, 1990, p. 352; OD] [?=*Alosculum* Wu, 1990, p. 351 [359] (type, *A. heptapetalum,* M)]. Irregular, cuplike sponges with longitudinally fluted or convolute margins that may merge to produce upwardly divergent, tubular projections or subparallel branches; simple, tubelike spongocoels penetrate virtually full length of branches; walls lack major canals in markedly uniform, three-dimensional, dictyonine skeleton where nodes slightly expanded at centers of dictyonalia; neither dermal nor gastral layers differentiated. *Triassic (Carnian):* China (Sichuan).——Fig. 309,*4a–b. *R. stephana,* Hanwang Formation, Hanwang-Jushui area; *a,* section through wall of

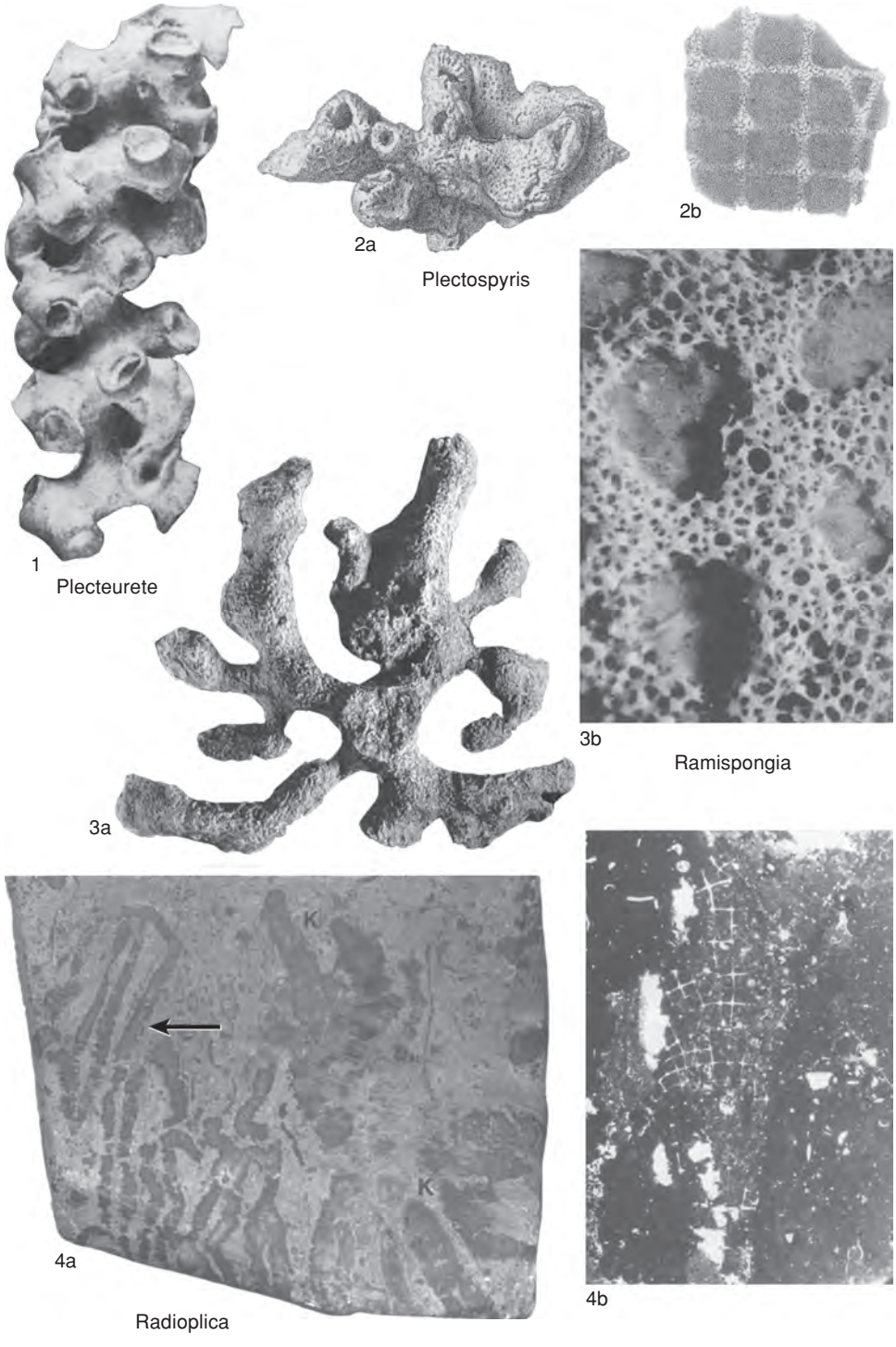


FIG. 309. Euretidae (p. 469–471).

fluted, bowl-shaped, figured sponge (*arrow*), associated with specimens of *Keriogastrospongia* (*K*) on right, ×1; *b,* photomicrograph of longitudinal section with upwardly divergent primary strands in thin wall, with gastral margin on right, IGASB T3(3), ×10 (Rigby, Wu, & Fan, 1998).

Ramispongia Quenstedt, 1877 in 1877–1878, p. 139 [**R. ramosa;* SD de Laubenfels, 1955, p. 83]. Large, sticklike, branched sponges with moderately thick walls to cylindrical to slightly compressed tubular branches, low, ringlike rims surrounding oscula that lie more or less uniformly next to one another on smooth, branch ends; dermal surface with small, round, regularly to irregularly alternating ostia; inner surface with rows of oval to slitlike, exhalant ostia; small, meshed, and somewhat regular, dictyonal skeleton composed of hexactines; dictyonal skeleton somewhat thickened at dermal surface, with specialized, dermal layer of small, fused pentactines. [Included in the family with some question.] *Jurassic:* Germany, Poland.——Fig. 309,*3a–b. *R. ramosa,* Weiss Jura, Erkenbrechtsweiler and Streitnberg, Germany, *a,* branched sponge, ×0.5; *b,* outer surface showing dictyonal dermal net and ostia of canals, ×10 (Schrammen, 1936).

Verrucocoelia Étallon 1859b, p. 537 [**Scyphia verrucosa* Goldfuss, 1829, p. 91; SD Hinde, 1893b, p. 200] [=*Mastoscinia* Pomel, 1872, p. 106, obj. (type, *Scyphia verrucosa* Goldfuss, 1829, p. 91, M)]. Axial tube or funnel that emits tubular, radial outgrowths that contract at ends, or hoodlike outgrowths with osculum faced obliquely downward; framework with cortex and pores on dermal side or no canalar features. Scopules in living examples, with dermalia and gastralia of pentactines. *?Lower Jurassic, Middle Jurassic–Holocene:* Morocco, *?Lower Jurassic;* Germany, England, *Middle Jurassic–Holocene;* India, *Eocene.*——Fig. 307,*3a–b. *V. verrucosa* (Goldfuss), Kimmeridgian beds, Upper Jurassic, Geisingen, Germany; *a,* cluster of radial tubules, each with deep spongocoel, IGPTU, Schrammen's collection, ×0.5; *b,* fragment of holotype, choanosomal skeleton with dictyonal structure, IPUB Goldfuss'collection, ×50 (Pisera, 1997; courtesy of Palaeontologica Polonica).

Wapkiosa de Laubenfels, 1955, p. 86, *nom. nov. pro Pleurothyris* Schrammen, 1912, p. 249, *non* Lowe, 1843 [**Pleurothyris tortuosa* Schrammen, 1912, p. 250; OD]. Tubular stalk expanding into scabbardlike growth or radially plicated funnel, with parietal oscula or short, open tubes along margins or outward plications; outermost skeletal meshwork irregular; no skeletal pores. *Upper Cretaceous:* Germany.——Fig. 305,*5a. *W. tortuosa* (Schrammen), Quadratenkreide, Cenomanian, Oberg; side view of small type with basal stalk and laterally flattened upper part with lateral oscula, ×1 (Schrammen, 1912).——Fig. 305,*5b. W. folium* Schrammen, Quadratenkreide, Cenomanian, Oberg; side view of type with lower stalk and flattened, upper part with parietal oscula on short tubes along margin, ×1 (Schrammen, 1912).

Zittelispongia Sintzova, 1879, p. 21 [**Z. alcyonoides* Sintzova, 1879, p. 22; OD]. Relatively large, irregularly spherical to angular masses of interconnected tubes and branches; dermal surface with common, irregularly spaced, inhalant ostia and gastral surface with similar exhalant ostia arranged in curved, parallel rows that are evident when thinly covering gastral layer is removed; interior skeleton a latticework of bundles of straight and curved needles and rays of hexactines, with thickened bracing structures at spicule centers; triangular to stretched rectangular spaces occurring between rays throughout skeleton, which is penetrated by large and small pores; gastral layer weblike and composed of hexactines of various sizes. *Upper Cretaceous:* Russia.——Fig. 308,*2a–d. *Z. alcyonoides,* Glauconitic marl, Saratov and Sosnovka areas; *a,* large type specimen with thin walls showing irregular, inhalant ostia on dermal surface and aligned, exhalant ostia on the gastral surface, ×1; *b,* figured type specimen showing branched, tubular, growth form, ×0.4; *c,* fragment of gastral layer of fused skeleton, magnification unknown; *d,* isolated hexactine from interior part of skeleton, magnification unknown (Sintzova, 1878).

Subfamily POLYTHYRIDINAE Schrammen, 1912

[*nom. transl.* Reid, herein, *pro* Polythyrididae Schrammen, 1912, p. 194] [=Polythyrididae Schrammen, 1912, p. 194, *partim*]

Funnel-shaped sponges in which paragastral surface is regularly ribbed longitudinally, and internal openings of parietal oscula or open lateral outgrowths occur along floors of furrows between paragastral ribs; latter may contain longitudinal clefts, or be pierced below their summits by apertures through which intervening furrows communicate; furrows on gastral side sometimes spanned in life by a secondary membrane, into which dictyonal meshwork may grow to form bridges; outside of funnel not ribbed or furrowed, except locally; modern examples with scopules and with hexactine dermalia and gastralia. [Habitus is a modification of that of Euretinae (e.g., *Periphragella* Marshall) in which an axial funnel bears lateral outgrowths, here complicated by plications of the axial funnel that are fused together externally. Taxon reduced to subfamily status because soft parts and skeleton are typically euretid.] *?Lower Cretaceous, Upper Cretaceous–Holocene.*

Polythyris Schrammen, 1912, p. 261 [**P. cuneata* Schrammen, 1912, p. 263; M]. Funnel-like with

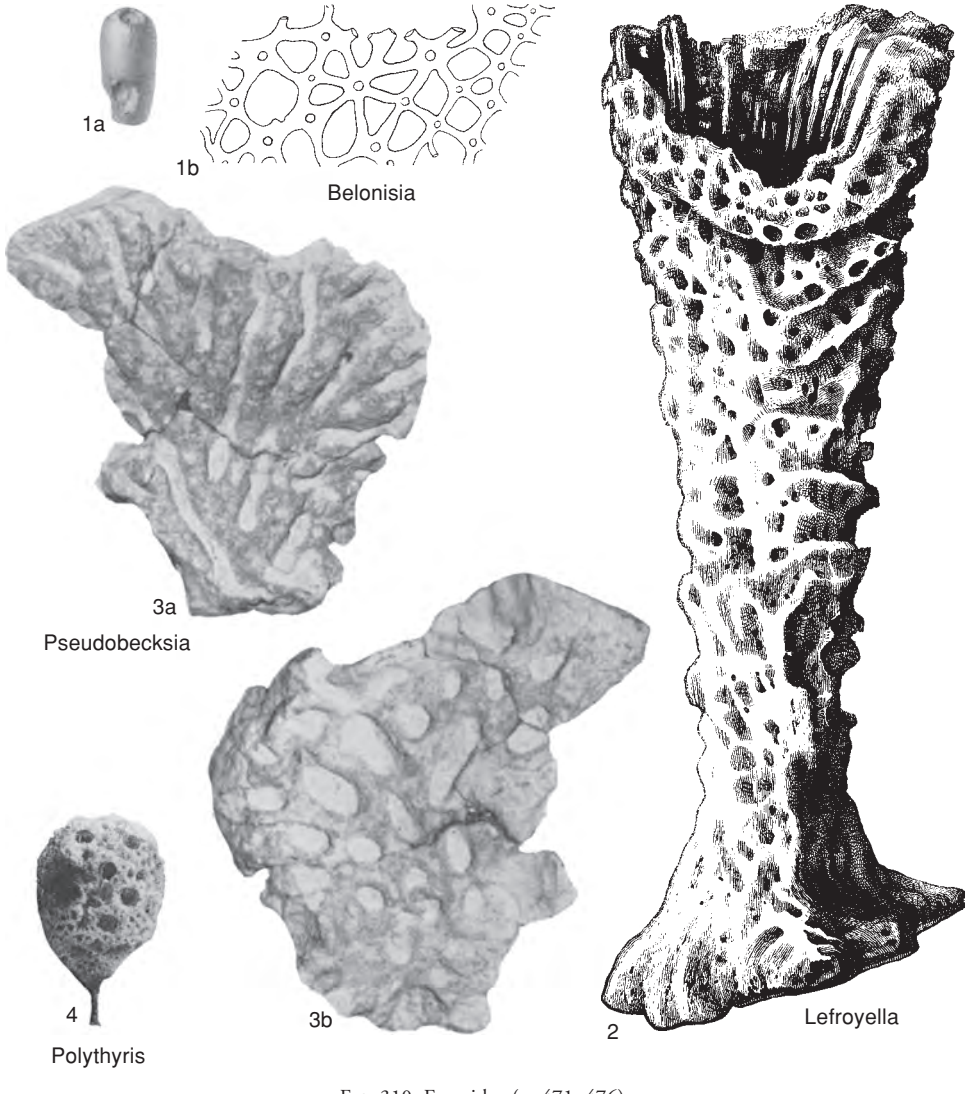


FIG. 310. Euretidae (p. 471–476).

parietal oscula that open internally in deep, longitudinal furrows on internal surface; no lateral outgrowths; outside with skeletal pores. *Upper Cretaceous:* Germany.——FIG. 310,*4. *P. cuneata,* Quadratenkreide, Cenomanian, Oberg; side view of small type with basal stalk and coarse oscula in upper, funnel-like part of sponge, ×1 (Schrammen, 1912).

Lefroyella THOMSON, 1877, p. 403 [**L. decora;* OD]. Funnel-like with lateral oscula at tops (ends) of stumplike or tubular lateral outgrowths, which may be united in transverse rows; internal longitudinal furrows, along which are internal apertures of lateral outgrowths; internal furrows may also intercommunicate laterally, though perforations in intervening ribs; cortex and skeletal pores on the dermal side; scopules and dermal and gastral hexactines in living example. *?Cretaceous, Neogene (Miocene)–Holocene:* Germany, Spain, Algeria, cosmopolitan.——FIG. 310,*2. *L. decora,* Holocene, Atlantic Ocean near Bermuda; side view of holotype, ×1 (Thomson, 1877).

Subfamily PSEUDOBECKSIINAE new subfamily

[Pseudobecksiinae REID, herein] [type genus, *Pseudobecksia* REID, 1964, p. lxv]

Funnel-like sponges in which thin, primary wall is convoluted to enclose two net-

works of cavaedial spaces, which open on opposite sides of funnel through apertures bounded by anastomosing folds of wall (not marginal surfaces); skeleton as in Euretinae. [Habitus specialized, seen otherwise only in Callodictyonidae (Becksiinae) of order Lychniscosa, in which it appears to be a modification of a simply plicated funnel.] *Cretacous (Coniacian–Maastrichtian).*

Pseudobecksia Reid, 1964, p. lxv [**P. schmidti;* OD]. Funnel-like with thin, primary wall convoluted to enclose two networks of passages that open on opposite sides of funnel; secondary meshwork with ostia on external surface of funnel, loose spicules unknown. *Cretaceous (Coniacian–Maastrichtian):* England.——Fig. 310,*3a–b. *P. schmidti,* Chalk, Rickmansworth, Hertfordshire; *a,* side view of branching holotype from dermal side; *b,* side view of same from gastral side showing apertures leading into cavaedial labyrinth, BM S.8631, ×0.5 (Reid, 1964; courtesy of The Palaeontographical Society, London).

Subfamily CHONELASMATINAE Schrammen, 1912

[*nom. transl.* Reid, herein, *ex* Chonelasmatidae Schrammen, 1912, p. 190]

Thin- to thick-walled Euretidae of funnel-like or flabellate types, and bilaterally compressed or stellate sponges with skeletal characters matched otherwise in funnel-like or flabellate genera; ostia and postica without order or in regular longitudinal series; thick-walled forms often with dictyonal strands showing strong, outward curvature, some with prominent, cortical meshwork; overlapping, tubular, inhalant and exhalant canals in modern examples; living forms with scopules and with pentactine or hexactine dermalia and gastralia. [The subfamily comprises various genera in which skeleton and soft parts are euretid but which do not appear to be allied closely to typical Euretinae. It may include forms close to root stock of Craticulariidae, or Leptophragmatinae of that family that appear to be euretid through loss of canalization.] *Jurassic (Oxfordian)–Holocene.*

Chonelasma Schulze, 1887a, p. 76 [**C. lamella;* SD Ijima, 1927, p. 165]. Funnel-like or flabellate, typically thick walled; skeletal framework with thick, cortical strata on both sides of an internal part, and with cortical parts traversed by radial epirhyses or aporhyses that open into meshes of interior; radial canals and apertures (ostia, postica) arranged without order or locally grouped more or less quadrately; dictyonal strands spread from internal part to both surfaces, running steeply to radially outward in cortical meshwork; plan views of latter may have irregular, strandlike series of beams interwoven diagonally; living examples with tubular, radial, inhalant and exhalant canals that overlap in outer part, and with scopules and dermal and gastral pentactines. [Alleged Cretaceous records (Schrammen, 1912, p. 217) refer to *Heterochone* Ijima; original diagnosis based on species of *Chonelasma* Schulze, *Heterochone* Ijima, and *Leptophragmella* Reid (see Reid, 1964, p. xcviii, footnote).] *Holocene:* cosmopolitan.——Fig. 311,*4a–c. *C. lamella,* near Kermadec Islands, South Pacific Ocean; *a,* side view of fragment with dictyonine skeletal net, ×1; *b,* dermal scopule, ×100; *c,* discohexaster with rough, terminal rays, ×150 (Schulze, 1887a).

Balantionella Schrammen, 1902, p. 23 [**B. elegans* Schrammen, 1902, p. 24; OD]. Sponge composed of thin-walled, small, baglike to leaflike branches that have large, oval openings, dermal surfaces with numerous rows of small, round, inhalant ostia of blind, radial canals; gastral surface without ostia but with regular quadrate meshes in skeleton that has hexatine junctions that lack lychniscoid structure and rays that have small spines; dermal layer not developed. *Upper Cretaceous:* Germany.——Fig. 311,*2a–b. *B. elegans,* Quadratenkreide, Cenomanian, Oberg; *a,* side view of branched stem; *b,* small, baglike structures showing regular, skeletal structure, ×1 (Schrammen, 1902).

Eubrochis Schrammen, 1902, p. 19 [**E. senonica;* OD] [=*Callibrochis* Schrammen, 1912, p. 246, obj.; *Oxyrhizium* Schrammen, 1912, p. 249 (type, *C. eximium*)]. Funnel-like, sometimes stalked; internal, skeletal meshwork with transverse beams forming irregularly meshed, transverse lamellae, through which dictyonal strands run longitudinally; internal structure exposed on gastral side, apart from accretion of small hexactines, or with covering cortex and pores in older parts; masked on dermal side by denser, irregular meshwork, with vague or distinct skeletal pores; loose spicules unknown. *Upper Cretaceous:* Germany.——Fig. 312,*1. *E. senonica,* Quadratenkreide, Campanian, Oberg; side view showing gastral surface on left and sections through wall on right, ×0.5 (Schrammen, 1902).

Habrosium Schrammen, 1912, p. 248 [**H. convolutum;* OD]. Irregular, funnel-like sponges with very thin, irregularly indented and folded wall; without obvious ostia, epirhyses, aporhyses, and postica; hexactinosan skeletal structure regular with hexactines fused with additional rays or beams; dermal layer with thickened, tangential rays, gastral surface lacking differentiated layer. [Tentatively included in the family.] *Upper Cretaceous:* Germany.——Fig. 311,*3. *H. convolutum,* Quadratenkreide, Campanian, Oberg; skeletal structure of the interior skeleton, ×45 (Schrammen, 1912).

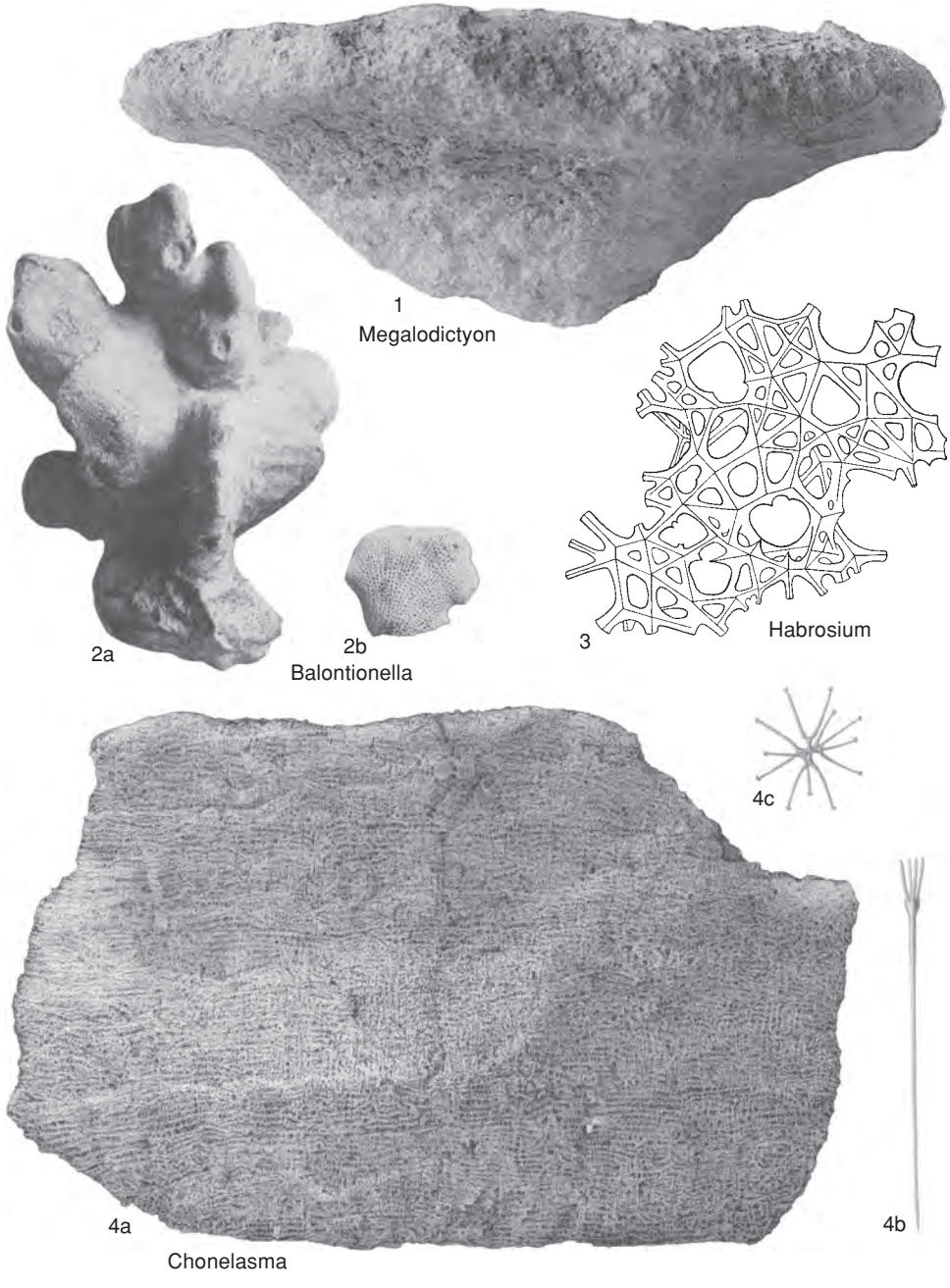


FIG. 311. Euretidae (p. 473–475).

Megalodictyon OPPLIGER, 1926, p. 35 [**M. fretreulensis;* OD]. Large, thick-walled funnel; surfaces with large, skeletal pores in irregular, cortical meshwork, with shallow epirhyses on dermal side; internal meshwork wide meshed, not canalized, with meshes between dictyonal strands predominantly rectangular; loose spicules unknown. [Apparently similar and possibly identical to living *Chonelasma* SCHULZE, 1887a.] *Jurassic (Oxfordian):* Switzerland, Germany.——FIG. 311,*1*. **M.*

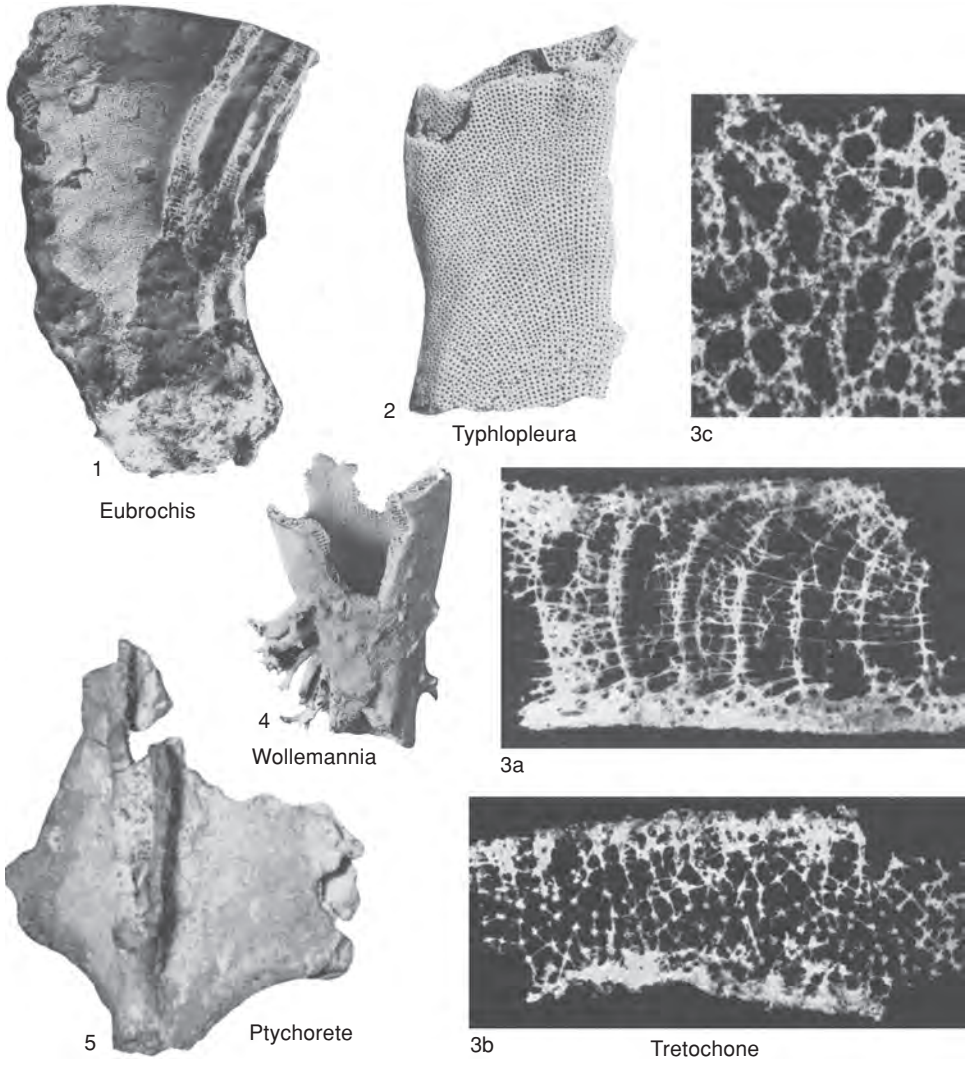


FIG. 312. Euretidae (p. 473–476).

fretreulensis, Gorge of l'Areuse, Switzerland; side view of thick-walled, funnel-shaped sponge with large, inhalant ostia, ×0.5 (Oppliger, 1926).

Ptychorete REID, 1964, p. lxiv [**P. ijimai;* OD]. Wall radially folded above tubular stalk to form radiating, bilaterally compressed, hollow flanges, continuous in middle, or with several such growths arising from branching stock; small, parietal oscula along narrow, folded margins; skeleton as in *Wollemannia* SCHRAMMEN. *Cretaceous (Coniacian–Maastrichtian):* Northern Ireland.——FIG. 312,*5.* **P. ijimai,* Glauconitic Chalk, Senonian, County Antrim; side view of incomplete, stellate holotype with two flanges laterally and broken one with flange section toward front, BM S.8619, ×1 (Reid, 1964; courtesy of The Palaeontographical Society, London).

Tretochone REID, 1959, p. 11 [**Ptychodesia duplicata* TOPSENT, 1928c, p. 1; OD]. Flabellate, inversely curved transversely (i.e., gastral side external), sometimes enrolled to form a funnel by union of lateral margins; dermal side with papilliform outgrowths, sometimes replaced locally by transverse, shelflike features; both skeletal surfaces with round, intracortical pores (ostia or postica) arranged in longitudinal series; gastral side with additional slitlike apertures, little wider than pores that open inward into longitudinal tunnels (amararhyses) in internal meshwork; dictyonal strands spreading to both

surfaces of skeletal framework, and beams connecting them arranged to form distally convex, transverse lamellae, whose margins unite at both surfaces to form cortical meshwork; branches of amararhyses run to round perforations at tops of outgrowths of dermal side and sometimes also transversely in shelflike features; living example with main canal system as in *Chonelasma* SCHULZE; pinular hexactines as dermalia and gastralia, and scopules. [Confused by IJIMA (1927, p. 116, 165), TOPSENT (1928c, p. 1), and DE LAUBENFELS (1955, p. 84) with *Ptychodesia* SCHRAMMEN (1912, p. 252; family Craticulariidae herein), which has no Holocene species.] *Holocene:* Pacific Ocean (Japan).——FIG. 312,*3a–c.* **T. duplicata* (TOPSENT), Sugami Bay; *a,* longitudinal section with transverse lamellae arcuate in direction of growth and emerging bilaterally; *b,* distal face of transverse lamella with cortical meshwork along top and bottom, ×5; *c,* tangential view of dermal cortex, all specimens in REID's collection, ×6 (Reid, 1964; courtesy of The Palaeontographical Society, London).

Typhlopleura SCHRAMMEN, 1902, p. 24 [**T. dichotoma;* OD]. Bilaterally compressed, forms scabbard- or leaflike growths with similar growths arising from their narrow margins, sometimes also reuniting marginally; margins with parietal oscula; exterior with skeletal pores in radiating, longitudinal series piercing fine, cortical meshwork; interior as in *Eubrochis* SCHRAMMEN, or with cortical meshwork and postica on gastral side. *Upper Cretaceous:* Germany.——FIG. 312,*2.* **T. dichotoma,* Mucronatenkreide, Maastrichtian, Misburg; side view of fragment of scabbardlike sponge with fine, cortical meshwork, ×1 (Schrammen, 1902).

Wollemannia SCHRAMMEN, 1912, p. 247 [**W. araneosa;* OD]. Similar to *Eubrochis* but with no skeletal pores; internal framework covered on dermal side or both sides by thin layers of fine, cortical meshwork that is sharply distinct from internal framework; loose spicules unknown. *Upper Cretaceous:* Germany.——FIG. 312,*4.* **W. araneosa,* Quadratenkreide, Cenomanian, Oberg; side view of type with steeply funnel-like form and regular, reticulate skeleton and canal pattern, ×1 (Schrammen, 1912).

Subfamily UNCERTAIN

Belonisia RAUFF, 1933, p. 26 [**B. necopinata;* M]. Nature uncertain; single example a small budlike sponge, possibly juvenile; exterior with small ostia in form of rounded, skeletal meshes; radial canals possibly internally; loose spiculation unknown. *Upper Cretaceous:* Germany.——FIG. 310,*1a–b.* **B. necopinata,* Greensand, upper Turonian, Ruhr Valley; *a,* side view of small sponge, ×1; *b,* drawing showing skeletal structure of outer skeleton, ×50 (Rauff, 1933; courtesy of Preussischen Geologischen Landsanstalt, E. Schweizerbart'sche Verlagsbuchhandlung).

Family CRATICULARIIDAE Rauff, 1893

[Craticulariidae RAUFF, 1893, p. 191] [=Euretidae ZITTEL, 1877b, p. 35, *partim;* Leptophragmidae SCHRAMMEN, 1912, p. 191; Craticularinae DE LAUBENFELS, 1936, p. 186; Leptophragmatidae DE LAUBENFELS, 1955, p. 80; Laocaetidae MEHL, 1992, p. 71]

Skeletal framework three dimensional initially, constructed as in Euretidae, but normally with fully developed epirhyses and aporhyses; skeletal canals typically radial and blind, arranged with epirhyses and aporhyses in alternating, longitudinal series, and often so that each canal of one sort stands quincuncially between four of others; apertures then arranged in longitudinal and transverse rows; some genera with epirhyses open at both ends or arranged without order, or without aporhyses in some individuals; dictyonal strands spread subequally to both surfaces from interior, or run mainly or all to dermal surface; beams between ends of strands usually forming cortical meshwork, which secondary accretions may make thicker or denser; superficial meshwork in some genera, formed from dictyonal hexactines, or additionally by ankylosis of dermal or gastral stauractines; scopules in a living example. [Only Mesozoic and Cenozoic forms are discussed here. Older forms are treated in the section on Paleozoic hexactinosans, p. 437 herein.] *Triassic (Carnian)–Holocene.*

Three subfamilies are included herein, Craticulariinae *s.s.,* Laocoetidinae DE LAUBENFELS, and Leptophragmatinae SCHRAMMEN.

A. Craticulariinae: superficial meshwork formed partly by dictyonal hexactines, partly by fused dermal or gastral stauractines.

B. Laocoetidinae: superficial meshwork formed from dictyonal hexactines only; dermalia, gastralia pentactines where known, sometimes trapped in superficial meshes but not forming distinct tangential networks.

C. Leptophragmatinae: superficial meshwork absent.

Subfamily CRATICULARIINAE Rauff, 1893

[*nom. transl.* Reid, herein, *pro* Craticulariidae Rauff, 1893, p. 191] [=Craticulariidae Rauff, 1893, p. 191, *partim;* Sphenaulacidae Schrammen, 1937, p. 43]

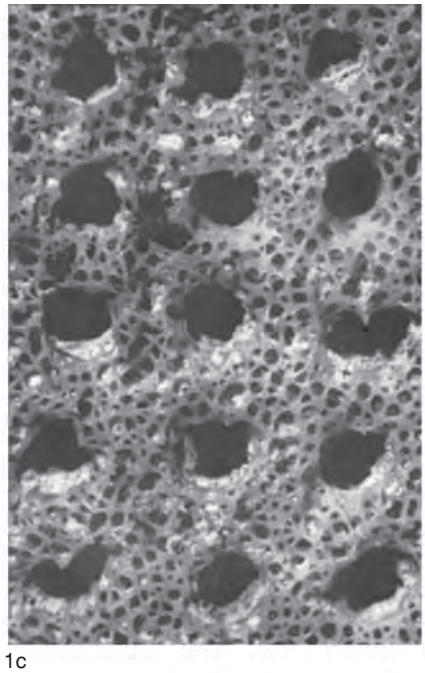
Craticulariidae in which dermal or gastral stauractines are united to form superficial meshwork in fully developed individuals; tubular to funnel shaped to dishlike, branched tubular, or flabellate sponges, seldom thin walled, with nodular or rootlike, basal masses; ostia and postica grouped quadrately or less regularly, usually round or ovate although sometimes finely denticulated; sometimes in longitudinal furrows; dictyonal strands generally spread equally or subequally to both skeletal surfaces with meshes often mainly rectangular; outermost meshwork usually forming denser cortex on both sides; superficial meshwork of dictyonal origin variably developed, but usually present to some extent, dermal or gastral stauractines simply cemented at points of contact, or additionally connected by siliceous filaments that may form networks in paratangential meshes; connected gastralia in one genus only. [Craticulariinae comprise the Craticulariidae Rauff *sensu* Schrammen, 1937, less *Pachyascus* Schrammen, 1937 (herein in Laocoetidinae de Laubenfels), plus the Sphenaulacidae Schrammen, 1937. Known examples are Jurassic sponges; some genera are recorded from Lower Cretaceous (e.g., Lagneau-Hérenger, 1962), but characteristic dermal structures have not been verified.] *Triassic–Paleogene (Thanetian).*

Craticularia Zittel, 1877b, p. 46 [**Scyphia parallela* Goldfuss, 1826, p. 8; SD Hinde, 1893b, p. 198; not *Scyphia paradoxa* Münster, 1883, SD de Laubenfels, 1955, p. 80; =*Scyphia procumbens* Goldfuss, 1826, p. 11 (see Ziegler, 1962, p. 575)] [=*Paracraticularia* Schrammen, 1937, p. 28 (type, *Scyphia procumbens* Goldfuss, 1826, p. 11, SD de Laubenfels, 1955, p. 80); *Desmocinia* Pomel, 1872, p. 83 (type, *Scyphia procumbens* Goldfuss, 1826, p. 11, OD), suppressed under *Code* Art. 23.2 (ICZN, 1999)]. Tubular or branched-tubular, with some branches sometimes ending blindly; skeletal canals in regular series with apertures typically arranged quadrately; apertures (ostia, postica) rounded, quadrate, or finely denticulated by skeletal outgrowths; dictyonal strands spread equally or subequally to both sides of skeletal framework; outermost meshwork of both sides forming a more or less distinct cortex; both sides with superficial outgrowths formed from dictyonal hexactines, and with additional fused dermal stauractines in fully grown examples; basal mass nodular to rootlike. [Records from later systems refer to forms (mainly *Laocoetis* Pomel, 1872, p. 92) that lack connected dermal stauractines.] *Middle Jurassic–Upper Jurassic:* Poland, Germany.——Fig. 313,*1a–c.* **C. parallela* (Goldfuss), Middle Jurassic beds, Callovian, Ardèche, France; *a,* side view of characteristic specimen with branches and regular series of inhalant ostia, PIUZ E/6, ×1; *b,* vertical section showing upwardly divergent, skeletal structure interrupted by smaller inhalant and larger exhalant canals, PIUZ E/1, ×5; *c,* photomicrograph of outer surface showing aligned, inhalant ostia and small, skeletal pores in the fused skeleton, PIUZ E/1, ×10 (Ziegler, 1962; courtesy of *Eclogae Geologicae Helvetiae,* Birkhäuser Verlag AG).

Dictyonocoelia Étallon, 1859b, p. 536 [**Scyphia schweiggeri* Goldfuss, 1829, p. 91; OD] [=*Thyroidium* de Laubenfels, 1955, p. 80, obj., *nom. nov. pro Thyridium* Schrammen, 1937, p. 31, *non* Dejean, 1833]. Tubular to funnel-like or flabellate, thin or thick walled; skeleton mainly similar to that of *Craticularia* Zittel, but postica open along shallow, longitudinal furrows and dermal stauractines are finely spined. [The type species was written *S. schweiggeri* by Étallon, 1859b.] *Upper Jurassic, ?Lower Cretaceous:* Germany, Poland.——Fig. 314,*3a–b.* **D. schweiggeri* (Goldfuss), Weiss Jura, Upper Jurassic, Hossingen, Germany; *a,* dictyonal structure of gastral surface of wall, ×5; *b,* broad, discoidal sponge with regular, radiate, skeletal and canal structure, ×0.5 (Schrammen, 1937).——Fig. 314,*3c. D. lineatum* (Schrammen), Weiss Jura, Upper Jurassic, Heuchstetten, Germany; enlarged, outer part of sponge with fine, skeletal structure preserved between circular, inhalant ostia, ×5 (Schrammen, 1936).

Diphyllospira Herrmann-Degen, 1980, p. 19 [**D. ectophoios;* OD]. Sponges consisting of two non-overlapping, spiralled to occasionally twisted parts; margins of both are distinct and not intergrown with other, so that sponges appear as a double screw, but they may be locally intertwisted along long axis; parenchymal skeleton consisting of smooth hexactines and is euretoid; dictyonal cortex is thicker the dermal surface than on gastral; canal system is craticulariid. *Paleogene (Thanetian):* Egypt.——Fig. 314,*2.* **D. ectophoios,* "Chalk member" of Tarawan Formation, Bulaq Oasis, between Kharga and Baris, southwestern Egypt; side view showing double spriralling form of the genus, ×0.5 (Herrmann-Degen, 1980).

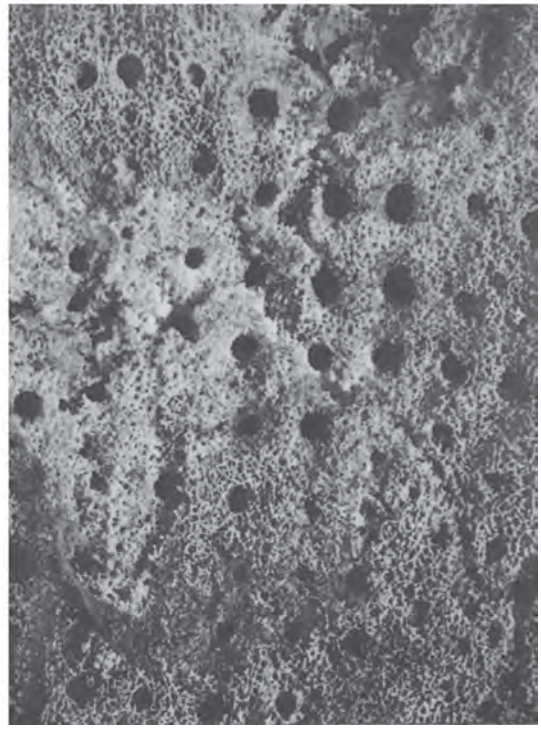
1a



1c

1b

Craticularia



2

Pycnocalyptra

FIG. 313. Craticulariidae (p. 477–481).

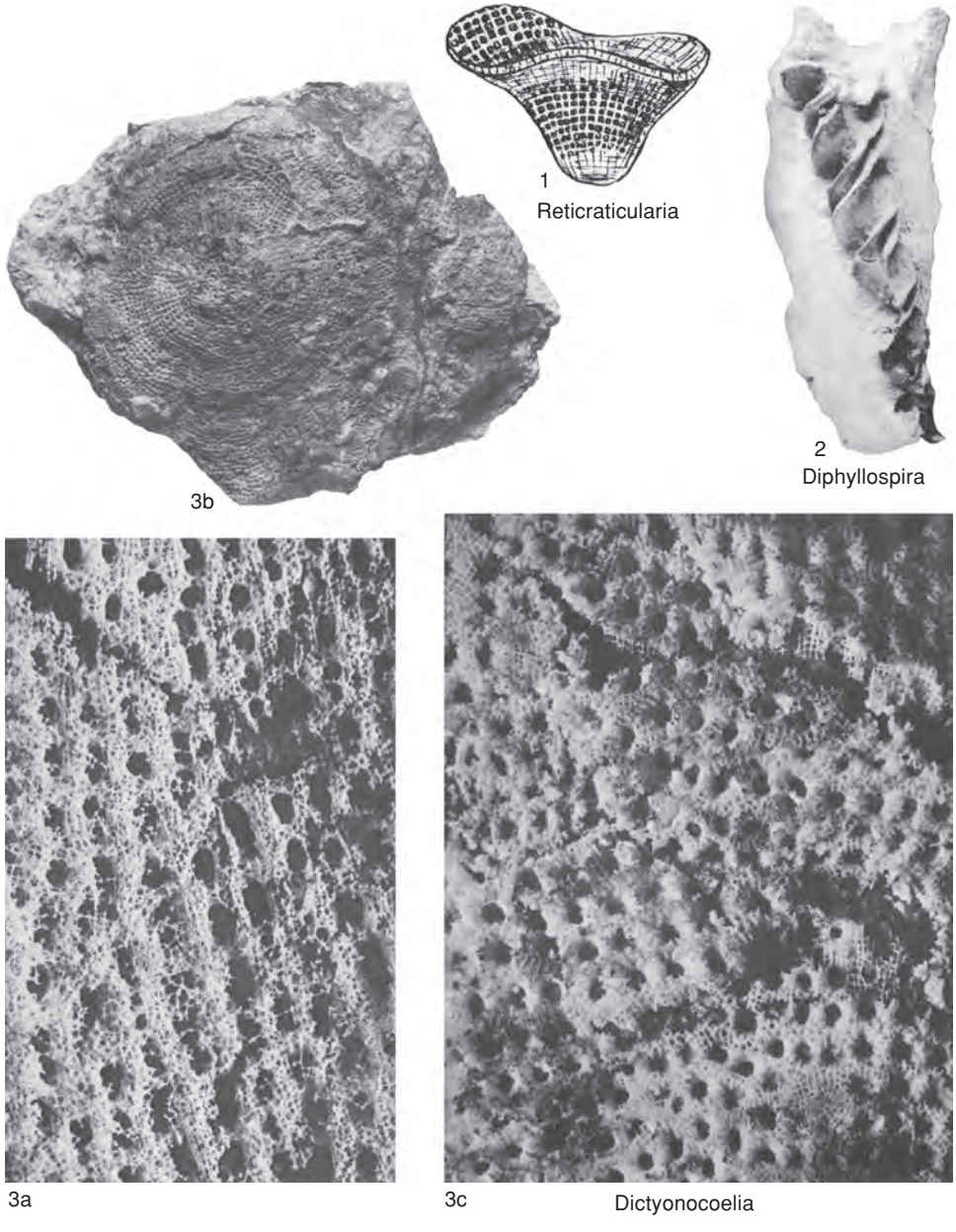


FIG. 314. Craticulariidae (p. 477–481).

Eutactostomium HERRMANN-DEGEN, 1980, p. 17 [**E. helicosoma* HERRMANN-DEGEN, 1980, p. 18; OD]. Sponges with form of a bilaterally flattened tube that spirals around vertical axis; in spiral structure, regularly crossing, round openings are part of short, tubular, recumbent projections or are reduced, parietal oscula; dictyonine, parenchymal skeleton consisting of smooth, very regular hexactines, which are thickened in both gastral and dermal layers; small ostia and postica perforate these layers in regular, vertical rows in a quadrunxial pattern; canal system with craticular diplorhysis. *Paleogene (Thanetian):* Egypt.——FIG. 315,*3. *E. helicosoma,* Chalk member, Tarawan Formation, Bulaq Oasis, between Kharga and Baris, southwestern Egypt; frontal view of spiralled sponge showing characteristic growth form, ×1 (Herrmann-Degen, 1980).

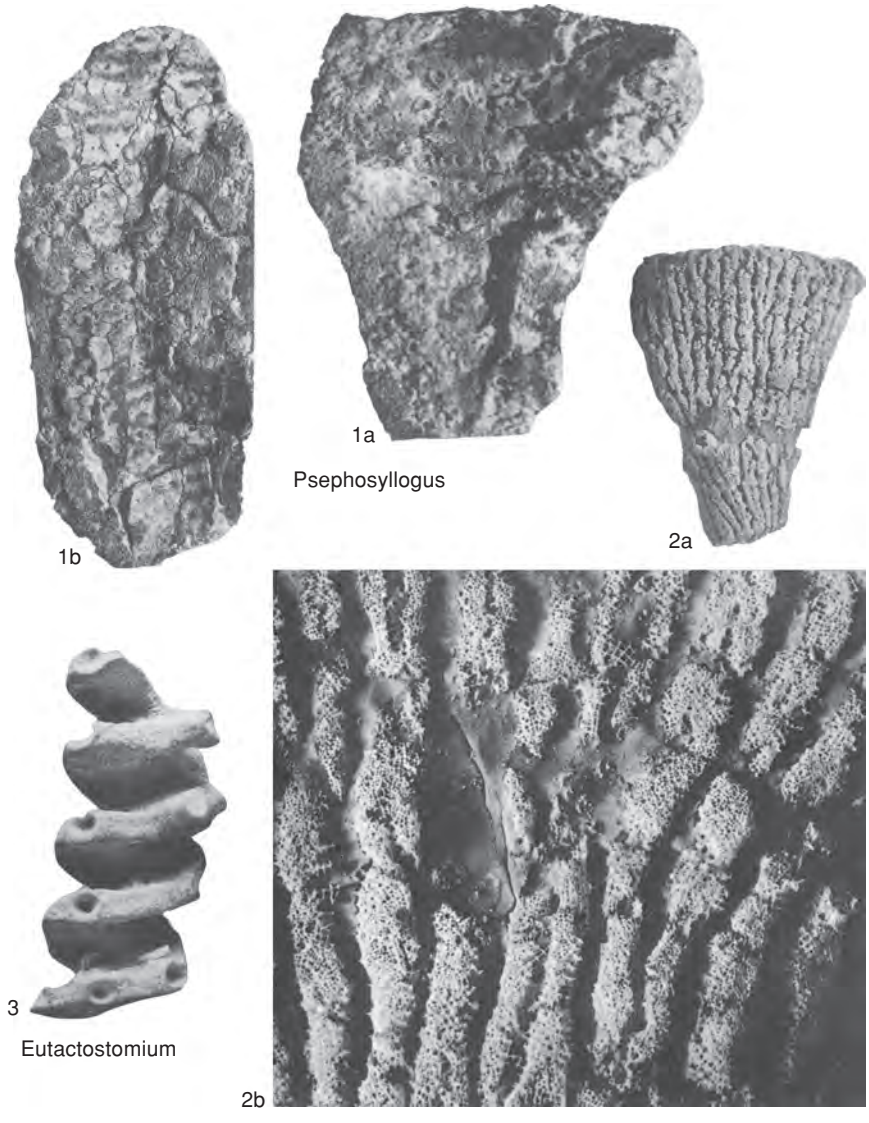


FIG. 315. Craticulariidae (p. 479–481).

Psephosyllogus SCHRAMMEN, 1937, p. 33 (SCHRAMMEN, 1936, p. 181, *nom. nud.*) [**P. diligens;* M]. Similar to *Pycnocalyptra,* but connected stauractines are known from dermal side only, and (some) apopores in transverse corrugations of gastral side; moderately thick walls with inhalant prosopores oval and in vertical rows. [Could be identical with *Pycnocalyptra,* based on individual differences.] *Upper Jurassic:* Germany, Poland.——FIG. 315,*1a–b.* **P. diligens,* Weiss Jura, Heuchstetten, Germany; *a,* gastral view with moderately thick, broken wall and exhalant ostia, ×1; *b,* inner or gastral surface with apopores in transverse corrugations, ×0.5 (Schrammen, 1937).

Pycnocalyptra REID, *nom. nov.* herein (SCHRAMMEN, 1937, p. 33, *nom. nud.*) [**P. calyx* SCHRAMMEN, 1937, p. 34; OD]. Funnel- or dishlike, thick walled with swollen base; ostia and postica widely spaced, puncturelike in flat surfaces; both sides with connected stauractines (dermalia and gastralia), with paratangential meshes filled by networks of siliceous filaments. [DE LAUBENFELS (1955, p. 79) subse-

quently designated the type species for *Pycnocalyptra,* but according to *Code* Article 13.3 (ICZN, 1999), subsequent designation is admissable only for genera established prior to 1931 (see also p. xix, herein).] *Upper Jurassic:* Germany.——Fig. 313,*2. *P. calyx,* Weiss Jura, Heuchstetten; enlarged outer surface showing dictyonal skeletal area perforated by inhalant ostia, ×5 (Schrammen, 1936).

Reticraticularia Lagneau-Hérenger, 1962, p. 54 [**R. albiensis* Lagneau-Hérenger, 1962, p. 55; OD]. Small, cup-shaped, pedunculate sponges with thin walls and undulating rims; both dermal and gastral surfaces with similar, moderately large ostia arranged in very regular, quadrangular patterns and separated by narrow, skeletal elements; dermal and gastral layers dictyonine with plain nodes. *Cretaceous (Albian):* France.——Fig. 314,*1. **R. albiensis,* Andon; side view showing form of thin-walled sponge and regularly distributed, moderately large, inhalant and exhalant ostia of syntype, ×1 (Lagneau-Hérenger, 1962).

Sphenaulax Zittel, 1877b, p. 47 [**Scyphia costata* Goldfuss, 1826, p. 6; M] [=*Cnemiseudea* du Fromentel, 1860a, p. 28, obj., suppressed under *Code* Art. 23.2 (ICZN, 1999); *Rhabdocnemis* Pomel, 1872, p. 80, obj. (type, *Scyphia costata* Goldfuss, 1826, p. 6, SD Rauff, 1893, p. 66), suppressed under *Code* Art. 23.2 (ICZN, 1999); *Calycospongia* Wu & Xiao, 1989, p. 14 (type, *C. pleiopetala,* OD)]. Cylindrical or funnel-like; outside with well-marked, longitudinal furrows, along which are ostia of inhalant, skeletal canals (epirhyses); gastral side not furrowed; dermal furrows straight sided, or denticulated by outgrowths that may unite to bridge them; dermal stauractines also fuse to form a tangential network and extend across furrows, but do not line them; wall wrongly said to be radially folded. *Triassic (Carnian)–Upper Jurassic:* China (Sichuan), *Carnian;* Germany, *Upper Jurassic.*——Fig. 315,*2a–b. **S. costata* (Goldfuss), Weiss Jura, Streitberg; *a,* side view of funnel-like sponge with longitudinal grooves, ×0.5; *b,* enlarged, dermal part of wall with longitudinal grooves and fine-textured skeleton, ×4 (Schrammen, 1937).

Subfamily LAOCOETIDINAE de Laubenfels, 1955

[*nom. transl.* Reid, herein, *ex* Laocoetididae de Laubenfels, 1955, p. 82]

Craticulariidae without superficial meshwork formed by union of dermal or gastral stauractines, although superficial dictyonal meshwork is usually present; thick- or thin-walled sponges, generally similar to Craticulariinae in habitus and skeletal structure. Characteristic arrangement of ostia and postica usually clearly apparent, but obscured in one genus by ostia having very irregular shapes in some examples. [Name Laocoetididae was published (de Laubenfels, 1955, p. 82) without diagnosis in definition of family Myliusiidae "de Laubenfels *nov.*" (*recte* Schulze, 1885), apparently as an unadopted alternative to Leptophragmatidae Schrammen, since *Laocoetis* Pomel, 1872 (p. 92) (=*Laocoetis* de Laubenfels, *nom. null.*) is placed in that family (de Laubenfels, 1955, p. 80). Herein used for Craticulariidae similar to Craticulariinae but lacking connected dermalia or gastralia; comprises all (certain) post-Jurassic genera but those in Leptophragmatinae. Immature Craticulariinae also lack connected dermalia and gastralia (as also may imperfect examples), but their absence in genera herein listed (except, perhaps *Pachyascus* Schrammen) is considered due to permanent lack of fusion in life. Occasional dermalia or gastralia trapped in the skeletal framework are also pentactines in cases known to the writer.] *Triassic (Carnian)–Neogene (Miocene, ?Pliocene).*

Laocoetis Pomel, 1872, p. 92 [**L. crassipes* Pomel, 1872, p. 93; SD de Laubenfels, 1955, p. 80] [=*Rhabdocoetis* Pomel, 1872, p. 102 (type, *Ocellaria cancellata* Roemer, 1864, p. 17, OD), suppressed under *Code* Art. 23.2 (ICZN, 1999); *Laocoetis* Moret, 1924, p. 20, *nom. null.; Poteridium* Rauff, 1933, p. 22 (type, *P. cretaceum,* M); *Aulacosia* Rauff, 1933, p. 34, obj. (type, *Ocellaria cancellata* Roemer, 1864, p. 17, M)]. Funnel-like, tubular or flabelliform, with a massive, tuberous base in some species; skeletal canals in regular series with their apertures in longitudinal and transverse rows or less regularly arranged; beams between ends of dictyonal strands forming cortical meshwork at both skeletal surfaces; dermal or both sides usually with superficial outgrowths or meshwork formed from dictyonal hexactines or partly from siliceous filaments; much of dermal surface sometimes covered by upward extension of basal skeleton, which forms a thick, secondary cortex; no fused stauractines on either side. *Middle Jurassic (Bajocian)–Neogene (Miocene, ?Pliocene):* Hungary, *Bajocian;* Germany, *Upper Jurassic;* Europe, Algeria, *Cretaceous–Miocene, ?Pliocene.*——Fig. 316,*1a. **L. crassipes,* Miocene, Djebel Djambeida, Algeria; side view of large, funnel-shaped sponge with ostia of canals in regular series, ×0.25 (Pomel, 1872).——Fig. 316,*1b–c. *L. cancellata* (Roemer), Cuvieri beds, Turonian, Vienenburg, Germany; *b,* gastral view of small fragment showing radial alignment of ovoid, exhalant ostia in depressed areas, ×1; *c,*

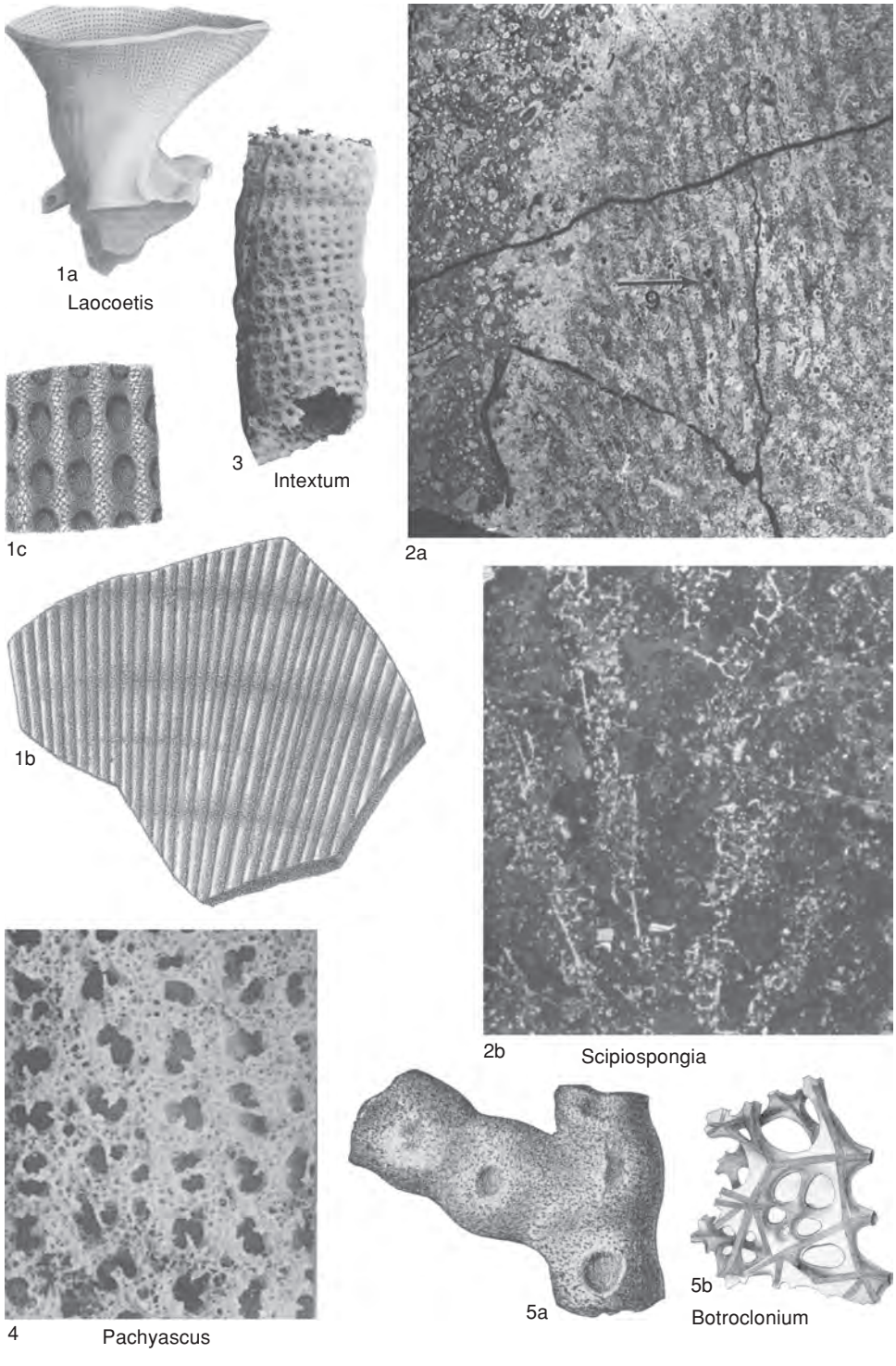


FIG. 316. Craticulariidae (p. 481–483).

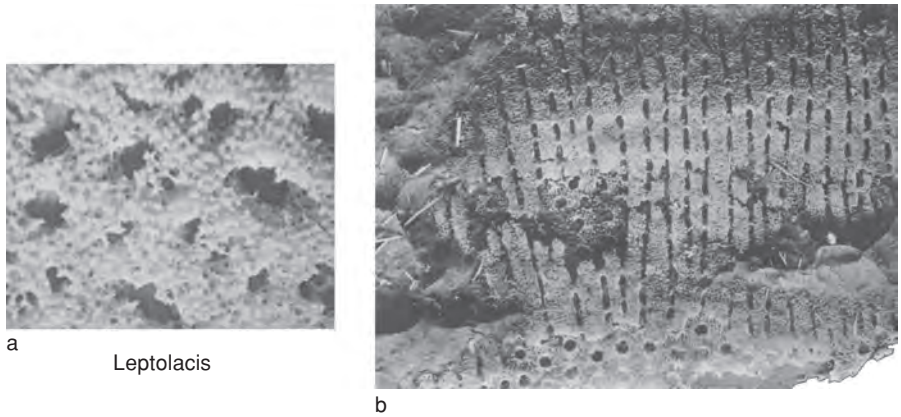


FIG. 317. Craticulariidae (p. 483).

enlarged section showing ostia in radial series, enlarged (Roemer, 1864).

Botroclonium POČTA, 1883, p. 28 [**B. arborescens* POČTA, 1883, p. 29; SD DE LAUBENFELS, 1955, p. 84]. Branching growths with oscula of local, gastral cavities along one side; axial paragaster absent or only locally present; ostia of epirhyses arranged quadrately or irregularly; postica crowded in walls of local, gastral cavities; superficial meshwork formed from dictyonal hexactines may bridge or veil ostia. *Upper Cretaceous:* Czech Republic, Slovakia.——FIG. 316,*5a–b. *B. arborescens,* Korytzaner Schichten, Kamajk; *a,* side view of branched sponge with oscula along one side, ×0.66; *b,* part of skeletal structure, ×40 (Počta, 1883).

Intextum DE LAUBENFELS, 1955, p. 84, *nom. nov. pro Syringium* SCHRAMMEN, 1912, p. 256, *non* PRINCIPI, 1909 [**Syringium textum* SCHRAMMEN, 1912, p. 256; OD]. Tubular, externally similar to *Laocoetis* but epirhyses open at both ends; no dictyonal cortex on gastral side; superficial outgrowths on dermal side form veils across ostia. [A pseudogenus, possibly due to preservation.] *Upper Cretaceous:* Germany.——FIG. 316,*3. *I. textum* (SCHRAMMEN), Quadratenkreide, Cenomanian, Oberg; side view of tubular type with distinct epirhyses that have minor outgrowths along their margins, ×1 (Schrammen, 1912).

Leptolacis SCHRAMMEN, 1937, p. 60 (SCHRAMMEN, 1936, p. 183, *nom. nud.*) [**L. striata;* OD]. Flabelliform, thin walled; apertures of skeletal canals irregularly shaped and arranged without order on possible dermal side, elongate slits arranged in longitudinal series and rough transverse rows on possible gastral side; dictyonal superficial outgrowths or meshwork on the dermal side. *Upper Jurassic:* Germany.——FIG. 317*a–b. *L. striata,* Weiss Jura, Gerstetten; *a,* enlargement of exterior showing skeletal structure and occurrence of inhalant ostia, ×5 (Schrammen, 1936); *b,* inner surface of the wall showing prominent alignment of elongate slits between skeletal tracts, with round ostia in gastral layer at base of figure, ×4 (Schrammen, 1937).

Pachyascus REID, *nom. nov.* herein (SCHRAMMEN, 1937, p. 35, *nom. nud.*) [**P. formosus* SCHRAMMEN, 1937, p. 35*;* OD]. Tubular to funnel-like, fairly thick walled; ostia and postica arranged quadratically or less regularly, sometimes locally evident order; ostia characteristically irregular and variable in shape because outgrowths of skeletal surface may sometimes unite across them. [DE LAUBENFELS (1955, p. 79) subsequently designated the type species for *Pachyascus,* but according to *Code* Article 13.3 (ICZN, 1999), subsequent designation is admissable only for genera established prior to 1931 (see also p. xix, herein).] *Upper Jurassic–Lower Cretaceous:* Germany.——FIG. 316,*4. *P. formosus,* Weiss Jura, Upper Jurassic, Oberdigisheim; skeletal tracts with dictyonal structure separated by rows of inhalant ostia, ×5 (Schrammen, 1936).

Scipiospongia RIGBY, WU, & FAN, 1998, p. 133 [**S. columnaria;* OD]. Steeply obconical, thick-walled dictyonine with vertical rows of inhalant-exhalant canals in possible craticulariid pattern, cross connecting to longitudinal, upwardly divergent canals, separated by distinct skeletal tracts in which thickened, primary strands form vertical rods at canal boundaries and remainder of net of girderlike tracts composed mainly of short beams and synapticulae, producing dominantly triangular, skeletal pores. *Triassic (Carnian):* China (Sichuan).——FIG. 316,*2a–b. *S. columnaria,* Hanwang Formation, Jushui; *a,* holotype, vertical section with light gray matrix filling canals between darker gray skeletal tracts, radial canals show as circular cross sections in upper part, thick microbial crust coats sponge on left, *arrow* showing position of *b,* ×1; *b,* photomicrograph of characteristic, girderlike tracts in holotype where rodlike, vertical strands are parallel to matrix-filled, vertical canals, IGASB R6-21(065), ×10 (Rigby, Wu, & Fan, 1998).

Subfamily LEPTOPHRAGMATINAE Schrammen, 1912

[*nom. transl.* Reid, herein, *ex* Leptophragmatidae de Laubenfels, 1955, p. 80, *nom. correct. pro* Leptophragmidae Schrammen, 1912, p. 191]

Typically thin-walled Craticulariidae of tubular, funnel-like, flabellate, or various special habits; canals small, closely spaced, normally in regular series; apertures (ostia, postica) typically rounded, puncturelike, usually in longitudinal and transverse rows, but sometimes in longitudinal series only; rarely with canalization imperfect in some individuals, then absent internally or seen on dermal side only; dictyonal strands of internal meshwork gradually spread or mainly or all directed toward dermal skeletal surface, which they approach steeply or radially; sometimes radial for most of their length; meshwork seen in tangential sections, hence, often irregular; superficial meshwork absent, except where older parts are coated by basal skeleton or analogous meshwork of gastral side. [A mainly Cretaceous group, centered morphologically on *Leptophragma* Zittel, without superficial specializations of earlier Craticulariinae.] *?Jurassic, Cretaceous (?Berriasian–?Aptian, Albian)–Holocene.*

Leptophragma Zittel, 1877b, p. 48 [**Scyphia murchisoni* Goldfuss, 1831, p. 219; SD de Laubenfels, 1955, p. 80] [=*Polystigmatium* Schrammen, 1912, p. 254 (type, *P. striatopunctatum*)]. Tubular, scabbardlike, funnel-like, or flabellate; often stalked; sometimes irregularly compressed, convolute, or lobate marginally when funnel-like; dictyonal strands of some species run steeply to radially outward. Dermalia, gastralia pentactines (rarely trapped in meshes). [Distinguished by Schrammen (1912, p. 254) on the basis of spherical swelling of nodes at skeletal surfaces.] *?Jurassic, ?Lower Cretaceous, Upper Cretaceous:* Europe.——Fig. 318,*5. L. striatopunctatum* (Schrammen), Quadratenkreide, Cenomanian, Oberg, Germany; skeletal fragment of dictyonal hexactines, ×45 (Schrammen, 1912).

Leptophragmella Reid, 1963a, p. 226 [**Chonelasma choanoides* Schulze & Kirkpatrick, 1910a, p. 302; OD; =*C. lamella choanoides* Schulze & Kirkpatrick, 1910a, p. 302, *non C. lamella* F. E. Schulze, 1886]. Similar to *Leptophragmus* in growth form; canalization normal or showing reduction, consisting in ultimate reduction of shallow epirhyses only; aporhyses or corresponding soft structures opening between successive, transverse, skeletal lamellae; no superficial meshwork; loose spicules pentactine dermalia and gastralia, dermal and gastral scopules, parenchymal uncinates, oxyhexasters and discohexasters. [The only known living craticulariid sponge.] *Holocene:* Antarctic Ocean.——Fig. 318,*4a–c. *L. choanoides* (Schulze & Kirkpatrick); *a,* side view of funnel-shaped, typical form, ×1; *b,* pentactine dermalia; *c,* parenchymal skeleton with associated scopules and small, spinose hexasters, ×100 (Schulze & Kirkpatrick, 1910a).

Pleurostoma F. A. Roemer, 1840 in 1840–1841, p. 5 [**P. radiatum;* SD de Laubenfels, 1955, p. 81]. Bilaterally compressed, scabbardlike, with parietal oscula along narrow margins; or initially of this habitus, expanding above into funnel; postica sometimes in longitudinal furrows. *Upper Cretaceous:* Europe.——Fig. 318,*3. *P. radiatum,* Quadratenkreide, Cenomanian, Oberg, Germany; side view of upper part of scabbardlike sponge with prominent rows of inhalant ostia and oscula along upper, narrow margin, ×1 (Schrammen, 1912).

Pseudoguettardia Moret, 1926a, p. 16 [**Guettardia thiolati* d'Archiac, 1846, p. 197; OD]. Sponges with folded, thin, finlike walls arranged in a cross or starlike pattern around central axis, similar to in *Guettardia;* dermal surface marked by irregularly placed, small, cuplike depressions; wall pierced by small, equidistant canals in moderately regular alignment locally; dense hexactinosan skeleton with regular, robust, unperforated nodes. *Paleogene (Eocene):* Spain.——Fig. 318,*7a–c. *P. thiolata* (d'Archiac), Rocher de la Gourêpe, Lutetian, Biarritz; *a,* side view of double-walled, folded, fin fragment with scattered, small depressions and fine epirhyses in dermal surface, ×1; *c,* fragments of skeleton, scale unknown (Moret, 1926b; courtesy of Société Géologique de France).

Ptychocoetis Pomel, 1872, p. 101 [**Pleurostoma trilobata* F. A. Roemer, 1864, p. 14; OD] [=*Pleuroguettardia* Reid, 1963a, p. 226 (type, *Guettardia stumpeli* Schrammen, 1912, p. 240, OD)]. Wall folded longitudinally above the base to form radiating and bilaterally compressed hollow flanges, continuous in the middle; rounded to elongate parietal oscula along outward margins of flanges. *Upper Cretaceous:* Europe.——Fig. 318,*6. *P. trilobata* (Roemer), Quadratenkreide, Cenomanian, Oberg, Germany; side view of sponge with folded wall and oscula along crests of folds, ×1 (Schrammen, 1912).

Ptychodesia Schrammen, 1912, p. 252 [**P. papillata;* OD]. Ovate plate with papilliform outgrowths on one side, apertures leading into them on the other; additional longitudinal plications may be locally developed, with papillae then rising along them; papillate side probably dermal. *Upper Cretaceous:* Europe.——Fig. 318,*2. *P. papillata,* Quadratenkreide, Cenomanian, Oberg, Germany; papilliform probably dermal surface on plate with ostia on ridge crests, and fine skeletal structure between, ×1 (Schrammen, 1912).

Strephinia Hinde, 1884a, p. 96 [**S. convoluta;* SD de Laubenfels, 1955, p. 80]. Convoluted funnels or lamella arising from a branched, tubular stock, or latter only; dermal surface of skeletal framework

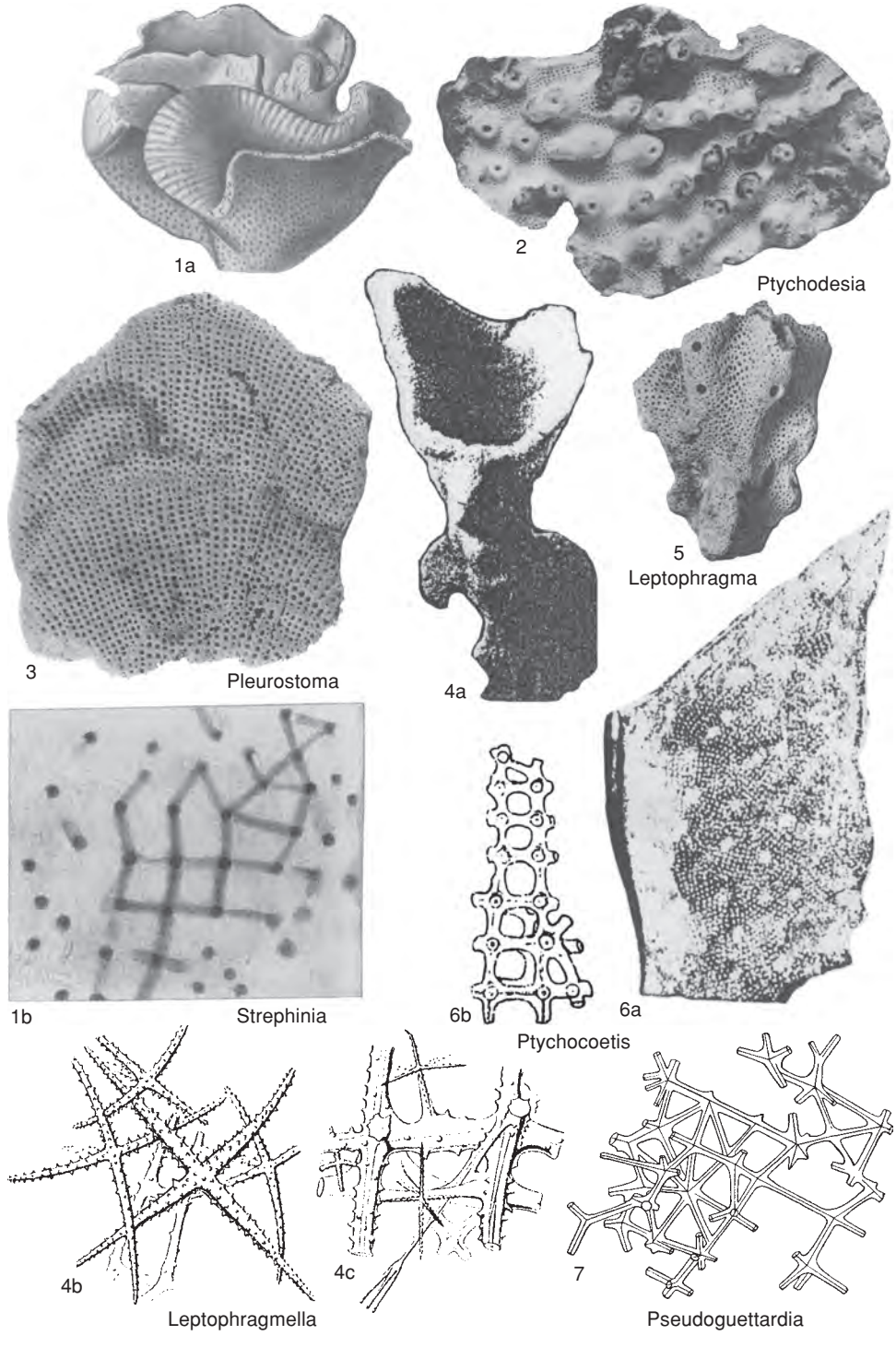


FIG. 318. Craticulariidae (p. 484–486).

with alternating, round or ovate apertures of short, radial canals that open internally in floors of longitudinal or locally reticulate furrows in gastral side of framework; furrows may be absent locally and such parts of surface resemble dermal side; dictyonal strands spread to both surfaces or run all to gastral side when apparent; no special cortical meshwork, although beams may be thickened at external surfaces; internal surfaces with numerous, partly attached, dictyonal hexatines with several free rays; lychniscs unknown. *Cretaceous (Albian–Cenomanian):* Europe.——Fig. 318,*1a–b. *S. convoluta,* Grey Chalk, Dover; *a,* side view of convoluted, funnel-like sponge with furrows on gastral surface and ovate ostia of radial canals on dermal surface, ×0.5; *b,* calcite-replaced, hexactine, skeletal structure, gray in light chalk, ×50 (Hinde, 1884a).

Subfamily CASEARIINAE Schrammen, 1937

[*nom. transl.* Reid, herein, *ex* Caseariidae Schrammen, 1937, p. 49] [=Monilispongiidae Wu, 1990, p. 354 [361]; Dracolychnidae Wu, 1990, p. 352; ?Innaecoelidae Boiko, 1990, p. 124; ?Tadassiidae Zhuravleva & Pyanovskaya, 1995, p. 31]

Cylindrical to top-shaped or open, funnel-shaped possible Craticulariidae in which body consists of a superimposed series of hemispherical to annular or discoidal growths, usually with a common, paragastral cavity; dermal surface may be constricted transversely at segment junctions; skeletal surfaces formed by tangential networks of ankylosed stauractines, interpreted as dermalia and gastralia; stauractine network of outside, continuous to paragastral margin at top of body, and extending through wall to paragastral surface between each segment; ostia and postica of radial canals, arranged quadrately in some examples under surface networks. *Triassic (Carnian)–Upper Jurassic.*

Casearia Quenstedt, 1858, p. 681 [**Scyphia articulata* Goldfuss, 1826, p. 8; SD Zittel, 1877b, p. 54] [=*Arthrocypellia* Pomel, 1872, p. 77, obj.; *Caesaria* de Laubenfels, 1955, p. 82, obj.; *Monilispongia* Wu & Xiao, 1989, p. 354 [361], obj.; ?*Innaecoelia* Boiko, 1990, p. 126, obj.]. Characters same as subfamily. [The genus *Casearia* Zittel is interpreted as a specialized relative of *Craticularia* Zittel, with a mode of growth analogous with that of thalamid Calcarea.] *Upper Triassic, Upper Jurassic:* Europe, China.——Fig. 319,*3a–b. *C. articulata* (Goldfuss), Upper Jurassic, Germany; *a,* side view of uniserial, chambered-appearing sponge, ×1; *b,* part of upper end of sponge showing regular, reticulate, skeletal structure, enlarged (Quenstedt, 1858).

Caucasocoelia Boiko, 1990, p. 124 [**C. kunae;* OD]. Cylindrical sponges composed of stacked, cuplike chambers with reticulate skeleton composed of hexactine spicules that are united at their tips to form an open textured, three-dimensional net. *Triassic (Norian–Rhetian):* Russia (northern Caucasus).——Fig. 319,*2a–b. *C. kunae,* Norian, White River; *a,* cylindrical type specimen showing upwardly arched chamber walls of fused hexactines, MIGACT 15/7, ×4; *b,* photomicrograph showing chamber walls of 2 or 3 layers of fused hexatines, approximately ×10 (Boiko, 1990).

Dracolychnos Wu & Xiao, 1989, p. 13 [**D. annulirotatus;* OD] [=*Dracholychnus* Wu, 1990, p. 352 [360], obj.] Low, funnel-shaped to broadly obconical, thin-walled, platelike sponges composed of annular, ringlike segments that produce somewhat irregular, concentric ridges on both top and bottom surfaces; chambers filled with fine, dictyonine structure, and each with distinct dermal and gastral layer and interwalls between chambers, commonly formed of two thickened, subparallel layers of dictyonalia. *Triassic (Carnian):* China (Sichuan).——Fig. 320,*1a–d. *D. annulirotatus,* Hanwang Formation, Hanwang-Jushui area; *a,* side view from below showing annulate, ringlike structure of funnel-shaped, figured specimen, ×1; *b,* view from above into shallow spongocoel partially encrusted with *Terebella*-like worm tubes and matrix, S-1059, ×1; *c,* photomicrograph of longitudinal section of figured specimen with arched, main chamber walls and upwardly radiating, primary strands in coarse skeleton, fine structure obscured by boring worm traces throughout, IGASB T3(a), ×10; *d,* photomicrograph with thick, distinctive, double-layered interwalls and lack of preservation of fine structure in chamber interiors, IGASB R6-18(058), ×20 (Rigby, Wu, & Fan, 1998).

Innaecoelia Boiko, 1990, p. 126 [**I. pamirica;* OD]. Cylindrical sponge with high, spherical-appearing chambers with netlike, hexagonal skeleton in walls; axial spongocoel or canal retrosiphonate; skeletal structure more complex than in *Caucasocoelia* or *Pseudoverticillites. Jurassic (Callovian):* Tadjhikistan.——Fig. 319,*1a–b. *I. pamirica,* upper Callovian, southwestern Pamir Mountains; *a,* section through spherical-appearing chambers showing their complex walls, MIGACT 15/11, ×2; *b,* photomicrograph showing hexactine spicules in thickened rays of fused skeleton, ×40 (Boiko, 1990).

Pseudoverticillites Boiko, 1990, p. 125 [**P. sahrajensis;* OD]. Cylindrical sponges composed of low, empty chambers; chamber walls of six-rayed spicules of uniform size that are fused at their tips to form a relatively simple, rectangular, skeletal net. *Triassic (Norian):* Russia (northern Caucasus).——Fig. 320,*2a–b. *P. sahrajensis,* Upper White River; *a,* longitudinal section of curved sponge showing low chambers and moderately thick walls of fused hexactines, MIGACT 15/9, approximately ×2; *b,* photomicrograph of skeletal structure of chamber wall of fused hexactines, ×30 (Boiko, 1990).

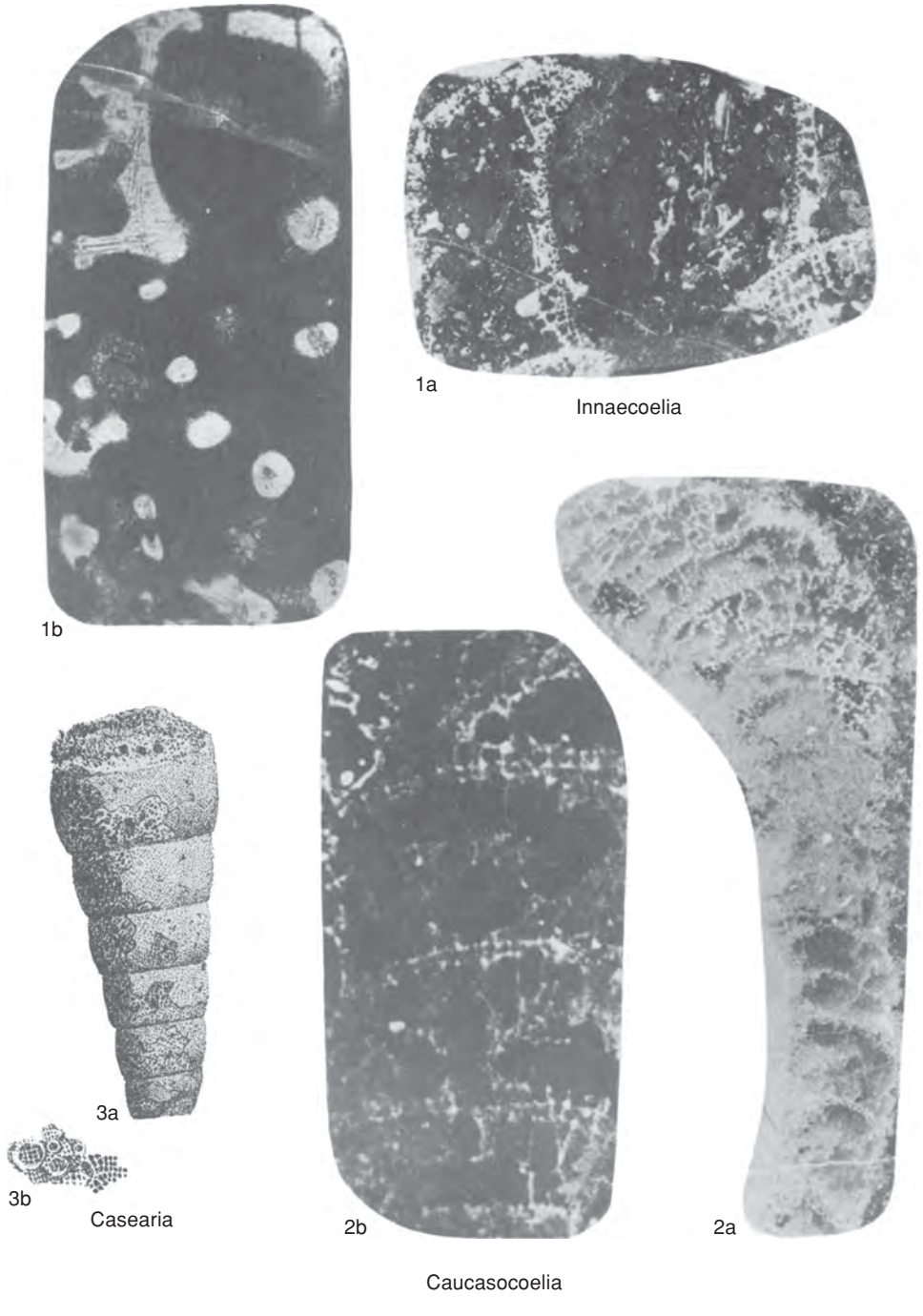


FIG. 319. Craticulariidae (p. 486).

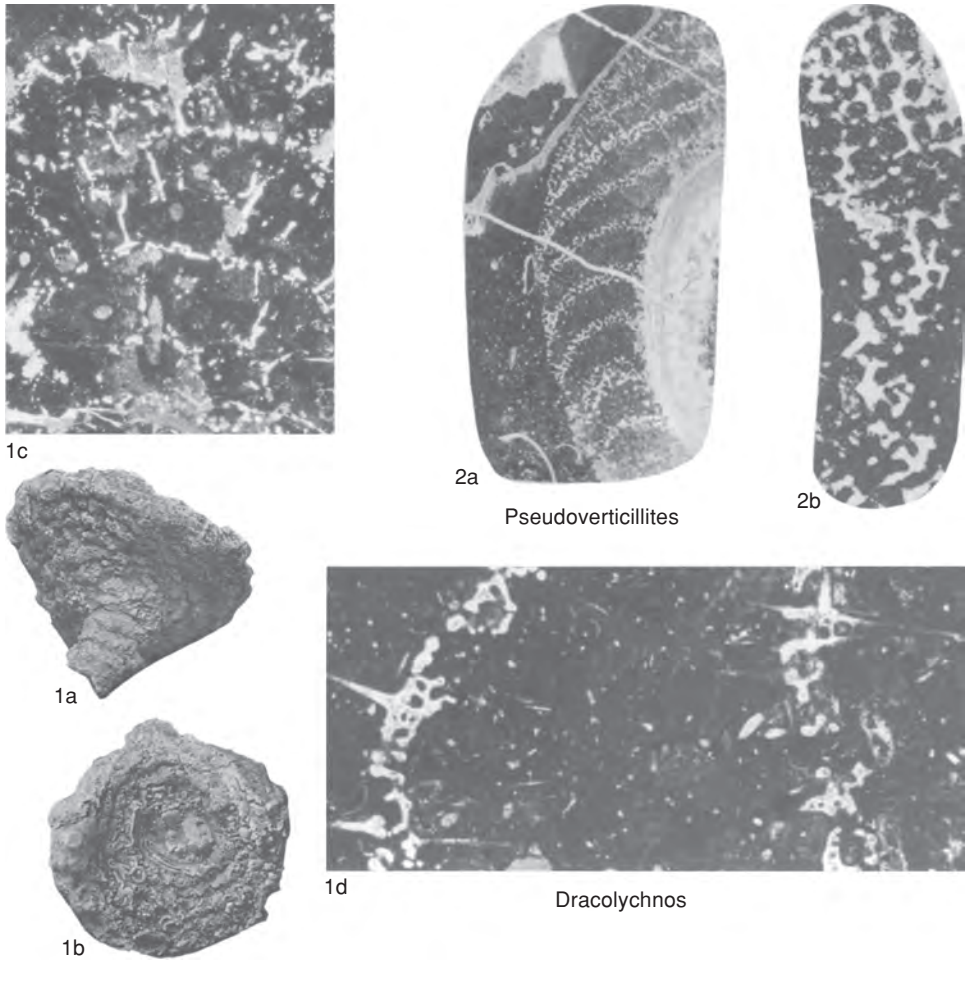


FIG. 320. Craticulariidae (p. 486).

Subfamily UNCERTAIN

Ecblastesia RAUFF, 1933, p. 24 [**E. intrinsecuscostata;* OD]. Nature uncertain; single specimen a group of small, conjoined funnels with separate, paragastral cavities; inside with postica in longitudinal furrows; outside with small, irregularly arranged ostia in parts; canalization obscure, supposedly craticulariid. *Upper Cretaceous:* Europe.——FIG. 321,*1. *E. intrisecuscostata,* Greensand, upper Turonian, Ruhr Valley, Germany; view from above of conjoined funnels where postica occur in grooves on gastral surface, ×1 (Rauff, 1933; courtesy of *Preussischen Geologischen Landsanstalt,* E. Schweizerbart'sche Verlagsbuchhandlung).

Mimeticosia RAUFF, 1933, p. 36 [**M. alata;* OD]. Nature uncertain; single specimen massive, cruciate in cross section, with no paragastral cavity; outside with quadratically arranged ostia, like those of *Laocoetis* species; interior a solid mass of irregular, skeletal tissue, with large, tubular canals running longitudinally and transversely. Loose spiculation unknown. [Basal part of plicated *Laocoetis,* with the paragastral cavity filled by possible secondary meshwork.] *Upper Cretaceous:* Europe.——FIG. 321,*4a–c. *M. alata,* Greensand, upper Turonian, Ruhr Valley, Germany; *a,* view from above of small, cross-shaped sponge; *b,* side view between divergent folds showing moderately large, longitudinal canals, ×1; *c,* vertical thin section showing skeletal structure and upwardly divergent, coarse canals in the interior, ×4 (Rauff, 1933; courtesy of *Preussischen Geologischen Landsanstalt,* E. Schweizerbart'sche Verlagsbuchhandlung).

Periplectum RAUFF, 1933, p. 38 [**P. constrictum;* OD]. Nature uncertain; single example fragment of seemingly bowl-like sponge; outside formed by meshwork of basal skeleton with irregularly distributed

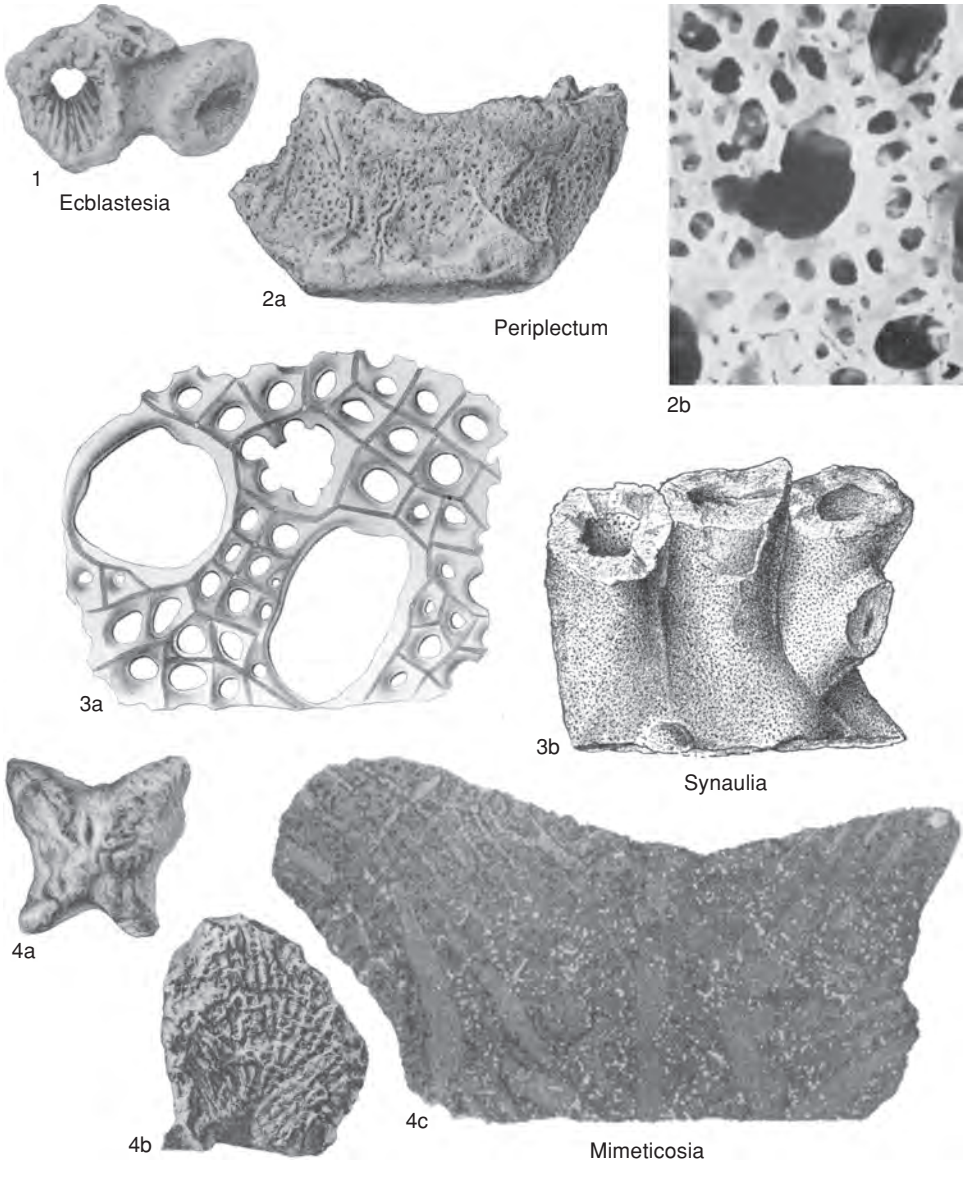


FIG. 321. Craticulariidae (p. 488–490).

ostia and local, sinuous furrows; parts of upper surface with postica of apparently radial aporhyses; loose spiculation unknown. [Basal parts of a possible *Laocoetis*.] *Upper Cretaceous:* Europe.——FIG. 321,*2a–b. *P. constrictum,* Greensand, upper Turonian, Ruhr Valley, Germany; *a,* side view of bowl-like fragment with irregular furrows and ostia in dermal layer, ×1; *b,* silicified skeletal fragment showing fused nature of secondary thickened elements in skeleton, ×20 (Rauff, 1933; courtesy of *Preussischen Geologischen Landsanstalt,* E. Schweizerbart'sche Verlagsbuchhandlung).

Synaulia POČTA, 1883, p. 25 [**S. germinata* POČTA, 1883, p. 26; SD DE LAUBENFELS, 1955, p. 84]. Nature uncertain; type species based on group of three broken, upright tubes fused together side by side, with a common, basal structure; paragastral cavities not continuous; exterior with small skeletal pores in irregular meshwork continuous with basal skeleton; gastral surfaces with postica in rough, longitudinal, and transverse rows; outer part of skeletal meshwork with vertical canals, arranged concentrically around inner part with radial canals. Loose spiculation unknown. [Basal parts of a compound possible

Laocoetis.] *Upper Cretaceous:* Czech Republic, Slovakia.——FIG. 321,*3a–b. *S. germinata,* Korytzaner Schichten, Zybslav; *a,* side view of upright tubes in holotype with cylindrical spongocoel with exhalant ostia in rows, exterior with fine, inhalant ostia, ×1; *b,* skeletal fragment with canals in dense net, ×40 (Počta, 1883).

Family CRIBROSPONGIIDAE F. A. Roemer, 1864

[*nom. correct.* REID, 1963a, p. 227, *pro* Cribrospongidea F. A. ROEMER, 1864, p. 10] [=Nelumbifoliidae WU, 1990, p. 356 (361)]

Skeletal framework three dimensional initially, constructed as in Euretidae, but with fully developed epirhyses and aporhyses; skeletal canals radial, blind, arranged in longitudinal series in which epirhyses and aporhyses alternate, often also occuring alternately in adjacent series, or having modifications of this pattern in which canals are open at both ends, intercommunicate, or form labyrinths internally, or lack regular arrangement; arrangement of apertures typically quincuncial when regular; dictyonal strands spread subequally to both surfaces, or run mainly or all to dermal side; beams between ends of strands usually forming cortical meshwork, which secondary accretions may thicken; strand system sometimes extensively disorganized by canalization; superficial meshwork in some genera formed from dictyonal hexactines, from hexactines plus siliceous filaments, or additionally by ankylosis of dermal or gastral stauractines or pentactines; sceptrules unknown. [Family is similar to Craticulariidae, but distinguished from it by a different serial arrangement of epirhyses and aporhyses, implying that chambers bearing structures and inhalant canals were formed alternately in each segment of the growing margin instead of separately in alternate segments.] A single living species, *Stereochlamis incerta* (IJIMA), is known from washed-out specimens only. *Middle Triassic–Holocene.*

Cribrospongia D'ORBIGNY, 1849, p. 547 [**Scyphia reticulata* GOLDFUSS, 1826, p. 11; M] [=*Tremadictyon* ZITTEL, 1877b, p. 46 , obj. (type, *S. reticulata,* SD HINDE, 1893b, p. 195)]. Funnel-like or variant shapes; skeletal canals in regular or approximate series, apertures alternating quincuncially or less regularly; apertures round, ovate, or irregularly denticulate; canals simply radial or with lateral branches, which may open into general meshwork or cross connect canals of same kind; internal meshwork with dictyonal strands spreading subequally to both surfaces, and fairly regular to extensively disorganized by minor canal branches; denser cortical meshwork at both surfaces; dermal or both surfaces with superficial outgrowths or meshwork formed from dictyonal hexactines or the latter and siliceous filaments, further external tangential networks formed by ankylosis of dermal or gastral stauractines or pentactines. [SALOMON (1990) and MEHL (1992) discussed the taxonomic history of *Porospongia* and associated genera and concluded that *Cribrospongia* and *Porospongia* were named by D'ORBIGNY in 1849, not in 1847, after an intensive search for documentation of the 1847 paper failed.] *Middle Triassic–Cretaceous (Albian):* Poland, *Middle Triassic;* Germany, France, Switzerland, *Jurassic;* Spain, *Albian.*——FIG. 322,*3a. C. radicatum* (QUENSTEDT), Weiss Jura, Upper Jurassic, Heuchstetten, Germany; enlarged part of inner surface with irregular pores and skeletal tracts with dictyonine structure, ×5 (Schrammen, 1936).——FIG. 322,*3b. C. elegans* (SCHRAMMEN), Weiss Jura, Upper Jurassic, Schwabtal, Germany; enlargement of inner or gastral surface with fine, skeletal tracts and irregular, exhalant ostia, ×5 (Schrammen, 1936).

Andreaea SCHRAMMEN, 1902, p. 25 [**A. hexagonalis;* OD]. Funnel-like or flabellate; epirhyses blind, arranged irregularly or in hexagonal groups; aporhyses quincuncially alternating and frequently opening at both ends; no superficial meshwork. *Cretaceous:* Germany.——FIG. 322,*4. *A. hexagonalis,* Quadratenkreide, Campanian, Misburg; side view of small, steeply obconical sponge with distinct epirhyses, ×1 (Schrammen, 1902).

Erineum SCHRAMMEN, 1937, p. 39 (SCHRAMMEN, 1936, p. 181, *nom. nud.*) [**E. minutum;* OD]. Sponge top shaped and of small size, with thick walls and deep spongocoel; exterior with small, irregularly placed ostia that alternate with those of gastral surface; inhalant and exhalant canals bent and end blindly in wall between exhalant ostia; skeletal structure irregular in interior but regular in the outer part. *Upper Jurassic:* Germany.——FIG. 322,*2a–b. *E. minutum,* Weiss Jura, Streitberg; side views of small sponge with irregular ostia, ×4 (Schrammen, 1937).

Eubrochus SOLLAS, 1876a, p. 400 [**E. clausus;* OD]. Club-shaped or vaselike sponges in which walls curve together to cover osculum; reticulate, dermal net preserved as molds of longitudinal and horizontal fibers that diverge upwardly from four centers in looplike fashion and overlap with fibers from other centers to produce three-dimensional, hexactinosid skeleton. [The genus is placed in the family because of its similarity to *Cribrospongia*.] *Cretaceous:* Europe.——FIG. 322,*1a–c. *E. clausus,* Coprolite bed of Cambridge beds, Cambridge, England; *a,* side view of holotype with reticulate skeleton, ×1; *b,* section of interior hexactinosid skeleton, ×25; *c,*

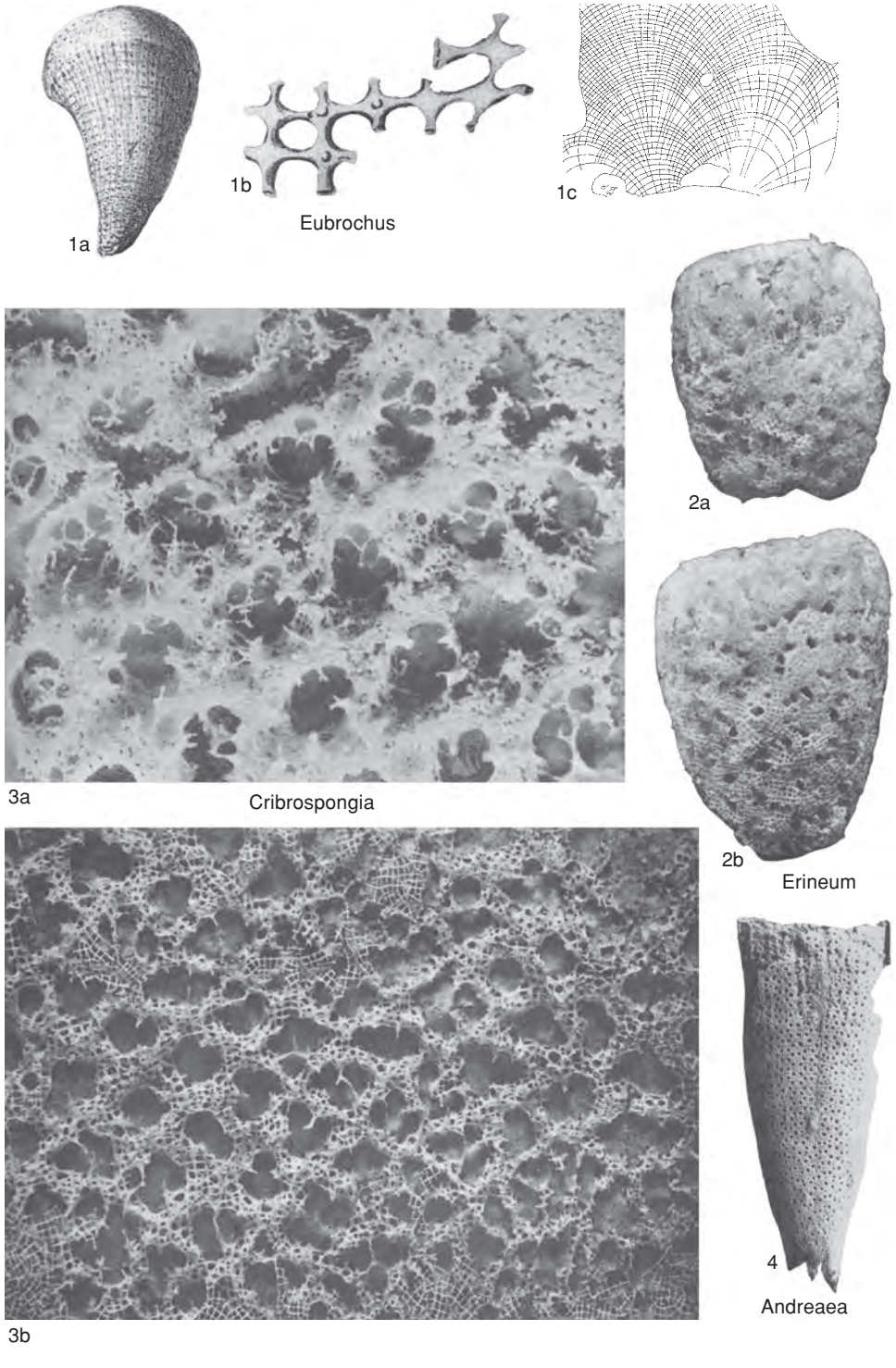
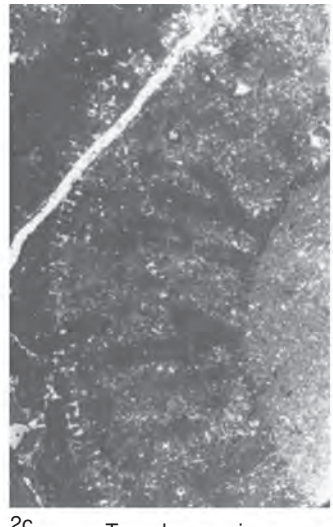
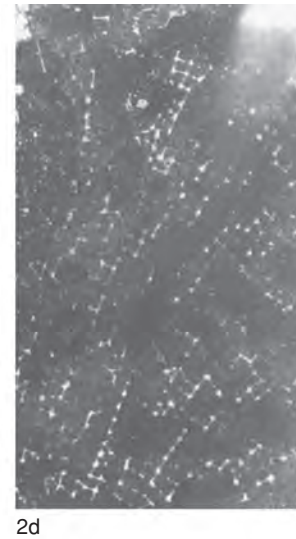
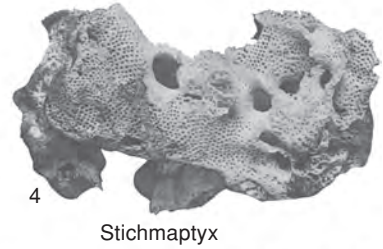
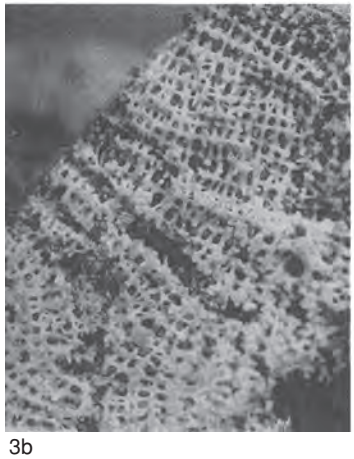


FIG. 322. Cribrospongiidae (p. 490–493).









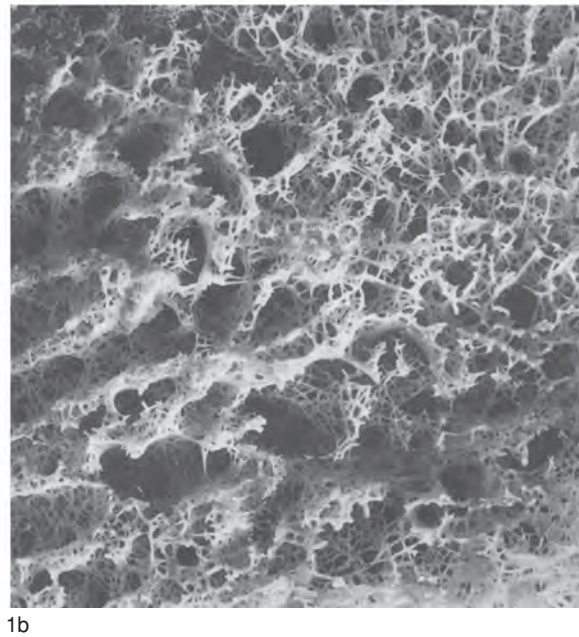


FIG. 323. Cribrospongiidae (p. 493–498).

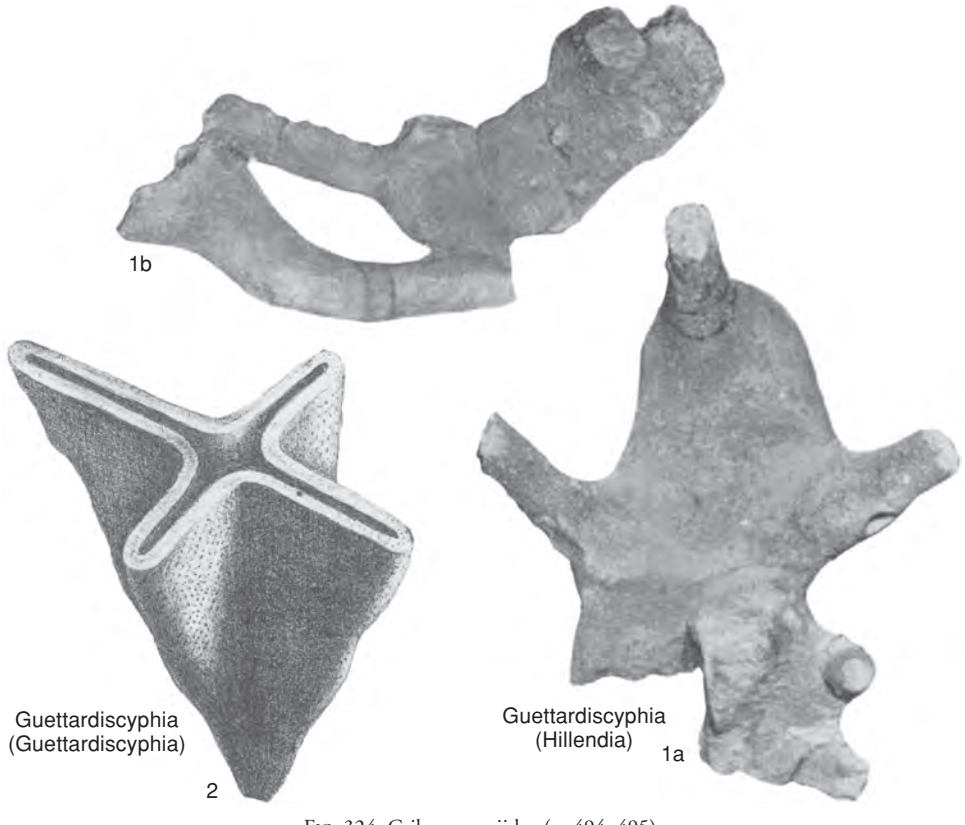


FIG. 324. Cribrospongiidae (p. 494–495).

woodcut showing skeletal fibers and their arcuate interrelationships that produce reticulate net, not to scale (Sollas, 1876a).

Feifelia SCHRAMMEN, 1937, p. 52 (SCHRAMMEN, 1936, p. 182, *nom. nud.*) [**F. gigas;* OD]. Large, vase- to pear-shaped, short-stalked, thick-walled sponges with deep spongocoel; exterior with small, closely spaced, irregularly distributed, branched, inhalant ostia; numerous large, exhalant ostia in longitudinal and transverse rows; coarse, dictyonine skeleton irregular to elongate and curving toward both gastral and dermal surfaces; stauractines may occur on both wall surfaces. *Jurassic:* Germany.——FIG. 323,*1a–b. *F. gigas,* Weiss Jura, Waldhausen; *a,* side view of small example of large species, ×0.5; *b,* section through wall near gastral surface, ×5 (Schrammen, 1937).

Gevreya MORET, 1927, p. 292 [**G. synthetica;* OD]. Long tube flaring distally in winglike folds as in *Guettardiscyphia,* spongocoel cylindrical but extending radially into lateral folds; large openings (possible oscules) occurring on folds and along sides and perhaps locally on crests of rootlike elements of base; hexactines of skeletal net very regularly arranged, forming cubic meshes, and lack lychniscoid structure; canal system little developed with pores only a little larger than cubic skeletal openings. [Included in the family with some question.] *Jurassic:* France.——FIG. 323,*3a–b. *G. synthetica,* Callovian, La-Voulte-sur-Rhone, Ardeche; *a,* restoration side view showing form of sponge and lateral oscules, slightly reduced; *b,* skeletal fragment showing robust, dictyonine net with regular, cubic structure, ×10 (Moret, 1928).

Guettardiscyphia DU FROMENTEL, 1860a, p. 39, *nom. nov. pro Guettardia* MICHELIN, 1847 in 1840–1847, p. 121, *non* NARDO, 1883 [**Guettardia stellata* MICHELIN, 1847 in 1840–1847, p. 121; OD] Body stellate, bilaterally compressed, or irregularly branched and sometimes partly saccular; parietal oscula along margins of radiating flanges or flattened branches, or variously placed when these are absent; epirhyses and aporhyses in regular, longitudinal series; epirhyses typically open at both ends, unless closed on gastral side by secondary, skeletal accretion; exterior of skeletal framework with ostia of epirhyses only, arranged alternately and often quincuncially; gastral side with twice as many apertures, of which half are true postica, arranged in longitudinal series and often grouped quadrately; dictyonal strands of interior run mainly or to dermal side, usually confined to tracts between

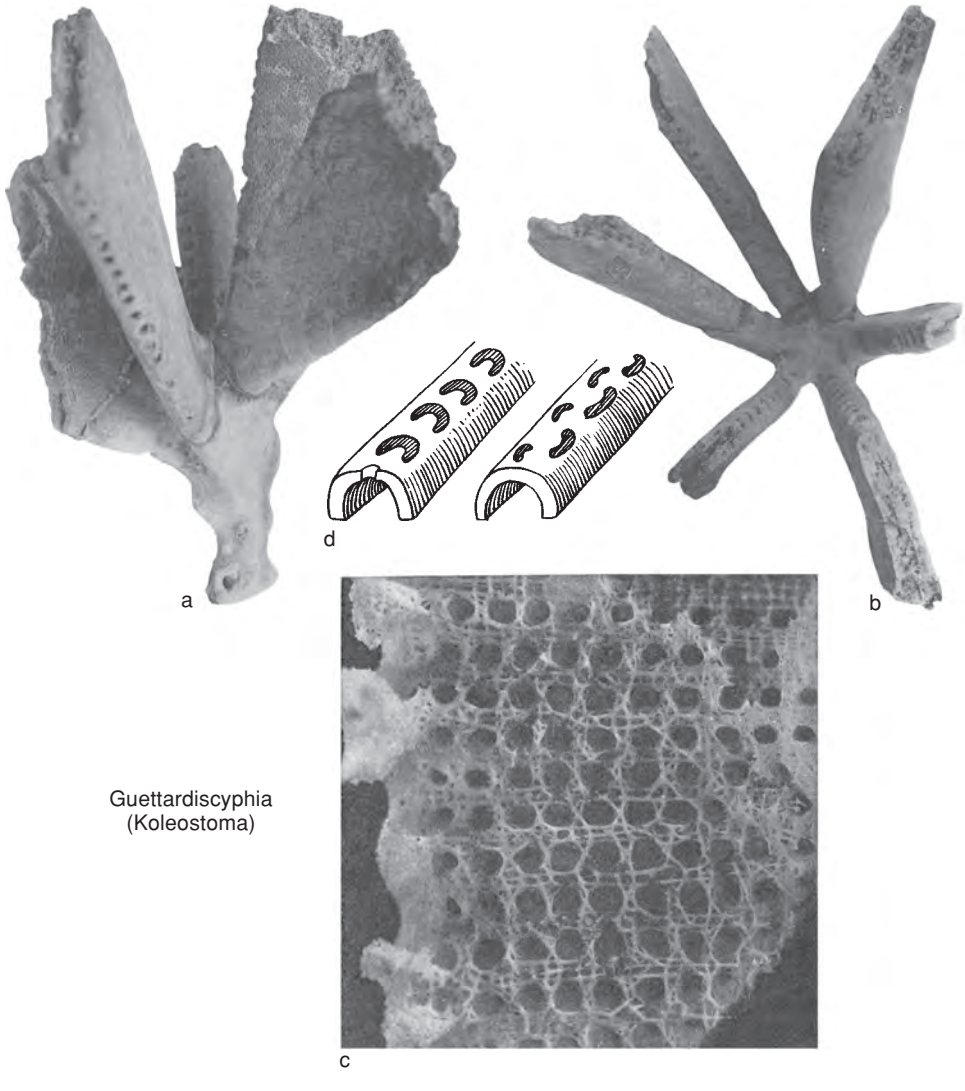


FIG. 325. Cribrospongiidae (p. 495).

series of skeletal canals; dense cortical meshwork on dermal side, and sometimes also superficial meshwork formed from dictyonal hexactines; internal structure exposed on gastral side, or partly obscured by skeletal accretion. *Cretaceous.*

G. (Guettardiscyphia) REID, *nom. nov.* herein [**Guettardia stellata* MICHELIN, 1847 in 1840–1847, p. 121; OD]. Wall folded longitudinally above tubular stalk to form radiate and bilaterally compressed, hollow flanges of typically triangular form that remain connected axially; rounded, parietal oscula along narrow margins of flanges; flanges freely open at top, partly closed by transverse bridges of secondary skeletal meshwork, or closed around a single axial oscu-lum. *Cretaceous:* France.——FIG. 324,*2. *G. (G.) stellata* (MICHELIN), Upper Cretaceous, Senonian, Honfleur; diagonal view of hollow, flanged sponge with open, axial spongocoel and relatively thin, folded walls, ×1 (Fromentel, 1860a).

G. (Hillendia) REID, 1964, p. lxiv [**H. polymorpha;* OD]. Bilaterally compressed to irregularly branched, sometimes partly saccular; parietal oscula rounded, marginal in compressed growths, variously placed in others. *Cretaceous (Turonian):* Great Britain.——FIG. 324,*1a–b. *G. (H.) polymorpha,* Chalk Rock, Hitchin, Hertfordshire; *a,* holotype with tubular branches from saccular growth, some with parietal oscula,

BM S.8610; *b,* paratype with irregularly branching form, BM S.8611, ×1 (Reid, 1964; courtesy of The Palaeontographical Society, London).

G. (Koleostoma) Regnard in Moret, 1926b, p. 220 [**K. godeti;* OD]. Initially similar to *Guettardiscyphia s.s.,* but radial flanges then separate axially, either singly or in pairs, to form bladelike or winglike branches; branches formed from single, radial flanges have parietal oscula along both narrow margins; parietal oscula rounded, or become crescentic through ingrowth of skeletal meshwork. [*Koleostoma godeti* was described as a new genus and new species by Regnard (1926, p. 473) in the paper apparently referred to by Moret as "Regnard, in litt."] *Cretaceous:* France.——Fig. 325*a–d. *G. (K.) godeti,* Cenomanian, Coulonge-les-Sablon; *a,* side view of plicate form with crescentic oscula along narrow margins; *b,* view from above showing growth form, ×1 (Regnard, 1926); *c,* photomicrograph of skeletal net, ×10 (Moret, 1926b; courtesy of Société Géologique de France); *d,* oblique view of crescentic parietal oscula on crests of folds, ×2 (de Laubenfels, 1955).

Haynespongia Rigby, 1981, p. 138 [**H. vokesae* Rigby, 1981, p. 140; OD]. Irregular, leaflike or anastomosing to thin-walled, tubular cribrospongiid lacking complex sculpture; hexactinosid net euretoid with primary framework at gastral margin from which strands diverge to meet dermal margin at high angles; primary canals show diplorhysis in craticulariid pattern with general alternation of epirhyses and aporhyses; although not in well-defined, linear series; apodiarhysal canals connecting to dermal surface and occurring in skeleton between epirhysal ostia. *Paleogene (Eocene):* USA (North Carolina).——Fig. 326,*1a–b. *H. vokesae,* Castle Hayne Limestone, Wayne County; *a,* side view of holotype with oscula along one margin, USNM 252494, ×1; *b,* photomicrograph of dermal surface of holotype with inhalant ostia and net with expanded nodes at ray junctions, ×20 (Rigby, 1981; courtesy of *Tulane Studies in Geology and Paleontology*).

Keuppiella Engeser & Mehl, 1993, p. 185, *nom. nov. pro Rhopalicus* Schrammen, 1937, p. 36, *non* Foerster, 1856 [**Scyphia pertusa* Goldfuss, 1826, p. 6; OD] [=*Walcottella* de Laubenfels, 1955, p. 82, obj., *non* Ulrich & Bassler, 1931]. Similar to *Cribrospongia* d'Orbigny, with cribiform, superficial meshwork veiling ostia or postica when fully developed, but without ankylosed dermalia or gastralia. *Upper Jurassic:* Germany.——Fig. 326,*2a–b. *K. pertusa* (Goldfuss), Weiss Jura, Schwabtal; *a,* enlarged view of dermal surface with irregularly spaced, inhalant ostia separating skeletal tracts, ×5 (Schrammen, 1936); *b,* irregular meshwork over inhalant ostia of dermal surface, ×5 (Schrammen, 1937).

Nelumbifolium Wu, 1990, p. 356 [**N. pectiniforme;* OD]. Open, funnel-shaped, thin-walled sponges with prominent ostia of exhalant-inhalant system in moderate, concentric, and radial series in rough to nodose, gastral and dermal surfaces; continuous, concentric and radial, midwall canals in coarse, somewhat open, irregular skeleton where radial strands most prominent, with second- and third-order subdividing elements commonly appearing spinose or with free rays, or small hexactines, or with synapticulae near nodes. *Triassic (Carnian):* China (Sichuan).——Fig. 327,*1a–b. *N. pectiniforme,* Hanwang Formation, Jushui; *a,* gastral view of funnel-shaped sponge with characteristic, coarse, aligned, ostia of exhalant canals separated by low nodes in lower part, but upper part encrusted, S-1150, ×1; *b,* relatively open, dictyonine, skeletal net with large hexactines as primary elements producing first-order quadrules, subdivided by second- and third-order hexactines, some with synapticulae, IGASB R6-2(2), ×10 (Rigby, Wu, & Fan, 1998).

Petalope Počta, 1883, p. 24 [**P. auriformis;* SD de Laubenfels, 1955, p. 82]. Sponge body irregular, with ear-shaped outline above a thick stalk and with thicker central part; radial canals numerous, blind, and curved; upper surface with irregularly distributed, round ostia of shallow canals in gastral layer where spicule rays somewhat thicker than in main skeleton; principal skeleton dictyonine with coarse, six-rayed, irregularly oriented spicules. [Included in the family with some question.] *Upper Cretaceous:* Czech Republic, Slovakia.——Fig. 326,*3a–b. *P. auriformis,* Korytzaner Schichten, near Zbyslav; *a,* side view of broadly obconical, ear-shaped sponge, ×1; *b,* a fragment of internal, dictyonine skeleton, approximately ×60 (Počta, 1883).

Polyopesia Schrammen, 1902, p. 25 [**P. angustata;* SD de Laubenfels, 1955, p. 79]. Tubular to funnel-like, flabelliform, or with branches of a tubular stock expanding into convoluted lamellae; dermal skeletal surface with alternating or irregularly arranged apertures of epirhyses, between which are small pores or papillae through which aporhyses open at this surface; gastral surface with alternating apertures of aporhyses only; aporhyses simply radial or intercommunicating, with cross passages sometimes forming diagonal network between epirhyses; no superficial meshwork. [Note: wrongly identified with *Hexactinella* Carter (family Tretodictyidae) by Schrammen (1912, p. 223) and followers]. *Upper Cretaceous:* Germany.——Fig. 327,*3a. *P. angustata,* Quadratenkreide, Cenomanian, Oberg; side view of fragment with irregularly distributed, papillate aporhyses, ×1 (Schrammen, 1912).——Fig. 327,*3b–c. P. laevis* (Schrammen), Quadratenkreide, Cenomanian, Oberg; *b,* gastral surface of earshaped variety with coarse apertures of aporhyses irregularly distributed; *c,* dermal surface of same specimen with papillate pores of aporhyses and intervening pores of epirhyses, ×1 (Schrammen, 1912).

Stereochlamis Schrammen, 1912, p. 231 [**S. praecissa;* SD de Laubenfels, 1955, p. 83] [=*Tretorete* Ijima, 1927, p. 298 (type, *T. incertum,* OD)]. Tubular, small; epirhyses and their apertures arranged without order; aporhyses alternating in longitudinal series; dictyonal strands run to dermal side only or largely disorganized; no cortical meshwork; no superficial meshwork. *Upper Cretaceous–Holocene:*

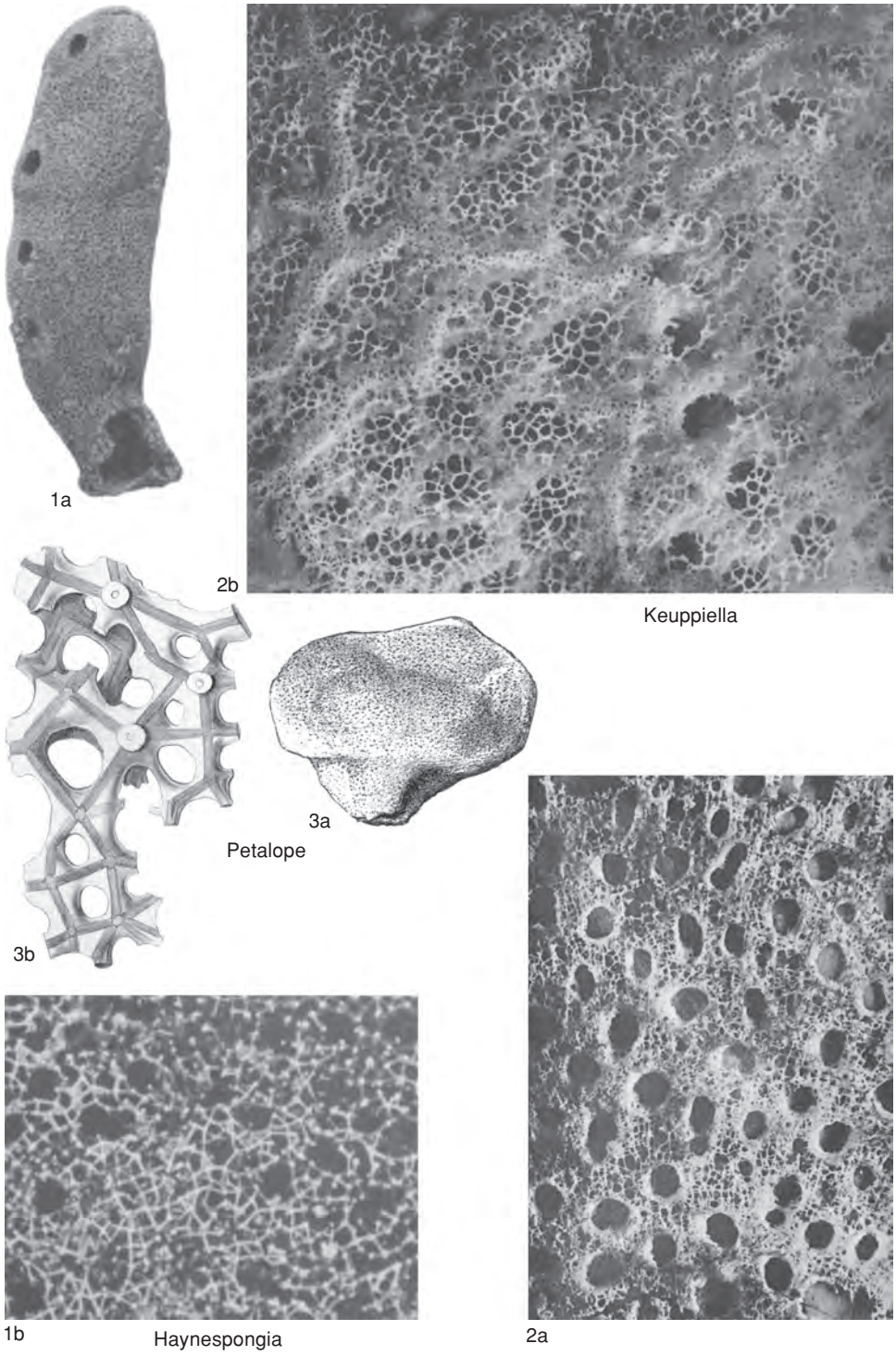


FIG. 326. Cribrospongiidae (p. 495).

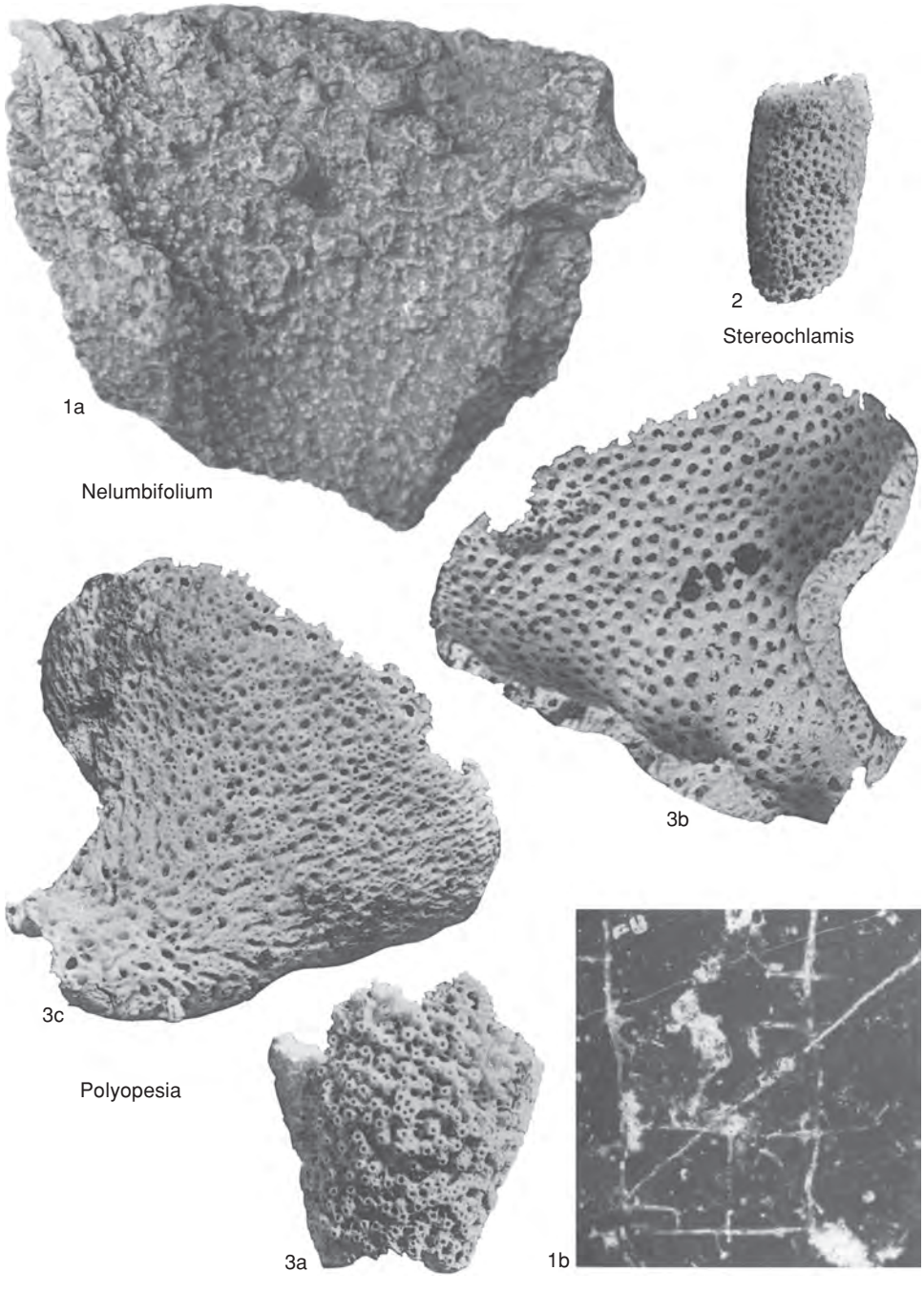


FIG. 327. Cribrospongiidae (p. 495–498).

Germany, Pacific and Indian Oceans.——Fig. 327,*2. *S. praecissa,* Quadratenkreide, Cenomanian, Oberg, Germany; side view of tubular to steeply obconical type with irregular skeletal and canal structure, ×2 (Schrammen, 1912).

Stichmaptyx Schrammen, 1912, p. 255 [**S. alatus;* OD]. Branched and anastomosed tubes, or with branches of tubular stock expanding into sinuously convoluted lamellae; aporhyses or both sets of canals arranged regularly; aporhyses may run obliquely; no superficial meshwork. *Cretaceous:* Germany.——Fig. 323,*4. *S. alatus,* Quadratenkreide, Cenomanian, Oberg; sponge of anastomosed tubes or branches with uniform ostia of canals between oscula, ×0.5 (Schrammen, 1912).

Tesselospongia Rigby, Wu, & Fan, 1998, p. 138 [**T. fistulosa;* OD]. Small, conicocylindrical sponges with deep, simple spongocoel and smooth walls marked by ostia of cribrospongiid, diplorhysal, canal system; skeleton well organized, uniform, simple, euretoid dictyonine with primary strands near gastral margin; skeletal structure diverging upwardly and outwardly to dermal margin where dermal cortex of swollen elements well defined and thicker than gastral layer. *Triassic (Carnian):* China (Sichuan).——Fig. 323,*2a–d. *T. fistulosa,* Hanwang Formation, Hanwang area; *a,* side view of subcylindrical holotype with weakly annulate, dermal layer pierced by numerous prominent, inhalant ostia, ×2; *b,* diagonal view from above of broken summit with central spongocoel and traces of radial canals, S-1001, ×2; *c,* photomicrograph of transverse section showing radial canals in thin wall and dermal layer of thickened spicules, IGASB T3(2), ×10; *d,* longitudinal section with upwardly divergent, simple, dictyonine, skeletal net interrupted by matrix-filled canals, IGASB T3(4), ×10 (Rigby, Wu, & Fan, 1998).

Family STAURODERMATIDAE Zittel, 1877

[Staurodermatidae Zittel, 1877b, p. 37]

Skeletal framework three dimensional initially, constructed as in Euretidae and with labyrinthine epirhyses and aporhyses; aporhyses open in local depressions in gastral surface of framework and epirhytic labyrinth perforates intervening framework; skeletal surfaces coated by tangential networks of ankylosed, dermal and gastral stauractines or pentactines in mature individuals; sceptrules unknown. [Originally (Zittel, 1877b) included a variety of Hexactinosa and Lychniscosa, with conspicuous superficial meshwork formed from dermalia or gastralia. Family herein defined in terms of general characters of the type genus *Stauroderma* Zittel.] *Jurassic–Neogene.*

Stauroderma Zittel, 1877b, p. 53 [**Spongites lochensis* Quenstedt, 1858, p. 669; OD]. Funnel- to platterlike, often large; dermal (outer, lower) surface of skeletal framework with ostia of short, radial epirhyses that divide into branches internally; these branches unite to form a labyrinth of divided and anastomosed, tubular passages; gastral (inner, upper) surface with alternating, rounded depressions in which groups of aporhyses open; intervening parts of surface with numerous small, round apertures and sinuous furrows through which epirhytic labyrinth opens; aporhyses branch and anastomose to form a second labyrinth in interspaces of epirhytic system, but do not perforate dermal surface; internal meshwork much disorganized by canalization, dictyonal strands spread to both sides where detectable; outermost meshwork of dermal side forming a fine-meshed cortex; dermal side also with superficial outgrowths formed from dictyonalia and siliceous filaments, which help define irregular denticulate outlines of ostia; mature individuals with ostia veiled by tangential networks of ankylosed dermal stauractines or pentactines, and gastral side coated continuously by similar network of fused gastralia that line (not span) the aporhytic depressions. *Jurassic:* Europe.——Fig. 328,*1. *S. lochensis* (Quenstedt), Weiss Jura, Lochen, Germany; skeletal fragment showing circular ostia in dermal surface of broad, platelike sponge, ×1 (Quenstedt, 1858).

Placochlaenia Pomel, 1872, p. 73 [**P. protuberans;* OD]. Platelike expansions, somewhat irregular, composed of coarse, irregularly anastomosing, siliceous fibers; upper surface with scattered, elongate or necked oscula of finely porous, gastral layer in which small hexactines show between coarser fibers; lower surface with pronounced, irregular, coarse fibers. *Neogene (Miocene):* northern Africa.——Fig. 328,*5a–c. *P. protuberans,* Terrain cartennien, Djebel Djambeida, Algeria; *a,* gastral or upper surface of platelike sponge with pronounced, scattered oscula, ×0.5; *b,* dermal or lower surface of same sponge with irregularly anastomosing, coarse, skeletal fibers, ×1; *c,* small stauractine in opening between skeletal fibers of upper surface, ×20 (Pomel, 1872).

Polyschema Oppliger, 1915, p. 29 [**P. hersbergense* Oppliger, 1915, p. 30; SD de Laubenfels, 1955, p. 80]. Cylindrical to cup-shaped forms with spongocoel open or covered, dermal surface with inhalant ostia irregularly distributed in short rows; gastral surface with larger, exhalant ostia; skeletal net dictyonine. *Jurassic:* Switzerland.——Fig. 328,*2a–b. *P. hersbergense,* Birmernsdorfer beds, Hersberge; *a,* side view of cylindrical specimen with irregular, inhalant ostia; *b,* cup-shaped specimen with broad spongocoel and thick walls, ×1 (Oppliger, 1915; courtesy of Komission der Schweizerischen Paläontologischen Abhandlungen, Basel).

Rhodanospongia Moret, 1927, p. 292 [**R. robusta;* OD]. Goblet-shaped sponge, robust dictyonine skeletal net with irregularly anastomosing, thick fibers in endosomal net and large pentacts with four

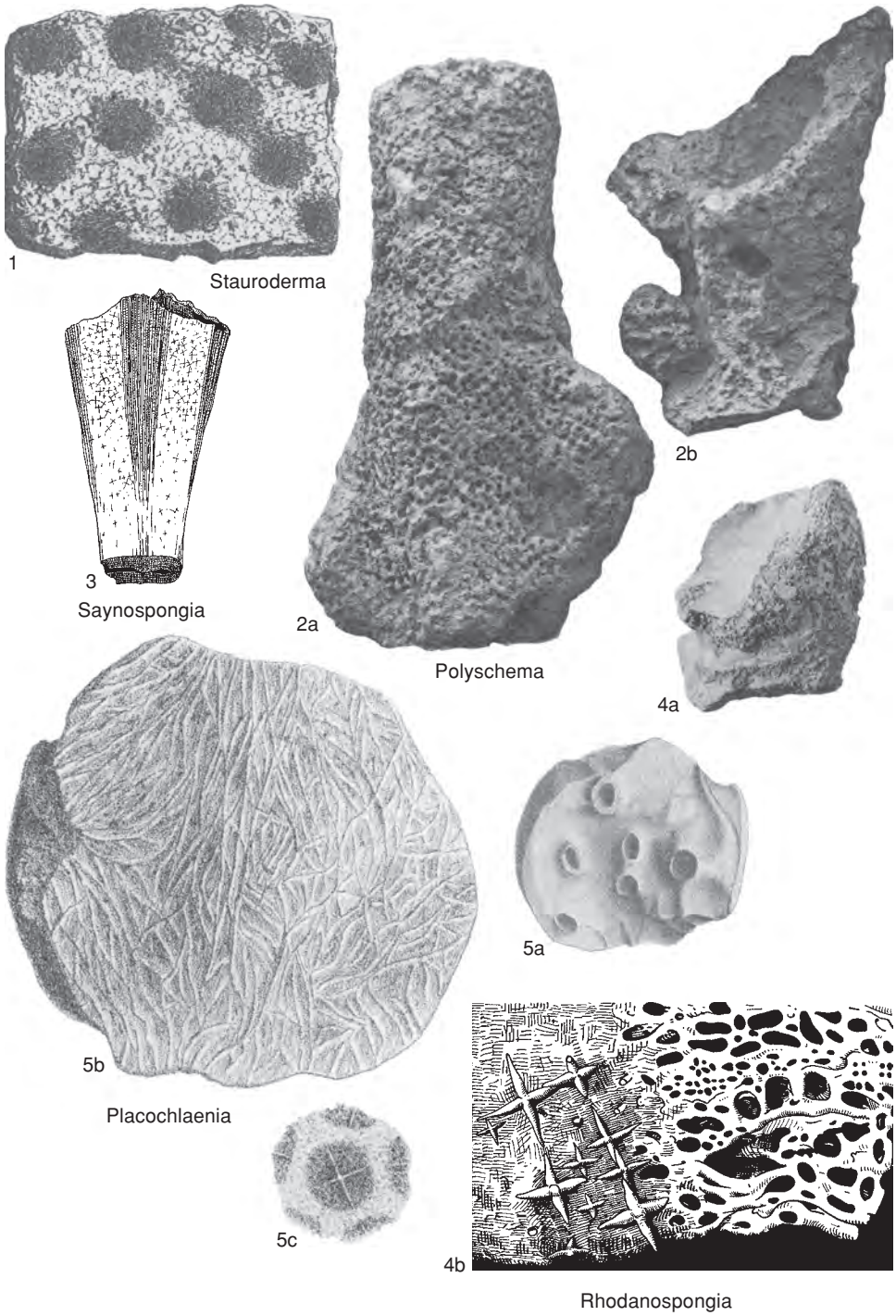


FIG. 328. Staurodermatidae (p. 498–500).

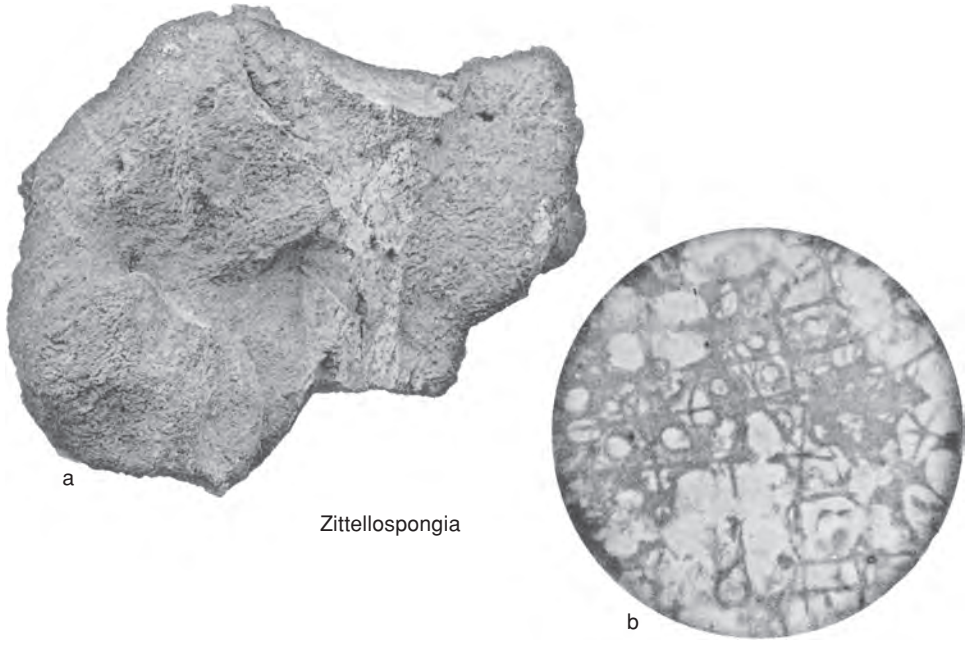


FIG. 329. Staurodermatidae (p. 500).

recurved clads at sponge surface and straight rhabd directed inwardly, in differentiated, dermal cortex. [Included in the family with some question.] *Jurassic:* France.——FIG. 328,*4a–b. *R. robusta,* Callovian, La Volte-sur Rhone, Ardeche; *a,* side view of lower stem and basal part of upper cup, size reduced; *b,* restoration showing thick, anastomosing rays on endosomal skeleton and large pentacts of dermal cortex, ×10 (Moret, 1928).

Saynospongia MORET, 1927, p. 292 [**Elasmoierea palmicea* DUMORTIER, 1871, p. 54; OD]. Small sponges shaped like a dagger sheath, with flattened spongocoel and moderately thick wall that has endosomal, dictyonine skeleton of fine, cubical cribwork, but with extended, longitudinal rays, and outer layer with less regularly oriented stauractines. *Jurassic:* France.——FIG. 328,*3. *S. palmicea* (DUMORTIER), Callovian, La Volte-sur-Rhone, Ardeche; side view of restoration showing flattened form of sponge with darker, regular, fine, endosomal skeleton and lighter, dermal layer of more irregularly oriented stauractines, ×1.5 (Moret, 1928).

Zittellospongia MALFATTI, 1901, p. 288 [**Z. meandriformis* MALFATTI, 1901, p. 289; OD] [=*Malfattispongia* GREGORIO, 1908, p. 83, obj.; *Zittelospongia* DE LAUBENFELS, 1955, p. 80, obj.]. Similar to *Paracraticularia* but more lumpy and crumpled with several shapes from platelike to rugose meandriform, with a shallow, oscular depression; other areas of sponge covered with dermal layer perforated by irregularly placed, small ostia that are openings to small, sinuous canals that extend throughout sponge; complex skeleton is a quadrate mesh produced by merged, crossing rays of hexactines; fine, axial canals show in spicules of internal parts of sponge. [Placed in the family with some question.] *Paleogene–Neogene:* Europe.——FIG. 329*a–b. *Z. meandriformis,* middle Miocene, Emilia, Italy; *a,* upper view of irregular type specimen, ×1; *b,* photomicrograph of skeletal structure, ×50 (Malfatti, 1901).

Family APHROCALLISTIDAE Gray, 1867

[Aphrocallistidae GRAY, 1867, p. 507] [=Mellitionidae ZITTEL, 1877b, p. 36; Melittionidae SCHULZE, 1887a, p. 74; Aphrocallistidae SCHULZE, 1904, p. 178]

Skeletal framework three dimensional initially, not constructed in layers, with subparallel, dictyonal strands when any are apparent, and with a single system of tubular to prismatic, skeletal canals (diarhyses) that perforate both skeletal surfaces; these canals occupied in living examples by single, lobate, flagellated chambers; dictyonal strands sometimes evident in meshwork between diarhyses, begin on gastral side of framework and run outwardly to dermal side, typically subradial or radial for most or all of their length; diarhyses oriented corre-

spondingly, open radially on dermal side, radially to obliquely downward on gastral side; other examples with no distinct strand system, although traces of pattern described may be locally present; occasional individual variants have diarhyses incompletely formed, lack apertures on gastral side; no superficial meshwork, although irregular, skeletal accretion may veil apertures of gastral side; scopules in living examples. *Lower Cretaceous–Holocene.*

Aphrocallistes GRAY, 1858, p. 114 [**A. beatrix;* OD] [=*Badinskia* POMEL, 1872, p. 84 (type, *B. lobata,* M, =*A. lobatus* (POMEL), 1872, p. 85, *non A. lobatus* SCHRAMMEN, 1912, p. 222; =lobate form of *A. cylindrodactylus* SCHRAMMEN, 1912, p. 221)]. Branched-tubular, forming funnel-like axes with lobate or radially diverticulated walls, or combining these habits or with intermediates between them; terminal oscula sometimes covered by a perforated sieve plate; skeletal characters of family; diarhyses closely spaced, with intervening skeletal partitions often two dimensional only and from quadrate with regular, dictyonal strands to irregularly triangular, with components distorted so that all six rays lie in one plane; relatively dense, cortical meshwork on dermal side, or none; sieve plate skeleton dictyonal; scopules in living examples; dermalia pentactines or hexactines, but gastralia usually rhabdodiactines. *Lower Cretaceous–Holocene:* Germany, Poland, Great Britain, *Lower Cretaceous–Upper Cretaceous;* USA (Washington, Oregon), Algeria, *Paleogene–Neogene;* Spain, Algeria, *Miocene;* cosmopolitan, *Holocene.*——FIG. 330,*1a–b. A. alveolites* SCHRAMMEN, Quadratenkreide, Cenomanian, Oberg, Germany; *a,* branched lobate form with perforated sieve plate, ×1; *b,* larger, branched form showing regular ostia pattern and thin walls in broken upper end, ×0.5 (Schrammen, 1912).——FIG. 330,*1c–d. A. cylindrodactylus* SCHRAMMEN, Quadratenkreide, Cenomanian, Oberg, Germany; *c,* branched cluster with sieve plates on ends of some branches but others broken, ×0.5; *d,* lobate form of species, ×1 (Schrammen, 1912).

Family TRETODICTYIDAE Schulze, 1887

[Tretodictyidae SCHULZE, 1887b, p. 78] [=Sclerothamnidae SCHULZE, 1885, p. 447; Volvulinidae SCHULZE, 1885, p. 447; Tretocalycidae SCHULZE, 1904, p. 179; SCHRAMMEN, 1912, p. 222; Hexactinellidae DE LAUBENFELS, 1936, p. 185 (not SCHMIDT, 1870)]

Skeletal framework three dimensional initially, constructed as in Euretidae, with a single system of intercommunicating, cleft-like to labyrinthine, skeletal canals (schizorhyses) that perforate both skeletal surfaces; these skeletal canals occupied in living examples by chamber-lined passages that are open beneath dermal membrane as well as on gastral side; dictyonal strands spread subequally to both surfaces from interior, or run mainly or all to dermal side; cortical modifications usually absent or slightly developed; some with superficial meshwork formed by union of dermal or gastral pentactines connected by direct ankylosis or networks of siliceous filaments. [For more information on the complex name history of Tretodictyidae, see REISWIG, 2002, p. 1,341–1,342.] *Upper Jurassic–Holocene.*

Subfamily TRETODICTYINAE Schulze, 1887

[*nom. transl.* REID, herein, *pro* Tretodictyidae SCHULZE, 1887b, p. 78] [=Tretodictyidae SCHULZE, 1887b, p. 78, *partim*]

Without connected dermalia or gastralia. *Upper Jurassic–Holocene.*

Tretodictyum SCHULZE, 1887b, p. 78 [**Hexactinella tubulosa* SCHULZE, 1887a, p. 328; SD IJIMA, 1927, p. 219]. Irregularly tuberous to shrublike with anastomosed branches; axial, paragastral cavities narrow when present, sometimes continuous in branched growths but more often discontinuous or absent; branches with lateral oscula when an axial paragaster is present, or with lateral, osculum-like apertures developed from canal system and usually all facing one direction; modern examples with scopules, oxyhexasters only, and dermalia pentactines to subpinular hexactines; no superficial meshwork. *Cretaceous (Coniacian)–Holocene:* Germany, *Coniacian–Maastrichtian;* cosmopolitan, *Holocene.*——FIG. 331,*2a–c. *T. tubulosum* (SCHULZE), Holocene, Enoshima, Japan, northern Pacific Ocean; *a,* side view of irregularly branching, dried specimen, ×0.5; *b,* dermal scopule with four barbed rays, ×100; *c,* simple oxyhexaster with long principal rays, ×200 (Schulze, 1887a).——FIG. 331,*2d. T. pumicosum* IJIMA, Holocene, off Great Kei Island, western Pacific Ocean; lateral view of small branched to lobate holotype of species, ×1 (Ijima, 1927).——FIG. 331,*2e. T. schrammeni* IJIMA, Holocene, off Great Kei Island, western Pacific Ocean; side view of largest branched fragment showing form of sponge, ×1 (Ijima, 1927).

Auloplax SCHULZE, 1904, p. 148 [**A. auricularis;* OD]. Flabellate, thick walled; schizorhyses longitudinal to irregularly labyrinthic tunnels, separated by typically thin partitions, and have appearance of radiate to divided and anastomosed, thin-walled tubes; surfaces irregularly cavernous where skeletal canals are labyrinthic; skeletal meshwork unusually coarse; dictyonal strands spreading to both surfaces; no distinct cortical meshwork, although meshwork at surfaces may be denser than in interior; single living species with pentactine dermalia and canalaria, hexactinoid discohexasters, and no sceptrules. *Cretaceous (?Coniacian–?Maastrichtian), Holocene:*

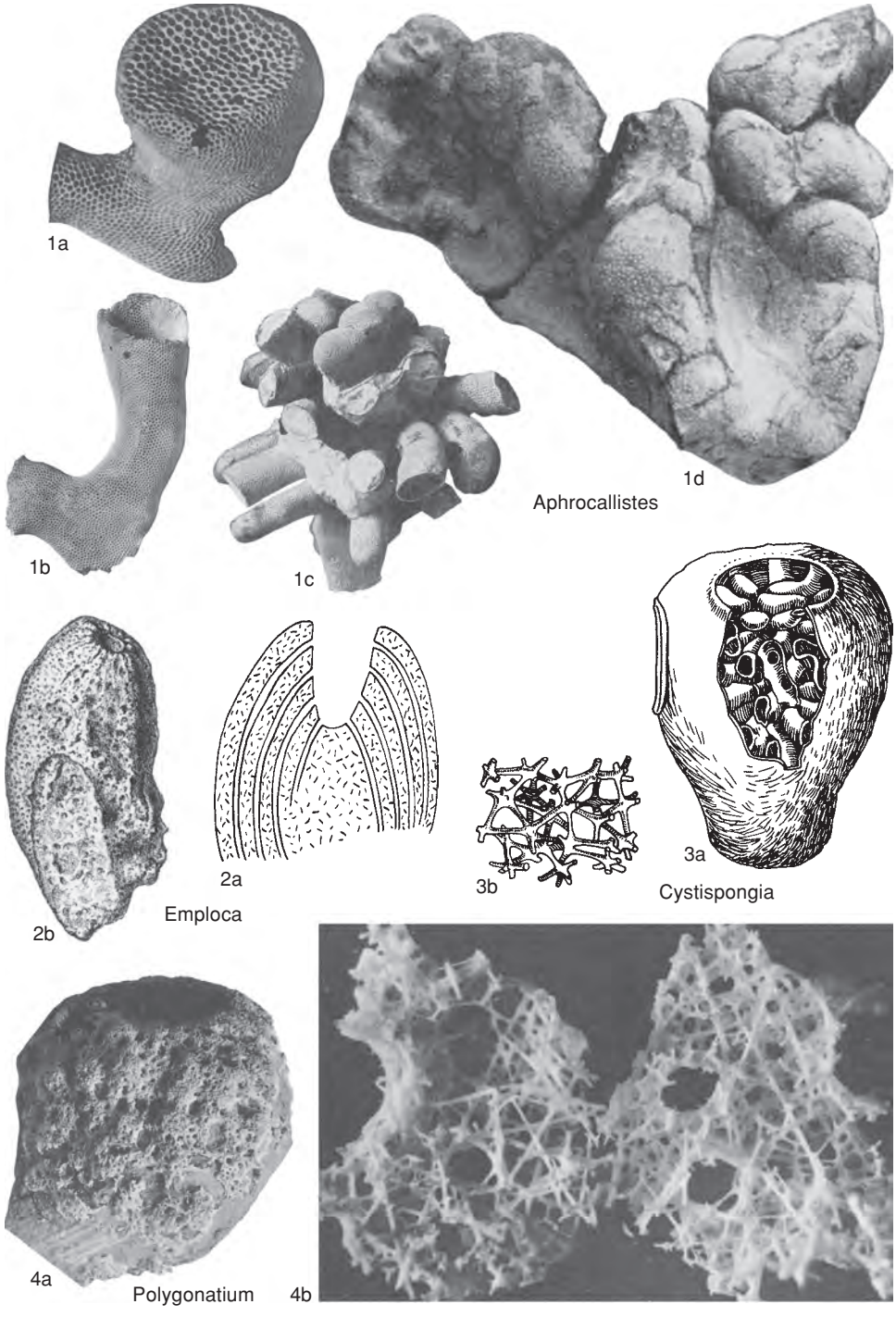


FIG. 330. Aphrocallistidae, Cystispongiidae, Aulocalycidae, and Emplocidae (p. 501–507).

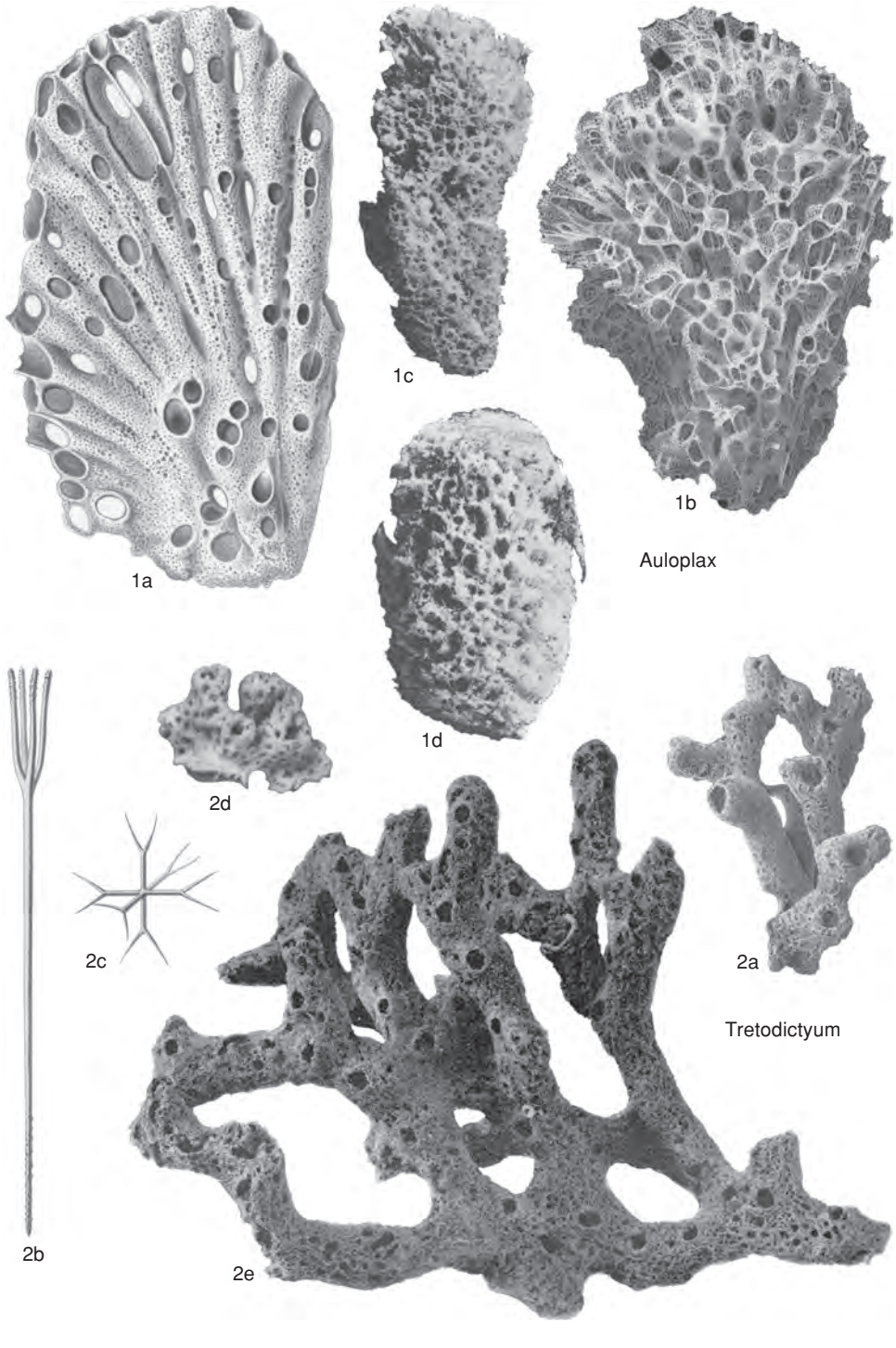


FIG. 331. Tretodictyidae (p. 501–504).

Germany, *?Coniacian–?Maastrichtian;* cosmopolitan, *Holocene.*——Fig. 331,*1a–b. *A. auricularis,* eastern North Atlantic Ocean, southwest of Cape Bojador, Holocene; *a,* hand sample showing growth form; *b,* skeleton with soft parts removed, ×1 (Schulze, 1904).——Fig. 331,*1c–d. A. spongiosus* Schrammen, Quadratenkreide, Cenomanian, Oberg, Germany; side views of subcylindrical to globular, thick-walled sponges with irregular, cavernous, skeletal structure and labyrinthic canals, ×1 (Schrammen, 1912).

Hexactinella Carter, 1885, p. 397 [**H. ventilabrum;* M]. Funnel-like, flabellate, branched-tubular, or variant conditions; schizorhyses from laterally intercommunicating, longitudinal clefts to irregularly labyrinthine passages; intervening parts of skeleton form radial septa or irregularly anastomosed trabeculae correspondingly; apertures of both surfaces similar, or those of gastral side rounded by secondary constriction; dictyonal strands spreading subequally to both sides, or running mainly or all to dermal side; meshwork denser at surfaces than internally, or not; without true, superficial meshwork, although secondary, dictyonal bridges may grow across schizorhyses at surfaces and internally, or parts of surface may be masked by irregular, secondary masses; living examples with scopules, discohexasters, and with pentactines or nonpinular hexactines as dermalia and gastralia. [Identified wrongly with *Polyopesia* Schrammen (family Cribrospongiidae) by Schrammen (1912, p. 233) and followers.] *Cretaceous–Holocene:* cosmopolitan.

H. (Hexactinella). Funnel-like or flabellate, sometimes irregularly corrugated, or compressed in funnel-like examples; dictyonal strands spreading to both surfaces. *?Cretaceous, Holocene:* Germany, *?Cretaceous;* Japan, *Holocene.*——Fig. 332,*1. *H. (H.) ventilabrum,* Holocene, Pacific Ocean, Tokyo Bay, Japan; part of skeletal fragment and loose spicules, with dermal surface at top, ×35 (de Laubenfels, 1955).

H. (Parahexactinella) Reid, 1963a, p. 228 [**Tretodictyum latum* Schulze, 1887a, p. 329; OD]. Branched-tubular, branches sometimes expanding into funnels, or with funnel-like or flabellate growths arising from a branched, solid stock; dictyonal strands spreading to both surfaces, or running mainly or all to dermal side. *Cretaceous–Holocene:* Germany, Great Britain, *Cretaceous*; Pacific Ocean, *Holocene.*——Fig. 332,*2. H. (P.) loeschmanni* (Schrammen), Quadratenkreide, Cenomanian, Oberg, Germany; side view of branched, tubular sponge, ×1 (Schrammen, 1912).

?Prohexactinella Moret, 1926b, p. 216 [**P. cenomanense;* OD; ?=*Proeuplectella fragilis* Moret, 1926b, p. 210, obj.] [?=*Proeuplectella* Moret, 1926b, p. 209 (type, *P. fragilis* Moret, 1926b, p. 210, M)]. Externally globular above a short stalk; paragastral cavity narrow; schizorhyses labyrinthic externally, but open by longitudinally elongate clefts on gastral side; dictyonal skeletal net robust and of large hexactines, no superficial meshwork; loose spicules unknown. [Distinction from *Hexactinella* Carter barely justified; based originally on absence of second-order (aporhytic) pores of *Polyopesia* Schrammen, misidentified with *Hexactinella* following Schrammen (1912, p. 222).] *Upper Cretaceous:* France.——Fig. 332,*5. *P. cenomanense,* Cenomanian, Mans, Sarthe; side view of globular sponge, ×1 (Moret, 1926b; courtesy of Société Géologique de France).

Psilocalyx Ijima, 1927, p. 219 [**P. wilsoni* Ijima, 1927, p. 265; OD] [=*Nitidus* de Laubenfels, 1955, p. 86, *nom. nov. pro Epaphroditus* Schrammen, 1937, p. 62, *non* Herman, 1912 (type, *Epaphroditus nitidus* Schrammen, 1937, p. 62)]. Thick-walled cup or hollow cylinder with a narrow, central cavity; schizorhyses labyrinthic, wide, open externally by rounded apertures in coarsely reticulate surface; living example with scopules, dermal pentactines, and discohexasters. *Upper Jurassic, Holocene:* Germany, *Upper Jurassic;* East Indies, *Holocene.*——Fig. 332,*6a–b.*P. wilsoni,* East Indies, Banda Sea, Holocene; *a,* holotype seen from side; *b,* holotype seen from above, ×1 (Ijima, 1927).——Fig. 332,*6c. P. nitidus* (Schrammen), Weiss Jura, Upper Jurassic, Streitberg, Germany; fragment showing characteristic skeletal structure with coarse ostia, ×4 (Schrammen, 1936).

Ramalmerina Brimaud & Vachard, 1987, p. 425 [**R. fischeri;* OD]. Hexactinellids with numerous branches that are disposed fanlike, diverging from common base; branches often bear an osculum several millimeters in diameter at point of their bifurcation; skeletal net fine, regular, displaying long hexactines arranged in rectangular mesh. *Neogene (Miocene):* Spain.——Fig. 332,*3a–b. *R. fischeri,* Tortonian strata, upper Miocene, Almeria, southern Spain; *a,* side view of branched sponge, IPM R6981, ×0.50; *b,* longitudinal section with preserved, opalline spicules in rectangular mesh, IPM R6981, ×50 (Brimaud & Vachard, 1987; courtesy of *Publications Scientifiques du Muséum national d'Histoire naturelle, Paris*).

Sclerothamnopsis Wilson, 1904, p. 84 [**S. compressa;* OD]. Branched hexactinellid with oscula situated at extremities or on surface of branches; branches traversed by canals without well-defined patterns; skeleton fine textured with dermalia of hexactines; oxyhexasters present. *Neogene (Miocene)–Holocene:* Spain, *Miocene;* eastern Pacific, *Holocene.*——Fig. 332,*4. *S. compressa,* Tortonian strata, upper Miocene, Almeria, Spain; branched tubular form with many small oscula, IPM R6980, ×1 (Brimaud & Vachard, 1987; courtesy of *Publications Scientifiques du Muséum national d'Histoire naturelle, Paris*).

Subfamily PLACOTREMATINAE new subfamily

[Placotrematinae Reid, herein] [type genus, *Placotrema* Hinde, 1884a, p. 127]

With connected dermalia or gastralia, united by ankylosis of paratangential rays or by networks of siliceous filaments in meshes between them. [Contains one living

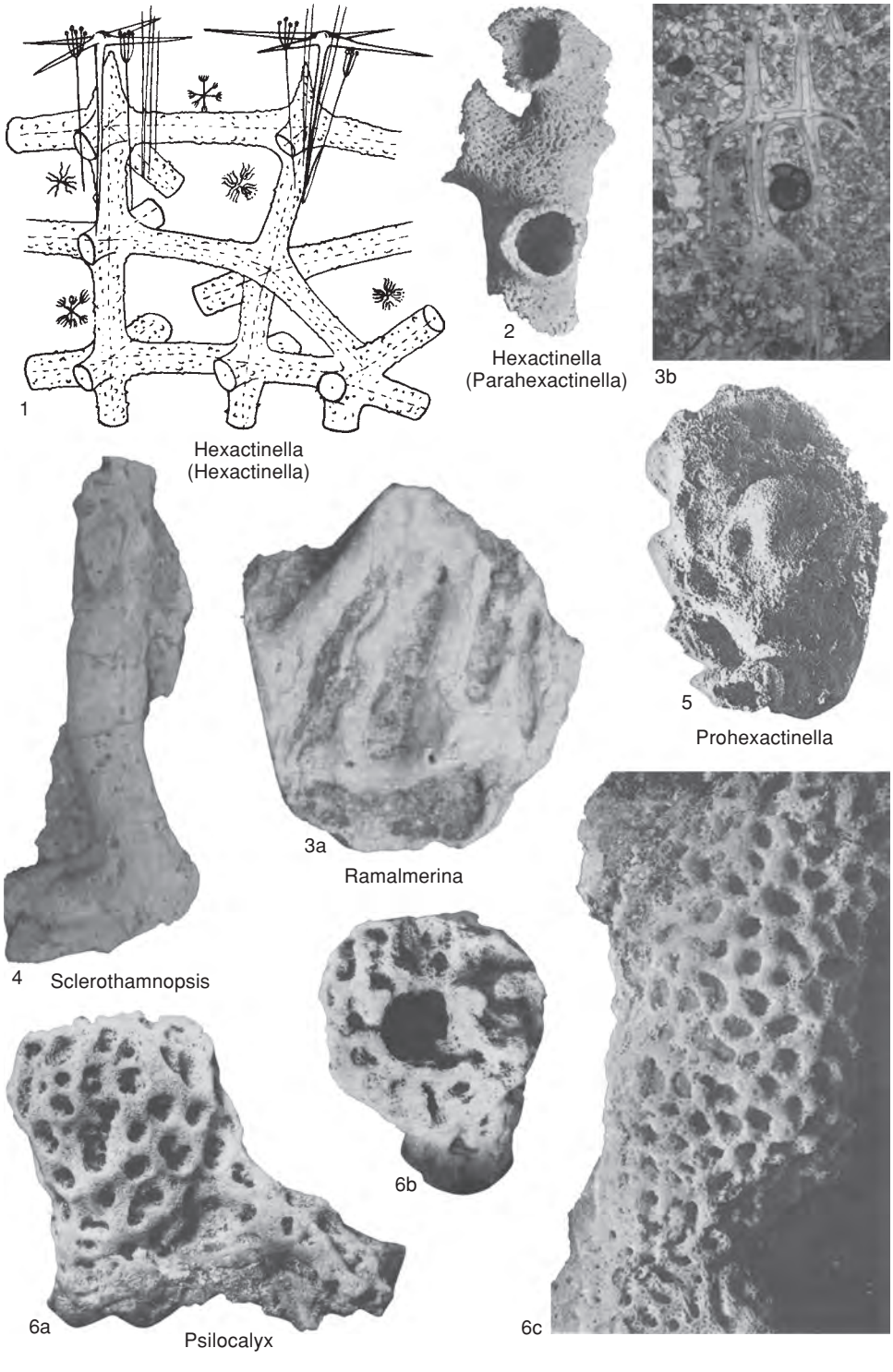


Fig. 332. Tretodictyidae (p. 504).

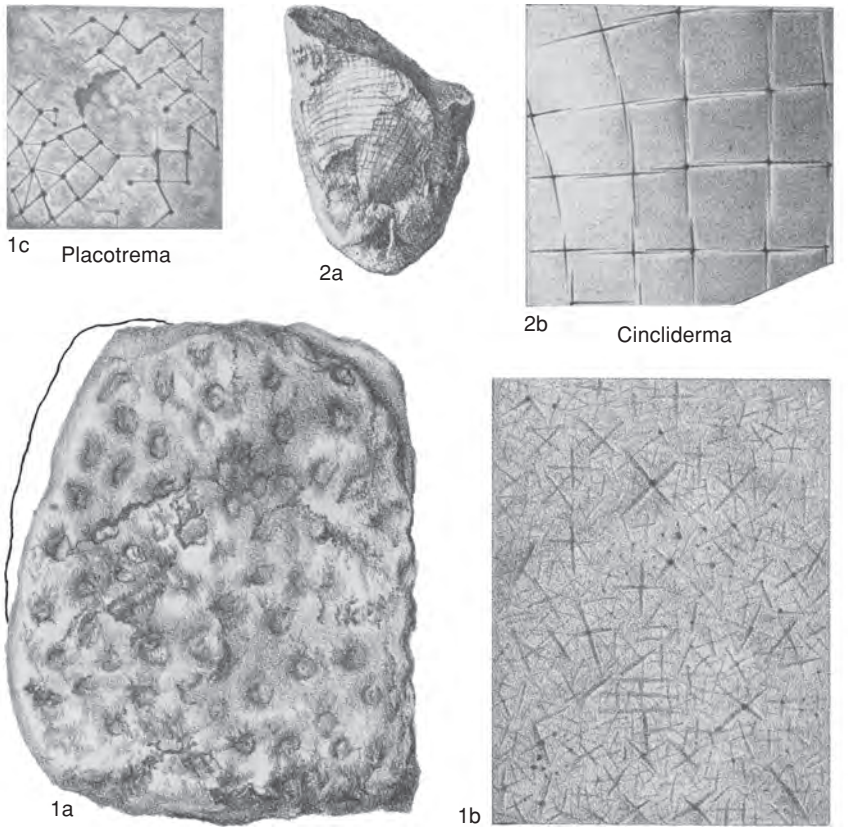


FIG. 333. Tretodictyidae (p. 506).

member, *Fieldingia* KENT, 1870, which has no fossil record.] *Cretaceous (Turonian).*

Placotrema HINDE, 1884a, p. 127 [**P. cretaceum;* OD]. Usually platterlike or flabellate, sometimes irregularly convoluted, rarely funnel-like; dermal surface of skeletal framework with closely spaced, round or ovate apertures of internally labyrinthic schizorhyses, between which skeletal meshwork forms divided and anastomosed trabeculae; gastral side similar, but coated by dense, tangential layer of superficial meshwork formed from large and small pentactines united mainly by siliceous filaments that form networks between tangential rays; this meshwork perforated at intervals by irregularly alternating, round or ovate, osculum-like openings; dictyonal skeleton fine meshed, with strands spreading to both surfaces; loose spiculation unknown. *Cretaceous (Turonian):* England.——FIG. 333,*1a–c.* **P. cretaceum,* Upper Chalk, Kent; *a,* upper surface with oscula, ×1; *b,* drawing of dermal layer where spicules preserved as molds, ×15; *c,* drawing of internal skeleton from fractured surface where spicules preserved as molds, ×20 (Hinde, 1884b).

Cinclíderma HINDE, 1884a, p. 127 [**C. quadratum* HINDE, 1884a, p. 128; OD]. Nodular or possibly funnel-like; schizorhyses wide, tunnel-like, labyrinthic; skeletal framework coarse meshed, with meshwork between radiating, dictyonal strands often largely irregular; surfaces coated by tangential networks of connected dermal or gastral pentactines, united by ankylosis of their tangential rays only, or with additional smaller pentactines or siliceous filaments in intervening meshes; major meshes of this meshwork typically quadrate and sometimes regularly subdivided if smaller pentactines occur; loose spiculation unknown. *Cretaceous (Turonian):* England.——FIG. 333, *2a–b.* **C. quadratum,* Upper Chalk, southern England; *a,* basal part of funnel-shaped sponge with dermal layer, ×1; *b,* part of dermal layer with coarse, reticulate skeleton, smaller, intermingled spicules in quadrules not represented, ×10 (Hinde, 1884b).

Family CYSTISPONGIIDAE new family

[Cystispongiidae Reid, herein] [type genus, *Cystispongia* F. A. Roemer, 1864, p. 7]

Tuberlike or pyriform sponges, with dense, external capsule enclosing a labyrinth of thin-walled passages; skeletal meshwork euretoid; loose spicules and nature of internal passages unknown. [Internal passages are comparable with either euretid cavaedia or tretodictyid schizorhyses. The single included genus, *Cystispongia* F. A. Roemer, is a true hexactinosan, although the name *Cystispongia* has been applied to various Lychniscosa.] *Upper Cretaceous (Coniacian)–Neogene.*

Cystispongia F. A. Roemer, 1864, p. 7 [**Cephalites bursa* Quenstedt, 1852, p. 670; SD Rauff, 1893, p. 65] [=*Cyrtobolia* Počta, 1883, p. 38 (type, *Achilleum formosum* Reuss, 1846 in 1845–1846, p. 79, SD de Laubenfels, 1955, p. 83)]. Tuberlike or pyriform, sometimes with a terminal depression but with no axial, paragastral cavity; interior a labyrinth of thin-walled, tubular passages; external surface of mature examples formed by a shell-like capsule, which covers surface completely or has osculum-like, terminal perforation, or terminal and lateral perforations; internal meshwork simple, dictyonal strands spreading from axis when apparent; capsule formed by dictyonal meshwork with triangular meshes and spherically swollen, multiradiate nodes, or possibly with this meshwork covered externally by a thin, siliceous membrane; loose spiculation unknown. *Upper Cretaceous (Coniacian)–Neogene:* Europe.——Fig. 330,*3a–b. C. bursa* (Quenstedt), Brogniarti-Planer, Turonian, northern Germany; *a,* side view of pyriform example with oscule-like openings in dermal layer, ×1; *b,* fragment of endosomal skeleton, ×12 (de Laubenfels, 1955).

Family AULOCALYCIDAE Ijima, 1927

[Aulocalycidae Ijima, 1927, p. 128]

Skeletal framework three dimensional and constructed so that individual spicular rays or strandlike series of skeletal beams are interwoven diagonally, often also with many anaxial synapticula; canalization absent or limited to occurrence of ostia or shallow epirhyses; sceptrules and uncinates absent in Holocene examples. [Relationship to other Hexactinosa uncertain, but skeletal structure corresponds with the cortical meshwork of several genera (e.g., *Heterochone* Ijima, *Euryplegma* Schulze).] *Upper Jurassic.*

?Polygonatium Schrammen, 1937, p. 56 (Schrammen, 1936, p. 182, *nom. nud.*) [**P. sphaeroides;* OD]. Globular with large osculum and short stalk; exterior with rounded ostia of varying sizes, arranged without order; outer meshwork of framework formed by union of dictyonal hexactines of various sizes with their rays overlapping diagonally, united where they cross one another and also in part by synapticula; meshwork denser at surface, there pierced by ostia; inner part unknown; dermal stauractines may be fused to parts of external surface; other loose spicules unknown. [Skeletal meshwork aulocalycoid as known, but possibly only part of a structure with euretoid meshwork internally (cf. e.g., *Heterochone* Ijima, family Euretidae).] *Upper Jurassic:* Germany.——Fig. 330,*4a–b. *P. sphaeroides,* Weiss Jura, Streitberg; *a,* side view of type specimen with shallow spongocoel on summit of globular sponge, with round ostia of various sizes in dermal surface, ×2; *b,* fragment of dictyonal, skeletal structure, ×20 (Schrammen, 1937).

Family EMPLOCIDAE de Laubenfels, 1955

[Emplocidae de Laubenfels, 1955, p. 80]

Hexactinosid sponges with multilayered skeleton in which radially disposed, longitudinal, subdermal canals occur in successive zones separated by layers of regular, rectangular cribwork, so that transverse sections resemble growth rings; skeleton simple, dictyonine network with imperforate nodes; dermal skeleton not preserved. *Middle Jurassic.*

Emploca Sollas, 1883, p. 541 [**E. ovata* Sollas, 1883, p. 542; OD] [=*Taxoploca* Sollas, 1888, p. xxviii, obj.]. Cylindrical to ovate sponges with thick walls around deep, cylindrical spongocoel with unobstructed, circular osculum at summit; exhalant canals in ringlike, successive zones approximately parallel to outer margin and open onto gastral surface of spongocoel; inhalant canals, with small, round ostia evenly distributed on dermal surface, continue inwardly obliquely downward toward axis; skeleton simple, hexactinosan network with imperforate nodes; dermal skeleton not preserved. *Middle Jurassic:* England.——Fig. 330,*2a–b. *E. ovata,* Inferior Oolite, Bristol; *a,* diagrammatic vertical section showing growth form and exhalant canal system, ×2 (de Laubenfels, 1955); *b,* side view of small sponge, ×1 (Sollas, 1883).

Family UNCERTAIN

Carinthiaspongus Krainer & Mostler, 1992, p. 138 [**C. ramosus;* OD]. Isolated, large pentactines with smooth, proximal ray and four irregularly branched

rays in a plane; coarse branches longest near spicule center and shorter distally, mainly parallel to four principal rays or directed upwardly and outwardly. *Middle Triassic:* Austria.——Fig. 334,*7. *C. ramosus,* Rote Knollenkalke, Ladinian, Karawanken, Kärnten; distal view of isolated spicule with smooth, proximal ray and branched, lateral rays, ×75 (Krainer & Mostler, 1992).

Caseispongia Quenstedt, 1877 in 1877–1878, p. 106 [**C. articulata;* OD]. Annulate, chambered sponge with deep, broad spongocoel; thick walls with layered, dictyid skeletal structure; outer dermal layer fine textured, intermediate layer of regular, reticulate, coarser structure, inner or gastral layer of somewhat coarser and more irregular, dictyid structure; coarse, exhalant canals extending from middle of wall into spongocoel. *Jurassic:* Germany.——Fig. 335,*5a–c. *C. articulata,* Weiss Jura, Heuberg; *a,* side view of moderately complete, annulate, chambered-type sponge with a fine-textured, dermal layer and coarse, exhalant canals in inner part of wall, at spongocoel margin in upper chamber, ×1; *b,* transverse section of same sponge showing coarse, exhalant canals leading into matrix-filled spongocoel, ×1; *c,* transverse section of fragment showing three layers of dictyid skeleton, with fine, dermal layer at top, approximately ×5 (Quenstedt, 1877–1878).

Furcicanalis Wu & Xiao, 1989, p. 16 [**F. goniconus;* OD]. Obconical sponges with angular, transverse sections, moderately thick walls, and open spongocoel; outer, thin, inhalant canals straight and converging near midwall to form larger, straight, exhalant canals of inner wall; main dictyonine strands of skeleton undulate, and those in thin, dermal and gastral layers and canal walls coarser than in other parts of wall; secondary hexactines constructing rectangular to multiangular meshes. *Upper Triassic (Carnian):* China.——Fig. 334,*6. *F. goniconus,* Upper Member of Hanwang Formation, Shifang County, Sichuan; transverse section of holotype with pentagonal outline and thick walls where thin, inhalant canals converge to form coarser, inner, exhalant canals, CCG 189-129, ×2 (Wu & Xiao, 1989).

Idiodictyon de Laubenfels, 1955, p. 95, *nom. nov. pro Eudictyon* Bistram, 1903, p. 84, *non* Marshall, 1875b, p. 211 [**Eudictyon steinmanni* Bistram, 1903, p. 86; OD]. Cup-shaped sponge with thin walls and broad spongocoel; dictyid skeleton of fused, regular hexactines, gastral layer of regularly arranged and spaced, separate hexactines with coarse, thick rays. *Lower Jurassic:* Germany.——Fig. 335,*1a–c. *I. steinmanni* (Bistram), lower Lias, Comasker Alps; *a,* side view of thin-walled, cup-shaped sponge, ×1; *b,* fragment of hexactinosid, endosomal skeleton, ×25; *c,* part of gastral layer of skeleton, ×20 (Bistram, 1903).

Imbricareola Wu & Xiao, 1989, p. 15 [**I. prunivalvaris;* OD]. Steeply obconical, small sponges with deep, open spongocoel surrounded by thin wall composed largely of irregularly distributed, large, thin-walled, hemispherical to subspherical, hollow nodes that open into spongocoel; wall in transverse sections appears petalloid and perforated by numerous crooked, thin canals; skeleton of irregularly oriented, fused hexactines and associated smaller, second-order hexactines. *Upper Triassic:* China.——Fig. 335,*2a–b. *I. prunivalvaris,* Upper Member of Hanwang Formation, Carnian, Jiangyou County, Sichuan; *a,* side view of nodose, small holotype, CCG 935-784, ×1; *b,* transverse section of paratype showing petalloid structure and canalled, thin wall, CCG 177-265, ×4 (Wu & Xiao, 1989).

Misonia Krautter, 1996, p. 306 [**M. baldensis;* OD]. Cup-shaped hexactinosan with a broad, deep, central spongocoel and a thick wall, with an encrusting base; unbranched epirhyses and aporhyses quadcunxially arranged in longitudinal and horizontal rows and ending deep within sponge wall; dictyonal skeleton very regular and of hexactines arranged in narrow, quadratic meshes; microscleres unknown. *Lower Jurassic (Pliensbachian):* Italy.——Fig. 334,*3. *M. baldensis,* Misone Limestone, Trento platform, southern Alps; transverse section showing thick wall with radial canals and central spongocoel, ×0.5 (Krautter, 1996).

Multiloqua de Laubenfels, 1955, p. 82, *nom. nov. pro Polyphemus* Schrammen, 1937, p. 47, *non* Bernhauer, 1914 [**Polyphemus strombiformis* Schrammen, 1937, p. 48; OD]. Small, spherical, pear- or top-shaped sponge with smooth, outer, cover layer; hemispherical or flat, upper surface with central, round osculum to spongocoel; through folding, thin wall forms a plicate structure with folds separated by deep cavaedia; outer, cavaedial system alternating with an inner one whose openings are in spongocoel surface; porous epirhyses and aporhyses in walls connect outer and inner cavaedia; dictyonalia of principal skeleton hexactines, but outer, cover layer mesh composed of large stauractines and associated, smaller stauractines. *Jurassic:* Germany.——Fig. 334,*2a–b. *M. fungulus* (Quenstedt), Kimmeridgian marls, Upper Jurassic, Bärenthal; *a,* side view showing characteristic growth form, ZPAL Pf. VIII/304, ×1; *b,* summit view of same sponge with shallow spongocoel partially filled with matrix, ×1 (Pisera, 1997; courtesy of *Palaeontologica Polonica*).

Mysterium de Laubenfels, 1955, p. 86, *nom. nov. pro Mystrium* Schrammen, 1937, p. 60, *non* Herman, 1912 [**Mystrium porosum* Schrammen, 1937, p. 60; OD]. Very small, fig or club shaped with massive, thick wall and deep spongocoel; dermal surface with tiny, broadly spaced, irregular ostia of tubular, epirhysal canals that end in interior between exhalant canals; dictyonalia hexactines in close-meshed and only locally regularly meshed skeleton; dermal layer with thickened elements in fused structure. *Jurassic:* Germany.——Fig. 334,*1. *M. porosum* (Schrammen), Weiss Jura, Upper Jurassic, Streitberg; side view of dermal surface of club-shaped sponge, ×4 (Schrammen, 1937).

Octobrum de Laubenfels, 1955, p. 86, *nom. nov. pro Rhabdium* Schrammen, 1937, p. 63, *non* Schaum,

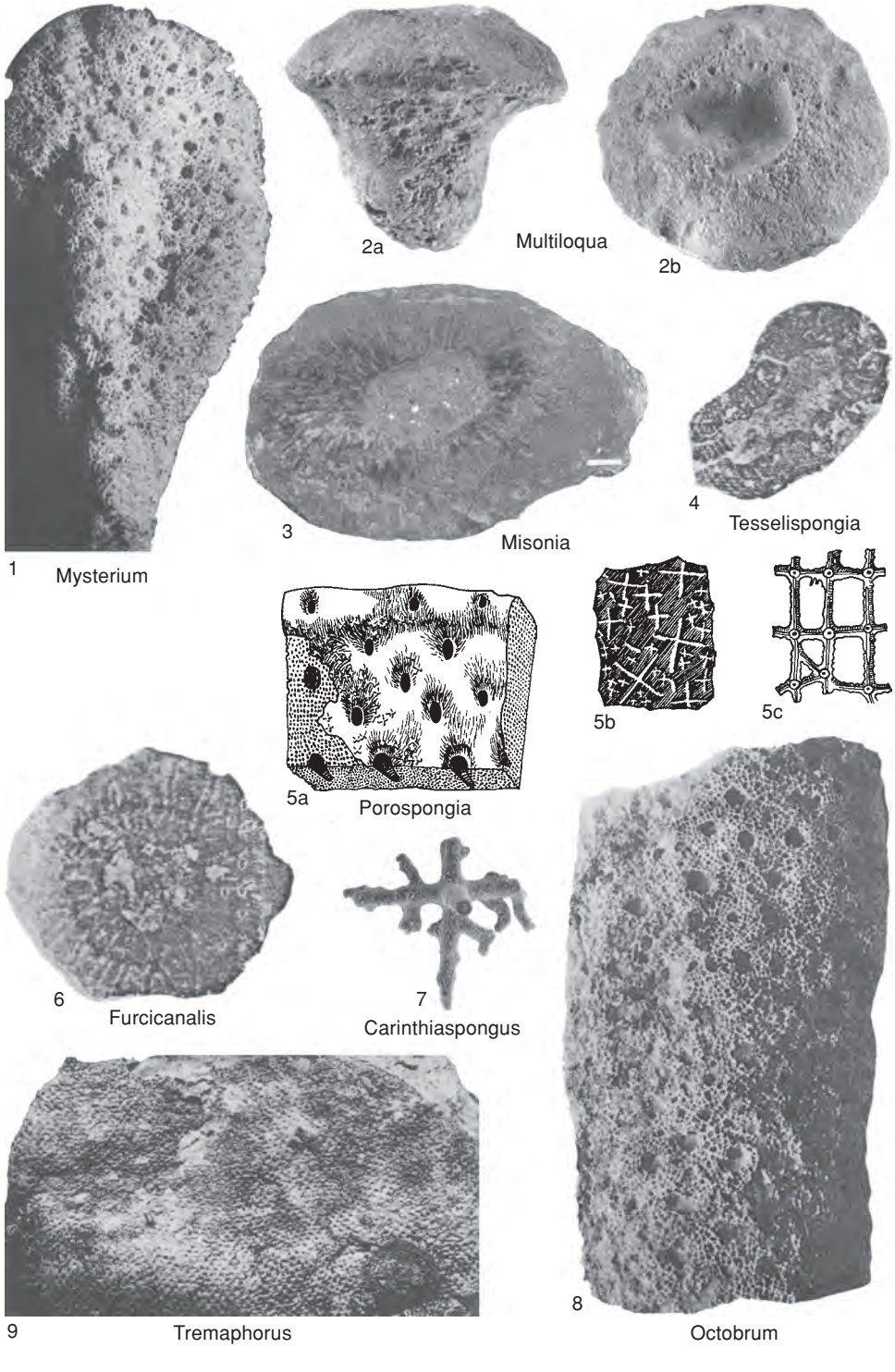


Fig. 334. Uncertain (p. 507–511).

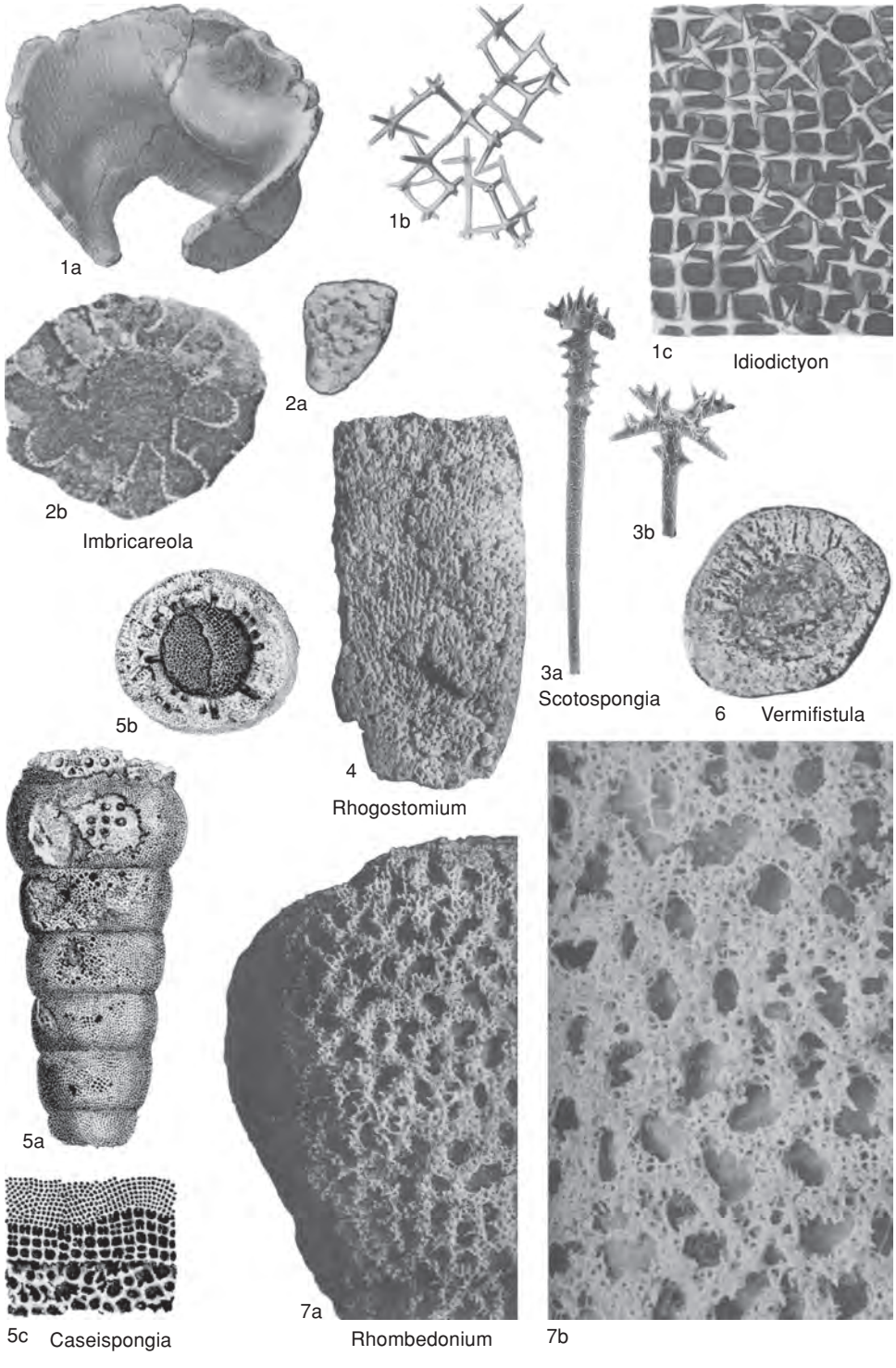


FIG. 335. Uncertain (p. 508–511).

1859 [**Rhabdium angustatum* SCHRAMMEN, 1937, p. 63; OD]. Sponge rod shaped; outer surface with small, irregularly spaced ostia; dictyonalia hexactines fused into moderately regular framework; dermal layer not differentiated. *Jurassic:* Germany.——FIG. 334,*8. *O. angustatum* (SCHRAMMEN), Weiss Jura, Upper Jurassic, Heuchstetten; side view of cylindrical holotype with irregularly spaced ostia, ×4 (Schrammen, 1937).

Porospongia D'ORBIGNY, 1849, p. 547 [**Manon marginatum* GOLDFUSS, 1829, p. 94; SD RAUFF, 1893, p. 65] [=*Porostoma* FROMENTEL, 1860a, p. 43 (type, *P. marginata,* OD]. Lamellate, upper surface with many large oscules leading from short cloacas; dense dermis with stauractines and hexactines; type species has rim around oscules but others do not. [SALOMON (1990) and MEHL (1992) discussed the taxonomic history of *Porospongia* and associated genera and concluded that *Porospongia* and *Cribrospongia* were named by D'ORBIGNY in 1849, not in 1847, after an intensive search for documentation of the 1847 paper failed.] *Upper Jurassic:* Europe.——FIG. 334,*5a–c. P. impressa* (GOLDFUSS), Germany; *a,* part of side view of sponge showing common oscules, ×1; *b,* part of dermal layer, ×6; *c,* part of fused, endosomal skeleton, ×12 (de Laubenfels, 1955).

Rhogostomium SCHRAMMEN, 1937, p. 58 (SCHRAMMEN, 1936, p. 182, *nom. nud.*) [**R. corrugatum;* OD]. Sponges flat or funnel shaped with massive, thick walls; small, oval to crevicelike, inhalant and exhalant ostia occur in closely spaced, alternating to irregular arrangements in more or less distinct rows; epirhyses and aporhyses end blindly beneath skeletal surface; fused and somewhat irregular, dictyonal skeleton is of hexactines, which are more or less thickened in outer, dermal layer. *Jurassic:* Germany.——FIG. 335,*4. *R. corrugatum,* Weiss Jura, Upper Jurassic, Heuchstetten; side view of exterior of flattened sponge showing nature of ostia, ×0.5 (Schrammen, 1937).

Rhombedonium SCHRAMMEN, 1937, p. 59 (SCHRAMMEN, 1936, p. 182, *nom. nud.*) [**R. cypelliaeforme;* OD]. Small, top-shaped sponge with thick wall and deep spongocoel; dermal surface with irregularly rounded, inhalant ostia without distinct arrangement, as openings to branched epirhyses that end under skeletal surface as postica; gastral, upper surface with large, round, clearly to obscurely alternating postica of aporhyses that initiate between inhalant canals within skeleton; distinctly irregular and wide-meshed, dictyonal skeleton composed of fused hexactines, more or less thickened in dermal layer. *Jurassic:* Germany.——FIG. 335,*7a–b. *R. cypelliaeforme,* Weiss Jura, Upper Jurassic, Streitberg; *a,* side view of small sponge with relatively coarse, inhalant ostia, ×4; *b,* enlarged view of dermal surface showing open, skeletal net and coarse ostia, ×6 (Schrammen, 1936).

Scotospongia KRAINER & MOSTLER, 1992, p. 138 [**S. aculeata;* OD]. Large pentactines with a long, proximal ray that is coarsely spinose in upper part, and four other rays arranged in transverse plane, and all with large spines that are generally directed upwardly. *Middle Triassic:* Austria.——FIG. 335,*3a–b. *S. aculeata,* Rote Knollenkalke, Ladinian, Karawanken, Kärnten; *a,* side view of typical spicule with long, proximal ray that is spinose near top, and spinose transverse rays, above; *b,* oblique view from above showing coarse spines on transverse rays and upper part of proximal ray, ×100 (Krainer & Mostler, 1992).

Tesselispongia WU & XIAO, 1989, p. 17 [**T. tubifasciculata;* OD]. Branched to unbranched, tubular to pillar-shaped sponges with thin, smooth walls and open spongocoels; walls may lack canals or have some radial canals where inhalant and exhalant canals alternate in position; skeleton of very small, regular hexactines that may be coarser in dermal or gastral areas, and may have growth rings where coarser. *Upper Triassic (Carnian):* China.——FIG. 334,*4. *T. tubifasciculata,* upper Member of Hanwang Formation, Mianzhu County, Sichuan; diagonal section through branched sponge showing open spongocoel and moderately thick walls with regular canals, particularly in diagonal section on right, CCG 208-527, ×2 (Wu & Xiao, 1989).

Tremaphorus SCHRAMMEN, 1937, p. 62 (SCHRAMMEN, 1936, p. 183, *nom. nud.*) [**T. punctatus;* OD]. Sponge flat, probably funnel or ear shaped, with a proportionally thin wall; dermal surface with closely spaced, pinpoint-sized ostia; epirhyses and aporhyses ending blindly with skeleton between postica; dictyonal skeleton narrow meshed, in inner part of wall regularly meshed, and in outer part strongly thickened in dermal layer. *Jurassic:* Germany.——FIG. 334,*9. *T. punctatus,* Weiss Jura, Upper Jurassic, Erkenbrechtsweiler; dermal surface with regular ostia in thickened, outer part of skeleton, ×1 (Schrammen, 1937).

Vermifistula WU & XIAO, 1989, p. 16 [**V. microdictya;* OD]. Steeply obconical to pillar-shaped or cylindrical sponges with deep, open spongocoel; moderately thick walls with numerous crooked, inhalant canals that converge irregularly to form somewhat coarser, inner, exhalant canals; skeleton of small, closely spaced hexactines fused at various angles to construct triangular to pentagonal, mesh spaces in wall that shows growth rings. *Upper Triassic (Carnian):* China.——FIG. 335,*6. *V. microdictya,* Upper Member of Hanwang Formation, Shifang County, Sichuan; transverse section showing thick wall around spongocoel and crooked, inhalant and exhalant canals, CCG 179-529, ×2 (Wu & Xiao, 1989).

MESOZOIC AND CENOZOIC HEXACTINELLID SPONGES: LYCHNISCOSA AND ORDER UNCERTAIN

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Order LYCHNISCOSA Schrammen, 1903

[*nom. transl.* de Laubenfels, 1936, p. 185, *ex* tribus Lychniscosa Schrammen, 1903, p. 7]

Dictyonine Hexasterophora with lychniscs at some stage of ontogeny, in either all or some individuals of any given species, or regarded as derived from a genus having lychniscs; primary skeletal framework sometimes composed of dictyonalia united to form a single, netlike layer of dictyonal meshwork, but usually composed of three-dimensional meshwork in which dictyonal strands are present and have little or no layered arrangement; secondary components may be added at surfaces or within primary meshes; lychnisc octahedra usually present throughout primary meshwork or absent at surfaces, although present internally; octahedra extensively suppressed in some genera through failure to produce them or to secondary solidification in ontogeny; in latter instances, sometimes only seen in some individual sponges; secondary dictyonal meshwork with nodal octahedra or not; cortical meshwork may be absent, or formed by secondary accretion of dictyonal hexactines at surfaces by modification of outermost, primary meshwork or by outgrowth of anastomosing, siliceous filaments from outermost, dictyonal beams; skeletal canalization absent, intracortical only, or fully developed, with distinct, inhalant and exhalant canals (epirhyses, aporhyses) or a single system only; superficial meshwork sometimes present, formed from dictyonal hexactines, adventitious siliceous filaments, or both, or partly or wholly from connected dermalia or gastralia; latter pentactines in known examples; basal skeleton formed from dictyonal hexactines or from siliceous filaments that grow downwardly from dictyonal skeleton; some genera with peripheral structures, supported by loose spicules only or containing rigid structures; hexasters present in living examples, but uncinates and sceptrules unknown. [The name Lychniscosa Schrammen, 1903, differs from the earlier Lychniskophora Schrammen, 1902 in lacking the root *-phor-* (signifying bearers). Lychniscosa is, therefore, a separate name and not a form of the name Lychniskophora.]

Cryptogenic; presumably derived from an unknown primitive lyssacine with hexaster microscleres. According to Ijima (1927), origin of lychnisc octahedra before union of the dictyonalia in ontogeny implies origin of Lychniscosa independently of Hexactinosa in phylogeny. Now almost extinct (5 extant genera). *Jurassic–Holocene.*

Family CALYPTRELLIDAE Schrammen, 1912

[Calyptrellidae Schrammen, 1912, p. 196]

Skeletal framework a single layer of dictyonal meshwork with mainly quadratic meshes; loose spiculation unknown. *Upper Cretaceous.*

Calyptrella Schrammen, 1912, p. 306 [**C. bertae* Schrammen, 1912, p. 307; OD]. Divided and anastomosed tubes; fixation by small, rootlike processes formed from siliceous filaments growing out from dictyonal framework. *Cretaceous (Coniacian–Maastrichtian):* Germany.——Fig. 336*a–b*. **C. bertae,* Quadratenkreide, Cenomanian, Oberg; *a,* characteristic cluster of anastomosed tubes, ×1; *b,* smaller fragment showing skeletal texture and rootlike attachment processes, ×2 (Schrammen, 1912).

Family CALLODICTYONIDAE Zittel, 1877

[Callodictyonidae Zittel, 1877b, p. 38]

Dictyonal framework three dimensional initially, and uncanalled or with intracortical features only as ostia or postica, or shallow epirhyses or aporhyses; peripheral structures

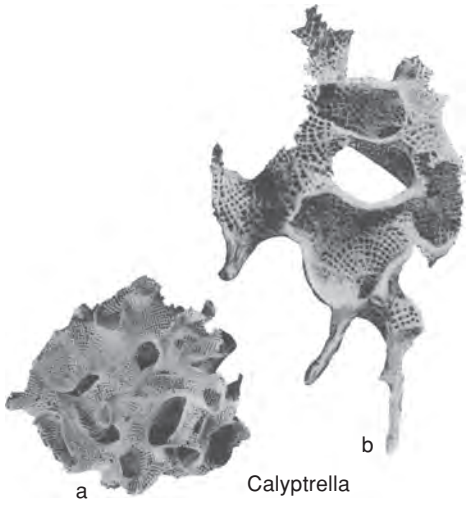


FIG. 336. Calyptrellidae (p. 513).

usually absent (or unknown), but some branched-tubular genera have soft, peripheral capsule or rigid, peripheral meshwork; primary, dictyonal meshwork with gradually diverging, dictyonal strands, without layered arrangement, or locally or mainly arranged so that meshwork shows layered construction; meshes between strands usually regularly quadrate; cortical structures formed by simple thickening of components at surfaces with solidification of lychniscs in some genera; by formation of porous, siliceous membranes from networks of siliceous filaments that cross individual meshes or surface in general; by accretion of secondary dictyonal hexactines, with or without nodal octahedra; by structural modification of outermost meshwork; by anastomosing, siliceous fibers that pass into basal skeleton; or by combinations or two or more of these developments; peripheral meshwork of dictyonal origin when present; basal meshwork formed from secondary hexactines, or from anastomosing siliceous fibers that grow down from surface of dictyonal framework; loose spiculation unknown except in two living genera (with discohexasters; dermal, gastral, and peripheral pentactines). [The scope given to this family is analogous with that given to the family Euretidae of the order Hexactinosa, but with genera with peripheral structures (not present in Euretidae) excluded, apart from a few whose inclusion is more convenient.] *Upper Jurassic–Holocene.*

Subfamily CALLODICTYONINAE Zittel, 1877

[*nom. transl.* REID, herein, *ex* Callodictyonidae ZITTEL, 1877b, p. 38]

Tubular to funnel-like, flabellate, or scabbardlike sponges, the latter with parietal oscula along narrow margins; cortical features and basal skeleton formed by outgrowth of siliceous filaments, or by accretion of small, dictyonal hexactines, with or without nodal octahedra; canalization restricted to ostia or postica, or with shallow, radial canals when cortical meshwork is spicular. [Probably includes several main lines of descent. Genera with cortical and basal meshwork formed from siliceous fibers are most similar to Microblastidinae and Becksinae.] *Upper Jurassic–Upper Cretaceous.*

Callodictyonella STRAND, 1928, p. 33 [**Callodictyon infundibulum* ZITTEL, 1877b, p. 57; OD] [=*Callodictyon* ZITTEL, 1877b, p. 57, obj., *non* SOLLAS, 1877]. Thin-walled cup with very wide spongocoel; wall uniform and composed of layers of united hexactines that form a uniform, quadrate mesh; ray junctions with perforated, octahedral lanterns and with spinose, skeletal beams; dermal layer formed of flattened extensions of rays from outer, skeletal layer; canals and ostia absent. *Upper Cretaceous:* Germany.——FIG. 337,*1a–d. *C. infundibulum* (ZITTEL), Quadratenkreide, Campanian, Oberg; *a,* side view showing uniform, skeletal structure lacking large canals, but with remnants of more dense dermal layer left and right, ×2; *b,* photomicrograph of dermal layer with alternating mesh spaces filled, ×50; *c–d,* camera lucida drawings of structure of dermal layer and interior net, ×45 (Schrammen, 1912).

Beaussetia MORET, 1926b, p. 233 [**B. membraniformis;* OD]. Flabellate, with marginal attachments; primary framework regular but masked at both surfaces by fine, irregular meshwork, formed by union of small, secondary hexactines arranged without order; this cortical meshwork pierced by small, skeletal pores, in longitudinal series on one side but without order on other; attachment structures formed by similar meshwork. *Upper Cretaceous:* France.——FIG. 338,*3a–b. *B. membraniformis,* Santonian, Saint-Cyr; *a,* inner face of flabellate fragment with regular rows of skeletal pores, slightly enlarged, ×1; *b,* outer surface with skeletal pores less regularly distributed, ×1 (Moret, 1926b; courtesy of Société Géologique de France).

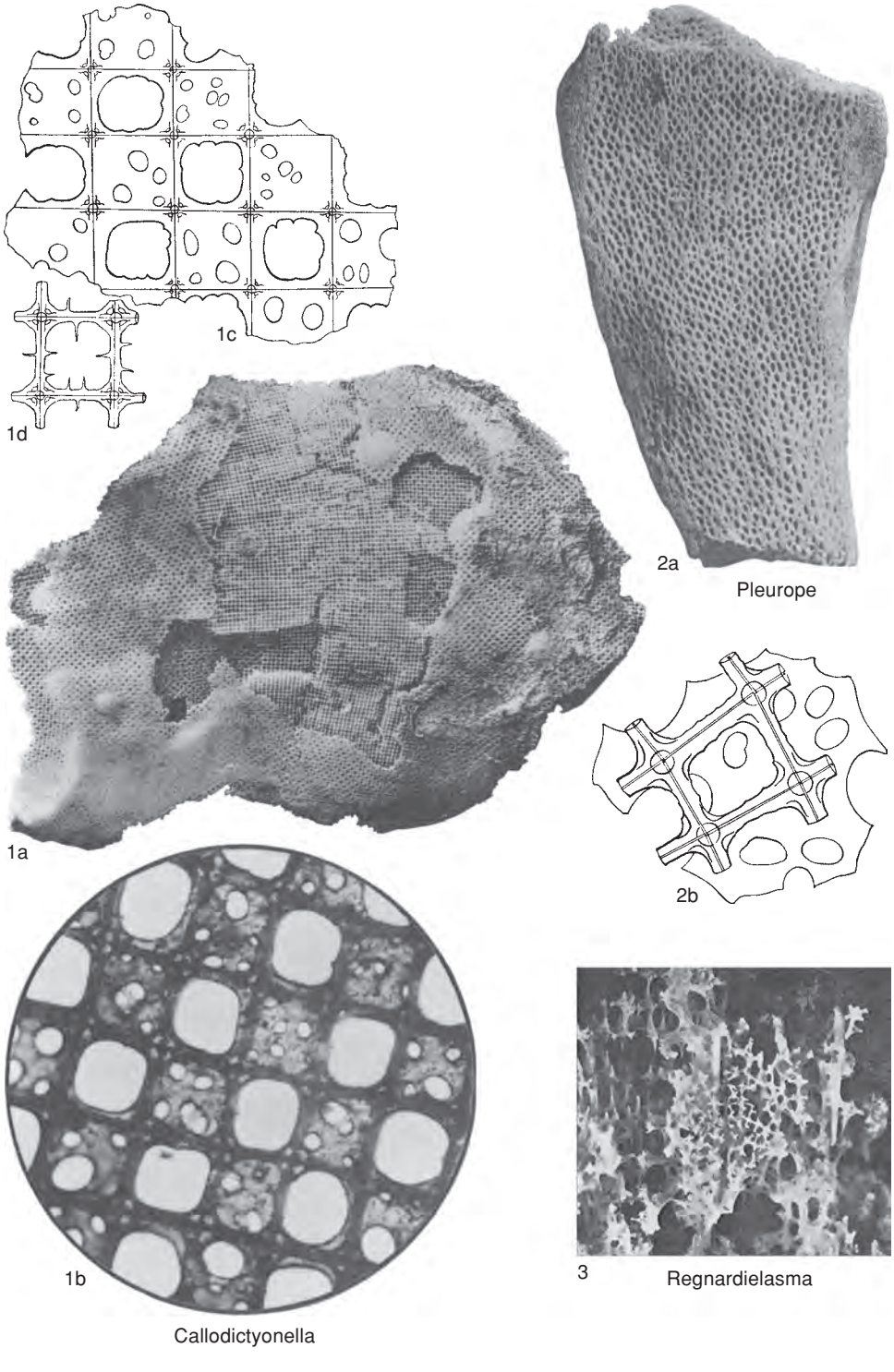


FIG. 337. Callodictyonidae (p. 514–518).

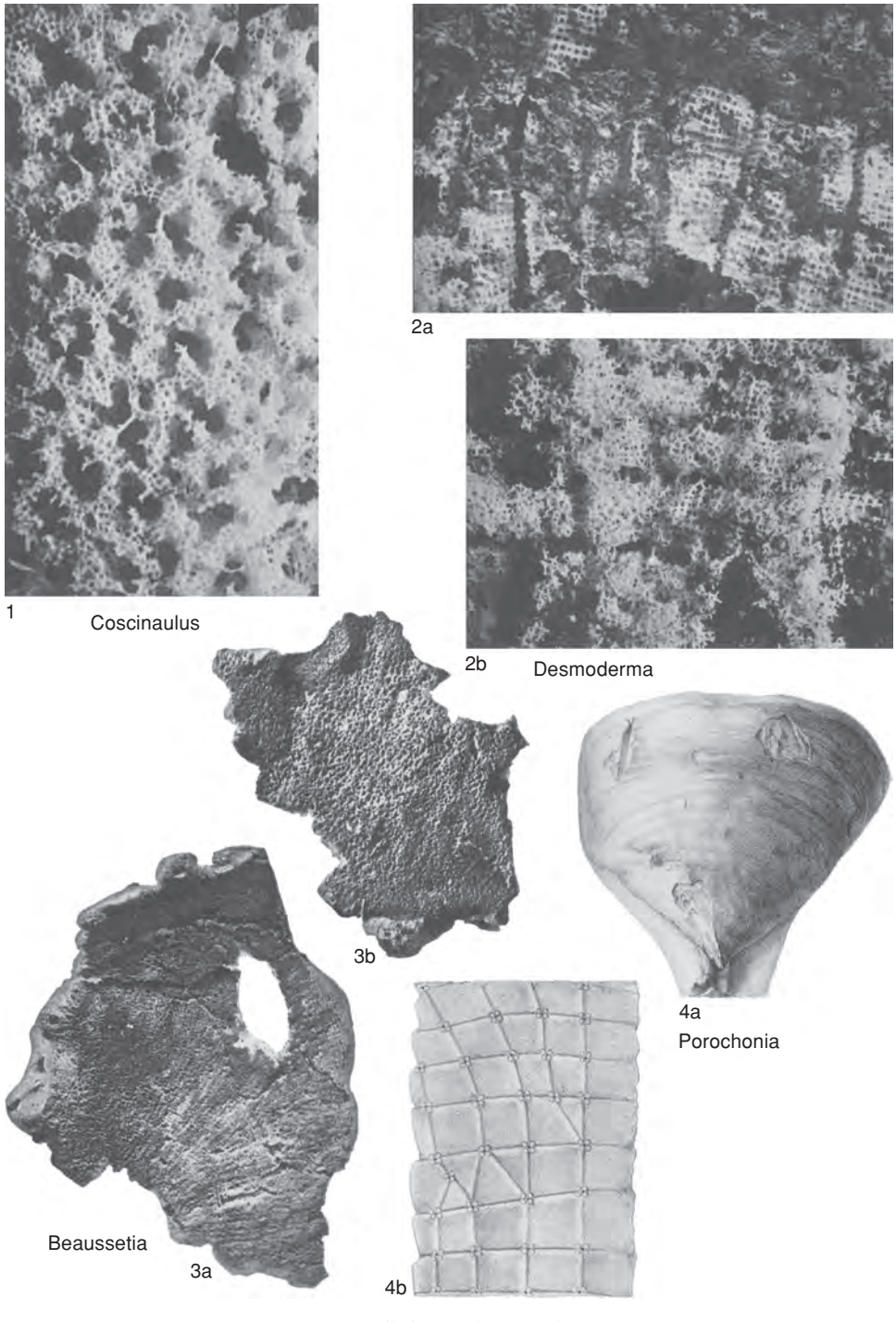


FIG. 338. Callodictyonidae (p. 514–518).

Cinclidella SCHRAMMEN, 1912, p. 334 [**C. solitaria;* OD]. Narrow funnel with basal root processes; dictyonal framework formed from large and small, dictyonal hexactines, larger forming regular, primary framework and smaller uniting to form irregular meshwork within or outside primary

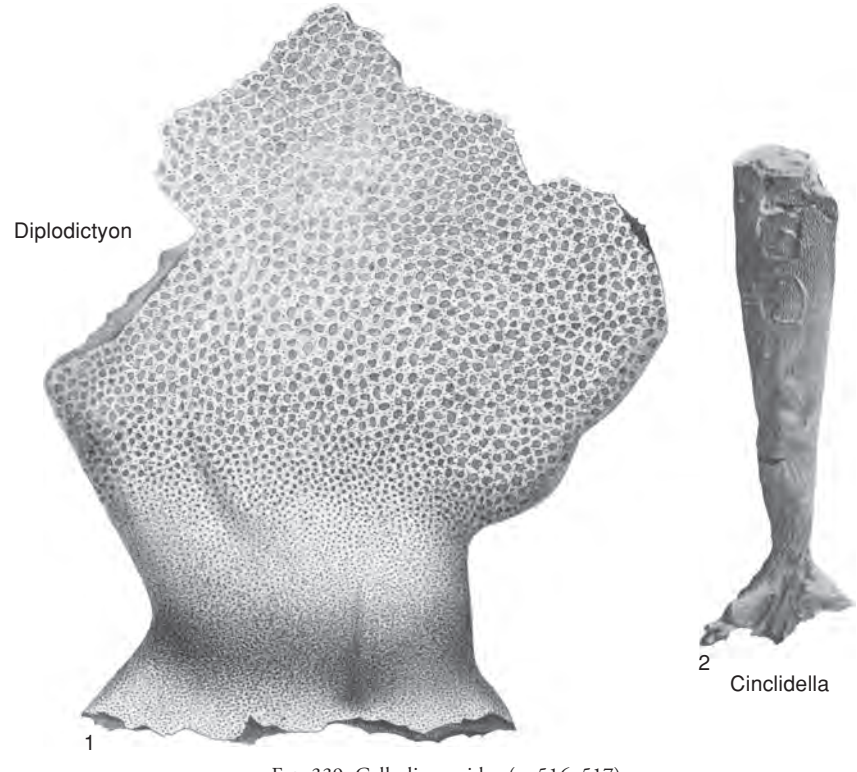


FIG. 339. Callodictyonidae (p. 516–517).

meshes; dermal surface of primary framework coated by fine, secondary meshwork, pierced by ostia or shallow epirhyses that open into underlying, primary meshes; components of cortical meshwork with or without nodal octahedra; ostia arranged without order or in longitudinal series; no similar cortex on gastral side. *Upper Cretaceous:* Germany.——FIG. 339,*2. *C. solitaria,* Cuvierplaner, Turonian, Heere; side view of steeply obconical sponge with rootlike base, ×0.5 (Schrammen, 1912).

Coscinaulus SCHRAMMEN, 1937, p. 20 (SCHRAMMEN, 1936, p. 180, *nom. nud.*) [**C. micropora;* OD]. Tubular; outside with ostia, some arranged in rough, longitudinal series, along which shallow grooves may occur; meshwork of this surface irregular; internal meshwork regular, not canalized; characters of gastral side not known. *Upper Jurassic:* Germany, Poland.——FIG. 338,*1. *C. micropora,* Weiss Jura, Erkenbrechtsweiler, Germany; enlarged part of outer skeleton showing small, inhalant pores and dimensions of skeletal net, ×5 (Schrammen, 1936).

Desmoderma SCHRAMMEN, 1937, p. 19 (SCHRAMMEN, 1936, p. 180, *nom. nud.*) [**D. evestigata;* OD]. Flabellate or possibly funnel-like; both surfaces with irregular, longitudinal furrows, more distinct on one side than other; small, round skeletal pores located along furrows, and locally grouped quadrately; internal meshwork regular, not canalized; cortical meshwork denser and more or less irregular on side with less distinct furrows. [Based on a fragment of doubtful habitus; referred to Ventriculitidae by SCHRAMMEN (1937), but epirhyses and aporhyses absent.] *Upper Jurassic:* Germany.——FIG. 338,*2a–b. *D. evestigata,* Weiss Jura, Upper Jurassic, Schwabtal; *a,* enlargement of inner surface showing regular, reticulate, skeletal net with longitudinal furrows; *b,* enlargement of outer surface of wall with less regularity and aligned, inhalant ostia, ×5 (Schrammen, 1937).

Diplodictyon ZITTEL, 1877b, p. 59 [**Scyphia heteromorpha* REUSS, 1846 in 1845–1846, p. 1; OD]. Similar to *Pleurope* ZITTEL, but with external cortex and basal skeleton formed by irregularly united, dictyonal hexactines, without nodal octahedra; gastral surface with simple, open meshes. *Upper Cretaceous:* Germany.——FIG. 339,*1. *D. heteromorpha* (REUSS), Bohemia; side view showing basal stalk and upper, flattened, funnel-like part of sponge with large, inhalant ostia, ×1 (Reuss, 1846).

Pleurope ZITTEL, 1877b, p. 58 [**Pleurostoma lacunosa* F. A. ROEMER, 1841 in 1840–1841, p. 12; OD]. Bilaterally flattened, scabbard shaped or leaflike, with parietal oscula along two narrow margins; dictyonal framework regular throughout; exterior of framework densely coated with downwardly directed, siliceous fibers, united by transverse synapticula, and continuous with basal skeleton; external surface

with ostia of shallow epirhyses, arranged without order, that perforate this cortical layer to open into meshes of underlying, dictyonal framework; gastral surface with simple, open meshes, or formed by a siliceous membrane pierced by postica arranged without order. *Cretaceous (Coniacian–Maastrichtian):* Germany.——Fig. 337,*2a–b. *P. lacunosa* (F. A. Roemer), Quadratenkreide, Cenomanian, Oberg; *a,* side view of laterally flattened, type sponge with uniform epirhyses throughout, ×1; *b,* fragment of gastral layer with simple, open meshes of lychniscoid structure, ×45 (Schrammen, 1912).

Porochonia Hinde, 1884a, p. 143 [**Ventriculites simplex* Smith, 1848, p. 204; OD]. Funnel-like, usually stalked, with basal root processes; dictyonal meshwork regular throughout; exterior of framework coated by finely porous, siliceous membrane with numerous small, round ostia that are arranged without order; gastral side with simple, dictyonal meshes, or with some development of structure seen on dermal side; basal meshwork fibrous. [A further external skeletal membrane claimed by Hinde (1884a, p. 143) does not exist.] *Cretaceous (Turonian):* England.——Fig. 338,*4a–b. *P. simplex* (Smith), Upper Chalk; *a,* side view showing smooth, dermal layer of funnel-shaped sponge, ×0.5; *b,* drawing of spicular structure of interior skeleton preserved as a mold in chalk, ×20 (Hinde, 1884a).

Regnardielasma Zhuravleva in Rezvoi, Zhuravleva, & Koltun, 1962, p. 46, *nom. nov. pro Elasma* Regnard in Moret, 1926b, p. 233, *non* Jaennicke, 1867, *nec* Wright & Studer, 1887 [**Elasma moreti* Regnard, 1926, p. 476; OD]. Sheets planar to wavy and undulating with uniform thickness, with very small pores on one side only; canals not visible; skeletal net of large hexactines forming regular, cubic, lychniscoid net with cortex on both surfaces, but more prominent on one; large pentacts occur on surface at regular distances and regularly oriented with major axis of sponge. [Moret (1926b, p. 233) cited this new genus and species as being described by Regnard "in litt.," and that publication also has a date of 1926. Apparently that reference was available in proof to Moret.] *Upper Cretaceous (Cenomanian):* France.——Fig. 337,*3. *R. moreti* (Regnard), Coulonges-les-Sablons; side view of fragment with cubic structure formed by large hexactines in a lychniscoid structure, with part of finer, cortex structure in center and large pentacts on right, ×10 (Moret, 1926b; courtesy of Société Géologique de France).

Subfamily MICROBLASTIDINAE Schrammen, 1912

[*nom. transl.* Reid, herein, *ex* Microblastididae Schrammen, 1912, p. 195]

Goblet- to mushroom-shaped sponges in which wall is plicated longitudinally above a tubular stalk; outwardly or downwardly facing folds pierced by parietal oscula, or bearing short, terminally open outgrowths; folds continuous to marginal part of body, or die out submarginally so that unfolded brim is formed; cortical features and basal skeleton formed by outgrowth of siliceous filaments. [Here reduced to subfamily because skeletal characters are not distinguishable from those of some Callodictyoninae (*Callodictyon* Zittel, *Porochonia* Hinde). Probably similar to the ancestry of Becksinae and Coeloptychidae.] *Cretaceous.*

Microblastidium Schrammen, 1902, p. 15 [**M. decurrens;* OD]. Narrow funnel with wall plicated longitudinally, and with irregular papillae or short, tubular outgrowths along outward plications; dictyonal framework mainly regular throughout; external meshes covered by cribiform lamella or netted, siliceous filaments; round perforations in these structures forming ostia, arranged without order; gastral side of framework mainly with simple meshes only, but coated in parts by superficial network of siliceous filaments that grew out from underlying surface. *Cretaceous:* Germany, France.——Fig. 340,*1a. *M. decurrens,* Quadratenkreide, Cenomanian, Oberg, Germany; side view of papillose-appearing, funnel-like sponge, ×0.5 (Lagneau-Hérenger, 1962; courtesy of Société Géologique de France).——Fig. 340,*1b. M. gaultinum* Lagneau-Hérenger, Valanginian, Chateauneuf-de-Chabre, France; side view of longitudinally plicated form with ostia, ×1 (Lagneau-Hérenger, 1962; courtesy of Société Géologique de France).

Spirolophia Pomel, 1872, p. 106 [**Pleurostoma tortuosa* F. A. Roemer, 1864, p. 15; OD] [=*Marshallia* Zittel, 1877b, p. 58, obj. (type, *Pleurostoma tortuosa* Roemer, 1864, p. 15, SD de Laubenfels, 1955, p. 91)]. Funnel-like or mushroomlike, with wall longitudinally plicated above tubular stalk, but folds die out near top to produce unfolded brim; folds may be spirally twisted; parietal oscula along outwardly facing plications; dictyonal framework regular throughout; outside with cribiform lamella and ostia as in *Callodictyon* Zittel or less regularly developed; simple meshes only on gastral side; root structure fibrous. [Listed by de Laubenfels (1955, p. 91) as *Marshallia* and *Spirolophia* (p. 103); latter name used here because genus was regarded as recognizable, although of uncertain position.] *Upper Cretaceous:* Germany.——Fig. 340,*2a–b. *S. tortuosa* (F. A. Roemer), Quadratenkreide; *a,* side view of twisted, plicate sponge with unfolded, oscular margin, Hannover, UG, ×0.5 (Roemer, 1864); *b,* drawing of lychniscoid, skeletal structure with spinose rays or bars, Cenomanian, Oberg, ×45 (Schrammen, 1912).

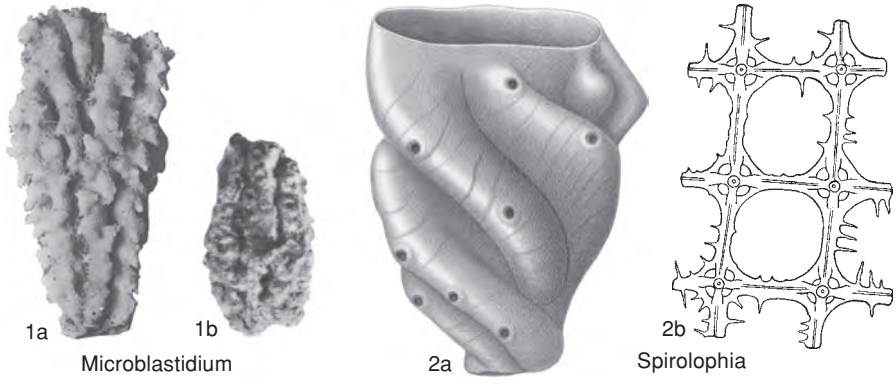


FIG. 340. Callodictyonidae (p. 518).

Subfamily BECKSINAE Schrammen, 1912

[*nom. transl.* REID, herein, *ex* Becksidae SCHRAMMEN, 1912, p. 196]

Goblet to mushroom-shaped sponges with distinct, central cavity or everted upper surface, in which anastomosing folds of thin wall enclose dermally and gastrally lined networks of cavaedial passages; apertures between divided and anastomosed folds at outer or lower surface of body lead into dermally lined cavaedia, and similar apertures in inner or upper surface lead into gastrally lined cavaedia; folds may continue to top or periphery of body, or die out submarginally so that unfolded rim is produced; root skeleton fibrous. [Reduced here to subfamily status because skeletal characters are not distinguishable from those of Callodictyoninae; and restricted to genera with a habitus similar to that of *Becksia* SCHLÜTER. For other genera included by SCHRAMMEN (1912), see Callicylicinae.] *Cretaceous–Paleogene (Oligocene).*

Becksia SCHLÜTER, 1868, p. 93 [**B. soekelandi;* OD]. Cuplike, fixed by spinelike root processes that grow out from external surface; wall mainly folded to enclose two networks of tubular passages that open on opposite sides, folds die out to produce unfolded brim in complete individuals; uppermost, dermally lined tubes sometimes form horizontal ring below unfolded margin, seen in views of interior; skeletal meshwork mainly or all regular; external surfaces with outermost beams thickened, or with some meshes covered by cribiform, siliceous lamella; usually no cortical features on gastral side; root structure fibrous. *Cretaceous:* Germany, France.——FIG. 341,*1a.* **B. soekelandi,* upper Quadraten-Schichten, between Lette, Coesfeld, Holtwick and Legden, Germany; part of fused, spinose, lychniscoid skeleton, ×50 (de Laubenfels, 1955).——FIG. 341, *1b–d. B. augusta* SCHRAMMEN, Quadratenkreide, Cenomanian, Oberg, Germany; *b,* side view of folded wall that encloses tubular passages in type specimen, ×0.5; *c,* exterior with folded wall and small, tubular openings, ×1; *d,* interior surface with tubular openings, ×1 (Schrammen, 1912).

Discoptycha DEFRETIN-LEFRANC, 1961, p. 96 [**D. simplex;* OD]. Discoidal sponge with slender stalk; lower face with alternating, narrow grooves and broad ribs or folds that may bifurcate; upper surface with inverse, broad grooves and narrow and high ribs that may anastomose or branch in vicinity of center; skeleton with regular, cubic, lychniscoid mesh; canal system absent. *Upper Cretaceous (Coniacian):* France.——FIG. 342,*2a–b.* **D. simplex,* Upper Cretaceous beds, Cambrésis à Rumilly; *a,* upper face of discoidal sponge with radial furrows and ridges, ×0.5; *b,* drawing of lower face with irregular, lychniscoid, skeletal mesh between small, inhalant pores, ×20 (Defretin-Lefranc, 1961).

Manzonispongia ENGESER & MEHL, 1993, p. 188, *nom. nov. pro Manzonia* GIATTINI, 1909, p. 59, *non* BRUSINA, 1870, *nec* POMEL, 1883 [**Manzonia aprutina* GIATTINI, 1909, p. 59; OD]. Ovoid to tubular or meandriform sponges without a spongocoel; skeleton resulting from complicated merging of tubes or of sheets of thin walls separated or defined by inhalant and exhalant lacunae (cavaedia); canal system absent; skeletal net regular, a cubic mesh of large lychniscs. *Paleogene (Oligocene)–Neogene (Miocene):* Spain, *Oligocene;* Italy, Spain, *Miocene.*——FIG. 342,*1a–b. M. betica* BRIMAUD & VACHARD, Tortonian, Miocene, Betique Region, southern Spain; *a,* side view of irregular, tubular sponge with large cavaedia, ×5; *b,* photomicrograph showing lychniscs in skeleton, ×20 (Brimaud & Vachard, 1986; courtesy of

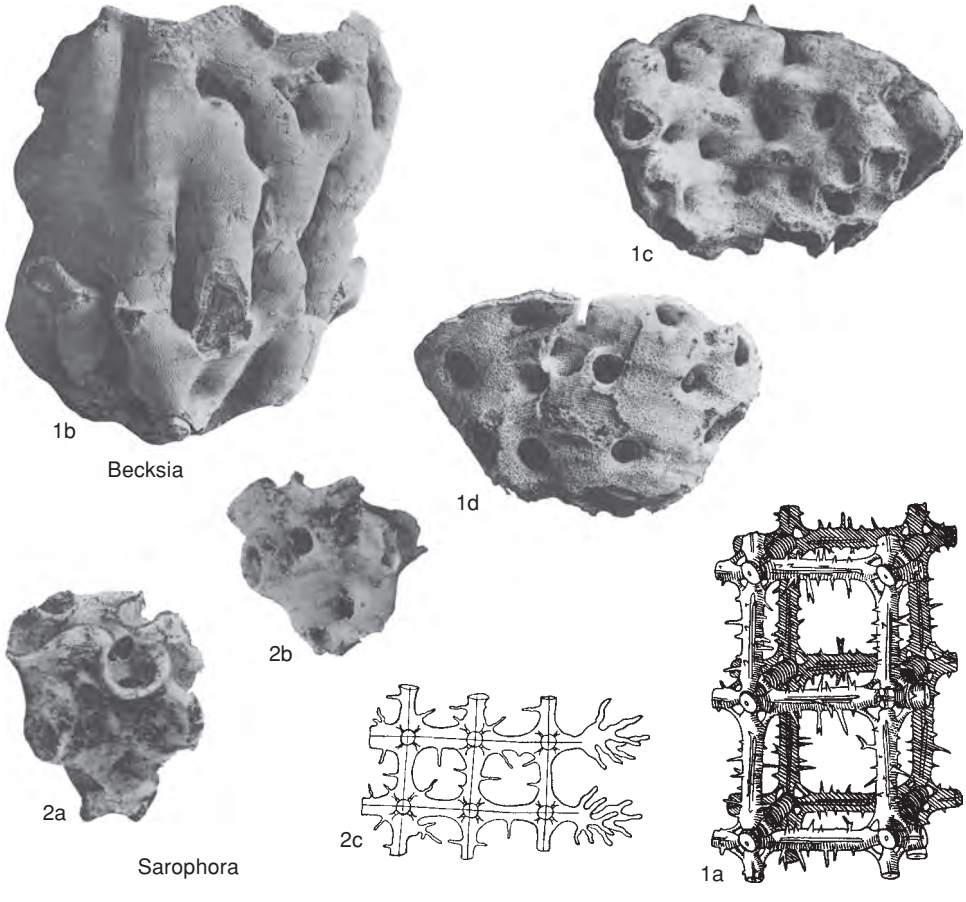


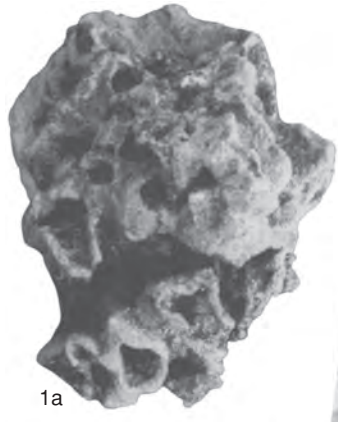
FIG. 341. Callodictyonidae (p. 519–523).

Publications Scientifiques du Muséum national d'Histoire naturelle, Paris).

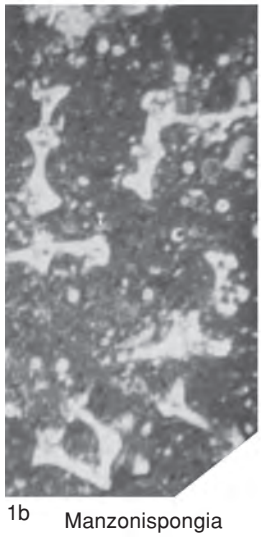
Oncolpia POMEL, 1872, p. 105 [**Brachiolites elegans* SMITH, 1848, p. 355; OD]. Mushroomlike to globular with tall, oscular chimney, supported by tubular stalk with branching roots at base; wall folded as in *Becksia* SCHLÜTER above stalk, and with similar, unfolded brim that forms oscular chimney, if chimney present; dictyonal meshwork mainly regular; external surfaces with irregularly arranged ostia perforating cribiform, siliceous membrane that coats surface of framework; internal and paragastral surfaces with simple meshes only, or with cribiform structure developed locally; root structure fibrous. *Upper Cretaceous:* Europe.

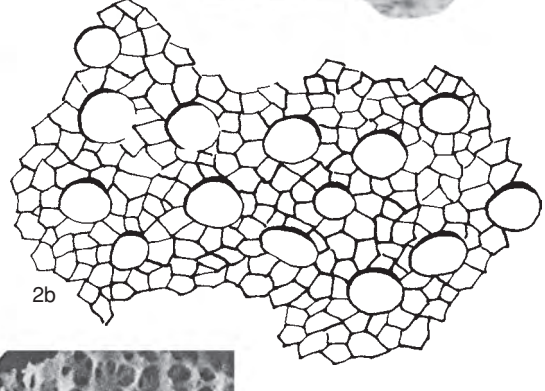
O. (Oncolpia). Cavaediate part of body globular to discoidal, sometimes varying in different individuals; unfolded brim growing upwardly to horizontally outward or slightly downwardly, sometimes forming tall, oscular chimney when body is globular; apertures between divided and anastomosed folds arranged alternately or irregularly; folding not radial on either surface, except sometimes locally on outwardly to downwardly facing surface. *Upper Cretaceous:* Europe.——FIG. 343,*1. *O. (O.) elegans* (SMITH), Upper Chalk, England; side view of irregular sponge with folded wall, chimneylike summit, and stalk, approximately ×0.5 (Smith, 1848).

O. (Polyptycha) DEFRETIN-LEFRANC, 1961, p. 98 [**P. becksioides;* OD]. Mushroom shaped, with a narrow, unfolded brim at periphery; anastomosed folds of lower surface forming radiate, locally bifurcated ribs, apertures leading into dermally lined cavaedia in intervening furrows; upper surface as in *Oncolpia.* [Reduced to subgenus level because structure is identical with *Oncolpia* except for radial direction of downwardly facing folds.] *Cretaceous (Coniacian–Maastrichtian):* France.——FIG. 343,*2a–b.*

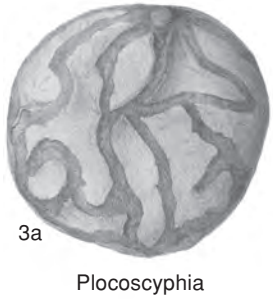

1a


2a


1b Manzonispongia


2b

Discoptycha


3a

Plocoscyphia

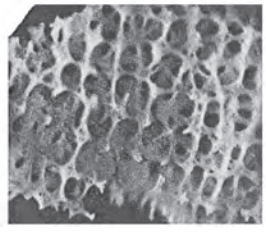

3b

FIG. 342. Callodictyonidae (p. 519–523).

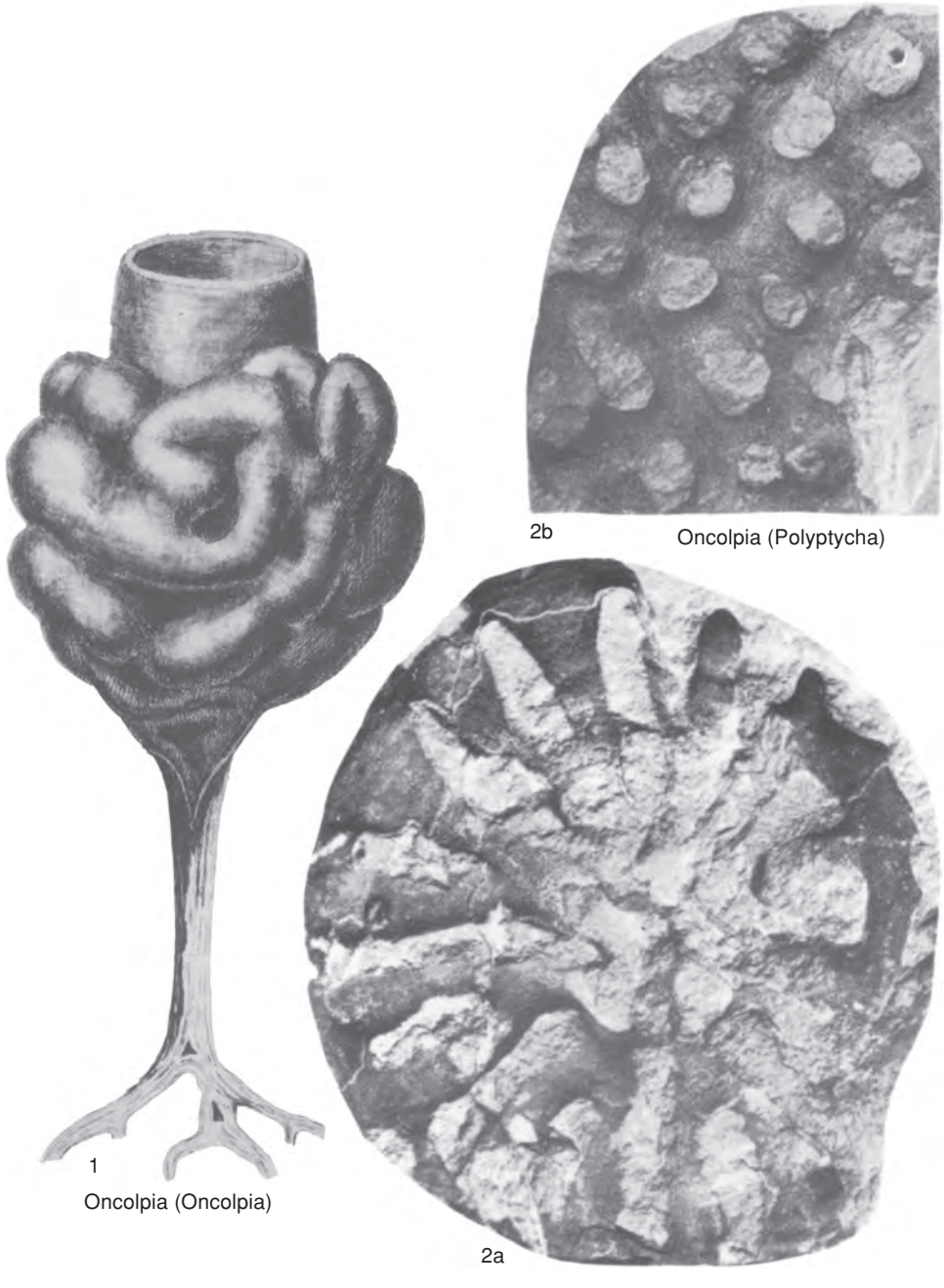


FIG. 343. Callodictyonidae (p. 520–522).

**O. (P.) becksioides,* Upper Cretaceous beds, Coniacian, Cambrésis and Lezennes, France; *a,* lower surface of discoidal sponge with branched ridges radiating from stalk area; *b,* impression of upper surface, ×1 (Defretin-Lefranc, 1961).

Plocoscyphia REUSS, 1846 in 1845–1846, p. 77 [**Scyphia labyrinthica* REUSS, 1844, p. 173; M; *not Spongus labyrinthicus* MANTELL, 1822, p. 165, =*P. labyrinthica* HINDE, 1884a, p. 137, *non* REUSS, 1846] [=*Gyrispongia* QUENSTEDT, 1878 in 1877–

1878, p. 478 (type, *G. subruta* QUENSTEDT, 1878 in 1877–1878, p. 480, SD DE LAUBENFELS, 1955, p. 92, possible weathered specimen]. Character not fully known; based on an incomplete specimen that resembles a globular *Oncolpia;* possibly identical with that genus. [Name used for various plexiform Lychniscosa, following ZITTEL (1877b); restricted by SCHRAMMEN (1912) and followers to forms with no central cavity, thus excluding the type species *P. labyrinthica*.] *Upper Cretaceous:* Europe.——FIG. 342,*3a. *P. labyrinthica,* Upper Chalk, Kent, England; flint nodule with anastomosing folds of sponge wall in surface, ×0.5 (Hinde, 1884a).——FIG. 342,*3b. P. communis* MORET, Cenomanian, Coulonges, France; typical meandriform skeleton, ×1 (Moret, 1926b; courtesy of Société Géologique de France).

Sarophora SCHRAMMEN, 1912, p. 305 [**S. armata* SCHRAMMEN, 1912, p. 306; OD]. Cuplike; wall folded to enclose two systems of tubes as in *Becksia* SCHLÜTER, but without unfolded brim, and some gastrally lined tubes also open externally through oscula at ends of stumplike outgrowths; dictyonal framework regular throughout, without distinct, cortical features, but with freely projecting rays of dictyonalia at surfaces that bear spines in pinular manner. [Does not include *Sarophora aptiensis* LAGNEAU-HÉRENGER, 1962, pl. 16, *6*.] *Upper Cretaceous:* Germany.——FIG. 341,*2a–c. *S. armata,* Quadratenkreide, Cenomanian, Oberg; *a,* cuplike sponge with folded walls to form tubular systems; *b,* tubular openings in wall of cuplike sponge, ×1; *c,* drawing of lychniscoid, skeletal structure with projecting, pinnulate rays at sponge surface, ×45 (Schrammen, 1912).

Subfamily CALLICYLICINAE new subfamily

[Callicylicinae REID, herein] [type genus, *Callicylix* SCHRAMMEN, 1912, p. 302]

Body composed entirely of similar, divided and anastomosed tubes, or with additional distinct, axial tube or funnel, or additional small, peripheral tubes; a peripheral capsule in some genera, supported by loose pentactines or stauractines only, or by additional rigid meshwork. *Upper Jurassic–Holocene.*

Callicylix SCHRAMMEN, 1912, p. 302 [**C. farreides;* OD]. Globular, columnar or shaped irregularly, with similar divided and anastomosed tubes only, or with a distinct axial tube when globose to columnar; soft or rigid capsule sometimes present; surfaces of tubes have open, primary meshes only, with no cortical modification, or modified by secondary accretion of dictyonal hexactines; latter as large as primary components or smaller and with or without nodal octahedra; also scattered sporadically, or sufficiently numerous to produce meshwork enclosing secondary ostia or postica; capsule supported by loose pentactines only, or additionally by dictyonal meshwork growing into it from margins of covered tubes; hexasters and pentactine dermalia and gastralia in living species. [Here includes *Cyclostigma* SCHRAMMEN, 1912, as subgenus, and living species of *Aulocystis* SCHULZE, 1887a, *non* SCHLÜTER, 1885, other than *Neoaulocystis grayi* (BOWERBANK).] *Cretaceous (Aptian)–Holocene:* Europe.

C. (Callicylix). Description as for genus. *Cretaceous (Aptian)–Holocene:* Europe.——FIG. 344,*1. *C. (C.) farreides,* Aptian, Quadratenkreide, Oberg, Germany; side view of globular sponge of anastomosed tubes, ×1 (Schrammen, 1912).

C. (Cyclostigma) SCHRAMMEN, 1912, p. 303 [**Plocoscyphia acinosa* SCHRAMMEN, 1902, p. 17; SD DE LAUBENFELS, 1955, p. 92]. Tube surfaces typically with ostia on dermal side, sometimes also with postica on gastral side; rigid capsule sometimes present. [Reduced to subgenus level because distinction from *Callicylix s.s.* depends only on presence of ostia, which may locally occur in *Callicylix* species]. *Cretaceous (Aptian–Maastrichtian):* Spain, Germany.——FIG. 344,*3a. *C. (C.) acinosa* (SCHRAMMEN), Quadratenkreide, Cenomanian, Oberg, Germany; side view of tubuled sponge, ×1 (Schrammen, 1902).——FIG. 344,*3b–c. C. (C.) tubules* LAGNEAU-HÉRENGER, Aptian, Can Cabanas Castellet, Catalogne, Spain; *b,* side view of subcylindrical sponge with osculum at top and tubular surfaces and ostia exposed on side; *c,* side view of same specimen with ostia and tubes obscured with dermal cortex, ×0.5 (Lagneau-Hérenger, 1962; courtesy of Société Géologique de France).

Brachiolites SMITH, 1848, p. 352 [**B. fenestratus* SMITH, 1848, p. 367; SD REID, 1958b, p. 263]. Normally columnar or globular, but sometimes aberrantly branched-tubular without anastomoses; free peripheral tubes widely open or contracted at ends; tube walls sometimes with small parietal perforations; dictyonal framework mainly regular but with irregular meshwork at dermal surface formed by secondary accretion or partly from primary structure; nodal octahedra solidified in meshwork of both surfaces; dermal side with distinct ostia or not; gastral side with meshwork formed by dictyonal strands and connecting beams only, or with meshwork masked locally by secondary accretion, and typically no distinct postica; peripheral meshwork absent. [Limited to type species by REID (1962, p. 34–35), other species placed elsewhere.] *Lower Cretaceous (Albian):* England.——FIG. 345,*2. *B. fenestratus,* Chalk Marl and Upper Greensand, Cretaceous; enlargement of part of dermal surface showing distinctive, peripheral tubes and dictyonal framework of main skeleton, scale uncertain (Smith, 1848).

Centrosia SCHRAMMEN, 1912, p. 301 [**C. incrustans* SCHRAMMEN, 1912, p. 302; OD]. Nodular or encrusting, with margins of tubes opening at surface joined by smaller, tubular bridges that here perforated walls or possibly also bowl shaped, with

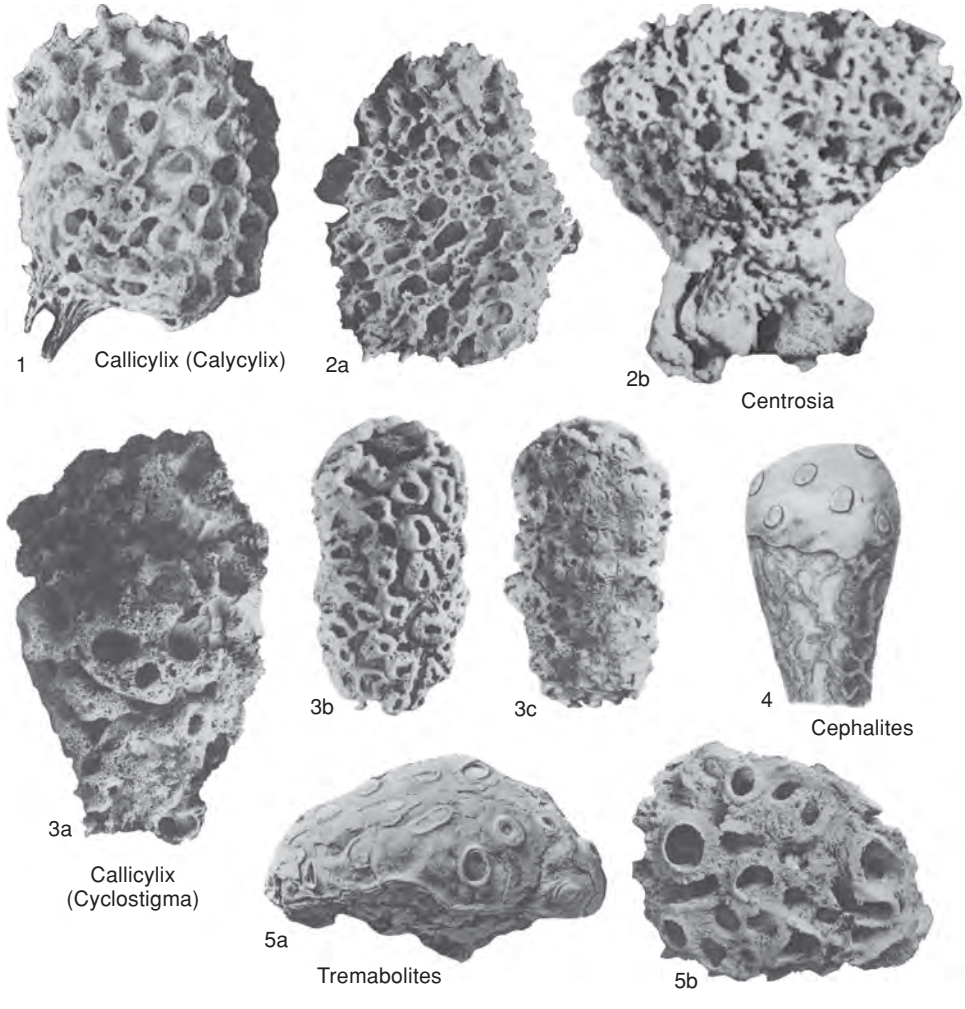


FIG. 344. Callodictyonidae (p. 523–525).

bridges on outside; dictyonal framework mainly regular, but meshwork becoming less regular and more dense at surfaces. *Cretaceous:* Spain, Germany.——FIG. 344,*2a. *C. incrustans,* Quadratenkreide, Cenomanian, Oberg, Germany; type sponge with two sizes of tubular openings, smaller of which bridge larger ones, approximately ×1 (Schrammen, 1912).——FIG. 344,*2b. C. regulate* LAGNEAU-HÉRENGER, Aptian, Can Cabanas Castellet, Catalogne, Spain; side view of bowl-shaped sponge with larger ostia to tubes and smaller pores between, ×1 (Lagneau-Hérenger, 1962).

Cephalites SMITH, 1848, p. 279 [**C. perforatus* SMITH, 1848, p. 294; SD RAUFF, 1893, p. 65]. Similar to *Tremabolites* ZITTEL, but forming narrow, erect column with capsular skeleton restricted to summit; supported by branching root processes that are formed from anastomosed, siliceous filaments. [Name formerly applied to Camerospongiidae here placed under *Stamnia* POMEL, 1872, *Rhytistamnia* POMEL, 1872, and *Toulminia* ZITTEL, that cannot be included in a genus with the type *C. perforatus.*] *Upper Cretaceous:* England.——FIG. 344,*4. *C. perforatus,* Chalk; side view of upper part of sponge with capsular summit, approximately ×0.5 (Smith, 1848).

Ceriodictyon OPPLIGER, 1907, p. 15 [**C. ceniformis;* M]. Conical mass of anastomosed, thin-walled tubes or lamella, whose connected margins form peripheral network; skeletal walls with nodal octahedra internally, solid nodes at surface. [Possibly identical with *Brachiolites* SMITH.] *Upper Jurassic:* Switzerland.——FIG. 345,*1a–c. *C. ceniformis,* Birmenstorfer beds, Mont Rivel; *a,* view from above of sponge composed of anastomosed, thin-walled tubes, ×0.5; *b,* side view of obconical sponge, ×1;

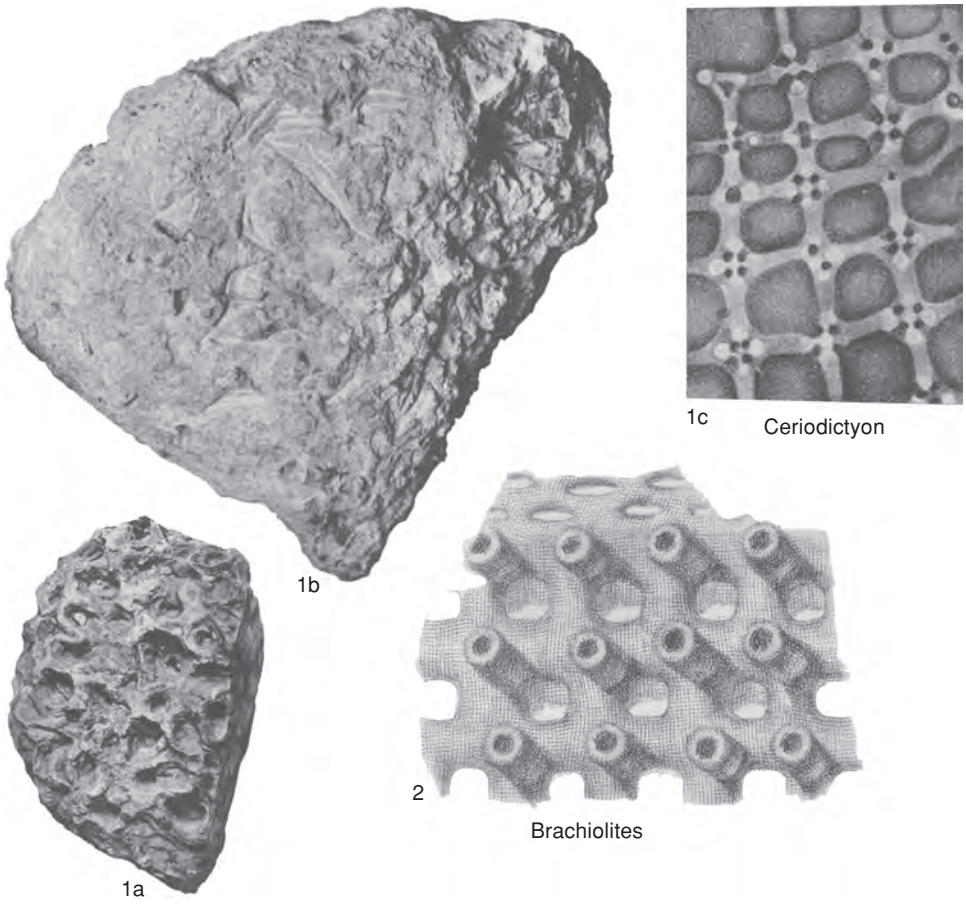


FIG. 345. Callodictyonidae (p. 523–525).

c, photomicrograph of skeleton with distinct, lychniscoid structure, approximately ×40 (Oppliger, 1907).

Tremabolites ZITTEL, 1877b, p. 55 [**Manon megastoma* F. A. ROEMER, 1840 in 1840–1841, p. 3; SD DE LAUBENFELS, 1955, p. 89] [=*Pachychlaenia* POMEL, 1872, p. 72, obj., senior objective synonym suppressed under *Code* Art. 23.2 (ICZN, 1999) as *nom. oblit.*]. Nodular or flattened, sometimes elongate, often convex above and flat below; upper surface covered by dense, rigid capsule that is pierced by oscula of tubes that open through it; each osculum usually with small but prominent rim; lower surface with apertures between divided and anastomosed tubes, and sometimes also parietal oscula in tube walls; these apertures sometimes denticulated by spinose, secondary outgrowths; internal tube walls with unmodified meshwork or accretion of secondary hexactines, which may form meshwork outlining ostia and postica. [Included by SCHRAMMEN (1912) in Camerospongiidae, but developed from sponges indistinguishable from *Cyclostigma* species until the capsule is fully developed.] *Lower Cretaceous–Upper Cretaceous:* Europe; southern France, *Albian;* northern France, Germany, *Turonian–Maastrichtian.*——FIG. 344,*5a–b.* **T. megastoma* (F. A. ROEMER), Mukronatenkreide-Quadratenkreide, Cenomanian, Misburg and Oberg, Germany; *a,* side view of flattened, nodular sponge with rigid, outer layer of skeleton pierced by oscula with low rims; *b,* side view of similar form but outer skeletal layer around oscula absent, ×0.5 (Schrammen, 1912).

Family COELOPTYCHIDAE F. A. Roemer, 1864

[*nom. correct.* ZITTEL, 1877b, p. 59, *pro* family Coeloptychidea F. A. ROEMER, 1864, p. 3]

Radially symmetrical, sometimes stalked Lychniscosa, with three-dimensional, skeletal meshwork and only intracortical canalization, in which an annular to hemispherical,

peripheral skeleton truncates longitudinal plications of wall, or radiating tubes that arise from plications of an axial funnel; cortical modification by formation of cribiform lamella across individual meshes, or a continuous, finely porous, cortical membrane; membrane usually more or less restricted to exposed parts of dermal, skeletal surface; peripheral skeleton dense when fully formed, consisting of full-sized dictyonalia, additional smaller hexactines, and anastomosed, siliceous filaments; or skeleton also with seeming stauractines in parts; a sieve plate may cover upwardly facing plications, or line an axial funnel; basal skeleton fibrous. [Separation from Callodictyonidae is essentially arbitrary, based on specialization; possibly derived from forms similar to *Spirolophia* POMEL and *Oncolpia* POMEL.] *Lower Cretaceous–Upper Cretaceous.*

Subfamily COELOPTYCHINAE F. A. Roemer, 1864

[*nom. transl.* REID, herein, *ex* Coeloptychidae F. A. ROEMER, 1864, p. 3]

Coeloptychidae in which wall is plicated longitudinally, without formation of separate tubes in normal examples; peripheral skeleton annular; upper surface of plications covered by sieve plate formed from anastomosed, siliceous filaments. [Corresponds with family Coeloptychidae as restricted by ZITTEL (1877b, p. 39) and SCHRAMMEN (1912, p. 323).] *Lower Cretaceous–Upper Cretaceous.*

Coeloptychium GOLDFUSS, 1826, p. 31 [**C. agaricoides;* OD] [=*Homoptychium* POMEL, 1872, p. 69 (type, *Coeloptychium deciminum* F. A. ROEMER, 1840 in 1840–1841, p. 10, OD, type species only specifically distinct from *C. agaricoides* GOLDFUSS); *Schizoptychium* POMEL, 1872, p. 69 (type, *Coeloptychium incisum* F. A. ROEMER, 1840 in 1840–1841, p. 10, SD REID, herein, type species not generically distinguishable from *C. agaricoides* GOLDFUSS)]. Funnel or mushroom shaped, with wall plicated longitudinally above a tubular stalk; outwardly or downwardly facing folds forming simple or dichotomized ribs, pierced by series of parietal oscula; similar oscula may occur on stalk; peripheral skeleton continuously annular, or incised between folds from above or below; sieve plate usually continuous across upwardly or inwardly facing folds, but sometimes exposing them locally; with or without dense, radial bands above covered folds; externally exposed surfaces of stalk and folded wall with finely porous, cortical covering, pierced by alternating or irregularly distributed ostia; cortical meshwork poorly developed or lacking on surfaces between folds and on gastral surface; accessory sieve plates may form transverse diaphragms within stalk. *Lower Cretaceous–Upper Cretaceous:* Germany.

- **C. (Coeloptychium).** Funnel to mushroom shaped; peripheral skeleton continuously annular except as irregularity. *Lower Cretaceous–Upper Cretaceous (Campanian):* Germany, Poland, Belgium England, Ireland.——FIG. 346,*5. *C. (C.) agaricoides,* Lower Cretaceous, near Peine and Theidessen, Germany; mushroom-shaped sponge with furrowed gastral and lateral surface, prominent stalk, ×1 (Roemer, 1840–1841).
- **C. (Lophoptychium)** POMEL, 1872, p. 69 [**Coeloptychium lobatum* GOLDFUSS, 1829, p. 94; OD]. Mushroom shaped, but with a conical, central cavity lined by sieve plate; peripheral skeleton deeply incised from below, between downwardly facing folds. [Barely distinct from *Coeloptychium s.s.,* but retained because of distinctive appearance of the type species.] *Cretaceous (Coniacian–Maastrichtian):* Germany.——FIG. 346, *1. *C. (L.) lobatum* (GOLDFUSS), near Coesfeld; diagonal view of complete, lobate sponge, with broad, funnel-shaped spongocoel, ×1 (Goldfuss, 1833).
- **C. (Myrmecioptychium)** SCHRAMMEN, 1912, p. 333 [**M. bodei;* OD]. Similar to *Coeloptychium s.s.,* but with short, open outgrowths along downwardly facing folds instead of simple, parietal oscula. [Separation barely justified; may be based on individuals of a normal *Coeloptychium* species. No known suitable figures.] *Upper Cretaceous:* Germany, Poland, Russia.

Troegerella ULBRICH, 1974, p. 69 [**T. subherzynica;* OD]. Sponge body whisklike with thin-walled, slender, funnel-like, axial part and nine radially arranged, bladelike expansions closely spaced under funnel edge; expansions hollow with oval or round parietal oscula on their narrow sides; placement of ostia, postica, epi- and aporhyses corresponding to broad, regular, skeletal meshes; subgastral cavities in lower part of funnel and in radial expansions are separated from spongocoel in upper part of funnel by a sieve plate; skeleton as in *Coeloptychium. Cretaceous (Campanian):* Germany.——FIG. 346,*3a–b. *T. subherzynica,* Ilsenburmergel, Stapelburg; *a,* side view of holotype showing digitate form and broad spongocoel with coarse, exhalant ostia in gastral surface; *b,* view of same from above, SSSBGF 210/751, ×0.5 (Ulbrich, 1974).

Subfamily CAMEROPTYCHINAE new subfamily

[Cameroptychinae REID, herein] [type genus, *Cameroptychium* LEONHARD, 1897, p. 37]

Coeloptychidae in which radiating, separate or anastomosing tubes arise from

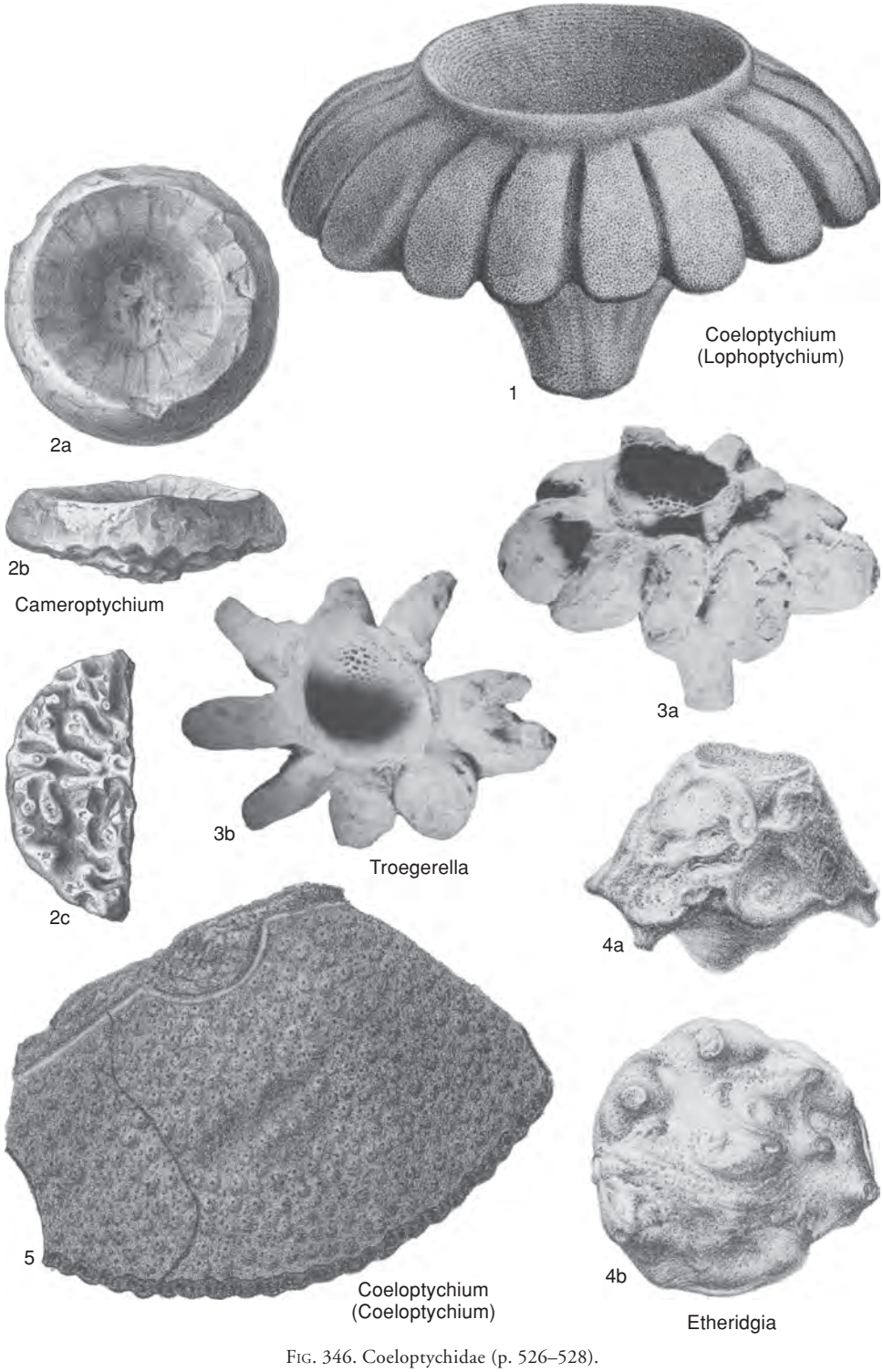


Fig. 346. Coeloptychidae (p. 526–528).

plications of axial funnel; peripheral skeleton annular to hemispherical, truncating tubes, and also attached to margin of axial funnel; underside with exposed surfaces of lowermost tubes, between which are apertures leading into dermally lined cavaedia; sieve plate lining axial funnel or absent. [Includes Coeloptychidae placed by SCHRAMMEN (1912) and others in Camerospongiidae SCHRAMMEN; here regarded as deriving from Callodictyonidae (probably Becksinae) near source of Coeloptychinae, to which Cameroptychinae are basically similar in habitus.] *Upper Cretaceous.*

Cameroptychium LEONHARD, 1897, p. 37 [**C. patella;* M] [=?*Solenothyia* POMEL, 1872, p. 68 (type, *Camerospongia schloenbachi* F. A. ROEMER, 1864, p. 5, OD); type species seems to be a *Cameroptychium;* was basis of ZITTEL's (1877b) diagnosis of *Camerospongia* D'ORBIGNY, with which *Cameroptychium* was confused; suppressed under *Code* Art. 23.2 (ICZN, 1999) as *nom. oblit.*]. Discoidal to hemispherical, with small, central stalk and wide to deep and narrow, central cavity that is lined by sieve plate; exposed tubes of underside simply dichotomise or divide and anastomose, with parietal oscula or none; peripheral skeleton entire, or perforated opposite ends of underlying tubes; stalk and tubes of underside with finely porous, cortical covering, which may close parietal oscula, or form spines that project across spaces between tubes; sieve plate formed from adventitious lychniscs, which unite to form a layer of regularly quadratic meshwork, with beams oriented longitudinally and transversely. *Upper Cretaceous:* Europe.——FIG. 346,*2a–c.* **C. patella,* Upper Cretaceous beds, Turonian, Oppeln, Germany; *a,* view onto gastral surface of broad, central cavity, with regular skeletal net, from above; *b,* view from side; *c,* view of dermal surface with exposed, branching tubes, from below, ×0.5 (Leonhard, 1897).

Etheridgia TATE, 1865, p. 42 [**E. mirabilis* TATE, 1865, p. 43; OD]. Truncated-conical to hemispherical, with narrow, central cavity and no stalk in most individuals; tubes of underside usually broad, once dichotomous, not united except at periphery; peripheral skeleton incomplete, with apertures at opposite ends of underlying tubes, or additional sinuous clefts that extend between them; exposed parts of tubes of underside with finely porous, cortical covering, which grows out locally to form spinelike root processes; no sieve plate. *Cretaceous (Coniacian–Maastrichtian):* England. ——FIG. 346,*4a–b.* **E. mirabilis,* Upper Chalk, Island Magee, Whitehead and Woodburn; *a,* side view of holotype showing osculum to deep spongocoel and rootlike attachments; *b,* view of base with upper parts of rootlike processes, ×1 (Tate, 1865).

Family VENTRICULITIDAE Smith, 1848

[*nom. correct.* ZITTEL, 1877b, p. 36, *pro* Ventriculidae SMITH, 1848, p. 203]

Lychniscosa with initially three-dimensional, dictyonal frameworks, not constructed in layers, and with fully developed, intradictyonal epirhyses and aporhyses, unless epirhyses are replaced by superficial furrows; marginal surfaces not covered by a siliceous membrane; epirhyses and aporhyses sometimes separate tubular, radial cavities, arranged alternately in longitudinal series, and in alternate positions in adjacent series; their apertures quincuncially alternate correspondingly; other forms have different conditions, in which similar cavities intercommunicate or form labyrinths, epirhyses lack regular arrangement or occur between series of aporhyses, or surfaces have superficial furrows that may replace epirhyses; dermal surface of dictyonal framework usually formed by finely porous, cortical layer, produced by modification of outermost dictyonalia and usually pierced by small, accessory, intracortical ostia; cortex may be equally developed on gastral side, or less developed, or absent; superficial meshwork often present, formed by siliceous filaments that grew from distal rays of dictyonalia at surface of dictyonal framework, or rarely from adventitious, dictyonal hexactines; basal skeleton constructed in same way as superficial meshwork and forming branching roots where it consists of siliceous fibers; sometimes canalized by longitudinal canals that run downwardly from positions of covered ostia; loose spicules unknown. *Jurassic–Upper Cretaceous.*

This family is interpreted more broadly than by SCHRAMMEN (1912) to take in all genera with diplorhytic canalization that is plainly intradictyonal, but the interpretation excludes the Pachyteichismatidae included by ZITTEL (1877b) and DE LAUBENFELS (1955). The skeletal canals do not result from plication of the wall, as claimed by many authors (e.g., ZITTEL, 1877b; SCHRAMMEN, 1912) for some of the genera included (e.g., *Ventriculites* MANTELL, *Rhizopoterion* ZITTEL); in early ontogeny,

they arise by progressive differentiation from small, intracortical ostia, identical with those that persist in the adult. Furrowing seen in some genera represents subdermal or subgastral channeling of the dictyonal surface, or sometimes coalescence of series of radial epirhyses.

Subfamily VENTRICULITINAE Smith, 1848

[*nom. transl.* Reid, herein, *ex* Ventriculitidae Smith, 1848, p. 203]

Typical Ventriculitidae, with epirhyses and aporhyses or their ostia and postica in regular series or not, or with epirhyses or aporhyses more or less replaced by deep, external furrows; superficial structures and basal skeleton formed from anaxial, siliceous outgrowths. *Jurassic–Upper Cretaceous.*

Ventriculites Mantell, 1822, p. 168 [**Alcyonium chonoides* Mantell, 1815, p. 402; OD; =*Ventriculites radiatus* Mantell, 1822, p. 168, SD Pomel, 1872, p. 89] [=*Ocellarioscyphia* de Fromentel, 1860a, p. 40 (type, *Ventriculites radiatus* Mantell, 1822, p. 168, SD de Laubenfels, 1955, p. 106, =*Alcyonium chonoides* Mantell, 1815, p. 402); *Stelgis* Pomel, 1872, p. 149 (type, *Ventriculites radiatus* Mantell, 1822, p. 168), which Pomel (1872) changed to *Stelgis mantelli* for some unknown reason; *Cladostelgis* Pomel, 1872, p. 150 (type, *Verrucospongia damoecornis* Roemer, 1864, p. 45); *Pleurostelgis* Pomel, 1872, p. 150 (type, *Manon miliare* Reuss, 1846 in 1845–1846, p. 78)]. Funnel shaped or tonguelike, or with other variants of these shapes; dermal surface variable, typically sculptured to produce alternating tubercles or longitudinal ribs, or combinations of these features: epirhyses open in floors of intervening furrows, in quincunx or not, or more or less obsolete; alternatively surface is sometimes reticulate in aspect, with varying proportions of alternating, simple epirhyses and longitudinal furrows, produced by merger of series of epirhyses; gastral surface with alternating postica of aporhyses, not furrowed; finely porous, dictyonal cortex on dermal side, or both sides; superficial filaments poorly developed or conspicuous on dermal side, where they arch between tubercles or ribs. [Variable (tuberculate, costate, reticulate) development of dermal, skeletal surface is characteristic of the type *V. chonoides,* of which differently developed individuals have been called *V. radiatus* Mantell, *V. mammillaris* Smith, and *V. decurrens* Smith).] *Upper Cretaceous:* Europe.——Fig. 347,*1a–c. V. striatus* Smith, Germany; *a,* side view of steeply funnel-shaped sponge, ×0.5; *b,* transverse section showing alternating epirhyses and aporhyses; ×1; *c,* part of skeleton showing lychniscoid structure, ×12 (de Laubenfels, 1955).

Astropegma Pomel, 1872, p. 84 [**Ventriculites stellata* Roemer, 1864, p. 18; SD de Laubenfels, 1955, p. 87]. Cup shaped, with thick walls of angular, irregular, lychniscoid mesh; openings grouped into starlike clusters. [Questionably included in the subfamily and family.] *Lower Cretaceous:* Algeria, Germany.——Fig. 348,*3a–b. A. stellata* (Roemer), Peine, Germany; *a,* thick-walled, cuplike sponge with characteristic starlike, skeletal mesh of outer wall, ×1; *b,* enlarged section of wall showing fine-textured, lychniscoid, skeletal mesh of tracts, approximately ×5 (Roemer, 1840–1841).

Coscinopora Goldfuss, 1826, p. 30 [**C. infundibuliformis;* OD] [=*Coscinoscyphia* de Fromentel, 1860a, p. 38, obj.; *Coccinopora* Schlüter, 1870, p. 141, obj.]. Funnel-like or in variants of this shape, with or without stalk; epirhyses and aporhyses radial, separate, closely spaced, arranged alternately in regular, longitudinal series, and in alternate positions in adjacent series; ostia and postica correspondingly quincuncially alternating; ostia round or rhomboidal; postica ovate, elongate longitudinally; finely porous, dictyonal cortex well developed on dermal side, with incorporated dictyonalia lacking distal rays and nodal octahedra; less developed or absent on gastral side where cortical dictyonalia have freely projecting, distal rays that are spines in pinular manner; many lychnisc octahedra solidified in internal meshwork; no superficial meshwork, except where siliceous fibers of basal skeleton coat lower parts. [Difficult to distinguish from some forms of *Sporadoscinia* Pomel (*S. alcyonoides* Mantell) unless skeletal details are preserved. According to Schrammen (1912, p. 292–293) cortical dictyonalia are sometimes reduced to stauractines.] *Upper Cretaceous:* Europe.——Fig. 347,*4a–b. *C. infundibuliformis,* Quadratenkreide, Cenomanian, Oberg, Germany; *a,* finely porous, outer, dictyonal cortex seen from inside, with lychniscs and coarser, inhalant ostia; *b,* upper surface of gastral layer with dictyonalia with projecting, distal, pinular rays, ×45 (Schrammen, 1912).

Etalloniella Oppliger, 1926, p. 35 [**Étallonia idanensis* Oppliger, 1915, p. 55; OD]. Cup shaped or broadly obconical to cylindrical with a broad spongocoel, walls thin and lacking differentiated outer layers; dermal surface with numerous small, round to pointed, conical nodes that separate branched furrows, in which occur numerous fine ostia of epirhysal, radial canals that extend straight or slanting to middle of wall and there end blindly, as part of diplorhysal canal system; small postica of aporhysal canals occur scattered in gastral surface; skeleton is regular, fine, lychniscoid meshwork with octahedral lanterns at ray junctions. *Jurassic:* Europe.——Fig. 347,*2a–c. *E. idanensis* (Oppliger), Weiss Jura, Upper Jurassic, La Latte near Nantes, France; *a,* side view of cylindrical fragment with characteristic dermal nodes; *b,* broad, funnel-shaped sponge with stalk and broad, oscular depression, ×1; *c,* photomicrograph showing lychniscoid skeletal structure, ×50 (Oppliger, 1915).

Flabellispongia Trest'yan, 1972, p. 35 [174] [**F. bicostata;* OD]. Leaf-shaped to lamellar or lobate,

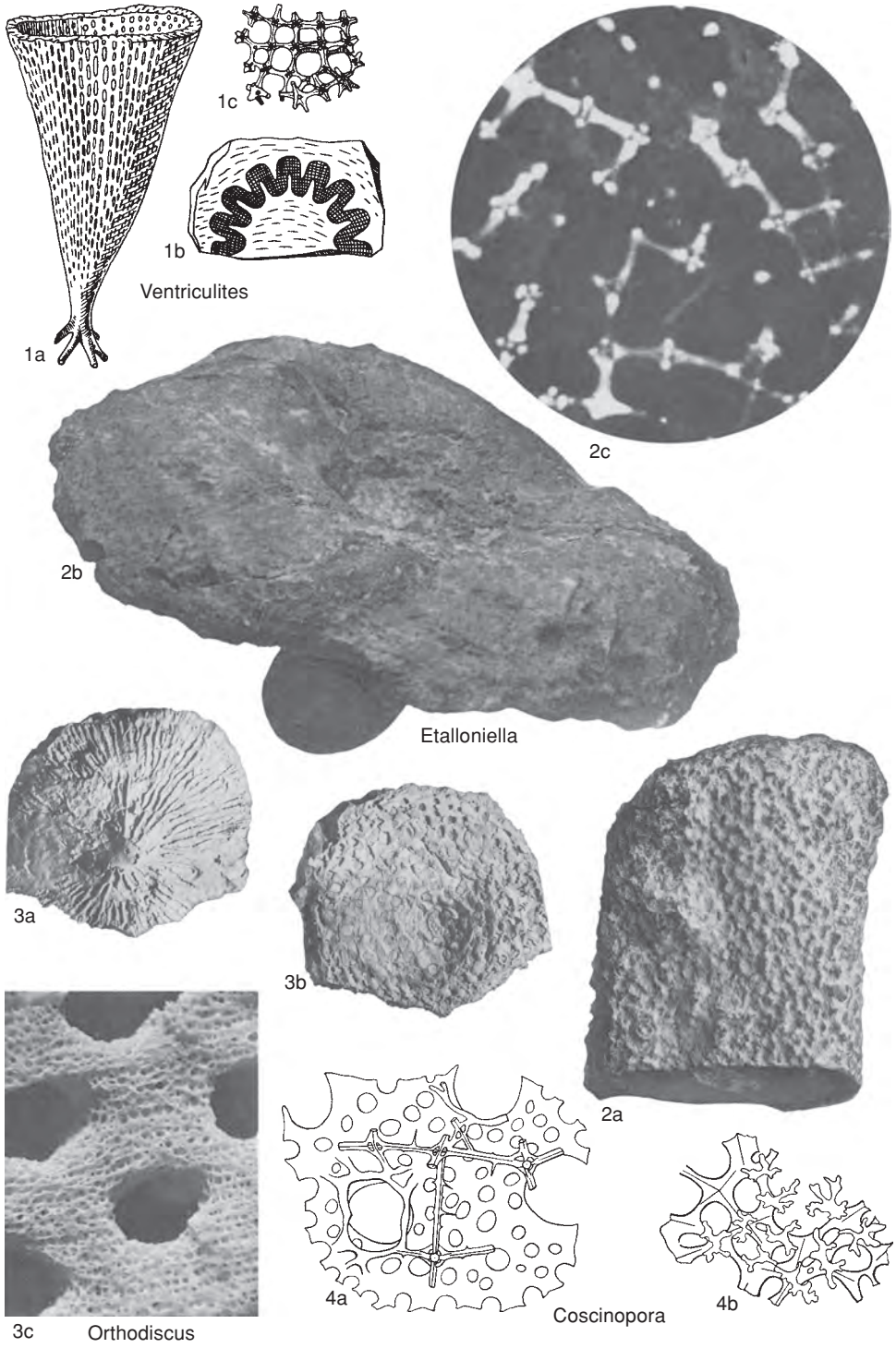


FIG. 347. Ventriculitidae (p. 529–532).

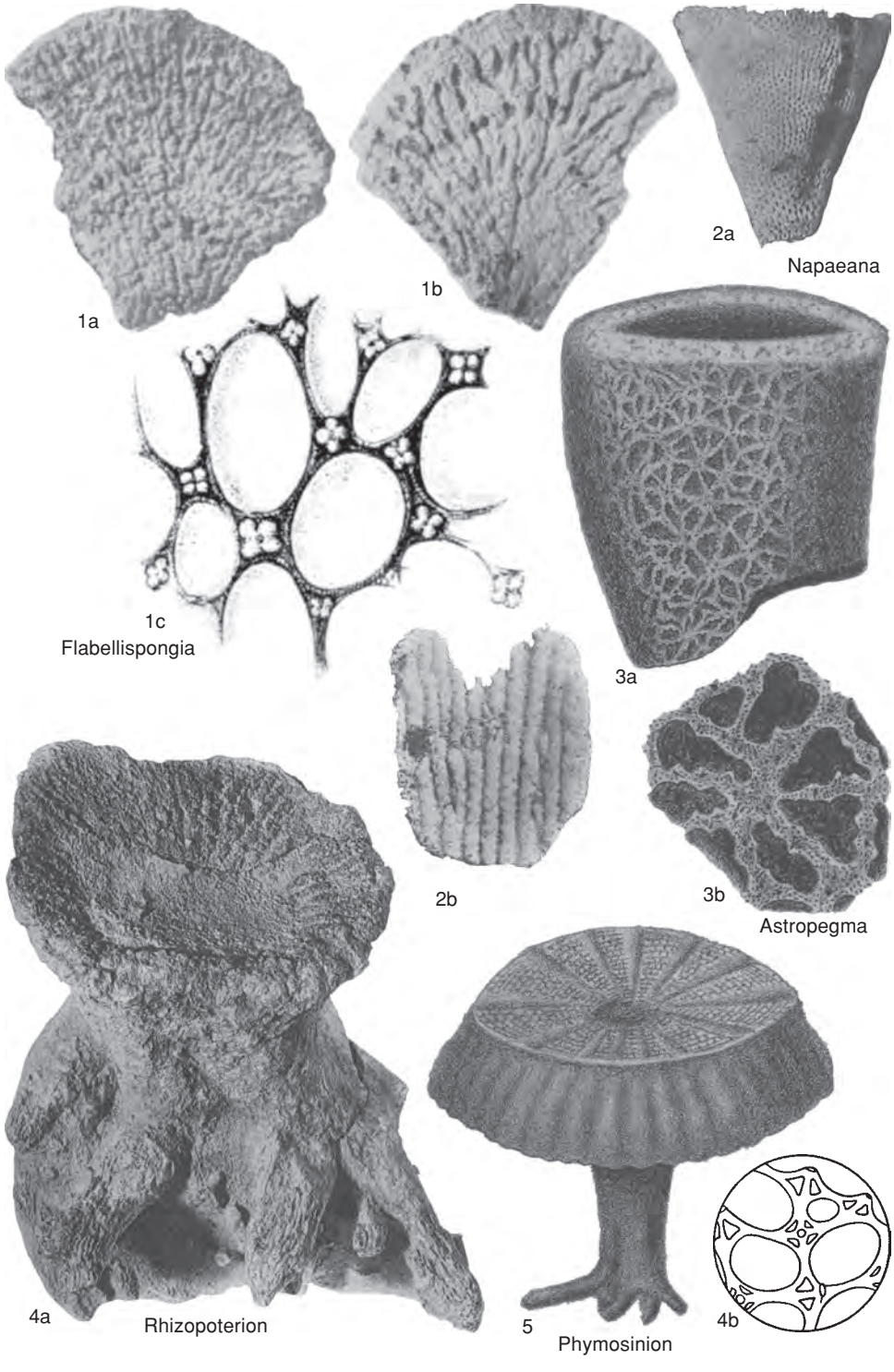


FIG. 348. Ventriculitidae (p. 529–534).

vertically growing, solitary sponges with flat body walls, commonly curved or with flexures and both sides of wall with grooves alternating with ridges; canal system radial with both inhalant and exhalant canals terminating blindly in wall; skeleton lychniscoid with perforated nodes; basal layer with regular structure and both dermal and gastral layers with well-developed cortex of irregular structure. *Cretaceous (Cenomanian):* Russia (middle Dniester region, Moldavia and Ukraine).——Fig. 348,*1a–c.* **F. bicostata,* upper Cenomanian, Naslavcha village, Moldavia; *a,* dermal side of fan-shaped fragment; *b,* gastral side of same, ×1; *c,* photomicrograph showing lychniscoid structure in basal skeleton, ×40 (Trest'yan, 1972).

?Leiostracosia Schrammen, 1902, p. 12 [**L. punctata;* OD] [?=*Pachylepisma* Schrammen, 1902, p. 14 (type, *P. robusta,* M)]. Funnel-like or with variants of this shape, stalked; ostia and epirhyses arranged without order or in longitudinal series between series of aporhyses, sometimes more or less quadratically when in series; aporhyses in regular, longitudinal series, sometimes also grouped quadratically; postica in longitudinal furrows; finely porous, dictyonal cortex on dermal side only; superficial outgrowths short spines on dermal side, denticulate outlines of ostia; forming branching and anastomosing filaments on gastral side. *Cretaceous (Barremian–Maastrichtian):* France, *Barremian–Santonian;* Germany, *Turonian–Maastrichtian;* Europe, *Coniacian–Maastrichtian.*——Fig. 349,*1a–b.* **L. punctata,* Quadratenkreide, Cenomanian, Misburg and Oberg, Germany; *a,* funnel-like sponge from above with radiating structure where aporhyses are arranged in rows on gastral surface; *b,* side view of cylindrical stalk with vertical rows of epirhyses, ×0.5 (Schrammen, 1912).——Fig. 349,*1c. L. brandesi* Schrammen, Quadratenkreide, Cenomanian, Oberg, Germany; side view of subcylindrical sponge with irregular, inhalant epirhyses in upper part, but more regular aporhyses on gastral surface of lower spongocoel visible in broken base, ×0.5 (Schrammen, 1912).——Fig. 349,*1d. L. robusta* Schrammen, Quadratenkreide, Cenomanian, Misburg, Germany; side view of globular sponge with irregular epirhyses, ×0.5 (Schrammen, 1912).

Lepidospongia F. A. Roemer, 1864, p. 9 [**L. denticulata;* OD] [=*Plectodermatium* Schrammen, 1902, p. 12 (type, *P. fragilis,* OD)]. Funnel-like in variants of this shape, or sometimes flabellate; often stalked; strong roots; dermal surface with ostia of epirhyses in longitudinal furrows, between which surface forms regularly bifurcated ribs; aporhyses in longitudinal series, run into ribs of dermal side, not opening in furrows; finely porous, dictyonal cortex on dermal side only or on both sides; superficial filaments of dermal side may arch over furrows; filaments of gastral side form paratangential network, parts of which develop into quadrately arranged, scalelike plates or continuous, transverse bands of finely porous, siliceous material; postica hidden when these structures are fully developed; roots may be canalized as in *Rhizopoterion* Zittel. *Cretaceous (Coniacian–Maastrichtian):* Germany, Poland, ?France.——Fig. 349,*5a–b. L. fragilis* (Schrammen), Quadratenkreide, Campanian, Misburg, Germany; *a,* dermal surface of funnel-like fragment with radial ribs, ×1; *b,* gastral surface with quadrately arranged plates, ×1 (Schrammen, 1902).

Licmosinion Pomel, 1872, p. 89 [**L. cymoria;* OD]. Tonguelike, leaflike, or forming convoluted plate; both surfaces with alternating or irregularly distributed apertures of short, radial, skeletal canals that are presumably epirhyses on one side and aporhyses on other; both surfaces with finely porous, dictyonal cortex, with small, intracortical ostia or postica between large apertures. [No known suitable figures.] *Lower Cretaceous:* Algeria.

Napaeana de Laubenfels, 1955, p. 87, *nom. nov. pro Eudictyon* Schrammen, 1902, p. 15, *non* Marshall, 1875b, *nec* Bistram, 1903, p. 84 [**Eudictyon striatum* Schrammen, 1902, p. 15; OD] [=*Napaea* Schrammen, 1912, p. 273, obj., *non* Robineau-Desvoidy, 1830]. Funnel-like, thin walled, stalked; epirhyses and aporhyses regularly alternating in longitudinal series and in adjacent series with ostia and postica quincuncially alternating correspondingly; ostia sometimes in shallow, longitudinal furrows; aporhyses may then also open by small, accessory pores between successive ostia; finely porous, dictyonal cortex on both skeletal surfaces; superficial filaments of gastral side form paratangential network, parts of which develop into scalelike plates or longitudinal bands of finely porous, siliceous material; postica hidden when these structures fully developed. *Cretaceous (Coniacian–Maastrichtian):* Germany.——Fig. 348,*2a–b.* **N. striata* (Schrammen), Quadratenkreide, Cenomanian, Oberg; *a,* side view of upper, funnel-like part of sponge with regularly spaced ostia; *b,* gastral surface with longitudinal bands between small postica, ×1 (Schrammen, 1912).

Orthodiscus Schrammen, 1924a, p. 25 [**O. fragilis* Schrammen, 1924a, p. 26; OD]. Discoidal or umbrella-like, stalked, with small, central cavity or not; dermal (=lower) surface with deep, longitudinal furrows between which occur bifurcating ribs; small ostia may be present along floors of these furrows; epirhyses more or less obsolete; gastral (=upper) surface not furrowed; postica large, arranged without order or alternately; aporhyses run into ribs of dermal side; dictyonal cortex on both surfaces; superficial filaments may form network on gastral side. [Possibly only an extreme form of *Ventriculites* Mantell.] *?Lower Cretaceous, Upper Cretaceous:* Germany, France, Poland.——Fig. 347,*3a–c.* **O. fragilis,* Mukronatenkreide, Cenomanian, Misburg, Germany; *a,* discoidal sponge from below with strong, radial ridges; *b,* discoidal sponge from above with large postica, ×0.5; *c,* skeletal net of fragment of upper side, ×4 (Schrammen, 1924a; courtesy of E. Schweizerbart'sche Verlagsbuchhandlung).

Phymosinion Pomel, 1872, p. 89 [**Coeloptychium muricatum* F. A. Roemer, 1840 in 1840–1841, p. 11; OD]. Bowl shaped or discoidal, with small,

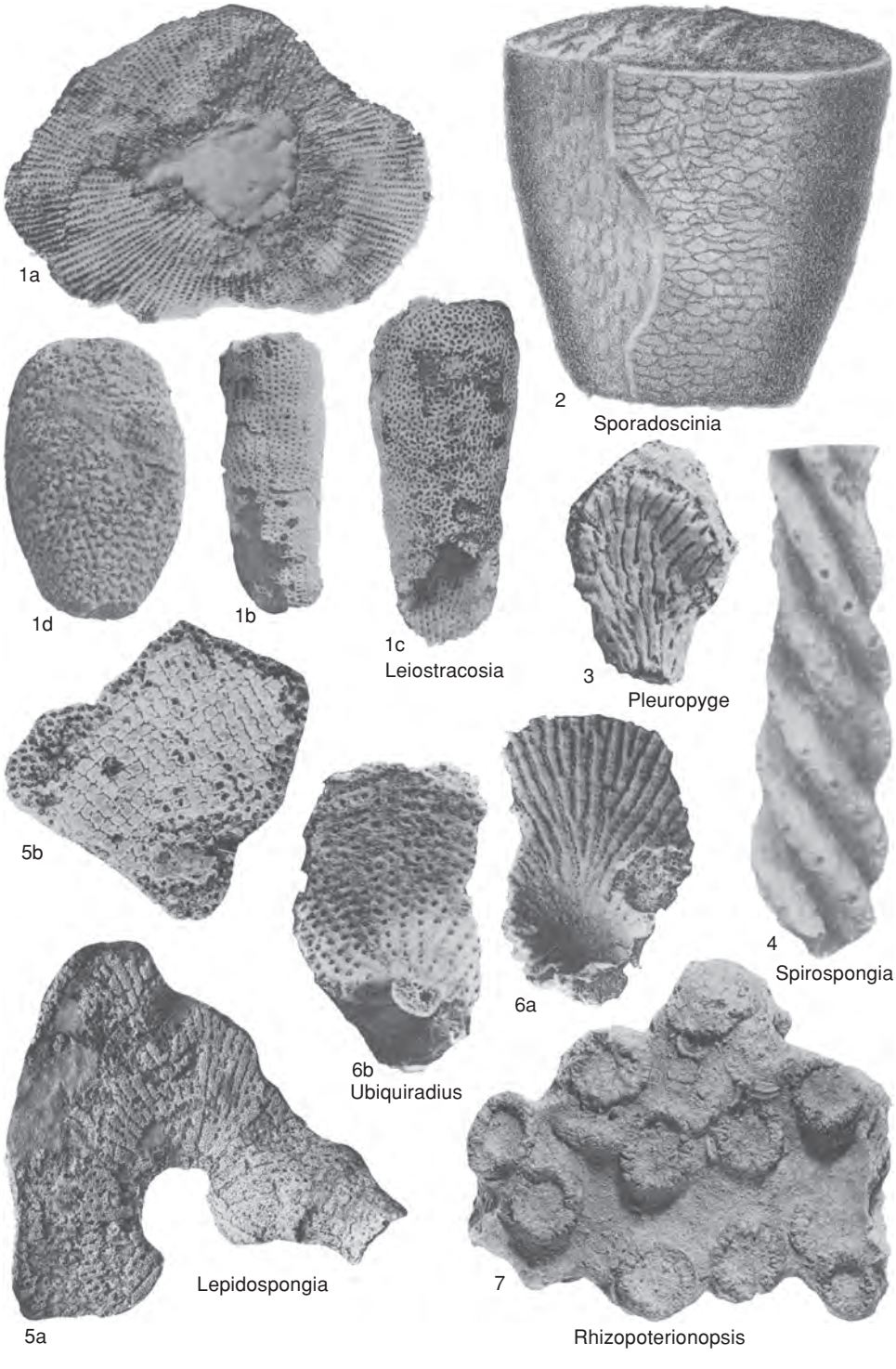


FIG. 349. Ventriculitidae (p. 532–535).

central stalk; dermal surface with ostia of simple epirhyses, arranged alternately or in rough, longitudinal series, and correspondingly arranged, perforated tubercles; gastral side with alternating postica arranged in longitudinal series, along which surface is usually furrowed longitudinally; aporhyses simple, run into tubercles of dermal side, at tops of which they open through small, accessory pores; finely porous, dictyonal cortex on dermal side, less developed or absent on gastral side; no distinct, superficial meshwork. *Upper Cretaceous:* Europe.——Fig. 348,*5.* **P. muricatum* (Roemer), Plänerkalke, Turonian, Alfeld, Germany; gastral surface with tubercles perforated with aporhyses, ×1 (Roemer, 1840–1841).

Pleuropyge Schrammen, 1912, p. 274 [**P. plana;* OD]. Bilaterally compressed above a stalk, with parietal oscula or short, open outgrowths along narrow margins; broad sides with irregularly alternating, longitudinal furrows, in floors of which may be ovate or slitlike ostia of short epirhyses; gastral side not furrowed, but with irregularly alternating postica; finely porous cortex on dermal side; incompletely known. [Character of inside from Wagner (1963, p. 215).] *Cretaceous (Turonian–Maastrichtian):* Germany.——Fig. 349,*3.* **P. plana,* Quadratenkreide, Cenomanian, Oberg; side view of small, laterally flattened sponge with furrowed, dermal surface and parietal oscula along upper margin, ×1 (Schrammen, 1912).

Rhizopoterion Zittel, 1877b, p. 51 [**Siphonia cervicornis* Goldfuss, 1826, p. 18; OD] [=*Rhizocheton* Lachasse, 1943, p. 53 (type, *Rhizocheton jacobi* Lachasse, 1943, p. 55; OD); ?*Retispongia* d'Orbigny, 1849, p. 547 (type, *Scyphia oeynhausii* Goldfuss, 1831, p. 219; ?*Retiscyphia* de Fromentel, 1860a, p. 41 (type, *Scyphia oeynhausii* Goldfuss, 1831, p. 219)]. Hollow-cylindrical to funnel-like, or in variants of these shapes, stalked or not, often with massive roots; epirhyses and aporhyses simple, regularly alternating in longitudinal series and in adjacent series, or modified by intercommunication between cavities of same sort and sometimes wholly labyrinthine; ostia alternating in longitudinal series irrespective of internal modifications; sometimes in longitudinal furrows, between which surface forms bifurcate ribs; postica alternating regularly or more or less irregularly; finely porous, dictyonal cortex usually present on both skeletal surfaces; superficial filaments may occur on either side, denticulate outlines of ostia or arch over them, developed similarly on gastral side or form paratangential network above skeletal surface; root often strongly canalized with numerous tubular canals that run downwardly from ostia, which are covered by basal meshwork. [Type species poorly known; probably identical with *R. cribrosum* (Phillips, 1829 in 1829–1836). Characterization by Schrammen (1912, p. 271) reflects confusion with *Ventriculites* Mantell, due to misidentification of *R. cribrosum* as *V. radiatus* Mantell, as for example by Scrammen (1912, p. 265). *Rhizocheton* based on a typical *Rhizopoterion;* proposed because *Rhizopoterion cervicornia* (Goldfuss) is incompletely known, but not otherwise justified. *Retispongia* exterior as in *Rhizopoterion* species, but inside supposedly without canalar features; this diagnosis based on a figure only; type species identified with *Ventriculites radiatus* Mantell by Goldfuss (1826, p. 16) and others (e.g., Schrammen, 1912, p. 265) applying that name to *Rhizopoterion cribrosum* (Phillips).] *Cretaceous (Albian–Maastrichtian):* Europe.——Fig. 348,*4a–b.* *R. jacobi* (Lachasse), upper Campanian, Charentes, France; *a,* side view of funnel-shaped sponge, UPLGS, ×1; *b,* drawing of lychniscoid, skeletal structure, ×100 (Lachasse, 1943; courtesy of Société Géologique de France).

Rhizopoterionopsis Lachasse, 1943, p. 51 [**R. caillauense* Lachasse, 1943, p. 52; OD]. Compound, with multiple funnels arising from a common, branching stock; other characters as in simple forms of *Rhizopoterion* Zittel. *Cretaceous (Coniacian–Maastrichtian):* France.——Fig. 349,*7.* **R. caillauense,* upper Campanian, Charentes, France; view from above of branched structure, UPLGS, ×0.50 (Lachasse, 1943; courtesy of Société Géologique de France).

Spirospongia Kravtsov, 1968, p. 124 [401] [**S. krymica;* OD]. Small, solitary sponge with dermal surface marked by three or four, upwardly spiraled, ridgelike folds, the crests of which are perforated by spiral row of large, circular, inhalant ostia to canals that apparently empty into narrow, petalloid, central spongocoel; skeleton lychniscoid in fine lattice, with perforated, nodal expansions. *Cretaceous (Maastrichtian):* Russia (Crimea).——Fig. 349,*4.* **S. krymica,* Maastrichtian sandy marl, Bel'bek River; side view of spiraled holotype showing dermal ridges with large, inhalant ostia on their crests, LGI 280/1, ×1 (Kravtsov, 1968).

Sporadoscinia Pomel, 1872, p. 84 [**Scyphia retiformis* F. A. Roemer, 1840 in 1840–1841, p. 7; SD Rauff, 1893, p. 66; =*Scyphia decheni* Goldfuss, 1831, p. 219]. Hollow, cylindrical to funnel-like, or in variants of these shapes; epirhyses and aporhyses radial, separate, or interconnected by tangential passages between cavities of same sort; epirhyses sometimes alternating in series with aporhyses, as in *Coscinopora* Goldfuss, but typically more numerous and arranged without order, in hexagonal groups, in longitudinal series between series of aporhyses, or more or less quadratically; their arrangement sometimes varies through two or more of these conditions; ostia arranged correspondingly, and round, triangular, quadrate, polygonal, irregular, or transversely ovate or slitlike; aporhyses regularly alternating in longitudinal series irrespective of epirhytic variations; postica ovate, elongate longitudinally; finely porous, dictyonal cortex with small, intracortical ostia on both skeletal surfaces; superficial outgrowths absent, inconspicuous, or prominent, sometimes denticulating outlines of ostia or arching over them, or forming paratangential network on gastral side; longitudinal furrowing along series of ostia or postica may occur in oldest

parts, although not typical of genus. *Lower Cretaceous–Upper Cretaceous:* France, Germany, England, Poland; Spain, *Albian.*——Fig. 349,*2. *S. decheni* (Goldfuss), Lower Cretaceous, near Peine, Germany; side view of sculptured, cup-shaped sponge with fine, outer pores and elongate pores in gastral surface, ×1 (Roemer, 1841).

Ubiquiradius de Laubenfels, 1955, p. 81 [**Actinocyclus mirus* Schrammen, 1912, p. 277; OD] [=*Actinocyclus* Schrammen, 1912, p. 277 (type, *Coeloptychium alternans* F. A. Roemer, 1840 in 1840–1841, p. 10, OD), *non* Ehrenburg, 1831; *Porocyclus* Defretin-Lefranc, 1961, p. 69, obj.]. Similar to to *Leiostracosia* Schrammen, but with aporhyses more or less replaced by deep, superficial furrows; stalked, widely funnel-like to umbrella shaped with convex, gastral surface; ostia and epirhyses in longitudinal series, sometimes also grouped quadrately; gastral surface deeply furrowed longitudinally, with postica along floors of furrows; epirhyses run into ribs between furrows of gastral side; aporhyses more or less obsolete; finely porous, dictyonal cortex on both skeletal surfaces; superficial outgrowths mainly on dermal side, where filaments may denticulate or arch over ostia. [Named (de Laubenfels, 1955, p. 81) as *nom. nov. pro Actinocyclus* Schrammen, 1912, *non* Ehrenburg, 1831, but type species of *Actinocyclus* Schrammen is *Coeloptychium alternans* F. A. Roemer, 1841 in 1840–1841, p. 10 (OD, Schrammen, 1912, p. 276).] *Cretaceous (Coniacian–Maastrichtian):* Germany.——Fig 349,*6a–b. *U. mirus* (Schrammen), Quadratenkreide, Cenomanian, Oberg; *a,* side view of gastral surface with ostia in furrows between ribs; *b,* dermal surface with rows of inhalant ostia in fine-textured, skeletal structure, ×1 (Schrammen, 1912).

Subfamily BOLITESIINAE Schrammen, 1912

[*nom. transl. et correct.* Reid, herein, *ex* Bolitesidae Schrammen, 1912, p. 197]

Specialized Ventriculitidae with very wide epirhyses and aporhyses, arranged alternately in regular series; epirhyses open through both skeletal surfaces; skeletal meshes filled by networks of anastomosing, siliceous filaments; epirhyses and aporhyses also intercommunicate through small pores in intercanalar partitions. [Made a separate family by Schrammen (1912, p. 334); but arrangement of canals is of the regular ventriculitid type, as seen for example in *Rhizopoterion cribrosum* (Phillips), *Sporadoscinia alcyonoides* (Mantell); and anastomosing internal filaments correspond with typical, ventriculitid, superficial filaments.] *Cretaceous (Coniacian–Maastrichtian).*

Bolitesia Schrammen, 1912, p. 335 [**B. mirabilis;* OD]. Flabellate; base unknown; dermal side with quincuncially alternating ostia of wide epirhyses that run obliquely through wall to gastral side; gastral side with quadrately arranged apertures, which are alternately internal openings of epirhyses and postica of aporhyses that end blindly under dermal surface; dictyonal cortex on both surfaces, not strongly differentiated. *Cretaceous (Coniacian–Maastrichtian):* Germany.——Fig. 350,*1a–b. *B. mirabilis,* Quadratenkreide, Cenomanian, Oberg; *a,* dermal surface of fragment with wide ostia of epirhyses, ×1; *b,* photomicrograph of skeletal structure of upper surface, ×40 (Schrammen, 1912).

Subfamily STAURONEMATINAE Sollas, 1877

[*nom. transl.* Reid, herein, *ex* Stauronematidae Wagner, 1963, p. 219, *nom. correct. pro* Stauronemata Sollas, 1877b, p. 23]

Ventriculitidae with tubular, radial epirhyses and aporhyses arranged alternately in longitudinal series and in adjacent series, and with superficial or basal meshwork formed mainly or entirely from dictyonal hexactines. [Interpreted as a small stock diverging from the same source as Ventriculitinae, but distinguished by the spicular character of superficial structures; perhaps most similar to *Coscinopora* Goldfuss of Ventriculitinae.] *Lower Cretaceous (Albian)–Upper Cretaceous (Turonian).*

Stauronema Sollas, 1877b, p. 23 [**S. carteri;* OD]. Tongue shaped to triangular and saddle shaped, with small stalk in some individuals, or discoidal following continued growth of broken examples; skeletal framework initially without superficial meshwork, but becoming densely coated on convex (possibly dermal) side by superficial meshwork up to several times thicker; this surface with transverse corrugations or concentric corrugations in discoidal individuals; other primary surface exposed, with regularly alternating, round or ovate apertures of skeletal canals, or concealed by a thin, superficial cover; main superficial mass formed from irregularly oriented, dictyonal hexactines, with or without nodal octahedra, and other beams arising as siliceous outgrowths; this meshwork usually canalized by irregular network of fine, branching and anastomosing canals; surface with cover of fine, branching spinules, and irregular, scattered, small pores through which canal network opens; under this meshwork, or exposed on this side if meshwork absent, round, regularly alternating apertures of radial canals of primary framework; latter mainly regular internally, with nodal octahedra often solidified except in young examples; concave (possibly gastral) dictyonal surface with well-developed, dense cortex; superficial meshwork of this side formed by branched and anastomosed spinules on

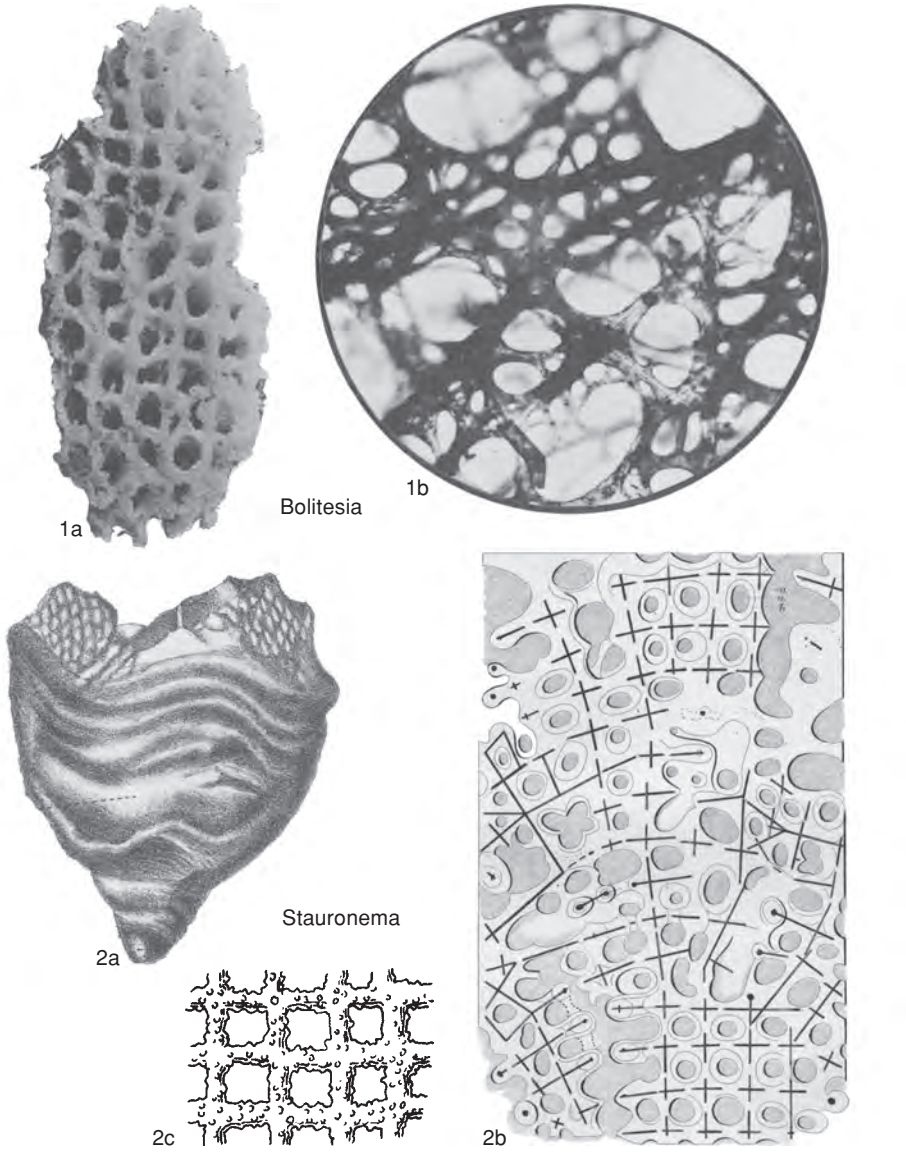


FIG. 350. Ventriculitidae (p. 535–536).

beams at surface, or also containing scattered, paratangential lychniscs. *Lower Cretaceous (Albian)–Upper Cretaceous (Turonian):* Great Britain.——FIG. 350,*2a–c. *S. carteri,* Cambridge Upper Greensand, Lower Cretaceous, Folkestone; *a,* side or posterior view of average-sized specimen, with dense mass, below, and oscular plate, above, ×1; *b,* skeletal network of oscular plate with casts of sexiradiate spicules filled with iron pyrite; longitudinal strands vertical and transverse strands more or less horizontal, ×20 (Sollas, 1877b) ; *c,* part of endosomal skeleton with cubical cribwork and thickened rays, ×1 (de Laubenfels, 1955).

Subfamily LYCHNISCAULINAE new subfamily

[Lychniscaulinae REID, herein] [type genus, *Lychniscaulus* SCHRAMMEN, 1937, p. 18]

Early Ventriculitidae with epirhyses and aporhyses in alternating, longitudinal series

when in any regular arrangement; without finely porous, cortical coverings or basal or superficial meshwork formed from anaxial, siliceous outgrowths. [Relationship to later forms uncertain, but arrangement of skeletal canals in the type genus *Lychniscaulus* SCHRAMMEN is matched in *Leiostracosia* SCHRAMMEN (*Upper Cretaceous*) of Ventriculitinae]. *Upper Jurassic.*

Lychniscaulus SCHRAMMEN, 1937, p. 18 (SCHRAMMEN, 1936, p. 180, *nom. nud.*) [**L. vannus;* OD]. Cylindrical, thick walled, with a deep, narrow, paragastral cavity; dermal side with round ostia of epirhyses, arranged in longitudinal series and more or less quadratically; gastral side with elongate postica arranged similarly; skeletal meshwork regular internally but forming denser and irregular, meshed cortex on dermal side; no superficial structures. *Upper Jurassic:* Germany.——FIG. 351,*1a–b. *L. vannus,* Weiss Jura, Streitberg; *a,* side view showing relatively coarse canals regularly arranged in steeply obconical sponge, ×1 (Schrammen, 1936); *b,* enlargement of outer surface with inhalant ostia in rows through regular, skeletal meshwork, ×5 (Schrammen, 1937).

Discophyma OPPLIGER, 1915, p. 43 [**Stauroderma etalloni* OPPLIGER, 1907, p. 11; SD DE LAUBENFELS, 1955, p. 90] [=*Placotelia* OPPLIGER, 1907, p. 13 (type, *P. marcoui* OPPLIGER, 1907, p. 14, SD REID, herein, ?=*Porostoma marginata* DE FROMENTEL, 1860a, p. 43, =*P. marconi* DE LAUBENFELS, 1955, p. 91, *nom. null.*]. Funnel-like, initially narrow, then widely expanded; upper surface and underside sometimes with concentric corrugations; ostia and postica in rough, longitudinal series, or in concentric rows that may follow corrugations; postica in longitudinal furrows in narrow part or generally; skeletal canals simple, blind, or with fine, lateral branches from simple, main trunks; skeleton more or less irregular, with nodal octahedra absent in parts. [Known only from poorly calcified material. Identity of *Placotelia* with *Discophyma* OPPLIGER recognized by OPPLIGER (1926, p. 22), but name *Discophyma* adopted. Not available under *Code* Art. 23.2 (ICZN, 1999), as *nom. oblit.*] *Upper Jurassic:* Switzerland, France, Poland.——FIG. 351,*2a–b. **D. etalloni* (OPPLIGER), Weiss Jura, Andelot, Zürich, Switzerland; *a,* upper, gastral surface with postica in radial grooves; *b,* lower or dermal surface with irregularly distributed to obscurely concentric placed inhalant ostia, ×0.25 (Oppliger, 1915).——FIG. 351,*2c. D. laciniatum* OPPLIGER, Wangenerschichten, Baden, Switzerland; view from above of broad, thin-walled, funnel-shaped sponge with radially ridged, gastral surface perforated by coarse, exhalant ostia, ×0.25 (Oppliger, 1926).——FIG. 351,*2d. D. cribratum* OPPLIGER, Wangenerschichten, Baden, Switzerland; view into funnel-shaped, thin-walled, discoidal sponge with concentric rings of moderately fine, exhalant ostia, ×0.25 (Oppliger, 1926).

Family CAMEROSPONGIIDAE Schrammen, 1912

[Camerospongiidae SCHRAMMEN, 1912, p. 312]

Ventriculitid-like Lychniscosa in which marginal surface around terminal osculum is coated by dense, siliceous membrane, and comparable sponges in which blind or open, tubular outgrowths emitted from axial tube or funnel; these types intergrade through sponges with wall externally sculptured as in *Ventriculites* MANTELL; some depressed or pyriform with marginal membrane then capsulelike; epirhyses and aporhyses simple to labyrinthine where wall is compact; ostia alternating or without order; postica alternating, sometimes in longitudinal series; cavities of tubular outgrowths correspond with aporhyses of other forms; external surface with finely porous, cortical coverings, variably developed, sometimes forming spinelike outgrowths; marginal membrane formed from small, dictyonal hexactines and anastomosing, siliceous filaments, or also incorporating stauractine marginalia; basal skeleton of root processes formed from anastomosing, siliceous fibers. [The intergradation of Camerospongiidae in which tubes are emitted from an axis with others having typical, intradictyonal epirhyses and aporhyses was not known to SCHRAMMEN, who united the former type with cavaediate sponges here referred to the Callicylicinae (*Tremabolites* ZITTEL) and Coeloptychidae (*Cameroptychium* LEONHARD). In addition, ZITTEL's (1877b, p. 56–57) characterization of the type *Camerospongia* D'ORBIGNY was based on *Cameroptychium* species [*C. campanulatum* (SMITH), *C. schloenbachi* (F. A. ROEMER).] The family characterization is emended here accordingly. The group is retained as a separate family because of distinctive specialization but includes forms not distinguishable from *Ventriculites* MANTELL of the Ventriculitinae except by the marginal membrane (*Rhytistamnia* POMEL).] *Lower Cretaceous (Valanginian)–Upper Cretaceous.*

Camerospongia D'ORBIGNY, 1849, p. 548 [**Scyphia fungiformis* GOLDFUSS, 1831, p. 218; OD] [=*Cameroscyphia* FROMENTEL, 1860a, p. 41, obj.]. Biconical to hemispherical, cushion shaped or

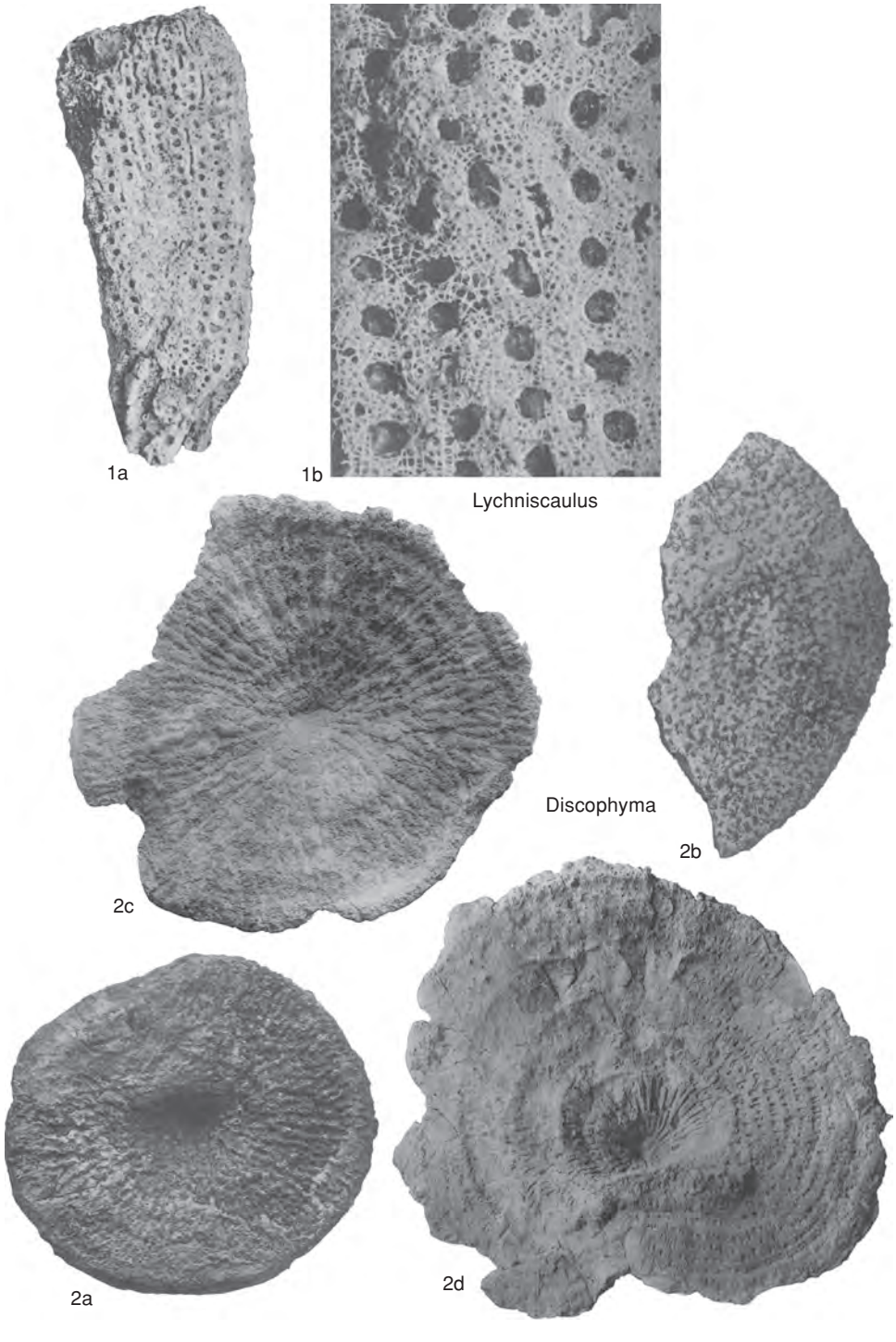


FIG. 351. Ventriculitidae (p. 537).

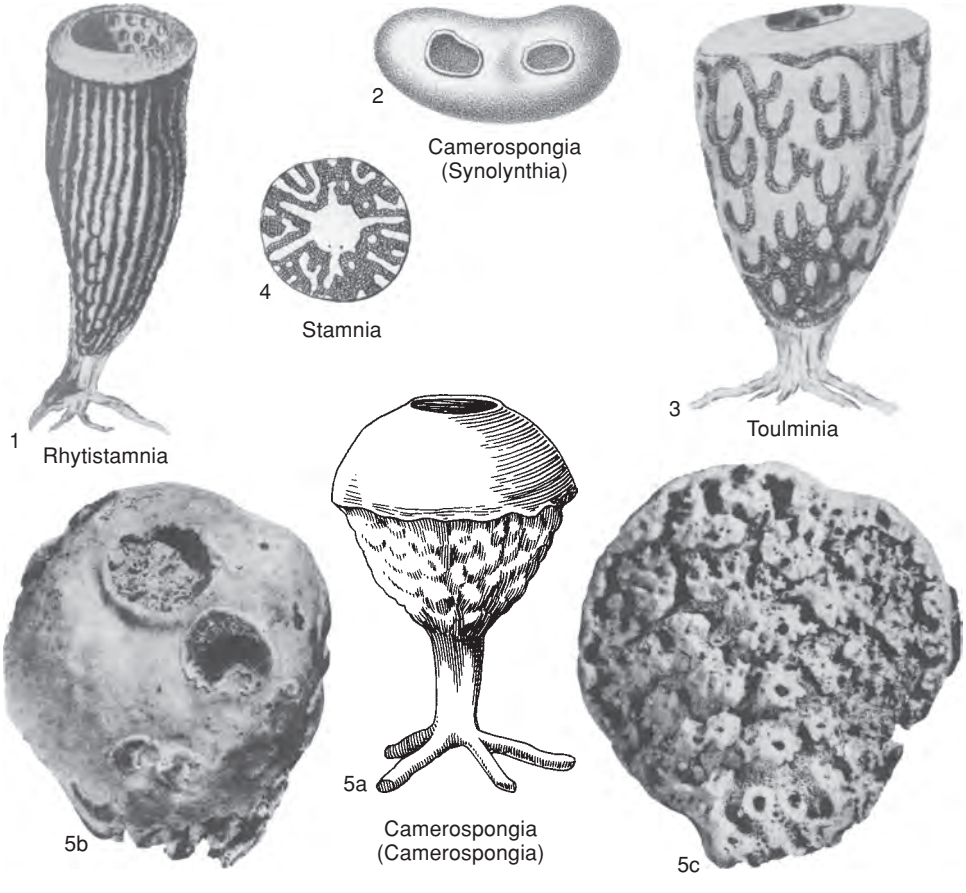


FIG. 352. Camerospongiidae (p. 539–540).

pyriform, with central or marginal root, or forming a colony of marginally attached to completely confluent sponges; upper surface rounded or flattened, formed by siliceous marginal membrane around central osculum with prominent rim, or with more than one osculum in compound examples; underside or lateral surfaces formed by dermal, skeletal surface that may be simply developed with irregularly distributed ostia, or irregularly furrowed to tuberculate with ostia between ribs or tubercles; skeletal canals more or less radial, simple or branched, or continuous labyrinths, also typically wider than intervening skeletal partitions and hence resembling thin-walled tubes; paragastral surface with closely spaced, alternating postica; aporhyses may also open through small, accessory pores on dermal side, sometimes perforate tubercles that become papilliform; dermal surface with finely porous, cortical meshwork that may form spinelike outgrowths, and passes into root structure; gastral side without similar cortex, although accretion of small hexactines may occur. *Cretaceous (Valanginian–Maastrichtian):* Europe.

C. (Camerospongia). Solitary, biconical to hemispherical or pyriform, with central or eccentric stalk and roots or sometimes sessile; underside simple reticulate to furrowed or tuberculate, sometimes with prominent, papilliform outgrowths from which solid spines radiate laterally and may unite locally to form bridges. *Cretaceous (Valanginian–Maastrichtian):* Europe.——FIG. 352,*5a. *C. (C.) fungiformis* (GOLDFUSS); side view of complete sponge with basal stalk and rimmed osculum, ×1 (de Laubenfels, 1955). ——FIG. 352,*5b–c. C. (C.) asymmetrica* LAGNEAU-HÉRENGER, Aptian, Can Casanyas Castellet, Catalogne, Spain; *b,* side view of globular sponge with a cortex and eccentric osculum, ×1; *c,* opposite side showing anastomosing, small tubes, with ostia, that constitute main body of sponge, ×1 (Lagneau-Hérenger, 1962; courtesy of Société Géologique de France).

C. (Synolynthia) POMEL, 1872, p. 76 [**Choanites subrotundus* MANTELL, 1822, p. 179; OD]. Solitary, hemispherical to cushionlike, with a marginal root or group of roots, or compound,

hemispherical to pyriform with two or more oscula, or forming linear colonies of marginally attached to completely confluent individuals; paragastral cavity or cavities small, pitlike, separate in compound examples; linear colonies formed by budding from side opposite root or roots; dictyonal structure radiating from this margin across body, and continuous through budded individuals. [Essentially intergrading with *Camerospongia s.s.,* but includes compound species and the *Cystispongia* species of SCHRAMMEN (1912).] *Cretaceous (Hauterivian–Maastrichtian):* Europe.——FIG. 352,*2. C.(S.) reniformis* ROEMER, Quadratenkreide, Cenomanian, Ilsenburg, Germany; view from above showing two oscula in cushionlike, small sponge, ×1 (Roemer, 1864).

Rhytistamnia POMEL, 1872, p. 66 [**Cephalites longitudinalis* SMITH, 1848, p. 281; OD]. Habitus as in *Stamnia* POMEL, 1872 (p. 66), but dermal surface tuberculate or furrowed longitudinally as in *Ventriculites* MANTELL of Ventriculitidae; epirhyses simple, with ostia in furrows of dermal side, or more or less obsolete; aporhyses simple, running radially into ribs or tubercles of dermal side; postica alternating; dermal surface with finely porous cortex, with small, intracortical ostia. [Type species not distinguishable from forms of *Ventriculites chonoides* MANTELL except by marginal membrane.] *Cretaceous (Turonian–Maastrichtian):* Europe.——FIG. 352,*1. *R. longitudinalis* (SMITH), Chalk, Upper Cretaceous; side view of steeply obconical sponge with furrowed, dermal surface, ×1 (Smith, 1848).

Stamnia POMEL, 1872, p. 66 [**Cephalites alternans* SMITH, 1848, p. 283; SD DE LAUBENFELS, 1955, p. 107] [=*Sestrostamnia* POMEL, 1872, p. 66 (type, *Cephalites alternans* SMITH, 1848, p. 283); ?*Tretostamnia* POMEL, 1872, p. 70 (type, *T. favosa,* M); ?*Xystrostamnia* POMEL, 1872, p. 66 (type, *Cephalites paradox* SMITH, 1848, p. 283)]. Carrot shaped, with flat, marginal surface, deep, narrow, paragastral cavity, and small stalk and roots; wall compact, with simple, radial or branching, and anastomosing epirhyses and aporhyses; ostia and postica alternating or without order; dermal or both surfaces with finely porous, cortical covering. *Cretaceous (Turonian):* Europe.——FIG. 352,*4. *S. alternans* (SMITH), Chalk, England; transverse section showing broad, central cavity and folded walls, ×1 (Smith, 1847).

Toulminia ZITTEL, 1877b, p. 56 [**Cephalites catenifer* SMITH, 1848, p. 286; SD DE LAUBENFELS, 1955, p. 90; =*Ventriculites benettiae* MANTELL, 1822, p. 177, subj.] [=*Oncostamnia* POMEL, 1872, p. 67, obj.; *Phymostamnia* POMEL, 1872, p. 67 (type, *Cephalites bullatus* SMITH, 1848, p. 284, OD); *Phalacrus* SCHRAMMEN, 1912, p. 321, *non* PAYKULL, 1800, *nom. nov. pro Ornatus* DE LAUBENFELS, 1955, p. 90, *nom. null.*]. Top shaped with compact, outer surface, flat top, and small, basal stalk, or with radiating, tubular outgrowths arising from tubular axis below annular membrane that forms summit; epirhyses typically absent; aporhyses in blind, papilliform, or widely open, radial outgrowths, which may be united laterally in groups or connected by secondary bridges at their summits; ends of radial outgrowths round or diamond shaped when closed or papilliform, round or horseshoe shaped to continuously interconnected when freely open; development of these features may vary between different individuals; gastral wall with alternating apertures (postica) that lead into hollow outgrowths; dermal side with or without finely porous, cortical structures, which may form bridges between ends of open outgrowths; gastral meshwork unmodified, or with small hexactines attached to dictyonalia at surface. [Variable development is characteristic of the type species, of which differently developed individuals were types of the nominal species *V. benettiae* MANTELL, *C. catenifer* SMITH, *C. microta* F. A. ROEMER, and *C. bullatus* SMITH. Type species of *Phymostamnia* was based on a form of *T. benettiae* in which tubular outgrowths are terminally diamond shaped with a perforation in the upper angle. This form grades although *microta* and *catenifer* forms into typical *benettiae,* with open tubes continuously connected by secondary bridges.

Ornatus was proposed as a *nom. nov.* by DE LAUBENFELS (1955, p. 90) for *Phalacrus* SCHRAMMEN, 1912, p. 321, *non* PAYKULL, 1800, but the designated type species *P. expectatus* SCHRAMMEN, 1912 was never described by SCHRAMMEN, although three other species were. Sponges are *Toulminia* forms with papilliform or separate open lateral tubes.] *Upper Cretaceous:* Germany.——FIG. 352,*3. *T. catenifer* (SMITH), Chalk, Quadratenkreide–Mucronatenkreide; side view of top-shaped sponge with flat top and tubular outgrowth in thick wall, approximately ×1 (Smith, 1848).

Family POLYBLASTIDIIDAE Schrammen, 1912

[Polyblastidiidae SCHRAMMEN, 1912, p. 194]

Branched-tubular Lychniscosa with three-dimensional, skeletal meshwork in which skeletal wall is apparently folded longitudinally; wall with shallow epirhyses but no aporhyses, although gastral side of skeleton deeply furrowed longitudinally; dermal surface of dictyonal framework with shallow, longitudinal furrows, along which are alternating ostia of shallow, pitlike epirhyses, between rounded or slightly tuberculate ribs; gastral side with deep, longitudinal furrows and no aporhyses or postica, although small pores in floors of furrows may perforate ribs of dermal side; some furrows locally intercommunicate through apertures in intervening ridges; dermal side of framework with dictyonal cortex as finely porous, siliceous

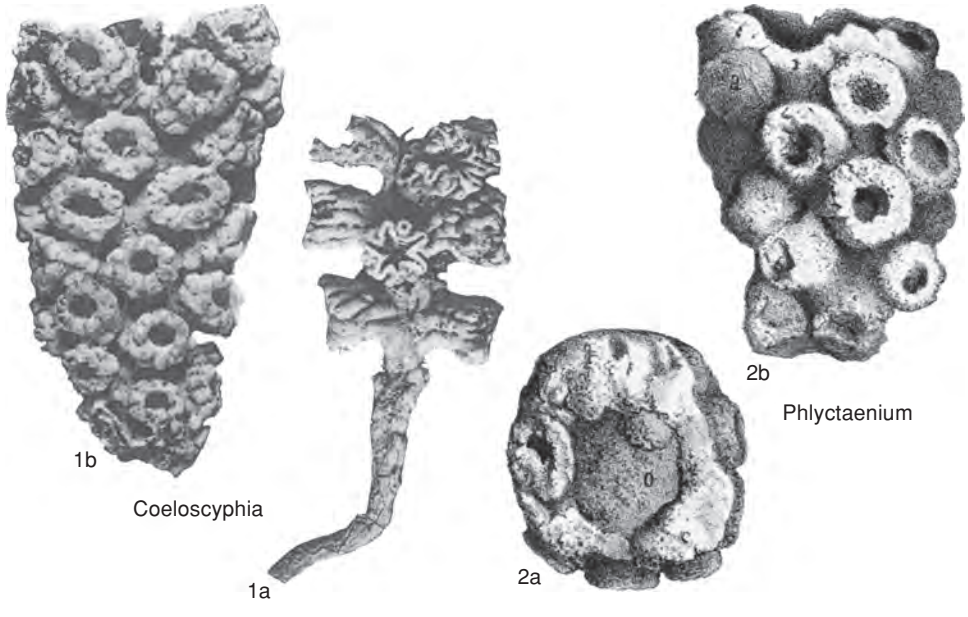


FIG. 353. Polyblastidiidae (p. 541).

membrane; gastral side with no dictyonal cortex, but with anastomosing, superficial filaments that grow out from projecting rays of dictyonalia at surface; basal skeleton formed from siliceous fibers. [*Coeloscyphia* TATE (=*Polyblastidium* ZITTEL), was regarded as a ventriculitid by ZITTEL and could be a form in which radial, flagellated chambers or chamber-bearing structures, represented by aporhyses in Ventriculitidae, were replaced by continuous, longitudinal folds of the chamber layer. A similar development occurs in *Ubiquiradius* DE LAUBENFELS, here placed in the Ventriculitidae because of its apparent relationship to *Leiostracosia* SCHRAMMEN. The gastral furrows of *Coeloscyphia* were also apparently internal in life, because the superficial filaments grow into and over them.

The nominal genera *Coeloscyphia* TATE and *Polyblastidium* ZITTEL were made types of separate families by DE LAUBENFELS (1855), but their respective type species (*C. sulcata* TATE, *P. luxurians* ZITTEL) are thought here to be based on different specimens of one species, *C. racemosa* (SMITH).] *Upper Jurassic–Cretaceous (Coniacian).*

Coeloscyphia TATE, 1865, p. 43 [**C. sulcata;* OD; =*Brachiolites racemosus* SMITH, 1848, p. 364] [=*Polyblastidium* ZITTEL, 1877b, p. 52 (type, *P. luxurians* ZITTEL, 1877b, p. 52, OD, =*Brachiolites racemosus* SMITH, 1848, p. 364]. Axial tube or group of connected tubes, above a stalk with basal roots, emitting radiating, budlike outgrowths with open ends; ends of outgrowths exposing interior structure when incomplete, covered by cortex of dermal side when fully developed. [*Polyblastidium* ZITTEL, 1877b, is regarded as synonym of *Coeloscyphia* TATE, 1865, because *C. sulcata* TATE and *P. luxurians* ZITTEL are considered identical biologically. Synonymy of *P. luxurians* and *Brachiolites racemosus* SMITH, 1848 was recognized by SCHRAMMEN (1912).] *Cretaceous (Coniacian–Maastrichtian):* Ireland, Germany.——FIG. 353,*1a–b. *C. racemosa* (SMITH), Quadratenkreide, Cenomanian, Oberg, Germany; *a,* axial cluster of radiating tubes, above a stalk, where each tube ends in radiating outgrowths; *b,* obconical cluster of radiating tubes with less distinct, radial structure on their outer ends, ×1 (Schrammen, 1912).

Phlyctaenium ZITTEL, 1878c, p. 177 [**Mastospongia cylindrata* QUENSTEDT, 1878 in 1877–1878, p. 150; SD DE LAUBENFELS, 1955, p. 89]. Top shaped to cylindrical, outer surface with large nodes, broad osculum, skeleton lychniscoid. *Upper Jurassic:* Germany.——FIG. 353,*2a–b. *P. cylindratum* (QUENSTEDT), Weiss Jura, Kimmeridgian, Friedingen; *a,* view from above of broad osculum and thick walls; *b,* view from side of nodose walls, ×1 (Quenstedt, 1877–1878).

Family DACTYLOCALYCIDAE Gray, 1867

[Dactylocalycidae Gray, 1867, p. 505] [=?Lithospongiae Duchassaing & Michelotti, 1864, p. 25; Aphrocallistidae Sollas, 1877b, p. 23, *partim;* Maeandrospongidae Zittel, 1877b, p. 38, *partim;* Auloplacidae Schrammen, 1912, p. 227; Euretidae Ijima, 1927, p. 163, *partim*]

Lychniscosa with three-dimensional, dictyonal meshwork and single system of intradictyonal skeletal canals as labyrinth of divided and anastomosed, tubular passages that open through both skeletal surfaces, but without connected dermalia or gastralia; cortical meshwork when present formed by modification of outermost primary meshwork, or by secondary accretion of dictyonal hexactines; superficial meshwork and basal skeleton of dictyonal hexactines; lychnisc octahedra may be solidified or largely aborted at surfaces or throughout skeleton; pentactinal dermalia and gastralia and hexaster microscleres in two living genera. [The living type genus *Dactylocalyx* Stutchbury has usually been placed in the Hexactinosa because of extensive suppression of lychnisc octahedra, which occur only in some specimens of the type species (*D. pumiceus* Stutchbury), and then only in small parts of the skeleton. Analogous suppression of lychnisc octahedra occurs in the fossil *Moretiella* Breistroffer, and in *Caiathiscus* Sollas if this is a dactylocalycid. The soft parts of *Dactylocalyx* are unfortunately not known fully. Reiswig (2002) has discussed the history of interpretation of the family.] *Jurassic (Bajocian)–Holocene.*

Subfamily DACTYLOCALYCINAE Gray, 1867

[*nom. transl.* Reid, herein, *ex* Dactylocalycidae Gray, 1867, p. 505]

Sponges of varying habitus, in which skeletal pores are not restricted to special, paragaster-like depressions on either side of wall. *Jurassic (Bajocian)–Cretaceous (Maastrictian).*

?Calathiscus Sollas, 1883, p. 546 [**C. variolatus;* M]. Tubular, straight or horn shaped; skeletal pores without order or locally alternating in vertical rows; skeleton very irregular with many solid nodes and others that have structures that appear to be imperfectly developed octahedra. [Known only from poor, calcified material, not certainly lychniscosan; has been considered ventriculitid (e.g., by Hinde, 1893b, p. 197), but the skeletal canals are labyrinthine, and resemblance to those of *Dactylocalyx* was noted by Sollas (1883, p. 546).] *Jurassic (Bajocian):* England.——Fig. 354,*2a–b.* **C. variolatus,* Inferior Oolite, Burton Bradstock; *a,* side view of large, subcylindrical sponge, ×0.5; *b,* drawing of enlarged section of skeletal structure, replaced by calcite, ×50 (Hinde, 1893b).

Exanthesis Regnard in Moret, 1926b, p. 231 [**Plocoscyphia reticulata* Hinde, 1884a, p. 135; M] [=*Periphora* Regnard, 1926, p. 483 (type, *P. robusta,* M)]. Body irregularly spreading or columnar, composed of dividing and anastomosing tubes, in columnar forms margins of open, peripheral tubes sometimes growing together locally to make reticulate, peripheral surface; skeletal pores rounded to slitlike or shaped irregularly, similar or differently developed on opposite surfaces, and arranged without order or with rough, longitudinal alignments; skeletal canals sometimes poorly developed; skeletal meshwork more or less regular internally, except when canals are close together, becoming irregular or forming cortex at surfaces; nodal octahedra may be absent in well-developed, cortical meshwork; accretion of dictyonal hexactines may thicken cortical meshwork or build superficial bridges on dermal side. [*Exanthesis* was described as a new genus by Regnard (1926, p. 475) in a paper apparently referred to by Moret as "Regnard, in litt."] *Cretaceous (Aptian–Maastrichtian):* France, England, Spain.

E. (Exanthesis). Irregularly spreading to columnar, with peripheral tubes reticulated; skeletal pores round to slitlike or shaped irregularly and similarly or differently developed on opposite surfaces; skeletal canals well developed; distinct, dense, cortical meshwork, thickest on dermal side where accretion of dictyonal hexactines may also be extensive; cortical and superficial dictyonalia without nodal octahedra in most instances. [*Periphora* Regnard, 1926 based on an *Exanthesis* similar to the type *E. reticulatus;* characters of the latter then not fully known.] *Cretaceous (Aptian–Cenomanian):* France, England, Spain.——Fig. 354,*4a–c.* **E. (E.) reticulatus* (Hinde), Cenomanian; *a,* side view of irregular sponge of anastomosing tubes, Cape de la Hève, Normandy, France, ×1 (Moret, 1926b; courtesy of Société Géologique de France); *b,* side view of sponge with apertures of irregular tubes in upper part, Upper Greensand, Eastborne, England, ×0.5; *c,* fragments of internal skeleton showing so-called lantern development, Upper Greensand, Eastborne, England, ×25 (Hinde, 1884a).

E. (Eligma) Regnard, 1926, p. 484 [**E. douvillei;* M]. Irregularly spreading to roughly columnar, with peripheral tubes mainly separate and often of convoluted shapes; skeletal pores mainly rounded, apart from denticulation by projecting, skeletal rays, and usually similar on both surfaces; skeletal canals well or poorly developed, sometimes more or less limited to enlarged

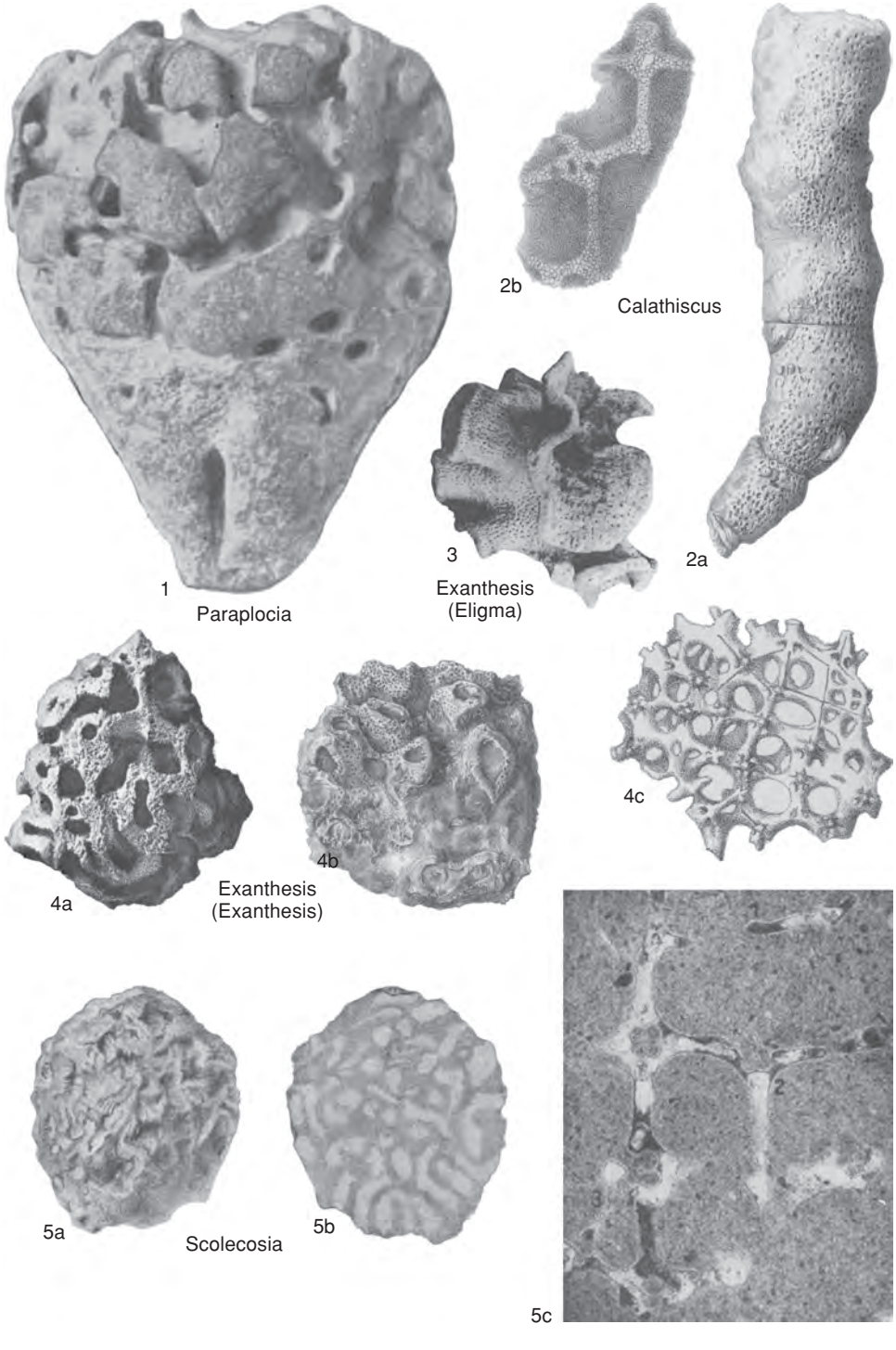


FIG. 354. Dactylocalycidae (p. 542–544).

skeletal meshes, or only recognizable near surfaces so that no continuous labyrinth is present; meshwork at surfaces not forming definite cortex, although less regular than that of interior, and usually with nodal octahedra. [Type species possibly based on incompletely canalized individuals of *E. (E.) labrosa* (SMITH) because fully canalized examples are otherwise indistinguishable.] *Cretaceous (Albian–Maastrichtian):* France, England.——FIG. 354,*3. *E. (E.) douvillei,* chalk of Rouen, Cenomanian, Coulonges-les-Sablons, Orne, France; side view of irregular, small sponge, ×0.66 (Regnard, 1926; courtesy of Société Géologique de France).

Moretiella BREISTROFFER, 1949, p. 103, *nom. nov. pro Moretia* HÉRENGER, 1945, p. 689, *non* ROBINEAU-DESVOIDY, 1863 [**Moretia elegans* HÉRENGER, 1945, p. 689; OD] [=*Neomoretia* ZHURAVLEVA in REZVOI, ZHURAVLEVA, & KOLTUN, 1962, p. 46, obj., proposed as a new name for *Moretia*]. Tubular to funnel-like or flabellate, thick walled; exterior of skeletal framework irregularly sculptured with rounded to slitlike or irregularly shaped, skeletal pores that may have longitudinal alignment; skeletal canals well developed; gastral side smooth but with rounded apertures; skeletal meshwork regular in interior, passing outwardly on both sides into irregular, cortical meshwork that is thick on dermal side; dermal, cortical meshwork loose toward surface, formed partly by accretion of hexactines that also build irregular, superficial bridges across skeletal pores; nodal octahedra absent in cortical meshwork and also more or less extensively in interior. [Placed in a separate family Moretiellidae by HÉRENGER, but skeletal characters similar to those of *Exanthesis reticulatus* (HINDE).] *Cretaceous (Aptian–Cenomanian):* Spain.——FIG. 355*a–d. *M. elegans* (HÉRENGER), Aptian, Can Casanyas Castellet, Catalogne; *a,* side view of subcylindrical sponge with elongate, skeletal pores in dermal layer, ×0.5; *b,* enlargement of part of skeletal net with spines that border some of pores; *c,* regular, dictyonal, interior, skeletal network interrupted by canals; *d,* part of gastral surface with dictyonal structure around exhalant ostia partially obscured by a cortex, ×10 (Lagneau-Hérenger, 1962; courtesy of Société Géologique de France).

Paraplocia POMEL, 1872, p. 104 [**Spongia labyrinthica* MANTELL, 1822, p. 165; OD] [?=*Oncotoechus* SCHRAMMEN, 1912, p. 308 (type, *O. cavernosus* SCHRAMMEN, 1912, p. 309, SD DE LAUBENFELS, 1955, p. 91)]. Club shaped, composed of peripherally separate or reticulated, divided and anastomosed tubes, or tubes or solid outgrowths that arise from an axial tube; conditions variable between different individuals; peripheral reticulation of tubes spread variably from lowest parts upwardly; skeletal pores round, arranged without order, or locally opening in sinuous grooves that are imperfectly enclosed canals; skeletal canals well developed; no special cortical meshwork; tubes and cavaedial interspaces of lower parts infilled with secondary, dictyonal meshwork, which is heavily thickened; no apparent basal attachment. *Cretaceous (Turonian):* Germany.——FIG. 354,*1. *P. cavernosa* SCHRAMMEN, Scaphitenplaner, Oppeln; side view of obconical sponge with irregularly anastomosing outgrowths with prominent, small ostia in upper part, ×1 (Schrammen, 1912).

?Scolecosia RAUFF, 1933, p. 54 [**S. scrobiculata;* OD]. Body lenticular, containing labyrinth of vermiform, anastomosed canals that open at surfaces; intervening partitions with simple, regular, skeletal meshwork; further details unknown. [Based on a single, phosphatized pseudomorph.] *Cretaceous (Turonian):* Germany.——FIG. 354,*5a–c. *S. scrobiculata,* Greensand, upper Turonian, Ruhr Valley; *a,* side view of sponge with labyrinthic canals and skeletal structure, ×1; *b,* vertical section through sponge showing complex, internal, canal pattern and skeleton, ×1; *c,* thin section showing lychniscoid, skeletal structure partially replaced by phosphorite, ×50 (Rauff, 1933; courtesy of *Preussischen Geologischen Landsanstalt,* E. Schweizerbart'sche Verlagsbuchhandlung).

Subfamily OPHRYSTOMATINAE Schrammen, 1912

[*nom. transl.* REID, 1957b, p. 825, *ex* Ophrystomatidae SCHRAMMEN, 1912, p. 197]

Platelike sponges with skeletal canals of one surface restricted to local, paragaster-like depressions that open through a dense, cortical covering, and analogous nodular to hemispherical sponges with a deep, central cavity. [Reduced to subfamily by REID (1957b) on recognition of presence of a dactylocalycid canal system in the first good spicular material; represented in living sponges by the incompletely known "*Cystispongia" superstes* SCHMIDT (1880).] *Cretaceous (Albian–Cenomanian).*

Ophrystoma ZITTEL, 1877b, p. 55 [**Porospongia micrommata* F. A. ROEMER, 1864, p. 9; M]. Platelike, sometimes folded irregularly; one surface with alternating or irregularly distributed and rounded to slitlike skeletal pores spaced about their own width apart; other surface imperforate between rounded, paragaster-like pits, with skeletal pores in their walls; surface between these pits formed by dense, irregular meshwork, composed of small, dictyonal hexactines without nodal octahedra; internal meshwork more or less lacunar, forms branched and anastomosed, skeletal trabeculae that are exposed at margins of plate; other skeletal surface with irregular meshwork, not forming a thick cortex; pitted side probably gastral. *Cretaceous (Albian–Cenomanian):* Germany, England.——FIG. 356,*1. *O. micrommata* (ROEMER), Varians-Pläner, Cenomanian, Langelsheim, Germany; plate fragment with irregular rimmed, paragaster-like pits

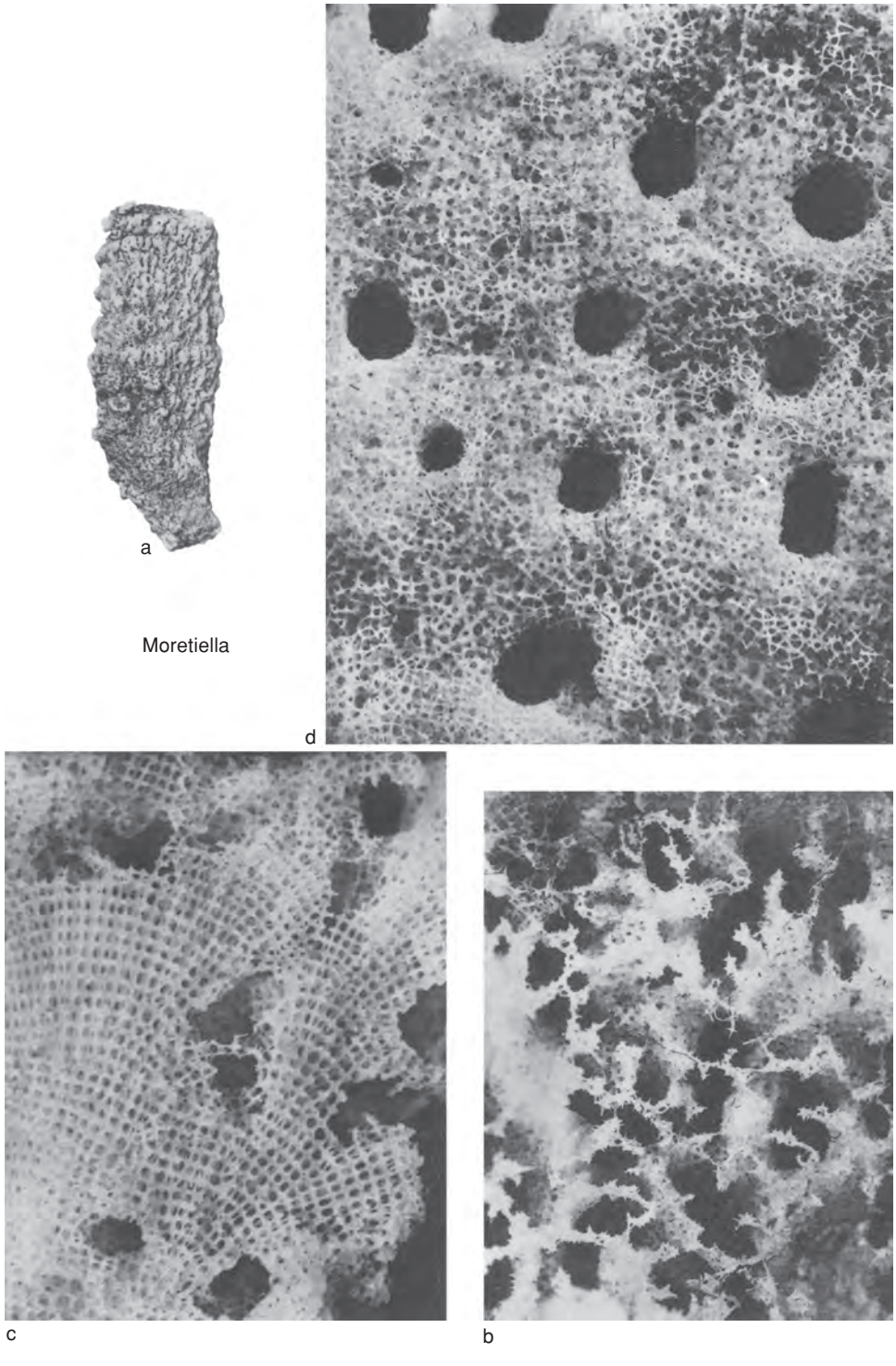


Fig. 355. Dactylocalycidae (p. 544).

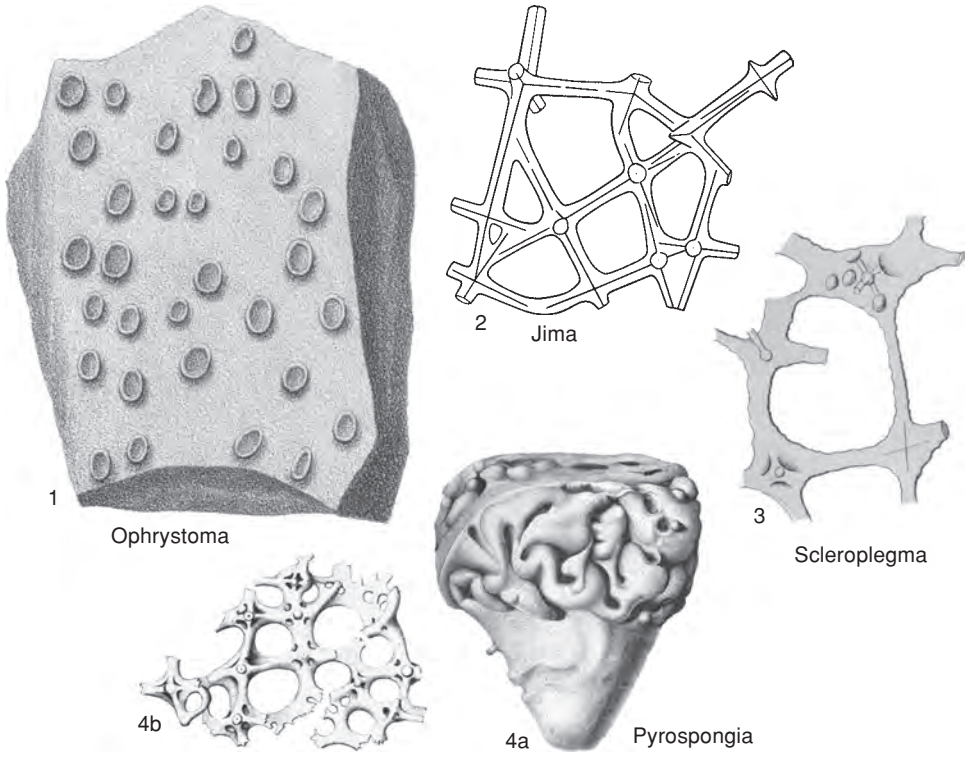


FIG. 356. Dactylocalycidae (p. 544–546).

separated by irregular, dense, skeletal structure, ×1 (Roemer, 1864).

Subfamily UNCERTAIN

Jima DE LAUBENFELS, 1955, p. 84, *nom. nov. pro Pleurotoma* SCHRAMMEN, 1912, p. 257, *non* EHRENBERG, 1839 [**Pleurotoma ijimai* SCHRAMMEN, 1912, p. 257; M]. Thin-walled, tubular sponges. *Upper Cretaceous:* Germany.——FIG. 356,*2. *J. ijimai* (SCHRAMMEN), Quadratenkreide, Oberg; sample of lychniscoid skeletal structure of thin wall, ×45 (Schrammen, 1912).

Meandrospongia D'ORBIGNY, 1849, p. 550 [**M. foliacea;* OD] [=*Maeandrospongia* ROEMER, 1864, p. 52, obj.]. Subcylindrical to steeply obconical meandriform, perhaps branched, thin-walled sponge with many round openings but oscules absent; pores not apparent in original material. [No known suitable figures.] *Cretaceous (Turonian):* Europe.

Pyrospongia ZAHÁLKA, 1901, p. 37 [**P. vrbaei;* SD DE LAUBENFELS, 1955, p. 84]. Sponges bulb shaped with thick, high walls of meandering, flexuous, rounded lobes; irregular, radial canals converging to vertical, axial possible spongocoel from small openings on surface; skeleton lychniscoid with prominent lanterns in interior. *Upper Cretaceous:* Czech Republic, Slovakia.——FIG. 356,*4a–b. *P. vrbaei,* Couches de Teplice, upper Turonien, Teplice, near Prague; *a,* side view of bulbous sponge showing structure of walls and canal development, ×0.5; *b,* skeletal fragment showing lychniscoid structure, ×50 (Zahálka, 1901).

Scleroplegma SCHMIDT, 1880, p. 56 [**S. lanterna;* SD DE LAUBENFELS, 1955, p. 84]. Cylindrical to keg-shaped, thick-walled sponges with a similar-shaped spongocoel; skeleton lychniscoid with round to prismatic mesh spaces and irregular canals. *Upper Cretaceous–Holocene:* Germany, Atlantic Ocean. ——FIG. 356,*3. *S. lanterna,* Holocene, Atlantic Ocean; skeletal fragment showing lychniscoid structure of network, magnification unknown (Schmidt, 1879).

Family SPORADOPYLIDAE Schrammen, 1937

[Sporadopylidae SCHRAMMEN, 1937, p. 17]

Lychniscosa with three-dimensional, skeletal meshwork and single system of intradictyonal, skeletal canals, in form of

quincuncially alternating, radial passages that open through both skeletal surfaces, or of canals of this type that pass into a labyrinth on one side of wall; nodal octahedra well developed or more or less suppressed, sometimes only detectable in small parts of individual sponges. [The family type *Sporadopyle* ZITTEL and the further included genus *Xenoschrammenum* DE LAUBENFELS (=*Amphiblestrum* SCHRAMMEN, 1937, *non* GRAY, 1848) were stated by SCHRAMMEN (1937, p. 17) to have alternating epirhyses and aporhyses; but the type species *S. obliqua* (GOLDFUSS) and *X. venosum* (SCHRAMMEN) have the structure stated here in material identified by SCHRAMMEN.

The radial cavities resemble diarhyses of aphrocallistid Hexactinosa, but their size is more suggestive of chamber-lined canals in some instances.] *Upper Jurassic–Cretaceous (Cenomanian).*

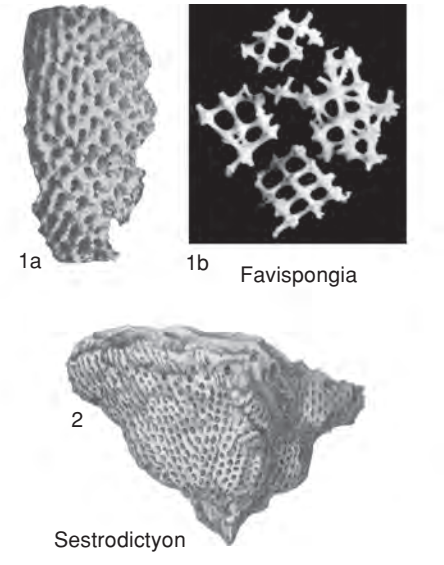


FIG. 357. Sporadopylidae (p. 547).

Favispongia QUENSTEDT, 1878 in 1877–1878, p. 118 [**Scyphia obliqua* GOLDFUSS, 1826, p. 9; SD SCHRAMMEN, 1937, p. 17] [=*Sporadopyle* ZITTEL, 1877b, p. 47, obj.]. Tubular to funnel-like, thick walled, usually small; exterior with alternating, round to slitlike, skeletal pores, sometimes also furrowed longitudinally or diagonally; skeletal canals tubular, narrow, pass directly through framework or anastomose on gastral side; internal meshwork regular to more or less irregular, with nodal octahedra well developed; denser, cortical meshwork on dermal side. [Many records refer to Hexactinosa, with which this form has been confused.] *Upper Jurassic; ?Lower Cretaceous:* Europe.——FIG. 357,*1a–b. *F. obliqua* (GOLDFUSS), Weiss Jura, Upper Jurassic, Streitberg, Germany; *a,* side view showing tubular nature of skeleton and distribution of pores, ×2 (Schrammen, 1937); *b,* skeletal fragments showing regular network and swollen, nodal octahedra at some junctions, ×20 (Schrammen, 1936).

Sestrodictyon HINDE, 1884a, p. 101 [**S. convolutum* HINDE, 1884a, p. 102; M]. Irregularly convoluted plates that may pass into funnels by enrollment and union of margins; radial canals freely open on both sides of skeletal framework, or with apertures covered on one side by anastomosing bridges of secondary, dictyonal meshwork that build an irregularly furrowed and perforated secondary surface; those of other side locally in variably developed, longitudinal furrows; this surface also sometimes with small, secondary outgrowths that usually remain separate; lychnisc octahedra rare or absent. *Cretaceous (Albian–Cenomanian):* Switzerland.——FIG. 357,*2. *S. convolutum,* Alpine Chalk, Appenzell; side view of funnel-like form with coarse openings of radial canals, ×0.5 (Hinde, 1884).

Xenoschrammenum DE LAUBENFELS, 1955, p. 79, *nom. nov. pro Amphiblestrum* SCHRAMMEN, 1937, p. 57, *non* GRAY, 1848 [**Amphiblestrum venosum* SCHRAMMEN, 1937, p. 58; OD]. Based on platelike fragments; one side with regularly alternating, ovate apertures, aligned longitudinally, that may become subdivided by secondary partition to form two pores of similar or different sizes; skeletal canals running radially inwardly from this side, through most of framework thickness, then forming a labyrinth that opens through small, rounded pores arranged without order on other side; meshwork fairly regular internally, with dictyonal strands curved strongly to side with pores regularly alternating; lychnisc octahedra only seen locally; irregular meshwork at surfaces. [Funnel-like according to SCHRAMMEN (1937, p. 57), but this habit is not known in the type.] *Upper Jurassic, ?Lower Cretaceous:* Germany, France, Spain.——FIG. 358*a–c. *X. venosum* (SCHRAMMEN), Weiss Jura, Upper Jurassic, Heuchstetten, Germany; *a,* outer surface of fragment with regular skeleton; *b,* inner surface of fragment with more irregular skeleton, ×1 (Schrammen, 1937); *c,* fragment of articulated, skeletal net, ×20 (Schrammen, 1936).——FIG. 358*d. X. robustum* LAGNEAU-HÉRENGER, Hauterivian, Malleval, France; basal part of cylindrical sponge characterized by coarse pores and fibers of skeletal net, ×1 (Lagneau-Hérenger, 1962).——FIG. 358*e–g. X. fragile* LAGNEAU-HÉRENGER, Aptian, Can Casanyas Castellet, Catalogne, Spain; *e,* broad, plate- to cup-shaped sponge seen from above, ×1; *f,* enlarged view of gastral surface with dictyonal net between exhalant pores that may be bordered by

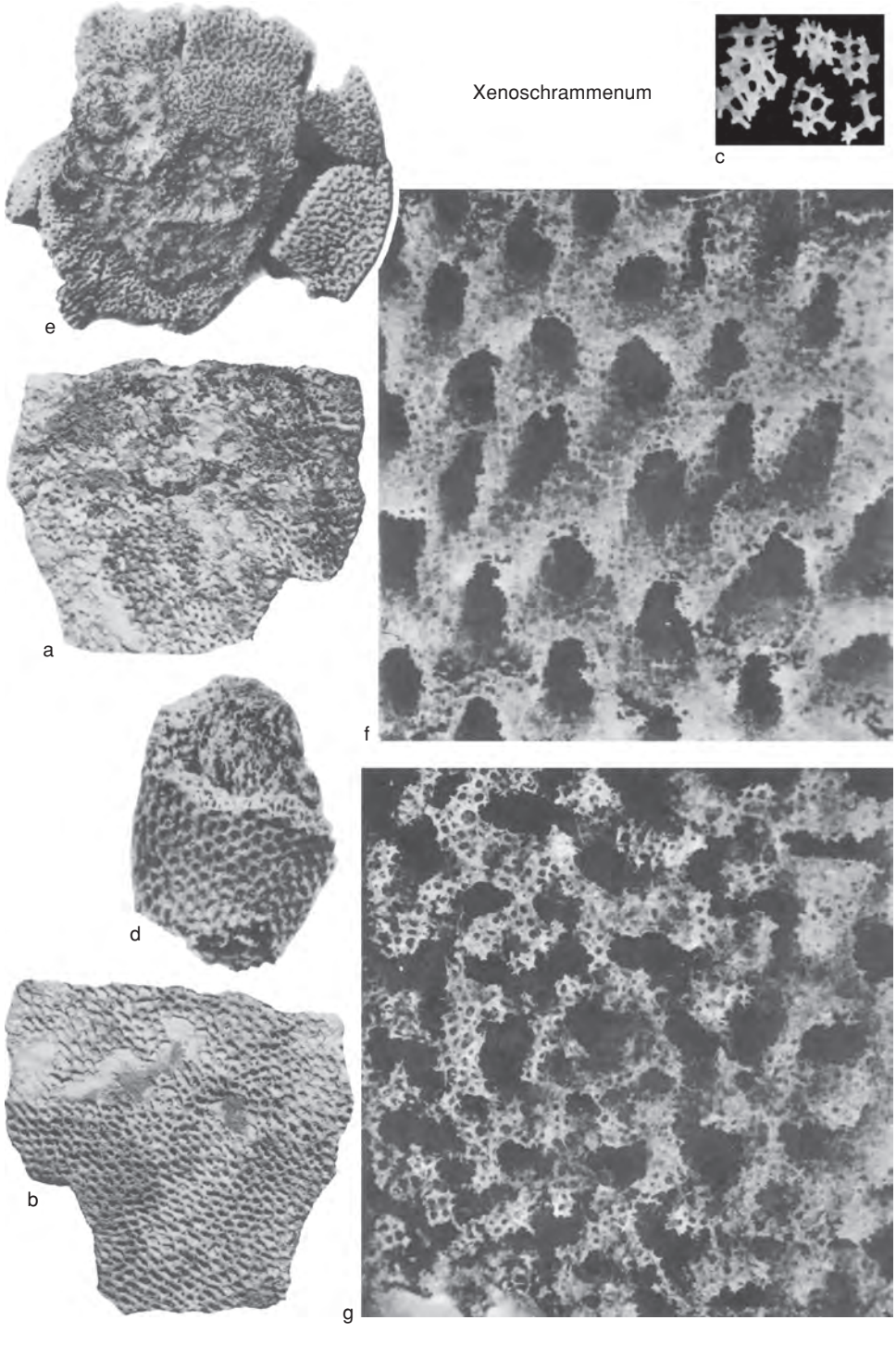


FIG. 358. Sporadopylidae (p. 547–549).

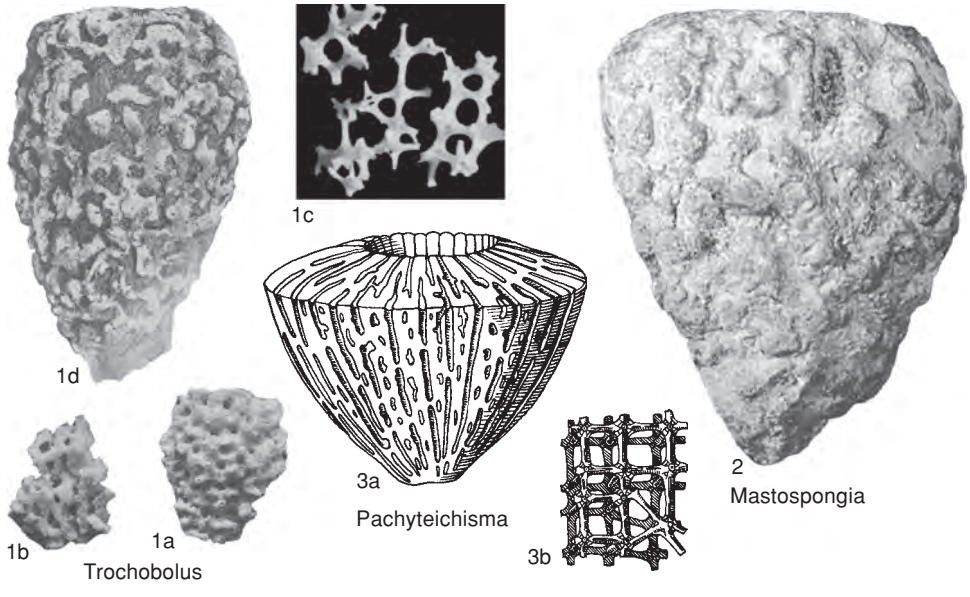


FIG. 359. Pachyteichismatidae (p. 549–550).

spinose ray elements; *g,* enlarged view of dermal surface with coarser, skeletal net that is jagged along pore margins, ×10 (Lagneau-Hérenger, 1962).

Family PACHYTEICHISMATIDAE Schrammen, 1937

[*nom. transl.* LAGNEAU-HÉRENGER, 1962, p. 85, *ex* Pachyteichismatinae SCHRAMMEN, 1937, p. 3]

Lychniscosa with three-dimensional, skeletal meshwork; intradictyonal, skeletal canals vary from separate or intercommunicating, longitudinal clefts to continuously labyrinthine passages that open through both skeletal surfaces; external surfaces and walls of canals may show further small, skeletal pores that lead into underlying meshes of skeletal framework; superficial outgrowths and basal skeleton formed from dictyonal hexactines when present. [Skeletal canals of this family were interpreted as cavaedia by SCHRAMMEN (1937, p. 3), who believed them to be formed by radial to labyrinthine convolution of the wall. They interrupt the skeleton in the manner of intradictyonal canals, however, and are broadly comparable with those of Sporadopylidae. The canals are especially large in some species but not larger than intradictyonal schizorhyses of some Tretodictyidae (Hexactinosa).] *Upper Jurassic–Lower Cretaceous.*

Pachyteichisma ZITTEL, 1877b, p. 49 [**P. carteri* ZITTEL, 1877b, p. 50; SD DE LAUBENFELS, 1955, p. 87] [=*Lancispongia* QUENSTEDT, 1877 in 1877–1878, p. 92 (type, *L. lopas* QUENSTEDT, 1877 in 1877–1878, p. 95, SD REID, herein]. Top shaped with narrow paragaster to funnel-like, thick walled; skeletal canals radial in outer part of wall, become labyrinthine on gastral side; apertures of dermal side in longitudinal series, ovate to cleftlike; between open features may be further blind, radial canals, only open if surface is eroded; apertures of gastral side rounded or shaped irregularly, in longitudinal series or without order, sometimes in longitudinal furrows when arranged serially; skeletal meshwork very regular internally, but forming an irregular trellis work at surfaces; apertures of dermal side sometimes bridged by secondary outgrowths. *Upper Jurassic–Lower Cretaceous:* Europe; Switzerland, Germany, *Kimmeridgian;* France, *Valanginian– Albian.*——FIG. 359,*3a–b.* **P. carteri,* Upper Jurassic, Kimmeridgian, Germany; *a,* side view of thick-walled, top-shaped sponge with alternating epirhyses and aporhyses, ×0.5; *b,* part of lychniscoid skeleton, ×10 (de Laubenfels, 1955).

Mastospongia QUENSTEDT, 1877 in 1877–1878, p. 146 [**M. coniformis* QUENSTEDT, 1877 in 1877–1878, p. 152; SD DE LAUBENFELS, 1955, p. 106]. Top shaped with normal or reduced paragaster, thick walled; skeletal canals as in *Trochobolus* ZITTEL and *Pachyrhachis* SCHRAMMEN, but dermal side has perforated, conical or cylindrical outgrowths. [Comprises a form placed formerly into

Phlyctaenium ZITTEL, but the type of that genus (*Mastospongia cylindrata* QUENSTEDT, 1877 in 1877–1878, p. 172; SD DE LAUBENFELS, 1955, p. 89) is thought to be a *Verrucocoelia* (KOLB, 1910 in 1910–1911, p. 203; SCHRAMMEN, 1937, p. 7–8).] *Upper Jurassic–Lower Cretaceous:* Germany.——FIG. 359,*2. *M. coniformis,* Kimmeridgian marls, Upper Jurassic, Bärenthal; side view of top-shaped sponge with low, tubular outgrowths, ZPAL Pf. VIII/218, ×1 (Pisera, 1997; courtesy of *Palaeontologica Polonica*).

Trochobolus ZITTEL, 1877b, p. 50 [**T. crassicosta;* SD DE LAUBENFELS, 1955, p. 87] [=*Pachyrhachis* SCHRAMMEN, 1937, p. 5 (type, *P. labyrinthica* SCHRAMMEN, 1937, p. 7, SD DE LAUBENFELS, 1955, p. 87)]. Cylindrical or top shaped with narrow paragaster, or expanded into funnel or stalked, bowl shapes; skeletal canals labyrinthine; dermal side with apertures arranged alternately, without order, or in reticulating, diagonal or partly longitudinal furrows, between which surface forms ridges or tubercular prominences; apertures of gastral side alternating or without order; skeleton as in *Pachyteichisma* ZITTEL. [*Pachyrhachis* used by SCHRAMMEN (1937, p. 5) for thick-walled forms with large, labyrinthine canals, some of which lack superficial furrowing of the dermal side; but furrowing is present in the type designated by DE LAUBENFELS (1955, p. 87); ENGESER and MEHL (1993, p. 190) concluded that *Trochobolus* may be a younger, subjective synonym of *Cyathoplocia* POMEL, 1872, because ZITTEL (1877b) placed *Scyphia texata* GOLDFUSS, 1826, the type species of the latter genus, in *Trochobolus.*] *Upper Jurassic–Lower Cretaceous:* Europe; France, Switzerland, Germany, Poland, Spain, *Kimmeridgian;* France, *Albian.*——FIG. 359,*1a–c. T. texta* SCHRAMMEN, Weiss Jura, Upper Jurassic, Streitberg, Germany; *a,* side view of small, top-shaped sponge with relatively coarse, irregular inhalant ostia, ×2; *b,* view of gastral surface of small fragment with irregularly spaced exhalant ostia and texture essentially similar to that of dermal surface, ×2; *c,* enlarged parts of reticulate, skeletal net, ×20 (Schrammen, 1936). ——FIG. 359,*1d. T. labyrinthica* SCHRAMMEN, Weiss Jura, Upper Jurassic, Gerstetten, Germany; side view of somewhat coarser species with light matrix filling canals and darker areas with skeletal net preserved, ×0.5 (Schrammen, 1937).

Family CYPELLIIDAE Schrammen, 1937

[*nom. correct.* DE LAUBENFELS, 1955, p. 90, *pro* family Cypelliadae SCHRAMMEN, 1937, p. 10]

Lychniscosa with three-dimensional, dictyonal meshwork, with simple to labyrinthine skeletal canals that open through both surfaces of dictyonal framework; dermal pentactines attached to dermal and marginal surfaces more or less isolated, or numerous and united to form dense, superficial meshwork that covers skeletal pores of dictyonal framework; apertures of skeletal canals without order, or in longitudinal or rough, transverse rows on gastral side; dictyonal meshwork mainly irregular, with more or less extensive development of porous, siliceous lamella in some meshes. [The dermalia were called stauractines by SCHRAMMEN (1937, p. 10) but are pentactines in material studied in preparation for this volume. The spicules were previously described as pentactines by ZITTEL (1877b, p. 53) in defining the family type *Cypellia* POMEL, 1872 (p. 76). Dermal and marginal surfaces are typically continuous so that no distinction can be made between dermalia and marginalia.] *Jurassic.*

Cypellia POMEL, 1872, p. 76 [**Scyphia rugosa* GOLDFUSS, 1826, p. 9; OD] [=*Phanerochiderma* SCHRAMMEN, 1937, p. 11, obj.; *Cryptochiderma* SCHRAMMEN, 1937, p. 14 (type, *Scyphia inberbis* QUENSTEDT, 1877 in 1877–1878, p. 125, OD)]. Cylindrical to top shaped with deep, narrow, paragastral cavity, or expanded into funnel or bowl shaped; apertures of skeletal canals arranged without order, or in longitudinal or rough, transverse rows on gastral side; superficial meshwork well developed in fully grown examples; pentactines in single, paratangential layer or numerous and overlapping, united by cementation only, or by branching, siliceous filaments that may thicken into more or less continuous, siliceous lamella in parts. *Upper Jurassic:* Europe.——FIG. 360,*2a–c. *C. rugosa* (GOLDFUSS), Weiss Jura, Streitberg, Germany; *a,* nearly complete individual showing growth form of sponge, ×1; *b,* small individual with superficial meshwork locally lamellar, ×4 (Schrammen, 1937); *c,* dermalia in reticular net, ×10 (Schrammen, 1936).

Paracypellia REID, *nom. nov.* herein (SCHRAMMEN, 1936, p. 179, *nom. nud.;* SCHRAMMEN, 1937, p. 13, *nom. nud.*) [**Cypellia prolifera* ZITTEL, 1878d, p. 61; OD; =*Nexispongia libera* QUENSTEDT, 1878 in 1877–1878, p. 162, *nom. oblit.* under *Code* Art. 23.2 (ICZN, 1999)]. Colonial, with clusters of cylindrical individuals arising from a common base or branching stock; superficial meshwork typically dense, with parts forming more or less continuous, siliceous lamella or scales in which spicules are imbedded; other characters as for *Cypellia* POMEL, 1872. *Upper Jurassic:* Germany, Poland.——FIG. 360,*1a. *P. prolifera* (ZITTEL), Weiss Jura, Streitburg, Germany; spicular structure of outer, superficial scales, ×10 (Schrammen, 1936).—— FIG. 360,*1b–c. *P. prolifera* [as *Nexispongia libera* QUENSTEDT], Weiss Jura, Upper Jurassic, Heuberg, Germany; *b,* branched colony showing growth form with basal, central stalk, from below; *c,* branched

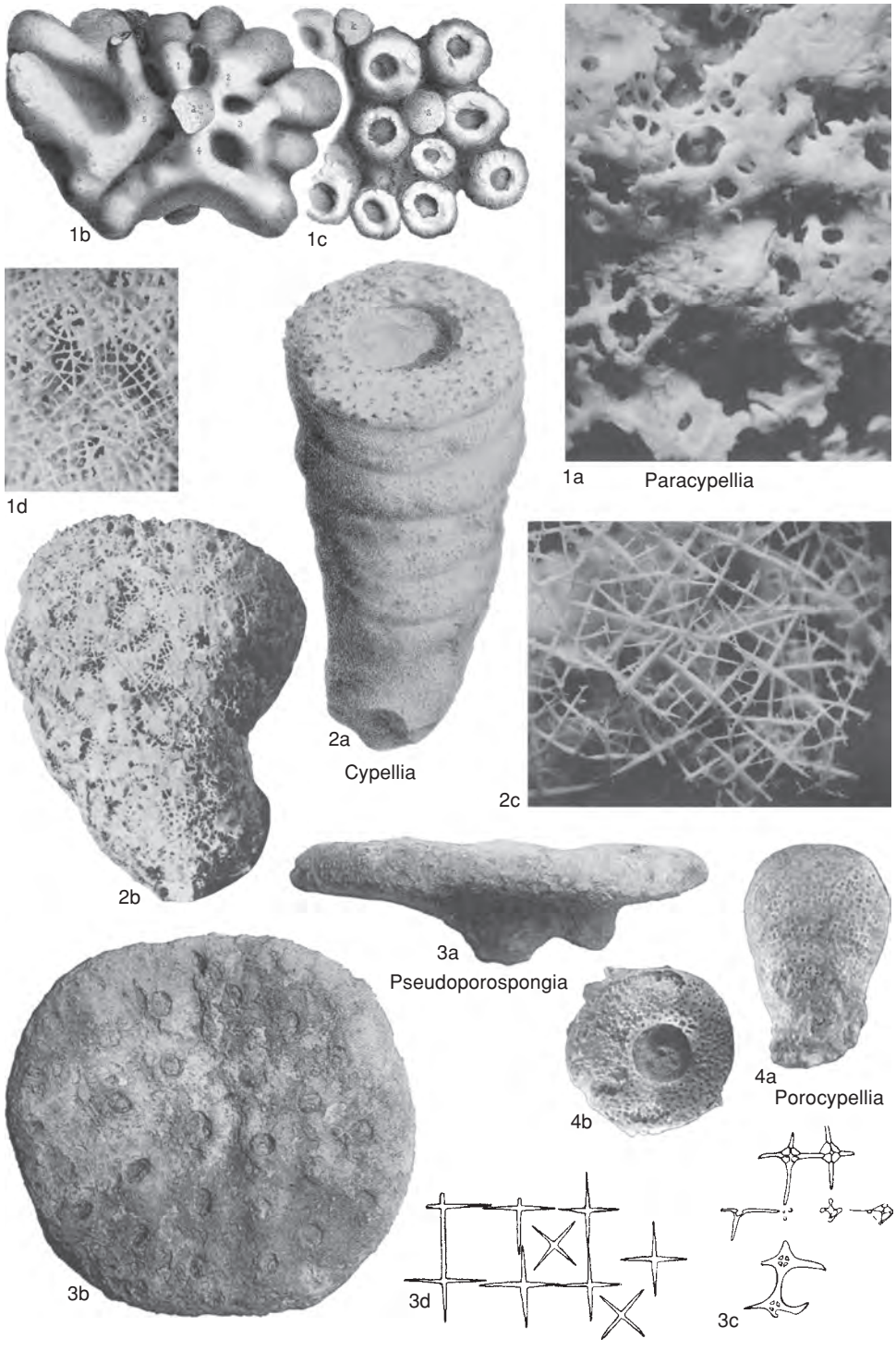


FIG. 360. Cypelliidae (p. 550–552).

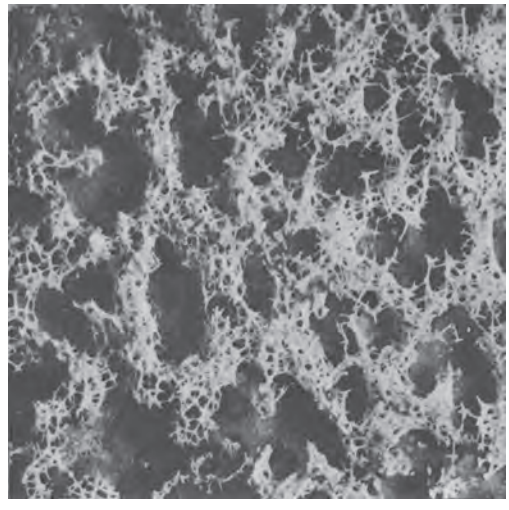


FIG. 361. Cypelliidae (p. 552).

colony from above, ×0.5 (Quenstedt, 1877–1878).——FIG. 360,*1d. P. minor* SCHRAMMEN, Weiss Jura, Upper Jurassic, Streitberg, Germany; dermalia, in part over inhalant ostia, ×5 (Schrammen, 1936).

Porocypellia POMEL, 1872, p. 77 [**Scyphia pyriformis* GOLDFUSS, 1826, p. 10; OD]. Small, hemispherical to club-shaped sponges with single osculum in summit; skeleton lychniscoid with small, octahedral nodes, thickened dermal layer developed; skeleton pierced by numerous, irregularly placed, circular pores. [Included in the family with some question.] *Jurassic:* Germany.——FIG. 360,*4a–b. *P. pyriformis* (GOLDFUSS), Kimmeridgian limestone, Upper Jurassic, Genkingen; *a,* side view of small, club-shaped sponge with uniform, dermal layer, ZPAL Pf. VIII/260, ×2; *b,* oscular view of same specimen with deep, central spongocoel, ×2 (Pisera, 1997; courtesy of *Palaeontologica Polonica*).

Pseudoporospongia HÉRENGER, 1942, p. 155 [**P. tarraconensis;* OD]. Sponge broadly obconical with flattened, undulating, discoidal upper part, above a distinct stalk; upper surface with ovate oscula 4 to 5 mm in diameter, with slightly elevated rims and separated 1 to 1.5 cm in somewhat irregular, concentric circles around a larger, central opening; principal skeleton lychniscose of small spicules with perforated nodes, dermal layer of reticulated stauractines and other irregularly oriented stauractines. *Middle Jurassic (Callovian):* Spain (Catalonia).——FIG. 360,*3a–d. *P. tarraconensis,* Terracuques de Llebra Rasquera, northeastern Spain, *a,* side view of typical specimen showing upper discoidal part and lower stalk, slightly reduced; *b,* view of upper surface with characteristic ovate oscula arranged in somewhat concentric circles, slightly reduced; *c,* drawing of lychniscoid spicular elements of main skeleton, scale unknown; *d,* drawing of dermal net of stauractines, scale unknown (Hérenger, 1942).

Sporadopyge SCHRAMMEN, 1937, p. 16 (SCHRAMMEN, 1936, p. 180, *nom. nud.*) [**S. speciosa;* M]. Broadly funnel-like to discoidal; exterior with closely spaced, small, skeletal pores, arranged without order; gastral side with larger pores spaced more widely; no continuous superficial meshwork, although dermal pentactines occur fused to surface of skeletal framework. *Upper Jurassic:* Germany, Poland.——FIG. 361. **S. speciosa,* Weiss Jura, Streitberg, Germany; outer surface of dictyonal skeleton with large, inhalant ostia and small, skeletal pores, ×5 (Schrammen, 1936).

Family UNCERTAIN

Cavispongia QUENSTEDT, 1877 in 1877–1878, p. 153 [**Spongites cylindrata* QUENSTEDT, 1843, p. 418; SD DE LAUBENFELS, 1955, p. 90]. Massive, large, irregularly obconical sponges without spongocoels but with numerous tightly packed, thin-walled tubes with oscular openings on upper, flat to slightly concave summit; lateral surfaces with irregular outgrowths separated by meandering furrows; skeleton regular with square meshes; may include coarse pentactines as part of dermal skeleton. [Fossils are chiefly casts; included by DE LAUBENFELS (1955) in the Cypellidae, were included in the Neoaulocystidae ZHURAVLEVA, 1962, by PISERA (1997)]. *Jurassic:* Germany.——FIG. 362,*1a–b. *C. cylindrata* (QUENSTEDT), Kimmeridgian marls and limestone, Upper Jurassic, Hettingen and Wilmandingen; *a,* side view of top-shaped sponge with irregular, deep furrows between outgrowths, ZPAL Pf. VIII/73, ×1; *b,* summit view with several isolated oscula,

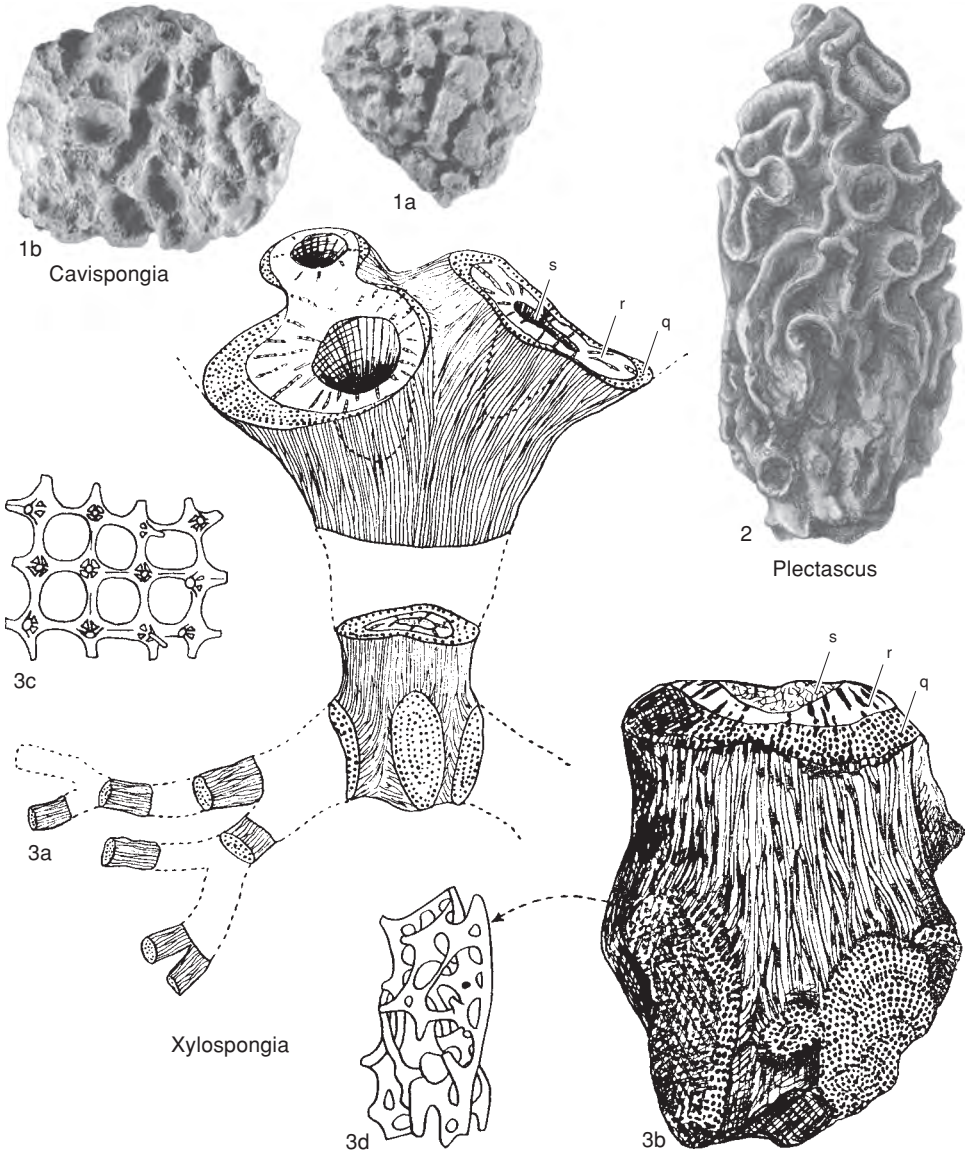


FIG. 362. Uncertain (p. 552–555).

ZPAL Pf. VIII/262, ×1.5 (Pisera, 1997; courtesy of *Palaeontologica Polonica*).

Plectascus SCHRAMMEN, 1912, p. 307 [**Dendrospongia clathrata* F. A. ROEMER, 1864, p. 20; OD] [=*Dendrospongia* F. A. ROEMER, 1864, p. 20, SD DE LAUBENFELS, 1955, p. 102, *nom. oblit.; Code* Art. 23.2 (ICZN, 1999)]. Branching and anastomosing tubes; surfaces with quadrately arranged ostia or postica that are in longitudinal furrows on dermal side; further details unknown. [Lychniscosan *teste* SCHRAMMEN (1912) but resembles some craticulariid Hexactinosa.] *Cretaceous (Cenomanian–Turonian):* Germany, England.——FIG. 362,*2. P. labrosus* (SMITH), Upper Greensand, Cenomanian, Folkestone, England; side view of characteristic sponge with folded wall, ×0.5 (Hinde, 1884a).

Sclerokalia HINDE, 1884a, p. 145 [**S. cunningtoni;* M]. Cup shaped, very thick walled, supposedly unattached; dermal side without canalar features; gastral side with vertical rows of postica of skeletal canals

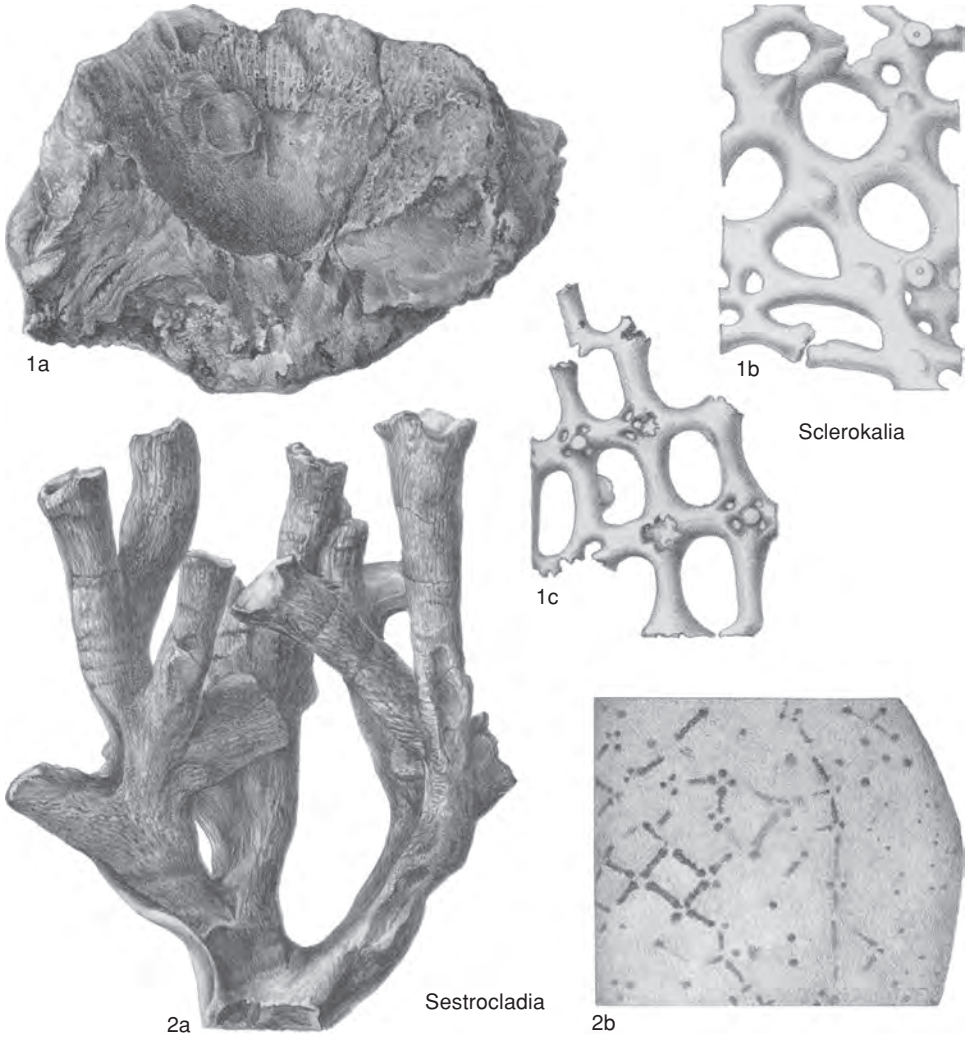


FIG. 363. Uncertain (p. 553–554).

that appear to be shallow; skeletal meshwork regular internally, with nodal octahedra; outer meshwork irregular, without octahedra, and with thick, porous lamella developed at gastral surface. [Based on one imperfect example; possibly a pachyteichismatid with incomplete canalization.] *Cretaceous (Albian):* England.——FIG. 363,*1a–c. *S. cunningtoni,* Upper Greensand, Warminster, Wiltshire; *a,* side view across broken, thick wall of funnel-shaped sponge with rows of exhalant ostia on gastral surface, ×0.5; *b,* drawing of enlarged, dermal, skeletal net; *c,* drawing of enlarged, spicular mesh immediately interior to dermal layer showing octahedral nodes, ×25 (Hinde, 1884a).

Sestrocladia HINDE, 1884a, p. 117 [**S. furcatus;* M]. Branched, tubular, dermal, skeletal surface with ovate ostia in vague, longitudinal furrows; other details unknown. [Supposedly ventriculitid (HINDE, 1884a, p. 117) or polyblastidiid (DE LAUBENFELS, 1955, p. 89, as coeloscyphiid).] *Cretaceous (Cenomanian):* England.——FIG. 363,*2a–b. *S. furcatus,* Grey Chalk, Dover; *a,* side view of branched, tubular sponge with dermal ostia in discontinuous, longitudinal furrows, ×0.5; *b,* drawing of enlarged skeletal structure with octahedral nodes in calcareous replacement, ×25 (Hinde, 1884a).

Xylospongia HÉRENGER, 1942, p. 176 [**X. tarraconensis;* OD]. Large, steeply obconical sponge with

branched, rootlike base, and with upper part where shallow, oscular depressions mark limited branching; upper part of wall layered, with dermal part vertically fibrous and with more or less parallel, longitudinal canals; principal, inner, skeletal layer with regular, lychniscoid structure with perforated nodes and with canals relatively rare and alternating, more or less radial, inhalant and exhalant openings; gastral layer of anastomosing, irregular fibers that are somewhat coarser than dermal layer and with finer, longitudinal canals; rootlike basal parts composed mainly of outer, fibrous layer. *Upper Cretaceous (Coniacian–Maastrichtian):* Spain.——Fig. 362,*3a–d. *X. tarraconensis,* Valldarques Lleida, Catalonia, northeastern Spain; *a,* drawing of reconstruction showing growth form and layered, skeletal structure with outer, longitudinally fibrous part (*q*), and principal skeleton (*r*) around shallow, oscular, summit depressions (*s*), approximately ×0.5; *b,* fragment showing layered, skeletal structure, with outer, vertically fibrous, dermal layer (*q*), inner, regular, lychniscoid, skeletal layer (*r*), and (*s*) irregular, fibrous, gastral layer, approximately natural size; *c,* regular, lychniscoid structure of principal, skeletal layer, magnification unknown; *d,* irregular, skeletal structure of outer, fibrous layer, magnification unknown (Hérenger, 1942).

Order UNCERTAIN

Acanothyia Pomel, 1872, p. 68 [**Camerospongia polydactyla* Roemer, 1864, p. 5; SD de Laubenfels, 1955, p. 94] [=*Acanothyra* de Laubenfels, 1955, p. 94, *nom. null.*].*Cretaceous (Cenomanian):* Germany.

Antrispongia Quenstedt, 1877 in 1877–1878, p. 413 [**A. dilabyrinthica;* SD de Laubenfels, 1955, p. 94]. The genus might might be included in either the Euretidae or Calypterellidae. *Lower Cretaceous:* England.

Baccispongia Quenstedt, 1877 in 1877–1878, p. 314 [**B. baccata;* SD de Laubenfels, 1955, p. 94]. Cup shaped, lumpy. *Jurassic:* Germany.

Bothroconis King, 1850, p. 14 [**B. plana;* OD]. Vaselike to flat, creeping sponges with flaring rim; skeletal structure unknown. *Permian:* England.

Crucispongia Quenstedt, 1877 in 1877–1878, p. 164 [**C. annulata* Quenstedt, 1877 in 1877–1878, p. 165; SD de Laubenfels, 1955, p. 94]. Annulate cup. *Jurassic:* Germany.

Diplopleuriana Reid, herein, *nom. nov. pro Diplopleura* Regnard, 1926, p. 485, *non* Stimpson, 1857 [**Diplopleura hatoni* Regnard, 1926, p. 485; OD]. Irregular, flattened sponge with short stalk; exterior with numerous irregularly distributed, fine pores; interior surface lacking pores and exhalant canals; skeleton regular lychniscoid. *Cretaceous (Cenomanian):* France.

Farreopsis Schrammen, 1924a, p. 29 [**F. diffusa;* OD]. Large, thin-walled sponge of broad, irregularly anastomosing tubes; canal system poorly developed; skeletal structure of fused, cubic meshes; outer, free radial rays of dermal and gastral hexactines long and conical. *Upper Cretaceous:* Germany.

Hodsia Moiseev, 1944, p. 19 (Moiseev, 1939, p. 816, *nom. nud.*) [**H. caucasia;* OD]. Cylindrical sponges with narrow, axial spongocoel; thick walls formed of branched, upwardly and outwardly divergent, angular to rounded tracts that roughly parallel coarse canals; these tracts irregularly cross connected with finer tracts and both are interrupted by canals or connecting pores; spicule structure unknown. [The name was proposed by Moiseev (1939, p. 816) but no description was given until the genus and species were described by Moiseev in 1944.] *Triassic (Norian–Rhaetian):* Russia (Caucasus region).——Fig. 364,*1a–b. *H. caucasia,* Norian–Rhaetian sediments, Hosdia Valley; *a,* transverse section showing thick walls around small, axial spongocoel, with divergent and cross-connecting tracts interrupted by somewhat coarser canals, tracts thickened in dermal and gastral regions, ×4; *b,* diagonal section showing upwardly divergent and moderately uniform, skeletal structure, ×4 (Moiseev, 1944).

Lonsda de Laubenfels, 1955, p. 94, *nom. nov. pro Conis* Lonsdale, 1849, p. 63, *non* Brandt, 1835 [**Conis contortuplicata* Lonsdale, 1835, p. 63; OD]. Many-ridged mass. [de Laubenfels, 1955, p. 86, also proposed *Lonsda* as a new name for *Gonis,* a misspelling of *Conis.*] *Cretaceous:* England.

?Pachylepisma Schrammen, 1902, p. 14 [**P. robusta;* M] [?=*Leiostracosia* Schrammen, 1902, p. 12 (type, *L. punctata,* OD)]. Barrel-shaped to funnel-shaped sponges with broad stem; thick wall around broad spongocoel; exterior marked with numerous irregularly distributed ostia of blind, inhalant canals that alternate in interior with large, exhalant canals; skeleton lychniscoid with common, short spines and exterior with broadened, tangential rays. *Upper Cretaceous:* Germany.——Fig. 364,*2. *P. robusta,* Quadratenkreide, Misburg; side view of holotype showing barrel-shaped form and rough exterior with round, irregularly distributed, exhalant ostia, ×0.5 (Schrammen, 1902).

Pinnatispongia Dong & Knoll, 1966, p. 177 [**P. bengtsoni;* OD]. Isolated pentactines with principal, curved ray and four small, propeller-like, lateral rays that diverge nearly normal to central ray at its summit; central ray longer and much thicker and ornamented with three or four rows of nearly parallel barbs that lend featherlike appearance to spicules. *Cambrian (Furongian):* China.——Fig. 364,*3. *P. bengtsoni,* Bitiao Formation, middle upper Cambrian, Huayuan, Hunan; side view of type spicule, ×60 (Dong & Knoll, 1996).

Rugosoderma Howell, 1957b, p. 6 [**R. texasense;* OD]. Sponge with numerous thin-walled branches that have small, horizontal, dermal ridges and vertical lines of pits on gastral surface; skeleton reported to be similar to *Coeloscyphia,* with small knobs at spicule centers. *Lower Cretaceous:* USA (Texas).——Fig. 364,*4. *R. texasense,* Fort Worth

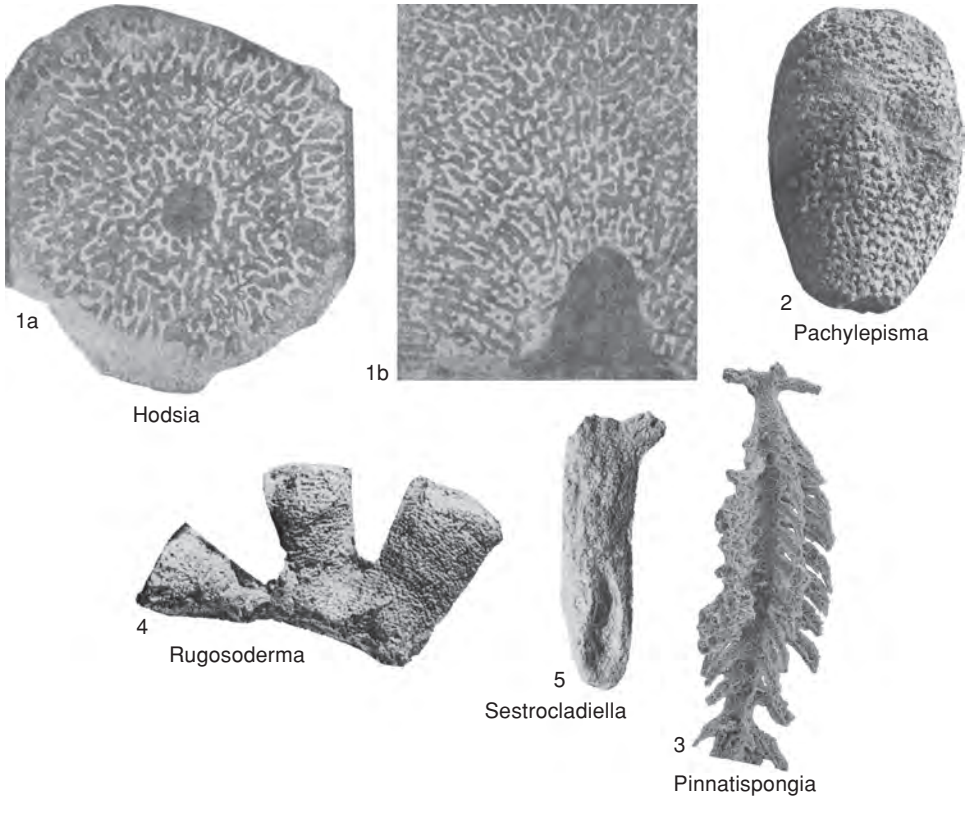


FIG. 364. Uncertain (p. 555–556).

Formation, near Blum, Hill County; side view of holotype showing rough, dermal surface and branching habit, PU 76286, ×1 (Howell, 1957b).

Sestrocladiella HOWELL, 1957b, p. 5 [**S. bifurca;* OD]. Small, moderately thick-walled sponge as columnar individual that branches in uppermost part; dermal surface indented with irregularly spaced, round pits separated by rounded ridges; pits extending through wall as canals, at least locally; skeleton reported to be similar to that in *Ceoloscyphia,* with small knobs at spicule centers. *Lower Cretaceous:* USA (Texas). ——FIG. 364,*5.* **S. bifurca,* Fort Worth Formation, near Blum, Hill County; side view of holotype showing pitted, dermal surface and small, upper branch of generally columnar form, with diagonal section of broad spongocoel near base, PU 76284, ×1 (Howell, 1957b).

Spongus MANTELL, 1822, p. 164 [**S. townsendi;* SD DE LAUBENFELS, 1955, p. 94]. Cup shaped. *Cretaceous:* England.

HETERACTINIDA

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Class HETERACTINIDA de Laubenfels, 1955

[Heteractinida DE LAUBENFELS, 1955, p. 93]

Sponges in which the spicules, probably originally calcitic, have a hexagonal symmetry, or are derivable therefrom by addition or suppression of rays. *Lower Cambrian–Permian (Cisuralian).*

MORPHOLOGY AND PHYLOGENY

The Heteractinida is a minor class of sponges and has only a Paleozoic record. Most characteristic forms have spicules with six rays in one plane, to which are added in later forms a long, proximal ray and sometimes a short distal ray. Such spicules are most commonly and best preserved as calcite, which would seem thus to be their original substance. Their rays are characteristically thick, and suturing between rays and a central disk appears to be absent. Except in Cambrian members and related genera of eiffeliids, the heteractinid sponges have thick body walls consisting of closely packed spicules whose six coplanar rays are subparallel to the outer surface of the sponge. The eiffeliids and several other pre-Carboniferous genera lack skeletal canals as the fossils are now preserved, and their surfaces lack skeletal pores other than interspicular spaces.

Astraeospongium ROEMER, 1852, is the best-known and perhaps most typical member of the class. The mid-Silurian type species, *A. meniscus* (ROEMER, 1848), has spicules that lack mostly or entirely any proximal and distal rays. Similar concavo-convex, obconical, or discoidal Devonian sponges, also assigned to *Astraeospongium,* have spicules with a higher proportion of proximal and distal rays.

A globose Silurian species with stronger proximal rays is known, and the Ordovician genera *Constellatospongia* RIGBY, 1977b, and *Asteriospongia* RIGBY, 1977a, also have spicules with strong, proximal and distal rays. The Silurian *Astraeospongium* may have been ancestral to the Silurian and Devonian *Ensiferites* REIMANN, 1945b, which is also globose to discoidal. *Ensiferites* has spicules in which the proximal ray is very long and stout and the six paratangential rays are relatively short. A consistent feature of these Siluro-Devonian species is the greater stoutness of spicules on upper surfaces compared with those on lower surfaces or in the interior.

VANDERCAMMEN (1950) described a sponge from the Early Carboniferous (Tournaisian) of Belgium that he assigned to *Asteractinella* HINDE, 1888, a genus originally described by HINDE from isolated, siliceous or silicified spicules from the Visean of Scotland. VANDERCAMMEN's sponge has the form of a thick-walled, plicated obcone, easily derivable from the form of *Astraeospongium.* Its spicules include some with six paratangential rays and a long proximal ray; others of the same umbrella-like shape with more than six paratangential rays, often with tuberculate distal surfaces; and large, stout-rayed oxyasters, with multiple rays radiating from a common center.

Regispongia RIGBY, 1978, has a very similar complement of spicules. It first appeared in the Chesterian (Late Mississippian) and persisted into the lower Permian rocks. It is conicocylindrical with a central cloaca, but large specimens may be externally subplicate, recalling VANDERCAMMEN's sponge in a subdued way. The related *Wewokella* GIRTY, 1912, also possesses tetraradiates, that is, spicules with three coplanar rays and a proximal ray. Such spicules may be regarded as reduced versions of the spicules with six coplanar rays. Other six-rayed spicules have a

rosette of spines at the center of the distal surface, again easy to derive from the Early Carboniferous species. There seems to be little doubt that VANDERCAMMEN's sponge is related to *Wewokella.*

Although these Carboniferous genera differ from *Astraeospongium* in having multiple spicule rays, the general form of the skeletal net, the stoutness of the spicule rays, and their calcitic composition accords with the earlier genus. These Permo-Carboniferous species possess radial, inhalant and exhalant skeletal canals, although they are not always well developed in many individuals. The Devonian *Stellarispongia* RIGBY, 1976a, possesses strongly developed skeletal canals within a spicular context like that of *Astraeospongium.* It is quite possible that *Stellarispongia* is the connecting link between *Astraeospongium* and VANDERCAMMEN's *Asteractinella.* It is already more strongly cup shaped than *Astraeospongium* but lacks the plicate outline of the Carboniferous form.

Tracing the *Astraeospongium* lineage back before the Silurian, we find two mid-Ordovician genera, *Astraeoconus* RIETSCHEL, 1968, and *Toquimiella* RIGBY, 1967a. *Astraeoconus* is much thinner walled than *Astraeospongium* and has a definite cloaca. Its spiculation is entirely of regular sexiradiates with six coplanar rays parallel to the sponge surface, and the body wall is several spicule layers thick. *Toquimiella* is similar in general form but its sexiradiates are peculiar and also bilaterally symmetrical about a plane parallel to the longitudinal axis of the sponge, a feature that occurs also in some specimens of the Carboniferous *Wewokella.*

One predicts a Cambrian ancestor of this lineage to have a spiculation of sexiradiates and a very thin walled body. Such skeletons exist in *Jawonya* and *Wagima,* described by KRUSE (1987) from the Middle Cambrian of northern Australia, and in *Eiffelia* WALCOTT, 1920, of the Middle Cambrian Burgess Shale. Neither is a generalized ancestral forms, however, for all three have some advanced structures. *Eiffelia* has a skeleton of regularly oriented and placed, large spicules and similar smaller spicules in a complex skeleton. On the other hand, *Jawonya* and *Wagima* have skeletons of small, irregularly oriented and placed octactines and polyactines, as one would expect in an ancestral form for the *Astraeospongium* lineage, but both Australian Cambrian genera have pronounced, collarlike oscula; and *Wagima* has domed, sievelike screens over the inhalant ostia, as advanced-appearing features.

Two Lower Cambrian genera, *Kuraya* ROMANENKO, 1968, and *Blastasteria* DEBRENNE, TERMIER, & TERMIER, 1971, may be early representatives of the lineage. They are characterized by spicules in which the six tangential rays are reflexed at a 45° angle toward the sponge body, a feature that occurs locally also in the late Paleozoic *Wewokella, Asteractinella,* and *Tholiasterella.* Otherwise they are globose, thin-walled forms like *Eiffelia.* The spicules of *Blastasteria* possess proximal rays, which may be present possibly in *Eiffelia* but which have not been demonstrated unequivocally. A possible conservative survivor of this early, thin-walled group (RIGBY, 1991a) is the Pennsylvanian *Zangerlispongia* RIGBY & NITECKI, 1975, with a spiculation of tuberculate sexiradiates.

The peculiar spongelike genus *Chancelloria* WALCOTT, 1920, occurs with *Eiffelia* in the Burgess Shale and has a worldwide distribution in rocks of Early and Middle Cambrian age. It and such related forms as *Archiasterella* SDZUY, 1969, *Allonia* DORÉ & REID, 1965, and *Nabaviella* MOSTLER & MOSLEH-YAZDI, 1976, and, with some question, *Uranosphaera* BEDFORD & BEDFORD, 1934, have been considered to be heteractinid sponges by these workers and others (RIGBY & NITECKI, 1975). Chancelloriids were interpreted to be the stem group of all sponges by SDZUY (1969). The chancelloriids are now considered not to be sponges, however, but Coeloscleritophora with an armor of spiny sclerites (BENGTSON, 1990b, p. 45).

An additional group of fossils that have been considered to be possible heteractinid sponges include four genera from the Lower Cambrian of Australia, Siberia, and Morocco. The four genera, associated with archaeocyathids, form a morphological

series: *Uranosphaera* Bedford & Bedford, 1934, *Gonamispongia* Korshunov, 1968, *Girphanovella* Zhuravleva, 1967, and *Radiocyathus* Okulitch, 1937. *Uranosphaera* consists of an external layer of starlike spicules with about twelve reflexed, often branching, tangential rays, that may fuse with those of neighboring spicules. *Gonamispongia* is very similar, except that all the spicules are fused into a rigid mesh and a proximal ray extends inwardly from the center of each spicule. *Girphanovella* has an additional inner cloacal lining of similar spicules connected to the outer layer by the proximal rays. Finally, *Radiocyathus* has both layers coated with a continuous, perforate, calcareous sheet. It is tempting to see in this series the progressive calcification of a system of soft parts (perhaps as much ontogenetic as phylogenetic). Whether these spheroidal to conical objects had the hollow interior filled with a soft thallus, in the manner of the receptaculitids, surrounded by a variably calcified fuzz of branches, or whether they are related to the archaeocyathids, with some kind of pre-metazoan tissue in the intervallum, cannot be settled here. Debrenne, Termier, and Termier (1971) were the first to call attention to the relationship between these four genera and proposed a classification for them, placing them with *Kuraya* and *Blastasteria* in the proposed class Radiocyatha. These authors considered the radiocyathids to be more primitive than true sponges, possibly similar to protozoans that may have been ancestral to some metazoans. Nitecki and Debrenne (1979) concluded that the radiocyathids may be more closely related to receptaculitids than to archaeocyathids. Inasmuch as they were not included in the 1972 revision of the Archaeocyatha part of *Treatise Part E* (Teichert, 1972) (except *Radiocyathus*), it seems appropriate to treat them here, although their status as Porifera is doubtful.

Kuraya and *Blastasteria,* discussed earlier as relatives of *Eiffelia,* co-occur with the four Lower Cambrian genera of the *Uranosphaera-Radiocyathus* group. It is not beyond belief that they are all related, as Debrenne, Termier, and Termier (1971) and Nitecki and Debrenne (1979) stated. Nevertheless, *Karaya* and *Blastasteria* have symmetrical, unbranched, six-rayed spicules, like those of normal heteractinids, and are therefore treated as such here.

Finally, it should be pointed out that *Leptopoterion* Ulrich, 1889, and *Anomaloides* Ulrich, 1878, are probably algae related to the receptaculitids (see Rauff, 1892; Rietschel, 1968a).

As interpreted here, the true heteractinid sponges constitute branched lineages of *Eiffelia-Zangerlispongia,* and *Astraeospongium* and its relatives. The Lower Cambrian *Kuraya* and *Blastasteria* are the earliest known representatives. Thicknesses of their tangential rays suggests that they may have led directly to *Astraeospongium* itself, with the slender-rayed *Eiffelia* as a Cambrian offshoot. We do not know, however, how much iterative evolution has taken place in the heteractinids, and the suggestion is supported chiefly by parsimony. *Eiffelia* may have given rise to the similarly slender-rayed Cambrian *Eiffelospongia,* Ordovician *Toquimiella,* and Pennsylvanian *Zangerlispongia.* In these sublineages there is a common trend from spheroidal to conical shape and the development of a thicker body wall. In *Astraeospongium* the interior hollow space was eliminated completely. Isolated Ordovician spicules have been assigned to *Astraeospongium,* but they could well have come from a related genus or genera with a different body form.

Ensiferites evolved as early as in the Silurian (sometimes misidentified in collections as *Anomaloides*) and diversified with several species in the Devonian (Reimann, 1945b; Rigby, 1979). It is distinguished by a spheroidal to discoidal shape and octactine-based spicules with very stout, proximal rays and six finer, tangential rays. It may represent a side branch of the lineage. *Ensiferites* may have additional rays on distal surfaces of the tangential rays or as supernumerary rays from tips of distal rays, which demonstrates that the potentiality for additional rays was already present in the Devonian.

Stellarispongia is a Devonian relative of *Astraeospongium* (which also persisted into the Devonian) that differs in having skeletal canals and in resembling a thick-walled cup rather than a thick saucer. In shape it is not far from the lowermost Carboniferous *Asteractinella* of VANDERCAMMEN (1950), which has added radial plications. In spiculation, however, this is the major break in the history of the heteractinids. All the post-Devonian genera have various polyactines along with sexiradiates and umbrella-shaped septiradiates of the earlier forms. It is possible that the fragmental type materials of *Tholiasteralla* and *Asteractinella* of HINDE (1887b, 1888) are not heteractinids but rather siliceous sponges (see REID, 1963b; FINKS, 1960).

There is not such doubt about the completely preserved *Asteractinella* of VANDERCAMMEN, however. The slightly later appearing *Regispongia* (late Mississippian to early Permian) and Pennsylvanian *Wewokella* could be envisaged easily to have evolved from VANDERCAMMEN's sponge. The cup shape becomes a tube; the new polyactines, as well as the older spicule types, are all retained; and a new simplification sets in, in that the tangential rays of many spicules are reduced to three, making them like the tetraradiates of the typical Calcarea. A tendency to fusion of the spicules by secondary calcite becomes more pronounced in the Permian (Cisuralian) *Talpaspongia,* which if it differs from *Wewokella* at all, does so in this and in a broader cloaca and somewhat finer spicules. The heteractinids die out with *Talpaspongia* in the Artinskian (Leonardian). There is a remote possibility that the Devonian *Protoleucon* BOLKHOVITINOVA, 1923, is related to *Wewokella;* this is based on its form and references to star-shaped bodies in its description. It would be worth examining the specimens (which we have not seen) with this in mind. The Pennsylvanian *Zangerlispongia* in its distal tuberculation suggests relationship to *Asteractinella* or *Tholiasterella,* but its thin-walled nature and well-organized skeletal net may indicate a descent from the *Eifellia-Toquimiella* stock.

CLASSIFICATION

Heteractinida DE LAUBENFELS, 1955, is used here as the name of the class. That name is distinct from Heteractinellidae HINDE, 1887b, both as a name (the stems differ: heteractin- vs. heteractinell-) and as a concept. DE LAUBENFELS (1955, p. 93) ascribed the name Heteractinida to HINDE, apparently in the belief that he was merely changing the ending. Both names are available for the class because the *Code* (ICZN, 1999) recognizes class and order level as a single group for the purposes of attribution of authorship but does not require priority. (Heteractinellidae was originally proposed as a suborder.) Differences in concepts of the groups are significant, however. The usage here conforms to that of DE LAUBENFELS's in including both the Octactinellidae and Heteractinellidae in the Heteractinida (as was done earlier by REID, 1963b, p. 234; RIGBY, 1983b, p. 73; 1986a, p. 56). The original Heteractinellidae of HINDE as a concept is equivalent to the family Wewokellidae of the present classification, although emended from HINDE's original definition. In addition to the polyactines that HINDE considered diagnostic, octactines and their derivatives are present in all the species preserved as whole individuals; and, indeed, those polyactines are probably octactine derivatives. Thus, the present classification assigns HINDE's original heteractinellid genera, *Asteractinella* and *Tholiasterella,* along with *Wewokella* and *Talpaspongia,* to HINDE's Octactinellida, which HINDE originally proposed as a separate and equal category. The order Wewokellida CRONEIS & TOOMEY, 1965, is equivalent to HINDE's suborder Heteractinellidae in its concept.

The Octactinellida are here interpreted as all those sponges centering about *Astraeospongium,* characterized by coarse-rayed spicules composed of radially fibrous calcite and derivable from the plan of an octactine. They are essentially the so-called true heteractinids. The other possible order dealt with here, the Hetaircyathida BEDFORD & BEDFORD, 1937, is not considered to be related to them at all.

The subgroup in which the spicules are primarily radially symmetrical, very coarse-rayed sexiradiates, or octactines with a long proximal and short, distal ray and in which the body wall consists of solidly and irregularly oriented and packed spicules are placed in the family Astraeospongiidae Miller, 1889. *Kuraya* and *Blastasteria* have relatively thin body walls but are placed here because of the coarseness and irregular orientation of their spicules. Stratigraphic occurrence of these early genera suggests that they may have been ancestral to the thinner-walled eiffeliids, with which they might also be placed on account of their thin wall, and are possibly also ancestral to the later astraeospongiids.

The thin-walled forms with symmetrically arranged, relatively slender-rayed spicules, that either lack proximal and distal rays or have them very weakly developed, are here assigned to the family Eiffeliidae Rigby, 1986a. They could have resulted from iterative evolution from more typical astraeospongiids, but their concentration in the Cambrian and Ordovician (except for *Zangerlispongia*) suggests they are a natural, early separated group.

The late Paleozoic Wewokellidae King, 1943, have spicules with more rays (polyactines) and fewer rays (tetraradiates) present alongside the earlier octactine types. They are also characterized by secondary calcareous overgrowth on the spicules and fusion of the skeletons in all but some of the early species. In addition to the octactines, the coarseness of their rays composed of radially fibrous calcite relates them to the typical astraeospongiids. Extra rays in some *Ensiferites* spicules, as well as skeletal canals in *Asteriospongia, Constellatospongia,* and *Stellarispongia,* show that the Ordovician to Devonian astraeospongiids were beginning to approach the morphology of the succeeding wewokellids of the Mississippian.

A dubious order of convenience included here is the group of genera connecting *Uranosphaera* with *Radiocyathus.* As discussed above these are probably neither heteractinids nor sponges. *Uranosphaera* was included by de Laubenfels (1955) in his family Asteractinellidae, equivalent to the Wewokellidae of the present work. *Radiocyathus* was included by Okulitch (1955) in the Archaeocyatha but was considered probably not a member by Hill (1972). Nevertheless the two genera are clearly related to one another through *Gonamispongia* and *Girphanovella,* and the group must be recognized somehow. Debrenne, Termier, and Termier (1971) proposed a classification of the group, modified only slightly by Nitecki and Debrenne (1979), and included within their class Radiocyatha the families Uranosphaeridae, to include the genera *Kuraya, Uranosphaera,* and *Gonamispongia,* Girphanovellidae, to include the genera *Blastasteria* and *Girphanovella,* and Radiocyathidae, to include *Radiocyathus.*

A slightly different classification for these problematic fossils is proposed here. The ordinal name Hetairacyathida Bedford & Bedford, 1937, and the family name Hetairacyathidae Bedford & Bedford, 1934, are available and valid for this group. (They were based on *Hetairacyathus* Bedford & Bedford, 1937, a junior synonym of *Radiocyathus.*) It is possible that *Kuraya* and *Blastasteria* belong here also, but a final judgment cannot be made without seeing all the specimens.

A classification of heteractinid sponges published by Rigby (1976b) differs from that used here by including *Eiffelia, Toquimiella,* and *Zangerlispongia* in the Chancelloriidae and by deriving the Wewokellidae from this group, with the Astraeospongiidae, including *Astraeoconus,* as a side branch. More recent versions (Rigby, 1986a, 1991a, 1991b) removed *Chancelloria* from the Heteractinida, erected the family Eiffeliidae for the thin-walled forms, and used the Astraeospongiidae for octactine-based genera and the Wewokellidae for those derived genera with polyactine-based skeletons. Ziegler and Rietschel (1970) separated the chancelloriids from the Octactinellida, as here, and included *Eiffelia* with the octactinellids (as did Finks, 1967b, 1970 by implication). They considered both groups to be related to

the Calcarea and to be separate offshoots of the Dialytina, which they conceived to be the basic calcisponge stock. RIETSCHEL (1968a, p. 16) earlier pointed out that the trigonal symmetry of the octactinellid spicule relates them to the Calcarea and presented much the same distribution of genera as in his later work with ZIEGLER (ZIEGLER & RIETSCHEL, 1970).

Order OCTACTINELLIDA Hinde, 1887

[*nom. transl.* FINKS & RIGBY, herein, *pro* subclass Octactinellida REID, 1957a, p. 285, *nom. transl. et correct. ex* suborder Octactinellidae HINDE, 1887b, p. 91]

Fundamental spicules with six equally spaced rays either parallel to surface of sponge or irregularly oriented, rays either in one plane or frequently reflexed toward sponge body, and with variably developed proximal and distal rays along an axis at right angles to six; proximal ray usually longer than often suppressed, distal ray, and may be longer than paratangential rays. Earlier forms with only six paratangential rays on most spicules; later forms may suppress alternate three paratangential rays or increase their number; distal ray may be replaced by rays that radiate in all directions of upper hemisphere, and polyasters may be present with rays radiating in all directions of a sphere from common center. Rays usually stoutly and bluntly conical, sometimes bent, may be flattened in paratangential plane, or constricted near crossing, sometimes bearing distal tubercles, may be fused with neighboring rays. These listed features seem to result from deposition of secondary calcite about originally slender, symmetrical ray that lacks possible axial canal; where not recrystallized, both primary and secondary deposits appear to be fibrous calcite, fibers radiating from ray axis. *Lower Cambrian–Permian (Cisuralian).*

Family ASTRAEOSPONGIIDAE Miller, 1889

[Astraeospongiidae MILLER, 1889, p. 153]

Spicules sexiradiates, septiradiates, or octactines with stout rays; body wall thin in early genera and thick in later ones, composed of several layers of densely packed, irregularly arranged and oriented spicules; body spheroidal, discoid, meniscate, conoidal, or open-cup shaped; osculum and spongocoel developed in early genera (*Kuraya* and *Blastasteria*) but not in later ones. *upper Lower Cambrian–Devonian.*

Astraeospongium ROEMER, 1852, p. 155 [**Blumenbachium meniscus* ROEMER, 1848, p. 683; OD] [=*Octacium* SCHLÜTER, 1885, p. 151 (type, *O. rhenanum,* M); *Acanthaspongia* M'COY, 1846, p. 67 (type, *A. silurensis,* SD DE LAUBENFELS, 1955, p. 78); *Acanthospongia* ROEMER, 1861, p. 14, obj.]. Sponge discoidal, concavoconvex (concave side up) or squat, inverted cone; no spongocoel preserved, entire sponge filled with closely packed spicules. Spicules sexiradiates, or octactines with short, distal ray and longer, proximal ray; tangential rays may be bent or distorted, and frequently flattened in tangential plane; spicules regularly larger on upper than on lower surface. [*Blumenbachium* KOENIG, 1820, type species *B. globosum* KOENIG, 1820, by monotypy, was specifically stated by ROEMER, 1854, not to be a synonym. Even if it were, it would be a *nomen oblitum* by the *Code* (ICZN, 1999).] *?Ordovician; Silurian–Devonian:* cosmopolitan.——FIG. 365,*2. **A. meniscus* (ROEMER), Brownsport Formation, middle Silurian, Perry County, Tennessee, USA; view into shallow, saucer-shaped, gastral area showing several orders of octactine-based spicules, ×1 (Rigby, 1987b).

Asteriospongia RIGBY, 1977a, p. 123 [**A. anatrope;* OD]. Thick-walled, dome-shaped sponges in which large, nearly vertical, excurrent canals empty onto rounded summit that lacks spongocoel; skeletal net of moderately regularly spaced, but irregularly oriented, small octactines or octactine-based derivatives, such as sexiradiates, in felted mass; outer one-fifth of wall dense, produced by calcareous overgrowths on spicules. *Middle Ordovician:* Canada (District of Franklin, Melville Peninsula, Baffin Island).——FIG. 366,*1a–b. **A. anatrope,* Bad Cache Rapids Limestone, Wildernessian-Barneveldian; *a,* upper surface of inverted, bowl-shaped holotype, with distinctive canals on spongocoel-free, domed surface, GSC 43201, ×1; *b,* horizontal section with small, octactine spicules, some to right secondarily enlarged, in dense skeleton, perforated by small and large canals, GSC 43202e, ×10 (Rigby, 1977a; courtesy of Minister of Public Works and Government Services Canada, 2000 and the Geological Survey of Canada).

Blastasteria DEBRENNE, TERMIER, & TERMIER, 1971, p. 442 [**B. bedfordorum;* OD; *nom. nov. pro Uranosphaera hexaster* BEDFORD & BEDFORD, 1936, p. 10, fig. 39, *non* BEDFORD & BEDFORD, 1934, p. 7, fig. 36]. Body an invaginated sphere, with broad spongocoel whose lining is continuous with that of exterior over rounded, oscular lip, spicules with six reflexed, tangential rays and longer, proximal ray. [Genus differs from *Kuraya* in having a spongocoel

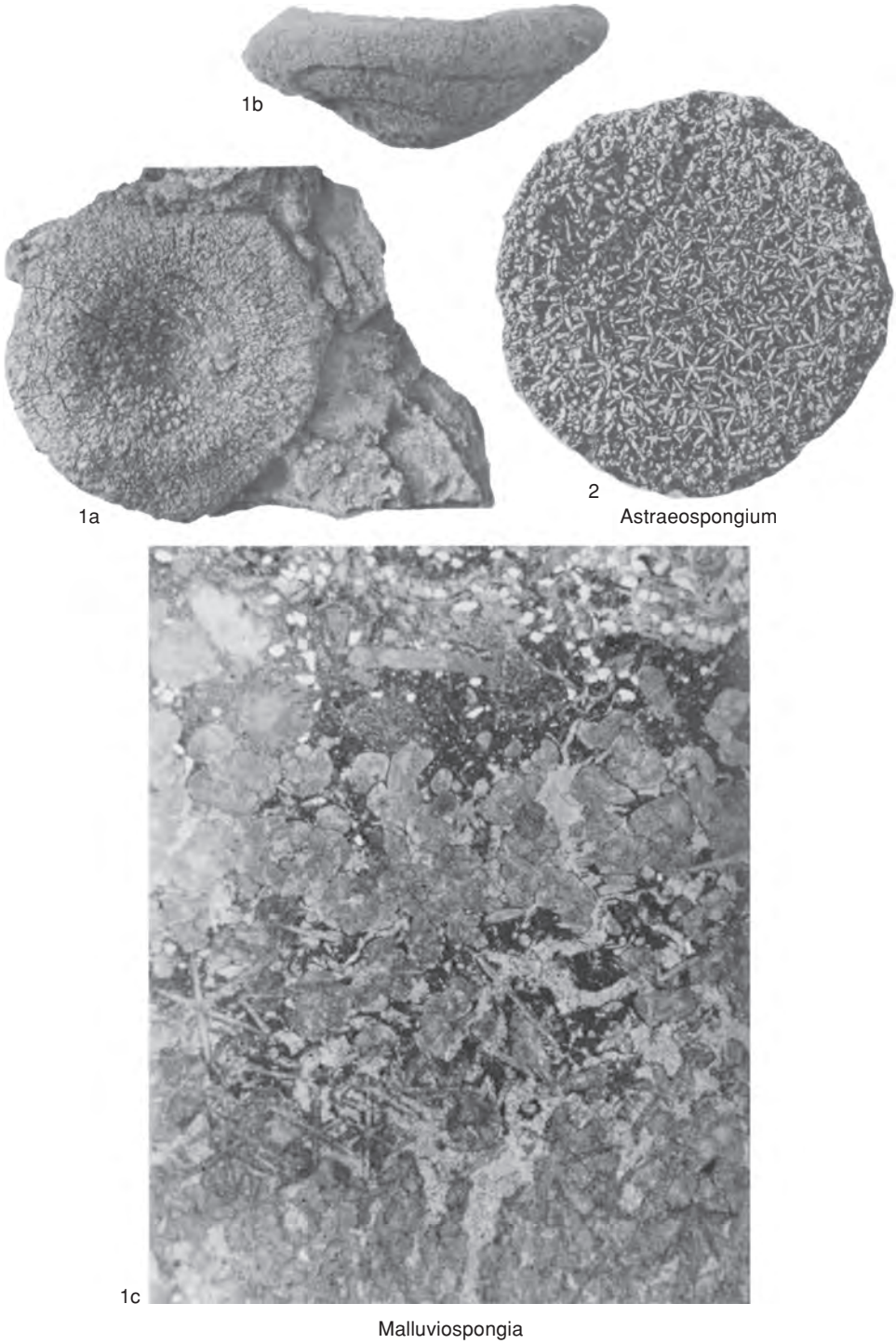


FIG. 365. Astraeospongiidae (p. 562–569).

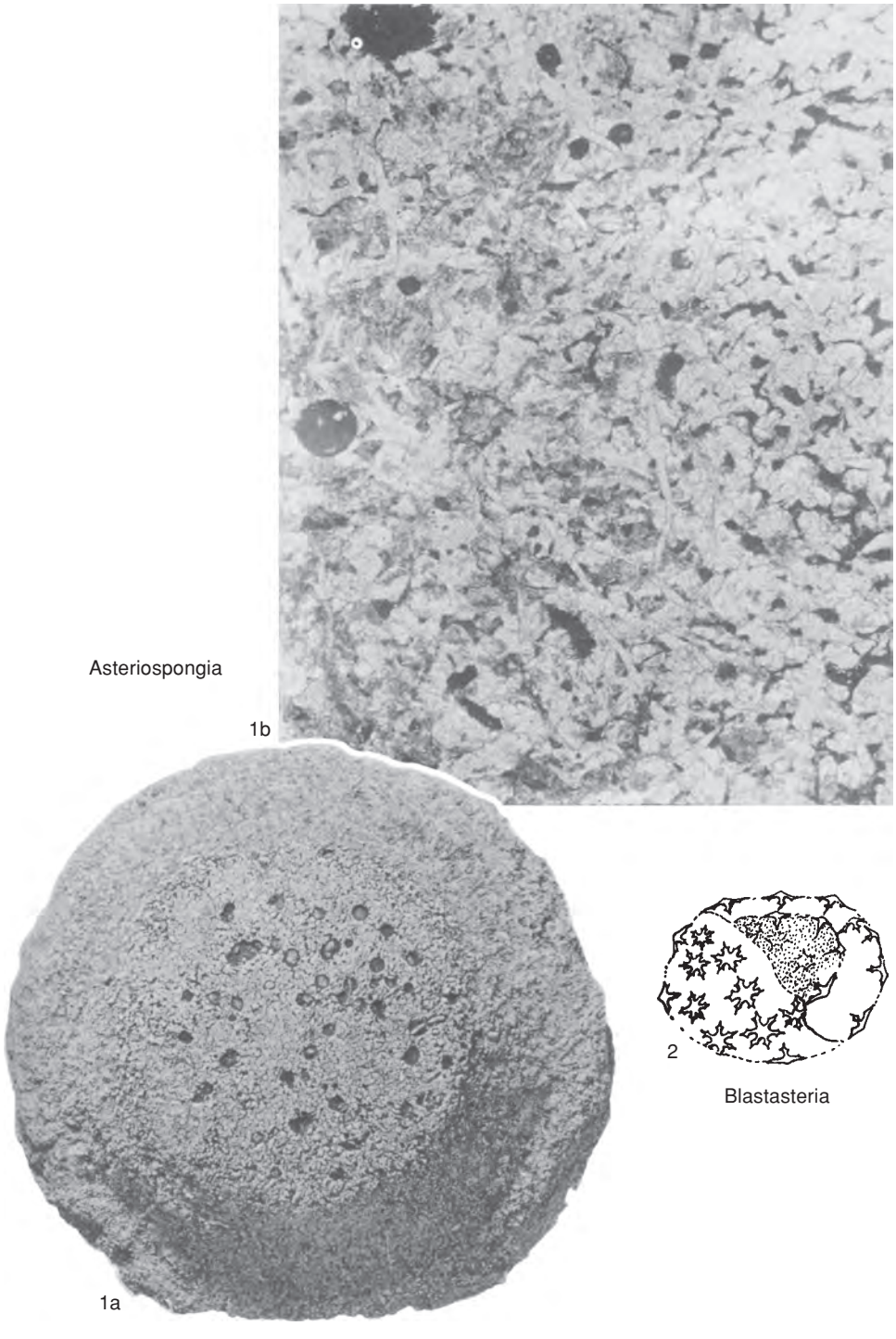


FIG. 366. Astraeospongiidae (p. 562).

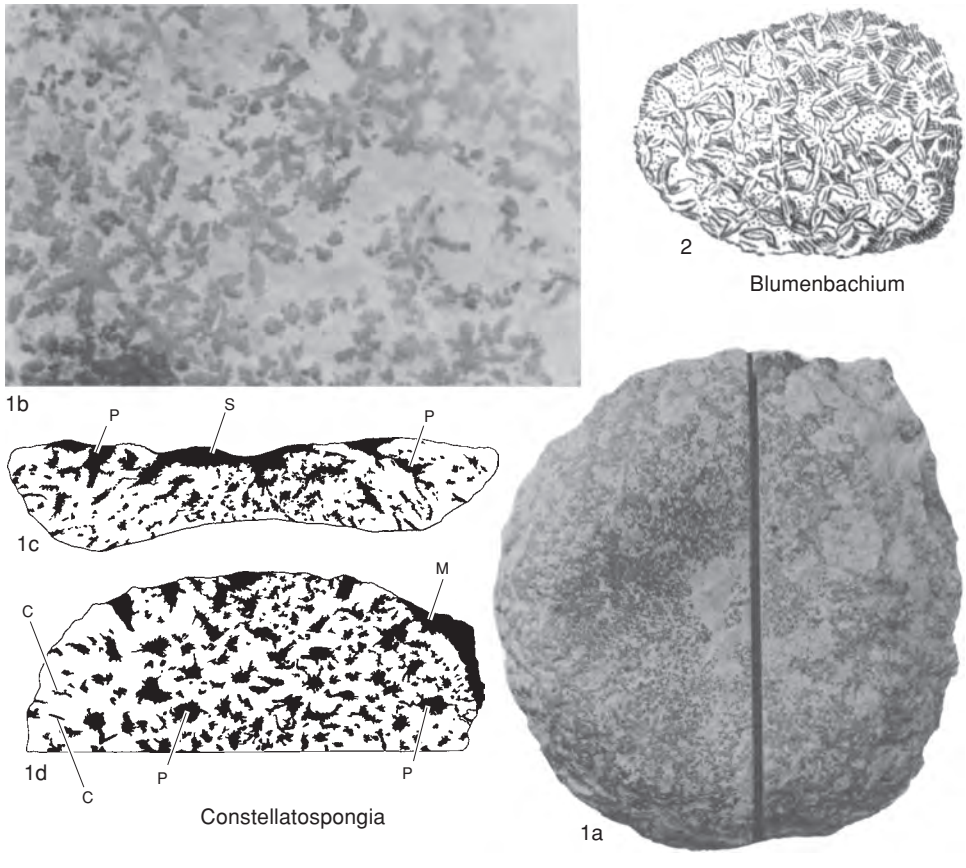


FIG. 367. Astraeospongiidae (p. 562–566).

lining of spicules and in having proximal rays on the spicules.] *Lower Cambrian:* Australia.——FIG. 366,*2. *B. bedfordorum;* restoration, ×2.4 (Debrenne, Termier, & Termier, 1971; courtesy of Société Géologique de France).

Blumenbachium KOENIG, 1820, p. 3 [**B. globosum;* M]. Globose to hemispherical sponge with interior filled with irregularly porous material showing obscure concentric and radial structure; arched surface covered with star-shaped, 3- to 5-pointed, spiculelike objects, mostly with four seemingly flattened, tangential rays. [Description based on original illustration.] *?Devonian:* Germany.——FIG. 367,*2. *B. globosum;* side view of globose holotype with large spicules that dominantly have four tangential rays at sponge surface, scale not given (Koenig, 1820).

Constellatospongia RIGBY, 1977b, p. 131 [**C. pervia;* OD]. Thick-walled, saucer-shaped sponges, with lateral slopes pierced by large, irregular, parietal gaps that rise approximately normal to outer slopes and empty into broad, shallow spongocoel; intermediate and smaller canals radiate approximately normal to parietal gaps into dense, spicular, sponge wall; base slightly invaginated, gaps absent; spicules relatively fine octactines with six horizontal rays locally roughly concentric to surface of sponge and marking former positions of exterior sexiradiates or octactines with distal rays aborted; proximal and distal rays essentially same diameter and length as horizontal rays in interior spicules; some exterior spicules with small nodes or irregularities on basic, octactine spicule, probably result of minor secondary calcification. *Upper Ordovician:* Canada (Manitoba).——FIG. 367,*1a–d. *C. pervia,* Churchill River Group, Richmondian, Herriot Creek southwest of Churchill, northern Manitoba; *a,* uparched base of saucer-shaped holotype, with dimples along lateral slopes at parietal gaps, ×0.5; *b,* photomicrograph of base exterior with octactine or sexiradiate spicules of two orders of size, some of which have six tangential rays that are knobby with secondary overgrowths, ×5; *c,* tracing of vertical section through holotype with matrix-filled, parietal gaps (*P*) and spongocoel (*S*) shown in black, ×1; *d,* tracing of horizontal section at approximately

a

b

Ensiferites

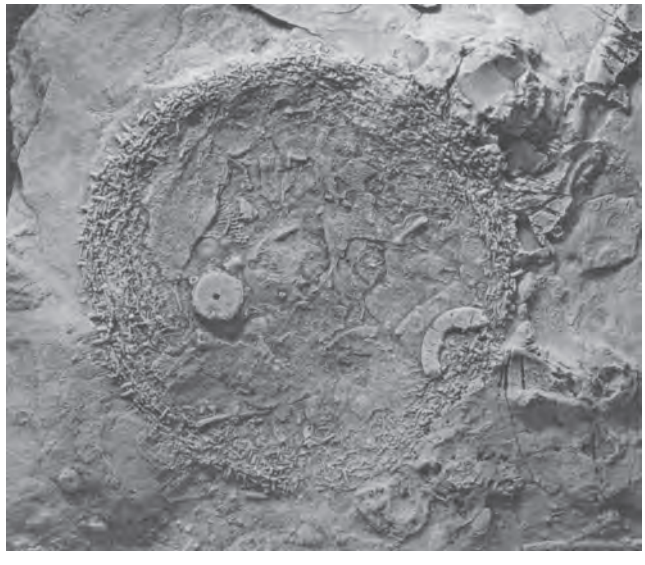
c

FIG. 368. Astraeospongiidae (p. 566–567).

midheight in holotype showing parietal gaps (*P*) and smaller canals (*C*) in interior of sponge, with matrix (*M*) on margin, GSC 45686, ×1 (Rigby, 1977b; courtesy of Minister of Public Works and Government Services, 2000, and the Geological Survey of Canada).

Ensiferites REIMANN, 1945b, p. 17 [**E. armatus;* OD]. Sponges irregularly globular, discoidal, or mushroom shaped, possibly hollow; osculum and canal system ill defined or absent; outer spicules consisting of six small and symmetrically disposed, tangential rays, a very much stouter and longer, proximal ray that may be fusiform or abruptly constricted at junction with tangential rays, and a knoblike, distal ray that may have branching; spicules larger on presumed upper surface than on lower one; proximal rays of smaller spicules interspersed among larger ones (on both surfaces) and may be mistaken for monaxons. Interior spicules simple or modified small octactines, irregularly oriented. Comitalia-like, fine monaxons also may be present parallel to proximal rays. *Silurian (Wenlock)–Upper Devonian:* USA (New York, Michigan, Tennessee, Arizona).

——FIG. 368*a–c.* **E. armatus,* Onondaga Limestone, Eifelian, Buffalo, New York; *a,* holotype from above with prominent, converging, proximal, spicule rays and dermal layer of matted, tangential rays of octactines, ×1; *b,* photomicrograph of part of skeleton with distinct, tangential rays in dermal layer and long, proximal rays extending into inte-



Ensiferites

FIG. 369. Astraeospongiidae (p. 566–567).

rior of sponge, BMS E16060, ×5; *c,* photomicrograph of outer part of holotype showing short, robust, distal rays and finer, matted, tangential rays, BMS E14876, ×5 (Rigby, Schumacher, & Meader, 1979).——FIG. 369. *E. bennetti* REIMANN, Onondaga Limestone, Eifelian, Buffalo, New York; holotype with central, saucerlike, gastral surface partially obscured by matrix, but with dense, dermal layer well exposed around margin where robust, distal rays project outwardly, ×1 (Rigby, Schumacher, & Meader, 1979).

Kuraya ROMANENKO, 1968, p. 271 [**K. sphaerica;* OD]. Oblate, spheroidal sponges, thin walled with large osculum; spicules sexiradiates with rays reflexed toward sponge body at 45°. [Genus differs from *Eiffelia* in reflexion of the paratangential rays and in the irregular arrangement of the spicules.] *upper Lower Cambrian:* Russia (Siberia), Australia.——FIG. 370,*1a–c. *K. sphaerica,* Lenan, Lower Cambrian limestone, Altay Highlands, Siberia; *a,* small holotype with spicules having six tangential rays, ZSGU 435/7; *b,* small paratype with sexiradiate spicules well developed, ZSGU 435/9; *c,* generalized diagram of sponge body, ×5 (Romanenko, 1968).

Magenia FINKS, 1995, p. 5 [**M. david* FINKS, 1995, p. 6; OD]. Sponge oblately globose, possibly hollow, but without osculum; spicules of presumed upper surface with six broad, tangential rays like equilateral triangles, a very short or absent distal ray, and possibly a stout, proximal ray; spicules of presumed lower surface with six slender, tangential rays, a well-developed short to knoblike, distal ray, and a stouter proximal ray about twice length of tangential rays. *Silurian (Wenlock–Ludlow):* USA (Oklahoma).——FIG. 371*a–c. *M. david,* Henry house Formation, Pontoon County; *a,* possible upper surface of holotype with broad-rayed octactines; *b,* side and part of basal surface (above) with slender-rayed octactines, ×2; *c,* side of spheroidal holotype showing some spicules with knob as distal ray, USNM 127738, ×10 (Finks, 1995).

Malluviospongia RIGBY & GOODBODY, 1986, p. 345 [**M. densa* RIGBY & GOODBODY, 1986, p. 347; OD]. Saucer- to bowl-shaped or stalked, obconical sponges; thick walls perforated by well-defined, irregularly placed, radial canals that empty into more open canals near spongocoel floor and flank; skeleton of walls zoned with compact, dermal layer of small, lumpy, octactine-based spicules; interior of wall of moderately well organized, clearly defined octactines of several ranks, which grade gastrally into lumpy, coarsely overgrown, grotesque spicules. *Lower Devonian–Middle Devonian:* Canada (Northwest Territories, Ellesmere Island).——FIG. 365,*1a–c. *M. densa,* Bird Fiord Formation, Eifelian, District of Franklin, southwestern Ellesmere Island; *a,* vertical view of holotype with simple, open spongocoel and thick walls with grossly lumpy spicules that define radial canals, UA 7535, ×1; *b,* side view of paratype showing annulate, lower part, UA 7537, ×1; *c,* photomicrograph of vertical section of paratype showing well-organized skeleton with ranked octactines in lower, dermal part and lumpy overgrowths on spicules in upper, endosomal and gastral part between dark, matrix-filled canals and beneath quartz-rich fill of spongocoel, UA 7538, ×10 (Rigby & Goodbody,

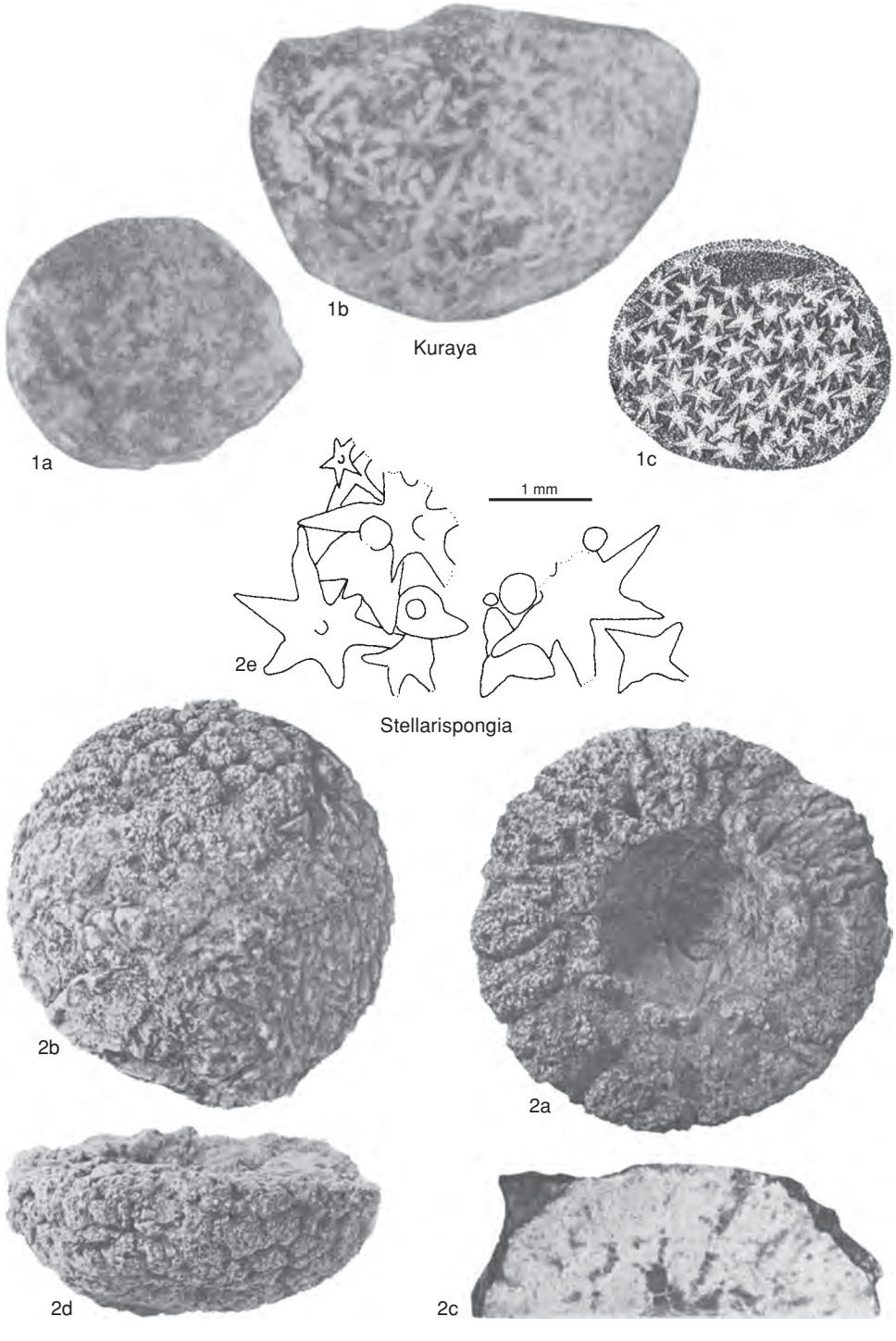


FIG. 370. Astraeospongiidae (p. 567–569).

FIG. 371. Astraeospongiidae (p. 567).

1986; courtesy of *Canadian Journal of Earth Sciences*).

Stellarispongia RIGBY, 1976a, p. 120 [**S. aspera* RIGBY, 1976a, p. 121; OD]. Thick-walled, bowl-shaped sponges with upper surface partly occupied by deep, central, spongocoel depression; strongly developed radial canals may extend from exterior to spongocoel wall, connected laterally by smaller canals parallel to outer surface; canals near surface form deep, radial grooves on upper surface and reticulation on exterior surface; dermal spicules with four to six stout, tangential rays, a knoblike, distal ray (sometimes absent), and probably longer, proximal ray; grotesque, larger spicules produced by overgrowths; smaller, more delicate, interior spicules have six tangential rays consistently developed. *Lower Devonian (Emsian):* Canada (Ellesmere Island).——FIG. 370,*2a–e. *S. aspera,* Blue Fiord Formation, District of Franklin, southwestern Ellesmere Island; *a,* top view of holotype with simple, broad spongocoel and thick walls indented by prominent canals, ×1; *b,* base of holotype with rounded, sculptured exterior, ×1; *c,* side view showing saucerlike shape of sponge, GSC 43208, ×1; *d,* horizontal section through paratype showing coarse, radial canals in thick walls, GSC 43209, ×1; *e,* camera lucida drawings illustrating several ranks of spicules and grotesque larger spicules produced from overgrowths, GSC 43208, ×15 (Rigby, 1976a; courtesy of *Canadian Journal of Earth Sciences*).

Family EIFFELIIDAE Rigby, 1986

[Eiffeliidae RIGBY, 1986a, p. 56]

Spicules sexiradiates, or septiradiates or octactines with slender rays and very short, proximal and distal rays; spicules of more

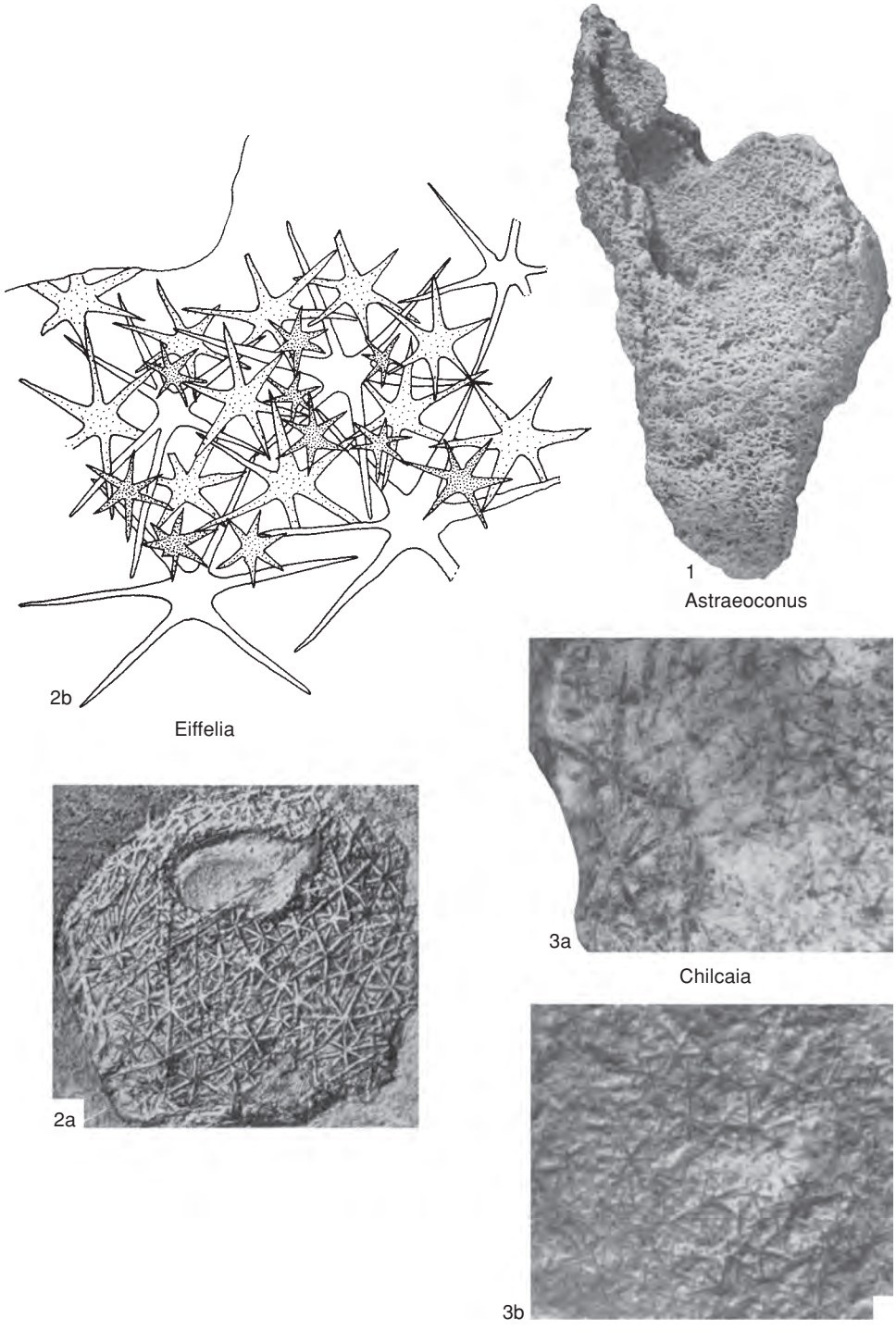


FIG. 372. Eiffeliidae (p. 571–572).

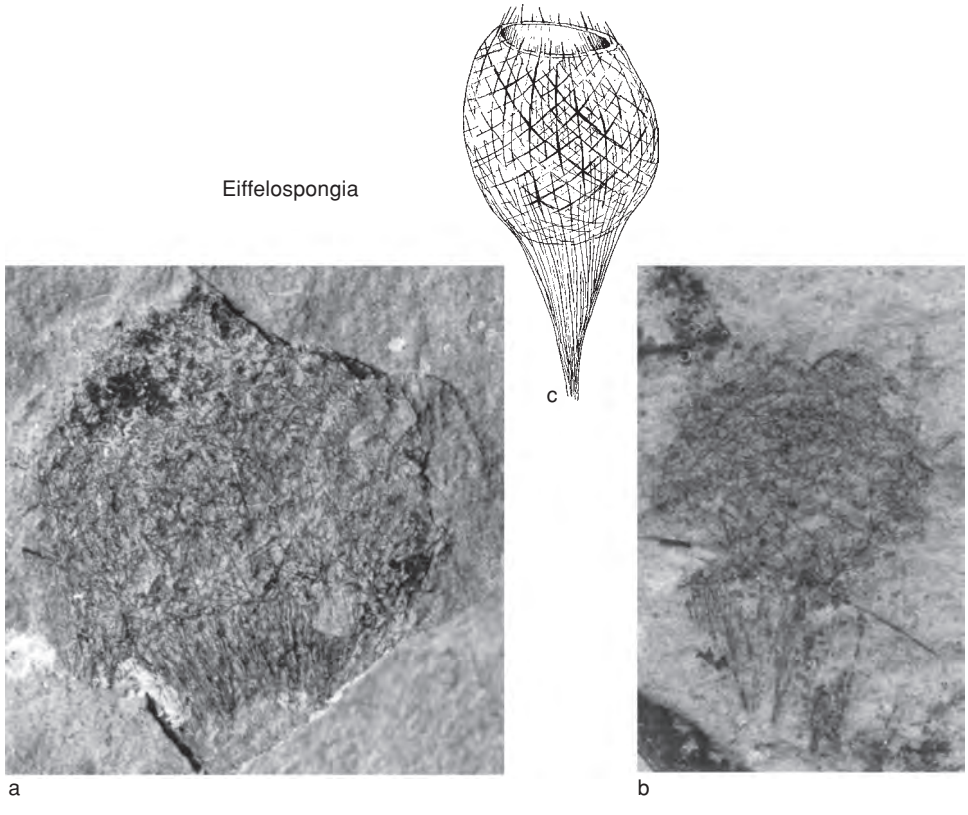


FIG. 373. Eiffeliidae (p. 572).

than one size order arranged more or less quincuncially with relatively uniform orientation; body wall thin; spongocoel and osculum present; sponges globose or obconical. *Lower Cambrian–Carboniferous (Middle Mississippian).*

Eiffelia WALCOTT, 1920, p. 323 [**E. globosa* WALCOTT, 1920, p. 324; OD]. Globose, thin-walled sponges with circular osculum; oscular rim enrolled or situated in shallow depression; body wall supported by one or few layers of spicules of at least four size orders, arranged so succeeding orders occur between rays of immediately larger orders, spicules with six long, evenly spaced, thin, tapering rays tangential or reflexed to sponge surface; it is not certain whether seventh, inwardly directed ray was present; spicules regularly and quincuncially arranged and contratangent so that rays outline triangular interspaces. *Lower Cambrian–Middle Cambrian:* Siberian Platform, Mongolia, China, Europe, Africa, Australia, China, Canada, USA. ——FIG. 372,*2a–b. *E. globosa,* Stephen Formation, Albertan, Burgess Quarry, Mount Field, British Columbia, Canada; *a,* lectotype showing globose form, open osculum, and thin, skeletal net of ranked, sexiradiate spicules, ×3 (Walcott, 1920); *b,* camera lucida drawing of part of skeleton showing orientation and positions of ranked sexiradiates in lectotype, USNM 66522, ×3.7 (Rigby, 1986c).

Astraeoconus RIETSCHEL, 1968a, p. 17 [**A. calcarius* RIETSCHEL, 1968, p. 18; OD]. Sponge conical, thin walled, with broad, open osculum; spicules regular sexiradiates parallel to sponge surface; interspicular spaces larger on spongocoel surface than on external surface. *Lower Ordovician–lower Upper Ordovician:* USA (?Colorado), *Lower Ordovician;* USA (Oklahoma), *lower Upper Ordovician.*——FIG. 372,*1. *A. calcarius,* Bromide Formation, Blackriveran, Criner Hills, Oklahoma; side view of holotype showing obconical form with walls made of regular sexiradiates, SMF 18434, ×4 (Rietschel, 1968a).

Chilcaia CARRERA, 1994, p. 214 [**C. bimuralis* CARRERA, 1994, p. 215; M]. Discoidal to lamellar sponges with multilayered walls of sexiradiates of at least four ranks, one surface (possibly dermal) of wall with spicules irregularly distributed and grouped by ranks; other side (possibly gastral) with

intermix of spicules of all ranks, but large, first-order sexiradiates rare. *upper Lower Ordovician:* Argentina (San Juan Province).——Fig. 372,*3a–b.* **C. bimuralis,* San Juan Formation, Llanvirn, Cerro La Chilca, Precordillera; *a,* photomicrograph of part of holotype with sexiradiate spicules of four orders, CEGH-UNC 9335, ×4.5; *b,* regular arrangement of sexiradiate in paratype fragment, CEGH-UNC 6336, ×2.8 (Carrera, 1994; courtesy of *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*).

Eiffelospongia Rigby & Collins, 2004, p. 88 [**E. hirsuta;* OD]. Small, heteractinid sponges with skeleton of long, thin-rayed sexiradiates in a moderately well organized skeleton, with regularly oriented spicules of at least two ranks; a prominent, basal, goatee-like root tuft is developed; sponges round to oval or keg shaped with deep spongocoel and flat, oscular margin; possible dermal layer principally of irregular monactines. *Middle Cambrian:* British Columbia, Canada.——Fig. 373*a–c.* **E. hirsuta,* Trilobite beds, Stephen Shale, Albertan, Mount Stephen; *a,* diagonally flattened holotype with thin, hexiradiate-based skeleton preserved in upper part and prominent root tuft at base, ROM 43828, ×7; *b,* paratype with well-preserved, hexiradate spicules in upper globular part of skeleton, above long-rayed oxeas of root tuft, ROM 53543, ×7; *c,* restoration of species, ×3 (Rigby & Collins, 2004).

Gondekia Rigby, 1991b, p. 38 [**Astraeospongia lancifer* Reiman, 1945a, p. 16; OD]. Thin-walled, saucer- to funnel-shaped, eiffeliid sponge with skeleton a felted mass of sexiradiates of at least three ranks with regular spacing and orientation; spicules lacking proximal and distal rays in all ranks; unornamented rays straight and locally flattened and bladelike. *Devonian (Givetian):* Canada (Ontario), USA (New York).——Fig. 374*a–b.* **G. lancifer* (Reiman), Hungry Hollow Formation, Arkona, Ontario, Canada; *a,* holotype fragment of well-organized sexiradiates in felted skeleton, ×1.4; *b,* photomicrograph showing three-dimensional relationships of three orders of spicules, BMS 13030, ×7 (Rigby, 1991b).——Fig. 374*c–d.* Ludlowville Formation, Givetian, Darian Lakes State Park, western New York; *c,* small, saucer-shaped sponge from below, with skeleton of felted, small sexiradiates, ×1; *d,* photomicrograph of closely packed sexiradiates of three ranks, each with six tangential rays in felted skeleton, USNM 463515, ×10 (Rigby, 1994).

Petaloptyon Raymond, 1931, p. 198 [**P. danei;* OD] [=*Canistrumella* Rigby, 1986a, p. 58]. Open conical or vasiform to basketlike sponges with alternating, longitudinal panels with and without circular to elliptical, parietal gaps that are circular to polygonal and separated by less than their diameters, occurring in crude, vertical rows; skeleton a felt of spicules principally with five tangential rays although some with four and six also occur, and largely aborted, proximal and distal rays; walls thin; base probably stalked. *Middle Cambrian:* Canada (British Columbia).——Fig. 375*a–e.* **P. danei,* Stephen Formation, *Ogygopsis* shale, Mount Stephen near Field; *a,* figured specimen with alternating panels with and without gaps, ×1; *b,* photomicrograph showing spicules in tracts between gaps and moderately uniformly spaced spicules in panel without gaps, ×5; *c,* photomicrograph of large, five-rayed spicules with centra, ×15; *d,* restoration showing growth form based on fragments and related sponges, approximately natural size; *e,* sketch of spicules showing range of form, most common are five-rayed spicules, ROM 43123, ×25 (Rigby, 1986a).

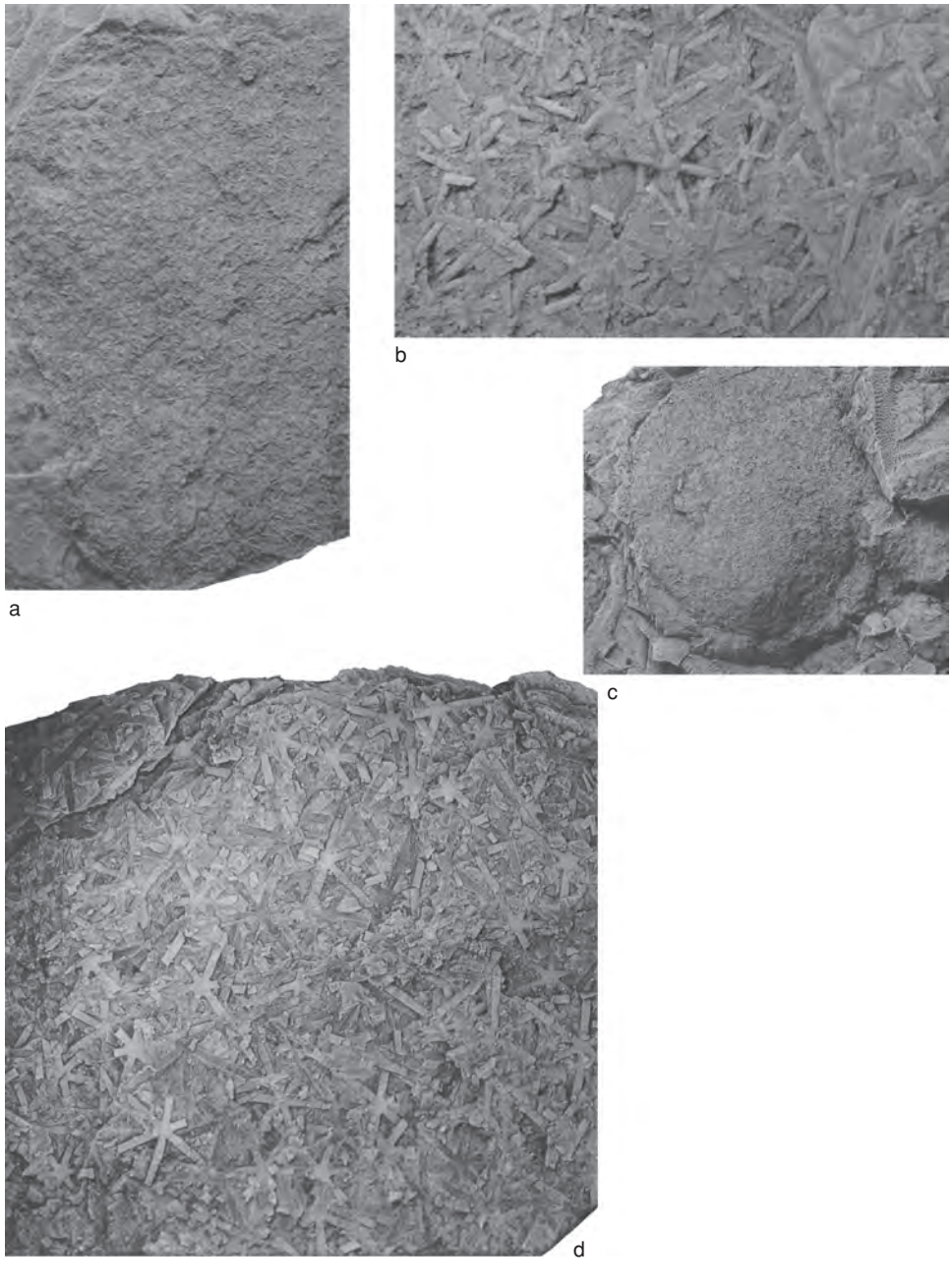
Toquimiella Rigby, 1967a, p. 512 [**T. curvata;* OD]. Sponges low, conical or saucer shaped with flat base; moderately thick walled, presence of spongocoel not established; spicules with six very thin, tangential rays, round node representing distal ray, and possible but not demonstrated proximal ray; two of tangential rays oriented parallel to longitudinal axis of sponge, two lateral rays in upper half of spicule smoothly curve toward top of sponge while lower two lateral rays more abruptly curve toward bottom, with geniculation at midlength; spicules at least three orders of size, with smaller size external to larger; within each size rank spicules are in longitudinal rows overlapping basally, but different ranks arranged quincuncially with respect to one another. *Middle Ordovician:* USA (Nevada).——Fig. 376*a–b.* **T. curvata,* Antelope Valley Formation, Toquima Range; *a,* photomicrograph of low, obconical holotype with typical spicules on upper right of specimen, MCZ 9391, ×10; *b,* generalized drawings of ranked spicules characteristic of genus, approximately ×75 (Rigby, 1967a).

Zangerlispongia Rigby & Nitecki, 1975, p. 330 [**Z. richardsoni* Rigby & Nitecki, 1975, p. 331; OD]. Sponge small, obconical, thin-walled cup; at least three ranks of spicules with six tangential rays, no proximal or distal rays, and with tubercles on outer surface of spicule near centrum; spicule ranks arranged quincuncially with overlapping, slightly reflexed rays. *Carboniferous (Middle Pennsylvanian):* USA (Illinois).——Fig. 377*a–b.* **Z. richardsoni,* Carbondale Formation, Farmington; *a,* flattened holotype showing steeply obconical form of sponge and its well-preserved, sexiradiate skeleton, ×5; *b,* photomicrograph of latex mold of holotype showing four ranks of spicules and sculpture of central disc of coarser spicules, FMNH 24821, ×9 (Rigby & Nitecki, 1975).

Family WEWOKELLIDAE King, 1943

[Wewokellidae R. H. King, 1943, p. 26] [=suborder Heteractinellidae Hinde, 1887b, p. 92, *emend.;* order Wewokellida Croneis & Toomey, 1965, p. 12; *emend.,* Finks & Rigby, herein]

Spicule rays very stout; spicules including regular septiradiates, often with reflexed rays, septiradiate derivatives with a variable



Gondekia

FIG. 374. Eiffeliidae (p. 572).

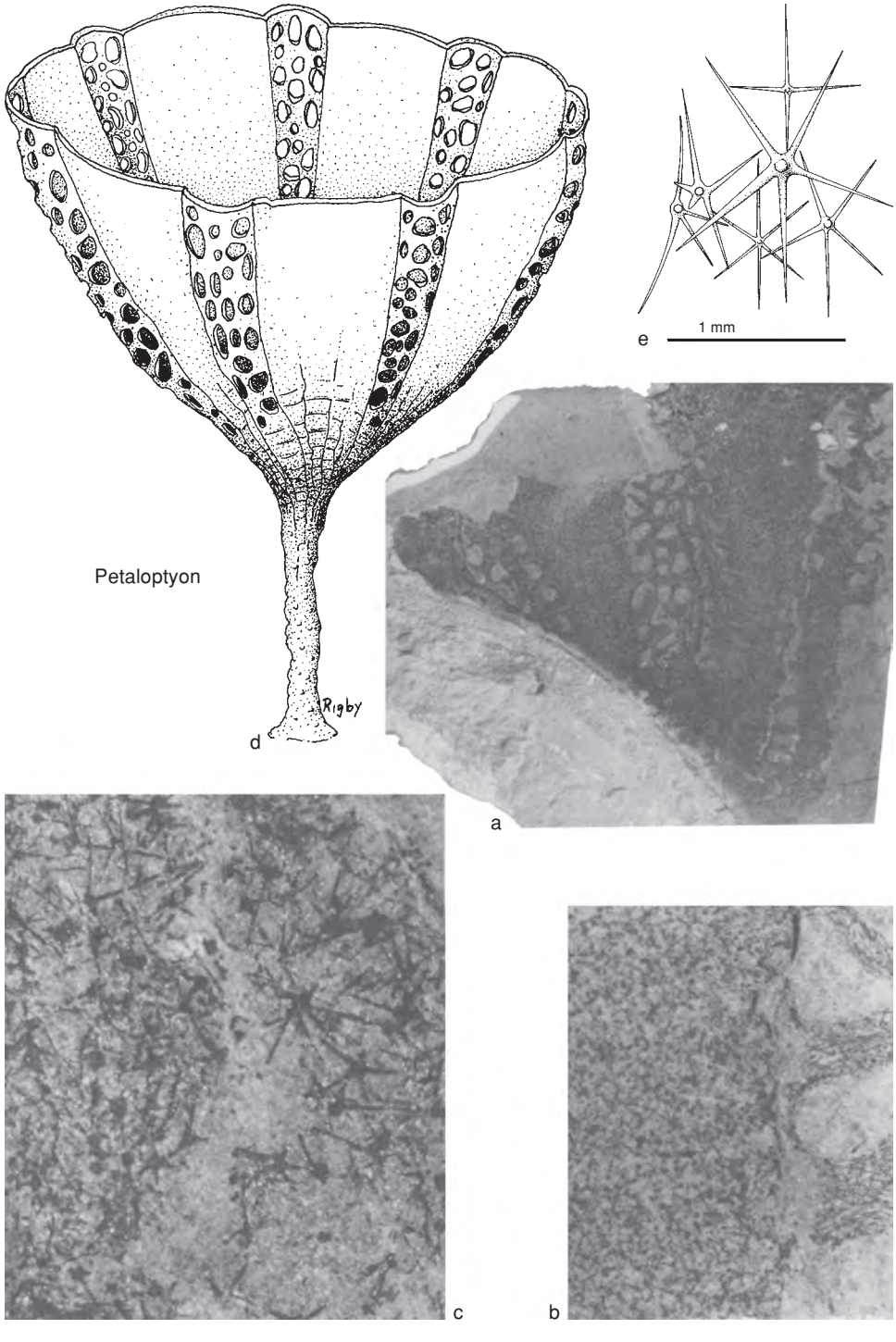


FIG. 375. Eiffeliidae (p. 572).

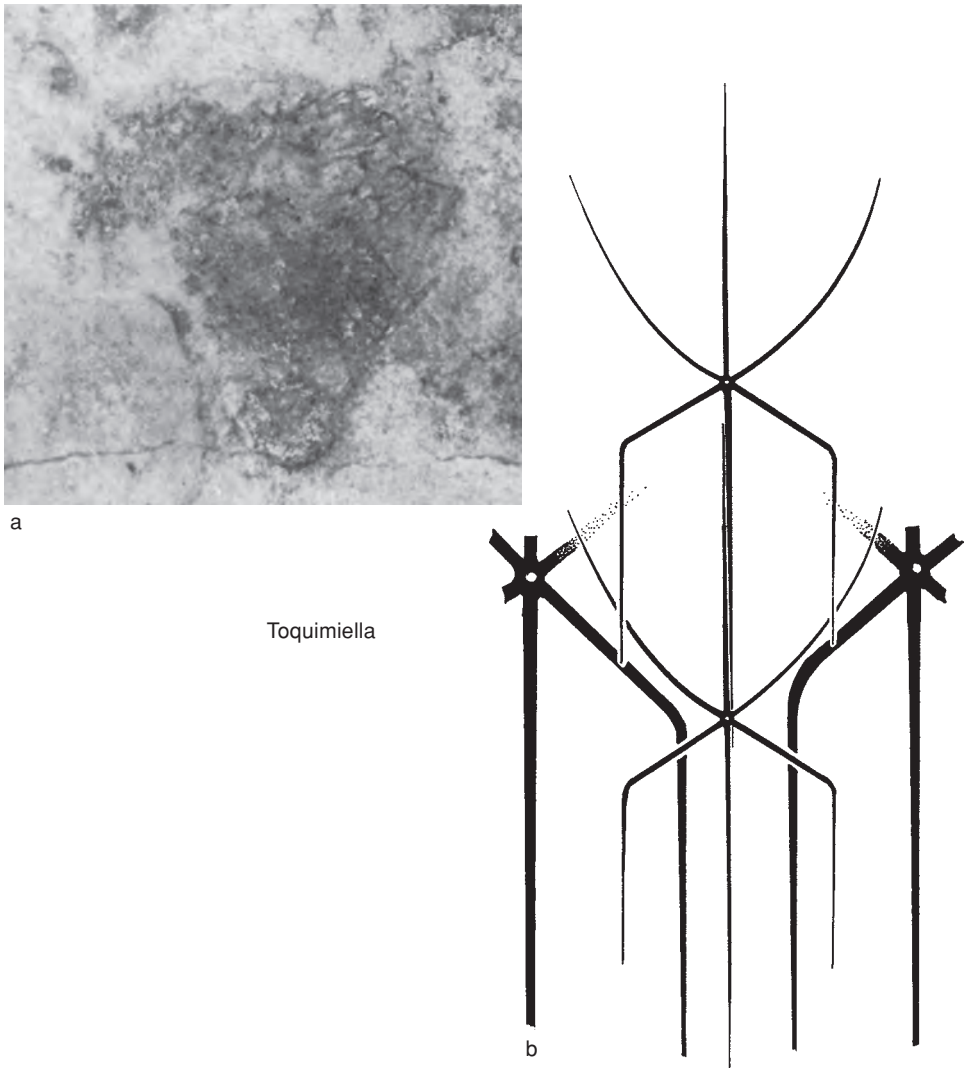
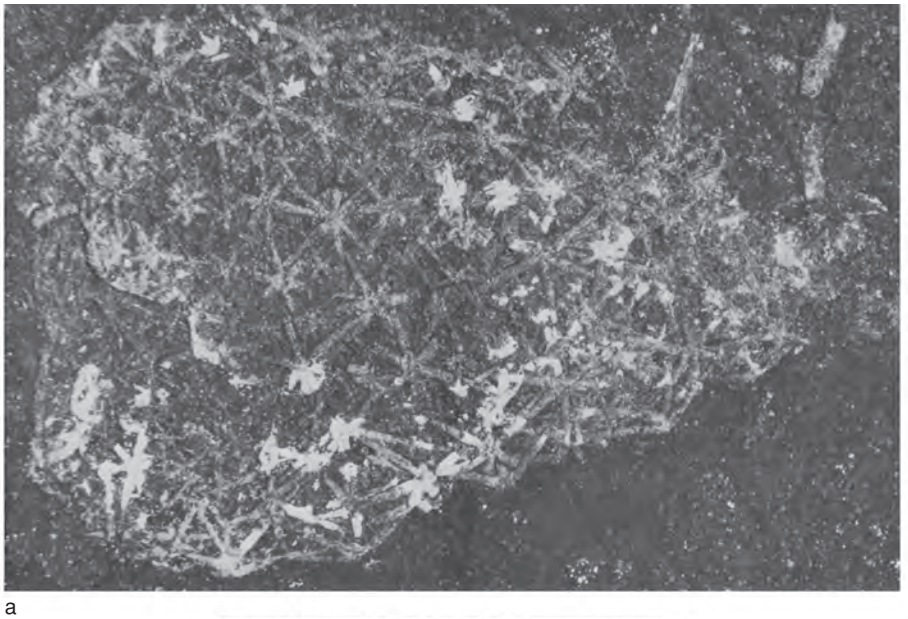


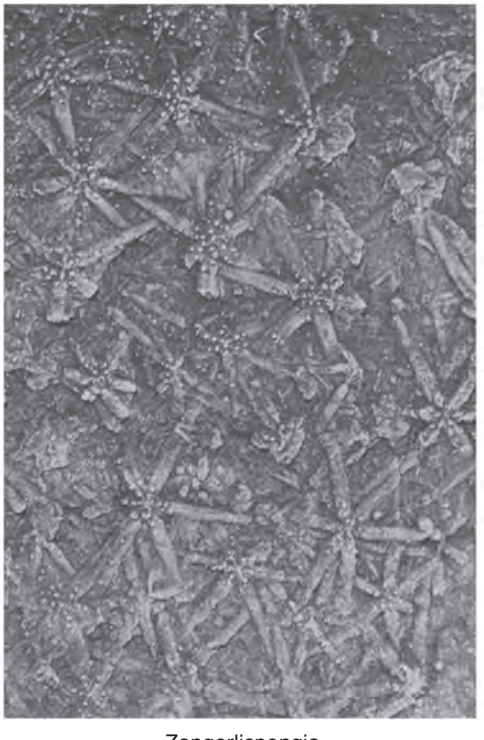
FIG. 376. Eiffeliidae (p. 572).

number of extra tangential and distal rays, tetraradiates with three tangential and one proximal rays, and polyasters with subequal rays radiating in all directions from common center; tangential rays sometimes distally tuberculate; body wall very thick with spicules arranged irregularly and densely packed; inhalant and exhalant canals variably developed; sponge body, where known, cup shaped, obconical, or tubular with more or less well developed spongocoel and osculum. *Carboniferous (Mississippian)–Permian (Cisuralian).*

Wewokella GIRTY, 1912, p. 121 [**W. solida;* OD]. Sponge body obconical, pyriform, claviform, or conicocylindrical, often irregular and geniculate; large specimens may be longitudinally fluted in upper, widest part; cloaca relatively narrow and body wall thick; cloaca may be only terminal or replaced in lower part by subparallel, longitudinal, exhalant canals; radial, exhalant canals enter cloaca



a



b

Zangerlispongia

FIG. 377. Eiffeliidae (p. 572).

and radial, inhalant canals lead in from outer surface; principal spicules tetraradiates with three rays parallel to outer surface and 120° from each other (one ray points to base of sponge) and a proximal ray at 90°; less common septiradiates with six tangential rays, two of which are often parallel to longitudinal axis of sponge and longer than others, or else six of equal length and may be reflexed toward proximal ray; on some septiradiates, at outer surface distal ray may be represented by knob or rosette of small rays directed outwardly in all directions; dermal layer of such smaller spicules, together with minute sphaeractines or polyactines that have radiate subequal rays, may occur in patches on surface, especially at points of attachment to shells or crinoid stems; similar polyactines scattered among larger spicules of interior; spicules commonly fused together by secondary calcite deposits; both primary spicule rays and secondary material consist of fibrous calcite with fibers perpendicular to spicule surfaces. *Carboniferous (Mississippian–Pennsylvanian):* USA (Alabama), *Mississippian;* USA (Oklahoma, Colorado), *Pennsylvanian.*——Fig. 378,*1a–b. *W. solida,* Wewoka Formation, Desmoinesian, Colgate quadrangle, Oklahoma; *a,* side view of steeply obconical holotype with main body spicules obscured by secondary overgrowth, ×1; *b,* photomicrograph of central part of holotype with small, triactine spicules among coarser, secondarily enlarged, main body spicules with triactine bases, USNM 12058, ×4 (Rigby, 1978).

Asteractinella Hinde, 1888, p. 172 [**A. expansa* Hinde, 1888, p. 173; SD Vandercammen, 1950, p. 7]. Founded on isolated spicules and fragments of coherent mesh; spicule types including polyactines with one long, proximal ray and six to fourteen rays divergent at various angles, polyactines with dozen or so equal rays radiating in all directions, and polyactines with similar number of tangential rays in one plane, coalescent into broad, central disk beneath which three to four proximal rays diverge; rays conical and blunt. *Carboniferous (Visean):* Scotland.——Fig. 379,*2a–c. *T. expansa,* Lower Limestone series, Law quarry, Dalry, Ayrshire; assorted typical spicules, ×10 (Hinde, 1887a).

Regispongia Rigby, 1978, p. 706 [**Wewokella contorta* King, 1943, p. 27; OD]. Cylindrical to obconical sponges with shallow to deep spongocoel and thick wall of profusely rayed polyactines and outer, relatively thin, dermal layer of similar, although distinctly smaller, polyactines, minor triactines and octactines also may be present; other spicules may occur as accessory types because of great variation in numbers of rays within polyactines; entire skeletal net weakly to strongly fused by additional calcification; canals irregularly radial and small, because of great irregularity of spicule placement and orientation and because of additional calcification. *Carboniferous (Pennsylvanian)–Permian (Cisuralian):* North and South America, Europe, China (Yunnan).——Fig. 378,*2a–c. *R. contorta* (King), Graham Formation, Missourian, Jacksboro, Texas, USA; *a,* side view of holotype, subcylindrical sponge with deep spongocoel, UK 58690, ×1; *b,* photomicrograph of dermal part of skeleton of holotype with large, dermal, octactine-based skeleton in center surrounded by other overgrown, polyactine spicules, UK 58690, ×4; *c,* photomicrograph of skeleton of reference specimen where spicules have been grossly calcified and polyactine-based net obscured, USNM 240691, ×4 (Rigby, 1978).

Talpaspongia King, 1943, p. 28 [**T. clavata* King, 1943, p. 29; OD]. Differs from *Wewokella* in having a broader spongocoel, a thinner body wall, and somewhat finer spicules that are more consistently fused together by secondary deposits. *Permian (Asselian–Sakmarian):* USA (Texas, New Mexico), China (Guangxi).——Fig. 379,*1a–b. *T. clavata,* Talpa Formation, Runnels County, Texas; *a,* transverse section of holotype showing large spongocoel and dense skeleton of wall, ×4; *b,* photomicrograph of transverse section showing swollen spicule rays as light gray circles and rods and canals as darker gray, circular, matrix fillings, Utbeg 8740, ×8 (King, 1943).

Tholiasterella Hinde, 1887b, p. 76 [**T. gracilis* Hinde, 1887b, pl. 7,*1a–1g;* SD de Laubenfels, 1955, p. 93]. Known only from isolated spicules that have six to nine blunt, conical, distally tuberculate, tangential rays radiating from central disk, to which is attached a long proximal ray; spicules with six rays have hexagonal symmetry. [Figure and explanations were published by Hinde in 1887b, and the full description by Hinde in 1888 (p. 168).] *Carboniferous (Visean, ?Pennsylvanian):* Scotland, *Visean;* USA (Indiana), *?Pennsylvanian.*——Fig. 379,*3a–b. *T. gracilis,* Lower Limestone, Law Quarry, Dalry, Ayrshire, Scotland; *a,* interior of lectotype fragment of dermal layer with several size ranks of commonly octactine spicules; *b,* isolated spicule showing sculpture of central disc of polyactine spicule and smaller, attached spicule, ×10 (Hinde, 1887b).

Family NUCHIDAE Pickett, 2002

[Nuchidae Pickett, 2002b, p. 1,134]

Small, globular to obconical heteractinids with a coarsely perforate, largely aspiculate wall, and distal oscule with raised, imperforate rim. *Lower Cambrian–Middle Cambrian.*

Nucha Pickett & Jell, 1983, p. 90 [**N. naucum;* OD]. Hollow, subspherical chambers with prominent rimmed oscula at both upper and lower poles, wall perforated by closely spaced pores of various sizes; distinct, isolated-appearing chambers

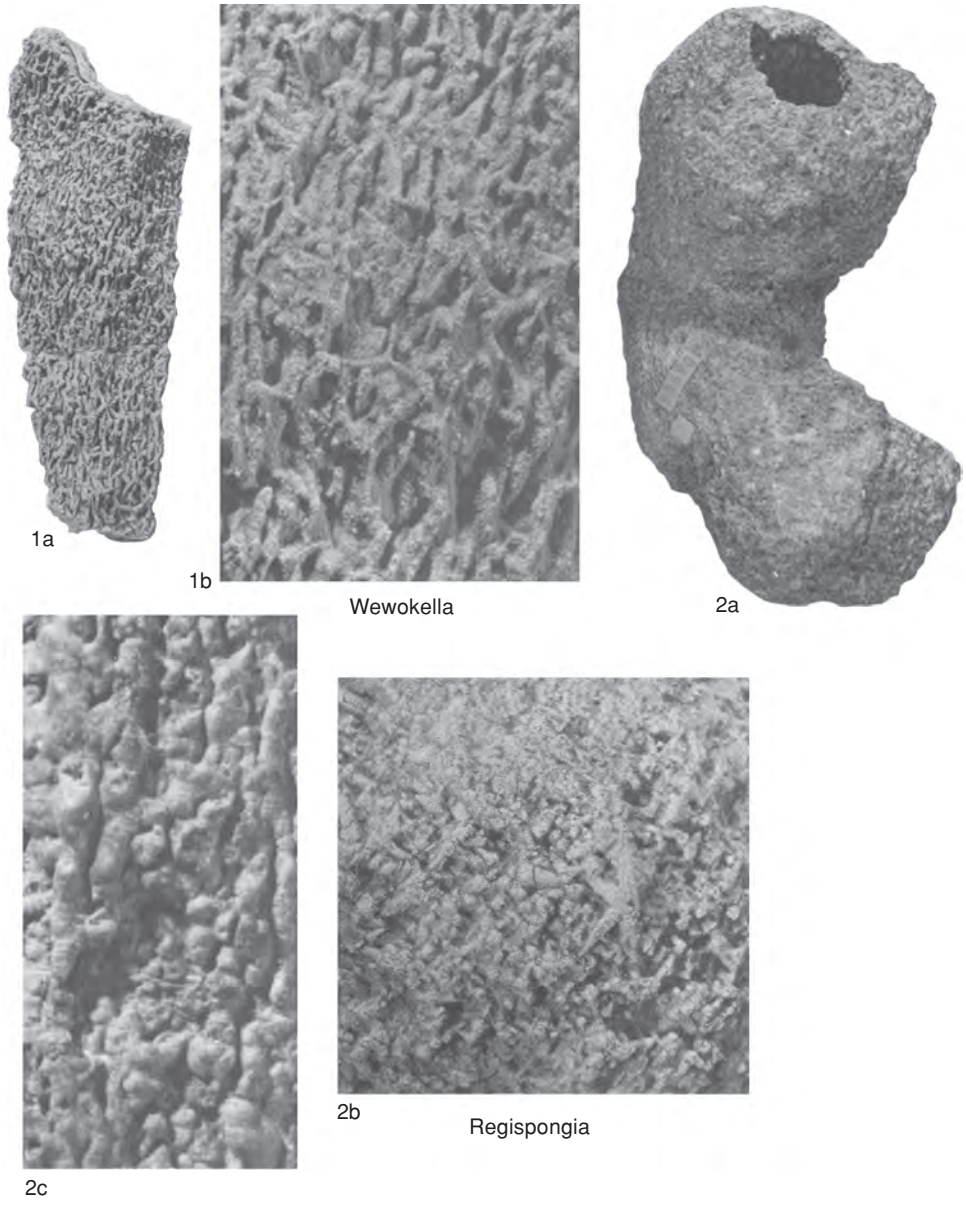


FIG. 378. Wewokellidae (p. 575–577).

probably joined into linear series at poles. *Middle Cambrian:* Australia (New South Wales), Canada.——FIG. 380,*3a–b. *N. naucum,* Coonigan Formation, Mootwingee, New South Wales; *a,* oblique view of holotype showing rimmed osculum and porous exowalls; *b,* view from above of globular holotype, NMV P75209, ×4 (Pickett & Jell, 1983).

Jawonya KRUSE, 1987, p. 543 [**J. gurumal;* OD]. Sponges moderately thin walled, of subspherical to rounded, obconical chambers with closely spaced exopores that may have radial partitions that project inwardly from pore margins in large specimens. Proximal oscule simple, unelaborated, but distal one with imperforate, asiphonate rim. Octactine and octactine-based, polyactine spicules small and adherent to or embedded in sclerosome, commonly irregularly oriented with reference to sponge axis. *Lower Cambrian–lower Middle Cambrian:* Australia (Northern Territory, South Australia).——FIG.

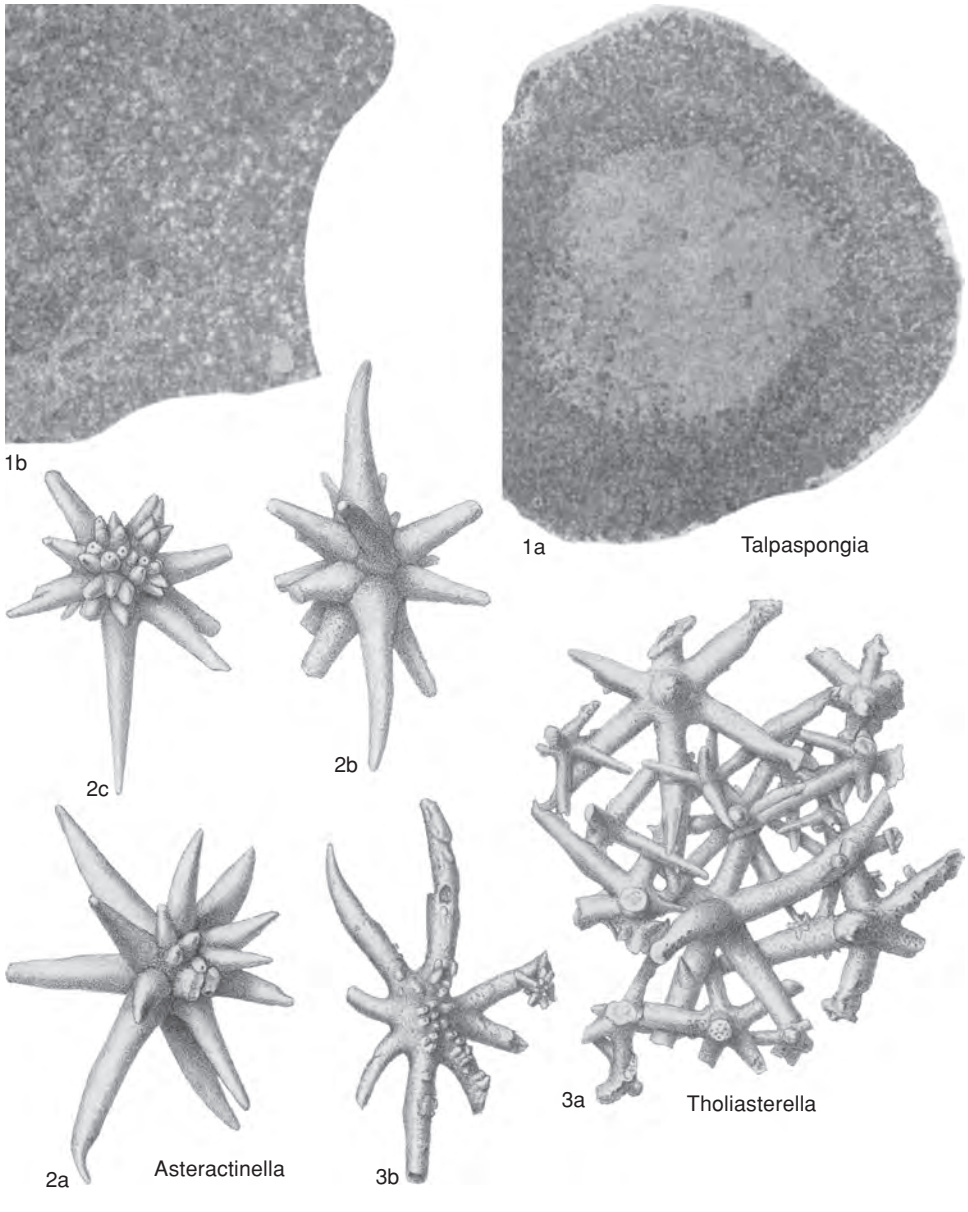


FIG. 379. Wewokellidae (p. 577).

380,*2a–c. *J. gurumal,* Tindall Limestone, Ordian, Katherine, Northern Territory; *a,* side view of holotype with porous, lower part and upper, collarlike, oscular region, NTGS P8553, ×1; *b,* octactines in paratype; *c,* octactines and polyactines in chamber wall of paratype, NTGS P8575, ×80 (Kruse, 1990).

Wagima KRUSE, 1987, p. 545 [**W. galbanyin;* OD]. Skeleton of thin-walled, subspherical chambers with closely spaced ostia screened externally by domed, multiperforate sieves. Proximal oscule unknown; distal one with imperforate, ambisiphonate rim. Octactine and octactine-based, polyactine spicules small and irregularly oriented and adherent or imbedded in sclerosome. *lower Middle Cambrian:* Australia (Northern Territory).——FIG. 380,*1. *W. galbanyin,* Tindall Limestone, Ordian, Fenton Airfield; side view of holotype showing subspherical chamber with domed, multiperforate sieves around wall, NTGS P8598, ×1 (Kruse, 1990).

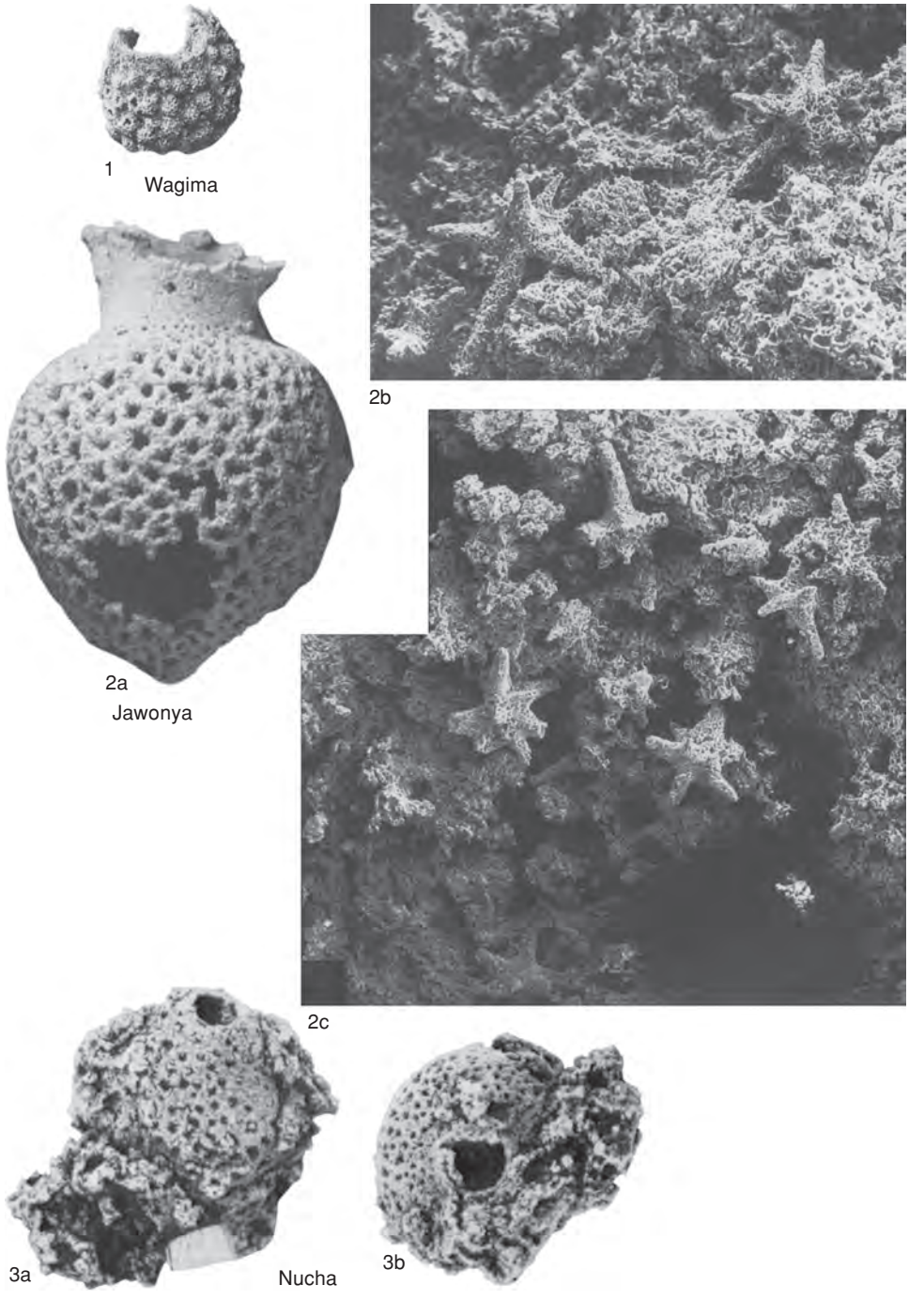


FIG. 380. Nuchidae (p. 577–579).

?Order HETAIRACYATHIDA Bedford & Bedford, 1937

[*nom. correct.* Okulitch, 1955, p. 18, *pro* Hetairacyathina Bedford & Bedford, 1937, p. 27, *nom. nov. pro* Heterocyathina Okulitch, 1935, p. 90, based on invalid generic name]

Double walls thin and sheathlike, strengthened by radiating rods or spicule-like structures. [Considered as possible aberrant archaeocyathans by Okulitch (1955, p. 18) and Hill (1972, p. 141). Their inclusion here as possible poriferans is questioned.] *Lower Cambrian.*

Family HETAIRACYATHIDAE Bedford & Bedford, 1937

[Hetairacyathidae Bedford & Bedford, 1937, p. 27, *nom. nov. pro* Heterocyathidae Bedford & Bedford, 1934, p. 6, based on invalid junior homonym, see *Radiocyathus* below]

Organisms spheroidal, conical or tubular with single or double wall enclosing central cavity that may open to exterior by osculum-like opening; each wall composed of starlike objects with eight to twelve rays, radiating from common center and sometimes branching; rays of adjacent stars fusing when in contact; if wall is double, rods connect the two, each rod running from center of a star; interspaces between rays in each wall may be calcified by continuous, perforated sheet, making two porous walls. [These organisms may be variably calcified algae, or archaeocyathids.] *Lower Cambrian.*

Girphanovella Zhuravleva, 1967, p. 107 [**G. girphanovae* Zhuravleva, 1967, p. 108; OD]. Spheroidal or tubular with broad cloaca with spicular lining; osculum not known but presumed narrow; spicules with eight to twelve branching, reflexed, tangential rays that fuse with those of neighboring spicules; exterior dermal layer with spicules of two sizes, larger with proximal ray that extends to cloacal lining; spicules of cloacal lining like smaller, dermal ones. [Genus differs from *Gonamispongia* chiefly having a cloacal lining.] *upper Lower Cambrian:* Russia (Siberia).——Fig. 381,*4a–c. *G. girphanovae,* Lenan; *a,* weathered surface of spheroidal type specimen showing coarse spicules of dermal layer, ×1; *b,* transverse section showing double-walled appearance, ×2; *c,* spicules of outer layer showing fine and coarse skeletal elements, ×10 (Zhuravleva, 1967).

Gonamispongia Korshunov, 1968, p. 127 [**G. ignorabilis* Korshunov, 1968, p. 129; OD]. Broadly conical, thin walled (less than 1 mm thick); spicules with eight to ten tangential rays (less than 1 mm long) radiating from central disk, sometimes bifurcating at ends that fuse to neighboring spicules to form rigid mesh that curls inwardly at oscular rim; much longer, proximal ray (2 mm) extending inwardly from centrum of each spicule. *Lower Cambrian:* Russia (Siberia).——Fig. 381,*1a–c. *G. ignorabilis,* Aldanian, Kenyada beds, Gonam River Basin; *a,* vertical section of conical holotype with thin walls and broad spongocoel, ×1; *b,* longitudinal section of sponge showing spicules with several tangential rays that connect to rays of adjacent spicules, ×2; *c,* vertical section showing dense, outer, skeletal layers and spicule with proximal ray, YaFAN, 84,3, ×10 (Korshunov, 1968).

Radiocyathus Okulitch, 1937 (April), p. 252, *nom. nov. pro Heterocyathus* Bedford & Bedford, 1934, p. 6, *non* Milne-Edwards & Haime, 1848 [**Heterocyathus minor* Bedford & Bedford, 1934, p. 7; OD] [=*Hetairacyathus* Bedford & Bedford, 1937 (Sept.), p. 27, *nom. nov. pro Heterocyathus* Bedford & Bedford, 1934, p. 6, *non* Milne-Edwards & Haime, 1848]. Conical or tubular with solid, but perforated, double wall; on intervallum side of each wall are rodlike, spicule rays in plane of wall, radiating from centers a few millimeters apart; their exterior surfaces tuberculate; proximal ray extending from each center of radiation in outer wall to inner wall. [This genus resembles a *Girphanovella* in which the space between the spicule rays in the plane of the wall are continuously calcified.] *Lower Cambrian:* Australia.——Fig. 381,*2a–c. *R. minor* (Bedford & Bedford), Lower Cambrian limestone, Ajax Mine, Beltana, South Australia; *a,* double walls of obconical or cylindrical holotype that are connected across intervallum by rods or spicules, lower one is outer wall, ×4; *b,* side view of outer wall with characteristic ridges or lines of tubercles radiating out from separated centers, ×4; *c,* surface of inner wall with radiating ridges or lines of tubercles, BMNH, ×3 (Bedford & Bedford, 1936).

Uranosphaera Bedford & Bedford, 1934, p. 7 [**U. polyaster;* OD]. Spheroidal; round osculum with thickened lip; spicules with about twelve tangential rays, reflexed toward sponge interior and often bifurcated or trifurcated; apparently no proximal or distal rays. *Lower Cambrian:* South Australia.——Fig. 381,*3a–b. *U. polyaster,* Lower Cambrian limestone, Ajax Mine, Beltana; *a,* dermal surface of fragment of hollow, spherical holotype with rimmed, possible oscular opening surrounded by wall composed of polyactinal spicules that have reflexed, interdigitating rays; *b,* side view of fragment showing strongly reflexed, spicule rays, BMNH, ×4 (Bedford & Bedford, 1936).

Order and Family UNCERTAIN

Archicladium Qian & Xiao, 1984, p. 71 [85] [**A. tridactyles;* OD]. Spicules small with several equally spaced, side-by-side rays and central axis pointing

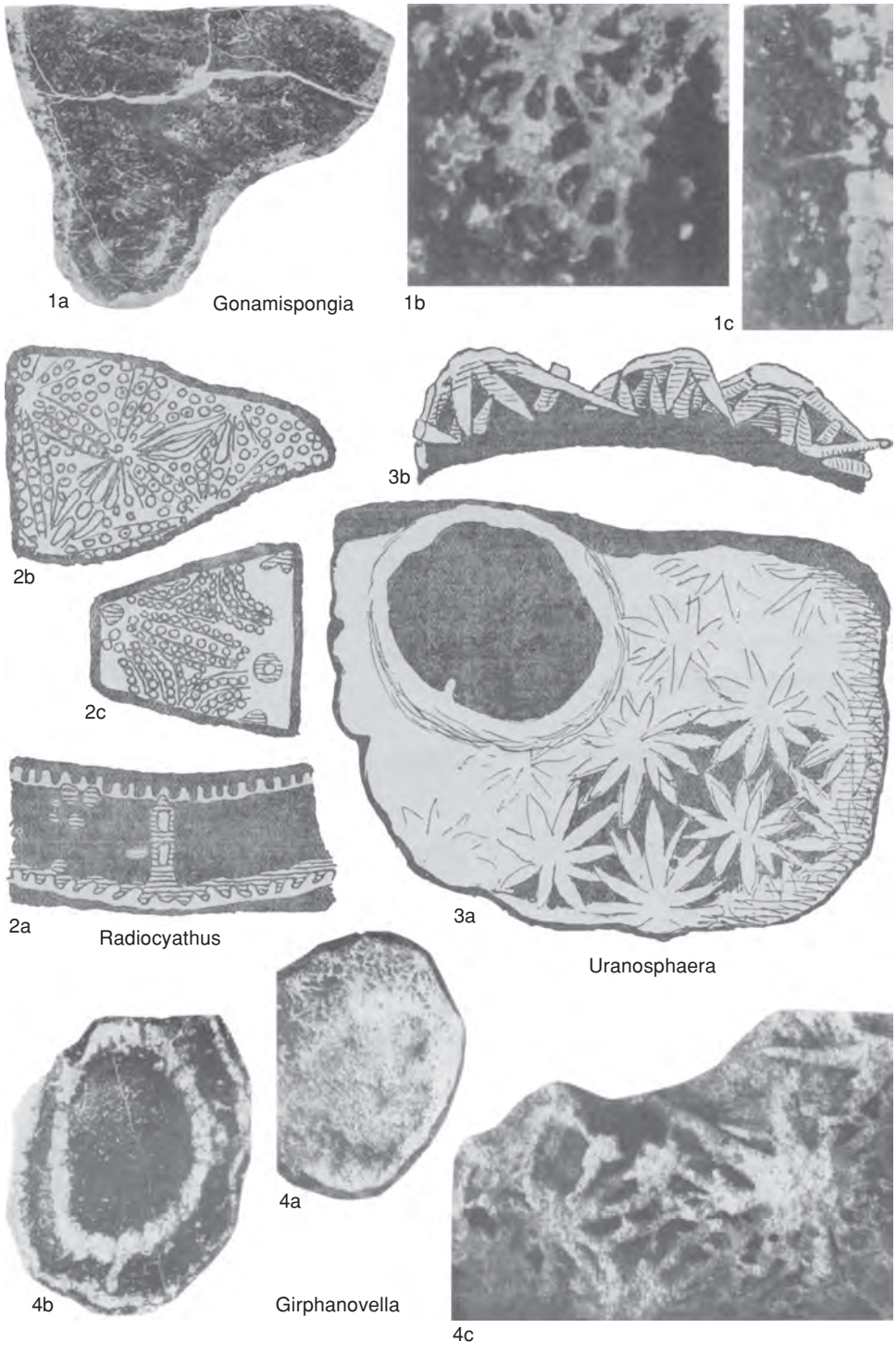


FIG. 381. Hetairacyathidae (p. 581).

in opposite direction; rays long with circular cross section and tapering slightly toward tip; central axis short with rounded end; both rays and axis smooth, without preserved openings. *lower Lower Cambrian:* China (Xinjiang).——FIG. 382,*2a–b. *A. tridactyles,* Meishucuan, Yurtus Formation; isolated spicules with short, knoblike axis and opposed parallel rays, *a,* ×50; *b,* ×40 (Qian & Xiao, 1984).

Polycladium QIAN & XIAO, 1984, p. 71 [86] [**P. yurtusensis;* OD]. Small spicules with radial symmetry consisting of central axis, round central disc, and five to seven radiating rays; central axis joining central disc in center; rays abut central disc on upper side; outer surface smooth. [Genus is based on isolated spicules that may belong to chancelloriids and thus are probably not sponges.] *lower Lower Cambrian:* China (Xinjiang).——FIG. 382,*1. *P. yurtusensis,* Meishucuan, Yurtus Formation; isolated spicule with seven reflexed rays and central axis showing through in poorly preserved, central region, ×100 (Qian & Xiao, 1984).

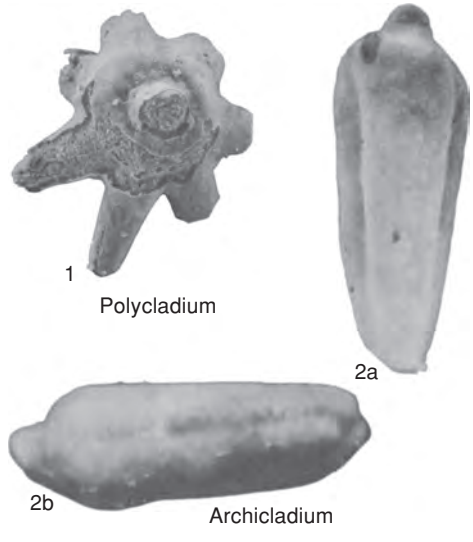


FIG. 382. Uncertain (p. 581–583).

Class, Order, and Family UNCERTAIN

Heterostella FEDOROV, 1987, p. 133 [**H. eleganta* FEDOROV, 1987, pl. 35,*8–15;* OD]. Isolated, starlike, polyactine spicules with distal ray commonly reduced or shorter than proximal ray, or rarely both proximal and distal rays are reduced; four to nine dermal rays straight to slightly curved, of variable lengths, and perpendicular to distal and proximal rays; a slightly convex disc occurring at ray junction; larger spicules with narrow, cylindrical canal. [Possible axial canals in rays of some of the large spicules suggest spicules were originally siliceous; therefore the genus may not be a heteractinid but a hexactinellid. For this reason it is placed in uncertain taxonomic position here.] *Lower Cambrian:* Russia (Yakutia-Sakha Republic).

Nabaviella MOSTLER & MOSLEH-YAZDI, 1976, p. 24 [**N. elegans* MOSTLER & MOSLEH-YAZDI, 1976, p. 25; OD]. Siliceous spicules having one central ray that on one end has 3 to 11 recurved, lateral rays and other end may have expanded knob or disc. *Eoarchean–Lower Ordovician, ?Middle Ordovician:* Iran, Kashmir, Australia, *Eoarchean–Upper Cambrian;* Kazakhstan, *Lower Ordovician, ?Middle Ordovician.*——FIG. 383,*1a. N.* sp., Ajax Limestone, Lower Cambrian, Mt. Scott Range, South Australia; isolated spicule with characteristic, recurved rays, SAMP30222, ×50 (Bengtson, 1990a).——FIG. 383,*1b. N. acanthomorpha* TIWARI, Precambrian-Cambrian boundary sequence, Pohru Valley, Kashmir; side view of isolated spicule with swollen, acanthose, proximal part and reflexed, upper, lateral rays, WIF, ×10 (Tiwari, 1997).

Taraxaculum BENGTSON, 1990a, p. 33 [**T. volans* BENGTSON, 1990a, p. 34; OD]. Siliceous spicules with central shaft and four to seven irregularly radiating, lateral rays at one end and opposite end of central shaft pointed or split into two short processes. No axial canal or filament known. *Lower Cambrian:* Australia (South Australia).——FIG. 383,*2. *T. volans,* Ajax Limestone, Mt. Scott Range; side view of holotype, isolated spicule with upper, radiating, lateral rays and split, basal part of central shaft, SAMP 30228, ×30 (Bengtson, 1990a).

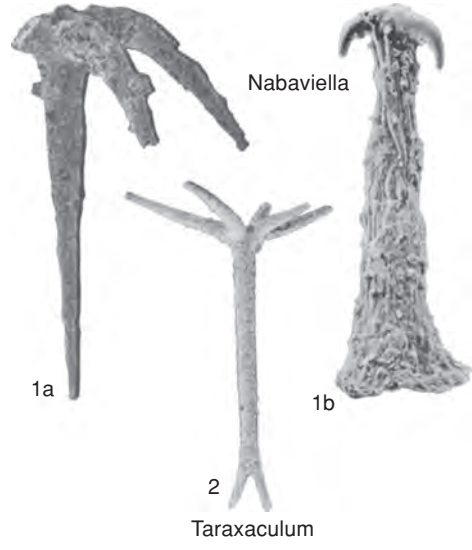


FIG. 383. Uncertain (p. 583).