MESOZOIC AND CENOZOIC CHORISTID DEMOSPONGES

R. E. H. REID

[formerly of Department of Geology, The Queens University of Belfast]

Subclass CHORISTIDA Sollas, 1880

[*nom. transl.* REID, herein, *ex* order Choristida SOLLAS, 1886, p. 177, *nom. transl. et correct. ex* suborder Choristidae SOLLAS, 1880d, p. 386] [=Tetractinellidae MARSHALL, 1876, p. 134, *sensu* ZITTEL, 1878b, p. 96]

Demospongea with triactinal, tetractinal, or pentactinal megascleres but without any spicules developed as desmas, and similar sublithistid, monaxonid, microspiculate, and askeletose sponges. Megascleres usually including both tetractines and monaxons; the latter oxeas in most genera, but other diactines (e.g., strongyles) or monactines (e.g., styles) in some; tetractinal megascleres calthrops, triaenes, or both, intergrading or not; either calthrops or triaenes accompanied in some genera by variants with more or fewer rays; a few genera with triactinal or pentactinal (centrotriaene) megascleres but no tetractines; triaenes typically arranged radially. Choanosomal megascleres of forms with triaenes may be mainly or all monaxons, which are felted without order or arranged radially; spicules of microspiculate genera diactinal to polyactinal, with triactines or tetractines always present and tetractines predominant in most genera; principal microscleres of forms with megascleres may be streptoscleres, euasters, or sigmaspires, which are not found together, except that simple euasters may accompany streptoscleres; additional microrhabds or spiny variants in some genera; a few genera with these microscleres only, or no microscleres although megascleres are present. Canal systems of modern forms eurypylous, aphodal, or diplodal; their ectosome a dermis or a cortex. Cortex sometimes packed with microscleres to form an external armor. Reproduction mainly unknown and then presumably oviparous or asexual, but a few with incubated amphiblastulae or parenchymelloid embryos. Spongin typically absent, but reportedly rarely present and then cementing megascleres. Included monaxonid genera agree closely with various choristid genera except for having only monaxon megascleres. *Ordovician–Holocene.*

This taxon, here ranked as a subclass, is used *sensu* SOLLAS (1880d, 1888) as including all nonlithistid genera with tetractinal megascleres, irrespective of whether these are calthrops or triaenes, and comparably microspiculate sponges in which typical megascleres are absent. It is not used *sensu* DE LAUBENFELS (1936, p. 166), as restricted to forms in which tetractines are long-shafted triaenes, or in the further restricted sense of BERGQUIST and HOGG (1969, p. 217), which excludes Choristida *sensu* DE LAUBENFELS in which the microscleres are sigmaspires.

The division by DE LAUBENFELS (1936, p. 166, 177; 1955, p. 42–43) of SOLLAS's order Choristida into orders Choristida *sensu* DE LAUBENFELS and Carnosa CARTER *sensu* DE LAUBENFELS (not *sensu* CARTER), with the latter comprising forms that typically lack long-shafted triaenes, was effectively a reversion to SOLLAS's (1886) provisional distinction between the suborders Triaenina SOLLAS and Tetradina SOLLAS. This arrangement was rejected by SOLLAS (1888) after study of the microscleres, which he used for his final distinctions between the suborders Sigmatophora SOLLAS, Astrophora SOLLAS, and Microsclerophora SOLLAS. DE LAUBENFEL's use of the megascleres is here rejected as inconsistent with probable relationships among the Choristida, which were more correctly understood by SOLLAS (1888), and with both the intergradation of megascleric calthrops and short-shafted and long-shafted triaenes and the presence of long-shafted triaenes in some Carnosa *sensu* DE LAUBENFELS. The name Choristida SOLLAS is also preferred for the subclass to the alternative Tetractinellida MARSHALL *sensu* ZITTEL (1878b), because the latter taxon has been used by various authors, including MARSHALL (1876) and SOLLAS (1888), as including the Lithistida.

Division of the subclass into orders is based mainly on the methods used by SOLLAS (1888) to distinguish suborders of his order Choristida with the following differences: (a) suborders are raised in rank to orders; (b) names based on spicular characters are replaced by names based on type genera; and (c) a division (Demus, SOLLAS) of SOLLAS's suborder Astrophora is made a separate order. Equivalents are as follows: suborder Microsclerophora SOLLAS: order Plakinida REID, herein; suborder Sigmatophora SOLLAS: order Craniellida REID, herein; suborder Astrophora SOLLAS in part (Demus Euastrosa SOLLAS, Demus Sterrastrosa SOLLAS): order Ancorinida REID herein; and suborder Astrophora SOLLAS in part (Demus Streptastrosa SOLLAS): order Pachastrellida REID, herein.

A few modern monaxonids are so similar to various sponges with tetractinal megascleres that their inclusion in this subclass seems well justified; but their treatment as Choristida depends on soft parts and microscleres, not available for study in the fossils. These forms are mentioned in diagnoses of the subclass and orders, but no attempt is made here to identify fossil examples. The most likely fossil examples are monaxonids placed here in the family Ophiraphiditidae SCHRAMMEN of the order Epipolasida SOLLAS, subclass Monaxonida, which agree with the choristid Cephaloraphiditidae REID except for absence of tetractines.

Order PLAKINIDA Reid, 1968

[Plakinida REID, 1968a, p. 22] [=Microsclerophora SOLLAS, 1887, p. 423; Megasclerophora VON LENDENFELD, 1903, p. 28; Homosclerophora DENDY, 1905, p. 64]

Microspiculate sponges with tetractinal or triactinal spicules, to which diactines or forms with more than four rays may be added, and askeletose sponges with amphiblastular embryos like those seen in some forms with spicules; tetractine spicules simple, partly or all lophose, or developed as candelabras; triactine spicules typically triodal, often linked with diactine spicules morphologically by intermediates with one short ray and two larger ones more or less straightened into line; some with diactines and triactines only, with either predominant; triaenes absent in most but some with short-shafted triaenes, which may be varied as diaenes or tetraenes; one modern species with triaenes and very small amphiasters. *?Upper Jurassic, Lower Cretaceous (?Albian), Upper Cretaceous (?Cenomanian, ?Santonian, Campanian)–Holocene.*

This order includes forms regarded as similar to *Plakina* SCHULZE (Plakinidae) and others (Thrombidae, Acanthastrellidae) having spicules of similar size, although genera are not certainly allied to *Plakina.* The latter applies specially to *Thrombus* SOLLAS (Thrombidae; Eocene, Holocene), in which shafts of small triaenes may have a swelling suggesting a spicular center that does not correspond with the center from which the rays radiate.

Because of the small size of the spicules, the fossils ascribed to this order are rare and mainly from deposits yielding microscleres. The oldest are small, isolated calthrops and lophose calthrops from the Carboniferous (Visean) of Ireland, not ascribed to any genus but similar to those of some living Plakinidae. Spicules like those of *Acanthastrella* SCHRAMMEN occur in the Upper Jurassic (Kimmeridgian) of Germany, and this genus occurs in the Upper Cretaceous of Germany. Spicules like those of modern species of *Plakina* and *Thrombus* occur in the Eocene of New Zealand, and some other loose Cretaceous spicules may be plakinid.

The family Helobrachiidae SCHRAMMEN, 1910, which was included in this order (as Homosclerophora DENDY, 1905) by REZVOI, ZHURAVLEVA, and KOLTUN (1962), comprises one genus with large megascleres and is here referred to the order Pachastrellida.

Family PLAKINIDAE Schulze, 1880

[Plakinidae SCHULZE, 1880, p. 441] [=Corticiolae VOSMAER, 1885, p. 323]

Microspiculate sponges, without triaenes unless a subtriaene occurs as a variant of a calthrops; spicules typically including tetractines, which are often predominant, although diactines, triactines, pentactines, or forms with more rays may occur; some genera with triactines and diactines only, with either predominant. Diactines commonly irregular, intergrading with triactines. Tetractines all simple or some lophose, then sometimes candelabras (*s.s.*). One modern genus viviparous, with amphiblastula embryos. [Monolophose and trilophose tetractines have triaenose symmetry but are not classed as triaenes, being simply two forms in a series from monolophose to tetralophose; this type of variation does not occur in triaenes *s.s.* The doubtful records above are based on isolated spicules, not identified generically. The Carboniferous (Mississippian) record is acceptable as genuine, since spicules concerned include small, lophose calthrops.] *Lower Cretaceous (?Albian), Paleogene (upper Eocene)–Holocene.*

Plakina SCHULZE, 1880, p. 448 [**P. monolopha;* SD DE LAUBENFELS, 1955, p. 44]. Simple, encrusting sponges with thin dermis or no ectosome; eurypylous; spicules simple diactines, triactines, and tetractines, and monolophose to tetralophose tetractines; embryos incubated amphiblastulae. *Lower Cretaceous (?Albian), Paleogene (upper Eocene)–Holocene:* England, *?Albian*; New Zealand, *upper Eocene;* cosmopolitan, *Holocene.*——FIG. 127,*1a–i.* **P. monolopha,* Holocene, Mediterranean Sea; *a–e,* various diactine to tetractine megascleres; *f–i,* monolophous tetractines, ×400 (Schulze, 1880).——FIG. 127,*1j–l. P. trilopha* SCHULZE, Holocene, Mediterranean Sea; trilophose tetractines, ×400 (Schulze, 1880).——FIG. 127,*1m–p. P. australis* HINDE & HOLMES, Oamaru Formation, upper Eocene, New Zealand; *m,* monolophose calthrops; *n,* dilophose calthrops; *o–p,* trilophose calthrops, last placed with this species by HINDE and HOLMES, 1892, ×600 (Hinde & Holmes, 1892).

Acanthoplakina BURTON, 1959, p. 156 [**Plakinolopha spinosa* KIRKPATRICK, 1900, p. 350; OD]. Spicules diactines, triactines, and calthrops, with strong, lateral spines, repeatedly branched (polycladose) tips, or both; successive divisions of tips in planes rotating at right angles; rays of calthrops often with whorl of large spines near their origins; diactines may be larger than other spicules. *Paleogene (upper Eocene)–Holocene:* New Zealand, *upper Eocene;* Indian Ocean, Western Pacific, *Holocene.*——FIG. 127,*4. A.* sp., upper Eocene, Otago, New Zealand; characteristic spiny calthrops, ×600 (Hinde & Holmes, 1892).

Corticium SCHMIDT, 1862, p. 42 [**C. candelabra;* OD]. Aphodal to diplodal; spicules simple calthrops and subtriaenes, lophose calthrops and candelabras (tetralophose calthrops, with one branching ray distinct from others, and its branches often spiny). *Paleogene (upper Eocene)–Holocene:* New Zealand, *upper Eocene;* cosmopolitan, *Holocene.*——FIG. 127,*2a–c. C.* spp., upper Eocene, Otago, New Zealand; candelabra spicules, ×600 (Hinde & Holmes, 1892).

Family THROMBIDAE Sollas, 1887

[Thrombidae SOLLAS, 1887, p. 428]

Microspiculate sponges whose characteristic spicules are short-shafted, spiny triaenes, sometimes having a central or subcentral enlargement of axial filament of rhabdome; sometimes also with monaene, diaene, tetraene, or mesotriaene variants of characteristic triaenes; one modern species with very small, additional amphiasters (possible amphitetraenes). [The group is sometimes included with Plakinidae, but axial enlargement in rhabdomes suggests a spicular center; if this is correct, the seeming triaenes are trichodiactines, not tetractines. This feature does not occur in Plakinidae *s.s.*] *?Upper Cretaceous, Paleogene (upper Eocene)–Holocene.*

Thrombus SOLLAS, 1886, p. 179 [**T. challengeri;* OD]. Encrusting to nodular; spicules sometimes trichotriaenes or mesotriaene variants of this type (mesotrichotriaenes), to which other variants (e.g., monaenes, diaenes) or very small amphiasters (possible amphitetraenes) may be added; sometimes partly or all sigmatriaenes (short-shafted protriaenes with cladal tips flexed outwardly) and monaene to tetraene variants; central enlargement of rhabdal axis sometimes marked by external annulation; second rhabdal ray of mesotriaenes up to about half length of primary one. *?Upper Cretaceous, Paleogene (upper Eocene)–Holocene:* northern Germany, *?Upper Cretaceous;* New Zealand, *upper Eocene;* Indian Ocean, Western Pacific, Caribbean, Atlantic, *Holocene.*——FIG. 127,*3a. T.* sp.? SCHRAMMEN, Mukronatenkreide, Campanian, Misburg, Germany; trichotriaene, lacking characteristic spines, ×50 (Schrammen, 1924a; courtesy of E. Schweizerbart'sche Verlagsbuchhandlung).——FIG.

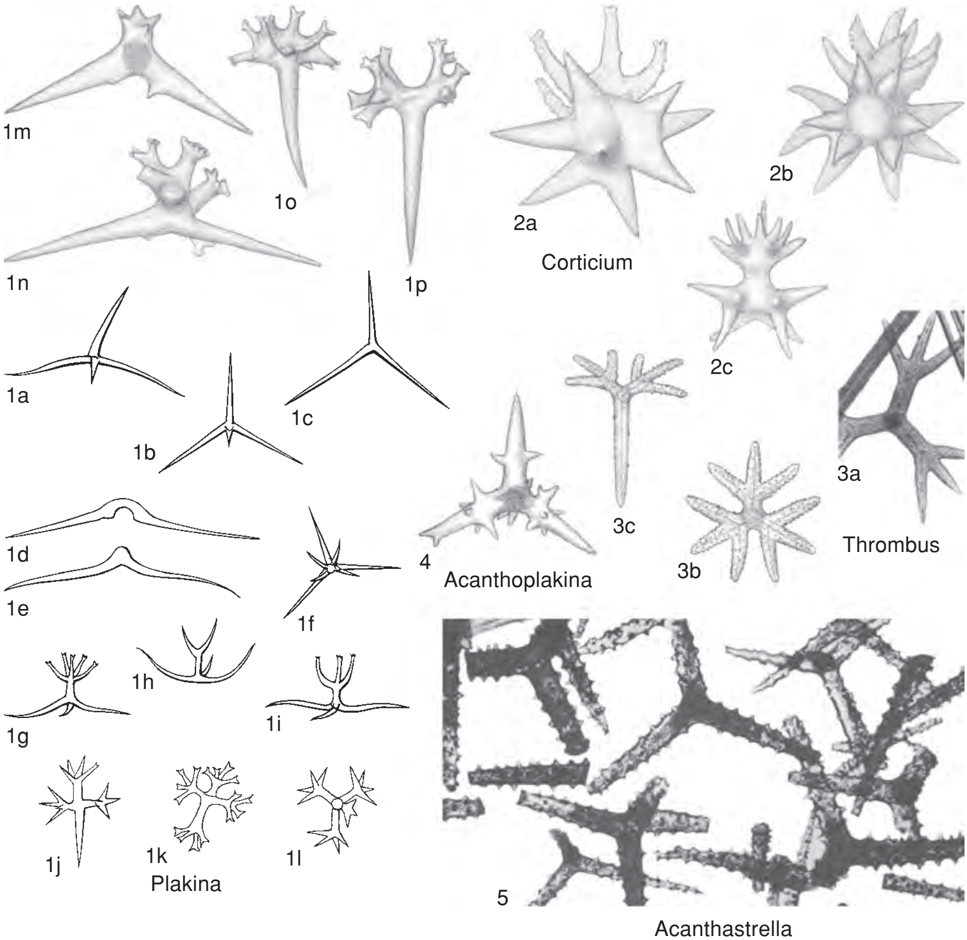

FIG. 127. Plakinidae, Thrombidae, and Acanthastrellidae (p. 177–178).

127,*3b–c*. *T.* sp., upper Eocene, Otago, New Zealand; cladome of trichotriaene and trichodiaene, ×200 (Hinde & Holmes, 1892).

Family ACANTHASTRELLIDAE Schrammen, 1924

[Acanthastrellidae SCHRAMMEN, 1924a, p. 37]

Spicules small, spiny, grading from calthrops into short-shafted triaenes, some approaching size of true megascleres; other characters unknown. [The relationships of this group are doubtful, possibly with recent families Plakinidae, Pachastrellidae, or Plakinastrellidae (no known fossils). The axial enlargement seen in triaenes of Thrombidae is not developed. Similarly shaped calthrops to triaenes from Carboniferous (Mississippian, Ireland) are of megascleric size and occur with apparently related pentactines (tetraenes) and hexactines.] *?Upper Jurassic, Upper Cretaceous (Campanian).*

Acanthastrella SCHRAMMEN, 1924a, p. 44 [**A. panniculosa;* OD]. Encrusting or nodular; rays of spicules unbranched; spines without order or locally with more or less annular or spiral arrangement. *?Upper Jurassic, Upper Cretaceous (Campanian):* southern Germany [loose spicules only], *?Upper Jurassic;* northern Germany, *Campanian.*——FIG. 127,*5*. **A. panniculosa,* Mucronatenkreide, Campanian, Misburg; isolated triaenes with spinose rays, ×50 (Schrammen, 1924; courtesy of E. Schweizerbart'sche Verlagsbuchhandlung).

Order PACHASTRELLIDA new order

[Pachastrellida REID, herein] [=Demus Streptastrosa SOLLAS, 1888, p. cxxvii]

Choristid sponges whose characteristic microscleres are streptoscleres (plesiasters, metasters, and related forms of spirasters and amphiasters), having triaenes, calthrops, or both among their megascleres, and similar sponges having euasters or diactinal microscleres but no typical triaenes; streptoscleres often accompanied by microrhabds and in some forms by simple oxyasters having 4 to 6 rays. *Carboniferous–Holocene.*

Due to absence of microscleres in fossils, recognition of genera referred to this order is based on comparison of their megascleres with those of modern examples and especially on occurrence of megascleric calthrops or comparable spicules (triactines, centrotriaenes). These calthrops and comparable spicules are confined to this order in the modern Choristida; the same is here assumed to be true of the fossils, although without direct knowledge of their microscleres.

Genera with streptoscleres were formerly placed by REID (1968a) in an order Poecillastrida REID, equivalent to DENDY's (1924a) Streptosclerophora. Because of the absence of microscleres in fossils, it is here more convenient to follow SOLLAS in including forms with calthrops, with euasters or diactinal microscleres, in the family Pachastrellidae CARTER. This also seems consistent with their probable relationships. The order name is changed to allow for this difference in concept, and because (a) the name Poecillastrida can be criticized as resembling Poecillosclerida TOPSENT, which refers to the Desmacidontida of this classification, and (b) *Poecillastra* SOLLAS is not the type genus of a family and is also regarded by some authors as a synonym of *Pachastrella* SCHMIDT.

The order appears to be first represented by loose calthrops or subtriaenes from the Upper Ordovician of Sweden (REIF, 1968), assuming that these did not belong to other unknown forms. Branching calthrops like those of some modern *Pachastrella* species (e.g., *P. abyssi* SCHMIDT) occur from the Carboniferous (Visean) of Ireland.

Family PACHASTRELLIDAE Carter, 1875

[*nom. transl.* SOLLAS, 1886, p. 177, *ex* "group" (subfamily) Pachastrellina CARTER, 1875, p. 185] [=Calthropellidae VON LENDENFELD, 1907, p. 301; Halinidae DE LAUBENFELS, 1934, p. 1]

Megascleres typically include calthrops, replaced sometimes by subtriaenes or centrotriaenes; some genera with both calthrops and typical triaenes, intergrading or not; monaxon megascleres present or absent; microscleres of modern examples include either streptoscleres or euasters, to which microrhabds or variants may be added, or microrhabds only. Subtriaenes may be nearly triactinal, with one ray represented by a rudiment. [This family includes the zoological families Pachastrellidae CARTER and Calthropellidae VON LENDENFELD, united for convenience. Because these families cannot be distinguished without reference to microscleres, the reference of fossils without microscleres to living genera is always doubtful.] *Carboniferous–Holocene.*

Halinidae DE LAUBENFELS, as used in the previous *Treatise Part E* (DE LAUBENFELS, 1955), is a junior synonym of five older family names based on included genera: Pachastrellidae CARTER, 1875; Plakinidae SCHULZE, 1880; Corticidae VOSMAER, 1885; Calthropellidae VON LENDENFELD, 1907; and Acanthastrellidae SCHRAMMEN, 1924a. Here *Plakina* SCHULZE and *Corticium* SCHMIDT are in the Plakinidae and *Acanthastrella* SCHRAMMEN in the Acanthastrellidae.

The following key shows pachastrellid genera suggested by a number of types of megascleric skeletons, including some not recorded below.

A. With calthrops or subtriaene variants, or both intergrading; sometimes also with other variants having more or fewer rays.

A_1. Oxea megascleres absent.

a. No distinct category of dichotriaene megascleres; branching rays uncommon or absent in calthrops etc.; *Halina* BOWERBANK

(Halininae) or *Calthropella* SOLLAS (Calthropellinae).

b. With no subordinate dichotriaenes, which may form an ectosomal skeleton; main megascleres simple and branching calthrops, the branches of the latter sometimes resembling zygomes of desmas: *Propachastrella* SCHRAMMEN (subfamily unknown).

A_2. Oxea megascleres present.

c. No triaenes, unless calthrops are varied as subtriaenes; *Pachastrella* SCHMIDT (Pachastrellinae).

d. With calthrops or subtriaenes accompanied by short-shafted orthotriaenes or plagiotriaenes, intergrading or not: *Poecillastra* SOLLAS (Pachastrellinae).

e. With calthrops and dichotriaenes: *Chelotropella* VON LENDENFELD (Calthropellinae).

f. With calthrops and centrotriaenes: *Yodomia* LEBWOHL (Pachastrellinae).

B. No calthrops or comparable subtriaenes; oxeas present.

B_1. Megascleres other than oxeas are triactines or subtriactines, the latter spicules with a fourth ray represented by a rudiment or an internal axial rudiment.

a. Rays of triactinal spicules straight or branching, not curved nor terminally hooked: *Nethca* SOLLAS (Pachastrellinae) or *Pachastrissa* VON LENDENFELD (Calthropellinae).

b. Rays of triactinal spicules unbranched, markedly curved, or hooked terminally: *Helobrachium* SCHRAMMEN (subfamily unknown).

B_2. With centrotriaenes, whose cladi branch repeatedly: *Triptolemma* DE LAUBENFELS (Halininae).

Subfamily PACHASTRELLINAE Carter, 1875

[*nom. correct.* REID, herein, *pro* "group" (subfamily) Pachastrellina CARTER, 1875, p. 185]

Characteristic microscleres of modern species are streptoscleres, often accompanied by microrhabds or variants; euasters (unless triactinal or tetractinal plesiasters are considered as such). *Carboniferous (?Mississippian), ?Jurassic, ?Cretaceous, Paleogene (?upper Eocene), Holocene.*

Pachastrella SCHMIDT, 1868, p. 15 [**P. monilifer;* OD]. Encrusting to massive, funnel-like or lamellar; megascleres typically oxeas and calthrops or equiradiate subtriaenes, calthrops and subtriaenes intergrade if both are present; triactines or pentactines may occur as tetractine variants; calthrops sometimes simple, but often with one to all four rays branching; irregularly branching form common; subtriaenes with three rays bent toward or away from the fourth; no distinct category of triaenes; no radial arrangement of megascleres; all modern species with streptoscleres; microrhabds often also present, commonly stout microstrongyles, sometimes also including slender, rough to finely spinulate spicules, which may be straight, bent, or spirally twisted so as to resemble spinispiras. [Supposed fossil records all doubtful, based on isolated calthrops or on material lacking oxeas. Fossil spicules ascribed to *Pachastrella* SCHMIDT, with termination *-ites;* invalid under *Code* Article 20 (ICZN, 1999).] *Carboniferous (?Mississippian), ?Jurassic, ?Cretaceous, Paleogene (?upper Eocene), Holocene:* Ireland, Scotland, *?Mississippian;* England, Germany, *?Jurassic;* Czech Republic, Slovakia, England, Germany, Poland, *?Cretaceous;* New Zealand, *?upper Eocene;* cosmopolitan, *Holocene.*——FIG. 128,*4a–g. P. abyssi* SCHMIDT, Holocene, South Atlantic; *a,* calthrops, ×25; *b,* calthrops with branching rays, ×50; *c–f,* streptoscleres; *g,* microstrongyle, ×540 (Sollas, 1888).

Nethea SOLLAS, 1888, p. 103 [**Tisiphonia nana* CARTER, 1880b, p. 138; OD]. Encrusting, massive, lamellar, or other shapes; megascleres oxeas and triactines or subtriactines, the last with three main rays fully developed, simple or branched, and a fourth represented by a rudiment, or an internal axial rudiment; microscleres microoxeas and spirasters. *Upper Cretaceous (?Coniacian–?Maastrichtian), Holocene:* northern England, *?Coniacian–?Maastrichtian;* cosmopolitan, *Holocene.*——FIG. 128,*5a–b. N. ? plana* (HINDE), Upper Chalk, ?Senonian, Upware, northern England; *a,* sponge, ×1; *b,* triactine megascleres, similar to those of living *N. amygdaloides* (CARTER), ×10 (Hinde, 1884a).

Subfamily CALTHROPELLINAE von Lendenfeld, 1907

[*nom. transl.* REID, herein, *ex* Calthropellidae VON LENDENFELD, 1907, p. 301]

Characteristic microscleres of modern species are euasters; streptoscleres absent. *?Cretaceous, Holocene.*

Calthropella SOLLAS, 1888, p. 107 [**C. simplex;* SD VON LENDENFELD, 1903, p. 83] [=*Corticellopsis* BERGQUIST, 1968, p. 62 (type, *Corticella*

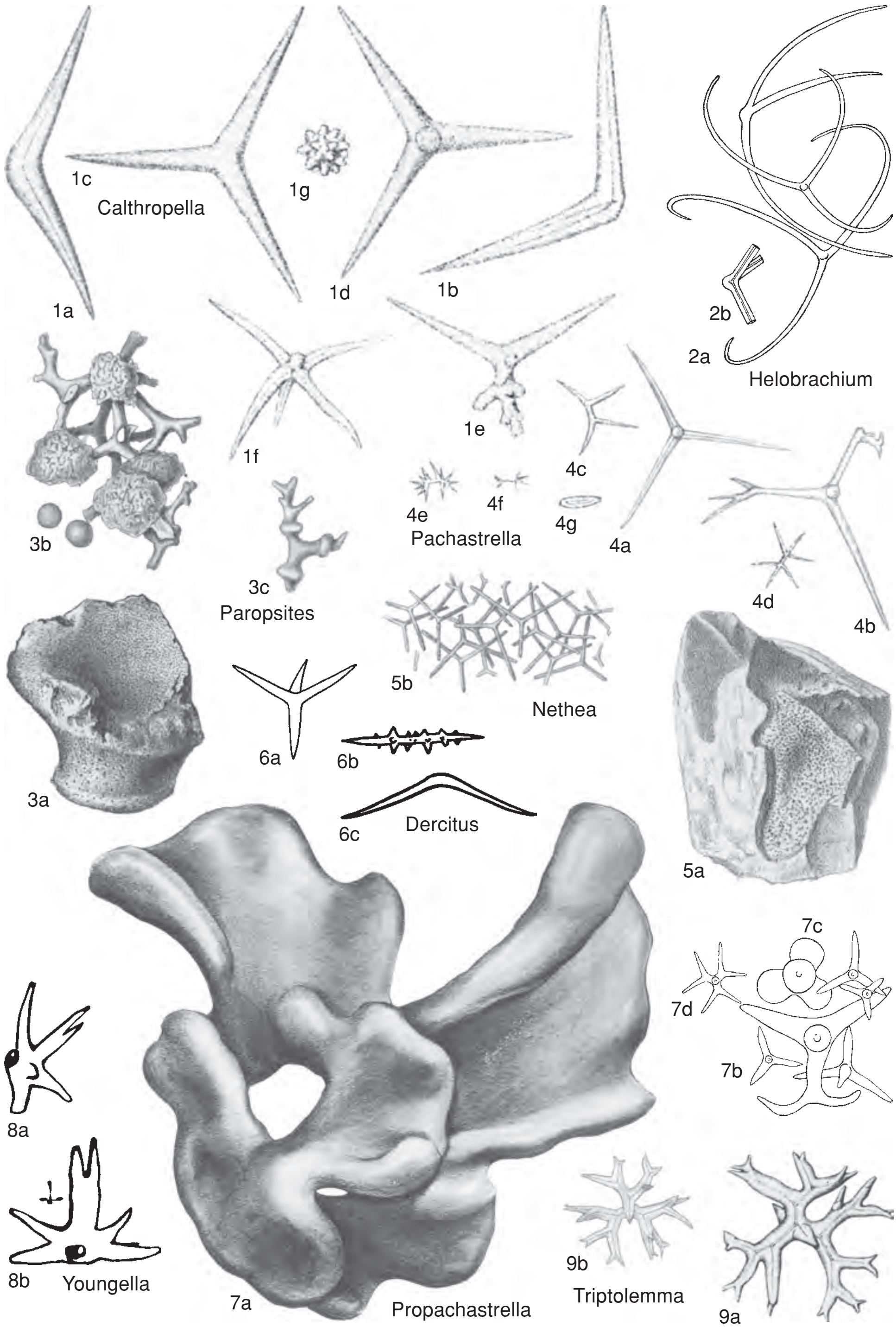

FIG. 128. Pachastrellidae (p. 180–183).

novaezealandiae BERGQUIST, 1961, p. 45)]. Encrusting to massive; megascleres calthrops and subordinate variants; the latter monactines (rare), diactines, triactines, pentactines, or hexactines, sometimes mainly triactines or all pentactines or hexactines; rays of megascleres all unbranched or dichotomous in occasional examples; no oxeas; microscleres spherasters or strongylasters plus oxyasters, the latter distinct or developmental stages of the others. [Possible identification of supposed fossil *Pachastrella* species lacking oxeas: but see also *Halina* BOWERBANK.] *?Cretaceous* (*fide* DE LAUBENFELS, 1955, untraced), *Holocene:* cosmopolitan.——FIG. 128,*1a–g*. **C. simplex,* Holocene, Cape Verde Islands, eastern Atlantic; *a–b,* calthrops reduced to diactinate; *c,* triod; *d–e,* calthrops, the latter with stunted cladi, making it appear like a lithistid spicule; *f,* triode with three adventitious rays, ×25; *g,* microsclere or young spheraster, ×225 (Sollas, 1888).

Subfamily HALININAE de Laubenfels, 1934

[*nom. transl.* REID, herein, *ex* Halinidae DE LAUBENFELS, 1934, p. 1]

Characteristic microscleres of modern species are spiny microrhabds or variants; sometimes also with euasters or toxas. [Originally invalid (junior) substitute for family name Pachastrellidae CARTER, 1875, based on the idea that family type should be oldest genus included; here adopted in new sense for Pachastrellidae grouped with *Halina* BOWERBANK.] *Lower Cretaceous (?Albian), Paleogene (upper Eocene)–Holocene.*

Dercitus GRAY, 1867, p. 542 [**Hymeniacidon bucklandi* BOWERBANK, 1858, p. 288; SD DE LAUBENFELS, 1936, p. 43] [=*Halina* BOWERBANK, 1858, p. 288, *non* DE BLAINVILLE, 1830 (type, *H. bucklandi* BOWERBANK, 1858, p. 288); *Battersbya* BOWERBANK, 1874b, p. 343 (type, *Hymeniacidon bucklandi* BOWERBANK, 1864, p. 234)]. Encrusting to nodular, with a cortex; megascleres typically regular calthrops or slightly subtriaenose variants, with unbranched rays, not accompanied by monaxons; other variants unusual; microscleres toxas and spiny microrhabds, which may pass into sanidasters or amphiasters. [ENGESER and MEHL (1993) considered *Dercites* and *Dercitus* as the same genus. They have different type species and probably should be kept separate, with *Dercites* as the unidentifiable form as treated by DE LAUBENFELS (1955, p. 105).] *Lower Cretaceous (?Albian), Holocene:* southern England, *?Albian;* cosmopolitan, *Holocene.*——FIG. 128,*6a–c*. **D. bucklandi* (BOWERBANK), Holocene, Europe; *a,* calthrops, ×50; *b,* spiny microxea; *c,* toxa, ×300 (de Laubenfels, 1955).

Triptolemma DE LAUBENFELS, 1955, p. 43, *nom. nov. pro Triptolemus* SOLLAS, 1888, p. 93, obj., *non* PECKHAM, 1885 [**Triptolemus cladosus* SOLLAS, 1888, p. 93; OD]. Characteristic megascleres centrotriaenes, with rhabdal rays short, equal, conical, and cladi irregularly polycladose; sometimes also with oxeas, but no calthrops or other tetractines; microscleres spiny microrhabds, spinispira-like strongylospires, or amphiasters. [Diagnosis by DE LAUBENFELS, 1955, in which he cited calthrops as megascleres, does not fit characters of type or any species.] *Paleogene (upper Eocene)–Holocene:* New Zealand, *upper Eocene;* eastern Atlantic, Indonesia, *Holocene.*——FIG. 128,*9a*. **T. cladosa* (SOLLAS), Holocene, Indonesia; centrotriaene, ×150 (Sollas, 1888).——FIG. 128,*9b*. *T. australis* (HINDE & HOLMES), upper Eocene, Otago, New Zealand; characteristic centrotriaene, showing one of rhabdal rays only, ×40 (Hinde & Holmes, 1892).

Subfamily UNCERTAIN

Fossil Pachastrellidae *s.l.* with megascleres comparable to those of living species or more than one subfamily above, or with no living species.

Acanthophora SOLLAS, 1873, p. 79 [**A. hartogii;* OD]. Massive, lobose with oxea megascleres and tornote, triradiate to hexiradiate microscleres, but poorly known. [No known suitable figures.] *Lower Cretaceous:* Europe.

Helobrachium SCHRAMMEN, 1910, p. 128 [**H. consecatum;* OD]. Encrusting to irregularly lobate; principal megascleres subtriactines with three long, curved to terminally hooked rays, and a fourth ray represented by a buttonlike rudiment; hooked ends may intermesh so that skeleton is loosely coherent without zygosis; oxeas also present; microspiculation unknown (no exact modern couterpart, but comparable subtriactines occur in *Nethea* SOLLAS of Pachastrellinae and *Pachastrissa* VON LENDENFELD of Calthropellinae). [The genus was placed in the lithistid suborder Megamorina by DE LAUBENFELS (1955, p. 50–51) and said to have "typical megaclone desmas," with additional triactines; but spiculation as given by SCHRAMMEN (1910) and above are to the present author's knowledge.] *Upper Cretaceous (Coniacian–Maastrichtian):* northern Germany.——FIG. 128,*2a–b*. **H. consecatum,* Quadratenkreide, Senonian, Oberg; *a,* triactine spicules with long, curved rays that have axial canals; *b,* part of small spicule with node that has short canal suggesting rudimentary fourth ray, ×10 (Schrammen, 1910).

Paropsites POČTA, 1884, p. 40 [**P. hindei;* OD]. Sponge basin shaped with a thick, basal stalk, thick walled with well-developed, radial, canal system; gastral surface with round, exhalant ostia; spicules are oxeas with associated, small spheres, and calthrops with tips of rays finely branched. *Creta-*

ceous: Europe.——FIG. 128,*3a–c*. **P. hindei,* Malnitzer Schichten, Bohemia; *a,* side view of typical sponge, ×0.5; *b,* skeletal fragment with small spheres and calthrops; *c,* isolated, small spicule with ringlike structures on rays, ×50 (Počta, 1884).

Propachastrella SCHRAMMEN, 1910, p. 71 [**Pachastrella primaeva* VON ZITTEL, 1878b, p. 9; OD]. Lamellar, leaf or ear shaped to irregularly lobate or nodular; principal megascleres simple and branching calthrops; distinct dichotriaenes also present, sometimes forming an ectosomal skeleton; terminal branches of branched calthrops may resemble zygomes of desmas, although not articulated; some examples also with calthrops in which unbranched rays are shortened and swollen, or with pentactinal to polyactinal calthrops variants; no oxea megascleres, microspiculation unknown (no exact counterpart in living sponges, and calthrops and dichotriaenes found together in both Pachastrellinae and Calthropellinae). [Comparable modern forms include *Pachastrella chuni* VON LENDENFELD, 1907 (Pachastrellinae), *Chelotropella sphaerica* VON LENDENFELD, 1907 (Calthropellinae), calthrops and dichotriaenes in both, although oxeas also present.] *Cretaceous (Turonian–Maastrichtian):* France, Germany, Poland.——FIG. 128,*7a–d*. **P. primaeva* (VON ZITTEL), Mucronatenkreide, Senonian, Misburg, Germany; *a,* leaflike, irregularly lobate sponge, ×0.5; *b–c,* spicules of type species, calthrops, latter with swollen rays, Quadratenkreide, Oberg, Germany; *d,* dermal dichotriaene, Quadratenkreide, Oberg, Germany, ×10 (Schrammen, 1910).

Youngella DE LAUBENFELS, 1955, p. 44, *nom. nov. pro Chlamys* YOUNG & YOUNG, 1877, p. 429, *non* KNOCH, 1801 [**Chlamys magna* YOUNG & YOUNG, 1877, p. 429; OD]. Resembles *Corticium* but poorly known. *Carboniferous:* Scotland.——FIG. 128,*8a–b*. **Y. magna* (YOUNG & YOUNG), Carboniferous limestone, Cunning Baidland, Ayrshire; isolated bitornote spicules of type suite, ×6 (Young & Young, 1877).

Family COSTAMORPHIIDAE Mostler, 1986

[Costamorphiidae MOSTLER, 1986, p. 343]

Sponges whose megascleres are composed of diverse calthrops, asterlike triaenes or of calthrops-derived needles and diverse triders, all showing outer sculpture of riblike halfrings with irregular margins; known only from isolated spicules. *Upper Triassic.*

Costamorpha MOSTLER, 1986, p. 343 [**C. zlambachensis;* OD]. Sponges whose skeleton is composed of calthrops and associated mesotriaenes with characteristic outer sculpture of irregular half rings. *Upper Triassic:* Austria.——FIG. 129,*1a–b*. **C. zlambachensis,* Zlambach Formation, Rhaetian, St. Agatha; *a,* holotype calthrop; *b,* drawing of characteristic calthrop, scale not given but approximately ×100 (Mostler, 1986).

Family THENEIDAE Gray, 1872

[*nom. correct.* SOLLAS, 1886, p. 178, *pro* Theneadae GRAY, 1872a, p. 460]

Sponges with triaene and oxea megascleres and streptosclere microscleres; no megascleric calthrops, triactines, or centrotriaenes; triaenes usually long shafted; architecture radiate or not; some anchored by protruded anatriaenes, or rarely by distally knobbed pseudotylostyles, in which terminal knob may contain axial rudiments of anatriaene cladi; modern examples eurypylous and noncorticate. [Diagnoses were sometimes based on soft parts and microscleres (e.g., SOLLAS, 1888), which then would include some genera with calthrops, which here are included in the family Pachastrellidae (subfamily Pachastrellinae). MALDONADO (2002, p. 141) included the Theneidae in the Pachastrellidae, but they are retained here as separate families. Sponges considered here as within the Theneidae were included with Ancorinidae by DE LAUBENFELS (1936, 1955) through identification of streptoscleres with ancorinid sanidasters.] *Upper Cretaceous (?Turonian, Coniacian)–Holocene.*

Thenea GRAY, 1867, p. 541 [**Tethea muricata* BOWERBANK, 1858, p. 308; OD]. Typically symmetrical, usually globular, hemispherical, or mushroomlike, and attached by a diffuse root tuft or by a group of more compact, rootlike processes; often hispid or with a prominent equatorial fringe of hisapidating spicules; pores mainly in special lateral areas; internal skeleton radiate; triaenes typically including dichotriaenes, with short, primary cladi and long branches, additional protriaenes, and small anatriaenes; radical megascleres usually large anatriaenes, to which a few pseudotylostyles may be added, but occasionally all pseudotylostyles; with streptoscleres only, or with plesiaster-variant oxyasters having four or one to several more rays (supposed records based on isolated megascleres). *Cretaceous (?Turonian, Coniacian–Maastrichtian), Paleogene (?upper Eocene), Holocene:* Czech Republic, Slovakia, England, *?Turonian, Coniacian–Maastrichtian;* New Zealand, *?upper Eocene;* cosmopolitan, *Holocene.*——FIG. 129,*2a–e*. *T. wyvillii* SOLLAS, Holocene, Philippine Islands; *a,* side view of sponge showing roots, ×0.5; *b,* dichotriaene, ×10; *c,* internal anatriaene, ×100; *d,* metaster, ×300; *e,* calthrops-like oxyaster (plesiaster), ×49

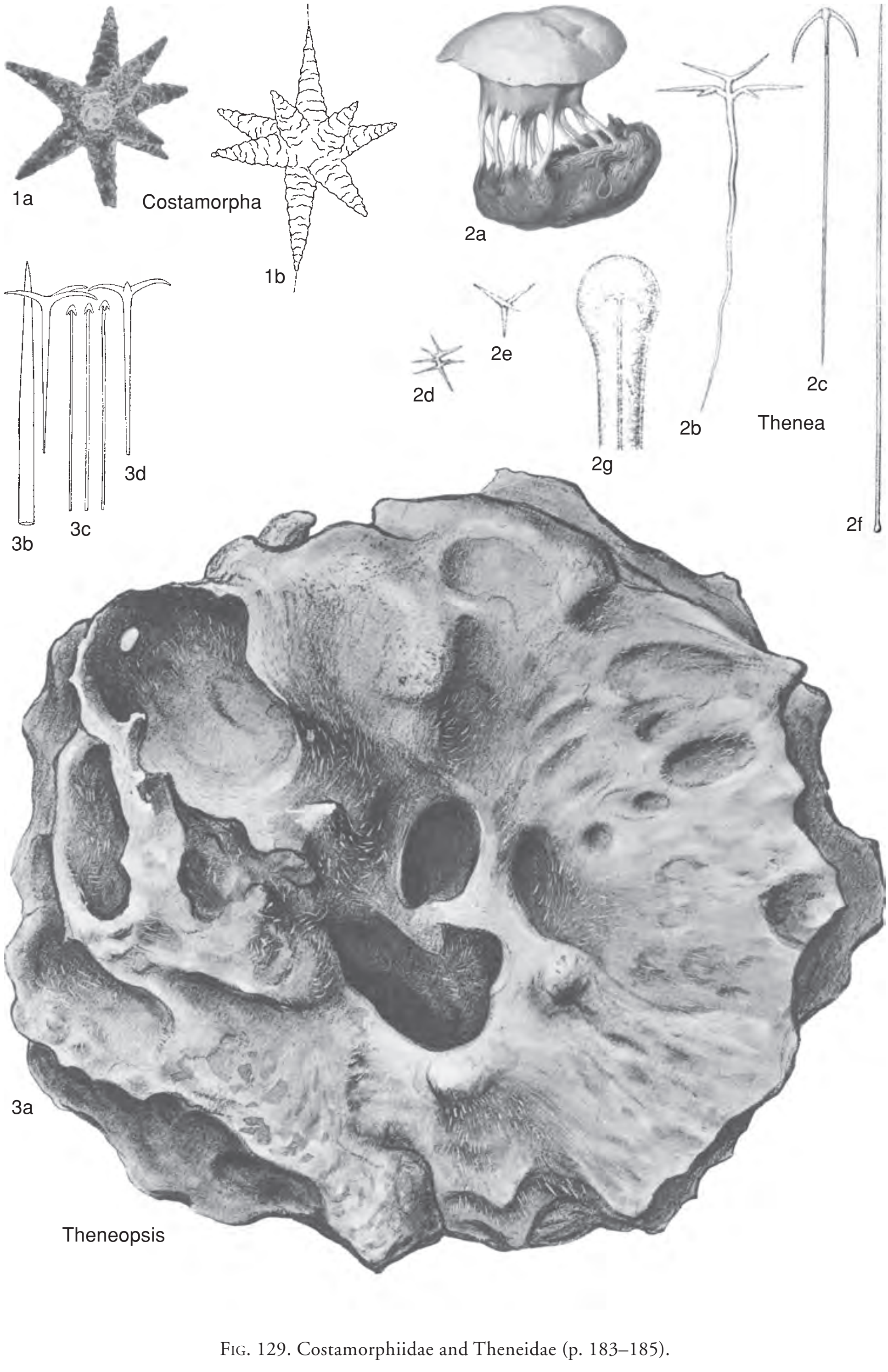

FIG. 129. Costamorphiidae and Theneidae (p. 183–185).

(Sollas, 1888).——Fig. 129,*2f–g. T. delicata* Sollas, Holocene, South Indian Ocean; *f,* radical pseudotylostyle, ×15; *g,* terminal knob (tylus) of same, showing axial rudiments, ×180 (Sollas, 1888).

?Theneopsis Schrammen, 1910, p. 54 [**Tethyopsis steinmanni* von Zittel, 1878b, p. 9, OD] [=*Tethyopsis* von Zittel, 1878b, p. 9, obj., *non* Stewart, 1870, p. 281]. Nodular or tuberlike, some examples lacunar internally; megascleres large oxeas, smaller orthotriaenes and delicate, but long-shafted anatriaenes arranged perpendicular to external surface or to surfaces of internal lacunae; microscleres unknown. [Name suggests relationship to *Thenea,* but compared with *Sphincterella* de Laubenfels (as *Sphinctrella* Schmidt, *non* Schmarda) by original author; could equally be ancorinid or geodiid.] *Cretaceous (upper Campanian):* northern Germany.——Fig. 129,*3a–d.* **T. steinmanni* (von Zittel), Quadratenkreide, Misburg; *a,* irregular, tuberlike sponge with internal lacunae, ×1; *b–d,* spicules including orthotriaenes, anatriaenes, incomplete, and oxea, incomplete, ×10 (Schrammen, 1910).

Order ANCORINIDA Reid, 1968

[Ancorinida Reid, 1968a, p. 22; *emend.,* Reid, herein]

Choristid sponges with triaenes and euaster microscleres, or with additional spinulated microrhabds or sanidasters or these types of microscleres only, and similar monaxonids that differ only in absence of triaenes; some with sterrasters or aspidastera in addition to normal euasters; most choristids with oxea megascleres in addition to triaenes, and some with strongyles or styles. *Carboniferous (Mississippian)–Holocene.*

Recognition of fossils referred to this order may be based on comparison of megascleres with those of modern examples or recognition of sterraster or aspidaster microscleres, which occur in some sediments. The oldest apparent sterrasters are Carboniferous (Mississippian), and occur with dichotriaene megascleres like those of various modern Geodiidae, of which these microscleres are characteristic. Since this family is the most specialized of the order, both the family and the order are likely to be older than the known record.

The order Ancorinida was originally taken as including all choristids with microscleres of the above types and all monaxonids with true euasters (i.e. not pseudoeuasters; Reid, 1968a). The choristid Calthropellidae von Lendenfeld and Halinidae de Laubenfels are now included in the order Pachastrellida (family Pachastrellidae) following Sollas (1888), and most of the monaxonids are placed in the order Epipolasida de Laubenfels. This change is partly for convenience in paleontology; but it also seems clear that the monaxonids have varied affinities and that some, at least, are allied to the Spirastrellida, although the latter have spinispira microscleres when any distinctive forms are present. *Tethya* Lamarck in particular agrees closely with the typical Spirastrellida biochemically (Bergquist & Hogg, 1969), although the microscleres are euasters like those of typical Ancorinida. Biochemical agreement is thought here to be probably more significant than occurrence of similar microscleres, which should be seen as representing parallel developments.

Some modern monaxonids do, however, seem likely to belong with the order Ancorinida, and Dendy (1916) claimed a series of pairs of similar choristid and monaxonid species within the genus *Aurora* Sollas. Some fossils placed here in the artificial order Epipolasida could be monaxonid Ancorinida; but there is no way by which they can be recognized as such.

Family ANCORINIDAE Schmidt, 1870

[Ancorinidae Schmidt, 1870, p. 64] [=Stellettidae Sollas, 1888, p. cxxxiv, *nom. transl. et correct.* Sollas, 1888, p. cxxxiv, *ex* group (=subfamily) Stellettina Carter, 1875, p. 184]

Sponges with triaene and oxea megascleres and with euaster microscleres that do not include sterrasters or aspidasters; no megascleric calthrops or triactines; some genera with typical microscleres accompanied by microrhabds or sanidasters; may also have diaenes or monaenes as subordinate variants of triaenes, or diaenes as typical megascleres of special oscular outgrowths; styles or strongyles sometimes present as oxea variants; whole skeleton commonly radiate; but some have choanosomal oxeas irregularly felted and only triaenes radial; modern examples typically aphodal, with cortex or not; euasters in forms from oxyaster to sterrospheraster, alone or in various combinations; few with dermal armor formed by cortex packed with spherasters or sterrospherasters; triaenes sometimes inconspicuous or vestigial, so that sponge may at first seem monaxonid (some purely monaxonid sponges included in zoology, on basis of detailed resemblance in soft parts and microscleres, not available in paleontology). *Jurassic–Holocene.*

Subfamily ANCORININAE Schmidt, 1870

[*nom. transl.* DE LAUBENFELS, 1936, p. 167, *ex* Ancorinidae SCHMIDT, 1870, p. 64; *emend.,* REID, herein]

Euaster microscleres of modern examples typically accompanied by differentiated microrhabds that are rough, finely spined, or developed as sanidasters; these microrhabds often intergrading with diactinal, euaster variants, from which they are only distinguished by slightly further modification (e.g., thickening, shortening), or with a typical, radiate euaster through irregular intermediates. [The subfamily is emended by removal of genera with microscleres identified as streptoscleres, that are here placed in Pachastrellidae (Pachastrellinae) or Theneidae, because identification of streptoscleres with ancorinid sanidasters (DE LAUBENFELS, 1936) is rejected. Microscleres taken as typical of Ancorininae are occasionally present in species or genera referred to the subfamily Stellettinae; but, broadly, Ancorinidae either have or do not have these microscleres. Subfamilies employed by DE LAUBENFELS (1936) are retained here accordingly.

A few Ancorinidae have simple microxeas that are microrhabds that seem to be allied to oxea megascleres homologically; these genera are here placed in the Stellettinae.] *Jurassic–Holocene.*

Ancorina SCHMIDT, 1862, p. 51 [**A. cerebrum;* SD DE LAUBENFELS, 1936, p. 167]. Sponges spherical, of moderate size with skeleton containing oxeas, anatriaenes, dichotriaenes, and three kinds of asters; dermal layer consisting of bundles of anchorate spicules and main web of fibers including those and other kinds of spicules. *Holocene:* cosmopolitan.——FIG. 130,*2a–f.* **A. cerebrum,* Zara and Quarnero, Adriatic Sea; various spicules from fibrous skeleton of type sponge, including large anatriaenes and dichotriaenes, *b,e,f,* ×60; *a,c,d,* ×125 (Schmidt, 1862).

Discispongia KOLB, 1910 in 1910–1911, p. 251 [**D. unica;* OD]. Discoidal to cup-shaped form with skeleton of oxeas and various triaenes; canal system not developed. *Jurassic:* Europe.——FIG. 130,*6a–d.* **D. unica,* Weiss Jura, Kimmeridgian, Sontheim, Germany; *a,* discoidal holotype from above with marginal ring, ×0.5; *b,* protriaene; *c,* dichotriaene, ×25; *d,* anatriaene, ×50 (Kolb, 1910–1911).

Ecionemia BOWERBANK, 1862, p. 1,101 [**E. acervus;* OD] [=*Ecionema* SOLLAS, 1886, p. 192, *nom. null.*]. Massive, lobate, pyriform, cup-shaped, or related shapes; megascleres oxeas and orthotriaenes, plagiotriaenes, or protriaenes, or with additional anatriaenes; radiate architecture; euasters are tylasters, spherasters, or both; microrhabds smooth, finely spined, or developed as sanidasters; cortex typically absent. [Separation from *Ancorina* SCHMIDT controversial, here based chiefly on absence of dichotriaenes, oxyasters, cortex.] *Paleogene (Eocene)–Holocene:* Western Australia, *Eocene, Miocene;* cosmopolitan, *Holocene.*——FIG. 130,*1. E. glauteri* CHAPMAN & CRESPIN, Miocene, Western Australia; rodlike specimen with expanded base, possibly a stalk, preserving oxeas, protriaenes and spherasters, sanidasters, WAGS, ×1 (Chapman & Crespin, 1934, courtesy of The Royal Society of Western Australia).

Subfamily STELLETTINAE Carter, 1875

[*nom. transl.* VON LENDENFELD, 1907, p. 253, *ex* Stellettidae SOLLAS, 1886, p. 187, *nom. transl. et correct. ex* group Stellettina CARTER, 1875, p. 184; *sensu* DE LAUBENFELS, 1936, p. 167; *emend.,* REID, herein]

Microscleres of modern examples are typically euasters only, without microrhabds except as otherwise unmodified, diactinal, euaster variants; rarely, also with smooth microxeas. [The Stellettinae *sensu* VON LENDENFELD comprises the Ancorinidae without special oscular tubes, seen in forms grouped as Tethyopsidinae VON LENDENFELD (1907, p. 253), without reference to microscleres. Emendation of Stellettinae *sensu* DE LAUBENFELS allows inclusion of *Penares* GRAY, in which microxeas are thought to be related to oxea megascleres, not to microrhabds typical of the Ancorininae.] *?lower Lower Jurassic, Cretaceous (?Albian, Turonian)–Holocene.*

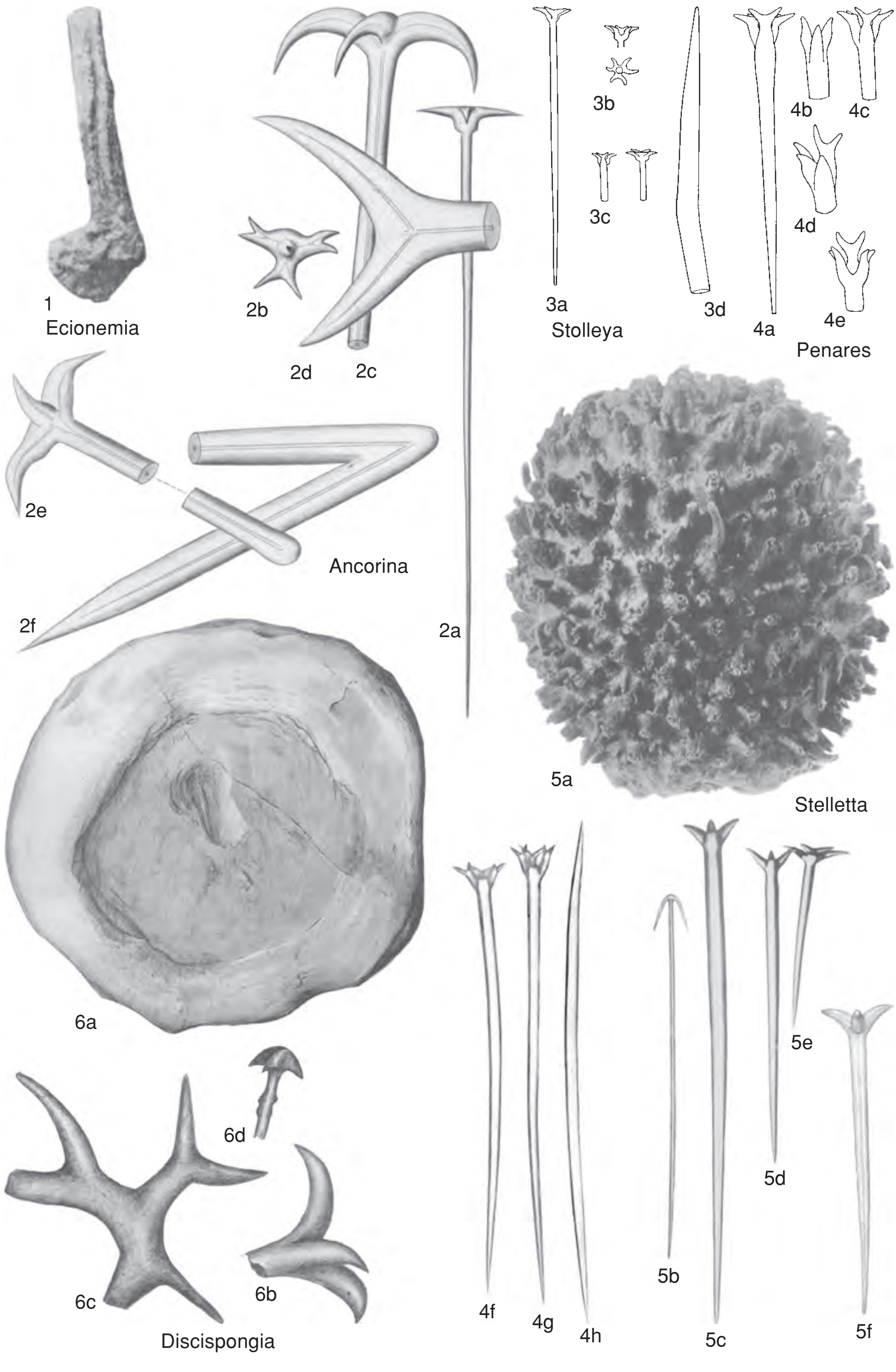

FIG. 130. Ancorinidae (p. 186–188).

Stelletta Schmidt, 1862, p. 46 [**S. boglicii;* SD Sollas, 1888, p. cxxxix, not *S. grubii* Schmidt, 1862, p. 46, SD de Laubenfels, 1955, p. 42]. Massive, spherical, cylindrical, cuplike, or related shapes; surface hispid in some species or rarely conulose; megascleres radially arranged oxeas and plagiotriaenes, orthotriaenes, or dichotriaenes, or also including anatriaenes; euasters typically oxyasters and tylasters (chiasters), found mainly in choanosome and ectosome respectively, but sometimes lacking oxyasters or with tylasters replaced by strongylasters or spherasters; strongly corticate, with cortex two layered, the inner layer fibrous (supposed fossil records based on isolated megascleres). *?lower Lower Jurassic, Cretaceous (?Coniacian–?Maastrichtian), Cretaceous (?Albian), Paleogene (?Eocene), Holocene:* Austria, *?lower Lower Jurassic;* southern England, *?Albian;* Czech Republic, Slovakia, England, Germany, *?Coniacian–?Maastrichtian;* New Zealand, Western Australia, *?Eocene;* cosmopolitan, *Holocene.*——Fig. 130,*5a–e. S. arghulana* von Lendenfeld, Holocene, Arghulas Bank, South Africa; *a,* side view of whole sponge, ×0.5; *b,* anatriaene, ×100; *c–d,* plagiotriaenes; *e,* dichotriaene, ×25 (von Lendenfeld, 1907).——Fig. 130,*5f. S.* sp., upper Eocene, Otago, New Zealand; triaene ascribed to *S.* sp., ×40 (Hinde & Holmes, 1892).

Penares Gray, 1867, p. 542 [**Stelletta helleri* Schmidt, 1864, p. 32; OD]. Nodular or massive; megascleres oxeas and dichotriaenes, arranged more or less radially or also with styles or subtylostyles; microscleres oxyasters and smooth microxeas, the latter centrotylote or not; ectosome thin, packed with tangentially arranged microxeas (doubtful record based on megascleres). *Cretaceous (?Campanian), Holocene:* northern Germany, *?Campanian;* South Africa, *Holocene.*——Fig. 130,*4a–e. P.* sp.?, Quadratenkreide, Oberg; triaene spicules of genus, ×10 (Schrammen, 1910).——Fig. 130,*4f–h. P. obtusus* von Lendenfeld, Holocene, Arghulas Bank, South Africa, megascleres; *f–g,* dichotriaenes; *h,* oxea; ×20 (von Lendenfeld, 1907).

?Stolleya Schrammen, 1899, p. 7 [**S. microtulipa;* SD de Laubenfels, 1955, p. 42]. Form of body uncertain; collapsed examples nodular or crustlike, or with traces of rounded elevations with osculum-like pits at their summits; megascleres large oxeas and smaller, long-shafted dichotriaenes with small cladomes, or also with subordinate plagiotriaenes or protriaenes as variants of typical dichotriaenes; cladal branches of most dichotriaenes more or less in one plane; microscleres unknown. [Compared with *Anthastra* Sollas of Stellettinae by original author but could represent several other genera: e.g., see *Penares* Gray.] *Cretaceous (Turonian–Maastrichtian):* England, northern Germany.——Fig. 130,*3a–d.* **S. microtulipa,* Quadratenkreide, upper Campanian, Oberg, northern Germany, spicules of type species; *a,* dichotriaene; *b,* cladome of dichotriaene; *c,* cladal ends of further dichotriaenes; *d,* oxea, incomplete, ×10 (Schrammen, 1910).

Family GEODIIDAE Gray, 1867

[*nom. correct.* Sollas, 1888, p. cxliii, *pro* Geodiadae Gray, 1867, p. 504] [=Sterrastrosa Sollas, 1888, p. 209; Erylidae von Lendenfeld, 1910, p. 11]

Sponges similar to Ancorinidae but distinguished by having a cortex that is densely packed with sterrasters or aspidasters to form a stony, dermal armor. Most with other euasters in choanosome, their forms ranging as in Ancorinidae; some also with microrhabds or spheres, or with spheres as sole choanosomal microscleres. [Dermal sterrasters and aspidasters are formed in the choanosome, but moved outwardly and accumulated in the cortex. Sterrasters originate from highly polyactinal oxyasters, whose rays grow in all directions equally; aspidasters from similar prototypes with rays all in one plane. The Carboniferous (Mississippian) record from loose triaenes and sterrasters is not determinable at the generic level.] *Carboniferous (Mississippian)–Holocene.*

Subfamily GEODIINAE Gray, 1867

[*nom. correct.* Reid, herein, *pro* Geodina Sollas, 1888, p. cxlviii, *nom. transl. ex* Geodiadae Gray, 1867, p. 504]

With sterrasters but not aspidasters. *Carboniferous (Mississippian)–Holocene.*

Geodia Lamarck, 1815, p. 333 [**G. gibberosa;* OD] [=*Cydonium* Fleming, 1828, p. 516 (type, *C. mulleri,* OD); *Silicosphaera* Hughes, 1985, p. 603 (type, *S. asteroderma,* OD), described from isolated sterraster microscleres]. Massive, globose, lobate, forming thick-walled cups or related shapes; intracortical canals (chones) cribiporal or with exhalant chones opening through single apertures (uniporal); exhalant, pore sieves or other apertures usually localized, in a small, central cavity in some uniporal forms, mainly on inner face if body is cup shaped, or in special lateral areas; typical megascleres oxeas and orthotriaenes or dichotriaenes, to which anatriaenes, protriaenes, or both may be added; sometimes with subordinate, triaene variants (e.g., diaenes) or oxea variants (e.g., strongyles; some with additional small oxeas (e.g., 0.10 as large as main ones), distributed generally or localized in cortex; microscleres other than sterrasters are smaller euasters in range of oxyaster to spheraster, of one sort only or more than one; no microrhabds; some species with spherasters of choanosome entering cortex in walls of chones, or with protruded megascleres (supposed fossil records based chiefly on loose megascleres). *?Lower Jurassic, Cretaceous (?Aptian, Albian)–Holocene:* Austria, *?Lower Jurassic;*

southern England, *?Aptian, Albian;* England, Germany, Poland, *?Upper Chalk;* USA (Alabama), *Paleocene;* New Zealand, *?upper Eocene;* Western Australia, Spain, *Miocene;* cosmopolitan, *Holocene.*——FIG. 131,*1a–g. G. stellata* VON LENDENFELD, Holocene, Arghulas Bank, South Africa; *a,* vertical or axial section through sponge with radiate structure, ×0.5; *b–c,* small diaene and triaene, with short, extra, rhabdal ray, pointing upwardly, ×50; *d,* dichotriaene, ×33; *e–f,* small anatriaenes (shown with rhabdome incomplete), ×50; *g,* group of elliptical sterrasters, ×150 (von Lendenfeld, 1907).

Caminus SCHMIDT, 1862, p. 48 [**C. vulcani;* OD]. Globular to massive or lobate; inhalant chones as in *Geodia,* but exhalant water leaving through oscula of a few local, paragastral cavities; typical megascleres strongyles and orthotriaenes, but latter may be varied as dichotriaenes and strongyles may grade into oxea or amphitylote (=tylostrongyle) variants; no anatriaenes; accessory microscleres euasters and spheres or spheres only. *Upper Cretaceous (?Turonian–?Maastrichtian), Paleogene (Eocene)–Holocene:* Czech Republic, Slovakia, England (supposed records based on loose megascleres), *?Turonian–?Maastrichtian;* Western Australia, *Eocene;* cosmopolitan, *Holocene.*——FIG. 131,*2a–d. C. sphaeroconia* SOLLAS, Holocene, Brazil, South Atlantic; *a,* side view of complete sponge, ×0.5; *b,* vertical section showing exhalant canals and paragastral cavity, ×1; *c,* exceptionally large, somal sphere; *d,* compounded spheres, ×400 (Sollas, 1888).

Conciliaspongia ROBINSON & HASLETT, 1995, p. 199 [**C. rarus;* OD]. Sponge characterized by oblong to oval, siliceous microscleres whose surfaces are covered with pentameral pores except for single small, barren patch that has an X standing out in relief, which is interpreted as hilum; two larger pores occur in areas between greatest angles of X. [Taxonomic placement of these isolated microscleres is uncertain, but they are grouped here with apparently related forms such as *Geodia.*] *Paleogene (middle lower Miocene:)* Ecuador.——FIG. 131,*5.* **C. rarus,* Dos Bocas Formation, 3 km south of San Pedro; holotype microsclere with characteristic surface sculpture, Slide JW 199, BMNH, ×200 (Robinson & Haslett, 1995; courtesy of *Journal of South American Earth Sciences*).

Cydonium FLEMING, 1828, p. 516 [**C. mulleri;* OD]. Distinguished from *Geodia* LAMARCK in usage of SOLLAS (1888), restricting *Geodia* to forms with a distinct, paragastral cavity when young, sometimes also when adult, and with sphinctrate, uniporal, exhalant chones; this usage now generally rejected since characters relied upon are not constant. [There is one record under SOLLAS's usage.] *Paleogene (Eocene):* Western Australia.

?Geodiopsis SCHRAMMEN, 1910, p. 117 [**Geodia cretacea* SCHRAMMEN, 1899, p. 8; SD DE LAUBENFELS, 1955, p. 42]. Form unknown; megascleres stout oxeas and protriaenes, slender anatriaenes, and variants, the last with a short, second, rhabdal ray or developed as pseudotylostyles; only microscleres known are smooth, spherical bodies. [The genus is a geodiid if microscleres are sterrasters, but closest resemblance is to Tetillidae (spp. of *Tetilla* SCHMIDT, *Cinachyra* SOLLAS) if they are spheres.] *Cretaceous (Coniacian–Maastrichtian):* northern Germany.——FIG. 131, *3a–f.* **G. cretacea* (SCHRAMMEN), Quadratenkreide, Campanian, Oberg; spicules of type species including stout protriaene, oxea, anatriaene, 2 below, and variants, above, ×10 (Schrammen, 1910).

?Geoditesia ZHURAVLEVA in REZVOI, ZHURAVLEVA, & KOLTUN, 1962, p. 51, *nom. nov. pro Geodites* CARTER, 1871, p. 129, obj., *non* RAFINESQUE, 1832 [**Geodites haldonensis* CARTER, 1871, p. 129; OD]. Sponge and microscleres unknown; type species based on stout triaenes, dichotriaenes, and diaenes, loose in sediment, like those of various modern ancorinids and geodiids; some also like or more like dermalia of contemporaneous megamorine lithistids. [Used by ZHURAVLEVA as equivalent to *Geodites* CARTER *s.l.,* with records from the Carboniferous–Quaternary. *Geodites* used for loose trianes, dichotriaenes, and a diaene ascribed to *Geodia* LAMARCK, 1815, with termination *-ites;* invalid under *Code* Article 20 (ICZN, 1999). Also used as a generic name for supposedly geodiid spicules, not identified as *Geodia.*] *Carboniferous (Mississippian)–Paleogene (upper Eocene):* southern England.——FIG. 131,*4a–e.* **G. haldonensis* (CARTER), Upper Greensand, Upper Cretaceous, Exeter, England; *a,* spheroidal, siliceous spicule, lateral view, ×75; *b,* triaene; *c,* diaene; *d,* anatriaene; *e,* dichotriaene, ×25 (Carter, 1871).

Pachymatisma BOWERBANK, 1842, p. 244 [**Halichondria johnstonia* BOWERBANK, 1842, p. 198; OD]. Nodular to massive; inhalant chones as in *Geodia;* exhalant chones with single apertures, conspicuous or not, distributed generally or in lines that follow ridges of surface; megascleres orthotriaenes and strongyles, to which subordinate variants may be added, or with additional cortical oxeas; no anatriaenes; accessory microscleres euasters and microrhabds, of which latter are numerous in external layer of cortex; microrhabds typically rough or finely spined, but not developed as sanidasters (supposed record based on loose megascleres). *Cretaceous (?Albian), Holocene:* southern England, *?Albian;* cosmopolitan, *Holocene.*——FIG. 132,*2a.* **P. johnstonia* (BOWERBANK), Holocene, littoral specimens, British Isles; holotype, ×1 (Bowerbank, 1874b).——FIG. 132,*2b–c. P. ? virga* HINDE, ?Albian, southern England; *b,* strongyle, ×40; *c,* strongyle, ×30 (Hinde, 1885).

Rhaxella HINDE, 1890, p. 59 [**R. perforata;* OD]. Sponges palmate, flabellate, or funnel shaped with thin walls composed entirely of aggregated masses of globular or spheroidal, sterraster spicules; plates of wall interweave to form labyrinthine interspaces; sterrasters ranging ellipsoidal to nearly spherical with prominent hilum or depression on one side. *Upper Jurassic:* England.——FIG.

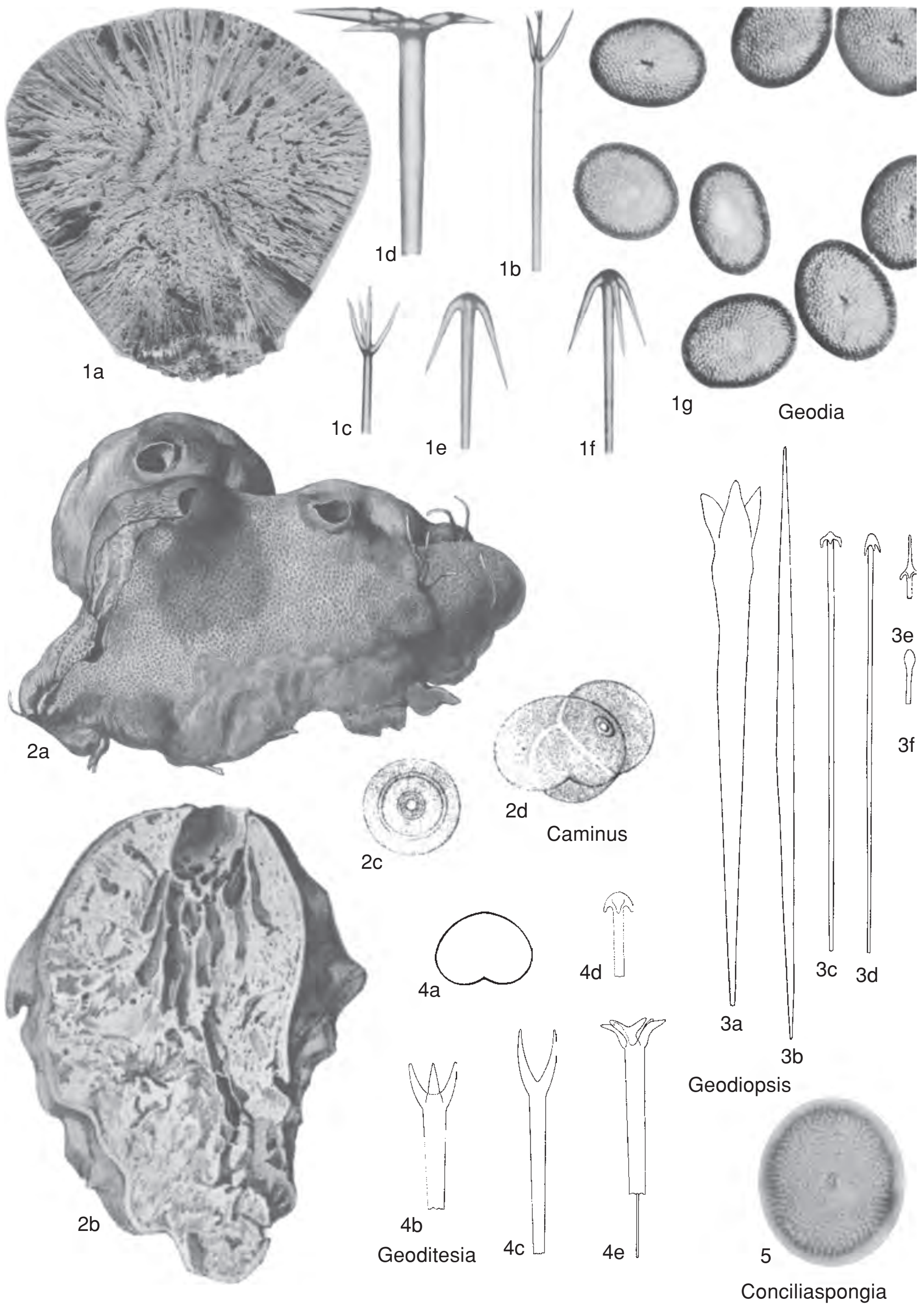

FIG. 131. Geodiidae (p. 188–189).

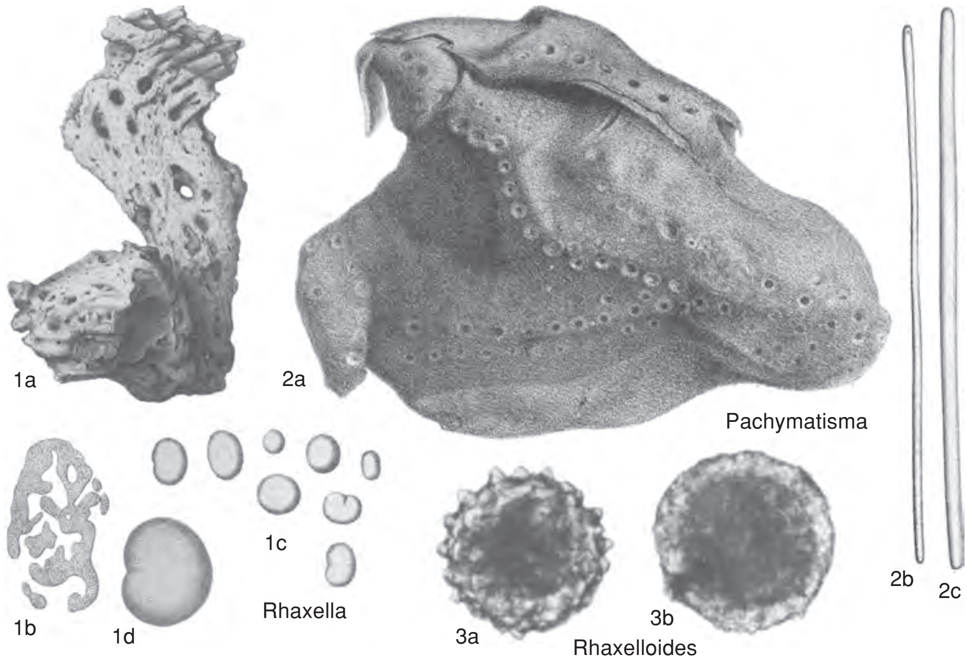

FIG. 132. Geodiidae (p. 189–191).

132,*1a–d*. **R. perforata,* Lower Calcareous Grit, Oxfordian, Scarborough, Yorkshire; *a,* side view of subpalmate sponge with labyrinthine upper end, ×0.5; *b,* transverse section showing complex, canal pattern of interior, ×1; *c,* drawings of several sterrasters showing range of size and shape, ×40; *d,* globose sterraster with minute points of surface produced by tips of radial fibers, ×100 (Hinde, 1890).

Rhaxelloides TREJO, 1967, p. 37 [**R. sphaerica;* OD]. Isolated microscleres star shaped, spherical to cylindrical; spherical forms 80 to 170 microns in diameter and of two types: hollow with small and irregularly distributed protuberances, and solid with large, conical, regularly distributed protuberances. *Upper Cretaceous:* Mexico.——FIG. 132,*3a–b*. **R. sphaerica,* Malpaso, Chiapas; *a,* typical solid, spherical spicule with large protuberances; *b,* typical hollow, spherical spicule with small, surficial protuberances, ×205 (Trejo, 1967).

Subfamily ERYLINAE Sollas, 1888

[*nom. correct.* REID, herein, *pro* Erylina SOLLAS, 1888, p. cxlvii]

With aspidasters. *Upper Jurassic–Holocene.*

Erylus GRAY, 1867, p. 549 [**Stelletta mammillaria* SCHMIDT, 1862, p. 48; OD]. Encrusting to massive, lobate, spheroidal or cylindrical; inhalant chones with single apertures only (uniporal); exhalant apertures oscula or pores of single chones; megascleres oxeas, strongyles, or both, and orthotriaenes or dichotriaenes; no anatriaenes; internal architecture not radiate except near cortex; accessory microscleres microrhabds and euasters, latter of a single sort or more in range from oxyaster to spheraster; microrhabds centrotylote or not, sometimes forming a layer at surface of cortex; aspidasters range from thin discs with radial canals or ridges to thicker, tuberculate bodies, like flattened sterrasters. *Paleogene (upper Eocene)–Holocene:* New Zealand, *upper Eocene;* Western Australia, *?Miocene;* cosmopolitan, *Holocene.*

E. (Erylus). Adult aspidaster resembles a flattened sterraster, with tuberculate surfaces; tubercles without order or in groups, sometimes stellate in form; opposite sides may be ornamented differently. *Paleogene (?upper Eocene), Neogene (?Miocene), Holocene:* New Zealand, *?upper Eocene;* Western Australia, *?Miocene;* cosmopolitan, *Holocene.*——FIG. 133,*3a–f*. *E. (E.) lendenfeldi* SOLLAS, Holocene, Indian Ocean, aspidasters; *a–b,* adult examples with opposite sides differently ornamented, ×200; *c–e,* developmental stages, ×200; *f,* stellate tuberculation, ×770 (Dendy, 1916; courtesy of Academic Press Ltd.).

E. (Triate) GRAY, 1867, p. 549 [**Stelletta discophora* SCHMIDT, 1862, p. 47; OD]. Adult aspidaster a very thin disc or elliptical plate,

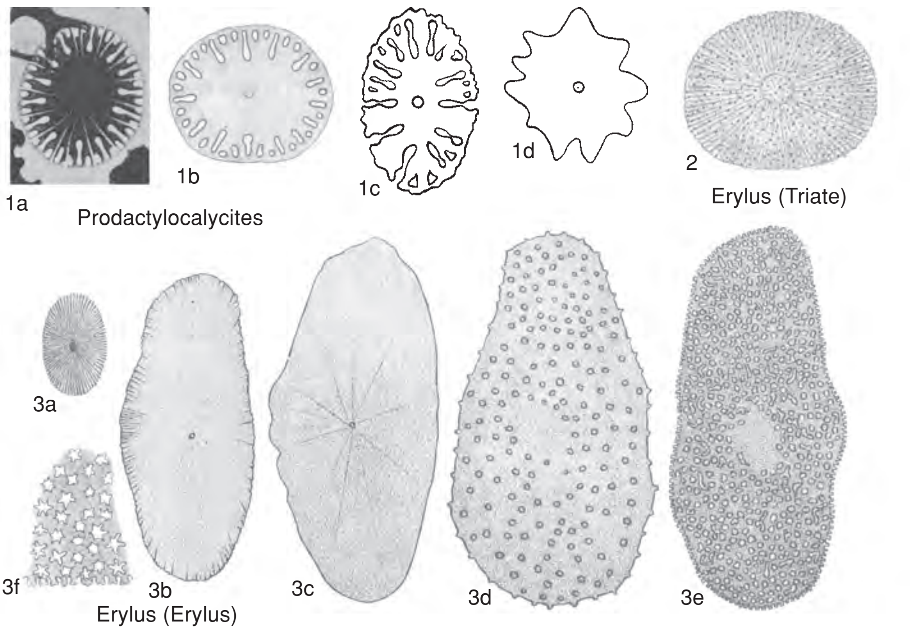

FIG. 133. Geodiidae (p. 191–192).

finely granulate or smooth; may be radially ridged along tracks of original rays (resembles young stages of *E. (Erylus)* aspidasters). *Paleogene (upper Eocene)–Holocene:* New Zealand, *upper Eocene;* East Atlantic, Mediterranean, Indian Ocean, *Holocene.*——FIG. 133,*2.* **E. (T.)* sp., upper Eocene, Otago, New Zealand; aspidaster, ×200 (Hinde & Holmes, 1892).

Prodactylocalycites REID, *nom. nov.* herein, *nom. nov. pro Dactylocalycites* CARTER, 1871, p. 123 (invalid, *Code* Art. 20, ICZN, 1999), *sensu* DE LAUBENFELS, 1955, p. 58 [**Dactylocalycites callodiscus* CARTER, 1871, p. 123; OD]. Sponge unknown; represented by spicules called pinakids, in form of thin discs with marginal notches or submarginal perforations, located between fine, tubular canals that radiate from center. [Spicules sometimes thought to be dermalia of a lithistid, by comparison with phyllotriaenes and discotriaenes, but distinguished from known lithistid dermalia by the multiple radial canals; here compared with aspidasters of *Triate* GRAY. The invalid name *Dactylocalycites* CARTER (1871, p. 123) was proposed to refer to spicules, not entire sponges; phyllotrianes, discotrianes, and pinakids were referred to *Dactylocalyx* STUTCHBURY, 1842, p. 87.] *Upper Jurassic–Holocene:* southern Germany, *Upper Jurassic;* southern England, Germany, *Albian–Campanian;* New Zealand, *upper Eocene;* West Atlantic (Barbados), *Paleogene–Neogene;* Indian Ocean, *Holocene.*——FIG. 133,*1a.* **P. callodiscus* (CARTER), Quadratenkreide, Campanian, Oberg, Germany; pinakid disc showing canals, ×50 (Schrammen, 1924a; courtesy of E. Schweizerbart'sche Verlagsbuchhandlung).——FIG. 133,*1b. P.* sp., upper Eocene, Otago, New Zealand; dermal disc (pinakid) with submarginal perforations, ×200 (Hinde & Holmes, 1892).——FIG. 133,*1c–d. P. ellipticus* (CARTER), Upper Greensand, Upper Cretaceous, Exeter, England; modified pinakids, ×75 (Carter, 1871).

Family PAELOSPONGIIDAE Mostler, 1986

[Paelospongiidae MOSTLER, 1986, p. 337]

Family known only from isolated megascleres that are characteristically complexly developed triaenes, including mesotriaenes, and dichotriaenes with missing rhabds; their cladi have characteristic spinose development and each of many spines has its own canal. *Upper Triassic.*

Paelospongia MOSTLER, 1986, p. 337 [**P. longiradiata;* OD]. Spicules are mesotriaenes with rhabds of variable length and strong, spinose cladi. *Upper Triassic:* Italy, Austria.——FIG. 134,*1a–b.* **P. longiradiata,* Zlambach Formation, Rhaetian, St. Agatha, Austria; *a,* photomicrograph of holotype mesotriaene, ×100; *b,* drawing of spinose mesotriaene characteristic of genus, scale not given but approximately ×50 (Mostler, 1986).

Actinospongiella Reid, herein, *nom. nov. pro Actinospongia* Mostler, 1986, p. 342, *non* d'Orbigny, 1849 [**Actinospongia hexagona* Mostler, 1986, p. 342; OD]. Spicules are strongly spinose dichotriaenes with rhabd missing or reduced to button. *Upper Triassic:* Austria.——Fig. 134,*2*. **A. hexagona* (Mostler), Zlambach Formation, Rhaetian, St. Agatha; photomicrograph of characteristic dichotriaene, scale not given but approximately ×100 (Mostler, 1986).

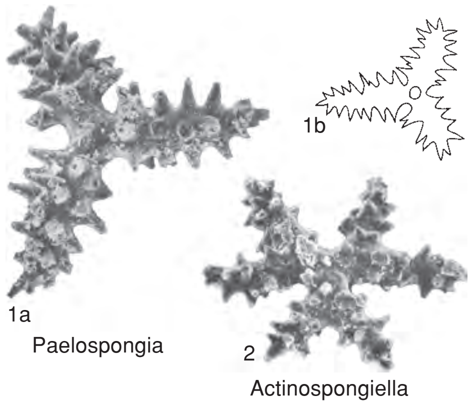

Fig. 134. Paelospongiidae (p. 192–193).

Order CRANIELLIDA Reid, 1968

[Craniellida Reid, 1968a, p. 22] [=suborder Sigmatophora Sollas, 1887, p. 423; suborder Spirosclerina Reid, 1963d, p. 199; "Spirophorides" (no rank given) Borojevic, Cabioch, & Lévi, 1968, p. 4]

Choristid sponges that typically have sigmaspire microscleres, although a few have only microrhabds or no microscleres, and monaxonids that resemble choristids except for absence of tetraxial megascleres (triaenes); some choristids with sigmaspires accompanied by microrhabds, spheres, or cheloids, or rarely replaced by toxaspires; most choristids with long-shafted triaenes, which are typically protriaenes and anatriaenes; protriaenes of some with unequal cladi and varied as diaenes and monaenes; single genera with additional subtriaene or amphitriaene megascleres and one with amphitriaenes only; dichotrianes absent in most, and may be polycladose when present; additional oxea megascleres in most choristids, and oxeas only in monaxonids; megascleric calthrops unknown; euasters and streptoscleres absent. *Upper Cretaceous (Campanian)–Holocene.*

Recognition of possible fossil examples of this order is based entirely on occurrences of megascleres like those of modern species. Slender protriaenes and mesotriaene variants, like those of various living Tetillidae, first appear in the Carboniferous (Visean) of Ireland. Polycladose dichotriaenes, like those of *Tetilla infrequens* (Hentschel), occur in the lower Cenomanian of southern England.

This order has no obvious relationship to the other Choristida, although it shares possession of tetraxial megascleres. Modern examples can commonly be recognized by the general aspect of their megascleres, of which asymmetrical (anisocladose) protriaenes are peculiar to this order. They are also unusual in the rarity of dichotriaenes that, when present, are prodichotriaenes whose cladi may branch more than once. The latter forms do not occur in Pachastrellida or Anocorinida, although similar branching occurs in the spicules of some Plakinida.

Two modern monaxonids, *Trachygellius* Topsent and *Raphidotethya* Burton, are so much like the typical choristids, apart from lacking triaenes, that their inclusion in the order seems appropriate; but no fossils of this type can be recognized in the absence of microscleres and soft parts.

Family TETILLIDAE Sollas, 1886

[Tetillidae Sollas, 1886, p. 178; *sensu* de Laubenfels, 1936, p. 170] [=Craniellidae de Laubenfels, 1936, p. 173]

Sponges with triaene and oxea megascleres and, typically, with sigmaspire microscleres, no megascleric calthrops; some with typical microscleres accompanied by microrhabds or spheres or with microrhabds only or no microscleres; triaenes typically long-shafted protriaenes and anatriaenes, although either may be absent; often including hairlike (trichodal) protriaenes with unequal cladi (commonly one long, two short), which are distinctive in absence of sigmaspires; all types sometimes vary as diaenes or monaenes, which predominate in some species; a few with additional orthotriaenes, subtriaenes, amphitriaenes, or

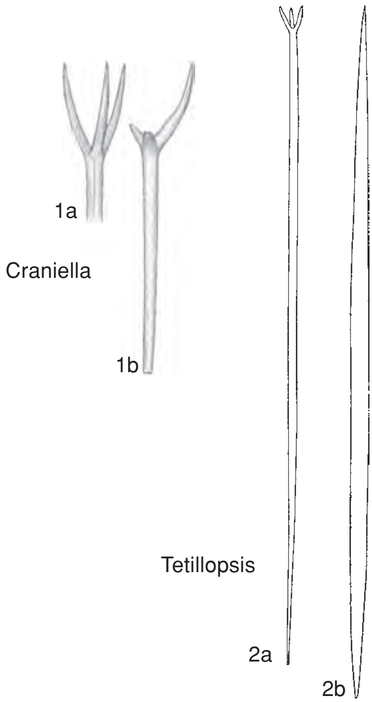

FIG. 135. Tetillidae (p. 194).

vestigial triaenes only; no typical dichotriaenes, although rarely a triaene may have cladi branching once or more often; main skeleton typically radiate, rarely plumose; some with special, cortical oxeas, arranged radially or tangentially; most anchored by protruded anatriaenes, replaced rarely by distally knobbed pseudotylostyles; modern examples eurypylous, with ectosome varying from minimal dermis to two-layered cortex; some viviparous, with parenchymella-like embryos. [The group was divided by DE LAUBENFELS (1936, 1955) into the Craniellidae, with sigmaspires, and Tetillidae, without microscleres, on the basis of absence of microscleres in type species of *Tetilla* SCHMIDT, *T. euplocamos* SCHMIDT. (see DE LAUBENFELS (1955, p. 42) for remarks on *Tetillopsis* SCHRAMMEN). This division is not followed here because the species has trichodal triaenes like those of many species with sigmaspires, and because various species of Craniellidae also lack microscleres. The Carboniferous record is based on loose protriaenes like those of living tetillids, from the Visean of Fermanagh, Ireland.] *Upper Cretaceous (Campanian)–Holocene.*

?Tetillopsis SCHRAMMEN, 1910, p. 49 [**T. doeringi;* SD DE LAUBENFELS, 1955, p. 42, as *T. dorinzi, nom. null.,* here accepted as a typographical mistake intended to refer to *T. doeringi* SCHRAMMEN]. Form unknown; megascleres oxeas and slender protriaenes; no anatriaenes; microscleres unknown. [Position uncertain, but megascleres are comparable with those of living *Tetilla sandalina* SOLLAS, for example, that lacks anatriaenes.] *Upper Cretaceous (Campanian):* Germany.——FIG. 135,*2a–b. T. longitridens* SCHRAMMEN, Quadratenkreide, Oberg; oxea and protriaene, ×10 (Schrammen, 1910).

Craniella SCHMIDT, 1870, p. 66 [**C. tethyoides;* SD DE LAUBENFELS, 1936, p. 175; not *Alcyonium cranium* MÜLLER, 1776, p. 255, as cited in DE LAUBENFELS, 1955, p. 42]. Megascleres typical of family; main skeleton radiate; ectosome developed as a cortex with radial, cortical oxeas in an inner, fibrous layer and a cavernous, outer layer; sigmaspires present and rarely accompanied by chelalike variants. [The genus was also treated by DE LAUBENFELS (1936) as including noncorticate sponges, here regarded as species of *Tetilla* SCHMIDT, 1868, by restriction of that genus to forms lacking sigmaspires. Doubtful Eocene records (HINDE & HOLMES, 1892, p. 235; CHAPMAN & CRESPIN, 1934, p. 110) are based on loose triaenes only. MÜLLER's article cited by DE LAUBENFELS, as listed above, was published in 1776.] *Paleogene (?Eocene), Holocene:* Australia, New Zealand, *?Eocene;* cosmopolitan, *Holocene.* ——FIG. 135,*1a–b. C. cranium;* loose protriaenes similar to those of living *Craniella cranium* (MÜLLER), ×50, ×40 (Hinde & Holmes, 1892).

Order UNCERTAIN

Choristid and sublithistid sponges with modern counterparts, but possessing tetraxial megascleres; no microscleres known.

Family CEPHALORAPHIDITIDAE Reid, 1968

[Cephaloraphiditidae REID, 1968c, p. 1,252]

Megascleres include sinuous monaxons (ophirhabds), to which oxeas, strongyles, amphitylotes, or styles may be added, and short-shafted triaenes or subtriaenes with unbranched cladi; ophirhabds typically intertwined to form a loosely coherent, skeletal framework, without formation of zygomes; tetraxial megascleres arranged ra-

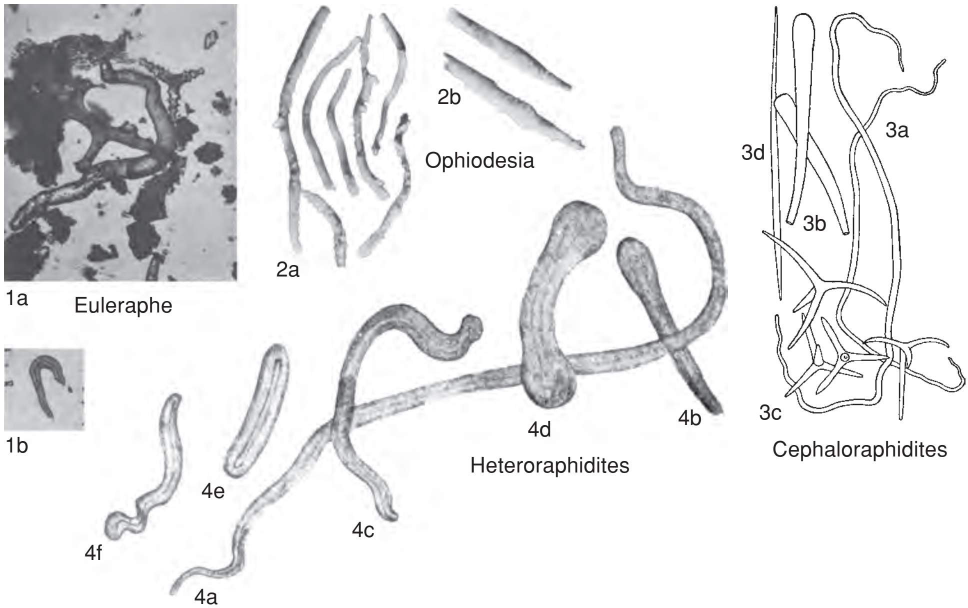

FIG. 136. Cephaloraphiditidae (p. 195–197).

dially with their cladi at surface of skeleton or scattered among ophirhabds; no microscleres known. [Members of this family were placed by SCHRAMMEN (1903, p. 17) in the family Ophiraphiditidae SCHRAMMEN; but the type genus, *Ophiraphidites* CARTER, 1876, is known only from fragmentary material, in which tetraxial megascleres are absent. ZITTEL (1878b) had previously identified *Ophiraphidites* with Cretaceous forms possessing triaenes, and was followed by SCHRAMMEN in this usage; but the most nearly similar modern sponge, "*Jaspis*" *serpentina* WILSON, has no tetraxial megascleres in life. It seems better to place the forms with monaxons only in the order Epipolasida of the subclass Monaxonida, therefore, which is also appropriate because the microscleres of *J. serpentina* are euasters. If that species is a so-called epipolasid derivative of a form with tetraxons, its euasters should place the Cephaloraphiditidae in the order Ancorinida.

The combination of ophirhabds and triaenes are also appropriate in a source stock of the lithistid order Megalithistida; but the known cephaloraphiditids occur too late in time, and the microscleres of living megalithistids are microrhabds and spirasters.] *Jurassic–Neogene.*

Cephaloraphidites SCHRAMMEN, 1899, p. 6 [**C. cavernous;* SD DE LAUBENFELS, 1955, p. 43]. Thick-walled cup with shallow, paragastral cavity; external and paragastral surfaces with numerous small, skeletal pores (ostia, postica), from which radiate skeletal canals; principal megascleres ophirhabds and clublike styles (rhopalostyles); additional oxeas and short-shafted triaenes in meshes of skeletal framework; microscleres unknown. [The type species was based on a fragment; but the habit is known from *C. milleporatus* SCRHAMMEN, 1899, which has similar spicules.] *Cretaceous (Campanian):* Germany. ——FIG. 136,*3a–d. C. milleporatus* SCHRAMMEN, Quadratenkreide, Oberg; spicule suite including *a,* ophirhabds; *b,* rhopalostyles; *c,* triaenes; and *d,* an oxea, ×10 (Schrammen, 1910).

Euleraphe SCHRAMMEN, 1937, p. 82 (SCHRAMMEN, 1936, p. 184, *nom. nud.*) [**E. incrustans;* OD]. Thin crusts on other sponges; canal system barely developed in inner part; spicules short and sinuous, termed eulerhabds, forming thick blanket. *Jurassic:* Germany.——FIG. 136,*1a–b.* **E. incrustans,* Weiss Jura, Gerstetten; *a,* sinuous eulerhabd with associated acanthotriaene; *b,* strongly curved eulerhabd, ×50 (Schrammen, 1937).

Heteroraphidites SCHRAMMEN, 1901, p. 17 [**H. spongiosus* SCHRAMMEN, 1901, p. 18; OD]. Globose or tuberose, attached sponges with skeleton largely of strongyles and tylostyles, with large

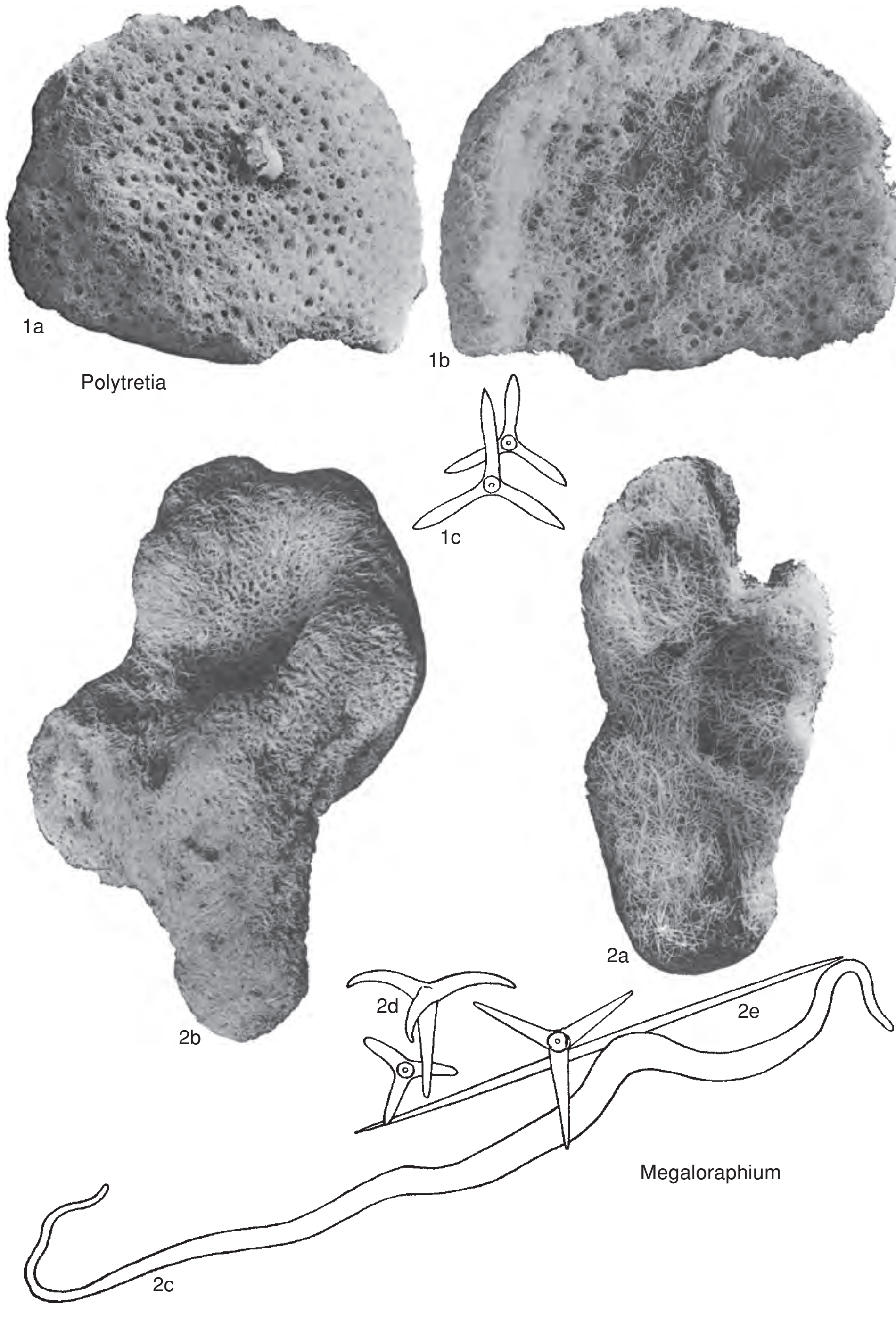

FIG. 137. Cephaloraphiditidae (p. 197).

amphioxeas; tetractine spicules rare; microscleres unknown. *Upper Cretaceous–Neogene:* cosmopolitan.——FIG. 136,*4a–f.* **H. spongiosus,* Quadratenkreide, Campanian, Oberg, Germany; representative spicules (Schrammen, 1901).

Megaloraphium SCHRAMMEN, 1910, p. 127 [**M. auriforme;* OD]. Irregularly ear shaped; skeletal pores typically absent although a few small examples may occur; no skeletal canals; main megascleres very large ophirhabds (e.g., 10 mm long); oxeas and small triaenes in skeletal meshes; microscleres unknown. *Cretaceous (Campanian):* Germany.——FIG. 137,*2a–e.* **M. auriforme,* Quadratenkreide, Oberg; *a,* young individual without skeletal pores but with well-preserved, spicular structure; *b,* example with a few small pores in parts, ×1; *c–e,* spicule suite including ophirhabd, triaenes, oxea, ×16 (Schrammen, 1910).

Ophiodesia SCHRAMMEN, 1937, p. 70 (SCHRAMMEN, 1936, p. 183, *nom. nud.*) [**O. solivaga;* OD]. Flat, ear-shaped sponges with moderately thick wall; megascleres are sinuous ophirabds and lumpy styles. *Upper Jurassic:* Germany.——FIG. 136,*2a–b.* **O. solivaga,* Weiss Jura, Streitberg; *a,* ophirhabds; *b,* nodular styles, ×10 (Schrammen, 1937).

Polytretia SCHRAMMEN, 1910, p. 126 [**P. seriatopora;* OD]. Ear shaped; convex side more or less smooth with large, skeletal pores from which short canals run inwardly; concave side irregularly sculptured with large postica in depressed parts, typically in groups of 5 to 10; main megascleres ophirhabds; oxeas and triaenes in skeletal meshes; microscleres unknown. *Cretaceous (Campanian):* Germany.——FIG. 137,*1a–c.* **P. seriatopora,* Quadratenkreide, Oberg; *a,* convex surface with large, skeletal pores; *b,* concave surface with large, exhalant postica, ×1; *c,* triaenes as seen from below, ×16 (Schrammen, 1910).

Rhabdospongia SOLLAS, 1873, p. 79 [**R. cummunis;* OD]. Sponges more or less rodlike, megascleres are sinuous oxeas. [No known suitable figures.] *Lower Cretaceous:* Europe.

Family HELMINTHOPHYLLIDAE Schrammen, 1937

[Helminthophyllidae SCHRAMMEN, 1937, p. 69]

Sublithistid sponges whose principal megascleres are short, curved monaxons (kyphorhabds), with successive, semiannular swellings interrupted on concave sides, and with weakly developed, zygomelike expansions at ends in some examples; dichotriaenes occur as dermalia; no other spicules known. [The kyphorhabds are arranged so that their ends abut on other examples and are loosely coherent when zygomelike ends are developed. The sublithistid character of the single known genus was recognized by SCHRAMMEN (1937, p. 70).] *Upper Jurassic (Kimmeridgian).*

Helminthophyllum SCHRAMMEN, 1937, p. 69 (SCHRAMMEN, 1924a, p. 150, *nom. nud.;* SCHRAMMEN, 1936, p. 183, *nom. nud.*) [**H. feifeli;* OD]. Earlike or platelike; no skeletal pores or canals; main megascleres kyphorhabds; dermalia short-shafted dichotriaenes; no other spicules known. *Upper Jurassic (Kimmeridgian):* Germany.——FIG. 138,*2.* **H. feifeli,* Weiss Jura; kyphorhabds, ×20 (Schrammen, 1937).

Family SCOLIORAPHIDIDAE Zittel, 1879

[*nom. correct.* DE LAUBENFELS, 1955, p. 42, *pro* Scolioraphidae ZITTEL, 1879, p. 2]

Some spicules strikingly annulate; microscleres unknown. *Cretaceous.*

Scolioraphis ZITTEL, 1878b, p. 4 [**S. cerebriformis;* SD DE LAUBENFELS, 1955, p. 42]. Meandriform leaves or irregular shapes containing dense masses of annulate, lumpy spicules. *Upper Cretaceous:* Europe.——FIG. 138,*4.* **S. cerebriformis,* Quadratenkreide, Campanian, Sutmerberges, Germany; characteristic spicules, ×25 (de Laubenfels, 1955).

Condylacanthus FISCHER, 1867, p. 237 [**C. gaudryi;* OD]. Spicules elongate, needlelike with regular, prominent annulations; head with three short branches, each of which is trilobed and tuberculose. *Cretaceous:* France.——FIG. 138,*5.* **C. gaudryi,* sandstone of Chalk, Pontavesnes by Beauvais, Oise; isolated spicule, ×40 (Fischer, 1867).

Family UNCERTAIN

Arthaberia SIEMIRADZKI, 1913, p. 190 [**A. balinensis;* OD]. Semilithistid, top-shaped sponge with thick walls and numerous oval ostia on upper surface; lower surface finely porous; skeleton of very long but thin, rodlike spicules that have curved nodes scattered here and there on their sides; these are sometimes associated with same size rhizomorines in upper layer, but latter were not observed in interior where rodlike spicules form closely packed fibers that are radially arranged; outer, dermal layer formed by growth of nodose, triaene, anchorlike spicules whose epirhabd follows fiber trend, but whose zygomes occur singly or generally form three-rayed structures. *Jurassic:* Poland.——FIG. 138,*6a–b.* **A. balinensis,* Krakau; *a,* side view, ×1; *b,* section through outer part of wall with radially oriented, monaxial spicules in interior and three-rayed spicules in outer wall, ×3 (Siemiradzki, 1913).

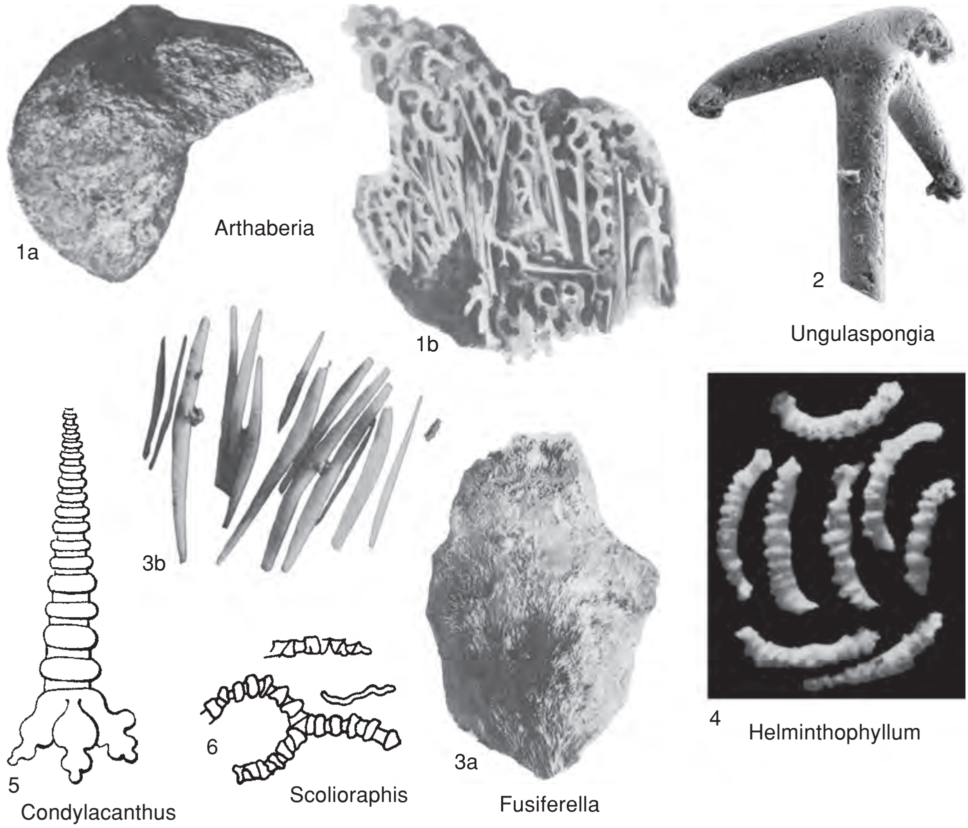

FIG. 138. Helminthophyllidae, Scolioraphididae, and Uncertain (p. 197–198).

Fusiferella DE LAUBENFELS, 1955, p. 43, *nom. nov. pro Atractophora* SCHRAMMEN, 1924a, p. 76, *non* STALL, 1853 [**Atractophora armata* SCHRAMMEN, 1924a, p. 76; OD]. Sponge elongate, with skeleton composed of spindle-shaped, straight to curved amphioxeas that form thick bundles that are radially arranged in wall and form a fur of slanting spicules on surface. *Upper Cretaceous:* Germany. ——FIG. 138,*1a–b*. **F. armata* (SCHRAMMEN), Mukronatenkreide, Campanian, Misburg; *a,* holotype with skeletal bundles, ×0.5; *b,* amphioxeas, ×10 (Schrammen, 1924a; courtesy of E. Schweizerbart'sche Verlagsbuchhandlung).

Ungulaspongia MOSTLER, 1996c, p. 157 [**U. permica;* OD]. Isolated, anatriaene spicules whose three reflexed clads have expanded radially spinose or nodose, pawlike tips. *Permian (Roadian):* USA (Texas).——FIG. 138,*3*. **U. permica,* Road Canyon Formation, Glass Mountains; isolated, holotype anatriaene with clads having characteristic, pawlike tips, ×150 (Mostler, 1996c).